ENGINEERS

GEOTECHNICAL INVESTIGATION

MUSANTE PROPERTY IMPROVEMENTS
651 VISTA DRIVE
EMERALD, CALIFORNIA 94062

Prepared for
Mr. Brian Musante
651 Vista Drive
Emerald Hills, California 94062

March 2018
Project No. 4351-1

PLN 2018-00309

March 21, 2018
4351-1

Mr. Brian Musante
651 Vista Drive
Emerald Hills, California 94062

RE: GEOTECHNICAL INVESTIGATION
PROPERTY IMPROVEMENTS
651 VISTA DRIVE
EMERALD HILLS, CALIFORNIA

Dear Mr. Musante:

In accordance with your request, we have performed a geotechnical investigation for the proposed property improvements to be constructed at 651 Vista Drive in an unincorporated area of San Mateo County in Emerald Hills, California. The accompanying report summarizes the results of our subsurface exploration, laboratory testing, and engineering analysis, and presents our geotechnical recommendations for the proposed property improvements.

We refer you to the text of our report for specific recommendations.

Thank you for the opportunity to work with you on this project. Please call if you have questions or comments about site conditions or the findings and recommendations from our site investigation.

Very truly yours,

ROMIG ENGINEERS, INC.

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Green Civil Engineering (email)
Attn: Mr. Hon-Cheong Lee

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GEOTECHNICAL INVESTIGATION
MUSANTE PROPERTY IMPROVEMENTS
651 VISTA DRIVE
EMERALD HILLS, CALIFORNIA 94062

PREPARED FOR:

MR. BRIAN MUSANTE

651 VISTA DRIVE

EMERALD HILLS, CALIFORNIA 94062

PREPARED BY:

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1390 EL CAMINO REAL, SECOND FLOOR

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MARCH 2018

ROMIG ENGINEERS

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GEOTECHNICAL INVESTIGATION
FOR
MUSANTE PROPERTY IMPROVEMENTS
651 VISTA DRIVE
EMERLAD HILLS, CALIFORNIA

INTRODUCTION

This report presents the results of our geotechnical investigation for the proposed property improvements to be constructed at 651 Vista Drive in an unincorporated area of San Mateo County in Emerald Hills, California. The location of the site is shown on the Vicinity Map, Figure 1. The purpose of this investigation was to evaluate subsurface conditions at the site and to provide geotechnical recommendations for the proposed improvements.

Project Description

The project consists of winterization and stabilization of the existing and proposed grading at your property in Emerald Hills. We understand the former residence was destroyed by a fire and the debris has been removed from the property. The property generally slopes steeply toward the northeast to a drainage swale. We observed a near vertical cut that was up to about 6 feet high near the top of the hillside and two benches with man-made fill slopes constructed downslope of the cut. We observed tension cracks at the top of the upper man-made fill slope and shallow landsliding, indicating the fill slope is unstable. We understand the man-made cuts and fills at the property need to be restored for long term stability. This work is expected to include overexcavation of the man-made fill slopes, creating a keyway and level benches cut into weathered bedrock, and backfilling and compacting on-site soil to finished slopes no steeper than 2:1 (horizontal:vertical). No proposed structures are currently planned for the property.

Scope of Work

The scope of our work for this investigation was presented in our agreement with Mr. Brian Musante dated February 21, 2018. In order to accomplish our investigation, we performed the following work.

- Review of geologic, geotechnical, and seismic conditions in the vicinity of the site.
- Subsurface exploration consisting of drilling, sampling, and logging of two exploratory borings near the top of the man-made fill slopes.
- Laboratory testing of selected samples to aid in soil classification and to help evaluate the engineering properties of the soil and bedrock encountered at the site.
- Engineering analysis and evaluation of the subsurface data to develop geotechnical design criteria.
- Preparation of this report presenting our findings and geotechnical recommendations for the proposed property improvements.

Limitations

This report has been prepared for the exclusive use of Mr. Brian Musante for specific application to developing geotechnical design criteria for the proposed property improvements to be constructed at 651 Vista Drive in an unincorporated area of San Mateo County in Emerald Hills, California. We make no warranty, expressed or implied, for the services performed for this project. Our services have been performed in accordance with the geotechnical engineering principles generally accepted at this time and location. This report was prepared to provide engineering opinions and recommendations only. In the event there are any changes in the nature, design or location of the project, or if any future improvements are planned, the conclusions and recommendations contained in this report should not be considered valid unless 1) the project changes are reviewed by us, and 2) the conclusions and recommendations presented in this report are modified or verified in writing.

The analysis, conclusions, and recommendations presented in this report are based on site conditions as they existed at the time of our investigation; the currently planned improvements; review of readily available reports relevant to the site conditions; and laboratory test results. In addition, it should be recognized that certain limitations are inherent in the evaluation of subsurface conditions, and that certain conditions may not be detected during an investigation of this type. Changes in the information or data gained from any of these sources could result in changes in our conclusions or recommendations. If such changes occur, we should be advised so that we can review our report in light of those changes.

REVIEW OF PREVIOUS SITE INVESTIGATION

Michelucci & Associates prepared a previous geotechnical report, dated December 9, 1996 and an updated supplemental letter, dated May 26, 2015 for underpinning and/or replacing existing foundations of the former residence at the subject site. This previous investigation included five exploratory borings ranging in depth from 5.5 to 12.5 feet, where they encountered up to 2.5 feet of fill consisting of fat clay. Below the fill or at the surface, they encountered up to 3.5 feet of native soil consisting of fat clay underlain by weathered Franciscan Formation bedrock which extended to the maximum depth explored. A Liquid Limit of 54 and a Plasticity Index of 29 were measured on a sample of surface soil recovered from the Boring No.1. These test results indicate the surface soil has high plasticity and a high potential for expansion. The locations of the borings are shown on the site plan and the boring logs are attached in Appendix B. Michelucci & Associates concluded the former residence had been affected by significant differential foundation settlement associated with a very shallow building foundation that bears on weak compressible and expansive surface soil. They recommended that the residence be underpinned or replaced with drilled or hand-excavated piers embedded into bedrock below any fill or soft surface soils.

SITE EXPLORATION AND RECONNAISSANCE

Site reconnaissance and subsurface exploration were performed on March 2, 2018. Subsurface exploration was performed using portable Minuteman drilling and sampling equipment. Two exploratory borings were advanced to depths of 7.3 and 16 feet. The locations of the borings are shown on the Site Plan, Figure 2. The boring logs and the results of our laboratory tests performed on samples of soil collected during our investigation are attached in Appendices A and B, respectively.

Surface Conditions

The site is located in a residential area northeast of Vista Drive. At the time of our investigation, the site was vacant. We understand the former residence was destroyed by a fire and the debris has been removed from the property. The site was landscaped with native grasses, small to medium shrubs and trees.

The property generally slopes steeply with an average inclination of about 2.5:1 (horizontal:vertical) toward the northeast to a drainage swale. We observed a near vertical cut of up to about 6 feet high near the top of the hillside at the northwest portion of the property. Additional fill had been placed above the near vertical cut, which sloped steeply towards the northeast. Two benches with man-made fill slopes were constructed downslope of the cut and extended along the west portion of the property. We observed tension cracks at the top of the upper man-made fill slope and shallow landsliding, indicating the upper fill slope is unstable. We understand the man-made cuts and fills at the property need to be restored for long term stability.

Subsurface Conditions

At the locations of our exploratory borings, which were advanced near the top of the man-made fill slopes, we generally encountered about 4 feet of fill consisting of fat clay of high plasticity. Below the fill, we encountered about 2 feet of residual soil consisting of fat clay of high plasticity underlain by very severely weathered siltstone, sandstone, and serpentinite bedrock of the Franciscan Complex which extended to the maximum depth explored of 16 feet.

A Liquid Limit of 63 and a Plasticity Index of 33 were measured on a sample of near-surface soil recovered from Boring EB-1. These test results indicate the near-surface soil at the site has high plasticity and a high potential for expansion.

Ground Water

Free ground water was not encountered in the borings during our investigation. The borings were backfilled with grout after sampling was completed; therefore, a stabilized ground water level was not obtained. Please be cautioned that fluctuations in the level of ground water can occur due to variations in rainfall, landscaping, underground drainage patterns, and other factors. It is also possible and perhaps even likely that perched ground water conditions could develop in the soils and near the surface of the bedrock during and after significant rainfall or due to landscape watering at your property and the upslope areas.

