Bay City Geology, Inc.

GEOLOGIC AND SOILS ENGINEERING INVESTIGATION

PROPOSED 2-STORY SINGLE-FAMILY RESIDENCE OVER 2-CAR GARAGE AND RETAINING WALLS

Tract: 7972, Lot: 74,
APN: 5209-023-002

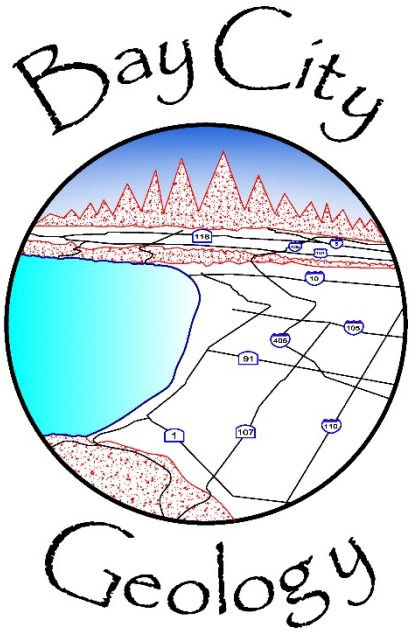
2553 N. Onyx Drive
(aka 2532 N. Forest Park Drive)
Los Angeles, California 90032

for

Marcio Troncoso

Project 2421

August 8, 2022



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August 8, 2022 Project 2421

Marcio Troncoso

Subject: **GEOLOGIC AND SOILS ENGINEERING INVESTIGATION**
Proposed Two-Story Single-Family Residence
Over Two-Car Garage and Retaining Walls
2553 N. Onyx Drive
(aka 2532 N. Forest Park Drive)
Los Angeles, California

Dear Mr. Troncoso:

Bay City Geology, Inc. is pleased to submit this engineering geology and geotechnical engineering report to provide recommendations for the proposed project.

Based on this investigation, it is our opinion that the proposed construction is feasible from an engineering geology and geotechnical engineering standpoint provided the recommendations contained herein are incorporated into the project design plans and specifications. This report should be reviewed in detail prior to proceeding further with the planned development. When final plans for the site development become available, or if the proposed construction is revised, the plans should be forwarded to this office for review and comment.

The scope of this investigation is limited to the project area as depicted on the Geologic Map herein. This report is not a comprehensive evaluation of the entire property and may not contain sufficient information for other than the intended use. Prior to use by others, Bay City Geology, Inc. should be consulted to determine if additional work is required. If the project is delayed more than one year, this office should be contacted to verify current site conditions and prepare an update report.

We appreciate the opportunity of serving you on this project. If you have any questions pertaining to our report, or if we can be of further service, please do not hesitate to contact us. This report may not be copied. If you wish additional copies, you may order them from this office.

Respectfully submitted,
BAY CITY GEOLOGY, INC.





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GEOLOGIC AND SOILS ENGINEERING INVESTIGATION
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INTRODUCTION

This report details the results of a limited Geologic and Soils Engineering Investigation on a portion of the subject property. The purpose of this investigation has been to ascertain the subsurface conditions pertaining to the proposed two-story single-family residence over two-car garage and retaining walls. Review of the project included reconnaissance mapping, description of earth materials, determining geologic structure, obtaining representative earth samples, performing laboratory testing, engineering analyses, and preparation of this report. Findings, conclusions and appropriate recommendations are included herein.

SCOPE

The scope of this investigation includes the following:

- Review of preliminary plans by Castillo Engineering.
- Review of (2) test pit explorations. Explorations were backfilled with the excavated materials.
- Preparation of the enclosed Geologic Map and Cross-Sections (see Appendix I).
- Sampling of representative earth materials, laboratory testing and analyses (see Appendix II).
- Review of reference materials and available public reports at the City of Los Angeles, Department of Building & Safety (see Appendix V).
- Presentation of findings, conclusions, and recommendations for the proposed project.

KEG Group, Inc. prepared the topographic base map, dated May 25, 2022, utilized in this investigation. Preliminary building plans were prepared by Castillo Engineering and plotted onto the base map. It consists of one sheet plotted to a scale of one-inch equals ten feet.

The scope of this investigation is limited to the project area explored as depicted on the enclosed Geologic Map. This report is not a comprehensive evaluation of the entire property. This report has not been prepared for use by other parties or for other purposes and may not contain sufficient information for other than the intended use. Prior to use by others, Bay City Geology, Inc. should be consulted to determine if additional work is required. If the project is delayed more than one year, this office should be contacted to verify current site conditions and prepare an update report.

PROPOSED DEVELOPMENT

It is our understanding that the subject site will be developed with a two-story single-family residence over a two-car garage and retaining walls. Grading and earthwork should be anticipated to consist conventional cuts and retaining wall backfilling methods. Also, installation of temporary bracing and/or shoring should be anticipated for the proposed project. Final building plans have not been prepared and await the conclusions and recommendations of this investigation.

SITE DESCRIPTION

Location and Description

The subject site is vacant and undeveloped. The site is located on the southeasterly flank of a north-south trending ridge within the western portion of the Repetto Hills. The adjacent lot to the north of the subject site is developed with a single-family residence; the majority of the nearby properties to the south, east, and west are vacant.

The subject property essentially consists of a hillside lot with slopes ascending from the street (Onyx Drive) to the west. Vegetation onsite is moderately dense consisting of grasses, shrubs, and trees. Access to the property is via Onyx Drive from Commadore Street in the Rose Hill neighborhood of the City of Los Angeles.

Topography
Maximum topographic relief of the hillside onsite and ascending offsite to the west is approximately (76) feet. Within the proposed development area onsite, the maximum topographic relief is approximately (42) feet. Onsite and offsite to the west, the ascending natural hillside displays variable slope gradients ranging from as steep as 1.08H:1V, near the toe-of-slope, to flatter than 3H:1V in the mid-slope area of the hillside, and to about 1.42H to 1.86H:1V, (horizontal to vertical), within the upper portion of the hillside. Details of the topography are depicted on the Location Map and Geologic Map in Appendix I.

Drainage
Surface water at the site consists of direct precipitation onto the property. Much of this water drains as sheet flow down descending slopes to low-lying areas, offsite and/or to the street.

Groundwater
No active surface groundwater seeps or springs were observed on the subject site. The subsurface exploration did not encounter groundwater to a depth of (8) feet below adjacent site grades. Seasonal fluctuations of groundwater levels may occur by varying amounts of rainfall, irrigation and recharge. Due to the elevated nature of the property, groundwater is not anticipated to pose a problem to the proposed project.

SUMMARY OF FINDINGS

Previous Work
The subject property is vacant and unimproved. No geology and/or geotechnical reports were found on file at the City of Los Angeles Department of Building and Safety, covering the site.

Stratigraphy
The site is underlain by marine sedimentary rocks of Miocene time, which are covered by Quaternary earth materials and minor amounts of anthropogenic artificial fill materials. The earth materials encountered on the subject property are briefly described below. Approximate depths and more detailed descriptions are given in the enclosed Exploration Logs (see Appendix I).

Artificial Fill (Af)
Minor amounts of artificial fill materials were encountered in one of the test pit explorations with an observed thickness of about (3) feet. The existing artificial fill materials generally consist of medium- to dark-brown sandy silt. The approximate limit of the existing fill materials is shown on the attached Geologic Map and Cross-Sections.

Native Soil (Qs)
Native soil consists of dark brown sandy clay. The soil is derived from weathered bedrock materials that have accumulated on natural descending slopes. Encountered soil varies between (3.0) and (4.0) feet in thickness.

Bedrock (Tpsh)
Bedrock exposed at the surface onsite and underlying the native soil is assigned to the Puente Formation of Miocene time. Onsite, it consists of interbedded siltstone and sandstone that is orange-brown to light-gray, locally siliceous, thinly and well-bedded, and dense to very dense.

Geologic Structure

The local area has been uplifted, tilted, faulted and folded by past tectonic forces. Lamar (1970) has mapped the site as being located on a large bedrock block of the southern limb of the west-northwest to east-southeast (**WNW-ESE**) trending Elysian Park Anticline. The bedrock block containing the subject site has been dissected by the sub-parallel, high-dip angle Elysian Park fault to the southwest of the site, another unnamed sub-parallel, high-dip angle fault to the northeast of the site, and unnamed high dip-angle faults to the northwest and southeast of the site.

At the subject site, the bedrock structure is consistent within the proposed development area and similar to the local structure, (Plate 2). The bedrock bedding exhibits a general east-west (**E-W**) strike with southerly (**S**) dips ranging between (41) and (46) degrees. The bedrock bedding structure is obliquely oriented with respect to the west (**W**) ascending hillside slope face. Thus, the sandstone and siltstone bedrock (Tpsh) bedding structure underlying the subject site is considered neutrally oriented with respect to the west (**W**) ascending hillside.

However, vertical excavations for the proposed new retaining walls with an approximately east-west (**E-W**) alignment should be anticipated to encounter adversely oriented bedrock bedding structure. Additionally, no dominant patterns of adversely orientated fractures or joints were observed during the subsurface investigation at the subject site. Preliminary geologic data, as depicted in Cross-Section A, indicates the proposed development is feasible from the standpoint of engineering geology and soils engineering provided the recommendations contained herein are followed and maintained.

Seismicity

All of Southern California is in a seismically active region. There are several active and/or potentially active faults within Los Angeles County. Therefore, any future movement on these faults could possibly affect the structure due to seismic shaking. The time, location, magnitude, amount of fault displacement, and shaking duration of an earthquake cannot be accurately predicted.

Ground motion caused by an earthquake is likely to occur at the site during the lifetime of the development due to the proximity of several active and potentially active faults. The Applied Technology Council (ATC) in conjunction with the Structural Engineers Association of California (SEAOC), the American Society of Civil Engineers (ASCE), and the United States Geological Survey (USGS) have developed and maintain a website and search engine computer program for the prediction of peak and design-level earthquake ground motions. The earthquake induced ground motions anticipated for the subject site, as determined from the ATC website search engine output, are provided in the Appendix III. Generally, on a regional scale, quantitative predictions of ground motion values are linked to peak acceleration and repeatable acceleration, which is a response to earthquake magnitudes relative to the fault distance from the subject property.

This seismic evaluation is designed to provide the client with current, rational, and believable seismic data that could affect the property during the lifetime of the proposed improvements. The minimum design acceleration for a project is listed in the current Building Code. It is recommended that the structural design of the proposed development be based on current design acceleration practices of similar projects in the area.

Malibu Coast – Santa Monica – Hollywood – Raymond Fault System

The Malibu Coast - Santa Monica - Hollywood - Raymond Fault System consists of a zone with one or more fault strands with poorly known geometry which are most likely linked. The length of the fault system is at least (25) miles. The fault zone forms the central portion of a major tectonic boundary separating the east-west trending Transverse Ranges geomorphic province, to the north, from the northwest-southeast

trending Peninsular Ranges geomorphic province, including the Los Angeles Basin to the south. A recent study suggests the Malibu Coast - Santa Monica - Hollywood – Raymond Fault System has undergone at least six surface ruptures over the past 50,000 years, with the most recent approximately 1,000 to 2,000 years ago. Such surface ruptures could produce displacements of approximately (1.1) to (2.0) meters.

Raymond Fault Zone
Recently, in 2017, the State of California re-classified the Raymond fault as an active fault and established the Raymond Fault Earthquake Fault Zone, in accordance with the Alquist-Priolo (AP) Earthquake Fault Zoning Act of 1972. Also, in 2017, the California Geological Survey (CGS) released the *Los Angeles Quadrangle (EZRIM) Earthquake Zones of Required Investigation Map*, (1999, 2017), (Plate 3).

The subject property is not located within the Raymond Fault Earthquake Fault Zone, as delineated by the California Geological Survey (CGS), (Plate 3). Thus, seismically induced ground rupture at the site is not anticipated. However, the subject site is located approximately (2.72) miles south-southeast (SSE) of the Raymond Fault Earthquake Fault Zone, as delineated by the CGS, (Plate 3). Ground acceleration and shaking should be anticipated due to the relatively close proximity of the site to the mapped surface traces of the Raymond fault and to several other active and/or potentially active faults within the local area.

Generally, all of southern California is located in a seismically active region and some areas have a higher potential for seismic damage than other areas. The nearer a property is to an active fault, then a greater probability for significant ground shaking and higher ground acceleration should be anticipated. Thus, earthquake insurance and building code upgrades is suggested.

Liquefaction
Liquefaction is a process by which sediments below the water table temporarily lose strength and behave as a viscous liquid rather than a solid. The types of sediments most susceptible are clay-free deposits of sand and silts; gravel only occasionally liquefies. The actions in the soil which produce liquefaction are as follows: seismic waves, primarily shear waves, passing through saturated granular layers, distort the granular structure, and cause loosely packed groups of particles to collapse. The pore-water pressure between grains increases if drainage cannot occur. If the pore-water pressure rises to a level approaching the weight of the overlying soil, the granular soil layer temporarily behaves as a viscous liquid rather than a solid.

In the liquefied condition, soil may deform with little shear resistance; deformations large enough to cause damage to buildings and other structures are called ground failures. The ease with which a soil can be liquefied depends primarily on the looseness of the material, the depth, thickness, and areal extent of the liquefied layer, the ground slope, and the distribution of loads applied by buildings and other structures.

The State of California has prepared Seismic Hazard Zone Reports and Maps to regionally map areas where historic occurrence of liquefaction, or local geological, geotechnical and groundwater conditions indicate a potential for permanent ground displacement. The maps may not identify all areas that have potential for liquefaction, strong ground shaking, or other earthquake-related geologic hazards.

The subject site is not located within a Liquefaction Hazard Zone as designated on the California Geological Survey (CGS) *Los Angeles Quadrangle (EZRIM) Earthquake Zones of Required Investigation Map,* (1999, 2017), (Plate 3). Additionally, the subject property is underlain at shallow depth by Miocene-age sandstone and siltstone bedrock (Tpsh). The age and density of the underlying bedrock preclude the potential for liquefaction to occur at the subject site. Therefore, it is the opinion of this firm that the potential for liquefaction at the subject site is nil.

Landslides
The State of California has prepared Seismic Hazard Evaluation reports to regionally map areas of potential increased risk of permanent ground displacement based on historic occurrence of landslide movement, local topographic expression, and geological and geotechnical subsurface conditions. The maps may not identify all areas that have potential for earthquake-induced landsliding, strong ground shaking, or other earthquake-related geologic hazards.

Portions of the subject site are located within an earthquake-induced landslide hazard zone on the California Geological Survey (CGS) *Los Angeles Quadrangle (EZRIM) Earthquake Zones of Required Investigation Map*, (1999, 2017), (Plate 3). Also, ancient or recent bedrock landslides were not observed on the property. Also, no recent surficial slope failures or slumps were observed within the proposed project area on the property.

Slope Stability
Portions of the subject site are located within an earthquake-induced landslide hazard zone on the California Geological Survey (CGS) *Los Angeles Quadrangle (EZRIM) Earthquake Zones of Required Investigation Map* (1999, 2017), (Plate 3). Also, the scope of the proposed development includes construction of a new two-story residence over partial subterranean garage and retaining walls set into the approximately (76)-foot high east facing hillside, displaying variable slope gradients ranging from as steep as 1.08H:1V, near the toe-of-slope, to flatter than 3H:1V in the mid-slope area of the hillside, and to about 1.42H to 1.86H:1V, (horizontal to vertical), within the upper portion of the hillside.

The proposed development is not considered exempt from the 2020 Los Angeles Building Code (LABC) §91.1803.5.11-12 requirements for a site-specific study to determine the potential hazard from earthquake ground motion induced slope instability, per LADBS Information Bulletin P/BC 2020-044. Therefore, global slope stability analyses for both the static and seismic loading conditions and are required for the proposed development, in accordance with LADBS Information Bulletins P/BC 2020-044 & -049. A detailed discussion of slope stability analyses performed is included herein, in Appendix III – Engineering Analysis.

CONCLUSIONS

1. Based on the results of this investigation and a thorough review of the proposed development, as discussed, the project is suitable for the intended use providing the following recommendations are incorporated into the design and subsequent construction of the project. Also, the development must be performed in an acceptable manner conforming to Building Code requirements of the controlling governing agency.

2. The SITE CLASS based on California Building Code is C – Soft Rock & Very Stiff Soil. Additional seismic design values are listed in Appendix III.

3. Based upon field observations, laboratory testing and analysis, the sandstone and siltstone bedrock (Tpsh) underlying the subject site should possess sufficient strength to support new foundations for the proposed project.

RECOMMENDATIONS

Specific Recommendations

1. New foundations for the proposed two-story residence over garage and retaining walls should consist of shallow conventional foundations. New conventional foundations for the proposed project should

bear entirely into the competent sandstone and siltstone bedrock (Tpsh) bearing material underlying the proposed development area at the subject site.

2. **All foundation excavations shall be observed and verified by the project engineering geologist and/or soils engineer during construction prior to placing steel and concrete.** The required excavation observations are intended to verify conformance of the excavations with the recommendations provided herein, with the design structural engineering plans, with the current Building Code, and with the specific requirements of the local governmental reviewing agency.
3. **Prior to beginning any site grading, removals, and/or excavations for foundations a project pre-construction / pre-grading meeting should be held on-site.** The project pre-construction / pre-grading meeting should be attended by the project engineering geologist and/or soils engineer and by representatives of the property owner, the project architect, the project structural engineer, the project civil engineer, the general contractor, and/or the grading contractor, and by the local building department official/inspector.
4. The property owner shall maintain the site as outlined in the 'Drainage and Maintenance' section of Appendix IV – General Recommendations.

Conventional Foundations

New foundations for the proposed two-story residence over garage and retaining walls should consist of shallow conventional foundations. New conventional foundations for the proposed project should bear entirely into the competent sandstone and siltstone bedrock (Tpsh) bearing material underlying the proposed development area at the subject site.

The minimum conventional foundation design recommendations are given as follows:

- *Allowable Bearing Pressures:*
  - Strip Footings — 2,000 pounds per square foot
  - Column Footings — 2,500 pounds per square foot
  - Maximum Allowable — 5,000 pounds per square foot
- *Allowable Bearing Pressure Increases:*
  - For Additional Footing Width — 200 pounds per square foot, per foot
  - For Additional Footing Depth — 500 pounds per square foot, per foot
- *Minimum Footing Widths:*
  - Strip Footings — 12 inches
  - Column Footings — 24 inches (square)
- *Minimum Footing Embedment Depths:*
  - Strip Footings — 24 inches
  - Column Footings — 24 inches
  - All foundation embedment depths shall be measured into the recommended bearing material, below the lowest adjacent grade.
- *Lateral Resistance Parameters:*
  - Coefficient of Friction — 0.35
  - Passive Earth Resistance (acting as a fluid) — 350 pounds per square foot, per foot
  - Maximum Passive Earth Pressure — 4,200 pounds per square foot

- Lateral loads may be resisted by friction acting at the base of the footings and/or by passive resistance within the recommended bearing material.

The foundation bearing values provided above are for the total of dead and frequently applied live loads and include a Factor-of-Safety of at least (3). These bearing values may be increased by a factor of (1/3) for temporary loads, such as, wind and seismic forces. The bearing values given above are net bearing values; the weight of concrete below grade may be neglected.

When combining passive earth pressure and friction for lateral resistance, the passive earth pressure component should be reduced by one-third. The coefficient of friction should be applied to dead load forces only.

All continuous footings shall be reinforced with a minimum of (4) #(4) bars, two placed near the top and two near the bottom. Reinforcing recommendations are minimums and may be revised by the project structural engineer.

All foundation excavations are required to be observed by the project soils engineer and/or project engineering geologist. Footing depths will be measured from the lowest adjacent grade of recommended bearing material. Footing depths will not be measured from any proposed elevations or grades. Any foundation excavations that are not the recommended depth into the recommended bearing material will not be acceptable to this office.

Foundation Settlement

Foundation loads for the proposed two-story residence over garage are anticipated to be light to moderate. Also, the recommended sandstone and siltstone bedrock (Tpsh) bearing material underlying the proposed development area has been observed to be competent and dense. Therefore, significant static settlement of the new foundations is not anticipated for the expected foundation loading conditions.

Conservatively, static settlement of the proposed development should be anticipated to occur. Static settlement on the order of (½) to (¾)-inches between walls or piers, within (20) feet or less, of each other, and under similar loading conditions, is considered normal. Total static settlement on the order of less than (1)-inch should be anticipated.

Foundation Setback/Clearance

Standard requirements for building foundation setbacks are from either descending and/or ascending slopes are provided in 2019 California Building Code (CBC) §1808.7 *et seq.* Generally, footings adjacent to a descending slope steeper than 3H:1V (horizontal to vertical) in gradient shall be located a distance one-third of the vertical height of the slope with a minimum of (5) feet and a maximum of (40) feet measured horizontally from the slope face, or the upper surface of the recommended bearing material. Where the slope is steeper than 1H:1V (horizontal to vertical), the required setback shall be measured from an imaginary plane at (45) degrees to the horizontal, projected upward from the toe of the slope. Buildings adjacent to ascending slopes shall have a building clearance from the toe of the slope a horizontal distance equal to one-half the vertical height of the slope but need not exceed (15) feet. Standard building setback/clearance distances may be reduced by one-half for in-ground swimming pools.

Expansive Soils

Potentially expansive earth materials were encountered during the subsurface exploration of the subject property. Our experience and soils laboratory testing indicates that the onsite earth materials should be anticipated to exhibit a MEDIUM expansion potential. As such, all new foundations and new hardscape shall be designed for an expansive soil condition, in accordance with 2020 Los Angeles Building Code (LABC) §91.1808.6 and LADBS Information Bulletin P/BC 2017-116.

Expansive soils can be a problem, as variation in moisture content will cause a volume change in the soil. Expansive soils heave when moisture is introduced and contract as they dry. During inclement weather and/or excessive landscape watering, moisture infiltrates the soil and causes the soil to heave (expansion). When drying occurs the soils will shrink (contraction). Repeated cycles of expansion and contraction of soils can cause pavement, concrete slabs on grade and foundations to crack. This movement can also result in misalignment of doors and windows. To reduce the effect of expansive soils, foundation systems are usually deepened and/or provided with additional reinforcement design by the structural engineer.

Planning of yard improvements should take into consideration maintaining uniform moisture conditions around structures. Soils should be kept moist, but water should not be allowed to pond. These designs are intended to reduce, but will not eliminate, deflection and cracking and do not guarantee or warrant that cracking will not occur.

Site Drainage

Proper surface drainage is critical to the future performance of the project. Saturation of a soil can cause it to lose internal shear strength and increase its compressibility, resulting in a change in the designed engineering properties. Proper site drainage should be maintained at all times.

All site drainage should be collected and transferred to the street, or an approved drainage facility (per 2020 LABC §91.7013.9-10) in non-erosive drainage devices. The proposed development should be provided with roof drainage. Discharge from downspouts, roof drains and scuppers should not be permitted on unprotected soils within (5) feet of the building perimeter. Drainage should not be allowed to pond anywhere on the site, and especially not against any foundation or retaining wall. Drainage should not be allowed to flow uncontrolled over any descending slope. Planters located within wall backfill and/or near foundations should be sealed to prevent moisture intrusion into the subgrade earth materials.

SUSMP Infiltration

Recently, in compliance with state and federal environmental protection legislation, municipalities have begun requiring that development projects include a "Standard Urban Storm water Mitigation Plan" (SUSMP). The project SUSMP shall include "Best Management Practices" (BMPs) for the mitigation and management of storm water runoff at the project site.

Additionally, the project SUSMP should incorporate a "Low Impact Development" (LID) design strategy. LID is a storm water management strategy that seeks to mitigate the impacts of increases in runoff and storm water pollution as close to its source as possible. LID comprises a set of site design approaches and BMPs that promote the use of natural systems for infiltration, evapotranspiration, and use of storm water.

The primary tenet of the LID strategy is the disposal of a certain amount, typically the first (0.75)-inches, of storm water generated on a site by infiltration into the on-site soils. However, this requirement goes against prudent engineering practice. Increasing the moisture content of a soil can have severe adverse effects including, but not limited to:

- loss of soil internal shear strength,
- increase in soil compressibility,
- changes in the design engineering properties of the on-site soils.

Thus, any overlying structures or improvements, including: buildings, pavements, and concrete flatwork, could sustain significant damage due to saturation of the subgrade soils. Structures serviced by subterranean levels could be adversely impacted by storm water disposal by increasing the design fluid

pressures on retaining walls and causing leaks in the walls. Proper drainage is critical to the performance of any structure in the built environment.

The City of Los Angeles Bureau of Sanitation Watershed Protection Division (WPD) and the City of Los Angeles Department of Building and Safety (LADBS) both require a minimum setback of (10) feet from any proposed or existing site improvements, and from adjacent properties. Additionally, infiltration of storm water shall me a minimum of (10) feet above the groundwater table, as per LADBS Information Bulletin P/BC 2017-118.

The County of Los Angeles Department of Public Works Geotechnical and Materials Engineering Division (GMED) requires a minimum setback of (15) feet from any adjacent foundations. Additionally, infiltration of storm water shall me a minimum of (10) feet above the groundwater table, as per GMED Policy GS200.1 (2021).

The California Storm Water Quality Association recommends that infiltration devices should be installed no closer than (6) meters, or (19½) feet, from buildings, slopes and highway pavement. The Storm Water Managers Resource Center recommends that infiltration devices should be sited (25) feet down-gradient of structures. Often, these setback magnitudes are not possible on most urban projects.

The project site is underlain by sandstone and siltstone bedrock (Tpsh) overlain by minor native soil (Qs). The sandstone and siltstone bedrock (Tpsh) is considered to exhibit variable drainage properties in the "poor" to "nearly impervious" drainage range. Therefore, the sandstone bedrock (Tpsh) underlying the subject site is not considered suitable for infiltration of storm water.

Additionally, the subject site is located within a Hillside Grading Area, as designated on the Parcel Profile Report by the City of Los Angeles. As such, storm water infiltration is not allowed under the requirements of LADBS Information Bulletin P/BC 2017-118.

Establishment of a proposed storm water infiltration facility at the subject site is anticipated to increase the potential for adverse conditions including:

- Perched groundwater may be anticipated due to any storm water infiltration at the site.
- On-site earth materials may be expected to exhibit a MEDIUM expansion potential. Thus, soil heaving from expansion due to soil saturation may be anticipated.
- A partial basement level is not present on site. However, partial basements and/or subterranean levels are planned for the proposed development. Also, partial basement and/or subterranean levels may be present on neighboring or nearby sites. Due to the marginal to unsatisfactory anticipated permeability characteristics of the on-site earth materials, saturation from storm water infiltration may be anticipated to adversely affect basement levels or retaining structures.

We recommend that the design team (including the structural engineer, waterproofing consultant, plumbing engineer, and landscape architect) be consulted in regards to the design and construction of alternative SUSMP BMP method systems for the proposed development, including:

- Storm water capture and re-use systems;
- High efficiency biofiltration/bioretention systems

Also, the client/property owner should be aware that environmental legislation and/or storm water mitigation regulations are relatively new to many building departments (and very dynamic), and may be subject to change without notice.

Lastly, the storm water mitigation and/or infiltration methods mentioned herein are widely accepted by most building departments. But, the specific requirements of the reviewing agency responsible for the project will also greatly impact the final design of the BMP storm water mitigation system.

Retaining Walls

New interior (building) and exterior (site) retaining walls should be anticipated for the proposed project. New retaining walls for the proposed project should be anticipated to support between about (10) feet and (26) feet of earth materials with both level and transitioned backslopes, exhibiting a maximum lope gradient of 3H:1V, (horizontal to vertical). Additionally, new retaining walls with an approximately east west (**E-W**) alignment may be anticipated to support adversely oriented (or "daylighted") bedrock bedding structure surcharge.

All proposed new retaining walls shall conform to the requirements of 2020 Los Angeles Municipal Code §12.21C8, 2020 Los Angeles Building Code (LABC) §91.1610.1 & §91.1803.5.12.1, §91.1807.2.2, and LADBS Information Bulletins P/BC 2020-083. Retaining walls may be designed as follows:

Retaining Wall Design Recommendations

Retaining Wall	Retained Material & Soil Type	Retained Height (feet)	Backslope Gradient (MAX.) & Surcharge	Active Earth Pressure EFW (psf/ft)	At-Rest Earth Pressure EFW (psf/ft)	Seismic Lateral Increment EFW (psf/ft)
Restrained Walls	Sandstone & Siltstone Bedrock (Tpsh) w/ minor Soil (Qs), Extg. Fill (Af), and/or Select Engineered. Fill (SM)	0 – 26 MAX.	LEVEL Backslope and/or Fav. / Adv. Bedrock Surcharge	-----	60	30
Cantilevered Walls		0 – 10 MAX.	LEVEL Backslope and/or Fav. / Adv. Bedrock Surcharge	30	-----	
			Complex Backslope 5H:1V w/ 1.42 H:1V Above. and/or Fav. / Adv. Bedrock Surcharge	30	-----	

Retaining Wall Lateral Loads
The retaining wall design lateral loads are provided herein, (in the table above), with the assumption that the retaining walls have been outfitted with a permanent drainage system and has been properly backfilled. Wall backfilling and permanent drainage system recommendations are provided herein, (below), and in the enclosed 'Retaining Wall Backfilling' section of 'Appendix IV – General Recommendations.'

Cantilevered Retaining Walls
Cantilevered retaining walls, (such as exterior "site" retaining walls), should typically be designed to allow wall deflection of about (1%) to (2%) of the retained height ("H") of the wall. Cantilevered retaining walls shall be designed utilizing the Active Earth Pressure Equivalent Fluid Weight(s), ("Active Earth Press. EFW"), provided above, with a triangular distribution of earth pressure.

Restrained Retaining Walls
Interior retaining walls are walls which are planned to be incorporated into any proposed structure(s), such as "building" or "basement" retaining walls. Interior retaining walls are recommended to be designed as restrained retaining walls.

Restrained retaining walls, where the allowable wall deflection is limited to less than the typical (1%) to (2%) of the retained height ("H") of the wall, shall be designed for the At-Rest Earth Pressure Equivalent Fluid Weight, ("At-Rest Earth Press. EFW"), as provided above, utilizing a triangular distribution of earth pressure, as provided in 2019 California Building Code (CBC) §1610.1.

Additionally, as an alternative, restrained retaining walls may be designed utilizing a trapezoidal distribution of earth pressure. Restrained retaining walls with a trapezoidal earth pressure distribution should utilize a Design Earth Pressure ('DEP') of (37.5) * "H" pounds per square foot, (where "H" is the retained height of the wall), as provided on the enclosed 'Retaining Wall Design, At-Rest Earth Pressure' calculation plate, in 'Appendix III – Engineering Analysis.'

Retaining Wall Seismic Lateral Earth Pressures
As provided in 2019 CBC §1803.5.12.1 & §1807.2.2, all retaining walls planned to be greater than (6) feet in height shall be designed to withstand seismic lateral earth pressures. All retaining walls greater than (6) feet in height shall be designed for the Seismic Lateral Increment Equivalent Fluid Weight ("Seismic Lateral Increment EFW"), provided above, utilizing a triangular distribution of earth pressure.

Wall Foundations
Retaining wall foundations may be designed as provided in the foundation design recommendations section(s) of this report, (above).

Wall Drainage
Retaining walls should be provided with a permanent wall subdrainage system to eliminate the build-up of excess hydrostatic pressure behind the wall. Final design of the recommended retaining wall subdrainage system shall be provided by the project civil/structural engineer responsible for retaining wall design.

Typically, the recommended retaining wall subdrainage system should consist of a (4)-inch diameter (Schedule 40) Polyvinyl chloride (PVC) perforated pipe placed behind the wall, above the wall foundation, with perforations facing downward, and encased in a gravel pocket. The gravel pocket shall consist of a minimum of (1) cubic foot of (¾)-inch crushed rock gravel per lineal foot of subdrain pipe.

As an alternative to the recommended PVC pipe and gravel pocket subdrain system, the retaining wall subdrain system may consist of a gravel pocket and weepholes. The weepholes should be a minimum of (4) inches in diameter and should be placed with maximum spacing of (8) feet on center of the entire length

of the wall. The gravel pocket shall consist of a minimum of (1) cubic foot of (¾)-inch crushed rock gravel per lineal foot of wall.

Additionally, a vertical (or "chimney") drain system is recommended to be installed along the back of the retaining wall. The vertical drain system should consist of a minimum of a (6)-inch wide pocket of (¾)-inch crushed rock gravel extending up the back of the wall from the wall subdrain system to within (24) inches of the final grade behind the wall. Also, prefabricated wall vertical drainage products, such as MiraDRAIN 6000 or equivalent, may be utilized in addition to the recommended gravel pocket vertical drain system.

Basement, or partial basement, retaining walls should be provided with wall subdrainage and vertical drainage systems which either include a sump pump, or outlet to an area drain with sump pump. The retaining wall subdrainage and vertical drainage systems may outlet to an area drain to remove drainage to the street, or another appropriate location approved by the project civil engineer and the local governmental reviewing agency.

Lastly, for retaining walls which <u>are not planned</u> to be provided with the recommended wall subdrainage and vertical drainage systems, the retaining walls <u>shall be</u> designed to withstand a hydrostatic loading surcharge in addition to the lateral soil and surcharge loads given above. The hydrostatic loading surcharge shall be taken as an equivalent fluid weight of (62.4) pounds per square foot, per foot of wall height. The hydrostatic loading surcharge shall be applied to the full retained height of the retaining wall.

Wall Backfilling
All required retaining wall backfill should be compacted to at least (90) percent of the Proctor maximum dry density, per the latest edition of ASTM D 1557. Proper compaction of the backfill is recommended to provide lateral support to adjacent properties, structures, and improvements.

Even with proper compaction of the required backfill, settlement of the backfill may occur because of the significant depth of the backfill. Accordingly, utility lines, footings, or falsework should be planned and designed to accommodate such potential settlements. All grading and drainage requirements listed in the enclosed 'Retaining Wall Backfilling' section in Appendix IV – General Recommendations shall apply.

Select Engineered Backfill
On-site earth materials that are planned to be removed and/or over-excavated during construction are considered to be granular and cohesive, low plasticity, and LOW expansivity soils. The on-site earth materials are considered acceptable to be utilized as engineered, compacted wall backfill materials. All retaining wall backfilling shall be performed as outlined in the enclosed 'Retaining Wall Backfilling' section in Appendix IV – General Recommendations.

Importing of earth fill materials should also be anticipated for the grading and earthwork required for retaining wall backfill. Imported earth fill materials must be approved by the project soils engineer prior to being placed as engineered, compacted fill. Imported earth materials should consist of "Select Engineered Fill Materials." The select engineered, compacted fill material should consist of largely granular soils with the following earth material strength parameters:

<u>Select Engineered Backfill Parameters</u>
- USCS Soil Type (SM), as approved by the project soils engineer
- Angle of Internal Friction "ϕ" = 30 degrees
- Cohesive Strength "c" = 300 pounds per square foot
- Soil Wet Density "γ" = 130 pounds per cubic foot
- Expansive Index "EI" = LOW (20-50)

Wall Waterproofing
Water and moisture affecting retaining walls is a common post-construction complaint. Poorly applied or omitted waterproofing can lead to standing water inside proposed structures or efflorescence on the wall. We recommend that all retaining walls be waterproofed. Waterproofing design and inspection of installation is not the responsibility of the geotechnical engineer. Bay City Geology, Inc. does not practice in the field of water and moisture vapor transmission evaluation/mitigation. Therefore, we recommend that a qualified person/firm be engaged/consulted to evaluate the general and specific water and moisture vapor transmission paths and any impact on the proposed development. This person/firm should provide recommendations for mitigation of potential adverse impact of water and moisture vapor transmission on various components of the structure as deemed necessary. The actual waterproofing design shall be provided by the architect, structural engineer or contractor with experience in waterproofing.

Slough Protection
Some surficial erosion and/or raveling of slope faces may occur during inclement weather. In order to mitigate the possible impact of eroded materials affecting yard areas and the proposed development, it is recommended that retaining walls supporting a 5H:1V, (horizontal to vertical) or steeper, backslope shall be provided with a minimum of (24) inches of freeboard. The recommended wall freeboard shall be designed for impact loading with a minimum equivalent fluid weight of (125) pounds per cubic foot.

Any sloughed earth materials that accumulate behind the walls must be cleaned out each time deposition occurs, to allow them to function as envisioned. Additionally, all slopes should be planted and maintained as described in the Drainage and Maintenance section. In addition, deep-rooted shrubs should be planted in staggered rows that do not exceed (10) feet on center over the slope face.

Temporary Excavations
Temporary excavations for construction of the proposed project should be anticipated to include removals between about (12) feet and (40) feet in height for construction of the proposed new two-story residence over garage and retaining walls. Conventional excavation equipment may be used to make these excavations. Excavations should expose competent, dense sandstone and siltstone bedrock (Tpsh) overlain by minor native soil (Qs). All temporary excavations should be observed and verified by the project soils engineer and/or project engineering geologist during construction so that modifications can be made if variations in the earth materials occur.

All excavations should be stabilized within (30) days of initial excavation. If this time is exceeded, the project soils engineer must be notified, and modifications, such as shoring or slope trimming may be required. Water should not be allowed to pond on top of, or at the toe of, the excavations, nor to flow toward them. All excavations should be protected from inclement weather. Excavations should be kept moist, not saturated, to reduce the potential for raveling and sloughing during construction. No vehicular surcharge should be allowed within (3) feet of any excavation.

Vertical Excavations
The sandstone and siltstone bedrock (Tpsh) and native soil (Qs) underlying the subject site are considered suitable for vertical excavations up to (5) feet in height. Vertical excavations greater than (5) feet in height should be trimmed and laid-back at a maximum gradient of 1H:1V, (horizontal to vertical). Alternatively, excavations greater than (5) feet in height should be provided with temporary bracing and/or shoring.

Earthwork & Bulking/Shrinkage
The temporary excavations planned for the construction proposed development should be anticipated to encounter sandstone and siltstone bedrock (Tpsh) that is competent and dense. The “Ease of Excavation” (or “Diggability Index”) of the sandstone and siltstone bedrock (Tpsh) should be anticipated to be “Medium-

Hard" (M-H). A "Bulking" (or "Swell") factor for the sandstone and siltstone bedrock (Tpsh) of about (60%) may be utilized for earthwork calculations.

Temporary Bracing/Shoring

The temporary excavations for construction of the proposed project should be anticipated to include removals (12) feet and (40) feet in height for construction of the proposed new two-story residence over garage and retaining walls. Also, the planned temporary excavations should be anticipated to support level and transitioned backslopes and to remove lateral support from neighboring structures and/or adjacent private properties. Additionally, retaining wall excavations with an approximate east-west (E-W) alignment should be anticipated to encounter adversely oriented (or "daylighted") bedrock bedding structure.

The planned temporary excavations for the proposed new residence and retaining walls should be provided with engineered temporary bracing/shoring. Also, the recommended temporary bracing/shoring may be incorporated into the final design of the proposed new residence and retaining walls. The final temporary bracing/shoring design recommendations shall be provided by the project shoring engineer.

Temporary bracing/shoring may be designed as follows:

Temporary Shoring Design Recommendations

Temporary Shoring	Retained Material & Soil Type	Retained Height (feet)	Backslope Gradient (MAX.) & Surcharge Cond.	Active Earth Pressure EFW (psf/ft)	Restrained Design Earth Pressure (psf)*
Retaining Wall Excavations	Sandstone & Siltstone Bedrock (Tpsh) w/ minor Soil (Qs) and/or Ex. Fill (Af)	0 – 40 MAX.	LEVEL & Fav. / Adv. Bedrock Surcharge	25	16 * H
		0 – 17 MAX.	1H:1V (MAX.) & Fav. / Adv. Bedrock Surcharge	25	16 * H

* - "H" is defined as the height of the retained excavation above the dredge-line.

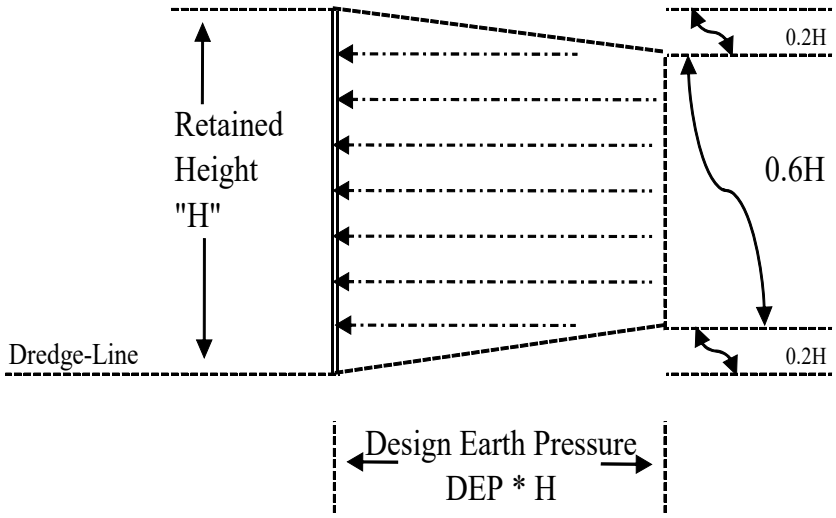
Bracing/Shoring Design

Temporary bracing/shoring should utilize either drilled, cast-in-place (CIP) shoring piles or steel soldier beams, wood lagging, and, (where applicable), raker braces and walers. Alternatively, sheet piling may be used in place of the soldier beams and wood lagging. The recommended CIP shoring piles, steel soldier beams, sheet piling, and/or raker brace foundations shall be embedded into the recommended competent, dense sandstone and siltstone bedrock (Tpsh) bearing material underlying the proposed development area at the site and anticipated to be encountered at the base of the planned excavation, (or "dredge-line").

Temporary bracing/shoring should be designed for the active earth pressure equivalent fluid weight(s), ("EFW's"), given above utilizing a triangular earth pressure distribution. The temporary bracing/shoring should also be allowed to deflect a minimum of (0.01 * H) to (0.02 * H); (where "H" is the retained height of the excavation above the "dredge-line"). Also, for design of individual CIP shoring piles, steel soldier beams, and/or raker braces the design earth pressure should be multiplied by the individual support element spacing distance.

