Brunsing Associates, Inc.

GEOTECHNICAL INVESTIGATION

NASH MILL ROAD ASSOCIATION
LANDSLIDE EVALUATION AND REPAIR
NASH MILL ROAD
PHILO, CALIFORNIA

Project Number 13658.01

August 22, 2024

Engineers and Geologists

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PHILO, CALIFORNIA

Project Number 13658.01

prepared for

Nash Mill Road Association

prepared by

Brunsing Associates, Inc.

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August 22, 2024

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1.0 INTRODUCTION

This report presents the results of our geotechnical investigation that Brunsing Associates, Inc. (BAI) has performed for the landslide located on Nash Mill Road, California. The subject landslide is located near the coordinates of latitude 39.127328° and longitude -123.492166°. The approximate location of the site is shown on the Vicinity Map, Plate 1. The landslide has damaged Nash Mill Road rendering it intermittently impassible. It is our understanding that the Nash Mill Road Association (Client) is seeking remediation recommendations to stabilize the roadway.

The purpose of our investigation was to evaluate the site soil and bedrock conditions in order to provide conclusions and recommendations regarding site grading, surface and subsurface drainage improvements and a geologic hazard assessment. Our approach to providing the geotechnical guidelines for the design of the project utilized our knowledge of the soil, bedrock and geologic conditions in the site vicinity and our experience with similar projects in the area. Field exploration for this investigation was directed toward confirming anticipated soil, bedrock and geologic conditions, in order to provide the basis for our conclusions and recommendations. As outlined in our Professional Services Agreement, dated August 11, 2023, and our change order dated April 17, 2024 our scope of services for the geotechnical investigation included subsurface exploration, and engineering and geologic analyses, in order to provide conclusions and recommendations regarding:

- Site preparation, grading and excavation characteristics.
- Engineered fill slope design criteria.
- Site drainage improvements including subdrains.
- Additional geotechnical services as appropriate.

2.0 INVESTIGATION

2.1 Research

As part of our investigation, we reviewed published geotechnical literature, including geologic, fault and seismic hazard maps for the site and vicinity. A list of selected published references reviewed for this investigation is presented in Appendix A.

2.2 Field Reconnaissance

BAI's senior engineering geologists visited the site along with BAI's principal engineering geologist to perform a site reconnaissance on January 8, 2024.

BAI's principal geotechnical engineer performed a reconnaissance of the site on March 7, 2024. He observed the existing landslide conditions, drainage conditions and photographed the site.

2.3 Field Exploration

The field exploration consisted of drilling, logging and sampling four exploratory borings, B-1 was advanced on December 14th, 2023, to a maximum depth of 35.5 feet below the surface.

Borings B-2, B-3 and B-4 were completed on May 1, 2024 to depths between 21.5 and 27.5 feet below the surface. The approximate location of the borings are shown on the Site Map, Plate 2. The borings were advanced using truck mounted drilling equipment equipped with 8-inch hollow stem and 6-inch solid stem flight augers.

Our senior engineering geologist logged the borings and obtained relatively undisturbed soil and bedrock samples using a 3.0-inch (CA), 2.5-inch (CM) and 2.0-inch (SPT) outside diameter, modified California split-barrel samplers. The inside of the sampler barrels contained liners for retaining the soil and bedrock samples. The samplers were driven by a 140-pound drop hammer falling 30 inches per blow. Blows required to drive the CA and CM samplers were converted to Standard Penetration Test (SPT) blow counts for correlation with empirical test data using a conversion factor of 0.64 and 0.79, respectively. SPT blow counts provide a relative measure of soil and bedrock consistency and strength and are utilized in our engineering analyses. Blow counts are presented on the boring logs alongside the sample locations.

The test boring locations are shown on the Site Map, Plate 2. The logs of the test borings showing the various soil and bedrock materials encountered and the depths at which samples were obtained are presented on Plates 3 through 6. The soils are classified in accordance with the Unified Soil Classification System outlined on Plate 7. The soil and bedrock descriptive properties are presented on Plates 8 and 9, respectively.

2.4 Slope Inclinometer Monitoring

Slope inclinometer casing was installed in borings B-1 after drilling was completed. The casing was comprised of 2.75-inch diameter, acrylonitrile butadiene styrene (ABS) plastic pipe with machined grooves on the inside to allow for insertion of an inclinometer probe which measures tilt of the casing. An initial reading set (“base reading”) was taken on the inclinometers on December 21, 2023. Subsequent readings were taken on January 8 and February 20, 2024. The February 20, 2024, reading showed that the casing had been sheared off at a depth below 20 feet from the top of casing. Plots of the inclinometer data from boring B-1 are presented in Appendix B.

2.5 Laboratory Testing

Soil and bedrock samples obtained during our subsurface exploration were transported to our laboratory and examined to confirm field classifications. Laboratory tests were performed on selected samples to estimate their pertinent geotechnical engineering characteristics. Laboratory testing consisted of moisture content, density, classification and unconsolidated-undrained triaxial compression tests.

The test results are presented opposite the samples tested on the boring logs. A key to test data is provided on Plate 7. Atterberg limits test results are presented on Plate 10. Triaxial compression test results are presented on Plates 11 and 12.

3.0 SITE CONDITIONS

The project site is located in Mendocino County east of the Highway 128 corridor, approximately 5 miles north of the town of Philo. The site is approximately 1.5 miles northeast of the intersection of Nash Mill Road and Highway 128. The site consists of moderate to steeply northwest facing slopes which are generally well vegetated with forest and brush. Mill Creek is located approximately 1/4 miles to the northwest of the site. The site is bordered by Mill Creek to the northwest, undeveloped forested terrain to the east and west, and an unpaved road to the south. Regional drainage is provided by the Navarro River which is located approximately 2 miles southwest.

The project site consists of the areas of Nash Mill Road and those areas immediately adjacent which have been disturbed by the recent slope instability. It appears that this area of recent instability is part of a larger historic instability extends upslope (to the southeast) to the unpaved access road and beyond and downslope (to the northwest) to Mill Creek and measures approximately 1,600 linear feet long by 200 wide or more. Available geologic mapping published in 1980 indicates a landslide in this general area, and anecdotal information provided by the Client indicates that the area of instability was present at the time of the construction of Nash Mill Road. Based on our observations the unstable areas consist of a landslide complex composed of overlapping areas of instability. These appear to express themselves as a combination of translational and rotational landsliding as well as soil creep withing the near surface deposits. Hummocky terrain, topographic inflections and leaning, “pistol butted” trees suggest active downslope movement has been occurring for some time.

Nash Mill Road traverses this area of recent instability which extends approximately 70 feet upslope of Nash Mill Road and 150 feet downslope. Based on information provided by the Client, we understand this recent instability began during the winter of 2017 and has continued intermittently until the present. The Client suggests that at times the movements have been significant and have temporarily disrupted traffic along Nash Mill Road. We understand passage has been maintained by grading consisting of cutting and filling of the adjacent slopes and the placement of imported fill from a nearby quarry.

An inboard earthen drainage ditch was observed upslope of Nash Mill Road. Part of the water in this drainage ditch is being captured by an 18-inch corrugated polycarbonate culvert which crossed Nash Mill Road near the western extent of the instability. This culvert discharges approximately 35 feet downslope of Nash Mill Road along the western perimeter of the area of instability. Both the drainage ditch and the culvert were flowing at the times of our site visits.

Seepage was observed within the unstable area immediately upslope of Nash Mill Road and as well as several locations withing the unstable area downslope of Nash Mill Road. Groundwater was encountered in all of the exploratory borings at depths ranging from 16.5 to 24.0 feet below the surface.

4.0 SITE GEOLOGY AND SOIL CONDITIONS

Based on our literature review, the site is underlain by sedimentary bedrock of the Jurassic to Cretaceous aged Franciscan Formation. The bedrock is described as consisting of shale and sandstones which are pervasively sheared. Shearing approaches that of mélange units but lacks exotic blocks. This was confirmed by our subsurface investigation which encountered sheared sandstone and shale bedrock at depths of 9 to 17 feet below the existing ground surface which extended to the maximum depths explored. In general, the bedrock is crushed to closely fractured, soft to low hardness and deeply to moderately weathered.

The bedrock is overlain by localized deposits of artificial fill, landslide deposits, and residual soil deposits. Fill was encountered in all of the borings. It is our understanding that portions of this material had been imported to the site intermittently in the past to construct and maintain the roadway. This fill extended to between 3 and 9.5 feet below the surface. The fill appeared to consist of onsite material (colluvial soils and/or landslide deposits) and imported soils which had been reworked by grading at some time prior to our exploration and consisted of sandy clay and clayey gravels. The fill was generally soft/loose to medium stiff/medium dense. Boring B-1 and B-2 were advanced on the downslope side and upslope side, respectively, of Nash Mill Road. Boring B-1 encountered heterogenous fill deposits that extended to 9.5 feet below the surface. The fill appeared to consist of recently placed clayey/silty gravel deposits which were medium dense and moist which extended to 4 feet below the surface underlain by older fill consisting of sandy silt that extended to 9.5 feet below the surface. It is our understanding that these fills were placed to construct the road and maintain access following landsliding. Underlying the fill in B-1 landslide deposits were encountered consisting of silty sand that were loose to medium dense and moist. These deposits were underlain by bedrock deposits consisting of sheared shale and sandstone crushed, friable and deeply weathered. Red brown staining was observed within fractures. The bedrock extended to the maximum depth explored (35.5 feet below the surface). A thin layer of sandy silt was observed at 25.5 feet. Boring B-2 was advanced upslope of Nase Mill Road and encountered fill deposits that extended to 5 feet below the surface and consisted of bank run imported fill quarried and imported to the site to maintain access and provided for a level drilling platform. These deposits were underlain by landslide deposits to a depth of 9.5 feet consisting of silty sand that were very loose to loose, wet and contained a few gravels. Underlying the landslide deposits in B-2 sheared sandstone and shale bedrock was encountered that extended to the maximum depths explored (27.5 feet below the surface). Boring B-3 and B-4 were advanced adjacent to the eastern and western extents of the project site and encountered similar deposits. In B-3 and B-4 the surficial deposits (fill/landslide deposits/residual soil) extended to depths of 8 to 12 feet below the surface and were underlain by sheared shale and sandstone bedrock that extended to the maximum depths explored (21.5 and 24.5 feet below the surface, respectively). A possible older landslide plane might have been observed at about 22 feet below the ground surface. Groundwater was encountered at depths between 16.5 and 24 feet below the surface and as perched seeps within the landslide deposits.

No evidence of active faulting was observed in the site vicinity and none of the geologic references that we reviewed show faults on or trending towards the property. The active San Andreas fault is located near the coastline, approximately 13.5 miles southwest of the site. The active Maacama fault zone is located approximately 16.5 miles northeast of the site.

5.0 DISCUSSIONS AND CONCLUSIONS

5.1 General

Based upon the results of our investigation, we conclude that the proposed landslide repair is feasible from a geotechnical point of view. The main geotechnical considerations affecting the design and construction of the project is the areas of potential instability underlying the site, the areas of undocumented fill, site drainage, groundwater, the steep slopes within and surrounding the site, and the potential for strong seismic shaking.

Mitigation of the area of instability can consist of the removal of the unstable material to expose supporting bedrock and the subsequent reconstruction of the road. During roadway construction subsurface drainage should be improved by the construction of a network of subdrains at the interface between the bedrock and the fills. We anticipate that the roadway construction will require hillside grading including keying and benching into supporting bedrock and the construction of engineered fill slopes. We anticipate that fill slopes in excess of 1.5:1 (horizontal to vertical) and up to 1:1 will be required. Fills placed with slopes in excess of 2:1 should be reinforced with geogrid according to the specifications of this report. We anticipate that cuts and fills of up to 20 vertical feet will be required to repair and stabilize the landslide area and achieve the desired grades.