GEOLOGIC SETTING

As part of our investigation, we briefly reviewed our local experience and geologic information in our files pertinent to the general area of the site. The information reviewed indicates a majority of the site is mapped as being underlain by middle and lower Eocene age bedrock (Tw) of the Whiskey Hill Formation, with a small north portion of the site mapped as being underlain by Cretaceous and Jurassic-age sandstone bedrock (fs) of the Franciscan Complex(Brabb, Graymer and Jones, 2000). The Whiskey Hill formation is expected to consist primarily of light-gray to buff coarse-grained arkosic sandstone, with light-gray to buff silty claystone, glauconitic sandstone, and tuffaceous siltstone. The Franciscan Complex, which was encountered in our borings and the Michelucci borings, is generally found to consist of predominantly hard and well indurated, yellowish-gray, graywacke sandstone interbedded with shale. The sandstone formation weathers to grayish-yellow sandy clay and clayey and silty sand. The geology of the site vicinity is shown on the Vicinity Geologic Map, Figure 3.

The lot and immediate site vicinity are located in a gently to steeply sloping hillside area. The site is located at an elevation of approximately 260 feet above sea level.

Faulting and Seismicity

There are no mapped through-going faults within or adjacent to the site and the site is not located within a State of California Earthquake Fault Zone (formerly known as a Special Studies Zone), an area where the potential for fault rupture is considered probable. The closest active fault is the San Andreas Fault, which is located approximately 2.0 miles southwest of the property. Thus, the likelihood of surface rupture occurring from active faulting at the site is low.

The San Francisco Bay Area is an active seismic region. Earthquakes in the region result from strain energy constantly accumulating because of the northwestward movement of the Pacific Plate relative to the North American Plate. On average about 1.6-inches of movement occur per year. Historically, the Bay Area has experienced large, destructive earthquakes in 1838, 1868, 1906, and 1989. The faults considered most likely to produce large earthquakes in the area include the San Andreas, San Gregorio, Hayward, and Calaveras faults. The San Gregorio fault is located approximately 11 miles southwest of the site. The Hayward and Calaveras faults are located approximately 17 and 23 miles northeast of the site, respectively. These faults and significant earthquakes that have been documented in the Bay Area are listed in Table 1, and are shown on the Regional Fault and Seismicity Map, Figure 4.

In the future, the subject property will undoubtedly experience severe ground shaking during moderate and large magnitude earthquakes produced along the San Andreas fault or other active Bay Area fault zones. The Working Group On California Earthquake Probabilities, a panel of experts that are periodically convened to estimate the likelihood of future earthquakes based on the latest science and ground motion prediction modeling, concluded there is a 72 percent chance for at least one earthquake of Magnitude 6.7 or larger in the Bay Area before 2045. The Hayward fault has the highest likelihood of an earthquake greater than or equal to magnitude 6.7 in the Bay Area, estimated at 14 percent, while the likelihood on the San Andreas and Calaveras faults is estimated at approximately 6 and 7 percent, respectively (Working Group, 2015).

Table 1. Earthquake Magnitudes and Historical Earthquakes
Musante Property Improvements
Emerald Hills, California

Fault	Maximum Magnitude (Mw)	Historical Earthquakes	Estimated Magnitude
San Andreas	7.9	1989 Loma Prieta	6.9
		1906 San Francisco	7.9
		1865 N. of 1989 Loma Prieta Earthquake	6.5
		1838 San Francisco-Peninsula Segment	6.8
		1836 East of Monterey	6.5
Hayward	7.1	1868 Hayward	6.8
		1858 Hayward	6.8
Calaveras	6.8	1984 Morgan Hill	6.2
		1911 Morgan Hill	6.2
		1897 Gilroy	6.3
San Gregorio	7.3	1926 Monterey Bay	6.1

Earthquake Design Parameters

The State of California currently requires that buildings and structures be designed in accordance with the seismic design provisions presented in the 2016 California Building Code and in ASCE 7-10, "Minimum Design Loads for Buildings and Other Structures." Based on site geologic conditions and on information from our subsurface exploration at the site, the site may be classified as Site Class C, very dense soil and soft rock, in accordance with Chapter 20 of ASCE 7-10. Spectral Response Acceleration parameters and site coefficients may be taken directly from the U.S.G.S. website based on the longitude and latitude of the site. For site latitude (37.4668), longitude (-122.2601) and Site Class C, design parameters are presented on Table 2.

Table 2. 2016 CBC Seismic Design Criteria
Musante Property Improvements
Emerald Hills, California

Spectral Response Acceleration Parameters		Design Value
Mapped Value for Short Period -	S_S	2.131
Mapped Value for 1-sec Period -	S_1	1.012
Site Coefficient -	F_a	1.0
Site Coefficient -	F_v	1.3
Adjusted for Site Class -	S_{MS}	2.131
Adjusted for Site Class -	S_{M1}	1.315
Value for Design Earthquake -	S_{DS}	1.420
Value for Design Earthquake -	S_{D1}	0.877

CONCLUSIONS

From a geotechnical viewpoint, the site is suitable for the proposed property improvements provided the recommendations presented in this report are followed during design and construction. Specific geotechnical recommendations for the project are presented in the following sections of this report.

The primary geotechnical concerns for the project are the expansive nature of the fill and native soil across the site; the presence of up to about 4 feet of undocumented fill near the top of the man-made fill slopes; the presence of up to about 6 feet high near vertical cuts near the top of the slope; the steeply sloping terrain on the property; the potential for erosion and downslope soil creep of the surface and near-surface soil, and the potential for severe ground shaking at the site during a major earthquake. In order to winterize and stabilize the undocumented man-made fills on the property, in our opinion the existing fill slopes should be over excavated and properly compacted to current earthwork standards on a series of level benches and keyways cut into weathered bedrock. The lateral extent of the repair is expected to include the limits of the fill as depicted approximately in Figure 2 of our report. The actual extent of the fill and overexcavating may need to be adjusted in the field as the extent of the fill and underlying soil are established during grading. The earthwork for the proposed grading should also follow the general criteria presented in "Earthwork" section of our report. We also recommend oversteepened cut slopes near the top of the hillside be modified to an inclination no steeper than 2:1 (horizontal:vertical).

A member of our staff should observe and test on nearly a full time basis during the overexcavation of the man-made fill slopes, and backfilling and compaction of the proposed fill slopes on the property.

Because subsurface conditions may vary from those encountered at the locations of our exploratory borings, and to confirm that our recommendations are properly implemented, we recommend that we be retained to: 1) review the grading and improvement plans for conformance with our recommendations; and 2) observe and test during all phases of earthwork and drainage construction.

EARTHWORK

Clearing and Subgrade Preparation

All deleterious materials, such as existing foundations, slabs and utilities to be abandoned, existing fill, pavement, concrete, vegetation, roots, topsoil, etc., should be cleared from areas to be built on or paved. The actual stripping depth should be determined by a member of our staff at the time of construction. Excavations that extend below finish grade should be backfilled with structural fill that is water-conditioned, placed, and compacted as recommended in the section titled "Compaction."

After the site has been properly cleared, stripped, and excavated to the required grades, exposed soil surfaces in areas to receive structural fill should be scarified to a depth of 6 inches, moisture conditioned, and compacted as recommended for structural fill in the section titled "Compaction."

On-site soils should be kept in a moist condition throughout the construction period to help mitigate the potential effects of the expansive on-site soils on the proposed improvements.

Large fills are generally not desirable on a hillside site like this. Where fills are to be constructed on slopes having an inclination steeper than 6 horizontal to 1 vertical, the fill should be benched, and a key excavated into the underlying bedrock with subdrains installed, as shown in the attached Figure 5, and discussed further below.

Proposed Fill Slope Recommendations

After existing man-made fills slopes have been overexcavated, the keyway or upslope benches should be excavated down to competent weathered bedrock and compacted under our direction as shown in the attached Figure 5. The new fill slope construction should begin with a base keyway excavated at the base of the fill slope. The key should have a width of at least 12 feet and extend at least 2 to 3 feet into weathered bedrock. The base key and benches should be inclined into the back of the benches at an inclination of at least 1.5 percent. Subdrains should be included at the back of the keyways and probably within at least the two benches higher up within the fill slope area as directed by our representative in the field.

