REPORT
GEOTECHNICAL ENGINEERING INVESTIGATION
HILLSIDE/ADELINE AREA SANITARY SEWER REHABILITATION PROJECT
VARIOUS STREET LOCATIONS
UNINCORPORATED SAN MATEO COUNTY
BURLINGAME, CALIFORNIA

For
CSG Consultants, Inc.
and The County of San Mateo

BAGG ENGINEERS

March 3, 2020
BAGG Job No. CSGCO-20-01

CSG Consultants, Inc.
550 Pilgrim Drive
Foster City, California 94404

Attention: Katherine Sheehan
Ed Slintak

DRAFT REPORT
GEOTECHNICAL ENGINEERING INVESTIGATION
County of San Mateo
Hillside/Adeline Area
Sanitary Sewer Collection
System Rehabilitation and
Replacement Project
Unincorporated San Mateo County
Burlingame, California

INTRODUCTION

This report presents the results of our geotechnical engineering investigation for the above captioned project in County of San Mateo, California. The proposed sanitary sewer alignments are shown on the attached Plate 1, Vicinity Map. The locations of our test borings drilled for this investigation are shown on the attached Plate 2. The purpose and scope of our services is presented below, followed by a discussion of the field exploration and laboratory testing carried out for this study, and our findings, conclusions, opinions, and recommendations.

PURPOSE AND SCOPE OF SERVICES:

The purpose of our geotechnical engineering services was to explore the subsurface conditions at the subject roadways in order to develop geotechnical engineering recommendations for the sanitary sewer line, via pipe bursting technique, pipe reaming and/or open cut trenching. As part of our investigation we also obtained cores of the roadway pavement at each boring location consisting of asphaltic concrete, Portland cement concrete and/or both. We accomplished this task by drilling 5 borings, up to 10 feet in depth and drilling a pavement core at boring B-6.

The borings were advanced with a truck-mounted drilling rig equipped with 8-inch diameter hollow-stem augers. The subsurface conditions were logged and undisturbed Modified California samples were taken. Selected soil samples from the borings were then tested in our laboratory for direct shear, saturated direct shear, moisture/density measurements, sieve analysis, #200 wash and Atterberg Limits as judged appropriate. Information obtained from these tasks was then used to perform engineering analyses required to develop conclusions, opinions, and recommendations regarding:

- existing subsurface conditions and their potential impact on the project, including loose soft, or expansive soils, potentially very hard bedrock conditions, and the depth, type, and consistency of any fill materials beneath the site, if encountered;
- recommendations for utility trench excavation and backfill;
- feasibility of trenchless pipe bursting and pipe reaming techniques; and
- criteria for subgrade preparation, and baserock placement, and asphaltic concrete and portland cement concrete pavement.

Based on our understanding of the proposed project, the scope of our services consisted of the following specific tasks:

- Visit the site, mark the boring locations, and contact Underground Service Alert.

- Drill 6 exploratory borings at the site with a truck-mounted drilling rig using hollow stem augers to a depth of up to 10 feet. The exploration was directed by one of our engineers, who also measured the existing pavement section thickness, maintained a continuous log of the materials encountered, collected soil samples for visual examination and laboratory testing. When completed, the borings were sealed with neat cement grout per standard protocol. The soil and bedrock cuttings were stored in 5-gallon buckets and hauled off the site to San Mateo County, Grant Yard.
- Perform laboratory testing of selected samples of the soils in order to evaluate their engineering characteristics. Tests included Atterberg Limits testing, moisture/density measurements, sieve analysis, corrosion tests, saturated direct shear and direct shear as judged appropriate.
- Based on information obtained from the above tasks, perform engineering analyses to develop conclusions, opinions, and recommendations oriented toward the above purposes of our investigation.
- Prepare a geotechnical investigation report summarizing our findings and including a vicinity map, a site plan showing the boring locations, a regional geologic map, the boring logs, the results of our laboratory testing, and our conclusions and recommendations.

PROJECT DESCRIPTION:

It is our understanding that the project will consist of replacement of the existing 6-inch sanitary sewer pipes around Adeline Drive, Hillside Drive and Newton Drive located within unincorporated County of San Mateo, California. The total replaced length of the sewer pipe is estimated to be 6,700 lineal feet. We understand the replacement of the sanitary sewer lines will be via conventional excavation and backfilling operations, however trenchless methods of pipe replacement such as pipe bursting and pipe reaming are being considered as well.

SITE CONDITIONS:

The sites of the proposed sanitary sewer alignments consist of winding roadways through the Burlingame Hills. Both the Adeline Drive and Hillside Drive right-of-ways are about 20 to 25 feet wide and Newton Drive right-of-way is about 15 feet wide with shoulders bounded by a combination of natural sloping terrain and residential homes. Adeline Drive has been built along a north facing hillside and along south side of Mills Canyon Park and consists of a series of cut slopes and sliver fills. Hillside Drive is situated between Adeline Drive and Newton Drive from north facing Adeline Drive and south facing Newton Drive and also consists of a series of sliver fills and cut slopes. Newton Drive is connected to Hillside Drive starting from west and ending on east of Hillside Drive; its length is approximately 1,600 lineal feet and consists of a series of sliver fills and cut slopes as well. Based on *Geology of the Onshore Part of San Mateo County, California: Derived from the Digital Database Open File 98-137,* most of the planned sewer alignments are in areas underlain by sheared rock (mélange) of the Franciscan Complex (Cretaceous and Jurassic) described as follows:

> "Predominantly greywacke, siltstone and shale, substantial portions of which have been sheared, but includes hard blocks of all other Franciscan rock types."

A small portion at the west of Adeline Drive alignment is shown by the referenced map to be underlain by greenstone, also of the Franciscan (Cretaceous and Jurassic) described as follows,

> "Dark green to red altered basaltic rocks, including flows, pillow lavas, breccias, tuff breccias, tuffs, and minor related intrusive rocks, in unknown proportions. Unit includes some Franciscan chert and limestone bodies that are too small to show on map. Greenstone crops out in lenticular bodies varying in thickness from a few meters to many hundreds of meters."

There is also a small portion at the west of Adeline Drive alignment shown by the referenced map to be underlain no only by greenstone but also by Serpentine describe as follows,

> "Greenish-gray to bluish-green sheared serpentine, enclosing variably abundant blocks of unsheared rock. Blocks are commonly less than 3 m in diameter, but range in size from several centimeters to several meters; they consist of greenish-black serpentine, schist, rodingite, ultramafic rock, and silica-carbonate rock.

The geology of the alignment areas and surrounding region are shown on the attached Plate 3, Regional Geologic Map.

FIELD EXPLORATION AND LABORATORY TESTING

Subsurface conditions at the project site were explored by advancing 2 borings on Adeline Drive, 3 borings on Hillside Drive and 1 boring on Newton Drive at the approximate locations shown on the attached Plate 2, site plan. The borings were advanced with a truck-mounted drilling rig to depths of up to 10 feet adjacent to the existing sewer lines. A modified California sampler was driven into the subsurface materials with a 140-pound hammer with a 30-inch free fall. The attached Plate 2 depicts the approximate locations of the borings drilled for this investigation.

A laboratory testing program was designed and conducted on samples collected from the borings to evaluate the engineering characteristics of the subsurface materials and to assist in the classification. The laboratory tests consisted of moisture content and dry density measurements, direct shear strength testing, and Atterberg Limits testing. The results of the laboratory tests are presented on the boring logs on Plates 9 through 14. The Atterberg Limits test results are also presented in more detail on the attached Plate 15. In addition to the noted tests for soil engineering properties we also performed two soil corrosion tests (Plate 16).

The subsurface materials were visually classified in the field; the classifications were then checked by visual examination of samples in the laboratory. In addition to sample classification, the boring logs contain interpretation of where stratum changes or gradational changes occur between samples. The boring logs depict BAGG's interpretations of subsurface conditions only at the locations indicated on Plates 2, and only on the dates noted on the logs.

The representation of the materials encountered in the boring logs, and the results of laboratory tests as well as explanatory/illustrative data are attached, as follows:

- Plate 5, Unified Soil Classification System, illustrates the general features of the soil classification system used on the boring logs.

- Plate 6, Soil Terminology, lists and describes the soil engineering terms used on the boring logs.

- Plate 7, Bedrock Terminology, lists and describes the bedrock terms used on the boring logs.

- Plates 8, Key to Symbols, lists and describes the terms and symbols used in the boring logs.

- Plate 9 through 14, Boring Logs, give a graphical description of the subsurface soil conditions encountered at each of the boring locations.

- Plate 15, Atterberg Limits, presents the results of four tests performed on samples of near-surface soils taken.

- Plate 16, Corrosivity tests Summary.

SURFACE CONDITIONS

The borings for this investigation were advanced through the pavement surface of Adeline Drive, Hillside Drive and Newton Drive. The existing pavement was highly variable, consisting of about 3 to 6” of asphaltic concrete over 3 to 8” of AB, except that in boring B1 the AC was placed over a 5" concrete (PCC) layer placed directly on subgrade soil. The presence of petromat was visible in the cores obtained at Boring B-1, B-2, and B-4 at approximately 3.5 inches below ground surface (bgs.) AC Cores obtained from borings B-5 and B-6 did not show visible petromat in the cores. In some locations, the driller was not able to drill the originally marked borings because of the height of the drill rig mast with regard to the power lines above it. Therefore, for the safety of the crew and the residents of the area, the boring were relocated within the USA marked area. Borings B-2, B-3, B-4 and B-5 were drilled in pavement covered roadway shoulders, and B-1 was advanced in one of the pavement lanes of the right-of-way. At boring B-6, the boring was terminated since a steel pipe was encountered at approximately 3 feet below ground surface (bgs). At that location, a second boring was drilled 2 feet apart from the first borehole (B-6) within the USA marked area; unfortunately, an unknown object was encountered at approximately 2.5 feet bgs as well and the drilling operations were suspended for the safety reasons. The table below summarizes the pavement section thickness at each of the boring locations that were advanced within the roadways.

TABLE 2
Summary of Existing
Pavement Section Data

Boring No.	Street	Section Thickness (inches)			Subgrade Information			
		AC	AB	PCC	Material Type	Blow Counts (bpf)	Dry Unit Weight (pcf)	Moisture Content (%)
B-1	Adeline Drive	3	-	5	SANDY LEAN CLAY (native)	43	116	12.6
B-2*	Adeline Drive	3.5	-	6.5	SANDY FAT CLAY(fill)	57	111	18.2
B-3	Hillside Drive	4	3	-	SANDY FAT CLAY (native)	26	104	22.5
B-4	Hillside Drive	4	5	-	SANDY LEAN CLAY (fill)	32	110	11.6
B-5	Newton Drive	4.5	4	-	SANDY LEAN CLAY (native)	31	120	11.9
B-6	Hillside Drive	6	4		CLAYEY SAND WITH GRAVEL	N/A	N/A	N/A

Notes:
B-3, B-4, B-5 and B-6 were drilled on the road shoulder.
Blow Counts are based on 3-inch O.D. Modified California Sampler barrel driven by 140-lb hammer with 30-inch free fall.
Pavement cores were obtained at borings B-1 thru B6.
At B6, a steel pipe was encountered at approximately 3 feet below surface therefore, no soil samples were recovered.
*Pavement section core was obtained from the right-of-way of the road 12 feet adjacent to boring B-2

SUBSURFACE CONDITIONS

The subsurface soil and bedrock conditions along the planned sewer main alignments consisted of fill soils over native clayey materials underlain by Franciscan Formation bedrock. In general, the soils along the Adeline Drive, Hillside Drive, and Newton Drive alignment were predominantly clayey. Groundwater was not encountered in any of the borings. As part of our geotechnical investigation we also performed corrosion testing on two of soil samples obtained from borings B-1 and B-4. Test results indicate that the soil resistivity is mildly corrosive and the concentration of Chloride and Sulfate is negligible in the soil. The pH in the soil is negligible as well. Corrosivity tests summary is also presented in more details on the attached plate 16. A brief discussion of the underlying subsurface soil and bedrock conditions encountered for each of the planned alignments is presented below.

