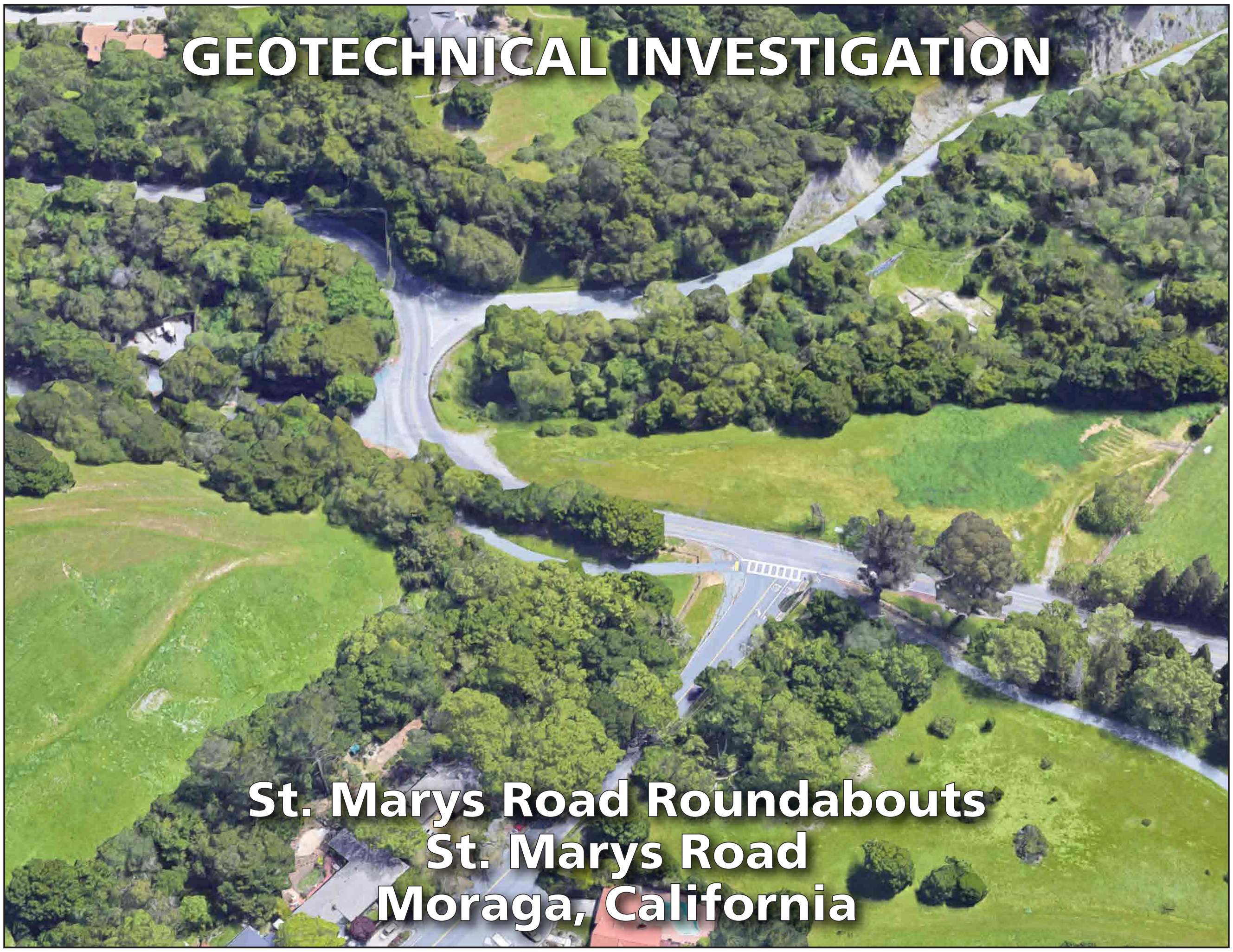

PREPARED FOR:

KIMLEY-HORN
4637 CHABOT DRIVE, SUITE 300
PLEASANTON, CA 94588

PREPARED BY:

GEOCON CONSULTANTS, INC.
6671 BRISA STREET
LIVERMORE, CALIFORNIA 94550

GEOCON PROJECT NO. E8980-04-01 **JUNE 2019**

Project No. E8980-04-01
June 19, 2019

Kimley-Horn
4637 Chabot Drive, Suite 300
Pleasanton, California 94588

Attention: Ms. Prasanna Muthireddy

Subject: ST. MARY'S ROAD ROUNDABOUTS
ST. MARY'S ROAD AT RHEEM BOULEVARD AND BOLLINGER CANYON ROAD
MORAGA, CALIFORNIA
GEOTECHNICAL INVESTIGATION

Dear Ms. Muthireddy:

In accordance with your authorization, we have performed a geotechnical investigation for the subject project in Moraga, California. Our investigation was performed to observe the soil and geologic conditions that may impact site development for the project as presently planned. The accompanying report presents the results of our investigation and conclusions and recommendations pertaining to the geotechnical aspects of the proposed project. The findings of this study indicate the site is suitable for development as planned provided the recommendations of this report are implemented during design and construction.

If you have any questions regarding this report, or if we may be of further service, please contact the undersigned at your convenience.

Sincerely,

GEOCON CONSULTANTS, INC.

DRAFT

Shane Rodacker, PE, GE
Senior Engineer

DRAFT

Jacob Bishop-Moser, EIT
Senior Staff Engineer

(1/e-mail) Addressee

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GEOTECHNICAL INVESTIGATION

1. PURPOSE AND SCOPE

This report presents the results of a geotechnical investigation for roadway improvements on St. Mary's Road between Rheem Boulevard and Bollinger Canyon Road in Moraga, California (see Vicinity Map, Figure 1). The purpose of this investigation was to evaluate the subsurface soil and geologic conditions in the area of planned development and provide conclusions and recommendations pertaining to the geotechnical aspects of project design and construction, based on the conditions encountered during our study.

The scope of this investigation included field exploration, laboratory testing, engineering analysis and the preparation of this report. Our field exploration was performed on May 7, 2019 and included the drilling of 6 exploratory borings to depths of approximately 20 ¼ feet or less. The locations of the soil borings are depicted on the Site Plan, Figure 2. A detailed discussion of our field investigation and soil boring logs are presented in Appendix A.

Laboratory tests were performed on selected soil samples obtained during the investigation to evaluate pertinent geotechnical parameters. Appendix B presents the laboratory test results in tabular format and graphical format.

The opinions expressed herein are based on analysis of the data obtained during the investigation and our experience with similar soil and geologic conditions. References reviewed to prepare this report are provided in the *List of References* section.

If project details vary significantly from those described herein, Geocon should be contacted to determine the necessity for review and possible revision of this report.

2. SITE CONDITIONS AND PROJECT DESCRIPTION

The area of improvement is St. Mary's Road adjacent to and between the intersections with Rheem Boulevard and Bollinger Canyon Road in Moraga. St. Mary's Road is a single lane of travel in each direction with paved shoulders three feet or less in width within the limits of the project. Rheem Boulevard is a single lane of travel in each direction but the eastbound direction widens to form two turn lanes as it approaches St. Mary's Road. Bollinger Canyon Road is a single lane of travel in each direction, but a paved triangular median area diverges a sweeping right turn from northbound St. Mary's Road. Las Trampas Creek is conveyed beneath St. Mary's Road just west of Bollinger Canyon Road via a concrete box culvert. A crude wooden retaining wall was observed in the slope above the culvert outfall on the southeastern side of St. Mary's Road. Topographically, the site generally descends from the east and west toward Las Trampas Creek, which flows north to south within the project limits. The slope at the culvert outfall is approximately 25 feet high with overall inclinations on the order of 1½:1 (horizontal:vertical).

Based on the topographic and layout information provided by Kimley-Horn, we understand the proposed project will include the construction of a roundabout at the intersection of St. Mary's Road and Rheem Boulevard and smaller roundabout at the intersection of St. Mary's Road and Bollinger Canyon Road. Roadway widening will be required at the approaches to the roundabouts for each of the subject streets, including a significant widening on the south side of St. Mary's Road at Rheem Boulevard. Additionally, a new retaining wall will be constructed on the south side of St. Mary's Road, near the top of the slope that descends to Las Trampas Creek. The new retaining wall is to be 85 linear feet and have a retained height of 3 to 4 feet. Grading plans were not provided, but we anticipate cuts and fills of two feet or less to attain design subgrade elevations throughout the project.

3. GEOLOGIC SETTING

Available geologic mapping by the United States Geological Survey (USGS) indicates most of the site is underlain by Holocene-age alluvium. The southeastern margin of the project area, generally where Bollinger Canyon Road extends away from St. Mary's Road, is underlain by Pliocene-age Orinda Formation.

