TRC

Geotechnical Investigation
Skyline College Parking Lot 10 and FMC Portable
San Bruno, California

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San Mateo County Community College District

San Mateo, California

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GEOTECHNICAL INVESTIGATION
SKYLINE COLLEGE PARKING LOT 10 AND FMC PORTABLE
SAN BRUNO, CALIFORNIA

1.0 INTRODUCTION

This report presents the results of our geotechnical investigation for Parking Lot 10 and the FMC Portable at the Skyline College campus in San Bruno, California. The site location is shown on the Vicinity Map, Figure 1. The purpose of our investigation was to evaluate the subsurface conditions at the project locations and to provide geotechnical recommendations for design of the proposed Parking Lot 10 and evaluate potential causes of observed movement of the FMC portable.

For our use, we received several site plans from CSW/ST2. As you know, we performed an investigation for the Facilities Maintenance Center at Skyline College, titled “Updated Geotechnical Investigation and Geologic Hazard Evaluation, Skyline College Facilities Maintenance Center, San Bruno, California,” dated April 16, 2007. In addition, we performed an investigation for the proposed Building 4 and 11 at Skyline College as well as several previously constructed buildings.

1.1 Project Description

The proposed Parking Lot 10 will be paved, and will include lights, a bus shelter, and concrete pavements as part of the improvements. We understand that minor cuts and fills are anticipated. Structural loads have not been made available to us; however, we assume that structural loads will be representative for this type of construction.

The FMC existing portable will be improved to mitigate and reduce potential future building movements. We understand the northwestern corner of the building has experienced movement and the door on the northwest side of the building will not open.

1.2 Scope of Services

Our scope of services was presented in our agreement with you dated March 5, 2009. To accomplish this work, we have provided the following services:

- Exploration of subsurface conditions by drilling four borings and retrieving soil samples for observation and laboratory testing (three in the parking lot and one near the FMC building).
- Evaluation of the physical and engineering properties of the subsurface soils by visually classifying the samples and performing various laboratory tests on selected samples.
- Engineering analysis to evaluate site earthwork, foundations, pavements, and potential causes of movement.
- Preparation of this report to summarize our findings and to present our conclusions and recommendations.

2.0 SITE CONDITIONS

2.1 Surface

We performed a visual site reconnaissance in the vicinity of both the proposed Parking Lot 10 and FMC portable area during our field exploration. The project locations are located on the campus at 3300 College Drive in San Bruno, California. The proposed Parking Lot 10 is located near the center of campus, south of portable classrooms 3A-E and west of the soccer field. Currently the area is a temporary staff and ADA gravel parking lot.

The FMC portable is in the southern part of campus, located to the west of the new U-shaped FMC building which is under construction. The portable is surrounded by storage bins and an upslope to the southwest, paved road to the northwest, new FMC building to the northeast, and a downslope to the southeast. During a site visit after the rain ponding water was observed, with saturated soil along the southwest side of the portable.

2.2 Exploration Program

Subsurface exploration was performed on March 13, 2009, using conventional, truck-mounted drilling equipment to investigate, sample, and log the subsurface soils. Three exploratory borings were drilled to depths of 10 to 15 feet in the proposed Parking Lot 10. One exploratory boring was drilled to a depth of 7½ feet near the existing FMC portable. The borings were backfilled with cement grout in accordance with San Mateo County Environmental Health Division guidelines. A representative bulk sample of the surface soil was obtained for pavement design purposes. The approximate locations of the borings are shown on the Site Plan, Figure 2 and 2A. Logs of our borings and details regarding our field investigation are included in Appendix A. Our laboratory tests are presented in Appendix B.

2.3 Floor Level Survey and Visual Observations

A floor level survey was performed on Friday, March 13, 2009. The floor level survey was performed using a monometer and taking elevations points near the corners, edges, and center of the existing portable to determine the relative levelness of the floor. The exposed floor surface had thin carpet. The results indicated up to 1½ inches of elevation difference across the raised floor, the lowest elevation located along the southeastern edge of the portable and highest elevation located at the northern corner.

2.4 Subsurface

Borings EB-1 and EB-2 for Parking Lot 10 encountered 8 and 3 inches of aggregate base, respectively. Below the existing aggregate base section, our exploratory borings EB-1 to EB-3 encountered fill consisting of medium dense to dense sand with varying amounts of fines and gravel and very stiff to hard clay to depths of 10, 5, and 3 feet, respectively. Below the fill borings EB-2 and EB-3 encountered medium dense to dense clayey sand with gravel to a depth of approximately 15 feet, the maximum depth explored. A plasticity Index (PI) test performed on the clay fill obtained at a depth of 2 feet in Boring EB-3 resulted in a PI of 30, indicating the clay fill at the site has high plasticity and expansion potential.

Boring EB-1A for the FMC portable encountered friable, very severely weathered bedrock (Franciscan Greenstone) to a depth of approximately 7½ feet, the maximum depth explored. A Plasticity Index (PI) test performed on a bedrock sample obtained at a depth of 2 feet in Boring EB-1A, resulted in a PI of 12, indicating the bedrock has a low plasticity and expansion potential.

2.5 Ground Water

Free ground water was not encountered in the borings at the time of drilling. The CGS has not developed a report for the San Francisco South Quadrangle and no other data regarding depth to ground water was encountered during our literature search; therefore, no historical high ground water data is currently available. We estimate depth to ground water is on the order of greater than 20 feet. Fluctuations in the level of the ground water may occur due to variations in rainfall, underground drainage patterns, and other factors not evident at the time of our exploration.

3.0 CONCLUSIONS AND DEVELOPMENT CONSIDERATIONS

3.1 Conclusions

From a geotechnical engineering viewpoint the proposed Parking Lot 10 improvements may be constructed as planned, provided design and construction are performed in accordance with the recommendations presented in this report. A discussion regarding the potential causes of observed movement of the FMC existing portable is in Section 6.0 below. The primary geotechnical concerns for Parking Lot 10 are discussed below.

3.1.1 Expansion Potential of Surficial Soils

As discussed above some of the near-surface clays have moderate to high plasticity and expansion potential. To reduce the potential for damage to the Parking Lot 10 planned structures, we recommend that slabs-on-grade have sufficient reinforcement and be supported on a layer of non-expansive fill, and that footings be deepened to be below the zone of seasonal moisture content changes. Detailed recommendations are presented in the following sections of this report.

3.1.2 Undocumented Fill

Our exploratory borings EB-1 to EB-3 encountered fill consisting of medium dense to dense sand with varying amounts of fines and gravel and very stiff to hard clay to depths of 10, 5, and 3 feet, respectively. We understand no buildings are planned and the improvements consist only of light and bus shelter structures and asphalt concrete pavement. Therefore, the undocumented fill may stay in place subsequent to reworking as described below. Please refer to the following Subgrade Preparation section in this report for further recommendations.