Temporary bracing/shoring which is not allowed to deflect a minimum of (0.01 * H) to (0.02 * H); (where "H" is the retained height of the excavation above the "dredge-line"), should be designed for the restrained condition. Restrained bracing/shoring should be designed for the restrained design earth pressure ("DEP") given above utilizing a trapezoidal distribution of earth pressure.

Trapazoidal Distribution of Earth Pressure



In addition to the lateral earth pressure(s) given above, the temporary bracing/shoring should be designed to resist the surcharge loading imposed by any existing/proposed structures and/or by adjacent traffic loads. Surcharge loads may be determined utilizing the attached *Figures 11 & 12* obtained from the NAVFAC DM 7.02 (1986).

Shoring Pile Design

Drilled, cast-in-place ("CIP") shoring piles should be a minimum of (18) inches in diameter. The vertical capacity of the shoring piles may be determined using a pile skin-friction value of (400) pounds per square foot for the portions of shoring piles in contact with the recommended competent, dense sandstone and siltstone bedrock (Tpsh) bearing material underlying the subject site and anticipated to be encountered at the base of the planned excavation, (or "dredge-line").

The minimum shoring pile embedment depth required for the shoring piles to achieve the recommended pile skin friction shall be (12) feet below the dredge-line and into the recommended bearing material. Piles may be assumed fixed at (3) feet into the recommended bearing material.

Structural concrete should be used for the shoring piles below the "dredge-line," (or base of the excavation). Lean-mix concrete may be employed above the "dredge-line." Alternatively, lean-mix concrete may be used throughout the shoring piles where the reinforcing consists of a wide-flange beam section. The slurry must be of sufficient strength to impart the lateral bearing pressure developed by the wide-flange beam section to the earth materials.

The frictional resistance between the shoring piles and retained earth materials may be used to resist the vertical component of the anchor load. The coefficient of friction may be taken as (0.35) based on uniform contact between the steel beam and lean-mix concrete and the retained earth materials. The coefficient of friction value provided above for the interface between the lean-mx concrete and the retained earth materials includes a Factor-of-Safety of at least (2).

Shoring Pile Lateral Resistance
The shoring piles may be designed to resist lateral loads utilizing the passive pressure within the recommended competent, dense sandstone and siltstone bedrock (Tpsh) bearing material below the "dredge-line," (or base of the excavation). Passive earth pressure within the recommended competent, dense sandstone and siltstone bedrock (Tpsh) bearing material may be computed as an equivalent fluid having a density of (350) pounds per cubic foot, with a maximum allowable earth pressure of (4,200) pounds per square foot, and beginning at a depth of (3) feet below the "dredge-line," (or base of the excavation). To develop the full lateral resistance value, provisions should be implemented to assure firm contact between the shoring piles and the recommended bearing material. Shoring piles should be spaced no closer than (3) diameters-on-center in the direction perpendicular to the direction of lateral loading to be considered isolated and avoid any reduction in pile lateral capacity due to group effects.

Raker Brace ("Dead-Man") Footing Design
The recommended raker braces may be supported by conventional ("dead-man") footings bearing entirely into the recommended competent, dense sandstone and siltstone bedrock (Tpsh) bearing material underlying the subject site and anticipated to be encountered at the base of the planned excavation (or "dredge-line"). Raker brace conventional foundations should consist of pad footings with a minimum embedment of (36) inches into the recommended bearing material.

Structural concrete shall be used for the recommended raker brace ("dead-man") footings. Recommended raker brace ("dead-man") footings may be designed as provided in the foundation design recommendations section(s) of this report; (above). The final design of the recommended raker brace ("dead-man") footings shall be provided by the project shoring engineer.

Lagging
The earth materials on-site have been observed to be firm to dense and competent. It is recommended that the exposed earth materials be observed by the engineering geologist and/or geotechnical engineer to verify the cohesive nature of the earth materials and the area where lagging may be omitted. At this time, it is anticipated that continuous lagging will be required for the majority of the temporary excavations.

The recommended CIP shoring piles, steel soldier beams, sheet piling, and/or raker braces should be designed for the full anticipated pressures. Due to arching in the earth materials, the pressure on the lagging will be less. It is recommended that the lagging be designed for the full design pressure but may be limited to a maximum of (400) pounds per square foot.

Shoring Deflection
It is difficult to accurately predict the amount of deflection of a shored embankment. It should be realized that some deflection will occur. It is estimated that the deflection could be on the order of (1) inch at the top of the shored embankment. If greater deflection occurs during construction, additional bracing may be necessary to minimize settlement of adjacent buildings and utilities in adjacent street and alleys. If desired to reduce the deflection, a greater active pressure could be used in the shoring design. Where internal bracing is used, the rakers should be tightly wedged to minimize deflection. The proper installation of the raker braces and the wedging will be critical to the performance of the shoring.

We recommend that deflection at the top of the shored embankment be limited to a maximum of (½) inch, where a structure is within a 1H:1V (horizontal to vertical) plane projected up from the base of the shored embankment. A maximum deflection of (1) inch may be allowed provided there are no structures within a 1H:1V (horizontal to vertical) plane projected upward from the base of the embankment.

Shoring Monitoring
Because of the depth of the excavation, some means of monitoring the performance of the shoring system is suggested. The monitoring should consist of periodic surveying of the lateral and vertical locations of the tops of all soldier beams or sheet piling and the lateral movement along the entire lengths of selected soldier beams or sheet piling and raker brace locations. Also, some means of periodically checking the load on selected anchors will be necessary, where applicable.

Some movement of the shored embankments should be anticipated as a result of the excavation. It is recommended that photographs of the existing buildings on the adjacent properties be made during construction to record any movements for use in the event of a dispute.

Shoring Observation
The installation of shoring should be observed by a representative of this office. Many building officials require that continuous geotechnical observation be performed during shoring installation. The observations ensure that the recommendations of the geotechnical report are implemented and so that modifications of the recommendations can be made if variations in the earth material or groundwater conditions warrant. The observations will allow for a report to be prepared on the installation of shoring for the use of the local building official, where necessary.

Slabs-on-Grade & Hardscape
Concrete conventional slabs-on-grade and/or outdoor concrete flatwork should be a minimum of (4) inches in thickness. Slabs-on-grade should be reinforced with a minimum of (#4) reinforcing bars, placed at (16) inches on center each way. Conventional slabs-on-grade and concrete flatwork may be supported directly on the competent sandstone and siltstone bedrock (Tpsh) bearing material and/or on new properly placed engineered, compacted fill materials and should be underlain by (4) inches of crusher-run base mechanically compacted into place.

Alternatively, where removal and recompaction of any unsuitable native soil (Qs) is considered impractical or unattainable, structurally supported slabs and/or raised raised floor construction may be utilized for the proposed development. The recommended structural slabs and/or raised decking should be designed to derive support from and span between individual foundation elements that bear entirely into the recommended competent sandstone and siltstone bedrock (Tpsh) bearing material.

Grading and earthwork for subgrade preparation and slab support should include the following:

- Any unsuitable earth materials within the footprint of any proposed floor-slab or exterior slab areas should be over-excavated and removed to expose competent sandstone and siltstone bedrock (Tpsh) bearing materials. The minimum over-excavation for placement of engineered compacted fill materials shall be (24) inches.

- The bottom of the over-excavation should be observed by the project soils engineer and/or engineering geologist.

- The bottom of the over-excavation should be scarified about (6) inches, moisture conditioned, and compacted.

- Engineered fill should be placed in loose lifts of about (4) to (6) inches in thickness and compacted.
- Engineered fill should be moisture controlled to be within (3) percent of the optimum moisture content.
- Engineered fill should be compacted to a minimum of (90) percent of the Modified Proctor Maximum Dry Density, per the latest edition of ASTM D 1557.
- Engineered fill should be tested for compaction with a minimum frequency of at every (2) vertical feet or (500) cubic yards of fill placed, whichever is MORE restrictive.
- Engineered fill should be surface tested for compaction at the proposed subgrade elevation.
- The project soils engineer and/or engineering geologist should be contacted to provide periodic observation of the grading operation and perform compaction testing of the engineered compacted fill placed.
- The project soils engineer and/or engineering geologist should prepare a final report detailing the grading and earthwork performed, placement and testing of the engineered compacted fill, and providing the as-built condition of the project area with respect to engineering geology.

Foundation excavation spoils should either be removed from the slab areas or compacted into place by mechanical means and tested for compaction.

For interior slabs and/or slabs where moisture control is required, a vapor retarder with a minimum thickness of (15)-mil should be placed below the concrete slab. The vapor retarder should conform to ASTM E1745 Class A with water vapor transmission rate <0.01 perms and should be installed in accordance with ASTM E1643. The structural engineer should provide design considerations such as reinforcement to offset potential increase in curling stresses in the slab.

Slabs, walkways, and decking are likely to crack as a result of shrinkage and curing processes of concrete. Typical concrete shrinkage can result in cracks and gaps along control joints and where slabs connect with structures. Slabs should be provided with proper control joints in an effort to control the location of the cracking. The gaps will require periodic caulking to limit infiltration of moisture.

Provisions for cracks should be incorporated into the design and construction of the foundation system, slabs and proposed floor coverings. Concrete slabs should have sufficient control joints spaced at a maximum of approximately (8) feet. Slabs-on-grade should be quartered or saw cut slabs to mitigate cracking and be isolated from the stem wall footing. Exterior slabs planned adjacent to descending slopes or planter areas should be provided with a thickened edge. The thickened edge should be a minimum of (12) inches wide and (24) inches deep and two #(4) bars.

Movement of slabs adjacent to structures can be mitigated by doweling slabs to perimeter footings. Doweling should consist of (#4) bars bent around exterior footing reinforcement. Dowels should be extended at least (2) feet into planned exterior slabs. Doweling should be spaced consistent with the reinforcement schedule for the slab. With doweling, (⅜) inch minimum thickness expansion joint material should be provided. Where expansion joint material is provided, it should be held down about (⅜) inch below the surface. The expansion joints should be finished with a color matched, flowing, flexible sealer (e.g., pool deck compound) sanded to add mortar-like texture. As an option to doweling, an architectural separation could be provided between the main structures and abutting appurtenant improvements.

These recommendations are considered as minimums unless superseded by the project structural engineer.

The on-site earth materials are anticipated to exhibit a MEDIUM expansion potential. Thus, in accordance with 2019 California Building Code (CBC) §1808.6.4, prior to pouring conventional slabs-on-grade, the existing slab sub-grade earth materials should be pre-saturated to a minimum moisture content of (110) percent of the optimum moisture content, per the latest edition of ASTM D 1557. Pre-saturation of the slab sub-grade earth materials shall extend to a minimum depth of (24) inches below grade.

For exterior areas, new hardscape, (e.g.: walkway areas, pool areas, and driveway areas), may consist of flexible paving, including: A/C pavement and/or flexible and permeable paving stones. New flexible paving may be cast over newly placed engineered, compacted fill materials. New flexible paving should be designed for an expansive soil condition. Grading and earthwork, as outlined above and with a (24) inch over-excavation, should be utilized for preparation of subgrade soils for support of new flexible paving.

Additionally, the property owner should be aware that removal of all existing fill materials and/or native soil materials in the area of new flexible paving is not required. However, pavement constructed over native soil/existing fill materials will most likely have a shorter design life and increased maintenance costs. Also, if necessary, a 'Request for Modification' of the Building Code to allow placement of new engineered, compacted fill over competent native soil and/or existing fill materials should be submitted along with this geotechnical report.

Raised Floor Construction

Raised floor construction may be utilized for the proposed development. Raised floor construction can be susceptible to moisture related problems due to inadequate design and construction, and/or property owner negligence.

Some common moisture-related problems affecting raised floor systems include:

- Structural wood decay;
- High indoor humidity and resulting condensation;
- Expansive soils causing soil softening, soil heaving and/or foundation distress;
- Metal corrosion; and
- Mold growth.

Proper site drainage is critical to moisture control of any foundation system. For raised floor systems, it is especially important that standing water be kept out of the crawlspace. Gutters and downspouts which direct drainage away from the building perimeter foundations and crawlspace are of paramount importance. Floor areas of adjacent patios and/or porches should be sloped to direct drainage away from the structure.

Whenever possible, the elevation of the crawlspace floor should be higher than the exterior grade. The exterior grade outside the crawlspace should be crowned and/or sloped to direct drainage away from the structure.

Where the exterior grade is higher than the crawlspace floor, the crawlspace floor should be sloped to provide positive drainage within the crawlspace, and a perimeter drain with a sump pit and sump pump that outlets to the exterior grade should be installed within the crawlspace.

Control of ground moisture is also essential for raised floor systems and crawlspaces. Exposed soil in crawlspaces should be covered with a vapor retarder. The ground cover vapor retarder should have a minimum thickness of (15)-mil and conform to ASTM E1745 Class A with water vapor transmission rate <0.01 perms and should be installed in accordance with ASTM E1643.

Additionally, the crawlspace should be provided with adequate, and minimum Code-required, ventilation. Vent openings should be screened to inhibit pest entry and should not allow rain water or runoff to enter the crawlspace.

Lastly, as with any structure, long-term performance of raised a floor system requires regular building inspections and maintenance. The crawlspace should be inspected periodically to check for excessive moisture conditions from leaky plumbing, HVAC ducts, or standing water, and damaging pests. Necessary corrective measures or repairs should be made promptly to avoid problems related to moisture or pests.

Concrete Mix Design

Our experience indicates that the earth materials at the site contain negligible to severe levels of sulfates and should be categorized as sulfate exposure class: S2. Thus, a concrete mix design including: Type V Portland cement is recommended for the project. Also, we recommend that a low permeability concrete be utilized at the site to limit moisture transmission through slabs and foundations. For this purpose, the water/cement (*w/cm*) ratio to be used at the site should be limited to (0.45). Limited use (subject to approval of mix designs) of a water reducing agent may be included to increase workability. The concrete should be properly cured to minimize risk of shrinkage cracking. The code dictates at least (7) days of moist curing. Two to three weeks is preferred to minimize cracking. One-inch hard rock mixes should be provided. Pea gravel mixes are specifically not recommended but could be utilized for relatively non-critical improvements (e.g., flatwork) and other improvements provided the mix designs consider limiting shrinkage.

Contractors/other designers should take care in all aspects of designing mixes, detailing, placing, finishing, and curing concrete. The mix designers and contractor are advised to consider all available steps to reduce cracking. The use of shrinkage compensating cement or fiber reinforcing should be considered. Mix designs proposed by the contractor should be considered subject to review by the project engineer.

REVIEWS

Plan Review and Plan Notes

The final grading, building, and/or structural plans shall be reviewed and approved by the consultants to ensure that all recommendations are incorporated into the design or shown as notes on the plan.

The final plans should reflect the following:

1. This Geologic and Soils Engineering Investigation by Bay City Geology, Inc. is a part of the plans.
2. Plans must be reviewed and signed by the engineering geologist and soils engineer.
3. The project engineering geologist and/or soils engineer must review all grading.
4. The project engineering geologist and/or soils engineer shall review all foundation excavations prior to placing steel and concrete.

Construction Review

Onsite reviews will be required to verify all geologic and geotechnical work. It is required that all footing excavations, seepage pits, and grading be reviewed by this office. This office should be notified at least two working days in advance of any field reviews so that staff personnel may be made available.

The property owner should take an active role in project safety by assigning responsibility and authority to individuals qualified in appropriate construction safety principles and practices. Generally, site safety should be assigned to the general contractor or construction manager that is in control of the site and has the required expertise, which includes but not limited to construction means, methods and safety precautions.

LIMITATIONS

General

Findings, conclusions and recommendations contained in this report are based upon the surface mapping, subsurface exploration, data analyses, and specific information as described and past experience. Earth materials and conditions immediately adjacent to, or beneath those observed may have different characteristics, such as, earth type, physical properties and strength. Therefore, no representations are made as to the nature, quality, or extent of latent earth materials. Site conditions can and do change from those that were first envisioned. During construction, if subsurface conditions differ from those encountered in the described exploration, this office should be advised immediately so that appropriate action can be taken.

The scope of this investigation is limited to the project area explored as depicted on the Geologic Map. This report is not a comprehensive evaluation of the entire property. This report has not been prepared for use by other parties or for other purposes and may not contain sufficient information for other than the intended use. Prior to use by others, Bay City Geology, Inc. should be consulted to determine if additional work is required. If the project is delayed more than one year, this office should be contacted to verify current site conditions and prepare an update report.

Findings, conclusions and recommendations presented herein are based on experience and background. Therefore, findings, conclusions and recommendations are professional opinions and are not meant to indicate a control of nature.

Potentially expansive soils were encountered on the subject property. Design for foundations, slabs on grade, and retaining walls have been provided to mitigate this soil condition. These designs do not guarantee or warrant that cracking will not occur.

This limited report provides information regarding the geologic findings on the subject property. It is not designed to provide a guarantee that the site will be free of hazards in the future, such as, landslides, slippage, differential settlement, debris flows, seepage, concentrated drainage or flooding. Hillside properties are subject to hazards, which are not found with flatland properties. It may not be possible to eliminate all hazards, but homeowners must maintain their property and improve deficiencies.

CONSTRUCTION NOTICE

Construction can be difficult. Recommendations contained herein are based upon surface reconnaissance and subsurface explorations deemed suitable for the scope of the project.

It is this Corporation's aim to advise you through this report of the general site conditions, suitability for construction, and overall stability. It must be understood that the opinions are based upon testing, analysis, and interpretation thereof.

Quantities for foundation concrete and steel may be estimated, based on the findings provided in this report. However, you must be aware that depths and magnitudes will most-likely vary between the explorations provided in this report.

APPENDIX I

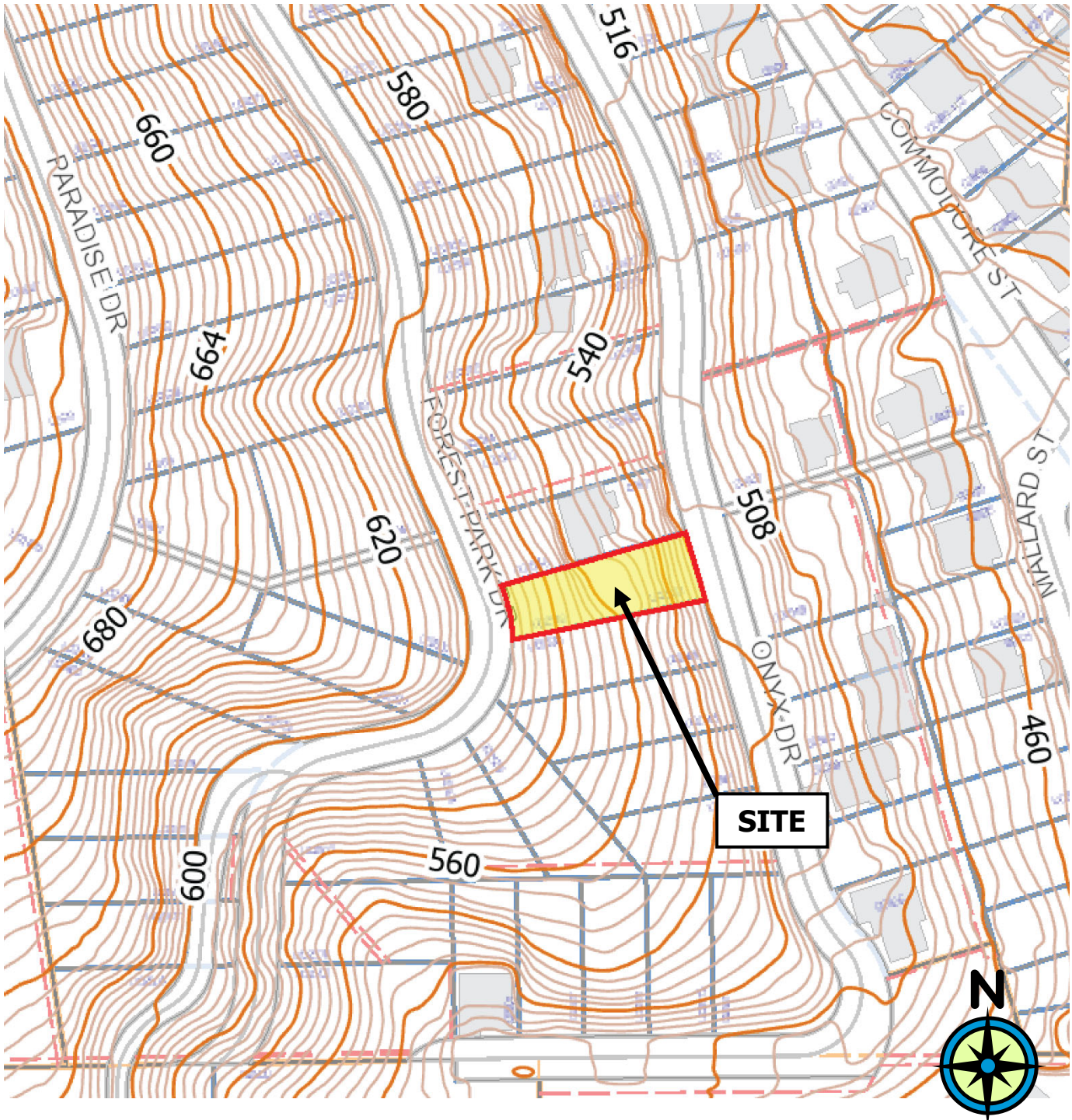
Location Maps

Geologic Map

Cross Sections

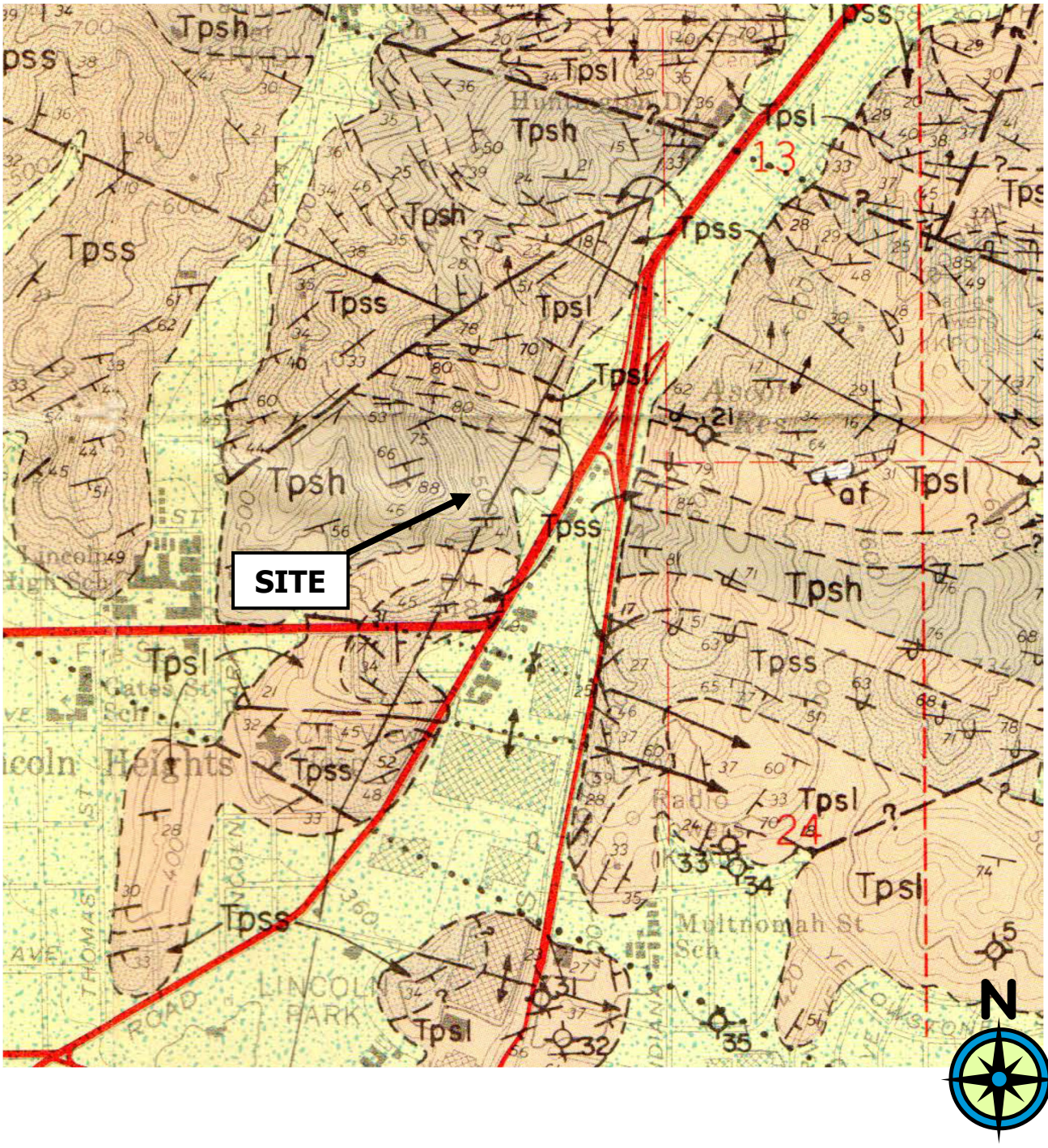
Field Exploration
Exploration Logs 1 through 2

LOCATION



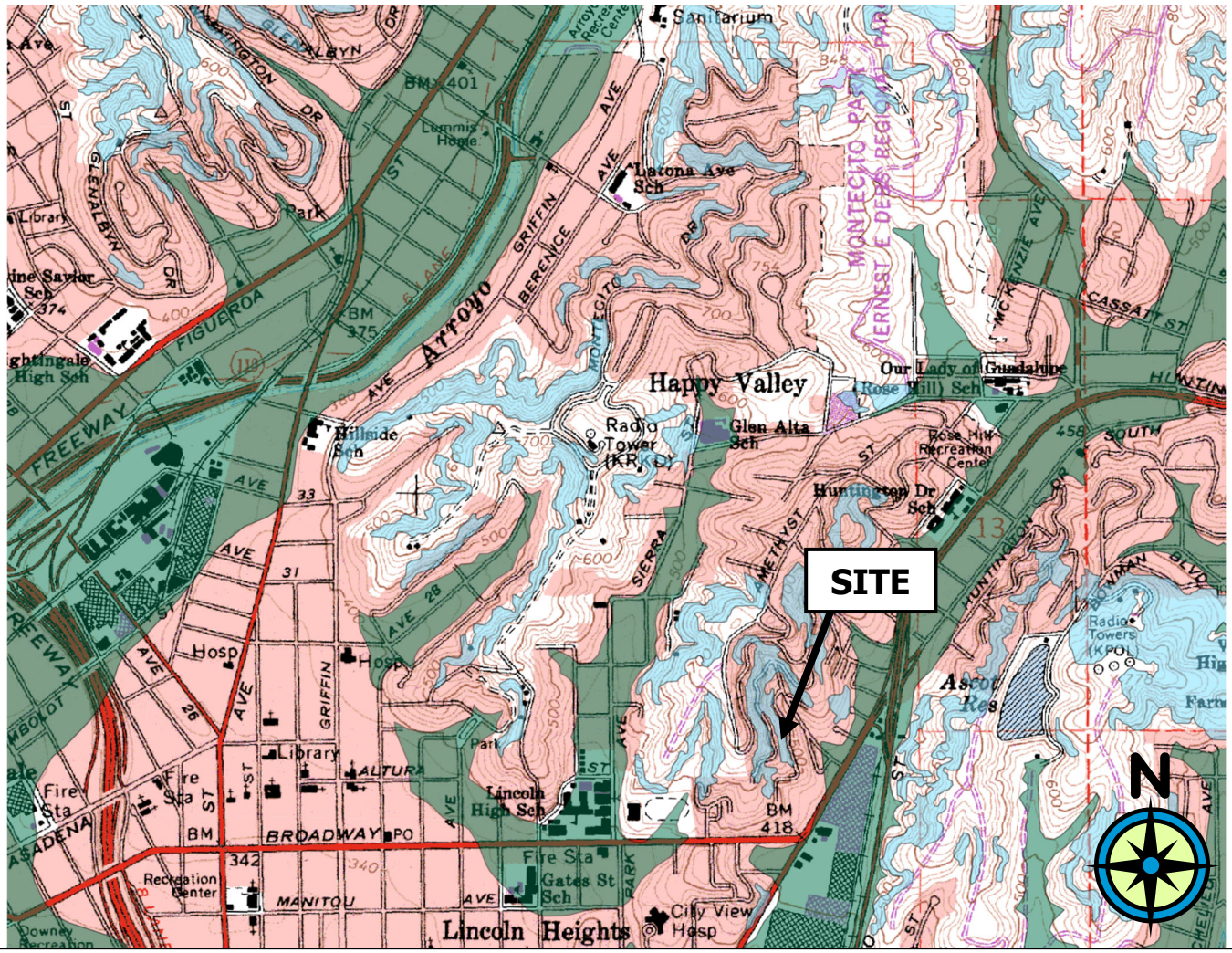
Reference:	Navigate LA (http://navigatela.lacity.org)
Project Address:	2553 Onyx Drive Los Angeles, California

REGIONAL GEOLOGY MAP



Reference:	Geologic Map of the Elysian Park – Repetto Hills Area
Project Address:	2553 Onyx Drive Los Angeles, California Plate 2

SEISMIC HAZARD MAP



MAP EXPLANATION

EARTHQUAKE FAULT ZONES

Earthquake Fault Zones
Zone boundaries are delineated by straight-line segments; the boundaries define the zone encompassing active faults that constitute a potential hazard to structures from surface faulting or fault creep such that avoidance as described in Public Resources Code Section 2621.5(a) would be required.

Active Fault Traces
Faults considered to have been active during Holocene time and to have potential for surface rupture: Solid Line in Black or Red where Accurately Located; Long Dash in Black or Solid Line in Purple where Approximately Located; Short Dash in Black or Solid Line in Orange where Inferred; Dotted Line in Black or Solid Line in Rose where Concealed; Query (?) indicates additional uncertainty. Evidence of historic offset indicated by year of earthquake-associated event or C for displacement caused by fault creep.

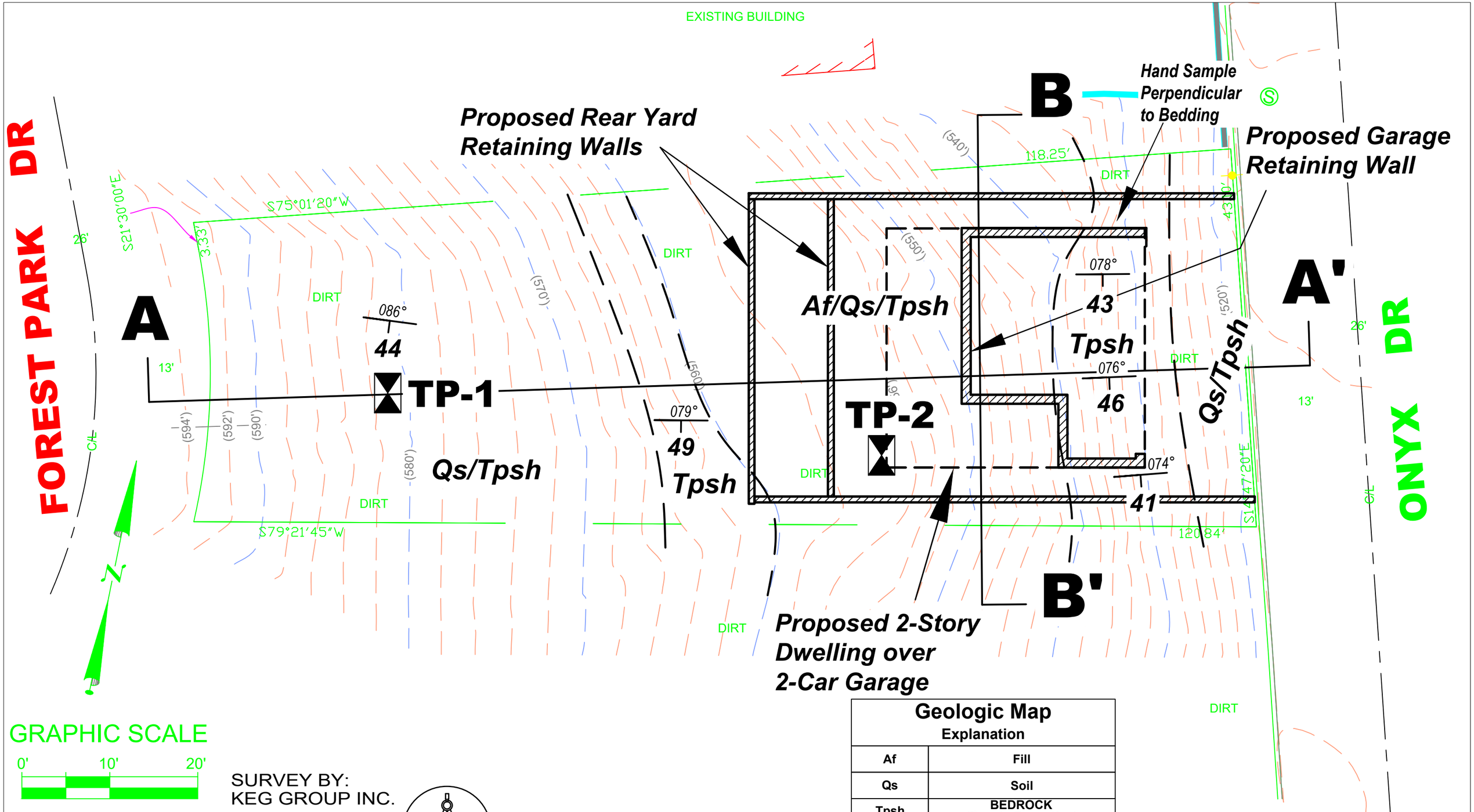
SEISMIC HAZARD ZONES

Liquefaction Zones
Areas where historical occurrence of liquefaction, or local geological, geotechnical and ground water conditions indicate a potential for permanent ground displacements such that mitigation as defined in Public Resources Code Section 2693(c) would be required.

Earthquake-Induced Landslide Zones
Areas where previous occurrence of landslide movement, or local topographic, geological, geotechnical and subsurface water conditions indicate a potential for permanent ground displacements such that mitigation as defined in Public Resources Code Section 2693(c) would be required.

Reference:	State of California Seismic Hazard Map of the Los Angeles Quadrangle
Project Address:	2553 Onyx Drive Los Angeles, California

Plate 3



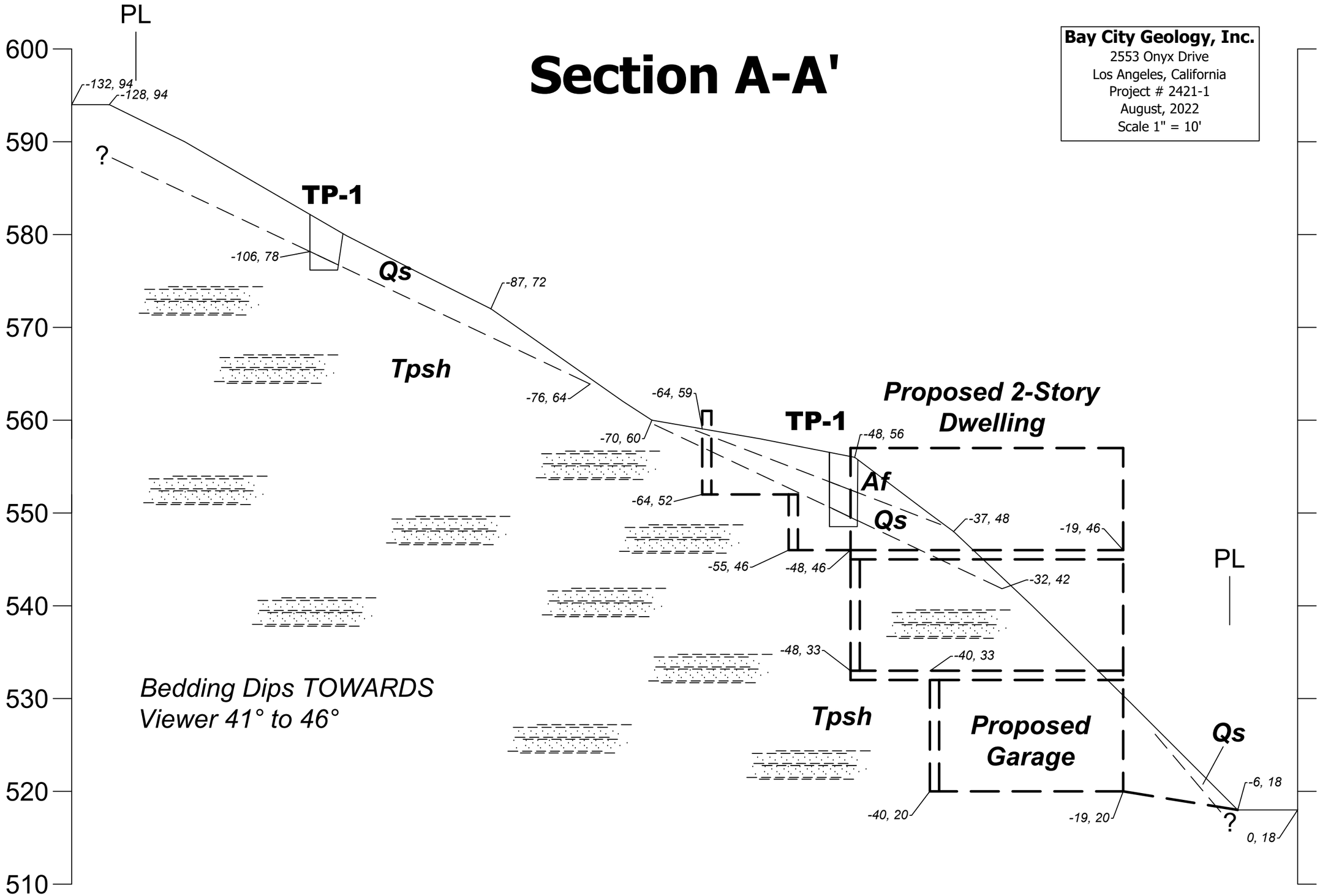
SURVEY BY:
KEG GROUP INC.
(818)919-8133
4705 KESTER AVE. SHERMAN OAKS, CA 91403

Geologic Map Explanation	
Af	Fill
Qs	Soil
Tpsh	BEDROCK (Puente Formation)
TP-2	Location of Test Pits
33	Bedding Attitude
	Approximate Geologic Contact
A A'	Line of Cross Section

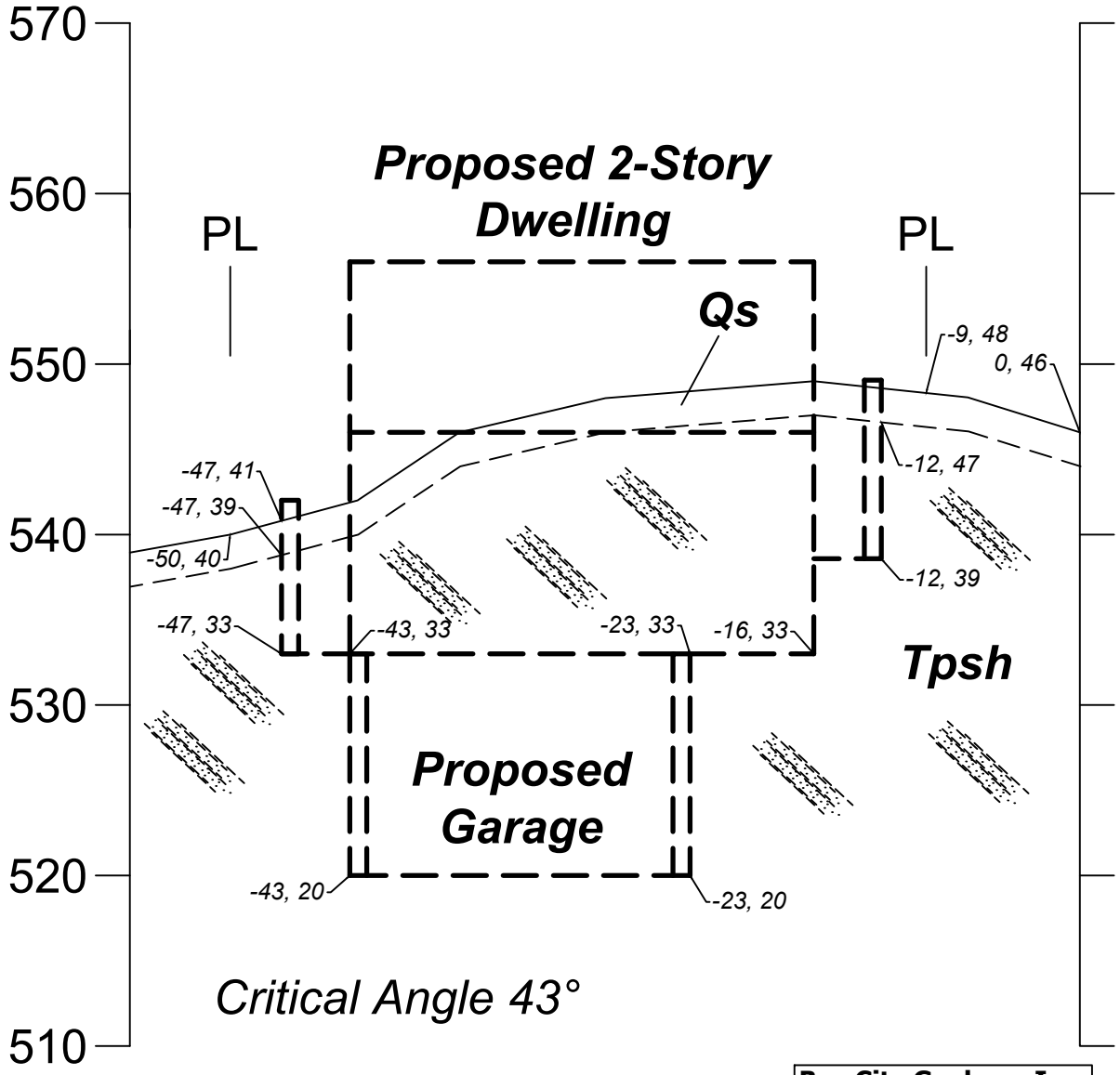
Bay City Geology, Inc.	
Scale 1"=10'	
August, 2022	Project Number: 2421-1
Project Address:	2553 Onyx Drive Los Angeles, California

Section A-A'

Bay City Geology, Inc.
2553 Onyx Drive
Los Angeles, California
Project # 2421-1
August, 2022
Scale 1" = 10'



Section B-B'



Bay City Geology, Inc.
2553 Onyx Drive
Los Angeles, California
Project # 2421-1
August, 2022
Scale 1" = 16'

Field Exploration

A field exploration of the site was conducted on June 10, 2022. The soils and geologic conditions were mapped by a representative of this office (refer to Geologic Map & Exploration Logs). Subsurface exploration was performed by manually trenching into the underlying earth materials. Explorations were excavated to a maximum depth of (8) feet. The Geologic Map in Appendix I depicts locations of the subsurface explorations. The test pits were logged by the engineering geologist using both visual and tactile methods.