4. SOIL AND GROUNDWATER CONDITIONS

4.1 Artificial Fill

Our soil borings B1 through B3 encountered undocumented fills (surfacing materials) that remain from a construction yard associated with a recent PG&E gas transmission line project. The fills extended to depths of approximately 18 inches less below existing grade. As observed in our soil borings, the fill materials consisted of loose, coarse gravel. Artificial fill may exist in other areas not described herein. For example, previous grading operations for St. Mary's Road likely included fills across the Las Trampas Creek drainage and backfills for the existing box culvert.

4.2 Alluvium

Geologic references map Holocene-age alluvium through much of the project area. As encountered in our borings B1 through B4 and B6, the alluvial materials were observed as medium stiff to very stiff fat clays with variable amounts of silt and/or sand. The alluvial materials extended to a depth of approximately 16 ½ feet below existing grade in our Boring B1.

4.3 Orinda Formation

Geologic references map Orinda Formation in the southeastern margin of the project area. As encountered in our Borings B1 and B5, the formational materials were observed as fractured and moderately weathered to weathered claystone with interbedded sand layers. The formational materials were encountered at/near existing grade in Boring B5 and at a depth of approximately 16 ½ feet in Boring B1 - below the alluvial deposits described above. Our Boring B1 encountered Orinda Formation to the maximum depth explored – approximately 20 ½ feet below existing grade.

4.4 Groundwater

Groundwater was not encountered in our soil borings. Actual groundwater levels will fluctuate seasonally and with variations in rainfall, temperature and other factors and may be higher or lower than observed during our study.

4.5 Soil Corrosion Screening

A soil sample obtained during our field exploration was subjected to laboratory testing for minimum resistivity, pH, and chloride and water-soluble sulfate. The laboratory test results and published screening levels are presented in Appendix B. Soil corrosivity should be considered in the design of buried metal pipes, underground structures, etc.

Water-soluble sulfate test results on selected samples of site soils indicate an S0 exposure classification for sulfate attack on normal portland cement concrete (PCC) as defined in Chapter 318, Table 19.3.1.1 of the ACI *Building Code Requirements for Structural Concrete*. ACI does not set forth requirements for S0 sulfate exposure classification. In addition, the soil sample that we tested would not be classified as corrosive to buried metal improvements based on Caltrans criteria.

Geocon does not practice in the field of corrosion engineering and mitigation. If corrosion sensitive improvements are planned, it is recommended that a corrosion engineer be retained to evaluate corrosion test results and incorporate the necessary precautions to avoid premature corrosion of buried metal pipes and concrete structures in direct contact with the soils.

5. CONCLUSIONS AND RECOMMENDATIONS

5.1 General

5.1.1 No overriding geotechnical constraints were encountered during our investigation that would preclude the project as presently proposed.

5.1.2 Based on the assumed structural loading and site topography, we anticipate the planned retaining wall will be supported by cast-in-drilled-hole (CIDH) piles. Other foundation types may be feasible but should be reviewed case-by-case once project design plans are available.

5.1.3 The proposed project redevelops a site with past episodes of grading and construction. As such, unknown underground improvements and areas of undocumented fill materials (not discussed herein) may be present; if encountered, supplemental recommendations will be provided during site development.

5.1.4 Project grading plans were not available at the time of this report. Once available, the grading plans should be provided for our review and possible revisions to this report. Any changes in the design, location or elevation of the proposed improvements, as outlined in this report, should be reviewed by this office.

5.2 Soil and Excavation Characteristics

5.2.1 The onsite alluvial soils can generally be excavated with moderate effort using conventional excavation equipment. Excavation in formational materials may require heavy effort; drilled shafts for CIDH piles may require heavy effort or special equipment where formational materials are encountered. Excavations in formational materials may generate oversize material (greater than 6 inches in nominal dimension). Unknown or unanticipated constituents may exist, especially within areas of artificial fill. Below-grade improvements associated with prior site development may also be present.

5.2.2 It is the responsibility of the contractor to ensure that all excavations and trenches are properly shored and maintained in accordance with applicable Occupational Safety and Health Administration (OSHA) rules and regulations to maintain safety and maintain the stability of adjacent existing improvements.

5.2.3 The materials encountered at the site should be considered “expansive” as defined by 2016 CBC. (Expansion Index of 20 or higher). The recommendations of this report assume proposed foundation systems will derive support in properly compacted fills and/or competent native soils. Our laboratory test results from samples of onsite soils correlate with medium to high expansion potential, based on local geotechnical engineering practice.

5.3 Materials for Fill

5.3.1 Soils generated from cut operations or foundation excavations at the site are suitable for use as engineered fill in structural areas provided they do not contain deleterious matter, organic material, or cementations larger than 6 inches in maximum dimension. Excavated soils may be wet and require drying prior to use as engineered fill.

5.3.2 Import and low-expansive fill material should be primarily granular with a “low” expansion potential (Expansion Index less than 50), a Plasticity Index less than 15, be free of organic material and construction debris, and not contain rock larger than 6 inches in greatest dimension.

5.3.3 Environmental characteristics and corrosion potential of import soil materials may also be considered. Proposed import materials should be sampled, tested, and approved by Geocon prior to its transportation to the site.

5.4 Grading

5.4.1 All clearing operations and earthwork (including over-excavation, scarification, and recompaction) should be observed and all fills tested for recommended compaction and moisture content by representatives of Geocon.

5.4.2 A preconstruction conference should be held at the site prior to the beginning of grading operations with the Town, contractor, civil engineer and geotechnical engineer in attendance. Special soil handling requirements can be discussed at that time.

5.4.3 Site preparation should commence with the removal of all existing improvements from the area to be graded. All active or inactive utilities within the construction area should be protected, relocated, or abandoned. Any pipelines to be abandoned that are greater than 2 inches and less than 18 inches in diameter should be removed or filled with sand-cement slurry. Utilities larger than 18 inches in diameter should be removed. Excavations or depressions resulting from demolition and site clearing operations, or other existing excavations or depressions, should be restored with engineered fill in accordance with the recommendations of this report.

5.4.4 If not removed by proposed cuts to establish subgrade elevations, the existing fills at the site should be over-excavated to expose competent native soils. The resultant over-excavation bottom should then be scarified to a depth of approximately 1 foot, moisture conditioned to at least 2% above optimum moisture and recompacted to at least 90% relative compaction.

5.4.5 In general, over-excavated materials may be used for engineered fill. The open-graded gravel present at the former PG&E construction yard would require blending with native soils if re-used as fill. Over-excavations and the exposed bottom surfaces and bottom processing should be observed by our representatives. Supplemental recommendations may be provided based on site conditions during grading.

5.4.6 Lime treatment may be implemented to improve the pavement support characteristics of site soils and improve the durability of finished subgrade with the respect to wet weather conditions and construction traffic. For planning purposes, it should be assumed that subgrade soils would be treated with approximately 5% lime by dry weight to a depth of at least 12 inches. The lime material should be Hi-Calcium quicklime and an in-place soil density of 110 pounds per cubic foot may be assumed. Lime-treatment should include two mixing periods with both mixes to the same depth. The second mixing should occur approximately 24 hours after initial mixing. Lime-treated soils should be compacted to at least 90% relative compaction.

5.4.7 All structural fill and backfill should be placed in layers no thicker than will allow for adequate bonding and compaction (typically 8 to 12 inches). Fill soils should be placed and compacted to at least 90% relative compaction at least 2% above optimum moisture. Fill areas with in-place density tests showing moisture contents less than those recommended may require additional moisture conditioning prior to placing additional fill.

5.5 Temporary Excavations

5.5.1 The native alluvium can be considered a Type B soil in accordance with OSHA guidelines. Where free water, sandy or cohesionless soils or undocumented fills are encountered the materials should be downgraded to Type C. The contractor should have a “competent person” as defined by OSHA evaluate all excavations. All onsite excavations must be conducted in such a manner that potential surcharges from existing structures, construction equipment, and vehicle loads are resisted. The surcharge area may be defined by a 1:1 projection down and away from the bottom of an existing foundation or vehicle load. Penetrations below this 1:1 projection will require special excavation measures such as sloping and possibly shoring.

5.5.2 It is the contractor's responsibility to provide sufficient and safe excavation support as well as protecting nearby utilities, structures, and other improvements that may be damaged by earth movements.

5.6 Retaining Walls

5.6.1 Lateral earth pressures may be used for the design of the planned retaining wall. Lateral earth pressures against the wall may be assumed to be equal to the pressure exerted by an equivalent fluid. The unit weight of the equivalent fluid depends on the design conditions. Table 5.6 summarizes the weights of the equivalent fluid based on the different design conditions.

