Stevens Ferrone & Bailey
Engineering Company, Inc

Geotechnical Engineering
Engineering Geology
Storm Water Management
Construction Observation & Testing Services

August 28, 2018

Mr. Todd Kurtin
Lomas – Corona Station, LLC
13848 Weddington Street
Sherman Oaks, CA 91401

Re: Geotechnical Investigation
Corona Station - Petaluma, California
SFB Project No.: 825-1

Mr. Kurtin:

As requested, Stevens, Ferrone & Bailey Engineering Company, Inc. has performed a geotechnical investigation for the proposed Corona Station development project in Petaluma, California. The accompanying report presents the results of our field investigation, laboratory tests, and engineering analysis. The geotechnical conditions are discussed, and recommendations for the geotechnical engineering aspects of the project are presented. Conclusions and recommendations contained herein are based upon applicable standards of our profession at the time this report has been prepared. Should you have any questions or require additional information, please do not hesitate to contact me.

Sincerely,

Stevens, Ferrone & Bailey
Engineering Company, Inc.

Ken Ferrone
President

OL/KCF:lc\encl.
Copies: Addressee (1 by email)

Stevens Ferrone & Bailey Engineering Company, Inc

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August 28, 2018

GEOTECHNICAL INVESTIGATION
CORONA STATION
PETALUMA, CALIFORNIA
SFB PROJECT NO. 825-1

Prepared For:

Lomas - Corona Station, LLC
13848 Weddington Street
Sherman Oaks, CA 91401

Prepared By:

Stevens, Ferrone & Bailey Engineering Company, Inc.

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1.0 INTRODUCTION

This report presents the results of our geotechnical investigation for the proposed residential development to be located at approximate address 890 McDowell Boulevard in Petaluma, California as shown on the Site Plan, Figure 1. The purpose of our investigation was to evaluate the geotechnical conditions at the site and provide recommendations regarding the geotechnical engineering aspects of the project.

Based on the information indicated on the Site Plan, as well as information provided by Mr. Todd Kurtin of Lomas – Corona Station, LLC, it is our understanding that the project will consist of developing approximately 6.6 acres of land for a medium density residential development consisting of 115 single family homes. Remedial grading will be performed for site development. Associated underground utilities, parking areas, roadways, and open space areas are planned.

The conclusions and recommendations provided in this report are based upon the information presented above; Stevens, Ferrone & Bailey Engineering Company, Inc. (SFB) should be consulted if any changes to the project occur to assess if the changes affect the validity of this report.

2.0 SCOPE OF WORK

This investigation included the following scope of work:

- Reviewing published and unpublished geotechnical and geological literature relevant to the site;
- Reviewing logs of six previous soil borings and eight previous monitoring wells drilled to maximum depths of about 31 feet[1,2];
- Performing reconnaissance of the site and surrounding area;
- Mapping the approximate locations of environmental soil excavation areas;
- Performing a subsurface exploration program, including drilling five exploratory borings to a maximum depth of about 46-1/2 feet;
- Performing laboratory testing of samples retrieved from the borings;
- Performing engineering analysis of the field and laboratory data; and
- Preparing this report.

The data obtained and the analyses performed were for the purpose of providing geotechnical design and construction criteria for site earthwork, underground utilities, drainage, building foundations, retaining walls and soundwalls, and pavements. Evaluating the potential for flooding was beyond our scope of work. In addition, toxicity potential assessment of onsite materials or groundwater (including mold) was beyond our scope of work.

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[1] Pinnacle Environmental, Inc. *Soil Excavation Workplan, of an Industrial Property,* 890 N. McDowell Boulevard & 320 Corona Road, Petaluma, California, 94954 report dated December 15, 2017

[2] Pinnacle Environmental, Inc. *Phase II Environmental Site Assessment of an Industrial Property,* 890 N. McDowell Boulevard & 320 Corona Road, Petaluma, California, 94954 report dated October 12, 2017

3.0 SITE INVESTIGATION

Reconnaissance of the site and surrounding area was performed on July 23 & 24, 2018, including drilling five exploratory borings to depths of about 46-1/2 feet. Subsurface exploration was performed using a truck-mounted drill rig equipped with 4-inch diameter, continuous flight, solid stem augers. Logs of SFB's borings and details regarding SFB's field investigation are included in Appendix A. The results of SFB's laboratory tests are discussed in Appendix B. Logs of the previous subsurface explorations are included in Appendix C. The approximate locations of SFB's borings and those from the previous subsurface investigations are shown on the Site Plan, Figure 1.

On July 20, 2018, we mapped the approximate locations of excavations that were performed for the purpose of removing contaminated soil. The excavations were being performed under the direction of an environmental engineering firm (Pinnacle Environmental, Inc.). The approximate locations of the excavations are shown on Figure 1.

It should be noted that changes in the surface and subsurface conditions can occur over time as a result of either natural processes or human activity and may affect the validity of the conclusions and recommendations in this report.

3.1 Site History and Surface Description

Based on review of historical aerial images available at NETRonline[3] and review of the prior Phase II Environmental assessment report prepared by Pinnacle Environmental[2], it is our understanding that the site was developed as a feed mill facility with at least three buildings on the northern and central portions of the site from the 1940's through the 1980's until the buildings were destroyed in a fire. Between the 1980's and 1993, the site was used by a wooden truss construction company and as a truck maintenance facility and included two metal warehouse buildings, an office, a well pump building, and a few storage buildings.

At the time of our investigation, and as shown on Figure 1, the roughly triangle shaped site was bounded by Corona Road to the northwest, the Northwestern Pacific/SMART railway to the northeast, Corona Creek and undeveloped land to the southeast, and North McDowell Boulevard to the southwest. The site had a plan area of about 6.6 acres with maximum dimensions of about 1,067 feet by 430 feet. The site was generally flat, with surface elevations between 32 and 35 feet (datum unknown). The regional grades sloped gently to the southwest.

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[3] https://www.historicaerials.com (accessed 07/19/18)

Beginning in 2010, it is our understanding that the site has been the subject of Phase I and Phase II environmental site assessments including numerous subsurface explorations. Subsequently, the site was cleared of existing buildings, and six areas of the site were reportedly excavated to between 2 and 10 feet below the current grade. Excavation 4 (shown on Figure 1) reportedly extended to 10 feet below the existing grade; the remaining excavations extended to roughly 2 feet below existing grade.

At the time of our field exploration, the east side of the site was covered by gravel and being used for truck parking. The rest of the site was vacant. Besides the prior excavation areas, the site was bare or was covered by short weeds.

3.2 Subsurface

The near-surface materials encountered by our borings at the site (except for Boring SFB-3) generally consisted of clayey or sandy fills that extended to depths of about 2 feet, although deeper fill between 6 and 8 feet thick was encountered in Borings SFB-4 and SFB-5, respectively. Fills encountered in our borings and in environmental excavations discussed above are heterogeneous, and weak and compressible if they were not placed and compacted in accordance with acceptable engineering standards. The results of Boring SFB-3 indicate that no fill was encountered by the boring

Below fills, our borings and the previous borings and wells encountered predominately stiff to hard silty to sandy clays and interbedded medium dense to dense sand layers with varying silt and clay contents. Sand lenses up to 8 feet thick were encountered in our borings, and clayey sand lenses up to 12 feet thick were encountered in the previous borings. The thickest sand lenses were encountered below 35 feet in SFB-1 and SFB-4, and below 19 feet in MW-3. According to the results of laboratory testing, clayey near-surface soils have high to very high plasticity and expansion potential.

Detailed descriptions of materials encountered in our exploratory borings are presented on the boring logs in Appendix A. Our attached boring logs and related information depict location specific subsurface conditions encountered during our field investigation. SFB's borings were backfilled with lean cement grout in accordance with Sonoma County requirements prior to leaving the site. The approximate locations of our borings were determined using pacing or landmark references and should be considered accurate only to the degree implied by the method used.

3.3 Groundwater

Groundwater was measured in Borings SFB-1, SFB-3, SFB-4 and SFB-5 at depths of about 8 to 10 feet. No groundwater was encountered in Boring SFB-2 to the maximum depth explored in this boring of about 16½ feet. Review of onsite monitoring well data indicated groundwater was measured at the site between 6½ and 7½ feet below the existing site surface, corresponding to elevations 26.9 and 25.8 feet[4] (Mean Sea Level (msl) Datum). Based on this information, we recommend a design groundwater depth of about 6 feet below existing grades be used for the project

It should be noted that our borings might not have been left open for a sufficient period of time to establish equilibrium groundwater conditions. In addition, fluctuations in the groundwater level could occur due to change in seasons, variations in rainfall, and other factors.

3.4 Hydrologic Soil Group

Surficial soils at the site have been mapped as Clear Lake Clay by USDA Web Soil Survey (WSS)[5]; The soils have been categorized as having moderately low to moderately high transmission rates (approximately 0.06 to 0.2 inches per hour), and are assigned to Hydrologic Soil Group D by USDA Natural Resources Conservation Service (NRCS).

Group D soils are defined as having a very slow infiltration rate when thoroughly wet (high runoff potential) and may consist chiefly of clays that have a high shrink-swell potential, soils that have a high-water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material.

3.5 Geology and Seismicity

According to Clahan, et al, (2003)[6], and Wagner and Gutierrez (2010)[7], the site is mapped as being underlain by undivided Holocene basin deposits (Qha) and described as alluvium deposited on fans, terraces, or in basins; composed of sand, gravel, silt and clay that are poorly sorted(Clahan, et al, 2003).

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[4] Pinnacle Environmental, Inc., 2017, "Phase II Environmental Site Assessment of an Industrial Property, 890 N. Mc.Dowell Boulevard & 320 Corona Road, Petaluma California, 94954

[5]http://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm

[6]Clahan, Bezore, Koehler, and Witter, 2003, *Geologic Map of the Cotati 7.5' Quadrangle, Sonoma County, California: A Digital Database*, California CGS.

[7]Wagner & Gutierrez, 2010, *Geologic Map of the Napa 30' X 60' Quadrangle, California,* CGS.

The project site is located in the San Francisco Bay Area, which is considered one of the most seismically active regions in the United States. Significant earthquakes have occurred in the San Francisco Bay Area and are believed to be associated with crustal movements along a system of sub-parallel fault zones that generally trend in a northwesterly direction. According to the Alquist-Priolo Earthquake Fault Zones Map of the Cotati Quadrangle, the site is not located in an earthquake fault zone as designated by the State of California[8].

Earthquake intensities will vary throughout the San Francisco Bay Area, depending upon numerous factors including the magnitude of earthquake, the distance of the site from the causative fault, and the type of materials underlying the site. The U.S. Geological Survey (2016)[9] has stated that there is a 72 percent chance of at least one magnitude 6.7 or greater earthquake striking the San Francisco Bay region between 2014 and 2043. Therefore, the site and proposed development will probably be subjected to at least one moderate to severe earthquake that will cause strong ground shaking.

According to the U.S. Geological Survey's Unified Hazard Tool using the Dynamic: Conterminous U.S. 2008 (v3.3.1) model (accessed 7/23/2018), the resulting deaggregation calculations indicate there is a 10% probability that the site will experience peak ground acceleration exceeding 0.47g in 50 years (design basis ground motion based on stiff soil site condition; mean return time of 475 years). The actual ground surface acceleration may vary depending upon the local seismic characteristics of the underlying bedrock and the overlying unconsolidated soils.

3.6 Liquefaction & Lateral Spreading

Soil liquefaction is a phenomenon primarily associated with saturated, cohesionless, soil layers located close to the ground surface. These soils lose strength during cyclic loading, such as imposed by earthquakes. During the loss of strength, the soil acquires mobility sufficient to permit both horizontal and vertical movements. Soils that are most susceptible to liquefaction are clean, loose, uniformly graded, saturated, fine-grained sands that lie close to the ground surface. According to ABAG and the U.S. Geological Survey, the site is located in an area that has been characterized as having moderate liquefaction susceptibility[10,11]. Sowers, et al, (1998)[12] mapped the

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[8]Hart and Bryant, *Fault-Rupture Hazard Zones in California*, CDMG Special Publication 42, Interim Revision 2007.
[9]Aagaard, Blair, Boatwright, Garcia, Harris, Michael, Schwartz, and DiLeo, *Earthquake Outlook for the San Francisco Bay Region 2014–2043*, USGS Fact Sheet 2016–3020, Revised August 2016 (ver. 1.1).
[10]Witter, Knudsen, Sowers, Wentworth, Koehler, and Randolph, 2006, *Maps of Quaternary Deposits and Liquefaction Susceptibility in the Central San Francisco Bay Region, California*", USGS Open File Report 2006-1037.
[11]Knudsen, Sowers, Witter, Wentworth, and Helly, 2000, "*Preliminary Maps of Quaternary Deposits and Liquefaction Susceptibility, Nine-County San Francisco Bay Region, California*", USGS Open File Report 00-444.
[12]Sowers, Noller, and Lettis, 1998, "*Liquefaction Susceptibility Map, Napa, California, 1: 100,000 Quadrangle: A Digital Database",* USGS Open File Report 98-460.

site as having high liquefaction susceptibility. As of the date of this report, the liquefaction potential of the site has not been evaluated by the State of California[13].

SFB performed SPT-based liquefaction analyses based on procedures described by the Southern California Earthquake Center (SCEC, Martin and Lew, 1999), EERI Monograph 12 (2008)[14], updated SPT based liquefaction triggering procedures (2014)[15], and in accordance with the 2008 California Geological Survey's (CGS) Special Publication 117A guidelines. We also evaluated the liquefaction potential of silty soils encountered using criteria published by Andrews and Martin (2000)[16]. As required by the 2016 California Building Code, a peak ground acceleration from a Maximum Considered Earthquake (MCE) was used in our analyses; the MCE peak ground acceleration has a 2% probability of being exceeded in a 50-year period (mean return time of 2,475 years). Using the U.S. Geological Survey's 2008 hazard data model and applying the ASCE 7-10 Standard for risk category I/II/III (accessed 7/30/2018)[17], the Maximum Considered Earthquake geometric mean peak ground acceleration (PGA_m) for the site is shown to be 0.61g, with a mean earthquake magnitude of 7.09.

Using a design groundwater depth of 6 feet below the existing grades, the results of our analyses indicate that saturated, medium dense sand lenses encountered in Borings SFB-1, SFB-3, MW-1, MW-3, MW-6, and MW-8 have a high potential for liquefying when subjected to an MCE earthquake event.

During a Maximum Considered Earthquake Event, we estimate that the liquefaction of the sand lenses encountered in the borings could result in residual volumetric strain between 1/2 and 4% causing total aerial ground surface settlements between 1/2 and 1½ inches, and differential settlements of about 1/2 to 1 inch across typical residential building foundations. It is our understanding that according to the 2016 California Building Code, the proposed buildings are required to withstand these estimated settlements without failure or collapse. The actual ground surface damage will vary depending on the thickness of the overlying non-liquefiable soils and the underlying liquefiable soils[18].

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[13]Seismic Hazards Mapping Act, 1990.

[14] Idriss & Boulanger, 2008, *Soil Liquefaction During Earthquakes*, Earthquake Engineering Research Institute, MNO-12.

[15] Boulanger & Idriss, 2014, *CPT and SPT Based Liquefaction Triggering Procedures*, Center for Geotechnical Modeling, Report No. UCD/CGM-14/01, April 2014.

[16] Andrews and Martin, 2000, *Criteria for Liquefaction of Silty Soils*, paper presented during the 12th World Conference on Earthquake Engineering.

[17] https://earthquake.usgs.gov/designmaps/us/application.php?

[18]Ishihara, K., 1985, *Stability of Natural Deposits During Earthquakes*, Proceedings of the Eleventh International Conference on Soil Mechanics and Foundation Engineering, San Francisco, CA Volume 1, p. 321-376, August.

As part of our analyses, we evaluated the potential for lateral spreading to impact the site. Lateral spreading occurs when soils liquefy during an earthquake event and the liquefied soils move laterally to unconfined spaces, such as creek banks, which causes significant horizontal ground displacements. Based on the results of our site reconnaissance, the shallow drainage channel adjacent the northwest side of Corona Road appears to be less than 5 feet deep, and Corona Creek adjacent the southeast side of the site appears to be on the order of 10 feet deep. In the area of Corona Creek, Boring SFB-4 encountered liquefiable sands at a depth of about 26 feet, 16 feet below the estimated depth of Corona Creek. Therefore, it is our opinion that the potential for lateral spreading at the site is low since liquefiable sands are not exposed in the Corona Creek embankment or within 16 feet of the base of the creek.

4.0 CONCLUSIONS AND RECOMMENDATIONS

It is our opinion that the site is suitable for the proposed project from a geotechnical engineering standpoint. The conclusions and recommendations presented in this report should be incorporated in the design and construction of the project to reduce soil or foundation related issues. The following are the primary geotechnical considerations for development of the site.

EXISTING FILL MATERIALS: As described previously, undocumented fills extending to depths of about 2 feet below existing grades were encountered in Borings SFB-1, SFB-2, and fills between 6 and 8 feet deep were encountered in Borings SFB-4 and SFB-5. In addition, between 2 and 10 feet of fill reportedly exists in the prior excavations on the site (the approximate locations of the excavations are shown on Figure 1). It is our opinion that the fills are heterogeneous and weak and compressible under the proposed improvement loads.

In order to reduce the potential for damaging differential settlement of overlying improvements (such as new fills, building foundations, driveways, exterior flatwork, and pavements), we recommend that these fills be completely removed and re-compacted. Generally, we recommend the process consist of over-excavating the entire site about one foot, scarifying and recompacting the bottom 12 inches in-place, and replacing the excavation with compacted fill materials except in the area of Excavation 4 and the areas around SFB-4 and SFB-5 where the over-excavation should extend to the bottom of fill.

Over-excavations should be performed so that no more than 5 feet of differential fill thickness exists below the proposed building foundations. Re-compaction should also extend at least 5 feet beyond building footprints and at least 3 feet beyond exterior flatwork (including driveways) and pavement wherever possible. The over-excavation should extend to depths where competent soil is encountered. Where the over-excavation limits abut adjacent property or improvements, SFB should be consulted to determine the actual vertical and lateral extent of over-excavation so that adjacent property or improvements are not adversely impacted. There would be no need to over-excavate fills within areas that do not support improvements, such as open spaces. Removed fill materials can be used as new fill provided it is placed and compacted in accordance with the recommendations presented in this report.

The extent of fill removal and re-compaction will vary across the site and should be determined in the field by SFB at the time of the earthwork operations.

EXPANSION POTENTIAL: The clayey onsite near-surface soils have high to very high plasticity and expansion potential and will be subjected to volume changes during seasonal fluctuations in moisture content. To reduce the potential for post-construction distress to the proposed structures resulting from swelling and shrinkage of these materials, we recommend that the proposed residences be supported on a post-tensioned slab foundation system that is designed to reduce the impact of the expansive soils. It should be noted that special design considerations will be required for exterior slabs.

LIQUEFACTION POTENTIAL: The results of our liquefaction analyses indicate saturated, medium dense sand lenses up to 12 feet thick encountered in the onsite borings have a high potential for liquefying when subjected to an MCE earthquake event. Based on our calculations, if the site were to be subjected to an MCE earthquake event, residual volumetric strains between ½ and 4% could occur, causing total aerial ground surface settlements of about 1/2 to 1½ inches, with differential settlements of about 1/2 to 1 inch across typical building column spacing (if the buildings are supported on a shallow foundation system). It is our understanding that according to the 2016 California Building Code, the proposed buildings are required to withstand these estimated settlements without failure or collapse. The actual ground surface damage will vary depending on the thickness of the overlying non-liquefiable soils and the underlying liquefiable soils[19]. It should be noted that after a major liquefaction event, phenomena such as sand boils, ground cracking, and differential movement of overlying improvements such as roadways and utilities may be observed and may require repair.