Site grading will be limited to the area of Nash Mill Road and those areas immediately adjacent. Landslide deposits and unstable areas will remain upslope and downslope of the proposed repair. To minimize the potential for movement withing these deposits and to limit the groundwater intrusion into the area of repair, we recommend that a series of horizontal drains be installed upslope of the area of repair. These drains should be spaced approximately 6 feet apart and advanced a minimum of 20 feet into bedrock as determined the representative of BAI in the field. Horizontal well depths of 30 to 50 feet should be anticipated. If site grading/mitigation is completed prior to the next rainy season, horizontal drains may not be required (depending on conditions encountered in the field during construction). BAI should be consulted during site grading to assess the need for horizontal drains.

If site grading is not completed prior to the next rainy season, we recommend that horizontal drains be installed to minimize groundwater intrusion into the area of instability during the wet season. Concurrently a curtain drain should be installed on the upslope side of Nash Mill Road, extending across the project area. The drain should be a minimum of 12 inches wide and extend through the near surface materials and a minimum of 1 foot into bedrock. The depth of the subdrain should be determined by a representative of BAI in the field at the time of construction, however, for planning purposes, depths of 10 feet should be anticipated. Class 2 permeable material should be used in lieu of ¾-inch crushed rock to eliminate the need for filter fabric. The subdrain should be constructed according to the general detail provided on Plate 13. General horizontal and curtain drain locations have been indicated on the Site Map, Plate 2.

5.2 Undocumented Fill/Landslide Deposits/Residual Soil

The project area is blanketed with areas of undocumented fill and landslide deposits. These deposits are generally of heterogenous composition and poorly consolidated. As a result, these materials are prone to erratic settlement and are unsuitable for the support of earthen fill. In addition, our exploration encountered residual soils which contained medium to high plasticity clays that are unstable and prone to downslope movement. These unsuitable deposits extend to depths between 9 and 26 feet below the surface. Engineered fill support should be obtained from the supporting bedrock encountered at depths ranging from 12 to 26 feet below the surface. Within the project area the undocumented fill, landslide deposit, and residual soils should be removed in their entirety and replaced as reinforced engineered fill according to the specifications of this report.

5.3 Seismicity and Faulting

As is typical of the Mendocino County area, the site will be subject to strong ground shaking during future, nearby, large magnitude earthquakes. The intensity of ground shaking at the site will depend on the distance to the causative earthquake epicenter, the magnitude of the shock, and the response characteristics of the underlying earth materials. Generally, earthen fills founded in supporting materials and designed in accordance with current building codes and geotechnical standards are well suited to resist the effects of ground shaking.

No evidence of faulting was observed by BAI or shown in the site vicinity on the published geologic maps that we reviewed for this investigation. Therefore, the potential for fault rupture at the site is considered low.

5.4 Slope Stability Analysis

Our slope stability analysis was performed to correspond, as a minimum, to the guidelines by (1) American Society of Civil Engineers (ASCE) and Southern California Earthquake Center (SC/EC) “Recommended Procedures for Implementation of Division of Mines and Geology Special Publication 117, Guidelines for Analyzing and Mitigating Landslide Hazards in California”, dated June 2002 and (2) California Geological Survey (CGS) “Guidelines for Evaluating and Mitigating Seismic Hazards in California” dated 2008. These publications suggest a factor of safety greater than or equal to 1.5 for static conditions and 1.1 for seismic (pseudo-static) conditions, permanent displacement between 5 and 15 centimeters (cm), and horizontal seismic coefficient of 0.15.

Cross Section A-A’, shown in Appendix C, was created from the topographic map shown on Plate 2, our surface reconnaissance and data from our subsurface exploration. The location of the cross section used for our stability analyses is shown on Plate 2. For our analysis we have analyzed the repaired conditions of the project area and have assumed that the grading was completed according to the recommendations of this report. For the purposes of our analysis, we have assumed that the reinforced engineered fill slopes will be constructed at slope inclinations of 1:1.

From our subsurface exploration, six soil and bedrock units, with different density and strength parameters, were identified within the slope for our stability analyses. Unit “1” is the old landslide deposits. Unit “2” is the engineered fill with geogrid. Unit “3” is the upper current landslide deposits. Unit “4” is the lower current landslide deposits. Unit “5” is the supporting bedrock. Unit “6” is surface soils below landslide. Table 1 summarizes soil and bedrock parameters used. For the purposes of our analysis the relatively minor deposits of residual soil have been incorporated into the old landslide deposits (Unit 1) and the lower landslide deposits (Unit 4).

Table 1: Soil and Bedrock Parameters

Unit	Wet Density (pcf)	Cohesion (psf)	Friction Angle (ϕ)
1	120	200	20
2	125	300	30
3	125	300	20
4	125	200	20
5	135	2650	0
6	112	200	20

The above assigned strengths were determined from strength test results obtained from this site and a site in the vicinity, as well as from back-analysis of the slope stability calculations. The stability of the slope was analyzed using the computer program SLIDE 5.0 by Rocscience, Inc.

The results of our stability analyses show that the slope and road repaired as a compacted engineered fill reinforced with geogrid is stable for both static and seismic conditions, if the recommendations presented below are followed. The results of our stability analyses are presented in Appendix C.

Our analysis indicates that under static and seismic loads the unimproved landslide deposits located downslope of Nash Mill Road may fail. Over time the accumulated effect of these failures may expose the reinforced engineered fill buttress, potentially damaging it, or leaving it vulnerable to erosion. Should the buttress be exposed, it may be necessary to armor or repair the area to minimize damage and erosion to the buttress. BAI should be consulted to provide recommendations for the armoring and repair of the damaged areas.

6.0 RECOMMENDATIONS

6.1 Site Grading

6.1.1 Clearing and Stripping

Areas to be graded should be cleared of existing vegetation, rubbish, and debris. After clearing, surface soils that contain organic matter should be stripped. In general, the depth of required stripping will be about 4 to 6 inches; deeper stripping and grubbing may be required to remove isolated concentrations of organic matter or roots. The cleared materials should be removed from the site or stockpiled for later use in landscape areas, as appropriate.

6.1.2 Fill and Cut Slopes

Cut slopes should be constructed at an inclination of 2H:1V or flatter. Fill slopes comprising the engineered fill buttress and roadway can be constructed no steeper than 1H:1V with the compacted fill reinforced with geogrids, see Appendix C for geogrid details. At the toe of fill slopes, an initial keyway should be excavated a minimum of 3 feet into supporting bedrock on the downhill side, in accordance with the Keyway/Bench Drainage Detail, Plate 14. Depending on the location of the keyway, depths of keyway can vary and will need to be determined by BAI. BAI anticipates that the initial keyway will be approximately 28 feet below existing ground surface, or deeper depending on the conditions encountered in the field. The initial keyway excavation should have a downward gradient of about one percent into the slope. We anticipate that temporary cut and fill slopes may need to be constructed to provide access during construction. These may be constructed at inclinations of 1.5:1 or steeper with the approval of BAI in the field during construction. The final inclination of fill slopes not being utilized as the engineered fill buttress should have final grades no steeper than 2:1.

The initial keyway should have a perforated pipe and gravel drain placed on the uphill side, as shown in the Keyway/Bench Drainage Detail, Plate 14. Additional subdrains may be needed on subsequence benches as determined by BAI. The perforated pipe should be a 4-inch diameter, SDR 35, or other non-corrosive equivalent pipe with a pipe stiffness of at least 40 pounds per square inch. The pipe should be placed with the perforations down. The gravel should consist of clean, free-draining 3/4-inch crushed rock, or Class 2 permeable material per section 68 of Caltrans Standard Specifications. Drain rock, excluding the Class 2 Permeable Material, should be completely wrapped in geotextile filter fabric (Mirafi 140, or equivalent) so there is no natural soil to drain rock contact. Significant subsurface drainage was encountered during our exploration. We anticipate that a minimum of 3 to 4 subdrains will be required.

6.1.3 Fill Area Preparation

Within fill areas, unsuitable materials, undocumented fills and landslide deposits should be removed to their full depth as determined in the field by BAI. These materials extended to depths between 12 and 23 feet below the surface and may be deeper depending on conditions encountered in the field during construction.

After the recommended excavations of unsuitable material and slide debris are complete, BAI should observe the bedrock encountered to confirm suitable materials are exposed. We anticipate that the onsite materials are suitable for re-use during landslide repair as compacted and engineered fill. The fill material should be checked by BAI prior to use and should meet the parameters used in our slope stability analysis.

The area of support for the compacted fill slope should be keyed and benched prior to placement of compacted fill. Fill material, on-site or imported, should be free of perishable matter and rocks greater than three inches in largest dimension, have an expansion index less than 30 and be approved by BAI before fill placement. Fill should be placed in thin lifts (six to eight inches depending on compaction equipment), moisture conditioned to near optimum moisture content, and compacted to at least 90 percent relative compaction, to achieve planned grades.

6.1.4 Geogrid Reinforced Fill Slope

Fill material for the geogrid reinforced fill should meet our design criteria used in our slope stability analysis. BAI should approve the material before use and check our analysis and recommendations prior to use. The fill material should be a mixture of fines and gravels (3-inch minus angular or subangular rock fragments). Rounded gravel should not be used. After approximately two feet of fill has been placed and compacted within the keyway, a Miragrid 2xt geogrid or equivalent, should be placed over the fill, as detailed in Appendix C. The initial geogrid layer should be a minimum width of 10 feet and should run the whole length of the keyway. Geogrid spacing is shown in Appendix C.

6.2 Drainage Improvements

6.2.1 Horizontal Drains

If needed, the installations of horizontal drains will minimize intrusions of groundwater into the project area. Horizontal drains should be installed within the slope above the project area. Horizontal drains should consist of drilled holes at least 3.25 inches in diameter in which a Schedule 80 PVC casing at least 1½ inch diameter is installed. To facilitate drainage, drill holes should be angled at least 2 degrees above horizontal. The outer casing will extend through engineered fill and should be solid (blank) casing; the remaining casing should be slotted (0.02-inch slots) and should extend a minimum of 20 feet into bedrock. Horizonal drains should be placed at 6-foot intervals along the area of repair. The drains should be collected into a solid discharge pipe sloped to drain by gravity. Discharge of the drains should be directed to an erosion resistant area away from the area of instability. BAI represented should direct the need and placement of horizontal drainage. It is anticipated that, should a grading repair be completed prior to the rainy season, horizontal drains may not be required.

6.2.2 Surface Drainage

Surface drainage should be by sheet flow directed to erosion resistant areas away from the project site. We recommend an earthen drainage ditch be constructed at the upper extent of the project site to intercept surface water and direct it away from the area of repair.

We noted an existing earthen drainage ditch on the inboard side of the project site. This should be maintained and sloped to drain by gravity away from the area of repair. A culvert was observed west of the project site which appears to have been designed to capture the water in the drainage ditch and move it across and downslope of Nash Mill Road. The culvert consists of an 18-inch diameter polycarbonate pipe which discharges approximately 35 feet north and downslope of Nash Mill Road. The culvert discharges into an erosional gully located near the toe of the area of current instability. This culvert should be redirected downslope and away from the area of instability and discharged to existing drainage courses or erosion resistant area. The erosional gully should be repaired by grading according to the specifications of this report to match the adjacent slopes and be designed to drain by sheet flow away from the project area.

7.0 ADDITIONAL SERVICES

Prior to construction, BAI should review the final grading plans, and geotechnical related specifications for conformance with our recommendations. During construction, BAI should be retained to provide periodic observations, together with field and laboratory testing, during site preparation, placement and compaction of fills. Our observations and tests would allow us to verify conformance of the work to project guidelines, determine that soil and bedrock conditions are as anticipated, and to modify our recommendations, if necessary.

8.0 LIMITATIONS

This geotechnical investigation was performed in accordance with the usual and current standards of the profession, as they relate to this and similar localities. No other warranty, expressed or implied, is provided as to the conclusions and professional advice presented in this report. Our conclusions are based upon reasonable geological and engineering interpretation of available data.