3.2 Plans, Specifications, and Construction Review

Because subsurface conditions may vary from those encountered in our borings, and to verify that our recommendations have been properly implemented, we recommend that we be retained to 1) review final construction plans and specifications and 2) observe the earthwork and foundation construction. Also, geotechnical conditions can be affected by the construction process. For the above reasons our geotechnical recommendations are contingent upon our firm providing geotechnical observation and testing services during construction.

4.0 EARTHWORK

4.1 Clearing and Site Preparation

The site should be cleared of all surface and subsurface improvements to be removed and deleterious materials including slabs, irrigation lines, pavements, and debris. Abandonment of existing buried utilities is discussed below. Excavations extending below the planned finished site grades should be cleaned and backfilled with suitable material compacted as recommended in the “Compaction” section of this report. We recommend that backfilling of holes or pits resulting from demolition and removal of buried structures be carried out under our observation and that backfill be tested during placement.

After clearing, any vegetated areas should be stripped to sufficient depth to remove all surface vegetation and topsoil containing greater than 3 percent organic matter by weight. At the time of our field investigation, we estimated that a stripping depth of approximately three inches would be required in vegetated areas. The actual stripping depth required depends on site usage prior to construction and should be established in the field by us at the time of construction. The stripped materials should be removed from the site or may be stockpiled for use in landscaped areas, if desired.

4.2 Removal of Existing Fill

We understand no buildings are planned and the improvements consist only of light and bus shelter structures and asphalt concrete pavement. The undocumented fill encountered in our borings may stay in place. Please refer to the following Subgrade Preparation section in this report for further recommendations.

4.3 Abandoned Utilities

Existing underground utilities should be removed or abandoned in-place by grouting or plugging the ends with concrete. The decision to abandon in-place versus removal should be based on the level of risk associated with the particular utility line.

It should be noted that fills associated with underground utilities abandoned in-place may have an increased potential for settlement, and partially grouted or plugged pipelines will have a potential risk of collapse that may result in ground settlement, soil piping, and leakage of pipeline constituents. The potential risks are relatively low for small diameter pipes (4 inches or less) and increasingly higher with increasing diameter.

4.4 Subgrade Preparation

After the site has been properly cleared, stripped, and necessary excavations have been made, exposed surface soils in those areas to receive fill or pavements should be scarified to a depth of 12 inches, moisture conditioned, and compacted in accordance with the recommendations for fill presented in the “Compaction” section. Larger equipment will be needed to scarify and compact to a depth of 12 inches.

The finished compacted subgrade should be firm and non-yielding under the weight of compaction equipment. If the relative compaction of the subgrade is less than recommended or the surface of the subgrade has significant yielding, then the area should be over-excavated and rebuilt or reworked until the subgrade conforms to our recommendations.

4.5 Material for Fill

All on-site soils below the stripped layer having an organic content of less than 3 percent by weight are suitable for use as fill at the site. In general, fill material should not contain rocks or lumps larger than 6 inches in greatest dimension, with 15 percent or less larger than 2½ inches in the greatest dimension.

Imported and non-expansive fill material should be inorganic and should have a Plasticity Index of 15 or less. Imported fill should have sufficient binder to reduce the potential for sidewall caving of foundation and utility trenches. Samples of proposed import fill should be submitted to us at least four days prior to delivery to the site to allow for visual review and laboratory testing. This will allow us to evaluate the general conformance of the import fill with our recommendations. It should be noted, that laboratory testing can take up to ten days to complete.

Consideration should also be given to the environmental characteristics and corrosion potential of any imported fill. Suitable documentation should be provided for import material. In addition, it may be appropriate to perform laboratory testing of the environmental characteristics and corrosion potential of imported materials. Import soils should not be more corrosive than the on-site native materials, including pH, soluble sulfates, chlorides, and resistivity.

4.6 Compaction

All fill, as well as scarified surface soils in those areas to receive fill or slabs-on-grade, should be compacted to at least 90 percent relative compaction as determined by ASTM Test Designation D1557, latest edition, at a moisture content at least 1 percent over laboratory optimum, except for the native expansive clays. The native expansive clays should be compacted to between 87 and 92 percent relative compaction at a moisture content at least 3 percent over optimum. Fill should be placed in lifts no greater than 8 inches in uncompacted thickness. Each successive lift should be firm and non-yielding under the weight of construction equipment.

In pavement areas, the upper 12 inches of subgrade and full depth of aggregate base should be compacted to at least 95 percent relative compaction (ASTM D1557, latest edition), except for the native clays, which should be compacted as noted above. Aggregate base and all import soils should be compacted at a moisture content near the laboratory optimum.

4.7 Wet Weather Conditions

It should be understood that earthwork may be very difficult during wet weather, especially for fill materials with a significant amount of clay. If the percent water in the fill increases significantly above the optimum moisture content, the soils will become soft, yielding, and difficult to compact. Therefore, we recommend that earthwork be performed during periods of suitable weather conditions, such as the “summer” construction season.

There are several alternatives to facilitate fill placement if earthwork is performed during the wet winter season, and the moisture content of the fill materials increases significantly above optimum moisture.

- Scarify and air dry until the fill materials have a suitable moisture content for compaction
- Over-excavation the fill and replace with suitable on-site or import materials with an appropriate moisture content.
- Install a geo-synthetic (geotextile or geogrid) to reduce surface yielding and reinforce soft fill

The implementation of these methods should be reviewed on a case-by-case basis so that a cost effective approach may be used for the specific conditions at the time of construction.

4.8 Trench Backfill

Bedding and pipe embedment materials to be used around underground utility pipes should be well graded sand or gravel conforming to the pipe manufacturer’s recommendations and should be placed and compacted in accordance with project specifications, local requirements or governing jurisdiction. General fill to be used above pipe embedment materials should be placed and compacted in accordance with local requirements or the recommendations contained in this section, whichever is more stringent.

On-site soils may be used as general fill above pipe embedment materials provided they meet the requirements of the “Material for Fill” section of this report. General fill should be placed in lifts not exceeding 8 inches in uncompacted thickness and should be compacted to at least 90 percent relative compaction (ASTM D1557, latest edition) by mechanical means only. Water jetting of trench backfill should not be allowed. The upper 6 inches of general fill in all pavement areas subject to wheel loads should be compacted to at least 95 percent relative compaction.

Utility trenches located adjacent to footings should not extend below an imaginary 1:1 (horizontal:vertical) plane projected downward from the footing bearing surface to the bottom edge of the trench. Where utility trenches will cross beneath footing bearing planes, the footing concrete should be deepened to encase the pipe or the utility trench should be backfilled with sand/cement slurry or lean concrete within the foundation bearing plane.

4.9 Temporary Slopes and Trench Excavations

The contractor should be responsible for all temporary slopes and trenches excavated at the site and design of any required temporary shoring. Shoring, bracing, and benching should be performed by the contractor in accordance with the strictest governing safety standards.