Representative samples of the on-site earth materials were obtained from the explorations. Hand samples taken from test pits and/or hand-auger explorations were obtained using a (6) inch long, brass ring lined, steel barrel hand-sampler; driven with a slide-safety hammer. The soil is retained in the brass rings of (2½) inches in diameter and (1) inch in height. The samples are transported in moisture tight containers. Locations of earth material samples are indicated on the Exploration Logs.

Project Address: *2553 Onyx Drive* **Date Logged:** *06/10/22*

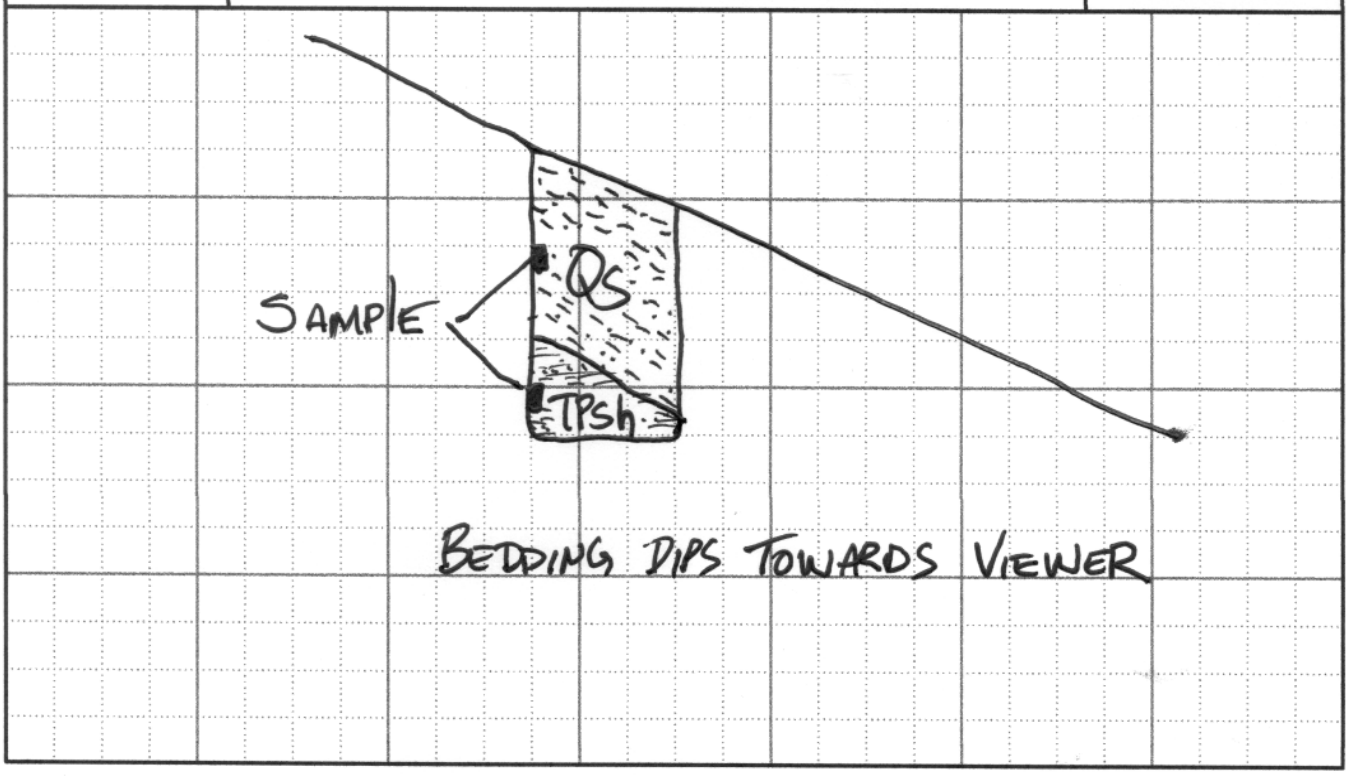
Project Number: *2421* **Logged By:** *J. Miller*

EXPLORATION: TP-1

Attitudes	DESCRIPTION
b = bedding	
	0.0 - 4.0' SOIL; Qs, sandy clay, dark-brown, slightly moist, firm, roots.
86°, 44°S - b	**4.0 - 6.0' BEDROCK; Tpsh,** siltstone and sandstone, light-brown to light-gray and orange-brown, slightly moist, dense, locally siliceous, well-bedded, moderately weathered and fractured.

GRAPHIC PROFILE

Scale: 1"=4'



Project Address: *2553 Onyx Drive* **Date Logged:** *06/10/22*

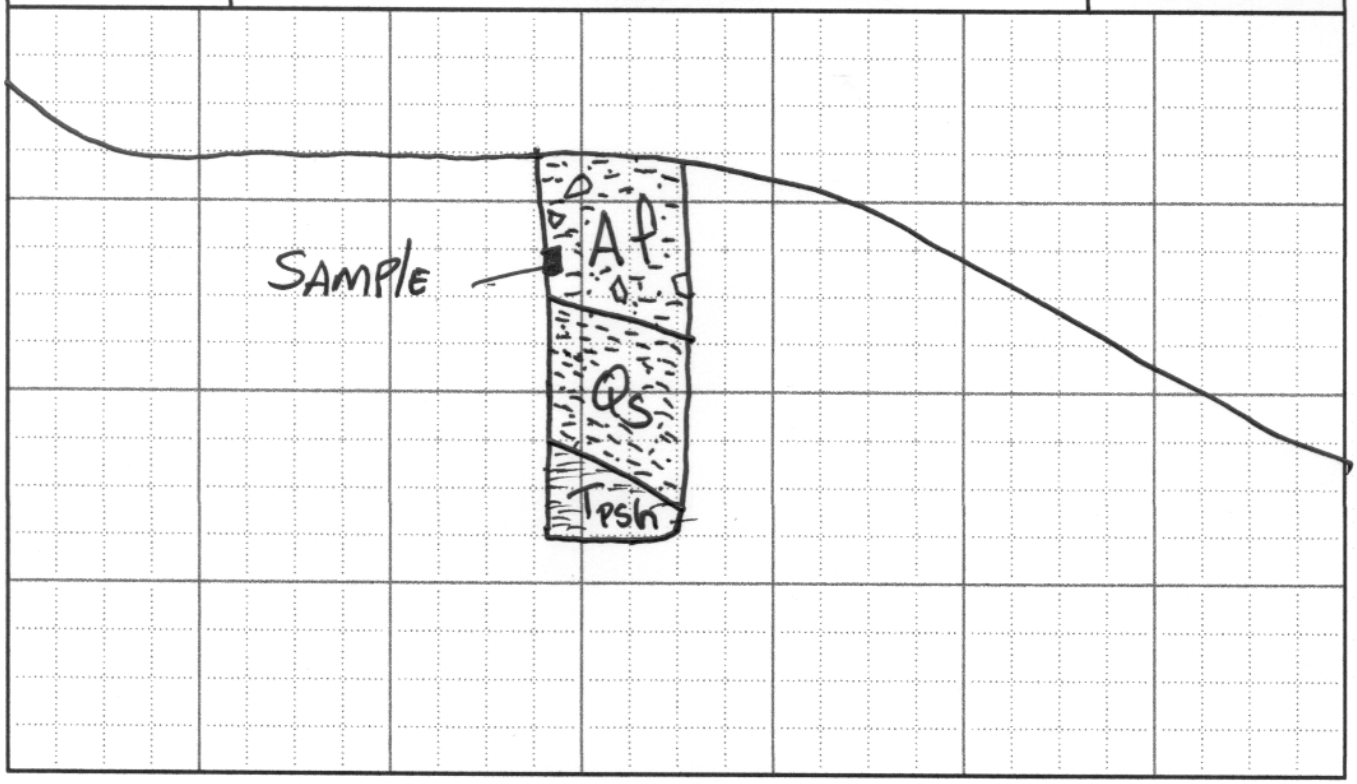
Project Number: *2421* **Logged By:** *J. Miller*

EXPLORATION: TP-2

Attitudes	DESCRIPTION
b = bedding	**0.0 - 3.0' FILL; Af,** sandy silt, medium- to dark-brown, mottled, slightly moist, medium firm, metal and glass debris. **3.0 - 6.0' SOIL; Qs,** sandy clay, dark-brown, slightly moist, firm, roots. **6.0 - 8.0' BEDROCK; Tpsh,** siltstone and sandstone, light-brown to light-gray and orange-brown, slightly moist, dense, locally siliceous, well-bedded, moderately weathered and fractured.

GRAPHIC PROFILE

Scale: 1"=4'



APPENDIX II - LABORATORY TESTING

Laboratory testing was performed on representative earth material samples obtained during our field exploration. Samples were tested for the purpose of estimating material properties for use in subsequent engineering evaluations.

The physical properties of the earth materials were tested at AGI Geotechnical, Inc., a City of Los Angeles Approved testing laboratory. In accordance with the 2020 Los Angeles Building Code §91.7008.5, we, the undersigned geologist and engineer, for Bay City Geology, Inc., have reviewed, concur with, and accept professional responsibility for use of all the laboratory testing data and results provided by AGI Geotechnical, Inc., in the enclosed laboratory testing report.

Laboratory testing was performed on samples obtained as outlined in Appendix I. All samples were sent to the laboratory for examination, testing, and classification using the Unified Soil Classification System (USCS).

Moisture and Density Tests

The dry unit weight and moisture content of the undisturbed samples were determined in accordance with ASTM D2216 and ASTM D2937. Classification of the obtained soil samples were performed utilizing the USCS in accordance with ASTM D2487 and ASTM D2488.

Direct Shear Tests

Direct shear tests were performed in accordance with ASTM D3080 procedures using a strain-controlled direct shear machine. The desired normal load is applied to the specimen and allowed to come to equilibrium. The rate of deflection on the sample is approximately (0.005) inches per minute. The samples are tested at higher and/or lower normal loads in order to determine the angle of internal friction and the cohesive strength of the earth material samples.

Expansion Index Tests

Expansion characteristics of the soil were determined in accordance with ASTM D4829 procedures. The sample is remolded and compacted into an expansion mold with a degree of saturation between 40-60%. A vertical confining pressure of (144) pounds per square foot is applied to the sample. The sample is inundated with distilled water. The deformation is recorded after (24) hours.

A. G. I. GEOTECHNICAL, INC.
16555 Sherman Way, Suite A - Van Nuys, CA 91406 - Office: (818) 785-5244 - Facsimile: (818) 785-6251

July 21, 2022

Project No. 20-3437-00

Jonathan Miller
Bay City Geology, Inc.
24736 Calvert St.
Woodland Hills, CA 91367

Subject: Results of Laboratory Testing
Project No. 2421, 2553 Onyx Drive

As requested, A.G.I. Geotechnical, Inc. has completed the soils engineering laboratory testing on the soil samples you provided. Laboratory testing was performed under the supervision of the undersigned Geotechnical Engineer. Services performed by this facility were conducted in a manner consistent with the level of care and skill ordinarily exercised by members of the profession currently practicing in the same locality under similar conditions. No other warranties are either expressed or implied. Interpretation and application of the laboratory test results are beyond the scope of our services.

If you have any questions, please do not hesitate to contact this office.

Respectfully submitted,
A.G.I. GEOTECHNICAL, INC.

Bruce Smith, R.G.E. 2673
Senior Engineer



MBS:mg

Distribution: (2) Addressee

UNIT WEIGHT & WATER CONTENT OF UNDISTURBED SAMPLES

JOB NUMBER:	*2421*	***DATE:***	***6/30/2022***
PPROJECT:	*BCG-2553 Onyx Drive*	***SAMPLED BY:***	***Jonathan***
TESTED BY:	*RT*	***RING TYPE* (1 OR 2):***	***1***

* RING TYPE 1: SMALL 2.42" ϕ, 45 GRAMS
RING TYPE 2: LARGE 2.62" ϕ, 45 GRAMS

UNIT WEIGHT DATA (ALL WEIGHTS IN GRAMS)

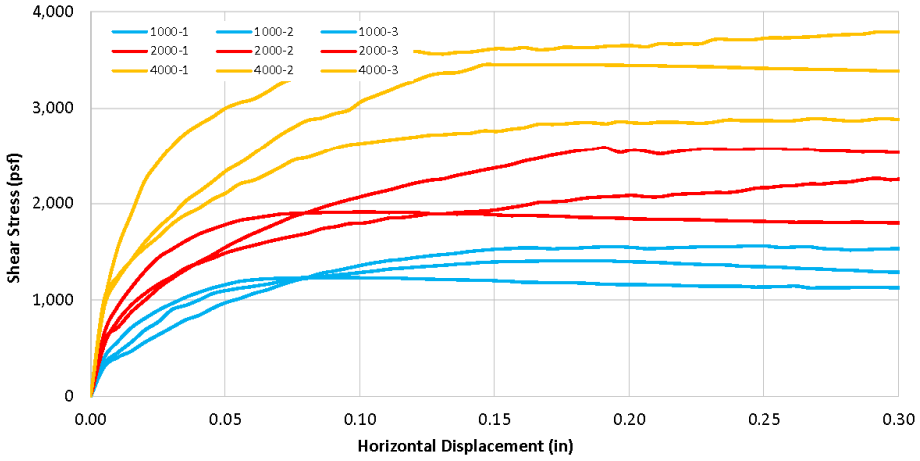
BORING / TESTPIT NO.	***TP1***		***TP2***	***Outcrop***					
SAMPLE DEPTH (FT)	***2***	***5***	***2***	***0***					
NUMBER OF RINGS	***4***	***4***	***4***	***4***					
WEIGHT OF RINGS & WET SAMPLE	***611.9***	***669.6***	***595.5***	***658.9***					
WEIGHT OF 1-RING & WET SAMPLE	153.0	167.4	148.9	164.7					
WEIGHT OF 1-RING	45.0	45.0	45.0	45.0					
WEIGHT OF WET SOIL	108.0	122.4	103.9	119.7					
TARE NO.									
TARE WEIGHT	***48.5***	***47.3***	***42.0***	***46.7***					
WET WEIGHT SOIL & TARE	***117.7***	***126.6***	***136.0***	***161.5***					
DRY WEIGHT SOIL & TARE	***107.0***	***109.5***	***120.9***	***138.2***					
WEIGHT OF WATER	10.7	17.1	15.1	23.3					
DRY WEIGHT SOIL	58.5	62.2	78.9	91.5					
BORING / TESTPIT NO.	TP1		TP2	Outcrop					
SAMPLE DEPTH (FT)	2.0	5.0	2.0	0.0					
WET DENSITY (PCF)	89.4	101.4	86.0	99.1					
WATER CONTENT (%)	18.3	27.5	19.1	25.5					
DRY DENSITY (PCF)	75.6	79.5	72.2	79.0					
REMARKS									

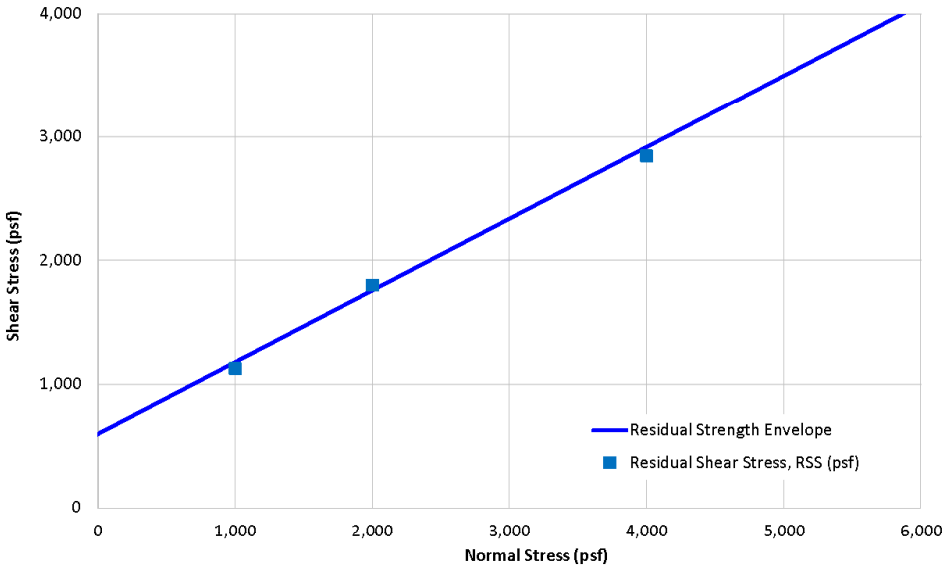
AGI GEOTECHNICAL, INC.

UNDISTURBED SATURATED DIRECT SHEAR TEST (ASTM:D-3080)

Boring:	Outcrop
Depth (ft):	0.0
Geology:	Bedrock
Classification:	Sandstone

Specimen	Load (psf)	Water (%)	Dry γ (pcf)	Wet γ (pcf)
1	1,000	41.9	80.3	113.9
2	2,000	43.0	77.1	110.3
3	4,000	41.1	79.7	112.5





Normal Stress (psf)	Residual Shear Stress, RSS (psf)			Min. RSS (psf)	Cohesion (psf)	Friction (deg)
1,000	1,520	1,290	1,125	1,125	552	29.8
2,000	2,534	2,108	1,805	1,805		
4,000	3,672	3,382	2,843	2,843		

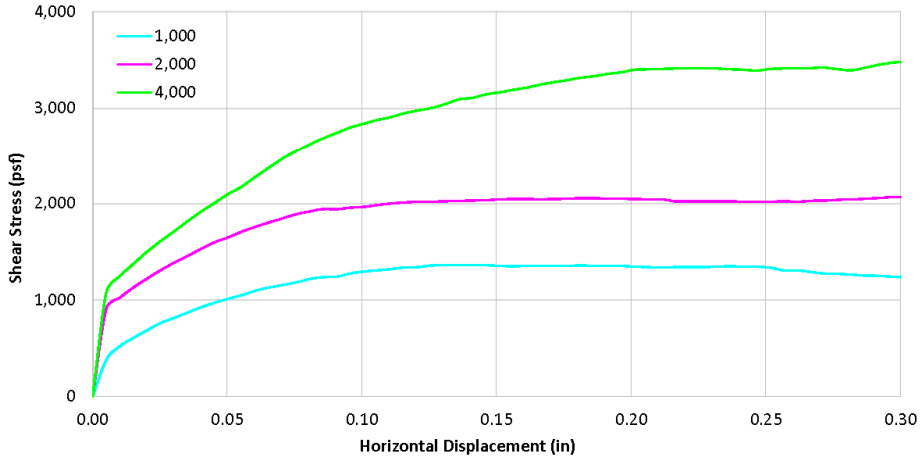
AGI GEOTECHNICAL, INC.
16555 Sherman Way, Van Nuys, California, Ph (818) 785-5244, Fax (818) 785-6251

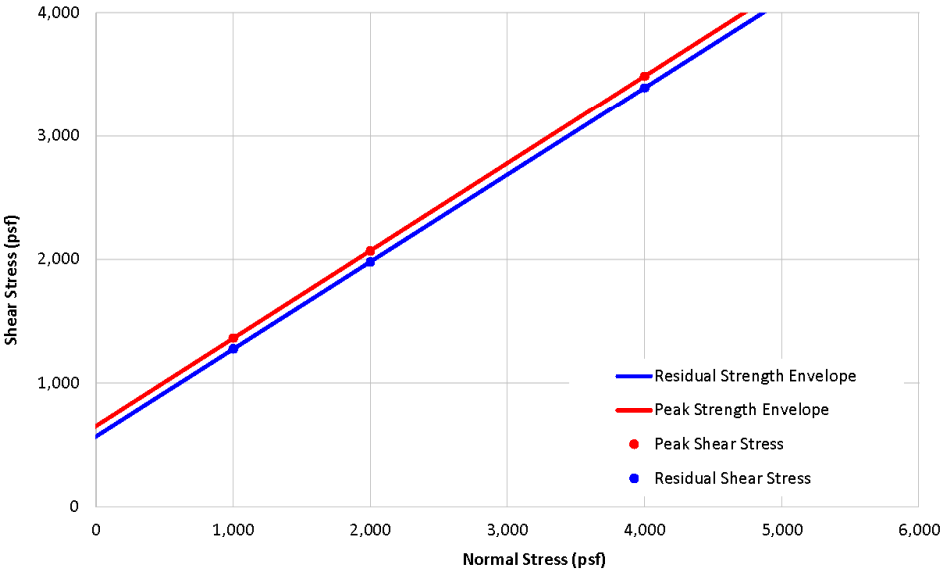
Proj. No.:	2421	Date: July 12, 2022
Project:	2553 Onyx Dr.	
Calc. By:	MG	

UNDISTURBED SATURATED DIRECT SHEAR TEST (ASTM:D-3080)

Boring:	**TP-1**
Depth (ft):	**5.0**
Geology:	**Bedrock**
Classification:	**Sandstone**

Specimen	Load (psf)	Water (%)	Dry γ (pcf)	Wet γ (pcf)
1	1,000	45.7	75.6	110.2
2	2,000	43.5	72.9	104.6
3	4,000	36.1	89.9	122.4





Normal Stress (psf)	Peak Shear Stress (psf)	Residual Shear Stress (psf)	Peak Cohesion (psf)	Peak Friction (deg)
1,000	1,362	1,275	653	35.3
2,000	2,068	1,978	Residual Cohesion (psf)	Residual Friction (deg)
4,000	3,487	3,392	568	35.2

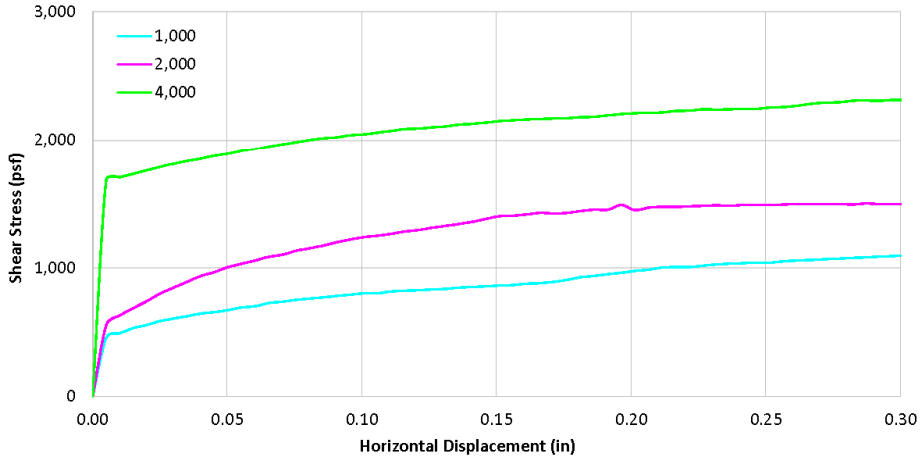
AGI GEOTECHNICAL, INC.
16555 Sherman Way, Van Nuys, California, Ph (818) 785-5244, Fax (818) 785-6251

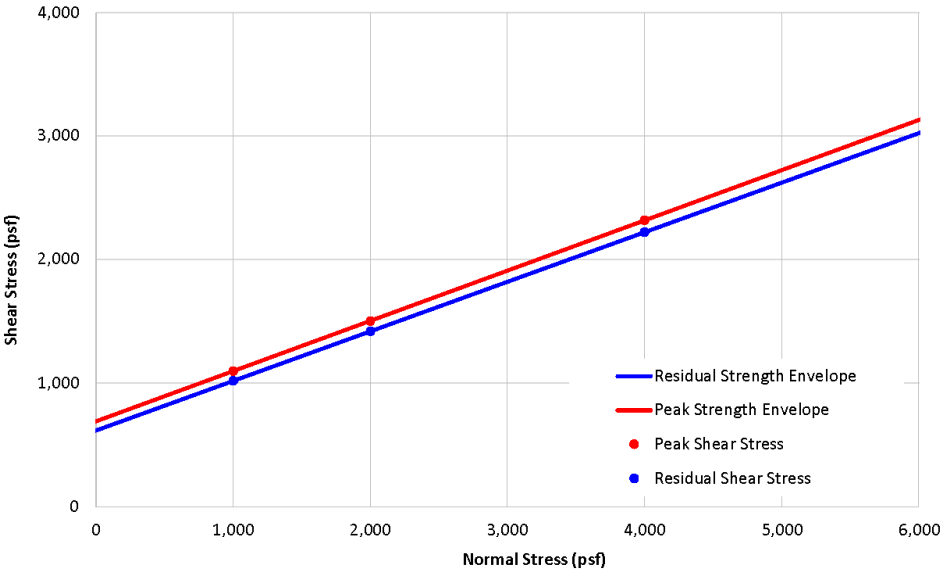
Proj. No.:	2421	Date: July 2, 2022
Project:	2553 Onyx Dr.	
Calc. By:	MG	

UNDISTURBED SATURATED DIRECT SHEAR TEST (ASTM:D-3080)

Boring:	**TP-1**
Depth (ft):	**2.0**
Geology:	**Existing Soils**
Classification:	**Sandy CLAY (CL)**

Specimen	Load (psf)	Water (%)	Dry γ (pcf)	Wet γ (pcf)
1	1,000	39.4	75.8	105.7
2	2,000	36.3	75.1	102.4
3	4,000	33.7	75.9	101.5





Normal Stress (psf)	Peak Shear Stress (psf)	Residual Shear Stress (psf)	Peak Cohesion (psf)	Peak Friction (deg)
1,000	1,097	1,017	690	22.1
2,000	1,501	1,418	Residual Cohesion (psf)	Residual Friction (deg)
4,000	2,315	2,219	617	21.8

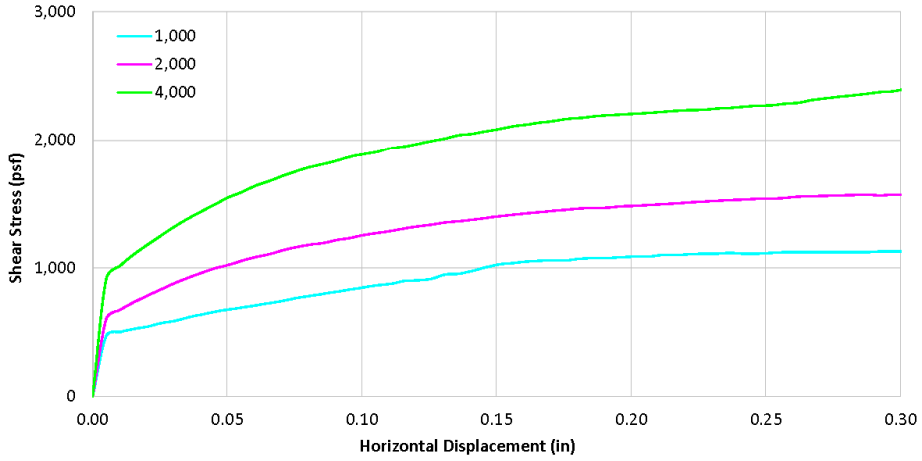
AGI GEOTECHNICAL, INC.
16555 Sherman Way, Van Nuys, California, Ph (818) 785-5244, Fax (818) 785-6251

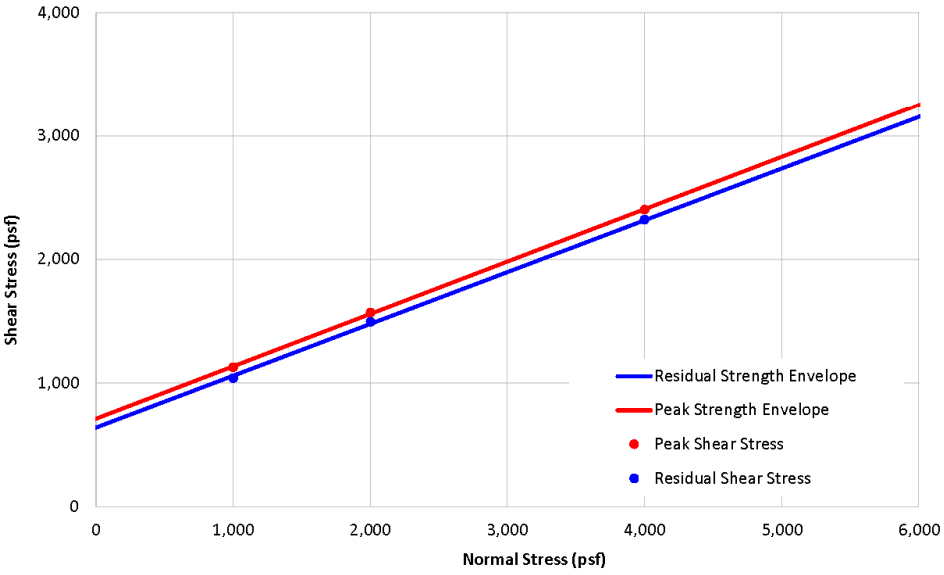
Proj. No.:	2421	Date: July 6, 2022
Project:	2553 Onyx Dr.	
Calc. By:	MG	

UNDISTURBED SATURATED DIRECT SHEAR TEST (ASTM:D-3080)

Boring:	TP-2
Depth (ft):	2.0
Geology:	Fill
Classification:	Sandy CLAY (CL)

Specimen	Load (psf)	Water (%)	Dry γ (pcf)	Wet γ (pcf)
1	1,000	40.4	67.6	94.9
2	2,000	36.7	72.8	99.5
3	4,000	36.4	76.2	103.9





Normal Stress (psf)	Peak Shear Stress (psf)	Residual Shear Stress (psf)	Peak Cohesion (psf)	Peak Friction (deg)
1,000	1,127	1,039	712	22.9
2,000	1,571	1,495	Residual Cohesion (psf)	Residual Friction (deg)
4,000	2,402	2,321	640	22.7

AGI GEOTECHNICAL, INC.
16555 Sherman Way, Van Nuys, California, Ph (818) 785-5244, Fax (818) 785-6251

Proj. No.:	2421	Date:July 5, 2022
Project:	2553 Onyx Dr.	
Calc. By:	MG	

A. G. I. GEOTECHNICAL, INC.
16555 Sherman Way, Suite A - Van Nuys, CA 91406 - Office: (818) 785-5244 - Facsimile: (818) 785-6251

July 21, 2022 Project No. 20-3437-00

Jonathan Miller
Bay City Geology, Inc.
24736 Calvert St.
Woodland Hills, CA 91367

Subject: Results of Laboratory Testing, Project No. 2421, 2553 Onyx Drive

EXPANSION TESTS (ASTM:D-4829)

Expansion test was performed on representative sample of the on-site soil in accordance with ASTM:D-4829 to evaluate their volume change with increasing moisture conditions. The result is as follows:

Sample	Expansion Limits	Expansion Index	Potential Expansion
TP2-Bulk	51-90	65	Medium

APPENDIX III

ENGINEERING ANALYSIS

Slope Stability Analyses

Retaining Wall Calculations

Temporary Bracing/Shoring Calculations

Seismic Design Considerations

Slope Stability Analyses

Portions of the subject site are located within an earthquake-induced landslide hazard zone on the California Geological Survey (CGS) *Los Angeles Quadrangle (EZRIM) Earthquake Zones of Required Investigation Map* (1999, 2017), (Plate 3). Also, the scope of the proposed development includes construction of a new two-story residence over partial subterranean garage and retaining walls set into the approximately (76)-foot high east facing hillside, displaying variable slope gradients ranging from as steep as 1.08H:1V, near the toe-of-slope, to flatter than 3H:1V in the mid-slope area of the hillside, and to about 1.42H to 1.86H:1V, (horizontal to vertical), within the upper portion of the hillside.

The proposed development is not considered exempt from the 2020 Los Angeles Building Code (LABC) §91.1803.5.11-12 requirements for a site-specific study to determine the potential hazard from earthquake ground motion induced slope instability, per LADBS Information Bulletin P/BC 2020-044. Therefore, global slope stability analyses for both the static and seismic loading conditions and are required for the proposed development, in accordance with LADBS Information Bulletins P/BC 2020-044 & -049.

Global Stability Analyses

The global slope stability analyses were performed using the computer program GSTABL7 v.2 with STEDwin - 3.07 (2002), by Gregory Geotechnical Software and Annapolis Engineering Software. The computerized stability analyses include a critical surface search routine where potential failure surfaces were calculated for the prescribed loading conditions and initiation points.

Circular Failure Surfaces

The global slope stability analyses modeling circular failure surfaces were performed using the Modified Bishop Method of Slices. The computerized analyses search routines identified the (10) Most Critical potential failure surfaces for the proposed "As-Built" slope geometry along geologic Cross-Section A for the prescribed loading conditions. The minimum calculated Factor(s)-of-Safety (FS's) for the analyses performed are tabulated and presented below.

Global Slope Stability Analyses

Analysis No.	Analysis Type	Min. FS	Code Required Min. FS
24211A01	Section A, Search Routine – 10 Critical Surfaces; Circular Failures; Pseudo-static Loading	1.007	1.0
24211A11	Section A, Search Routine – 10 Critical Surfaces; Circular Failures; Static Loading	1.659	1.5

Slope Geometry

The slope geometry along geologic Cross-Section A was analyzed, including the "As-Built" conditions for the proposed development. Also, for the simplicity of the analyses, the existing hillside was assumed to be comprised of Miocene-age sandstone and siltstone bedrock (Tpsh). The minor mantle of native soil (Qs), which was observed to be up to a maximum of about (4) feet thick on the upper portion of the hillside, was ignored for the analyses.

Earth Material Strength Parameters

The earth materials underling the proposed development area were sampled and tested in accordance with ASTM methods and the results were presented in Appendix II, above. Based upon the laboratory testing, we have conservatively selected the following strength parameters for the earth materials analyzed.

Earth Material Strength Parameters					
Earth Material	Saturated Unit Weight (pcf)	Friction Angle "ϕ" (degrees)		Cohesive Strength "c" (psf)	
		Peak	Ultimate / Residual	Peak	Ultimate / Residual
Sandstone & Siltstone Bedrock (Tpsh) * *(Across Bedding Strengths)*	112.7	35.3	35.2	653	568

*Values determined from the laboratory testing results presented in Appendix II, (above).

Boundary Loads
For these analyses, we have conservatively assumed a uniform boundary load of (500) pounds per square foot to model the proposed new residence foundation loading.

Horizontal Seismic Coefficient (Keq)
Slope stability analyses for the pseudo-static (seismic) loading conditions are provided, below, in accordance with the LADBS Information Bulletins P/BC 2020-044 & -049, the 2020 Los Angeles Building Code (LABC) §91.1803.5.11-12, and the California Geological Survey (CGS) *Special Publication 117A Guidelines for Analyzing and Mitigating Seismic Hazards in California,* (2008). The pseudo-static global stability analyses incorporate the proposed "As-Built" geometry of the east facing hillside, as depicted on geologic Cross-Section A.

A conservative horizontal seismic coefficient (**Keq**) value of (**0.347**) has been utilized for the pseudo-static analyses. The seismic coefficient value utilized in the analysis was determined in accordance with: **Chapter 5 - Analysis of Earthquake-Induced Landslide Hazards** (pp. 19 - 33) of California geologic Survey (CGS) *Special Publication 117A Guidelines for Analyzing and Mitigating Seismic Hazards in California* (2008).

For Pseudo-static Slope stability Analyses:

Keq = Feq * (MHAr) * (1/***g***); Therefore: **Keq** = 0.493*(0.703) * ***g*** * (1/***g***) ≈ **0.347**
Note: "***g***" is the acceleration due to Gravity,

Where: Feq = 0.493

The term "Feq" is a site-specific factor representing the maximum tolerable slope displacement, and local seismicity at the subject site. This value was determined from Figure 1, (p. 30), of CGS *Special Publication 117A Guidelines for Analyzing and Mitigating Seismic Hazards in California* (2008).

Where: MHAr = 0.702***g*** and MHAr = (2/3) * (PGA_M) = (2/3) * (1.054) * ***g*** = 0.703 * ***g***

The term "MHAr" is the maximum (average) horizontal acceleration for the potential failure mass at the subject site, considering the Soft Rock & Very Stiff Soil (Site Class – C) Condition. This value was derived from the Site Adjusted Peak Ground Acceleration (PGA_M) in accordance with the 2019 California Building Code (CBC) and ASCE 7-16.

Where: M = M7
"M" is the magnitude threshold for predominant earthquakes on local and/or regional faults which are anticipated to affect the project site. This value was determined from the USGS Unified Hazard Tool Website (2022).

Where: r = r ≤ 10 km
The term "r" is the minimum distance from the project site to the nearest potentially seismogenic local and/or regional fault. This value was determined from the USGS Unified Hazard Tool Website (2022).