The resulting excavation bottom and sidewalls should be benched prior to and as the structural backfill is being placed and compacted as discussed in the "Earthwork" section. Imported backfill materials such as Class 2 aggregate base or quarry fines should be approved by a member of our staff prior to delivery to the site. The backfill should be moisture conditioned, and compacted as recommended in the section of this report titled "Compaction." A member of our staff should observe and test on nearly a full time basis during excavation and backfilling of the proposed fill slopes on the property.

Subsurface Drainage

Subdrains should be included at the back of the keyways and at least two to three of the benches as discussed above and/or as directed by our field representative during construction. The subdrains should consist of an 18-inch width of Caltrans Class 2 permeable material. Four-inch diameter rigid plastic pipe (Schedule 40 PVC, SDR35 or equal) should be placed with perforations down on a 4-inch thick bed of Class 2 permeable material. The Class 2 permeable material should be continued up to within 12-inches of the elevation of the next bench. The pipe should slope at a minimum inclination of 1.5 percent and should drain to a low point or points and then be connected to a suitable discharge location. We recommend the project surveyor locate all subsurface drains, solid pipes and cleanouts on an as built drawing of the repair. This plan will assist should any future maintenance or repair work be needed.

Material for Fill

All on-site soil containing less than 3 percent organic material by weight (ASTM D2974) is suitable for use as structural fill. However, structural fill placed at the site, should not contain rocks or pieces larger than 6 inches in greatest dimension, and contain no more than 15 percent larger than 2.5 inches. Imported fill should have a plasticity index of less than 15 percent or be predominately granular, and should have sufficient binder so as not to slough or cave into foundation excavations and utility trenches. Our representative should approve import materials prior to their use on-site.

For better performance, if the on-site highly expansive fill and native soil is utilized for structural fill, to reduce the plasticity and moisture content of the highly expansive material it may be treated with a lime/cement treatment. Please note soils treated with lime do not promote healthy growth of vegetation at the surface. Please contact us if you would like to proceed with this increased stability performance option.

Compaction

Scarified soil surfaces and all structural fill should be compacted in uniform lifts no thicker than 8 inches in pre-compacted thickness, conditioned to the appropriate moisture content, and compacted as recommended for structural fill in Table 3. The relative compaction and moisture content recommended in Table 3 is relative to ASTM Test D1557, latest edition.

Table 3. Compaction Recommendations
Musante Property Improvements
Emerald Hills, California

General	Relative Compaction*	Moisture Content*
• Scarified subgrade in areas to receive structural fill.	90 percent	At least 3 percent above optimum
• Structural fill composed of native soil.	90 percent	At least 3 percent above optimum
• Structural fill composed of non-expansive fill.	90 percent	Above optimum
• Structural fill below a depth of 4 feet.	93 percent	At least 3 percent above optimum
Pavement Subgrade		
• On-site soil.	95 percent	At least 3 percent above optimum
• Aggregate base.	95 percent	Near optimum
Utility Trench Backfill		
• On-site soil.	90 percent	At least 3 percent above optimum
• Imported sand.	95 percent	Near optimum

* Relative to ASTM Test D1557, latest edition.

Temporary Slopes and Excavations

The contractor should be responsible for the design and construction of all temporary slopes and any required shoring. Shoring and bracing should be provided in accordance with all applicable local, state and federal safety regulations, including the current OSHA excavation and trench safety standards.

Because of the potential for variation of the on-site soils, field modification of temporary cut slopes and shoring may be required. Unstable materials encountered on slopes during and after excavation should be trimmed off even if this requires cutting the slopes back to a flatter inclination.

Protection of structures or improvements near excavations and trenches will also be the responsibility of the contractor.

Finished Slopes

We recommend that new finished slopes be cut or filled to an inclination preferably no steeper than 2:1 (horizontal:vertical). Exposed slopes may be subject to minor sloughing and erosion that could require periodic maintenance. We recommend that all slopes and soil surfaces disturbed during construction be planted to with erosion-resistant vegetation.

Surface Drainage

Finished grades should be designed to prevent ponding of water and to direct surface water runoff to the existing drainage swale. A v-ditch should be installed at the top of the fill slopes to divert water away.

FUTURE SERVICES

Plan Review

Romig Engineers should review the completed grading and drainage plans for conformance with the recommendations presented in this report. We should be provided with these plans as soon as possible upon their completion in order to limit the potential for delays in the permitting process that might otherwise be attributed to our review process. The County will likely require a "clean" geotechnical plan review letter prior to approval of the plans. Since our plan reviews often result in recommendations for modification of the plans, our generation of a "clean" review letter often requires two iterations.

At a minimum, we recommend that the following note be added to the plans. "Earthwork, grading, overexcavation of existing man-made fill slopes, keyway and upslope bench excavations, subdrain installation, backfilling and compaction of proposed fill slopes, and site drainage should be performed in accordance with the geotechnical report prepared by Romig Engineers, Inc., dated March 21, 2018. Romig Engineers should be notified at least 48 hours in advance of any earthwork and should observe and test during earthwork and foundation construction as recommended in the geotechnical report."

Construction Observation and Testing

Earthwork construction should be observed and tested by us to: 1) confirm that subsurface conditions are compatible with those used in the analysis and design; 2) observe compliance with the design concepts, specifications, and recommendations, and; 3) allow design changes in the event that subsurface conditions differ from those anticipated. The recommendations presented in this report are based on a limited number of borings. The nature and extent of variation across the site may not become evident until construction. If variations are exposed during construction, it will be necessary to reevaluate our recommendations.

❖ ❖ ❖ ❖ ❖

REFERENCES

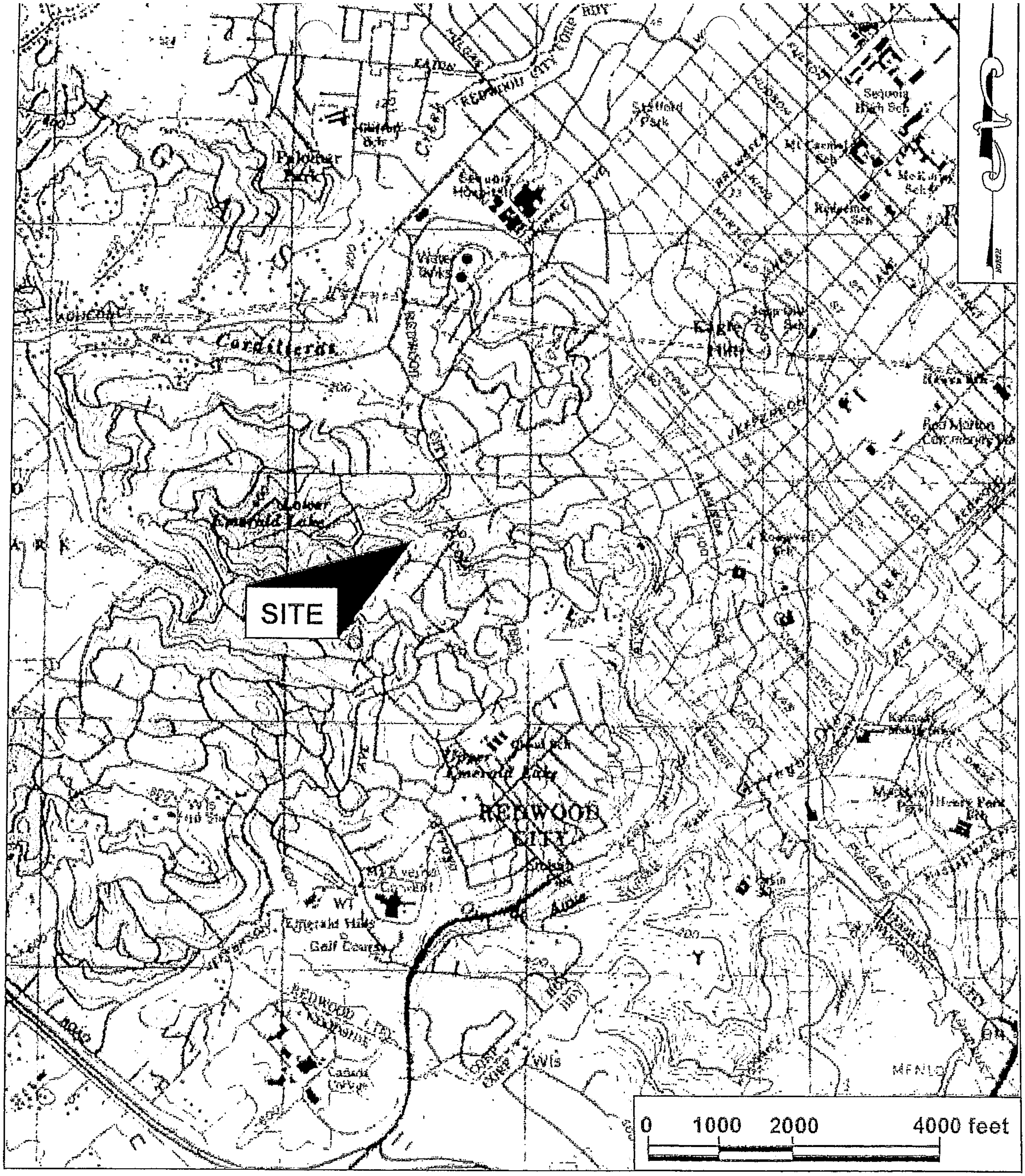
American Society of Civil Engineers, 2010, Minimum Design Loads for Buildings and Other Structures, ASCE Standard 7-10.