4.10 Surface Drainage

Positive surface water drainage gradients (2 percent minimum) should be provided adjacent to the structures to direct surface water away from foundations and slabs towards suitable discharge facilities. Ponding of surface water should not be allowed on or adjacent to structures, slabs-on-grade, or pavements. Roof runoff should be directed away from foundation and slabs-on-grade. Downspouts may discharge onto splash-blocks provided the area is covered with concrete slabs or asphalt concrete pavements.

4.11 Landscaping Considerations

As some of the near-surface soils are highly expansive, we recommend greatly restricting the amount of surface water infiltrating these soils near structures and slabs-on-grade. This may be accomplished by:

- Selecting landscaping that requires little or no watering, especially within 3 feet of structures, slabs-on-grade, or pavements,
- Using low precipitation sprinkler heads,
- Regulating the amount of water distributed to lawn or planter areas by installing timers on the sprinkler system,
- Providing surface grades to drain rainfall or landscape watering to appropriate collection systems and away from structures, slabs-on-grade, or pavements,
- Preventing water from draining toward or ponding near building foundations, slabs-on-grade, or pavements, and
- Avoiding open planting areas within 3 feet of the building perimeter.

We recommend that the landscape architect consider these items when developing the landscaping plans.]

4.12 Construction Observation

A representative from our company should observe and test the geotechnical aspects of the grading and earthwork for general conformance with our recommendations including, site preparation, selection of fill materials, and the placement and compaction of fill. To facilitate your construction schedule we request sufficient notification (48 hours) for site visits. The project plans and specifications should incorporate all recommendations contained in the text of this report.

5.0 FOUNDATIONS

The structures may be supported on footings or drilled piers as discussed in the following sections.

5.1 Footings

The proposed light and bus shelter structures may be supported on conventional continuous and/or isolated spread footings bearing on natural, undisturbed soil or compacted fill. All footings should have a minimum width of 12 inches and should extend at least 18 inches below lowest adjacent finished grade. Lowest adjacent finished grade may be taken as the bottom of interior slab-on-grade or the finished exterior grade, excluding landscape topsoil, whichever is lower. Because of the moderate to high expansion potential of the near-surface soils, we recommend this relatively deeper footing to place the bearing surfaces below the zone of significant moisture fluctuation in order to reduce the effects of shrinkage.

Footings constructed in accordance with the above recommendations would be capable of supporting maximum allowable bearing pressures of 2,000 pounds per square foot (psf) for dead loads, 3,000 psf for combined dead and live loads, and 4,000 psf for all loads including wind or seismic. These allowable bearing pressures are based upon factors of safety of 3.0, 2.0, and 1.5 for dead, dead plus live, and seismic loads, respectively.

These maximum allowable bearing pressures are net values; the weight of the footing may be neglected for design purposes. All footings located adjacent to utility trenches should have their bearing surfaces below an imaginary 1:1 (horizontal:vertical) plane projected upward from the bottom edge of the trench to the footing.

All continuous footings should be reinforced with top and bottom steel to provide structural continuity and to help span local irregularities. Footing excavations should be kept moist by regular sprinkling with water to prevent desiccation. We consider it essential that we observe the all footing excavations before reinforcing steel is placed.

Structural loads were not available for our review at the time of our investigation. Therefore, we assumed column dead plus live loads on the order of 50 kips for our settlement analysis. Based on these loads and the maximum allowable bearing pressures recommended above, we estimate that the total footing static settlement should be less than approximately ½-inch with maximum post-construction differential movement across columns of ¼-inch. We should be retained to review the final foundation plans and structural loads to confirm the above settlement estimates.

Lateral loads may be resisted by friction between the footings and the supporting subgrade. A maximum allowable frictional resistance of 0.3 may be used for design. In addition, lateral resistance may be provided by passive pressure acting against foundations poured neat against competent soil. We recommend that an allowable passive pressure based on an equivalent fluid pressure of 300 pounds per cubic foot (pcf) be used in design. The upper 12 inches of soil should be neglected when calculating lateral passive resistance unless covered by concrete slabs or pavements.

5.2 Friction Piers

Alternatively, the proposed lights and bus shelter structures may be supported on drilled cast-in-place, straight-shaft friction piers. The piers should have a minimum diameter of at least 12 inches and extend at least 5 feet below the existing ground surface. Piers may be designed for an allowable skin friction of 300 pounds per square foot (psf) for combined dead plus live loads with a one-third increase allowed for either transient wind or seismic loading. Piers should have a minimum center-to-center spacing of at least three pier diameters.

Resistance to uplift loads will be developed in friction along the pier shafts. We recommend that an allowable uplift frictional resistance of 180 psf be used.

Lateral loads exerted on the structure supported on piers may be resisted by a passive resistance based on an equivalent fluid pressure of 300 pounds per cubic foot (pcf) acting against two times the projected diameters of the individual pier shaft below rough pad grade, with a maximum of 1,500 psf at depth. The upper 12 inches of soil should be neglected when determining the lateral capacity of the piers.

The bottoms of pier excavations should be dry, reasonably clean, and free of loose soil before reinforcing steel is installed and concrete is placed. We recommend that the excavation of all piers be performed under our direct observation to establish that the piers are founded in suitable materials and constructed in accordance with the recommendations presented in this report.

Total settlement for the recommended pier foundations should not exceed ¼-inch and post construction differential settlement across the shade structure on piers should be less than ¼-inch due to static loads.

6.0 PAVEMENTS

6.1 Asphalt Concrete

We obtained representative bulk samples of the surface soils from the proposed Parking Lot 10 and performed an R-value test to provide data for pavement design. The results of the test indicate an R-value of 20. We judge an R-value of 20 to be applicable for design. Using estimated traffic indices for various pavement-loading requirements, we developed the following recommended pavement sections based on Procedure 608 of the Caltrans Highway Design Manual, presented in Table 1 below.

Table 1. Recommended Asphalt Concrete Pavement Design Alternatives
Pavement Components
Design R–Value = 20

General Traffic Condition	Design Traffic Index	Asphalt Concrete (Inches)	Aggregate Baserock* (Inches)	Total Thickness (Inches)
Automobile Parking	4.0	2.5	5.5	8.0
	4.5	2.5	7.0	9.5
Automobile Parking Channel	5.0	3.0	7.0	10.0
	5.5	3.0	9.0	12.0
Truck Access & Parking Areas	6.0	3.5	9.5	13.0
	6.5	4.0	10.5	14.5

*Caltrans Class 2 aggregate base; minimum R-value equal to 78.

The traffic indices used in our pavement design are considered reasonable values for the proposed development and should provide a pavement life of approximately 20 years with a normal amount of flexible pavement maintenance. Because the native soils at the site are moderately expansive, some increased maintenance and reduction in pavement life can be expected. The traffic parameters used for design were selected based on engineering judgment and not on information furnished to us such as an equivalent wheel load analysis or a traffic study.

6.2 Portland Cement Concrete Pavements

Recommendations for Portland Cement Concrete (PCC) pavements are presented below in Table 2. Since the expected Average Daily Truck Traffic (ADTT) is not known at this time, we have provided alternatives for minimum pavement thickness. An allowable ADTT should be chosen that is greater than expected for the development.