CORROSION POTENTIAL: Corrosivity tests were performed on two samples retrieved from the borings; the results of the corrosion testing are included in Appendix B. Please be aware that we are not corrosion protection experts; we recommend corrosion protection measures be designed and constructed so that all concrete and metal is protected against corrosion for the life of the project. We also recommend additional testing be performed if the corrosion test results are deemed insufficient by the designers of the corrosion protection measures. Landscaping soils typically contain fertilizers and other materials than can be highly corrosive to metals and concrete; landscaping soils commonly are in contact with foundations. Consideration should be given to testing the corrosion potential characteristics of proposed landscaping soils and other types of imported or modified soils and forwarding the results to your corrosion protection designers and installers.

ADDITIONAL RECOMMENDATIONS: Detailed drainage, earthwork, foundation, and pavement recommendations for use in design and construction of the project are presented below. We recommend SFB review the design and specifications to verify that the recommendations presented in this report have been properly interpreted and implemented in the design, plans, and specifications. We also recommend SFB be retained to provide consulting services and to perform construction observation and testing services during the construction phase of the project to

[19]Ishihara, K., 1985, *Stability of Natural Deposits During Earthquakes*, Proceedings of the Eleventh International Conference on Soil Mechanics and Foundation Engineering, San Francisco, CA Volume 1, p. 321-376, August.

observe and test the implementation of our recommendations, and to provide supplemental or revised recommendations in the event conditions different than those described in this report are encountered. We assume no responsibility for misinterpretation of our recommendations.

It is the responsibility of the contractors to provide safe working conditions at the site at all times. We recommend all OSHA regulations be followed, and excavation safety be ensured at all times. It is beyond our scope of work to provide excavation safety designs.

4.1 Earthwork

4.1.1 Clearing and Site Preparation

The site should be cleared of all obstructions including existing utilities and pipelines and their associated backfill, existing pavements, fencing, gravel, and debris. Holes resulting from the removal of underground obstructions extending below the proposed finish grade should be cleared and backfilled with fill materials as specified in **Section 4.1.4, *Fill Material***, and compacted to the requirements in **Section 4.1.5, *Compaction***. Wells and septic systems, if any, should be abandoned in accordance with Sonoma County standards.

From a geotechnical standpoint, any existing gravel, trench backfill materials, clay or concrete pipes, pavements, and concrete that are removed can be used as new fill onsite provided the materials are broken up to meet the size requirement for fill material, and debris is removed as discussed in in **Section 4.1.4, *Fill Material***. We recommend fill materials composed of broken up concrete or asphalt concrete not be located within 3 feet of the ground surface in yard areas. Consideration should be given to placing these materials below pavements, directly under building footprints, or in deeper excavations. We recommend backfilling operations for any excavations be performed under the observation and testing of SFB.

After clearing, portions of the site containing surface vegetation should be stripped to an appropriate depth to remove these materials. The amount of actual stripping should be determined in the field by SFB at the time of construction. Stripped materials should be removed from the site or stockpiled for later use in landscaping, if desired.

4.1.2 Existing Fill Re-Compaction

As described previously, undocumented fills extending to depths of about 2 feet below existing grades were encountered in Borings SFB-1, SFB-2, and fills between 6 and 8 feet deep were encountered in Borings SFB-4 and SFB-5. In addition, between 2 and 10 feet of fill reportedly exists in the prior environmental excavations on the site (the approximate locations of the excavations are shown on Figure 1).

Where proposed improvements including new fill, building foundations, driveways, exterior flatwork, and pavements will be constructed, we recommend these fills be completely removed and re-compacted. There would be no need to over-excavate the fills within areas that do not support improvements, such as within open spaces. Besides environmental Excavation 4, and the area around SFB-4 and SFB-5, the process can consist of over-excavating one foot, scarifying and recompacting the bottom 12 inches in-place, and replacing the excavation with compacted fill materials. The areas around SFB-4 and SFB-5, and within Excavation 4 should be completely over-excavated to the bottom of fill materials, depths of approximately 6, 8, and 10 feet thick, respectively.

The over-excavation and re-compaction of existing fills should extend at least 5 feet beyond building footprints and at least 3 feet beyond exterior flatwork (including driveways) and pavement wherever possible. Where the over-excavation limits abut adjacent property, SFB should be consulted to determine the actual vertical and lateral extent of over-excavation so that adjacent property is not adversely impacted. Over-excavations should be performed so that no more than 5 feet of differential fill thickness exists below the proposed building foundations.

The extent of the removal and re-compaction will vary across the site and should be determined in the field by SFB at the time of the earthwork operations.

Removed existing fill materials may be used as new fill onsite provided it satisfies the recommendations provided in **Section 4.1.4, *Fill Material***. Compaction should be performed in accordance with the recommendations in **Section 4.1.5, *Compaction***.

4.1.3 Subgrade Preparation

After the completion of clearing, site preparation, and fill re-compaction, soil exposed in areas to receive improvements (such as structural fill, building foundations, driveways, exterior flatwork, and pavements) should be scarified to a depth of about 12 inches, moisture conditioned to approximately 3 to 5 percent over optimum water content, and compacted to the requirements for structural fill. If building pads or pavement subgrade are allowed to remain exposed to sun, wind or rain for an extended period of time, or are disturbed by borrowing animals, the exposed subgrade or pavement subgrade may need to be reconditioned (moisture conditioned and/or scarified and recompacted) prior to foundation or pavement construction. SFB should be consulted on the need for subgrade reconditioning when the subgrade is left exposed for extended periods of time.

4.1.4 Fill Material

From a geotechnical and mechanical standpoint, onsite soils having an organic content of less than 3 percent by volume can be used as fill. Fill should not contain rocks or lumps larger than 6 inches in greatest dimension with not more than 15 percent larger than 2.5 inches. If required, imported fill should have a plasticity index of 25 or less and have a significant amount of cohesive fines.

In addition to the mechanical properties specifications, all imported fill material should have a resistivity (100% saturated) no less than the resistivity for the onsite soils, a pH of between approximately 6.0 and 8.5, a total water-soluble chloride concentration less than 300 ppm, and a total water-soluble sulfate concentration less than 500 ppm. We recommend import samples be submitted for corrosion and geotechnical testing at least two weeks prior to being brought onsite.

4.1.5 Compaction

Within the upper 5 feet of the finished ground surface, we recommend structural fill be compacted between 88 and 92 percent relative compaction, and structural fill below a depth of 5 feet be compacted to at least 90 percent relative compaction, as determined by ASTM D1557 (latest edition). We recommend the new fill be moisture conditioned approximately 3 to 5 percent over optimum water content. The upper 6 inches of subgrade soils beneath pavements should be compacted to at least 95 percent relative compaction. Fill material should be spread and compacted in lifts not exceeding approximately 8 to 12 inches in uncompacted thickness.

4.1.6 Utility Trench Backfill

Pipeline trenches should be backfilled with fill placed in lifts of approximately 8 inches in uncompacted thickness. Thicker lifts can be used provided the compaction methods are approved by SFB and the required minimum degree of compaction is achieved. Backfill should be placed by mechanical means only. Jetting is not permitted.

Onsite trench backfill should be compacted to at least 90 percent relative compaction. Imported trench sand backfill should be compacted to at least 95 percent relative compaction and sufficient water is added during backfilling operations to prevent the soil from "bulking" during compaction. The upper 3 feet of trench backfill in foundation, slab, and pavement areas should be entirely compacted to at least 95 percent relative compaction. To reduce piping and settlement of overlying improvements, we recommend rock bedding and rock backfill (if used) be completely surrounded by a filter fabric such as Mirafi 140N (or equivalent); alternatively, filter fabric would not be necessary if Caltrans Class 2 permeable material is used in lieu of rock bedding and rock backfill.

Sand or gravel backfilled trench laterals that extend toward driveways, exterior slabs-on-grade, or under building foundations, and are located below irrigated landscaped areas such as lawns or planting strips, should be plugged with onsite clays, low strength concrete, or sand/cement slurry. The plug for the trench lateral should be located below the edge of pavement or slabs, and under the perimeter of the foundation. The plug should be at least 24 inches thick, extend the entire width of the trench, and extend from the bottom of the trench to the top of the sand or gravel backfill.

Where trenches are sloped 5 percent or steeper, we recommend a low permeability plug composed of low strength concrete, sand/cement slurry, or onsite clays be installed in the trench every 50 feet on-center. The plug will reduce piping from water seepage that may cause surface settlement. The plug should be at least 12 inches thick, extend at least 1 foot beyond the edges and bottom of the trench, and extend to within 1 foot of the finished ground surface or to the base of the pavement section. Alternatively, a subdrain can be installed at the base of the utility trench to remove collected water within the trench; the subdrain can discharge to nearby drainage inlets.

4.1.7 Exterior Flatwork

We recommend that exterior slabs (including patios, sidewalks, and driveways) be placed directly on the properly compacted fills. We do not recommend using aggregate base, gravel, or crushed rock below these improvements. If imported granular materials are placed below these elements, subsurface water can seep through the granular materials and cause the underlying soils to saturate or pipe. Prior to placing concrete, subgrade soils should be moisture conditioned to increase their moisture content to approximately 3 to 5 percent above laboratory optimum moisture (ASTM D-1557).

The highly expansive surficial clayey soils on the site could be subjected to volume changes during fluctuations in moisture content. As a result of these volume changes, some vertical movement of exterior slabs (such as driveways, sidewalks, patios, exterior flatwork, etc.) should be anticipated. This movement could result in damage to the exterior slabs and might require periodic maintenance or replacement. Adequate clearance should be provided between the exterior slabs and building elements that overhang these slabs, such as window sills or doors that open outward.

We recommend reinforcing exterior slabs with steel bars in lieu of wire mesh. To reduce potential crack formation, we recommend the installation of #4 bars spaced at approximately 18 inches on center in both directions be used. Score joints and expansion joints should be used to control cracking and allow for expansion and contraction of the concrete slabs. We recommend appropriate flexible, relatively impermeable fillers be used at all cold/expansion joints. The installation of dowels at all expansion and cold joints will reduce differential slab movements; we recommend dowels be at least 30 inches long and be spaced at maximum lateral spacing of 18 inches. Although exterior slabs that are adequately reinforced will still crack, trip hazards requiring replacement of the slabs will be reduced if the slabs are properly reinforced.

4.1.8 Construction during Wet Weather Conditions

If construction proceeds during or shortly after wet weather conditions, the moisture content of the onsite soils could be significantly above optimum. Consequently, subgrade preparation, placement and/or reworking of onsite soil or fills as structural fill may not be possible. Alternative wet weather construction recommendations can be provided by our representative in the field at the time of construction, if appropriate. All the drainage measures recommended in this report should be implemented and maintained during and after construction, especially during wet weather conditions.

4.1.9 Surface Drainage, Irrigation, and Landscaping

Ponding of surface water must not be allowed on driveways, pavements, adjacent to foundations, at the top or bottom of slopes, and at the top or adjacent to retaining walls. Ponding of water should also not be allowed on the ground surface adjacent to or near exterior slabs, including driveways, walkways, and patios. Surface water should not be allowed to flow over the top of slopes, down slope faces, or over retaining walls.

We recommend positive surface gradients of at least 2 percent be provided adjacent to foundations to direct surface water away from the foundations and toward suitable discharge facilities. Roof downspouts and landscaping drainage inlets should be connected to solid pipes that discharge the collected water into appropriate water collection facilities. We recommend the surface drainage be designed in accordance with the latest edition of the California Building Code.

In order to reduce differential foundation movements, landscaping (where used) should be placed uniformly adjacent to the foundation and exterior slabs. We recommend trees be no closer to the structure or exterior slabs than half the mature height of the tree; in no case should tree roots be allowed to extend near or below the foundations or exterior slabs.

Drainage inlets should be provided within enclosed planter areas and the collected water should be discharged onto pavement, into drainage swales, or into storm water collection systems. In order to reduce the potential for heaving, we recommend lining planting areas and collecting the accumulated surface water in subdrain pipes that discharge to appropriate collection facilities. The drainage should be designed and constructed so that the moisture content of the soils surrounding the foundations do not become elevated and no ponding of water occurs. The inlets should be kept free of debris and be lower in elevation than the adjacent ground surface.

We recommend regular maintenance of the drainage systems be performed, including maintenance prior to rainstorms. The inspection should include checking drainage patterns to make sure they are performing properly, making sure drainage systems and inlets are functional and not clogged, and checking that erosion control measures are adequate for anticipated storm events. Immediate repairs should be performed if any of these measures appears to be inadequate.

Irrigation should be performed in a uniform, systematic manner as equally as possible on all sides of the foundations and exterior slabs to maintain moist soil conditions. Over-watering must be avoided. To reduce moisture changes in the natural soils and fills in landscaped areas, we recommend that drought resistant plants and low flow watering systems be used. All irrigation systems should be regularly inspected for leakage.

4.1.10 Storm Water Collection Facilities

To satisfy local and state permit requirements, most new development projects must control pollutant sources and reduce, detain, retain, and/or treat specified amounts of storm water runoff. The intent of these types of improvements is to conserve and incorporate on-site natural features, together with constructed hydrologic controls, to more closely mimic pre-development hydrology and watershed processes.

We recommend storm water collection improvements that are designed to detain, retain, and/or treat water such as bio-swales, porous pavement structures, and water detention basins, be lined with a relatively impermeable membrane in order to reduce water seepage and the potential for damage and distress to other infrastructure improvements (such as pavements, foundations, and walkways) which can occur as a result heaving and shrinking of surrounding soil or fill. We recommend a relatively impermeable membrane such as STEGO Wrap 15-mil or equivalent be installed below and along the sides of these facilities that direct collected water into subdrain pipes. The membrane should be lapped and sealed in accordance with the manufacture's specifications, including taping joints where pipes penetrate the membrane. A subdrain pipe should be used at the base of the infiltration materials to collect accumulated water and transmit the water to an appropriate facility.

We recommend improvements that are designed to detain or retain water such as bio-swales, porous pavement structures, and water detention basins, be lined with a relatively impermeable membrane in order to reduce water seepage and the potential for damage to other infrastructure improvements (such as pavements, foundations, and walkways). We recommend a relatively impermeable membrane such as STEGO Wrap 15-mil or equivalent be installed below and along the sides of these facilities that direct the collected water into subdrain pipes. The membrane should be lapped and sealed in accordance with the manufacture's specifications, including taping joints where pipes penetrate the membrane.

Soil filter materials within basins and swales will consolidate over time causing long-term ground surface settlement. Additional filling within the basins and swales over time will be needed to maintain design surface elevations. The soil filter materials, infiltration testing and procedures, and associated compaction requirements should be specified by the Civil Engineer and shown in detail on the grading and improvement plans.

Sidewalls of earthen swales and basins steeper than 2:1 (horizontal to vertical) will experience downward and lateral movements that can cause significant ground surface movements, including movement of adjacent improvements such as foundations, utilities, pavements, driveways, walkways, and curbs and gutters. The magnitude and rate of movement depends upon the swale and basin backfill material type and compaction. To reduce the potential for damaging movements, we recommend 2:1 sidewall slopes be used for earthen swales and basins, sidewalks be setback at least 1 foot from the top of the slope, and creep sensitive improvements (such as roadway curbs) be setback at least 5 feet from the top of the slopes, or the slopes/sidewalls be appropriately restrained using an engineered retaining system, such as deepened curbs and foundations that are designed to resist lateral earth pressures and act as a retaining wall.

SFB should be consulted regarding the use, location, and designs of storm water detention and filtration facilities. We also recommend SFB observe and document the installation of liners, subdrain pipes, and soil filter materials during construction for conformance to the recommendations in this report and the development's plans and specifications.

4.1.11 Future Maintenance

In order to reduce water created issues, we recommend regular maintenance of the site and each lot be performed, including maintenance prior to rainstorms. Maintenance should include recompacting loosened soils, collapsing and infilling holes with compacted soils or low strength sand/cement grout, removal and control of digging animals, modifying storm water drainage patterns to allow for sheet flow into drainage inlets or ditches rather than concentrated flow or ponding, removal of debris within drainage ditches and inlets, and immediately repairing any erosion or soil flow. The inspection should include checking drainage patterns, making sure drainage systems are functional and not clogged, and erosion control measures are adequate for anticipated storm events. Immediate repair should be performed if any of these measures appears to be inadequate. Temporary and permanent erosion and sediment control measures should be installed over any exposed soils immediately after repairs are made.

Differential movement of exterior slabs can occur over time as a result of numerous factors. We recommend homeowners and the HOA perform inspections and maintenance of the slabs, including infilling significant cracks, providing fillers at slab offsets, and replacing slabs if severely damaged.

4.1.12 Additional Recommendations

We recommend the drainage, irrigation, landscaping, and maintenance recommendations provided in this report be forwarded to your designers and contractors, and we recommend they be included in disclosure statements given to homeowners and their maintenance associations.

4.2 Foundation Support

4.2.1 Post-Tensioned Slabs

The proposed residential buildings can be supported on a post-tensioned slab foundation that is designed for the expansion potential of the onsite soils. In no case should a slab foundation bear upon fills with differential expansion characteristics. Recommendations for building pad preparation are described previously in **Sections 4.1.3, *Subgrade Preparation.*** Prior to the concrete pour, we recommend moisture contents of the subgrade materials be approximately 3 to 5 percent above laboratory optimum moisture. If the building pads are left exposed for an extended period of time prior to constructing foundations, we recommend SFB be contacted for recommendations to re-condition the pads in order provide adequate building support.

The post-tensioned slab thickness should be determined by the Structural Engineer; however, we recommend the post-tensioned slabs be at least 10 inches thick. An allowable bearing pressure of 1,500 pounds per square foot can be used for localized point and line loads. Deflection of the slab foundations should not exceed the values recommended in the most recent PTI Manual. Lateral loads, such as derived from earthquakes and wind, can be resisted by friction between the post-tensioned slab foundation bottom and the supporting subgrade. A friction coefficient of 0.25 is considered applicable.

At least 10 feet of cover should be provided between the outer face of slabs and un-retained slope faces, as measured laterally between slope faces and the slabs. Where less than 10 feet of cover exists, deepening of the edge of slabs may be necessary in order to achieve 10 feet of cover for buildings located near tops of slopes. Where slabs are located adjacent to utility trenches, the slab bearing surface should bear below an imaginary 1.5 horizontal to 1 vertical plane extending upward from the bottom edge of the adjacent utility trench. Alternatively, the slab reinforcing could be increased to span the area defined above assuming no soil support is provided.

A vapor retarder must be placed between the subgrade soils and the bottom of the slabs-on-grade. We recommend the vapor retarder consist of a single layer of Stego Wrap Vapor Barrier 15 mil or equivalent provided the equivalent satisfies the following criteria: permeance as tested before and after mandatory conditioning of less than 0.01 Perms and strength of Class A as determined by

ASTM E 1745 (latest edition), and a thickness of at least 15 mils. Installation of the vapor retarder should conform to the latest edition of ASTM E 1643 (latest edition) and the manufacturers requirements; including that all joints should be lapped at least 6 inches and sealed with Stego Tape or equal in accordance with the manufacturer's specifications. Protrusions where pipes or conduit penetrate the membranes should be sealed with either one or a combination of Stego Tape, Stego Mastic, Stego Pipe Boots, or a product of equal quality as determined by the manufacturer's instructions and ASTM E 1643. Care must be taken to protect the membrane from tears and punctures during construction. We do not recommend placing sand or gravel over the membrane.