Brabb, E.E. Graymer, R.W., and Jones, D.L., 2000, Geologic Map of the Palo Alto 30' x 60' Quadrangle, California: U.S. Geological Survey Miscellaneous Field Studies Map MF-2332, U.S. Geological Survey, Menlo Park, CA.

California Building Standards Commission, and International Code Council, 2016 California Building Code, California Code of Regulations, Title 24, Part 2.

U.S.G.S., 2018, U.S. Seismic Design Maps, Earthquake Hazards Program, http://earthquake.usgs.gov/designmaps/us/application.php

Working Group on California Earthquake Probabilities (WGCEP), 2015, Long-Term Time-Dependent Probabilities for the Third Uniform California Earthquake Rupture Forecast, Version 3 (UCERF 3), U.S. Geological Survey Open File Report 2013-1165.



Scale: 1 inch = 2000 feet
Base is United States Geological Survey Woodside and Palo Alto 7.5 Minute Quadrangle, dated 1997.

VICINITY MAP
MUSANTE PROPERTY IMPROVEMENTS
EMERALD HILLS, CALIFORNIA

FIGURE 1
MARCH 2018
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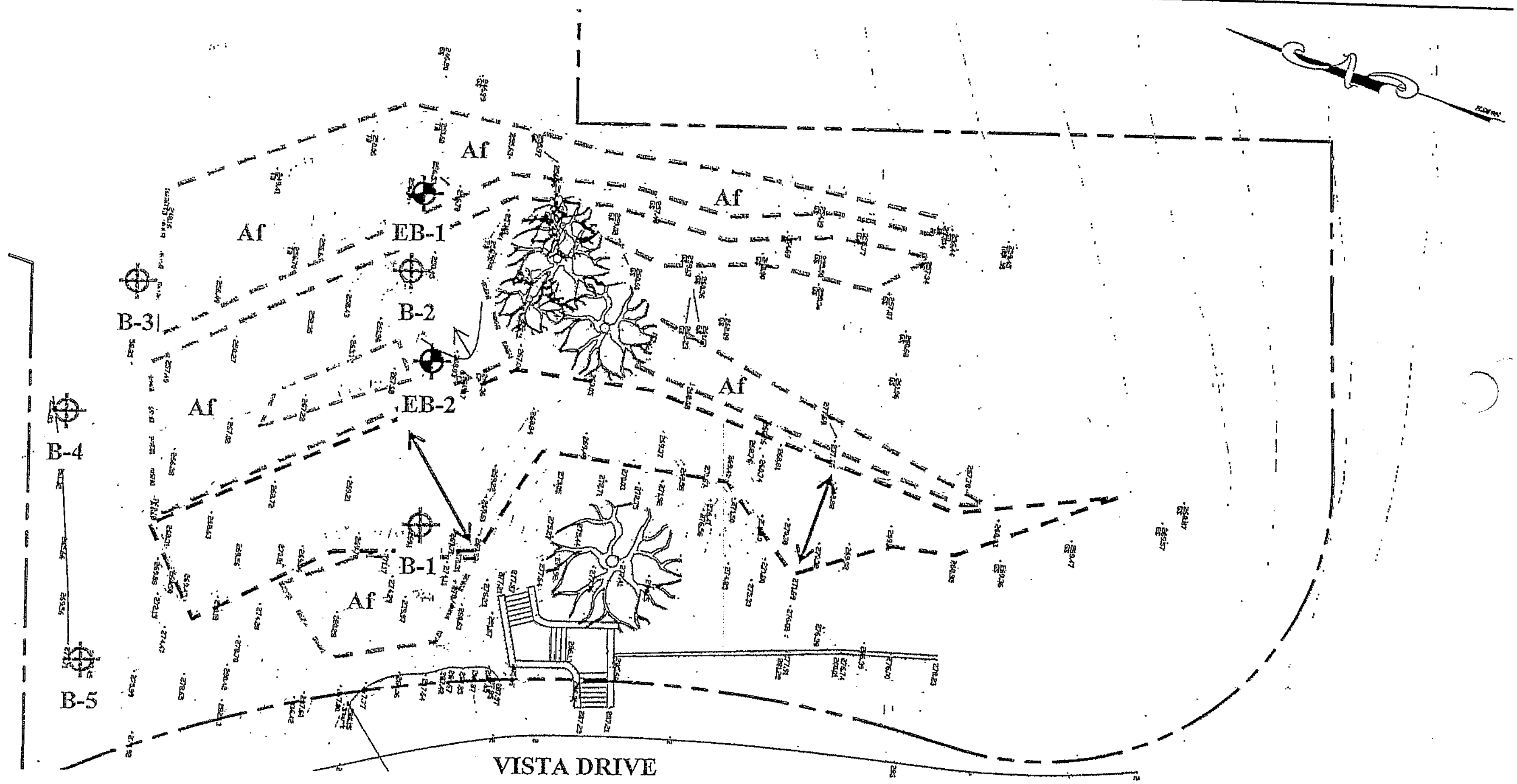

LEGEND

EB-2 — Approximate Locations of Exploratory Borings.
B-5 — Approximate Locations of Exploratory Borings (Michelucci & Associates, 1996.)
Af — Artificial fill
Fill
Cut
Approximate Scale: 1 inch = 30 feet.
Base is topographic survey prepared by GREEN Civil Engineering, undated.