Adeline Drive Alignment

The borings along the Adeline Drive alignment consisted of clayey soil. However, serpentine was present in Boring B-2 at approximately 5 feet bgs. The serpentine was greenish-gray to yellowish brown, intensely weathered and soft.

Test Boring B-1 was sandy lean clay, dry to moist, very stiff, fine sand, few medium to coarse sand, and trace organics. B-2 consisted of sandy fat clay, dark brown, moist, hard, fine sand and few to little medium to coarse sand as well. Serpentine was encountered in Test Borings B-2 from approximately 5 feet bgs to the bottom of the borehole.

The native clayey soils encountered generally possessed a moist and stiff consistency. Atterberg Limits test results on a representative sample of the native clayey material encountered at boring B-1 yielded Liquid Limit and Plasticity Index of 33 and 17, respectively; however, the clayey fill material encountered at boring B-2 yield Liquid Limit and Plastic Index of 59 and 41, respectively, which is indicative of high expansion potential.

The following is a description of the subsurface conditions based on our previous geotechnical investigation performed by BAGG Engineers to the County of San Mateo on various boring locations along Adeline Drive in 2013 with a referenced BAGG job number BKFEN-16-00:

> The subsurface conditions along the Adeline Drive alignment consisted of clayey fill or native clayey soils underlain by Franciscan Complex bedrock. In general, the fill and native clayey soil extended down to depths ranging from 4½ feet bgs in Test

Boring B-12 to 7½ feet bgs in Test Boring B-8. The clayey soils generally possessed a moist and stiff to very stiff consistency in Test Borings B-6 to B-9, but were very moist and medium stiff in borings B-11 and B-12.

Intensely weathered sandstone and shale were encountered in Test Borings B-7 through B-9, and are judged to have a generally 'soft rock' consistency. Greenstone encountered in Test Boring B-6 had a similar 'soft rock' consistency, however, refusal drilling conditions were encountered at a shallow depth of about 7 feet bgs in Test Borings B-11 and B-12 where hard greenstone and serpentine was present.

See appendix for boring logs and locations from our previous report.

Hillside Drive Alignment

The subsurface conditions along the Hillside Drive alignment consisted of clayey material. In general, the fill and native clayey soil extended down to depths ranging from 10 feet bgs in Test Boring B-3, and B-4. The clayey soils generally possessed a moist and stiff to very stiff consistency. The native material encountered in Test boring B-3 consisted of sandy fat clay, very stiff, moist, fine sand, trace fine gravels and trace organics underlain by sandy lean clay mottled grayish and yellowish brown, very stiff to hard, moist and fine sand.

In Test Boring B4, the clayey fill material encountered was sandy lean clay at approximately 1 foot bgs underlain by native sandy clay. The clayey material was dark brown, very stiff, dry to moist, fine sand, few to little medium to coarse sand, trace of fine gravel, and trace organics.

Newton Drive Alignment

The subsurface conditions in Boring B-5 on Newton Drive consisted of clayey native material. Sandy lean clay was encountered at approximately 1 foot bgs underlain by sandy lean clay with gravel. Sandy lean clay consisted of light to dark olive gray clayey mélange (Franciscan Complex Melange), very stiff to hard, moist, fine sand, some medium sand. Sand to gravel sized coherent shale fragments were encountered at 5 feet. Sandy lean clay with gravel consisted of dark olive brown, moist, very stiff was encountered at the bottom of the boring.

CONCLUSIONS AND RECOMMENDATIONS

GENERAL

Based on our findings, conventional excavation and backfill are feasible for the subject project from a geotechnical standpoint. Trenchless pipe bursting techniques will be feasible with the soil and weathered bedrock encountered along most of the alignment as well. Other conditions that may limit the use of trenchless pipe bursting technology, include a winding roadway alignment and the need for typical minimum 4 feet depth of trench (to prevent bulging of the roadway from displaced soil) and conflicts with other underground utilities that may be of consideration if pipe bursting techniques are being used. The attached boring logs and subsurface data should be reviewed by the underground contractor prior to commencing work.

EXCAVATION AND BACKFILL

Excavations should be performed per Cal OSHA requirements, and Type B or C soil conditions should be anticipated. Groundwater was not encountered; however, groundwater levels can fluctuate from seasonal rainfall or by other means. Therefore, as with any excavation; the contractor should be prepared to use a sump pump with a greater likelihood use in the deeper excavations. The means and methods of dewatering should be established by the contractor performing the work.

Numerous existing underground utilities, particularly PG&E and water lines are located under portions of Adeline, Hillside, and Newton Drives as evidence with the utility conflicts associated with our attempt to drill boring B-6 on Hillside Drive. Preservation of the existing utilities should be the responsibility of the contractor(s) performing the work.

While none of our borings encountered groundwater, it is possible to encounter soft and saturated soils. Under these conditions, it would be preferable to place a 4-6-inch layer of crushed rock in trenches as bedding material and approximately 12 inches in the bottom of the manhole excavations to provide a workable surface. The rock section should be underlain with Mirafi 500X fabric or equivalent.

The following recommendations should be adhered to during backfill of pits and/or trenches.

Excavation spoils are suitable for use as backfill material as discussed below, and Compaction should conform to the following:

- In general, soils used for backfill should be free of debris, roots and other organic matter, and rocks or lumps exceeding 3 inches in greatest dimension. The on-site soils can be used for backfill, but not for pipe bedding or shading.

- Pipe bedding and shading should conform with applicable San Mateo County standards.

- The upper 2 feet of the backfill soils in paved areas should be compacted to at least 95 percent of the maximum dry density, as determined by ASTM Test Method D1557, at slightly above optimum moisture content. In other areas and below a depth of 2 feet, compaction of fill and backfill should be to a minimum 90 percent of the maximum dry density.

- The top of the backfill should consist of a section that matches or exceeds the existing pavements which typically consists of 3-inches of asphaltic concrete over 5½-inches of concrete or 4-inches AC over 4-inches AB. Alternately, the replacement section may consist of 4 inches of asphaltic concrete over 8 inches of compacted Class 2 aggregate baserock on the compacted soil subgrade. Baserock should be compacted to a minimum 95 percent relative compaction based on the ASTM D1557 laboratory test method.

While on site native soil may be used as trench backfill, it is often most expedient and most cost effective to backfill with class II Baserock. Placement and compaction of backfill should be performed under BAGG's observation. It must be the contractor's responsibility to select equipment and procedures that will accomplish the earthwork as described above. The contractor must also organize the work in a manner such that our field representatives can observe and test the earthwork operations.

PIPE BURSTING

Pipe bursting is a method of trenchless replacement of worn out and/or undersized pipelines. Typical pipe bursting operations consist of inserting a cone-shaped tool, or 'bursting head', into an existing pipe and forcing it through, fracturing the pipe and pushing its fragments into the surrounding soil. At the same time, a new pipe is pulled in to the annulus left by the expanding operations. The new pipe can be of the same size or larger than the replaced pipe. The rear of the bursting head is connected to the new pipe, and the front end of the bursting head to a winching cable assembly. The bursting head and the new pipe are launched from an insertion pit. The cable is pulled from a reception pit.

Based on the findings of our borings, much of the alignment areas consist of several feet of fill over native clayey soils underlain by highly weathered bedrock. Most of the bedrock had 'soft rock' consistency, with some localized exceptions. These conditions are generally ideal for pipe bursting. The hard greenstone (gs) covered with several feet of coarse gravelly soil encountered in Boring B-3 could potentially cause more difficultly for pipe bursting techniques, as the granular soil and hard rock have higher strength and greater resistance to the outward displacement imposed by the pipe bursting technique, and the generally collapsible nature of non-cohesive granular soils. Therefore, where the alignments cross through areas mapped as greenstone (gs), pipe bursting techniques, as well as excavation, are anticipated to be more difficult. Additionally, we note that although the Franciscan mélange (fsr) is a predominantly soft rock formation, it can also contain localized zones of harder Franciscan rocks such as greenstone, or the serpentine encountered in Test Boring B-2; therefore, localized hard rock conditions should be anticipated through the areas mapped as mélange (fsr) as well. In addition to the hardness of bedrock with regard to displacement be the bursting head, a minimum depth of 4 feet bgs is required to prevent ground bulging and displacement of soil and damage to surrounding utilities is of consideration also.

As discussed above, trenchless pipe bursting techniques typically require the excavation of an insertion pit and receiving pit to perform the operations. These pits should be excavated and backfilled per the recommendations presented in the 'EXCAVATION AND BACKFILL' section presented above.

PIPE REAMING

Pipe reaming is a trenchless pipe replacement technique that removes the host pipe while at the same time installing a new replacement pipe. Pipe reaming technique is based on microtunnelling and is used for gravity sewers and other type of pipelines. It is particularly suited for replacing and upsizing pipes in stiff soils and rock and at shallow depth of a minimum of 2 feet below ground surface, where pipe bursting may not be an option. The Pipe reaming installation procedure consists of using a horizontal directional drilling (HDD) machine to insert a drill rod through the host pipe to be replaced. Once inserted the drill rods are connected to a reamer head with a swivel and a towing head. The directional drill back-reams through the host pipe enlarging the hole and the old pipe is ground up and replaced by the new pipe, the fragments of the old pipe along with other cuttings are suspended in drilling fluid and pushed ahead of the reamer through the existing pipe to a recovery pit or manhole where they are extracted, separated and disposed of. The new replacement pipe attached to the reaming tool is pulled in as the reamer advances.

Based on the findings of our borings, the shallow areas of the boreholes consist of fill over native clayey soils. These conditions are suitable for pipe reaming. The fat clay soil encountered in borings B-2 and B-3 within 1 to 4 feet below the ground surface could be more difficult for pipe reaming and take longer time to complete the reaming procedure due to the cohesiveness of the soils, but it can be accomplished.

As well as pipe bursting, pipe reaming techniques require the excavation of an insertion pit and recovery/receiving pit to perform the operations. These pits should be excavated and backfilled per the recommendations presented in the 'EXCAVATION AND BACKFILL' section presented above.

CLOSURE

This report has been prepared in accordance with generally-accepted engineering practices for the strict use of CSG Consultants, and other professionals associated with the specific project described in this report. BAGG Engineers should be provided the opportunity to review the improvement plans to confirm that the intent of the recommendations presented in this report are properly incorporated into the plans, and to check that our recommendations properly address the project in its final form.

The recommendations presented in this report are based on our understanding of the proposed construction as described herein, 6 widely spaced borings, a limited laboratory testing program, and available geologic literature. It is common place for unanticipated conditions to be encountered during earthwork excavation operations.

Subsurface conditions and standards of practice change with time. Therefore, we should be consulted to update this report if the construction does not commence within 18 months from the date that this report is submitted. Additionally, the recommendations of this report are only valid for the proposed development as described herein. If the proposed project is modified, our recommendations should be reviewed and approved or modified by this office in writing.