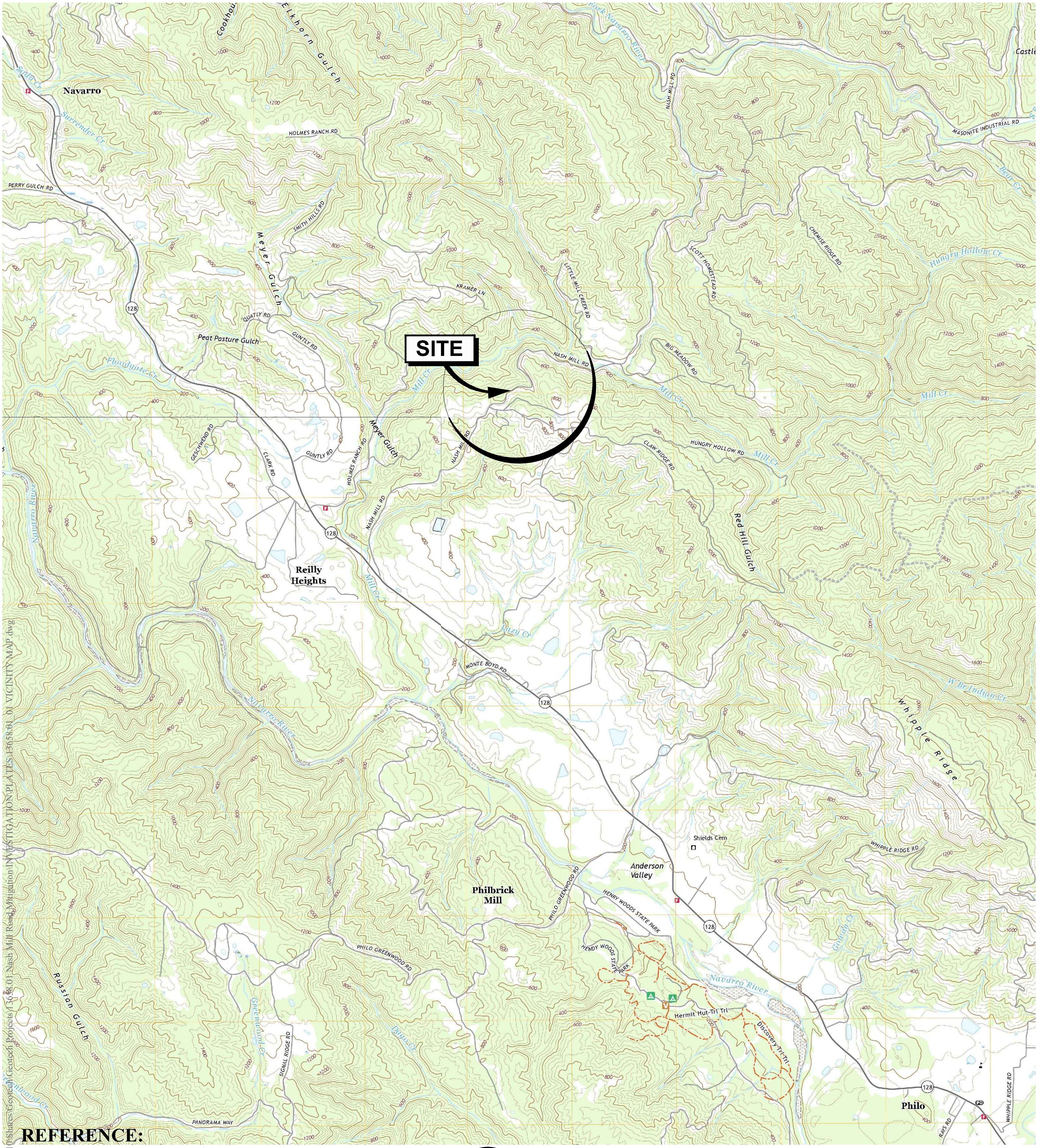
The samples taken and tested, and the observations made, are considered to be representative of the site; however, soil and geologic conditions may vary significantly between test borings and across the site. As in most projects, conditions revealed during construction excavation may be at variance with preliminary findings. If this occurs, the changed conditions must be evaluated by BAI, and revised recommendations be provided as required.

This report is issued with the understanding that it is the responsibility of the Owner, or his/her representative, to ensure that the information and recommendations contained herein are brought to the attention of all other design professionals for the project, and incorporated into the plans, and that the Contractor and Subcontractors implement such recommendations in the field. The safety of others is the responsibility of the Contractor. The Contractor should notify the owner and BAI if he/she considers any of the recommended actions presented herein to be unsafe or otherwise impractical.

Changes in the condition of a site can occur with the passage of time, whether they are due to natural events or to human activities on this, or adjacent sites. In addition, changes in applicable or appropriate codes and standards may occur, whether they result from legislation or the broadening of knowledge. Accordingly, this report may become invalidated wholly or partially by changes outside of our control. Therefore, this report is subject to review and revision as changed conditions are identified.

The recommendations contained in this report are based on certain specific project information regarding type of construction and current building locations, which have been made available to us. If conceptual changes are undertaken during final project design, we should be allowed to review them in light of this report to determine if our recommendations are still applicable.

PLATES



REFERENCE:
US TOPO
Navarro, Bailey Ridge, Cold Springs, Philo Quadrangles
7.5-Minute Series, USGS, 2021

NORTH

Latitude: 39.127328
Longitude: -123.492166

APPROXIMATE SCALE (FEET)
0 2000 4000 8000

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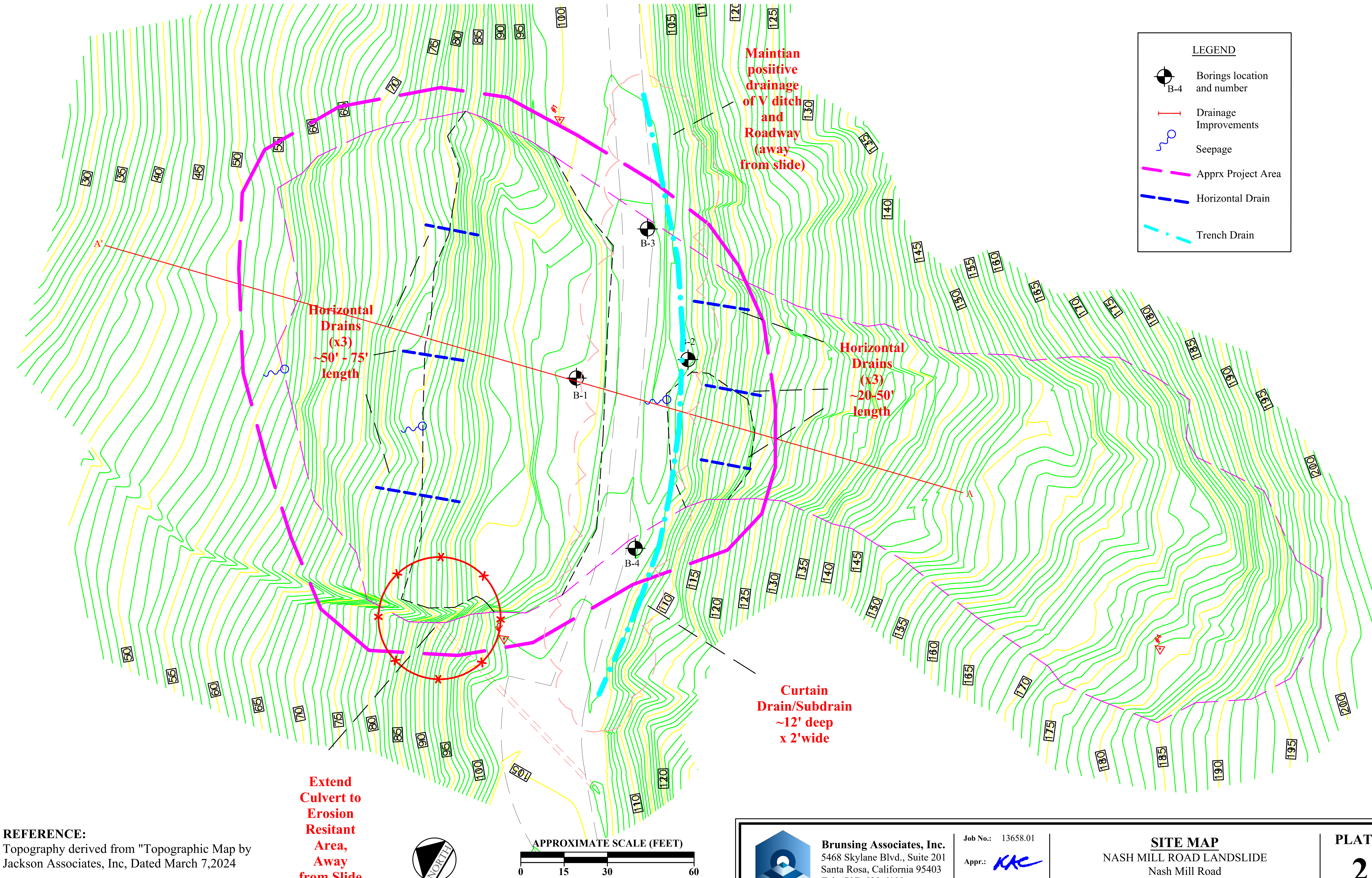
Job No.: 13658.01
Appr.: KAC
Date: 08/22/24

VICINITY MAP
NASH MILL ROAD LANDSLIDE
Nash Mill Road
Philo, California

PLATE
1



REFERENCE:
Topography derived from "Topographic Map by Jackson Associates, Inc, Dated March 7,2024

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SITE MAP
NASH MILL ROAD LANDSLIDE
Nash Mill Road
Philo, California

PLATE
2

Log of Boring B-1

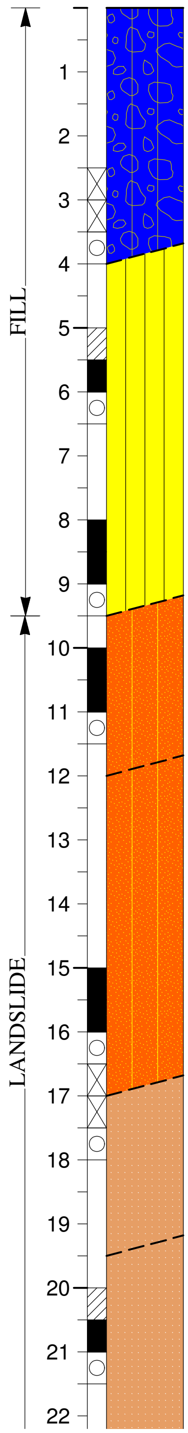
Equipment: Deeprock DR8K: 8-inch hollow-stem flight auger

Date: 12/14/23 **Logged By:** JNK

Elevation: 101 feet *** **Latitude:** 39.127301 **Longitude:** -123.492188

Laboratory Tests	Sampler Type*	Moisture Content (%)	Dry Density (pcf)	Blows/foot
	CA			15 **
50% Passing #200 LL=29, PI=6	CA			10 **
	CA			11 **
	CA	17.8	109	11 **
	CM			10 **
	SPT			12
	CA			14 **

Depth (ft.) Sample



RED AND YELLOW-BROWN SILTY GRAVEL (GM)
medium dense, moist

RED-BROWN SANDY SILT (ML)
stiff, moist
few gravels

BROWN SILTY SAND (SM)
loose to medium dense, wet

OLIVE-BROWN SILTY SAND (SM)
medium dense to loose, moist
few gravels

ORANGE-BROWN SANDSTONE
crushed, friable, deeply weathered

DARK GRAY WITH ORANGE SANDSTONE
crushed, friable, deeply weathered

Latitude/Longitude estimated from Google Earth.
* See Soil Classification Chart & Key to Test Data
** Equivalent "Standard Penetration" Blow Counts.
*** Elevations interpolated from Plate 2.