TABLE 5.6
RECOMMENDED LATERAL EARTH PRESSURES

Condition	Equivalent Fluid Density
Active	60 pcf
At-Rest	80 pcf

5.6.2 Unrestrained walls should be designed using the active case. Unrestrained walls are those that are allowed to rotate more than 0.01H (where H is the height of the wall). The above soil pressures assume level backfill under drained conditions within an area bounded by the wall and a 1:1 plane extending upward from the base of the wall and no surcharges within that same area. Where the ground surface is sloped behind the retaining wall at 2:1 or flatter, an additional 15 pcf should be added to the equivalent fluid density values recommended above.

5.6.3 Retaining walls greater than 2 feet tall (retained height) should be provided with a drainage system adequate to prevent the buildup of hydrostatic forces. Positive drainage for retaining walls should consist of a vertical layer of permeable material positioned between the retaining wall and the soil backfill. The permeable material may be composed of a composite drainage geosynthetic or a natural permeable material such as crushed gravel at least 12 inches thick and capped with at least 12 inches of native soil. A geosynthetic filter fabric should be placed between the gravel and the soil backfill. Provisions for removal of collected water should be provided for either system by installing a perforated drainage pipe along the bottom of the permeable material which leads to suitable drainage facilities.

5.6.4 Retaining walls may be supported by CIDH piles designed and constructed as recommended in below in Section 5.7.

5.7 CIDH Piles

5.7.1 Drilled cast-in-place, straight-shaft concrete piles should be a minimum of 18 inches in diameter and embedded at least 10 feet below the ground surface. The project structural engineer should determine the actual embedment depth based on design loads.

5.7.2 Piers should have a minimum center-to-center spacing of at least three pier diameters. Axial compression capacity may be designed using an allowable skin friction of 300 psf within the alluvial materials and 400 psf within the formational materials. The allowable axial capacity may be increased by one-third when considering transient wind or seismic loads. Where not protected by pavement, the upper two feet of soil should be ignored when calculating axial capacity.

6.6.3 Passive soil pressure resistance against lateral movement can be based upon an equivalent passive soil fluid weight of 250 pcf, and 350 pcf where within formational materials. The passive resistance can be assumed to act over a width of two pile diameters. Where not protected by pavement, the upper one foot of soil should be ignored when calculating passive soil resistance. Passive soil resistance should also be ignored where less than 10 feet of cover (measured horizontally) exists between the drilled shaft and a slope face.

5.8 Underground Utilities

5.8.1 Underground utility trenches should be backfilled with properly compacted material. The material excavated from the trenches should be adequate for use as backfill provided it does not contain deleterious matter, vegetation or rock larger than six inches in maximum dimension. Trench backfill should be placed in loose lifts not exceeding eight inches and should be compacted to at least 90% relative compaction at least 2% above optimum moisture (near optimum where backfill materials are predominantly sands and/or gravels).

5.8.2 Bedding and pipe zone backfill typically extends from the bottom of the trench excavations to a minimum of 6 inches above the crown of the pipe. Pipe bedding material should consist of crushed aggregate, clean sand or similar open-graded material. Proposed bedding and pipe zone materials should be reviewed by Geocon prior to construction; open-graded materials such as ¾ inch drain rock may require wrapping with filter fabric to mitigate the potential for piping. Pipe bedding and backfill should also conform to the requirements of the governing utility agency.

5.9 Exterior Flatwork

5.9.1 Exterior slabs, not subject to traffic loads, should be at least 4 inches thick and reinforced with No. 3 steel reinforcing bars placed 18 inches on center in both horizontal directions, positioned near the slab midpoint. Due to expansive soils conditions, we recommend that at least 6 inches of Class 2 Aggregate Base (AB) compacted to at least 90% relative compaction be used below exterior concrete slabs. Prior to placing AB, the subgrade should be moisture conditioned to at least 2% above optimum and properly compacted to at least 90% relative compaction.

5.9.2 In lieu of specific recommendations from the structural or civil engineer, we recommend that crack control joints be spaced at intervals not greater than 8 feet for 4-inch-thick slabs (10 feet for 5-inch slabs). Crack control joints should extend a minimum depth of one-fourth the slab thickness and should be constructed using saw-cuts or other methods as soon as practical after concrete placement.

5.9.3 The recommendations of this report are intended to reduce the potential for cracking of slabs due to soil movement. However, even with the incorporation of the recommendations presented herein, foundations, stucco walls, and slabs-on-grade may exhibit some cracking due to soil movement. This is common for project areas that contain expansive soils since designing to eliminate potential soil movement is cost prohibitive. The occurrence of concrete shrinkage cracks is independent of the supporting soil characteristics. Their occurrence may be reduced and/or controlled by limiting the slump of the concrete, proper concrete placement and curing, and by the placement of crack control joints at periodic intervals, in particular, where re-entrant slab corners occur.

5.10 Pavement Recommendations

5.10.1 The upper 12 inches of pavement subgrade should be scarified, moisture conditioned to at least 2% above optimum and compacted to at least 92% relative compaction (near optimum and at least 95% relative compaction if subgrade soils are lime-treated or comprised of import soils). Prior to placing aggregate base, the finished subgrade should be proof-rolled with a laden water truck (or similar equipment with high contact pressure) to verify stability.

5.10.2 Curb, gutter, and driveway encroachments should be designed and constructed in accordance with Town of Moraga requirements, as applicable.

5.10.3 We recommend the following asphalt concrete (AC) pavement sections for design to establish subgrade elevations in pavement areas. The project civil engineer should determine the appropriate Traffic Index (TI) based on anticipated traffic conditions. The flexible pavement sections below are based on estimated design TIs and an R-Value of 5 for the subgrade soils. We can provide additional sections based on other TIs if necessary.

TABLE 5.10
FLEXIBLE PAVEMENT SECTION RECOMMENDATIONS

Estimated Traffic Index	Alternative #1		Alternative #2		
	AC (inches)	AB (inches)	AC (inches)	AB (inches)	LTS (inches)
6.0	3 ½	10	3	4	12
7.0	4	12 ½	3½	4	12
8.0	4 ½	15	4	5	12

Note: The recommended flexible pavement sections are based on the following assumptions:

1. Subgrade soil has an R-Value of 5.
2. AB: Class 2 AB with a minimum R-Value of 78 and meeting the requirements of Section 26 of the latest Caltrans Standard Specifications.
3. AB is compacted to 95% or higher relative compaction at or near optimum moisture content. Prior to placing AB, the subgrade should be proof-rolled with a loaded water truck to verify stability.
4. AC: Asphalt concrete conforming to local agency standards or Section 39 of the latest Caltrans Standard Specifications.
5. LTS: Lime-treated subgrade per Section 5.4.

5.10.4 The AC sections in Table 5.10 are final, minimum thicknesses. If staged-pavements are used, the construction bottom AC lift should be at least 2 inches thick. Following construction, the finish top AC lift should be at least 1½ inches thick.

5.10.5 The performance of pavements is highly dependent upon providing positive surface drainage away from the edge of pavements. Ponding of water on or adjacent to the pavement will likely result in saturation of the subgrade materials and subsequent cracking, subsidence and pavement distress. If planters are planned adjacent to paving, it is recommended that the perimeter curb be extended at least 6 inches below the bottom of the aggregate base to minimize the introduction of water beneath the paving. Alternatives such as plastic moisture cut-offs or modified drop-inlets may also be considered in lieu of deepened curbs.

5.11 Surface Drainage

5.11.1 Proper surface drainage is critical to the future performance of the project. Uncontrolled infiltration of irrigation excess and storm runoff into the soils can adversely affect the performance of the planned improvements. Saturation of a soil can cause it to lose internal shear strength and increase its compressibility, resulting in a change to important engineering properties. Proper drainage should be maintained at all times.

5.11.2 All site drainage should be collected and transferred to the street in non-erosive drainage devices. Drainage should not be allowed to pond anywhere on the site, and especially not against any foundations or retaining walls. Drainage should not be allowed to flow uncontrolled over any descending slope. Planters which are located adjacent to foundations should be sealed or properly drained to prevent moisture intrusion into the materials providing foundation support.

5.11.3 Positive site drainage should be provided away from structures, pavement, and the tops of slopes to swales or other controlled drainage structures. Final soil grade should slope a minimum of 2% away from structures.

5.11.4 We recommend implemented measures to reduce infiltrating surface water near slabs-on-grade. Such measures may include:

- Selecting drought-tolerant plants that require little or no irrigation, especially within 5 feet of slabs-on-grade or pavements.
- Using drip irrigation or low-output sprinklers.
- Using automatic timers for irrigation systems.
- Appropriately spaced area drains.