Table 2. Recommended Minimum PCC Pavement Thickness

Allowable ADTT*	Minimum PCC Pavement Thickness (inches)
4	5
57	5½
480	6

*ADTT (average daily truck traffic, two directions, excluding two-axle four-tire trucks).

Our design is based on an R-value of 20 and a 28-day unconfined compressive strength for concrete of at least 3,500 pounds per square inch. In addition, our design assumes that pavements are restrained laterally by a concrete shoulder or curb and that all PCC pavements are underlain by at least 6 inches of Class 2 aggregate base. We recommend that adequate construction and control joints be used in design of the Portland Cement Concrete pavements to control the cracking inherent in this construction.

6.3 Pavement Cut-off

Surface water infiltration beneath pavements could significantly reduce the pavement design life. While the amount of reduction in pavement life is difficult to quantify, in our opinion, the normal design life of 20 years may be reduced to less than 10 years. Therefore, long-term maintenance greater than normal may be required.

To limit the need for additional long-term maintenance, it would be beneficial to protect at-grade pavements from landscape water infiltration by means of a concrete cut-off wall, deepened curbs, “Deep-Root Moisture Barrier,” or equivalent. However, if reduced pavement life and greater than normal pavement maintenance are acceptable, the cut-off barrier may be eliminated. If desired to install pavement cut-off barriers, they should be considered where pavement areas lie downslope of any landscape areas that are to be sprinkled or irrigated, and should extend to a depth of at least 4 inches below the base rock layer.

6.4 Asphalt Concrete, Aggregate Base and Subgrade

Asphalt concrete and aggregate base should conform to and be placed in accordance with the requirements of Caltrans Standard Specifications, latest edition, except that ASTM Test Designation D1557 should be used to determine the relative compaction of the aggregate base. Pavement subgrade should be prepared and compacted as described in our typical “Earthwork” section of our report.

6.5 Exterior Concrete Sidewalks and Flatwork

Exterior concrete sidewalks and flatwork should be at least 4 inches thick and underlain by at least 6 inches of Class 2 aggregate base compacted to a minimum of 90 percent relative compaction in accordance with ASTM Test Method D1557, latest edition. If concrete sidewalks or flatwork are subject to wheel loads, they should be designed in accordance with the “Portland Cement Concrete Pavements” section of this report.

7.0 FMC PORTABLE

7.1 Conclusions

It appears the portable is supported on perimeter foundations. Based on the floor level survey the raised floor does not appear to be level; there is approximately 1½ inches of elevation difference across the floor. Our exploratory boring performed next to the portable encountered weathered bedrock at the surface with low plasticity and expansion potential; therefore, the possibility of heave from expansive surficial soils is relatively low. Also because of the shallow bedrock encountered the likelyhood of settlement from compressible soils is also low. However, as discussed in the surface section above, ponding of surface water was observed along the southwest side of the portable.

Based on our exploration and floor survey there does not appear to be a major geotechncial cause for the building to not be level. We recommend releveling the raised floor/building in the process of improving the FMC portable. In addition, we recommend improving the existing surface drainage in accordance with the Surface Drainage section in this report.

8.0 LIMITATIONS

This report has been prepared for the sole use of the San Mateo County Community College District, specifically for design of the planned Parking Lot 10 and FMC Portable improvements at the Skyline College campus in San Bruno, California. The opinions presented in this report have been formulated in accordance with generally accepted geotechnical engineering practices that exist in the San Francisco Bay Area at the time this report was prepared. No other warranty, expressed or implied, is made or should be inferred. We are not responsible for data presented by others.

The opinions, conclusions and recommendations contained in this report are based upon information obtained from explorations at widely separated locations, site reconnaissance, review of data made available to us, and upon local experience and engineering judgment. The recommendations presented in this report are based on the assumption that soil and geologic conditions at or between borings do not deviate substantially from those encountered. In addition, geotechnical issues may arise that are not apparent at this time.

The geotechnical engineer should be retained to review final plans and specifications when they are available to verify these documents are consistent with the intent of the geotechnical recommendations. The recommendations provided in this report are based on the assumption that we will be retained to provide observation and testing services during construction in order to evaluate compliance with our recommendations. If we are not retained for these services, TRC cannot assume any responsibility for any potential claims that may arise during or after construction as a result of misuse or misinterpretation of TRC's report by others. Furthermore, TRC will cease to be the Geotechnical-Engineer-of-Record at the time another consultant is retained for follow-up service to this report.

The opinions presented in this report are valid as of the present date for the property evaluated. Changes in the condition of a property can occur with the passage of time, whether due to natural processes or the works of man, on this or adjacent properties. In addition, changes in applicable standards of practice can occur, whether from legislation or the broadening of knowledge. Accordingly, the opinions presented in this report may be invalidated, wholly or partially, by changes outside of our control. Therefore, this report is subject to review and should not be relied upon after a period of three years, nor should it be used, or is it applicable, for any property other than that evaluated.

9.0 REFERENCES

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State of California Department of Transportation, 1990, *Highway Design Manual*, Fifth Edition, July 1, 1990.

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TRC, 2007b, *Updated Geotechnical Investigation and Geologic Hazard Evaluation, Skyline College Facilities Maintenance Center, San Bruno, California*, unpublished consultant's report dated April 16, 2007.

TRC, 2007c, *Geotechnical Investigation and Geologic Hazards Evaluation, Skyline College Building 4, San Bruno, California*, unpublished consultant's report dated July 17, 2008.