Concrete slabs retain moisture and often take many months to dry; water added during the concrete pour further increases the curing time. If the slabs are not allowed to completely cure prior to constructing the super-structure, the concrete slabs will expel water vapor and the vapor will be trapped under impermeable flooring. The concrete mix design for the slabs should have a maximum water/cement ratio of 0.45; the actual water/cement ratio may need to be reduced if the concentration of soluble sulfates or chlorides in the supporting subgrade is detrimental to the concrete or reinforcement. The results of sulfate and chloride testing of onsite soil samples are included in Appendix B for reference. We recommend you consult with your concrete slab designers and concrete contractors regarding methods to reduce the potential for differential concrete curing.

An experienced Structural Engineer should design the post-tensioned slabs to resist the differential soil movement. The soil design parameters presented below were generated using the procedures presented in the 3rd edition of the PTI design manual[20], PTI standard requirements[21], and a PTI preferred computer program, VOLFLO (Version 1.5 Build 120704), was employed to simulate the wetting and drying scenarios of the soils beneath the post-tensioned slabs.

The values provided below are based upon the post-tensioned slab foundations being entirely surrounded by uniform, properly drained, moderately irrigated landscaping; if differing conditions will exist that will cause differential soil moisture adjacent or below the slabs, or if portions of the foundations will be located adjacent to relatively dry or wet soils, then we should be consulted; modifications to the values below would need to be in writing. Please refer to **Section 4.1.9, *Surface Drainage, Irrigation, and Landscaping***, for additional recommendations. We recommend the slab-subgrade friction values provided in the most recent PTI Manual be used in order to determine the friction that might be expected to exist during tendon stressing.

[20]Post-Tensioning Institute, 2008, *Design of Post-Tensioned Slabs-On-Ground (PTI DC10.1-08)*, Third Edition.
[21]Post-Tensioning Institute, 2012, *Standard Requirements for Design and Analysis of Shallow Post-Tensioned Concrete Foundations on Expansive Soils (PTI DC10.5-12)*.

SWELLING MODE

	Center Lift	Edge Lift
Edge Moisture Variation Distance (e_m)	9.0 feet	5.0 feet
Differential Soil Movement (y_m)	1.0 inch	2.0 inch

We recommend SFB review the foundation drawings and specifications prior to submittal to verify that the recommendations provided in this report have been used and properly interpreted in the design of the slabs.

4.2.2 Retaining Walls and Soundwalls

If segmental block walls with geogrid will be used at the site, SFB should be contacted to provide block wall and geogrid designs and specifications.

Where walls retain soil, they must be designed to resist both lateral earth pressures and any additional lateral loads caused by surcharging such as building and roadway loads. The recommendations provided below are for retaining walls that are located at least 1.5H feet away from a building, where H is the height of the retaining portion of the walls. Where concrete or masonry walls are used to retain soil, we recommend unrestrained walls (walls free to deflect and disconnected from other structures) be designed to resist an equivalent fluid pressure of 60 pounds per cubic foot. This assumes a level backfill. Restrained walls (walls restrained from deflection) should be designed to resist an equivalent fluid pressure of 60 pounds per cubic foot plus a uniform pressure of 12H pounds per square foot, where H is the height of the wall in feet. Walls with inclined backfill should be designed for an additional equivalent fluid pressure of 1 pound per cubic foot for every 1 degree of slope inclination. Walls subjected to surcharge loads should be designed for an additional uniform lateral pressure equal to one-third and one-half the anticipated surcharge load for unrestrained and restrained walls, respectively. These lateral pressures depend upon the moisture content of the retained soils to be constant over time. If the moisture content of the retained soils will fluctuate or increase compared to the moisture content at time of construction, then SFB should be consulted and provide written modifications to this design criteria.

For retaining walls that need to resist earthquake induced lateral loads from nearby foundations, walls that are to be designed to resist earthquake loads, and any retaining walls that are higher than 6 feet (as required by the 2016 CBC), we recommend the walls also be designed to resist a triangular pressure distribution equal to an equivalent fluid pressure of 45 pounds per cubic foot based on the ground acceleration from a design basis earthquake. This seismic induced earth pressure is in addition to the pressures noted above. Due to the transient nature of the seismic loading, a factor of safety of at least 1.1 can be used in the design of the walls when they resist seismic lateral loads. Some movement of the walls may occur during moderate to strong earthquake shaking and may result in distress as is typical for all structures subjected to earthquake shaking.

The recommended lateral pressures assume walls are fully-back drained to prevent the build-up of hydrostatic pressures. This can be accomplished by using ½ to ¾ inch crushed, uniformly graded gravel entirely wrapped in filter fabric such as Mirafi 140N or equal (an overlap of at least 12 inches should be provided at all fabric joints). The gravel and fabric should be at least 8 inches wide and extend from the base of the wall to within 12 inches of the finished grade at the top. Caltrans Class 2 permeable material (Section 68) may be used in lieu of gravel and filter fabric. A 4-inch diameter, perforated pipe should be installed at the base of the wall and centered within the gravel. The perforated pipe should be connected to a solid collector pipe that transmits the water directly to a storm drain, drainage inlet, or onto pavement. If weep holes are used in the wall, the use of perforated pipe within the gravel is not necessary provided the weep holes are kept free of animals and debris, are located no higher than approximately 6 above the lowest adjacent grade, and are able to function properly. As an alternative to using gravel, drainage panels (such as AWD SITEDRAIN Sheet 94 for walls or equal) may be used behind the walls in conjunction with perforated pipe (connected to solid collector pipe), weep holes, or strip drains (such as SITEDRAIN Strip 6000 or equal). If used, the drainage panels can be spaced on-center at approximately 2 times the panel width.

If heavy compaction equipment is used behind the walls, the walls should be appropriately designed to withstand loads exerted by the heavy equipment and/or temporarily braced. Fill placed behind walls should conform to the recommendations provided in **Section 4.1.4, *Fill Material***, and **Section 4.1.5, *Compaction***.

Retaining walls and soundwalls can be supported on drilled, cast-in-place, straight shaft friction piers that develop their load carrying capacity in the materials underlying the site. The piers should have a minimum diameter of 12 inches and a center-to-center spacing of at least three times the shaft diameter. We recommend that piers be at least 6 feet long. The pier reinforcing should be based on structural requirements but in no case should less than two #4 bars for the entire length of the pier be used.

The actual design depth of the piers should be determined using an allowable skin friction of 500 pounds per square foot (psf) for dead plus live loads, with a one-third increase for all loads including wind or seismic. Seventy percent of the skin friction value can be used to resist uplift. Lateral load resistance can be developed in passive resistance for pier foundations. A passive resistance equal to an equivalent fluid weighing 350 pounds per cubic foot acting against twice the projected diameter of pier shafts can be used. The upper two feet of pier embedment should be neglected in the vertical and passive resistance design as measured from finished grade. The portion of the pier shaft located within 10 feet (as measured laterally) of the nearest slope face should also be ignored in the design.

We recommend the pier foundations be located outside of (or beyond) a 1:1 (horizontal to vertical) plane projected upward from the base of any wall or utility trench, or the portion of a pier located within this zone should be ignored in the design of the pier.

The bottoms of the pier excavations should be relatively dry and free of all loose cuttings or slough prior to placing reinforcing steel and concrete. Any accumulated water in pier excavations should be removed prior to placing concrete. We recommend that the excavation of all piers be performed under the direct observation of SFB to confirm that the pier foundations are founded in suitable materials and constructed in accordance with the recommendations presented herein. Preliminarily, we recommend concrete pours of pier excavations be performed within 24 hours of excavation and prior to any rainstorms. Where caving or high groundwater conditions exist, additional measures such as using casing, tremie methods, and pouring concrete immediately after excavating may be necessary. SFB should be consulted on the need for additional measures for pier construction as needed during construction.

4.2.3 Seismic Design Criteria

The following parameters were calculated using U.S. Geological Survey's Seismic Design Map program[22], and were based on the site being located at approximate latitude 38.268°N and longitude 122.654°W. For seismic design using the 2016 California Building Code (CBC), we recommend the following seismic design values be used.

2016 CBC SEISMIC PARAMETERS		
Seismic Parameter	Design Value	CBC Reference
Site Class	D	Section 1613.3.2
S_S	1.57	Figure 1613.3.1(1)
S_1	0.619	Figure 1613.3.1(2)
F_a	1.0	Table 1613.3.3(1)
F_v	1.5	Table 1613.3.3(2)

[22]USGS Website, *https://earthquake.usgs.gov/hazards/interactive/index.php*, accessed 8/22/2018.

4.3 Pavements

Based on the results of laboratory testing of onsite materials, we recommend that an R-value of 5 be used in preliminary asphalt concrete pavement design. We recommend additional R-value tests be performed once the pavement subgrade is established to confirm the R-value used in the design. Pavement subgrade completely composed of sandy and gravelly fills will result in higher R-values and thinner pavement sections.

We developed the following alternative preliminary pavement sections using Topic 608 of the State of California Department of Transportation Highway Design Manual, the recommended R-value, and typical traffic indices for residential developments. The project's Civil Engineer or appropriate public agency should determine actual traffic indices. The pavement thicknesses shown below are SFB's recommended minimum values; governing agencies may require pavement thicknesses greater than those shown.

PRELIMINARY PAVEMENT DESIGN ALTERNATIVES SUBGRADE R-VALUE = 5			
Location	Pavement Components		Total Thickness (inches)
	Asphalt Concrete (inches)	Class 2 Aggregate Base (inches)	
T.I. = 4.5 (auto & light truck parking)	3.0	9.0	12.0
T.I. = 5.0 (access ways/courts)	3.0	11.0	14.0
T.I. = 6.0 (primary roadways)	3.0	14.0	17.0

If the pavements are planned to be placed prior to or during construction, the traffic indices and pavement sections may not be adequate for support of what is typically more frequent and heavier construction traffic. If the pavement sections will be used for construction access by heavy trucks or construction equipment (especially fork lifts with support footings), SFB should be consulted to provide recommendations for alternative pavement sections capable of supporting heavier use and heavier loads. If requested, SFB can provide recommendations for a phased placement of the asphalt concrete to reduce the potential for mechanical scars caused by construction traffic in the finished grade. Preliminary pavement sections should be revised, if necessary, when actual traffic indices are known and pavement subgrade elevations are determined.

Pavement, baserock, and asphalt concrete should be compacted to at least 95 percent relative compaction. The asphalt concrete compacted unit weight should be determined using Caltrans

Test Method 308-A or ASTM Test Method D1188. Asphalt concrete should also satisfy the S-value requirements by Caltrans.

We recommend regular maintenance of the asphalt concrete be performed at approximately five-year intervals. Maintenance may include sand slurry sealing, crack filling, and chip seals as necessary. If regular maintenance is not performed, the asphalt concrete layer could experience premature degradation requiring more extensive repairs.

5.0 CONDITIONS AND LIMITATIONS

SFB is not responsible for the validity or accuracy of information, analyses, test results, or designs provided to SFB by others or prepared by others. The analysis, designs, opinions, and recommendations submitted in this report are based in part upon the data obtained from our field work and upon information provided by others. Site exploration and testing characterizes subsurface conditions only at the locations where the explorations or tests are performed; actual subsurface conditions between explorations or tests may be different than those described in this report. Variations of subsurface conditions from those analyzed or characterized in this report are not uncommon and may become evident during construction. In addition, changes in the condition of the site can occur over time as a result of either natural processes (such as earthquakes, flooding, or changes in ground water levels) or human activity (such as construction adjacent to the site, dumping of fill, or excavating). If changes to the site's surface or subsurface conditions occur since the performance of the field work described in this report, or if differing subsurface conditions are encountered, we should be contacted immediately to evaluate the differing conditions to assess if the opinions, conclusions, and recommendations provided in this report are still applicable or should be amended.

We recommend SFB be retained to provide geotechnical services during design, reviews, earthwork operations, paving operations, and foundation installation to confirm and observe compliance with the design concepts, specifications and recommendations presented in this report. Our presence will also allow us to modify design if unanticipated subsurface conditions are encountered or if changes to the scope of the project, as defined in this report, are made.

This report is a design document that has been prepared in accordance with generally accepted geological and geotechnical engineering practices for the exclusive use of Lomas - Corona Station, LLC and their consultants for specific application to the proposed Corona Station & SMART Facility project in Petaluma, California, and is intended to represent our design recommendations to Lomas - Corona Station, LLC for specific application to the Corona Station & SMART Facility project in Petaluma, California,. The conclusions and recommendations contained in this report are solely professional opinions. It is the responsibility of Lomas - Corona Station, LLC to transmit the information and recommendations of this report to those designing and constructing the project. We will not be responsible for the misinterpretation of the information provided in this report. We recommend SFB be retained to review geological and geotechnical aspects of the construction calculations, specifications, and plans; we should also be retained to participate in prebid and preconstruction conferences to clarify the opinions, conclusions, and recommendations contained in this report.

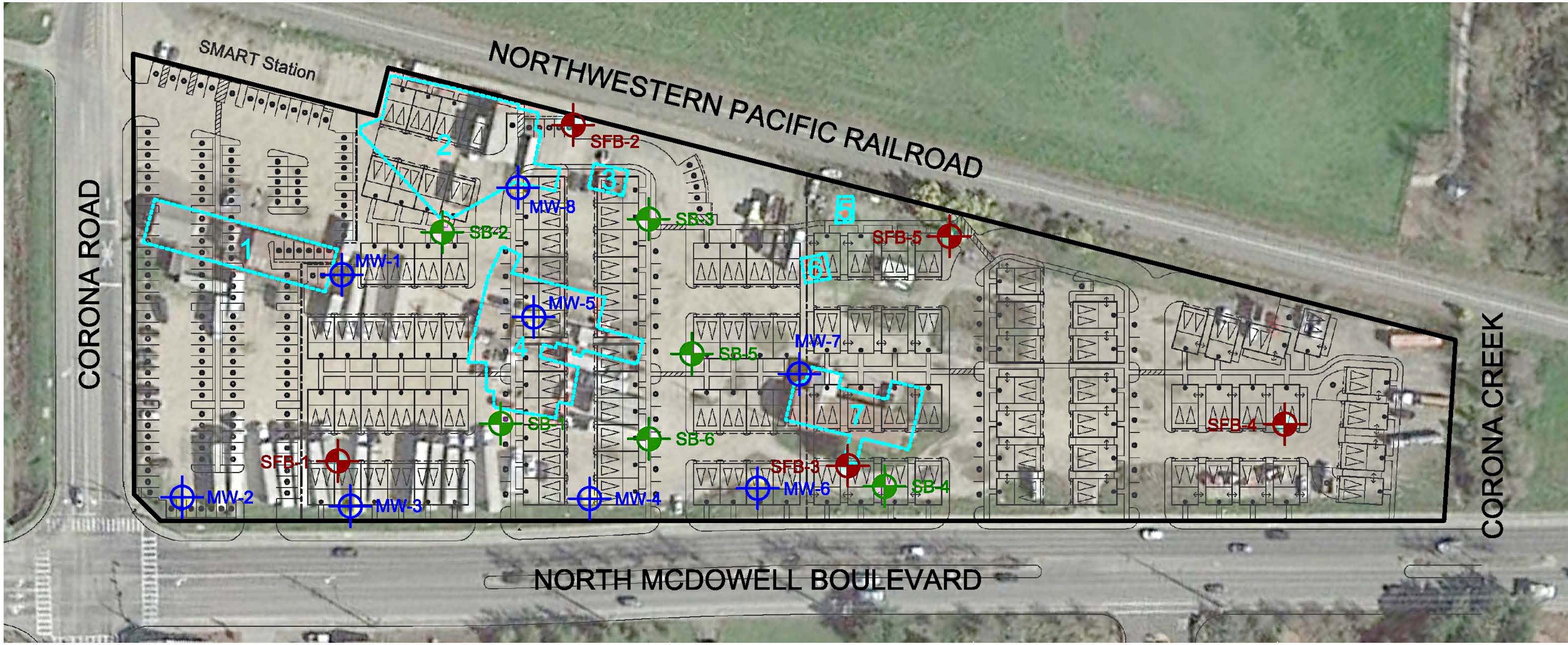
It should be understood that advancements in the practice of geotechnical engineering and engineering geology, or discovery of differing surface or subsurface conditions, may affect the validity of this report and are not uncommon. SFB strives to perform its services in a proper and professional manner with reasonable care and competence but we are not infallible. Geological engineering and geotechnical engineering are disciplines that are far less exact than other engineering disciplines; therefore, we should be consulted if it is not completely understood what the limitations to using this report are.

In the event that there are any changes in the nature, design or location of the project, as described in this report, or if any future additions are planned, the conclusions and recommendations contained in this report shall not be considered valid unless we are contacted in writing, the project changes are reviewed by us, and the conclusions and recommendations presented in this report are modified or verified in writing. The opinions, conclusions, and recommendations contained in this report are based upon the description of the project as presented in the introduction section of this report.

This report does not necessarily represent all of the information that has been communicated by us to Lomas - Corona Station, LLC and their consultants during the course of this engagement and our rendering of professional services to Lomas - Corona Station, LLC. Reliance on this report by parties other than those described above must be at their own risk unless we are first consulted as to the parties' intended use of this report and only after we obtain the written consent of Corona Station, LLC to divulge information that may have been communicated to Lomas - Corona Station, LLC. We cannot accept the consequences of the use of segregated portions of this report.

Please refer to Appendix D for additional guidelines regarding use of this report.

FIGURE



KEY

SFB-5	APPROXIMATE LOCATION OF SFB EXPLORATORY BORING (7/23/18 & 7/24/18)
SB-6	APPROXIMATE LOCATION OF PREVIOUS EXPLORATORY BORING (6/1/17 & 6/2/17)
MW-8	APPROXIMATE LOCATION OF EXISTING MONITORING WELL
(solid line)	APPROXIMATE PROJECT LIMIT
7	APPROXIMATE ENVIRONMENTAL SOIL EXCAVATION AREA

N

NOTE: Base map was created by overlaying the project conceptual site plan prepared by Van Tilburg, Banvard & Soderbergh, AIA and dated 7/9/18 on a Google Earth image dated 2/14/18.

APPROXIMATE SCALE: 1" = 80'

0 80' 160'

DATE	PROJECT NO.
August 2018	825-1

Stevens Ferrone & Bailey Engineering Company, Inc
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SITE PLAN

CORONA STATION
Petaluma, California

FIGURE 1

APPENDIX A
Field Investigation

APPENDIX A

Field Investigation

Our field investigation for the proposed Corona Station development project in Petaluma, California, consisted of surface reconnaissance and a subsurface exploration program. Geotechnical reconnaissance of the site and surrounding area and a subsurface exploration program was performed on July 23 and 24, 2018. The subsurface exploration consisted of five exploratory borings performed using a truck-mounted drill rig equipped with 4-inch diameter, continuous flight, solid stem augers. Our representative continuously logged the soils encountered in the borings in the field. The soils are described in general accordance with the Unified Soil Classification System (ASTM D2487). The borings logs and a soil classification key (Figure A-1) are included as part of this appendix.