Scale: 1" = 3'

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LOG OF BORING B-1
NASH MILL ROAD LANDSLIDE
Nash Mill Road
Philo, California

PLATE 3

SHEET 1 of 2

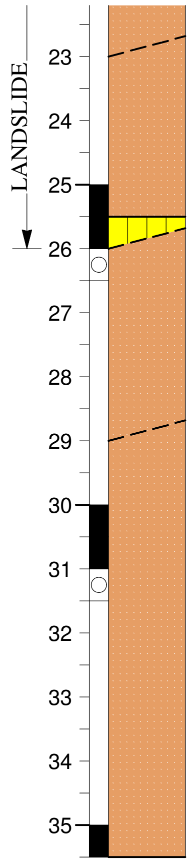
Log of Boring B-1

Equipment: Deeprock DR8K: 8-inch hollow-stem flight auger

Date: 12/14/23 **Logged By:** JNK

Elevation: 101 feet *** **Latitude:** 39.127301 **Longitude:** -123.492188

Laboratory Tests	Sampler Type*	Moisture Content (%)	Dry Density (pcf)	Blows/foot	Depth (ft.)
	CA			55/11" **	26
	CM			60 **	31
	CM			47/5" **	35



GRAY-BROWN SHEARED SANDSTONE
closely fractured, low hardness, deeply to moderately weathered

OLIVE-BROWN SANDY SILT (ML)
hard, saturated

ORANGE-BROWN SANDSTONE
close fracturing, low hardness, deeply to moderately weathered

GRAY TO ORANGE SANDSTONE
crushed to closely fractured, low hardness to hard, moderately weathered

Notes:
1. Free water encountered at 17 feet
2. No caving
3. Drilling refusal at 35.5 feet

Latitude/Longitude estimated from Google Earth.
* See Soil Classification Chart & Key to Test Data
** Equivalent "Standard Penetration" Blow Counts.
*** Elevations interpolated from Plate 2.

Scale: 1" = 3'

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LOG OF BORING B-1
NASH MILL ROAD LANDSLIDE
Nash Mill Road
Philo, California

PLATE 3

SHEET 2 of 2

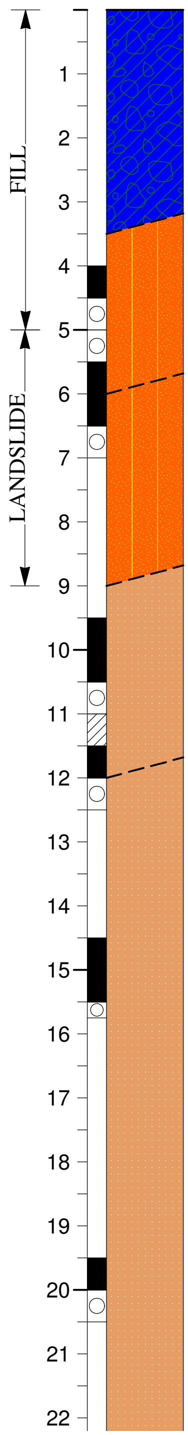
Log of Boring B-2

Equipment: Mobile B-53; 6-inch solid-stem flight auger

Date: 5/1/24 **Logged By:** JNK

Elevation: 103 feet *** **Latitude:** 39.127275 **Longitude:** -123.492105

Sampler Type*	Moisture Content (%)	Dry Density (pcf)	Blows/foot
CA			3 **
CM	28.0	90	6 **
CA	10.7	120	33 **
CM			27 **
CM	13.5	115	45/9" **
CM			40/6" **



GRAY TO RED-BROWN CLAYEY GRAVEL (GC)
loose, moist

RED-BROWN SILTY SAND (SM)
very loose, moist
few gravels

LIGHT OLIVE-BROWN MOTTLED GRAY SILTY SAND (SM)
loose, moist to wet

ORANGE TO OLIVE-BROWN SANDSTONE
crushed, soft to friable, deeply weathered

GRAY-BROWN SHEARED SANDSTONE
crushed, friable, deeply weathered

Latitude/Longitude estimated from Google Earth.
* See Soil Classification Chart & Key to Test Data
** Equivalent "Standard Penetration" Blow Counts.
*** Elevations interpolated from Plate 2.

Scale: 1" = 3'

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LOG OF BORING B-2
NASH MILL ROAD LANDSLIDE
Nash Mill Road
Philo, California

PLATE 4
SHEET 1 of 2

Log of Boring B-2

Equipment: Mobile B-53; 6-inch solid-stem flight auger

Date: 5/1/24 **Logged By:** JNK

Elevation: 103 feet *** **Latitude:** 39.127275 **Longitude:** -123.492105

Sampler Type*	Moisture Content (%)	Dry Density (pcf)	Blows/foot	Depth (ft.)	Sample
				23	
			▼	24	
SPT			25/1.5"	25	
				26	
SPT			47/6"	27	

Notes:
1. Groundwater at 16.5 and 24 feet
2. No caving
3. Drilling refusal at 26.5 feet

Latitude/Longitude estimated from Google Earth.
* See Soil Classification Chart & Key to Test Data
** Equivalent "Standard Penetration" Blow Counts.
*** Elevations interpolated from Plate 2.

Scale: 1" = 3'

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LOG OF BORING B-2
NASH MILL ROAD LANDSLIDE
Nash Mill Road
Philo, California

PLATE 4

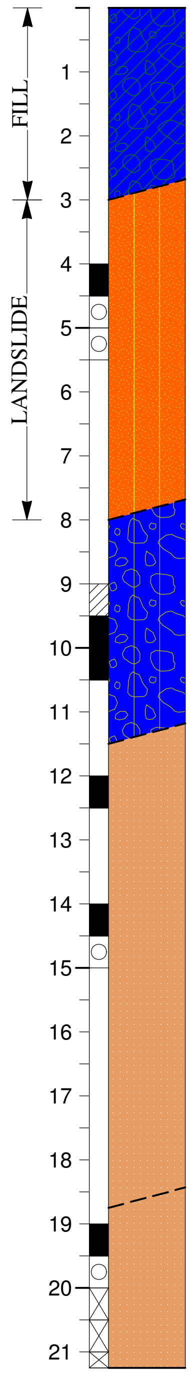
Log of Boring B-3

Equipment: Mobile B-53; 6-inch solid-stem flight auger

Date: 5/1/24 **Logged By:** JNK

Elevation: 102 feet *** **Latitude:** 39.127375 **Longitude:** -123.492011

Sampler Type*	Moisture Content (%)	Dry Density (pcf)	Blows/foot	Depth (ft.)
CA	17.2	113	8 **	5
CA			24 **	10
CA			16/1" **	12
CM			36/6" **	14.5
CM			33/6" **	19.5
SPT			61/8"	21



GRAY TO RED-BROWN CLAYEY GRAVEL (GC)
loose, moist

BROWN SILTY SAND (SM)
loose, moist
few gravels

OLIVE-BROWN WITH ORAGE SILTY GRAVEL (GM) WITH SAND
medium dense, moist
bedrock fragments

GRAY-BROWN SHEARED SANDSTONE
crushed, friable to low hardness, deeply weathered

GRAY SHEARED SANDSTONE
crushed, friable, deeply weathered

Notes:
1. Groundwater encountered at 18.5 and 19 feet
2. No caving
3. Drilling terminated at 21.5 feet

Latitude/Longitude estimated from Google Earth.
* See Soil Classification Chart & Key to Test Data
** Equivalent "Standard Penetration" Blow Counts.
*** Elevations interpolated from Plate 2.

Scale: 1" = 3'

BORING LOG 1 PER PAGE, 13658.01 GINT.GPJ, 8/22/24

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LOG OF BORING B-3
NASH MILL ROAD LANDSLIDE
Nash Mill Road
Philo, California

PLATE 5

SHEET 1 of 1

Log of Boring B-4

Equipment: Mobile B-53; 6-inch solid-stem flight auger

Date: 5/1/24 **Logged By:** JNK

Elevation: 103 feet *** **Latitude:** 39.127237 **Longitude:** -123.492292

Sampler Type*	Blows/foot	Depth (ft.)
CA	8 **	4
CA	19 **	7.5
CA	26 **	10
CM	32 **	10.5
CM	19 **	11.5
CM	32 **	17

Depth (ft.)	Unit	Description
0–6	FILL	GRAY TO RED-BROWN SILTY SAND (SM) loose, moist few gravels
6–9	LANDSLIDE	YELLOW-BROWN SILTY SAND (SM) medium dense, moist few bedrock fragments
9–12	LANDSLIDE	ORANGE-BROWN TO GRAY SILTY SAND (SM) medium dense to dense, moist bedrock fragments
12–19.5	POSSIBLE OLD LANDSLIDE	GRAY-BROWN WITH ORANGE SHEARED SHALE crushed, friable, deeply weathered
19.5–22	POSSIBLE OLD LANDSLIDE	OLIVE-ORANGE-BROWN SILTSTONE crushed, soft to friable, deeply weathered

Latitude/Longitude estimated from Google Earth.
* See Soil Classification Chart & Key to Test Data
** Equivalent "Standard Penetration" Blow Counts.
*** Elevations interpolated from Plate 2.

Scale: 1" = 3'

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LOG OF BORING B-4
NASH MILL ROAD LANDSLIDE
Nash Mill Road
Philo, California

PLATE 6

SHEET 1 of 2

Log of Boring B-4

Equipment: Mobile B-53; 6-inch solid-stem flight auger

Date: 5/1/24 **Logged By:** JNK

Elevation: 103 feet *** **Latitude:** 39.127237 **Longitude:** -123.492292

Sampler Type*	Blows/foot	Depth (ft.)	Sample
CM	32 **		
		23	
SPT	35	24	

Notes:
1. Groundwater encountered at 22 feet
2. No caving

Latitude/Longitude estimated from Google Earth.
* See Soil Classification Chart & Key to Test Data
** Equivalent "Standard Penetration" Blow Counts.
*** Elevations interpolated from Plate 2.

