APPENDIX 4.3

Revised Geologic Evaluation

REVISED GEOLOGIC EVALUATION ENVIRONMENTAL IMPACT REPORT HIGHLAND ESTATES RESIDENTIAL DEVELOPMENT PROJECT
San Mateo County, California

Impact Sciences, Inc.
Oakland, California

27 August 2009
Project No. 4872.02

Treadwell&Rollo
Environmental & Geotechnical Consultants

Treadwell&Rollo

27 August 2008
Project 4872.02

Ms. Jennifer Millman
Impact Sciences, Inc.
2101 Webster Street, Suite 1825
Oakland, California 94612

Subject: Revised Geologic Evaluation
Environmental Impact Report
Highland Estates Residential Development Project
San Mateo County, California

Dear Ms. Millman:

This letter transmits our revised geologic evaluation report for the Environmental Impact Report being prepared for the Highland Estates Residential Development project in unincorporated San Mateo County, California. We originally submitted a geologic evaluation report dated 23 September 2008. That report was attached to a Draft Environmental Impact Report (DEIR) for the project.

A project discussion meeting was held on 16 March 2009 between Treadwell & Rollo, Inc., Cotton Shires and Associates, Impact Sciences, San Mateo County staff, including the County Geologist Ms. Jean Demouthe, and the project geotechnical consultant Cornerstone Earth Group to discuss the geologic constraints to the project and come to a consensus on what, if any, further studies should be performed as part of the EIR.

During that meeting, it was agreed upon by all parties to further evaluate the landslides impacting the Ticonderoga lots by performing additional subsurface exploration in the area of the landslide and by conducting additional geologic mapping and evaluations for all of the four building sites, utilizing updated topographic surveys to be performed by BKF Engineers (the project surveyor and civil engineer).

This investigation has been performed in accordance with our updated proposal dated 14 April 2009 to address these concerns. Pertinent information from our prior investigation is reiterated in this stand-alone report for the project.

The Highland Estates site is an approximately 99-acre parcel that will be subdivided into eight single-family home lots approximately 0.4 to 0.5 acres each, an 84-acre open space parcel, and one 12-acre remainder parcel. We understand that three additional home lots are being considered in the southwest corner of the remainder parcel, two of which are located on the cul-de-sac at the end of Cobblehill Place and one at the end of Cowpens Way.

In general, we conclude that the proposed residential development is feasible from a geologic perspective, provided the residences and associated improvements are designed and built in accordance with a project specific geotechnical investigation. Mitigation measures such as a buttress fill landslide repair and drilled pier foundations may be required for certain lots within the development. The reader should refer to the text of the report for detailed findings and conclusions.

We appreciate the opportunity to assist you with this project.

Sincerely yours
TREADWELL & ROLLO, INC.

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REVISED GEOLOGIC EVALUATION ENVIRONMENTAL IMPACT REPORT HIGHLAND ESTATES RESIDENTIAL DEVELOPMENT PROJECT

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TABLE OF CONTENTS

TABLE OF CONTENTS (Cont.

LIST OF FIGURES

APPENDIX A

APPENDIX B

APPENDIX C

APPENDIX D

REVISED GEOLOGIC EVALUATION
ENVIRONMENTAL IMPACT REPORT
HIGHLANDS ESTATES RESIDENTIAL DEVELOPMENT PROJECT
SAN MATEO COUNTY, CALIFORNIA

1.0 INTRODUCTION

This report presents the results of our revised geologic evaluation as part of an Environmental Impact Report (EIR) being prepared for the development of eleven additional lots within the Highlands Estates development located in unincorporated San Mateo County, California, as shown on Figure 1, Site Location Map.

The Highland Estates site is an approximately 99-acre parcel that will be subdivided into eight single-family home lots approximately 0.4 to 0.5 acres each, an 84-acre open space parcel, and one 12-acre remainder parcel. We understand that three additional lots are being considered in the southwest corner of the remainder parcel, two of which are located on the cul-de-sac at the end of Cobblehill Place and one at the end of Cowpens Way.

The site is currently undeveloped and consists of several hills and canyons with a total topographic relief across the property of approximately 325 feet. Slopes on the property vary from gentle to steep, with gradients between flat to 2:1 (horizontal to vertical). Grading will be performed to create the building pads for the eleven single-family lots. Four of the lots will be located along Bunker Hill Drive (Lots 1 through 4), four lots will be located along Ticonderoga Drive (Lots 5 through 8), two possible lots will be located at the end of Cobblehill Place (Lots 9 and 10), and a possible lot will be located at the end of Cowpens Way (Lot 11) as shown on Figures 2a through 2d, Site Plan and Engineering Geologic Maps 1 through 4.

We previously conducted a geologic evaluation for the project and submitted the results of that investigation in our report dated 23 September 2008, in accordance with our prior proposal dated 18 August 2008. That report was incorporated into a DEIR that was published in December 2008. During the public review of the DEIR, Cotton Shires and Associates, geologic and geotechnical consultants for the Highlands Community Association, submitted a Supplemental Geologic and Geotechnical Evaluations letter dated 13 February 2009. This letter contained recommendations for further investigation to characterize the extent and depth of a landslide impacting the four lots (Lots 5 through 8) along Ticonderoga Drive and further analyses to develop a schematic buttress repair mitigation to be used to develop a grading plan describing the limits of mitigation grading and quantity of material to be removed and replaced. In addition, the letter recommended that additional studies be performed to evaluate: spring activity, stabilization piers, and historic landsliding for the Bunker Hill Drive lots; the potential for asbestos exposure from project grading; hydrology analyses and the potential for increased peak discharge to initiate debris flows or erosion; appropriate surface drainage control; evaluations of project slope stability under seismic ground shaking conditions; and an evaluation of the potential for adverse off-site impacts from the proposed property (landsliding into adjacent developed property).

A project meeting was held on 16 March 2009 between Treadwell & Rollo, Inc., Cotton Shires and Associates, Impact Sciences, San Mateo County Staff, including the County Geologist Ms. Jean Demouthe, and the project geotechnical consultant Cornerstone Earth Group. The purpose of this meeting was to discuss the geologic and geotechnical constraints to each of the four areas of development, and come to a consensus on what, if any, further studies should be performed as part of the EIR. During that meeting, it was agreed upon by all parties to further evaluate the landslides impacting the Ticonderoga lots by performing additional subsurface exploration in the area of the landslide and by conducting additional geologic mapping and evaluations for all of the four building sites, utilizing updated topographic surveys to be performed by BKF Engineers (the project surveyor and civil engineer).

2.0 SCOPE OF SERVICES

The objective of our supplemental investigation was to investigate the landslide and provide updated geologic information and recommendations for all of the building sites to be included in the revised Draft EIR. This report has been prepared in accordance with the scope of services presented in our proposal dated April 14, 2009. Pertinent information from our prior report has been incorporated into this complete stand-alone revised report.

The original scope of services for our prior investigation included:

- performing a site reconnaissance by our senior project geologist and senior staff geologist on 29 August 2008
- reviewing stereo-paired aerial photographs and published geologic literature of the site vicinity
- reviewing several documents/reports prepared by others for the proposed development of Highland Estates, including three reports by Soil Foundation Systems (SFS), one of which was a

supplemental report, one report by United Soil Engineering, and reports by Earth Systems Consultants and Lowney Associates in which they reviewed a 1993 SFS report

- performing an evaluation of the analyses and conclusions developed in the prior studies
- consulting with the County Geologist, Ms. Jean DeMouthe, and the County Geotechnical Engineer, Mr. Jay Mazzetta
- reviewing a third party peer review letter by Cotton Shires and Associates (CSA) and consulting with Ted Sayre of CSA on 15 November 2007 about his concerns with the site
- preparing five geologic cross-sections for use in our analyses and for data presentation
- compiling geologic data, performing analyses, and issuing this report.

As described in our proposal dated 14 April 2009, the additional scope of services for preparing this revised geologic investigation report included:

- performing additional site reconnaissance and geologic mapping of all four development areas (the lots along Ticonderoga Drive, Bunker Hill Avenue, and at the ends of Cowpens Way and Cobblehill Place), utilizing the new topographic survey for each of the building site areas
- preparing revised geologic cross-sections for each of the four development areas based on the updated topographic surveys
- performing additional consultation with Mr. Ted Sayre of Cotton Shires and Associates, Mr. Scott Fitinghoff of Cornerstone Earth Group, and Mr. Darwin Myers to review the updated maps and cross-sections for the Ticonderoga Drive lots to mutually agree on the locations for subsurface exploration within the landslides impacting the Ticonderoga Drive lots
- excavating and down-hole logging of three hand-dug test pits excavated in the area of the landsliding impacting the Ticonderoga Drive lots
- laboratory testing of samples obtained from the test pits
- preparing mitigation measures comparable to those discussed during the 16 March 2009 meeting, including developing a proposed schematic buttress fill plan and cross-section, showing the approximate depth and limits of grading to mitigate the landslide

- qualitatively evaluating the site hydrogeology characteristics
- performing static and pseudo-static (seismically loaded) quantitative slope stability analyses of the proposed buttress fill mitigation.

3.0 FIELD EXPLORATION AND LABORATORY TESTING

To augment the existing subsurface information and further evaluate subsurface conditions within the lots along Ticonderoga Drive that are impacted by landsliding, we performed a subsurface exploration program consisting of excavating and down-hole logging three test pits, designated TP-1 through TP-3. The approximate locations of our borings and test pits are shown on Figure 2b.

3.1 Test Pits

Between 5 June 2009 and 22 June 2009, our geologist and engineers observed the conditions exposed in three hand-excavated test pits, labeled TP-1 through TP-3. The test pits were excavated by Soil Stability Construction (SSC) to depths ranging between about 10 and 30 feet beneath the existing ground surface. Each pit measured approximately two feet by three feet in plan dimension and was shored during excavation using wood shoring in accordance with the OSHA approved shoring design by SSC.

Following excavation, our geologist down-hole logged the pits to their full depth by observing and characterizing the exposed soil, landslide deposits, bedrock, and groundwater conditions to evaluate the depth of landsliding and the rock bedding. Logs of the test pits are presented in Appendix A on Figures A-1 through A-3. The materials encountered in the test pits were classified according to the soil Classification Chart described on Figure A-4.

The depth of test pit excavation was established by our senior geologist based on the conditions observed in each pit. Furthermore, throughout the excavation and logging process, we invited Mr. Fitinghoff, Mr. Myers, and Mr. Sayre to observe the conditions exposed in the test pits to gain a better understanding of the landslide conditions and condition of the bedrock beneath the slides.

Our geologist collected samples of landslide deposits, bedrock, and landslide gouge for laboratory testing and classification. After logging was complete, the test pits were be backfilled with the excavated soil, compacted in lifts.

3.2 Laboratory Testing

Soil samples were re-examined in our office to confirm field classifications and to select representative samples for testing. Laboratory tests were performed on selected soil samples to determine maximum density and moisture relationships for a proposed buttress fill landslide repair and total shear strength and effective shear strength of remolded samples prepared to approximately 90% of the maximum density and 3% above the optimum moisture to simulate the proposed fill. The geotechnical laboratory test results are presented in Appendix B.

4.0 PREVIOUS INVESTIGATIONS

Several prior investigations were performed for the development of the site. When these investigations by others were prepared, Lots 1 through 4 were in the same configuration as the present development concept, but the other lots were in different areas/alignments. In the area of the originally proposed Lots 5 and 6, just south of the water tanks, there is now no planned development. Where Lots 7 through 14 were originally proposed, there is now only one lot (Lot 11) proposed, which is partially within the original layout of Lots of 12 through 14. In the area where Lots 15 through 18 were proposed, only two lots are now proposed (Lots 9 and 10). In addition, the current development concept includes developing new Lots 5 through 8, just north of and along Ticonderoga Drive. Originally, no lots were planned for this area.

We have included logs of all test pits and borings that were provided to us in Appendix A; however, we have only plotted the locations of those that were included within the lots included in the study.

4.1 United Soil Engineering

United Soil Engineering performed a study for former Lots 15 through 18, in 1977. Their study included:

- reviewing published and unpublished geologic maps of the area
- performing geologic reconnaissance and preliminary geologic mapping
- excavating and logging of nine test borings
- performing laboratory testing
- performing engineering and geologic analyses
- preparing a report.

Their subsurface exploration included drilling 9 borings to depths of 8 to 21.5 feet. The borings were drilled with continuous flight augers on a truck mounted rig. Samples were collected with a Standard Penetration sampler driven with a 140 pound hammer falling 30 inches. The logs are attached in the 1994 Soil Foundation Report. The borings encountered Franciscan formation sandstone and shale. The report provided recommendations for slope grading for the development of the lots.

4.2 Soil Foundation Systems (1990)

SFS performed a preliminary investigation in 1990 for Lots 1 through 18 and the previously proposed town homes off Polhemus Road. Their scope of services included:

- reviewing previous geotechnical reports for the subject property and vicinity
- reviewing published and unpublished geologic maps of the area
- reviewing historic aerial photographs
- performing geologic reconnaissance and preliminary geologic mapping
- excavating and logging of six test borings
- performing laboratory testing
- performing engineering and geologic analyses
- preparing a report.

Their subsurface exploration included drilling six borings in April 1990. The borings were drilled with continuous-flight augers and reached a maximum depth of 30 feet. Standard penetration samplers were driven with a 140 pound hammer dropping 30 inches. The borings encountered Franciscan formation materials, comprised predominantly of sheared shale and graywacke sandstone.

SFS concluded that in area proposed for Lots 1-4 (still the same as presently planned), there was no significant slope stability hazard. Even though the lots are steep to very steep, with a gradient of approximately 1½:1 to 2:1 (horizontal to vertical), they concluded graywacke sandstone is very shallow on the site and should be sufficiently stable. They recommended supporting residences on these lots on drilled piers, gaining support in the underlying sandstone.

Their borings encountered sandstone beneath 2 to 5 feet of surficial soil in the previously designated Lots 5 and 6. They concluded that there exists the potential for surface erosion and rock fall along high cut slopes. As described above, the current development concept does not include new development in this area.

4.3 Soil Foundation Systems (1993)

Soil Foundation Systems conducted a geotechnical investigation for Lots 1 through 18 and for the previously proposed town homes off Polhemus Road for the Highland Estates Development in 1993. Their investigation included:

- reviewing previous geotechnical reports for the subject property and vicinity
- reviewing published and unpublished geologic maps of the area
- reviewing historic aerial photographs
- performing geologic reconnaissance and preliminary geologic mapping
- preparing 10 geologic cross-sections
- excavating and logging 26 test borings and 3 test pits
- performing a hydrogeological study
- performing laboratory testing
- performing engineering and geologic analyses
- preparing of a report.

The borings and test pits were performed in July of 1992. The borings were drilled using four methods:

- A truck-mounted rig equipped with 6-inch diameter continuous flight augers. Holes were advanced to depths ranging from one foot to 42 feet. Sprague and Henwood, 2½-inch I.D. samplers were driven with a 140 pound automatic hammer dropping 30 inches. Borings B-1 through B-7, B-9, B-12, B-17 through B-24, and P-4 through P-6 were advanced using these drilling techniques.
- A minuteman rig equipped with a 3-inch diameter continuous flight auger. Borings were drilled ranging in depth from five to 20 feet. Samples were obtained with a 70 pound hammer operated manually by using the standard penetration sampler and the Sprague and Henwood, 2½-inch I.D. samplers. Borings B-14, B-16 and P-1 through P-3 were advanced using these drilling techniques.

- A remote and track rig equipped with an 8-inch diameter auger. Borings were extended to depths ranging from 8 to 12 feet. It appears from the logs that no samples were driven in borings using this technique of drilling and the borings were logged by observing cuttings. Borings B-8 and B-15 were logged using this method.
- A backhoe equipped with an 8-inch diameter auger. Holes extended up to 16 feet below ground surface (bgs). It appears from the logs that no samplers were driven in the borings using this technique of drilling and the borings were logged by observing cuttings. Borings B-10, B-11, B-13, B-25 and B-26 were logged using this method.

Soil Foundation Systems concluded that in the area of Lots 1-4, a small topographic swale exists in the lower portions of Lots 2 and 3. This colluvium is potentially susceptible to creep. Immediately south of Lot 4, on the contiguous ravine bank, a landslide was observed. The slide is separated from Lot 4 by a bedrock “nose” and coincides with a geologic contact of serpentinite with sheared Franciscan sandstones and shales. The movement of the landslide mass occurred in a direction approximately perpendicular to the alignment of the ravine and is buttressed by the slope on the opposite side of the ravine. Therefore, SFS concluded the proposed development area is outside the direct influence of this landslide. In the area of previous Lots 15 through 18 (now Lots 9 and 10), sandstone bedrock was encountered at a fairly shallow depth.

This investigation included performing static and pseudo-static (seismically loaded) slope stability analyses on ten cross-sections generated through the site, utilizing results from laboratory strength tests performed on samples obtained during drilling. The Factor of Safety (FS) values against landsliding varied between 1.68 and 3.15 for static conditions and between 0.92 and 2.05 for seismically loaded conditions. The slope with the lowest FS was a proposed 1:1 cut into the natural slope along Ticonderoga Drive. Based on the results of their analyses, they provided mitigation options with detailed recommendations for stability improvements on several of the slopes. Their mitigation options included buttress fill grading, drilled piers, and a combination of piers and grading. Their report also provided specific foundation recommendations for the residences, depending upon site geology and slope configurations, ranging from conventional shallow footings to drilled, end-bearing piers.

4.4 Earth Systems Consultants

Earth Systems Consultants (ESC) performed a geotechnical review of the 1993 report by SFS. Their review comments were generally minor and consisted primarily of pointing out several errors in borings logs and cross-sections. Earth Systems Consultants generally agreed with the geologic conclusions in the SFS report, however they raised questions relating to the slope stability analyses and seismic coefficients used in the analyses. All of the ESC comments were addressed in the Soil Foundation Systems 1994 supplemental report.

4.5 Lowney and Associates

Lowney and Associates performed a review of the slope stability analyses conducted by SFS in their 1993 investigation. Lowney concluded, after conducting their own stability analyses, that the SFS methods and results were consistent with the current standards of practice at that time. Lowney also reviewed proposed grading plans. They noted that in Lots 1 through 4 that there was no significant proposed grading. In the originally proposed Lots 7 through 14 (now only Lot 11), there was to be up to 15 feet of cut and 10 feet of fill with a proposed slope of 2:1. In proposed Lots 15 through 26, there were proposed cuts of 20 feet, with retaining walls constructed to increase slope stability. The review comments by Lowney were responded to by SFS in their 1994 supplemental report.

4.6 Soil Foundation Systems (1994)

After Earth System Consultants and Lowney and Associates presented their review comments of the SFS 1993 report, SFS issued a supplemental report in 1994. This supplemental work included two additional test borings and three test pits excavated in areas recommended by ESC during their review. SFS also conducted additional laboratory testing and performed several additional slope stability analyses, utilizing a higher seismic coefficient (0.20g to 0.22g). In addition to responding to the comments by ESC and Lowney and Associates, they included a report by Tensar Earth Technologies, Inc. containing additional modeling and stability analyses of proposed geogrid reinforced buttress fills.

5.0 AERIAL PHOTOGRAPH REVIEW AND SITE HISTORY

We reviewed individual and stereo-paired historical aerial photographs for evidence of any past grading, landslides, or development to provide a limited history of past land use. Sixteen sets of paired aerial photographs ranging from 1943 to 2005 were reviewed to evaluate the prevailing site conditions before development and document the development history of this area of the property.

TABLE 1
List of Aerial Photographs Reviewed

Date	Photo Number	Scale
10-11-1943	DDB-2B- 111 & 112	1:20,000
7-29-1946	AV9-16 7 through 9	1:23,600
5-10-1955	AV170-11 10 & 11 and AV170-10 11 & 12	1:10,000
5-27-1956	DDB-2R 58 & 59	1:20,000
9-8-1956	GS VLX 1-44	1:20,000
6-20-1961	AV432-9 7 & 8	1:12,000
4-18-1968	GS-VBZJ-1 213 & 214	1:30,000
12-30-1969	AV933-10 8 through 10	1:12,000
5-8-1973	3567-3 & 3567-1	1:12,000
5-12-1975	AV1188-9 8 & 9	1:12,000
6-19-1981	AV2020-9 7 through 9	1:12,000
6-6-1983	AV2265-9 8 & 9	1:12,000
5-30-1989	AV3556-9 9 & 10 and AV3556-8 11 through 13	1:12,000
9-1-1993	AV4515-10 9 & 10 and AV4515-9 12 & 13	1:12,000
6-4-2004	kAV8720-3 7 & 8	1:7,200
10-13-2005	KAV9200-42 4 & 5	1:7,200

The 1943 and 1946 photographs reveal there was no residential development at or near the site and the eastern slope of the site was covered with shrubs and trees, much like present day. The photographs reveal what appears to be an old landslide located approximately 130 feet southeast of the center of the smallest water tower within the site, which is 500 feet east of Yorktown Road. The possible landslide scarp is approximately 300 feet long and trends-south north. The landslide extends downhill to the east and is heavily vegetated. The photographs reveal no evidence of recent movement of this landslide.

The 1955 photographs show grading of Ticonderoga Drive has been started, but there are still no houses present at Highland Estates. It appears from the aerial photo that some areas within Highland Estates development have been cleared for future roads.

In the May 1956 photographs, the Highland Estates development area had been completely cleared and graded. No construction of the homes had been started, however residential construction had started on the community to the north of Highland Estates. The area encompassing the presently proposed Lots 5 through 8 was not graded and appears as it does presently.

By September of 1956, approximately one-third of the homes within the Highlands Estates development had been completed. All the streets had been graded and were aligned as they are presently. The housing development to the north of Burgoyne Court along Lexington Avenue had been completed. No landslides were observed in either 1956 photo.

By 1961, most of the Highland Estates development had been completed. Homes had not been constructed yet at the end of Sheraton Place, but the area had been graded. In addition, no homes had been built north of Yorktown Road, near the water tower, but the area had also been graded. The area between Oriskany Drive and Bennington Drive, along Bunker Hill Drive had yet to be developed.

The 1968 photographs reveal abundant oak trees in the area proposed for Lots 1 through 4. There is little vegetation, just grasses and scattered brush in the area proposed for Lots 9 and 10. Proposed Lot 11 appears to be covered with shrubs and low brush. The area proposed for Lots 5 through 8 appears as it does presently, with grasses and scattered oak trees.

By 1969, the areas to the north of Yorktown Road and at the end of Sheraton Place had now been fully developed with residential homes.

The 1975 photographs reveal the area between Oriskany Drive and Benninton Drive had been graded , and pads for future homes are visible in the photo. The construction of Highway 280 and the J. Arthur Younger Freeway, Highway 92, had been completed in the site vicinity.

The 1981 photographs show the site appears as it does today. All the homes between Oriskany Drive and Bennington Drive had been constructed.

Between 1983 and 2005, there appears to be no significant changes to the site. An area of seep was apparent in the area of the currently proposed Lots 5 through 8. The area of seep appears down slope of the 4th and 5th house west from the end of Cobblehill Place, in the areas previously identified by Soil Foundation Systems as a landslide. No other landslides were observed in the aerial photographs within the limits of the currently proposed lots.

6.0 SEISMICITY AND GEOLOGY

6.1 Regional Seismicity

The greater San Francisco Bay Area is recognized by geologists and seismologists as one of the most active seismic regions in the United States. The three major faults that pass through the Bay Area in a northwest direction have produced approximately 12 earthquakes per century strong enough to cause structural damage. The faults causing such earthquakes are part of the San Andreas fault system, a major rift in the earth's crust that extends for at least 700 miles along the California Coast, which includes the San Andreas, Hayward, and Calaveras fault zones. These and other faults of the region are shown on the Map of Major Faults and Earthquake Epicenters in the San Francisco Bay Area, Figure 3. For each of the active faults within 100 kilometers, the distance from the site and estimated mean characteristic Moment magnitude[1] [2007 Working Group on California Earthquake Probabilities (WGCEP) (2007) and Cao et al. (2003)] are summarized in Table 2.

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[1] Moment magnitude is an energy-based scale and provides a physically meaningful measure of the size of a faulting event. Moment magnitude is directly related to average slip and fault rupture area.

TABLE 2
Regional Faults and Seismicity

Fault Name	Distance (km)	Direction from Site	Mean Characteristic or Maximum Moment Magnitude	Mean Slip Rate (mm/yr)	Fault Length (km)
San Andreas – 1906 Rupture	0.6	Southwest	7.90	19	473
San Andreas – Peninsula	0.6	Southwest	7.15	17	85
Monte Vista-Shannon	12	Southeast	6.80	0.4	41
Northern San Gregorio	13	West	7.23	7	110
Total San Gregorio	13	West	7.44	5	176
South Hayward	29	Northeast	6.67	9	53
Total Hayward	29	Northeast	6.91	9	88
Total Hayward-Rodgers Creek	29	Northeast	7.26	9	151
San Andreas- North Coast South	36	Northwest	7.45	24	191
North Hayward	36	Northeast	6.49	9	35
Hayward – South East Extension	40	East	6.40	3	26
Total Calaveras	41	East	6.93	N/A	123
Mt Diablo	48	Northeast	6.65	2	25
San Andreas – Santa Cruz Mnts.	49	Southeast	7.03	17	62
Concord/Green Valley	53	Northeast	6.71	N/A	56
Sargent	55	Southeast	6.80	3	53
Zayante-Vergeles	58	Southeast	6.80	0.1	56
Greenville	60	East	6.94	2	51
Rodgers Creek	64	North	6.98	9	63
Point Reyes	64	Northwest	6.80	0.3	47
Monterey Bay-Tularcitos	70	Southeast	7.10	0.5	84
West Napa	72	North	6.50	1	30
Great Valley 6	73	East	6.70	1.5	45
Great Valley 7	76	East	6.70	1.5	45
Southern San Gregorio	76	South	6.96	3	66
Great Valley 5	82	Northeast	6.50	1.5	28
Great Valley 4	95	Northeast	6.60	1.5	42
Ortigalita	98	East	6.90	1	66

Figure 3 also shows the earthquake epicenters for events with magnitude greater than 5.0 from January 1800 through December 2000. Since 1800, four major earthquakes have been recorded on the San Andreas Fault. In 1836, an earthquake with an estimated maximum intensity of VII on the Modified Mercalli (MM) scale (Figure 4) occurred east of Monterey Bay on the San Andreas Fault (Toppozada and Borchardt 1998). The estimated Moment magnitude, M_w, for this earthquake is about 6.25. In 1838, an earthquake occurred with an estimated intensity of about VIII-IX (MM), corresponding to an M_w of about 7.5. The San Francisco Earthquake of 1906 caused the most significant damage in the history of the Bay Area in terms of loss of lives and property damage. This earthquake created a surface rupture along the San Andreas Fault from Shelter Cove to San Juan Bautista approximately 430 kilometers in length. It had a maximum intensity of XI (MM), a M_w of about 7.9, and was felt 560 kilometers away in Oregon, Nevada, and Los Angeles. The most recent earthquake to affect the Bay Area was the Loma Prieta Earthquake of 17 October 1989 with an M_w of 6.9. The epicenter of the earthquake was in the Santa Cruz Mountains approximately 67 km from the site.

In 1868, an earthquake with an estimated maximum intensity of X on the MM scale occurred on the southern segment (between San Leandro and Fremont) of the Hayward Fault. The estimated M_w for the earthquake is 7.0. In 1861, an earthquake of unknown magnitude (probably an M_w of about 6.5) was reported on the Calaveras Fault. The most recent significant earthquake on this fault was the 1984 Morgan Hill earthquake (M_w = 6.2).

The 2007 WGCEP at the U.S. Geologic Survey (USGS) predicted a 63 percent chance of a magnitude 6.7 or greater earthquake occurring in the San Francisco Bay Area in 30 years. More specific estimates of the probabilities for different faults in the Bay Area are presented in Table 3.

TABLE 3
WGCEP (2007) Estimates of 30-Year Probability of a Magnitude 6.7 or Greater Earthquake

Fault	Probability (percent)
Hayward-Rodgers Creek	31
N. San Andreas	21
Calaveras	7
San Gregorio	6
Concord-Green Valley	3
Greenville	3
Mount Diablo Thrust	1

6.2 Regional Geology

The site is located along Pulgas Ridge in San Mateo County, which is within the Coast Range geomorphic region of California. This geomorphic region is bordered to the east by the Great Valley, to the west by the Pacific Ocean, to the north by Klamath Mountains, and to the south by Transverse Ranges. The regional topography and geology are characterized by Northwest-Southeast fabric, resulting from active and potentially active strike-slip faults. The Coast Range is intensely folded with folded axes trending parallel to the faults.

The upper plate of the Coast Range thrust consists of the Great Valley sequence with the Coast Range ophiolite at the base, displaced by the San Andreas Fault. The upper portion of the Coast Range thrust forms a broad blanket over the Franciscan rocks, but there are several “windows” where Franciscan rocks of the lower plate are exposed. The serpentinite encountered on the site is most likely metamorphosed harzburgite of the Coast Range opholite sequence. The Coast Range thrust is truncated by several northwest trending faults; locally by the San Andreas, Pilarcitos, and Monte Vista faults.

The Coast Ranges have two different basement rocks, Franciscan and Salinian, which are in contact with each other along the San Andreas Fault, approximately ¾ mile southwest of the central portion of the site. Northeast of the fault is an area of serpentinite and Franciscan rock, which underlies the site. The Franciscan complex consists of greywacke, volcanic sills and dikes, chert, and serpentinite (Abrams, Gerda, 1992). Stratified marine and nonmarine sedimentary rocks overlay the Franciscan rocks (Abrams, Gerda, 1992).

According to the Geologic Map of the Onshore Part of San Mateo County, California (USGS, 1998), the area is underlain by Jurassic and Cretaceous Age (approximately 65 to 213 million years old) Franciscan mélange, with small local outcrops of chert. Jurassic Age serpentinite is mapped southwest of the site. (see Figure 5, Regional Geologic Map).

6.3 Site Geology

The site is underlain by many rock types of the Franciscan Formation, that is Cretaceous (65 to 145 million years old) to Jurassic (145 to 213 million years old) in age. The major Franciscan rock types encountered on site were: sandstone, serpentinite, chert, and sheared rock (mélange and shale). In addition, Franciscan greenstone is mapped in the nearby site vicinity (see Figure 5). Site specific geology is detailed in our Idealized Subsurface Profiles A-A’ through E-E’, Figure 6a through 6e.

6.3.1 Graywacke Sandstone

Graywacke sandstone is a sedimentary rock that is made up mostly of sand-size grains that were rapidly deposited very near the source rock from which they were weathered. Graywacke is typically deposited in deep ocean water near volcanic mountain ranges, where underwater landslides and density currents called turbidites quickly transport sediment short distances into a subduction zone or ocean trench. This type of sandstone contains fewer grains made of quartz and more made of feldspars and volcanic rock fragments, as well as silt and clay, than most sandstone. The volcanic rock fragments give graywacke a greenish-gray color.

6.3.2 Serpentinite

Serpentinite forms by the hydration of peridotite by chemical reactions, and is believed to result from tectonic movement and alteration at relatively low temperatures. Most of the serpentinite in the Bay Area is sheared and highly weathered, but in a few places it is largely massive and unsheared. Large massive bodies of serpentinite form ridges and appear to be resistant to erosion and soil development is very slight, but where weaker and weathered, forms thick soil profiles that can be highly to critically expansive. Serpentinite within the Bay Area sometimes contains chrysotile asbestos, a highly toxic fibrous crystal, which can be released into the air during excavation or mechanical disturbance of the rock.