Tension Cracks
Shallow Landsliding

SITE PLAN
MUSANTE PROPERTY IMPROVEMENTS
EMERALD HILLS, CALIFORNIA

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FIGURE 2
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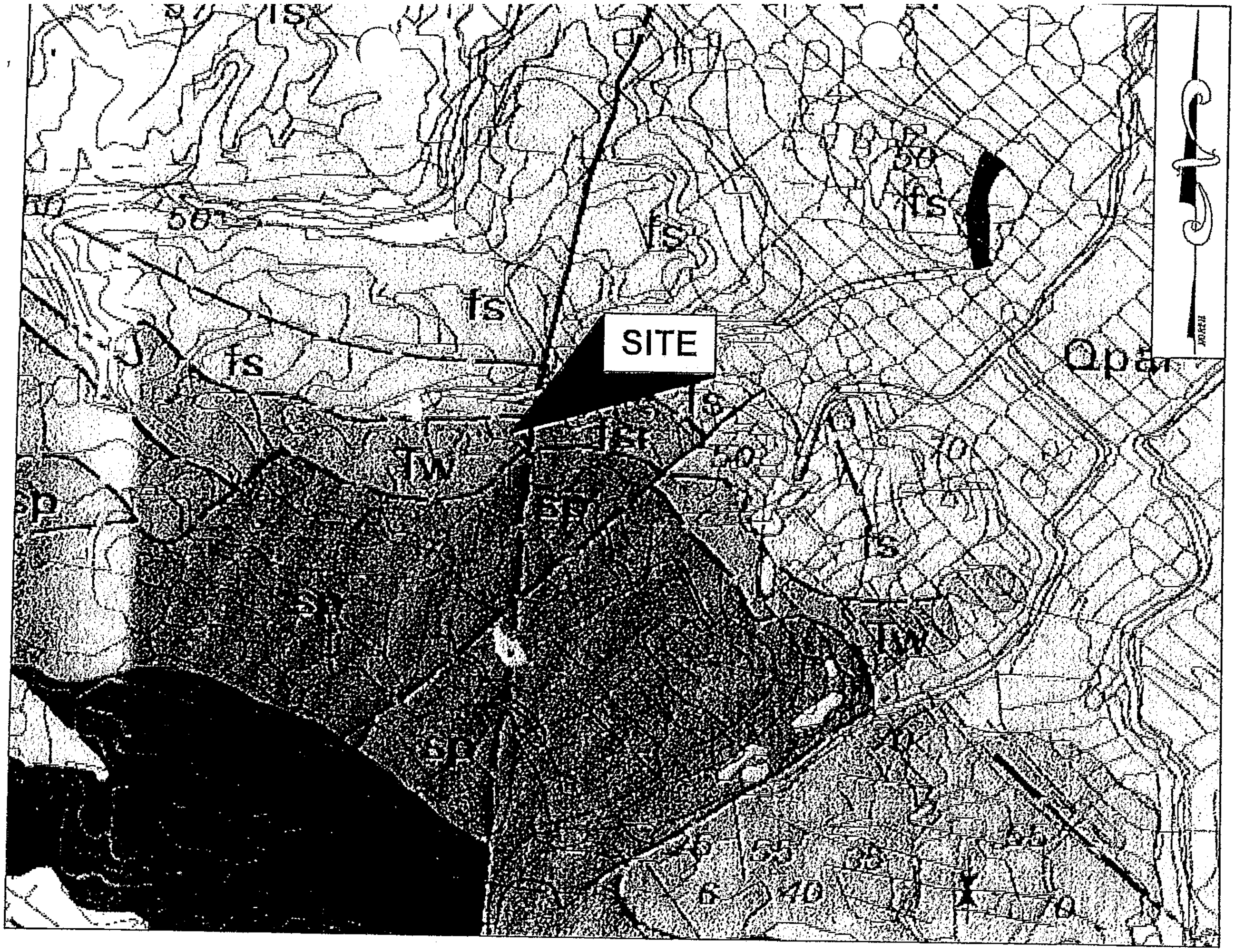

LEGEND

Qpaf	Alluvial fan and fluvial deposits		Geologic Contact - dashed where approximate, dotted where inferred.
Tw	Whiskey Hill Formation		
fs	Sandstone	?	Fault - dashed where approximate, dotted where inferred.
	Greenstone		
fsr	Sheared Rock		Anticline
sp	Serpentinite		Syncline

0 1000 2000 4000 feet

Scale: 1 inch = 2000 feet

Base is Geologic Map of San Mateo County, Brabb, Graymer, and Jones, dated 1998.

VICINITY GEOLOGIC MAP
MUSANTE PROPERTY IMPROVEMENTS
EMERALD HILLS, CALIFORNIA

FIGURE 3
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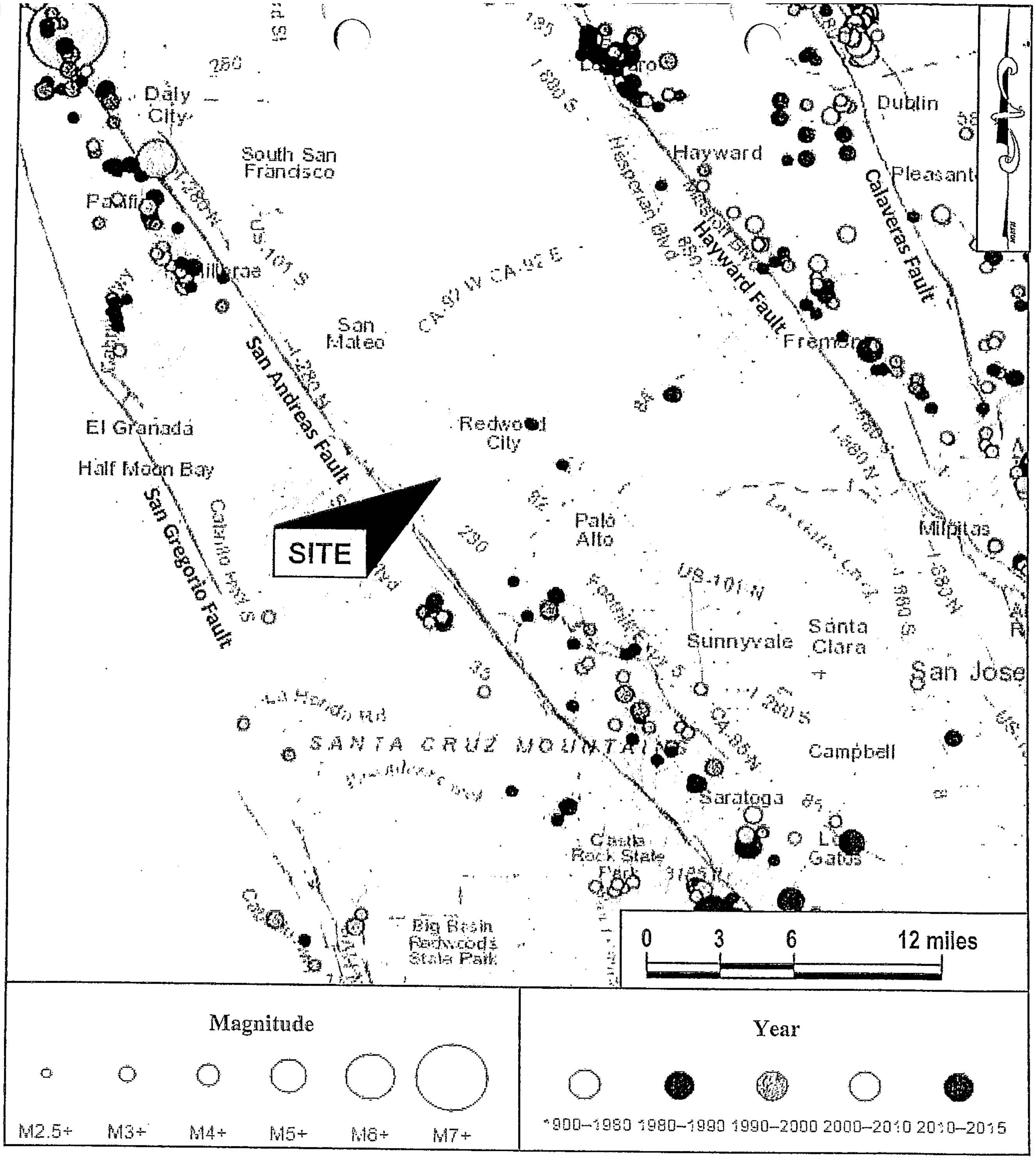

Earthquakes with M5+ from 1900 to 1980, M2.5+ from 1980 to January 2015. Faults with activity in last 15,000 years. Based on data sources from Northern California Earthquake Data Center and USGS Quaternary Fault and Fold Database, accessed May 2015.