Scale: 1" = 3'

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LOG OF BORING B-4
NASH MILL ROAD LANDSLIDE
Nash Mill Road
Philo, California

PLATE
6

UNIFIED SOIL CLASSIFICATION SYSTEM (USCS)

MAJOR DIVISIONS			SYMBOLS GRAPHIC	SYMBOLS LETTER	TYPICAL DESCRIPTIONS
COARSE-GRAINED SOILS MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	GRAVELS AND GRAVELLY SOILS MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	CLEAN GRAVELS (Less than 5% fines)		GW	WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
				GP	POORLY-GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
		GRAVELS WITH FINES (Greater than 12% fines)		GM	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES
				GC	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES
	SAND AND SANDY SOILS 50% OR MORE OF COARSE FRACTION PASSING THROUGH NO. 4 SIEVE	CLEAN SANDS (Less than 5% fines)		SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
				SP	POORLY-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
		SANDS WITH FINES (Greater than 12% fines)		SM	SILTY SANDS, SAND-SILT MIXTURES
				SC	CLAYEY SANDS, SAND-CLAY MIXTURES
FINE-GRAINED SOILS MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
				CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
				OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILT, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS
				CH	INORGANIC CLAYS OF HIGH PLASTICITY
				OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS				PT	PEAT, HUMOUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS

KEY TO TEST DATA

- LL - Liquid Limit
- PI - Plasticity Index
- ■ Sample Retained
- ▨ Sample Recovered, Not Retained
- ☒ Bulk Sample
- ◯ Sample Not Recovered
- CA - California Modified Split Barrel Sampler 3.0-inch O.D.
- CM - California Modified Split Barrel Sampler 2.5-inch O.D.
- SPT - California Split Barrel Sampler 2.0-inch O.D.
- SH - Shelby Tube
- RC - Rock Coring
- Recovery - Percent Core Recovered
- RQD - Rock Quality Designation (length of core pieces >= 4-inches / core length)

- Consol - Consolidation
- EI - Expansion Index
- SA - Sieve Analysis

Shear Strength, psf **Confining Pressure, psf**

Tx	1564	(1440)	- Unconsolidated Undrained Triaxial
TxCU	1564	(1440)	- Consolidated Undrained Triaxial
DS	2020	(1440)	- Consolidated Drained Direct Shear
FVS	520		- Field Vane Shear
UC	1500		- Unconfined Compression
PP	1500		- Field Pocket Penetrometer
Sat			- Sample saturated prior to test

- ▽ Initial Groundwater Level Reading
- ▼ Second Groundwater Level Reading

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SOIL CLASSIFICATION CHART & KEY TO TEST DATA

NASH MILL ROAD LANDSLIDE
Nash Mill Road
Philo, California

PLATE 7

RELATIVE DENSITY OF COARSE-GRAINED SOILS

Relative Density	Standard Penetration Test Blow Count (blows per foot)
Very loose	4 or less
Loose	5 to 10
Medium dense	11 to 30
Dense	31 to 50
Very dense	More than 50

CONSISTENCY OF FINE-GRAINED SOILS

Consistency	Identification Procedure	Approximate Shear Strength (psf)
Very soft	Easily penetrated several inches with fist	Less than 250
Soft	Easily penetrated several inches with thumb	250 to 500
Medium stiff	Penetrated several inches by thumb with moderate effort	500 to 1000
Stiff	Readily indented by thumb, but penetrated only with great effort	1000 to 2000
Very stiff	Readily indented by thumb nail	2000 to 4000
Hard	indented with difficulty by thumb nail	More than 4000

NATURAL MOISTURE CONTENT

Dry	No noticeable moisture content. Requires considerable moisture to obtain optimum moisture content* for compaction.
Damp	Contains some moisture, but is on the dry side of optimum.
Moist	Near optimum moisture content for compaction.
Wet	Requires drying to obtain optimum moisture content for compaction.
Saturated	Near or below the water table, from capillarity, or from perched or ponded water. All void spaces filled with water.

* Optimum moisture content as determined in accordance with ASTM Test Method D1557, latest edition.

Where laboratory test data are not available, the above field classifications provide a general indication of material properties; the classifications may require modification based upon laboratory tests.

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SOIL DESCRIPTIVE PROPERTIES
NASH MILL ROAD LANDSLIDE
Nash Mill Road
Philo, California

PLATE 8

Generalized Graphic Bedrock Symbols

Claystone	Siltstone	Tuff (Volcanic Ash)
Shale	Chert	Andesite
Sandstone	Serpentine	Basalt
Conglomerate	Greenstone	Schist

Stratification

Bedding of Sedimentary Rocks	Thickness of Beds
Massive	No apparent bedding
Very thick bedded	Greater than 4 feet
Thick bedded	2 feet to 4 feet
Thin bedded	2 inches to 2 feet
Very thin bedded	0.5 inches to 2 inches
Laminated	0.125 inches to 0.5 inches
Thinly laminated	less than 0.125 inches

Fracturing

Fracturing Intensity	Fracture Spacing
Little	Greater than 4 feet
Occasional	1 foot to 4 feet
Moderate	6 inches to 1 foot
Close	1 inch to 6 inches
Intense	0.5 inches to 1 inch
Crushed	less than 0.5 inches

Strength

Soft	Plastic or very low strength.
Friable	Crumbles by hand.
Low hardness	Crumbles under light hammer blows.
Moderate hardness	Crumbles under a few heavy hammer blows.
Hard	Breaks into large pieces under heavy, ringing hammer blows.
Very hard	Resists heavy, ringing hammer blows and will yield with difficulty only dust and small flying fragments.

Weathering

Deep	Moderate to complete mineral decomposition, extensive disintegration, deep and thorough discoloration, many extensively coated fractures.
Moderate	Slight decomposition of minerals, little disintegration, moderate discoloration, moderately coated fractures.
Little	No megascopic decomposition of minerals, slight to no effect on cementation, slight and intermittent, or localized discoloration, few stains on fracture surfaces.
Fresh	Unaffected by weathering agents, no disintegration or discoloration, fractures usually less numerous than joints.

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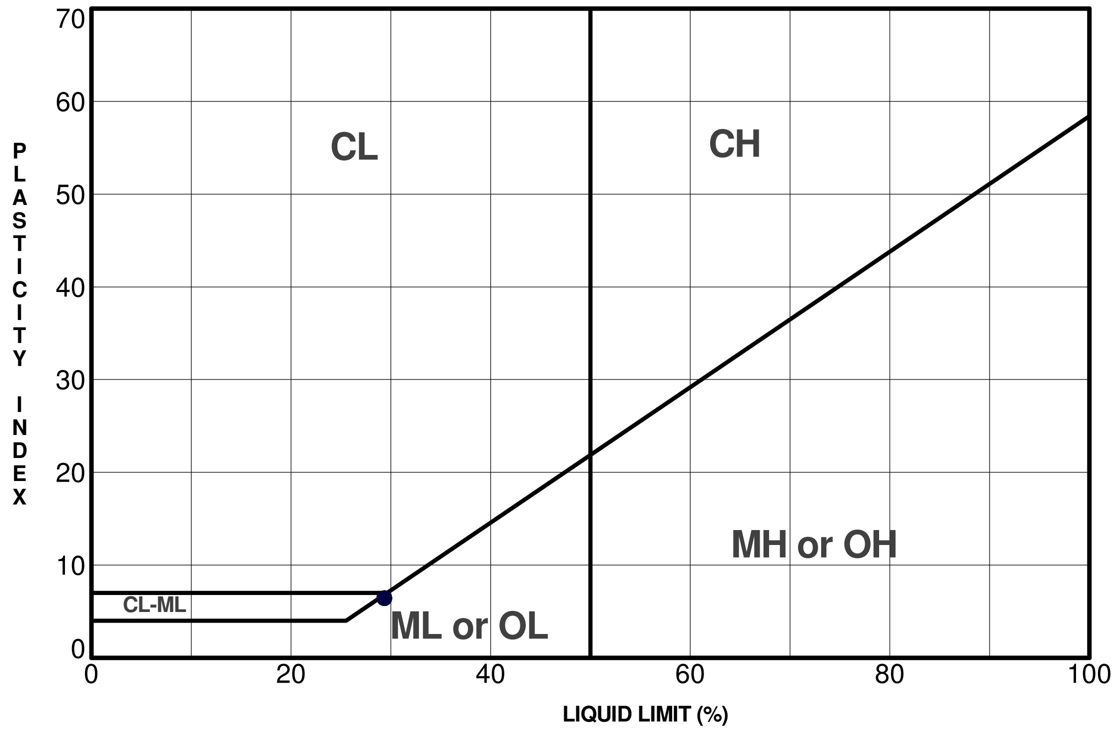
BEDROCK DESCRIPTIVE PROPERTIES
NASH MILL ROAD LANDSLIDE
Nash Mill Road
Philo, California

PLATE 9



SYMBOL	CLASSIFICATION AND SOURCE	LIQUID LIMIT (%)	PLASTIC LIMIT (%)	PLASTICITY INDEX	% PASSING No. 200 SIEVE
●	**RED-BROWN SANDY SILT (ML)** **B-1 @ 6.0 feet**	**29**	**23**	**6**	**50**

ASTM D4318

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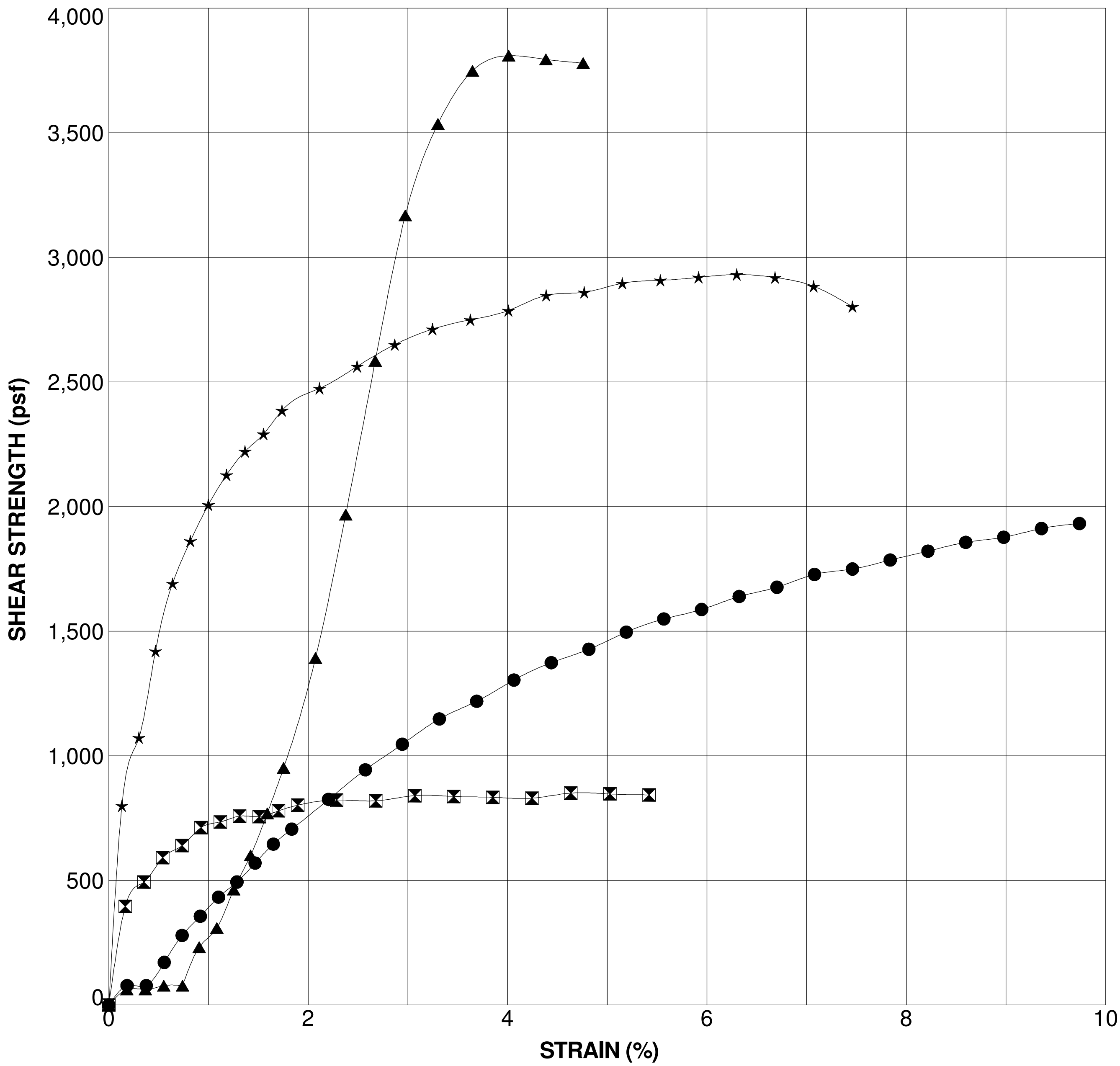
ATTERBERG LIMITS TEST RESULTS
NASH MILL ROAD LANDSLIDE
Nash Mill Road
Philo, California

PLATE
10



Sample Source	Classification	Confining Pressure (psf)	Ultimate Strength (psf)	Strain (%)	Dry Density (pcf)	Moisture Content (%)
● B-1 at 11 ft	BROWN SILTY SAND (SM)	1296	1932	9.7	109	17.8
⧗ B-2 at 6.5 ft	LIGHT OLIVE-BROWN MOTTLED GRAY SILTY SAND (SM)	864	850	4.6	90	28.0
▲ B-2 at 10.5 ft	ORANGE TO OLIVE-BROWN SANDSTONE	1440	3809	4.0	120	10.7
★ B-2 at 15.5 ft	GRAY-BROWN SHEARED SANDSTONE	1872	2931	6.3	115	13.5