The serpentinite outcrops observed on site were white-green to green, closely fractured, low to moderately hard, weak, little weathered, and sheared. It's not known if the serpentinite observed on site contains asbestos or not; therefore, during excavation, random samples should be tested to ensure there is not asbestos present.

6.3.3 Chert

Chert is a marine deposit, having been formed through deposition on the deep sea floor. The radiolarian chert and shale of the Franciscan Formation consist predominantly of thin, alternating beds, generally 1-5 inches thick, of chert and siliceous shale. In places these sedimentary rocks make up sections more than 1,000 feet thick. The larger deposits of radiolarian chert are closely associated with greenstone. Chert generally forms topographic high areas because it is resistant to weathering and hydrothermal alteration.

Massive chert generally produces large bold bare exposures and is either interbedded with thin-bedded radiolarian chert and shale or isolated and surrounded by slope debris and other surficial deposits. Some chert immediately adjacent to greenstone and chert completely enclosed by greenstone differs from typical bedded chert. This is most likely due to the heat and chemical effects of the intruded greenstone. The effect on some chert is brecciation and quartz veining and is generally 1 foot or more thick. Most exposures of radiolarian chert show virtually no weathering effects.

6.3.4 Greenstone

Greenstone of the Franciscan Formation is a product of volcanism. Most of the volcanic rocks were erupted on the sea floor, as evidenced by widespread pillow structure; marine chert and limestone are found in the space between some pillows. The greenstone of the Franciscan Formation is comprised mostly of fine and medium grained basalt that has been subjected to little or no alteration.

Most exposed greenstone of the Franciscan Formation is weathered of hydrothermally altered to brown and yellowish brown rock. Greenstone is a hill former and weathers to rock containing substantial proportions of clay minerals and the almost universal randomly oriented close fracturing. Since greenstone is a hill former, these influences are important influences on natural slopes. Most greenstone slopes are smooth and small; shallow landslides within weathered greenstone are common.

6.3.5 Mélange and Shale

Franciscan mélange is a disrupted accumulation of various sized masses of different rock types (blocks) within an intensely sheared matrix. Blocks are typically comprised of chert, serpentinite, and greenstone. Typically the sheared matrix of mélange is comprised of sheared shale and crushed greywacke sandstone.

6.4 Landslides

The previous study by SFS identified one landslide in the area of Lots 5 through 8, along Ticonderoga Drive. During our supplemental field mapping and investigation, we determined that the area is actually impacted by two separate smaller landslides. The landslide areas are characterized by hummocky topography, and over-steepened head scarps of up to about 2 and 8 feet in height respectively. The limits of the landslides are shown on Figure 2b. Detailed descriptions of these landslides are presented below in Section 7.2.

In addition, landsliding was mapped by SFS on the colluvial mantled slopes south of Lots 1 through 4. Based on our site observations during our supplemental field reconnaissance and mapping, this landsliding appears to be relatively shallow and constrained to the colluvium and topsoil mantling the bedrock on these slopes. A queried contact showing the mapped limits of suspected shallow sliding with relation to the proposed development is shown on Figure 2a. During our field reconnaissance, we did not observe evidence of landsliding on the slope within Lots 1 through 4 or on the slope below.

6.5 Groundwater

Previous subsurface explorations by SFS encountered groundwater in three borings, B-14, B-16, and B-17. Standpipe piezometers were installed in the boreholes and monitored for several months. Water levels in the piezometers revealed a saturated groundwater condition, with artesian water levels (water levels extending above the ground surface in the stand-pipes) following rain storms. SFS determined that the groundwater encountered was not aquifer fed, but rather runoff from higher up the ridge that percolated through sandstone fractures until it encountered the impermeable serpentinite, then surfaced.

Portions of the landslide materials observed in our test pits were saturated, with shallow water within the landslide masses being perched above the clay landslide gouge. Deep free-groundwater within the bedrock below the landslide mass was not observed.

7.0 SITE CONDITIONS

The site is located in unincorporated San Mateo County, west of the City of San Mateo. The site north of Highway 92 and east of Interstate 280. The parcel is surrounded by Bunker Hill Drive to the north and east, Polhemus Road to the southeast, Ticonderoga Drive and Cobblehill Place to the south, and Lexington Avenue and Yorktown Road to the west and northwest.

7.1 Lots 1 Through 4

Lots 1 through 4 are located on a southeast-facing slope on the southeast side of Bunker Hill Drive. The lots are bound to the northwest by Bunker Hill Drive, to the southeast by a natural drainage course and undeveloped slope, and to the northeast and southwest by developed residential parcels. The lots slope down moderately steep to very steep, with gradients between approximately 2:1 to 3:1 (see Figure 6a). Graywacke sandstone is present in the creek at the bottom of the drainage course.

A fill berm parallels Bunker Hill Drive, on top of which there are fill desiccation cracks. The fill covers an area up to about 30 feet wide by 170 feet long along the front of Lots 2 and 3, and is up to about 3 to 4 feet thick. Additional minor grading has been performed in Lot 1, resulting in a small roughly level fill pad and small cut slopes up to about 5 to 6 feet in height. Sandstone bedrock is exposed at the base of the larger cut slope.

Prior boring and test pits in this area found up to 2 to 3 feet of colluvium mantling the sandstone bedrock. Vegetation in these lots is dense and consists of mature oak and other trees, with associated grasses and brush. Site drainage is characterized by uncontrolled sheet-flow down to the southeast.

7.2 Lots 5 Through 8

Lots 5 through 8 are located on a south facing slope on the north side of Ticonderoga Drive. The lots slope down moderately steeply, with gradients between approximately 2:1 to 2½:1 (see Figures 6b and 6c). These lots are bound to the north by developed residential parcels which front on Cobblehill Place, to the west by a residential developed parcel that fronts on Ticonderoga Drive, to the south by Ticonderoga Drive, and to the east by undeveloped land.

The lots are dominated by a broad relatively flat to gently sloping area in their northern portion, then a steep cut-slope down to Ticonderoga Drive that appears to have been cut during the initial grading for the road. Minor amounts of fill are scattered along the northern portion of the sites, particularly along the property boundary where fill placed for the development of the backyard areas of the lots on Cobblehill Place extends onto these lots. Franciscan mélange including large blocks of sandstone is exposed in the road-cut along Ticonderoga Drive and at scattered outcrops along the site. Minor rills in the surficial soil mantling the sandstone have been created through the lots as a result of surface runoff.

As discussed above, we have identified two separate landslides within the limits of these lots (see Figure 2b). Landslide 1 is a relatively small landslide that is a shallow failure of the cutslope on the uphill side of Ticonderoga Drive in the southern portion of Lots 5 and 6. The landslide measures approximately 95 feet wide by about 55 feet long and up to about 7 feet thick as observed in our test pit TP-1. A 1- to 2-foot tall, near-vertical headscarp is located along the uphill limits of the slide, and the slide appears to toe out in the slope above Ticonderoga Drive (see Figure 6b).

Landslide 2 is a much larger landslide occupying portions of Lots 7 and 8. This landslide measures about 160 feet wide by up to about 105 feet long, and extends in depth up to about 26 feet below the existing ground surface, as observed in our test pit TP-2. The landslide extends beneath Ticonderoga Drive, at a depth about 6 to 7 feet below the ground surface at the upslope edge of the roadway as identified in our test pit TP-3. Our interpretation of the subsurface profile of the landslide is presented on Figure 6c. A headscarp up to about 8 feet in height is located around the uphill limits of the landslide, with a graben, or elongated depression of the ground surface, located immediately below the scarp in the western portion of the slide. The graben is about 2 feet deep, and appears to have enlarged over the past year. In addition, the concrete curb and gutter along the uphill side of Ticonderoga Drive has been distressed resulting in a portion of the concrete being offset laterally and vertically about 1 inch.

Detailed descriptions of the landslide deposits and bedrock materials encountered in all three test pits are provided in Appendix A on Figures A-1 through A-3, Log of Test Pits 1 through 3, respectively.

Vegetation in these lots consists of relatively sparse trees, with dense brush, ice-plant, and grasses. Site drainage is characterized by uncontrolled sheet-flow down to the south onto Ticonderoga Drive, and as concentrated runoff in the drainage rills.

7.3 Lots 9 And 10

Lots 9 and 10 will be located at the end of Cobblehill Place. The sites are bound to the southwest by Cobblehill Place and two residential developed lots and on all other sides by undeveloped land. The sites are gently to steeply sloped, running along the crest of a ridge at the head of a major, east-trending drainage swale.

The area is underlain by massive sandstone, with minor fill located in the western portions of the site from previous grading for Cobblehill Place and the adjacent two residences. In addition, undocumented fill is located in the central southwestern portion of the site, creating a relatively level fill pad as an extension of the end of Cobble Hill Place. A moderately steep fill slope with a gradient of between about 2:1 and 3:1 extends to the north, northeast and east below this pad (see Figure 6d). Based on prior borings, this fill appears to be about 6 to 7 feet thick. The proposed driveway for both residences crosses the fill pad, and a portion of the proposed residence for Lot 10 extends into the fill slope as shown on Figure 2c.

Vegetation in these lots is dense and consists of mature oak and other trees, with associated grasses and brush. Site drainage is characterized by uncontrolled sheet-flow down the sites into the east trending swale. In addition, runoff from Cobblehill Place has resulted in minor erosion scars up to approximately 1 foot deep crossing the property.

7.4 Lot 11

Lot 11 will be located at the end of Cowpens Way. The site is bound to the southwest by Cowpens Way and two residential developed lots, and on all other sides by undeveloped land. The southwestern portion of the site is relatively flat, with a slope extending down to the northeast in the northeastern portion of the site. This area was created by the placement of a wedge of fill, up to about 6 to 7 feet thick (see Figure 6e).

In addition, fill exists along the southwest property boundary from grading performed to create the pads for the two adjacent residences. Several large serpentinite and sandstone boulders were observed outcropping northwest of the site. Vegetation in these lots is dense and consists of mature oak and other trees, with associated grasses and brush. Site drainage is characterized by uncontrolled sheet-flow down to the northeast.

8.0 DISCUSSIONS AND CONCLUSIONS

On the basis of the results of this study, we conclude that the proposed residential developments are feasible from a geologic perspective. We have identified key geologic elements that should be addressed during design and construction. They are:

- adequate mitigation/repair of the active landslides that pose a potential hazard to the development of Lots 5 through 8 along Ticonderoga Drive
- proper site grading, including mass excavation and construction of permanent slopes
- sufficient subsurface and surface drainage
- selection of foundation systems that should result in satisfactory building performance
- evaluation of the potential for naturally occurring asbestos within the serpentinite.

These and other geological aspects of the project are discussed in the remainder of this section.

8.1 Landslide Hazard

The California Geological Survey (CGS) has been producing Seismic Hazard Zone maps for earthquake-induced landsliding and earthquake-induced liquefaction. CGS has not conducted mapping in the area of the subject site, and there is no published anticipated release date for a map for this area. The reports that accompany these maps by CGS typically contain a compilation of soil and bedrock strength parameters, based on a representative number of tests performed on samples obtained from that quadrangle. These strength test results have also not yet been published.

The landslides impacting Lots 5 through 8 along Ticonderoga Drive should be mitigated prior to the site development. Based on our investigation, we conclude that the smaller landslide, Landslide 1 that impacts Lots 5 and 6 will be removed during the site grading to construct the proposed building pads and driveways. It does not appear based on current development plans that additional mitigation will be necessary. The larger landslide impacting Lots 7 and 8 will not entirely be removed based on the proposed site grades; therefore it should be mitigated using a fully drained conventional buttress fill landslide repair that removes the landslide materials on-site and is founded in the underlying Franciscan mélange. Based on the geometry of the landslide slip surface observed in test pit TP-3, we conclude that a properly designed buttress fill repair should remove sufficient driving forces and mitigate further movement of the remaining small piece of the landslide beneath Ticonderoga Drive.

As discussed above, landsliding was mapped by SFS on the colluvial mantled slopes south of Lots 1 through 4. Based on our site observations during our supplemental field reconnaissance and mapping, this landsliding appears to be relatively shallow and constrained to the colluvium and topsoil mantling the bedrock on these slopes. Based on the proximity and location of the landslide and our understanding that the proposed homes will be founded on pier and grade-beam foundations bearing in the underlying sandstone bedrock, we conclude that a reactivation of this feature should not impact the proposed residences. The geotechnical investigation for the design of these structures should include provisions for a surface drainage system to mitigate new landslides developing within the thin veneer of soil mantling the bedrock on the slope below the sites.

Based on the current proposed development plans, we did not observe evidence of landsliding impacting Lots 9 through 11. However, we recommend that future project-specific design level geotechnical investigations should include additional slope stability analyses where significant site grading or alterations to the current slope configurations are planned. In addition, should CGS issue their maps prior to development, and if the maps show the proposed residence locations within earthquake-induced hazard zones, evaluations in accordance with State Publication SP117 should be performed.

8.1.1 Slope Stability Methodology and Evaluation

The stability of a schematic buttress fill repair for the landslide impacting Lots 7 and 8 was evaluated using the results of our field exploration, geologic interpretation, and laboratory testing. Idealized Geologic Cross-Section B-B' (Figure 6b) was developed by our engineering geologist along a critical alignment from a stability standpoint and modified based upon a schematic buttress fill concept, as shown in Appendix C. The location of this section was chosen to represent the most critical slope from a topographic standpoint as well as appropriately modeling the apparent direction of movement observed in our test pits.

We then developed a simplified two-dimensional model of the landslide and bedrock profile that was based on this section. We developed a typical buttress fill repair consisting of a keyway and series of benches cut into the Franciscan mélange below the depth of the landslide. The configuration used required the keyway to extend 3 feet below the depth of the landslide, with the keyway and bench widths at least 10 feet. The slope stability model subsurface profile evaluated in our studies is also presented in Appendix C.

We used the computer program Slope/W (version 6.22) by Geo-Slope International, Ltd. (2004) in our analyses. Factors of safety[2] were computed using various two-dimensional limit equilibrium methods, including Modified Bishop, Janbu, and Spencer's Methods. Given various parameters, the program internally searched for the most critical failure surface, i.e. lowest factor of safety. Typically a slope with a static factor of safety of at least 1.5, and a pseudo static factor of safety of 1.15 with a horizontally seismic coefficient of 0.10 to 0.15 times gravity (g) is generally considered stable (Seed, 1979).

The engineering properties of the buttress fill material used in our stability analyses were based on the results of our field investigation, laboratory testing, and engineering judgment. The engineering properties of the landslide materials beneath Ticonderoga Drive and existing fill and colluvium at the top of the slope were derived from CGS published strength parameters for use in slope stability modeling for

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[2] The factor of safety is the ratio of the available resistance to sliding divided by the driving force; the higher the factor of safety, the more stable the slope.

samples from the nearby Mindego Hill Quadrangle. The engineering properties of the Franciscan mélange bedrock beneath the proposed buttress fill were derived from CGS published strength parameters for the City and County of San Francisco. The engineering properties used in the stability analyses are presented in Table 4.

TABLE 4
Engineering Properties used in Slope Stability Studies

Material Description	Total Unit Weight (pcf)	Effective Strength Parameters	
		Effective Cohesion, c' (psf)	Effective Internal Friction, ϕ' (degrees)
Existing Fill	110	500	26.0
Colluvium	120	700	22.0
Buttress Fill	124	60	32.3
Existing Landslide	110	700	11.0
Franciscan Melange	135	800	22.0

8.1.2 Design Groundwater

We did not observe free groundwater in the bedrock below the landslides in our test pit. In addition, we have assumed that the proposed buttress will be fully drained. As a result, we have not included the influence of groundwater in our analyses.

8.1.3 Static Stability

Based on the results of a static analysis the resulting minimum factor of safety for the overall repaired slope is approximately 2.37; which is greater than the generally accepted minimum static factor of safety of 1.5 (see Appendix C).

8.1.4 Pseudo-Static Stability

We used a pseudo-static approach to evaluate the seismic slope stability of the proposed repair concept. In this method of analysis, an earthquake is represented by an equivalent horizontal static force. This seismic force is modeled by applying a horizontal ground acceleration (hga, horizontal seismic coefficient) multiplied by the mass of the potential slide material. In accordance with the 2006 International Building Code, we derived a peak seismic coefficient of 0.844g for a magnitude 7.9 Earthquake on the San Andreas Fault. This value corresponds to a repeatable acceleration of 0.563g, which was used in our pseudo-static analysis. Using this value, the resulting minimum factor of safety as shown in Appendix C for the overall repaired slope was determined to be less than 1.0. A yield analysis, that is the seismic force corresponding to a Factor of Safety equal to 1.0, was determined to be 0.378g (see Appendix C).

To better evaluate the effects of earthquake shaking, we estimated the seismic deformation of the repaired landslide during a design level earthquake using the method developed by Bray and Travasarou (2007). For this analysis, we determined the yield acceleration[3] of the repaired slope configuration. Based on the results of our analyses, the minimum yield acceleration for the repaired slide mass is approximately 0.378g. The initial Fundamental Period (Ts) for the slope was calculated to be 0.10 seconds, with a degraded period equal to 0.15 seconds. The spectral acceleration for the site was determined to be 1.175g. The results of the slope displacement analyses indicate that permanent slope displacements during the peak earthquake event are relatively small and are expected to be on the order of 8 to 9 centimeters.

We conclude based on this relatively small amount of deformation that a buttress fill bearing in the underlying mélange bedrock should adequately mitigate slope failure hazards for these lots. It should be noted that the yield coefficient is dependant upon the material strengths of the buttress fill materials. Use of materials with lower strengths than we tested, including the on-site materials comprising the upper 9 feet of the landslide deposits, will likely result in greater slope deformations.

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[3] The yield acceleration is the acceleration at which the slope becomes unstable; where the factor of safety is equal to 1.0.

8.2 Fault Rupture

Following passage of the Alquist-Priolo Special Studies Zone Act in 1972, construction of structures for human occupancy in designated Earthquake Fault Zones is not permitted until a site-specific evaluation of surface fault rupture and fault creep has been performed (CDMG, 1997). Theses zones are established along faults or segments of faults that are judged to be sufficiently active and well-defined as to constitute a potential hazard to structures from surface faulting or fault creep. As shown on Figure 7, the site is not located within an Alquist-Priolo Specials Studies Zone. Based on the distance to the San Andreas and other active faults, we conclude the potential building sites are free from active or potentially active faulting.

8.3 Strong Ground Shaking

During a major earthquake on one of the active faults in the general region, the site will experience strong to very strong ground shaking similar to other areas of the seismically active San Francisco Bay Region. The intensity of the earthquake ground motion at the site will depend upon the characteristics of the generating fault, distance to the earthquake epicenter, magnitude and duration of the earthquake, and specific site geologic conditions. During its history, the site has been subjected to strong ground shaking from moderate to large earthquakes on the Hayward, Calaveras, San Andreas, and other nearby potentially active faults, and future very strong ground shaking should be expected.

8.4 Seismically-Induced Ground Failures

During a major earthquake on a segment of one of the nearby faults, strong to very strong shaking is expected to occur at the project site. Strong shaking during an earthquake can result in ground failure such as that associated with soil liquefaction[4], cyclic densification[5], and lateral spreading[6].

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[4] Liquefaction is a transformation of soil from a solid to a liquefied state during which saturated soil temporally loses strength resulting from the buildup of excess pore water pressure, especially during earthquake-induced cyclic loading. Soil susceptible to liquefaction includes loose to medium dense sand and gravel, low-plasticity silt, and some low-plasticity clay deposits.

[5] Cyclic densification is a phenomenon in which non-saturated, cohesionless soil is densified by earthquake vibrations, resulting in ground surface settlement.

[6] Lateral spreading is a phenomenon in which surficial soil displaces along a shear zone that has formed within an underlying liquefied layer. Upon reaching mobilization, the surficial blocks are transported downslope or in the direction of a free face by earthquake and gravitational forces.

8.4.1 Liquefaction and Associated Hazards

As described above, CGS has not published the Seismic Hazard Zones map for this area. However, a preliminary liquefaction susceptibility map prepared by the USGS (1987) indicates the site area is within a non-liquefiable bedrock zone.

Soil susceptible to liquefaction includes loose to medium dense sand and gravel, low-plasticity silt, and some low-plasticity clay deposits. Flow failure, lateral spreading, differential settlement, loss of bearing strength, ground fissures and sand boils are evidence of excess pore pressure generation and liquefaction. Lateral spreading refers to the, lateral displacement of gently sloping ground as a result of pore pressure build-up or liquefaction during an earthquake in an underlying layer. Based on the relatively shallow depth to bedrock, and depth to groundwater in the areas of the proposed building sites, we conclude the potential for liquefaction and lateral spreading is negligible.

8.4.2 Cyclic Densification

Cyclic densification is a phenomenon in which non-saturated, cohesionless soil is densified by earthquake vibrations, causing settlement. Where bedrock is shallow or exposed at the ground surface, we judge the potential for cyclic densification is low. Where existing fill or soil is present on the site, the project geotechnical consultant should evaluate the likelihood of this phenomenon. Based on our understanding that the proposed structures will be supported on foundations bearing in the underlying bedrock, we anticipate cyclic densification of these materials should not pose a significant hazard to the proposed residences.

8.5 Non-Seismic Ground Failures

Potential geologic hazards associated with ground failure not caused by earthquakes such as expansive soil and collapsible soil, were evaluated and are discussed in this section.

8.5.1 Expansive Soil

Expansive soil shrinks and swells with changes in moisture content. The clay content, mineralogy, and porosity of the soil also influence the change in volume. The shrinking and swelling caused by expansive clay-rich soil often results in damage to overlying structures.

Typically soil derived from serpentinite in the Bay Area is expansive. SFS performed thirteen Atterberg Limit tests to evaluate the expansiveness of soils within the site. The results of their investigation indicate that soils on the site are not expansive, with an average Plasticity Index (PI) of 8, and a high PI of 12. Because grading will be performed for development, possibly exposing expansive soil and bedrock, we conclude that each lot should be evaluated during construction to evaluate the presence of expansive soils. If expansive soils are discovered on the site, mitigation measures may be required during construction.

The mitigation should be determined during the design level geotechnical investigation, but in general may require: 1) the excavation and removal of the expansive soil materials to a certain depth and replacement with non-expansive fill; 2) the placement of a layer of non-expansive fill, which may vary in thickness from 12 to 24-inches, above the expansive soil prior to constructing areas of pavement or foundations; 3) moisture conditioning the expansive soil several percent above the optimum moisture content or lime treating the expansive soil; 4) extending foundations below the zone of seasonal moisture change or designing them to withstand seasonal shrink-swell; 5) providing specific control of surface runoff and installation of sub-surface drainage elements; 6) the use of low water demand landscaping; and 7) a combination of any of the above measures.

8.5.2 Collapsible Soil

Soil collapse is the densification of sediments resulting from significant increases in their moisture content. This process typically results from moisture infiltration into the subsurface caused by poor surface drainage, irrigation water or leaking pipes. This phenomenon is more prevalent in low-density, silty, sandy soil deposited in semi-arid and arid climates where the soil has not been subjected to saturation. Based on the relatively shallow depth to bedrock observed over most of the site and the relative density of the surficial soils observed during our reconnaissance, we judge the potential for soil collapse at the site to be low.

8.5.3 Subsidence

Subsidence typically occurs as a result of subsurface fluid extraction (e.g. groundwater, petroleum) or compression of soft, geologically young sediments. Groundwater extraction for municipal and agricultural use has the potential to cause ground subsidence. Based on the sites topographic setting and historic depths to groundwater, we anticipate that the potential for subsidence to occur at the site will be low to negligible.

8.5.4 Soil Creep

SFS identified a colluvium filled swale in the lower portions of Lots 2 and 3 and noted that soil creep is likely to occur in this area and on other steep slopes across the site. Soil creep from native soil, colluvium, or fill (either existing undocumented fill or new engineered fill) may adversely impact the foundations of the proposed residences, site retaining walls, or other site improvements. SFS provided recommendations for supporting residences on drilled pier foundations, gaining support in the underlying bedrock to adequately mitigate distress to lots that may be impacted by creep.

T&R generally concurs with the SFS recommendations; however, the effects of soil creep on all proposed site improvements on slopes should be considered. We concur that a drilled pier foundation should mitigate these effects on the proposed residences. We recommend that the geotechnical engineer evaluate the layout of proposed underground utilities, exterior hardscape, and retaining walls to evaluate if creep will impact these structures. If necessary, recommendations for mitigating the adverse impacts of soil creep should be provided.

8.6 Serpentinite

Serpentinite rock is known to potentially contain naturally occurring asbestos fibers. We recommend that the lot-specific geotechnical investigations include testing of representative samples of serpentinite (if encountered) for asbestos, in accordance with guidelines set forth by the California Air Resources Board and the Bay Area Air Quality Management District. Based on the percent of asbestos measured within samples of the on-site material, these materials may or may not be suitable for use as fill, and/or may require special soil management, such as keeping the fill wet and capping the fill with at least one foot of non-asbestos containing soil.

8.7 Site Hydrology and Surface Drainage

During our site investigation, we did not observe evidence of seeps or springs within the proposed building sites on any of the 11 lots. In addition, as noted above, we did not observe free groundwater in any of the test pits to the depths explored in Lots 5 through 8. The sandstone bedrock underlying Lots 1 through 4 is well fractured, and should promote rapid downward percolation of surface runoff. The mélange underlying the remaining lots is moderately to highly plastic and generally has a low permeability which may result in an increased risk of surface soil saturation during periods of prolonged rainfall.

Control of surface drainage is critical to the successful development of the properties. The results of improperly controlled runoff may include foundation heave and/or settlement, erosion, gullying, ponding, and potential slope instability. The geotechnical investigation for the proposed development should provide appropriate recommendations to prevent water from ponding in pavement areas and adjacent to the foundation of the proposed residences by sloping the ground surface away from the homes and/or by providing area drains. In addition, recommendations should be provided for the collection and discharge of collected roof-gutter downspouts, retaining wall backdrain outfalls, and area drain outfalls to prevent water from being allowed to discharge freely onto the ground surface adjacent to the residences or site retaining walls, or to be allowed to flow over the top of any artificial slope. In our opinion, the collected water from the proposed lots may be discharged on site utilizing properly designed energy dissipaters located downslope of the homes in areas to be determined by the project geotechnical engineer during their investigation. We conclude that if the drainage systems are properly designed, they should effectively mitigate future development of springs, seeps, or shallow surface landsliding of the soils mantling the slopes in the immediate vicinity of the homes.

9.0 LIMITATIONS

The findings and conclusions and recommendations presented in this report apply only to the Lots 1 through 11 of the Highlands Estates as we have described, and are the result of our review of previous reports, air photos, and our limited site reconnaissance and our interpretations of the existing geological conditions at the time of our field activities. We have prepared this report for the exclusive use of our client in substantial accordance with the generally accepted geological engineering practice as it exists in the area at the time of our study. No warranty is expressed or implied.