Representative samples were obtained from our exploratory borings at selected depths appropriate to the investigation. Relatively undisturbed samples were obtained using a 3-inch O.D. split barrel sampler with liners, and disturbed samples were obtained using the 2-inch O.D. split spoon sampler. All samples were transmitted to our offices for evaluation and appropriate testing. Both sampler types are indicated in the "Sampler" column of the boring logs as designated in Figure A-1.

Resistance blow counts were obtained in our boring with the samplers by dropping a 140-pound safety hammer through a 30-inch free fall. The sampler was driven 18 inches and the number of blows were recorded for each 6 inches of penetration. The blows per foot recorded on the boring logs represent the accumulated number of converted blows that were required to drive the last 12 inches, or the number of inches indicated where hard resistance was encountered. The blow counts recorded on the boring logs have been converted to equivalent SPT field blowcounts with a 60% efficiency hammer, but have not been corrected for overburden, fines content, or other factors.

The attached boring logs and related information show our interpretation of the subsurface conditions at the dates and locations indicated, and it is not warranted that they are representative of subsurface conditions at other locations and times.

UNIFIED SOIL CLASSIFICATION SYSTEM

Major Divisions		grf	ltr	Description
Coarse Grained Soils	Gravel / Gravelly Soils		GW	Well-graded gravels or gravel sand mixtures, little or no fines
			GP	Poorly-graded gravels or gravel sand mixture, little or no fines
			GM	Silty gravels, gravel-sand-silt mixtures
			GC	Clayey gravels, gravel-sand-clay mixtures
	Sand And Sandy Soils		SW	Well-graded sands or gravelly sands, little or no fines
			SP	Poorly-graded sands or gravelly sands, little or no fines
			SM	Silty sands, sand-silt mixtures
			SC	Clayey sands, and-clay mixtures

Major Divisions		grf	ltr	Description
Soils	Silts And Clays LL < 50		ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity
			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
			OL	Organic silts and organic silt-clays of low plasticity
	Silts And Clays LL > 50		MH	Inorganic silts, micaceous or diatomaceous fine or silty soils, elastic silts
			CH	Inorganic clays of high plasticity, fat clays
			OH	Organic clays of medium to high plasticity
Highly Organic Soils			PT	Peat and other highly organic soils

GRAIN SIZES

U.S. STANDARD SERIES SIEVE: 200, 40, 10, 4

CLEAR SQUARE SIEVE OPENINGS: 3/4", 3", 12"

Silts and Clays	Sand			Gravel		Cobbles	Boulders
	Fine	Medium	Coarse	Fine	Coarse		

RELATIVE DENSITY

Sands and Gravels	Blows/Foot*
Very Loose	0 - 4
Loose	4 - 10
Medium Dense	10 - 30
Dense	30 - 50
Very Dense	Over 50

CONSISTENCY

Silts and Clays	Blows/Foot*	Strength (tsf)**
Very Soft	0 - 2	0 - 1/4
Soft	2 - 4	1/4 - 1/2
Firm	4 - 8	1/2 - 1
Stiff	8 - 16	1 - 2
Very Stiff	16 - 32	2 - 4
Hard	Over 32	Over 4

*Number of Blows for a 140-pound hammer falling 30 inches, driving a 2-inch O.D. (1-3/8" I.D.) split spoon sampler.
**Unconfined compressive strength.

SYMBOLS & NOTES

- Standard Penetration sampler (2" OD Split Barrel)
- Modified California sampler (3" OD Split Barrel)
- California Sampler (2.5" OD Split Barrel)
- Shelby Tube
- Pitcher Barrel
- HQ Core
- Ground Water level initially encountered
- Ground Water level at end of drilling

PI = Plasticity Index
LL = Liquid Limit
R = R-Value

Increasing Visual Moisture Content

Saturated
Wet
Moist
Damp
Dry

Constituent Percentage

trace	<5%
some	5-15%
with	16-30%
-y	31-49%

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KEY TO EXPLORATORY BORING LOGS

CORONA STATION
Petaluma, California

PROJECT NO.	DATE	FIGURE NO.
825-1	August 2018	A-1

DRILL RIG Mobile B-24, CFA	SURFACE ELEVATION ---	LOGGED BY HP
DEPTH TO GROUND WATER 9 feet	BORING DIAMETER 4-inch	DATE DRILLED 07/23/18

DESCRIPTION AND REMARKS	CONSIST	SOIL TYPE	DEPTH (FEET)	SAMPLER	SPT N-VALUE	WATER CONTENT (%)	DRY DENSITY (PCF)	UNC. COMP. (KSF)	OTHER TESTS
FILL: CLAY (CL), dark gray-brown, with silt, with sand(fine- to coarse-grained), some gravel(fine, subangular to subrounded), moist.	stiff		0						
CLAY (CH), very dark gray with orange mottling, silty, some sand(fine- to coarse-grained), trace rootlets, moist.	stiff				11	31	88		At 3.5': Liquid Limit = 78%; Plasticity Index = 58; Coarse Sand = 1%; Medium Sand = 3%; Fine Sand = 8%; Silt = 12%; Clay = 76%
					13	36			
Change color to dark gray-brown, some sand(fine- to medium-grained).			5		11	35	86	3.6	
CLAY (CL), light brown with black mottling, silty, with sand(fine- to medium-grained), moist.	very stiff		10		22	17	110		
CLAY (CL), light olive-brown, silty, trace sand(fine-grained), moist.	stiff								
Change color to yellowish olive-brown, with sand(fine-grained).			15		14	27	96		
Change color to light gray-brown, moist to wet.			20		12				
	very stiff		25		17				
Change color to light brown with black mottling, with sand(fine- to medium-grained).	hard		30		35				

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EXPLORATORY BORING LOG

CORONA STATION
Petaluma, California

PROJECT NO.	DATE	BORING NO.
825-1	**August 2018**	**SFB-1**

DRILL RIG Mobile B-24, CFA	SURFACE ELEVATION ---	LOGGED BY HP
DEPTH TO GROUND WATER 9 feet	BORING DIAMETER 4-inch	DATE DRILLED 07/23/18

DESCRIPTION AND REMARKS	CONSIST	SOIL TYPE	DEPTH (FEET)	SAMPLER	SPT N-VALUE	WATER CONTENT (%)	DRY DENSITY (PCF)	UNC. COMP. (KSF)	OTHER TESTS
CLAY (CL), continued. Change color to light brown with red-brown mottling, with sand(fine- to coarse-grained), trace organics.	very stiff		35		23				
SAND (SC), olive-brown, fine- to medium-grained, with clay, some silt, wet.	medium dense		40		22				At 41': Percent Passing #200 Sieve = 21.7%
Change color to olive-brown and yellowish-brown.	dense		45		33				
Bottom of Boring = 46.5 feet Notes: Stratification is approximate, variations must be expected. Blowcounts converted to SPT N-values. See Report for additional details.			50, 55, 60, 65						

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EXPLORATORY BORING LOG

CORONA STATION
Petaluma, California

PROJECT NO.	DATE	BORING NO.
825-1	**August 2018**	**SFB-1**

DRILL RIG Mobile B-24, CFA	SURFACE ELEVATION ---	LOGGED BY HP
DEPTH TO GROUND WATER Not Encountered	BORING DIAMETER 4-inch	DATE DRILLED 07/23/18

DESCRIPTION AND REMARKS	CONSIST	SOIL TYPE	DEPTH (FEET)	SAMPLER	SPT N-VALUE	WATER CONTENT (%)	DRY DENSITY (PCF)	UNC. COMP. (KSF)	OTHER TESTS
FILL: SAND (SP), red-brown, fine- to coarse-grained, gravelly(fine to coarse, subangular to subrounded), with clay, damp.	medium dense		0		12	17	103		
CLAY (CH), very dark gray, silty, trace sand(fine- to coarse-grained), moist.	stiff				11				
Change color to dark gray, with sand(fine- to coarse-grained).			5		15	20	104	3.7	
SAND (SC), gray-brown, fine- to coarse-grained, gravelly(fine, angular to subangular), with clay, moist.	medium dense		10		24	15			At 11': Percent Passing #200 Sieve = 17.2%
CLAY (CL), light brown, silty, some sand(fine- to medium-grained), moist.	very stiff		15		22				
Bottom of Boring = 16.5 feet Notes: Stratification is approximate, variations must be expected. Blowcounts converted to SPT N-values. See Report for additional details.			20, 25, 30						

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EXPLORATORY BORING LOG

CORONA STATION
Petaluma, California

PROJECT NO.	DATE	BORING NO.
825-1	**August 2018**	**SFB-2**

DRILL RIG Mobile B-24, CFA	SURFACE ELEVATION ---	LOGGED BY HP
DEPTH TO GROUND WATER 10 feet	BORING DIAMETER 4-inch	DATE DRILLED 07/23/18

DESCRIPTION AND CLASSIFICATION

DESCRIPTION AND REMARKS	CONSIST	SOIL TYPE	DEPTH (FEET)	SAMPLER	SPT N-VALUE	WATER CONTENT (%)	DRY DENSITY (PCF)	UNC. COMP. (KSF)	OTHER TESTS
CLAY (CH), very dark gray, silty, some sand(fine- to coarse-grained), moist.	stiff		0		14	30	89	3.4	
					15				
CLAY (CL), light gray, silty, with sand(fine- to coarse-grained), moist.	stiff to very stiff		5		16	18	110		
SAND (SC), yellowish-brown, fine- to coarse-grained, gravelly(fine, subangular to subrounded), with clay, wet.	medium dense		10		18	18	108		
CLAY (CL), light brown, silty, trace sand(fine-grained), moist.	very stiff		15		21				
Bottom of Boring = 16.5 feet Notes: Stratification is approximate, variations must be expected. Blowcounts converted to SPT N-values. See Report for additional details.			20						
			25						
			30						

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EXPLORATORY BORING LOG

CORONA STATION
Petaluma, California

PROJECT NO.	DATE	BORING NO.
825-1	**August 2018**	**SFB-3**

DRILL RIG Mobile B-24, CFA	SURFACE ELEVATION ---	LOGGED BY HP
DEPTH TO GROUND WATER 9 feet	BORING DIAMETER 4-inch	DATE DRILLED 07/24/18

DESCRIPTION AND REMARKS	CONSIST	SOIL TYPE	DEPTH (FEET)	SAMPLER	SPT N-VALUE	WATER CONTENT (%)	DRY DENSITY (PCF)	UNC. COMP. (KSF)	OTHER TESTS
Crushed rock about 2" thick.			0						
FILL: CLAY (CL), brown with gray mottling, sandy(fine- to coarse-grained), with gravel(fine, subangular to subrounded), some silt, moist.	very stiff				24	14	116		
FILL: CLAY (CL)/SAND (SC), mottled dark gray and bluish-gray, fine- to coarse-grained, with silt, trace rootlets, moist.	very stiff				17				At 6': Liquid Limit = 45% Plasticity Index = 26 Fine Gravel = 12% Coarse Sand = 7% Medium Sand = 10% Fine Sand = 22% Silt = 23% Clay = 26%
Some gravel(fine, subangular to subrounded), with organics, organic smell.	firm to stiff		5		5	25	93	2.2	
CLAY (CL), yellowish-brown, sandy(fine- to coarse-grained), with silt, with gravel(fine, subangular to subrounded), moist.	hard		10						
Change color to blue-gray.					39	18	114		
CLAY (CL), light brown, silty, with sand(fine- to coarse-grained), moist.	stiff to very stiff		15		16				
	hard		20		38				
Change color to yellowish-brown, sandy(fine- to coarse-grained), some gravel(fine, subangular to subrounded), wet.	very stiff		25		30				At 26': Percent Passing #200 Sieve = 36.8%
SAND (SC), yellowish-brown, fine- to coarse-grained, clayey, with silt, wet.	medium dense to dense								
CLAY (CL), yellowish-brown, silty, trace sand(fine- to medium-grained), moist.	very stiff		30		20				
Change color to light brown with dark brown mottling.									

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EXPLORATORY BORING LOG

CORONA STATION
Petaluma, California

PROJECT NO.	DATE	BORING NO.
825-1	**August 2018**	**SFB-4**

DRILL RIG Mobile B-24, CFA	SURFACE ELEVATION ---	LOGGED BY HP
DEPTH TO GROUND WATER 9 feet	BORING DIAMETER 4-inch	DATE DRILLED 07/24/18

DESCRIPTION AND REMARKS	CONSIST	SOIL TYPE	DEPTH (FEET)	SAMPLER	SPT N-VALUE	WATER CONTENT (%)	DRY DENSITY (PCF)	UNC. COMP. (KSF)	OTHER TESTS
CLAY (CL), light brown, sandy(fine- to medium-grained), with silt, moist.	very stiff		35		17				At 36': Percent Passing #200 Sieve = 50.2%
SAND (SC), light brown with black and orange mottling, fine- to coarse-grained, clayey, with silt, moist.	medium dense								
	dense		40		45				
Bottom of Boring = 41.5 feet Notes: Stratification is approximate, variations must be expected. Blowcounts converted to SPT N-values. See Report for additional details.			45						
			50						
			55						
			60						
			65						

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EXPLORATORY BORING LOG

CORONA STATION
Petaluma, California

PROJECT NO.	DATE	BORING NO.
825-1	**August 2018**	**SFB-4**

DRILL RIG Mobile B-24, CFA	SURFACE ELEVATION ---	LOGGED BY HP
DEPTH TO GROUND WATER 8 feet	BORING DIAMETER 4-inch	DATE DRILLED 07/24/18

DESCRIPTION AND CLASSIFICATION

DESCRIPTION AND REMARKS	CONSIST	SOIL TYPE	DEPTH (FEET)	SAMPLER	SPT N-VALUE	WATER CONTENT (%)	DRY DENSITY (PCF)	UNC. COMP. (KSF)	OTHER TESTS
FILL: SAND (SP), brown, fine- to coarse-grained, with clay, with gravel(fine, subangular to subrounded), some silt, damp to moist.	medium dense		0						
FILL: CLAY (CH), mottled dark gray and bluish-gray, with silt, some sand(fine- to coarse-grained), some gravel(fine, subangular to subrounded), moist.	very stiff				18				
	stiff				12	22			
	very stiff		5		18	22	103		
CLAY (CL), light bluish-gray, silty, with sand(fine- to medium-grained), moist.	very stiff								
	stiff		10		14	23	105	4.4	
CLAY (CL), olive-brown with bluish-gray mottling, silty, with sand(fine- to medium-grained), moist.	stiff to very stiff								
SAND (SC), gray-brown, fine- to coarse-grained, clayey, with silt, wet.	medium dense		15		21				
CLAY (CL), yellowish-brown, silty, with sand(fine- to medium-grained), moist.	very stiff								
Bottom of Boring = 16.5 feet Notes: Stratification is approximate, variations must be expected. Blowcounts converted to SPT N-values. See Report for additional details.			20						
			25						
			30						

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EXPLORATORY BORING LOG

CORONA STATION
Petaluma, California

PROJECT NO.	DATE	BORING NO.
825-1	**August 2018**	**SFB-5**

APPENDIX B

Laboratory Investigation

APPENDIX B
Laboratory Investigation

Our laboratory testing program for the proposed Corona Station & SMART Facility project in Petaluma, California was directed toward a quantitative and qualitative evaluation of the physical and mechanical properties of the soils underlying the site.

The natural water content was determined on seventeen (17) subsurface soil samples. The water contents are recorded on the boring logs at the appropriate sample depths.

Dry density determination was performed on fourteen (14) subsurface soil samples to evaluate their physical properties. The results of the tests are shown on the boring logs at the appropriate sample depths.

Atterberg Limit determinations were performed on two (2) subsurface soil samples to determine the range of water content over which these materials exhibit plasticity. These values are used to classify the soil in accordance with the Unified Soil Classification System and to indicate the soil's compressibility and expansion potentials. The results of the tests are presented on the boring log at the appropriate sample depth.

Gradation and hydrometer tests were performed on two (2) subsurface soil samples. These tests were performed to assist in the classification of the soils and to determine their grain size distributions. The results of the tests are presented on the boring log at the appropriate sample depth.

Unconfined compression tests were performed on five (5) relatively undisturbed subsurface soil samples to evaluate the undrained shear strengths of these materials. Failure was taken as the peak normal stress. The results of the tests are presented on the boring logs at the appropriate sample depths.

The percent passing the #200 sieve was determined on four (4) subsurface soil samples to aid in the classification of these soils. The results of these tests are shown on the boring logs at the appropriate sample depths.

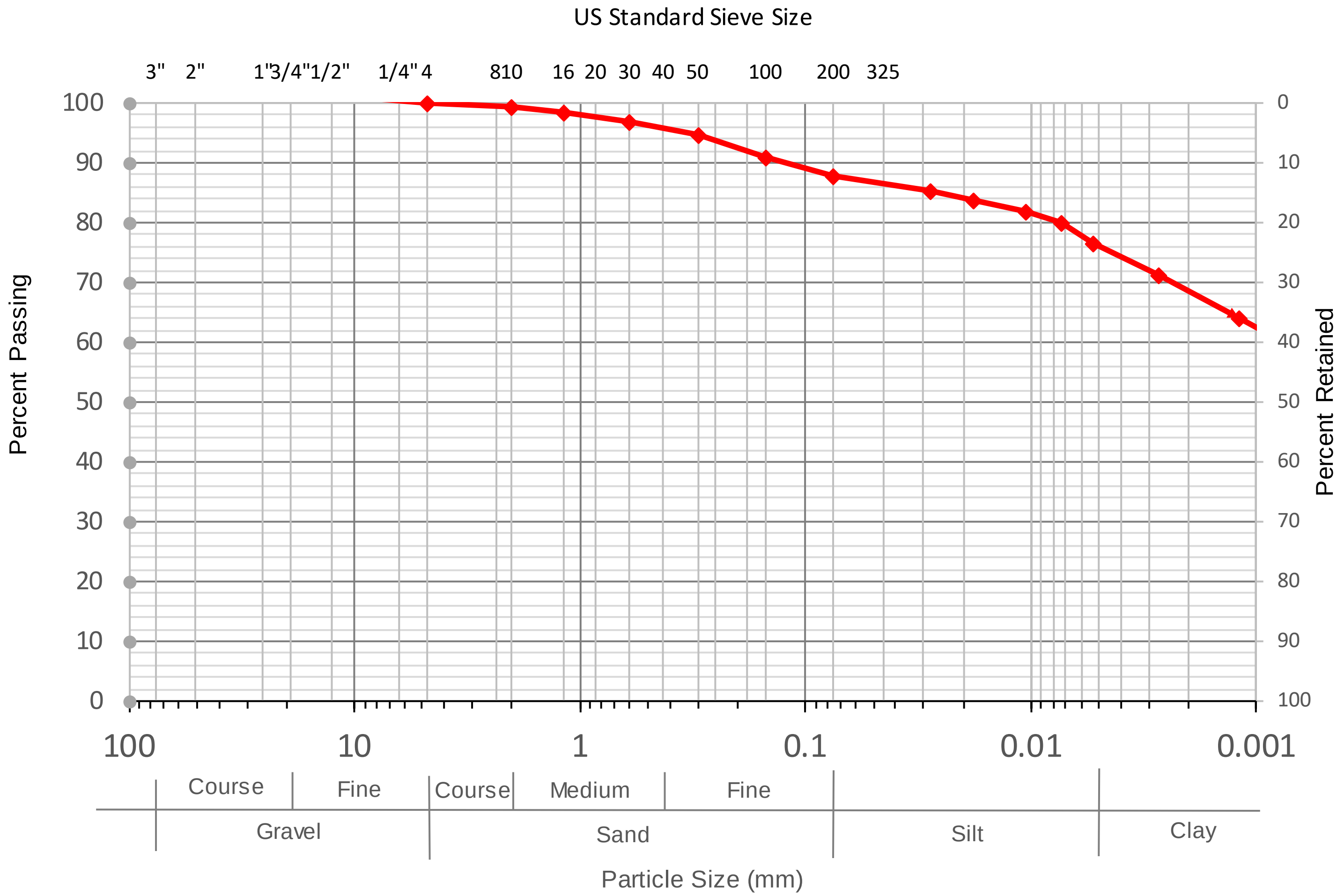
Two (2) onsite soil samples were tested for pH (ASTM D4972), chlorides (ASTM D4327), sulfates (ASTM D4327), sulfides (ASTM D4658M), resistivity at 100% saturation (ASTM G57), and Redox potential (ASTM D1498) for use in evaluating the potential for corrosion on concrete and buried metal such as utilities and reinforcing steel. The results of these tests are included in this appendix. We recommend these test results be forwarded to your underground contractors, pipeline designers, and foundation designers and contractors.