Sincerely,

Jason Van Zwol
Project Engineer

Amelia Reyes
Assistant Project Engineer

JVZ/EH

Attachments:

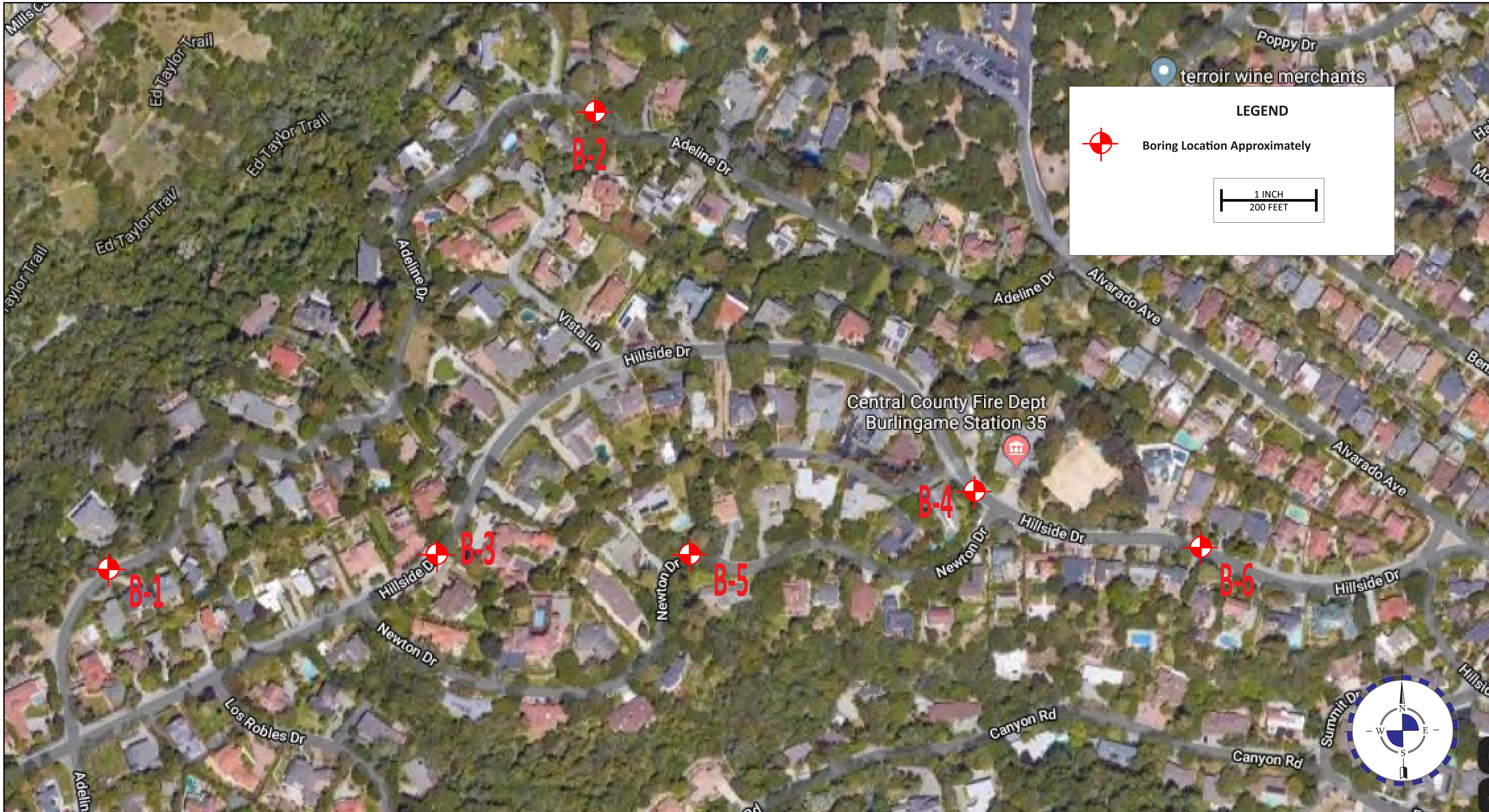
Plate 1	Vicinity Map
Plate 2	Site Plan with Boring Locations
Plate 3	Area Geologic Map
Plate 4	Regional Fault Map
Plate 5	Unified Soil Classification System
Plate 6	Soil Terminology
Plate 7	Rock Terminology
Plate 8	Key to Symbols
Plate 9 through 14	Boring Logs
Plate 15	Atterberg Limits Test Results
Plate 16	Corrosivity Report
Appendix	BKFEN-16-00 Site Plans and Boring Logs

SEWER PIPE REPLACEMENT PROJECT
VARIOUS STREET LOCATIONS
UNINCORPORATED SAN MATEO COUNTY
BURLINGAME, CALIFORNIA

BKF ENGINEERS

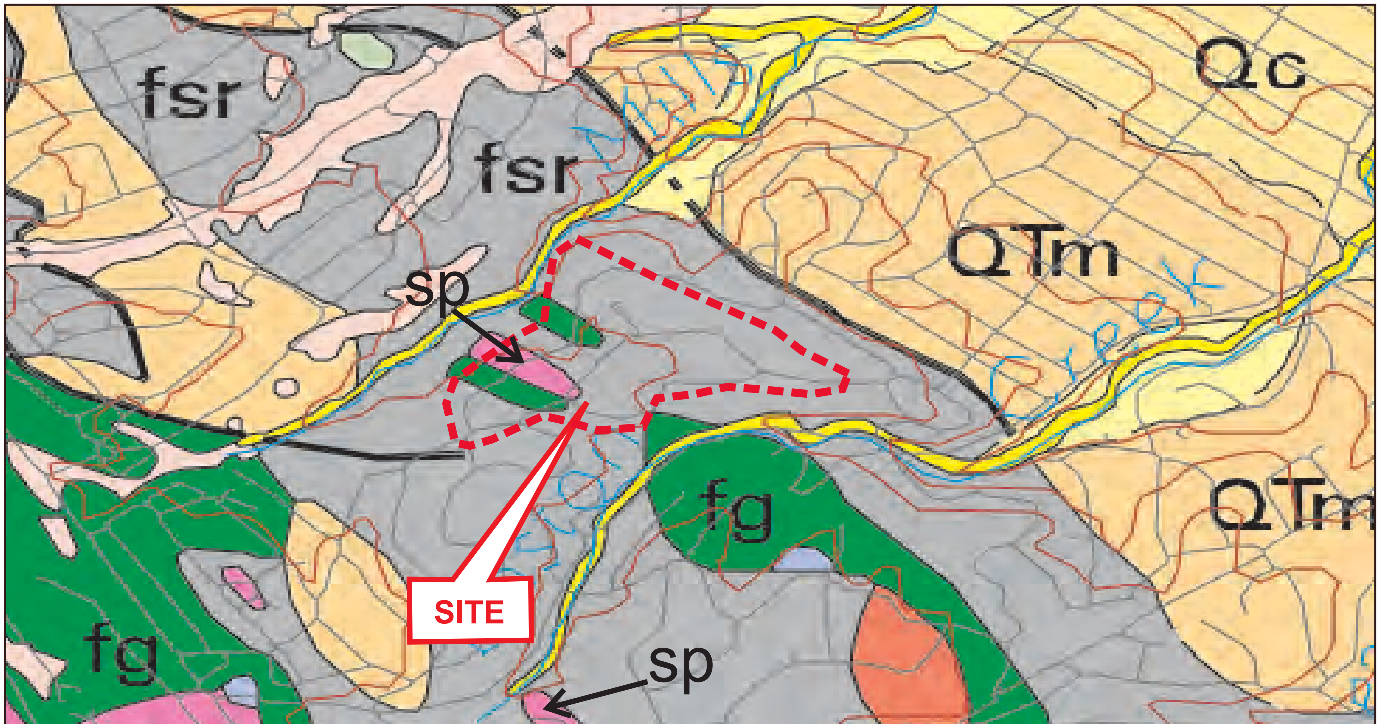
VICINITY MAP

DATE:	JOB NUMBER:	PLATE:
JANUARY 2020	CSGCO-20-01	1



Base Map: Google Maps, accessed on 01/07/2020.	GEOTECHNICAL ENGINEERING INVESTIGATION CITY OF BURLINGAME SEWER PIPE REPLACEMENT PROJECT VARIOUS STREET LOCATIONS BURLINGAME, CALIFORNIA	BAGG ENGINEERS	SITE PLAN WITH BORING LOCATIONS

JOB NO.:	SCALE:	DATE	PLATE
CSGCO-20-01	1” ≈ 200’	January 2020	2



LEGEND

fsr **Sheared Rock (Melange) –** Predominantly graywacke, siltstone, and shale, substantial portions of which have been sheared, but includes hard blocks of all other Franciscan rock types. Total thickness of unit is unknown, but is probably at least several tens of meters.

sp **Serpentine (Cretaceous and/or Jurassic) –** Greenish-gray to bluish-green sheared serpentine, enclosing variably abundant blocks of unsheared rock. Blocks are commonly less than 3 m in diameter, but range in size from several centimeters to several meters; they consist of greenish-blck serpentine, schist, rodingite, ultramafic rock, and silica-carbonate rock, nearly all of which are too small

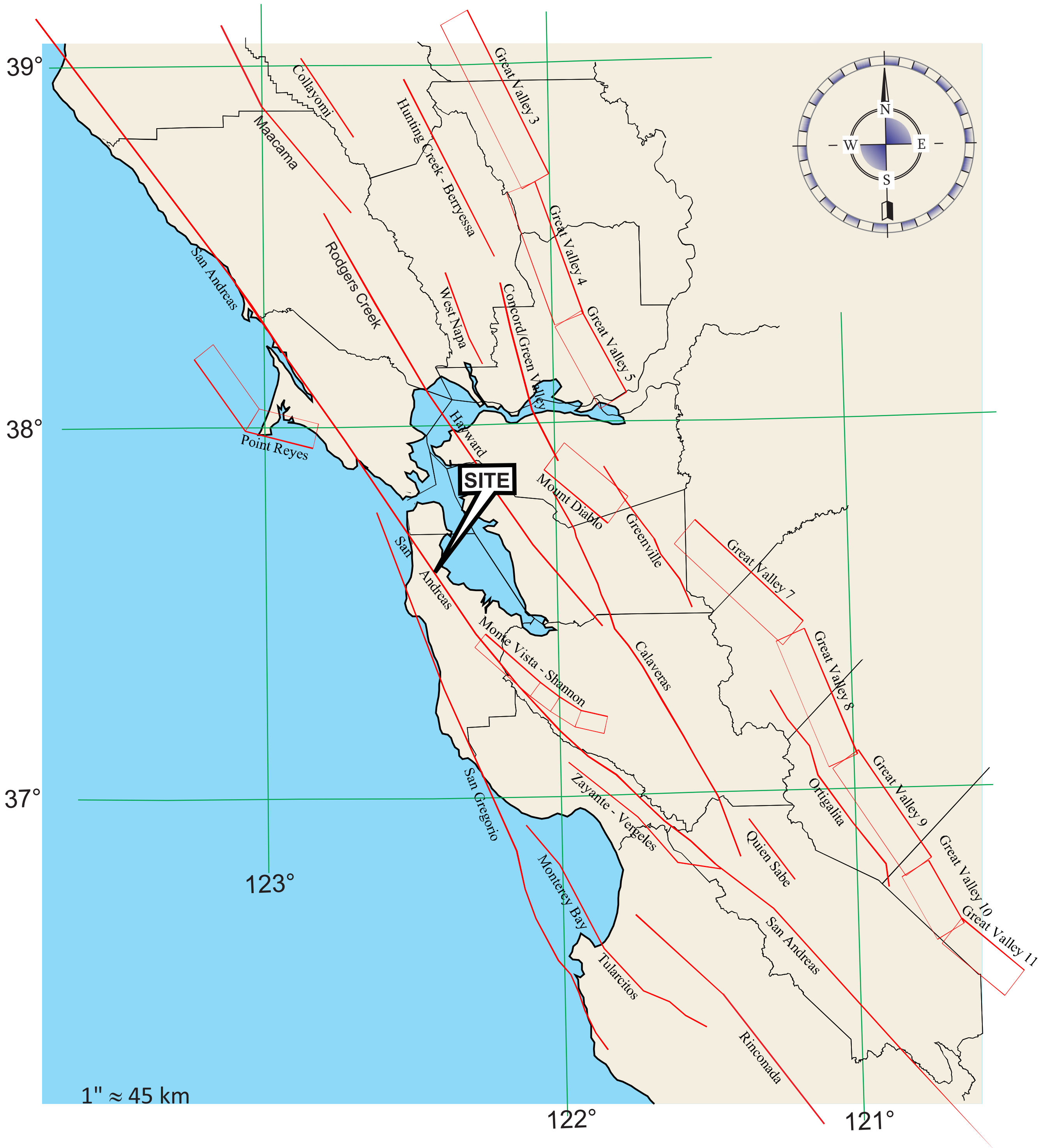
fg **Greenstone–** Dark-green to red altered basaltic rocks, including flows, pillow lavas, breccias, tuff breccias, tuffs, and minor related intrusive rocks, in unknown proportions. Unit includes some Franciscan chert and limestone bodies that are too small to show on map. Greenstone crops out in lenticular bodies varying in thickness from a few meters to many hundreds of meters.