6. FURTHER GEOTECHNICAL SERVICES

6.1 Plan and Specification Review

6.1.1 We should review project plans and specifications prior to final design submittal to assess whether our recommendations have been properly implemented and evaluate if additional analysis and/or recommendations are required.

6.2 Testing and Observation Services

6.2.1 The recommendations provided in this report are based on the assumption that we will continue as Geotechnical Engineer of Record throughout the construction phase and provide compaction testing and observation services and foundation observations throughout the project. It is important to maintain continuity of geotechnical interpretation and confirm that field conditions encountered are similar to those anticipated during design. If we are not retained for these services, we cannot assume any responsibility for others interpretation of our recommendations, and therefore the future performance of the project.

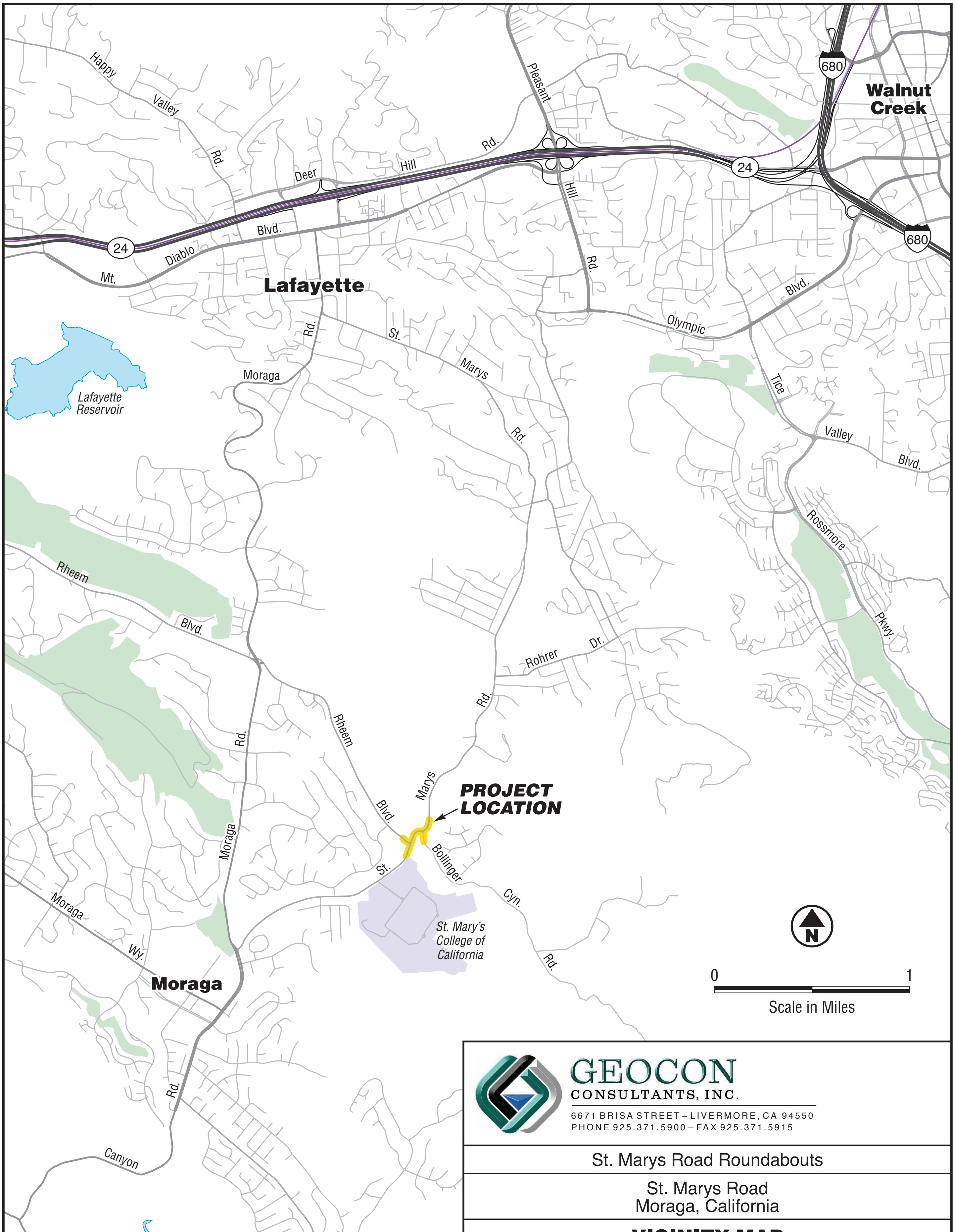
LIMITATIONS AND UNIFORMITY OF CONDITIONS

The recommendations of this report pertain only to the site investigated and are based upon the assumption that the soil conditions do not deviate from those disclosed in the investigation. If any variations or undesirable conditions are encountered during construction, or if the proposed construction will differ from that anticipated herein, Geocon Consultants, Inc. should be notified so that supplemental recommendations can be given. The evaluation or identification of the potential presence of hazardous or corrosive materials was not part of the geotechnical scope of services provided by Geocon Consultants, Inc.

This report is issued with the understanding that it is the responsibility of the owner, or of his representative, to ensure that the information and recommendations contained herein are brought to the attention of the architect and engineer for the project and incorporated into the plans, and the necessary steps are taken to see that the contractor and subcontractors carry out such recommendations in the field.

The findings of this report are valid as of the present date. However, changes in the conditions of a property can occur with the passage of time, whether they are due to natural processes or the works of man on this or adjacent properties. In addition, changes in applicable or appropriate standards may occur, whether they result from legislation or the broadening of knowledge. Accordingly, the findings of this report may be invalidated wholly or partially by changes outside our control. Therefore, this report is subject to review and should not be relied upon after a period of three years.

Our professional services were performed, our findings obtained, and our recommendations prepared in accordance with generally accepted geotechnical engineering principles and practices used in the site area at this time. No warranty is provided, express or implied.



GEOCON
CONSULTANTS, INC.

6671 BRISA STREET – LIVERMORE, CA 94550
PHONE 925.371.5900 – FAX 925.371.5915

St. Marys Road Roundabouts

St. Marys Road
Moraga, California

VICINITY MAP

E8980-04-01	June 2019	Figure 1

LEGEND:

B1 ⊗ Approximate Boring Location

0 — 80

Scale in Feet

GEOCON CONSULTANTS, INC.
6671 BRISA STREET – LIVERMORE, CA 94550
PHONE 925.371.5900 – FAX 925.371.5915

St. Marys Road Roundabouts

St. Marys Road
Moraga, California

SITE PLAN

E8980-04-01	June 2019	Figure 2

APPENDIX A

APPENDIX A
FIELD EXPLORATION

Fieldwork for our investigation included a site visit, subsurface exploration, and soil sampling. The locations of our borings are shown on the Site Plan, Figure 2. Soil boring logs are presented as figures following the text in this appendix. The borings were located by pacing from existing reference points. Therefore, the exploration locations shown on Figure 2 are approximate.

Our subsurface exploration was performed on May 7, 2019 and included the drilling and sampling of existing soils with a truck-mounted Mobile B-53 drill rig equipped with 8-inch hollow-stem augers. Sampling in the borings was accomplished using a 140-pound automatic hammer with a 30-inch drop. Samples were obtained with a 3-inch outside-diameter (OD), split spoon (California Modified) sampler and a 2-inch OD, Standard Penetration Test (SPT) sampler. The number of blows required to drive the sampler the last 12 inches (or fraction thereof) of the 18-inch sampling interval were recorded on the boring logs. The blow counts shown on the boring logs should not be interpreted as standard SPT "N" values; corrections have not been applied. Samples were collected at appropriate intervals, classified by our field engineer, retained in moisture-tight containers, and transported to the laboratory for testing and further classification. The applicable type of each sampling interval is noted on the exploratory boring logs.

Subsurface conditions encountered in the exploratory boring were visually examined, classified and logged in general accordance with the American Society for Testing and Materials (ASTM) Practice for Description and Identification of Soils (Visual-Manual Procedure D2488). This system uses the Unified Soil Classification System (USCS) for soil designations. The log depicts soil and geologic conditions encountered and depths at which samples were obtained. The log also includes our interpretation of the conditions between sampling intervals. Therefore, the logs contain both observed and interpreted data. We determined the lines designating the interface between soil materials on the logs using visual observations, drill rig penetration rates, excavation characteristics and other factors. The transition between materials may be abrupt or gradual. Where applicable, the field logs were revised based on subsequent laboratory testing.