GLOBAL STABILITY ANALYSES-

SLOPE GEOMETRY UTILIZED:	Section A
ANALYSIS NUMBER:	24211A01
ANALYSIS METHOD:	Modified Bishop's Method
ANALYSIS TYPE:	Search Routine for (10) Most Critical Surfaces
LOADING CONDITION:	Pseudo-static Loading
HORIZ. E.Q. COEFF. =	0.347

MINIMUM FACTOR OF SAFETY: 1.007

COMPUTER PROGRAM OUTPUT-

```
                                  ***  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 **
                  (All Rights Reserved-Unauthorized Use Prohibited)
 ********************************************************************************
                       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:        08/08/2022
 Time of Run:              02:22PM
 Run By:                   Username
 Input Data Filename:      D:\Users\Public\Public Documents\GSTABL7 DATA\JoesProjects\24211A01.in
 Output Filename:          D:\Users\Public\Public Documents\GSTABL7 DATA\JoesProjects\24211A01.OUT
 Unit System:              English
 Plotted Output Filename:  D:\Users\Public\Public Documents\GSTABL7 DATA\JoesProjects\24211A01.PLT
 PROBLEM DESCRIPTION:  BCG JN2421 2553 Onyx Dr
                       SecA, PStat, Bish, Search10
 BOUNDARY COORDINATES
    15 Top   Boundaries
    15 Total Boundaries
 Boundary     X-Left     Y-Left    X-Right    Y-Right    Soil Type
    No.         (ft)       (ft)       (ft)       (ft)    Below Bnd
     1          0.00     518.00       6.00     518.00        1
     2          6.00     518.00      19.00     520.00        1
     3         19.00     520.00      40.00     520.00        1
     4         40.00     520.00      40.10     532.00        1
     5         40.10     532.00      48.00     532.00        1
     6         48.00     532.00      48.10     546.00        1
     7         48.10     546.00      55.00     546.00        1
     8         55.00     546.00      55.10     552.00        1
     9         55.10     552.00      64.00     552.00        1
    10         64.00     552.00      64.10     559.00        1
    11         64.10     559.00      70.00     560.00        1
    12         70.00     560.00      87.00     572.00        1
    13         87.00     572.00     128.00     594.00        1
    14        128.00     594.00     132.00     594.00        1
    15        132.00     594.00     160.00     594.00        1
 User Specified Y-Origin =       450.00(ft)
 Default X-Plus Value = 0.00(ft)
 Default Y-Plus Value = 0.00(ft)
ISOTROPIC SOIL PARAMETERS
```

1 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	112.7	112.7	653.0	35.3	0.00	0.0	0

BOUNDARY LOAD(S)
2 Load(s) Specified

Load No.	X-Left (ft)	X-Right (ft)	Intensity (psf)	Deflection (deg)
1	19.10	39.90	500.0	0.0
2	40.11	47.90	500.0	0.0

NOTE - Intensity Is Specified As A Uniformly Distributed
Force Acting On A Horizontally Projected Surface.
Specified Peak Ground Acceleration Coefficient (A) = 1.054(g)
Specified Horizontal Earthquake Coefficient (kh) = 0.347(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.
1000 Trial Surfaces Have Been Generated.
10 Surface(s) Initiate(s) From Each Of 100 Points Equally Spaced
Along The Ground Surface Between X = 0.00(ft)
and X = 40.00(ft)
Each Surface Terminates Between X = 128.00(ft)
and X = 160.00(ft)
Unless Further Limitations Were Imposed, The Minimum Elevation
At Which A Surface Extends Is Y = 452.00(ft)
10.00(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 = 1000
Number of Trial Surfaces With Valid FS = 1000
Statistical Data On All Valid FS Values:
FS Max = 1.813 FS Min = 1.007 FS Ave = 1.424
Standard Deviation = 0.138 Coefficient of Variation = 9.71 %
Failure Surface Specified By 15 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	40.000	520.006
2	49.623	522.725
3	59.082	525.970
4	68.347	529.734
5	77.390	534.003
6	86.183	538.764
7	94.701	544.004
8	102.916	549.706
9	110.803	555.854
10	118.339	562.427
11	125.501	569.406
12	132.266	576.770
13	138.615	584.497
14	144.527	592.562
15	145.464	594.000

Circle Center At X = -4.389 ; Y = 695.526 ; and Radius = 181.046
Factor of Safety
*** 1.007 ***
Individual data on the 27 slices

Slice No.	Width (ft)	Weight (lbs)	Water Force Top (lbs)	Water Force Bot (lbs)	Tie Force Norm (lbs)	Tie Force Tan	Earthquake Force Hor (lbs)	Earthquake Force Ver (lbs)	Surcharge Load (lbs)
1	0.1	67.4	0.0	0.0	0.	0.	23.4	0.0	0.0
2	0.0	13.5	0.0	0.0	0.	0.	4.7	0.0	0.0
3	7.8	9536.6	0.0	0.0	0.	0.	3309.2	0.0	3895.0
4	0.1	109.9	0.0	0.0	0.	0.	38.1	0.0	0.0
5	0.1	188.4	0.0	0.0	0.	0.	65.4	0.0	0.0
6	1.5	4033.1	0.0	0.0	0.	0.	1399.5	0.0	0.0
7	5.4	13544.5	0.0	0.0	0.	0.	4699.9	0.0	0.0
8	0.1	275.1	0.0	0.0	0.	0.	95.5	0.0	0.0
9	4.0	11987.9	0.0	0.0	0.	0.	4159.8	0.0	0.0
10	4.9	13873.6	0.0	0.0	0.	0.	4814.1	0.0	0.0
11	0.1	310.1	0.0	0.0	0.	0.	107.6	0.0	0.0
12	4.2	14592.8	0.0	0.0	0.	0.	5063.7	0.0	0.0
13	1.7	5539.9	0.0	0.0	0.	0.	1922.4	0.0	0.0
14	7.4	25276.9	0.0	0.0	0.	0.	8771.1	0.0	0.0
15	8.8	31650.2	0.0	0.0	0.	0.	10982.6	0.0	0.0
16	0.8	3008.8	0.0	0.0	0.	0.	1044.1	0.0	0.0
17	7.7	28145.4	0.0	0.0	0.	0.	9766.5	0.0	0.0

18	8.2	29145.4	0.0	0.0	0.	0.	10113.5	0.0	0.0
19	7.9	26557.6	0.0	0.0	0.	0.	9215.5	0.0	0.0
20	7.5	23487.0	0.0	0.0	0.	0.	8150.0	0.0	0.0
21	7.2	20033.5	0.0	0.0	0.	0.	6951.6	0.0	0.0
22	2.5	6355.1	0.0	0.0	0.	0.	2205.2	0.0	0.0
23	4.0	8879.2	0.0	0.0	0.	0.	3081.1	0.0	0.0
24	0.3	521.2	0.0	0.0	0.	0.	180.9	0.0	0.0
25	6.3	9563.4	0.0	0.0	0.	0.	3318.5	0.0	0.0
26	5.9	3645.2	0.0	0.0	0.	0.	1264.9	0.0	0.0
27	0.9	75.9	0.0	0.0	0.	0.	26.3	0.0	0.0

Failure Surface Specified By 16 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	40.000	520.006
2	49.716	522.372
3	59.308	525.199
4	68.755	528.478
5	78.036	532.203
6	87.128	536.366
7	96.012	540.956
8	104.668	545.964
9	113.075	551.379
10	121.215	557.187
11	129.070	563.376
12	136.621	569.932
13	143.852	576.840
14	150.746	584.084
15	157.287	591.647
16	159.133	594.000

Circle Center At X = -4.683 ; Y = 724.849 ; and Radius = 209.660

Factor of Safety
*** 1.030 ***

Failure Surface Specified By 16 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	40.000	520.006
2	49.802	521.984
3	59.478	524.512
4	68.995	527.582
5	78.324	531.184
6	87.434	535.306
7	96.298	539.936
8	104.886	545.059
9	113.172	550.658
10	121.128	556.716
11	128.730	563.212
12	135.953	570.128
13	142.775	577.440
14	149.173	585.125
15	155.128	593.159
16	155.680	594.000

Circle Center At X = 9.931 ; Y = 694.437 ; and Radius = 177.004

Factor of Safety
*** 1.040 ***

Failure Surface Specified By 14 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	40.000	520.006
2	49.823	521.880
3	59.461	524.547
4	68.849	527.990
5	77.927	532.185
6	86.633	537.105
7	94.910	542.717
8	102.702	548.983
9	109.959	555.864
10	116.632	563.312
11	122.677	571.278
12	128.054	579.709
13	132.726	588.551
14	135.061	594.000

Circle Center At X = 22.063 ; Y = 641.110 ; and Radius = 122.425

Factor of Safety
*** 1.048 ***

Failure Surface Specified By 15 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	40.000	520.006
2	50.000	519.927
3	59.962	520.797

```
     4         69.797      522.608
     5         79.415      525.343
     6         88.731      528.978
     7         97.661      533.480
     8        106.123      538.808
     9        114.042      544.915
    10        121.346      551.745
    11        127.969      559.237
    12        133.852      567.323
    13        138.942      575.931
    14        143.193      584.982
    15        146.424      594.000
Circle Center At X =    45.828 ; Y =   625.183 ; and Radius =   105.338
       Factor of Safety
      ***    1.172   ***
Failure Surface Specified By 19 Coordinate Points
  Point      X-Surf      Y-Surf
   No.        (ft)        (ft)
    1          8.081      518.320
    2         18.078      518.094
    3         28.071      518.481
    4         38.021      519.480
    5         47.891      521.088
    6         57.644      523.297
    7         67.243      526.100
    8         76.652      529.487
    9         85.836      533.444
   10         94.760      537.956
   11        103.390      543.007
   12        111.695      548.578
   13        119.642      554.648
   14        127.202      561.193
   15        134.347      568.190
   16        141.049      575.611
   17        147.284      583.430
   18        153.028      591.616
   19        154.491      594.000
Circle Center At X =    16.765 ; Y =   681.115 ; and Radius =   163.026
       Factor of Safety
      ***    1.181   ***
Failure Surface Specified By 18 Coordinate Points
  Point      X-Surf      Y-Surf
   No.        (ft)        (ft)
    1         13.333      519.128
    2         23.326      518.738
    3         33.322      519.013
    4         43.278      519.952
    5         53.149      521.551
    6         62.893      523.801
    7         72.465      526.695
    8         81.824      530.218
    9         90.928      534.355
   10         99.737      539.088
   11        108.212      544.396
   12        116.315      550.256
   13        124.011      556.641
   14        131.266      563.523
   15        138.048      570.872
   16        144.326      578.656
   17        150.073      586.840
   18        154.421      594.000
Circle Center At X =    24.217 ; Y =   668.986 ; and Radius =   150.252
       Factor of Safety
      ***    1.182   ***
Failure Surface Specified By 18 Coordinate Points
  Point      X-Surf      Y-Surf
   No.        (ft)        (ft)
    1         12.929      519.066
    2         22.921      518.659
    3         32.917      518.950
    4         42.868      519.938
    5         52.726      521.619
    6         62.442      523.984
    7         71.969      527.021
    8         81.261      530.717
    9         90.273      535.052
   10         98.960      540.006
   11        107.279      545.554
   12        115.191      551.670
   13        122.657      558.323
```

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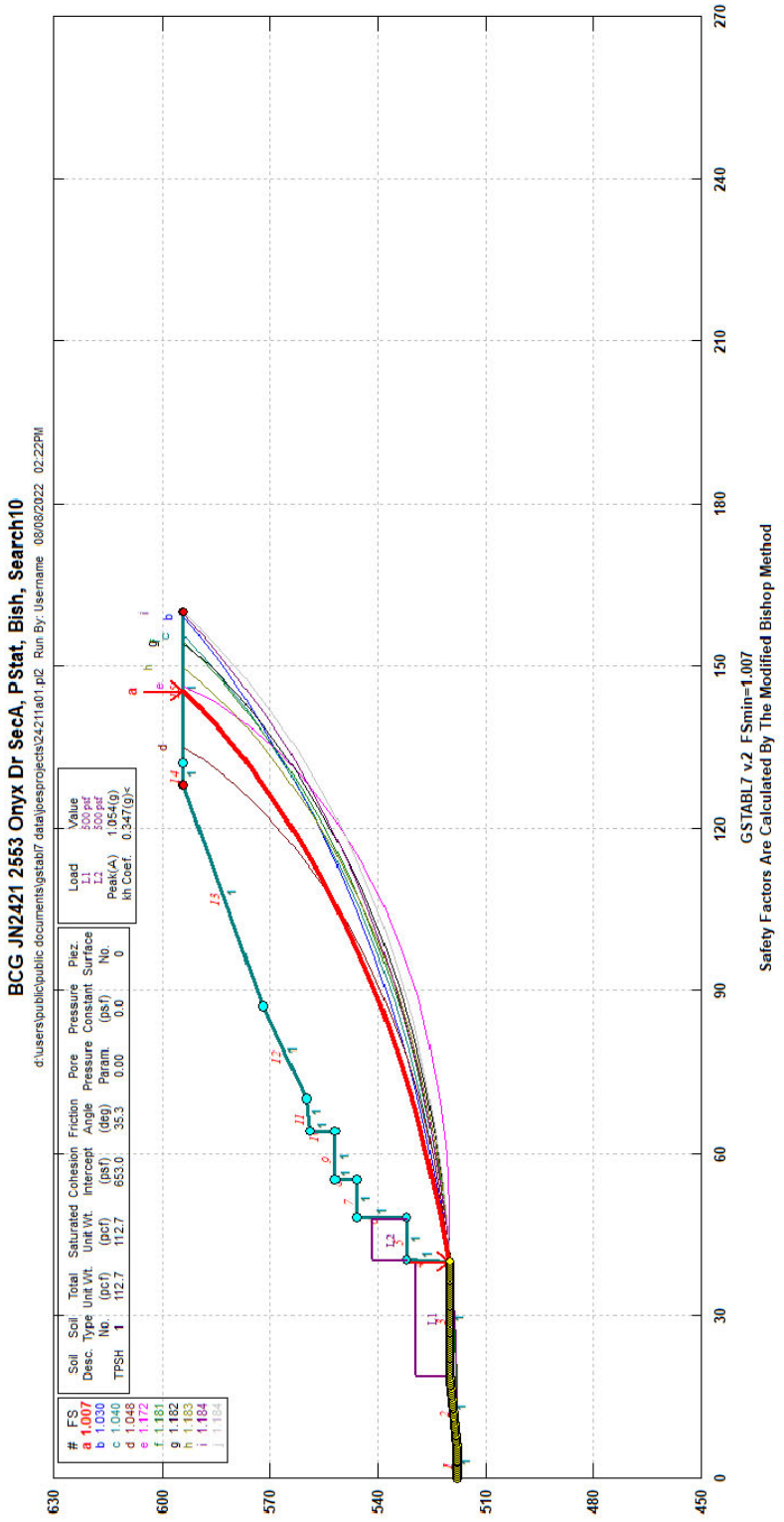
   14        129.639      565.482
   15        136.105      573.110
   16        142.023      581.171
   17        147.363      589.626
   18        149.715      594.000
Circle Center At X =    23.810 ; Y =   661.518 ; and Radius =   142.867
      Factor of Safety
     ***    1.183   ***
Failure Surface Specified By 19 Coordinate Points
  Point      X-Surf      Y-Surf
   No.        (ft)        (ft)
    1          6.061      518.009
    2         16.059      517.836
    3         26.051      518.227
    4         36.006      519.182
    5         45.890      520.698
    6         55.673      522.770
    7         65.324      525.391
    8         74.811      528.552
    9         84.104      532.245
   10         93.174      536.457
   11        101.991      541.174
   12        110.528      546.382
   13        118.757      552.063
   14        126.652      558.201
   15        134.188      564.774
   16        141.341      571.763
   17        148.087      579.145
   18        154.406      586.895
   19        159.558      594.000
Circle Center At X =    14.133 ; Y =   694.798 ; and Radius =   176.973
      Factor of Safety
     ***    1.184   ***
Failure Surface Specified By 19 Coordinate Points
  Point      X-Surf      Y-Surf
   No.        (ft)        (ft)
    1         15.758      519.501
    2         25.751      519.136
    3         35.747      519.411
    4         45.705      520.323
    5         55.585      521.870
    6         65.346      524.046
    7         74.947      526.840
    8         84.350      530.243
    9         93.517      534.239
   10        102.410      538.814
   11        110.992      543.947
   12        119.228      549.617
   13        127.086      555.803
   14        134.531      562.478
   15        141.536      569.616
   16        148.069      577.186
   17        154.106      585.159
   18        159.621      593.500
   19        159.907      594.000
Circle Center At X =    26.459 ; Y =   675.539 ; and Radius =   156.404
      Factor of Safety
     ***    1.184   ***
         **** END OF GSTABL7 OUTPUT ****
```


BCG JN2421 2553 Onyx Dr SecA, PStat, Bish, Search10
d:\users\public\public documents\gstabl7 data\jobes\projects\242111a01.pl2 Run By: Username 08/08/2022 02:22PM
GSTABL7 v.2 FSmin=1.007
Safety Factors Are Calculated By The Modified Bishop Method
FS
a 1.007
b 1.030
c 1.040
d 1.048
e 1.172
f 1.181
g 1.182
h 1.183
i 1.184
j 1.184
Soil Desc.
TPSH
Soil Type No. 1
Total Unit Wt. (pcf) 112.7
Saturated Unit Wt. (pcf) 112.7
Cohesion Intercept (psf) 653.0
Friction Angle (deg) 35.3
Pore Pressure Param. 0.00
Pressure Constant (psf) 0.0
Piez. Surface No. 0
Load
L1 800 psf
L2 800 psf
Peak(A) 1.054(g)
kh Coef. 0.347(g)<
630
600
570
540
510
480
450
0
30
60
90
120
150
180
210
240
270

GLOBAL STABILITY ANALYSES-

SLOPE GEOMETRY UTILIZED:	Section A
ANALYSIS NUMBER:	24211A02
ANALYSIS METHOD:	Modified Bishop's Method
ANALYSIS TYPE:	Search Routine for (10) Most Critical Surfaces
LOADING CONDITION:	Pseudo-static Loading
HORIZ. E.Q. COEFF. =	0.347

MINIMUM FACTOR OF SAFETY: 1.296

COMPUTER PROGRAM OUTPUT-

```
                                  ***  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 **
                  (All Rights Reserved-Unauthorized Use Prohibited)
 ********************************************************************************
                       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:        08/08/2022
 Time of Run:              02:24PM
 Run By:                   Username
 Input Data Filename:      D:\Users\Public\Public Documents\GSTABL7 DATA\JoesProjects\24211A02.in
 Output Filename:          D:\Users\Public\Public Documents\GSTABL7 DATA\JoesProjects\24211A02.OUT
 Unit System:              English
 Plotted Output Filename:  D:\Users\Public\Public Documents\GSTABL7 DATA\JoesProjects\24211A02.PLT
 PROBLEM DESCRIPTION:  BCG JN2421 2553 Onyx Dr
                       SecA, PStat, Bish, Search10
 BOUNDARY COORDINATES
    15 Top   Boundaries
    15 Total Boundaries
 Boundary     X-Left     Y-Left    X-Right    Y-Right    Soil Type
    No.         (ft)       (ft)       (ft)       (ft)    Below Bnd
     1          0.00     518.00       6.00     518.00        1
     2          6.00     518.00      19.00     520.00        1
     3         19.00     520.00      40.00     520.00        1
     4         40.00     520.00      40.10     532.00        1
     5         40.10     532.00      48.00     532.00        1
     6         48.00     532.00      48.10     546.00        1
     7         48.10     546.00      55.00     546.00        1
     8         55.00     546.00      55.10     552.00        1
     9         55.10     552.00      64.00     552.00        1
    10         64.00     552.00      64.10     559.00        1
    11         64.10     559.00      70.00     560.00        1
    12         70.00     560.00      87.00     572.00        1
    13         87.00     572.00     128.00     594.00        1
    14        128.00     594.00     132.00     594.00        1
    15        132.00     594.00     160.00     594.00        1
 User Specified Y-Origin =       450.00(ft)
 Default X-Plus Value = 0.00(ft)
 Default Y-Plus Value = 0.00(ft)
ISOTROPIC SOIL PARAMETERS
  1 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   112.7    112.7     653.0     35.3    0.00       0.0      0
BOUNDARY LOAD(S)
     2 Load(s) Specified
 Load        X-Left      X-Right     Intensity     Deflection
  No.          (ft)         (ft)        (psf)          (deg)
   1          19.10        39.90        500.0           0.0
   2          40.11        47.90        500.0           0.0
 NOTE - Intensity Is Specified As A Uniformly Distributed
        Force Acting On A Horizontally Projected Surface.
 Specified Peak Ground Acceleration Coefficient (A) =   1.054(g)
 Specified Horizontal Earthquake Coefficient (kh) =   0.347(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.
    1000 Trial Surfaces Have Been Generated.
      10 Surface(s) Initiate(s) From Each Of   100 Points Equally Spaced
    Along The Ground Surface Between  X =  40.10(ft)
                                  and  X =  48.00(ft)
    Each Surface Terminates Between   X = 128.00(ft)
                                  and   X = 160.00(ft)
    Unless Further Limitations Were Imposed, The Minimum Elevation
    At Which A Surface Extends Is  Y =    452.00(ft)
    10.00(ft) Line Segments Define Each Trial Failure Surface.
    ****  ERROR - RC11  ****
>>200 attempts to generate failure surface have failed. Revise limitations
    The Factor Of Safety For The Trial Failure Surface Defined
    By The Coordinates Listed Below Is Misleading.
    Failure Surface Defined By 17 Coordinate Points
      Point      X-Surf      Y-Surf
       No.        (ft)        (ft)
        1         47.84      532.00
        2         48.00      525.38
        3         63.77      520.00
        4         72.93      516.01
        5         82.61      513.49
        6         92.56      512.51
        7        102.55      513.09
        8        112.32      515.22
        9        121.64      518.85
       10        130.28      523.88
       11        138.03      530.20
       12        144.71      537.64
       13        150.14      546.04
       14        154.20      555.18
       15        156.78      564.84
       16        157.83      574.78
       17        161.32      581.49
    Factor Of Safety For The Preceding Specified Surface =  2.342
    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 =  1000
          Number of Trial Surfaces with Misleading FS =    1
          Number of Failed Attempts to Generate Trial Surface  =   29
          Number of Trial Surfaces With Valid FS =  970
          Percentage of Trial Surfaces With Non-Valid FS Solutions
          of the Total Attempted =   3.0 %
          Statistical Data On All Valid FS Values:
             FS Max =   1.984   FS Min =   1.296   FS Ave =   1.587
             Standard Deviation =    0.158   Coefficient of Variation =    9.94 %
          Failure Surface Specified By 15 Coordinate Points
            Point      X-Surf      Y-Surf
             No.        (ft)        (ft)
              1         40.180      532.000
              2         50.132      531.023
              3         60.132      530.980
              4         70.092      531.870
              5         79.926      533.686
              6         89.547      536.412
              7         98.872      540.024
              8        107.819      544.491
              9        116.309      549.774
             10        124.270      555.826
             11        131.631      562.595
             12        138.328      570.022
             13        144.302      578.041
             14        149.501      586.583
             15        153.115      594.000
          Circle Center At X =    55.598 ; Y =   637.889 ; and Radius =   107.006
                 Factor of Safety
                ***    1.296   ***
               Individual data on the    25  slices
                         Water  Water     Tie     Tie     Earthquake
                         Force  Force    Force   Force       Force   Surcharge
 Slice  Width   Weight    Top    Bot     Norm     Tan     Hor     Ver    Load
  No.    (ft)    (lbs)   (lbs)  (lbs)    (lbs)   (lbs)   (lbs)   (lbs)   (lbs)
   1      7.7     329.7     0.0     0.0       0.      0.   114.4     0.0   3860.1
   2      0.1       8.6     0.0     0.0       0.      0.     3.0     0.0      0.0
   3      0.1      87.6     0.0     0.0       0.      0.    30.4     0.0      0.0
   4      2.0    3406.9     0.0     0.0       0.      0.  1182.2     0.0      0.0
   5      4.9    8222.5     0.0     0.0       0.      0.  2853.2     0.0      0.0
```

6	0.1	202.8	0.0	0.0	0.	0.	70.4	0.0	0.0
7	5.0	11914.3	0.0	0.0	0.	0.	4134.3	0.0	0.0
8	3.9	9088.3	0.0	0.0	0.	0.	3153.6	0.0	0.0
9	0.1	272.4	0.0	0.0	0.	0.	94.5	0.0	0.0
10	5.9	18553.0	0.0	0.0	0.	0.	6437.9	0.0	0.0
11	0.1	292.6	0.0	0.0	0.	0.	101.5	0.0	0.0
12	9.8	34087.9	0.0	0.0	0.	0.	11828.5	0.0	0.0
13	7.1	27756.6	0.0	0.0	0.	0.	9631.5	0.0	0.0
14	2.5	10515.8	0.0	0.0	0.	0.	3649.0	0.0	0.0
15	9.3	39567.0	0.0	0.0	0.	0.	13729.7	0.0	0.0
16	8.9	38832.9	0.0	0.0	0.	0.	13475.0	0.0	0.0
17	8.5	36665.4	0.0	0.0	0.	0.	12722.9	0.0	0.0
18	8.0	33250.9	0.0	0.0	0.	0.	11538.1	0.0	0.0
19	3.7	14905.6	0.0	0.0	0.	0.	5172.2	0.0	0.0
20	3.6	13533.7	0.0	0.0	0.	0.	4696.2	0.0	0.0
21	0.4	1298.3	0.0	0.0	0.	0.	450.5	0.0	0.0
22	6.3	19601.3	0.0	0.0	0.	0.	6801.6	0.0	0.0
23	6.0	13444.9	0.0	0.0	0.	0.	4665.4	0.0	0.0
24	5.2	6849.1	0.0	0.0	0.	0.	2376.6	0.0	0.0
25	3.6	1510.2	0.0	0.0	0.	0.	524.0	0.0	0.0

Failure Surface Specified By 15 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	41.536	532.000
2	51.489	531.023
3	61.488	531.060
4	71.433	532.111
5	81.220	534.166
6	90.747	537.203
7	99.918	541.191
8	108.636	546.088
9	116.813	551.845
10	124.364	558.401
11	131.211	565.690
12	137.283	573.635
13	142.518	582.156
14	146.861	591.163
15	147.889	594.000

Circle Center At X = 56.122 ; Y = 629.368 ; and Radius = 98.454

Factor of Safety
*** 1.298 ***

Failure Surface Specified By 15 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	44.329	532.000
2	54.286	531.066
3	64.286	531.079
4	74.240	532.039
5	84.058	533.937
6	93.652	536.756
7	102.937	540.470
8	111.828	545.047
9	120.246	550.445
10	128.114	556.617
11	135.364	563.505
12	141.928	571.049
13	147.749	579.180
14	152.774	587.826
15	155.617	594.000

Circle Center At X = 59.149 ; Y = 636.454 ; and Radius = 105.500

Factor of Safety
*** 1.298 ***

Failure Surface Specified By 14 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	45.686	532.000
2	55.646	531.109
3	65.645	531.284
4	75.567	532.525
5	85.301	534.816
6	94.735	538.133
7	103.762	542.436
8	112.279	547.677
9	120.188	553.796
10	127.399	560.724
11	133.831	568.381
12	139.410	576.680
13	144.072	585.527
14	147.438	594.000

Circle Center At X = 59.020 ; Y = 624.614 ; and Radius = 93.569

```
       Factor of Safety
      ***    1.299   ***
Failure Surface Specified By 15 Coordinate Points
  Point      X-Surf      Y-Surf
   No.        (ft)        (ft)
    1         44.250      532.000
    2         54.203      531.041
    3         64.203      531.046
    4         74.156      532.014
    5         83.970      533.938
    6         93.552      536.798
    7        102.814      540.568
    8        111.669      545.214
    9        120.036      550.692
   10        127.835      556.950
   11        134.995      563.931
   12        141.449      571.570
   13        147.136      579.795
   14        152.005      588.530
   15        154.395      594.000
Circle Center At X =    59.154 ; Y =   634.554 ; and Radius =   103.631
       Factor of Safety
      ***    1.300   ***
Failure Surface Specified By 16 Coordinate Points
  Point      X-Surf      Y-Surf
   No.        (ft)        (ft)
    1         40.260      532.000
    2         50.210      531.001
    3         60.209      530.880
    4         70.180      531.638
    5         80.046      533.268
    6         89.731      535.759
    7         99.160      539.091
    8        108.259      543.238
    9        116.960      548.168
   10        125.193      553.843
   11        132.897      560.219
   12        140.010      567.248
   13        146.479      574.874
   14        152.253      583.038
   15        157.287      591.679
   16        158.379      594.000
Circle Center At X =    56.622 ; Y =   644.345 ; and Radius =   113.530
       Factor of Safety
      ***    1.300   ***
Failure Surface Specified By 15 Coordinate Points
  Point      X-Surf      Y-Surf
   No.        (ft)        (ft)
    1         45.606      532.000
    2         55.563      531.075
    3         65.562      531.205
    4         75.492      532.388
    5         85.242      534.611
    6         94.703      537.849
    7        103.771      542.066
    8        112.343      547.216
    9        120.324      553.240
   10        127.627      560.072
   11        134.168      567.635
   12        139.876      575.846
   13        144.687      584.613
   14        148.547      593.838
   15        148.596      594.000
Circle Center At X =    59.335 ; Y =   625.747 ; and Radius =    94.747
       Factor of Safety
      ***    1.301   ***
Failure Surface Specified By 15 Coordinate Points
  Point      X-Surf      Y-Surf
   No.        (ft)        (ft)
    1         43.771      532.000
    2         53.719      530.979
    3         63.718      530.920
    4         73.678      531.823
    5         83.504      533.679
    6         93.106      536.472
    7        102.395      540.175
    8        111.285      544.755
    9        119.693      550.168
   10        127.541      556.365
   11        134.758      563.288
```

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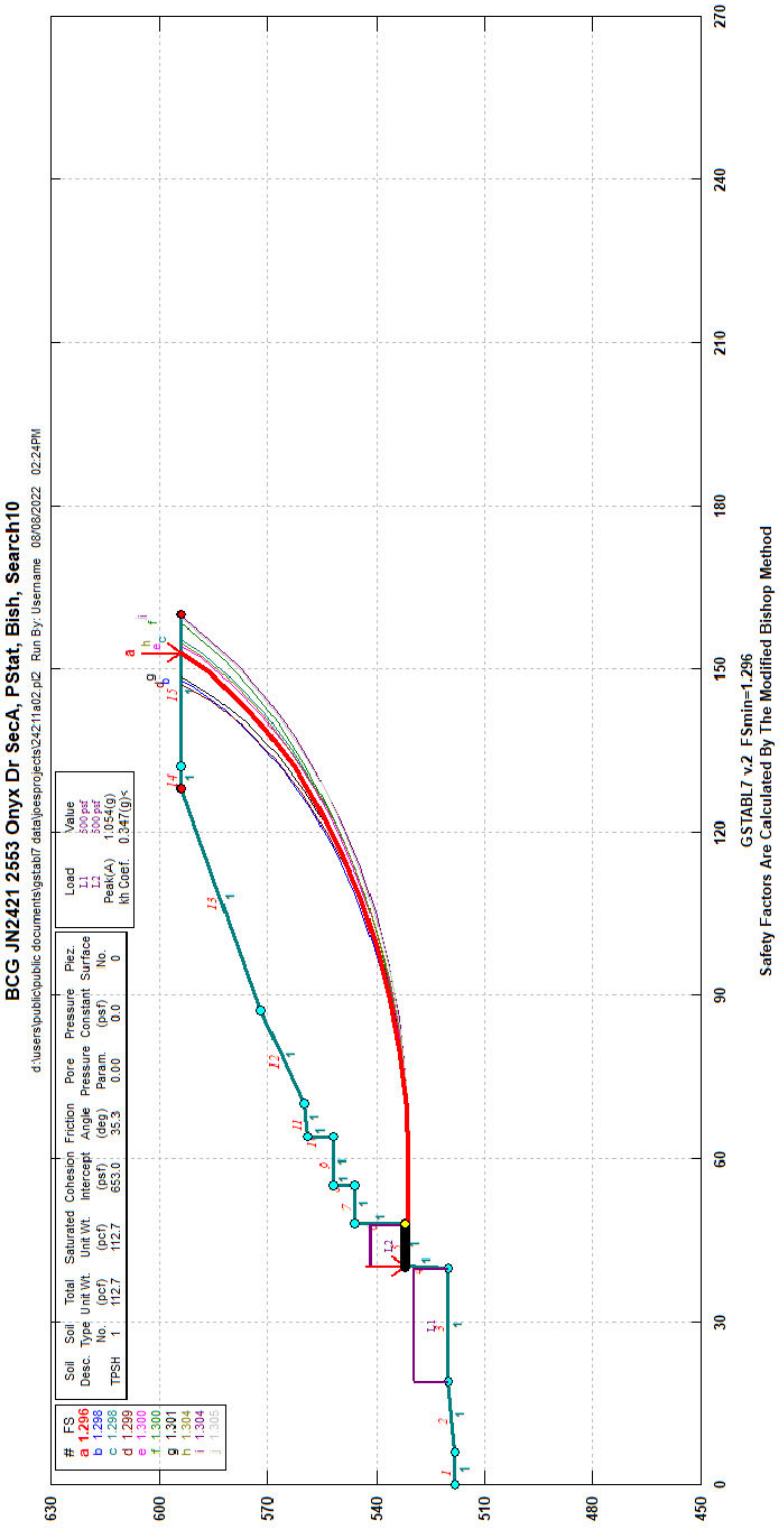
    12        141.275      570.872
    13        147.032      579.049
    14        151.976      587.741
    15        154.778      594.000
Circle Center At X =    59.333 ; Y =   634.687 ; and Radius =   103.859
       Factor of Safety
      ***    1.304   ***
Failure Surface Specified By 15 Coordinate Points
  Point      X-Surf      Y-Surf
   No.        (ft)        (ft)
    1         45.686      532.000
    2         55.642      531.066
    3         65.642      531.049
    4         75.602      531.951
    5         85.436      533.762
    6         95.063      536.469
    7        104.401      540.047
    8        113.370      544.468
    9        121.897      549.693
   10        129.908      555.679
   11        137.335      562.374
   12        144.117      569.723
   13        150.196      577.663
   14        155.520      586.128
   15        159.514      594.000
Circle Center At X =    60.822 ; Y =   639.786 ; and Radius =   108.844
       Factor of Safety
      ***    1.304   ***
Failure Surface Specified By 16 Coordinate Points
  Point      X-Surf      Y-Surf
   No.        (ft)        (ft)
    1         43.611      532.000
    2         53.561      530.997
    3         63.560      530.900
    4         73.528      531.707
    5         83.381      533.413
    6         93.040      536.004
    7        102.424      539.458
    8        111.458      543.747
    9        120.066      548.836
   10        128.178      554.684
   11        135.728      561.241
   12        142.653      568.455
   13        148.898      576.266
   14        154.409      584.609
   15        159.143      593.418
   16        159.391      594.000
Circle Center At X =    59.653 ; Y =   641.148 ; and Radius =   110.320
       Factor of Safety
      ***    1.305   ***
          **** END OF GSTABL7 OUTPUT ****
```


BCG JN2421 2553 Onyx Dr SecA, PStat, Bish, Search10
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FS
a 1.296
b 1.298
c 1.298
d 1.299
e 1.300
f 1.300
g 1.301
h 1.304
i 1.304
j 1.305
Soil Desc. Soil Type Total Unit Wt. (pcf) Saturated Unit Wt. (pcf) Cohesion Intercept (psf) Friction Angle (deg) Pore Pressure Param. Pressure Constant (psf) Piez. Surface No.
TPSH 1 112.7 112.7 653.0 35.3 0.00 0.0 0
Load
L1
L2
Peak(A)
kh Coef.
Value
500 pcf
500 pcf
1.054(g)
0.347(g)<
GSTABL7 v.2 FSmin=1.296
Safety Factors Are Calculated By The Modified Bishop Method
630
600
570
540
510
480
450
0
30
60
90
120
150
180
210
240
270

GLOBAL STABILITY ANALYSES-

SLOPE GEOMETRY UTILIZED:	Section A
ANALYSIS NUMBER:	24211A03
ANALYSIS METHOD:	Modified Bishop's Method
ANALYSIS TYPE:	Search Routine for (10) Most Critical Surfaces
LOADING CONDITION:	Pseudo-static Loading
HORIZ. E.Q. COEFF. =	0.347

MINIMUM FACTOR OF SAFETY: 1.421

COMPUTER PROGRAM OUTPUT-

```
                                    ***  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 **
                    (All Rights Reserved-Unauthorized Use Prohibited)
 ********************************************************************************
                         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:        08/08/2022
 Time of Run:              02:25PM
 Run By:                   Username
 Input Data Filename:      D:\Users\Public\Public Documents\GSTABL7 DATA\JoesProjects\24211A03.in
 Output Filename:          D:\Users\Public\Public Documents\GSTABL7 DATA\JoesProjects\24211A03.OUT
 Unit System:              English
 Plotted Output Filename:  D:\Users\Public\Public Documents\GSTABL7 DATA\JoesProjects\24211A03.PLT
 PROBLEM DESCRIPTION:  BCG JN2421 2553 Onyx Dr
                       SecA, PStat, Bish, Search10
 BOUNDARY COORDINATES
    15 Top   Boundaries
    15 Total Boundaries
 Boundary     X-Left     Y-Left    X-Right    Y-Right    Soil Type
    No.        (ft)       (ft)       (ft)       (ft)    Below Bnd
     1          0.00     518.00       6.00     518.00        1
     2          6.00     518.00      19.00     520.00        1
     3         19.00     520.00      40.00     520.00        1
     4         40.00     520.00      40.10     532.00        1
     5         40.10     532.00      48.00     532.00        1
     6         48.00     532.00      48.10     546.00        1
     7         48.10     546.00      55.00     546.00        1
     8         55.00     546.00      55.10     552.00        1
     9         55.10     552.00      64.00     552.00        1
    10         64.00     552.00      64.10     559.00        1
    11         64.10     559.00      70.00     560.00        1
    12         70.00     560.00      87.00     572.00        1
    13         87.00     572.00     128.00     594.00        1
    14        128.00     594.00     132.00     594.00        1
    15        132.00     594.00     160.00     594.00        1
 User Specified Y-Origin =       450.00(ft)
 Default X-Plus Value = 0.00(ft)
 Default Y-Plus Value = 0.00(ft)
ISOTROPIC SOIL PARAMETERS
  1 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   112.7    112.7     653.0     35.3    0.00       0.0      0
BOUNDARY LOAD(S)
     2 Load(s) Specified
 Load        X-Left      X-Right     Intensity     Deflection
  No.         (ft)         (ft)        (psf)          (deg)
   1         19.10        39.90        500.0           0.0
   2         40.11        47.90        500.0           0.0
 NOTE - Intensity Is Specified As A Uniformly Distributed
        Force Acting On A Horizontally Projected Surface.
 Specified Peak Ground Acceleration Coefficient (A) =   1.054(g)
 Specified Horizontal Earthquake Coefficient (kh) =   0.347(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.
    1000 Trial Surfaces Have Been Generated.
      10 Surface(s) Initiate(s) From Each Of   100 Points Equally Spaced
    Along The Ground Surface Between  X =  48.10(ft)
                                  and  X =  55.00(ft)
    Each Surface Terminates Between   X = 128.00(ft)
                                  and   X = 160.00(ft)
    Unless Further Limitations Were Imposed, The Minimum Elevation
    At Which A Surface Extends Is  Y =    452.00(ft)
    10.00(ft) Line Segments Define Each Trial Failure Surface.
    ****  ERROR - RC11  ****
>>200 attempts to generate failure surface have failed. Revise limitations
    The Factor Of Safety For The Trial Failure Surface Defined
    By The Coordinates Listed Below Is Misleading.
    Failure Surface Defined By 15 Coordinate Points
      Point      X-Surf      Y-Surf
       No.        (ft)        (ft)
        1         54.93      546.00
        2         55.00      539.41
        3         71.15      534.47
        4         80.65      531.36
        5         90.58      530.21
        6        100.55      531.08
        7        110.14      533.91
        8        118.96      538.61
        9        126.67      544.98
       10        132.95      552.76
       11        137.55      561.65
       12        140.28      571.27
       13        141.02      581.24
       14        153.07      579.85
       15        153.19      589.85
    Factor Of Safety For The Preceding Specified Surface =  2.359
    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 =  1000
          Number of Trial Surfaces with Misleading FS =    1
          Number of Failed Attempts to Generate Trial Surface  =   19
          Number of Trial Surfaces With Valid FS =  980
          Percentage of Trial Surfaces With Non-Valid FS Solutions
          of the Total Attempted =   2.0 %
          Statistical Data On All Valid FS Values:
             FS Max =   2.237   FS Min =   1.421   FS Ave =   1.741
             Standard Deviation =    0.198   Coefficient of Variation =   11.35 %
          Failure Surface Specified By 13 Coordinate Points
            Point      X-Surf      Y-Surf
             No.        (ft)        (ft)
              1         53.536      546.000
              2         63.496      545.099
              3         73.494      545.306
              4         83.407      546.616
              5         93.115      549.015
              6        102.499      552.473
              7        111.442      556.948
              8        119.835      562.383
              9        127.576      568.714
             10        134.570      575.862
             11        140.730      583.740
             12        145.981      592.250
             13        146.809      594.000
          Circle Center At X =    66.635 ; Y =   635.332 ; and Radius =    90.287
                Factor of Safety
               ***    1.421   ***
              Individual data on the    20  slices
                        Water  Water     Tie     Tie     Earthquake
                        Force  Force    Force   Force       Force   Surcharge
 Slice  Width   Weight    Top    Bot     Norm     Tan     Hor     Ver    Load
  No.    (ft)    (lbs)   (lbs)  (lbs)    (lbs)   (lbs)   (lbs)   (lbs)   (lbs)
   1      1.5      10.9     0.0    0.0       0.      0.     3.8     0.0     0.0
   2      0.1      35.4     0.0    0.0       0.      0.    12.3     0.0     0.0
   3      8.4    6170.2     0.0    0.0       0.      0.  2141.1     0.0     0.0
   4      0.5     391.8     0.0    0.0       0.      0.   136.0     0.0     0.0
   5      0.1     117.1     0.0    0.0       0.      0.    40.6     0.0     0.0
   6      5.9    9526.6     0.0    0.0       0.      0.  3305.7     0.0     0.0
   7      3.5    6285.5     0.0    0.0       0.      0.  2181.1     0.0     0.0
   8      9.9   22350.1     0.0    0.0       0.      0.  7755.5     0.0     0.0
   9      3.6    9584.3     0.0    0.0       0.      0.  3325.7     0.0     0.0
```

10	6.1	17492.8	0.0	0.0	0.	0.	6070.0	0.0	0.0
11	9.4	28609.7	0.0	0.0	0.	0.	9927.6	0.0	0.0
12	8.9	28226.5	0.0	0.0	0.	0.	9794.6	0.0	0.0
13	8.4	26204.3	0.0	0.0	0.	0.	9092.9	0.0	0.0
14	7.7	22810.7	0.0	0.0	0.	0.	7915.3	0.0	0.0
15	0.4	1191.9	0.0	0.0	0.	0.	413.6	0.0	0.0
16	4.0	10282.1	0.0	0.0	0.	0.	3567.9	0.0	0.0
17	2.6	5632.8	0.0	0.0	0.	0.	1954.6	0.0	0.0
18	6.2	9857.5	0.0	0.0	0.	0.	3420.6	0.0	0.0
19	5.3	3553.9	0.0	0.0	0.	0.	1233.2	0.0	0.0
20	0.8	81.7	0.0	0.0	0.	0.	28.3	0.0	0.0

Failure Surface Specified By 13 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	53.467	546.000
2	63.422	545.050
3	73.420	545.194
4	83.344	546.430
5	93.072	548.743
6	102.490	552.107
7	111.483	556.480
8	119.944	561.809
9	127.772	568.032
10	134.873	575.074
11	141.161	582.849
12	146.561	591.266
13	147.919	594.000

Circle Center At X = 67.110 ; Y = 636.304 ; and Radius = 91.329

Factor of Safety
*** 1.423 ***

Failure Surface Specified By 14 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	52.143	546.000
2	62.098	545.054
3	72.098	545.066
4	82.051	546.035
5	91.865	547.953
6	101.450	550.802
7	110.719	554.556
8	119.586	559.181
9	127.968	564.633
10	135.791	570.863
11	142.980	577.813
12	149.471	585.420
13	155.204	593.614
14	155.422	594.000

Circle Center At X = 66.985 ; Y = 649.175 ; and Radius = 104.238

Factor of Safety
*** 1.424 ***

Failure Surface Specified By 14 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	53.258	546.000
2	63.217	545.094
3	73.217	545.118
4	83.171	546.072
5	92.994	547.946
6	102.599	550.726
7	111.905	554.387
8	120.830	558.898
9	129.297	564.218
10	137.233	570.303
11	144.569	577.099
12	151.241	584.548
13	157.191	592.585
14	158.048	594.000

Circle Center At X = 67.990 ; Y = 652.223 ; and Radius = 107.240

Factor of Safety
*** 1.425 ***

Failure Surface Specified By 13 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	52.073	546.000
2	62.024	545.013
3	72.024	545.007
4	81.976	545.982
5	91.785	547.930
6	101.355	550.831
7	110.594	554.656

8	119.413	559.370
9	127.727	564.927
10	135.456	571.273
11	142.524	578.346
12	148.865	586.080
13	154.150	594.000

Circle Center At X = 67.083 ; Y = 646.665 ; and Radius = 101.778

Factor of Safety
*** 1.425 ***

Failure Surface Specified By 13 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	54.373	546.000
2	64.323	545.002
3	74.323	545.085
4	84.255	546.247
5	94.004	548.475
6	103.455	551.743
7	112.498	556.012
8	121.027	561.232
9	128.942	567.344
10	136.151	574.274
11	142.569	581.942
12	148.122	590.259
13	150.072	594.000

Circle Center At X = 68.559 ; Y = 637.370 ; and Radius = 92.465

Factor of Safety
*** 1.425 ***

Failure Surface Specified By 14 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	48.239	546.000
2	58.189	544.995
3	68.189	544.939
4	78.149	545.833
5	87.979	547.668
6	97.590	550.429
7	106.896	554.089
8	115.813	558.617
9	124.259	563.970
10	132.159	570.101
11	139.441	576.955
12	146.039	584.469
13	151.894	592.576
14	152.730	594.000

Circle Center At X = 63.804 ; Y = 649.849 ; and Radius = 105.009

Factor of Safety
*** 1.426 ***

Failure Surface Specified By 14 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	53.327	546.000
2	63.283	545.056
3	73.283	545.061
4	83.237	546.014
5	93.056	547.909
6	102.651	550.726
7	111.935	554.441
8	120.825	559.020
9	129.241	564.422
10	137.105	570.598
11	144.348	577.493
12	150.905	585.044
13	156.715	593.183
14	157.188	594.000