REFERENCES

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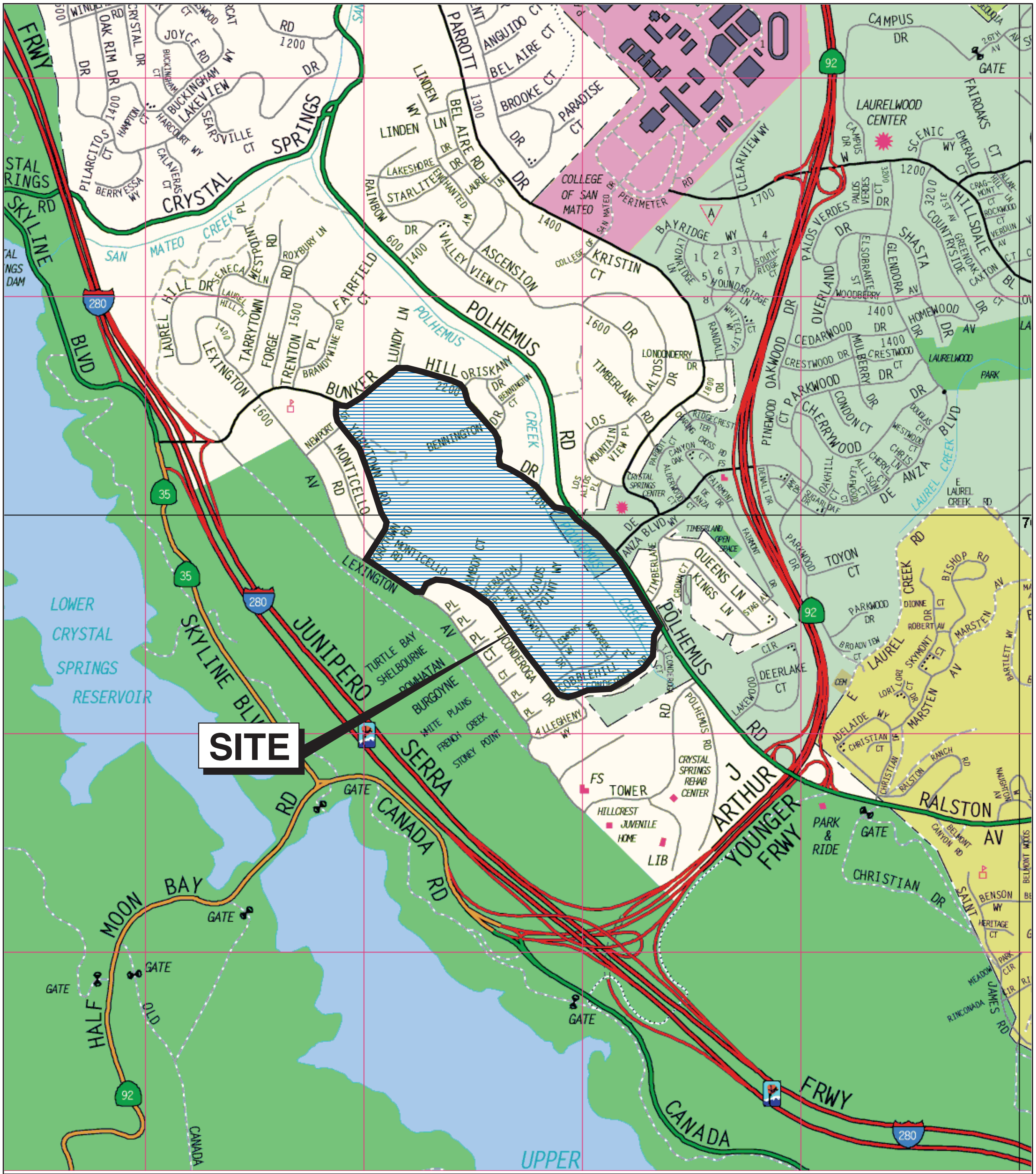
FIGURES



Base map: The Thomas Guide
San Mateo County
1999

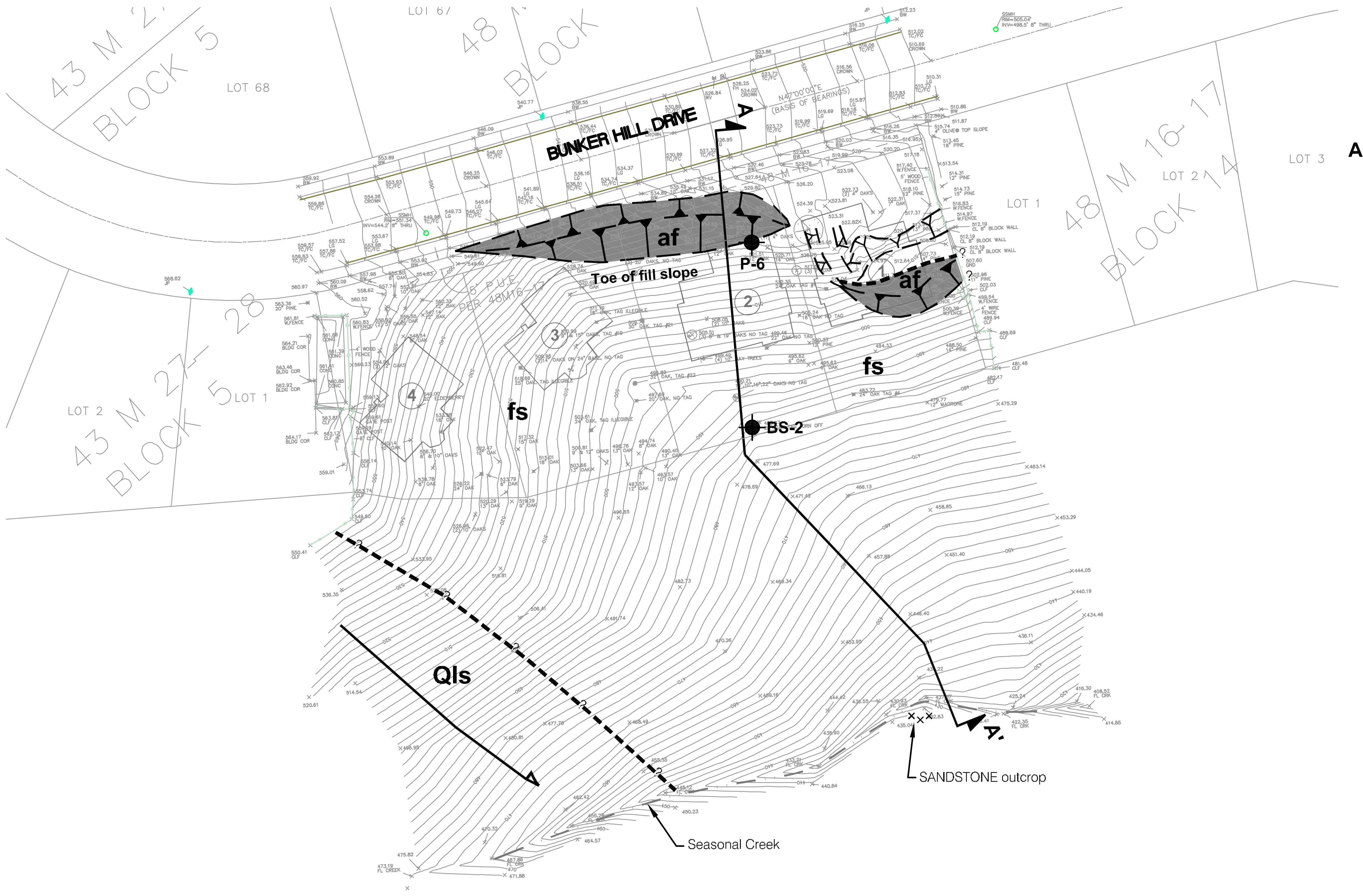
0 1/4 1/2 Mile
Approximate scale

HIGHLAND ESTATES
San Mateo County, California

Treadwell&Rollo

SITE LOCATION MAP

Date 08/06/09	Project No. 4872.02	Figure 1



EXPLANATION

P-6	Approximate location of boring by Soil Foundation systems, 1990
BS-2	Approximate location of boring by Soil Foundation Systems, 1993
A A'	Idealized subsurface profile
af	Artificial fill
fs	Franciscan sandstone
Qls	Landslide
	Cut slope
	Fill slope
	Direction of landslide
×ₓ×	Sandstone outcrop
①	Proposed lot number

0 60 Feet

Approximate scale

HIGHLAND ESTATES
San Mateo County, California

SITE PLAN AND ENGINEERING GEOLOGIC MAP 1

Date 08/18/09	Project No. 4872.02	Figure 2a

Treadwell&Rollo

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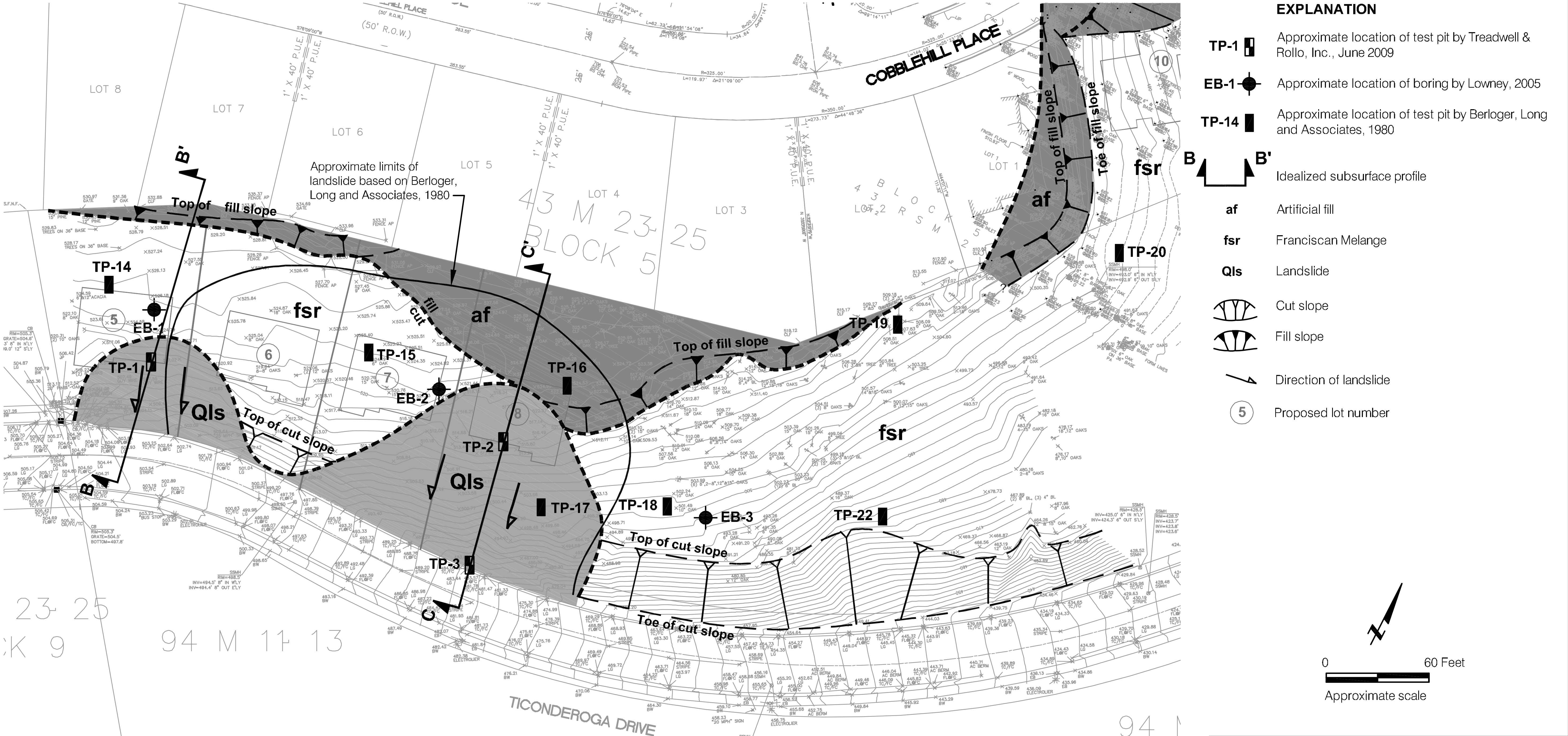
Reference: Base map from a site plan titled "Highland Estates - Ticonderoga, Partial Topopgrahic Survey, by BKF, dated 05/13/09.



Reference: Base map from a site plan titled "Highland Estates - Ticonderoga, Partial Topopgrahic Survey, by BKF, dated 05/13/09.

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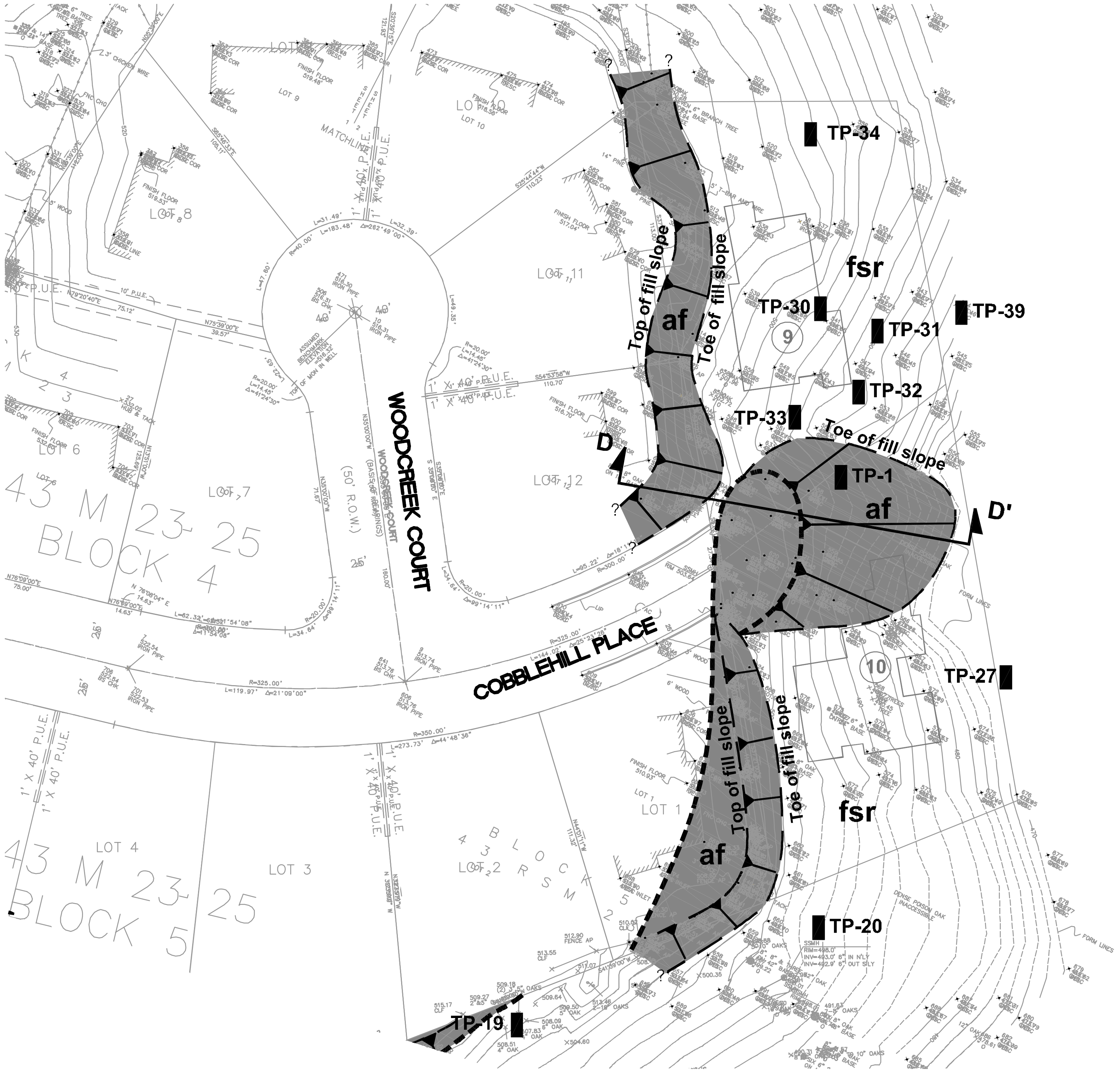
HIGHLAND ESTATES
San Mateo County, California

SITE PLAN AND ENGINEERING GEOLOGIC MAP 2

Date 07/06/09	Project No. 4872.02	Figure 2b

Treadwell&Rollo



Reference: Base map from a site plan titled "Highland Estates - Ticonderoga, Partial Topopgrahic Survey, by BKF, dated 05/13/09.

EXPLANATION

TP-19 ▮	Approximate location of test pit by Berloger, Long and Associates, 1980
D ⊓ D'	Idealized subsurface profile
af	Artificial fill
fsr	Franciscan Melange
Qls	Landslide
	Cut slope
	Fill slope
	Direction of landslide
⑨	Proposed lot number

0 60 Feet

Approximate scale

HIGHLAND ESTATES
San Mateo County, California

SITE PLAN AND
ENGINEERING GEOLOGIC MAP 3

Date 07/06/09	Project No. 4872.02	Figure 2c

Treadwell&Rollo

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EXPLANATION

TP-15 ▮	Approximate location of test pit by Berloger, Long and Associates, 1980
E ... E'	Idealized subsurface profile
af	Artificial fill
fm	Franciscan Melange
Qls	Landslide
	Cut slope
	Fill slope
	Direction of landslide
×ₓ×	Sandstone outcrop
⑪	Proposed lot number

0 60 Feet

Approximate scale

HIGHLAND ESTATES
San Mateo County, California

SITE PLAN AND ENGINEERING GEOLOGIC MAP 4

Date 07/06/09	Project No. 4872.02	Figure 2d

Treadwell&Rollo

Reference: Base map from a site plan titled "Highland Estates - Ticonderoga, Partial Topopgrahic Survey, by BKF, dated 05/13/09.

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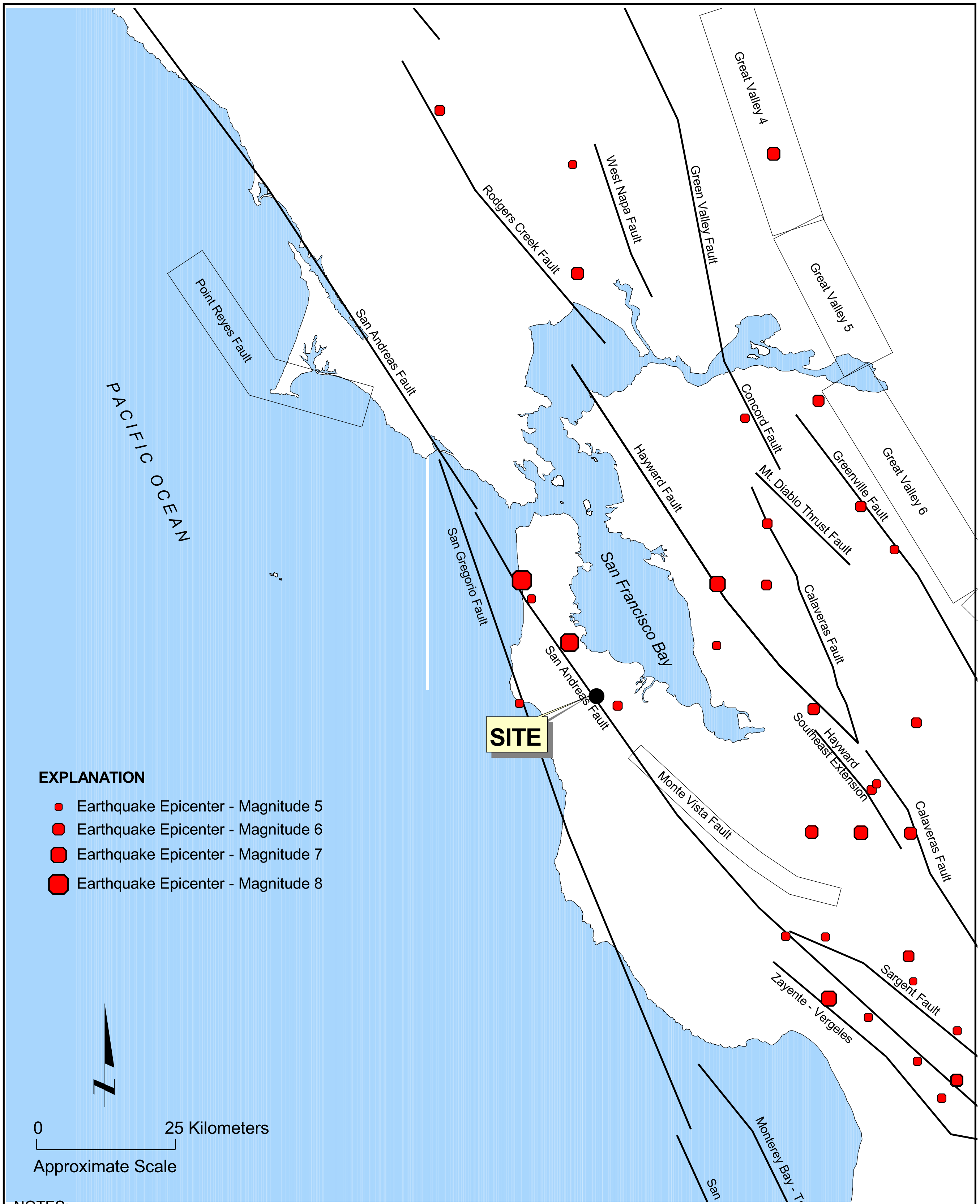


NOTES:
Digitized data for fault coordinates and earthquake catalog was developed by the California Department of Conservation Division of Mines and Geology. The historic earthquake catalog includes events from January 1800 to December 2000.

HIGHLAND ESTATES
San Mateo County, California

Treadwell&Rollo

MAP OF MAJOR FAULTS AND EARTHQUAKE EPICENTERS IN THE SAN FRANCISCO BAY AREA

Date: 08/06/09	Project No. 4872.02	Figure 3

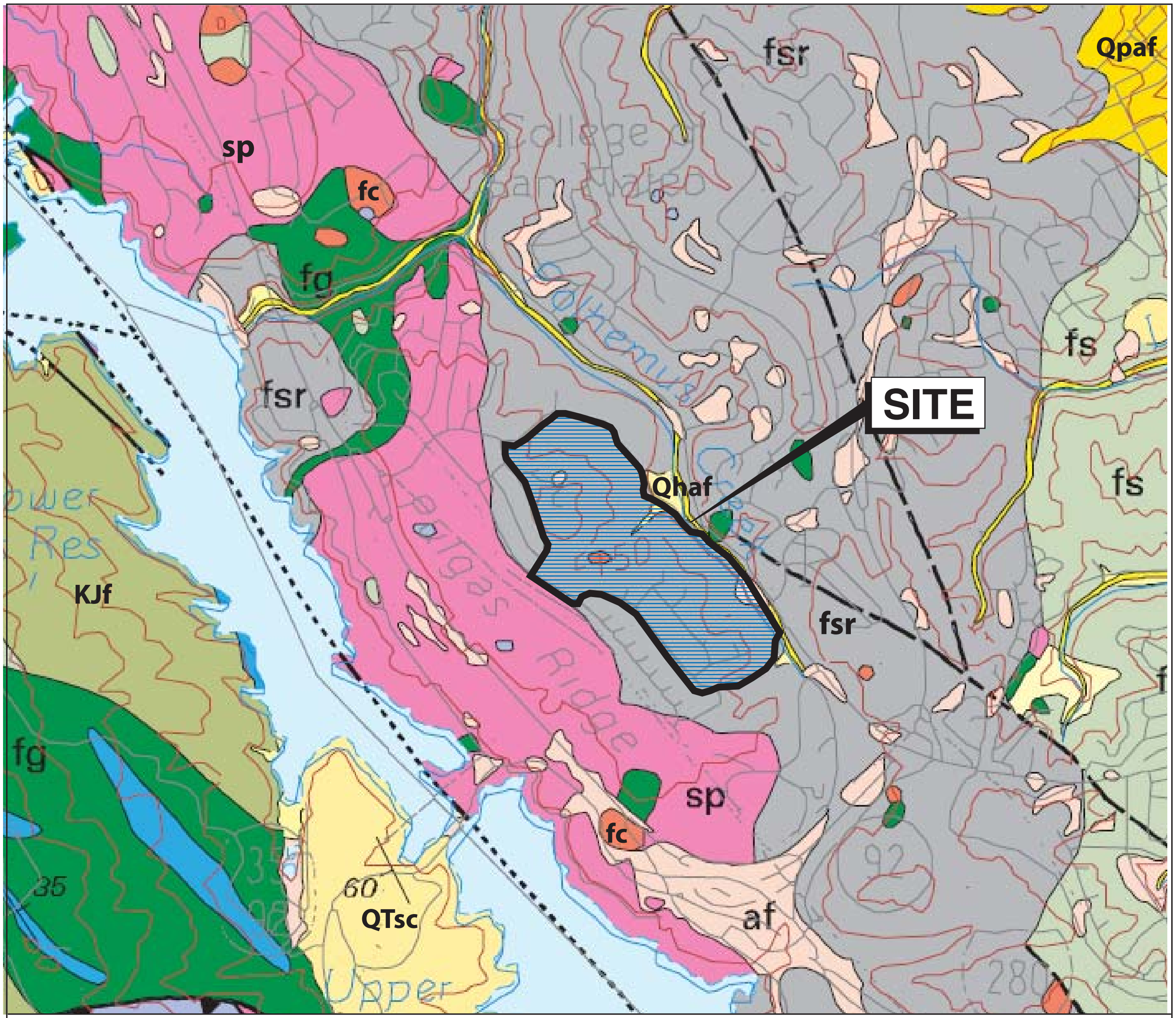
I	**Not felt by people, except under especially favorable circumstances. However, dizziness or nausea may be experienced.** Sometimes birds and animals are uneasy or disturbed. Trees, structures, liquids, bodies of water may sway gently, and doors may swing very slowly.
II	**Felt indoors by a few people, especially on upper floors of multi-story buildings, and by sensitive or nervous persons.** As in Grade I, birds and animals are disturbed, and trees, structures, liquids and bodies of water may sway. Hanging objects swing, especially if they are delicately suspended.
III	**Felt indoors by several people, usually as a rapid vibration that may not be recognized as an earthquake at first. Vibration is similar to that of a light, or lightly loaded trucks, or heavy trucks some distance away. Duration may be estimated in some cases.** Movements may be appreciable on upper levels of tall structures. Standing motor cars may rock slightly.
IV	**Felt indoors by many, outdoors by a few. Awakens a few individuals, particularly light sleepers, but frightens no one except those apprehensive from previous experience. Vibration like that due to passing of heavy, or heavily loaded trucks. Sensation like a heavy body striking building, or the falling of heavy objects inside.** Dishes, windows and doors rattle; glassware and crockery clink and clash. Walls and house frames creak, especially if intensity is in the upper range of this grade. Hanging objects often swing. Liquids in open vessels are disturbed slightly. Stationary automobiles rock noticeably.
V	**Felt indoors by practically everyone, outdoors by most people. Direction can often be estimated by those outdoors. Awakens many, or most sleepers. Frightens a few people, with slight excitement; some persons run outdoors.** Buildings tremble throughout. Dishes and glassware break to some extent. Windows crack in some cases, but not generally. Vases and small or unstable objects overturn in many instances, and a few fall. Hanging objects and doors swing generally or considerably. Pictures knock against walls, or swing out of place. Doors and shutters open or close abruptly. Pendulum clocks stop, or run fast or slow. Small objects move, and furnishings may shift to a slight extent. Small amounts of liquids spill from well-filled open containers. Trees and bushes shake slightly.
VI	**Felt by everyone, indoors and outdoors. Awakens all sleepers. Frightens many people; general excitement, and some persons run outdoors.** Persons move unsteadily. Trees and bushes shake slightly to moderately. Liquids are set in strong motion. Small bells in churches and schools ring. Poorly built buildings may be damaged. Plaster falls in small amounts. Other plaster cracks somewhat. Many dishes and glasses, and a few windows break. Knickknacks, books and pictures fall. Furniture overturns in many instances. Heavy furnishings move.
VII	**Frightens everyone. General alarm, and everyone runs outdoors.** People find it difficult to stand. Persons driving cars notice shaking. Trees and bushes shake moderately to strongly. Waves form on ponds, lakes and streams. Water is muddied. Gravel or sand stream banks cave in. Large church bells ring. Suspended objects quiver. Damage is negligible in buildings of good design and construction; slight to moderate in well-built ordinary buildings; considerable in poorly built or badly designed buildings, adobe houses, old walls (especially where laid up without mortar), spires, etc. Plaster and some stucco fall. Many windows and some furniture break. Loosened brickwork and tiles shake down. Weak chimneys break at the roofline. Cornices fall from towers and high buildings. Bricks and stones are dislodged. Heavy furniture overturns. Concrete irrigation ditches are considerably damaged.
VIII	**General fright, and alarm approaches panic.** Persons driving cars are disturbed. Trees shake strongly, and branches and trunks break off (especially palm trees). Sand and mud erupts in small amounts. Flow of springs and wells is temporarily and sometimes permanently changed. Dry wells renew flow. Temperatures of spring and well waters varies. Damage slight in brick structures built especially to withstand earthquakes; considerable in ordinary substantial buildings, with some partial collapse; heavy in some wooden houses, with some tumbling down. Panel walls break away in frame structures. Decayed pilings break off. Walls fall. Solid stone walls crack and break seriously. Wet grounds and steep slopes crack to some extent. Chimneys, columns, monuments and factory stacks and towers twist and fall. Very heavy furniture moves conspicuously or overturns.
IX	**Panic is general.** Ground cracks conspicuously. Damage is considerable in masonry structures built especially to withstand earthquakes; great in other masonry buildings - some collapse in large part. Some wood frame houses built especially to withstand earthquakes are thrown out of plumb, others are shifted wholly off foundations. Reservoirs are seriously damaged and underground pipes sometimes break.
X	**Panic is general.** Ground, especially when loose and wet, cracks up to widths of several inches; fissures up to a yard in width run parallel to canal and stream banks. Landsliding is considerable from river banks and steep coasts. Sand and mud shifts horizontally on beaches and flat land. Water level changes in wells. Water is thrown on banks of canals, lakes, rivers, etc. Dams, dikes, embankments are seriously damaged. Well-built wooden structures and bridges are severely damaged, and some collapse. Dangerous cracks develop in excellent brick walls. Most masonry and frame structures, and their foundations are destroyed. Railroad rails bend slightly. Pipe lines buried in earth tear apart or are crushed endwise. Open cracks and broad wavy folds open in cement pavements and asphalt road surfaces.
XI	**Panic is general.** Disturbances in ground are many and widespread, varying with the ground material. Broad fissures, earth slumps, and land slips develop in soft, wet ground. Water charged with sand and mud is ejected in large amounts. Sea waves of significant magnitude may develop. Damage is severe to wood frame structures, especially near shock centers, great to dams, dikes and embankments, even at long distances. Few if any masonry structures remain standing. Supporting piers or pillars of large, well-built bridges are wrecked. Wooden bridges that "give" are less affected. Railroad rails bend greatly and some thrust endwise. Pipe lines buried in earth are put completely out of service.
XII	**Panic is general.** Damage is total, and practically all works of construction are damaged greatly or destroyed. Disturbances in the ground are great and varied, and numerous shearing cracks develop. Landslides, rock falls, and slumps in river banks are numerous and extensive. Large rock masses are wrenched loose and torn off. Fault slips develop in firm rock, and horizontal and vertical offset displacements are notable. Water channels, both surface and underground, are disturbed and modified greatly. Lakes are dammed, new waterfalls are produced, rivers are deflected, etc. Surface waves are seen on ground surfaces. Lines of sight and level are distorted. Objects are thrown upward into the air.

HIGHLAND ESTATES
San Mateo County, California

MODIFIED MERCALLI INTENSITY SCALE

Treadwell&Rollo

Date 08/06/09 | Project No. 4872.02 | Figure 4



Base map: Geology of the onshore part of San Mateo County, California:
Derived from the Digital Database open-file 98-137.

EXPLANATION

af	**Older alluvial fan depostis (Pleistocene)**
Qhaf	**Alluvial fan and fluvial deposits (Holocene)**
Qpaf	**Alluvial fan and fluvial deposits (Pleistocene)**
QTsc	**Santa Clara Formation (lower Pleistocene and upper Pliocene)**
KJf	**Franciscan Complex, undivided (Cretaceous and Jurassic)**
fs	**Sandstone**
fg	**Greenstone**
fc	**Chert**
fsr	**Sheared rock (Melange)**
sp	**Serpentinite (Cretaceous and/ or Jurassic)**

Geologic contact dashed where approximate and dotted where concealed

Thrust fault dashed where approximate and dotted where concealed

0 2000 Feet

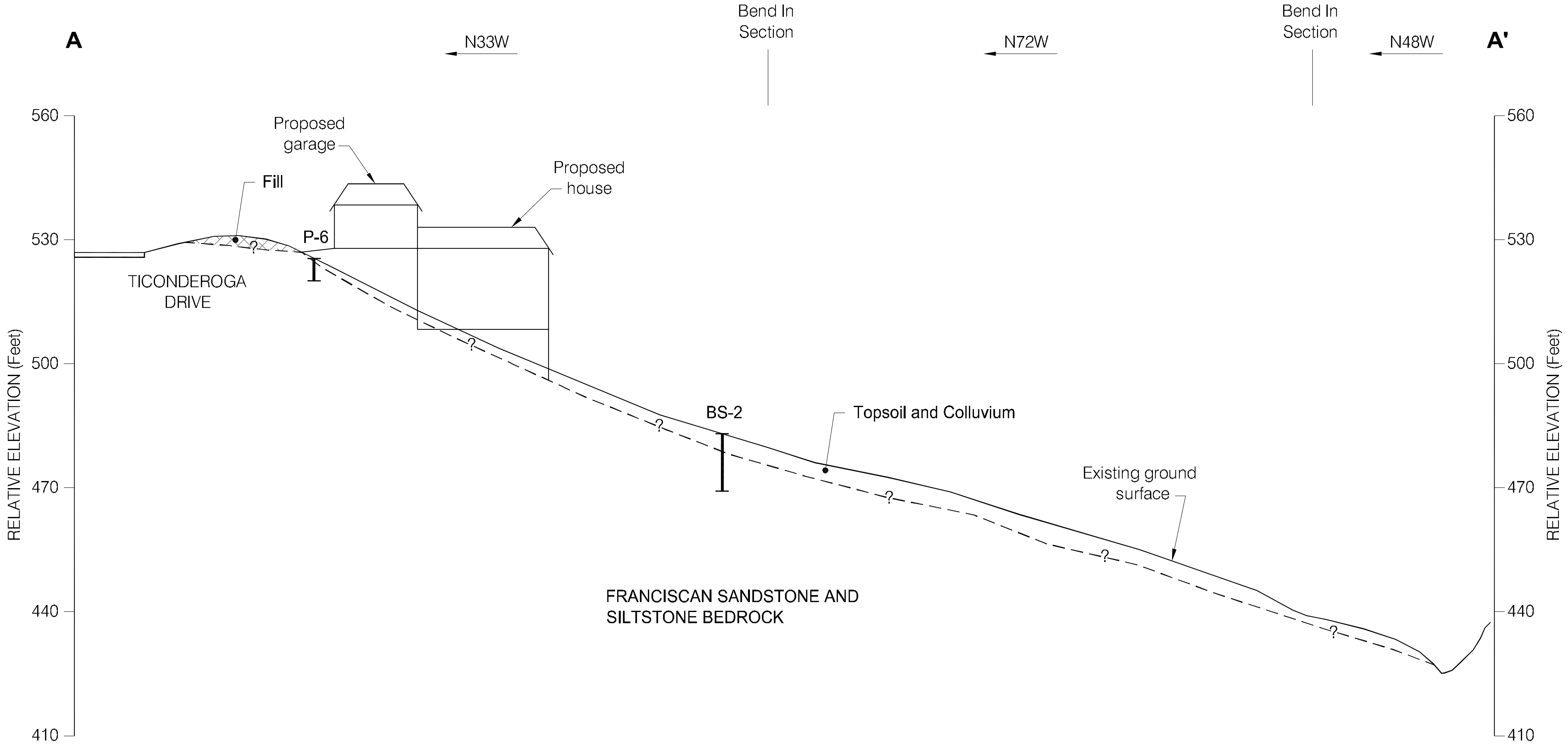
Approximate scale

HIGHLAND ESTATES
San Mateo County, California

Treadwell&Rollo

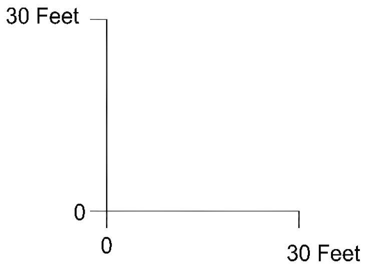
REGIONAL GEOLOGIC MAP

Date 08/06/09 | Project No. 4872.02 | Figure 5



Notes:
1. The above profile represents a generalized soil cross section interpreted from widely spaced test pits and borings. Soil deposits may vary in type, strength, and other important properties between points of exploration.