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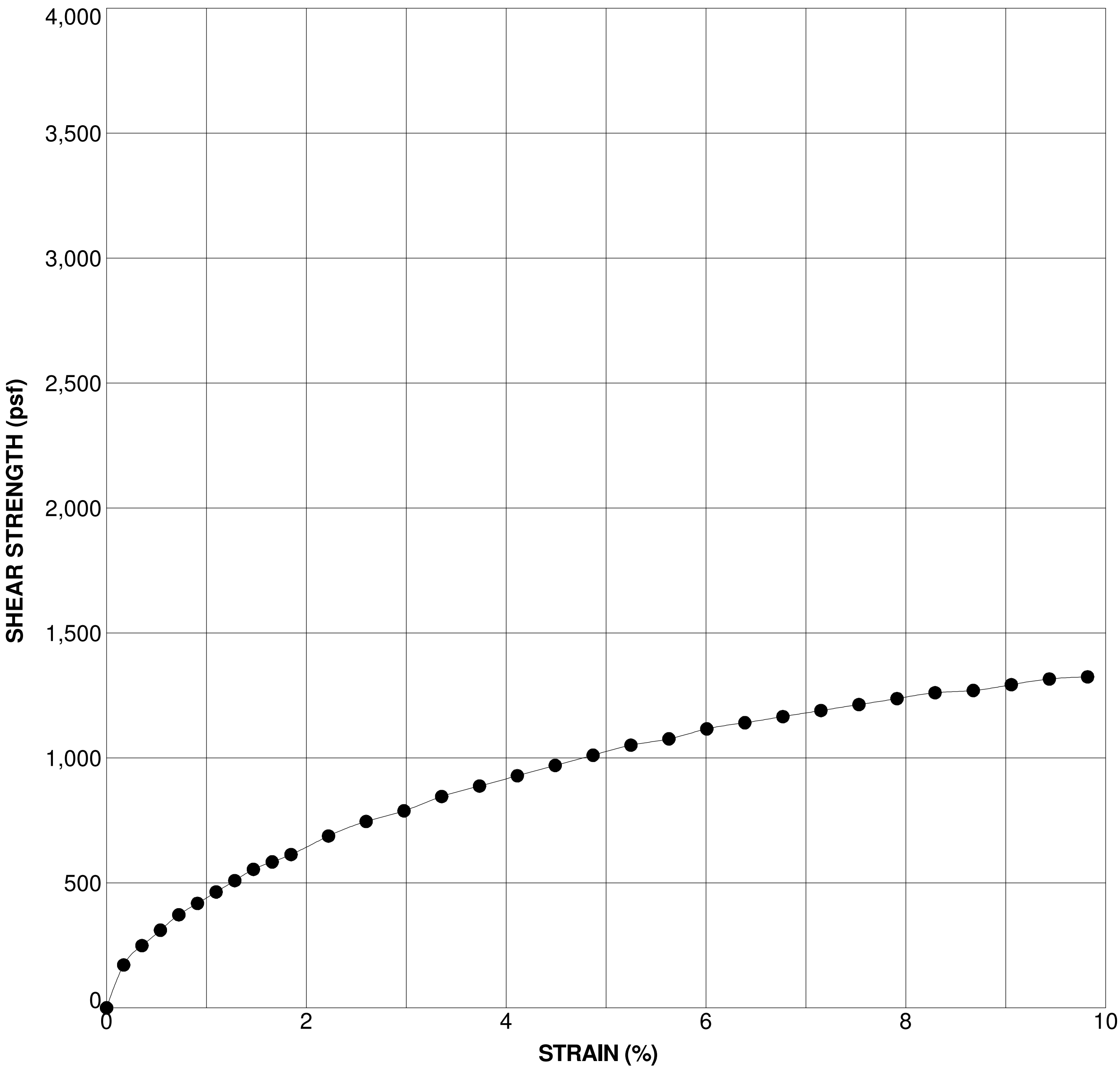
UNCONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST RESULTS

NASH MILL ROAD LANDSLIDE
Nash Mill Road
Philo, California

PLATE 11



Sample Source	Classification	Confining Pressure (psf)	Ultimate Strength (psf)	Strain (%)	Dry Density (pcf)	Moisture Content (%)
● B-3 at 5 ft	BROWN SILTY SAND (SM)	720	1324	9.8	113	17.2

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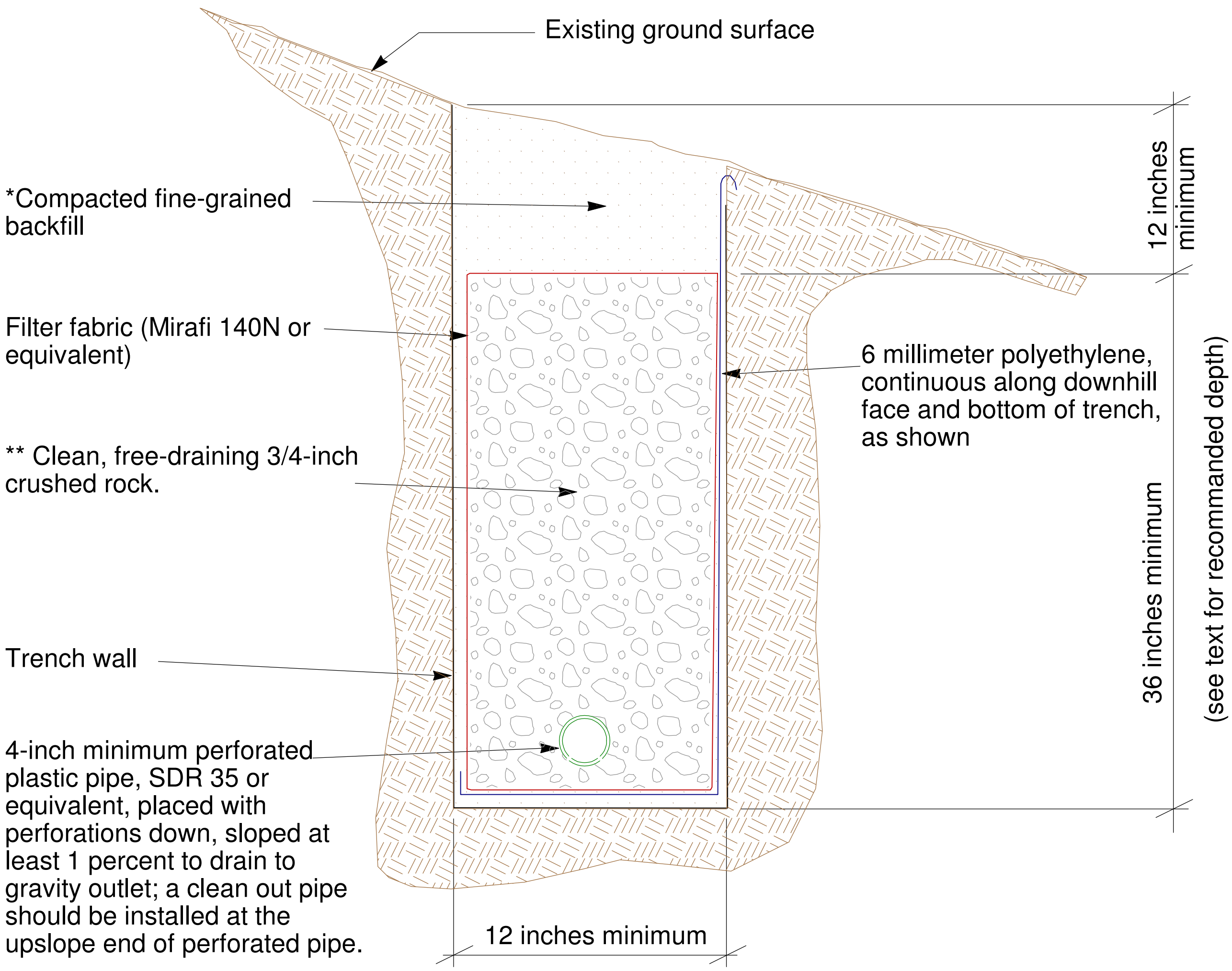
UNCONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST RESULTS

NASH MILL ROAD LANDSLIDE
Nash Mill Road
Philo, California

PLATE
12



TYPICAL SECTION
NO SCALE

* 90 percent relative compaction minimum in accordance with ASTM D 1557 Test Method, latest edition.

** Or, as an alternative, use Class 2 Permeable Material per Caltrans specifications.

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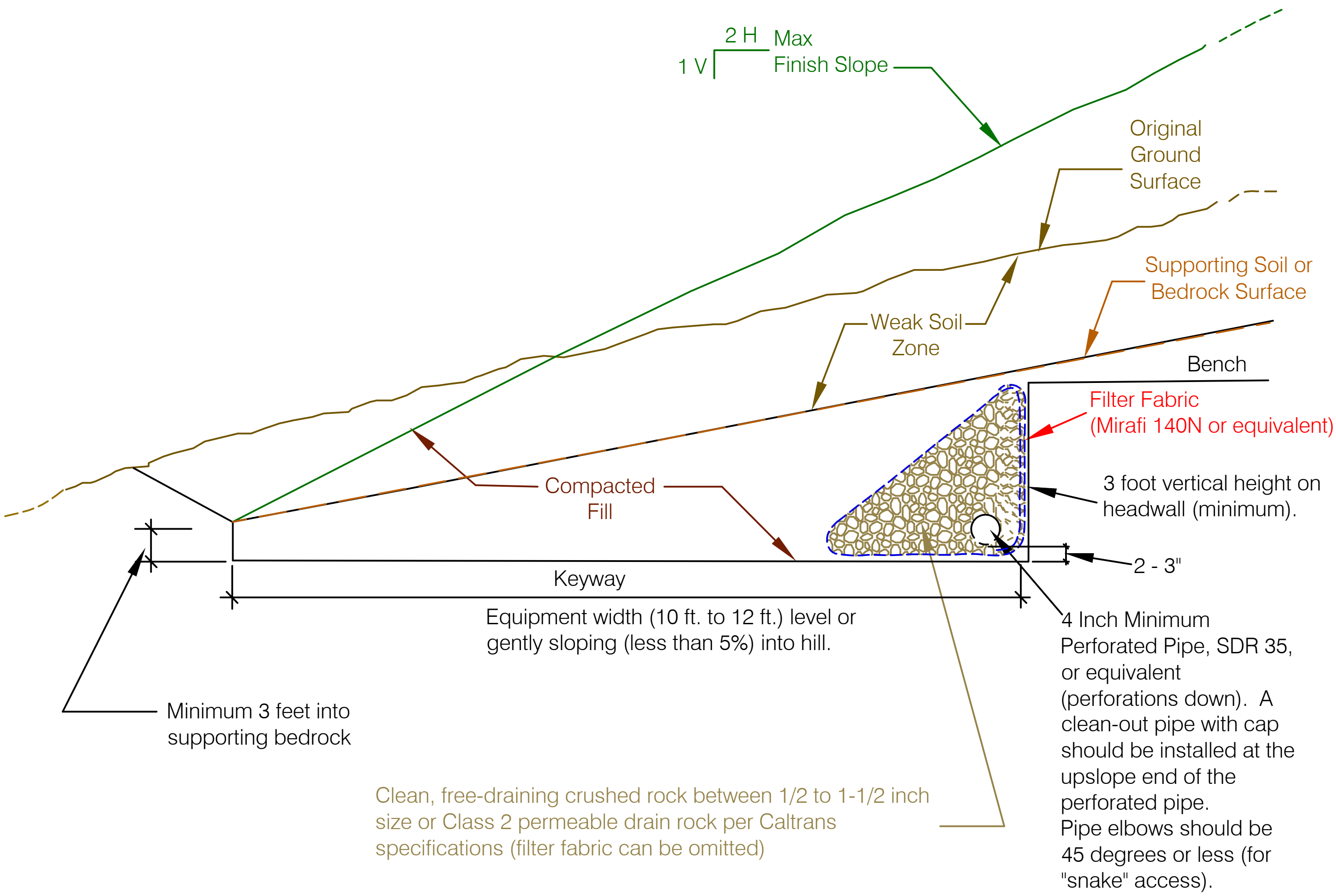
TYPICAL TRENCH SUBDRAIN DETAIL
NASH MILL ROAD LANDSLIDE
Nash Mill Road
Philo, California