Circle Center At X = 68.250 ; Y = 650.075 ; and Radius = 105.139

Factor of Safety
*** 1.426 ***

Failure Surface Specified By 14 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	49.494	546.000
2	59.440	544.960
3	69.439	544.878
4	79.401	545.757
5	89.232	547.588
6	98.841	550.355
7	108.141	554.030
8	117.046	558.581
9	125.472	563.966

```
    10        133.343      570.135
    11        140.585      577.031
    12        147.132      584.590
    13        152.923      592.742
    14        153.646      594.000
Circle Center At X =    65.308 ; Y =   648.683 ; and Radius =   103.893
       Factor of Safety
      ***    1.427   ***
Failure Surface Specified By 13 Coordinate Points
  Point      X-Surf      Y-Surf
   No.        (ft)        (ft)
    1         49.285      546.000
    2         59.229      544.948
    3         69.229      544.889
    4         79.186      545.823
    5         89.000      547.741
    6         98.575      550.624
    7        107.817      554.443
    8        116.634      559.162
    9        124.938      564.733
   10        132.649      571.100
   11        139.689      578.202
   12        145.989      585.968
   13        151.276      594.000
Circle Center At X =    64.825 ; Y =   645.375 ; and Radius =   100.582
       Factor of Safety
      ***    1.427   ***
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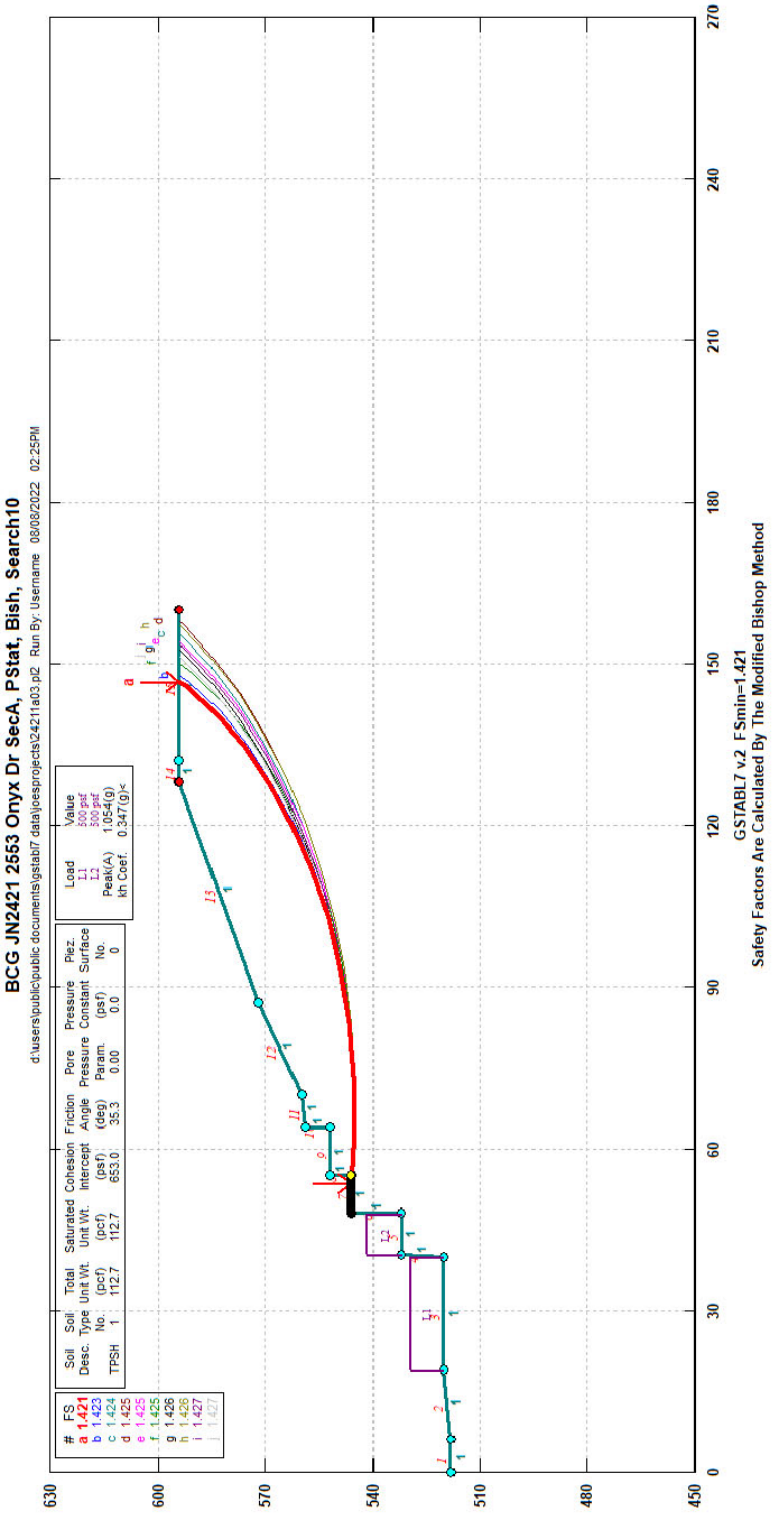
BCG JN2421 2553 Onyx Dr SecA, PStat, Bish, Search10
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GSTABL7 v2 FSmin=1.421
Safety Factors Are Calculated By The Modified Bishop Method
FS
a 1.421
b 1.423
c 1.424
d 1.425
e 1.425
f 1.425
g 1.426
h 1.426
i 1.427
Soil Desc.
Soil Type
Total Unit Wt. (pcf)
Saturated Unit Wt. (pcf)
Cohesion Intercept (psf)
Friction Angle (deg)
Pore Pressure Param.
Pressure Constant (psf)
Piez. Surface No.
TPSH 1 112.7 112.7 653.0 35.3 0.00 0.0 0
Load
L1
L2
Peak(A)
kh Coef.
Value
500 psf
500 psf
1.054(g)
0.347(g)<
0
30
60
90
120
150
180
210
240
270
450
480
510
540
570
600
630

GLOBAL STABILITY ANALYSES-

SLOPE GEOMETRY UTILIZED:	Section A
ANALYSIS NUMBER:	24211A04
ANALYSIS METHOD:	Modified Bishop's Method
ANALYSIS TYPE:	Search Routine for (10) Most Critical Surfaces
LOADING CONDITION:	Pseudo-static Loading
HORIZ. E.Q. COEFF. =	0.347

MINIMUM FACTOR OF SAFETY: 1.508

COMPUTER PROGRAM OUTPUT-

```
                                    ***  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 **
                    (All Rights Reserved-Unauthorized Use Prohibited)
 ********************************************************************************
                         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.
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 Run By:                   Username
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 Output Filename:          D:\Users\Public\Public Documents\GSTABL7 DATA\JoesProjects\24211A04.OUT
 Unit System:              English
 Plotted Output Filename:  D:\Users\Public\Public Documents\GSTABL7 DATA\JoesProjects\24211A04.PLT
 PROBLEM DESCRIPTION:  BCG JN2421 2553 Onyx Dr
                       SecA, PStat, Bish, Search10
 BOUNDARY COORDINATES
    15 Top   Boundaries
    15 Total Boundaries
 Boundary     X-Left     Y-Left    X-Right    Y-Right    Soil Type
    No.         (ft)       (ft)       (ft)       (ft)    Below Bnd
     1          0.00     518.00       6.00     518.00        1
     2          6.00     518.00      19.00     520.00        1
     3         19.00     520.00      40.00     520.00        1
     4         40.00     520.00      40.10     532.00        1
     5         40.10     532.00      48.00     532.00        1
     6         48.00     532.00      48.10     546.00        1
     7         48.10     546.00      55.00     546.00        1
     8         55.00     546.00      55.10     552.00        1
     9         55.10     552.00      64.00     552.00        1
    10         64.00     552.00      64.10     559.00        1
    11         64.10     559.00      70.00     560.00        1
    12         70.00     560.00      87.00     572.00        1
    13         87.00     572.00     128.00     594.00        1
    14        128.00     594.00     132.00     594.00        1
    15        132.00     594.00     160.00     594.00        1
 User Specified Y-Origin =       450.00(ft)
 Default X-Plus Value = 0.00(ft)
 Default Y-Plus Value = 0.00(ft)
ISOTROPIC SOIL PARAMETERS
  1 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   112.7    112.7     653.0     35.3    0.00       0.0      0
BOUNDARY LOAD(S)
     2 Load(s) Specified
 Load        X-Left      X-Right     Intensity     Deflection
  No.          (ft)         (ft)        (psf)          (deg)
   1          19.10        39.90        500.0           0.0
   2          40.11        47.90        500.0           0.0
 NOTE - Intensity Is Specified As A Uniformly Distributed
        Force Acting On A Horizontally Projected Surface.
 Specified Peak Ground Acceleration Coefficient (A) =   1.054(g)
 Specified Horizontal Earthquake Coefficient (kh) =   0.347(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.
1000 Trial Surfaces Have Been Generated.
10 Surface(s) Initiate(s) From Each Of 100 Points Equally Spaced
Along The Ground Surface Between X = 55.10(ft)
and X = 64.00(ft)
Each Surface Terminates Between X = 128.00(ft)
and X = 160.00(ft)
Unless Further Limitations Were Imposed, The Minimum Elevation
At Which A Surface Extends Is Y = 452.00(ft)
10.00(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 = 1000
Number of Trial Surfaces With Valid FS = 1000
Statistical Data On All Valid FS Values:
FS Max = 2.476 FS Min = 1.508 FS Ave = 1.863
Standard Deviation = 0.226 Coefficient of Variation = 12.15 %
Failure Surface Specified By 12 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	62.202	552.000
2	72.161	551.097
3	82.156	551.416
4	92.037	552.952
5	101.657	555.683
6	110.872	559.567
7	119.544	564.547
8	127.544	570.547
9	134.752	577.479
10	141.060	585.238
11	146.374	593.709
12	146.510	594.000

Circle Center At X = 74.562 ; Y = 632.807 ; and Radius = 81.746
Factor of Safety
*** 1.508 ***
Individual data on the 17 slices

Slice No.	Width (ft)	Weight (lbs)	Water Force Top (lbs)	Water Force Bot (lbs)	Tie Force Norm (lbs)	Tie Force Tan (lbs)	Earthquake Force Hor (lbs)	Earthquake Force Ver (lbs)	Surcharge Load (lbs)
1	1.8	16.5	0.0	0.0	0.	0.	5.7	0.0	0.0
2	0.1	41.3	0.0	0.0	0.	0.	14.3	0.0	0.0
3	5.9	5279.3	0.0	0.0	0.	0.	1831.9	0.0	0.0
4	2.2	2330.2	0.0	0.0	0.	0.	808.6	0.0	0.0
5	10.0	15540.7	0.0	0.0	0.	0.	5392.6	0.0	0.0
6	4.8	10098.3	0.0	0.0	0.	0.	3504.1	0.0	0.0
7	5.0	11802.7	0.0	0.0	0.	0.	4095.5	0.0	0.0
8	9.6	24899.2	0.0	0.0	0.	0.	8640.0	0.0	0.0
9	9.2	25664.0	0.0	0.0	0.	0.	8905.4	0.0	0.0
10	8.7	24511.2	0.0	0.0	0.	0.	8505.4	0.0	0.0
11	8.0	21693.7	0.0	0.0	0.	0.	7527.7	0.0	0.0
12	0.5	1188.0	0.0	0.0	0.	0.	412.2	0.0	0.0
13	4.0	9507.8	0.0	0.0	0.	0.	3299.2	0.0	0.0
14	2.8	5533.6	0.0	0.0	0.	0.	1920.2	0.0	0.0
15	6.3	8987.1	0.0	0.0	0.	0.	3118.5	0.0	0.0
16	5.3	2710.7	0.0	0.0	0.	0.	940.6	0.0	0.0
17	0.1	2.2	0.0	0.0	0.	0.	0.8	0.0	0.0

Failure Surface Specified By 12 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	60.314	552.000
2	70.264	551.000
3	80.264	551.058
4	90.201	552.174
5	99.965	554.336
6	109.445	557.518
7	118.535	561.686
8	127.133	566.792
9	135.142	572.780
10	142.473	579.581
11	149.043	587.120
12	153.860	594.000

Circle Center At X = 74.738 ; Y = 645.049 ; and Radius = 94.161
Factor of Safety
*** 1.510 ***
Failure Surface Specified By 12 Coordinate Points

Point	X-Surf	Y-Surf

```
   No.        (ft)        (ft)
    1         63.191      552.000
    2         73.141      551.001
    3         83.139      551.192
    4         93.044      552.569
    5        102.714      555.115
    6        112.014      558.791
    7        120.810      563.547
    8        128.980      569.315
    9        136.405      576.013
   10        142.982      583.546
   11        148.617      591.807
   12        149.757      594.000
Circle Center At X =    76.584 ; Y =   634.605 ; and Radius =    83.684
      Factor of Safety
     ***    1.511   ***
Failure Surface Specified By 13 Coordinate Points
  Point      X-Surf      Y-Surf
   No.        (ft)        (ft)
    1         61.842      552.000
    2         71.801      551.091
    3         81.800      551.182
    4         91.741      552.271
    5        101.523      554.348
    6        111.048      557.393
    7        120.222      561.373
    8        128.952      566.250
    9        137.151      571.976
   10        144.737      578.491
   11        151.634      585.732
   12        157.773      593.626
   13        158.008      594.000
Circle Center At X =    75.895 ; Y =   650.967 ; and Radius =    99.960
      Factor of Safety
     ***    1.511   ***
Failure Surface Specified By 12 Coordinate Points
  Point      X-Surf      Y-Surf
   No.        (ft)        (ft)
    1         61.932      552.000
    2         71.888      551.056
    3         81.887      551.134
    4         91.827      552.234
    5        101.601      554.344
    6        111.109      557.442
    7        120.251      561.496
    8        128.930      566.463
    9        137.057      572.290
   10        144.545      578.918
   11        151.316      586.277
   12        157.085      594.000
Circle Center At X =    76.129 ; Y =   648.622 ; and Radius =    97.660
      Factor of Safety
     ***    1.511   ***
Failure Surface Specified By 13 Coordinate Points
  Point      X-Surf      Y-Surf
   No.        (ft)        (ft)
    1         63.011      552.000
    2         72.972      551.122
    3         82.972      551.231
    4         92.912      552.325
    5        102.695      554.395
    6        112.226      557.420
    7        121.413      561.371
    8        130.165      566.209
    9        138.397      571.886
   10        146.029      578.348
   11        152.986      585.532
   12        159.200      593.366
   13        159.608      594.000
Circle Center At X =    76.872 ; Y =   652.286 ; and Radius =   101.239
      Factor of Safety
     ***    1.512   ***
Failure Surface Specified By 13 Coordinate Points
  Point      X-Surf      Y-Surf
   No.        (ft)        (ft)
    1         61.752      552.000
    2         71.711      551.088
    3         81.710      551.156
    4         91.655      552.204
    5        101.450      554.221
```

```
     6        111.000      557.188
     7        120.213      561.077
     8        129.000      565.849
     9        137.278      571.460
    10        144.966      577.854
    11        151.991      584.972
    12        158.284      592.743
    13        159.112      594.000
Circle Center At X =    76.016 ; Y =   652.932 ; and Radius =   101.935
       Factor of Safety
      ***    1.512   ***
Failure Surface Specified By 12 Coordinate Points
  Point      X-Surf      Y-Surf
   No.        (ft)        (ft)
    1         58.876      552.000
    2         68.815      550.897
    3         78.815      550.927
    4         88.747      552.090
    5         98.483      554.372
    6        107.898      557.742
    7        116.870      562.158
    8        125.284      567.563
    9        133.031      573.886
   10        140.011      581.047
   11        146.135      588.952
   12        149.198      594.000
Circle Center At X =    73.594 ; Y =   638.468 ; and Radius =    87.712
       Factor of Safety
      ***    1.513   ***
Failure Surface Specified By 12 Coordinate Points
  Point      X-Surf      Y-Surf
   No.        (ft)        (ft)
    1         56.628      552.000
    2         66.572      550.941
    3         76.572      550.938
    4         86.517      551.991
    5         96.294      554.087
    6        105.796      557.204
    7        114.916      561.306
    8        123.552      566.349
    9        131.607      572.274
   10        138.991      579.017
   11        145.623      586.502
   12        150.968      594.000
Circle Center At X =    71.614 ; Y =   645.292 ; and Radius =    94.488
       Factor of Safety
      ***    1.513   ***
Failure Surface Specified By 13 Coordinate Points
  Point      X-Surf      Y-Surf
   No.        (ft)        (ft)
    1         62.561      552.000
    2         72.516      551.046
    3         82.516      551.102
    4         92.459      552.169
    5        102.243      554.236
    6        111.768      557.280
    7        120.937      561.271
    8        129.656      566.169
    9        137.835      571.922
   10        145.391      578.473
   11        152.246      585.753
   12        158.330      593.689
   13        158.522      594.000
Circle Center At X =    76.957 ; Y =   649.776 ; and Radius =    98.830
       Factor of Safety
      ***    1.514   ***
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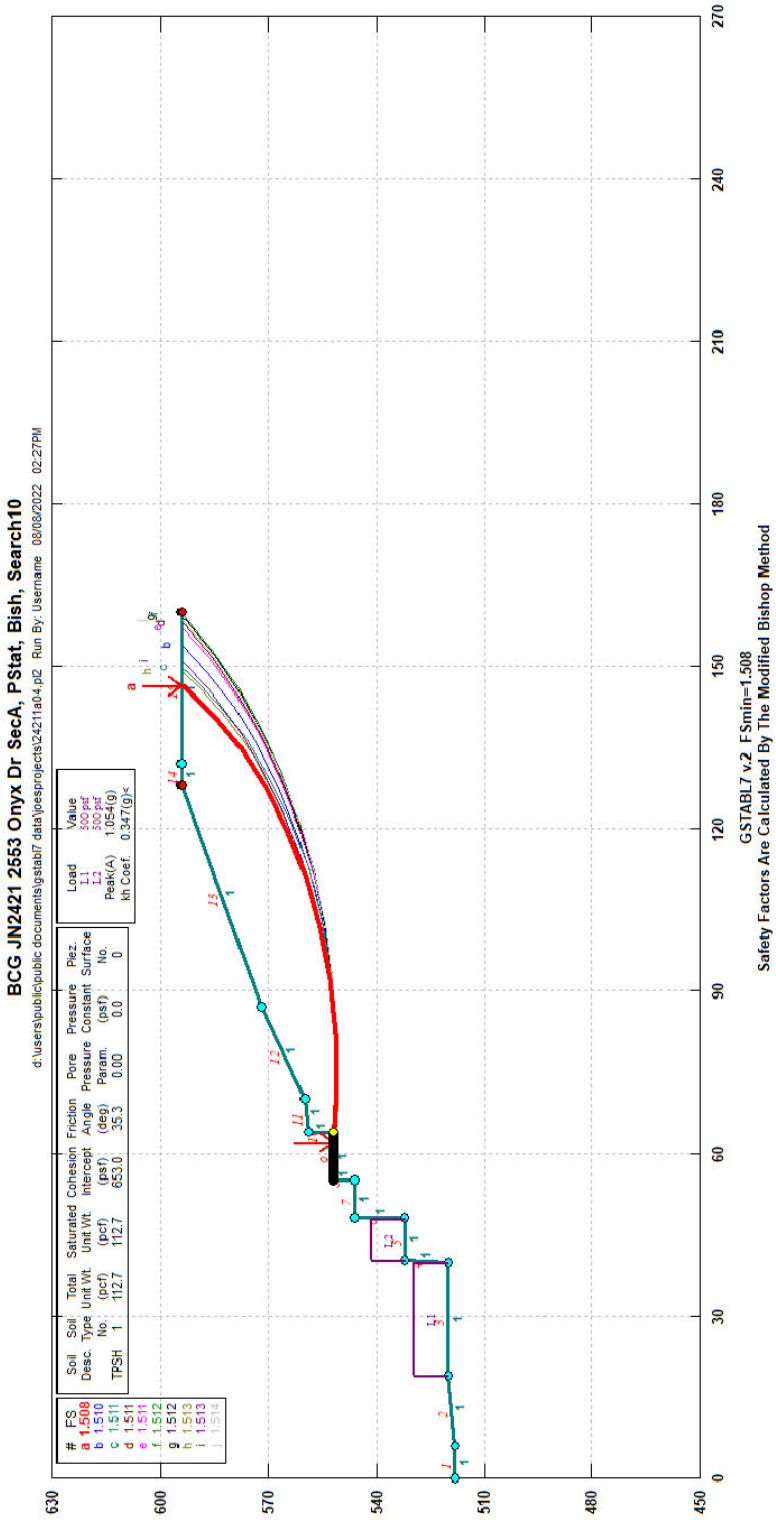
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FS
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b 1.510
c 1.511
d 1.511
e 1.511
f 1.512
g 1.512
h 1.513
i 1.513
j 1.514
Soil Desc.
Soil Type No.
Total Unit Wt. (pcf)
Saturated Unit Wt. (pcf)
Cohesion Intercept (psf)
Friction Angle (deg)
Pore Pressure Param.
Pressure Constant (psf)
Piez. Surface No.
TPSH 1 112.7 112.7 653.0 35.3 0.00 0.0 0
Load
L1 500 psf
L2 500 psf
Peak(A) 1.054(g)
kh Coef. 0.347(g)x
GSTABL7 v.2 FSmin=1.508
Safety Factors Are Calculated By The Modified Bishop Method
630
600
570
540
510
480
450
0
30
60
90
120
150
180
210
240
270

GLOBAL STABILITY ANALYSES-

SLOPE GEOMETRY UTILIZED:	Section A
ANALYSIS NUMBER:	24211A05
ANALYSIS METHOD:	Modified Bishop's Method
ANALYSIS TYPE:	Search Routine for (10) Most Critical Surfaces
LOADING CONDITION:	Pseudo-static Loading
HORIZ. E.Q. COEFF. =	0.347

MINIMUM FACTOR OF SAFETY: 1.664

COMPUTER PROGRAM OUTPUT-

```
                                    ***  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 **
                    (All Rights Reserved-Unauthorized Use Prohibited)
 ********************************************************************************
                         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.
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 Unit System:              English
 Plotted Output Filename:  D:\Users\Public\Public Documents\GSTABL7 DATA\JoesProjects\24211A05.PLT
 PROBLEM DESCRIPTION:  BCG JN2421 2553 Onyx Dr
                       SecA, PStat, Bish, Search10
 BOUNDARY COORDINATES
    15 Top   Boundaries
    15 Total Boundaries
 Boundary     X-Left     Y-Left    X-Right    Y-Right    Soil Type
    No.        (ft)       (ft)       (ft)       (ft)    Below Bnd
     1          0.00     518.00       6.00     518.00        1
     2          6.00     518.00      19.00     520.00        1
     3         19.00     520.00      40.00     520.00        1
     4         40.00     520.00      40.10     532.00        1
     5         40.10     532.00      48.00     532.00        1
     6         48.00     532.00      48.10     546.00        1
     7         48.10     546.00      55.00     546.00        1
     8         55.00     546.00      55.10     552.00        1
     9         55.10     552.00      64.00     552.00        1
    10         64.00     552.00      64.10     559.00        1
    11         64.10     559.00      70.00     560.00        1
    12         70.00     560.00      87.00     572.00        1
    13         87.00     572.00     128.00     594.00        1
    14        128.00     594.00     132.00     594.00        1
    15        132.00     594.00     160.00     594.00        1
 User Specified Y-Origin =       450.00(ft)
 Default X-Plus Value = 0.00(ft)
 Default Y-Plus Value = 0.00(ft)
ISOTROPIC SOIL PARAMETERS
  1 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   112.7    112.7     653.0     35.3    0.00       0.0      0
BOUNDARY LOAD(S)
     2 Load(s) Specified
 Load        X-Left      X-Right     Intensity     Deflection
  No.         (ft)         (ft)        (psf)          (deg)
   1         19.10        39.90        500.0          0.0
   2         40.11        47.90        500.0          0.0
 NOTE - Intensity Is Specified As A Uniformly Distributed
        Force Acting On A Horizontally Projected Surface.
 Specified Peak Ground Acceleration Coefficient (A) =   1.054(g)
 Specified Horizontal Earthquake Coefficient (kh) =   0.347(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.
1000 Trial Surfaces Have Been Generated.
10 Surface(s) Initiate(s) From Each Of 100 Points Equally Spaced
Along The Ground Surface Between X = 64.10(ft)
and X = 118.00(ft)
Each Surface Terminates Between X = 128.00(ft)
and X = 160.00(ft)
Unless Further Limitations Were Imposed, The Minimum Elevation
At Which A Surface Extends Is Y = 452.00(ft)
10.00(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 = 1000
Number of Trial Surfaces With Valid FS = 1000
Statistical Data On All Valid FS Values:
FS Max = 42.422 FS Min = 1.664 FS Ave = 3.138
Standard Deviation = 1.897 Coefficient of Variation = 60.46 %
Failure Surface Specified By 11 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	65.189	559.185
2	75.090	557.784
3	85.087	557.533
4	95.046	558.435
5	104.835	560.479
6	114.323	563.637
7	123.385	567.867
8	131.898	573.113
9	139.751	579.305
10	146.837	586.360
11	152.917	594.000

Circle Center At X = 82.260 ; Y = 644.139 ; and Radius = 86.652
Factor of Safety
*** 1.664 ***
Individual data on the 14 slices

Slice No.	Width (ft)	Weight (lbs)	Water Force Top (lbs)	Water Force Bot (lbs)	Tie Force Norm (lbs)	Tie Force Tan (lbs)	Earthquake Force Hor (lbs)	Earthquake Force Ver (lbs)	Surcharge Load (lbs)
1	4.8	405.6	0.0	0.0	0.	0.	140.8	0.0	0.0
2	5.1	2095.6	0.0	0.0	0.	0.	727.2	0.0	0.0
3	10.0	10661.9	0.0	0.0	0.	0.	3699.7	0.0	0.0
4	1.9	2954.7	0.0	0.0	0.	0.	1025.3	0.0	0.0
5	8.0	14589.2	0.0	0.0	0.	0.	5062.5	0.0	0.0
6	9.8	21498.2	0.0	0.0	0.	0.	7459.9	0.0	0.0
7	9.5	23587.2	0.0	0.0	0.	0.	8184.7	0.0	0.0
8	9.1	23835.4	0.0	0.0	0.	0.	8270.9	0.0	0.0
9	4.6	12209.3	0.0	0.0	0.	0.	4236.6	0.0	0.0
10	3.9	9703.9	0.0	0.0	0.	0.	3367.3	0.0	0.0
11	0.1	239.2	0.0	0.0	0.	0.	83.0	0.0	0.0
12	7.8	15505.6	0.0	0.0	0.	0.	5380.4	0.0	0.0
13	7.1	8919.4	0.0	0.0	0.	0.	3095.0	0.0	0.0
14	6.1	2617.4	0.0	0.0	0.	0.	908.2	0.0	0.0

Failure Surface Specified By 10 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	68.456	559.738
2	78.451	559.454
3	88.418	560.275
4	98.232	562.192
5	107.775	565.181
6	116.930	569.205
7	125.584	574.215
8	133.632	580.151
9	140.975	586.938
10	147.095	594.000

Circle Center At X = 76.038 ; Y = 649.713 ; and Radius = 90.294
Factor of Safety
*** 1.666 ***
Failure Surface Specified By 12 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	64.644	559.092
2	74.617	558.354
3	84.616	558.513
4	94.560	559.567
5	104.370	561.508

6	113.967	564.319
7	123.273	567.980
8	132.213	572.459
9	140.717	577.721
10	148.714	583.724
11	156.142	590.420
12	159.460	594.000

Circle Center At X = 77.903 ; Y = 669.303 ; and Radius = 111.005

Factor of Safety
*** 1.667 ***

Failure Surface Specified By 10 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	69.544	559.923
2	79.496	558.945
3	89.491	559.274
4	99.357	560.905
5	108.926	563.809
6	118.034	567.937
7	126.525	573.219
8	134.255	579.564
9	141.090	586.864
10	146.203	594.000

Circle Center At X = 82.003 ; Y = 635.159 ; and Radius = 76.261

Factor of Safety
*** 1.668 ***

Failure Surface Specified By 11 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	66.278	559.369
2	76.168	557.893
3	86.167	557.736
4	96.099	558.903
5	105.789	561.372
6	115.068	565.100
7	123.773	570.022
8	131.751	576.051
9	138.862	583.082
10	144.982	590.991
11	146.729	594.000

Circle Center At X = 82.345 ; Y = 633.135 ; and Radius = 75.495

Factor of Safety
*** 1.671 ***

Failure Surface Specified By 12 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	67.367	559.554
2	77.300	558.405
3	87.299	558.263
4	97.262	559.128
5	107.087	560.992
6	116.674	563.836
7	125.926	567.631
8	134.749	572.338
9	143.052	577.910
10	150.753	584.290
11	157.772	591.412
12	159.853	594.000

Circle Center At X = 83.746 ; Y = 656.958 ; and Radius = 98.772

Factor of Safety
*** 1.671 ***

Failure Surface Specified By 12 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	69.000	559.831
2	78.951	558.847
3	88.951	558.871
4	98.898	559.901
5	108.691	561.928
6	118.229	564.931
7	127.417	568.880
8	136.160	573.733
9	144.370	579.442
10	151.963	585.950
11	158.862	593.188
12	159.493	594.000

Circle Center At X = 83.737 ; Y = 657.716 ; and Radius = 98.989

Factor of Safety
*** 1.672 ***

Failure Surface Specified By 11 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	66.278	559.369
2	76.162	557.851
3	86.161	557.690
4	96.088	558.888
5	105.761	561.425
6	115.000	565.253
7	123.632	570.301
8	131.499	576.474
9	138.454	583.660
10	144.368	591.724
11	145.601	594.000

Circle Center At X = 82.342 ; Y = 631.012 ; and Radius = 73.422

Factor of Safety

*** 1.674 ***

Failure Surface Specified By 10 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	66.278	559.369
2	76.254	558.677
3	86.238	559.243
4	96.072	561.056
5	105.601	564.088
6	114.675	568.292
7	123.149	573.600
8	130.891	579.930
9	137.778	587.181
10	142.790	594.000

Circle Center At X = 76.789 ; Y = 637.985 ; and Radius = 79.315

Factor of Safety

*** 1.678 ***

Failure Surface Specified By 11 Coordinate Points

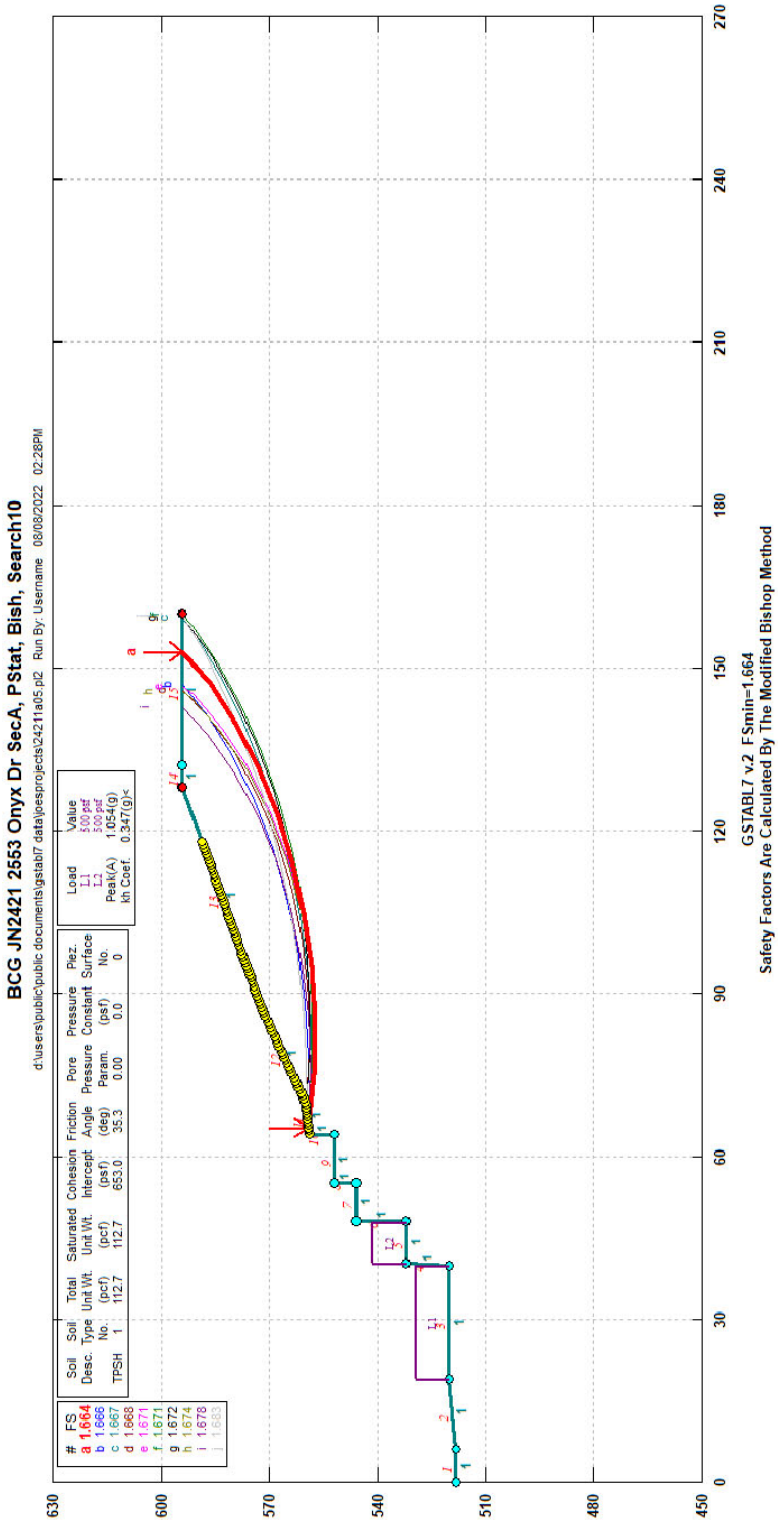
Point No.	X-Surf (ft)	Y-Surf (ft)
1	68.456	559.738
2	78.454	559.922
3	88.410	560.863
4	98.266	562.554
5	107.965	564.986
6	117.453	568.145
7	126.675	572.013
8	135.577	576.567
9	144.110	581.783
10	152.223	587.629
11	159.785	594.000

Circle Center At X = 71.023 ; Y = 691.769 ; and Radius = 132.056

Factor of Safety

*** 1.683 ***

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


BCG JN2421 2553 Onyx Dr SecA, PStat, Bish, Search10
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FS
a 1.664
b 1.666
c 1.667
d 1.668
e 1.671
f 1.671
g 1.672
h 1.674
i 1.678
j 1.683
Soil Desc.
Soil Type No.
Total Unit Wt. (pcf)
Saturated Unit Wt. (pcf)
Cohesion Intercept (psf)
Friction Angle (deg)
Pore Pressure Param.
Pressure Constant (psf)
Piez. Surface No.
TPSH 1 112.7 112.7 653.0 35.3 0.00 0.0 0
Load
L1 500 psf
L2 500 psf
Peak(A,) 1.054(g)
kh Coef. 0.347(g)<
GSTABL7 v.2 FSmin=1.664
Safety Factors Are Calculated By The Modified Bishop Method
630
600
570
540
510
480
450
0
30
60
90
120
150
180
210
240
270

GLOBAL STABILITY ANALYSES-

SLOPE GEOMETRY UTILIZED:	Section A
ANALYSIS NUMBER:	24211A11
ANALYSIS METHOD:	Modified Bishop's Method
ANALYSIS TYPE:	Search Routine for (10) Most Critical Surfaces
LOADING CONDITION:	Static Loading
HORIZ. E.Q. COEFF. =	0.0 / None Assigned

MINIMUM FACTOR OF SAFETY: 1.659

COMPUTER PROGRAM OUTPUT-

```
                                  ***  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 **
                  (All Rights Reserved-Unauthorized Use Prohibited)
 ********************************************************************************
                       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:        08/08/2022
 Time of Run:              02:31PM
 Run By:                   Username
 Input Data Filename:      D:\Users\Public\Public Documents\GSTABL7 DATA\JoesProjects\24211a11.in
 Output Filename:          D:\Users\Public\Public Documents\GSTABL7 DATA\JoesProjects\24211a11.OUT
 Unit System:              English
 Plotted Output Filename:  D:\Users\Public\Public Documents\GSTABL7 DATA\JoesProjects\24211a11.PLT
 PROBLEM DESCRIPTION:  BCG JN2421 2553 Onyx Dr
                       SecA, Stat, Bish, Search10
 BOUNDARY COORDINATES
    15 Top   Boundaries
    15 Total Boundaries
 Boundary     X-Left     Y-Left    X-Right    Y-Right    Soil Type
    No.        (ft)       (ft)       (ft)       (ft)    Below Bnd
     1          0.00     518.00       6.00     518.00        1
     2          6.00     518.00      19.00     520.00        1
     3         19.00     520.00      40.00     520.00        1
     4         40.00     520.00      40.10     532.00        1
     5         40.10     532.00      48.00     532.00        1
     6         48.00     532.00      48.10     546.00        1
     7         48.10     546.00      55.00     546.00        1
     8         55.00     546.00      55.10     552.00        1
     9         55.10     552.00      64.00     552.00        1
    10         64.00     552.00      64.10     559.00        1
    11         64.10     559.00      70.00     560.00        1
    12         70.00     560.00      87.00     572.00        1
    13         87.00     572.00     128.00     594.00        1
    14        128.00     594.00     132.00     594.00        1
    15        132.00     594.00     160.00     594.00        1
 User Specified Y-Origin =       450.00(ft)
 Default X-Plus Value = 0.00(ft)
 Default Y-Plus Value = 0.00(ft)
ISOTROPIC SOIL PARAMETERS
  1 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   112.7    112.7     568.0     35.2    0.00       0.0      0
BOUNDARY LOAD(S)
     2 Load(s) Specified
 Load        X-Left      X-Right     Intensity     Deflection
  No.         (ft)         (ft)        (psf)          (deg)
   1         19.10        39.90        500.0          0.0
   2         40.11        47.90        500.0          0.0
 NOTE - Intensity Is Specified As A Uniformly Distributed
        Force Acting On A Horizontally Projected Surface.
 A Critical Failure Surface Searching Method, Using A Random
 Technique For Generating Circular Surfaces, Has Been Specified.
 1000 Trial Surfaces Have Been Generated.
   10 Surface(s) Initiate(s) From Each Of   100 Points Equally Spaced
```

Along The Ground Surface Between X = 0.00(ft)
and X = 40.00(ft)
Each Surface Terminates Between X = 128.00(ft)
and X = 160.00(ft)
Unless Further Limitations Were Imposed, The Minimum Elevation
At Which A Surface Extends Is Y = 452.00(ft)
10.00(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 = 1000
Number of Trial Surfaces With Valid FS = 1000
Statistical Data On All Valid FS Values:
FS Max = 2.938 FS Min = 1.659 FS Ave = 2.294
Standard Deviation = 0.227 Coefficient of Variation = 9.91 %
Failure Surface Specified By 15 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	40.000	520.006
2	49.623	522.725
3	59.082	525.970
4	68.347	529.734
5	77.390	534.003
6	86.183	538.764
7	94.701	544.004
8	102.916	549.706
9	110.803	555.854
10	118.339	562.427
11	125.501	569.406
12	132.266	576.770
13	138.615	584.497
14	144.527	592.562
15	145.464	594.000

Circle Center At X = -4.389 ; Y = 695.526 ; and Radius = 181.046
Factor of Safety
*** 1.659 ***
Individual data on the 27 slices

Slice No.	Width (ft)	Weight (lbs)	Water Force Top (lbs)	Water Force Bot (lbs)	Tie Force Norm (lbs)	Tie Force Tan (lbs)	Earthquake Force Hor (lbs)	Earthquake Force Ver (lbs)	Surcharge Load (lbs)
1	0.1	67.4	0.0	0.0	0.	0.	0.0	0.0	0.0
2	0.0	13.5	0.0	0.0	0.	0.	0.0	0.0	0.0
3	7.8	9536.6	0.0	0.0	0.	0.	0.0	0.0	3895.0
4	0.1	109.9	0.0	0.0	0.	0.	0.0	0.0	0.0
5	0.1	188.4	0.0	0.0	0.	0.	0.0	0.0	0.0
6	1.5	4033.1	0.0	0.0	0.	0.	0.0	0.0	0.0
7	5.4	13544.5	0.0	0.0	0.	0.	0.0	0.0	0.0
8	0.1	275.1	0.0	0.0	0.	0.	0.0	0.0	0.0
9	4.0	11987.9	0.0	0.0	0.	0.	0.0	0.0	0.0
10	4.9	13873.6	0.0	0.0	0.	0.	0.0	0.0	0.0
11	0.1	310.1	0.0	0.0	0.	0.	0.0	0.0	0.0
12	4.2	14592.8	0.0	0.0	0.	0.	0.0	0.0	0.0
13	1.7	5539.9	0.0	0.0	0.	0.	0.0	0.0	0.0
14	7.4	25276.9	0.0	0.0	0.	0.	0.0	0.0	0.0
15	8.8	31650.2	0.0	0.0	0.	0.	0.0	0.0	0.0
16	0.8	3008.8	0.0	0.0	0.	0.	0.0	0.0	0.0
17	7.7	28145.4	0.0	0.0	0.	0.	0.0	0.0	0.0
18	8.2	29145.4	0.0	0.0	0.	0.	0.0	0.0	0.0
19	7.9	26557.6	0.0	0.0	0.	0.	0.0	0.0	0.0
20	7.5	23487.0	0.0	0.0	0.	0.	0.0	0.0	0.0
21	7.2	20033.5	0.0	0.0	0.	0.	0.0	0.0	0.0
22	2.5	6355.1	0.0	0.0	0.	0.	0.0	0.0	0.0
23	4.0	8879.2	0.0	0.0	0.	0.	0.0	0.0	0.0
24	0.3	521.2	0.0	0.0	0.	0.	0.0	0.0	0.0
25	6.3	9563.4	0.0	0.0	0.	0.	0.0	0.0	0.0
26	5.9	3645.2	0.0	0.0	0.	0.	0.0	0.0	0.0
27	0.9	75.9	0.0	0.0	0.	0.	0.0	0.0	0.0