Hydrometer Analysis – ASTM D422

Project Number: 825-1 **Project Name:** Corona Station

Sample Number: B-1 **Description:** Dark brown silty CLAY some sand (CH)

Depth: 3.5 **Test Date:** 08-13-18 **Tested By:** R



Composite Sieve Data

Standard Sieve Size	Percent Passing
3”	
1.5”	
3/4”	
3/8”	
#4	100
#10	99.5
#16	98.4
#30	97.0
#50	94.7
#100	90.8
#200	87.8

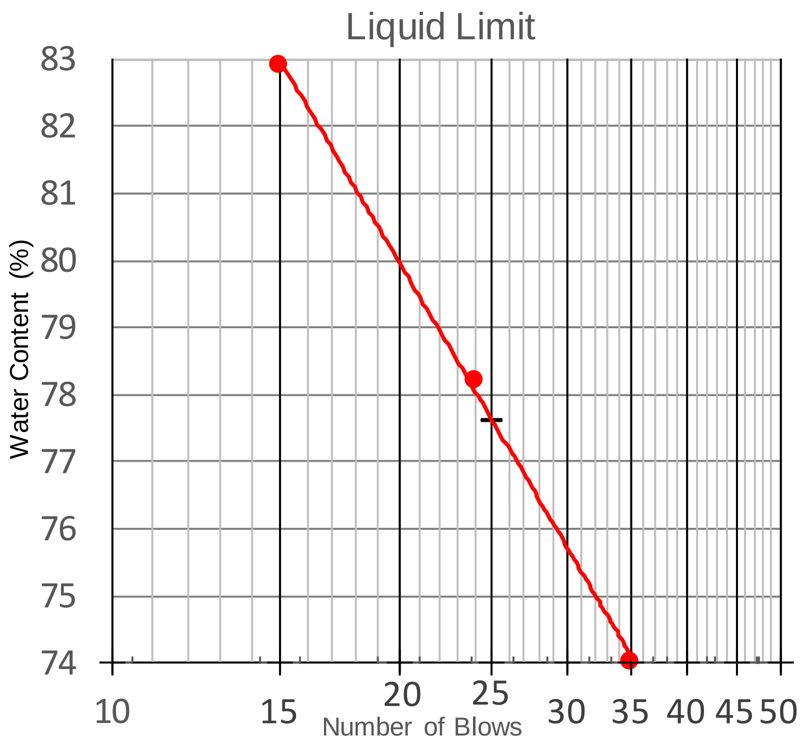
Particle Diameter (mm)	Percent Soil in Suspension
0.0280	85.4
0.0179	83.6
0.0105	81.8
0.0074	80.0
0.0053	76.5
0.0027	71.1
0.0013	64.0

Atterberg Limits Test – ASTM D4318

Project Number: 825-1 **Project Name:** Corona Station

Boring/Sample No: B-1 **Depth:** 3.5 **Date:** 08-13-18

Description of Sample: Dark brown silty CLAY some sand (CH) **Tested By** R

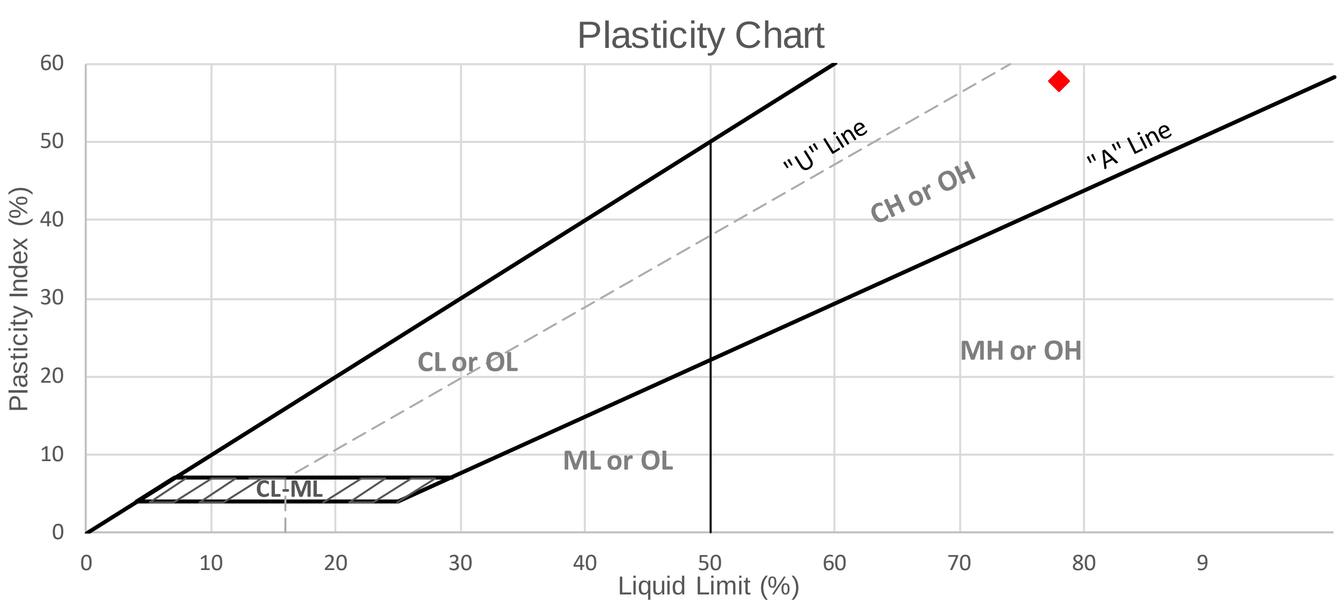


Plastic Limit Data

Trial	1	2	Ave
Water Content (%)	19.9	19.6	20

Data Summary

Liquid Limit	**78**
Plastic Limit	**20**
Plasticity Index	**58**
Natural Water Content	**35.6**
Liquidity Index	**0.269**
% Passing #200 Sieve	**87.8**



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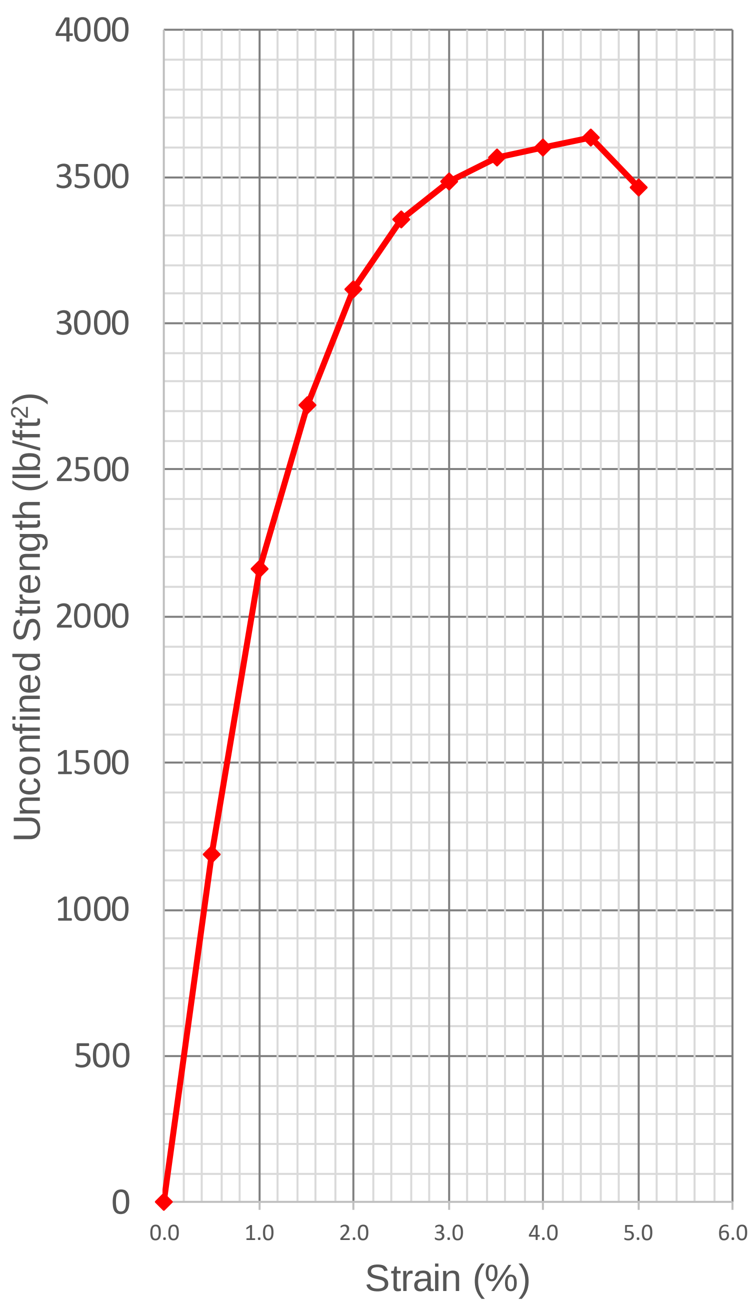
UNCONFINED COMPRESSIVE STRENGTH – D2166

Project Number: 825-1 **Boring #:** B-1 **Depth:** 6

Project Name: Corona Station **Date:** 8/8/2018

Description: Dark gray brown silty CLAY some sand (CH) **Tested By:** R



Soil Specimen Initial Measurements	
Diameter	2.42 in
Initial Area	4.60 in^2
Initial Length	5 in
Volume	0.01331 ft^3
Water Content	34.6
Wet Density	115.3 pcf
Dry Density	85.7 pcf

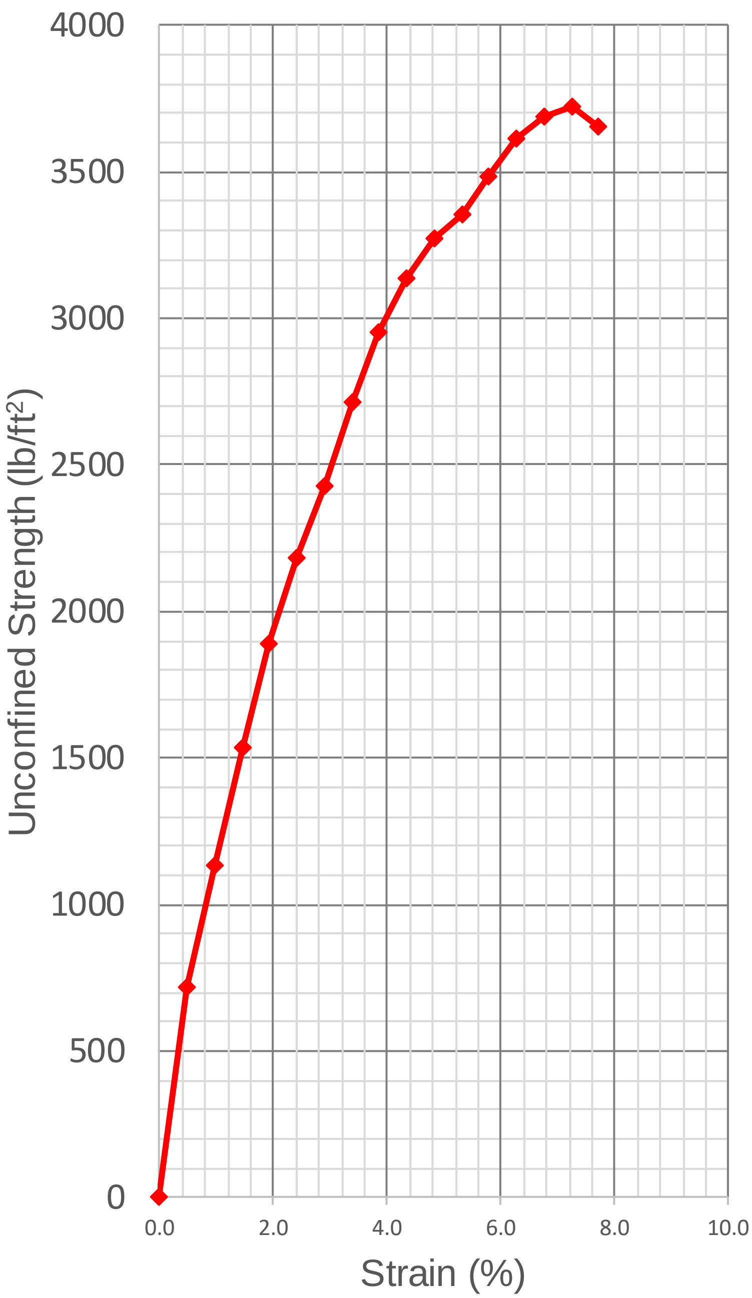
Max Unconfined Compressive Strength	
Elapsed Time	4.5 min
Vertical Dial	0.225 in
Strain	4.5 %
Area	0.03345 ft^2
Axial Load	121.5 lbs
Compressive Strength	3,632 psf

UNCONFINED COMPRESSIVE STRENGTH – D2166

Project Number: 825-1 **Boring #:** B-2 **Depth:** 6

Project Name: Corona Station **Date:** 8/8/2018

Description: Dark brown silty CLAY with sand (CL) **Tested By:** R



Soil Specimen Initial Measurements	
Diameter	2.42 in
Initial Area	4.60 in^2
Initial Length	5.18 in
Volume	0.01379 ft^3
Water Content	19.9
Wet Density	124.7 pcf
Dry Density	103.9 pcf

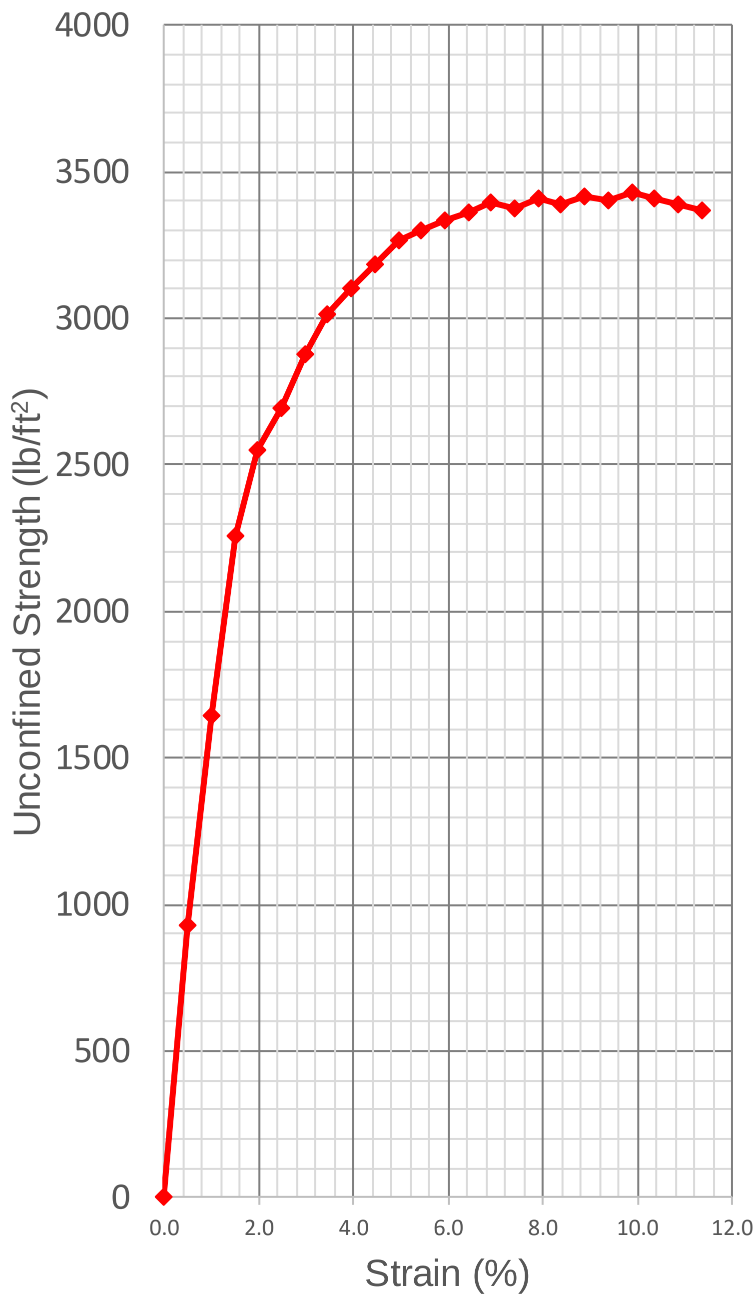
Max Unconfined Compressive Strength	
Elapsed Time	7.5 min
Vertical Dial	0.375 in
Strain	7.2 %
Area	0.03444 ft^2
Axial Load	128.1 lbs
Compressive Strength	3,720 psf

UNCONFINED COMPRESSIVE STRENGTH – D2166

Project Number: 825-1 **Boring #:** B-3 **Depth:** 2

Project Name: Corona Station **Date:** 8/8/2018

Description: Dark gray brown silty CLAY some sand (CH) **Tested By:** R



Soil Specimen Initial Measurements	
Diameter	2.42 in
Initial Area	4.60 in^2
Initial Length	5.07 in
Volume	0.01350 ft^3
Water Content	30.3
Wet Density	115.3 pcf
Dry Density	88.5 pcf

Max Unconfined Compressive Strength	
Elapsed Time	10 min
Vertical Dial	0.5 in
Strain	9.9 %
Area	0.03544 ft^2
Axial Load	121.5 lbs
Compressive Strength	3,428 psf