REGIONAL FAULT AND SEISMICITY MAP
MUSANTE PROPERTY IMPROVEMENTS
EMERALD HILLS, CALIFORNIA

FIGURE 4
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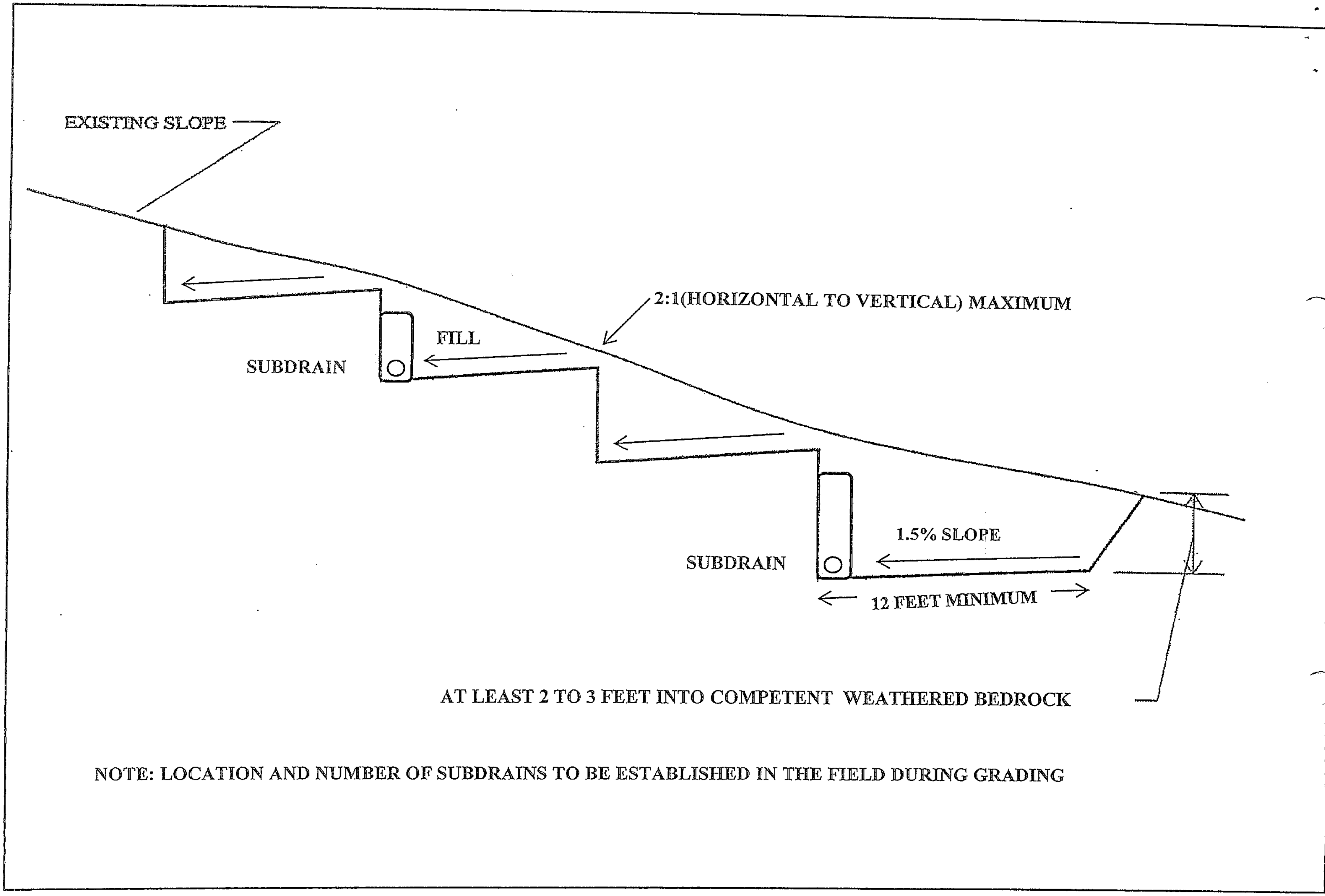

CONCEPTUAL BENCHING DETAIL
MUSANTE PROPERTY IMPROVEMENTS
EMERALD HILLS, CALIFORNIA

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FIGURE 5
MARCH 2018
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APPENDIX A

FIELD INVESTIGATION

The soils encountered during drilling were logged by our representative and samples were obtained at depths appropriate to the investigation. The samples were taken to our laboratory where they were examined and classified in accordance with the Unified Soil Classification System. The logs of our borings, as well as a summary of the soil classification system (Figure A-1) and bedrock descriptions (Figure A-2) used on the logs, are attached.

Several tests were performed in the field during drilling. The standard penetration test resistance was determined by dropping a 140-pound hammer through a 30-inch free fall, and recording the blows required to drive the 2-inch (outside diameter) sampler 18 inches. The standard penetration test (SPT) resistance is the number of blows required to drive the sampler the last 12 inches, and is recorded on the borings logs at the appropriate depths. The results of these field tests are also presented on the boring logs. Soil samples were also collected using 2.5-inch and 3-inch O.D. drive samplers. The blow counts shown on the logs for these larger diameter samplers do not represent SPT values and have not been corrected in any way.

The locations and elevations of the exploratory borings were determined by pacing using the topographic survey prepared by Green Civil Engineering, undated. The locations and elevations of the borings should be considered accurate only to the degree implied by the method used.

The boring logs and related information depict our interpretation of subsurface conditions only at the specific location and time indicated. Subsurface conditions and ground water levels at other locations may differ from conditions at the locations where sampling was conducted. The passage of time may also result in changes in the subsurface conditions.

HAMMER WEIGHT	140 #, 30" Drop	TYPE OF BORING 3.5" Auger (Minute...)	DATE OF BORING 10-11-96
SURFACE ELEVATION	---		
GROUNDWATER DEPTH	10-11-96	Dry	

DESCRIPTION OF MATERIALS	DEPTH IN FT.	SAMPLE NUMBER-SAMPLE DIAMETER	DRIVING RESISTANCE BLOWS PER FT.	DRY DENSITY P.C.F.	MOISTURE CONTENT %	UNCONFINED COMPRESSIVE STRENGTH P.S.F.	OTHER TESTS
Medium stiff, dark greyish brown, fine sandy silty clay with small pieces of brick, glass, etc., damp (Fill)		1) 2.5"	26	98	20	9870	
Medium stiff, dark greyish brown, fine sandy silty clay with clear to white quartz fragments, damp (Buried Topsoil)		2) 2"	27	107	12	8060	
	5	3) spt	28	---	--	----	
Stiff, olive brown, fine sandy silty clay with rock fragments, slightly damp to damp (Residual)		4) 2"	23	111	8	----	
Hard, reddish brown chert, dry, moderately weathered (Franciscan Assemblage)	10	5) 2"	50	116	8	5640	
		6) 2"	46	108	16	5650	
		7) spt*	80/6"	---	--	----	
Hard, olive and greyish brown, fine sandy and silty serpentinite, slightly damp, moderately weathered (Franciscan Assemblage)							
	15						
Boring terminated at 12 feet 6 inches							
	20						
* spt denotes Standard Penetration Test							
	25						
	30						
	35						

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Figure 5

HAMMER WEIGHT 140 .., 30" Drop	3.5" Auger (Minut[illegible])						DATE OF BORING 10-11-96	
SURFACE ELEVATION ---								
GROUNDWATER DEPTH 10-11-96 Dry								
DESCRIPTION OF MATERIALS	DEPTH IN FT.	SAMPLE	SAMPLE NUMBER-SAMPLE DIAMETER	DRIVING RESISTANCE BLOWS PER FT.	DRY DENSITY P.C.F.	MOISTURE CONTENT %	UNCONFINED COMPRESSIVE STRENGTH P.S.F.	OTHER TESTS
Stiff, dark brown, fine sandy silty clay with minor rootlets and rock fragments, damp (Topsoil)			1) 2.5"	56	114	14	16340	
Hard, olive and greyish brown, fine sandy silty shale/mudstone with minor rootlets, slightly damp (Franciscan Assemblage)			2) 2"	60	111	12	9170	
	5		3) spt*	90	---	--	----	
Hard, greyish brown, serpentinite with seams of greywacke sandstone, dry, deeply weathered (Franciscan Assemblage)								
Hard, olive and greyish brown, fine sandy silty shale/mudstone, slightly damp, deeply weathered (Franciscan Assemblage)	10							
Boring terminated at 5 feet 6 inches	15							
	20							
* spt denotes Standard Penetration Test	25							
	30							
	35							

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Figure 4

BORING SUPERVISOR		TYPE OF BORING	DATE OF BORING
HAMMER WEIGHT	140 #, 30" Drop	3.5" Auger (Minuteman)	10-11-96
SURFACE ELEVATION	---		
GROUNDWATER DEPTH	10-11-96	Dry	

DESCRIPTION OF MATERIALS	DEPTH IN FT.	SAMPLE	SAMPLE NUMBER-SAMPLE DIAMETER	DRIVING RESISTANCE BLOWS PER FT.	DRY DENSITY P.C.F.	MOISTURE CONTENT %	UNCONFINED COMPRESSIVE STRENGTH P.S.F.	OTHER TESTS
Stiff, medium and greyish brown, fine sandy silty clay with minor pebbles, damp (Topsoil)			1) 2.5"	52	107	7	----	PI
Hard, olive and greyish brown, silty shale/mudstone, slightly damp, deeply weathered (Franciscan Assemblage)			2) 2"	58	107	8	----	
	5		3) spt*	82	---	--	----	
Hard, greyish brown, serpentinite and greywacke sandstone, dry (Franciscan Assemblage)								
Boring terminated at 5 feet 6 inches	10							
	15							
	20							
* spt denotes Standard Penetration Test	25							
	30							
	35							