2. Cross-sections based on our site reconnaissance, topographic surveys by BKF Engineers, Inc., others.



Approximate Scale

HIGHLAND ESTATES
San Mateo County, California

IDEALIZED SUBSURFACE PROFILE A-A'

Date 08/25/09 | Project No. 4872.02 | Figure 6a

Treadwell&Rollo

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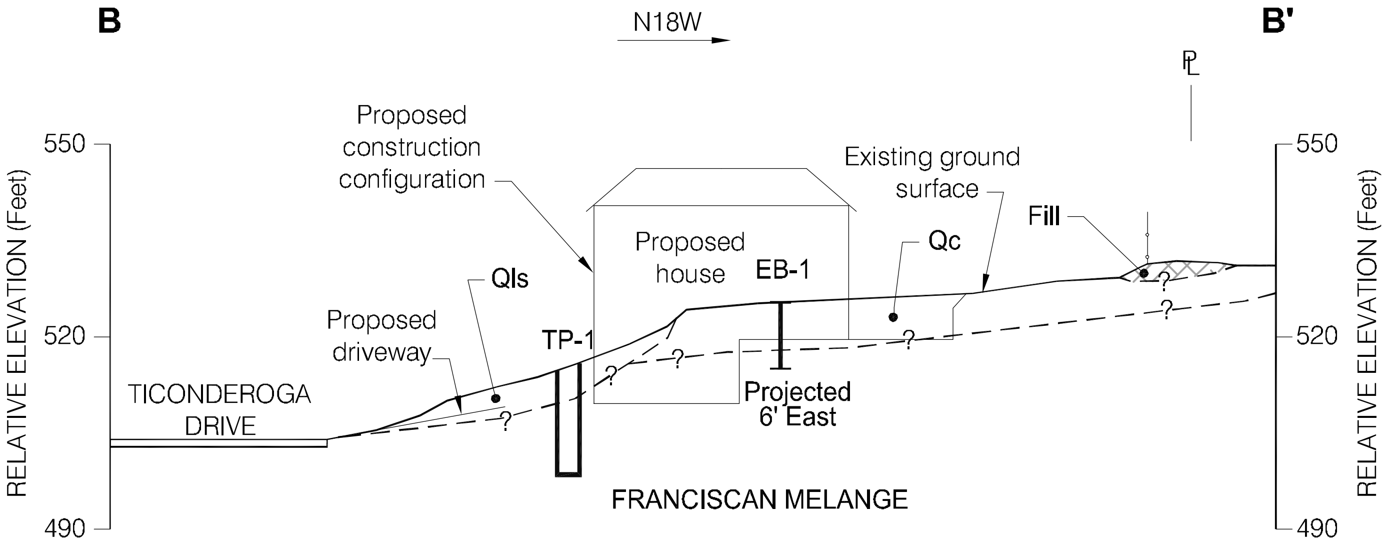
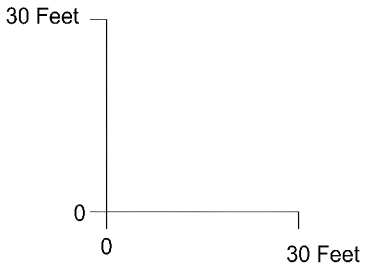


Notes:

1. The above profile represents a generalized soil cross section interpreted from widely spaced test pits and borings. Soil deposits may vary in type, strength, and other important properties between points of exploration.

2. Cross-sections based on our site reconnaissance, topographic surveys by BKF Engineers, Inc., others.



Approximate Scale

HIGHLAND ESTATES
San Mateo County, California

IDEALIZED SUBSURFACE
PROFILE B-B'

Date 08/06/09	Project No. 4872.02	Figure 6b

Treadwell&Rollo

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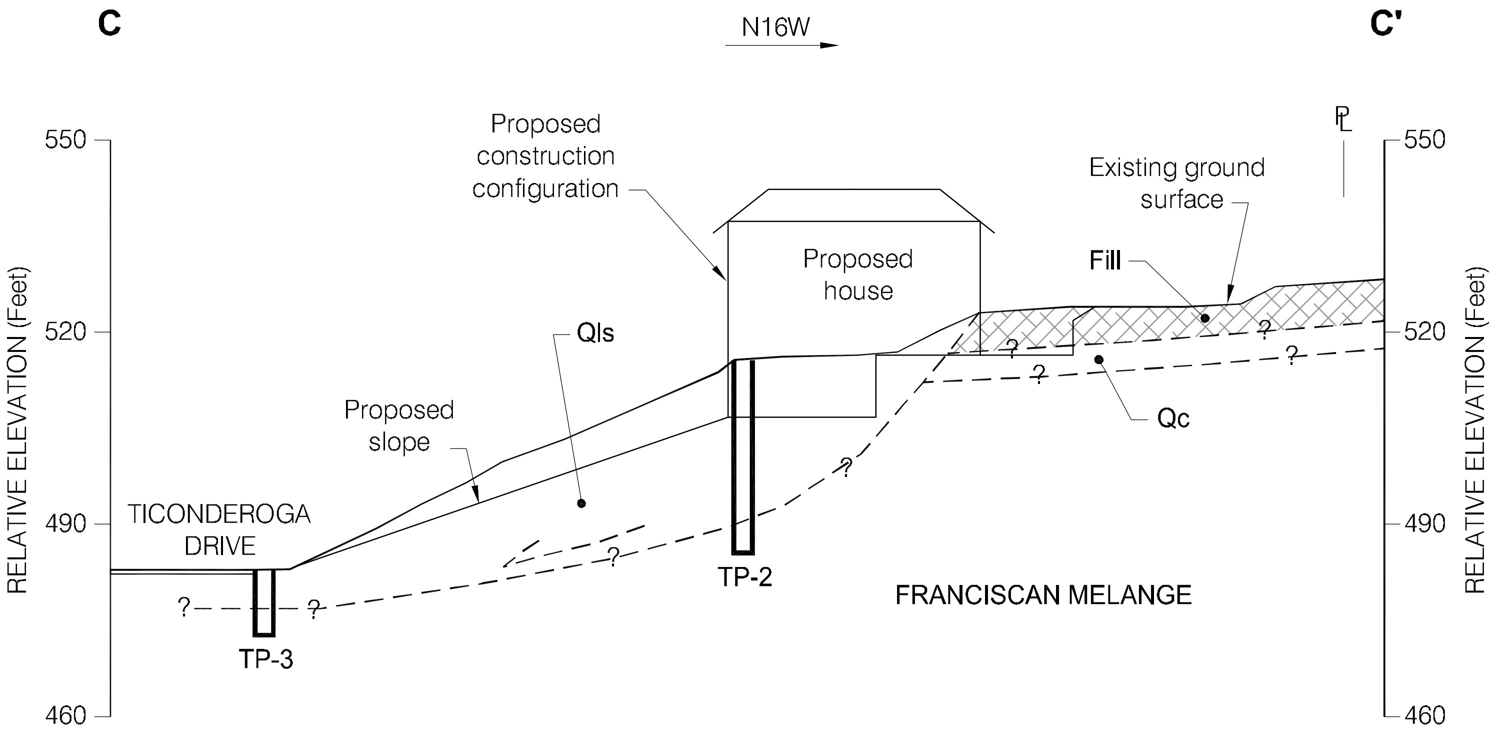
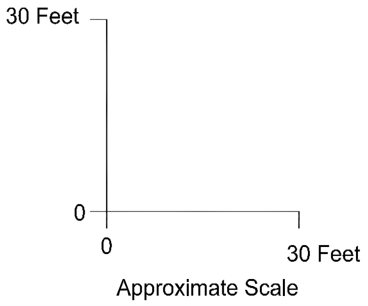


Notes:

1. The above profile represents a generalized soil cross section interpreted from widely spaced test pits and borings. Soil deposits may vary in type, strength, and other important properties between points of exploration.

2. Cross-sections based on our site reconnaissance, topographic surveys by BKF Engineers, Inc., others.



HIGHLAND ESTATES
San Mateo County, California

IDEALIZED SUBSURFACE PROFILE C-C'

Date 08/06/09	Project No. 4872.02	Figure 6c

Treadwell&Rollo

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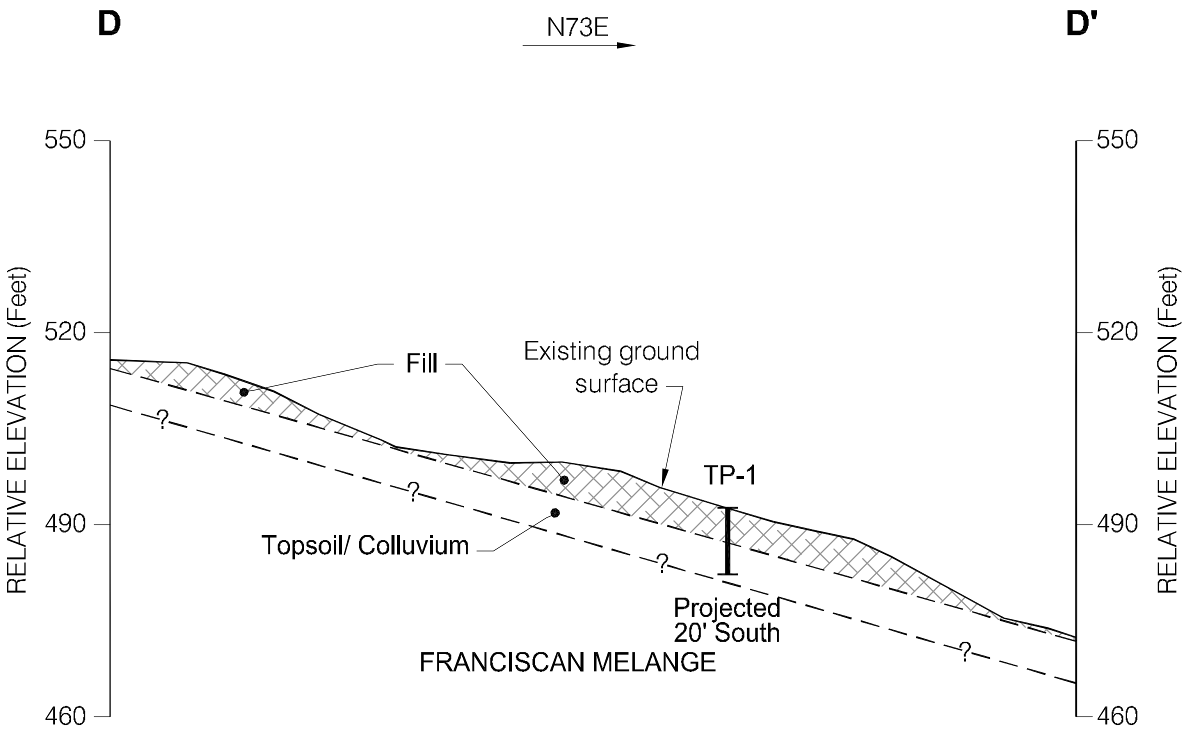
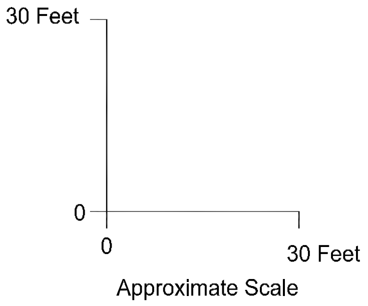


Notes:

1. The above profile represents a generalized soil cross section interpreted from widely spaced test pits and borings. Soil deposits may vary in type, strength, and other important properties between points of exploration.

2. Cross-sections based on our site reconnaissance, topographic surveys by BKF Engineers, Inc., others.



HIGHLAND ESTATES
San Mateo County, California

IDEALIZED SUBSURFACE
PROFILE D-D'

Date 08/06/09	Project No. 4872.02	Figure 6d

Treadwell&Rollo

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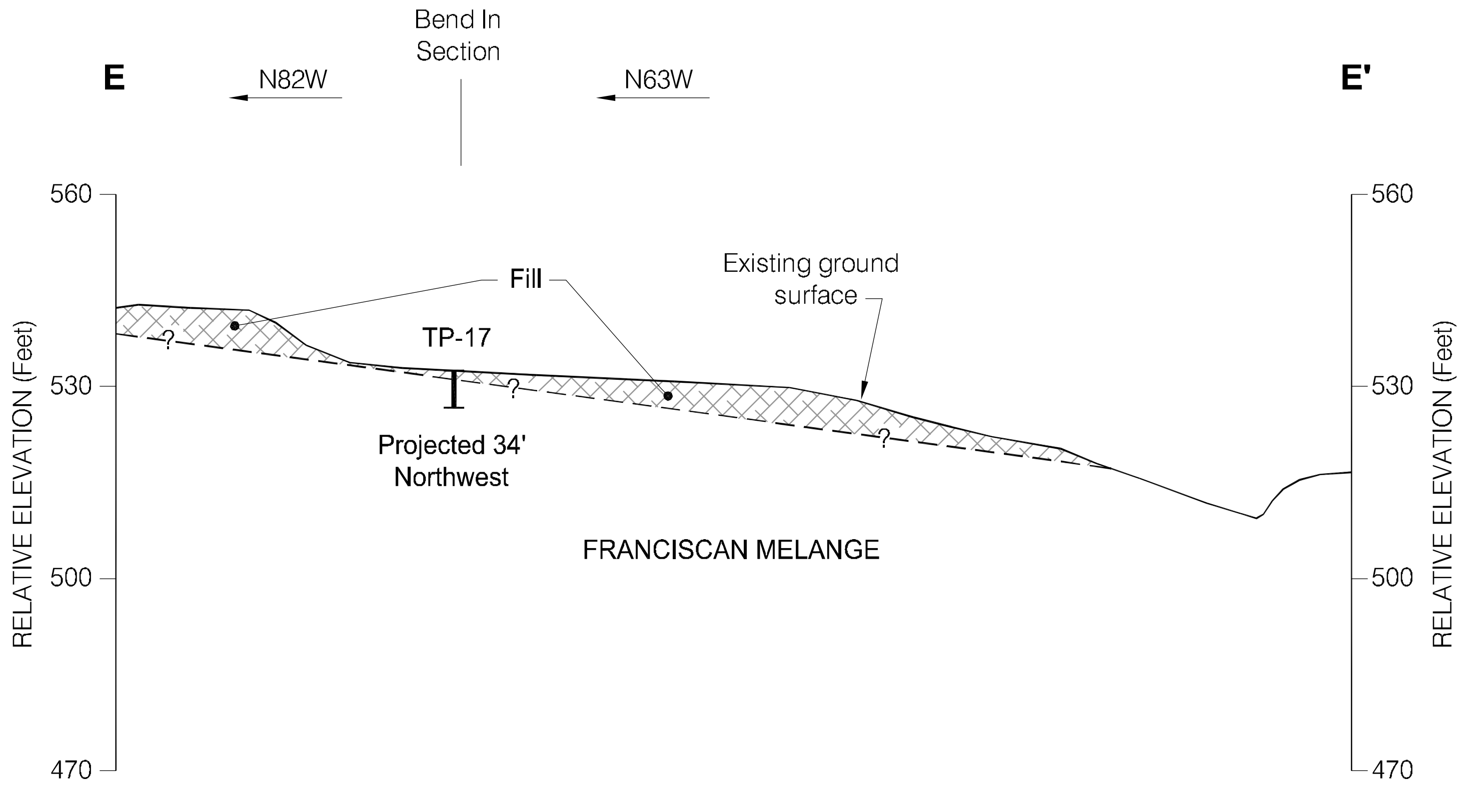

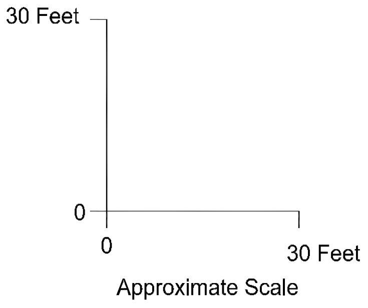

Approximate Scale

Notes:

1. The above profile represents a generalized soil cross section interpreted from widely spaced test pits and borings. Soil deposits may vary in type, strength, and other important properties between points of exploration.

2. Cross-sections based on our site reconnaissance, topographic surveys by BKF Engineers, Inc., others.

HIGHLAND ESTATES
San Mateo County, California

IDEALIZED SUBSURFACE
PROFILE E-E'

Date 08/06/09 | Project No. 4872.02 | Figure 6e

Treadwell&Rollo

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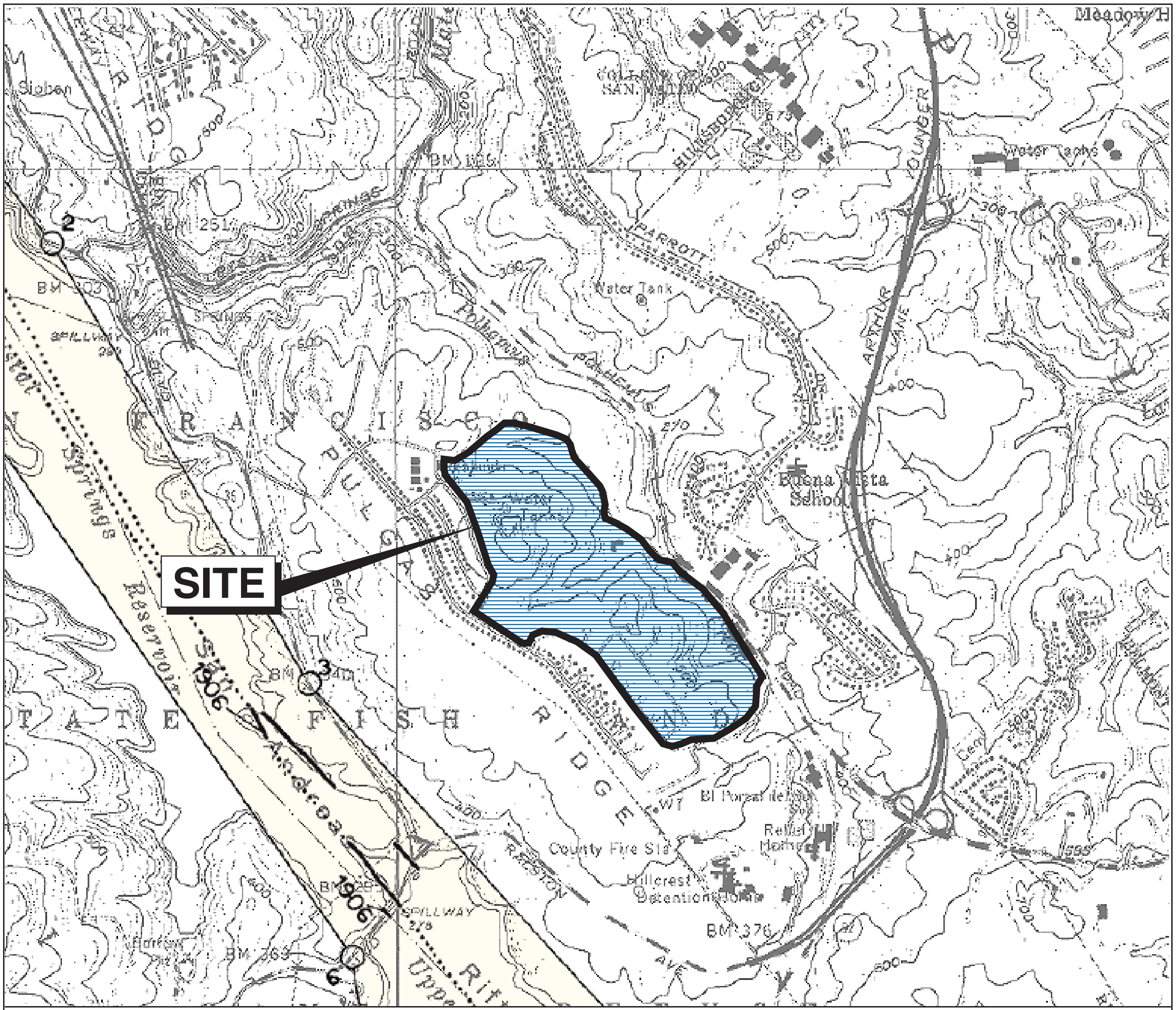


EXPLANATION

Potentially Active Faults

Faults considered to have been active during Quaternary time; solid line where accurately located, long dash where approximately located, short dash where inferred, dotted where concealed; query (?) indicates additional uncertainty. Evidence of historic offset indicated by year of earthquake-associated event or C for displacement caused by creep or possible creep.

Aerial photo lineaments (not field checked); based on youthful geomorphic and other features believed to be the results of Quaternary faulting.

Special Studies Zone Boundaries

These are delineated as straight-line segments that connect consecutively numbered turning points so as to define one or more special studies zone segments.

Seaward projection of zone boundary.

0 2000 Feet

Approximate scale

Reference:
State of California Special Studies Zones, San Mateo Quadrangle, July 1, 1974

HIGHLAND ESTATES
San Mateo County, California

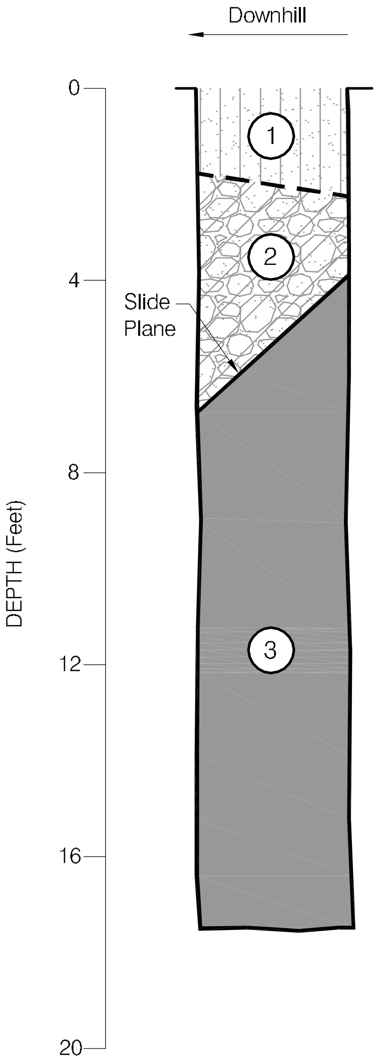
Treadwell&Rollo

REGIONAL ALQUIST-PRIOLO MAP

Date 08/06/09	Project No. 4872.02	Figure 7

APPENDIX A

Logs of Test Pits and Classification Chart



① SANDY SILTY (ML)
dark grayish brown (10YR 4/2), firm to stiff, dry, scattered sand and angular gravel to 1-inch diameter, abundant roots and rootlets
[TOPSOIL - DISPLACED]

② CLAYEY SAND with GRAVEL (SC)
olive gray (5Y 4/2), medium dense, firable, moist, scattered serpentinite fragments within a clayey sand matrix, fine-to medium-grained, sub-rounded ***[LANDSLIDE DEBRIS]***

③ Melange
very dark gray (5Y 3.1), predominantly sheared shale with scattered zones that are highly decomposed to silt and clay, discontinuous highly plastic clay seams throught, moist to wet ***[FRANCISCAN ASSEMBLAGE]***

0 4 Feet
Approximate scale

HIGHLAND ESTATES
San Mateo County, California

Treadwell&Rollo

LOG OF TEST PIT
TP-1

Date 08/25/09 | Project No. 4872.02 | Figure A-1

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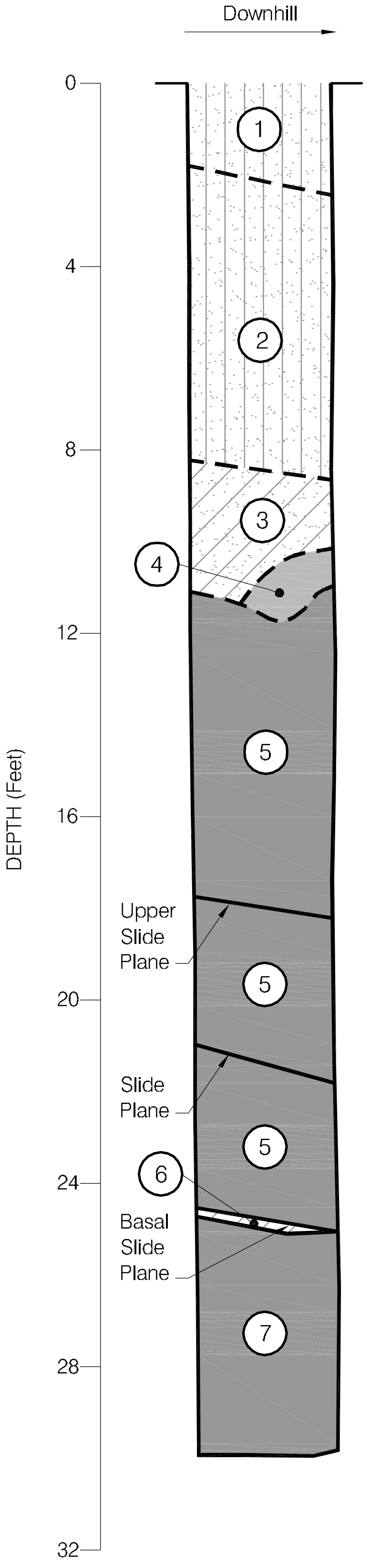

① SANDY SILTY (ML)
dark grayish brown (10YR 4/2), stiff, dry, scattered small desiccation cracks, abundant roots and rootlets, scattered sub-rounded gravel up to 1-inch diameter ***[FILL]***

② SANDY SILT (ML)
very dark grayish brown (10YR 3.2), homogeneous, firm, slightly moist, slightly oxidized, scattered roots and organics
[BURIED TOPSOIL - DISPLACED]

③ CLAYEY SAND (SC) dark yellowish brown (10YR 4/4), mottled with dark grayish brown (10YR 4/2), dense, dry to slightly moist, fine-to very fine-grained, homogeneous, trace organics ***[COLLUVIUM - DISPLACED]***

④ SANDSTONE
pale olive (5Y 6/3), very dense to indurated, well cemented, fine-grained, well graded, sub-rounded ***[COLLUVIUM - DISPLACED]***

⑤ Melange
greenish black (GLEY2 5B 2.5/1), predominantly sheared shale and angular serpentinite fragments within highly plastic clay matirx, moist to wet, heterogeneous with sub-parallel slip surfaces and discontinuous clay seams throughout ***[BEDROCK - DISPLACED]***

⑥ CLAY (CH)
greenish gray (GLEY 1 5GY 6/1) to light greenish gray (GLEY 1 5GY 7/1), homogeneous, highly plastic, wet to saturated, 1 to 1 1/2-inch thick , continuous ***[SLIDE GOUGE]***

⑦ Melange
very dark gray (GLEY 1 N 3/1), very dense, low hardness, predominantly sheared clay, slightly moist, 10 - 15-inches plastic clay around rock fragements ***[FRANCISCAN ASSEMBLAGE]***

0 4 Feet
Approximate scale

HIGHLAND ESTATES
San Mateo County, California

Treadwell&Rollo

LOG OF TEST PIT
TP-2

Date 08/25/09 | Project No. 4872.02 | Figure A-2

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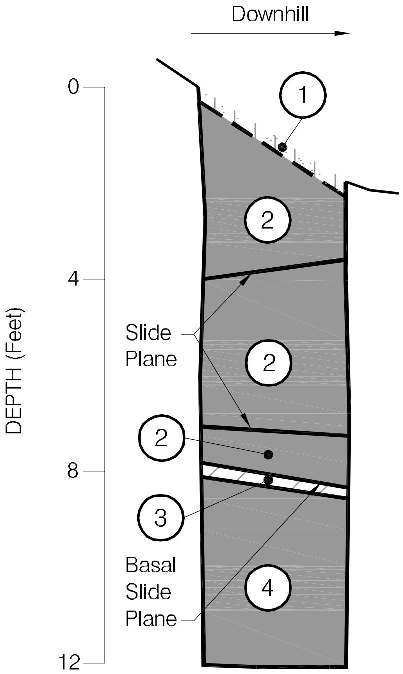

① SANDY SILT (ML)
very dark grayish brown (10YR 3.2), homogeneous, firm, slightly moist, slightly oxidized, scattered roots and organics ***[TOPSOIL - DISPLACED]***

② Melange
greenish black (GLEY2 5B 2.5/1), predominantly sheared shale and angular serpentinite fragments within highly plastic clay matirx, moist to wet, heterogeneous with sub-parallel slip surfaces and discontinuous clay seams throughout ***[BEDROCK - DISPLACED]***

③ CLAY (CH)
greenish gray (GLEY 1 5GY 6/1) to light greenish gray (GLEY 1 5GY 7/1), homogeneous, highly plastic, wet to saturated, 1 to 1 1/2-inch thick , continuous ***[SLIDE GOUGE]***

④ Melange
very dark gray (GLEY 1 N 3/1), very dense, low hardness, predominantly sheared clay, slightly moist, 10 - 15-inches plastic clay around rock fragements ***[FRANCISCAN ASSEMBLAGE]***

0 4 Feet
Approximate scale

HIGHLAND ESTATES
San Mateo County, California

Treadwell&Rollo

LOG OF TEST PIT
TP-3

Date 08/06/09 | Project No. 4872.02 | Figure A-3

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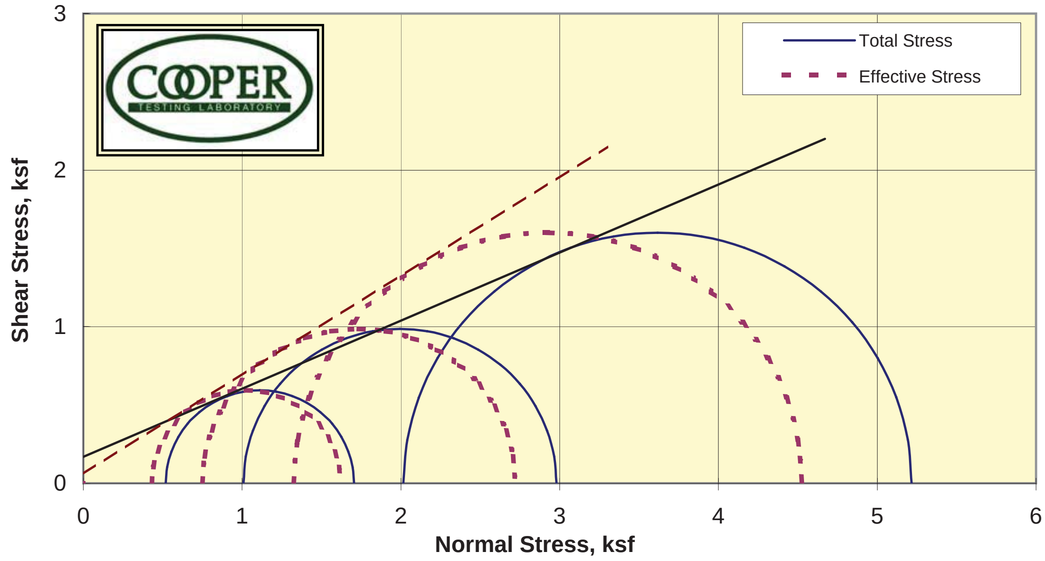
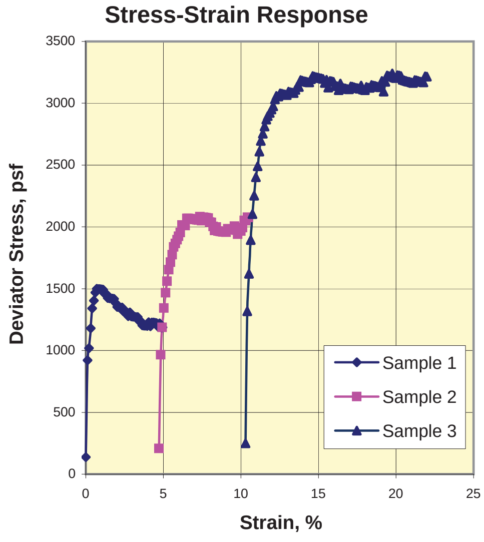
APPENDIX B

Laboratory Test Results

Triaxial Consolidated Undrained

(ASTM D4767 modified)





Sample:	1	2	3
MC, %	15.0		
Dry Dens., pcf.	109.2		
Sat. %	74.6		
Void Ratio	0.543		
Diameter in	2.37		
Height, in	5.00		
	Final		
MC, %	22.0	21.3	20.4
Dry Dens., pcf.	109.5	110.9	112.7
Sat. %	100.0	100.0	100.0
Void Ratio	0.594	0.574	0.551
Diameter, in	2.37	2.41	2.45
Height, in	4.99	4.77	4.53
Cell, psi	62.0	65.4	72.4
BP, psi	58.4	58.4	58.4
	Effective Stresses At:		
Strain, %	5.0	5.0	5.0
Deviator ksf	1.187	1.973	3.200
Excess PP	0.086	0.259	0.691
Sigma 1	1.619	2.721	4.525
Sigma 3	0.432	0.749	1.325
P, ksf	1.025	1.735	2.925
Q, ksf	0.593	0.986	1.600
Stress Ratio	3.748	3.634	3.416
Rate in/min	0.001	0.001	0.001

Total C	**0.17**	**Effective C**	**0.06**
Total Phi	**23.5**	**Effective Phi**	**32.3**

Job No.: 010-1055 **Date:** 8/3/2009

Client: Treadwell & Rollo BY:DC

Project: Highland Estates - 4872.01

Sample: Pit 2;1 @ 8'Very Dark Brown Sandy CLAY (Silty)

Remarks: ** Staged Test ** Strengths picked at 5% strain. Remolding Target= 109.5 pcf @ 15%. Sample started to fail during the first stage, which may affect the strength of subsequent stages.