Upon completion, our borings were backfilled per Contra Costa Environmental Health Division permit requirements.

UNIFIED SOIL CLASSIFICATION

MAJOR DIVISIONS					TYPICAL NAMES
COARSE-GRAINED SOILS MORE THAN HALF IS COARSER THAN NO. 200 SIEVE	GRAVELS MORE THAN HALF COARSE FRACTION IS LARGER THAN NO.4 SIEVE SIZE	CLEAN GRAVELS WITH LITTLE OR NO FINES	GW		WELL GRADED GRAVELS WITH OR WITHOUT SAND, LITTLE OR NO FINES
			GP		POORLY GRADED GRAVELS WITH OR WITHOUT SAND, LITTLE OR NO FINES
		GRAVELS WITH OVER 12% FINES	GM		SILTY GRAVELS, SILTY GRAVELS WITH SAND
			GC		CLAYEY GRAVELS, CLAYEY GRAVELS WITH SAND
	SANDS MORE THAN HALF COARSE FRACTION IS SMALLER THAN NO.4 SIEVE SIZE	CLEAN SANDS WITH LITTLE OR NO FINES	SW		WELL GRADED SANDS WITH OR WITHOUT GRAVEL, LITTLE OR NO FINES
			SP		POORLY GRADED SANDS WITH OR WITHOUT GRAVEL, LITTLE OR NO FINES
		SANDS WITH OVER 12% FINES	SM		SILTY SANDS WITH OR WITHOUT GRAVEL
			SC		CLAYEY SANDS WITH OR WITHOUT GRAVEL
FINE-GRAINED SOILS MORE THAN HALF IS FINER THAN NO. 200 SIEVE	SILTS AND CLAYS LIQUID LIMIT 50% OR LESS		ML		INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTS WITH SANDS AND GRAVELS
			CL		INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, CLAYS WITH SANDS AND GRAVELS, LEAN CLAYS
			OL		ORGANIC SILTS OR CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS LIQUID LIMIT 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 OR CLAYS OF MEDIUM TO HIGH PLASTICITY
	HIGHLY ORGANIC SOILS		PT		PEAT AND OTHER HIGHLY ORGANIC SOILS

BORING/TRENCH LOG LEGEND

- No Recovery
- Shelby Tube Sample
- Bulk Sample
- SPT Sample
- Modified California Sample
- Groundwater Level (At Completion)
- Groundwater Level (Seepage)

PENETRATION RESISTANCE

SAND AND GRAVEL			SILT AND CLAY			
RELATIVE DENSITY	BLOWS PER FOOT (SPT)*	BLOWS PER FOOT (MOD-CAL)*	CONSISTENCY	BLOWS PER FOOT (SPT)*	BLOWS PER FOOT (MOD-CAL)*	COMPRESSIVE STRENGTH (tsf)
VERY LOOSE	0 - 4	0 - 6	VERY SOFT	0 - 2	0 - 3	0 - 0.25
LOOSE	5 - 10	7 - 16	SOFT	3 - 4	4 - 6	0.25 - 0.50
MEDIUM DENSE	11 - 30	17 - 48	MEDIUM STIFF	5 - 8	7 - 13	0.50 - 1.0
DENSE	31 - 50	49 - 79	STIFF	9 - 15	14 - 24	1.0 - 2.0
VERY DENSE	OVER 50	OVER 79	VERY STIFF	16 - 30	25 - 48	2.0 - 4.0
			HARD	OVER 30	OVER 48	OVER 4.0

*NUMBER OF BLOWS OF 140 LB HAMMER FALLING 30 INCHES TO DRIVE LAST 12 INCHES OF AN 18-INCH DRIVE

MOISTURE DESCRIPTIONS

FIELD TEST	APPROX. DEGREE OF SATURATION, S (%)	DESCRIPTION
NO INDICATION OF MOISTURE; DRY TO THE TOUCH	$S<25$	DRY
SLIGHT INDICATION OF MOISTURE	$25 \le S < 50$	DAMP
INDICATION OF MOISTURE; NO VISIBLE WATER	$50 \le S < 75$	MOIST
MINOR VISIBLE FREE WATER	$75 \le S < 100$	WET
VISIBLE FREE WATER	100	SATURATED

QUANTITY DESCRIPTIONS

APPROX. ESTIMATED PERCENT	DESCRIPTION
<5%	TRACE
5 - 10%	FEW
11 - 25%	LITTLE
26 - 50%	SOME
>50%	MOSTLY

GRAVEL/COBBLE/BOULDER DESCRIPTIONS

CRITERIA	DESCRIPTION
PASS THROUGH A 3-INCH SIEVE AND BE RETAINED ON A NO. 4 SIEVE (#4 TO 3")	GRAVEL
PASS A 12-INCH SQUARE OPENING AND BE RETAINED ON A 3-INCH SIEVE (3"-12")	COBBLE
WILL NOT PASS A 12-INCH SQUARE OPENING (>12")	BOULDER

BEDDING SPACING DESCRIPTIONS

THICKNESS/SPACING	DESCRIPTOR
GREATER THAN 10 FEET	MASSIVE
3 TO 10 FEET	VERY THICKLY BEDDED
1 TO 3 FEET	THICKLY BEDDED
3 5/8-INCH TO 1 FOOT	MODERATELY BEDDED
1 1/4-INCH TO 3 5/8-INCH	THINLY BEDDED
3/8-INCH TO 1 1/4-INCH	VERY THINLY BEDDED
LESS THAN 3/8-INCH	LAMINATED

STRUCTURE DESCRIPTIONS

CRITERIA	DESCRIPTION
ALTERNATING LAYERS OF VARYING MATERIAL OR COLOR WITH LAYERS AT LEAST 1/4-INCH THICK	STRATIFIED
ALTERNATING LAYERS OF VARYING MATERIAL OR COLOR WITH LAYERS LESS THAN 1/4-INCH THICK	LAMINATED
BREAKS ALONG DEFINITE PLANES OF FRACTURE WITH LITTLE RESISTANCE TO FRACTURING	FISSURED
FRACTURE PLANES APPEAR POLISHED OR GLOSSY, SOMETIMES STRIATED	SLICKENSIDED
COHESIVE SOIL THAT CAN BE BROKEN DOWN INTO SMALLER ANGULAR LUMPS WHICH RESIST FURTHER BREAKDOWN	BLOCKY
INCLUSION OF SMALL POCKETS OF DIFFERENT SOIL, SUCH AS SMALL LENSES OF SAND SCATTERED THROUGH A MASS OF CLAY	LENSED
SAME COLOR AND MATERIAL THROUGHOUT	HOMOGENOUS

CEMENTATION/INDURATION DESCRIPTIONS

FIELD TEST	DESCRIPTION
CRUMBLES OR BREAKS WITH HANDLING OR LITTLE FINGER PRESSURE	WEAKLY CEMENTED/INDURATED
CRUMBLES OR BREAKS WITH CONSIDERABLE FINGER PRESSURE	MODERATELY CEMENTED/INDURATED
WILL NOT CRUMBLE OR BREAK WITH FINGER PRESSURE	STRONGLY CEMENTED/INDURATED

IGNEOUS/METAMORPHIC ROCK STRENGTH DESCRIPTIONS

FIELD TEST	DESCRIPTION
MATERIAL CRUMBLES WITH BARE HAND	WEAK
MATERIAL CRUMBLES UNDER BLOWS FROM GEOLOGY HAMMER	MODERATELY WEAK
1/8-INCH INDENTATIONS WITH SHARP END FROM GEOLOGY HAMMER	MODERATELY STRONG
HAND-HELD SPECIMEN CAN BE BROKEN WITH **ONE** BLOW FROM GEOLOGY HAMMER	STRONG
HAND-HELD SPECIMEN CAN BE BROKEN WITH **COUPLE** BLOWS FROM GEOLOGY HAMMER	VERY STRONG
HAND-HELD SPECIMEN CAN BE BROKEN WITH **MANY** BLOWS FROM GEOLOGY HAMMER	EXTREMELY STRONG