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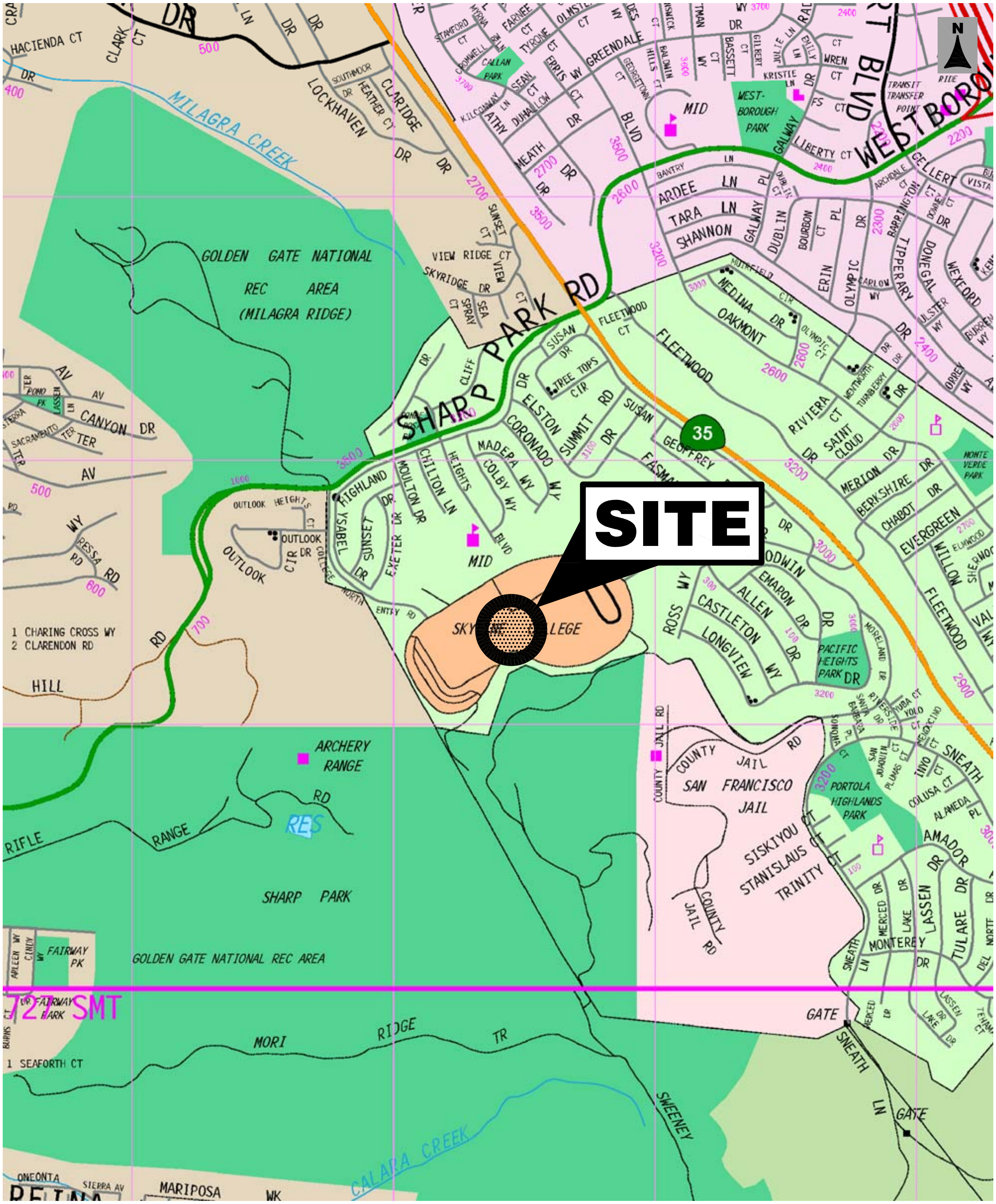

3/09*EB

VICINITY MAP

SKYLINE COLLEGE PARKING LOT 10 AND FMC PORTABLE
San Bruno, California

FIGURE 1
166904

LEGEND

● - Approximate location of exploratory boring

Base by Unknown.

SITE PLAN

SKYLINE COLLEGE PARKING LOT 10
AND FMC PORTABLE
San Bruno, California

TRC

FIGURE 2

166904

3/09*EB

LEGEND

◑ - Approximate location of exploratory boring

fg - Franciscan greenstone (Cretaceous-Jurassic)

Base by Sandis Humber Jones, dated 6-12-02.

SITE PLAN
SKYLINE COLLEGE PARKING LOT 10
AND FMC PORTABLE
San Bruno, California

FIGURE 2A

166904

4/07*EB

APPENDIX A

FIELD INVESTIGATION

The field investigation consisted of a surface reconnaissance and a subsurface exploration program using a conventional, truck-mounted, hollow-stem auger drilling equipment. Four exploratory borings were drilled on March 13, 2009 to maximum depths of 7½ to 15 feet. The approximate locations of the exploratory borings are shown on the Site Plan, Figure 2. The soils encountered were logged in the field by our representative and described in accordance with the Unified Soil Classification System (ASTM D2488). The boring logs, as well as the keys to the classification of soil and rock, are included as part of this appendix.

The locations of the borings were approximately determined by pacing from existing structures and site boundaries. Elevations of the borings were not determined. The locations of the borings should be considered accurate only to the degree implied by the method used.

Representative soil samples were obtained from the borings at selected depths. All samples were returned to our laboratory for evaluation and appropriate testing. Modified-California sampler (2.5-inch I.D.) penetration resistance blow counts were recorded while dropping a 140-pound hammer through a 30-inch free fall. The sampler was driven 18 inches or to 50 blows for 6 inches or less of penetration, whichever occurred first, and the number of blows was recorded for each 6 inches or less of penetration (ASTM D1586). Unless otherwise indicated, the blows per foot recorded on the boring logs represent the accumulated number of blows required to drive the last 12 inches or the inches of penetration noted. The sampler type is denoted at the appropriate depth on the boring log and symbolized as shown on Figure A-1.

Field tests included an evaluation of the unconfined compressive strength of the soil samples using a pocket penetrometer device. The results of these tests are presented on individual boring logs at the appropriate sample depths.

The attached boring logs and related information depict subsurface conditions at the location indicated and on the date designated on the logs. Subsurface conditions at other locations may differ from conditions occurring at these boring locations. The passage of time may result in altered subsurface conditions due to environmental changes. In addition, any stratification lines on the log represent the approximate boundary between soil types and the transition may be gradual.

* * * * * * * * * * * * *

PRIMARY DIVISIONS			SOIL TYPE		SECONDARY DIVISIONS
COARSE GRAINED SOILS MORE THAN HALF OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	GRAVELS MORE THAN HALF OF COARSE FRACTION IS LARGER THAN NO. 4 SIEVE	CLEAN GRAVELS (Less than 5% Fines)	GW		Well graded gravels, gravel–sand mixtures, little or no fines
			GP		Poorly graded gravels or gravel–sand mixtures, little or no fines
		GRAVEL WITH FINES	GM		Silty gravels, gravel–sand–silt mixtures, plastic fines
			GC		Clayey gravels, gravel–sand–clay mixtures, plastic fines
	SANDS MORE THAN HALF OF COARSE FRACTION IS SMALLER THAN NO. 4 SIEVE	CLEAN SANDS (Less than 5% Fines)	SW		Well graded sands, gravelly sands, little or no fines
			SP		Poorly graded sands or gravelly sands, little or no fines
		SANDS WITH FINES	SM		Silty sands, sand–silt–mixtures, non–plastic fines
			SC		Clayey sands, sand–clay mixtures, plastic fines
FINE GRAINED SOILS MORE THAN HALF OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE	SILTS AND CLAYS LIQUID LIMIT IS LESS THAN 50 %		ML		Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity
			CL		Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
			OL		Organic silts and organic silty clays of low plasticity
	SILTS AND CLAYS LIQUID LIMIT IS GREATER THAN 50 %		MH		Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts
			CH		Inorganic clays of high plasticity, fat clays
			OH		Organic clays of medium to high plasticity, organic silts
HIGHLY ORGANIC SOILS			PT		Peat and other highly organic soils

DEFINITION OF TERMS

U.S. STANDARD SIEVE SIZE — CLEAR SQUARE SIEVE OPENINGS

200 40 10 4 3/4" 3" 12"