Qtm **Merced Formation**- Medium-gray to yellowish orange, medium to very fine-grained, poorly indurated to friable sandstone, siltstone, and claystone, with some conglomerate lenses and few friable beds of white volcanic ash.

Qc **Colma Formation(Pleistocene)**-Yellowish-gray and gray to yellowish-orange and red-brown, friable to loose, fine-to medium-grained arkosic sand with subordinate amounts of gravel, silt, and clay.

Reference: *"Geology of the Onshore Part of San Mateo County, California"* by Graymer et al., 1998.

GEOTECHNICAL ENGINEERING INVESTIGATION SEWER PIPE REPLACEMENT CITY OF BURLINGAME COUNTY OF SAN MATEO, CALIFORNIA	AREA GEOLOGIC MAP		
	DATE: JANUARY 2020	PROJECT NUMBER: CSGCO-20-01	PLATE: 3



Reference: California Geological Survey Fault Model, 2002

GEOTECHNICAL ENGINEERING INVESTIGATION CITY OF BURLINGAME SEWER PIPE REPLACEMENT VARIOUS STREET LOCATIONS BURLINGAME, CALIFORNIA	REGIONAL FAULT MAP		
	DATE: January 2020	JOB NUMBER: CSGCO-20-01	PLATE 4

BAGG ENGINEERS

COARSE-GRAINED SOILS
LESS THAN 50% FINES*

GROUP SYMBOLS	ILLUSTRATIVE GROUP NAMES	MAJOR DIVISIONS
GW	Well graded gravel Well graded gravel with sand	GRAVELS More than half of coarse fraction is larger than No. 4 sieve size
GP	Poorly graded gravel Poorly graded gravel with sand	
GM	Silty gravel Silty gravel with sand	
GC	Clayey gravel Clayey gravel with sand	
SW	Well graded sand Well graded sand with gravel	SANDS More than half of coarse fraction is smaller than No. 4 sieve size
SP	Poorly graded sand Poorly graded sand with gravel	
SM	Silty sand Silty sand with gravel	
SC	Clayey sand Clayey sand with gravel	

NOTE: Coarse-grained soils receive dual symbols if:
(1) their fines are CL-ML (e.g. SC-SM or GC-GM) or
(2) they contain 5-12% fines (e.g. SW-SM, GP-GC, etc.)

FINE-GRAINED SOILS
MORE THAN 50% FINES*

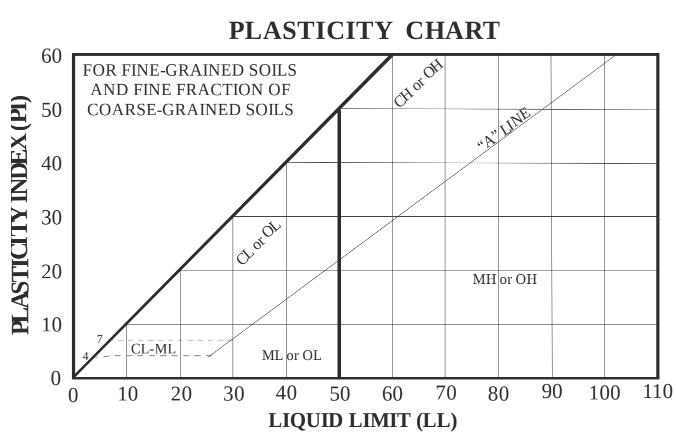
GROUP SYMBOLS	ILLUSTRATIVE GROUP NAMES	MAJOR DIVISIONS
CL	Lean clay Sandy lean clay with gravel	SILTS AND CLAYS liquid limit less than 50
ML	Silt Sandy silt with gravel	
OL	Organic clay Sandy organic clay with gravel	
CH	Fat clay Sandy fat clay with gravel	SILTS AND CLAYS liquid limit more than 50
MH	Elastic silt Sandy elastic silt with gravel	
OH	Organic clay Sandy organic clay with gravel	
PT	Peat Highly organic silt	HIGHLY ORGANIC SOIL

NOTE: Fine-grained soils receive dual symbols if their limits in the hatched zone on the Plasticity Chart(L-M)

SOIL SIZES

COMPONENT	SIZE RANGE
BOULDERS	ABOVE 12 in.
COBBLES	3 in. to 12 in.
GRAVEL	No. 4 to 3 in.
Coarse	¾ in to 3 in.
Fine	No. 4 to ¾ in.
SAND	No. 200 to No.4
Coarse	No. 10 to No. 4
Medium	No. 40 to No. 10
Fine	No. 200 to No. 40
*FINES:	BELOW No. 200

NOTE: Classification is based on the portion of a sample that passes the 3-inch sieve.



Reference: ASTM D 2487-11, Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System).

GENERAL NOTES: The tables list 30 out of a possible 110 Group Names, all of which are assigned to unique proportions of constituent soils. Flow charts in ASTM D 2487-11 aid assignment of the Group Names. Some general rules for fine grained soils are: less than 15% sand or gravel is not mentioned; 15% to 25% sand or gravel is termed "with sand" or "with gravel", and 30% to 49% sand or gravel is termed "sandy" or "gravelly". Some general rules for coarse-grained soils are: uniformly-graded or gap-graded soils are "Poorly" graded (SP or GP); 15% or more sand or gravel is termed "with sand" or "with gravel", 15% to 25% clay and silt is termed clayey and silty and any cobbles or boulders are termed "with cobbles" or "with boulders".

UNIFIED SOIL CLASSIFICATION SYSTEM

BVGG ENGINEERS

SOIL TYPES (Ref 1)

Boulders: particles of rock that will not pass a 12-inch screen.
Cobbles: particles of rock that will pass a 12-inch screen, but not a 3-inch sieve.
Gravel: particles of rock that will pass a 3-inch sieve, but not a #4 sieve.
Sand: particles of rock that will pass a #4 sieve, but not a #200 sieve.
Silt: soil that will pass a #200 sieve, that is non-plastic or very slightly plastic, and that exhibits little or no strength when dry.
Clay: soil that will pass a #200 sieve, that can be made to exhibit plasticity (putty-like properties) within a range of water contents, and that exhibits considerable strength when dry.

MOISTURE AND DENSITY

Moisture Condition: an observational term; dry, moist, wet, or saturated.
Moisture Content: the weight of water in a sample divided by the weight of dry soil in the soil sample, expressed as a percentage.
Dry Density: the pounds of dry soil in a cubic foot of soil.

DESCRIPTORS OF CONSISTENCY (Ref 3)

Liquid Limit: the water content at which a soil that will pass a #40 sieve is on the boundary between exhibiting liquid and plastic characteristics. The consistency feels like soft butter.
Plastic Limit: the water content at which a soil that will pass a #40 sieve is on the boundary between exhibiting plastic and semi-solid characteristics. The consistency feels like stiff putty.
Plasticity Index: the difference between the liquid limit and the plastic limit, i.e. the range in water contents over which the soil is in a plastic state.

MEASURES OF CONSISTENCY OF COHESIVE SOILS (CLAYS) (Ref's 2 & 3)

Very Soft	N=0-1*	C=0-250 psf	Squeezes between fingers
Soft	N=2-4	C=250-500 psf	Easily molded by finger pressure
Medium Stiff	N=5-8	C=500-1000 psf	Molded by strong finger pressure
Stiff	N=9-15	C=1000-2000 psf	Dented by strong finger pressure
Very stiff	N=16-30	C=2000-4000 psf	Dented slightly by finger pressure
Hard	N>30	C>4000 psf	Dented slightly by a pencil point

*__N__=blows per foot in the Standard Penetration Test. In cohesive soils, with the 3-inch-diameter ring sampler, 140-pound weight, divide the blow count by 1.2 to get N (Ref 4).

MEASURES OF RELATIVE DENSITY OF GRANULAR SOILS (GRAVELS, SANDS, AND SILTS) (Ref's 2 & 3)

Very Loose	N=0-4**	RD=0-30	Easily push a ½-inch reinforcing rod by hand
Loose	N=5-10	RD=30-50	Push a ½-inch reinforcing rod by hand
Medium Dense	N=11-30	RD=50-70	Easily drive a ½-inch reinforcing rod
Dense	N=31-50	RD=70-90	Drive a ½-inch reinforcing rod 1 foot
Very Dense	N>50	RD=90-100	Drive a ½-inch reinforcing rod a few inches

**__N__=Blows per foot in the Standard Penetration Test. In granular soils, with the 3-inch-diameter ring sampler, 140-pound weight, divide the blow count by 2 to get N (Ref 4).

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Ref 1: ASTM Designation: D 2487-06, **Standard Classification of Soils for Engineering Purposes** (Unified Soil Classification System).

Ref 2: Terzaghi, Karl, and Peck, Ralph B., **Soil Mechanics in Engineering Practice,** John Wiley & Sons, New York, 2nd Ed., 1967, pp. 30, 341, and 347.

Ref 3: Sowers, George F., **Introductory Soil Mechanics and Foundations: Geotechnical Engineering,** Macmillan Publishing Company, New York, 4th Ed., 1979, pp. 80, 81, and 312.

Ref 4: Lowe, John III, and Zaccheo, Phillip F., **Subsurface Explorations and Sampling,** Chapter 1 in "Foundation Engineering Handbook," Hsai-Yang Fang, Editor, Van Nostrand Reinhold Company, New York, 2nd Ed, 1991, p. 39.

SOIL TERMINOLOGY

WEATHERING DESCRIPTORS

Fresh	No discoloration, not oxidized, no separation, hammer rings when crystalline rocks are struck.
Slight	Discoloration or oxidation is limited to surface of, or short distance from, fractures; some feldspar crystals are dull, no visible separation, hammer rings when crystalline rocks are struck, body of rock not weakened.
Moderate	Discoloration extends from fractures, usually throughout; Fe-Mg materials are "rusty", feldspar crystals are "cloudy", all fractures are discolored or oxidized, partial separation of boundaries visible, texture generally preserved, hammer dose not ring when rock is struck, body of rock is slightly weakened.
Intense	Discoloration or oxidation throughout; all feldspars and Fe-Mg minerals are altered to clay to some extent; or chemical alteration produces in situ disaggregation, all fracture surfaces are discolored or oxidized, surfaces friable, partial separation, texture altered by chemical disintegration, dull sound when struck with hammer, rock is significantly weakened.
Decomposed	Discolored or oxidized throughout, but resistant mineral such as quartz may be unaltered, all feldspars and Fe-Mg minerals are completely altered to clay, complete separation of grain boundaries, resembles a soil, partial or complete remnant of rock structure may be preserved, can be granulated by hand, resistant minerals such as quartz may be present as "stringers" or "dykes".