IGNEOUS/METAMORPHIC ROCK WEATHERING DESCRIPTIONS

DEGREE OF DECOMPOSITION	FIELD RECOGNITION	ENGINEERING PROPERTIES
SOIL	DISCOLORED, CHANGED TO SOIL, FABRIC DESTROYED	EASY TO DIG
COMPLETELY WEATHERED	DISCOLORED, CHANGED TO SOIL, FABRIC MAINLY PRESERVED	EXCAVATED BY HAND OR RIPPING (Saprolite)
HIGHLY WEATHERED	DISCOLORED, HIGHLY FRACTURED, FABRIC ALTERED AROUND FRACTURES	EXCAVATED BY HAND OR RIPPING, WITH SLIGHT DIFFICULTY
MODERATELY WEATHERED	DISCOLORED, FRACTURES, INTACT ROCK-NOTICEABLY WEAKER THAN FRESH ROCK	EXCAVATED WITH DIFFICULTY WITHOUT EXPLOSIVES
SLIGHTLY WEATHERED	MAY BE DISCOLORED, SOME FRACTURES, INTACT ROCK-NOT NOTICEABLY WEAKER THAN FRESH ROCK	REQUIRES EXPLOSIVES FOR EXCAVATION, WITH PERMEABLE JOINTS AND FRACTURES
FRESH	NO DISCOLORATION, OR LOSS OF STRENGTH	REQUIRES EXPLOSIVES

IGNEOUS/METAMORPHIC ROCK JOINT/FRACTURE DESCRIPTIONS

FIELD TEST	DESCRIPTION
NO OBSERVED FRACTURES	UNFRACTURED/UNJOINTED
MAJORITY OF JOINTS/FRACTURES SPACED AT 1 TO 3 FOOT INTERVALS	SLIGHTLY FRACTURED/JOINTED
MAJORITY OF JOINTS/FRACTURES SPACED AT 4-INCH TO 1 FOOT INTERVALS	MODERATELY FRACTURED/JOINTED
MAJORITY OF JOINTS/FRACTURES SPACED AT 1-INCH TO 4-INCH INTERVALS WITH SCATTERED FRAGMENTED INTERVALS	INTENSELY FRACTURED/JOINTED
MAJORITY OF JOINTS/FRACTURES SPACED AT LESS THAN 1-INCH INTERVALS; MOSTLY RECOVERED AS CHIPS AND FRAGMENTS	VERY INTENSELY FRACTURED/JOINTED

GEOCON
CONSULTANTS, INC.
6671 BRISA STREET – LIVERMORE, CA 94550
PHONE 925.371.5900 – FAX 925.371.5915

KEY TO LOGS

PROJECT NO. **E8980-04-01** PROJECT NAME: **St. Mary's Road Roundabouts**

BORING B1

ELEV. (MSL.) 553 | DATE COMPLETED 5/7/2019

ENG./GEO. JBM | DRILLER EGI

EQUIPMENT Mobile B53 w/ 8" HSA | HAMMER TYPE Downhole-Wireline

DEPTH IN FEET	SAMPLE NO.	SOIL CLASS (USCS)	MATERIAL DESCRIPTION	PENETRATION RESISTANCE (BLOWS/FT.)	DRY DENSITY (P.C.F.)	MOISTURE CONTENT (%)
0		GP	FILL Loose, dry, gray (c) (angular) GRAVEL with few (f-c) sands			
2	B1-2-7 B1-2.5 B1-3	CH	ALLUVIUM Stiff, moist, black mottled with tan Silty fat CLAY with (f) sand -pp=3-4	18	103.5	21.4
4	B1-4 B1-4.5		-pp=3½-4½	23	108.8	17.2
9	B1-9 B1-9.5		-very stiff, black and dark brown, less silt -pp>4½	26	103.4	17.5 16.8
10			-beige with brown and orange, more sand			
14	B1-14.5		-stiff, dark brown, less sand -pp=2-3 -poor recovery	16		
17	B1-17		ORINDA FORMATION Fractured and weathered, light brown and gray CLAYSTONE with interbedded (f) sand	50/4"		
20	B1-20			50/3"		

END OF BORING AT APPROXIMATELY 20¼ FEET
NO FREE WATER ENCOUNTERED
BACKFILLED WITH GROUT AND RESURFACED WITH GRAVEL

Figure A2, Log of Boring B1, Page 1 of 1

GEOCON BORING LOG E8980-04-01 BORING LOGS.GPJ 06/19/19

GEOCON

SAMPLE SYMBOLS
- ... SAMPLING UNSUCCESSFUL
- ... STANDARD PENETRATION TEST
- ... DRIVE SAMPLE (UNDISTURBED)
- ... DISTURBED OR BAG SAMPLE
- ... CHUNK SAMPLE
- ... WATER TABLE OR SEEPAGE

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING OR TRENCH LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

PROJECT NO. **E8980-04-01** PROJECT NAME: **St. Mary's Road Roundabouts**

BORING B2

ELEV. (MSL.) **584** DATE COMPLETED **5/7/2019**

ENG./GEO. **JBM** DRILLER **EGI**

EQUIPMENT **Mobile B53 w/ 8" HSA** HAMMER TYPE **Downhole-Wireline**

DEPTH IN FEET	SAMPLE NO.	LITHOLOGY	GROUNDWATER	SOIL CLASS (USCS)	MATERIAL DESCRIPTION	PENETRATION RESISTANCE (BLOWS/FT.)	DRY DENSITY (P.C.F.)	MOISTURE CONTENT (%)
0	B2-0-5				Approximately 3 inches of gravel			
				CH	ALLUVIUM			
1					Stiff, moist, gray-brown fat CLAY with little (f) sand			
	B2-1.5				-pp=2½	15		
2	B2-2						94.7	26.3
3								
4	B2-4					21		
	B2-4.5				-pp=3-3½		101.4	23.3
5					END OF BORING AT APPROXIMATELY 5 FEET NO FREE WATER ENCOUNTERED BACKFILLED WITH COMPACTED CUTTINGS			

Figure A3, Log of Boring B2, Page 1 of 1

GEOCON

SAMPLE SYMBOLS

- ... SAMPLING UNSUCCESSFUL
- ... DISTURBED OR BAG SAMPLE
- ... STANDARD PENETRATION TEST
- ... CHUNK SAMPLE
- ... DRIVE SAMPLE (UNDISTURBED)
- ... WATER TABLE OR SEEPAGE

PROJECT NO. **E8980-04-01** PROJECT NAME: **St. Mary's Road Roundabouts**

BORING B3

ELEV. (MSL.) **589** DATE COMPLETED **5/7/2019**

ENG./GEO. **JBM** DRILLER **EGI**

EQUIPMENT **Mobile B53 w/ 8" HSA** HAMMER TYPE **Downhole-Wireline**

DEPTH IN FEET	SAMPLE NO.	LITHOLOGY	GROUNDWATER	SOIL CLASS (USCS)	MATERIAL DESCRIPTION	PENETRATION RESISTANCE (BLOWS/FT.)	DRY DENSITY (P.C.F.)	MOISTURE CONTENT (%)
0					Approximately 3 inches of gravel			
1				CH	ALLUVIUM Stiff, moist, dark brown and gray-brown fat CLAY with (f) sand -pp=2-2½	14		
2	B3-2						99.2	23.8
3								
4	B3-4				-medium stiff -pp=2½-3¼	12		
5	B3-4.5						101.0	23.9

END OF BORING AT APPROXIMATELY 5 FEET
NO FREE WATER ENCOUNTERED
BACKFILLED WITH COMPACTED CUTTINGS

Figure A4, Log of Boring B3, Page 1 of 1

GEOCON BORING LOG E8980-04-01 BORING LOGS.GPJ 06/19/19

GEOCON

SAMPLE SYMBOLS
... SAMPLING UNSUCCESSFUL
... DISTURBED OR BAG SAMPLE
... STANDARD PENETRATION TEST
... CHUNK SAMPLE
... DRIVE SAMPLE (UNDISTURBED)
... WATER TABLE OR SEEPAGE

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING OR TRENCH LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

PROJECT NO. **E8980-04-01** PROJECT NAME: **St. Mary's Road Roundabouts**

BORING B4

ELEV. (MSL.) 583 — DATE COMPLETED 5/7/2019

ENG./GEO. JBM — DRILLER EGI

EQUIPMENT Mobile B53 w/ 8" HSA — HAMMER TYPE Downhole-Wireline

DEPTH IN FEET	SAMPLE NO.	LITHOLOGY	GROUNDWATER	SOIL CLASS (USCS)	MATERIAL DESCRIPTION	PENETRATION RESISTANCE (BLOWS/FT.)	DRY DENSITY (P.C.F.)	MOISTURE CONTENT (%)
0				CH	Approximately 1½ inches of AC			
1					ALLUVIUM Medium stiff, moist, gray-brown fat CLAY with (f) sand -pp=2-3	12		
2	B4-2						96.2	25.9
3								
4	B4-4				-stiff	16		
	B4-4.5				-pp=3-3¾		92.8	30.0
5					END OF BORING AT APPROXIMATELY 5 FEET NO FREE WATER ENCOUNTERED BACKFILLED WITH COMPACTED CUTTINGS AND CAPPED WITH CONCRETE			