SILTS AND CLAY	SAND			GRAVEL		COBBLES	BOULDERS
	FINE	MEDIUM	COARSE	FINE	COARSE		

0.08 0.4 2 5 19 76mm

GRAIN SIZES

☒	TERZAGHI SPLIT SPOON STANDARD PENETRATION
⧗	MODIFIED CALIFORNIA
▯	ROCK CORE
▮	PITCHER TUBE
○	NO RECOVERY

SAMPLERS

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

RELATIVE DENSITY

SILTS AND CLAYS	STRENGTH+	BLOWS/FOOT*
VERY SOFT	0–1/4	0–2
SOFT	1/4–1/2	2–4
MEDIUM STIFF	1/2–1	4–8
STIFF	1–2	8–16
VERY STIFF	2–4	16–32
HARD	OVER 4	OVER 32

CONSISTENCY

*Number of blows of 140 pound hammer falling 30 inches to drive a 2–inch O.D. (1–3/8 inch I.D.) split spoon (ASTM D–1586).
+Unconfined compressive strength in tons/sq.ft. as determined by laboratory testing or approximated by the standard penetration test (ASTM D–1586), pocket penetrometer, torvane, or visual observation.

KEY TO EXPLORATORY BORING LOGS

Unified Soil Classification System (ASTM D–2487)

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FIGURE A–1

WEATHERING

FRESH	Rock fresh, crystals bright, few joints may show slight staining. Rock rings under hammer if cystalline.	**MODERATELY SEVERE**	All rock except quartz, discolored or stained. In granitoid rocks, all feldspars dull and discolored and majority show kaolinization. Rock shows severe loss of strength and can be excavated with geologist's pick. Rock goes "clunk" when struck.
VERY SLIGHT	Rock generally fresh, joints stained, some joints may show thin clay coatings, crystals in broken face show bright. Rock rings under hammer if crystalline.	**SEVERE**	All rock except quartz discolored or stained. Rock "fabric" clear and evident, but reduced in strength to strong soil. In granitoid rocks, all feldspars kaolinized to some extent. Some fragments of strong rock usually left.
SLIGHT	Rock generally fresh, joints stained, sand discoloration extends into rock up to 1 inch. Joints may contain clay. In granitoid rocks some occasional feldspar crystals are dull and discolored. Crystalline rocks ring under hammer.	**VERY SEVERE**	All rock except quartz discolored and stained. Rock "fabric" discernible, but mass effectively reduced to "soil" with only fragments of strong rock remaining.
MODERATE	Significant portions of rock show discoloration and weathering effects. In granitoid rocks, most feldspars are dull and discolored; some are clayey. Rock has dull sound under hammmer and shows significant loss of strength as compared with fresh rock.	**COMPLETE**	Rock reduced to "soil". Rock "fabric" not discernible or discernible only in small scattered locations. Quartz may be present as dikes or stringers.

HARDNESS

VERY HARD	Cannot be scratched with knife or sharp pick. Breaking of hand specimens requires several hard blows of geologist's pick.	**MEDIUM**	Can be grooved or gouged 1/16 inch deep by firm pressure on knife or pick point. Can be excavated in small chips to pieces abount 1 inch maximum size by hard blows of the point of a geologist's pick.
HARD	Can be scratched with knife or pick only with difficulty. Hard blow of hammer required to detach hand specimen.	**SOFT**	Can be gouged or grooved readily with knife or pick point. Can be excavated in chips to pieces several inches in size by moderate blows of a pick point. Small thin pieces can be broken by finger pressure.
MODERATELY HARD	Can be scratched with knife or pick. Gouges or grooves to 1/4 inch deep can be excavated by hard blow or point of a geologist's pick. Hard specimen can be detached by moderate blow.	**VERY SOFT**	Can be carved with knife. Can be excavated readily with point of pick. Pieces 1 inch or more in thickness can be broken with finger pressure. Can be scratched readily by fingernail.

JOINT BEDDING AND FOLIATION SPACING IN ROCK*

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

ROCK QUALITY DESIGNATOR (RQD)**

RQD, as a percentage	Diagnostic description
Exceeding 90	Excellent
90–75	Good
75–50	Fair
50–25	Poor
Less than 25	Very poor

*Joint spacing refers to the distance normal to the plane of the joints of a single system or "set" of joints that are parallel to each other or nearly so. The spacing of each "set" should be described, if possible to establish.

**RQD should always be given as a percentage. Diagnostic description is intended primarily for evaluating problems with tunnels or excavation in rock. RQD = 100 (lengths of core in pieces 4 in. and longer/length of run)(1 in. = 25.4 mm; 1 ft. = 0.305 m)

KEY TO BEDROCK DESCRIPTIONS

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FIGURE A–2

EXPLORATORY BORING: EB-1

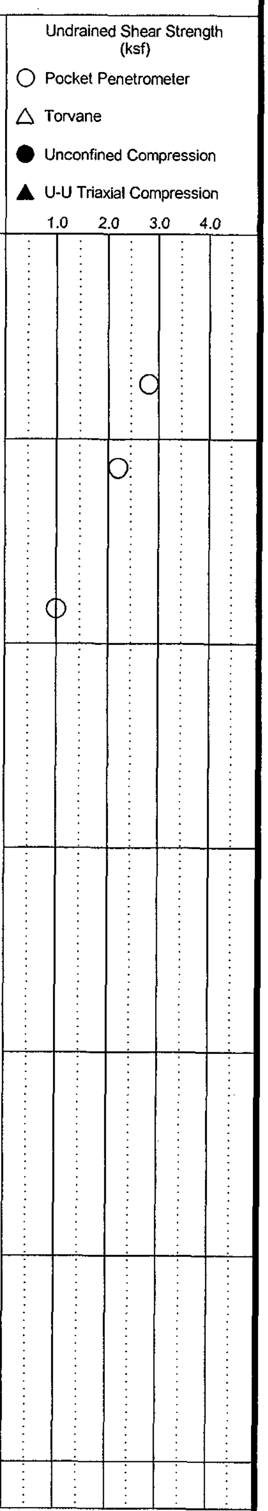
Sheet 1 of 1

DRILL RIG: MOBILE B-53
BORING TYPE: 8-INCH HOLLOW STEM AUGER
LOGGED BY: AC
START DATE: 3-13-09 FINISH DATE: 3-13-09

PROJECT NO: 166904
PROJECT: SKYLINE COLLEGE LOT 10 & FMC
LOCATION: SAN BRUNO, CA
COMPLETION DEPTH: 10.0 FT.