HIGHLAND ESTATES
San Mateo County, California

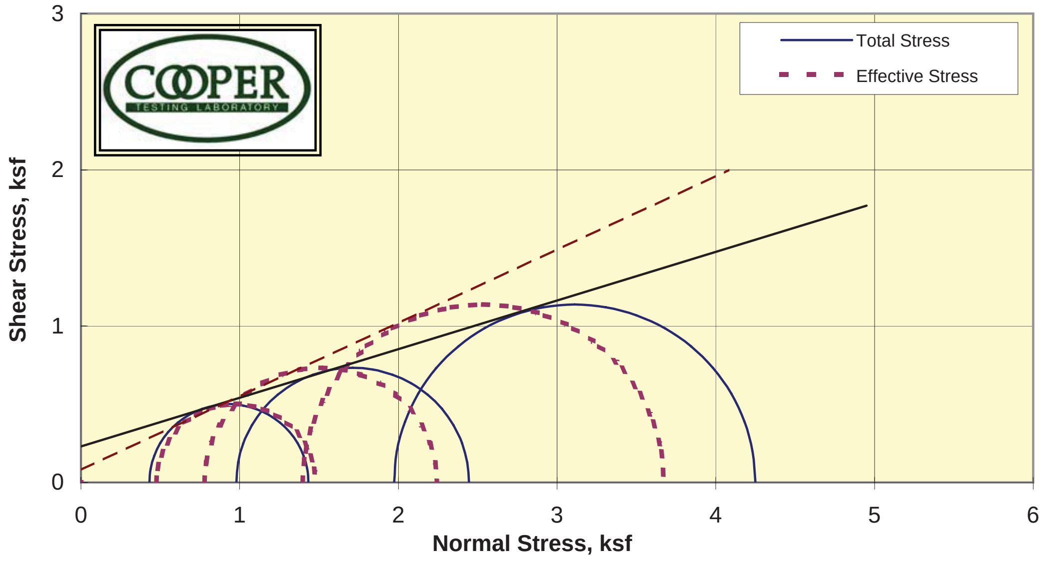
Treadwell&Rollo

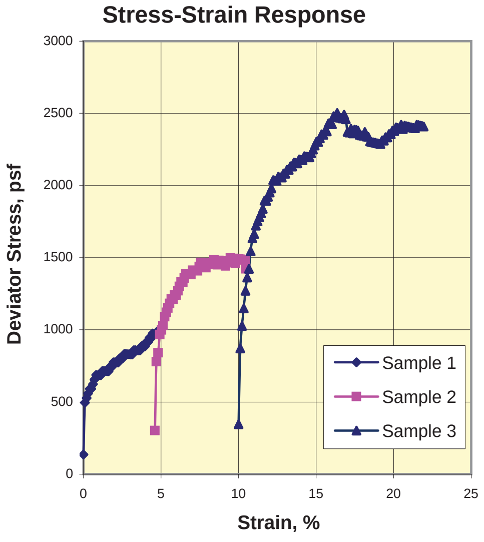
CONSOLIDATED - UNDRAINED TRIAXIAL COMPRESSION TEST

Date 08/25/09 | Project No. 4872.02 | Figure B-1

Triaxial Consolidated Undrained

(ASTM D4767 modified)





Sample:	1	2	3
MC, %	10.2		
Dry Dens., pcf.	123.8		
Sat. %	76.5		
Void Ratio	0.360		
Diameter in	2.38		
Height, in	5.00		
		Final	
MC, %	19.7	18.8	17.6
Dry Dens., pcf.	124.6	126.9	130.1
Sat. %	100.0	100.0	100.0
Void Ratio	0.532	0.509	0.475
Diameter, in	2.37	2.40	2.43
Height, in	5.00	4.78	4.55
Cell, psi	42.0	45.4	52.4
BP, psi	39.0	38.6	38.7
		Effective Stresses At:	
Strain, %	5.0	5.0	5.0
Deviator ksf	1.001	1.466	2.276
Excess PP	-0.043	0.202	0.576
Sigma 1	1.476	2.244	3.673
Sigma 3	0.475	0.778	1.397
P, ksf	0.976	1.511	2.535
Q, ksf	0.500	0.733	1.138
Stress Ratio	3.106	2.886	2.630
Rate in/min	0.001	0.001	0.001

Total C	**0.23**	**Effective C**	**0.08**
Total Phi	**17.3**	**Effective Phi**	**25.2**

Job No.: 010-1055 **Date:** 8/3/2009

Client: Treadwell & Rollo BY:DC

Project: Highland Estates - 4872.01

Sample: Pit 2;2 @ 15'Light Gray Sandy CLAY near Clayey SAND (Silty)

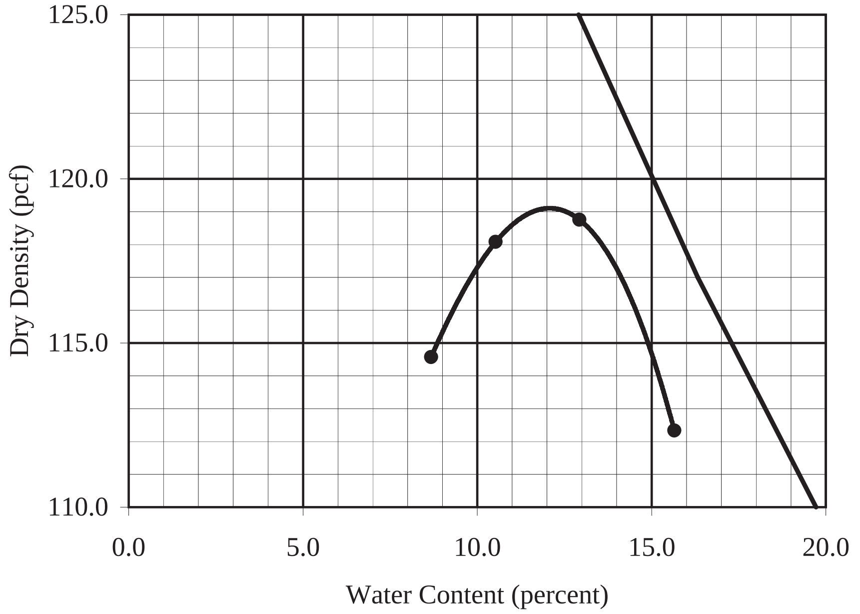
Remarks: ** Staged Test ** Strengths picked at 5% strain.
Remolding Target= 124 pcf @ 10%.

HIGHLAND ESTATES
San Mateo County, California

Treadwell&Rollo

CONSOLIDATED - UNDRAINED
TRIAXIAL COMPRESSION TEST

Date 08/25/09 | Project No. 4872.02 | Figure B-2



Sample Identification	Soil Data	Test Specifications
Bulk Sample No. 2 Tested 7/1/2009 by EKG	LL = ___ Gs (assumed) = 2.7 PI = ___ % > 3/4" sieve =	ASTM D 1557-91 Procedure A Hammer Weight: 10 lbs Hammer Drop: 18 in Number of Layers: 5 Blows per Layer: 25 Comp. Mold Size (ft^3) 0.033

Test Data

	1	2	3	4	5
Wt. Mold + Soil (lb)	13.54	13.74	13.86	13.72	
Wt. Mold (lb)	9.39	9.39	9.39	9.39	
Wet Wt. Soil + Dish (gm)	618.3	732.3	572.3	644.6	
Dry Wt. Soil + Dish (gm)	574.6	669.3	515.2	566.3	
Wt. Dish (gm)	71.0	71.0	73.7	66.1	
Dish ID Number	E-3	E-3	D-37	D-32	
Moisture Content (%)	8.7	10.5	12.9	15.7	
Dry Density (pcf)	114.6	118.1	118.8	112.3	

Soil Classification

Clayey Sand (SC), brown

Test Results

	Uncorrected	Rock Corrected
Maximum Dry Density (pcf)	119	-
Optimum Moisture Content (%)	12	-

Soil Source

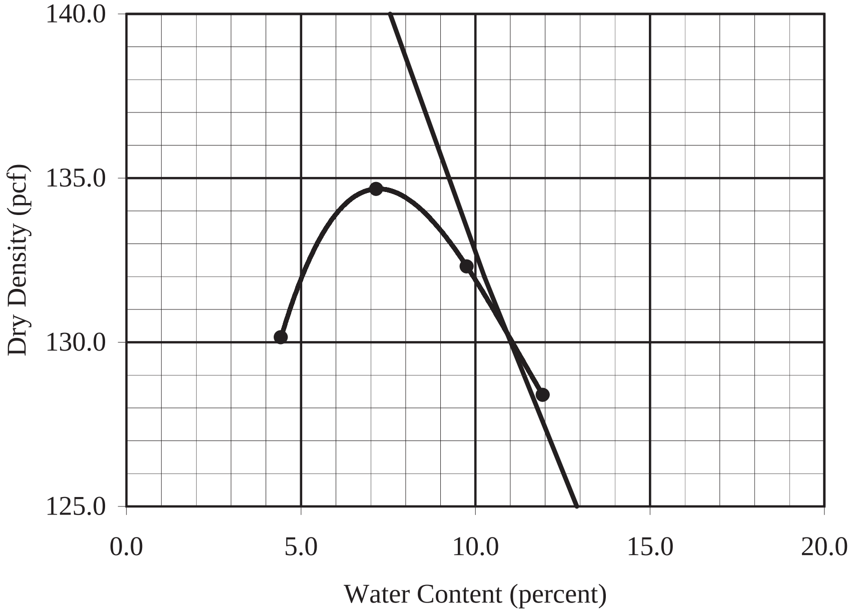
Test Pit 2, Lab Sample 1 (8')

HIGHLAND ESTATES
San Mateo County, California

Treadwell&Rollo

COMPACTION TEST RESULTS

Date 08/25/09 | Project No. 4872.02 | Figure B-3



Sample Identification	Soil Data	Test Specifications
Bulk Sample No. 1 Tested 7/1/2009 by EKG	LL = ___ Gs (assumed) = 2.7 PI = ___ % > 3/4" sieve =	ASTM D 1557-91 Procedure A Hammer Weight: 10 lbs Hammer Drop: 18 in Number of Layers: 5 Blows per Layer: 25 Comp. Mold Size (ft^3) 0.033

Test Data

	1	2	3	4	5
Wt. Mold + Soil (lb)	13.92	14.20	14.23	14.18	
Wt. Mold (lb)	9.39	9.39	9.39	9.39	
Wet Wt. Soil + Dish (gm)	639.2	609.2	820.6	725.3	
Dry Wt. Soil + Dish (gm)	615.3	573.2	754.1	657.3	
Wt. Dish (gm)	75.8	70.5	72.3	87.3	
Dish ID Number	D-30	D-33	D-38	D-11	
Moisture Content (%)	4.4	7.2	9.8	11.9	
Dry Density (pcf)	130.1	134.7	132.3	128.4	

Soil Classification

Sandy Clay with Rock Fragments (CL), gray

Test Results

	Uncorrected	Rock Corrected
Maximum Dry Density (pcf)	135	-
Optimum Moisture Content (%)	7	-

Soil Source

Test Pit 2, Lab Sample 2 (15')

HIGHLAND ESTATES
San Mateo County, California

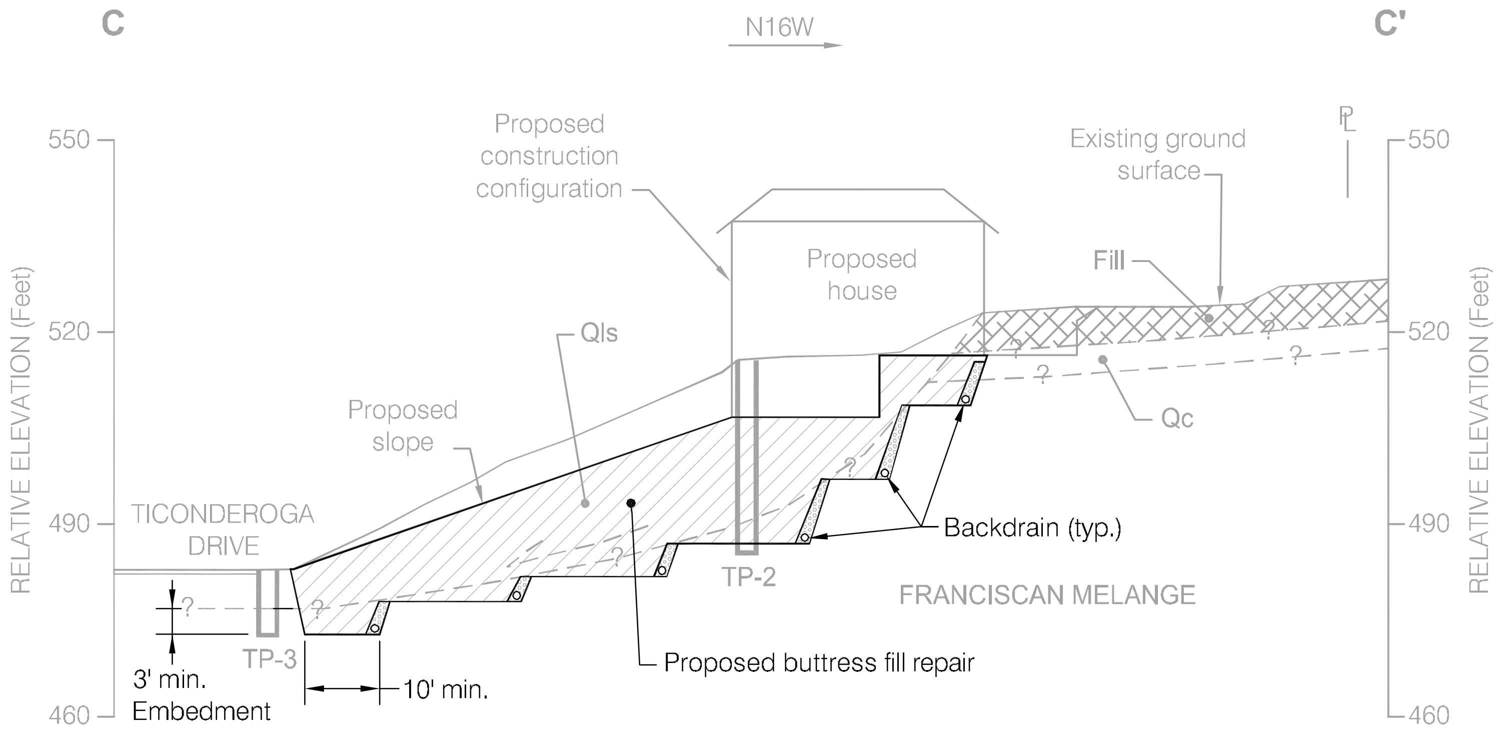
Treadwell&Rollo

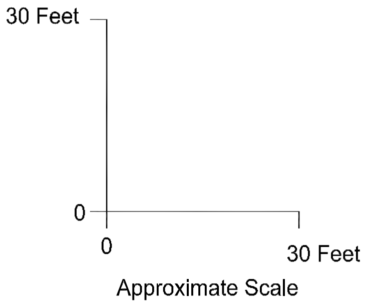
COMPACTION TEST RESULTS

Date 08/25/09	Project No. 4872.02	Figure B-4

APPENDIX C

Slope Stability Analysis Model and Results





Notes:

1. The above profile represents a generalized soil cross section interpreted from widely spaced test pits and borings. Soil deposits may vary in type, strength, and other important properties between points of exploration.

2. Cross-sections based on our site reconnaissance, topographic surveys by BKF Engineers, Inc., others.

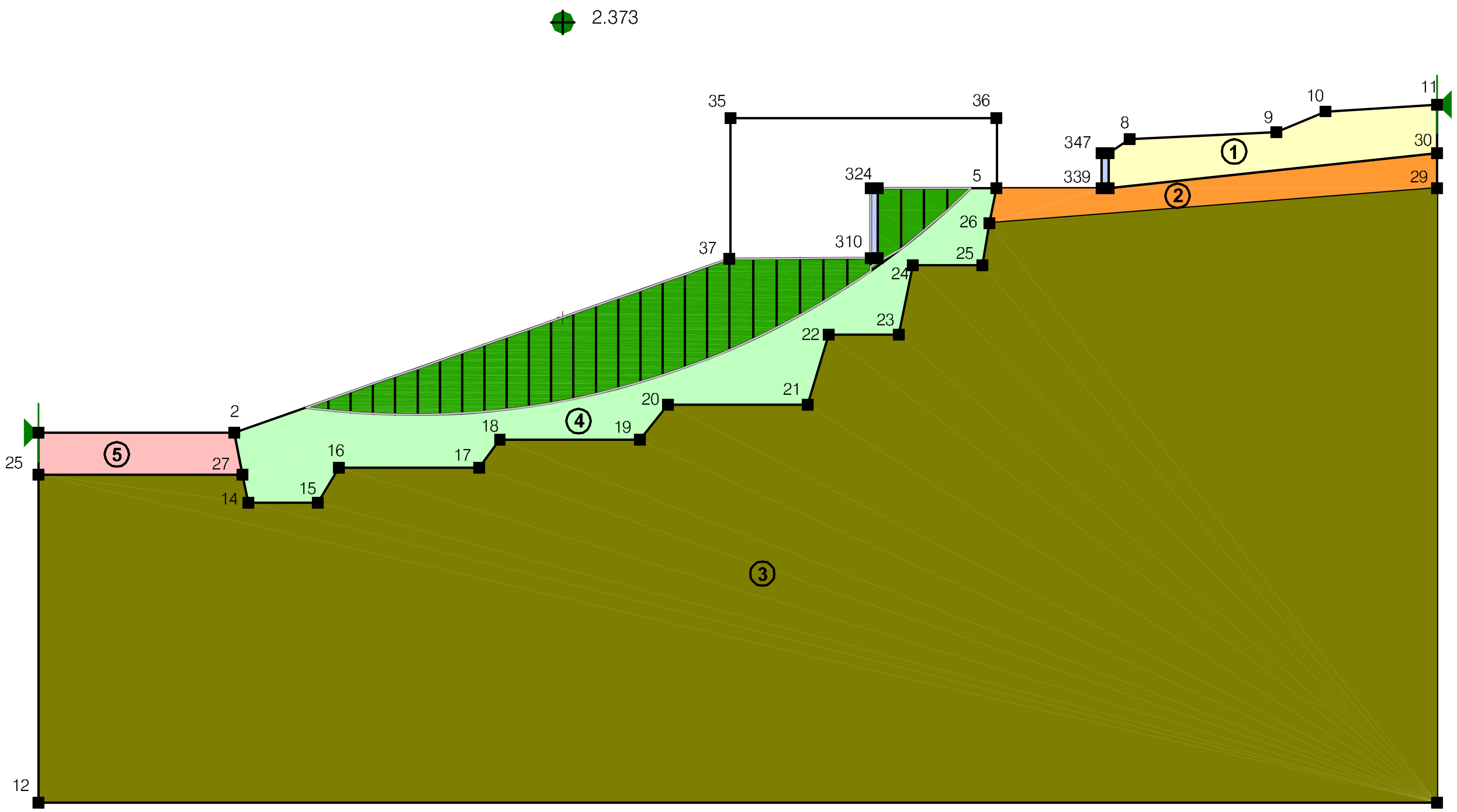
HIGHLAND ESTATES
San Mateo County, California

PROPOSED BUTTRESS FILL REPAIR
SUBSURFACE PROFILE

Date 08/18/09	Project No. 4872.02	Figure C-1

Treadwell&Rollo

R:\Trgraphics\4800's\4872.02\4872.02 Proposed Buttress Fill Repair Subsurface Profile.dwg 8/27/09



Material #: 1
Description: Existing Fill
Model: MohrCoulomb
Wt: 110
Cohesion: 500
Phi: 26

Material #: 2
Description: Colluvium
Model: MohrCoulomb
Wt: 120
Cohesion: 700
Phi: 22

Material #: 3
Description: Franciscan Melange
Model: MohrCoulomb
Wt: 135
Cohesion: 800
Phi: 22

Material #: 4
Description: Proposed Buttress Fill
Model: MohrCoulomb
Wt: 124
Cohesion: 60
Phi: 32.3

Material #: 5
Description: Landslide Deposits
Model: MohrCoulomb
Wt: 110
Cohesion: 700
Phi: 11

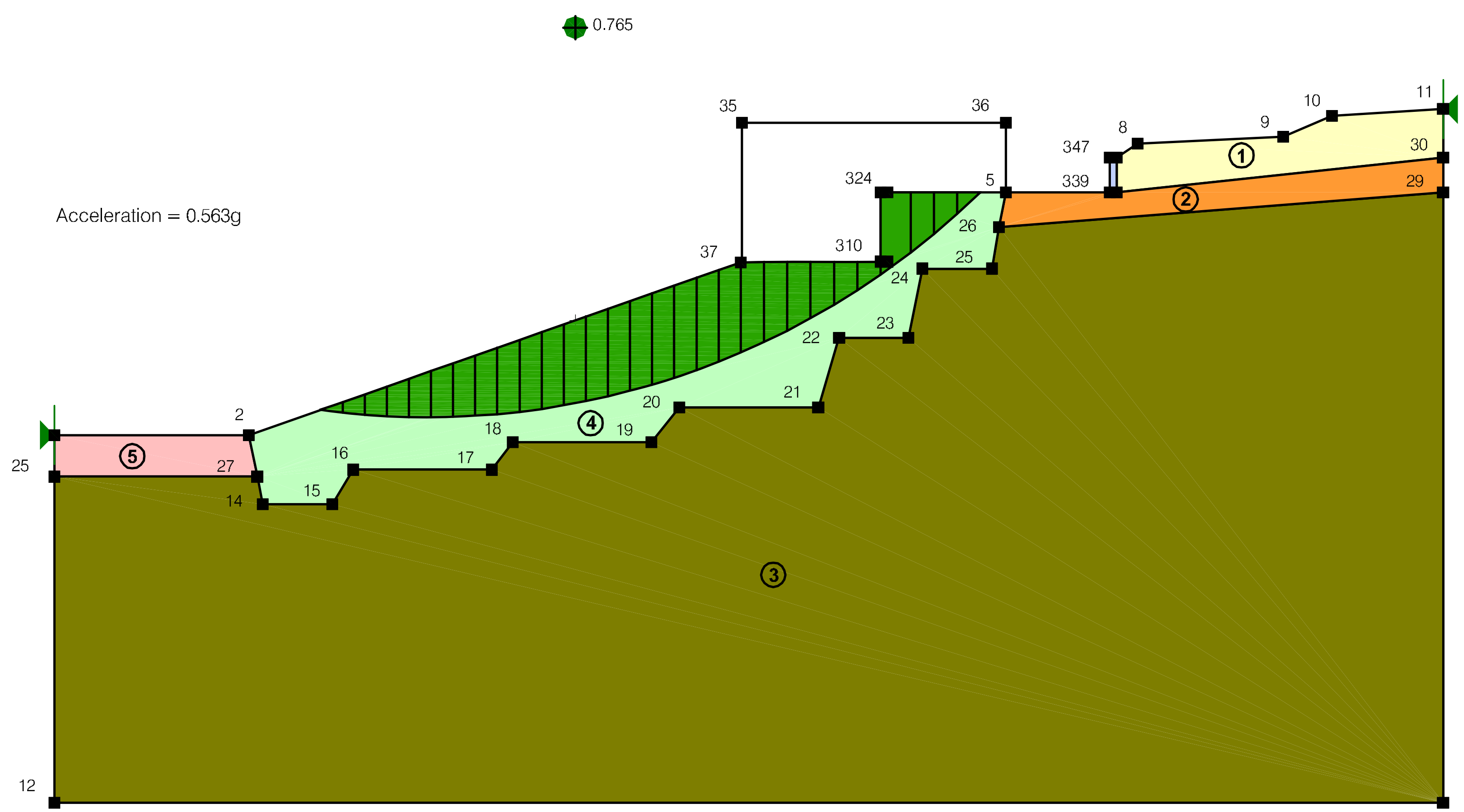
HIGHLAND ESTATES
San Mateo County, California

Treadwell&Rollo

STATIC SLOPE STABILITY ANALYSIS

Date 08/21/09	Project No. 4872.02	Figure C-2

R:\Trgraphics\4800's\4872.02\Appendix C\487202_ Slope Stability Analysis for Figure C-2_C-4.dwg 8/27/09



Material #: 1
Description: Existing Fill
Model: MohrCoulomb
Wt: 110
Cohesion: 500
Phi: 26

Material #: 2
Description: Colluvium
Model: MohrCoulomb
Wt: 120
Cohesion: 700
Phi: 22

Material #: 3
Description: Franciscan Melange
Model: MohrCoulomb
Wt: 135
Cohesion: 800
Phi: 22

Material #: 4
Description: Proposed Buttress Fill
Model: MohrCoulomb
Wt: 124
Cohesion: 60
Phi: 32.3

Material #: 5
Description: Landslide Deposits
Model: MohrCoulomb
Wt: 110
Cohesion: 700
Phi: 11

HIGHLAND ESTATES
San Mateo County, California

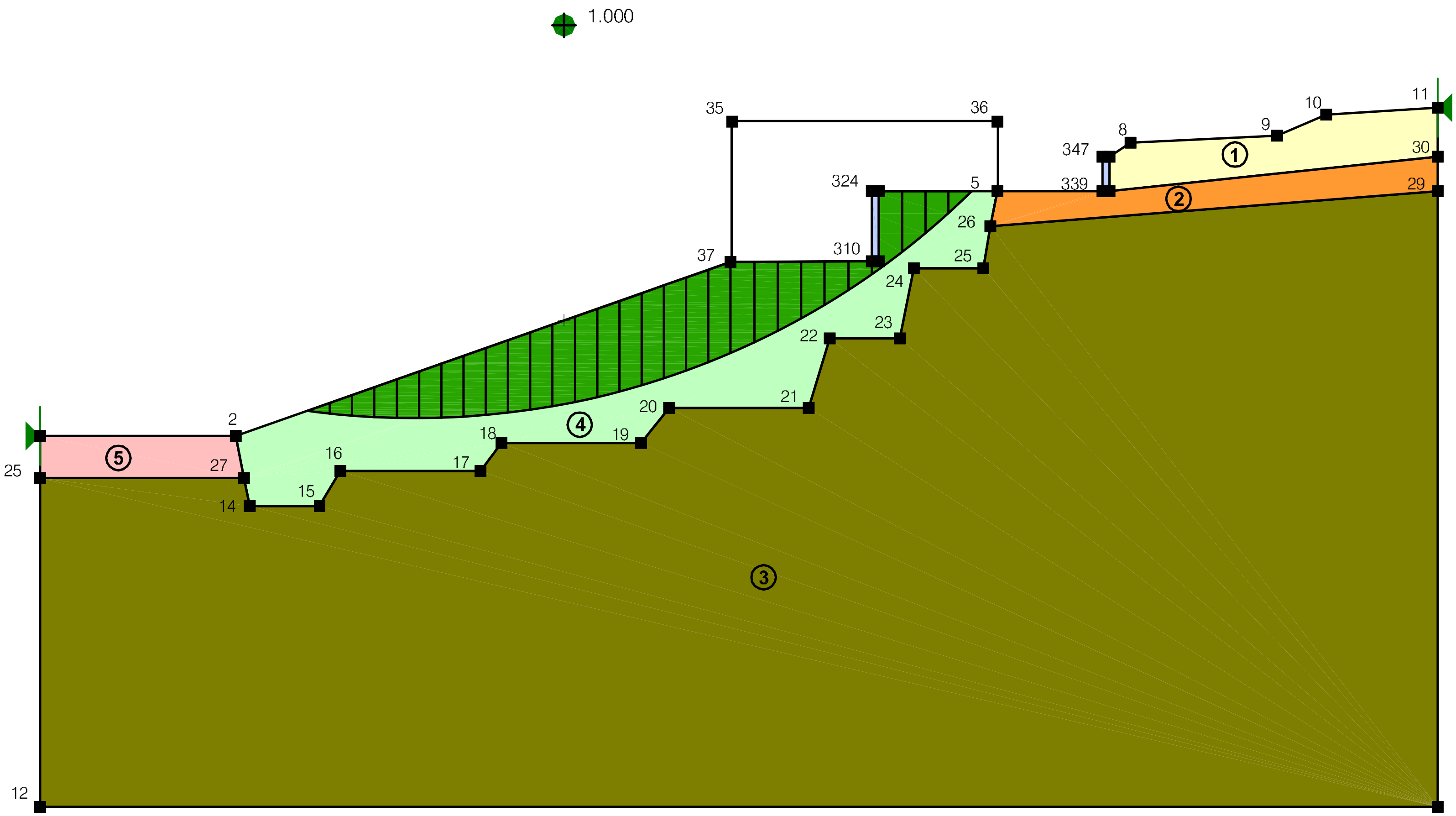
Treadwell&Rollo

PSEUDO-STATIC
SLOPE STABILITY ANALYSIS

Date 08/21/09	Project No. 4872.02	Figure C-3

R:\Trgraphics\4800's\4872.02\Appendix C\487202_ Slope Stability Analysis for Figure C−2_C−4.dwg 8/27/09

R:\Trgraphics\4800's\4872.02\Appendix C\487202_ Slope Stability Analysis for Figure C-2_C-4.dwg 8/27/09



Material #: 1
Description: Existing Fill
Model: MohrCoulomb
Wt: 110
Cohesion: 500
Phi: 26

Material #: 2
Description: Colluvium
Model: MohrCoulomb
Wt: 120
Cohesion: 700
Phi: 22

Material #: 3
Description: Franciscan Melange
Model: MohrCoulomb
Wt: 135
Cohesion: 800
Phi: 22

Material #: 4
Description: Proposed Buttress Fill
Model: MohrCoulomb
Wt: 124
Cohesion: 60
Phi: 32.3

Material #: 5
Description: Landslide Deposits
Model: MohrCoulomb
Wt: 110
Cohesion: 700
Phi: 11

HIGHLAND ESTATES
San Mateo County, California

Treadwell&Rollo

YIELD SLOPE STABILITY ANALYSIS

Date 08/21/09	Project No. 4872.02	Figure C-4

APPENDIX D

Selected Logs of Previous Investigation Test Borings and Pits

EXPLORATORY BORING: EB-1

Sheet 1 of 1

DRILL RIG: MINUTE MAN
BORING TYPE: 4 INCH FLIGHT AUGER
LOGGED BY: BM
START DATE: 3-9-05   FINISH DATE: 3-9-05

PROJECT NO: 1291-2B
PROJECT: TICONDEROGA DRIVE
LOCATION: SAN MATEO, CA
COMPLETION DEPTH: 20.0 FT.