Figure A5, Log of Boring B4, Page 1 of 1

GEOCON BORING LOG E8980-04-01 BORING LOGS.GPJ 06/19/19

GEOCON

SAMPLE SYMBOLS

- ... SAMPLING UNSUCCESSFUL
- ... STANDARD PENETRATION TEST
- ... DRIVE SAMPLE (UNDISTURBED)
- ... DISTURBED OR BAG SAMPLE
- ... CHUNK SAMPLE
- ... WATER TABLE OR SEEPAGE

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING OR TRENCH LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

PROJECT NO. **E8980-04-01** PROJECT NAME: **St. Mary's Road Roundabouts**

BORING B5

ELEV. (MSL.) **556** DATE COMPLETED **5/7/2019**

ENG./GEO. **JBM** DRILLER **EGI**

EQUIPMENT **Mobile B53 w/ 8" HSA** HAMMER TYPE **Downhole-Wireline**

DEPTH IN FEET	SAMPLE NO.	LITHOLOGY	GROUNDWATER	SOIL CLASS (USCS)	MATERIAL DESCRIPTION	PENETRATION RESISTANCE (BLOWS/FT.)	DRY DENSITY (P.C.F.)	MOISTURE CONTENT (%)
0					ORINDA FORMATION Fractured and weathered, light brown and gray CLAYSTONE with interbedded (f) sand			
1	B5-1					50/5"	102.6	9.2
2								
3								
	B5-3.5					50/4"		

END OF BORING AT APPROXIMATELY 3¾ FEET
NO FREE WATER ENCOUNTERED
BACKFILLED WITH COMPACTED CUTTINGS

Figure A6, Log of Boring B5, Page 1 of 1

GEOCON BORING LOG E8980-04-01 BORING LOGS.GPJ 06/19/19

GEOCON

SAMPLE SYMBOLS
- ... SAMPLING UNSUCCESSFUL
- ... STANDARD PENETRATION TEST
- ... DRIVE SAMPLE (UNDISTURBED)
- ... DISTURBED OR BAG SAMPLE
- ... CHUNK SAMPLE
- ... WATER TABLE OR SEEPAGE

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING OR TRENCH LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

PROJECT NO. **E8980-04-01** PROJECT NAME: **St. Mary's Road Roundabouts**

BORING B6

ELEV. (MSL.) **565** DATE COMPLETED **5/7/2019**

ENG./GEO. **JBM** DRILLER **EGI**

EQUIPMENT **Mobile B53 w/ 8" HSA** HAMMER TYPE **Downhole-Wireline**

DEPTH IN FEET	SAMPLE NO.	LITHOLOGY	GROUNDWATER	SOIL CLASS (USCS)	MATERIAL DESCRIPTION	PENETRATION RESISTANCE (BLOWS/FT.)	DRY DENSITY (P.C.F.)	MOISTURE CONTENT (%)
0	B6-0-5			CH	ALLUVIUM Stiff, moist, orange-brown and gray-brown (f-c) Sandy fat CLAY -pp=3-4			
1								
2	B6-1.5 B6-2					18	107.3	13.6
3								
4	B6-4.5				-damp -pp=4-4½	14		
5					END OF BORING AT APPROXIMATELY 5 FEET NO FREE WATER ENCOUNTERED BACKFILLED WITH COMPACTED CUTTINGS			

Figure A7, Log of Boring B6, Page 1 of 1

GEOCON

SAMPLE SYMBOLS

- ... SAMPLING UNSUCCESSFUL
- ... DISTURBED OR BAG SAMPLE
- ... STANDARD PENETRATION TEST
- ... CHUNK SAMPLE
- ... DRIVE SAMPLE (UNDISTURBED)
- ... WATER TABLE OR SEEPAGE

APPENDIX B

APPENDIX B
LABORATORY TESTING

Laboratory tests were performed in accordance with generally accepted test methods of the American Society for Testing and Materials (ASTM) or other suggested procedures. Selected samples were tested for grain size distribution, Atterberg Limits, unconfined compressive strength, in-situ dry density and/or moisture content, direct shear, R-Value and screening-level corrosion parameters. The results of our testing are summarized in tabular format below and the following figures. In-situ dry density and moisture content test results are included on the boring logs in Appendix A.

TABLE B-I
SUMMARY OF LABORATORY ATTERBERG LIMITS TEST RESULTS
ASTM D 4318

Sample No.	Liquid Limit	Plastic Limit	Plasticity Index
B1-2.5	55	16	39
B2-1.5	75	20	55

TABLE B-II
SUMMARY OF LABORATORY DIRECT SHEAR TEST RESULTS
ASTM D 3080

Boring No.	Sample Depth (feet)	Initial Average Dry Density (pcf)	Initial Average Moisture Content (%)	Cohesion (psf)	Angle of Shear Resistance (degrees)
B1	9.5	103.4	16.8	150	27

TABLE B-III
SUMMARY OF LABORATORY R-VALUE TEST RESULTS
ASTM D 2844

Sample No.	Soil Type (USCS Classification)	R-Value
B2-0-5	CLAY with little sand (CH)	18
B6-0-5	Sandy CLAY (CH)	21

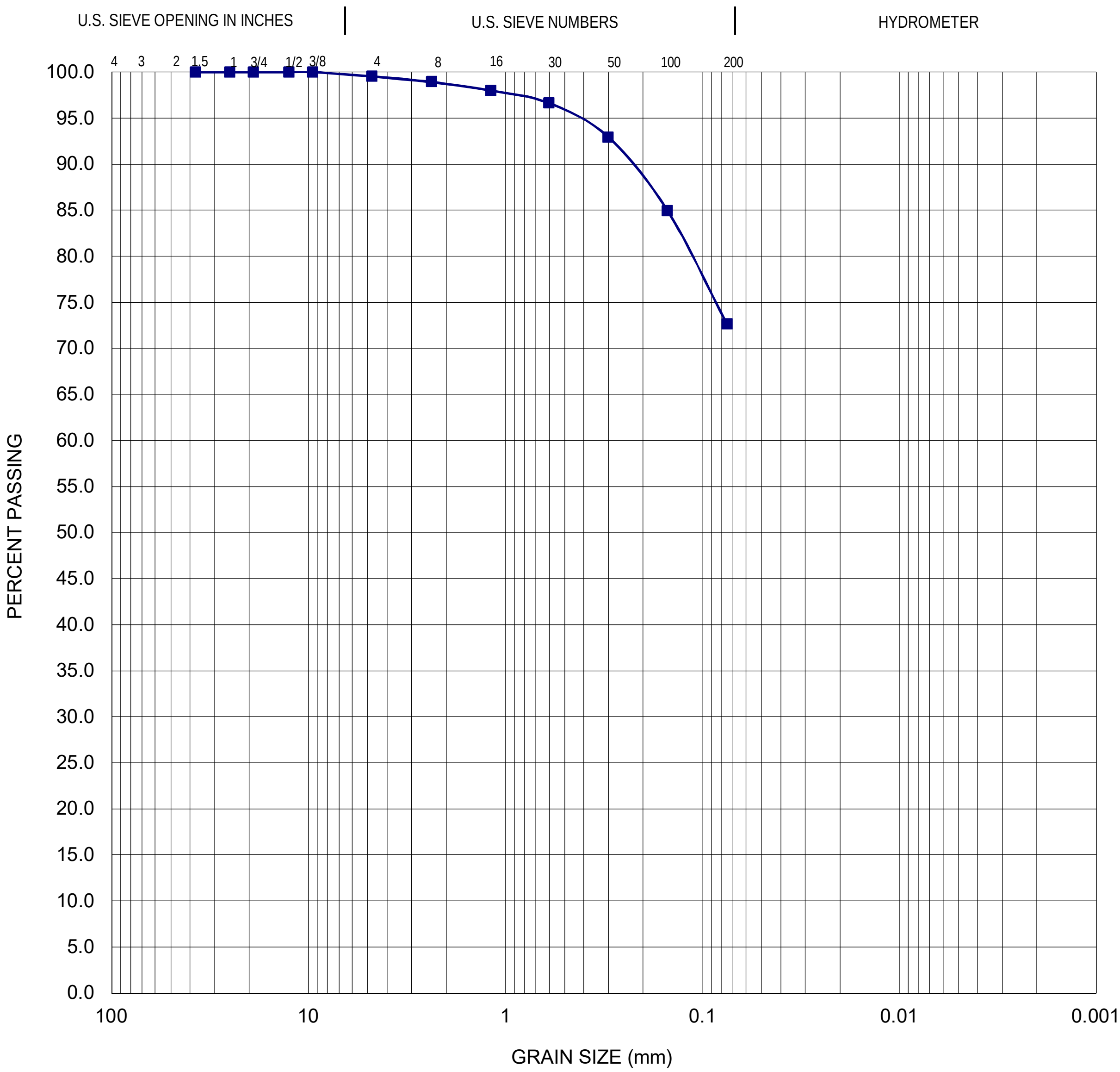
TABLE B-IV
SUMMARY OF SCREENING-LEVEL CORROSION PARAMETERS
AASHTO T291 (CHLORIDE)
CALIFORNIA TEST NO. 643 (pH AND RESISTIVITY) AND 417 (SULFATE)