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Figure 3

APPENDIX B

PREVIOUS EXPLORATION LOGS

Boring Logs B-1 through B-5
(Michelucci & Associates, 1996)

ROMIG ENGINEERS

DEPTH TO GROUND WATER: Not [illegible]untered **SURFACE ELEVATION:** NA **DATE DRILLED:** 3/2/18

CLASSIFICATION AND DESCRIPTION	SOIL CONSISTENCY/ DENSITY or ROCK HARDNESS* (Figure A-2)	SOIL TYPE	SOIL SYMBOL	DEPTH (FEET)	SAMPLE INTERVAL	PEN. RESISTANCE (Blows/ft)	WATER CONTENT (%)	SHEAR STRENGTH (TSF)*	UNCONFIN. COMP. (TSF)*
Fill: Grayish Brown, Fat Clay, moist to very moist, fine to coarse grained sand, fine sub-angular gravel, high plasticity.	Soft to Firm	CH		0		3 7	17 29		0.8
Residual Soil: Olive Brown, Fat Clay, moist, fine to coarse grained sand, high plasticity.	Very Stiff	CH		5		20	23		
Franciscan Complex: Green to Grayish Brown, Siltstone, sandstone, serpentinite, moist, very severely weathered, friable.	Soft to Medium	BR				50/5" 50/4"	13 4		
Bottom of Boring at 7.3 feet.				10 15 20					

Note: The stratification lines represent the approximate boundary between soil and rock types, the actual transition may be gradual.

*Measured using Torvane and Pocket Penetrometer devices.

EXPLORATORY BORING LOG EB-2
MUSANTE PROPERTY IMPROVEMENTS
EMERALD HILLS, CALIFORNIA

BORING EB-2
MARCH 2018
PROJECT NO. 4351-1

ROMIG ENGINEERS

DEPTH TO GROUND WATER: N... Encountered **SURFACE ELEVATION:** NA **DATE DRILLED:** 3/2/18

CLASSIFICATION AND DESCRIPTION	SOIL CONSISTENCY/ DENSITY or ROCK HARDNESS* (Figure A-2)	SOIL TYPE	SOIL SYMBOL	DEPTH (FEET)	SAMPLE INTERVAL	PEN. RESISTANCE (Blows/ft)	WATER CONTENT (%)	SHEAR STRENGTH (TSF)*	UNCONFIN. COMP. (TSF)*
Fill: Brown, Fat Clay, very moist, fine to coarse grained sand high plasticity.	Soft to Stiff	CH		0		2	25		1.5
Color transition to dark brown. ■ Liquid Limit = 63, Plasticity Index = 33.						11	23		2.5
Residual Soil: Olive Brown, Fat Clay, moist, fine to coarse grained sand, high plasticity.	Very Stiff	CH		5		27	19		3.0
Franciscan Complex: Green to Grayish Brown, Siltstone, sandstone, serpentinite, moist, very severely weathered, friable.	Soft	BR				40	13		1.8
				10		47	12		>4.5
Note: The stratification lines represent the approximate boundary between soil and rock types, the actual transition may be gradual.						31	16		3.3
*Measured using Torvane and Pocket Penetrometer devices.						41	27		3.0
				15		48	12		4.3
Bottom of Boring at 16 feet.				20					

EXPLORATORY BORING LOG EB-1
MUSANTE PROPERTY IMPROVEMENTS
EMERALD HILLS, CALIFORNIA

BORING EB-1
MARCH 2018
PROJECT NO. 4351-1

ROMIG ENGINEERS

WEATHERING

Fresh
Rock fresh, crystals bright, few joints may show slight staining. Rock rings under hammer if crystalline.

Very Slight
Rock generally fresh, joints stained, some joints may show thin clay coatings, crystals in broken face show bright. Rock rings under hammer if crystalline.

Slight
Rock generally fresh, joints stained, and discoloration extends into rock up to 1 inch. Joints may contain clay. In granitoid rocks some occasional feldspar crystals are dull and discolored. Crystalline rocks ring under hammer.

Moderate
Significant portions of rock show discoloration and weathering effects. In granitoid rocks, most feldspars are dull and discolored; some are clayey. Rock has dull sound under hammer and shows significant loss of strength as compared with fresh rock.

Moderately Severe
All rock except quartz discolored or stained. In granitoid rocks, all feldspars dull and discolored and majority show kaolinization. Rock shows severe loss of strength and can be excavated with geologist's pick. Rock goes "clunk" when struck.

Severe
All rock except quartz discolored or stained. Rock "fabric" clear and evident, but reduced in strength to strong soil. In granitoid rocks, all feldspars kaolinized to some extent. Some fragments of strong rock usually left.

Very Severe
All rock except quartz discolored and stained. Rock "fabric" discernible, but mass effectively reduced to "soil" with only fragments of strong rock remaining.

Complete
Rock reduced to "soil". Rock fabric not discernible or discernible only in small scattered locations. Quartz may be present as dikes or stringers.

HARDNESS

Very hard
Cannot be scratched with knife or sharp pick. Hand specimens requires several hard blows of geologist's.

Hard
Can be scratched with knife or pick only with difficulty. Hard blow of hammer required to detach hand specimen.

Moderately Hard
Can be scratched with knife or pick. Gouges or grooves to 1/4 inch deep can be excavated by hard blow of point of a geologist's pick. Hard specimen can be detached by moderate blow.

Medium
Can be grooved or gouged 1/16 inch deep by firm pressure on knife or pick point. Can be excavated in small chips to pieces about 1 inch maximum size by hard blows of the point of a geologist's pick.

Soft
Can be gouged or grooved readily with knife or pick point. Can be excavated in chips to pieces several inches in size by moderate blows of a pick point. Small thin pieces can be brocken by finger pressure.

Very Soft
Can be carved with knife. Can be excavated readily with point of pick. Pieces 1 inch or more in thickness can be broken with finger pressure. Can be scratched readily by fingernail.

JOINT BEDDING AND FOLIATION SPACING

Spacing	Joints	Bedding and Foliation
Less than 2 in.	Very Close	Very Thin
2 in. to 1 ft.	Close	Thin
1 ft. to 3 ft.	Moderately Close	Medium
3 ft. to 10 ft.	Wide	Thick
More than 10 ft.	Very Wide	Very Thick

ROCK QUALITY DESIGNATOR (RQD)

RQD, as a percentage	Descriptor
Exceeding 90	Excellent
90 to 75	Good
75 to 50	Fair
50 to 25	Poor
Less than 25	Very Poor

KEY TO BEDROCK DESCRIPTIONS
MUSANTE PROPERTY IMPROVEMENTS
EMERALD HILLS, CALIFORNIA

FIGURE A-2
MARCH 2018
PROJECT NO. 4351-1

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USCS SOIL CLASSIFICATION

PRIMARY DIVISIONS			SOIL TYPE	SECONDARY DIVISIONS
COARSE GRAINED SOILS (< 50 % Fines)	GRAVEL	CLEAN GRAVEL (< 5% Fines)	GW	Well graded gravel, gravel-sand mixtures, little or no fines.
			GP	Poorly graded gravel or gravel-sand mixtures, little or no fines.
		GRAVEL with FINES	GM	Silty gravels, gravel-sand-silt mixtures, non-plastic fines.
			GC	Clayey gravels, gravel-sand-clay mixtures, plastic fines.
	SAND	CLEAN SAND (< 5% Fines)	SW	Well graded sands, gravelly sands, little or no fines.
			SP	Poorly graded sands or gravelly sands, little or no fines.
		SAND WITH FINES	SM	Silty sands, sand-silt mixtures, non-plastic fines.
			SC	Clayey sands, sand-clay mixtures, plastic fines.
FINE GRAINED SOILS (> 50 % Fines)	SILT AND CLAY Liquid limit < 50%		ML	Inorganic silts and very fine sands, with slight plasticity.
			CL	Inorganic clays of low to medium plasticity, lean clays.
			OL	Organic silts and organic clays of low plasticity.
	SILT AND CLAY Liquid limit > 50%		MH	Inorganic silt, micaceous or diatomaceous fine sandy or silty soil.
			CH	Inorganic clays of high plasticity, fat clays.
			OH	Organic clays of medium to high plasticity, organic silts.
HIGHLY ORGANIC SOILS			Pt	Peat and other highly organic soils.
BEDROCK			BR	Weathered bedrock.