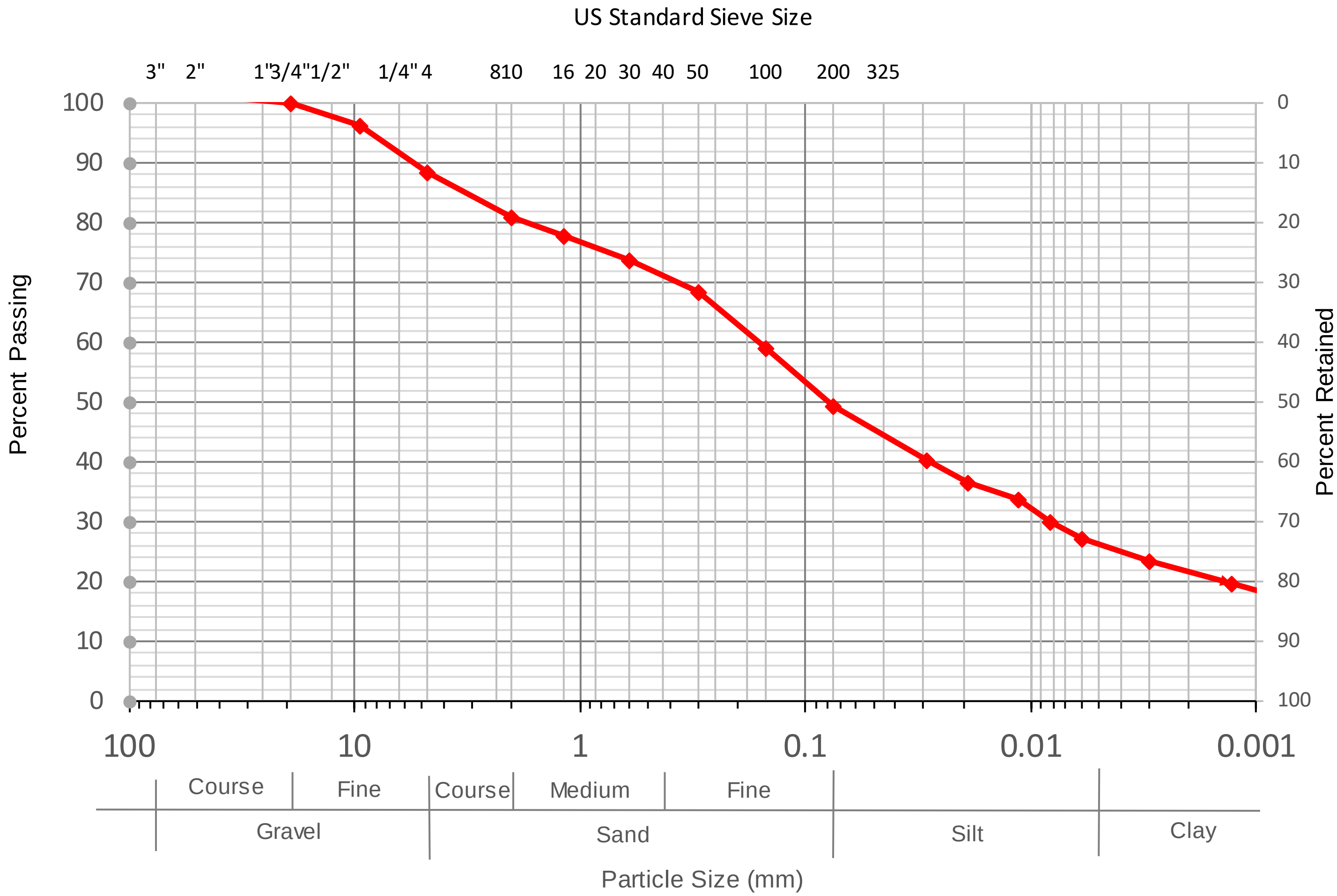
Stevens Ferrone & Bailey Engineering Company, Inc

Hydrometer Analysis – ASTM D422

Project Number: 825-1 **Project Name:** Corona Station

Sample Number: B-4 **Description:** Dark gray brown silty clayey SAND with organics some gravel (SC)

Depth: 6 **Test Date:** 08-13-18 **Tested By:** R



Composite Sieve Data

Standard Sieve Size	Percent Passing
3"	
1.5"	
3/4"	100
3/8"	96.2
#4	88.5
#10	81.0
#16	77.7
#30	73.6
#50	68.5
#100	59.1
#200	49.3

Particle Diameter (mm)	Percent Soil in Suspension
0.0293	40.3
0.0192	36.6
0.0114	33.8
0.0083	30.0
0.0060	27.2
0.0030	23.5
0.0013	19.7

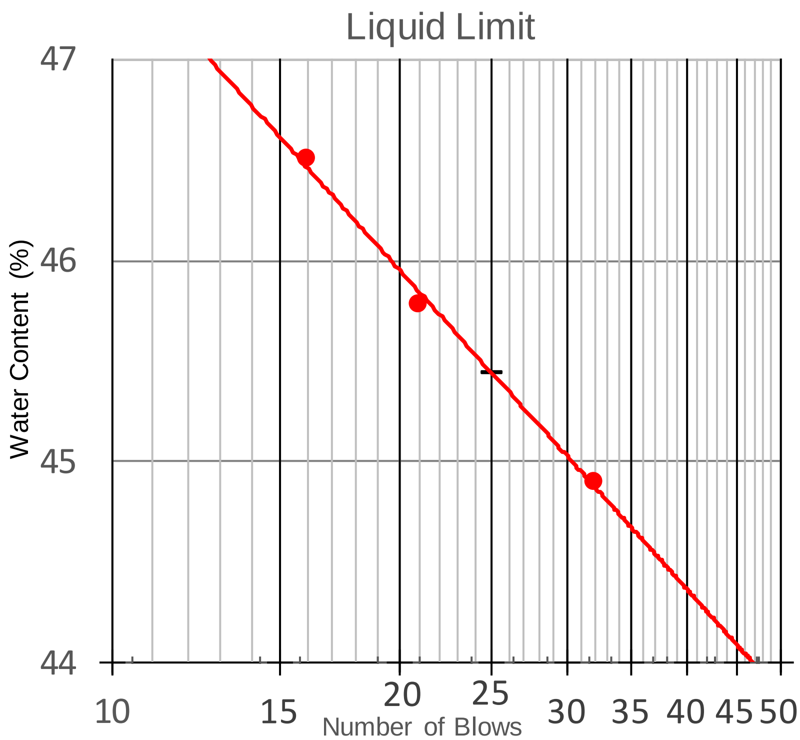
Stevens Ferrone & Bailey Engineering Company, Inc

Atterberg Limits Test – ASTM D4318

Project Number: 825-1 **Project Name:** Corona Station

Boring/Sample No: B-4 **Depth:** 6 **Date:** 08-13-18

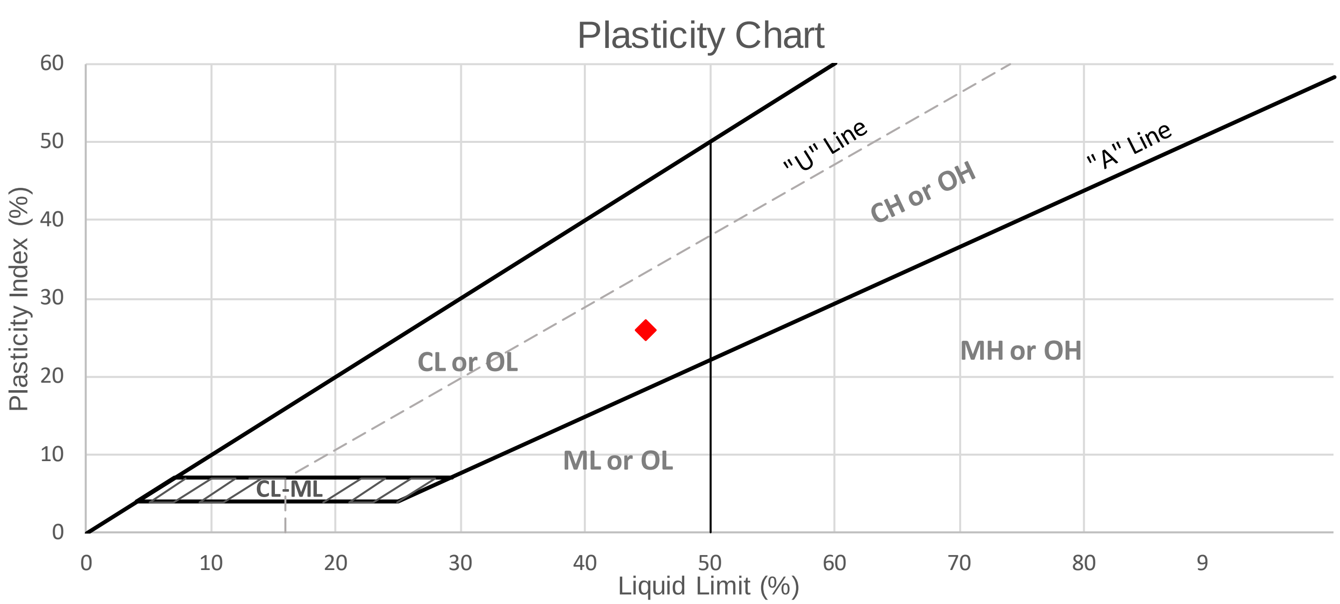
Description of Sample: Dark gray brown silty clayey SAND with organics some gravel (SC) **Tested By** R



Plastic Limit Data

Trial	1	2	Ave
Water Content (%)	18.8	18.9	19

Data Summary	
Liquid Limit	**45**
Plastic Limit	**19**
Plasticity Index	**26**
Natural Water Content	**25.1**
Liquidity Index	**0.235**
% Passing #200 Sieve	**49.3**

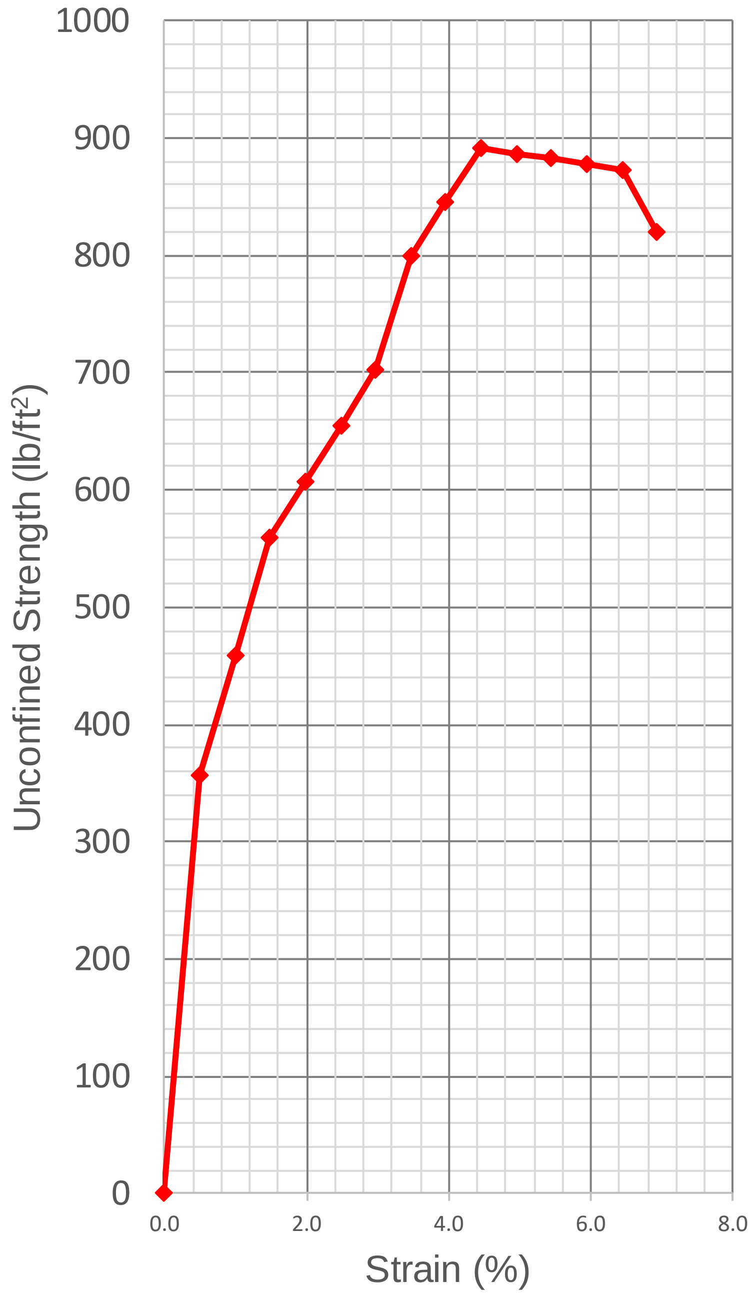


UNCONFINED COMPRESSIVE STRENGTH – D2166

Project Number: 825-1 **Boring #:** B-4 **Depth:** 6

Project Name: Corona Station **Date:** 8/8/2018

Description: Dark gray brown silty clayey SAND with organics some gravel (SC) **Tested By:** R



Soil Specimen Initial Measurements	
Diameter	2.42 in
Initial Area	4.60 in^2
Initial Length	5.05 in
Volume	0.01344 ft^3
Water Content	25.1
Wet Density	115.8 pcf
Dry Density	92.5 pcf

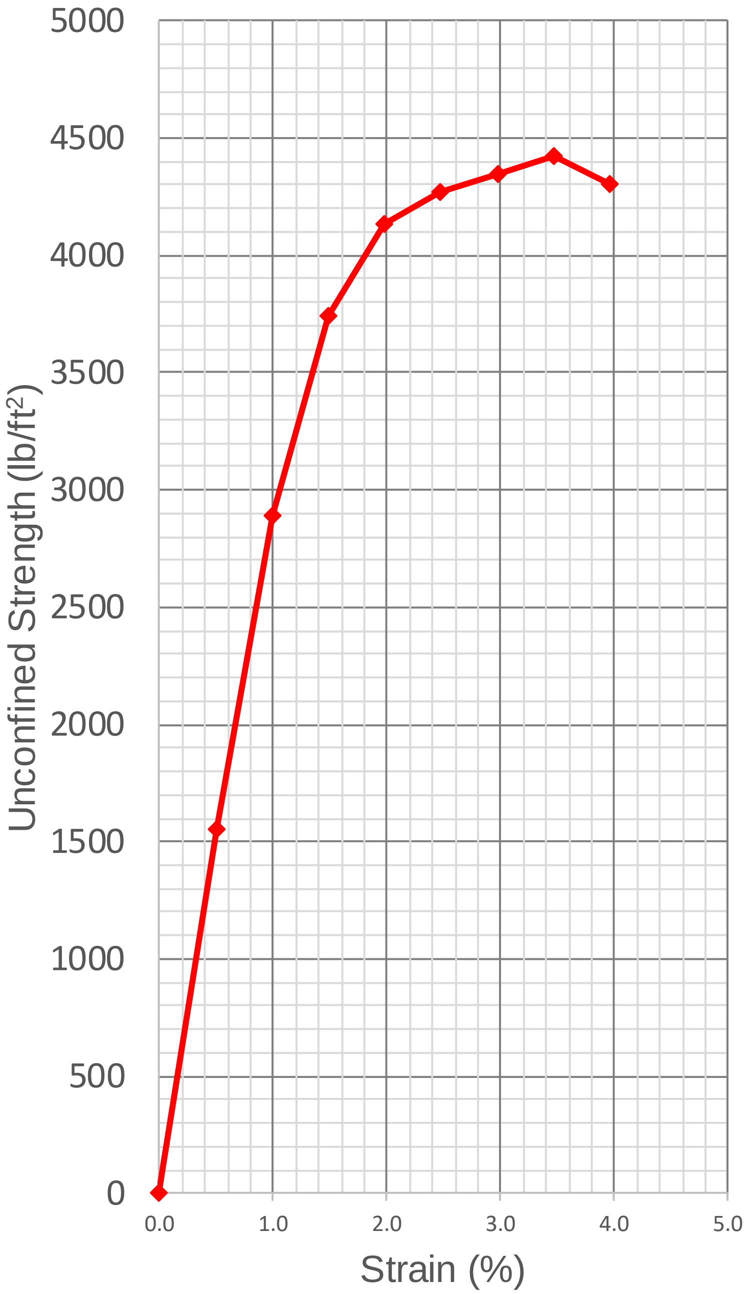
Max Unconfined Compressive Strength	
Elapsed Time	4.5 min
Vertical Dial	0.225 in
Strain	4.5 %
Area	0.03343 ft^2
Axial Load	29.8 lbs
Compressive Strength	2,217 psf

UNCONFINED COMPRESSIVE STRENGTH – D2166

Project Number: 825-1 **Boring #:** B-5 **Depth:** 11

Project Name: Corona Station **Date:** 8/8/2018

Description: Olive gray brown silty CLAY with sand (CL) **Tested By:** R



Soil Specimen Initial Measurements	
Diameter	2.42 in
Initial Area	4.60 in^2
Initial Length	5.05 in
Volume	0.01344 ft^3
Water Content	22.9
Wet Density	128.5 pcf
Dry Density	104.5 pcf

Max Unconfined Compressive Strength	
Elapsed Time	3.5 min
Vertical Dial	0.175 in
Strain	3.5 %
Area	0.03309 ft^2
Axial Load	146.5 lbs
Compressive Strength	4,427 psf

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www.cercoanalytical.com

Client:	Stevens, Ferrone & Bailey
Client's Project No.:	SFB 825-1
Client's Project Name:	890 N. McDowell Blvd., Petaluma, CA
Date Sampled:	07/23 & 24/18
Date Received:	26-Jul-18
Matrix:	Soil
Authorization:	Signed Chain of Custody

Date of Report: 9-Aug-2018

Job/Sample No.	Sample I.D.	Redox (mV)	pH	Conductivity (umhos/cm)*	Resistivity (100% Saturation) (ohms-cm)	Sulfide (mg/kg)*	Chloride (mg/kg)*	Sulfate (mg/kg)*
1807213-001	SFB-1 @ 2'	510	5.02	-	340	N.D.	180	110
1807213-002	SFB-4 @ 5.5'	360	7.38	-	930	N.D.	36	22
Method:		ASTM D1498	ASTM D4972	ASTM D1125M	ASTM G57	ASTM D4658M	ASTM D4327	ASTM D4327
Reporting Limit:		-	-	10	-	50	15	15
Date Analyzed:		7-Aug-2018	7-Aug-2018	-	8-Aug-2018	2-Aug-2018	7-Aug-2018	7-Aug-2018

* Results Reported on "As Received" Basis

N.D. - None Detected

Cheryl McMillen
Laboratory Director

Quality Control Summary - All laboratory quality control parameters were found to be within established limits

APPENDIX C

Logs of Previous Explorations

Pinnacle Environmental Inc.