BEDDING FOLIATION AND FRACTURE SPACING DESCRIPTORS

Millimeters	Feet	Bedding	Fracture Spacing
>10	<0.03	Laminated	Very Close
10-30	0.03-0.1	Very Thin	Very Close
30-100	0.1-0.3	Thin	Close
100-300	0.3-1	Moderate	Moderate
300-1000	1-3	Thick	Wide
1000-3000	3-10	Very Thick	Very Wide
>3000	>10	Massive	Extremely Wide

ROCK HARDNESS/STRENGTH DESCRIPTORS*

Extremely Hard	Core, fragment, or exposure cannot be scratched with knife or sharp pick; can only be chipped with repeated heavy hammer blows.
Very Hard	Cannot be scratched with knife or sharp pick. Core or fragment breaks with repeated heavy hammer blows.
Hard	Can be scratched with knife or sharp pick with difficulty (heavy pressure). Heavy hammer blow required to break specimen.
Moderately Hard	Can be scratched with knife or sharp pick with light or moderate pressure. Core or fragment breaks with moderate hammer blow.
Moderately Soft	Can be grooved $^{1}/_{16}$ inch (2mm) deep by knife or sharp pick with moderate or heavy pressure. Core fragment breaks with light hammer blow or heavy manual pressure.
Soft	Can be grooved or gouged easily by knife or sharp pick with light pressure, can be scratched with fingernail. Breaks wit light to moderate manual pressure.
Very Soft	Can be readily indented, grooved, or gouged with fingernail, or carved with a knife. Breaks with light manual pressure.
*Note:	Although "sharp pick" is included in those definitions, descriptions of ability to be scratched, grooved, or gouged by a knife is the preferred criteria.

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"Engineering Geology Field Manual, Second Edition, Volume 1, by U.S. Department of Interior, Bureau of Reclamation, 1998

(4/04)

KEY TO SYMBOLS

Symbol	Description
Strata symbols	
	Paving
	Concrete
	Sandy lean clay
	Aggregate Base
	Sandy fat clay
	Serpentinite
	Silty sand and gravel
Soil Samplers	
	Modified California Sampler: 24" long, 2.375" ID by 3" OD, split-barrel sampler driven w/ 140-pound hammer falling 30 inches (ASTM D3550)
Line Types	
	Denotes a sudden, or well identified strata change
	Denotes a gradual, or poorly identified strata change
Laboratory Data	
DS	Direct shear test performed on a sample at natural or field moisture content (ASTM D3080)

Symbol	Description
DSX	Direct shear test performed after the sample was submerged in water until volume changes ceased (ASTM D3080)
PI	Plasticity Index established per ASTM D4318 Test Method
LL	Liquid Limit established per ASTM D4318 Test Method
%Gravel	Percent of material that is retained on a #4 sieve (ASTM C136)
%Sand	Percent of material that passes through a #4 sieve but is retained on a #200 sieve (ASTM D136)
%Fines	Percent of soil particles finer than a No. 200 sieve (ASTM C117)
%Swell	Percent expansion of a submerged sample under a given surcharge pressure
%Consol	Percent consolidation of a submerged sample under a given surcharge pressure
bgs	Below the ground surface
NAT	Natural or field water content
AC	Asphaltic Concrete

KEY TO SYMBOLS

Symbol	Description
Strata symbols	
	Paving
	Concrete
	Sandy lean clay
	Aggregate Base
	Sandy fat clay
	Serpentinite
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Line Types	
———	Denotes a sudden, or well identified strata change
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%Fines	Percent of soil particles finer than a No. 200 sieve (ASTM C117)
%Swell	Percent expansion of a submerged sample under a given surcharge pressure
%Consol	Percent consolidation of a submerged sample under a given surcharge pressure
bgs	Below the ground surface
NAT	Natural or field water content
AC	Asphaltic Concrete

BAGG ENGINEERS

BORING LOG

Boring No. B-1

JOB NAME: CITY OF BURLINGAME SEWER PIPE REPLACEMENT
JOB NO.: CSGCO-20-01
CLIENT: CSG CONSULTANTS, INC.
DATE DRILLED: 1-4-2020
LOCATION: 2929 Adeline Drive, Burlingame, CA
ELEVATION:
DRILLER: Exploration Geoservices Inc.
LOGGED BY: AER
DRILL METHOD: Truck-Mounted Drilling Rig - 8" Diameter Hollow Stem Augers

Type of Strength Test	Test Surcharge Pressure, psf	Test Water Content, %	Shear Strength, psf	In-Situ Water Content, %	In-Situ Dry Unit Weight, pcf	Depth, ft.	Soil Symbols, Samplers and Blow Counts	USCS	Description	Remarks
						0			3" AC over 5" concrete	Petromat at 3" bgs
								CL	SANDY LEAN CLAY: brown, very stifF, dry to moist, fine sands, few medium to coarse sand, trace organics	NATIVE
DSX DS	400 400	16.0 NAT	690 980	13.7 12.6	118 116	3	12 18 25		... grayish brown, decreased sand content, trace to few fine subangular gravels, trace shale fragments	%Swell=0.6 LL=33, PI=17
DSX DSX	750 2500	14.1 12.6	1320 2120	12.0 11.2	124 127	6	7 22 20		... mottled dark gray and brown, fine sands, few to little medium to coarse sands, trace shale fragments	%Swell=1.2 %Swell=0.3
DS DS	1300 2800	NAT NAT	2460 2850	14.2 13.7	122 119	9	5 18 25		... dark brown with trace olive-gray and yellowish brown, trace coarse sand, trace fine gravel, trace shale	
						12			The boring was terminated at approximately 11.5 feet bgs. Groundwater was not encountered in the boring. Following completion of the boring, the borehole was backfilled with cement grout and capped with sacrete.	
						15				
						18				

BORING LOG

Boring No. B-2

BAGG ENGINEERS

JOB NAME: CITY OF BURLINGAME SEWER PIPE REPLACEMENT
JOB NO.: CSGCO-20-01
CLIENT: CSG CONSULTANTS, INC.
DATE DRILLED: 1-4-2020
LOCATION: 2856 Adeline Drive, Burlingame CA
ELEVATION:
DRILLER: Exploration Geoservices Inc.
LOGGED BY: AER
DRILL METHOD: Truck-Mounted Drilling Rig - 8" Diameter Hollow Stem Augers

Type of Strength Test	Test Surcharge Pressure, psf	Test Water Content, %	Shear Strength, psf	In-Situ Water Content, %	In-Situ Dry Unit Weight, pcf	Depth, ft.	Soil Symbols, Samplers and Blow Counts	USCS	Description	Remarks
						0			3" AC over 8" AB The pavement section shown in table 2, represents a core obtained from the right-of-way 12 feet adjacent to boring B-2	Petromat at 3.5" bgs
				18.2	111		28 22 35	CH	SANDY FAT CLAY: dark brown, hard, moist, fine sands, few to little medium to coarse sand, trace fine gravel	FILL LL=59, PI=41
						3				
DSX DSX	600 2100	23.2 22.6	1110 1730	18.0 18.0	104 104		38 41 50/4"	sp	SERPENTINE: greenish-gray to yellowish brown, intensely weathered, very closely fractured, soft	%Swell=1.5 %Swell=0.8
						6				
							50/5"		... moderately to intensely weathered, moderately soft to soft	
						9			The boring was terminated at approximately 9 feet bgs. Groundwater was not encountered in the boring. Following completion of the boring, the borehole was backfilled with cement grout and capped with sacrete.	
						12				
						15				
						18				

BORING LOG

Boring No. B-3

BAGG ENGINEERS

JOB NAME: CITY OF BURLINGAME SEWER PIPE REPLACEMENT
JOB NO.: CSGCO-20-01
CLIENT: CSG CONSULTANTS, INC.
DATE DRILLED: 1-4-2020
LOCATION: 2895 Hillside Drive, Burlingame CA
ELEVATION:
DRILLER: Exploration Geoservices Inc.
LOGGED BY: AER
DRILL METHOD: Truck-Mounted Drilling Rig - 8" Diameter Hollow Stem Augers

Type of Strength Test	Test Surcharge Pressure, psf	Test Water Content, %	Shear Strength, psf	In-Situ Water Content, %	In-Situ Dry Unit Weight, pcf	Depth, ft.	Soil Symbols, Samplers and Blow Counts	USCS	Description	Remarks
						0			4" AC over 3" AB	
								CH	SANDY FAT CLAY: brown, very stiff, moist, fine sands, few medium to coarse sand, trace fine gravels, trace organics	NATIVE
DSX DSX	320 1500	24.5 23.8	870 1340	22.4 22.7	104 104	3	8 8 18			%Swell=1.6 %Swell=0.1
								CL	SANDY LEAN CLAY: mottled grayish and yellowish brown, very stiff to hard, moist, fine sand	
DS	700	NAT	2900	16.4	115	6	28 44 50/4"			
						9	21 34 50/6"		...becomes more plastic	
						12			The boring was terminated at approximately 10 feet bgs. Groundwater was not encountered in the boring. Following completion of the boring, the borehole was backfilled with cement grout and capped with sacrete.	
						15				
						18				

BYGG ENGINEERS

BORING LOG

Boring No. B-4

JOB NAME: CITY OF BURLINGAME SEWER PIPE REPLACEMENT
JOB NO.: CSGCO-20-01
CLIENT: CSG CONSULTANTS, INC.
DATE DRILLED: 1-4-2020
LOCATION: 2835 Hillside Drive, Burlingame CA
ELEVATION:
DRILLER: Exploration Geoservices Inc.
LOGGED BY: AER
DRILL METHOD: Truck-Mounted Drilling Rig - 8" Diameter Hollow Stem Augers

Type of Strength Test	Test Surcharge Pressure, psf	Test Water Content, %	Shear Strength, psf	In-Situ Water Content, %	In-Situ Dry Unit Weight, pcf	Depth, ft.	Soil Symbols, Samplers and Blow Counts	USCS	Description	Remarks
						0			4" AC over 5" AB	Petromat at 3.5" bgs
								CL	SANDY LEAN CLAY: dark brown, dry to moist, fine sand, few coarse sand, trace fine gravel.	FILL
DSX	320	19.5	790	11.6	110	3	13 14 18	CL	SANDY LEAN CLAY: dark brown, very stiff, moist, fine sand, few to little medium to coarse sand, trace fine gravel	NATIVE %Swell=2.1 %Fines=41.2
						6	28 38 44	CL	SANDY LEAN CLAY: brown, very stiff, moist, trace fine gravel, trace organics	
DS DSX	1100 1100	NAT 22.3	2090 1340	19.8 19.8	101 106	9	16 33 20		... moderate plasticity fines, hard	%Swell=0.5 LL=44, PI=24
						12			The boring was terminated at approximately 10 feet bgs. Groudwater was not encountered in the boring. Following completion of the boring, the borehole was backfilled with cement grout and capped with sacrete.	
						15				
						18				

BORING LOG

Boring No. B-5

BAGG ENGINEERS

JOB NAME: CITY OF BURLINGAME SEWER PIPE REPLACEMENT
JOB NO.: CSGCO-20-01
CLIENT: CSG CONSULTANTS, INC.
DATE DRILLED: 1-4-2020
LOCATION: 125 Newton Drive, Burlingame CA
ELEVATION:
DRILLER: Exploration Geoservices Inc.
LOGGED BY: AER
DRILL METHOD: Truck-Mounted Drilling Rig - 8" Diameter Hollow Stem Augers

Type of Strength Test	Test Surcharge Pressure, psf	Test Water Content, %	Shear Strength, psf	In-Situ Water Content, %	In-Situ Dry Unit Weight, pcf	Depth, ft.	Soil Symbols, Samplers and Blow Counts	USCS	Description	Remarks
						0			4.5" AC over 4" AB	
				11.9	120	3	8 12 19	CL	SANDY LEAN CLAY: light to dark olive gray clayey melange (Franciscan Complex Melange), very stiff, moist, fine sand, some medium sand, sand- to gravel-sized coherent shale fragment	NATIVE LL=29, PI=15
							50/6"	SM/ GM	Broken/sheared siliceous shale in sampler.	%Gravel=41 %Sand=54 %Fines=5
DS DS	1100 2600	NAT NAT	2950 3720	8.6 11.2	132 125	6 9	20 25 28	CL	SANDY LEAN CLAY WITH GRAVEL: dark olive brown, moist, very stiff with sand and gravel ... hard	
						12 15 18			The boring was terminated at approximately 10 feet bgs. Groundwater was not encountered in the boring. Following completion of the boring, the borehole was backfilled with cement grout and capped with sacrete.	