This log is a part of a report by TRC, 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: 635.0 FT. (+/-)	SOIL TYPE	PENETRATION RESISTANCE (BLOWS/FT.)	SAMPLER	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	PERCENT PASSING NO. 200 SIEVE
635.0	0		8 inches aggregate base						
634.3			**SILTY SAND WITH GRAVEL (SM) [FILL]** medium dense, moist, dark brown, fine to coarse sand, fine to coarse subangular to subrounded gravel	SM, FILL	40	⧗	12	115	
632.8			**CLAYEY SAND (SC) [FILL]** medium dense, moist, dark brown fine to coarse sand, some fine subangular to subrounded gravel	SC, FILL	25	⧗	40	80	
630.8	5		**SANDY LEAN CLAY (CL) [FILL]** hard, moist, brown, fine to coarse sand, moderate plasticity	CL, FILL	19	⧗	20	107	
629.0			**SANDY LEAN CLAY (CL) [FILL]** very stiff, moist, dark gray, fine to medium sand, low plasticity, organics, sand lenses	CL, FILL	26	⧗	19	109	
625.0	10		Bottom of Boring at 10 feet						
	15								
	20								
	25								
	30								



GROUND WATER OBSERVATIONS:
NO FREE GROUND WATER ENCOUNTERED

TRC

EXPLORATORY BORING: EB-2

Sheet 1 of 1

DRILL RIG: MOBILE B-53
BORING TYPE: 8-INCH HOLLOW STEM AUGER
LOGGED BY: AC
START DATE: 3-13-09 FINISH DATE: 3-13-09

PROJECT NO: 166904
PROJECT: SKYLINE COLLEGE LOT 10 & FMC
LOCATION: SAN BRUNO, CA
COMPLETION DEPTH: 10.0 FT.

This log is a part of a report by TRC, 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)	MATERIAL DESCRIPTION AND REMARKS SURFACE ELEVATION: 635.0 FT. (+/-)	SOIL TYPE	PENETRATION RESISTANCE (BLOWS/FT.)	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	PERCENT PASSING NO. 200 SIEVE	Undrained Shear Strength (ksf) 1.0 2.0 3.0 4.0
635.0	0	3 inches aggregate base						
634.7		**POORLY GRADED SAND WITH SILT (SP-SM) [FILL]** medium dense, moist, olive gray with white mottles, fine to coarse sand	SP-SM, FILL	42	8	128		
632.5		**SILTY SAND WITH GRAVEL (SM) [FILL]** dense, moist, brown, fine to coarse sand, fine subangular to subrounded gravel	SM, FILL	56	8	127		
630.0	5	**CLAYEY SAND WITH GRAVEL (SC)** dense, moist, brown, fine to coarse sand, fine to coarse subangular to subrounded gravel	SC	52	11	127		
				47	6	113		○
625.3 625.0	10	**SANDY LEAN CLAY (CL)** very stiff, moist, brown, fine to coarse sand, some fine subangular to subrounded gravel, moderate plasticity Bottom of Boring at 10 feet	CL					
	15							
	20							
	25							
	30							

GROUND WATER OBSERVATIONS:
NO FREE GROUND WATER ENCOUNTERED

LA CORP.GDT 4/2/09 MV* AHT

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EXPLORATORY BORING: EB-3

Sheet 1 of 1

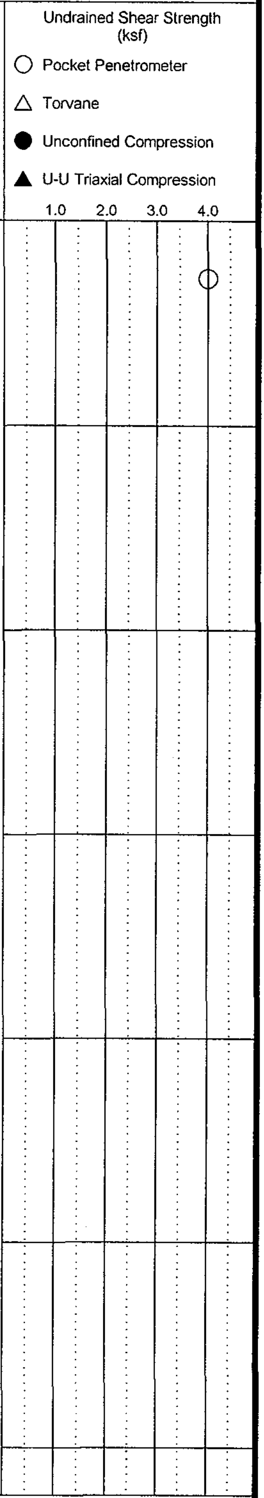
DRILL RIG: MOBILE B-53
BORING TYPE: 8-INCH HOLLOW STEM AUGER
LOGGED BY: AC
START DATE: 3-13-09 FINISH DATE: 3-13-09

PROJECT NO: 166904
PROJECT: SKYLINE COLLEGE LOT 10 & FMC
LOCATION: SAN BRUNO, CA
COMPLETION DEPTH: 15.0 FT.

This log is a part of a report by TRC, 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: 635.0 FT. (+/-)

ELEVATION (FT)	DEPTH (FT)	SOIL LEGEND	MATERIAL DESCRIPTION AND REMARKS	SOIL TYPE	PENETRATION RESISTANCE (BLOWS/FT.)	SAMPLER	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	PERCENT PASSING NO. 200 SIEVE
635.0	0	▩	**LEAN CLAY (CL) [FILL]** hard, moist, brownish gray, trace fine sand, low to moderate plasticity	CL, FILL	33	⧗	20	97	
633.3		▩	**FAT CLAY (CH) [FILL]** hard, moist, dark brown, fine to coarse sand, trace fine subangular to subrounded gravel Liquid Limit = 53, Plasticity Index = 30	CH, FILL	34	⧗	11	130	14
632.3		▨							
	5	▨	**CLAYEY SAND WITH GRAVEL (SC)** medium dense, moist, brown, fine to coarse sand, fine subangular to subrounded gravel olive	SC	32	⧗	9	133	
		▨	dense sand lens		65	⧗	15	124	
	10	▨	light brown						
		▨			75	⧗	14	121	
620.0	15		Bottom of Boring at 15 feet						
	20								
	25								
	30								



GROUND WATER OBSERVATIONS:
NO FREE GROUND WATER ENCOUNTERED

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EXPLORATORY BORING: EB-1A

Sheet 1 of 1

DRILL RIG: MOBILE B-53
BORING TYPE: 8-INCH HOLLOW STEM AUGER
LOGGED BY: AC
START DATE: 3-13-09 FINISH DATE: 3-13-09

PROJECT NO: 166904
PROJECT: SKYLINE COLLEGE LOT 10 & FMC
LOCATION: SAN BRUNO, CA
COMPLETION DEPTH: 7.5 FT.

This log is a part of a report by TRC, 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.