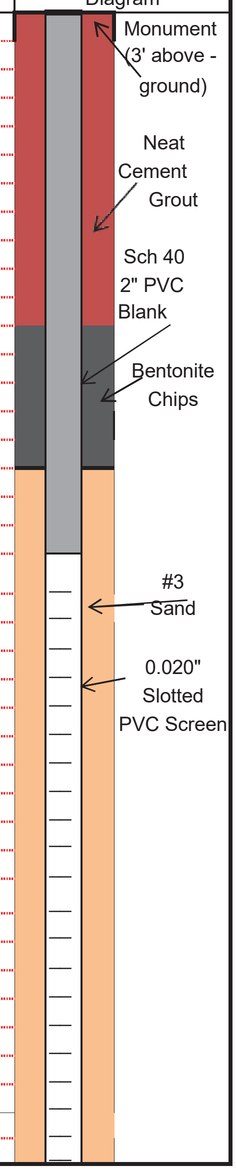
Boring/Well Number: **MW-1**

Project Number: 16-3985	Date Started: 5/31/17
Project Name: Corona Station	Date Completed: 5/31/17
Site Location: 320 Corona Rd, Petaluma	Casing Type/Diameter: Sch 40 PVC - 2"
Drill Rig: CME-75	Screen Type/Slot: Sch 40 PVC - 0.020"
Drilling Method: Hollow Stem Auguer	Gravel/Sand Pack Type: #3 Sand (Monterey)
Sampling Method: CA Split Spoon	Grout Type/Quantity: Neat Portland Cement
Boring Diameter: 8"	Depth to Water (encountered): 15.9'
Logged by: Francois Bush	Elevation of Top of PVC Casing:
Drilling Contractor: Cascade Drilling	Casing Stickup, 3 ft

Remarks: Groundwater Sample Collected @ between bgs Weather: Sunny, windy

Time	Blow Counts	PID Reading (ppm)	Sample ID.	Depth (ft BGS)	USCS	Lithologic Description
					GP	Light gray gravel with sand
				1		
					CL	Very dark gray CLAY, soft, damp, no odor (0% gvl, 0% sand,
				2		100% fines)
				3		
				4		
	6			X		
	10		MW-1	X 5		
1250	14	0	-5	X		
				6		
				7		
						Becomes light olive gray with little fine sand, medium stiff, dry
				8		no odor (0% gvl, 10% sand, 90% fines)
				9		
	6		MW-1	X		
1255	8	0	-10	X10		
	12			X		
				11		
				12		
				13		
				14		
	11		MW-1	X 15	SW	Olive brown fine to coarse SAND with some clay and little fine
1300	11	0	-15	X		gravel, loose, wet, no odor (5% gvl, 80% sand, 15% fines)
	15			X 16		
				17		
				18		
				19		
	5		MW-1	X		
1310	13	0	-20	X 20		

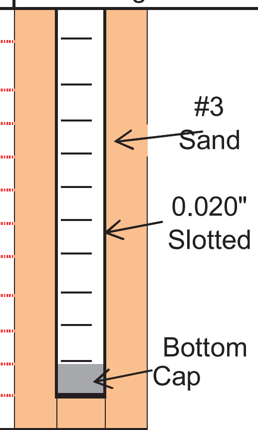
Well Completion Diagram



Boring/Well Number: **MW-1**

Time	Blow Counts	PID Reading (ppm)	Sample ID.	Depth (ft BGS)	USCS	Lithologic Description
	23	0		X 20		
	23			X	CL	Light ovile gray sandy CLAY, stiff, moist to wet, no odor (0% gvl, 15% sand, 85% fines)
				21		
				22		
				23		
				24		
	5			X		
1325	11	0		X 25	SC	Light olive gray clayey fine SAND, loose, wet, no odor (0% gvl, 55% sand, 45% fines)
	14			X		
				26		
				27		
				28		
				29		
				30		
				31		
				32		
				33		
				34		
				35		
				36		
				37		
				38		
				39		

Well Completion Diagram



Pinnacle Environmental Inc.

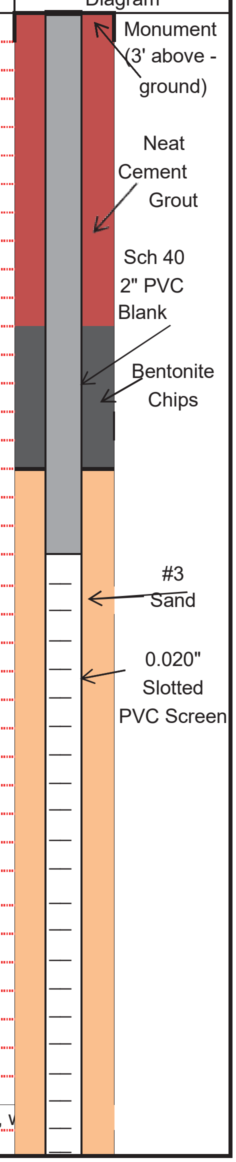
Boring/Well Number: **MW-2**

Project Number: 16-3985	Date Started: 5/30/17
Project Name: Corona Station	Date Completed: 5/30/17
Site Location: 320 Corona Rd, Petaluma	Casing Type/Diameter: Sch 40 PVC - 2"
Drill Rig: CME-75	Screen Type/Slot: Sch 40 PVC - 0.020"
Drilling Method: Hollow Stem Auguer	Gravel/Sand Pack Type: #3 Sand (Monterey)
Sampling Method: CA Split Spoon	Grout Type/Quantity: Neat Portland Cement
Boring Diameter: 8"	Depth to Water (encountered): 20.3'
Logged by: Francois Bush	Elevation of Top of PVC Casing:
Drilling Contractor: Cascade Drilling	Casing Stickup, 3 ft

Remarks: Groundwater Sample Collected @ between bgs Weather: Sunny, windy

Time	Blow Counts	PID Reading (ppm)	Sample ID.	Depth (ft BGS)	USCS	Lithologic Description
				_ _	GP	Light gray gravel with sand
				_ 1 _		
				_ _	CL	Very dark gray CLAY, medium stiff, dry, no odor (0% gvl,
				_ 2 _		0% sand, 100% fines)
				_ _		
				_ 3 _		
				_ _		
				_ 4 _		
	4			X		
1235	7		MW-2	X_ 5		
	9	0	-5	X		
				_ 6 _		
				_ _		
				_ 7 _		
				_ _		
				_ 8 _		
				_ _		
				_ 9 _		
	10		MW-2	X	SC/	Light olive gray clayey find SAND to sandy CLAY, dense/stiff,
1235	15	0	-10	X10	CL	moist to wet, no odor (0%gvl, 50%sand, 50%fines)
	17			X		
				_11_		
				_ _		
				_12_		
				_ _		
				_13_		
				_ _		
				_14_		
	6			X		
	13		MW-2	X 15	SP	Light tan fine to medium SAND, very dense, wet, no odor
1244	20	0	-15	X		gravel, loose, wet, no odor (5% gvl, 80% sand, 15% fines)
	21			X 16		
	6		MW-2	X		
1258	13		-17	X17_		
	15			X		
	15			X 18 _		
				_ _		
				_19_		
	9		MW-2	X	CL/	Light olive brown clayey find SAND to sandy CLAY, dense/stiff, w
1302	11	0	-20	X_ 20	SC/	no odor (0%gvl, 50%sand, 50%fines)

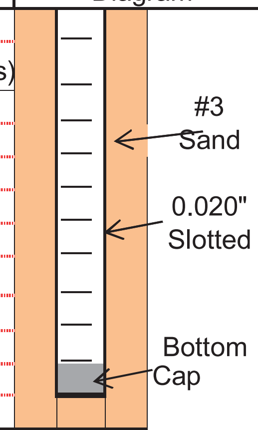
Well Completion Diagram



Pinnacle Environmental Inc.	**Boring/Well Number: MW-2** Page 2 of 2

Time	Blow Counts	PID Reading (ppm)	Sample ID.	Depth (ft BGS)	USCS	Lithologic Description
	12	0		X 20	CL/	Light olive brown clayey find SAND to sandy CLAY,
	12			X	SC	dense/stiff, wet, no odor (0%gvl, 50%sand, 50%fines)
				21		
				22		
				23		
				24		
	6		MW-2	X		Grades to olive brown CLAY, medium stiff, moist, no
1310	8	0	-25	X 25	CL	odor (0% gvl, 0% sand, 100% fines)
	12			X		
				26		
				27		
				28		
				29		
				30		
				31		
				32		
				33		
				34		
				35		
				36		
				37		
				38		
				39		

Well Completion Diagram



Pinnacle Environmental Inc.

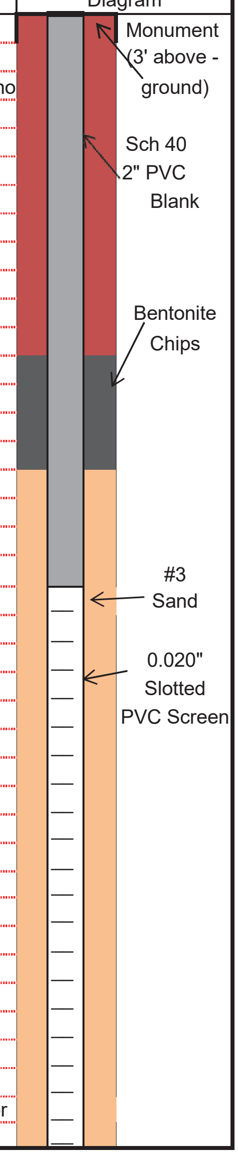
Boring/Well Number: MW-3

Project Number: 16-3985	Date Started: 5/30/17
Project Name: Corona Station	Date Completed: 5/30/17
Site Location: 320 Corona Rd, Petaluma	Casing Type/Diameter: Sch 40 PVC - 2"
Drill Rig: CME-75	Screen Type/Slot: Sch 40 PVC - 0.020"
Drilling Method: Hollow Stem Auguer	Gravel/Sand Pack Type: #3 Sand (Monterey)
Sampling Method: CA Split Spoon	Grout Type/Quantity: Neat Portland Cement
Boring Diameter: 8"	Depth to Water (encountered): 16.4'
Logged by: Francois Bush	Elevation of Top of PVC Casing:
Drilling Contractor: Cascade Drilling	Casing Stickup, 3 ft

Remarks: Groundwater Sample Collected @ between bgs Weather: Cloudy, breezy

Time	Blow Counts	PID Reading (ppm)	Sample ID.	Depth (ft BGS)	USCS	Lithologic Description
					GP	Light gray gravel with sand
				1		
					CL	Very dark gray CLAY with trace fine gravel, medium stiff, dry, no
				2		odor (2% gvl,0% sand, 98% fines)
				3		grades to no gravel (0% gvl,0% sand, 100% fines)
				4		
	4			X		
911	6	1.2	MW-3	X 5		
	7		-5	X		
				6		
				7		
				8		
				9		
	4		MW-3	X		becomes light olive brown, trace fine sand, damp
915	7	1.1	-10	X10		(0% gvl, 2% sand, 98% fines)
	10			X		
				11		
				12		
				13		
				14		
	6		MW-3	X 15		grades to no sand, damp (0% gvl,0% sand, 100% fines)
922	12	1.2	-15	X		
	13			X 16		
						water at 16.4' at 10:00
				17		
				18		
				19		
	9		MW-3	X	SC	Light olive brown clayey fine sand, dense, moist to wet, no odor
932	13	0.9	-20	X 20		(0% gvl, 60% sand, 40% fines)

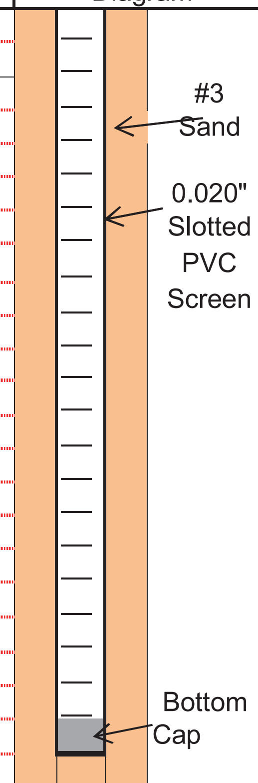
Well Completion Diagram



Boring/Well Number: MW-3

Time	Blow Counts	PID Reading (ppm)	Sample ID.	Depth (ft BGS)	USCS	Lithologic Description
	16			X 20	SC	
	16			X		
				21		
				22		
				23		
	4			X 24		
	5		MW-3	X		
932	12	0.9	-24	X 25		
	15			X		
				26		
				27		
				28		
				29		
	7			X		
	10		MW-3	X 30		
950	12	1.4	-30	X		
	12			X 31		
				32		
				33		
				34		
				35		
				36		
				37		
				38		
				39		

Well Completion Diagram



Pinnacle Environmental Inc.

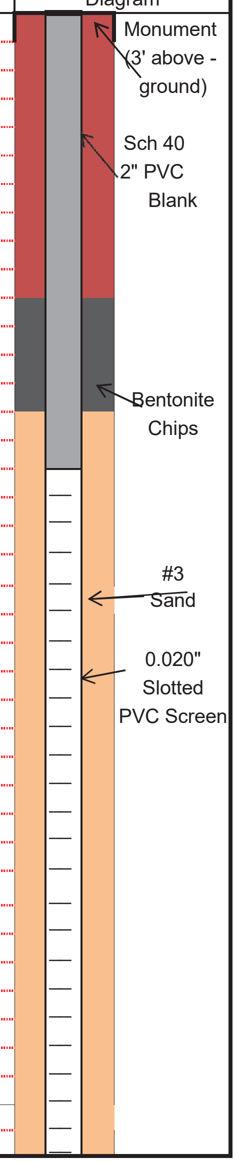
Boring/Well Number: **MW-4**

Project Number: 16-3985	Date Started: 5/31/17
Project Name: Corona Station	Date Completed: 5/31/17
Site Location: 320 Corona Rd, Petaluma	Casing Type/Diameter: Sch 40 PVC - 2"
Drill Rig: CME-75	Screen Type/Slot: Sch 40 PVC - 0.020"
Drilling Method: Hollow Stem Auguer	Gravel/Sand Pack Type: #3 Sand (Monterey)
Sampling Method: CA Split Spoon	Grout Type/Quantity: Neat Portland Cement
Boring Diameter: 8"	Depth to Water (encountered): 16'
Logged by: Francois Bush	Elevation of Top of PVC Casing:
Drilling Contractor: Cascade Drilling	Casing Stickup, 3 ft

Remarks: Groundwater Sample Collected @ between bgs Weather: Sunny, windy

Time	Blow Counts	PID Reading (ppm)	Sample ID.	Depth (ft BGS)	USCS	Lithologic Description
					CL	Very dark gray CLAY with trace of fine sand, soft, dry, no odor
				1		(0% gvl,2% sand, 98% fines)
				2		
				3		
				4		
	7			X		Grades to light olive gray with increase in find sand, medium
955	7	2	MW-4	X 5		stiff (0% gvl,25% sand, 75% fines)
	10		-5	X		
				6		
				7		
				8		
				9		
	9		MW-4	X		increase in sand, damp (0% gvl,35% sand, 65% fines)
1000	17	3.4	-10	X10		
	19			X		
				11		
				12		
				13		
				14		
						Groundwater at 14.3 feet bgs at 10:40
	4		MW-4	X 15		
1010	7	2	-15	X		decrease in sand (0% gvl,15% sand, 85% fines)
	20			X 16		
				17		
				18		
				19		
	5		MW-4	X		
1015	8	0	-20	X 20		

Well Completion Diagram

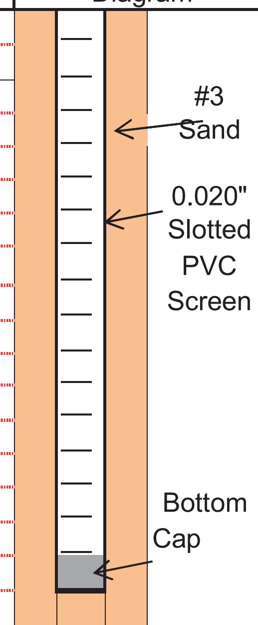


Pinnacle Environmental Inc.

Boring/Well Number: MW-4

Time	Blow Counts	PID Reading (ppm)	Sample ID.	Depth (ft BGS)	USCS	Lithologic Description
	9			X 20	CL	
				21		
				22		
				23		Becomes wet
	5			24		
	7		MW-4	X		
1025	9	0.3	-25	X 25		
	12			X		
				26		
				27		
	8		MW-4	X		
1035	19	2.2	-28	X 28		
	21			X		
				29		
				30		
				31		
				32		
				33		
				34		
				35		
				36		
				37		
				38		
				39		

Well Completion Diagram



Pinnacle Environmental Inc.

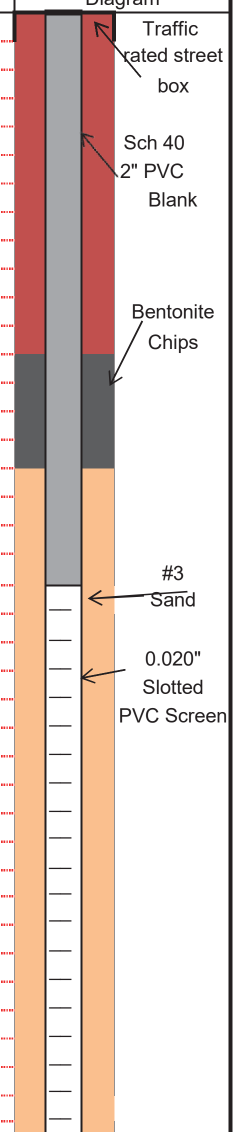
Boring/Well Number: MW-5

Project Number: 16-3985	Date Started: 5/31/17
Project Name: Corona Station	Date Completed: 5/31/17
Site Location: 320 Corona Rd, Petaluma	Casing Type/Diameter: Sch 40 PVC - 2"
Drill Rig: CME-75	Screen Type/Slot: Sch 40 PVC - 0.020"
Drilling Method: Hollow Stem Auguer	Gravel/Sand Pack Type: #3 Sand (Monterey)
Sampling Method: CA Split Spoon	Grout Type/Quantity: Neat Portland Cement
Boring Diameter: 8"	Depth to Water (encountered): 25.3'
Logged by: Francois Bush	Elevation of Top of PVC Casing:
Drilling Contractor: Cascade Drilling	Casing Stickup, 3 ft

Remarks: Groundwater Sample Collected @ between bgs Weather: Sunny, breezy

Time	Blow Counts	PID Reading (ppm)	Sample ID.	Depth (ft BGS)	USCS	Lithologic Description
					AF	Concrete
				1		
		4.3			CL	Very dark gray CLAY with trace fine gravel and sand, soft, dry,
				2		slight odor (heavy oil odor) (2% gvl,2% sand, 96% fines)
				3		
				4		
	9			X		
1517	9	0.3	MW-5	X 5		becomes light gray, increase in sand, no gravel, medium stiff
	12		-5	X		no odor (0% gvl,10% sand, 90% fines)
				6		
				7		
				8		
				9		
	13		MW-5	X		no sand
1522	15	0	-10	X10		(0% gvl, 0% sand, 100% fines)
	15			X		
				11		
				12		
				13		
				14		
	7		MW-3	X 15		becomes medium olive gray
1527	8	1.1	-15	X		
	16			X 16		
				17		
				18		
				19		
	4		MW-3	X		sampler wet
1535	8	0	-20	X 20		

Well Completion Diagram

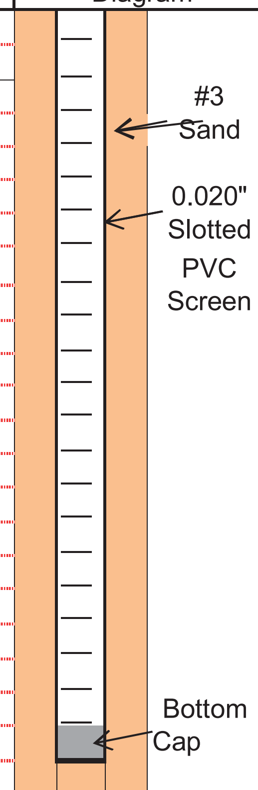


![Pinnacle Environmental Inc.]

Boring/Well Number: **MW-5**

Time	Blow Counts	PID Reading (ppm)	Sample ID.	Depth (ft BGS)	USCS	Lithologic Description
	23			X 20	CL	
				21		
				22		
				23		
				24		
	6		MW-5	X		some fine sand, soft, moist to wet
1540	8	0	-24	X 25		(0% gvl,10% sand, 90% fines)
	14			X		
				26		
				27		
	5		MW-5		SC	Light olive gray clayey fine SAND, medium dense,
1547	7	0.4	-28	28		wet, no odor (0% gvl, 60% sand, 40% fines)
	15					
				29		
	5			X		grades to light olive gray clayey fine SAND to sandy
	6		MW-5	X 30		CLAY, medium stiff, dense, wet, no odor
1553	17	0	-30	X		(0% gvl, 50% sand, 50% fines)
	29			X 31		
				32		
				33		
				34		
				35		
				36		
				37		
				38		
				39		

Well Completion Diagram



Pinnacle Environmental Inc.