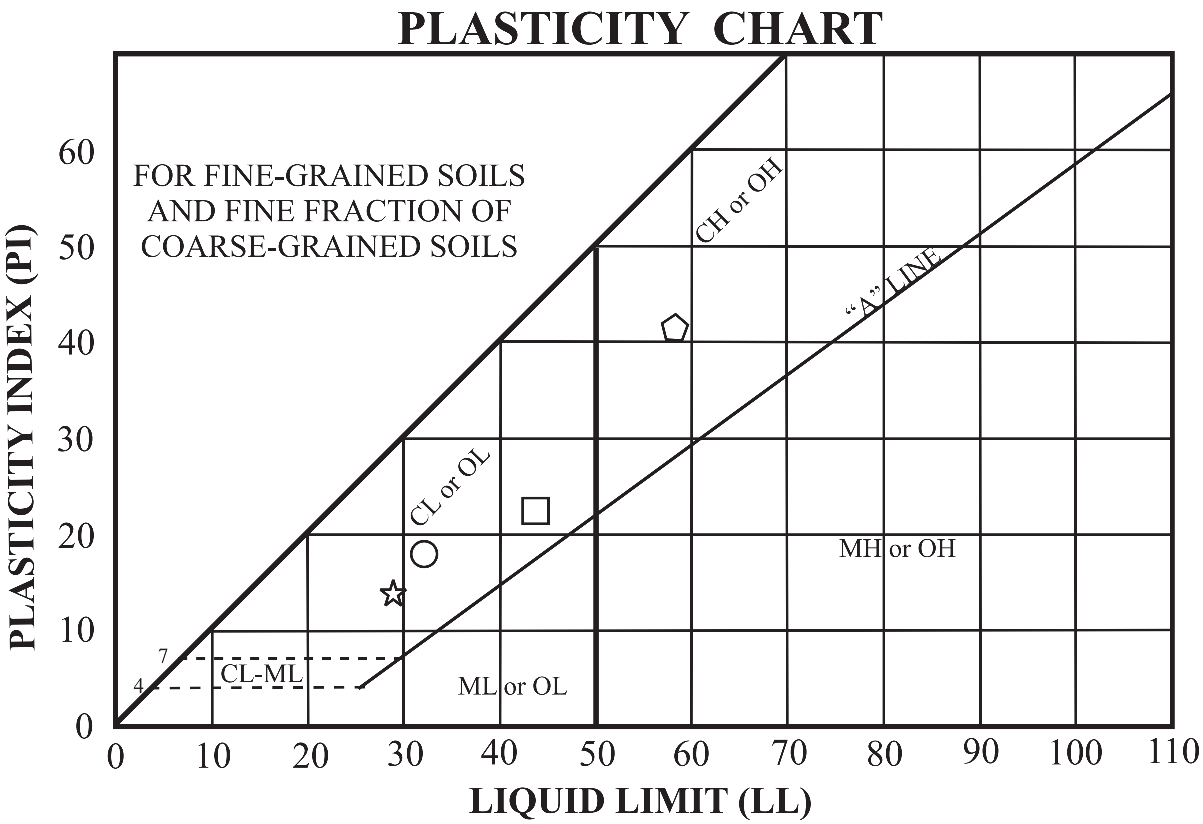
BORING LOG

Boring No. B-6

BYGG ENGINEERS

JOB NAME: CITY OF BURLINGAME SEWER PIPE REPLACEMENT
JOB NO.: CSGCO-20-01
CLIENT: CSG CONSULTANTS, INC.
DATE DRILLED: 1-4-2020
LOCATION: 2811 Hillside Drive, Burlingame CA
ELEVATION:
DRILLER: Exploration Geoservices Inc.
LOGGED BY: AER
DRILL METHOD: Truck-Mounted Drilling Rig - 8" Diameter Hollow Stem Augers

Type of Strength Test	Test Surcharge Pressure, psf	Test Water Content, %	Shear Strength, psf	In-Situ Water Content, %	In-Situ Dry Unit Weight, pcf	Depth, ft.	Soil Symbols, Samplers and Blow Counts	USCS	Description	Remarks
						0			6" AC over 4" AB	
								SC/ GC	CLAYEY SAND WITH GRAVEL: yellowish orange, moist, some clay, poorly graded sand, some gravel.	
						3			The boring was terminated at approximately 3 feet bgs, since a steel pipe was encountered in the borehole. Groundwater was not encountered in the boring. Following completion of the boring, the borehole was backfilled with cement grout and capped with sacrete.	
						6				
						9				
						12				
						15				
						18				



SYMBOL	SAMPLE SOURCE	DEPTH (FEET)	NATURAL WATER CONTENT (%)	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	SOIL DESCRIPTION
○	B-1	3.5	12.6	33	16	17	CL
⬠	B-2	2	18.2	59	18	41	CH
□	B-4	9	19.8	44	20	24	CL
☆	B-5	2.5	11.9	29	14	15	CL

CITY OF BURLINGAME
SEWER PIPE REPLACEMENT PROJECT
VARIOUS STREET LOCATIONS
BURLINGAME, CALIFORNIA

ATTERBERG LIMITS

DATE:	JOB NUMBER:	PLATE
JANUARY 2020	CSGCO-20-01	15

BAGG ENGINEERS

Corrosivity Tests Summary

CTL #	011-865	**Date:**	1/13/2020	**Tested By:**	PJ
Checked:	PJ				
Client:	BAGG Engineers	**Project:**	Burlingame Sewer Pipe Replacement	**Proj. No:**	CS5CO-20-01
Remarks:					

Sample Location or ID			Resistivity @ 15.5 °C (Ohm-cm)			Chloride	Sulfate		pH	ORP		Sulfide	Moisture	Soil Visual Description
			As Rec.	Min	Sat.	mg/kg	mg/kg	%		(Redox)		Qualitative	At Test	
						Dry Wt.	Dry Wt.	Dry Wt.		E_H (mv)	At Test	by Lead	%	
Boring	Sample, No.	Depth, ft.	ASTM G57	Cal 643	ASTM G57	ASTM D4327	ASTM D4327	ASTM D4327	ASTM G51	ASTM G200	Temp °C	Acetate Paper	ASTM D2216	
B1	2A	6	-	-	4,120	2	23	0.0023	8.1	490	19	Negative	12.0	Pale Olive Clayey SAND
B4	2	5.5	-	-	2,115	11	54	0.0054	7.2	517	19	Negative	14.3	Dark Brown Clayey SAND