Boring No. (sample depth in feet)	Soil Type (USCS Classification)	pH	Minimum Resistivity (ohm-cm)	Chloride (ppm)	Water-Soluble Sulfate (ppm)
B1-4	Silty fat CLAY (CH)	7.6	1,100	69	<10

*Caltrans considers a site corrosive to foundation elements if one or more of the following conditions exist for the representative soil samples at the site:

- The pH is equal to or less than 5.5.
- Chloride concentration is equal to or greater than 500 parts per million (ppm) or 0.05%.
- Sulfate concentration is equal to or greater than 1,500 ppm (0.2%)

**According to the American Concrete Institute 318 Chapter 19, Type II cement may be used where sulfate levels are below 2,000 ppm (0.2%)



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Boring: B1

Depth To Sample: 9'

Sieve Date: 5/22/19

Tested and Computed by: AC

Test Data

Sieve Number	1 1/2"	1"	3/4"	1/2"	3/8"	#4	#8	#16	#30	#50	#100	#200
% Passing	100	100	100	100	100	99.5	98.9	98.0	96.6	92.9	84.9	72.6

Geocon Consultants, Inc.
6671 Brisa Street
Livermore, CA 94550
Telephone: (925) 371-5900
Fax: (925) 371-5915

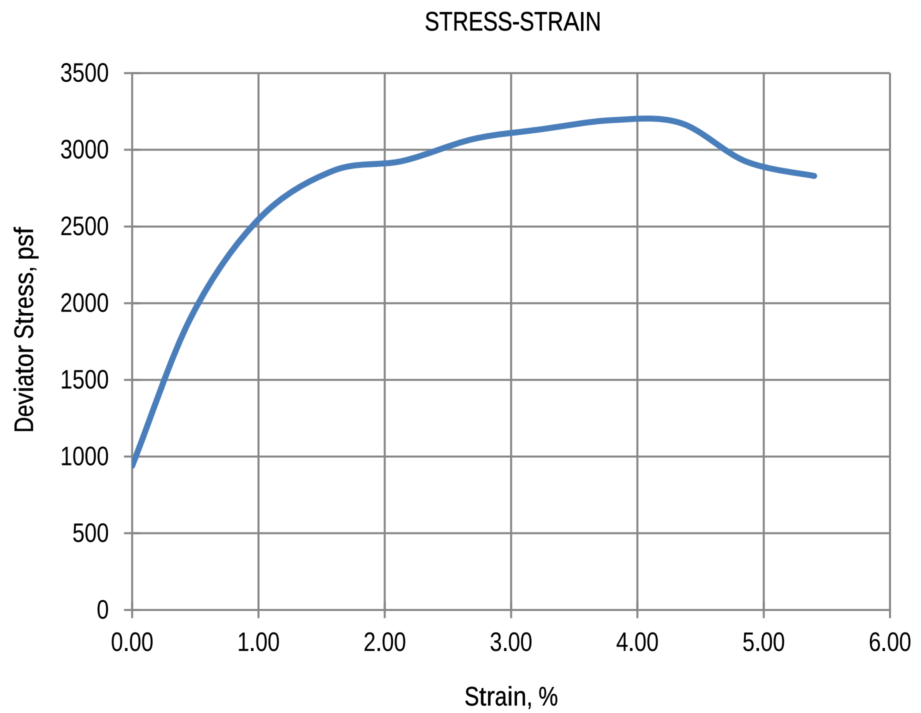
Particle Size Analysis - ASTM D422

Project: St. Mary's Road Roundabouts

Location: Moraga, CA

Project No.: E8980-04-01

Figure B1



Failure Photo

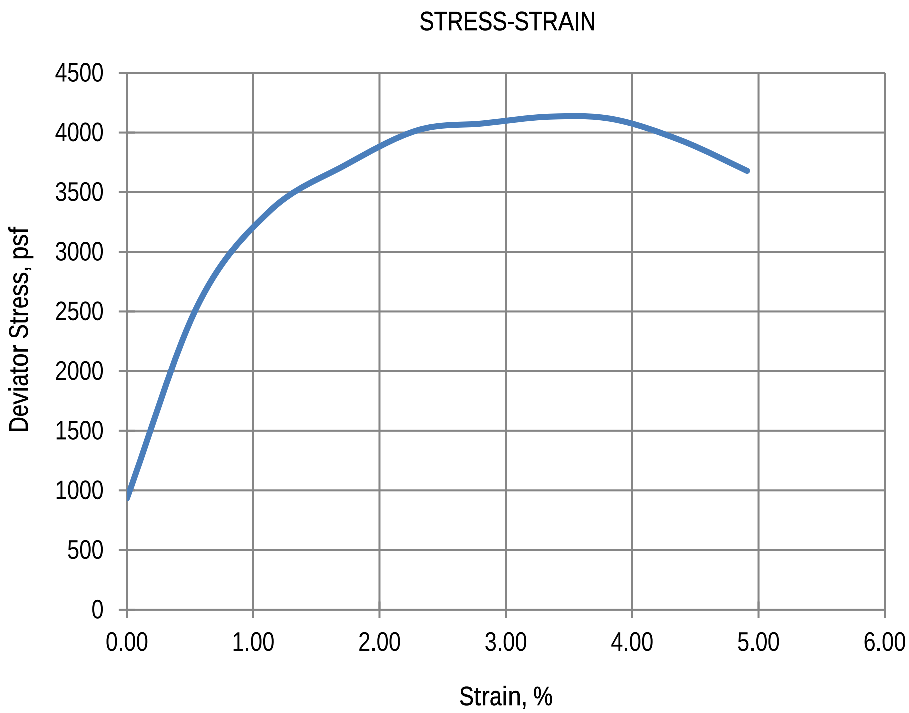
Sample Description	
Boring Number	B1
Sample Depth (feet)	3'
Material Description	Dark-brown mottled brown Silty CLAY with (f) sand
Initial Conditions at Start of Test	
Height (inch) average of 3	5.92
Diameter (inch) average of 3	2.40
Moisture Content (%)	21.4
Dry Density (pcf)	103.5
Estimated Specific Gravity	2.7
Saturation (%)	92.1
Shear Test Conditions	
Strain Rate (%/min)	0.9825
Major Principal Stress at Failure (psf)	3190
Strain at Failure (%)	3.8
Test Results	
Unconfined Compressive Strength (tons/ft^2)	1.6
Unconfined Compressive Strength (lbs/ft^2)	3193
Shear Strength (tons/ft^2)	0.8
Shear Strength (lbs/ft^2)	1597

Geocon Consultants, Inc.
6671 Brisa Street
Livermore, CA 94550
Telephone: 925-371-5900
Fax: 925-371-5915

Unconfined Compressive Strength (ASTM D2166)

Project: Town of Moraga St. Mary's Road
Location: Moraga, CA
Proj. No.: E8980-04-01

Figure B2



Failure Photo

Sample Description	
Boring Number	B1
Sample Depth (feet)	4.5'
Material Description	Brown mottled light-brown Silty CLAY with (f) sand
Initial Conditions at Start of Test	
Height (inch) average of 3	5.40
Diameter (inch) average of 3	2.41
Moisture Content (%)	17.2
Dry Density (pcf)	108.8
Estimated Specific Gravity	2.7
Saturation (%)	84.8
Shear Test Conditions	
Strain Rate (%/min)	0.9819
Major Principal Stress at Failure (psf)	4130
Strain at Failure (%)	3.4
Test Results	
Unconfined Compressive Strength (tons/ft^2)	2.1
Unconfined Compressive Strength (lbs/ft^2)	4133
Shear Strength (tons/ft^2)	1.0
Shear Strength (lbs/ft^2)	2067

Geocon Consultants, Inc.
6671 Brisa Street
Livermore, CA 94550
Telephone: 925-371-5900
Fax: 925-371-5915

Unconfined Compressive Strength (ASTM D2166)

Project: Town of Moraga St. Mary's Road
Location: Moraga, CA
Proj. No.: E8980-04-01

Figure B3

LIST OF REFERENCES

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California Department of Transportation, *Highway Design Manual*, Sixth Edition, November 20, 2017.

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