This log is a part of a report by Lowney Associates, and should not be used as a stand-alone document. This description applies only to the location of the exploration at the time of drilling. Subsurface conditions may differ at other locations and may change at this location with time. The description presented is a simplification of actual conditions encountered. Transitions between soil types may be gradual.

ELEVATION (FT)	DEPTH (FT)	SOIL LEGEND	MATERIAL DESCRIPTION AND REMARKS SURFACE ELEVATION: 525 FT. (+/-)	SOIL TYPE	PENETRATION RESISTANCE (BLOWS/FT.)	SAMPLER	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	PERCENT PASSING NO. 200 SIEVE
525.0	0	▨	**LEAN CLAY WITH SAND (CL) [COLLUVIUM]** very stiff, moist, brown with reddish brown mottles, fine sand, some fine and coarse gravel, low plasticity	CL	17	⧓	14	101	
		▨			14	⧓	21	100	
519.8	5	▨	**LEAN CLAY (CL) [COLLUVIUM]** medium stiff to stiff, moist, gray, some fine and coarse gravel, moderate plasticity	CL					
517.0		⠿	**SANDSTONE [FRANCISCAN FORMATION (fsr)]** moderately to severely weathered, very soft, olive to brown		18	⧓	11	127	
	10	⠿							
		⠿		fsr	27	⧖	6		
	15	⠿							
		⠿	completely weathered, soft with hard seams, gray with bluish gray mottles		32	⧓	25	93	
505.0	20		Bottom of Boring at 20 feet						
	25								
	30								

GROUND WATER OBSERVATIONS:
NO FREE GROUND WATER ENCOUNTERED

LA CORP.GDT 2/2/06 MV* FLL

TRC Lowney

EXPLORATORY BORING: EB-2

Sheet 1 of 1

DRILL RIG: MINUTE MAN
BORING TYPE: 4 INCH FLIGHT AUGER
LOGGED BY: BM
START DATE: 3-8-05 FINISH DATE: 3-8-05

PROJECT NO: 1291-2B
PROJECT: TICONDEROGA DRIVE
LOCATION: SAN MATEO, CA
COMPLETION DEPTH: 20.0 FT.

This log is a part of a report by TRC Lowney, and should not be used as a stand-alone document. This description applies only to the location of the exploration at the time of drilling. Subsurface conditions may differ at other locations and may change at this location with time. The description presented is a simplification of actual conditions encountered. Transitions between soil types may be gradual.

Undrained Shear Strength (ksf)
○ Pocket Penetrometer
△ Torvane
● Unconfined Compression
▲ U-U Triaxial Compression

ELEVATION (FT)	DEPTH (FT)	SOIL LEGEND	MATERIAL DESCRIPTION AND REMARKS SURFACE ELEVATION: 524 FT. (+/-)	SOIL TYPE	PENETRATION RESISTANCE (BLOWS/FT.)	SAMPLER	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	PERCENT PASSING NO. 200 SIEVE	Undrained Shear Strength (ksf) 1.0 2.0 3.0 4.0
524.0	0	▨	LEAN CLAY WITH SAND (CL) [LANDSLIDE DEPOSIT] stiff, moist to wet, brown, fine sand, some fine and coarse gravel, low plasticity	CL	8	⧗				○
							21	90		
	5				9	⧗	22			○
517.0			SANDSTONE [FRANCISCAN FORMATION (fsr)] moderately to severely weathered, soft, dark brown, friable, some clay seams	fsr	50/6"	⧗	5	113		
	10									
					24	⊠	7			
	15									
					19	⊠				
			Plasticity Index = 13, Liquid Limit = 29		47	⊠	10			
504.0	20		Bottom of Boring at 20 feet							
	25									
	30									

GROUND WATER OBSERVATIONS:
NO FREE GROUND WATER ENCOUNTERED

TRC Lowney

EXPLORATORY BORING: EB-3

Sheet 1 of 1

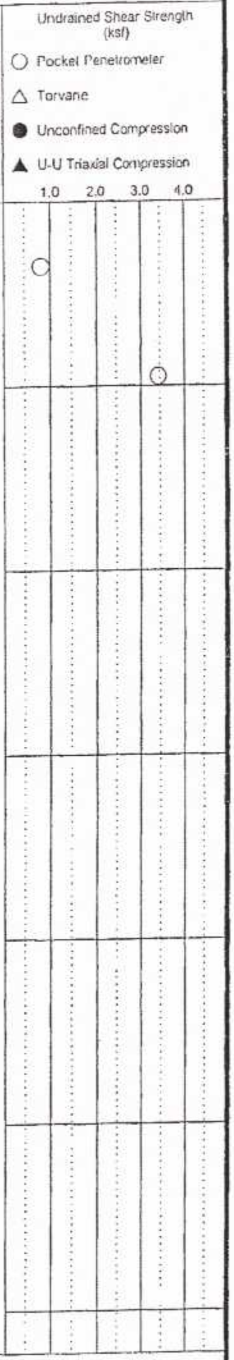
DRILL RIG: MINUTE MAN
BORING TYPE: 4 INCH FLIGHT AUGER
LOGGED BY: BM
START DATE: 3-8-05 FINISH DATE: 3-8-05

PROJECT NO: 1291-2B
PROJECT: TICONDEROGA DRIVE
LOCATION: SAN MATEO, CA
COMPLETION DEPTH: 20.0 FT.

This log is a part of a report by Lowney Associates, and should not be used as a stand-alone document. This description applies only to the location of the exploration at the time of drilling. Subsurface conditions may differ at other locations and may change at this location with time. The description presented is a simplification of actual conditions encountered. Transitions between soil types may be gradual.

SURFACE ELEVATION: 500 FT. (+/-)

ELEVATION (FT)	DEPTH (FT)	MATERIAL DESCRIPTION AND REMARKS	SOIL TYPE	PENETRATION RESISTANCE (BLOWS/FT.)	SAMPLER	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	PERCENT PASSING NO. 200 SIEVE
500.0	0	**LEAN CLAY WITH SAND (CL) [LANDSLIDE DEPOSIT]** medium stiff, moist to wet, brown, fine sand, some fine and coarse gravel, trace organics, low plasticity	CL	13		20	100	
496.5		**SANDY LEAN CLAY (CL) [COLLUVIUM]** very stiff, moist, gray, fine to coarse sand, some fine and coarse gravel, low plasticity	CL	24		13	113	
	5							
491.5		**SANDSTONE [FRANCISCAN FORMATION (fsr)]** moderate to severely weathered, soft, dark brown, friable, some fine sand	fsr	50/3"		6	124	
	10			49				
				59		8		
				32				
	15	increasing clay						
		abruptly severely weathered silty yellowish olive graywacke		55		3		
480.0	20	Bottom of Boring at 20 feet						
	25							
	30							

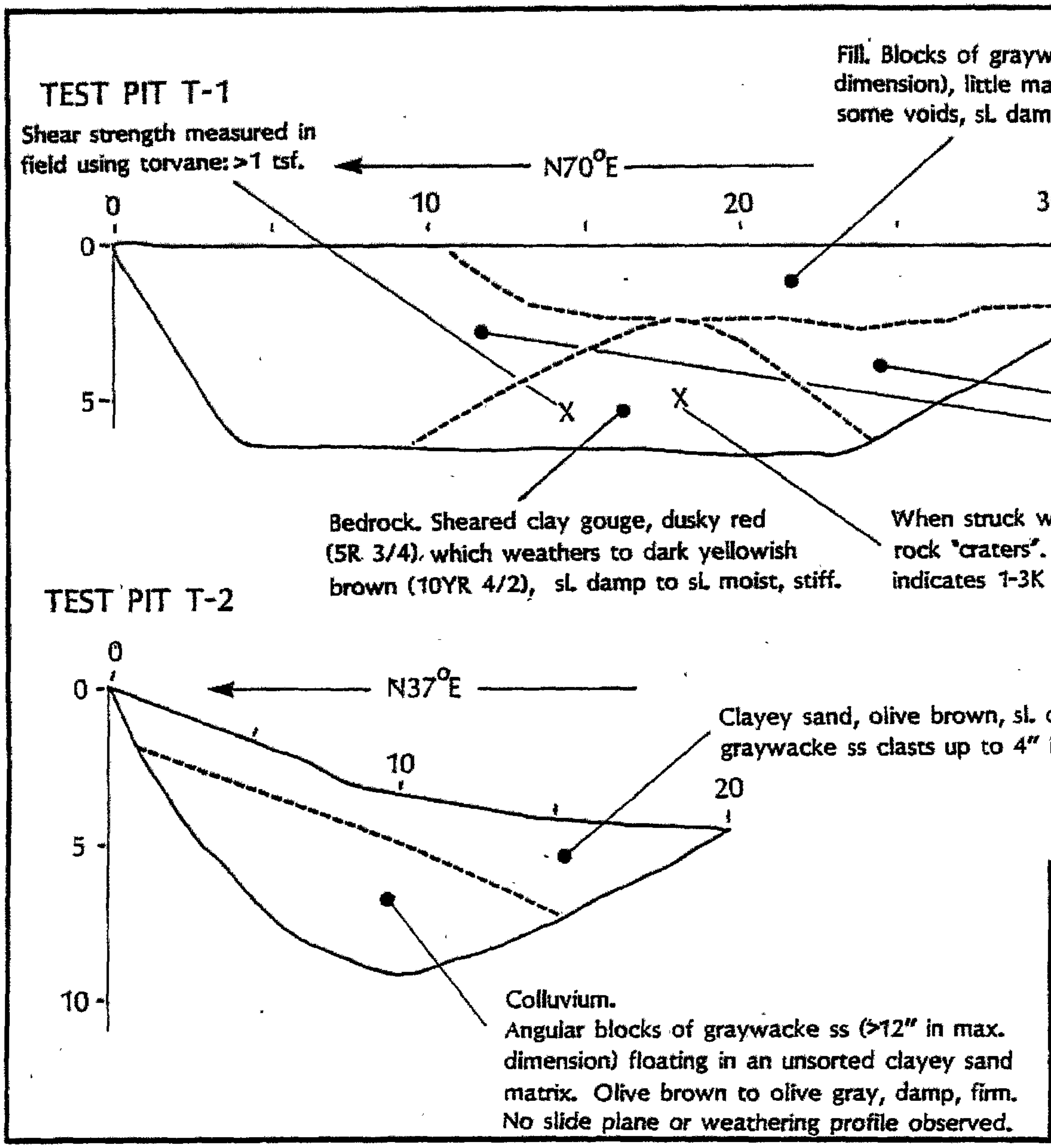


GROUND WATER OBSERVATIONS:
NO FREE GROUND WATER ENCOUNTERED

LA CORP.GDT 2/2/06 MV' FLL

File No. S22-634-2
July 20, 1993

Plate 4 - Logs of Test Pits: T-1 & T-2



Shear strength measured in field using torvane: >1 tsf.

Fill. Blocks of graywacke ss (to 6" in max. dimension), little matrix, no soil profile, some voids, sl. damp, loose to firm.

Colluvium. Blocks of graywacke ss (to 18" in max. dimension) floating in an unsorted matrix of sandy clay. Unstratified. Roots to floor on trench.

Bedrock. Sheared clay gouge, dusky red (5R 3/4), which weathers to dark yellowish brown (10YR 4/2), sl. damp to sl. moist, stiff.

When struck with 16 oz. ball peen hammar, rock "craters". This field test for strength indicates 1-3K psi (approx).

Clayey sand, olive brown, sl. damp, loose. Contains graywacke ss clasts up to 4" in max. dimension.

Colluvium.
Angular blocks of graywacke ss (>12" in max. dimension) floating in an unsorted clayey sand matrix. Olive brown to olive gray, damp, firm. No slide plane or weathering profile observed.

Logged by Darwin Myers, C.E.G. 946

LOG OF TEST PITS T-1 & T-2

SCALE:	FIGURE:
DATE:	

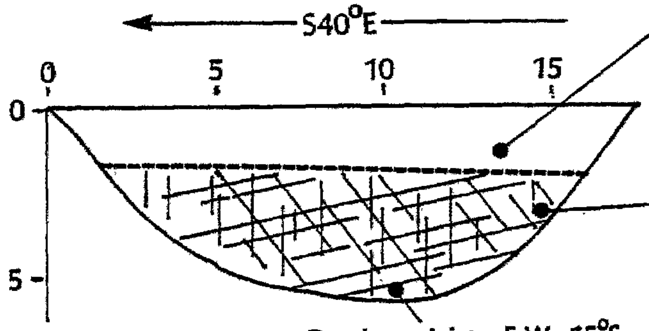
SOIL FOUNDATION SYSTEMS INC.

JOB NUMBER:

SOIL FOUNDATION SYSTEMS, INC.

File No. S22-634-2
July 20, 1993

TEST PIT T-3

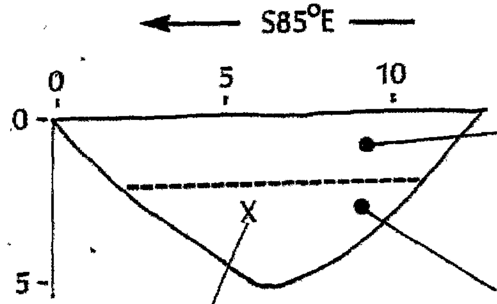


Top Soil.
Clayey silt with small angular clasts of graywacke sandstone. Dark yellowish brown (10YR 2/2), sl. damp, unstratified, loose.

Bedrock.
Massive graywacke sandstone, slightly weathered, light olive gray (5Y 5/2), joints typically spaced at 6" to 12", spheroidal weathering habit, very hard to rip.

Dominant joints: E-W, 15°S
S15W, 60°W
N50W, vertical

TEST PIT T-4



Top Soil.
Clayey sand with small angular fragments of graywacke ss, dark yellowish brown (10YR 2/2), sl. damp, loose to firm.

Bedrock.
Graywacke sandstone, fine- to med.-grained, joints spaced at 3" to 3', very hard to rip.

When struck with 16 oz. ball peen hammar, rock pits.
This field test for strength indicates 8-15K psi (approx.).

Logged by Darwin Myers, C.E.G. 946

LOG OF TEST PITS T-3 & T-4	
SCALE:	FIGURE:
DATE:	
SOIL FOUNDATION SYSTEMS INC.	
JOB NUMBER:	

Plate 5 - Logs of Test Pits: T-3 & T-4

SOIL FOUNDATION SYSTEMS, INC.

File S22-634-2
July 20, 1993

EXPLORATORY BORING LOG						LABORATORY TESTS							
Sample Number	Depth, feet	Boring Log	Unified Soil Classification System Symbols	Description	Standard Penetration Test, blows/foot	Moisture Content, %	Dry Density, p. c. f.	Unconfined Compressive Strength, k. s. f.	Direct Shear Test		Liquid Limit, %	Plasticity Index, %	Triaxial Compression
									"C", k. s. f.	"ϕ", degrees			
				Boring No. B-1		Date of Drilling: 7/16/92							
	2 4			Colluvium, clayey Silt, rust-brown, with angular sandstone fragments to 6" (Q_c)									
1-1	6 8			sandy, stiff, poorly sorted, unstratified	*77	11.0	116.3	10.0	@ 2% strain				
1-2	10 12 14			Siltstone breccia, sev. weathered. lt. to med. gray-brown, soft (stiff clayey Silt) - F_m	*46	12.5 13.0	113.7 123.9	9.0	@ 4% strain				x
1-3				mottled with gray caliche mod. weathered	*100	11.4	124.6	10.0	@ 3% strain				
				Bottom at 16 feet									
			Notes:	1) * denotes penetration resistance of 2½-inch I.D. sampler. 2) Direct shear test data in ( ) are for residual strength.									
				Boring No. B-2		Date of Drilling: 7/16/92							
	2 4			Colluvium, clayey Silt, rust-brown, with sandstone fragments - Q_c varved with olive brown sandy clay & maroon mudstone									
2-1	6 8			Clay/Siltstone breccia, severely weathered, olive gray, fragments showing preferred orientation, fractures "healed" with caliche	*73	10.8	113.0		1.0 (0.2	7 21)			
2-2	10 12			(F_m)	*100+	8.0	126.0	8.0	@ 2% strain				
				Bottom at 13 feet									

Plate 6 - Logs of Test Borings: B-1 & B-2

SOIL FOUNDATION SYSTEMS, INC.

File No. S22-634-2
July 20, 1993

EXPLORATORY BORING LOG						LABORATORY TESTS								
Sample Number	Depth, feet	Boring Log	Unified Soil Classification System Symbols	Description	Standard Penetration Test, blows/foot	Moisture Content, %	Dry Density, p.c.f.	Unconfined Compressive Strength, k.s.f.	Direct Shear Test "c", k.s.f.	Direct Shear Test "φ", degrees	Liquid Limit, %	Plasticity Index, %		
				Boring No. B-3		Date of Drilling: 7/20/92								
	2			clayey Silt, lt. gray-brown, loose										
3-1	4 6 8 10			Colluvium, clayey sandy Silt with SS fragments to 6" (poor sample) (Q_c)	*50/1"	13.2	-							
3-2	12 14			sheared Siltstone breccia, med. gray to olive gray, sl. damp, hard (F_m) moderately weathered	*50/2"	7.7	-							
				Bottom at 16'										

Plate 7 - Log of Test Boring: B-3

SOIL FOUNDATION SYSTEMS, INC.

EXPLORATORY BORING LOG						LABORATORY TESTS								
Sample Number	Depth, feet	Boring Log	Unified Soil Classification System Symbols	Description	Standard Penetration Test, blows/foot	Moisture Content, %	Dry Density, p. c. f.	Unconfined Compressive Strength, k. s. f.	Direct Shear Test "C", k. s. f.	Direct Shear Test "φ", degrees	Liquid Limit, %	Plasticity Index, %	Triaxial Compression	Swell/Compaction
				Boring No. B-4		Date of Drilling: 7/20/92								
4-A	2 4			sandy clayey Silt, tan-brown, sl. damp		13.5	107.0		2.0	8	33	6		x
									(UBC Swell Index: 9)					
4-1	6 8			sheared Siltstone, yellowish lt. green, sl. damp (F_m)	*85	(sample not recovered)								
4-2	10 12			Greywacke Sandstone, moderately weathered, med. brown, fine to med. grained	*100+	11.2	118.2						x	
	14			(S_s)										
4-3	16 18			massive, very hard	* 50/3"									
				Bottom at 20 feet										

Note: * denotes penetration resistance of 2½-inch I.D. sampler.

Data underlined are for recompacted samples.

				Boring No. B-5		Date of Drilling: 7/20/92								
	2 4			Colluvium, clayey Silt with angular 2" to 10" Sandstone talus (Q_c) very rocky										
				Bottom at 5 feet										

SOIL FOUNDATION SYSTEMS, INC.

Plate 8 - Logs of Test Borings: B-4 & B-5

File No. S22-634-2
July 20, 1993

EXPLORATORY BORING LOG						LABORATORY TESTS								
Sample Number	Depth, feet	Boring Log	Unified Soil Classification System Symbols	Description	Standard Penetration Test, blows/foot	Moisture Content, %	Dry Density, p. c. f.	Unconfined Compressive Strength, k. s. f.	Direct Shear Test "c", k. s. f.	Direct Shear Test "φ", degrees	Liquid Limit, %	Plasticity Index, %	Triaxial Compression	
				Boring No. B-6		Date of Drilling: 7/20/92								
	2 4 6			Fill, clayey Silt, dark brown-gray (Q_{af})										
6-1	8			mottled with med. gray clay & SS inclusions	*43	16.5	119.4		1.2	15				
	10			Shale/Siltstone clay gouge, purple tinted gray-brown cuttings, damp, hard										
6-2	12 14			Claystone, sandy, purple blue, becoming blue-gray (F_m)	*51	11.1	123.2						x	
	16			becoming blocky, slightly weathered										
				Bottom at 17 feet										
				Boring No. B-7		Date of Drilling: 7/20/92								
	2			Colluvium, sandy clayey Silt, tan-brown, sl. damp, loose										
	4 6			Siltstone, moderately weathered, pale yellowish brown, sheared, damp, soft (stiff clayey Silt)										
7-1	8 10			(F_m)	*50/5"	11.5	106.3							
	12 14			Graywacke Sandstone, sl. weathered, sl. damp, hard (S_s)										
				Bottom at 15 feet										

Plate 9 - Logs of Test Borings: B-6 & B-7

SOIL FOUNDATION SYSTEMS, INC.

File No. S22-634-2
July 20, 1993

EXPLORATORY BORING LOG						LABORATORY TESTS							
Sample Number	Depth, feet	Boring Log	Unified Soil Classification System Symbols	Description	Standard Penetration Test, blows/foot	Moisture Content, %	Dry Density, p.c.f.	Unconfined Compressive Strength, k.s.f.	Direct Shear Test		Liquid Limit, %	Plasticity Index, %	
									"C", k.s.f.	"φ", degrees			
				Boring No. B-8		Date of Drilling: 7/24/92							
				Colluvium, clayey Silt, med. brown-gray									
	2 4			silty Clay, purple-brown, with angular sandstone fragments (Q_c)									
	6 8			Sandstone, severely weathered, sandy Silt, orange brown (S_s)									
	10			becoming hard at 10'									
				Bottom at 12 feet Note: This hole was drilled with a portable rig									

SOIL FOUNDATION SYSTEMS, INC.

Plate 10- Log of Test Boring: B-8

File No. S22-634-2
July 20, 1993

EXPLORATORY BORING LOG						LABORATORY TESTS								
Sample Number	Depth, feet	Boring Log	Unified Soil Classification System Symbols	Description	Standard Penetration Test, blows/foot	Moisture Content, %	Dry Density, p. c. f.	Unconfined Compressive Strength, k. s. f.	Direct Shear Test "C", k. s. f.	Direct Shear Test "φ", degrees	Liquid Limit, %	Plasticity Index, %	Consolidation Test	
				Boring No. B-9		Date of Drilling: 7/16/92								
	2		ML	clayey Silt, lt. to med. brown, sl. damp, soft to firm										
	4													
9-1	6		ML	(poor sample) Alluvium, clayey Silt with rock fragments, dark brown, moderately moist, firm (Qa)	* 17	14.7								
	8													
9-2	12				* 30	22.0	106.9		0.65	5			x	
	14			Alluvium, sandy Silt with Sandstone fragments, lt. to med. brown, moist										
	16													
9-3	18		SM	(Qa)	* 43	16.9	112.9		0.7 (0.7	21 5)			x	
	20													
9-4	22			with fine sand laminae	* 85	11.0	127.2	6.0	@ 4%	strain				
				Sandstone, weathered, hard										

Bottom at 24 feet

Notes:

1) * denotes penetration resisitance of 2½-inch I.D. sampler.
2) Direct shear test data ( ) are for residual strength.

Plate 11 - Log of Test Boring: B-9

SOIL FOUNDATION SYSTEMS, INC.

File No. S22-634-2
July 20, 1993

EXPLORATORY BORING LOG						LABORATORY TESTS							
Sample Number	Depth, feet	Boring Log	Unified Soil Classification System Symbols	Description	Standard Penetration Test, blows/foot	Moisture Content, %	Dry Density, p. c. f.	Unconfined Compressive Strength, k. s. f.	Direct Shear Test "c", k. s. f.	Direct Shear Test "ϕ", degrees	Liquid Limit, %	Plasticity Index, %	
				Boring No. B-10		Date of Drilling: 7/21/92							
	2			Alluvium, clayey Silt, dark to med. brown									
	4		ML	becoming stiff, moist									
	6			(Qa)									
	8												
	10												
	12			Sandstone, sev. weathered, sandy Clay, tan-brown (Ss)									
	14			moderately weathered		Note: this hole was drilled using a backhoe-mounted rig							
				Bottom at 16 feet									
				Boring No. B-11		Date of Drilling: 7/21/92							
	2		ML	Alluvium, clayey Silt, med. brown, with angular rock fragments									
	4			(Qa)									
	6												
	8			clayey Sand, tan to rust-brown, sl. damp									
	10												
	12			Graywacke Sandstone, severely weathered, tan to olive brown, poorly sorted (Ss)		Note: this hole was drilled using a backhoe-mounted rig							
	14			becoming hard, fractured									
				Bottom at 15 feet									

Plate 12 - Log of Test Borings: B-10 & B-11

SOIL FOUNDATION SYSTEMS, INC

File No. S22-634-2
July 20, 1993

EXPLORATORY BORING LOG						LABORATORY TESTS								
Sample Number	Depth, feet	Boring Log	Unified Soil Classification System Symbols	Description	Standard Penetration Test, blows/foot	Moisture Content, %	Dry Density, p.c.f.	Unconfined Compressive Strength, k.s.f.	Direct Shear Test "C", k.s.f.	Direct Shear Test "ϕ", degrees	Liquid Limit, %	Plasticity Index, %		
				Boring No. B-12		Date of Drilling: 7/17/92								
	2 4		ML	Alluvium, clayey Silt, lt. brown, with fine angular rock fragments, damp, firm (Qa) cobble at 4'										
12-1	6			Alluvium, sandy Clay, red-brown, stiff (Qa)	* 34	15.0	111.4		0.7	10				
	8			Graywacke Sandstone, sev. weathered, yellowish orange-brown (Ss)										
				Bottom at 10'										
				Boring No. B-13		Date of Drilling: 7/21/92								
				clayey Silt, med. brown, damp, firm										
	2 4		ML	Alluvium, sandy Clay, rust-brown, sl. moist, stiff (Qa) .										
	6 8 10 12			Sandstone, severely weathered, fine to med. grained, light brown (Ss)										
				mod. weathered, tan-brown										
				Bottom at 14' Note: this hole drilled using backhoe-mounted rig										

Plate 13 - Logs of Test Borings: B-12 & B-13

SOIL FOUNDATION SYSTEMS, INC.

File No. S22-634-2
July 20, 1993

EXPLORATORY BORING LOG						LABORATORY TESTS								
Sample Number	Depth, feet	Boring Log	Unified Soil Classification System Symbols	Description	Standard Penetration Test, blows/foot	Moisture Content, %	Dry Density, p. c. f.	Unconfined Compressive Strength, k. s. f.	Direct Shear Test "c", k. s. f.	Direct Shear Test "φ", degrees	Liquid Limit, %	Plasticity Index, %		
				Boring No. B-14		Date of Drilling: 7/30/92								
				▼ (W/L: 17:30, 7/30/92) Silty Clay, black										
	2			sheared Serpentine, sev. weathered, blue-gray, moist (poor sample)										
14-1	4				**18	13.4	-				34	12		
	6			(Sp)										
	8			Clay gouge zone										
14-2	10			sheared Serpentine, sl. damp (Sp)	**27	11.8								
	12													
	14			massive, blocky										
	16			Note: ** denotes penetration resistance of Standard penentrometer driven with a 70-pound hammer dropping a distance of 30 inches.										
	18			Note: this hole drilled with portable rig										
				Bottom at 19 feet										
				Boring No. B-15		Date of Drilling: 7/24/92								
				clayey Silt, dark brown to black, damp, sl. organic										
	2			Serpentine, very severely to severely weathered, silty Clay, pale green-gray, with angular fragments (Sp)										
	4													
	6			very hard at 7'										
				Bottom at 8 feet Note: this hole drilled with portable rig										

Plate 14 - Logs of Test Borings: B-14 & B-15

SOIL FOUNDATION SYSTEMS, INC.

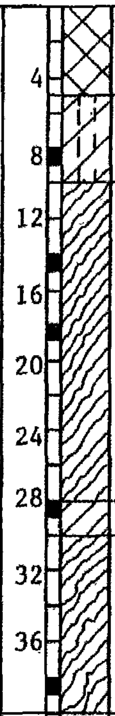
File No. S22-634-2
July 20, 1993

EXPLORATORY BORING LOG						LABORATORY TESTS								
Sample Number	Depth, feet	Boring Log	Unified Soil Classification System Symbols	Description	Standard Penetration Test, blows/foot	Moisture Content, %	Dry Density, p. c. f.	Unconfined Compressive Strength, k. s. f.	Direct Shear Test "c", k. s. f.	Direct Shear Test "φ", degrees	Liquid Limit, %	Plasticity Index, %		
				Boring No. B-16		Date of Drilling: 7/30/92								
				silty Clay, dark brown										
	2			sl. organic										
				▼ (W/L: 11:00; 7/30/92)										
	4			sheared Serpentine, very severely weathered, silty										
16-1	6			Clay with serpentine fragments, pale green-gray ***	10	28.6	95.9		0.4	25				
	8													
	10			(Sp)										
16-2	12			***	22	11.8	107.3		0.5	38				
	14													
	16			becoming hard										
	18													
16-3				(Sample not recovered)***	18									
				Bottom at 20 feet										

Note: *** denotes penetration resistance of 2-½ I.D. sampler driven with a 70-pound hammer dropping a distance of 30 inches.