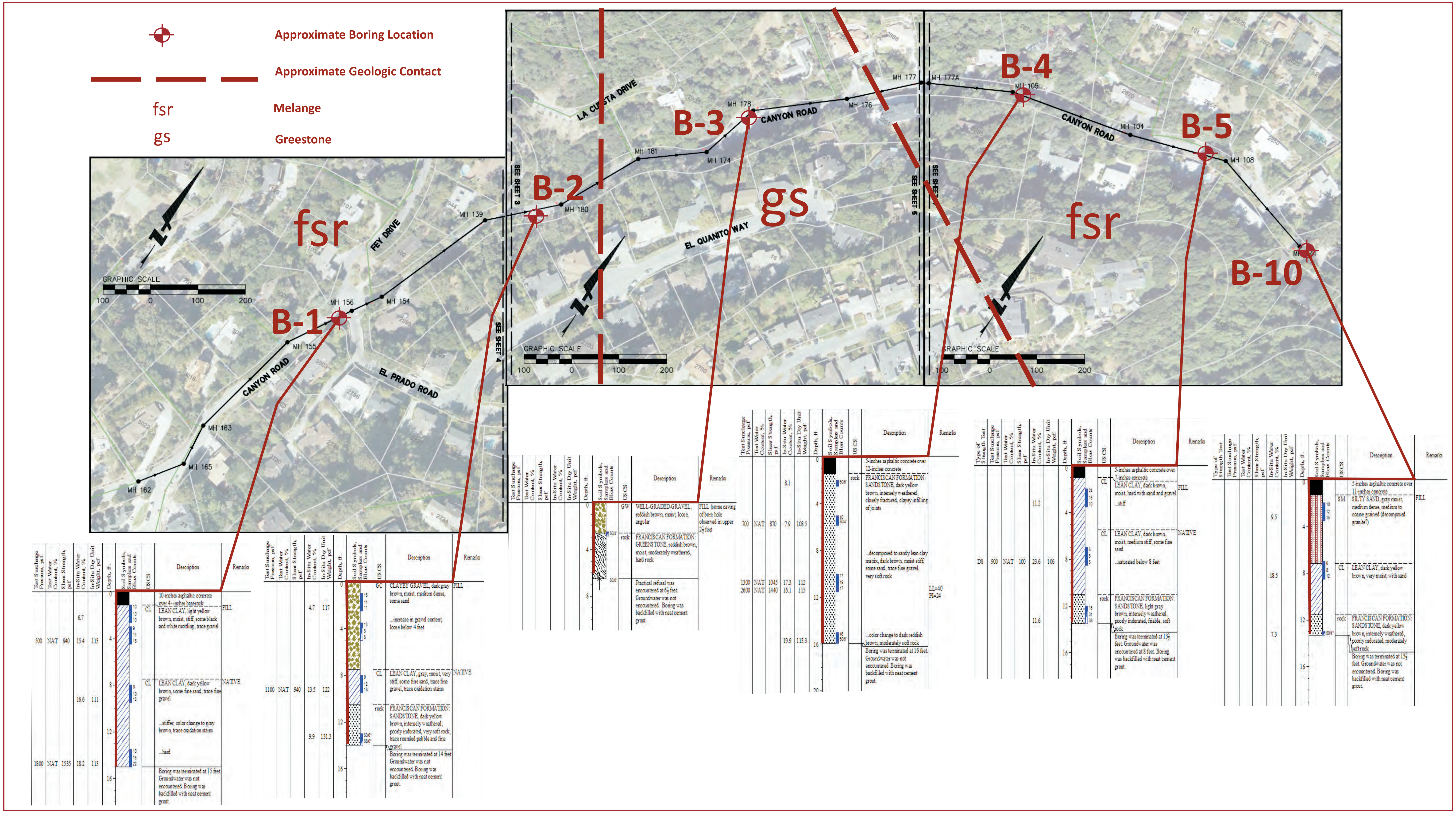
APPENDIX

SEWER LINE REPLACEMENT PROJECT
CANYON ROAD AND ADELINE ROAD
UNINCORPORATED SAN MATEO COUNTY
BURLINGAME, CALIFORNIA

BAGG ENGINEERS

VICINITY MAP

DATE:	JOB NUMBER:	PLATE:
February 2013	BKFEN-16-00	1



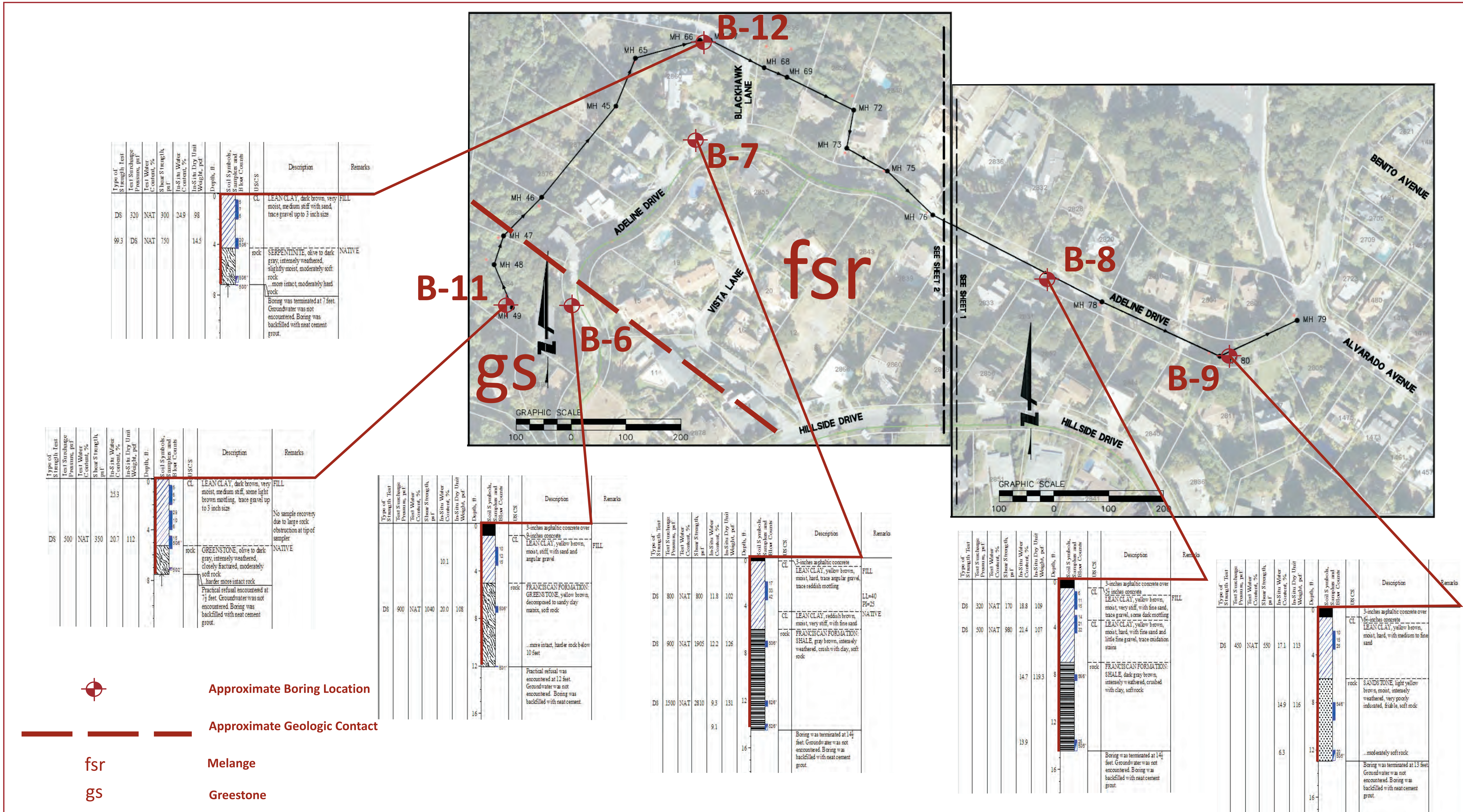
Base Map: BKF Engineers

SEWER LINE REPLACEMENT PROJECT
CANYON ROAD AND ADELINE DRIVE
UNINCORPORATED SAN MATEO COUNTY
BURLINGAME, CALIFORNIA

BAGG ENGINEERS

SITE PLAN - CANYON ROAD

JOB NO.	SCALE	DATE	PLATE
BKFEN-16-00	as indicated	FEBRUARY 2013	2A



Base Map: BKF Engineers

SEWER LINE REPLACEMENT PROJECT
CANYON ROAD AND ADELINE DRIVE
UNINCORPORATED SAN MATEO COUNTY
BURLINGAME, CALIFORNIA

BAGG ENGINEERS

SITE PLAN - ADELINE DRIVE

JOB NO.	SCALE	DATE	PLATE
BKFEN-16-00	as indicated	FEBRUARY 2013	2B

KEY TO SYMBOLS

Symbol	Description
Strata symbols	
	Paving
	Lean Clay
	Clayey gravel
	Sandstone
	Well graded gravel
	Greenstone
	Shale
	Silty sand
Misc. Symbols	
	Drilling refusal
	Water first encountered during drilling
Soil Samplers	
	Modified California Sampler: 2.375" ID by 3" OD, split-barrel sampler driven w/ 140-pound hammer falling 30 inches

Notes:

1. The borings were drilled on January 7,9 and 30, 2013 with a truck-mounted and portable minuteman drilling rigs using 4-inch diameter continuous flight augers.

2. The borings were located by pacing distanced from landmarks shown on the respective Site Plan. The indicated boring locations are therefore only approximate.

3. Groundwater was not encountered in any of the borings with the exception of boring B-5 which encountered groundwater about 5 feet below the ground surface. This groundwater was judged to be seepage from the nearby Canyon Creek.

4. The "Blow Count" column on the logs indicates the number of blows required to drive the sampler below the bottom of the boring, with the blow count given for each six inches of penetration, or portion thereof.

5. The soils' Group Names (e.g. SANDY LEAN CLAY) and Group Symbols (e.g. CL) were determined or estimated per ASTM D2487, Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System, Plate 4). Other soil engineering terms used on the boring logs are defined on Plate 5, Soil Terminology, and bedrock terms used in the boring logs are defined on Plate 6, Bedrock Terminology

6. In addition to interpretations of sample classification, there are interpretations of where stratum changes occur between samples, where gradational changes substantially occur, and where minor changes within a stratum are significant enough to log.

7. The boring logs are intended for use with this report only, and for the purposes outlined in the text. The logs depict interpretations of subsurface conditions at the locations shown on the Site Plan and on the dates noted on the logs.

BVGG ENGINEERS

KEY TO SYMBOLS

Symbol	Description
Soil Samplers	
◩	Standard Penetration Test: 1 3/8" ID by 2" OD, split-spoon sampler driven with 140-pound hammer falling 30" (ASTM D 1586-99)
Line Types	
______	Denotes a sudden, or well identified strata change
_ _ _	Denotes a gradual, or poorly identified strata change
Laboratory Data	
DS	Direct Shear test performed at field (Nat.) moisture content (ASTM D2166)
LL	Liquid Limit established per ASTM D4318 laboratory test method
PI	Plasticity Index established per ASTM D4318 laboratory test method
NAT	Denotes 'natural'

BVGG ENGINEERS

BORING LOG

Boring No. B-1

JOB NAME: Sewer Main Replacement Project
CLIENT: BKF Engineers
LOCATION: Canyon Road, Burlingame, California
DRILLER: West Coast Exploration
DRILL METHOD: 4-inch diameter continuous flight augers

JOB NO.: BKFEN-16-00
DATE DRILLED: 1/7/13
ELEVATION: 303 feet
LOGGED BY: MM
CHECKED BY:

Type of Strength Test	Test Surcharge Pressure, psf	Test Water Content, %	Shear Strength, psf	In-Situ Water Content, %	In-Situ Dry Unit Weight, pcf	Depth, ft.	Soil Symbols, Samplers and Blow Counts	USCS	Description	Remarks
						0			10-inches asphaltic concrete over 4- inches baserock	
				6.7			10 10 10	CL	LEAN CLAY, light yellow brown, moist, stiff, some black and white mottling, trace gravel	FILL
DS	500	NAT	940	15.4	113	4	9 11 18			
				16.6	111	8	8 10 12	CL	LEAN CLAY, dark yellow brown, moist stiff, some fine sand, trace fine gravel	NATIVE
						12			...more stiff, color change to gray brown, trace oxidation stains	
DS	1800	NAT	1535	18.2	113		10 16 22		...hard	
						16			Boring was terminated at 15 feet. Groundwater was not encountered. Boring was backfilled with neat cement grout.	
						20				
						24				

BORING LOG

Boring No. B-2

BAGG ENGINEERS

JOB NAME: Sewer Main Replacement Project
CLIENT: BKF Engineers
LOCATION: Canyon Road, Burlingame, California
DRILLER: West Coast Exploration
DRILL METHOD: 4-inch diameter continuous flight auger

JOB NO.: BKFEN-16-00
DATE DRILLED: 1/7/13
ELEVATION: 74 feet
LOGGED BY: MM
CHECKED BY:

Type of Strength Test	Test Surcharge Pressure, psf	Test Water Content, %	Shear Strength, psf	In-Situ Water Content, %	In-Situ Dry Unit Weight, pcf	Depth, ft.	Soil Symbols, Samplers and Blow Counts	USCS	Description	Remarks
						0		GC	CLAYEY GRAVEL, dark gray brown, moist, medium dense, some sand	FILL
				4.7	117		16, 11, 11			
						4	13, 5, 5		...increase in gravel content, loose below 4 feet	
						8		CL	LEAN CLAY, gray, moist, very stiff, some fine sand, trace fine gravel, trace oxidation stains	NATIVE
DS	1100	NAT	940	13.5	122		9, 12, 18			
						12		rock	FRANCISCAN FORMATION: SANDSTONE, dark yellow brown, intensely weathered, moderately to poorly indurated, soft, trace rounded pebble and fine gravel	
				9.9	131.3		50/6", 58/6"			
									Boring was terminated at 14 feet. Groundwater was not encountered. Boring was backfilled with neat cement grout.	
						16				
						20				
						24				

BORING LOG

Boring No. B-3

BVGG ENGINEERS

JOB NAME: Sewer Main Replacement Project
CLIENT: BKF Engineers
LOCATION: Canyon Road, Burlingame, California
DRILLER: West Coast Exploration
DRILL METHOD: 4-inch diameter continuous flight augers

JOB NO.: BKFEN-16-00
DATE DRILLED: 1/713
ELEVATION: 223 feet
LOGGED BY: MM
CHECKED BY:

Type of Strength Test	Test Surcharge Pressure, psf	Test Water Content, %	Shear Strength, psf	In-Situ Water Content, %	In-Situ Dry Unit Weight, pcf	Depth, ft.	Soil Symbols, Samplers and Blow Counts	USCS	Description	Remarks
						0		GW	WELL-GRADED-GRAVEL, reddish brown, moist, loose, angular	FILL (some caving of bore hole observed in upper $2\frac{1}{2}$ feet
							50/4"	rock	FRANCISCAN FORMATION: GREENSTONE, reddish brown, moist, moderately weathered, hard	
						4				
							50/0"		Practical refusal to drilling/ sampling was encountered at $6\frac{1}{2}$ feet. Groundwater was not encountered. Boring was backfilled with neat cement grout.	
						8				
						12				
						16				
						20				
						24				

BVGG ENGINEERS

BORING LOG

Boring No. B-4

JOB NAME: Sewer Main Replacement Project
CLIENT: BKF Engineers
LOCATION: Canyon Road, Burlingame, California
DRILLER: West Coast Exploration
DRILL METHOD: 4-inch diameter continuous flight augers

JOB NO.: BKFEN-16-00
DATE DRILLED: 1/7/13
ELEVATION: 190 feet
LOGGED BY: MM
CHECKED BY:

Type of Strength Test	Test Surcharge Pressure, psf	Test Water Content, %	Shear Strength, psf	In-Situ Water Content, %	In-Situ Dry Unit Weight, pcf	Depth, ft.	Soil Symbols, Samplers and Blow Counts	USCS	Description	Remarks
						0			5-inches asphaltic concrete over 12-inches concrete	
				8.1			60/6"	rock	FRANCISCAN FORMATION: SANDSTONE, dark yellow brown, intensely weathered, closely fractured, clayey infilling of joints, soft	
						4				
DS	700	NAT	870	7.9	108.5		40 50/4"			
						8			...decomposed to sandy lean clay matrix, dark brown, moist stiff, some sand, trace fine gravel, very soft	
DS	1300	NAT	1045	17.3	112		17 19 17			
DS	2600	NAT	1440	16.1	115					LL=40 PI=24
						12				
				19.9	113.3		46 50/5"		...color change to dark reddish brown, moderately soft	
						16			Boring was terminated at 16 feet. Groundwater was not encountered. Boring was backfilled with neat cement grout.	
						20				
						24				