PLATE 13

(NOT TO SCALE)



\\192.168.2.10\Shares\Geotech\Geotech Projects\13658.01 Nash Mill Road Mitigation\INVESTIGATION\PLATES\13658.01_14 KEYWAY-BENCH DRAINAGE DETAIL.dwg

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Brunsing Associates, Inc. 5468 Skylane Blvd., Suite 201 Santa Rosa, California 95403 Tel: (707) 528-6108	**Job No.:** 13658.01 **Appr.:** KAC **Date:** 08/22/24	**KEYWAY/BENCH DRAINAGE DETAIL** NASH MILL ROAD LANDSLIDE Nash Mill Road Philo, California	**PLATE** **14**

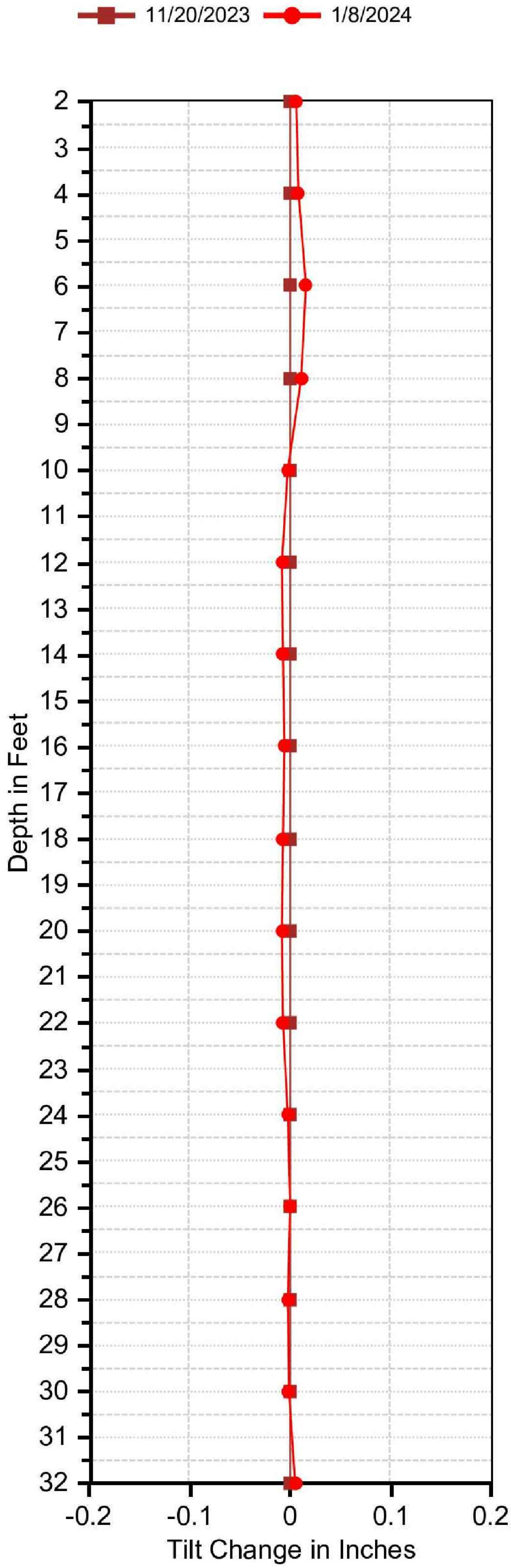
APPENDIX A

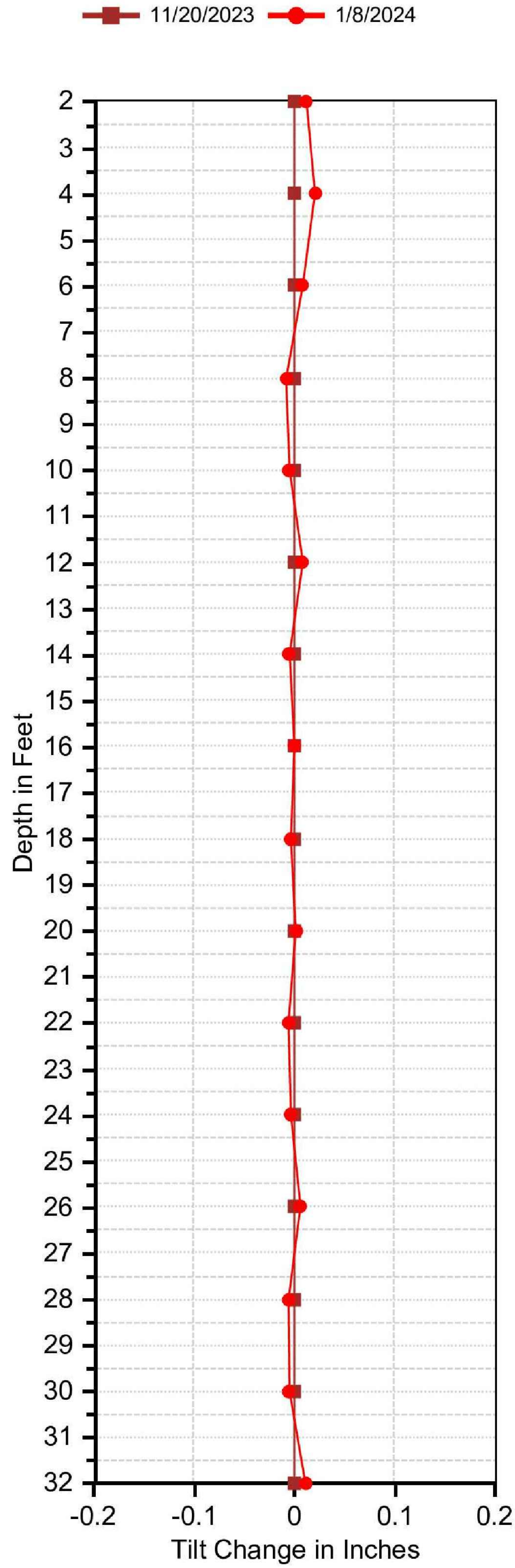
REFERENCES

- Maps of Active Fault Near-Source Zones in California and Adjacent Parts of Nevada: International Conference of Building Officials, 1998, CDMG with the Structural Engineers Association of California Seismology Committee.
- Geology and Geomorphic Features Related to Landsliding, Bailey Ridge 7.5' Quadrangle, Mendocino County, California, CDMG Open File Report 84-48 SF, 1984.
- "Topographic Map – Nash Mill Road Association" Prepared by Jackson and Associates, Inc. of Mines and Geology, 1980, Geology for Planning in Sonoma County, Special Report 120.

APPENDIX B

SLOPE INCLINOMETER DATA





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INCLINOMETER B-1 INCREMENTAL DISPLACEMENT

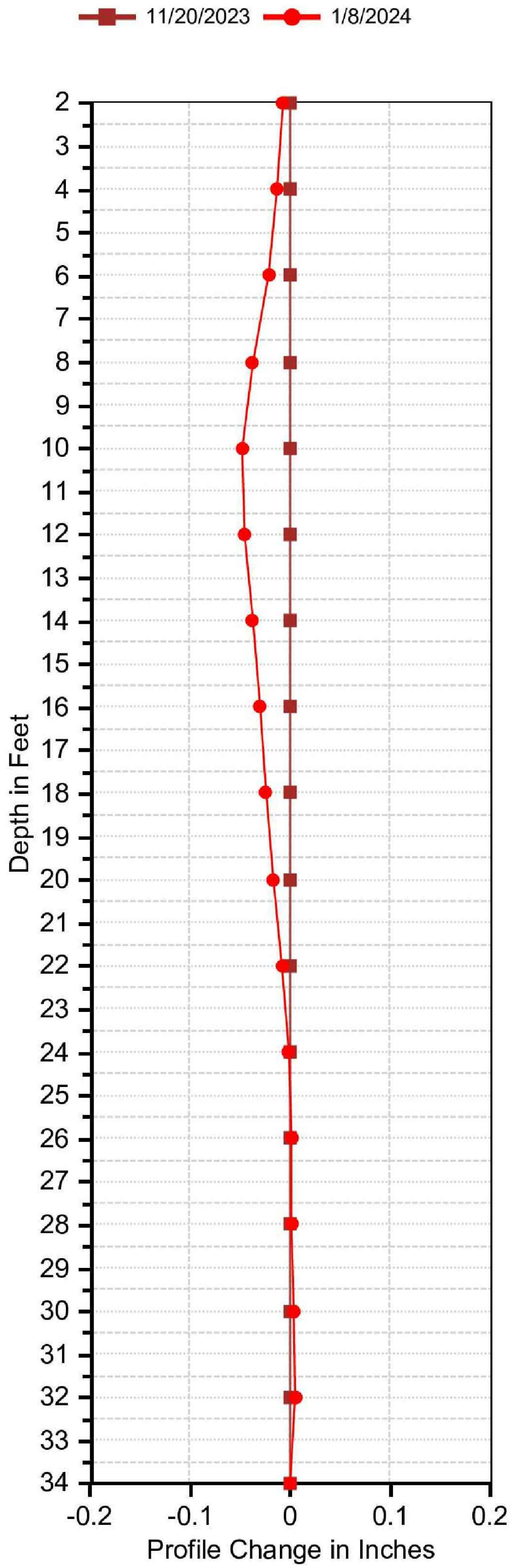
NASH MILL ROAD LANDSLIDE

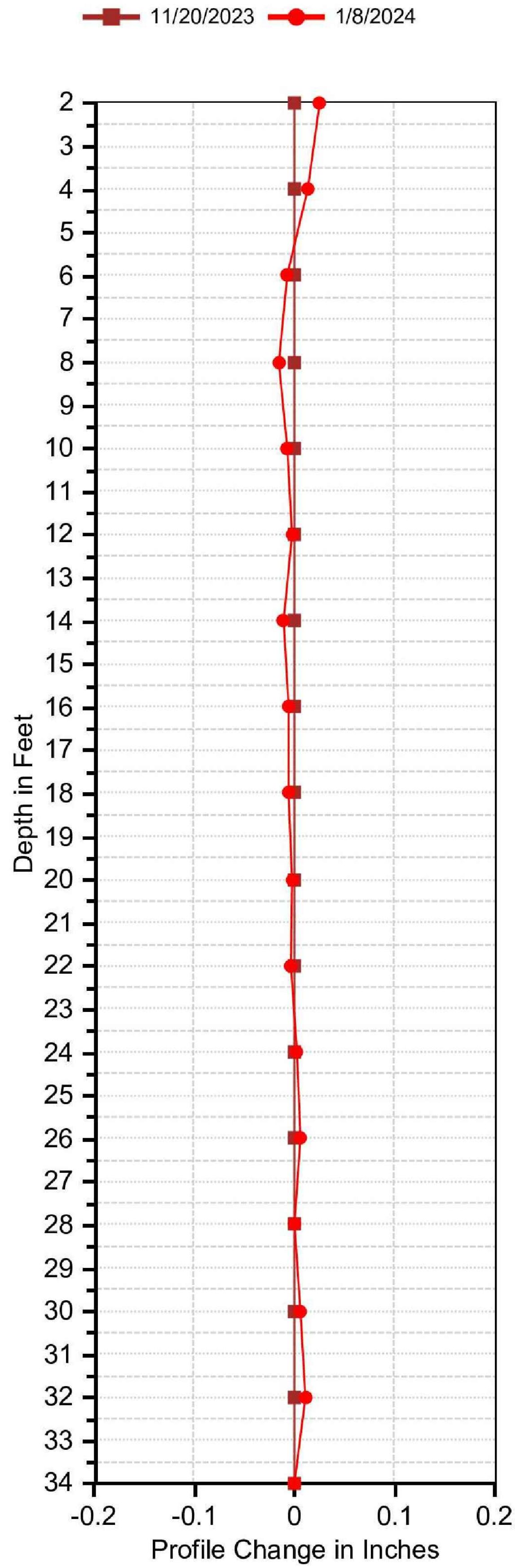
Nash Mill Road

Philo, California

PLATE

B-1





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INCLINOMETER B-1 CUMULATIVE DISPLACEMENT
NASH MILL ROAD LANDSLIDE
Nash Mill Road
Philo, California