Note: This hole drilled with a portable rig

File No. S22-634-2
July 20, 1993



EXPLORATORY BORING LOG						LABORATORY TESTS								
Sample Number	Depth, feet	Boring Log	Unified Soil Classification System Symbols	Description	Standard Penetration Test, blows/foot	Moisture Content, %	Dry Density, p.c.f.	Unconfined Compressive Strength, k.s.f.	Direct Shear Test "C", k.s.f.	Direct Shear Test "φ", degrees	Liquid Limit, %	Plasticity Index, %	Triaxial Compression	
				Boring No. B-17		Date of Drilling: 7/20/92								
	4			Fill, silty Clay, dark brown to green-black ▼ (W/L: 16:00; 7/20/92)										
17-1	8			Serpentine, very severely weathered	*83	11.6	126.1						x	
				▼ (W/L: 10:00; 7/20/92)										
	12													
17-2				sheared Serpentine, mod. weathered, blue-gray, moist	*25	11.8	132.5						x	
	16													
17-3				(Sp)	*48	9.5	129.9				20	4	x	
	20													
	24													
17-4	28			Clay gouge zone	*40	11.4	120.5							
	32			sheared Serpentine, sl. weathered, dark gray, sl. damp										
	36			(stiff silty Clay with serpentine fragments)										
17-5					*100+	10.4	122.3							
				Bottom at 42 feet										

Note: * denotes penertation resistance of 2½-inch I.D. sampler driven with a 140-pound hammoer dropping a distance of 30 inches.

Plate 16 - Log of Test Boring: B-17

SOIL FOUNDATION SYSTEMS, INC.

File No. S22-634-2
July 20, 1993

EXPLORATORY BORING LOG						LABORATORY TESTS								
Sample Number	Depth, feet	Boring Log	Unified Soil Classification System Symbols	Description	Standard Penetration Test, blows/foot	Moisture Content, %	Dry Density, p.c.f.	Unconfined Compressive Strength, k.s.f.	Direct Shear Test "c", k.s.f.	Direct Shear Test "ɸ", degrees	Liquid Limit, %	Plasticity Index, %		
				Boring No. B-18		Date of Drilling: 7/17/92								
	2			clayey Silt, dark gray, soft to firm, damp (Qc)										
	4													
18-1	6			Serpentine, severely weathered, greenish lt. gray, sl. damp hard at 7' (Sp)	* 23	3.0	127.9							
				Bottom at 7½ feet										
				Boring No. B-18A		Date of Drilling: 7/17/92								
	2			clayey Silt, dark gray, soft to firm, damp										
	4													
	6			Serpentine, severely weathered, lt. olive gray, damp, (stiff silty Clay)										
	8			(Sp)										
	10													
	12			moderately weathered, sl. damp										
	14													
18-2					* 38/2"									
				Bottom at 16 feet										

Plate 17 - Logs of Test Borings: B18 & B-18A

SOIL FOUNDATION SYSTEMS, INC.

File No. S22-634-2
July 20, 1993

EXPLORATORY BORING LOG						LABORATORY TESTS								
Sample Number	Depth, feet	Boring Log	Unified Soil Classification System Symbols	Description	Standard Penetration Test, blows/foot	Moisture Content, %	Dry Density, p.c.f.	Unconfined Compressive Strength, k.s.f.	Direct Shear Test "C", k.s.f.	Direct Shear Test "φ", degrees	Liquid Limit, %	Plasticity Index, %		
				Boring No. B-19		Date of Drilling: 7/17/92								
				clayey Silt, lt. brown, damp, moderately stiff										
	2			Serpentine, very severely weathered, lt. gray-green, with yellow-brown sandstone										
	4													
19-1				inclusions (Sp)	* 70/9"									
	6			Graywacke Sandstone, lt. gray-brown, moderately to severely weathered		12.7	115.0	5.0 @ 3 % strain						
	8													
	10			(Ss)										
	12													
	14													
19-2				poorly sorted, highly indurated	* 15/2"									
				Bottom at 16 feet										

Note: * denotes penetration resistance of 2½-inch I.D. sampler driven with a 140-pound hammer dripping a distance of 30".

Plate 18 - Log of Test Boring: B-19

SOIL FOUNDATION SYSTEMS, INC.

File No. S22-634-2
July 20, 1993

EXPLORATORY BORING LOG						LABORATORY TESTS								
Sample Number	Depth, feet	Boring Log	Unified Soil Classification System Symbols	Description	Standard Penetration Test, blows/foot	Moisture Content, %	Dry Density, p. c. f.	Unconfined Compressive Strength, k. s. f.	Direct Shear Test		Liquid Limit, %	Plasticity Index, %		
									"C", k. s. f.	"ϕ", degrees				
				Boring No. B-20		Date of Drilling: 7/17/92								
	4			clayey Silt & angular Sandstone cobbles & fragments										
	8			Clay/Siltstone breccia, very severely weathered, stiff silty Clay, med. gray, with olive brown sandstone fragments to 2" (Fm)		8.2	126.3							
20-1	12				*47	10.9	114.4	3.0	@ 4% strain					
20-2	16			Clay/Siltstone breccia, moderately weathered, grayish purple, contains olive brown sandstone fragments (Fm)	*100+	11.2	115.6		0.4	10	disturbed sample			
						11.0	122.7		(0.4	0)				
20-3	20				*100+	6.4	128.2							
	24													
	28													
	32			Graywacke Sandstone, moderately weathered, olive brown, hard, massive (Ss)										
	36													

Bottom at 38 feet

Notes:

1) * denotes penetration resistance of 2½-inch I. D. sampler driven with a 140-pound hammer dropping a distance of 30".
2) Direct shear test data in ( ) are for residual strength.

SOIL FOUNDATION SYSTEMS, INC.

Plate 19 - Log of Test Boring: B-20

File No. S22-634-2
July 20, 1993

EXPLORATORY BORING LOG						LABORATORY TESTS								
Sample Number	Depth, feet	Boring Log	Unified Soil Classification System Symbols	Description	Standard Penetration Test, blows/foot	Moisture Content, %	Dry Density, p.c.f.	Unconfined Compressive Strength, k.s.f.	Direct Shear Test		Liquid Limit, %	Plasticity Index, %	Compaction Test	Consolidation Test
									"c", k.s.f.	"φ", degrees				
				Boring No. B-21		Date of Drilling: 7/17/92								
21-A				clayey Silt, dk. brown, moderately firm, sl. damp		17.0	105.0		0.5	25	42	12	x	x
21-1	4			Clay/Siltstone breccia, v. sev. weathered, with sandstone inclusions	* 33	14.0	117.5		1.0 (0.9	10 4)				
21-2	8			sheared Siltstone breccia, blue-gray, mottled with purple Clay, sl. damp	* 56	14.1	119.1	4.0	@ 4% strain					
21-3	12 16			sheared Siltstone & Claystone breccia, grayish purple, with angular sandstone fragments (Fm)	* 78	8.7	127.2							
	20													
	24													
	28													
	32													
21-4				Graywacke Sandstone, mod. weathered, v. hard	* 75/10"	8.0	128.9	10.0	@ 3% strain					
				Bottom at 36'										
				Note: Data underlined are for recompacted samples.										

SOIL FOUNDATION SYSTEMS, INC.

Plate 20 - Log of Test Boring: B-21

File No. S22-634-2
July 20, 1993

EXPLORATORY BORING LOG						LABORATORY TESTS							
Sample Number	Depth, feet	Boring Log	Unified Soil Classification System Symbols	Description	Standard Penetration Test, blows/foot	Moisture Content, %	Dry Density, p. c. f.	Unconfined Compressive Strength, k. s. f.	Direct Shear Test "C", k. s. f.	Direct Shear Test "φ", degrees	Liquid Limit, %	Plasticity Index, %	Triaxial Compression
				Boring No. B-22		Date of Drilling: 7/16/92							
				Colluvium, clayey Silt, gray-brown (Qc)									
	4												
22-1				Claystone breccia, grayish red-purple, with orange-brown sandstone inclusions	* 68/9"	9.0	107.7						
	8					8.1	129.0						
22-2					* 89	8.6	132.7	8.0	@ 2% strain				
	12												
22-3					* 61/9"								
	16			(Fm)		13.2	125.5				29	8	x
	20												
	24												
	28			Graywacke Sandstone, moderately weathered, fractured									
	32												
				(Ss)		8.9	–						
	36												
22-4				very hard	* 50/3"								
				Bottom at 38 feet									

Plate 21 - Log of Test Boring: B-22

SOIL FOUNDATION SYSTEMS, INC.

File No. S22-634-2
July 20, 1993

EXPLORATORY BORING LOG						LABORATORY TESTS								
Sample Number	Depth, feet	Boring Log	Unified Soil Classification System Symbols	Description	Standard Penetration Test, blows/foot	Moisture Content, %	Dry Density, p.c.f.	Unconfined Compressive Strength, k.s.f.	Direct Shear Test		Liquid Limit, %	Plasticity Index, %		
									"C", k.s.f.	"φ", degrees				
				Boring No. B-23		Date of Drilling: 7/16/92								
	2 4			Colluvium, clayey Silt, lt. brown/grayish, with angular sandstone and siltstone fragments (Qc)										
23-1	6 8			Siltstone breccia, very sev. weathered, gray-green, with stiff brown clayey Silt	* 70	8.7	135.5							
23-2	10 12 14			Sandstone/Siltstone breccia, severely to moderately weathered, lt. yellow-brown to orange-brown (Fm)	* 86/10"	7.6	125.7							
23-3	16 18			Graywacke Sandstone, severely weathered, olive brown, hard, fractured (Ss)	* 50/3"	6.2					29	8		
				Bottom at 20 feet										

Plate 22 - Log of Test Boring: B-23

SOIL FOUNDATION SYSTEMS, INC.

File No. S22-634-2
July 20, 1993

EXPLORATORY BORING LOG						LABORATORY TESTS								
Sample Number	Depth, feet	Boring Log	Unified Soil Classification System Symbols	Description	Standard Penetration Test, blows/foot	Moisture Content, %	Dry Density, p. c. f.	Unconfined Compressive Strength, k. s. f.	Direct Shear Test		Liquid Limit, %	Plasticity Index, %		
									"c", k. s. f.	"φ", degrees				
				Boring No. B-24		Date of Drilling: 7/16/92								
				clayey Silt with Talus										
24-1	2 4 6 8			Fill, drain rock, subrounded gravel from 2" to 3", metamorphic clasts, little or no matrix										
	10 12 14 16			Claystone/Siltstone breccia, very severely weathered, clayey Silt, olive brown (Fm)										
	18 20 22			Claystone & Siltstone breccia, severely weathered, clayey Silt, med. brown, sl. damp (Fm)										
24-2	24			moderately weathered, lt. olive gray										
24-3	26			sl. weathered, med. gray, with highly indurated meta graywacke clasts										
				Bottom at 28'										

Plate 23 - Log of Test Boring: B-24

SOIL FOUNDATION SYSTEMS, INC.

File No. S22-634-2
July 20, 1993

EXPLORATORY BORING LOG						LABORATORY TESTS								
Sample Number	Depth, feet	Boring Log	Unified Soil Classification System Symbols	Description	Standard Penetration Test, blows/foot	Moisture Content, %	Dry Density, p. c. f.	Unconfined Compressive Strength, k. s. f.	Direct Shear Test		Liquid Limit, %	Plasticity Index, %		
									"c", k. s. f.	"φ", degrees				
				Boring No. B-25		Date of Drilling: 7/21/92								
				clayey Silt, med. brown										
	2			Sandstone, severely weathered, silty Sand, tan to orange-brown										
	4													
				(Ss)										
	6													
	8			moderately weathered										
				Bottom at 10"										
				Note: Boring Nos. 25 & 26 were drilled using a backhoe-mounted rig										
				Boring No. B-26		Date of Drilling: 7/21/92								
				clayey Silt, med. brown										
	2													
	4			Sandstone, severely weathered, tan brown, silty Sand										
	6													
				(Ss)										
	8													
	10			moderately weathered, oxide stained fractures										
	12													
	14													
				Bottom at 16'										

Plate 24 - Logs of Test Borings: B-25 & B-26

SOIL FOUNDATION SYSTEMS, INC.

File No. S22-634-2
July 20, 1993

EXPLORATORY BORING LOG						LABORATORY TESTS								
Sample Number	Depth, feet	Boring Log	Unified Soil Classification System Symbols	Description	Standard Penetration Test, blows/foot	Moisture Content, %	Dry Density, p. c. f.	Unconfined Compressive Strength, k. s. f.	Direct Shear Test		Liquid Limit, %	Plasticity Index, %		
									"C", k. s. f.	"φ", degrees				
				Hole P-1		Date of Drilling: 4/3/90								
	2		CL - ML	FILL: Mixture of silty to sandy Clay and rock fragments, failry stiff										
1-1	4			(moist and soft at base)	24*	39.8	73.8							
1-2	6			Colluvium - mixture of clayey sand and rock fragments and boulders, fairly dense (Qc)	40*/5"	11.4	103.8		0.3	15				
	8													
	10													
1-3	12			(sandstone/serpentine) Medium to dark gray rock	30*/4"	9.9	121.8	7.2 @ 6.2% strain						
				Bottom at 13 feet										
				Hole P-2		Date of Drilling: 4/3/90								
			CL	Sandy Clay w/Rock fragments										
	2			Sandstone, very hard refusal to drilling (Ss)										
	4													
				Bottom at 5 feet										

Plate 25 - Logs of Test Borings: P-1 & P-2

SOIL FOUNDATION SYSTEMS, INC.

File No. S22-634-2
July 20, 1993

Sample Number	Depth, feet	Boring Log	Unified Soil Classification System Symbols	Description	Standard Penetration Test, blows/foot	Moisture Content, %	Dry Density, p. c. f.	Unconfined Compressive Strength, k. s. f.	Direct Shear Test "C", k. s. f.	Direct Shear Test "φ", degrees	Liquid Limit, %	Plasticity Index, %	Compaction Test	
EXPLORATORY BORING LOG						LABORATORY TESTS								
				Hole P-3		Date of Drilling: 4/3/90								
3-A	2		ML	Dark brown clayey Silt, fairly stiff					(2.0	8)	32	10	x	
3-1	4			Light gray Shale, highly sheared, silty, interbedded w/sandstone (Fm)	35*	14.0	113.1		0.8	14				
	6													
	8													
3-2	10			Medium brown Sandsonte, highly fractures, hard (Ss)										
3-B	12												X	
	14													
3-3														
				Bottom at 15 feet										

Notes: • * penetration resistance for 2½-I.D. split-tube sampler.
• Numbers in ( ) are for recompacted samples.

Plate 26 - Log of Test Boring: P-3

SOIL FOUNDATION SYSTEMS, INC.

File No. S22-634-2
July 20, 1993

EXPLORATORY BORING LOG						LABORATORY TESTS								
Sample Number	Depth, feet	Boring Log	Unified Soil Classification System Symbols	Description	Standard Penetration Test, blows/foot	Moisture Content, %	Dry Density, p. c. f.	Unconfined Compressive Strength, k. s. f.	Direct Shear Test "C", k. s. f.	Direct Shear Test "ϕ", degrees	Liquid Limit, %	Plasticity Index, %		
				Hole P-4		Date of Drilling: 4/6/90								
	2		CL	FILL: Mixture of sandy Clay and rock fragments (serpentine), stiff										
	4			(Qaf)										
4-1	6		–		29*	13.5	117.3	2.4 @ 3.2% strain						
	8		ML											
4-2	10				84*	9.8	126.7							
	12													
	14													
4-3	16			Black to dark brown silty Clay with fine rock frgments, scattered tree roots	21*	18.3 14.5	112.0 114.3		0.5	20				
	18		CH											
4-4	20			becoming sandy and rocky	44*	22.9 19.9	103.6 109.9		0.5	14				
	22			(Qc)										
	24													
	26			Dark gray Serpentine, hard										
	28			(Sp)										

Bottom at 30 feet

Note: * penetration resistnace of 2½-inch I.D. split-tube sampler

Plate 27 – Log of Test Boring: P-4

SOIL FOUNDATION SYSTEMS, INC.

File No. S22-634-2
July 20, 1993

EXPLORATORY BORING LOG						LABORATORY TESTS								
Sample Number	Depth, feet	Boring Log	Unified Soil Classification System Symbols	Description	Standard Penetration Test, blows/foot	Moisture Content, %	Dry Density, p. c. f.	Unconfined Compressive Strength, k. s. f.	Direct Shear Test "c", k. s. f.	Direct Shear Test "φ", degrees	Liquid Limit, %	Plasticity Index, %		
				Hole P-5		Date of Drilling : 4/6/90								
	2			FILL: Mixture of light to dark brown silty clay, sandy Clay and Serpentine rock fragments, stiff										
	4		CL											
5-1	6		-	(Qaf)	20*	16.5	102.5							
	8		ML											
5-2	10				51*	16.6	115.0		1.4	0				
	12													
	14		CL	Black to dark brown silty Clay with rock fragments, stiff, moist										
	16			(Qc)										
	18			Medium to dark gray Serpentine rock, hard		11.2	120.2							
5-3	20			(highly expansive)- Sp	45*	10.1	131.8		0.5	14				
				Bottom at 21 feet										
				Hole P-6		Date of Drilling : 4/6/90								
			CL	Brown sandy Clay										
	2			Massive Sandstone, very hard										
	4			(Ss) (refusal to drilling)										
				Bottom at 5 feet										

Plate 28 - Log of Test Borings: P-5 & P-7

File No. S24-634-2S
November 7, 1994

EXPLORATORY BORING LOG

Location: Site #1

Boring No. BS-1

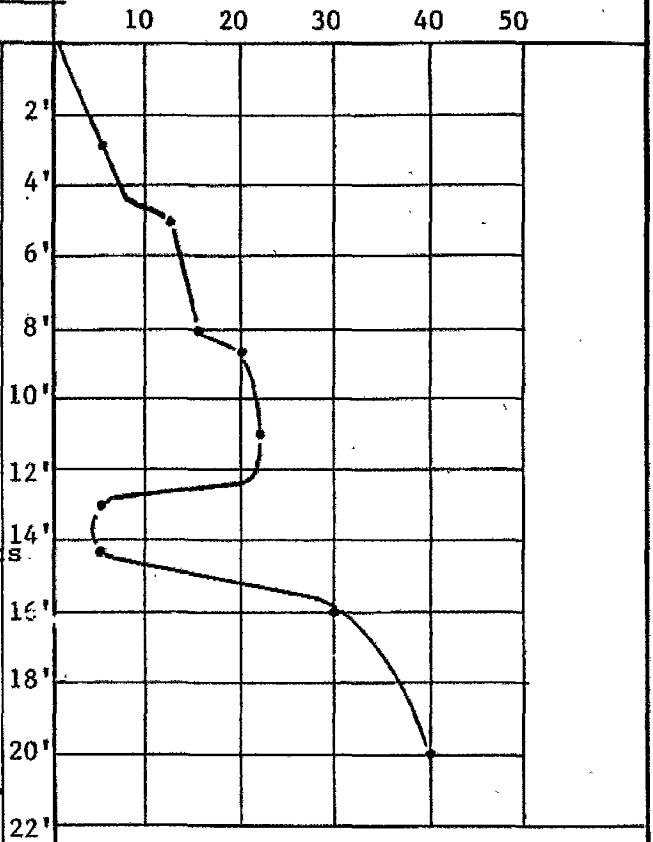
Date Drilled: 12/3/93

Equipment: Minuteman; 3" diameter continuour flight augers

Sample Number	Depth, feet	Boring Log	Unified Soil Classification System Symbols	Description	Standard Penetration Test, blows/foot
	2 4			Colluvium: clayey Silt with sandstone fragments, light brown (Qc)	
	6			Siltstone breccia, gray-green, firm, dry (Fm)	
	8 10 12			Siltstone/sandstone breccia, tan to medium brown, very firm, dry; (Fm) uniform resistance to drilling	
	14			very easy drilling from 13' to 15'; rock fragments	
	16 18 20			Sandstone/siltstone; gray-brown, very hard, fine grained, dry	
				Bottom at 21 feet	

Drilling Time per 12" Advance

(in minutes)



Notes: Small amount of water was periodically poured into the hole to facilitate removal of cuttings.

Plate A - Log of Test Boring, BS-1

SOIL FOUNDATION SYSTEMS, INC.

File No. S24-634-2S
November 7, 1994

EXPLORATORY BORING LOG

Location: Site #3

Boring No. BS-2

Date of Drilling: 12/3/93

Equipment: Minuteman; 3" diameter continuous flight augers

Drilling Time
12-inch Advance - minutes

Sample Number	Depth, feet	Boring Log	Unified Soil Classification System Symbols	Description	Standard Penetration Test, blows/foot
				Colluvium: dark brown clayey Silt, sandy (Qc)	
	2				
				Siltstone; light brown, dry, firm (Fm)	
	4				
	6				
	8			Sandstone; fine grained, dry, fairly hard (Ss)	
	10			becoming very hard at 9'	
				Bottom at 11 feet	

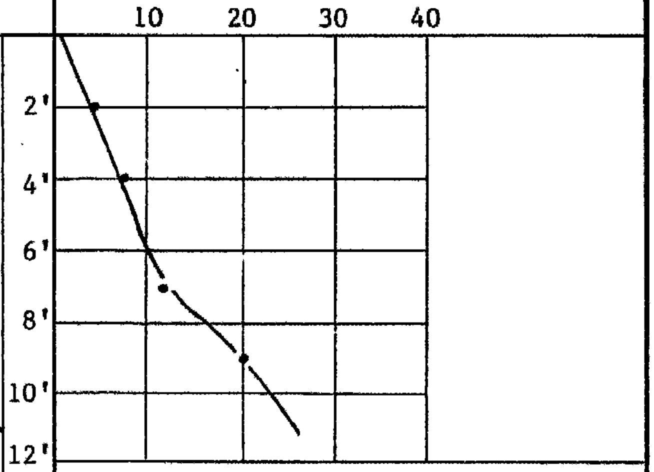
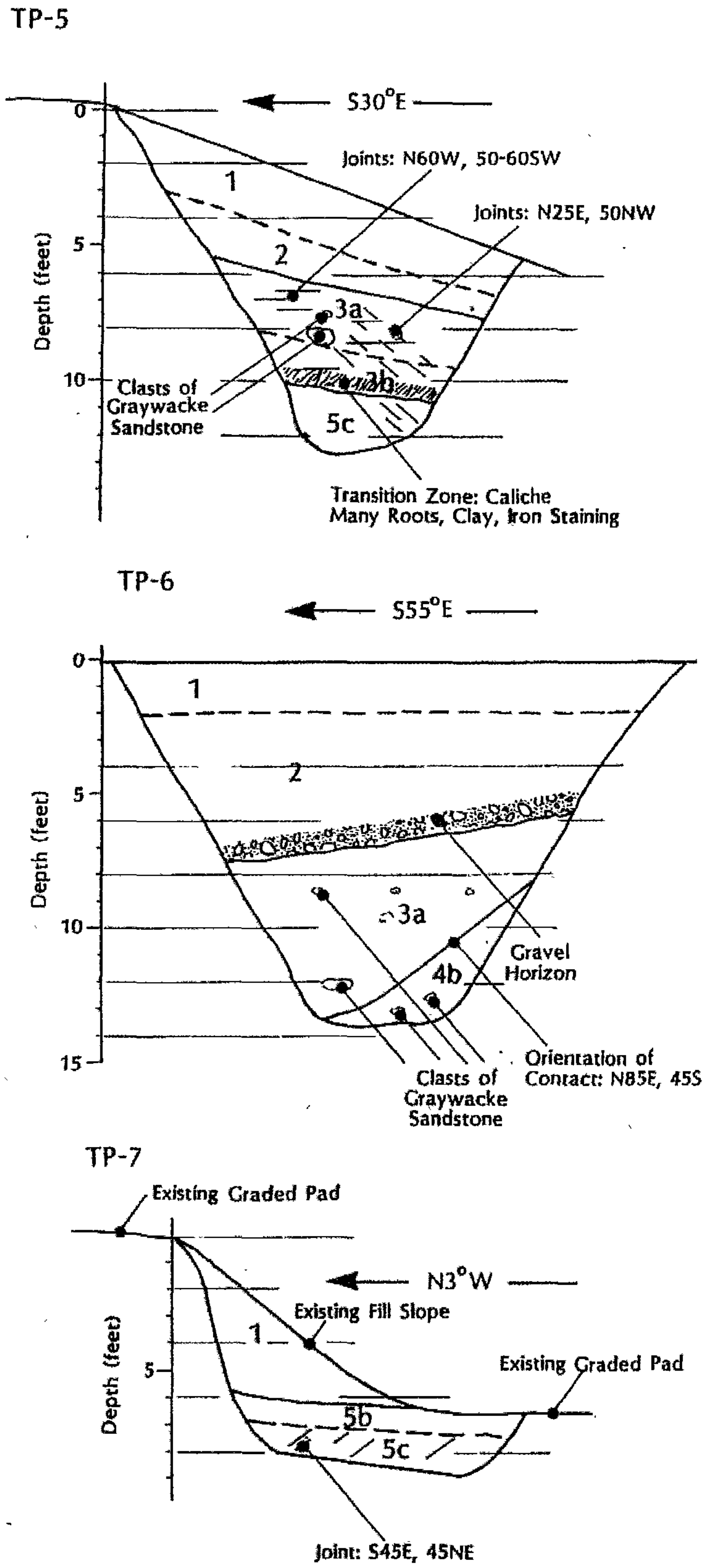


Plate B - Log of Test Boring, BS-2

SOIL FOUNDATION SYSTEMS, INC.



Lithological Units

1 **Fill**. Clayey sand with angular clasts of graywacke; dark yellowish brown (10YR4/2) damp, many roots; minor disseminated caliche, chunks of glass, loose to firm.

2 **Colluvium**. Clayey, sandy silt with graywacke inclusions up to 18" in maximum dimension. Unconsolidated and unsorted; moderate yellowish brown, damp; many roots; caliche staining at basal contact; firm.

3a **Sheared Siltstone/Shale**. With graywacke inclusions; severely weathered; dark yellowish brown (10YR4/2), many roots, minor caliche, moist to slightly moist, stiff to very stiff. Small partings dip in direction of slope at 25° ±5°.

3b **Sheared Siltstone/Shale**. With graywacke inclusions, moderately weathered, grayish red purple (5RP4/2), many roots, minor caliche; slightly moist, stiff to very stiff.

4b **Sandstone**. Clayey, moderately to severely weathered; light yellowish brown (6/4) arkostic (dull feldspars weathering to clay; mica flakes?) slightly moist, friable, medium compact to compact

5b **Graywacke Sandstone**. Moderately weathered; dark yellowish brown (10YR4/2), damp, roots, iron staining and minor caliche, fine- to medium-grained, compact (hard to rip).

5c **Graywacke Sandstone**. Slightly weathered, light olive gray (5Y 5/2), with dark yellowish brown (10YR4/2) staining on joint planes; joints typically spaced at 6" to 12"; damp, massive, very compact, (very hard to rip).

Symbols

Z	Geologic Contact (dashed where approximate)
⁘	Gravel Horizon
///	Joint Set

Test pits logged by Darwin Myers, CEG 946, on 3 December 1993

Plate C - Log of Test Pits TP-5 Through TP-7

SOIL FOUNDATION SYSTEMS, INC.

File No. 7-1967-S1

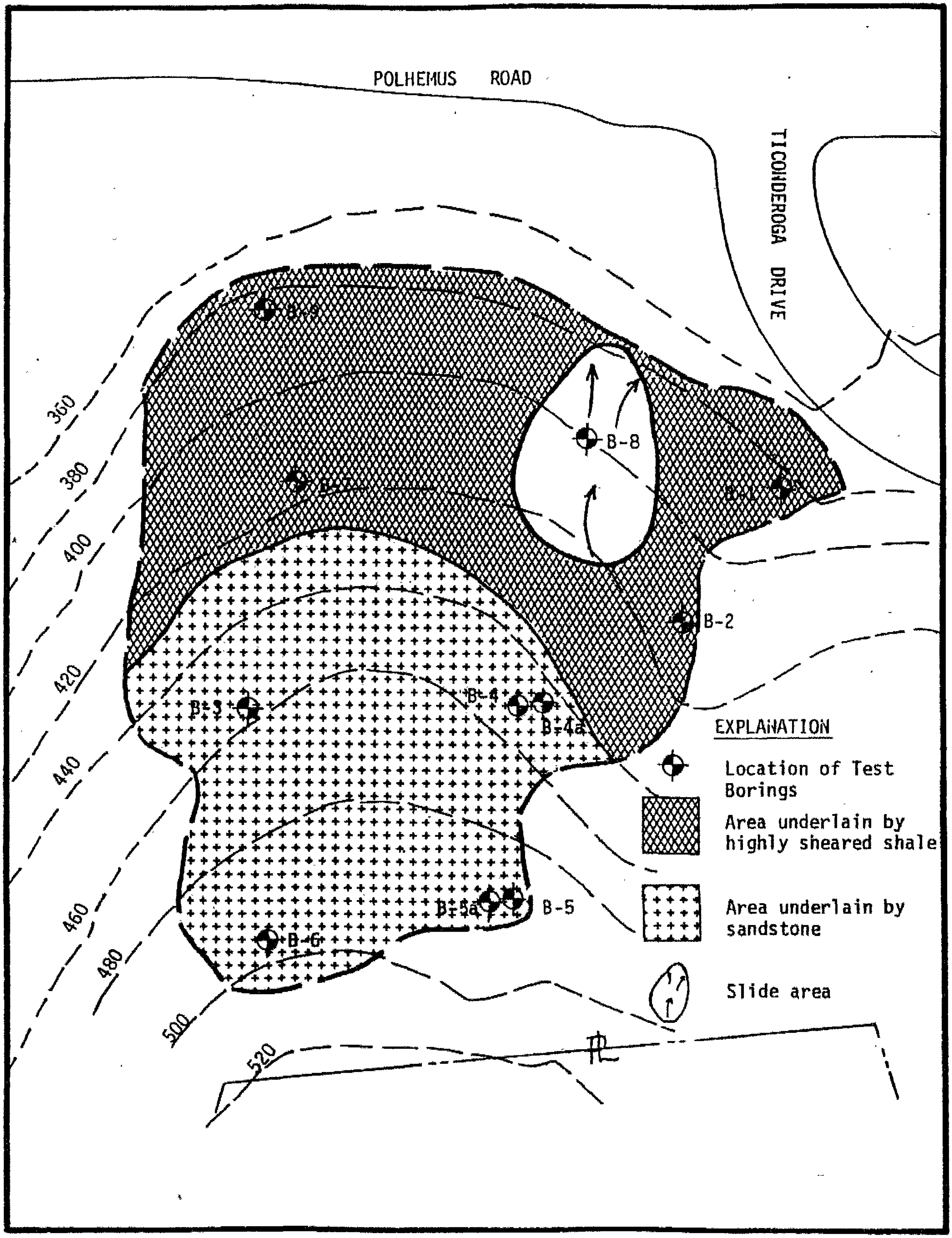


Fig. 1 - Site Plan

United Soil Engineering, Inc.

Logged By: TN

Date Drilled: 10-18-77

EXPLORATORY BORING LOG

Hole No. B-1

Job No. 7-1967-S1

Dry Density p.c.f.	Moisture Content %	Penet. Resist. Blows/Ft.	Unconf. Comp. Strength, k.s.f.	Direct Shear Test		Sample Number	Depth in Feet	Boring Log	DESCRIPTION
				"C" k.s.f.	"ø" Degree				
									Medium brown sandy clayey SILT with scattered gravel; residual soil, dry; SM stiff from 4'
		28					5 10		Yellowish-brown, very stiff, slightly damp, sandy gravelly CLAY; CL
							15		Gray-green to dark gray highly sheared shale with rounded shear pebbles (1/4 to 1" in diameter) and very dense fragments of sandstone (gray, calcite - veined) below 14'
		49					20		Light gray-brown, slightly damp, highly weathered & sheared *
									Boring terminated @ 21½'

Remarks: * = sandstone - some shear pebbles @ ½' maximum

Figure 3 - Log of Test Boring

UNITED SOIL ENGINEERING, INC.