BORING LOG

Boring No. B-5

BAGG ENGINEERS

JOB NAME: Sewer Main Replacement Project
CLIENT: BKF Engineers
LOCATION: Canyon Road, Burlingame, California
DRILLER: West Coast Exploration
DRILL METHOD: 4-inch diameter continous flight augers

JOB NO.: BKFEN-16-00
DATE DRILLED: 1/7/13
ELEVATION: 168 feet
LOGGED BY: MM
CHECKED BY:

Type of Strength Test	Test Surcharge Pressure, psf	Test Water Content, %	Shear Strength, psf	In-Situ Water Content, %	In-Situ Dry Unit Weight, pcf	Depth, ft.	Soil Symbols, Samplers and Blow Counts	USCS	Description	Remarks
						0			5-inches asphaltic concrete over 7-inches concrete	
				11.2			24 15 10	CL	LEAN CLAY, dark brown, moist, hard with sand and gravel ...stiff	FILL
						4				
DS	900	NAT	100	23.6	106	8	5 5 6	CL	LEAN CLAY, dark brown, moist, medium stiff, some fine sand ...saturated below 8 feet	NATIVE
				11.6		12	15 31 38	rock	FRANCISCAN FORMATION: SANDSTONE, light gray brown, intensely weathered, poorly indurated, friable, soft	
									Boring was terminated at 13½ feet. Groundwater was encountered at 8 feet. Boring was backfilled with neat cement grout.	
						16				
						20				
						24				

BORING LOG

Boring No. B-6

BAGG ENGINEERS

JOB NAME: Sewer Main Replacement Project
CLIENT: BKF Engineers
LOCATION: Adeline Drive, Burlingame, California
DRILLER: West Coast Exploration
DRILL METHOD: 4-inch diameter continuous flight augers

JOB NO.: BKFEN-16-00
DATE DRILLED: 1/7/13
ELEVATION: 302 feet
LOGGED BY: MM
CHECKED BY:

Type of Strength Test	Test Surcharge Pressure, psf	Test Water Content, %	Shear Strength, psf	In-Situ Water Content, %	In-Situ Dry Unit Weight, pcf	Depth, ft.	Soil Symbols, Samplers and Blow Counts	USCS	Description	Remarks
						0			3-inches asphaltic concrete over 9-inches concrete	
				10.1			10 12 15	CL	LEAN CLAY, yellow brown, moist, stiff, with sand and angular gravel	FILL
						4				
DS	900	NAT	1040	20.0	108		50/6"	rock	FRANCISCAN FORMATION: GREENSTONE, yellow brown, decomposed to sandy clay matrix, soft	NATIVE
						8			...more intact, harder rock below 10 feet	
						12	50/1"		Practical refusal was encountered at 12 feet. Groundwater was not encountered. Boring was backfilled with neat cement.	
						16				
						20				
						24				

BORING LOG

Boring No. B-7

BAGG ENGINEERS

JOB NAME: Sewer Main Replacement Project
CLIENT: BKF Engineers
LOCATION: Adeline Drive, Burlingame, California
DRILLER: West Coast Exploration
DRILL METHOD: 4-inch diameter continuous flight augers

JOB NO.: BKFEN-16-00
DATE DRILLED: 1/8/13
ELEVATION: 259 feet
LOGGED BY: MM
CHECKED BY:

Type of Strength Test	Test Surcharge Pressure, psf	Test Water Content, %	Shear Strength, psf	In-Situ Water Content, %	In-Situ Dry Unit Weight, pcf	Depth, ft.	Soil Symbols, Samplers and Blow Counts	USCS	Description	Remarks
						0			3-inches asphaltic concrete	
								CL	LEAN CLAY, yellow brown, moist, hard, trace angular gravel, trace reddish mottling	FILL
DS	800	NAT	800	11.8	102		17 33 42			LL=40 PI=25
						4				
								CL	LEAN CLAY, reddish brown, moist, very stiff, with fine sand	NATIVE
								rock	FRANCISCAN FORMATION: SHALE, gray brown, intensely weathered, crush with clay, soft	
DS	900	NAT	1905	12.2	126		50/6"			
						8				
DS	1500	NAT	2810	9.3	131	12	62/6"			
				9.1			52/6"			
									Boring was terminated at 14½ feet. Groundwater was not encountered. Boring was backfilled with neat cement grout.	
						16				
						20				
						24				

BVGG ENGINEERS

BORING LOG

Boring No. B-8

JOB NAME: Sewer Main Replacement Project
CLIENT: BKF Engineers
LOCATION: Adeline Drive, Burlingame, California
DRILLER: West Coast Exploration
DRILL METHOD: 4-inch diameter continuous flight augers

JOB NO.: BKFEN-16-00
DATE DRILLED: 1/8/13
ELEVATION: 209 feet
LOGGED BY: MM
CHECKED BY:

Type of Strength Test	Test Surcharge Pressure, psf	Test Water Content, %	Shear Strength, psf	In-Situ Water Content, %	In-Situ Dry Unit Weight, pcf	Depth, ft.	Soil Symbols, Samplers and Blow Counts	USCS	Description	Remarks
						0			3-inches asphaltic concrete over $5\frac{1}{2}$ inches concrete	
DS	320	NAT	170	18.8	109		6 11 15	CL	LEAN CLAY, yellow brown, moist, very stiff, with fine sand, trace gravel, some dark mottling	FILL
DS	500	NAT	980	21.4	107	4	14 21 32	CL	LEAN CLAY, yellow brown, moist, hard, with fine sand and little fine gravel, trace oxidation stains	NATIVE
				14.7	119.3	8	56/6"	rock	FRANCISCAN FORMATION: SHALE, dark gray brown, intensely weathered, crushed with clay, soft	
						12				
				13.9			25 50/5"			
						16			Boring was terminated at $14\frac{1}{2}$ feet. Groundwater was not encountered. Boring was backfilled with neat cement grout.	
						20				
						24				

BVGG ENGINEERS

BORING LOG

Boring No. B-9

JOB NAME: Sewer Main Replacement Project
CLIENT: BKF Engineers
LOCATION: Adeline Drive, Burlingame, California
DRILLER: West Coast Exploration
DRILL METHOD: 4-inch diameter continuous flight auger

JOB NO.: BKFEN-16-00
DATE DRILLED: 1/8/13
ELEVATION: 206 feet
LOGGED BY: MM
CHECKED BY:

Type of Strength Test	Test Surcharge Pressure, psf	Test Water Content, %	Shear Strength, psf	In-Situ Water Content, %	In-Situ Dry Unit Weight, pcf	Depth, ft.	Soil Symbols, Samplers and Blow Counts	USCS	Description	Remarks
						0			3-inches asphaltic concrete over $6\frac{1}{2}$-inches concrete	
DS	450	NAT	550	17.1	113		10 15 25	CL	LEAN CLAY, yellow brown, moist, hard, with medium to fine sand	
						4				
				14.9	116	8	54/6"	rock	SANDSTONE, light yellow brown, moist, intensely weathered, very poorly indurated, friable, soft	
				6.3		12	20 50/5"		...moderately soft	
									Boring was terminated at 13 feet. Groundwater was not encountered. Boring was backfilled with neat cement grout.	
						16				
						20				
						24				

BORING LOG

Boring No. B-10

JOB NAME: Sewer Main Replacement Project
CLIENT: BKF Engineers
LOCATION: Canyon Road, Burlingame, California
DRILLER: West Coast Exploration
DRILL METHOD: 4-inch diameter continuous flight augers

JOB NO.: BKFEN-16-00
DATE DRILLED: 1/8/13
ELEVATION: 160 feet
LOGGED BY: MM
CHECKED BY:

Type of Strength Test	Test Surcharge Pressure, psf	Test Water Content, %	Shear Strength, psf	In-Situ Water Content, %	In-Situ Dry Unit Weight, pcf	Depth, ft.	Soil Symbols, Samplers and Blow Counts	USCS	Description	Remarks
						0			5-inches asphaltic concrete over 11-inches concrete	
				9.5			10 12 15	SM	SILTY SAND, gray moist, medium dense, medium to coarse grained (decomposed granite)	FILL
						4				
				18.5		8	6 8 12	CL	LEAN CLAY, dark yellow brown, very moist, with sand	NATIVE
				7.3		12	50/4"	rock	FRANCISCAN FORMATION: SANDSTONE, dark yellow brown, intensely weathered, poorly indurated, moderately soft	
						16			Boring was terminated at 13½ feet. Groundwater was not encountered. Boring was backfilled with neat cement grout.	
						20				
						24				

BORING LOG

Boring No. B-11

BAGG ENGINEERS

JOB NAME: Sewer Main Replacement Project
CLIENT: BKF Engineers
LOCATION: 2884 Adeline Drive, Burlingame, CA (sewer easement in backyard)
DRILLER: Access Soil Drilling
DRILL METHOD: Minuteman

JOB NO.: BKFEN-16-00
DATE DRILLED: 1/30/13
ELEVATION: 242 feet
LOGGED BY: MM
CHECKED BY:

Type of Strength Test	Test Surcharge Pressure, psf	Test Water Content, %	Shear Strength, psf	In-Situ Water Content, %	In-Situ Dry Unit Weight, pcf	Depth, ft.	Soil Symbols, Samplers and Blow Counts	USCS	Description	Remarks
				25.3		0	5, 6, 7	CL	LEAN CLAY, dark brown, very moist, medium stiff, some light brown mottling, trace gravel up to 3 inch size	FILL
							29, 10, 6			No sample recovery due to large rock obstruction at tip of sampler
DS	500	NAT	350	20.7	112	4	15, 50/6"			
							50/2"	rock	GREENSTONE, olive to dark gray, intensely weathered, closely fractured, moderately soft ...harder more intact rock below 7'	NATIVE
						8			Practical refusal to drilling/ sampling encountered at $7\frac{1}{2}$ feet. Groundwater was not encountered. Boring was backfilled with neat cement grout.	
						12				
						16				
						20				
						24				

BVGG ENGINEERS

BORING LOG

Boring No. B-12

JOB NAME: Sewer Main Replacement Project
CLIENT: BKF Engineers
LOCATION: Blackhawk Lane, Burlingame, California
DRILLER: Access Soil Drilling
DRILL METHOD: Minuteman

JOB NO.: BKFEN-16-00
DATE DRILLED: 1/30/13
ELEVATION: 213 feet
LOGGED BY: MM
CHECKED BY:

Type of Strength Test	Test Surcharge Pressure, psf	Test Water Content, %	Shear Strength, psf	In-Situ Water Content, %	In-Situ Dry Unit Weight, pcf	Depth, ft.	Soil Symbols, Samplers and Blow Counts	USCS	Description	Remarks
						0		CL	LEAN CLAY, dark brown, very moist, medium stiff with sand, trace gravel up to 3 inch size	FILL
DS	320	NAT	300	24.9	98		5 7 6			
99.3	DS	NAT	750		14.5	4	20 50/6"			
								rock	SERPENTINITE, olive to dark gray, intensely weathered, slightly moist, moderately soft	NATIVE
							50/6"		...more intact, moderately hard rock	
							50/0"		Practical refusal to drilling/ sampling encountered at 7 feet. Groundwater was not encountered. Boring was backfilled with neat cement grout.	
						8				
						12				
						16				
						20				
						24