RELATIVE DENSITY

SAND & GRAVEL	BLOWS/FOOT*
VERY LOOSE	0 to 4
LOOSE	4 to 10
MEDIUM DENSE	10 to 30
DENSE	30 to 50
VERY DENSE	OVER 50

CONSISTENCY

SILT & CLAY	STRENGTH^	BLOWS/FOOT*
VERY SOFT	0 to 0.25	0 to 2
SOFT	0.25 to 0.5	2 to 4
FIRM	0.5 to 1	4 to 8
STIFF	1 to 2	8 to 16
VERY STIFF	2 to 4	16 to 32
HARD	OVER 4	OVER 32

GRAIN SIZES

BOULDERS	COBBLES	GRAVEL		SAND			SILT & CLAY
		COARSE	FINE	COARSE	MEDIUM	FINE	

12 " 3" 0.75" — SIEVE OPENINGS

4 10 40 200 — U.S. STANDARD SERIES SIEVE

Classification is based on the Unified Soil Classification System; fines refer to soil passing a No. 200 sieve.

* Standard Penetration Test (SPT) resistance, using a 140 pound hammer falling 30 inches on a 2 inch O.D. split spoon sampler; blow counts not corrected for larger diameter samplers.

^ Unconfined Compressive strength in tons/sq. ft. as estimated by SPT resistance, field and laboratory tests, and/or visual observation.

KEY TO SAMPLERS

- Modified California Sampler (3-inch O.D.)
- Mid-size Sampler (2.5-inch O.D.)
- Standard Penetration Test Sampler (2-inch O.D.)

KEY TO EXPLORATORY BORING LOGS
MUSANTE PROPERTY IMPROVEMENTS
EMERALD HILLS, CALIFORNIA

FIGURE A-1
MARCH 2018
PROJECT NO. 4351-1

ROMIG ENGINEERS

HAMMER WEIGHT	140 #, 30" Drop	BORING: 3.5" Auger (Minut[illegible])	DATE OF BORING: 10-11-96
SURFACE ELEVATION	---		
GROUNDWATER DEPTH	10-11-96	Dry	

DESCRIPTION OF MATERIALS	DEPTH IN FT.	SAMPLE	SAMPLE NUMBER-SAMPLE DIAMETER	DRIVING RESISTANCE BLOWS PER FT.	DRY DENSITY P.C.F.	MOISTURE CONTENT %	UNCONFINED COMPRESSIVE STRENGTH P.S.F.	OTHER TESTS
Stiff, dark brown, fine sandy silty clay with abundant small rootlets, slightly damp (Topsoil)			1) 2.5"	34	118	6	----	
Hard, olive and greyish brown, silty fine sandstone, slightly damp, moderately weathered (Franciscan Assemblage)			2) 2"	66	99	20	25660	
	5		3) spt*	45	---	--	----	
Boring terminated at 6 feet 10 inches			4) 2"	50/4"	109	9	----	
	10							
	15							
	20							
* spt denotes Standard Penetration Test	25							
	30							
	35							

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Figure 6

TYPE OF BORING	3.5" Auger (Minuten
DATE OF BORING	10-11-96
HAMMER WEIGHT	140 #, 30" Drop
SURFACE ELEVATION	---
GROUNDWATER DEPTH	10-11-96 Dry

DESCRIPTION OF MATERIALS	DEPTH IN FT.	SAMPLE	SAMPLE NUMBER-SAMPLE DIAMETER	DRIVING RESISTANCE BLOWS PER FT.	DRY DENSITY P.C.F.	MOISTURE CONTENT %	UNCONFINED COMPRESSIVE STRENGTH P.S.F.	OTHER TESTS
Loose, leaves and debris (from garage demolition) (Fill)								
Stiff, dark brown, fine sandy silty clay with rootlets, damp (Topsoil)			1) 2.5"	31	99	17	8640	
			2) 2"	35	102	14	5890	
	5		3) spt*	32	---	--	----	
Hard, olive and greyish brown, serpentinite, minor rootlets, slightly damp to damp, moderately to deeply weathered (Franciscan Assemblage)			4) 2"	61	106	18	9440	
Boring terminated at 7 feet 6 inches	10							
	15							
	20							
	25							
	30							
	35							

* spt denotes Standard Penetration Test

APPENDIX C

LABORATORY TESTS

Samples from subsurface exploration were selected for tests to help evaluate the physical and engineering properties of the soils encountered at the site. The tests that were performed are briefly described below.

The natural moisture content was determined in accordance with ASTM D2216 on nearly all of the soil samples recovered from the borings. This test determines the moisture content, representative of field conditions at the time the samples were collected. The results are presented on the boring logs at the appropriate sample depths.

The Atterberg Limits were determined on one sample in accordance with ASTM D4318. The Atterberg limits are the moisture content within which the soil is workable or plastic. The results of this test are presented in Figure B-1 and on the log of Boring EB-1 at the appropriate sample depth.

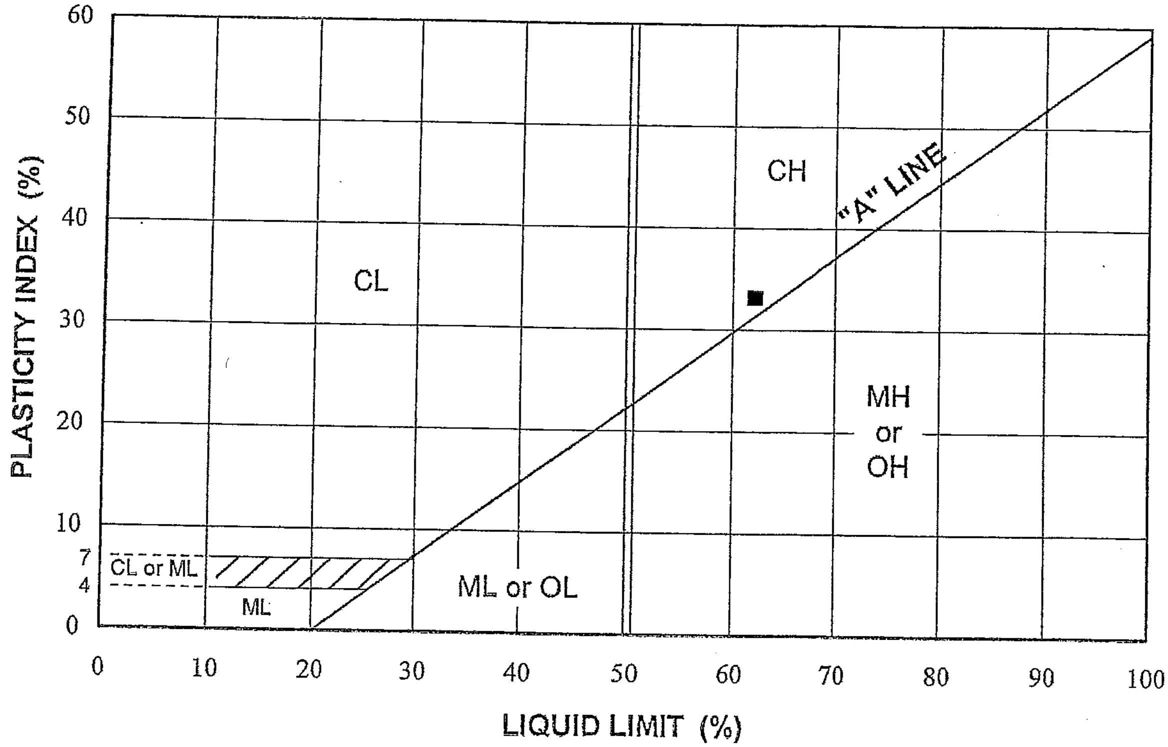

Chart Symbol	Boring Number	Sample Depth (feet)	Water Content (percent)	Liquid Limit (percent)	Plasticity Index (percent)	Liquidity Index (percent)	Passing No. 200 Sieve (percent)	USCS Soil Classification
■	EB-1	2-4	23	63	33			CH

PLASTICITY CHART
MUSANTE PROPERTY IMPROVEMENTS
EMERALD HILLS, CALIFORNIA

FIGURE B-1
MARCH 2018
PROJECT NO. 4351-1

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