Failure Surface Specified By 14 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	40.000	520.006
2	49.823	521.880
3	59.461	524.547
4	68.849	527.990
5	77.927	532.185
6	86.633	537.105
7	94.910	542.717
8	102.702	548.983

```
     9        109.959      555.864
    10        116.632      563.312
    11        122.677      571.278
    12        128.054      579.709
    13        132.726      588.551
    14        135.061      594.000
Circle Center At X =    22.063 ; Y =   641.110 ; and Radius =   122.425
       Factor of Safety
      ***    1.676   ***
Failure Surface Specified By 16 Coordinate Points
  Point      X-Surf      Y-Surf
   No.        (ft)        (ft)
    1         40.000      520.006
    2         49.802      521.984
    3         59.478      524.512
    4         68.995      527.582
    5         78.324      531.184
    6         87.434      535.306
    7         96.298      539.936
    8        104.886      545.059
    9        113.172      550.658
   10        121.128      556.716
   11        128.730      563.212
   12        135.953      570.128
   13        142.775      577.440
   14        149.173      585.125
   15        155.128      593.159
   16        155.680      594.000
Circle Center At X =     9.931 ; Y =   694.437 ; and Radius =   177.004
       Factor of Safety
      ***    1.760   ***
Failure Surface Specified By 16 Coordinate Points
  Point      X-Surf      Y-Surf
   No.        (ft)        (ft)
    1         40.000      520.006
    2         49.716      522.372
    3         59.308      525.199
    4         68.755      528.478
    5         78.036      532.203
    6         87.128      536.366
    7         96.012      540.956
    8        104.668      545.964
    9        113.075      551.379
   10        121.215      557.187
   11        129.070      563.376
   12        136.621      569.932
   13        143.852      576.840
   14        150.746      584.084
   15        157.287      591.647
   16        159.133      594.000
Circle Center At X =    -4.683 ; Y =   724.849 ; and Radius =   209.660
       Factor of Safety
      ***    1.762   ***
Failure Surface Specified By 17 Coordinate Points
  Point      X-Surf      Y-Surf
   No.        (ft)        (ft)
    1         13.737      519.190
    2         23.708      518.430
    3         33.708      518.565
    4         43.655      519.592
    5         53.470      521.503
    6         63.076      524.285
    7         72.394      527.913
    8         81.351      532.360
    9         89.875      537.589
   10         97.897      543.559
   11        105.354      550.222
   12        112.186      557.525
   13        118.337      565.409
   14        123.760      573.811
   15        128.410      582.664
   16        132.250      591.897
   17        132.912      594.000
Circle Center At X =    27.210 ; Y =   630.172 ; and Radius =   111.796
       Factor of Safety
      ***    1.893   ***
Failure Surface Specified By 18 Coordinate Points
  Point      X-Surf      Y-Surf
   No.        (ft)        (ft)
    1          9.293      518.507
```

2	19.266	517.774
3	29.266	517.831
4	39.230	518.677
5	49.096	520.307
6	58.803	522.711
7	68.290	525.873
8	77.497	529.775
9	86.368	534.391
10	94.847	539.693
11	102.881	545.648
12	110.419	552.218
13	117.416	559.363
14	123.827	567.038
15	129.611	575.194
16	134.734	583.783
17	139.163	592.748
18	139.663	594.000

Circle Center At X = 23.570 ; Y = 644.166 ; and Radius = 126.468

Factor of Safety

*** 1.894 ***

Failure Surface Specified By 16 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	14.949	519.377
2	24.931	518.766
3	34.926	519.092
4	44.846	520.352
5	54.605	522.534
6	64.117	525.620
7	73.298	529.583
8	82.068	534.387
9	90.351	539.991
10	98.072	546.345
11	105.165	553.394
12	111.568	561.076
13	117.223	569.323
14	122.082	578.063
15	126.102	587.220
16	128.349	594.000

Circle Center At X = 26.499 ; Y = 625.300 ; and Radius = 106.551

Factor of Safety

*** 1.895 ***

Failure Surface Specified By 18 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	7.677	518.258
2	17.662	517.707
3	27.660	517.897
4	37.617	518.826
5	47.477	520.488
6	57.188	522.876
7	66.696	525.975
8	75.948	529.769
9	84.894	534.238
10	93.485	539.355
11	101.674	545.095
12	109.417	551.424
13	116.669	558.309
14	123.393	565.711
15	129.550	573.591
16	135.108	581.904
17	140.035	590.606
18	141.638	594.000

Circle Center At X = 20.152 ; Y = 652.530 ; and Radius = 134.850

Factor of Safety

*** 1.895 ***

Failure Surface Specified By 17 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	9.293	518.507
2	19.250	517.584
3	29.250	517.508
4	39.220	518.281
5	49.089	519.897
6	58.785	522.343
7	68.238	525.604
8	77.382	529.654
9	86.148	534.464
10	94.476	540.001
11	102.303	546.224

```
   12        109.575      553.089
   13        116.239      560.545
   14        122.246      568.540
   15        127.553      577.015
   16        132.123      585.910
   17        135.445      594.000
Circle Center At X =    25.137 ; Y =   635.253 ; and Radius =   117.817
       Factor of Safety
      ***    1.897   ***
Failure Surface Specified By 17 Coordinate Points
  Point      X-Surf      Y-Surf
   No.        (ft)        (ft)
    1          6.061      518.009
    2         16.037      517.326
    3         26.036      517.469
    4         35.989      518.438
    5         45.828      520.226
    6         55.486      522.821
    7         64.896      526.204
    8         73.994      530.354
    9         82.719      535.241
   10         91.010      540.832
   11         98.810      547.089
   12        106.067      553.969
   13        112.731      561.425
   14        118.756      569.406
   15        124.101      577.858
   16        128.730      586.723
   17        131.794      594.000
Circle Center At X =    19.305 ; Y =   638.217 ; and Radius =   120.935
       Factor of Safety
      ***    1.900   ***
          **** END OF GSTABL7 OUTPUT ****
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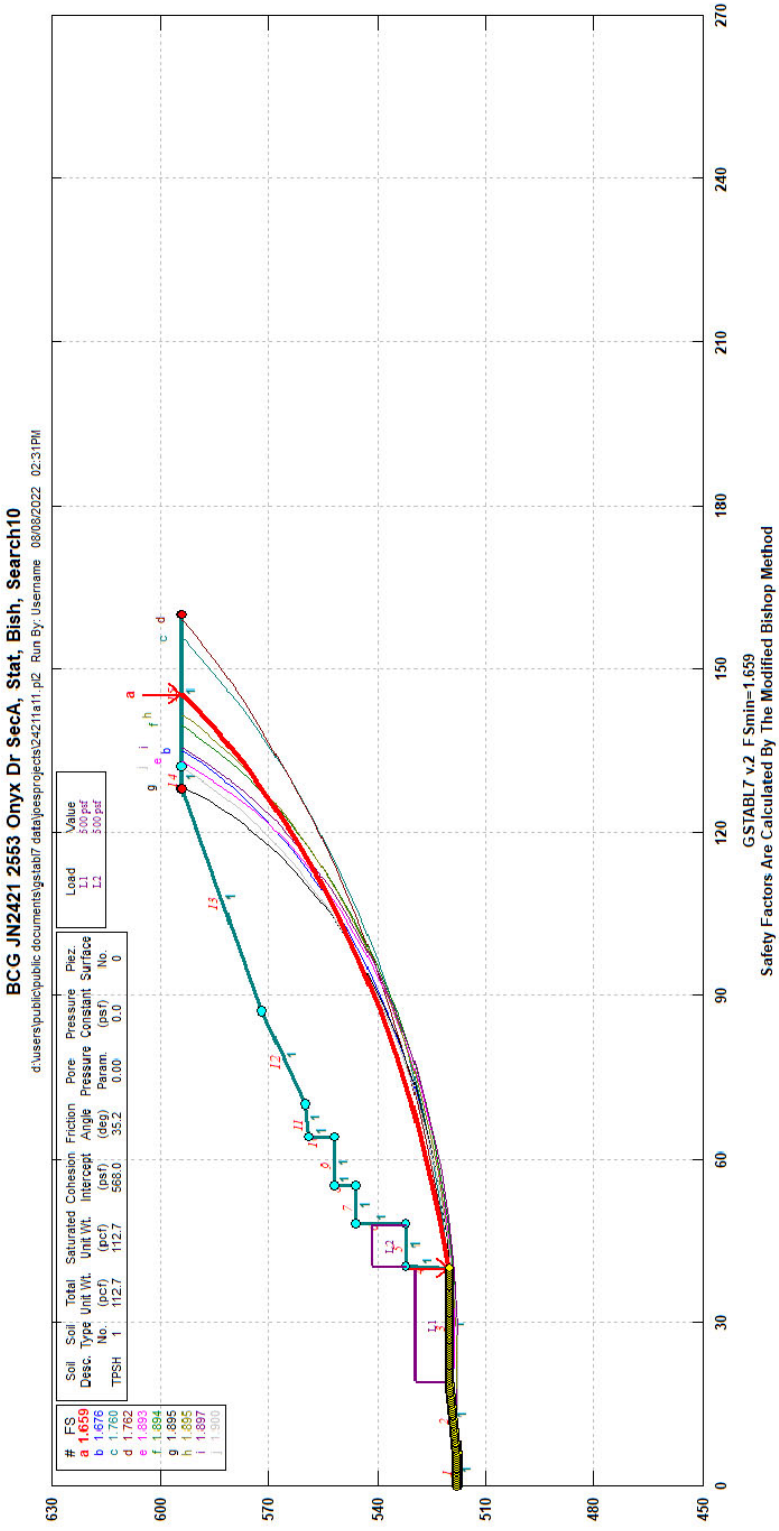
BCG JN2421 2553 Onyx Dr SecA, Stat, Bish, Search10
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GSTABL7 v.2 F Smin=1.659
Safety Factors Are Calculated By The Modified Bishop Method
FS
a 1.659
b 1.676
c 1.760
d 1.762
e 1.893
f 1.894
g 1.895
h 1.895
i 1.897
Soil Desc.
TPSH
Soil Type No.
1
Total Unit Wt. (pcf) 112.7
Saturated Unit Wt. (pcf) 112.7
Cohesion Intercept (psf) 568.0
Friction Angle (deg) 35.2
Pore Pressure Param. 0.00
Pressure Constant (psf) 0.0
Piez. Surface No. 0
Load
L1
L2
Value
500 psf
500 psf
630
600
570
540
510
480
450
0
30
60
90
120
150
180
210
240
270

GLOBAL STABILITY ANALYSES-

SLOPE GEOMETRY UTILIZED:	Section A
ANALYSIS NUMBER:	24211A12
ANALYSIS METHOD:	Modified Bishop's Method
ANALYSIS TYPE:	Search Routine for (10) Most Critical Surfaces
LOADING CONDITION:	Static Loading
HORIZ. E.Q. COEFF. =	0.0 / None Assigned

MINIMUM FACTOR OF SAFETY: 2.112

COMPUTER PROGRAM OUTPUT-

```
                                  ***  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 **
                  (All Rights Reserved-Unauthorized Use Prohibited)
 ********************************************************************************
                       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:        08/08/2022
 Time of Run:              02:32PM
 Run By:                   Username
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 Output Filename:          D:\Users\Public\Public Documents\GSTABL7 DATA\JoesProjects\24211a12.OUT
 Unit System:              English
 Plotted Output Filename:  D:\Users\Public\Public Documents\GSTABL7 DATA\JoesProjects\24211a12.PLT
 PROBLEM DESCRIPTION:  BCG JN2421 2553 Onyx Dr
                       SecA, Stat, Bish, Search10
 BOUNDARY COORDINATES
    15 Top   Boundaries
    15 Total Boundaries
 Boundary     X-Left     Y-Left    X-Right    Y-Right    Soil Type
    No.         (ft)       (ft)       (ft)       (ft)    Below Bnd
     1          0.00     518.00       6.00     518.00        1
     2          6.00     518.00      19.00     520.00        1
     3         19.00     520.00      40.00     520.00        1
     4         40.00     520.00      40.10     532.00        1
     5         40.10     532.00      48.00     532.00        1
     6         48.00     532.00      48.10     546.00        1
     7         48.10     546.00      55.00     546.00        1
     8         55.00     546.00      55.10     552.00        1
     9         55.10     552.00      64.00     552.00        1
    10         64.00     552.00      64.10     559.00        1
    11         64.10     559.00      70.00     560.00        1
    12         70.00     560.00      87.00     572.00        1
    13         87.00     572.00     128.00     594.00        1
    14        128.00     594.00     132.00     594.00        1
    15        132.00     594.00     160.00     594.00        1
 User Specified Y-Origin =       450.00(ft)
 Default X-Plus Value = 0.00(ft)
 Default Y-Plus Value = 0.00(ft)
ISOTROPIC SOIL PARAMETERS
  1 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   112.7    112.7     568.0     35.2    0.00       0.0      0
BOUNDARY LOAD(S)
     2 Load(s) Specified
 Load        X-Left      X-Right     Intensity     Deflection
  No.          (ft)         (ft)        (psf)          (deg)
   1          19.10        39.90        500.0           0.0
   2          40.11        47.90        500.0           0.0
 NOTE - Intensity Is Specified As A Uniformly Distributed
        Force Acting On A Horizontally Projected Surface.
 A Critical Failure Surface Searching Method, Using A Random
 Technique For Generating Circular Surfaces, Has Been Specified.
 1000 Trial Surfaces Have Been Generated.
   10 Surface(s) Initiate(s) From Each Of   100 Points Equally Spaced
```

```
    Along The Ground Surface Between  X =  40.10(ft)
                                and  X =  48.00(ft)
    Each Surface Terminates Between   X = 128.00(ft)
                                and   X = 160.00(ft)
    Unless Further Limitations Were Imposed, The Minimum Elevation
    At Which A Surface Extends Is  Y =    452.00(ft)
    10.00(ft) Line Segments Define Each Trial Failure Surface.
    ****  ERROR - RC11  ****
>>200 attempts to generate failure surface have failed. Revise limitations
    The Factor Of Safety For The Trial Failure Surface Defined
    By The Coordinates Listed Below Is Misleading.
    Failure Surface Defined By 17 Coordinate Points
      Point      X-Surf      Y-Surf
       No.        (ft)        (ft)
        1         47.84      532.00
        2         48.00      525.38
        3         63.77      520.00
        4         72.93      516.01
        5         82.61      513.49
        6         92.56      512.51
        7        102.55      513.09
        8        112.32      515.22
        9        121.64      518.85
       10        130.28      523.88
       11        138.03      530.20
       12        144.71      537.64
       13        150.14      546.04
       14        154.20      555.18
       15        156.78      564.84
       16        157.83      574.78
       17        161.32      581.49
    Factor Of Safety For The Preceding Specified Surface =  3.799
    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 =  1000
          Number of Trial Surfaces with Misleading FS =    1
          Number of Failed Attempts to Generate Trial Surface  =   29
          Number of Trial Surfaces With Valid FS =  970
          Percentage of Trial Surfaces With Non-Valid FS Solutions
          of the Total Attempted =   3.0 %
          Statistical Data On All Valid FS Values:
             FS Max =   3.364   FS Min =   2.112   FS Ave =   2.654
             Standard Deviation =    0.276   Coefficient of Variation =   10.40 %
          Failure Surface Specified By 14 Coordinate Points
            Point      X-Surf      Y-Surf
             No.        (ft)        (ft)
              1         40.499      532.000
              2         50.457      531.083
              3         60.454      531.333
              4         70.353      532.746
              5         80.021      535.304
              6         89.324      538.971
              7         98.136      543.698
              8        106.338      549.420
              9        113.816      556.058
             10        120.470      563.523
             11        126.208      571.713
             12        130.953      580.516
             13        134.639      589.812
             14        135.756      594.000
          Circle Center At X =    53.377 ; Y =   616.391 ; and Radius =    85.368
                 Factor of Safety
                ***    2.112   ***
              Individual data on the    24  slices
                          Water  Water     Tie     Tie     Earthquake
                          Force  Force    Force   Force       Force   Surcharge
 Slice  Width   Weight    Top    Bot      Norm     Tan     Hor     Ver    Load
  No.    (ft)    (lbs)   (lbs)  (lbs)    (lbs)   (lbs)   (lbs)   (lbs)   (lbs)
   1      7.4     284.3     0.0    0.0       0.      0.     0.0     0.0  3700.5
   2      0.1       7.7     0.0    0.0       0.      0.     0.0     0.0     0.0
   3      0.1      86.7     0.0    0.0       0.      0.     0.0     0.0     0.0
   4      2.4    3933.4     0.0    0.0       0.      0.     0.0     0.0     0.0
   5      4.5    7608.6     0.0    0.0       0.      0.     0.0     0.0     0.0
   6      0.1     200.6     0.0    0.0       0.      0.     0.0     0.0     0.0
   7      5.4   12510.2     0.0    0.0       0.      0.     0.0     0.0     0.0
   8      3.5    8158.7     0.0    0.0       0.      0.     0.0     0.0     0.0
   9      0.1     266.6     0.0    0.0       0.      0.     0.0     0.0     0.0
  10      5.9   18102.9     0.0    0.0       0.      0.     0.0     0.0     0.0
```

11	0.4	1091.2	0.0	0.0	0.	0.	0.0	0.0	0.0
12	9.7	32288.8	0.0	0.0	0.	0.	0.0	0.0	0.0
13	7.0	25844.3	0.0	0.0	0.	0.	0.0	0.0	0.0
14	2.3	8933.9	0.0	0.0	0.	0.	0.0	0.0	0.0
15	8.8	34042.2	0.0	0.0	0.	0.	0.0	0.0	0.0
16	8.2	31072.3	0.0	0.0	0.	0.	0.0	0.0	0.0
17	7.5	26670.5	0.0	0.0	0.	0.	0.0	0.0	0.0
18	6.7	21284.3	0.0	0.0	0.	0.	0.0	0.0	0.0
19	5.7	15443.8	0.0	0.0	0.	0.	0.0	0.0	0.0
20	1.8	4067.4	0.0	0.0	0.	0.	0.0	0.0	0.0
21	3.0	5399.0	0.0	0.0	0.	0.	0.0	0.0	0.0
22	1.0	1435.4	0.0	0.0	0.	0.	0.0	0.0	0.0
23	2.6	2235.3	0.0	0.0	0.	0.	0.0	0.0	0.0
24	1.1	263.7	0.0	0.0	0.	0.	0.0	0.0	0.0

Failure Surface Specified By 14 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	41.058	532.000
2	51.019	531.120
3	61.012	531.492
4	70.880	533.112
5	80.468	535.953
6	89.625	539.971
7	98.207	545.104
8	106.080	551.269
9	113.120	558.372
10	119.216	566.299
11	124.273	574.926
12	128.211	584.118
13	130.968	593.730
14	131.009	594.000

Circle Center At X = 53.056 ; Y = 610.844 ; and Radius = 79.752

Factor of Safety
*** 2.115 ***

Failure Surface Specified By 14 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	42.574	532.000
2	52.526	531.024
3	62.524	531.213
4	72.432	532.565
5	82.116	535.062
6	91.443	538.669
7	100.286	543.338
8	108.526	549.004
9	116.049	555.591
10	122.755	563.010
11	128.552	571.158
12	133.360	579.927
13	137.114	589.195
14	138.435	594.000

Circle Center At X = 55.961 ; Y = 616.409 ; and Radius = 85.464

Factor of Safety
*** 2.129 ***

Failure Surface Specified By 13 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	42.654	532.000
2	52.611	531.081
3	62.603	531.489
4	72.453	533.216
5	81.987	536.233
6	91.038	540.485
7	99.445	545.899
8	107.062	552.378
9	113.754	559.809
10	119.403	568.061
11	123.909	576.988
12	127.194	586.433
13	128.742	594.000

Circle Center At X = 54.541 ; Y = 606.404 ; and Radius = 75.348

Factor of Safety
*** 2.131 ***

Failure Surface Specified By 14 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	44.728	532.000
2	54.684	531.057
3	64.680	531.333
4	74.569	532.821

5	84.203	535.502
6	93.439	539.333
7	102.142	544.260
8	110.180	550.209
9	117.435	557.090
10	123.800	564.804
11	129.180	573.233
12	133.494	582.255
13	136.679	591.734
14	137.144	594.000

Circle Center At X = 57.473 ; Y = 612.880 ; and Radius = 81.878

Factor of Safety
*** 2.133 ***

Failure Surface Specified By 14 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	40.579	532.000
2	50.522	530.931
3	60.521	530.981
4	70.453	532.147
5	80.192	534.417
6	89.616	537.761
7	98.608	542.138
8	107.054	547.492
9	114.848	553.756
10	121.893	560.853
11	128.101	568.693
12	133.394	577.178
13	137.705	586.201
14	140.409	594.000

Circle Center At X = 55.110 ; Y = 619.974 ; and Radius = 89.166

Factor of Safety
*** 2.137 ***

Failure Surface Specified By 14 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	44.010	532.000
2	53.956	530.965
3	63.954	531.197
4	73.841	532.691
5	83.461	535.424
6	92.657	539.353
7	101.282	544.413
8	109.198	550.524
9	116.277	557.587
10	122.405	565.489
11	127.485	574.103
12	131.434	583.290
13	134.189	592.903
14	134.357	594.000

Circle Center At X = 57.157 ; Y = 609.670 ; and Radius = 78.775

Factor of Safety
*** 2.140 ***

Failure Surface Specified By 14 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	42.015	532.000
2	51.962	530.966
3	61.961	531.057
4	71.887	532.271
5	81.614	534.592
6	91.018	537.992
7	99.981	542.428
8	108.388	547.842
9	116.134	554.168
10	123.119	561.323
11	129.256	569.218
12	134.467	577.753
13	138.686	586.820
14	141.089	594.000

Circle Center At X = 56.195 ; Y = 619.498 ; and Radius = 88.640

Factor of Safety
*** 2.141 ***

Failure Surface Specified By 14 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	42.015	532.000
2	51.950	530.856
3	61.949	530.985
4	71.850	532.385

```
     5         81.493      535.032
     6         90.721      538.885
     7         99.385      543.880
     8        107.342      549.937
     9        114.464      556.956
    10        120.636      564.824
    11        125.757      573.413
    12        129.744      582.584
    13        132.533      592.188
    14        132.816      594.000
Circle Center At X =    55.975 ; Y =   609.045 ; and Radius =    78.300
       Factor of Safety
      ***    2.146   ***
Failure Surface Specified By 13 Coordinate Points
  Point      X-Surf      Y-Surf
   No.        (ft)        (ft)
    1         41.856      532.000
    2         51.794      530.891
    3         61.792      531.098
    4         71.676      532.615
    5         81.275      535.417
    6         90.424      539.456
    7         98.962      544.661
    8        106.743      550.943
    9        113.632      558.191
   10        119.509      566.282
   11        124.273      575.074
   12        127.840      584.416
   13        130.116      594.000
Circle Center At X =    55.229 ; Y =   606.795 ; and Radius =    75.981
       Factor of Safety
      ***    2.148   ***
          **** END OF GSTABL7 OUTPUT ****
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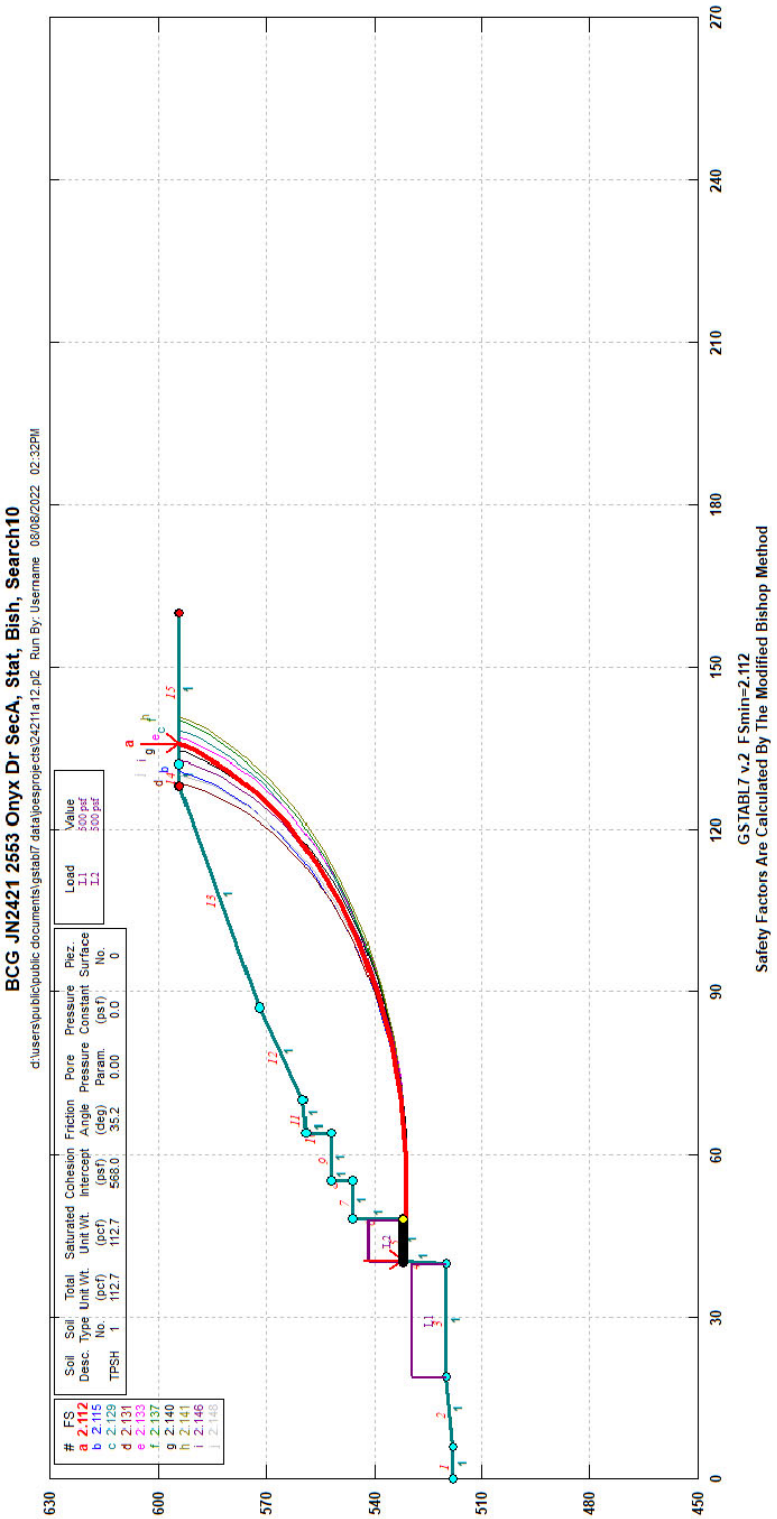
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GSTABL7 v.2 FSmin=2.112
Safety Factors Are Calculated By The Modified Bishop Method

GLOBAL STABILITY ANALYSES-

SLOPE GEOMETRY UTILIZED: Section A
ANALYSIS NUMBER: 24211A13
ANALYSIS METHOD: Modified Bishop's Method
ANALYSIS TYPE: Search Routine for (10) Most Critical Surfaces
LOADING CONDITION: Static Loading
HORIZ. E.Q. COEFF. = 0.0 / None Assigned

MINIMUM FACTOR OF SAFETY: 2.394

COMPUTER PROGRAM OUTPUT-

```
                                    ***  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 **
                  (All Rights Reserved-Unauthorized Use Prohibited)
    ********************************************************************************
                        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.
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    Run By:                   Username
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    Output Filename:          D:\Users\Public\Public Documents\GSTABL7 DATA\JoesProjects\24211a13.OUT
    Unit System:              English
    Plotted Output Filename:  D:\Users\Public\Public Documents\GSTABL7 DATA\JoesProjects\24211a13.PLT
    PROBLEM DESCRIPTION:  BCG JN2421 2553 Onyx Dr
                          SecA, Stat, Bish, Search10
    BOUNDARY COORDINATES
       15 Top   Boundaries
       15 Total Boundaries
    Boundary     X-Left     Y-Left    X-Right    Y-Right    Soil Type
       No.        (ft)       (ft)       (ft)       (ft)     Below Bnd
        1          0.00     518.00       6.00     518.00         1
        2          6.00     518.00      19.00     520.00         1
        3         19.00     520.00      40.00     520.00         1
        4         40.00     520.00      40.10     532.00         1
        5         40.10     532.00      48.00     532.00         1
        6         48.00     532.00      48.10     546.00         1
        7         48.10     546.00      55.00     546.00         1
        8         55.00     546.00      55.10     552.00         1
        9         55.10     552.00      64.00     552.00         1
       10         64.00     552.00      64.10     559.00         1
       11         64.10     559.00      70.00     560.00         1
       12         70.00     560.00      87.00     572.00         1
       13         87.00     572.00     128.00     594.00         1
       14        128.00     594.00     132.00     594.00         1
       15        132.00     594.00     160.00     594.00         1
    User Specified Y-Origin =       450.00(ft)
    Default X-Plus Value = 0.00(ft)
    Default Y-Plus Value = 0.00(ft)
   ISOTROPIC SOIL PARAMETERS
     1 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   112.7    112.7     568.0     35.2    0.00       0.0      0
   BOUNDARY LOAD(S)
       2 Load(s) Specified
    Load        X-Left      X-Right     Intensity     Deflection
     No.         (ft)         (ft)        (psf)          (deg)
       1         19.10        39.90        500.0          0.0
       2         40.11        47.90        500.0          0.0
    NOTE - Intensity Is Specified As A Uniformly Distributed
           Force Acting On A Horizontally Projected Surface.
    A Critical Failure Surface Searching Method, Using A Random
    Technique For Generating Circular Surfaces, Has Been Specified.
    1000 Trial Surfaces Have Been Generated.
      10 Surface(s) Initiate(s) From Each Of   100 Points Equally Spaced
    Along The Ground Surface Between  X =  48.10(ft)
                                  and  X =  55.00(ft)
    Each Surface Terminates Between   X = 128.00(ft)
                                  and   X = 160.00(ft)
    Unless Further Limitations Were Imposed, The Minimum Elevation
    At Which A Surface Extends Is  Y =    452.00(ft)
    10.00(ft) Line Segments Define Each Trial Failure Surface.
    ****  ERROR - RC11  ****
>>200 attempts to generate failure surface have failed. Revise limitations
```

The Factor Of Safety For The Trial Failure Surface Defined
By The Coordinates Listed Below Is Misleading.
Failure Surface Defined By 15 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	54.93	546.00
2	55.00	539.41
3	71.15	534.47
4	80.65	531.36
5	90.58	530.21
6	100.55	531.08
7	110.14	533.91
8	118.96	538.61
9	126.67	544.98
10	132.95	552.76
11	137.55	561.65
12	140.28	571.27
13	141.02	581.24
14	153.07	579.85
15	153.19	589.85

Factor Of Safety For The Preceding Specified Surface = 3.976
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 = 1000
Number of Trial Surfaces with Misleading FS = 1
Number of Failed Attempts to Generate Trial Surface = 19
Number of Trial Surfaces With Valid FS = 980
Percentage of Trial Surfaces With Non-Valid FS Solutions
of the Total Attempted = 2.0 %
Statistical Data On All Valid FS Values:
FS Max = 3.890 FS Min = 2.394 FS Ave = 2.998
Standard Deviation = 0.357 Coefficient of Variation = 11.92 %
Failure Surface Specified By 12 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	48.518	546.000
2	58.475	545.075
3	68.471	545.381
4	78.352	546.913
5	87.971	549.650
6	97.180	553.548
7	105.840	558.548
8	113.819	564.576
9	120.996	571.539
10	127.263	579.331
11	132.525	587.836
12	135.357	594.000

Circle Center At X = 61.043 ; Y = 625.894 ; and Radius = 80.870
Factor of Safety
*** 2.394 ***
Individual data on the 19 slices

Slice No.	Width (ft)	Weight (lbs)	Water Force Top (lbs)	Water Force Bot (lbs)	Tie Force Norm (lbs)	Tie Force Tan (lbs)	Earthquake Force Hor (lbs)	Earthquake Force Ver (lbs)	Surcharge Load (lbs)
1	6.5	220.0	0.0	0.0	0.	0.	0.0	0.0	0.0
2	0.1	40.7	0.0	0.0	0.	0.	0.0	0.0	0.0
3	3.4	2574.7	0.0	0.0	0.	0.	0.0	0.0	0.0
4	5.5	4259.3	0.0	0.0	0.	0.	0.0	0.0	0.0
5	0.1	115.6	0.0	0.0	0.	0.	0.0	0.0	0.0
6	4.4	6923.8	0.0	0.0	0.	0.	0.0	0.0	0.0
7	1.5	2477.0	0.0	0.0	0.	0.	0.0	0.0	0.0
8	8.4	15703.3	0.0	0.0	0.	0.	0.0	0.0	0.0
9	8.6	20275.6	0.0	0.0	0.	0.	0.0	0.0	0.0
10	1.0	2489.1	0.0	0.0	0.	0.	0.0	0.0	0.0
11	9.2	24278.6	0.0	0.0	0.	0.	0.0	0.0	0.0
12	8.7	23167.2	0.0	0.0	0.	0.	0.0	0.0	0.0
13	8.0	20402.2	0.0	0.0	0.	0.	0.0	0.0	0.0
14	7.2	16387.7	0.0	0.0	0.	0.	0.0	0.0	0.0
15	6.3	11645.3	0.0	0.0	0.	0.	0.0	0.0	0.0
16	0.7	1151.9	0.0	0.0	0.	0.	0.0	0.0	0.0
17	4.0	4618.5	0.0	0.0	0.	0.	0.0	0.0	0.0
18	0.5	389.5	0.0	0.0	0.	0.	0.0	0.0	0.0
19	2.8	984.0	0.0	0.0	0.	0.	0.0	0.0	0.0

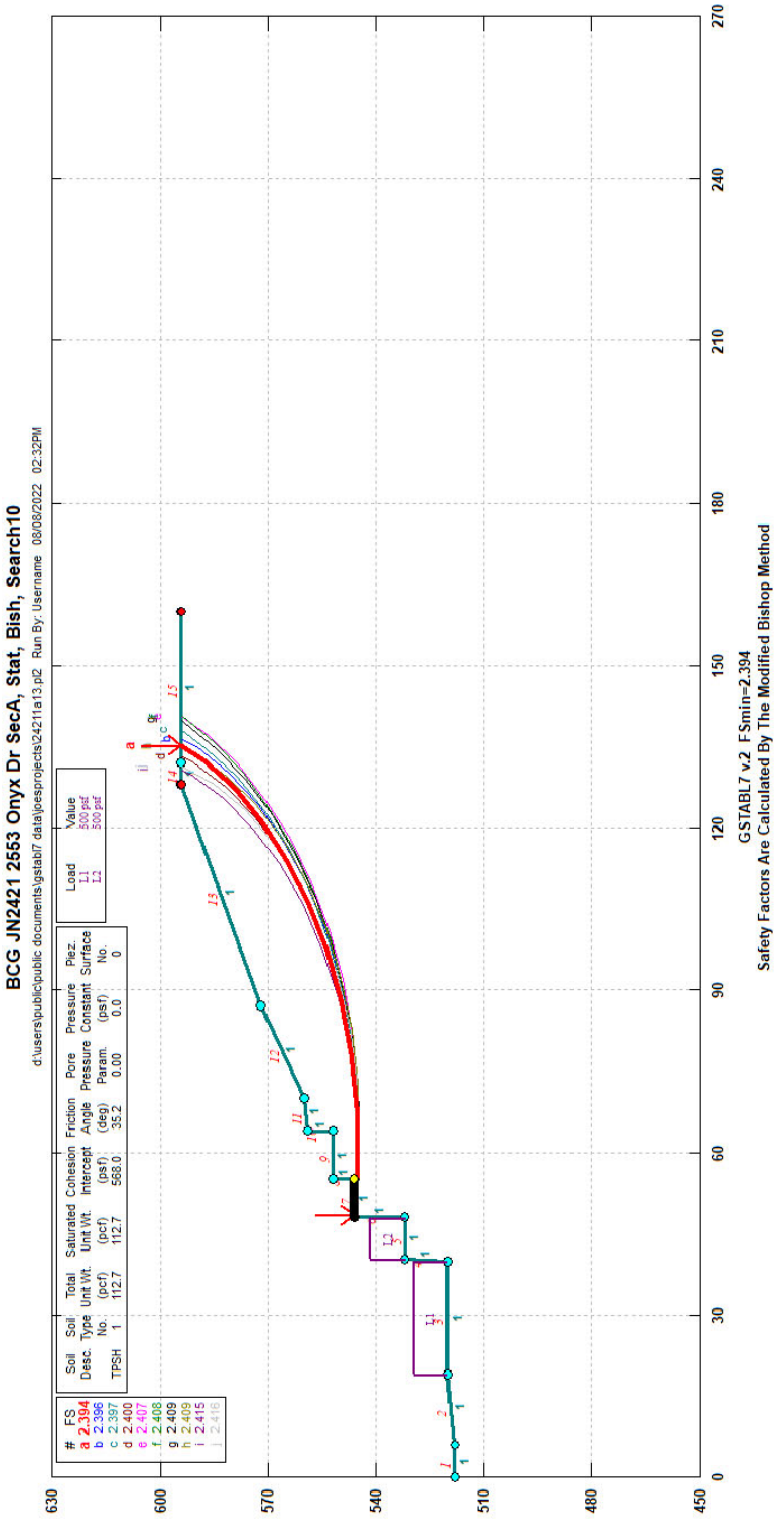
Failure Surface Specified By 12 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	52.561	546.000
2	62.513	545.027
3	72.508	545.352
4	82.377	546.968
5	91.953	549.849
6	101.075	553.945
7	109.590	559.188
8	117.355	565.490
9	124.238	572.744
10	130.123	580.829
11	134.912	589.608
12	136.614	594.000

Circle Center At X = 65.075 ; Y = 621.679 ; and Radius = 76.707

```
       Factor of Safety
      ***    2.396   ***
Failure Surface Specified By 12 Coordinate Points
  Point      X-Surf      Y-Surf
   No.        (ft)        (ft)
    1         50.470      546.000
    2         60.419      544.998
    3         70.417      545.227
    4         80.310      546.684
    5         89.949      549.347
    6         99.187      553.175
    7        107.884      558.111
    8        115.908      564.079
    9        123.137      570.988
   10        129.461      578.735
   11        134.784      587.200
   12        137.969      594.000
Circle Center At X =    63.602 ; Y =   625.812 ; and Radius =    80.885
       Factor of Safety
      ***    2.397   ***
Failure Surface Specified By 12 Coordinate Points
  Point      X-Surf      Y-Surf
   No.        (ft)        (ft)
    1         50.609      546.000
    2         60.563      545.037
    3         70.556      545.399
    4         80.414      547.080
    5         89.962      550.051
    6         99.034      554.259
    7        107.469      559.630
    8        115.119      566.070
    9        121.850      573.466
   10        127.544      581.687
   11        132.099      590.589
   12        133.307      594.000
Circle Center At X =    62.892 ; Y =   620.078 ; and Radius =    75.089
       Factor of Safety
      ***    2.400   ***
Failure Surface Specified By 12 Coordinate Points
  Point      X-Surf      Y-Surf
   No.        (ft)        (ft)
    1         52.352      546.000
    2         62.301      544.998
    3         72.299      545.211
    4         82.197      546.635
    5         91.849      549.250
    6        101.112      553.017
    7        109.850      557.880
    8        117.933      563.768
    9        125.242      570.593
   10        131.669      578.254
   11        137.118      586.639
   12        140.716      594.000
Circle Center At X =    65.584 ; Y =   626.977 ; and Radius =    82.051
       Factor of Safety
      ***    2.407   ***
Failure Surface Specified By 13 Coordinate Points
  Point      X-Surf      Y-Surf
   No.        (ft)        (ft)
    1         49.912      546.000
    2         59.854      544.926
    3         69.854      545.035
    4         79.770      546.325
    5         89.465      548.779
    6         98.801      552.361
    7        107.648      557.022
    8        115.883      562.696
    9        123.389      569.304
   10        130.061      576.752
   11        135.806      584.937
   12        140.543      593.744
   13        140.643      594.000
Circle Center At X =    63.935 ; Y =   629.273 ; and Radius =    84.445
       Factor of Safety
      ***    2.408   ***
Failure Surface Specified By 13 Coordinate Points
  Point      X-Surf      Y-Surf
   No.        (ft)        (ft)
    1         48.588      546.000
    2         58.520      544.837
    3         68.520      544.859
    4         78.447      546.066
    5         88.161      548.441
    6         97.525      551.950
    7        106.407      556.544
    8        114.683      562.158
    9        122.234      568.713
   10        128.956      576.117
   11        134.753      584.265
   12        139.544      593.043
   13        139.927      594.000
Circle Center At X =    63.334 ; Y =   628.940 ; and Radius =    84.241
```

```
       Factor of Safety
      ***    2.409   ***
Failure Surface Specified By 12 Coordinate Points
  Point      X-Surf      Y-Surf
   No.        (ft)        (ft)
    1         52.979      546.000
    2         62.917      544.892
    3         72.914      545.145
    4         82.784      546.753
    5         92.344      549.688
    6        101.416      553.894
    7        109.833      559.294
    8        117.437      565.788
    9        124.090      573.254
   10        129.665      581.555
   11        134.062      590.537
   12        135.205      594.000
Circle Center At X =    66.120 ; Y =   617.918 ; and Radius =    73.108
       Factor of Safety
      ***    2.409   ***
Failure Surface Specified By 12 Coordinate Points
  Point      X-Surf      Y-Surf
   No.        (ft)        (ft)
    1         49.006      546.000
    2         58.967      545.118
    3         68.957      545.570
    4         78.797      547.348
    5         88.314      550.421
    6         97.336      554.734
    7        105.703      560.209
    8        113.267      566.751
    9        119.892      574.241
   10        125.461      582.547
   11        129.874      591.521
   12        130.706      594.000
Circle Center At X =    60.636 ; Y =   619.735 ; and Radius =    74.646
       Factor of Safety
      ***    2.415   ***
Failure Surface Specified By 11 Coordinate Points
  Point      X-Surf      Y-Surf
   No.        (ft)        (ft)
    1         53.746      546.000
    2         63.698      545.022
    3         73.686      545.495
    4         83.502      547.407
    5         92.937      550.720
    6        101.794      555.363
    7        109.885      561.239
    8        117.042      568.224
    9        123.112      576.171
   10        127.968      584.913
   11        131.409      594.000
Circle Center At X =    65.444 ; Y =   613.929 ; and Radius =    68.929
       Factor of Safety
      ***    2.416   ***
          **** END OF GSTABL7 OUTPUT ****
```