PLATE
B-2

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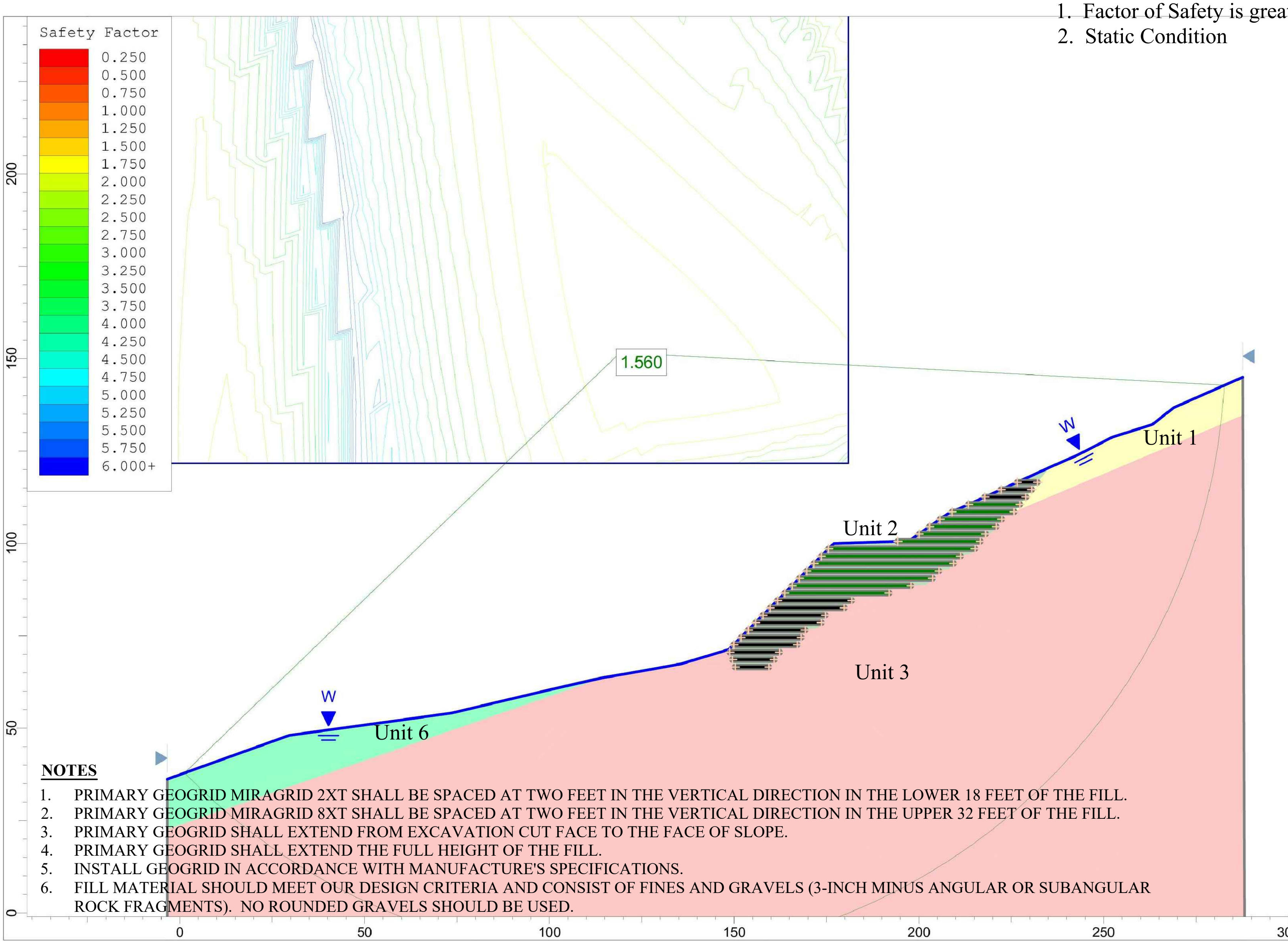
APPENDIX C

SLOPE STABILITY ANALYSIS

Notes:
1. Factor of Safety is greater than 1.5
2. Static Condition



NOTES

1. PRIMARY GEOGRID MIRAGRID 2XT SHALL BE SPACED AT TWO FEET IN THE VERTICAL DIRECTION IN THE LOWER 18 FEET OF THE FILL.
2. PRIMARY GEOGRID MIRAGRID 8XT SHALL BE SPACED AT TWO FEET IN THE VERTICAL DIRECTION IN THE UPPER 32 FEET OF THE FILL.
3. PRIMARY GEOGRID SHALL EXTEND FROM EXCAVATION CUT FACE TO THE FACE OF SLOPE.
4. PRIMARY GEOGRID SHALL EXTEND THE FULL HEIGHT OF THE FILL.
5. INSTALL GEOGRID IN ACCORDANCE WITH MANUFACTURE'S SPECIFICATIONS.
6. FILL MATERIAL SHOULD MEET OUR DESIGN CRITERIA AND CONSIST OF FINES AND GRAVELS (3-INCH MINUS ANGULAR OR SUBANGULAR ROCK FRAGMENTS). NO ROUNDED GRAVELS SHOULD BE USED.

APPROXIMATE SCALE (FEET)

0 20 40 80

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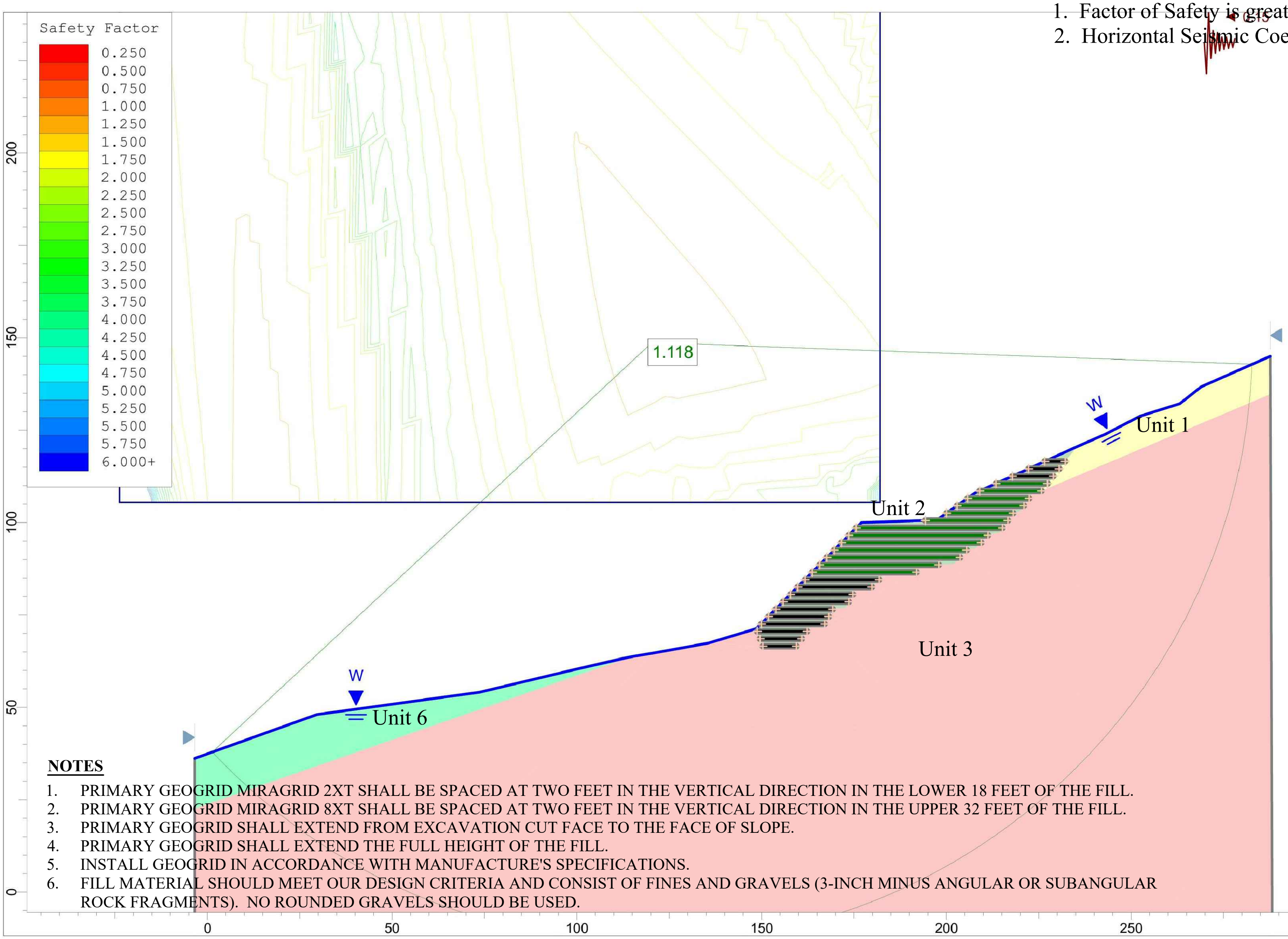
STATIC SLOPE STABILITY CROSS SECTION A-A'
NASH MILL ROAD LANDSLIDE
Nash Mill Road
Philo, California

PLATE
C-1

Notes:
1. Factor of Safety is greater than 1.1
2. Horizontal Seismic Coefficient 0.15



NOTES

1. PRIMARY GEOGRID MIRAGRID 2XT SHALL BE SPACED AT TWO FEET IN THE VERTICAL DIRECTION IN THE LOWER 18 FEET OF THE FILL.
2. PRIMARY GEOGRID MIRAGRID 8XT SHALL BE SPACED AT TWO FEET IN THE VERTICAL DIRECTION IN THE UPPER 32 FEET OF THE FILL.
3. PRIMARY GEOGRID SHALL EXTEND FROM EXCAVATION CUT FACE TO THE FACE OF SLOPE.
4. PRIMARY GEOGRID SHALL EXTEND THE FULL HEIGHT OF THE FILL.
5. INSTALL GEOGRID IN ACCORDANCE WITH MANUFACTURE'S SPECIFICATIONS.
6. FILL MATERIAL SHOULD MEET OUR DESIGN CRITERIA AND CONSIST OF FINES AND GRAVELS (3-INCH MINUS ANGULAR OR SUBANGULAR ROCK FRAGMENTS). NO ROUNDED GRAVELS SHOULD BE USED.

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APPROXIMATE SCALE (FEET)

0 20 40 80

Brunsing Associates, Inc.
5468 Skylane Blvd., Suite 201
Santa Rosa, California 95403
Tel: (707) 528-6108

Job No.: 13658.01
Appr.: KAC
Date: 08/22/24

SEISMIC SLOPE STABILITY CROSS SECTION A-A'
NASH MILL ROAD LANDSLIDE
Nash Mill Road
Philo, California

PLATE
C-2

DISTRIBUTION

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