Logged By: TN

Date Drilled: 10-18-77

EXPLORATORY BORING LOG

Hole No. B-2

Job No. 7-1967-S1

Dry Density p.c.f.	Moisture Content %	Penet. Resist. Blows/ft.	Unconf. Comp. Strength, k.s.f.	Direct Shear Test "C" k.s.f.	Direct Shear Test "Ø" Degree	Sample Number	Depth in Feet	Boring Log	DESCRIPTION
									Light to medium brown gravelly silty SAND; changing color to gray-brown; SM
		70+					5 10		Highly sheared fragments of sandstone & dark gray, yellow-green sheared shale; hard rock fragments @ 6 to 7½'
		21					15		Fairly smooth drilling form 7½' to 10½'. rocky from 10½' to 15'; Dark gray to medium brown & yellow-orange fragments of sandstone & chert in matrix of clayey sand;
									Boring terminated @ 16½'

Remarks:

Figure 4 - Log of Test Boring

UNITED SOIL ENGINEERING, INC.

Logged By: TN

Date Drilled: 10-18-77

EXPLORATORY BORING LOG

Hole No. B-3

Job No. 7-1967-S1

Dry Density p.c.f.	Moisture Content %	Penet. Resist. Blows/ft.	Unconf. Comp. Strength, k.s.f.	Direct Shear Test "C" k.s.f.	Direct Shear Test "Ø" Degree	Sample Number	Depth in Feet	Boring Log	DESCRIPTION
									Light yellow, light orange, and light tan (dry) colluvium;
		70+					5		composed of angular sandstone block in sandy SILT to silty sand matrix; dry through out; grades to in-place, tan-weathered (graywacke) sandstone.
							10		
									Boring terminated @ 10'

Remarks:

Figure 5 - Log of Test Boring

UNITED SOIL ENGINEERING, INC.

Logged By: TN

Date Drilled: 10-18-77

EXPLORATORY BORING LOG

Hole No. B-4

Job No. 7-1967-S1

Dry Density p.c.f.	Moisture Content %	Penet. Resist. Blows/ft.	Unconf. Comp. Strength,k.s.f.	Direct Shear Test		Sample Number	Depth In Feet	Boring Log	DESCRIPTION
				"C" k.s.f.	"ø" Degree				
								▨	Light tan and yellow (dry) colluvium (rock fragments to 1' in silty sandy matrix) rock
									Boring terminated @ 4'

Remarks: * refusal in rock

Figure 6 - Log of Test Boring

UNITED SOIL ENGINEERING, INC.

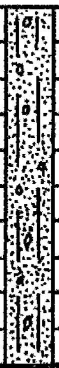
Logged By: TN

Date Drilled: 10-18-77

EXPLORATORY BORING LOG

Hole No. B-4a

Job No. 7-1967-S1

Dry Density p.c.f.	Moisture Content %	Penet. Resist. Blows/ft.	Unconf. Comp. Strength, k.s.f.	Direct Shear Test		Sample Number	Depth in Feet	Boring Log	DESCRIPTION
				"C" k.s.f.	"ø" Degree				
									Light tan and yellow (dry) rocky colluvium (rock fragments to 1' in silty sand matrix)
							5		
									(smoother) occasional rock fragments, weathered, dry sandstone
							10		

Remarks:

Figure 7 - Log of Test Boring

UNITED SOIL ENGINEERING, INC.

Logged By: TN

Date Drilled: 10-18-77

EXPLORATORY BORING LOG

Hole No. B-5

Job No. 7-1967-S1

Dry Density p.c.f.	Moisture Content %	Penet. Resist. Blows/Ft.	Unconf. Comp. Strength, k.s.f	Direct Shear Test		Sample Number	Depth in Feet	Boring Log	DESCRIPTION
				"C" k.s.F.	"Ø" Degree				
									Medium brown colluvium (angular sandstone blocks to 8" in sandy silt to silty sand matrix)- very dense @ 2 '
									Boring terminated @ 4'

Remarks:

Figure 8a - Log of Test Boring

UNITED SOIL ENGINEERING, INC.

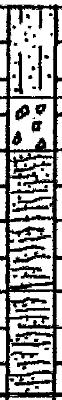
Logged By: TN

Date Drilled: 10-18-77

EXPLORATORY BORING LOG

Hole No. B-5a

Job No. 7-1967-S1

Dry Density p.c.f.	Moisture Content %	Penet. Resist. Blows/Ft.	Unconf. Comp. Strength, k.s.f	Direct Shear Test		Sample Number	Depth in Feet	Boring Log	DESCRIPTION
				"C" k.s.f.	"ø" Degree				
									Medium brown colluvium (angular sandstone blocks to 8 " in *
									sandstone block
							5		Light blue-gray fractured sandstone; fresh to slightly weathered; gradational to
							10		Fresh graywacke sandstone (very slow, steady, rough drilling)
									Boring terminated @ 11'

Remarks: * = sandy silt to silty sand matrix (very dense @ 2')

Figure 8b - Log of Test Boring

UNITED SOIL ENGINEERING, INC.

Logged By: TN

Date Drilled: 10-18-77

EXPLORATORY BORING LOG

Hole No. B-6

Job No. 7-1967-S1

Dry Density p.c.f.	Moisture Content %	Penet. Resist. Blows/ft.	Unconf. Comp. Strength, k.s.f.	Direct Shear Test		Sample Number	Depth in Feet	Boring Log	DESCRIPTION
				"C" k.s.f.	"ø" Degree				
									Medium brown, dry, blocky sandstone fragments to 1'6" in sandy clayey silt matrix (colluvium) grades to
							5		Light yellow brown weathered sandstone, some chert & shale, gritstone;
									Gray fresh sandstone;
									Boring terminated @ 8'

Remarks:

Figure 9 - Log of Test Boring

UNITED SOIL ENGINEERING, INC.

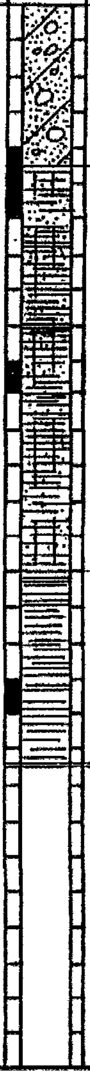
Logged By: TN

Date Drilled: 10-18-77

EXPLORATORY BORING LOG

Hole No. B-7

Job No. 7-1967-S1

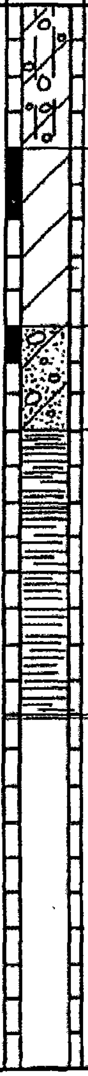
Dry Density p.c.f.	Moisture Content %	Penet. Resist. Blows/Ft.	Unconf. Comp. Strength, k.s.f.	Direct Shear Test		Sample Number	Depth in Feet	Boring Log	DESCRIPTION
				"C" k.s.f.	"Ø" Degree				
									Medium brown to light orange to light gray-green, highly weathered sandstone (dry, slightly gravelly & clayey silty SAND; SM
		28					5		Black, gray, dark moroon & gray-green highly sheared shale with greenstone (?) sheared lenticular bodies, some sheared pebbles to ½" maximum.
		26					10		(metabasalt (?) in tip)
		70+					15		
							20		Hightly sheared dark gray to orange, slightly damp claystone, shale and chert. possible old slide plane (clayey sand in sampler)
									Boring terminated @ 21½'

Remarks:

Figure 10 - Log of Test Boring

UNITED SOIL ENGINEERING, INC.

Logged By: TN	EXPLORATORY BORING LOG	Hole No. B-8
Date Drilled: 10-18-77		

Dry Density p.c.f.	Moisture Content %	Penet. Resist. Blows/ft.	Unconf. Comp. Strength, k.s.f.	Direct Shear Test		Sample Number	Depth in Feet	Boring Log	Job No. 7-1967-S1
				"C" k.s.f.	"φ" Degree				DESCRIPTION
									Medium brown, dry to slightly damp gravelly clayey SILT;
		16					5		Dark gray to blue-gray and yellow-brown, damp to moist CLAY (highly sheared shale?) probable slide material; CL
		14					10		Light orange to brown clayey gravelly SAND & sandy gravelly CLAY (old slide material?) CL
							15		Gray-green and orange, highly sheared shale with some rock fragments, some chert
							20		Boring terminated @ 20'

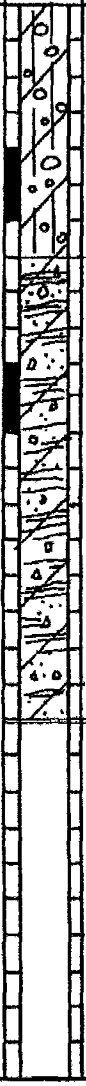
Remarks:

Figure 11 - Log of Test Boring

UNITED SOIL ENGINEERING, INC.

Logged By: TN	EXPLORATORY BORING LOG	**Hole No.** B-9
Date Drilled: 10-18-77		

Job No. 7-1967-S1

Dry Density p.c.f.	Moisture Content %	Penet. Resist. Blows/ft.	Unconf. Comp. Strength, k.s.f.	Direct Shear Test "C" k.s.f.	Direct Shear Test "ø" Degree	Sample Number	Depth In Feet	Boring Log	DESCRIPTION
									Medium browm, dry gravelly clayey SILT; changing color to yellow-brown
		48					5		
							10		Medium to dark gray & gray-green slightly damp, highly sheared shale with red-brown streaks; ocassional layers or zones of light sandy CLAY and clayey sand with rock fragments; sheared dark gray shale; dry to slightly damp through out.
							15		
							20		
									Boring terminated @ 21'

Remarks:

Figure 12 - Log of Test Boring

UNITED SOIL ENGINEERING, INC.

Job No. 805-10

TEST PIT LOGS

Test Pit Number	Depth (ft.)	Description
TP-1	0-6	Fill: heterogeneous mixture of sandy clay and gravelly clay, brown and light brown, damp, medium stiff, ($W < PL$), some gravels to 6" across; a 5/8" diameter cable at 4'; base marked by 2" to 3" brown organic material.
	6-7½	Soil: sandy clay, brown, damp ($W < PL$), medium to low plasticity, soft in upper few inches, then medium stiff, minor angular fragments of sandstone.
	7½-11	Subsoil: gravelly clay, brown, damp ($W < PL$), medium to low plasticity, gravels > 4" across comprise approximately 50 percent of this material, and percentage increasing with depth to possible bedrock at the bottom of the test pit.
		Total depth 11 feet; no free groundwater.
TP-2	0-1½	Soil: sandy clay, brown, damp ($W < PL$), medium to low plasticity, soft in upper few inches, then medium stiff, minor angular fragments of sandstone.
	1½-3	Subsoil: sandy clay with gravel, light brown, damp ($W < PL$), medium plasticity; increasing gravels with depth, fragments of sandstone commonly 1' to 3' across.
		Total depth 3 feet; no free groundwater.
TP-3	0-1½	Soil: sandy clay, brown, damp ($W < PL$), medium to low plasticity, soft in upper few inches, then medium stiff, minor angular fragments of sandstone.
	1½-6½	Subsoil: sandy clay with gravel, grading to gravelly clay or bedrock at depth, light brown, damp ($W < PL$), fragments of sandstone generally < 3" across.
		Total depth 6½'; no free groundwater.

Job No. 805-10

TEST PIT LOGS

Test Pit Number	Depth (ft.)	Description
TP-4	0-3½	Soil: sandy clay, brown, slightly damp ($W < PL$), medium to low plasticity, soft, with gravelly clay 3" thick at the base; contact with underlying subsoil approximately 25° downhill, no shearing observed.
	3½-6	Subsoil: sandy clay with gravel, grading to gravelly clay or bedrock at depth, light brown, damp ($W < PL$), fragments of sandstone generally <3" across.
		Total depth 6 feet; no free groundwater.
TP-5	0-2	Soil: sandy clay, brown, damp ($W < PL$), medium to low plasticity, soft in upper few inches, then medium stiff, minor angular fragments of sandstone.
	2-4½	Subsoil: sandy clay to gravelly clay, light brown, slightly damp ($W < PL$), gravels generally <3" across.
	4½-5	Bedrock: sandstone, fine- to medium-grained, light gray to light brown, micaceous, massive, very well indurated; generally breaks into pieces 6" to 3'.
		Total depth 5 feet; no free groundwater.
TP-6	0-4½	Soil?: silty gravel, dark brown, moist ($W \geq PL$), fragments of sandstone generally 6" across; very hard digging.
		Total depth 4½ feet; no free groundwater.

TEST PIT LOGS

Test Pit Number	Depth (ft.)	Description
TP-7	0-6½	Soil: sandy clay, brown, damp (W<PL), medium to low plasticity, soft in upper few inches, then medium stiff, minor angular fragments of sandstone.
	6½-10½	Talus: sandy gravel with minor clay, light brown, fragments of sandstone 6" to 1' across in sandy matrix, generally loose.
	10½-12	Bedrock: Franciscan sheared rock, dark gray, dominantly slickensided and sheared clay with subrounded inclusions up to 1" across.
		Total depth 12 feet; no free groundwater.
TP-8	0-2	Soil: sandy clay, brown, damp (W<PL), medium to low plasticity, soft in upper few inches, then medium stiff, minor angular fragments of sandstone.
	2-5	Colluvium?: clayey sand, brownish orange, damp (W<PL), friable.
	5-7½	Landslide shear zone?: clay to sandy clay, dark gray, moist (W≥PL), stiff, high plasticity.
	7½-10½	Colluvium?: clayey sand as above between 2 and 5 feet.
		Total depth 10½'; no free groundwater.
TP-9	0-2	Soil: sandy clay, brown, damp (W<PL), medium to low plasticity, soft in upper few inches, then medium stiff, minor angular fragments of sandstone.
	2-5	Colluvium?: clayey sand, brownish orange, damp (W<PL), friable.
	5-8	Bedrock: Franciscan sheared rock, dark gray, dominantly slickensided and sheared clay with subrounded inclusions up to 1" across.
		Total depth 8'; no free groundwater.

TEST PIT LOGS

Test Pit Number	Depth (ft.)	Description
TP-10	0-1½	Soil: sandy clay, brown, damp (W<PL), medium to low plasticity, soft in upper few inches, then medium stiff, minor angular fragments of sandstone.
	1½-4	Bedrock: sandstone, fine- to medium-grained, light gray to light brown, micaceous, massive, very well indurated; generally breaks into pieces 6" to 3'.
		Total depth 4'; no free groundwater.
TP-11	0-1	Soil: sandy clay, brown, damp (W<PL), medium to low plasticity, soft in upper few inches, then medium stiff, minor angular fragments of sandstone.
	1-3½	Bedrock: sandstone, fine- to medium-grained, light gray to light brown, micaceous, massive, very well indurated; generally breaks into pieces 6" to 3'.
		Total depth 3½'; no free groundwater.
TP-12	0-2	Soil: sandy clay, brown, damp (W<PL), medium to low plasticity, soft in upper few inches, then medium stiff, minor angular fragments of sandstone.
	2-4	Bedrock: sandstone, fine- to medium-grained, light gray to light brown, micaceous, massive, very well indurated; generally breaks into pieces 6" to 3'.
		Total depth 4'; no free groundwater.

TEST PIT LOGS

Test Pit Number	Depth (ft.)	Description
TP-13	0-2	Soil: sandy clay, brown, damp (W<PL), medium to low plasticity, soft in upper few inches, then medium stiff, minor angular fragments of sandstone.
	2-3½	Bedrock: sandstone, fine- to medium-grained, light gray to light brown, micaceous, massive, very well indurated; generally breaks into pieces 6" to 2'.
		Total depth 3½'; no free groundwater.
TP-14	0-4½	Soil: sandy clay, dark brown, damp (W<PL), firm to 2½', low plasticity; medium stiff below 2½'.
	4½-6	Subsoil: silty clay with minor sand, gray, damp to moist (W≥PL), medium stiff to stiff, high plasticity.
	6-7	Bedrock: Franciscan sheared rock, dark gray, dominantly slickensided and sheared clay with subrounded inclusions up to 2" across.
		Total depth 7'; no free groundwater.
TP-15	0-2½	Fill?: sandy clay, mottled dark brown and reddish-brown, slightly damp (W<PL), medium stiff to stiff, medium plasticity, layered structure (horizontal).
	2½-4	Soil: sandy clay, dark brown, damp (W<PL), firm to 3½', low plasticity; medium stiff below 3½'.
	4-5½	Subsoil: silty clay with minor sand, gray, damp to moist (W≥PL), medium stiff to stiff, high plasticity.
	5½-7	Bedrock: Franciscan sheared rock, dark gray, dominantly slickensided and sheared clay with subrounded inclusions up to 2" across.
		Total depth 7'; no free groundwater.

TEST PIT LOGS

Test Pit Number	Depth (ft.)	Description
TP-16	0-6	Fill: sandy clay as in TP-15; mottled light and dark brown, damp (W≤PL), and soft in top 2'; dark gray to dark brown, firm to very stiff, slightly damp (W<PL) below 2'.
	6-9	Soil: sandy clay, dark brown, damp (W<PL), firm to 7', low plasticity; medium stiff below 7'.
	9-10½	Subsoil: silty clay with minor sand, gray, damp to moist (W≥PL), medium stiff to stiff, high plasticity.
	10½-11½	Bedrock: Franciscan sheared rock, dark gray, dominantly slickensided and sheared clay with subrounded inclusions up to 1" across.
		Total depth 11½'; no free groundwater.
TP-17	0-2	Soil: silty clay with minor sand, gray, damp to moist (W<PL), medium stiff to stiff, high plasticity, soft in top foot.
	2-5½	Bedrock: Franciscan sheared rock, dark gray, dominantly slickensided and sheared clay with subrounded inclusions up to 1" across. Damp from 2 to 3½' (W<PL), slightly damp (W≤PL) below 3½'; large block of very fractured but hard greenstone at 5'.
		Total depth 5½'; no free groundwater.

TEST PIT LOGS

Test Pit Number	Depth (ft.)	Description
TP-18	0-1½	Soil: sandy clay, brown, damp (W<PL), medium to low plasticity, soft in upper few inches, then medium stiff, minor angular fragments of sandstone.
	1½-2	Subsoil: sandy clay with gravel, grading to gravelly clay or bedrock at depth, light brown, damp (W<PL), fragments of sandstone generally ≤3" across.
	2-5	Bedrock: sandstone, fine- to medium-grained, light gray to light brown, micaceous, massive, very well indurated; generally breaks into pieces 6" to 1½'.
		Total depth 5'; no free groundwater.
TP-19	0-1	Soil: sandy clay, dark brown, damp (W<PL), medium stiff, low plasticity.
	1-2	Subsoil: silty clay with minor sand, gray, damp to moist (W≥PL), medium stiff to stiff, high plasticity.
	2-5	Bedrock: Franciscan sheared rock, dark gray, dominantly slickensided and sheared clay with subrounded inclusions up to 2" across.
		Total depth 5'; no free groundwater.
TP-20	0-1½	Soil: sandy clay, dark brown, damp (W<PL), medium stiff, low plasticity.
	1½-5	Bedrock: Franciscan sheared rock, dark gray, dominantly slickensided and sheared clay with subrounded inclusions up to 1" across.
		Total depth 5'; no free groundwater.

TEST PIT LOGS

Test Pit Number	Depth (ft.)	Description
TP-21	0-1	Soil: sandy clay, dark brown, damp (W<PL), medium stiff, low plasticity.
	1-2	Subsoil: silty clay with minor sand, gray, damp to moist (W≥PL), medium stiff to stiff, high plasticity.
	2-6½	Bedrock: Franciscan sheared rock, dark gray, dominantly slickensided and sheared clay with subrounded inclusions up to 3" across, damp (W<PL).
		Total depth 6½'; no free groundwater.
TP-22	0-2½	Soil: sandy clay, dark brown, damp (W<PL), firm to 2½', low plasticity; medium stiff below 2½'.
	2½-3	Subsoil: silty clay with minor sand, gray, damp to moist (W≥PL), medium stiff to stiff, high plasticity.
	3-8½	Bedrock: Franciscan sheared rock, dark gray, dominantly slickensided and sheared clay with subrounded inclusions up to 3" across.
		Total depth 8½'; no free groundwater.
TP-23	0-4	Soil: sandy clay, dark brown, damp (W<PL), firm to 2½', low plasticity; medium stiff below 2½'.
	4-7	Bedrock: Franciscan sheared rock, dark gray, dominantly slickensided and sheared clay with subrounded inclusions up to 1" across, a 6" steel pipe 5½' deep headed toward a man-hole.
		Total depth 7'; no free groundwater.

Job No. 805-10

TEST PIT LOGS

Test Pit Number	Depth (ft.)	Description
TP-24	0-1	Soil: sandy clay, dark brown, damp (W<PL), medium stiff, low plasticity.
	1-6	Colluvium: sandy clay, dark brown, slightly damp (W<PL), medium stiff to stiff, medium to high plasticity.
	6-9	Bedrock: Franciscan sheared rock, dark gray, dominantly slickensided and sheared clay with subrounded inclusions up to 1" across.
		Total depth 9'; no free groundwater.
TP-25	0-4	Soil: sandy clay, dark brown, damp (W<PL), medium stiff, low plasticity.
	4-8¼	Bedrock: sandstone, fine- to medium-grained, light gray to light brown, micaceous, massive, very well indurated; generally breaks into pieces 6" to 2'.
		Total depth 8¼'; no free groundwater.
TP-26	0-4	Soil: sandy clay, dark brown, damp (W<PL), medium stiff, low plasticity.
	4-11	Colluvium: sandy clay, dark brown, slightly damp (W<PL), medium stiff to stiff, medium to high plasticity, with increasing gravel to bottom.
		Total depth 11'; no free groundwater.

Job No. 805-10

TEST PIT LOGS

Test Pit Number	Depth (ft.)	Description
TP-27	0-3	Soil: sandy clay, dark brown, damp (W<PL), firm to 2', low plasticity; medium stiff below 2'.
	3-5	Subsoil: silty clay with minor sand, gray, damp to moist (W≥PL), medium stiff to stiff, high plasticity.
	5-10¼	Bedrock: Franciscan sheared rock, dark gray, dominantly slickensided and sheared clay with subrounded inclusions up to 1" across, moist to very moist (W>PL).
		Total depth 10¼'; no free groundwater.
TP-28	0-3	Soil: sandy clay, dark brown, damp (W<PL), medium stiff, low plasticity.
	3-6	Colluvium: sandy clay, dark brown, slightly damp (W<PL), medium stiff to stiff, medium to high plasticity, with dispersed gravel and layers of gravel.
	6-11	Bedrock: Franciscan sheared rock, dark gray, dominantly slickensided and sheared clay with subrounded inclusions up to 1" across, slightly damp (W<PL); contact with overlying colluvium is oriented downhill about 23 degrees and is distinct, no shearing observed.
		Total depth 11'; no free groundwater.

TEST PIT LOGS

Test Pit Number	Depth (ft.)	Description
TP-29	0-2	Soil: sandy clay, dark brown, damp (W<PL), medium stiff to 1½, low plasticity.
	2-5	Colluvium?: sandy clay, dark brown, slightly damp (W<PL), firm to stiff, medium to high plasticity.
	5-8½	Bedrock: Franciscan sheared rock, dark gray, dominantly slickensided and sheared clay with subrounded inclusions up to 3" across, slightly damp (W<PL).
		Total depth 8½'; no free groundwater.
TP-30	0-2	Soil: sandy clay, dark brown, damp (W<PL), firm to 1, low plasticity; medium stiff below 1'.
	2-3½	Subsoil: sandy clay with gravel, grading to gravelly clay or bedrock at depth, light brown, damp (W<PL), fragments of sandstone generally <3" across.
	3½-5½	Bedrock: Franciscan sheared rock, dark gray, dominantly slickensided and sheared clay with subrounded inclusions up to 2" across, slightly damp (W<PL).
		Total depth 5½'; no free groundwater.
TP-31	0-1	Soil: sandy clay, dark brown, damp (W<PL), medium stiff, low plasticity.
	1-5	Bedrock: sandstone, fine- to medium-grained, light gray to light brown, micaceous, massive, very well indurated; generally breaks into pieces 6" to 2'.
		Total depth 5'; no free groundwater.

TEST PIT LOGS

Test Pit Number	Depth (ft.)	Description
TP-32	0-1½	Soil: sandy clay, dark brown, damp (W<PL), medium stiff, low plasticity.
	1½-6	Bedrock: contact between sandstone and Franciscan sheared rock, sandstone to west.
		Total depth 6'; no free groundwater.
TP-33	0-1½	Soil: sandy clay, dark brown, damp (W<PL), firm to 1', low plasticity; medium stiff below 1'.
	1½-9	Colluvium: sandy clay, light brown, moist (W>PL), medium to high plasticity; gray, with common organic material below 6', low plasticity.
	9-12½	Bedrock: Franciscan sheared rock, dark gray, dominantly slickensided and sheared clay with subrounded inclusions up to 3" across.
		Total depth 12½'; no free groundwater.
TP-34	0-1½	Soil: sandy clay, dark brown, damp (W<PL), medium stiff, low plasticity.
	1½-4	Bedrock: sandstone, fine- to medium-grained, light gray to light brown, micaceous, massive, very well indurated; generally breaks into pieces 6" to 1½'.
		Total depth 4'; no free groundwater.

TEST PIT LOGS

Test Pit Number	Depth (ft.)	Description
TP-35	0-2½	Soil: gravelly silt with some clay, abundant organic material; dark brown, slightly damp (W<PL), low plasticity, soft; gravels to 1' across.
	2½-8½	Colluvium: gravelly clay, light brown, slightly damp (W<PL), medium to low plasticity, medium stiff.
	8½-18½	Talus: sandy gravel with minor clay, light brown, slightly damp, very loose; gravels all subangular sandstone commonly 6" to 8" across, but some 2' to 3'.
		Total depth 18½'; no free groundwater.
TP-36	0-3	Soil: gravelly silt with some clay, abundant organic material; dark brown, slightly damp (W<PL), low plasticity, soft; gravels to 1' across.
	3-6½	Colluvium and Talus: sandy gravel with minor clay to gravelly clay.
	6½-8½	Bedrock: Franciscan sheared rock, dark gray, dominantly slickensided and sheared clay with subrounded inclusions up to 1" across, slightly damp (W<PL).
		Total depth 8½'; no free groundwater.

TEST PIT LOGS

Test Pit Number	Depth (ft.)	Description
TP-37	0-3	Soil: gravelly silt with some clay, abundant organic material; dark brown, slightly damp (W<PL), low plasticity, soft; gravels to 1' across.
	3-12	Talus: sandy gravel with minor clay, light brown, slightly damp, very loose; gravels all subangular sandstone commonly 6" to 8" across, but some 2' to 3'.
TP-38	0-3	Soil: sandy clay, dark brown, damp (W<PL), firm to 2½', low plasticity; medium stiff below 2½'.
	3-4	Colluvium: gravelly clay, light brown, slightly damp (W<PL), medium to low plasticity, medium stiff.
	4-6	Bedrock: sandstone, fine- to medium-grained, light gray to light brown, micaceous, massive, very well indurated; generally breaks into pieces 6" to 1½'.
		Total depth 6'; no free groundwater.
TP-39	0-2½	Soil: sandy clay with minor gravel.
	2½-9	Bedrock: sheared sandstone, probably intermediate between sandstone as in TP-18 and Franciscan sheared rock as in TP-7.
		Total depth 9'; no free groundwater.

TEST PIT LOGS

Test Pit Number	Depth (ft.)	Description
TP-40	0-1½	Soil: sandy clay, dark brown, damp (W<PL), firm to 1', low plasticity; medium stiff below 1'.
	1½-3	Bedrock: sandstone, fine- to medium-grained, light gray to light brown, micaceous, massive, very well indurated; generally breaks into pieces 6" to 18".
		Total depth 3'; no free groundwater.
TP-41	0-3	Soil: sandy clay with gravel.
	3-8	Talus: sandy gravel with minor clay, light brown, slightly damp, very loose; gravels all subangular sandstone commonly 6" to 8" across, but some 2' to 3'.
		Total depth 8'; no free groundwater.
TP-42	0-3	Soil: sandy clay with gravel.
	3-6	Colluvium: gravelly clay, light brown, slightly damp (W<PL), medium to low plasticity, medium stiff.
	6-10	Bedrock: sandstone, fine- to medium-grained, light gray to light brown, micaceous, massive, very well indurated; generally breaks into pieces 6" to 2'.
		Total depth 10'; no free groundwater.

TEST PIT LOGS

Test Pit Number	Depth (ft.)	Description
TP-43	0-3	Soil: sandy clay with minor gravel.
	3-5½	Colluvium: gravelly clay with some large boulders.
	5½-7½	Bedrock: Franciscan sheared rock, dark gray, dominantly slickensided and sheared clay with subrounded inclusions up to 1" across, damp (W≤PL).
		Total depth 7½'; no free groundwater.
TP-44	0-2½	Soil: sandy clay, dark brown, damp (W<PL), firm to 2½', low plasticity; medium stiff below 2½'.
	2½-5	Colluvium: sandy clay with minor gravel, light brown, slightly damp (W<PL), medium to high plasticity.
	5-8½	Bedrock: sandstone, medium- to coarse-grained, light brown, slightly damp, poorly indurated, friable, broken into pieces 3/4" to 2"; easily excavated.
		Total depth 8½'; no free groundwater.
TP-45	0-2	Soil: sandy clay, dark brown, damp (W<PL), firm to 1', low plasticity; medium stiff below 1'.
	2-11	Colluvium: sandy clay, dark brown, slightly damp (W<PL), firm to stiff, medium to high plasticity.
		Total depth 11'; no free groundwater.

Job No. 805-10

TEST PIT LOGS

Test Pit Number	Depth (ft.)	Description
TP-46	0-3	Soil: sandy clay, dark brown, damp (W<PL), firm to 2½', low plasticity; medium stiff below 2½'.
	3-9	Colluvium: sandy clay with minor gravel.
	9-11	Bedrock (in place?): sandstone, fine- to medium grained, light gray to light brown, micaceous, massive, very well indurated; generally breaks into pieces 6" to 3'.
		Total depth 11'; no free groundwater.
TP-47	0-4½	Soil: sandy clay, dark brown, damp (W<PL), firm to 2½', low plasticity; medium stiff below 2½'.
	4½-6	Alluvium: sandy clay with large gravel up to 3' across, light brown, moist (W≥PL), high plasticity.
	6-12	Bedrock: Franciscan sheared rock, dark gray, dominantly slickensided and sheared clay with subrounded inclusions up to 1' across.
		Total depth 12'; free groundwater at 6'.

Job No. 805-10

TEST PIT LOGS

Test Pit Number	Depth (ft.)	Description
TP-48	0-2½	Soil: sandy clay with gravel.
	2½-7	Talus: sandy clay with large gravel up to 3' across.
	7-9	Bedrock: Franciscan sheared rock, dark gray, dominantly slickensided and sheared clay with subrounded inclusions up to 1' across.
		Total depth 9'; no free groundwater.
TP-49	0-2	Soil: sandy clay, dark brown, damp (W<PL), firm to 2½', low plasticity; medium stiff below 2½'.
	2-6	Talus: sandy clay with large gravels.
	6-8	Bedrock: Franciscan sheared rock, dark gray, dominantly slickensided and sheared clay with subrounded inclusions up to 1' across.
		Total depth 8'; no free groundwater.

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