BCG JN2421 2553 Onyx Dr SecA, Stat, Bish, Search10
d:\users\public\public documents\gstabl7 data\joesprojects\24211a13.pl2 Run By: Username 08/08/2022 02:32PM
GSTABL7 v.2 FSmin=2.394
Safety Factors Are Calculated By The Modified Bishop Method
FS
a 2.394
b 2.396
c 2.397
d 2.400
e 2.407
f 2.408
g 2.409
h 2.409
i 2.415
j 2.416
Soil Desc.
Soil Type No.
Total Unit Wt. (pcf)
Saturated Unit Wt. (pcf)
Cohesion Intercept (psf)
Friction Angle (deg)
Pore Pressure Param.
Pressure Constant (psf)
Piez. Surface No.
TPSH 1 112.7 112.7 568.0 35.2 0.00 0.0 0
Load
L1
L2
Value
500 psf
500 psf
0
30
60
90
120
150
180
210
240
270
450
480
510
540
570
600
630

GLOBAL STABILITY ANALYSES-

SLOPE GEOMETRY UTILIZED:	Section A
ANALYSIS NUMBER:	24211A14
ANALYSIS METHOD:	Modified Bishop's Method
ANALYSIS TYPE:	Search Routine for (10) Most Critical Surfaces
LOADING CONDITION:	Static Loading
HORIZ. E.Q. COEFF. =	0.0 / None Assigned

MINIMUM FACTOR OF SAFETY: 2.562

COMPUTER PROGRAM OUTPUT-

```
                                    ***  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 **
                  (All Rights Reserved-Unauthorized Use Prohibited)
 ********************************************************************************
                       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:        08/08/2022
 Time of Run:              02:34PM
 Run By:                   Username
 Input Data Filename:      D:\Users\Public\Public Documents\GSTABL7 DATA\JoesProjects\24211a14.in
 Output Filename:          D:\Users\Public\Public Documents\GSTABL7 DATA\JoesProjects\24211a14.OUT
 Unit System:              English
 Plotted Output Filename:  D:\Users\Public\Public Documents\GSTABL7 DATA\JoesProjects\24211a14.PLT
 PROBLEM DESCRIPTION:  BCG JN2421 2553 Onyx Dr
                       SecA, Stat, Bish, Search10
 BOUNDARY COORDINATES
    15 Top   Boundaries
    15 Total Boundaries
 Boundary     X-Left     Y-Left    X-Right    Y-Right    Soil Type
    No.         (ft)       (ft)       (ft)       (ft)    Below Bnd
     1          0.00     518.00       6.00     518.00        1
     2          6.00     518.00      19.00     520.00        1
     3         19.00     520.00      40.00     520.00        1
     4         40.00     520.00      40.10     532.00        1
     5         40.10     532.00      48.00     532.00        1
     6         48.00     532.00      48.10     546.00        1
     7         48.10     546.00      55.00     546.00        1
     8         55.00     546.00      55.10     552.00        1
     9         55.10     552.00      64.00     552.00        1
    10         64.00     552.00      64.10     559.00        1
    11         64.10     559.00      70.00     560.00        1
    12         70.00     560.00      87.00     572.00        1
    13         87.00     572.00     128.00     594.00        1
    14        128.00     594.00     132.00     594.00        1
    15        132.00     594.00     160.00     594.00        1
 User Specified Y-Origin =       450.00(ft)
 Default X-Plus Value = 0.00(ft)
 Default Y-Plus Value = 0.00(ft)
ISOTROPIC SOIL PARAMETERS
  1 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   112.7    112.7     568.0     35.2    0.00       0.0      0
BOUNDARY LOAD(S)
     2 Load(s) Specified
 Load        X-Left      X-Right     Intensity     Deflection
  No.          (ft)         (ft)        (psf)          (deg)
   1          19.10        39.90        500.0           0.0
   2          40.11        47.90        500.0           0.0
 NOTE - Intensity Is Specified As A Uniformly Distributed
        Force Acting On A Horizontally Projected Surface.
 A Critical Failure Surface Searching Method, Using A Random
 Technique For Generating Circular Surfaces, Has Been Specified.
 1000 Trial Surfaces Have Been Generated.
   10 Surface(s) Initiate(s) From Each Of   100 Points Equally Spaced
```

Along The Ground Surface Between X = 55.10(ft)
and X = 64.00(ft)
Each Surface Terminates Between X = 128.00(ft)
and X = 160.00(ft)
Unless Further Limitations Were Imposed, The Minimum Elevation
At Which A Surface Extends Is Y = 452.00(ft)
10.00(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 = 1000
Number of Trial Surfaces With Valid FS = 1000
Statistical Data On All Valid FS Values:
FS Max = 4.380 FS Min = 2.562 FS Ave = 3.262
Standard Deviation = 0.426 Coefficient of Variation = 13.07 %
Failure Surface Specified By 11 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	58.246	552.000
2	68.196	550.997
3	78.190	551.346
4	88.045	553.040
5	97.582	556.048
6	106.626	560.316
7	115.011	565.765
8	122.584	572.296
9	129.207	579.788
10	134.758	588.106
11	137.628	594.000

Circle Center At X = 70.620 ; Y = 624.899 ; and Radius = 73.942
Factor of Safety
*** 2.562 ***
Individual data on the 16 slices

Slice No.	Width (ft)	Weight (lbs)	Water Force Top (lbs)	Water Force Bot (lbs)	Tie Force Norm (lbs)	Tie Force Tan (lbs)	Earthquake Force Hor (lbs)	Earthquake Force Ver (lbs)	Surcharge Load (lbs)
1	5.8	188.0	0.0	0.0	0.	0.	0.0	0.0	0.0
2	0.1	46.0	0.0	0.0	0.	0.	0.0	0.0	0.0
3	4.1	3759.2	0.0	0.0	0.	0.	0.0	0.0	0.0
4	1.8	1792.9	0.0	0.0	0.	0.	0.0	0.0	0.0
5	8.2	10787.7	0.0	0.0	0.	0.	0.0	0.0	0.0
6	8.8	16668.3	0.0	0.0	0.	0.	0.0	0.0	0.0
7	1.0	2277.3	0.0	0.0	0.	0.	0.0	0.0	0.0
8	9.5	22114.3	0.0	0.0	0.	0.	0.0	0.0	0.0
9	9.0	22343.6	0.0	0.0	0.	0.	0.0	0.0	0.0
10	8.4	20544.2	0.0	0.0	0.	0.	0.0	0.0	0.0
11	7.6	17096.8	0.0	0.0	0.	0.	0.0	0.0	0.0
12	5.4	10491.2	0.0	0.0	0.	0.	0.0	0.0	0.0
13	1.2	2025.3	0.0	0.0	0.	0.	0.0	0.0	0.0
14	2.8	3815.3	0.0	0.0	0.	0.	0.0	0.0	0.0
15	2.8	2473.9	0.0	0.0	0.	0.	0.0	0.0	0.0
16	2.9	953.2	0.0	0.0	0.	0.	0.0	0.0	0.0

Failure Surface Specified By 11 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	60.943	552.000
2	70.897	551.034
3	80.885	551.516
4	90.699	553.436
5	100.132	556.753
6	108.988	561.399
7	117.079	567.276
8	124.236	574.260
9	130.309	582.204
10	135.171	590.943
11	136.331	594.000

Circle Center At X = 72.573 ; Y = 620.046 ; and Radius = 69.033
Factor of Safety
*** 2.563 ***
Failure Surface Specified By 11 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	55.639	552.000
2	65.596	551.074
3	75.588	551.482
4	85.436	553.219
5	94.965	556.252
6	104.005	560.528

```
     7        112.394      565.971
     8        119.983      572.483
     9        126.637      579.948
    10        132.236      588.233
    11        135.099      594.000
Circle Center At X =    67.539 ; Y =   625.925 ; and Radius =    74.876
       Factor of Safety
      ***    2.566   ***
Failure Surface Specified By 11 Coordinate Points
  Point      X-Surf      Y-Surf
   No.        (ft)        (ft)
     1         58.426      552.000
     2         68.380      551.038
     3         78.367      551.542
     4         88.173      553.503
     5         97.586      556.877
     6        106.405      561.592
     7        114.438      567.548
     8        121.514      574.614
     9        127.479      582.640
    10        132.206      591.453
    11        133.123      594.000
Circle Center At X =    69.944 ; Y =   619.174 ; and Radius =    68.154
       Factor of Safety
      ***    2.572   ***
Failure Surface Specified By 11 Coordinate Points
  Point      X-Surf      Y-Surf
   No.        (ft)        (ft)
     1         60.584      552.000
     2         70.533      550.997
     3         80.528      551.338
     4         90.386      553.016
     5         99.930      556.001
     6        108.987      560.239
     7        117.395      565.653
     8        125.000      572.147
     9        131.665      579.601
    10        137.271      587.882
    11        140.306      594.000
Circle Center At X =    73.002 ; Y =   625.349 ; and Radius =    74.393
       Factor of Safety
      ***    2.573   ***
Failure Surface Specified By 12 Coordinate Points
  Point      X-Surf      Y-Surf
   No.        (ft)        (ft)
     1         55.729      552.000
     2         65.661      550.830
     3         75.660      550.939
     4         85.563      552.326
     5         95.208      554.968
     6        104.435      558.822
     7        113.094      563.825
     8        121.042      569.893
     9        128.149      576.928
    10        134.298      584.815
    11        139.388      593.422
    12        139.636      594.000
Circle Center At X =    69.822 ; Y =   628.658 ; and Radius =    77.943
       Factor of Safety
      ***    2.573   ***
Failure Surface Specified By 11 Coordinate Points
  Point      X-Surf      Y-Surf
   No.        (ft)        (ft)
     1         59.954      552.000
     2         69.912      551.074
     3         79.893      551.689
     4         89.661      553.830
     5         98.984      557.446
     6        107.642      562.451
     7        115.427      568.726
     8        122.157      576.123
     9        127.670      584.466
    10        131.836      593.557
    11        131.962      594.000
Circle Center At X =    70.923 ; Y =   615.974 ; and Radius =    64.907
       Factor of Safety
      ***    2.581   ***
Failure Surface Specified By 11 Coordinate Points
  Point      X-Surf      Y-Surf
   No.        (ft)        (ft)
```

1	61.483	552.000
2	71.419	550.872
3	81.411	551.277
4	91.223	553.206
5	100.624	556.613
6	109.394	561.419
7	117.325	567.510
8	124.230	574.743
9	129.948	582.947
10	134.343	591.929
11	134.987	594.000

Circle Center At X = 73.782 ; Y = 615.997 ; and Radius = 65.168

Factor of Safety

*** 2.581 ***

Failure Surface Specified By 12 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	56.538	552.000
2	66.498	551.104
3	76.495	551.372
4	86.392	552.800
5	96.057	555.369
6	105.357	559.043
7	114.167	563.774
8	122.367	569.497
9	129.847	576.135
10	136.505	583.596
11	142.250	591.781
12	143.449	594.000

Circle Center At X = 69.246 ; Y = 636.625 ; and Radius = 85.574

Factor of Safety

*** 2.583 ***

Failure Surface Specified By 12 Coordinate Points

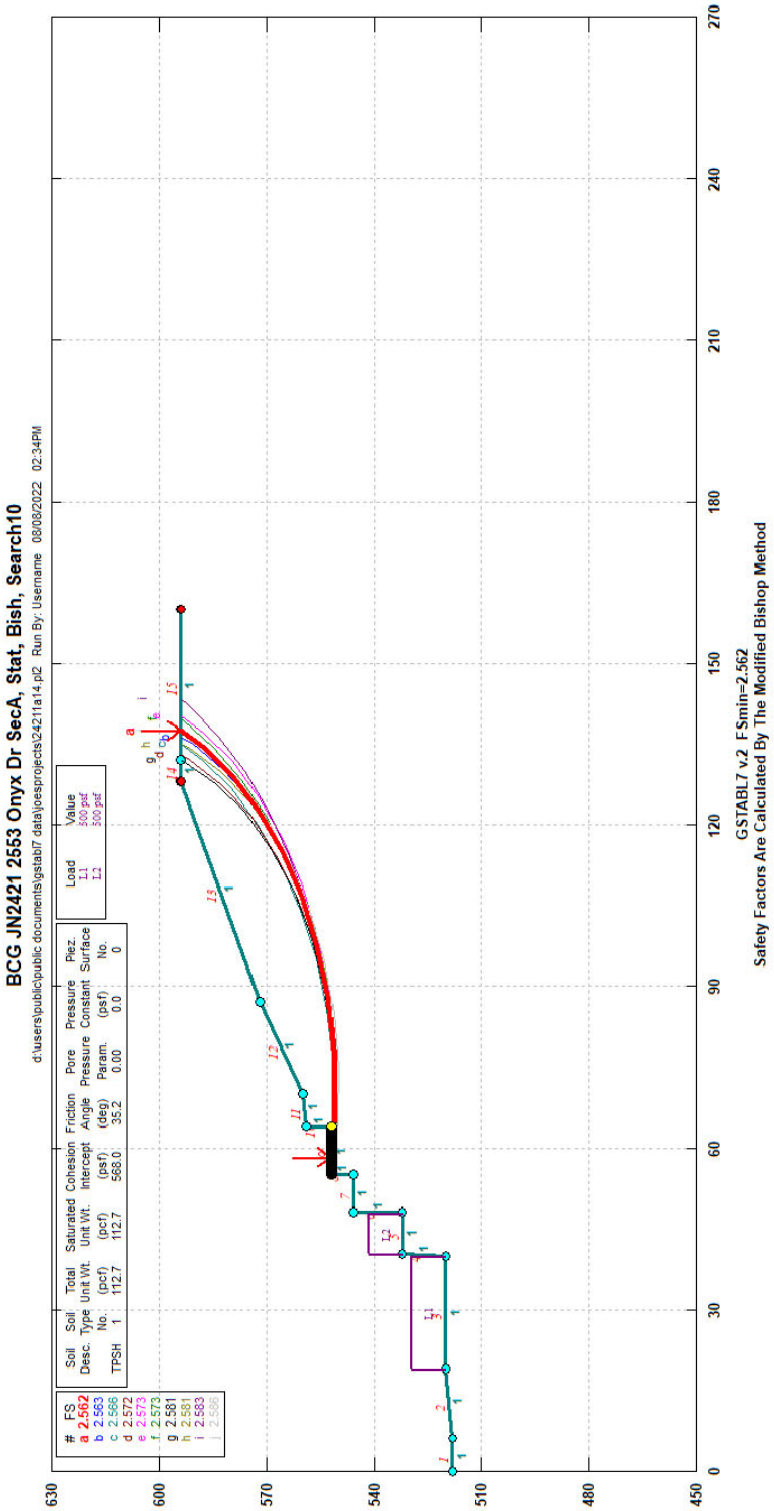
Point No.	X-Surf (ft)	Y-Surf (ft)
1	55.100	552.000
2	64.975	550.424
3	74.973	550.233
4	84.901	551.432
5	94.566	553.998
6	103.782	557.880
7	112.370	563.004
8	120.163	569.270
9	127.011	576.557
10	132.782	584.724
11	137.363	593.613
12	137.498	594.000

Circle Center At X = 71.347 ; Y = 621.953 ; and Radius = 71.815

Factor of Safety

*** 2.586 ***

**** END OF GSTABL7 OUTPUT ****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GSTABL7 v.2 FSmin=2.562
Safety Factors Are Calculated By The Modified Bishop Method
FS
a 2.562
b 2.563
c 2.566
d 2.572
e 2.573
f 2.573
g 2.581
h 2.581
i 2.583
Soil Desc.
TPSH
Soil Type No. 1
Total Unit Wt. (pcf) 112.7
Saturated Unit Wt. (pcf) 112.7
Cohesion Intercept (psf) 568.0
Friction Angle (deg) 35.2
Pore Pressure Param. 0.00
Pressure Constant (psf) 0.0
Piez. Surface No. 0
Load
L1
L2
Value
500 psf
500 psf
630
600
570
540
510
480
450
0
30
60
90
120
150
180
210
240
270

GLOBAL STABILITY ANALYSES-

SLOPE GEOMETRY UTILIZED:	Section A
ANALYSIS NUMBER:	24211A15
ANALYSIS METHOD:	Modified Bishop's Method
ANALYSIS TYPE:	Search Routine for (10) Most Critical Surfaces
LOADING CONDITION:	Static Loading
HORIZ. E.Q. COEFF. =	0.0 / None Assigned

MINIMUM FACTOR OF SAFETY: 2.855

COMPUTER PROGRAM OUTPUT-

```
                                  ***  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 **
                  (All Rights Reserved-Unauthorized Use Prohibited)
 ********************************************************************************
                       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.
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 Time of Run:              02:34PM
 Run By:                   Username
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 Output Filename:          D:\Users\Public\Public Documents\GSTABL7 DATA\JoesProjects\24211a15.OUT
 Unit System:              English
 Plotted Output Filename:  D:\Users\Public\Public Documents\GSTABL7 DATA\JoesProjects\24211a15.PLT
 PROBLEM DESCRIPTION:  BCG JN2421 2553 Onyx Dr
                       SecA, Stat, Bish, Search10
 BOUNDARY COORDINATES
    15 Top   Boundaries
    15 Total Boundaries
 Boundary     X-Left     Y-Left    X-Right    Y-Right    Soil Type
    No.        (ft)       (ft)       (ft)       (ft)    Below Bnd
     1          0.00     518.00       6.00     518.00        1
     2          6.00     518.00      19.00     520.00        1
     3         19.00     520.00      40.00     520.00        1
     4         40.00     520.00      40.10     532.00        1
     5         40.10     532.00      48.00     532.00        1
     6         48.00     532.00      48.10     546.00        1
     7         48.10     546.00      55.00     546.00        1
     8         55.00     546.00      55.10     552.00        1
     9         55.10     552.00      64.00     552.00        1
    10         64.00     552.00      64.10     559.00        1
    11         64.10     559.00      70.00     560.00        1
    12         70.00     560.00      87.00     572.00        1
    13         87.00     572.00     128.00     594.00        1
    14        128.00     594.00     132.00     594.00        1
    15        132.00     594.00     160.00     594.00        1
 User Specified Y-Origin =       450.00(ft)
 Default X-Plus Value = 0.00(ft)
 Default Y-Plus Value = 0.00(ft)
ISOTROPIC SOIL PARAMETERS
  1 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   112.7    112.7     568.0     35.2    0.00       0.0      0
BOUNDARY LOAD(S)
     2 Load(s) Specified
 Load        X-Left      X-Right     Intensity     Deflection
  No.         (ft)         (ft)        (psf)          (deg)
   1         19.10        39.90        500.0          0.0
   2         40.11        47.90        500.0          0.0
 NOTE - Intensity Is Specified As A Uniformly Distributed
        Force Acting On A Horizontally Projected Surface.
 A Critical Failure Surface Searching Method, Using A Random
 Technique For Generating Circular Surfaces, Has Been Specified.
 1000 Trial Surfaces Have Been Generated.
   10 Surface(s) Initiate(s) From Each Of   100 Points Equally Spaced
```

Along The Ground Surface Between X = 64.10(ft)
and X = 118.00(ft)
Each Surface Terminates Between X = 128.00(ft)
and X = 160.00(ft)
Unless Further Limitations Were Imposed, The Minimum Elevation
At Which A Surface Extends Is Y = 452.00(ft)
10.00(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 = 1000
Number of Trial Surfaces With Valid FS = 1000
Statistical Data On All Valid FS Values:
FS Max = 61.124 FS Min = 2.855 FS Ave = 6.691
Standard Deviation = 4.360 Coefficient of Variation = 65.17 %
Failure Surface Specified By 10 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	65.733	559.277
2	75.687	558.319
3	85.676	558.787
4	95.497	560.671
5	104.951	563.932
6	113.844	568.504
7	121.997	574.295
8	129.243	581.186
9	135.436	589.038
10	138.311	594.000

Circle Center At X = 77.465 ; Y = 627.968 ; and Radius = 69.686
Factor of Safety
*** 2.855 ***
Individual data on the 13 slices

Slice No.	Width (ft)	Weight (lbs)	Water Force Top (lbs)	Water Force Bot (lbs)	Tie Force Norm (lbs)	Tie Force Tan (lbs)	Earthquake Force Hor (lbs)	Earthquake Force Ver (lbs)	Surcharge Load (lbs)
1	4.3	272.5	0.0	0.0	0.	0.	0.0	0.0	0.0
2	5.7	2188.5	0.0	0.0	0.	0.	0.0	0.0	0.0
3	10.0	10117.2	0.0	0.0	0.	0.	0.0	0.0	0.0
4	1.3	1882.3	0.0	0.0	0.	0.	0.0	0.0	0.0
5	8.5	13813.2	0.0	0.0	0.	0.	0.0	0.0	0.0
6	9.5	17892.6	0.0	0.0	0.	0.	0.0	0.0	0.0
7	8.9	17840.8	0.0	0.0	0.	0.	0.0	0.0	0.0
8	8.2	15796.2	0.0	0.0	0.	0.	0.0	0.0	0.0
9	6.0	10310.5	0.0	0.0	0.	0.	0.0	0.0	0.0
10	1.2	1878.4	0.0	0.0	0.	0.	0.0	0.0	0.0
11	2.8	3437.9	0.0	0.0	0.	0.	0.0	0.0	0.0
12	3.4	2765.1	0.0	0.0	0.	0.	0.0	0.0	0.0
13	2.9	803.9	0.0	0.0	0.	0.	0.0	0.0	0.0

Failure Surface Specified By 10 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	66.822	559.461
2	76.755	558.303
3	86.750	558.631
4	96.585	560.439
5	106.043	563.686
6	114.915	568.300
7	123.004	574.179
8	130.131	581.193
9	136.139	589.187
10	138.741	594.000

Circle Center At X = 79.602 ; Y = 624.997 ; and Radius = 66.770
Factor of Safety
*** 2.858 ***
Failure Surface Specified By 10 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	67.911	559.646
2	77.881	558.872
3	87.862	559.486
4	97.662	561.477
5	107.091	564.806
6	115.969	569.410
7	124.123	575.199
8	131.396	582.062
9	137.649	589.866
10	140.107	594.000

Circle Center At X = 78.525 ; Y = 630.378 ; and Radius = 71.524

Factor of Safety
*** 2.861 ***
Failure Surface Specified By 10 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	68.456	559.738
2	78.401	558.691
3	88.382	559.299
4	98.126	561.547
5	107.366	565.372
6	115.847	570.669
7	123.338	577.294
8	129.632	585.065
9	134.558	593.768
10	134.643	594.000

Circle Center At X = 79.738 ; Y = 619.005 ; and Radius = 60.331
Factor of Safety
*** 2.872 ***
Failure Surface Specified By 10 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	66.278	559.369
2	76.254	558.677
3	86.238	559.243
4	96.072	561.056
5	105.601	564.088
6	114.675	568.292
7	123.149	573.600
8	130.891	579.930
9	137.778	587.181
10	142.790	594.000

Circle Center At X = 76.789 ; Y = 637.985 ; and Radius = 79.315
Factor of Safety
*** 2.879 ***
Failure Surface Specified By 9 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	70.633	560.447
2	80.633	560.361
3	90.551	561.641
4	100.201	564.264
5	109.402	568.180
6	117.982	573.316
7	125.781	579.575
8	132.652	586.841
9	137.767	594.000

Circle Center At X = 76.261 ; Y = 633.282 ; and Radius = 73.052
Factor of Safety
*** 2.883 ***
Failure Surface Specified By 9 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	70.089	560.063
2	80.026	558.946
3	90.007	559.559
4	99.733	561.884
5	108.913	565.850
6	117.271	571.340
7	124.558	578.189
8	130.555	586.192
9	134.519	594.000

Circle Center At X = 81.487 ; Y = 616.713 ; and Radius = 57.785
Factor of Safety
*** 2.885 ***
Failure Surface Specified By 10 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	70.089	560.063
2	80.000	558.735
3	89.992	559.148
4	99.760	561.288
5	109.009	565.091
6	117.457	570.441
7	124.849	577.176
8	130.960	585.092
9	135.604	593.948
10	135.621	594.000