MATERIAL DESCRIPTION AND REMARKS

SURFACE ELEVATION: 699.0 FT. (+/-)

ELEVATION (FT)	DEPTH (FT)	SOIL LEGEND	MATERIAL DESCRIPTION AND REMARKS	SOIL TYPE	PENETRATION RESISTANCE (BLOWS/FT.)	SAMPLER	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	PERCENT PASSING NO. 200 SIEVE
699.0	0		**FRANCISCAN FORMATION (Fs) - Greenstone** very severely weathered to CLAYEY SAND WITH GRAVEL (SC), very dense, moist, light brown, fine to coarse sand, fine subangular gravel Liquid Limit = 35, Plasticity Index = 12		54	⧓	9	127	
					50/5"	⧓	13	123	
	5				50/5"	⊠	9		
					50/5"	⊠	12		
691.5			Bottom of Boring at 7½ feet						
	10								
	15								
	20								
	25								
	30								

Undrained Shear Strength (ksf)

○ Pocket Penetrometer
△ Torvane
● Unconfined Compression
▲ U-U Triaxial Compression

1.0 2.0 3.0 4.0

GROUND WATER OBSERVATIONS:
NO FREE GROUND WATER ENCOUNTERED

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APPENDIX B

LABORATORY PROGRAM

The laboratory-testing program was directed toward a quantitative and qualitative evaluation of the physical and mechanical properties of the soils and bedrock underlying the site and to aid in verifying soil classification.

Moisture Content: The natural water content was determined (ASTM D2216) on 17 samples of the materials recovered from the borings. These water contents are recorded on the boring logs at the appropriate sample depths.

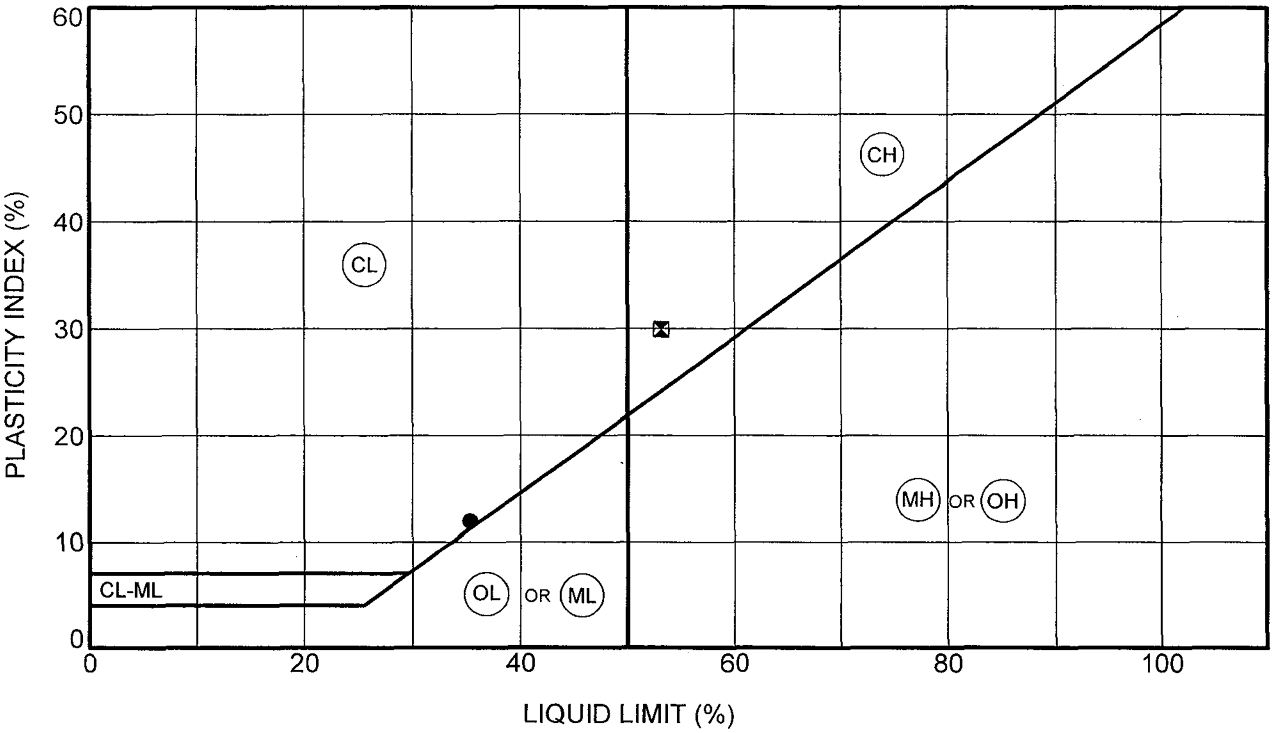
Dry Densities: In place dry density determinations (ASTM D2937) were performed on 15 samples to measure the unit weight of the subsurface soils. Results of these tests are shown on the boring logs at the appropriate sample depths.

Plasticity Index: Plasticity Index (PI) tests (ASTM D4318) were performed on two samples of the subsurface soils to measure the range of water contents over which these materials exhibit plasticity. The Plasticity Index was used to classify the soil in accordance with the Unified Soil Classification System and to evaluate the soil expansion potential. Results of these tests are presented on Figure B-1 and on the logs of the borings at the appropriate sample depths.

R-Value: An R-value resistance test (California Test Method No. 301) was performed on one representative sample of the surface soils at the site to provide data for the pavement design. The test indicated an R-value of 20 at an exudation pressure of 300 pounds per square inch.

Washed Sieve Analyses: The percent soil fraction passing the No. 200 sieve (ASTM D1140) was determined on one samples of the subsurface soil to aid in the classification of these soils. Results of this test are shown on the boring logs at the appropriate sample depth.

* * * * * * * * * * * * *



Symbol	Boring No.	Depth (ft.)	Natural Water Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Passing No. 200 Sieve	Unified Soil Classification Description
●	**EB-1A**	**2.0**	**9**	**35**	**23**	**12**		**SANDY LEAN CLAY (CL)**
☒	**EB-3**	**2.0**	**20**	**53**	**23**	**30**		**FAT CLAY (CH)**

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PLASTICITY CHART AND DATA

Project: SKYLINE COLLEGE LOT 10 & FMC

Location: SAN BRUNO, CA

Project No.: 166904

COOPER
TESTING LABORATORY

R-value Test Report (Caltrans 301)

Job No.: 028-2186
Client: TRC
Project: Skyline College Lot 10 & FMC - 166904
Sample EB-3 @ 2.0'
Soil Type: Brown Clayey SAND w/ Gravel

Date: 03/24/09
Tested MD
Reduced RU
Checked DC

Initial Moisture, 8.0%
R-value by Stabilometer 20
Expansion Pressure 0 psf

Remarks:

Specimen Number	A	B	C	D
Exudation Pressure, psi	558	255	302	
Prepared Weight, grams	1200	1200	1200	
Final Water Added, grams/cc	35	55	45	
Weight of Soil & Mold, grams	3176	3275	3233	
Weight of Mold, grams	2096	2120	2104	
Height After Compaction, in.	2.3	2.57	2.46	
Moisture Content, %	11.2	13.0	12.1	
Dry Density, pcf	127.9	120.4	124.0	
Expansion Pressure, psf	0.0	0.0	0.0	
Stabilometer @ 1000				
Stabilometer @ 2000	91	130	116	
Turns Displacement	3.12	3.74	3.54	
R-value	33	14	21