Circle Center At X = 82.638 ; Y = 616.070 ; and Radius = 57.396
Factor of Safety
*** 2.891 ***

```
Failure Surface Specified By  9 Coordinate Points
  Point      X-Surf      Y-Surf
   No.        (ft)        (ft)
    1         66.278      559.369
    2         76.264      558.839
    3         86.215      559.828
    4         95.901      562.313
    5        105.099      566.237
    6        113.596      571.510
    7        121.196      578.008
    8        127.725      585.584
    9        132.992      594.000
Circle Center At X =    74.749 ; Y =   624.635 ; and Radius =    65.814
       Factor of Safety
      ***    2.896   ***
Failure Surface Specified By 10 Coordinate Points
  Point      X-Surf      Y-Surf
   No.        (ft)        (ft)
    1         66.822      559.461
    2         76.624      557.479
    3         86.621      557.241
    4         96.505      558.757
    5        105.972      561.979
    6        114.729      566.807
    7        122.506      573.093
    8        129.064      580.643
    9        134.199      589.224
   10        136.015      594.000
Circle Center At X =    82.994 ; Y =   613.641 ; and Radius =    56.542
       Factor of Safety
      ***    2.897   ***
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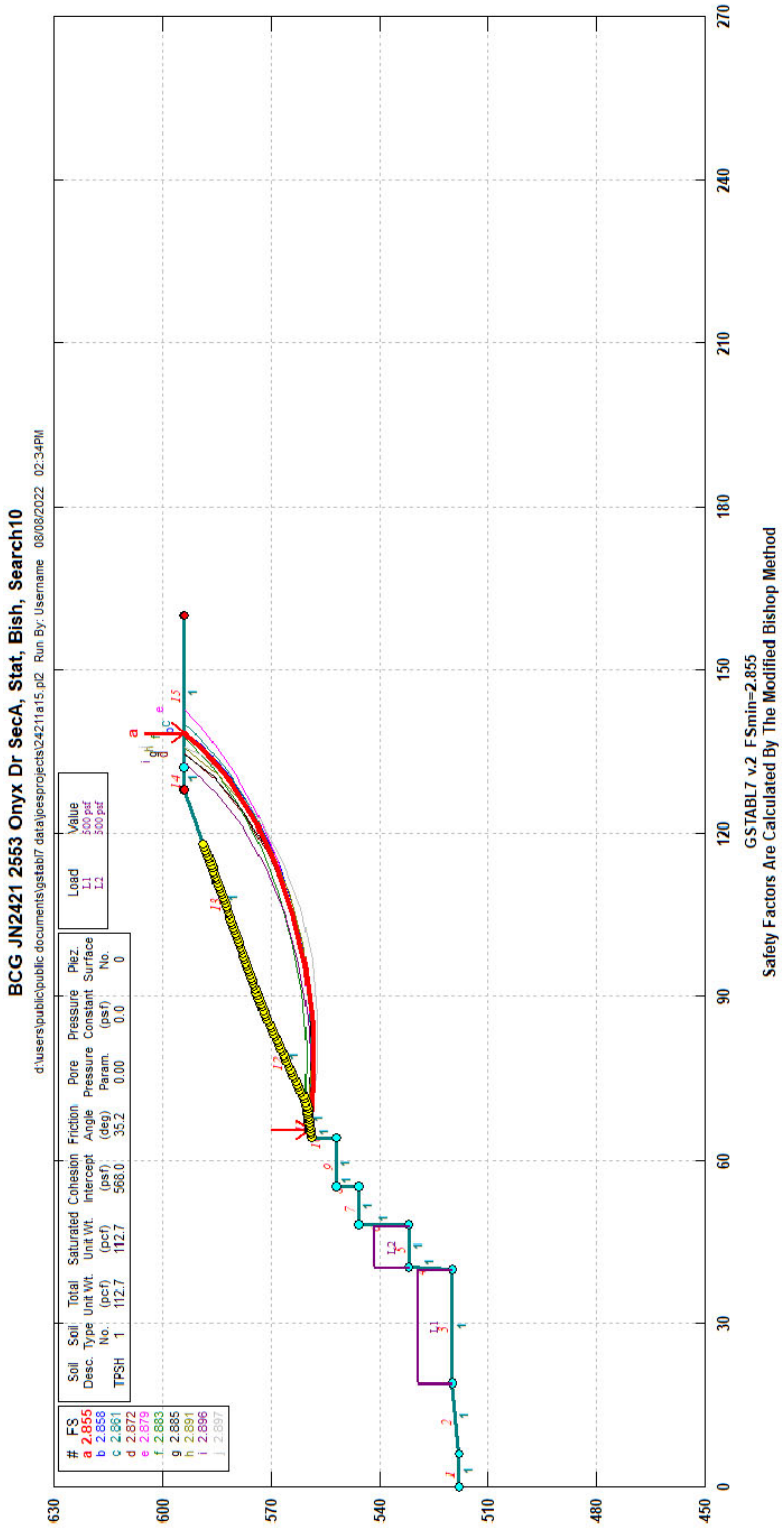
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GSTABL7 v.2 FSmin=2.855
Safety Factors Are Calculated By The Modified Bishop Method
FS
a 2.855
b 2.858
c 2.861
d 2.872
e 2.879
f 2.883
g 2.885
h 2.891
i 2.896
j 2.897
Soil Desc.
Soil Type No.
Total Unit Wt. (pcf)
Saturated Unit Wt. (pcf)
Cohesion Intercept (psf)
Friction Angle (deg)
Pore Pressure Param.
Pressure Constant (psf)
Piez. Surface No.
TPSH 1 112.7 112.7 568.0 35.2 0.00 0.0 0
Load
L1
L2
Value
550 psf
350 psf
630
600
570
540
510
480
450
0
30
60
90
120
150
180
210
240
270

Bay City Geology, Inc.

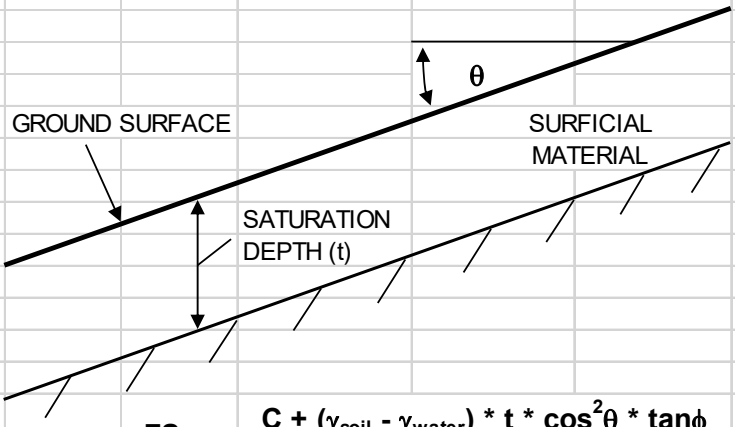
SURFICIAL STABILITY

File No.: **2421**
Project: **2553 Onyx Dr**

CALCULATE THE SURFICIAL STABILITY OF THE EARTH MATERIAL USING THE INFINITE SLOPE ANALYSIS WITH PARALLEL SEEPAGE. THIS METHOD WAS RECOMMENDED BY THE ASCE AND THE BUILDING AND SAFETY ADVISORY COMMITTEE (8/16/78). MODIFIED FROM SKEMPTON & DeLORY, 1957.

CALCULATION PARAMETERS

EARTH MATERIAL:	SOIL (Qs)				
COHESION:	617	psf	SHEAR DIAGRAM:	Lowest Ult. Vals.	
PHI ANGLE:	21.8	degrees	SLOPE ANGLE:	45.0	degrees
DENSITY:	103.2	pcf	SATURATION DEPTH (t):	3.0	feet



$$FS = \frac{C + (\gamma_{soil} - \gamma_{water}) * t * \cos^2\theta * \tan\phi}{\gamma_{soil} * t * \cos\phi * \sin\phi}$$

SAFETY FACTOR = 4.14

CONCLUSIONS:

THE CALCULATION INDICATES THAT THE EXISTING SLOPE, WITH AN APPROXIMATE GRADIENT OF 1H:1V, (OR FLATTER), IS SURFICIALLY STABLE.

Bay City Geology, Inc.

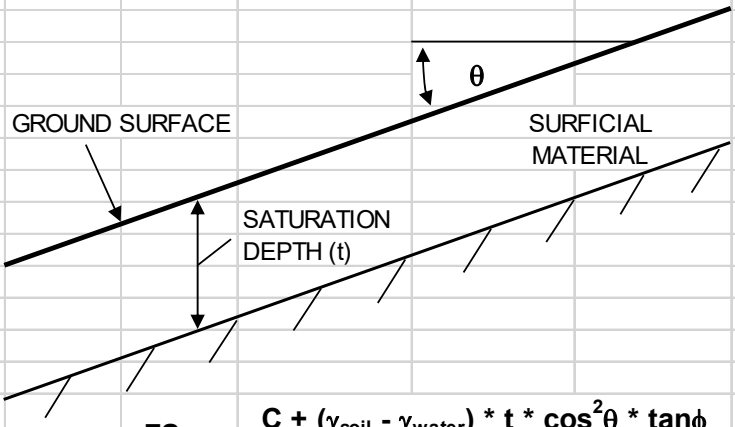
SURFICIAL STABILITY

File No.: **2421**
Project: **2553 Onyx Dr**

CALCULATE THE SURFICIAL STABILITY OF THE EARTH MATERIAL USING THE INFINITE SLOPE ANALYSIS WITH PARALLEL SEEPAGE. THIS METHOD WAS RECOMMENDED BY THE ASCE AND THE BUILDING AND SAFETY ADVISORY COMMITTEE (8/16/78). MODIFIED FROM SKEMPTON & DeLORY, 1957.

CALCULATION PARAMETERS

EARTH MATERIAL:	EX. FILL (Af)				
COHESION:	640	psf	SHEAR DIAGRAM:	Lowest Ult. Vals.	
PHI ANGLE:	22.7	degrees	SLOPE ANGLE:	45.0	degrees
DENSITY:	99.4	pcf	SATURATION DEPTH (t):	3.0	feet



$$FS = \frac{C + (\gamma_{soil} - \gamma_{water}) * t * \cos^2\theta * \tan\phi}{\gamma_{soil} * t * \cos\phi * \sin\phi}$$

SAFETY FACTOR = 4.45

CONCLUSIONS:

THE CALCULATION INDICATES THAT THE EXISTING SLOPE, WITH AN APPROXIMATE GRADIENT OF 1H:1V, (OR FLATTER), IS SURFICIALLY STABLE.

Bay City Geology, Inc.

RETAINING WALL - COMPLEX BACKSLOPE

SHEET 1

File No. **2421**
Project: **2553 Onyx Dr**

ASSUME: Upper Rear Wall

CALCULATE THE DESIGN MINIMUM EQUIVALENT FLUID PRESSURE (EFP) FOR PROPOSED RETAINING WALLS WITH A COMPLEX BACKSLOPE. THE LOWER WALL HEIGHT, UPSLOPE DISTANCE TO CHANGE IN SLOPE, AND BACKSLOPE AND SURCHARGE CONDITIONS ARE LISTED BELOW. ASSUME THE BACKFILL IS SATURATED WITH NO EXCESS HYDROSTATIC PRESSURE.

CALCULATION PARAMETERS

EARTH MATERIAL:	Fav./Adv. Tpsh/Qs/Af		INITIAL BACKSLOPE:	11.3	degrees
SHEAR DIAGRAM:	Lowest Vals.		UPPER BACKSLOPE:	35.2	degrees
LOWER WALL	10	feet	LOWER SURCHARGE:	0	pounds
NO UPPER WALL:	0	feet	SURCHARGE TYPE:	U	Uniform
COHESION:	552	psf	UPPER SURCHARGE:	0	pounds
PHI ANGLE:	21.8	degrees	SURCHARGE TYPE:	U	Uniform
DENSITY:	112.7	pcf	INITIAL FAILURE ANGLE:	10	degrees
SAFETY FACTOR:	1.5		FINAL FAILURE ANGLE:	80	degrees
WALL FRICTION:	0	degrees	SLOPE CHANGE DIST.:	6	feet
CD (C/FS):	368.0	psf	FINAL TENSION CRACK:	20	feet
PHID = ATAN(TAN(PHI)/FS) =	14.9	degrees			

Run Calculation

CALCULATED RESULTS

CRITICAL FAILURE ANGLE	41	degrees
AREA OF LOWER TRIAL FAILURE WEDGE	47.9	square feet
AREA OF UPPER TRIAL FAILURE WEDGE	5.9	square feet
TOTAL EXTERNAL SURCHARGE - LOWER WEDGE	0.0	pounds
TOTAL EXTERNAL SURCHARGE - UPPER WEDGE	0.0	pounds
WEIGHT OF LOWER TRIAL FAILURE WEDGE	5403.9	pounds
WEIGHT OF UPPER TRIAL FAILURE WEDGE	665.1	pounds
NUMBER OF TRIAL WEDGES ANALYZED	803	trials
LENGTH OF FAILURE PLANE	9.3	feet
DEPTH OF TENSION CRACK	5.8	feet
HORIZONTAL DISTANCE TO UPSLOPE TENSION CRACK	7.0	feet
CALCULATED HORIZONTAL THRUST ON WALL	**-702.4**	**pounds**
CALCULATED EQUIVALENT FLUID PRESSURE	**-14.0**	**pcf**
DESIGN EQUIVALENT FLUID PRESSURE	**30.0**	**pcf**

CONCLUSIONS:

THE CALCULATION INDICATES THAT THE PROPOSED RETAINING WALL SURCHARGED BY A COMPLEX BACKSLOPE MAY BE DESIGNED FOR AN EQUIVALENT FLUID PRESSURE OF 30 POUNDS PER CUBIC FOOT.

Bay City Geology, Inc.

RETAINING WALL - COMPLEX BACKSLOPE

SHEET 2

File No. 2421
Project: 2553 Onyx Dr

ASSUME: Upper Rear Wall

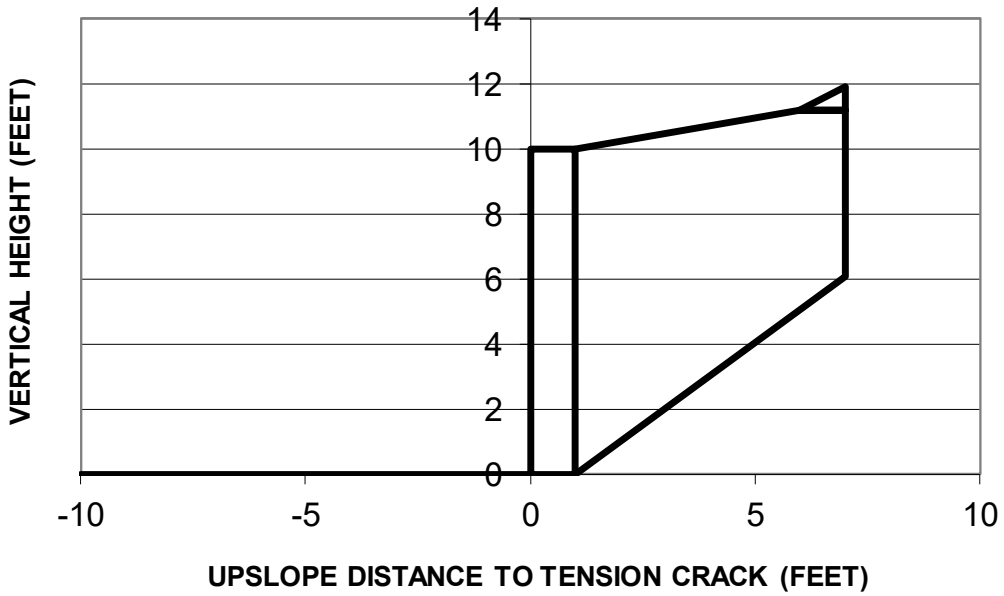
CALCULATE THE DESIGN MINIMUM EQUIVALENT FLUID PRESSURE (EFP) FOR PROPOSED RETAINING WALLS WITH A COMPLEX BACKSLOPE. THE LOWER WALL HEIGHT, UPSLOPE DISTANCE TO CHANGE IN SLOPE, AND BACKSLOPE AND SURCHARGE CONDITIONS ARE LISTED BELOW. ASSUME THE BACKFILL IS SATURATED WITH NO EXCESS HYDROSTATIC PRESSURE.

CALCULATION RESULTS

EARTH MATERIAL:	Fav./Adv. Tpsh/Qs/Af		INITIAL BACKSLOPE:	11.3	degrees
SHEAR DIAGRAM:	Lowest Vals.		UPPER BACKSLOPE:	35.2	degrees
LOWER WALL	10	feet	LOWER SURCHARGE:	0	pounds
NO UPPER WALL:	0	feet	SURCHARGE TYPE:	U	Uniform
COHESION:	552	psf	UPPER SURCHARGE:	0	pounds
PHI ANGLE:	21.8	degrees	SURCHARGE TYPE:	U	Uniform
DENSITY:	112.7	pcf	CRITICAL FAILURE ANGLE	41	degrees
SAFETY FACTOR:	1.5		FAILURE PLANE LENGTH	9.3	feet
WALL FRICTION	0	degrees	TENSION CRACK DEPTH	5.8	feet
			TENSION CRACK DIST.	7	feet

CALCULATED HORIZONTAL THRUST ON WALL	**-702.4**	**pounds**
CALCULATED EQUIVALENT FLUID PRESSURE	**-14.0**	**pcf**
DESIGN EQUIVALENT FLUID PRESSURE	**30.0**	**pcf**

GENERAL SHAPE OF CRITICAL FAILURE



Bay City Geology, Inc.

RETAINING WALL

File No. **2421**
Project: **2553 Onyx Dr**

ASSUME: Site Walls w/ LEVEL B.S.

CALCULATE THE DESIGN MINIMUM EQUIVALENT FLUID PRESSURE (EFP) FOR THE PROPOSED RETAINING WALLS. THE WALL HEIGHT, BACKSLOPE GEOMETRY, AND SURCHARGE CONDITIONS ARE LISTED BELOW. ASSUME THE BACKFILL IS SATURATED WITH NO EXCESS HYDROSTATIC PRESSURE. USE THE MONONOBE-OKABE METHOD FOR SEISMIC FORCES.

CALCULATION PARAMETERS

EARTH MATERIAL:	Fav./Adv. Tpsh/Qs/Af		WALL HEIGHT	10	feet
SHEAR DIAGRAM:	Lowest Vals.		BACKSLOPE ANGLE:	0	degrees
COHESION:	552	psf	SURCHARGE:	0	pounds
PHI ANGLE:	21.8	degrees	SURCHARGE TYPE:	P	Point
DENSITY	112.7	pcf	INITIAL FAILURE ANGLE:	10	degrees
SAFETY FACTOR:	1.5		FINAL FAILURE ANGLE:	80	degrees
WALL FRICTION	0	degrees	INITIAL TENSION CRACK:	1	feet
CD (C/FS):	368.0	psf	FINAL TENSION CRACK:	20	feet
PHID = ATAN(TAN(PHI)/FS) =		14.9 degrees			
HORIZONTAL PSEUDO STATIC SEISMIC COEFFICIENT (k_h)				0	*g
VERTICAL PSEUDO STATIC SEISMIC COEFFICIENT (k_v)				0	*g

Run Calculation

CALCULATED RESULTS

CRITICAL FAILURE ANGLE	53	degrees
AREA OF TRIAL FAILURE WEDGE	9.3	square feet
TOTAL EXTERNAL SURCHARGE	0.0	pounds
WEIGHT OF TRIAL FAILURE WEDGE	1052.2	pounds
NUMBER OF TRIAL WEDGES ANALYZED	1420	trials
LENGTH OF FAILURE PLANE	1.7	feet
DEPTH OF TENSION CRACK	8.7	feet
HORIZONTAL DISTANCE TO UPSLOPE TENSION CRACK	1.0	feet
CALCULATED HORIZONTAL THRUST ON WALL	**73.6**	**pounds**
CALCULATED EQUIVALENT FLUID PRESSURE	**1.5**	**pcf**
DESIGN EQUIVALENT FLUID PRESSURE	**30.0**	**pcf**

THE CALCULATION INDICATES THAT THE PROPOSED RETAINING WALL MAY BE DESIGNED FOR AN EQUIVALENT FLUID PRESSURE OF 30 POUNDS PER CUBIC FOOT.

Bay City Geology, Inc.

Project:	2553 Onyx Dr			
File No.:	2421			
Description:	Retaining Wall Design, At-Rest Pressure			
[Assume: Retaining Adv./Neut. Bedrock (Tpsh) w/ minor Soil (CL) and/or Ex. Fill (CL); Wall Ht. = 26 ft. Max.]				
Soil Weight		γ	112.7	pcf
Internal Friction Angle		ϕ	29.8	degrees
Cohesion		c	552	psf
Height of Retaining Wall		H	26	feet
Backslope Inclination Angle		β	0	degrees

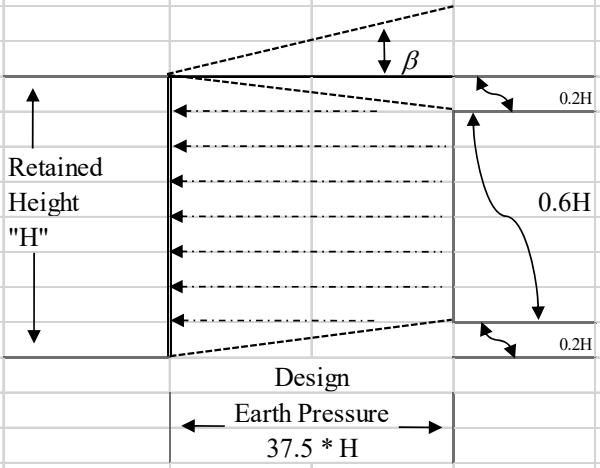
Retaining Wall Design based on At Rest Earth Press. - Triangular Earth Press. Distrib.

$\sigma'_h = K_o\sigma'_v$				
	$K_o = (1 - \sin\phi) * (1 + \sin\beta)$		0.503	
	$\sigma'_v = \gamma H$		2930.2	psf
σ'_h =	1474.0	psf		
EFP =	56.7	pcf		
P_o =	19161.6	lbs/ft	(based on a triangular distribution of pressure)	
Design wall for an EFP of		60	pcf	

Retaining Wall Design based on At Rest Earth Press. - Trapezoidal Earth Press. Distrib.

P_o =	19161.6	lbs/ft		
$\sigma'_{h,\,max}$ =	35.4	H	(based on a trapezoidal distribution of pressure)	
$\sigma'_{h,\,max}$ =	737.0	psf		
Design restrained wall for		37.5	H	psf

Trapazoidal Distribution of Earth Pressure



Bay City Geology, Inc.

Project: 2553 Onyx Dr

File No.: 2421

Description: Retaining Wall - Seismicaly Induced Pressure

[Assume: Retaining Adv./Neut. Bedrock (Tpsh) w/ minor Soil (CL) and/or E. Fill (CL); Wall = 26 ft. MAX.]

Seismically Induced Lateral Soil Pressure on Retaining Wall

Input:

Max. Height of Retaining Wall:	(H)	26.0	feet
Retained Soil Unit Weight:	(γ)	112.7	pcf
Site Modified Peak Ground Accel.:	(PGA_M)	1.054	g
Horizontal Ground Acceleration:	(k_h) = (1/2)*(2/3)*(PGA_M)	0.351	g

Seismic Lateral Increment (ΔP_{AE}), per LADBS IB P/BC 2020-083:

$\Delta P_{AE} = (0.5*\gamma*H^2)*(0.75*k_h)$

ΔP_{AE} = 10037.4 lbs/ft

Seismic Lateral Increment (ΔP_{AE}) applied at (1/3) * H above the base of the wall, per Mikola & Sitar (2013).

Design Seismic Lateral Equivalent Fluid Pressure using an "Upright" triangular earth pressure distribution.

Seismic Design EFP = $2*\Delta P_{AE}/H^2$

Seismic Design EFP = 29.7 pcf

Design wall for an Seismic Lateral Soil EFP of 30 pcf

Bay City Geology, Inc.

TEMPORARY SHORING

File No. **2421**
Project: **2553 Onyx Dr**

ASSUME: Wall Ex. w/ LEVEL B.S. & minor Soil/Fill

CALCULATE THE DESIGN MINIMUM EQUIVALENT FLUID PRESSURE (EFP) FOR PROPOSED TEMPORARY SHORING. THE SHORED EMBANKMENT HEIGHT, BACKSLOPE GEOMETRY, AND SURCHARGE CONDITIONS ARE LISTED BELOW. ASSUME THE RETAINED EARTH MATERIALS ARE SATURATED AND FREE DRAINING.

CALCULATION PARAMETERS

EARTH MATERIAL:	Bedrock (Tpsh)		RETAINED LENGTH	40	feet
SHEAR DIAGRAM:	Lowest Resid. Vals.		BACKSLOPE ANGLE:	0	degrees
COHESION:	552	psf	SURCHARGE:	0	pounds
PHI ANGLE:	29.8	degrees	SURCHARGE TYPE:	P	Point
DENSITY	112.7	pcf	INITIAL FAILURE ANGLE:	10	degrees
SAFETY FACTOR:	1.25		FINAL FAILURE ANGLE:	80	degrees
PILE FRICTION	0	degrees	INITIAL TENSION CRACK:	1	feet
CD (C/FS):	441.6	psf	FINAL TENSION CRACK:	53	feet
PHID = ATAN(TAN(PHI)/FS) =		24.6	degrees		
HORIZONTAL PSEUDO STATIC SEISMIC COEFFICIENT (k_h)				0	*g
VERTICAL PSEUDO STATIC SEISMIC COEFFICIENT (k_v)				0	*g

Run Calculation

CALCULATED RESULTS

CRITICAL FAILURE ANGLE	57	degrees
AREA OF TRIAL FAILURE WEDGE	470.5	square feet
TOTAL EXTERNAL SURCHARGE	0.0	pounds
WEIGHT OF TRIAL FAILURE WEDGE	53030.1	pounds
NUMBER OF TRIAL WEDGES ANALYZED	3763	trials
LENGTH OF FAILURE PLANE	33.0	feet
DEPTH OF TENSION CRACK	12.3	feet
HORIZONTAL DISTANCE TO UPSLOPE TENSION CRACK	18.0	feet
CALCULATED THRUST ON PILE	**17921.8**	**pounds**
CALCULATED EQUIVALENT FLUID PRESSURE	**22.4**	**pcf**
DESIGN EQUIVALENT FLUID PRESSURE	**25.0**	**pcf**

THE CALCULATION INDICATES THAT THE PROPOSED SHORING PILES MAY BE DESIGNED FOR AN EQUIVALENT FLUID PRESSURE OF 25 POUNDS PER CUBIC FOOT. THE FLUID PRESSURE SHOULD BE MULTIPLIED BY THE PILE SPACING.

Bay City Geology, Inc.

TEMPORARY SHORING

File No. **2421**
Project: **2553 Onyx Dr**

ASSUME: Wall Excavations w/ 1H:1V Max. B.S.

CALCULATE THE DESIGN MINIMUM EQUIVALENT FLUID PRESSURE (EFP) FOR PROPOSED TEMPORARY SHORING. THE SHORED EMBANKMENT HEIGHT, BACKSLOPE GEOMETRY, AND SURCHARGE CONDITIONS ARE LISTED BELOW. ASSUME THE RETAINED EARTH MATERIALS ARE SATURATED AND FREE DRAINING.

CALCULATION PARAMETERS

EARTH MATERIAL:	Bedrock (Tpsh)		RETAINED LENGTH	17	feet
SHEAR DIAGRAM:	Lowest Resid. Vals.		BACKSLOPE ANGLE:	45	degrees
COHESION:	552	psf	SURCHARGE:	0	pounds
PHI ANGLE:	29.8	degrees	SURCHARGE TYPE:	P	Point
DENSITY	112.7	pcf	INITIAL FAILURE ANGLE:	10	degrees
SAFETY FACTOR:	1.25		FINAL FAILURE ANGLE:	80	degrees
PILE FRICTION	0	degrees	INITIAL TENSION CRACK:	1	feet
CD (C/FS):	441.6	psf	FINAL TENSION CRACK:	30	feet
PHID = ATAN(TAN(PHI)/FS) =	24.6	degrees			
HORIZONTAL PSEUDO STATIC SEISMIC COEFFICIENT (k_h)	0	*g			
VERTICAL PSEUDO STATIC SEISMIC COEFFICIENT (k_v)	0	*g			

Run Calculation

CALCULATED RESULTS

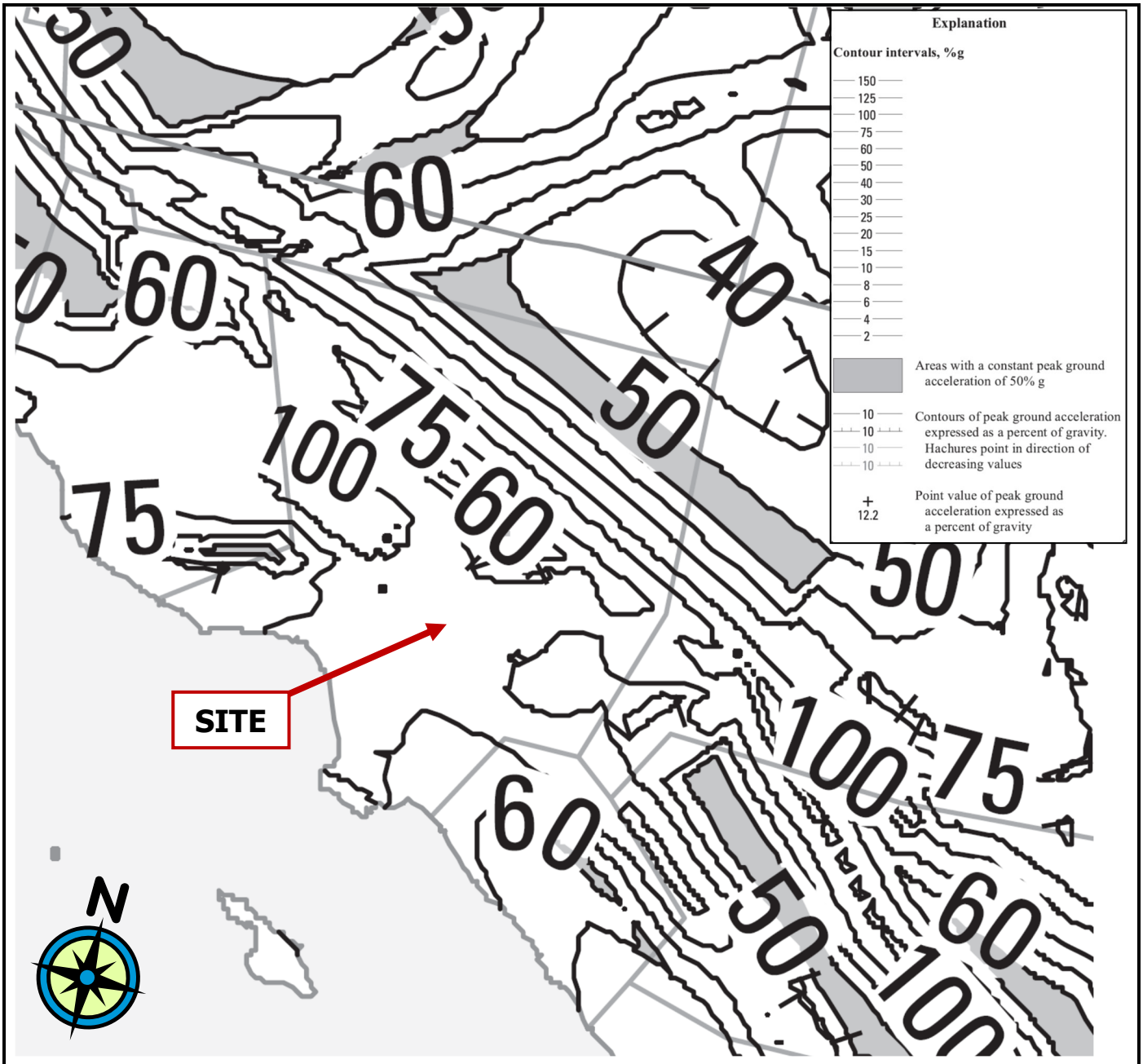
CRITICAL FAILURE ANGLE	45	degrees
AREA OF TRIAL FAILURE WEDGE	510.0	square feet
TOTAL EXTERNAL SURCHARGE	0.0	pounds
WEIGHT OF TRIAL FAILURE WEDGE	57477.0	pounds
NUMBER OF TRIAL WEDGES ANALYZED	2130	trials
LENGTH OF FAILURE PLANE	42.4	feet
DEPTH OF TENSION CRACK	17.0	feet
HORIZONTAL DISTANCE TO UPSLOPE TENSION CRACK	30.0	feet
CALCULATED THRUST ON PILE	**3186.9**	**pounds**
CALCULATED EQUIVALENT FLUID PRESSURE	**22.1**	**pcf**
DESIGN EQUIVALENT FLUID PRESSURE	**25.0**	**pcf**

THE CALCULATION INDICATES THAT THE PROPOSED SHORING PILES MAY BE DESIGNED FOR AN EQUIVALENT FLUID PRESSURE OF 25 POUNDS PER CUBIC FOOT. THE FLUID PRESSURE SHOULD BE MULTIPLIED BY THE PILE SPACING.

Seismic Design Considerations

Any new structures to be developed in the proposed development area should be designed in accordance with the seismic design considerations contained in 2019 California Building Code (CBC) §1613 and ASCE Standard: ASCE/SEI 7-16, the following parameters should be considered for design.

MAXIMUM CONSIDERED EARTHQUAKE GEOMETRIC MEAN



Reference:	Portion of Figure 22-9, ASCE Standard: ASCE/SEI 7-16	Plate 4
Project Address:	2553 Onyx Drive Los Angeles, California	Latitude = 34.076352° Longitude = -118.197213°

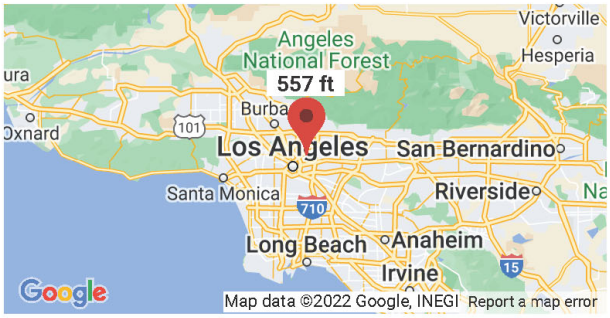
This is a beta release of the new ATC Hazards by Location website. Please contact us with feedback.

The ATC Hazards by Location website will not be updated to support ASCE 7-22. Find out why.

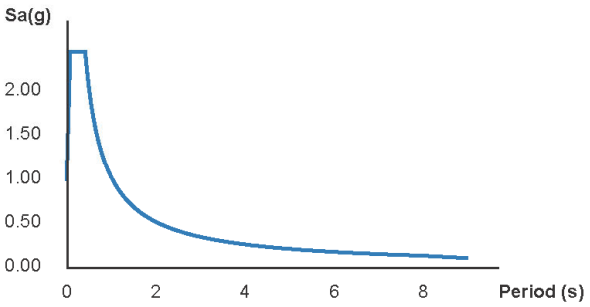
Hazards by Location

Search Information

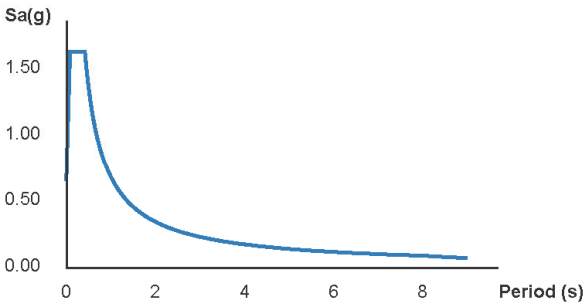
Coordinates:	34.076352, -118.197213
Elevation:	557 ft
Timestamp:	2022-08-05T16:51:27.044Z
Hazard Type:	Seismic
Reference Document:	ASCE7-16
Risk Category:	II
Site Class:	C



MCER Horizontal Response Spectrum



Design Horizontal Response Spectrum



Basic Parameters

Name	Value	Description
S_S	2.031	MCE_R ground motion (period=0.2s)
S_1	0.728	MCE_R ground motion (period=1.0s)
S_{MS}	2.437	Site-modified spectral acceleration value
S_{M1}	1.019	Site-modified spectral acceleration value
S_{DS}	1.625	Numeric seismic design value at 0.2s SA
S_{D1}	0.679	Numeric seismic design value at 1.0s SA

Additional Information

Name	Value	Description
SDC	D	Seismic design category
F_a	1.2	Site amplification factor at 0.2s

F_v	1.4	Site amplification factor at 1.0s
CR_S	0.888	Coefficient of risk (0.2s)
CR_1	0.891	Coefficient of risk (1.0s)
PGA	0.878	MCE_G peak ground acceleration
F_{PGA}	1.2	Site amplification factor at PGA
PGA_M	1.054	Site modified peak ground acceleration
T_L	8	Long-period transition period (s)
SsRT	2.031	Probabilistic risk-targeted ground motion (0.2s)
SsUH	2.287	Factored uniform-hazard spectral acceleration (2% probability of exceedance in 50 years)
SsD	2.465	Factored deterministic acceleration value (0.2s)
S1RT	0.728	Probabilistic risk-targeted ground motion (1.0s)
S1UH	0.817	Factored uniform-hazard spectral acceleration (2% probability of exceedance in 50 years)
S1D	0.757	Factored deterministic acceleration value (1.0s)
PGAd	0.987	Factored deterministic acceleration value (PGA)

The results indicated here DO NOT reflect any state or local amendments to the values or any delineation lines made during the building code adoption process. Users should confirm any output obtained from this tool with the local Authority Having Jurisdiction before proceeding with design.

Please note that the ATC Hazards by Location website will not be updated to support ASCE 7-22. Find out why.

Disclaimer

Hazard loads are provided by the U.S. Geological Survey Seismic Design Web Services.

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U.S. Geological Survey - Earthquake Hazards Program

Unified Hazard Tool

Please do not use this tool to obtain ground motion parameter values for the design code reference documents covered by the U.S. Seismic Design Maps web tools (e.g., the International Building Code and the ASCE 7 or 41 Standard). The values returned by the two applications are not identical.

Input

Edition
Dynamic: Conterminous U.S. 2014 (u…

Spectral Period
Peak Ground Acceleration

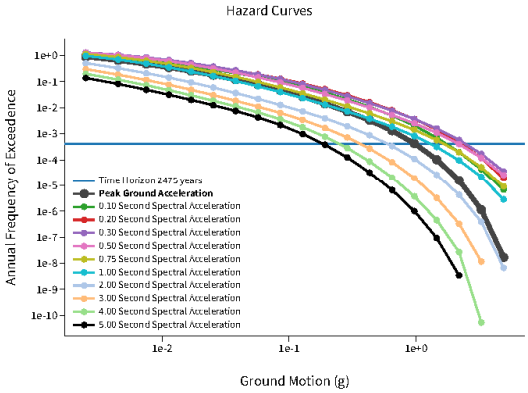
Latitude
Decimal degrees
34.076352

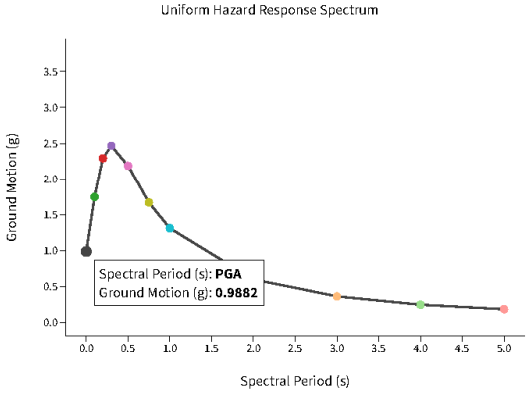
Time Horizon
Return period in years
2475

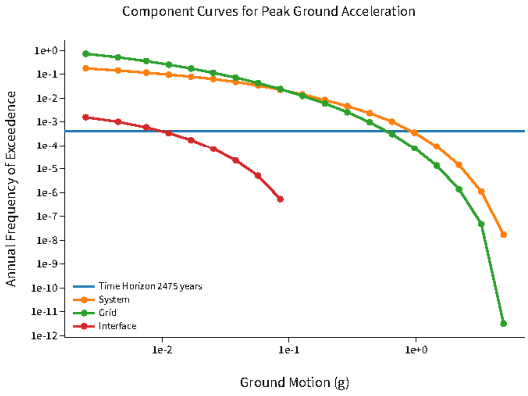
Longitude
Decimal degrees, negative values for western longitudes
-118.197213

Site Class
360 m/s (C/D boundary)

Hazard Curve





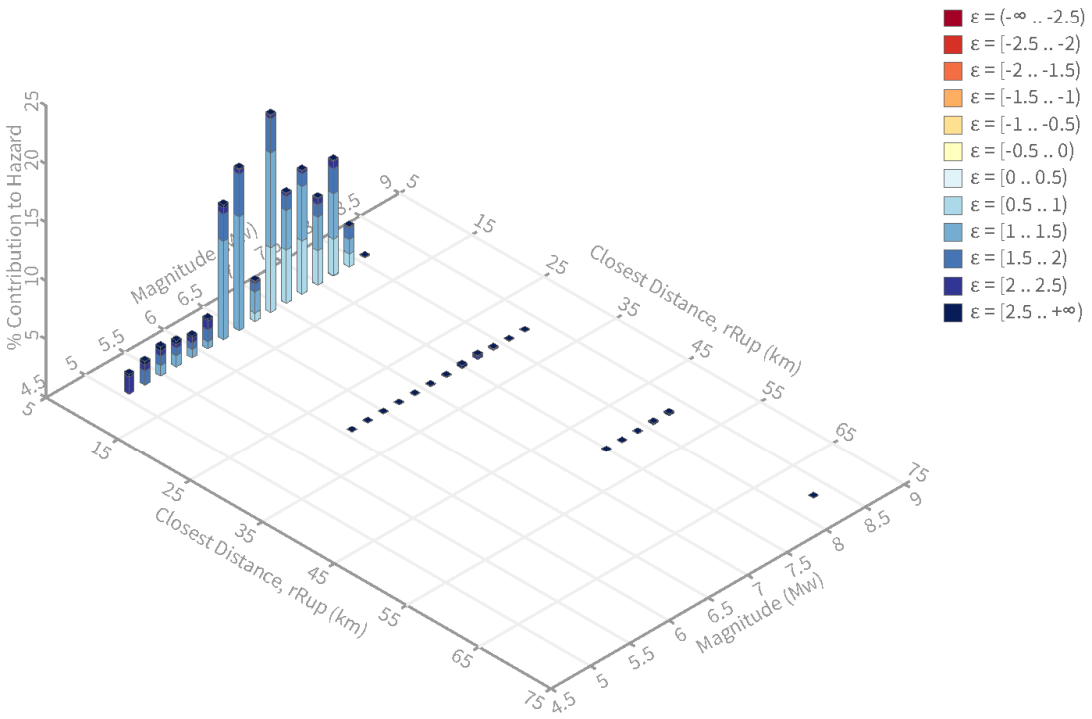


View Raw Data

Deaggregation

Component

Total



Summary statistics for, Deaggregation: Total

Deaggregation targets

Return period: 2475 yrs
Exceedance rate: 0.0004040404 yr^{-1}
PGA ground motion: 0.98816143 g

Recovered targets

Return period: 2918.3088 yrs
Exceedance rate: 0.00034266422 yr^{-1}

Totals

Binned: 100 %
Residual: 0 %
Trace: 0.05 %

Mean (over all sources)

m: 6.85
r: 7.62 km
ε_0: 1.34 σ

Mode (largest m-r bin)

m: 6.9
r: 6.15 km
ε_0: 1.19 σ
Contribution: 16.89 %

Mode (largest m-r-ε_0 bin)

m: 6.53
r: 5.46 km
ε_0: 1.15 σ
Contribution: 9.73 %

Discretization

r: min = 0.0, max = 1000.0, Δ = 20.0 km
m: min = 4.4, max = 9.4, Δ = 0.2
ε: min = -3.0, max = 3.0, Δ = 0.5 σ

Epsilon keys

ε0: [-∞ .. -2.5)
ε1: [-2.5 .. -2.0)
ε2: [-2.0 .. -1.5)
ε3: [-1.5 .. -1.0)
ε4: [-1.0 .. -0.5)
ε5: [-0.5 .. 0.0)
ε6: [0.0 .. 0.5)
ε7: [0.5 .. 1.0)
ε8: [1.0 .. 1.5)
ε9: [1.5 .. 2.0)
ε10: [2.0 .. 2.5)
ε11: [2.5 .. +∞]

Deaggregation Contributors

Source Set ↳ Source	Type	r	m	ε_0	lon	lat	az	%
UC33brAvg_FM31	System							44.48
Elysian Park (Upper) [1]		4.21	6.70	1.14	118.200°W	34.074°N	226.05	25.51
Compton [2]		16.11	7.37	1.29	118.334°W	33.836°N	205.41	4.11
Raymond [2]		5.46	7.10	1.40	118.193°W	34.123°N	4.08	3.67
Puente Hills [4]		7.76	7.10	1.06	118.233°W	34.034°N	215.26	2.88
Puente Hills [3]		7.90	7.22	1.03	118.217°W	34.023°N	196.93	1.21
Raymond [1]		7.29	7.45	1.38	118.142°W	34.121°N	45.22	1.17
Sierra Madre [5]		15.84	7.70	1.94	118.160°W	34.215°N	12.67	1.07
UC33brAvg_FM32	System							39.63
Elysian Park (Upper) [1]		4.21	7.05	1.05	118.200°W	34.074°N	226.05	18.82
Puente Hills (Santa Fe Springs) [1]		11.98	6.98	1.22	118.144°W	33.926°N	163.56	4.92
Compton [2]		16.11	7.39	1.27	118.334°W	33.836°N	205.41	4.27
Raymond [2]		5.46	7.09	1.40	118.193°W	34.123°N	4.08	3.17
Puente Hills (LA) [1]		7.03	7.14	0.88	118.254°W	34.014°N	216.94	1.51
Raymond [1]		7.29	7.47	1.38	118.142°W	34.121°N	45.22	1.16
Hollywood [0]		6.43	7.08	1.35	118.225°W	34.127°N	335.86	1.12
Sierra Madre [5]		15.84	7.73	1.93	118.160°W	34.215°N	12.67	1.04
UC33brAvg_FM32 (opt)	Grid							8.14
PointSourceFinite: -118.197, 34.099		5.65	5.68	1.67	118.197°W	34.099°N	0.00	2.59
PointSourceFinite: -118.197, 34.099		5.65	5.68	1.67	118.197°W	34.099°N	0.00	2.59
UC33brAvg_FM31 (opt)	Grid							7.75
PointSourceFinite: -118.197, 34.099		5.70	5.65	1.69	118.197°W	34.099°N	0.00	2.58
PointSourceFinite: -118.197, 34.099		5.70	5.65	1.69	118.197°W	34.099°N	0.00	2.58

APPENDIX IV – GENERAL RECOMMENDATIONS

Drainage and Maintenance

Maintenance of the property and structures located within must be performed to minimize the chance of serious damage and/or instability to improvements. Most problems are associated with or triggered by water. Therefore, a comprehensive drainage system should be designed and incorporated into the final plans. In addition, pad areas should be maintained and planted in a way that will allow this drainage system to function as intended. The following are specific drainage, maintenance, and landscaping recommendations. Reductions in these recommendations will reduce their effectiveness and may lead to damage and/or instability to the improvements. It is the responsibility of the property owner to ensure that the residence and drainage devices are maintained in accordance with the following recommendations and the requirements of all applicable government agencies.

Drainage
Positive pad drainage should be incorporated into the final plans. The pad should slope away from the footings at a minimum five percent slope for a horizontal distance of five feet. In areas where there is insufficient space for the recommended five-foot horizontal distance concrete or other impermeable surface should be provided for a minimum of three feet adjacent the structure. Pad drainage should be at a minimum of two percent slope where water flows over lawn or other planted areas. Drainage swales should be provided with area drains about every fifteen feet. Areas drains should be provided in the rear and side yards to collect drainage. All drainage from the pad should be directed so that water does not pond adjacent to the foundations or flow towards them. Roof gutters and downspouts are required for the proposed structures and should be connected into a buried area drain system. All drainage from the site should be collected and directed via non-erosive devices to a location approved by the building official. Area drains, subdrains, weep holes, roof gutters and downspouts should be inspected periodically to ensure that they are not clogged with debris or damaged. If they are clogged or damaged, they should be cleaned out or repaired.

Landscaping (Planting)
Planters placed immediately adjacent to the structures are not recommended. If planters are proposed immediately adjacent to structures, impervious above-grade or below-grade planter boxes with solid bottoms and drainage pipes away from the structure are suggested. All slopes should be maintained with a dense growth of plants, ground-covering vegetation, shrubs and trees that possess dense, deep root structures and require a minimum of irrigation. Plants surrounding the development should be of a variety that requires a minimum of watering. It is recommended that a landscape architect be consulted regarding planting adjacent to improvements. It will be the responsibility of the property owner to maintain the planting. Alterations of planting schemes should be reviewed by the landscape architect.

Irrigation
An adequate irrigation system is required to sustain landscaping. Over-watering resulting in runoff and/or ground saturation must be avoided. Irrigation systems must be adjusted to account for natural rainfall conditions. Any leaks or defective sprinklers must be repaired immediately. To mitigate erosion and saturation, automatic sprinkling systems must be adjusted for rainy seasons. A landscape architect should be consulted to determine the best times for landscape watering and the proper usage.

Pools/Plumbing
Leakage from a swimming pool or plumbing can produce a perched groundwater condition that may cause instability or damage to improvements. Therefore, all plumbing should be leak-free. Pools located adjacent to descending slopes should be provided with a pool subdrain system.

Retaining Wall Backfilling

Walls to be backfilled must be reviewed by the project soils engineer prior to commencement of the backfilling operation.

1. Adequate permanent drainage is required behind the wall to minimize the buildup of hydrostatic pressures. A perforated pipe, with perforations placed down, shall be installed at the base of the wall footing. The pipe shall be encased in at least (1) foot of (¾) inch gravel. The pipe shall exit from behind the retaining wall and drain to a location approved by the architect or civil engineer.

   When space does not permit the installation of standard pipe and gravel drainage system, e.g. walls adjacent the property line, a flat drainage product is acceptable subject to approval of the governing agency.

   If a drainage system is not provided the walls should be designed to resist an external hydrostatic pressure due to water in addition to the lateral earth pressure in Retaining Walls section of this report. The entire wall should be design for full hydrostatic pressure based on a water level at the ground surface. In addition, floors would need to be designed for hydrostatic uplift and waterproofed.

2. A continuous vertical drain, consisting of a gravel blanket (6) inches thick or geotextile vertical drainage system, shall be placed along the back side of the wall to within (2) feet of the ground surface.

3. It is recommended that the retaining walls be waterproofed. Waterproofing design and inspection of installation is not the responsibility of the geotechnical engineer. Bay City Geology, Inc. does not practice in the field of water and moisture vapor transmission evaluation/mitigation. Therefore, we recommend that a qualified person/firm be engaged/consulted to evaluate the general and specific water and moisture vapor transmission paths and any impact on the proposed development. This person/firm should provide recommendations for mitigation of potential adverse impact of water and moisture vapor transmission on various components of the structure as deemed necessary.

4. After the wall backdrain system has been placed and the waterproofing installed, fill may be placed, if sufficient room allows, in layers not exceeding (4) inches in thickness and compacted to (90) percent of the maximum density, as determined by ASTM D1557. Where cohesionless soil having less than (15) percent finer than (0.005) millimeters is used for fill, the fill material shall be compacted to a minimum of (95) percent of the maximum dry density.

5. Where space does not permit compaction of material behind the wall (<24 inches wide), a granular backfill shall be used. This granular backfill shall consist of (½) inch to (¾) inch crushed rock gravel and should be densified by tamping into place. The crushed rock gravel backfill should not exceed a depth of (10) feet.

6. All granular free-draining wall backfills shall be capped with a clayey compacted soil within the upper (2) feet of the wall backfill. This compacted material should start below any required wall freeboard.

7. A concrete-lined swale drain should be placed behind any retaining wall that can intercept surface runoff from upslope areas. This surface runoff shall be transferred to an area approved by the building official.

8. A minimum freeboard of (24) inches shall be maintained at all times for all exterior retaining walls surcharged with a sloping back-cut. Any slough, debris or trash should be removed immediately. Swales shall be maintained, by sealing any and all cracks or repairing breaks that occur over the life of the swale.

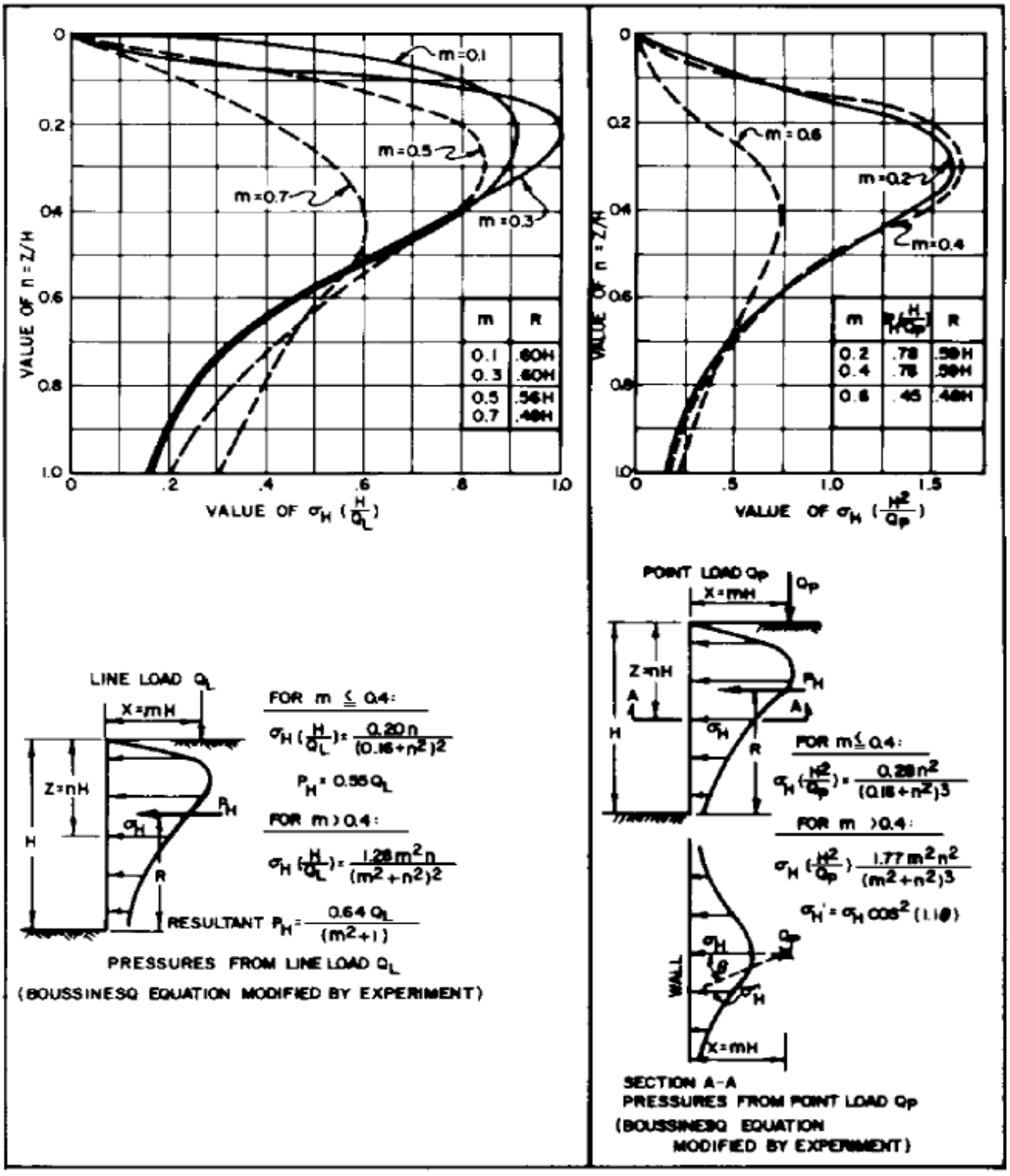


FIGURE 11
Horizontal Pressures on Rigid Wall from Surface Load

7.2-74

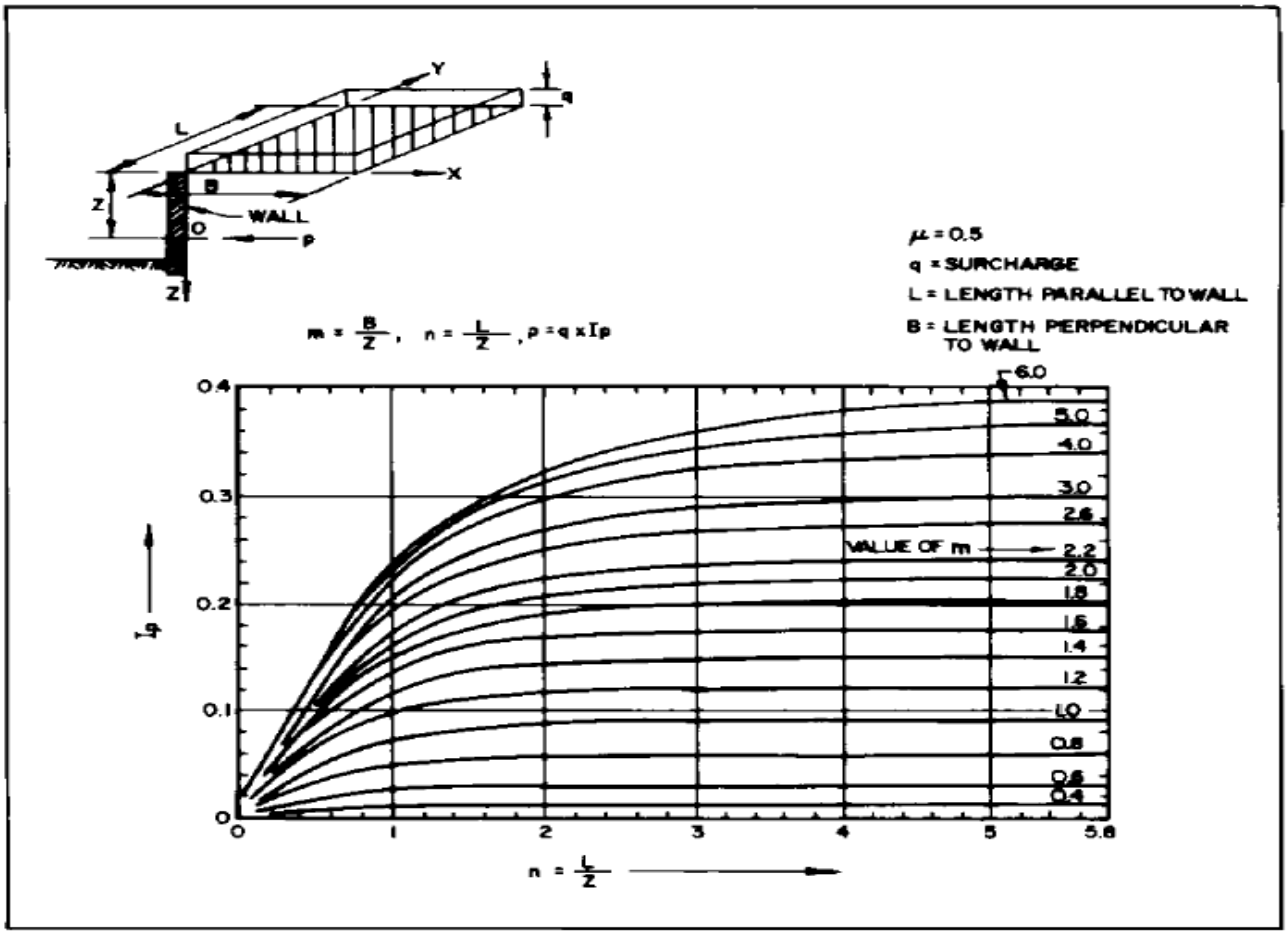


FIGURE 12
Lateral Pressure on an Unyielding Wall due to
Uniform Rectangular Surface Load

7.2-75

APPENDIX V - REFERENCES

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