Boring/Well Number: **MW-6**

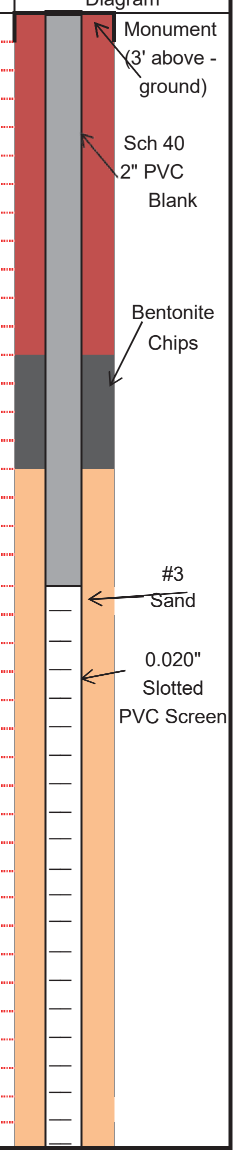
Page 1 of 2

Project Number: 16-3985	Date Started: 6/1/17
Project Name: Corona Station	Date Completed: 6/1/17
Site Location: 320 Corona Rd, Petaluma	Casing Type/Diameter: Sch 40 PVC - 2"
Drill Rig: CME-75	Screen Type/Slot: Sch 40 PVC - 0.020"
Drilling Method: Hollow Stem Auguer	Gravel/Sand Pack Type: #3 Sand (Monterey)
Sampling Method: CA Split Spoon	Grout Type/Quantity: Neat Portland Cement
Boring Diameter: 8"	Depth to Water (encountered): 16'
Logged by: Francois Bush	Elevation of Top of PVC Casing:
Drilling Contractor: Cascade Drilling	Casing Stickup, 3 ft

Remarks: Groundwater Sample Collected @ between bgs Weather: Cloudy, breezy

Time	Blow Counts	PID Reading (ppm)	Sample ID.	Depth (ft BGS)	USCS	Lithologic Description
					CL	Very dark gray CLAY with trace of fine sand, soft, dry, no odor
				1		(0% gvl,2% sand, 98% fines)
				2		
				3		
				4		
	10			X		becomes light gray with little fine sand, hard, dry, no odor
800	12	0.3	MW-6	X 5		(0% gvl,10% sand, 90% fines)
	13		-5	X		
				6		
				7		
				8		
				9		
	5		MW-6	X		becomes light olive brown, no sand, medium stiff, damp
810	8	0	-10	X10		(0% gvl, 0% sand, 100% fines)
	11			X		
				11		
				12		
				13		
				14		
	4		MW-6	X 15		
815	8	0.5	-15	X		
	12			X 16		Water at 16 feet at 0905
				17		
				18		
				19		
	7		MW-6	X		becomes medium olive brown, soft, damp (sampler wet)
830	9	0.4	-20	X 20		

Well Completion Diagram

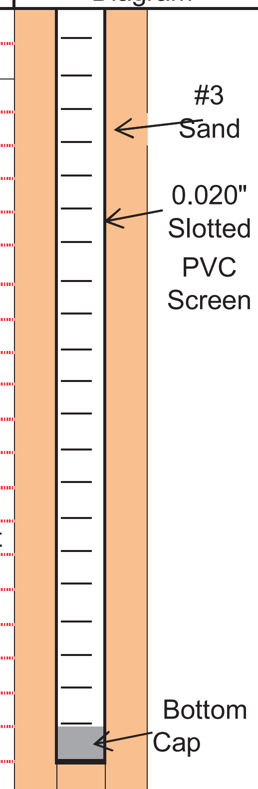


Pinnacle Environmental Inc.

Boring/Well Number: MW-6

Time	Blow Counts	PID Reading (ppm)	Sample ID.	Depth (ft BGS)	USCS	Lithologic Description
	16			X 20	CL	
				21		
				22		
				23		
				24		
	4		MW-6	X		
843	5	0	-25	X 25		
	8			X		
				26		
	4			X 27		
847	5		MW-6	X	SC	Olive brown clayey fine to medium SAND, loose, wet
	8		27	X 28		no odor (0% gvl,70% sand, 30% fines)
				29		
	4		MW-6	X 30		
852	9	0.5	-30	X		
	10			X 31		
				32		
				33		
				34		
				35		
				36		
				37		
				38		
				39		

Well Completion Diagram



Pinnacle Environmental Inc.

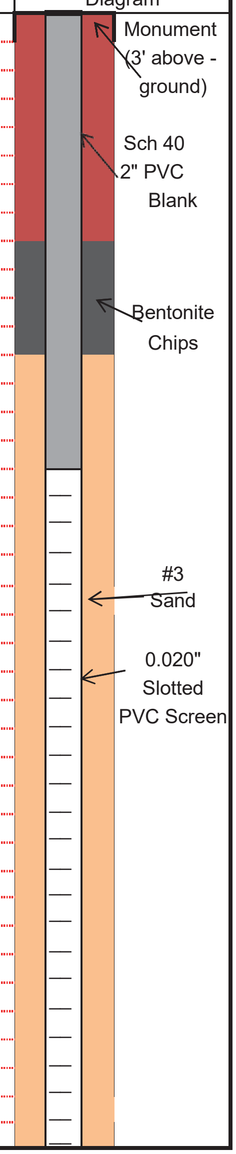
Boring/Well Number: MW-7

Project Number: 16-3985	Date Started: 6/1/17
Project Name: Corona Station	Date Completed: 6/1/17
Site Location: 320 Corona Rd, Petaluma	Casing Type/Diameter: Sch 40 PVC - 2"
Drill Rig: CME-75	Screen Type/Slot: Sch 40 PVC - 0.020"
Drilling Method: Hollow Stem Auguer	Gravel/Sand Pack Type: #3 Sand (Monterey)
Sampling Method: CA Split Spoon	Grout Type/Quantity: Neat Portland Cement
Boring Diameter: 8"	Depth to Water (encountered): 15'
Logged by: Francois Bush	Elevation of Top of PVC Casing:
Drilling Contractor: Cascade Drilling	Casing Stickup, 3 ft

Remarks: Groundwater Sample Collected @ between bgs Weather: Sunny, windy

Time	Blow Counts	PID Reading (ppm)	Sample ID.	Depth (ft BGS)	USCS	Lithologic Description
				_ _	CL	Very dark gray CLAY with trace of fine sand, soft, dry, no odor
				_ 1 _		(0% gvl,2% sand, 98% fines)
				_ _		
				_ 2 _		
				_ _		
				_ 3 _		
				_ _		
				_ 4 _		
	9			X		becomes olive gray with little fine gravel and coarse sand
1040	9	0	MW-7	X_ 5		(5% gvl,5% sand, 90% fines)
	15		-5	X		
				_ 6 _		
				_ _		
				_ 7 _		
				_ _		
				_ 8 _		
				_ _		
				_ 9 _		
	5		MW-7	X	SC	Olive gray clayey fine SAND, dense, dry, no odor
1045	11	0.4	-10	X10		(0% gvl, 60% sand, 40% fines)
	15			X		
				_11_		
				_ _		
				_12_		
				_ _		
				_13_		
				_ _		
				_14_		
				_ _		
	4		MW-7	X 15	CL	Olive gray CLAY, stiff, damp to moist (sampler wet), no odor
1050	8	0	-15	X		(0% gvl,0% sand, 100% fines)
	12			X 16		
				_ _		
				_ 17_		
				_ _	SC	Olive gray clayey fine SAND, dense, wet to moist, no odor
				_ 18 _		(0% gvl, 60% sand, 40% fines)
				_ _		
				_19_		
	8		MW-7	X		
1054	12	0	-20	X_ 20		

Well Completion Diagram

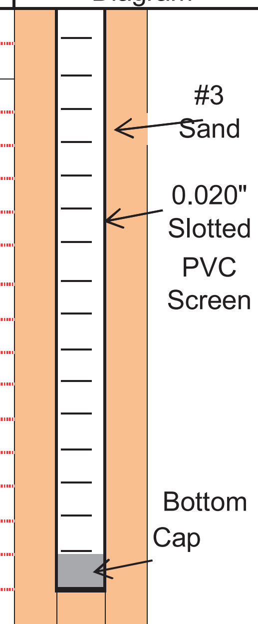


Pinnacle Environmental Inc.

Boring/Well Number: **MW-7**

Time	Blow Counts	PID Reading (ppm)	Sample ID.	Depth (ft BGS)	USCS	Lithologic Description
	16			X 20	SC	
				21		
				22		
				23		
				24		
	6		MW-7	X		grades to increase in clay, dense/stiff, moist to wet
1058	8	0	-25	X 25		(0% gvl, 50% sand, 50% fines)
	9			X		
				26		
				27		
	6		MW-7	X		Olive gray CLAY with trace of fine sand, stiff, dry, no
1103	10	0.5	-28	X 28	CL	odor (0% gvl, 2% sand, 98% fines)
	12			X		
				29		
				30		
				31		
				32		
				33		
				34		
				35		
				36		
				37		
				38		
				39		

Well Completion Diagram



Pinnacle Environmental Inc.

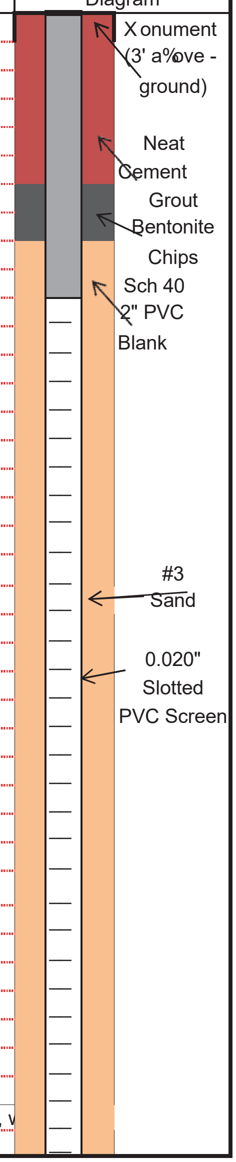
Boring/Well Number: MW-8

Project Num%er: 1M43985	Date Started: 5/31/17
Project Name: Corona Station	Date Completed: 5/31/17
Site 6ocation: 320 Corona Rd, Petaluma	Casing Type/Diameter: Sch 40 PVC - 2"
Drill Rig: CX E-75	Screen Type/Slot: Sch 40 PVC - 0.020"
Drilling X ethod: Hollow Stem Auguer	Gravel/Sand Pack Type: #3 Sand (X onterey)
Sampling X ethod: CA Split Spoon	Grout Type/Quantity: Neat Portland Cement
Boring Diameter: 8"	Depth to Water (encountered): 7.2'
6ogged %y: Francois Bush	Elevation of Top of PVC Casing:
Drilling Contractor: Cascade Drilling	Casing Stickup, 3 ft

Remarks: Groundwater Sample Collected @ %etween %gs Weather: Sunny, windy

Time	Blow Counts	PID Reading (ppm)	Sample ID.	Depth (ft BGS)	USCS	6ithologic Description
				_ _	GP	6ight gray gravel with sand
				_1_		
				_ _	SC	6ight gray to dark gray clayey find SAND, dense, dry, no odor
				_2_		(0Y gvl,M0Y sand, 40Y fines)
				_ _		
				_3_		
				_ _		
				_4_		
	2			L		
740	3	1.7	XW-8	L_5		
	4		-5	L		
				_M_		
				_ _		
				_7_		Becomes wet, water level measured at 7.2' @0930
				_ _		
				_8_		
				_ _		
				_9_		
	M		XW-8	L		
745	8	11.2	-10	L 10		
	15			L		
				_11_	C6	Dark gray sandy C6Ab, stiff, moist to damp, no odor
				_ _		(0Y gvl,20Y sand, 80Y fines)
				_12_		
				_ _		
				_13_		
				_ _		
				_14_		
				_ _		
	5		XW-8	L 15		
750	8	10.5	-15	L		
	15			L 1M		
	5		XW-8	L		
755	8	5.1	-17	L 17_	SC	Dark gray clayey find SAND, dense, moist, no odor
	10			L		(0Y gvl,M0Y sand, 40Y fines)
	17			L 18_		
				_ _		
				_19_		
	5		XW-8	L		6ight olive %rown clayey find SAND to sandy C6Ab, dense/stiff, w
800	9	5	-20	L_ 20	SC	no odor (0Y gvl, 50Y sand, 50Y fines)

Well Completion Diagram

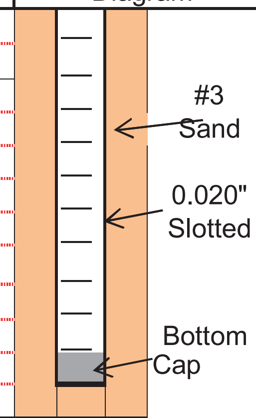


Pinnacle Environmental Inc.

Boring/Well Number: MW-8

Time	Blow Counts	PID Reading (ppm)	Sample ID.	Depth (ft BGS)	USCS	Lithologic Description
	13			X 20	SC	
				21		
				22		Becomes light olive brown, moist to wet
				23		
				24		
	6		MW-8	X		Grades to olive brown CLAY, medium stiff, moist, no
1310	8	2	-25	X 25	CL	odor (0% gvl, 0% sand, 100% fines)
	12			X		
				26		
				27		
				28		
				29		
				30		
				31		
				32		
				33		
				34		
				35		
				36		
				37		
				38		
				39		

Well Completion Diagram



Pinnacle Environmental Inc.

Boring/Well Number: SB-1

Project Number: 16-3985	Date Started: 6/2/17
Project Name: Corona Station	Date Completed: 6/2/17
Site Location: 320 Corona Rd, Petaluma	Casing Type/Diameter: N/A
Drilling Rig: CME-75	Screen Type/Slot: N/A
Drilling Method: Hollow Stem Auguer	Gravel/Sand Pack Type: N/A
Sampling Method: CA Split Spoon	Grout Type/Quantity: Neat Portland Cement
Boring Diameter: 8"	Depth to Water: 13.9'
Logged by: Francois Bush	Elevation of Top of PVC Casing:
Drilling Contractor: Cascade Drilling	Casing Stickup

Remarks: Groundwater Sample Collected @11:05 between bgs

PID reading (ppb)	Time	Sample ID	% gvl/sand/fines	Depth (ft BGS)	USCS	Lithologic Description
				_ _	GP	Gray sandy GRAVEL, dense
			5/5/90	_ 1 _	CL	Dark gray CLAY with little fine gravel and sand, medium stiff, dry,dry, no odor
				_ 2 _		
				_ 3 _		
				_ 4 _		
				X		becomes light olive gray CLAY, very stiff, dry, no odor
0	1034	SB-1-5	0/0/100	X 5		
				X		
				_ 6 _		
				_ 7 _		
				_ 8 _		
				_ 9 _		
				X		grades to medium olive brown, little fine sand
0	1038	SB-1-10	0/10/90	X_10		
				X		
				_11_		
				_12_		
				_13_		
				_ 14 _		
				X		
0	1043	SB-1-15	0/0/100	X_15		becomes medium soft, no sand, damp to moist
				X		
				_ 16		
				_17		
				_18		
				_19		
				X		becomes stiff to very stiff, damp to moist
0	1047	SB-1-20	0/0/100	X_ 20		

Pinnacle Environmental Inc.

Boring/Well Number: SB-1

PID reading (ppb)	Time	Sample ID	% gvl/sand/fines	Depth (ft BGS)	USCS	Lithologic Description
				X 20	CL	
				21		
			0/70/30	22	SC	Olive brown clayey fine to medium SAND, medium dense no odor
				23		
				24		
		SB-1		X		
0	1055	-25	0/70/30	X 25		
				X		
				26		
				27		
				28		
				29		
				30		
				31		
				32		
				33		
				34		
				35		
				36		
				37		
				38		
				39		

Boring/Well Number: SB-2

Page 1 of 1

Project Number: 16-3985	Date Started: 6/2/17
Project Name: Corona Station	Date Completed: 6/2/17
Site Location: 320 Corona Rd, Petaluma	Casing Type/Diameter: N/A
Drilling Rig: CME-75	Screen Type/Slot: N/A
Drilling Method: Hollow Stem Auguer	Gravel/Sand Pack Type: N/A
Sampling Method: CA Split Spoon	Grout Type/Quantity: Neat Portland Cement
Boring Diameter: 8"	Depth to Water: 18.2'
Logged by: Francois Bush	Elevation of Top of PVC Casing:
Drilling Contractor: Cascade Drilling	Casing Stickup

Remarks: Groundwater Sample Collected @12:40 between bgs

PID reading (ppb)	Time	Sample ID	% gvl/sand/fines	Depth (ft BGS)	USCS	Lithologic Description
				_ _	GP	Gray sandy GRAVEL, dense
			0/0/100	_ 1 _	CL	Dark gray CLAY, soft, dry, no odor
				_ 2 _		
				_ 3 _		
				_ 4 _		
				X		becomes dark gray, medium stiff
0	1214	SB-2-5	0/0/100	X 5		
				X		
				_ 6 _		
				_ 7 _		
				_ 8 _		
				_ 9 _		
				X		becomes bluish-gray, trace fine sand, slight odor
118	1219	SB-2-10	0/2/98	X_10		
				X		
				_11_		
				_12_		
				_13_		
				_ 14		
				X		
0.3	1224	SB-2-15	0/2/98	X_15		becomes olive brown with some blue-gray motteling, very stiff no odor
				X		(sampler wet)
				_ 16		
				_17		
				_18		
				X_19		
				X	SC	Olive gray clayey fine to medium SAND, loose, wet, no odor
0	1230	SB-2-20	0/70/30	X_ 20		

Figure A-

Boring/Well Number: SB-3

ProMct Number61/ -3985	: ate Started6/ 2121 7
ProMct Name6Corona Station	: ate Completed6/ 2121 7
Site Location63D0 Corona Hd, Petaluma	Casing Type2 iameter6 N2A
: rilling Hig6C" E-75	Screen Type2Slot6 N2A
: rilling " ethod6 @lloj Stem Auguer	Gravel2Sand Pack Type6 N2A
Sampling " ethod6CA Split Spoon	Grout Type2Quantity6 Neat Portland Cement
Boring : iameter6 8Y	: epth to Water6D4.5'
Logged by6 Francois Bush	Elevation of Top of PVC Casing6
: rilling Contractor6 Cascade : rilling	Casing Stickup

Hemarks6 Groundj ater Sample Collected O 156D0 betj een bgs

PI: reading (ppb)	Time	Sample I:	% gvl2sand2fines	: epth (ft BGS)	USCS	Lithologic : escription
				_ _	GP	Gray sandy GHAVEL, dense
			020100	_ 1 _	CL	Very dark gray CLAR, soft, dry, no odor
				_ D_		
				_ 3 _		
				_ 4 _		
				X		grades to olive broj n CLAR j ith some fine sand, medium stiff, damp, no odor
0	1435	SB-3-5	021090	X 5		
				X		
				_ / _		
				_ 7 _		
				_ 8 _		
				_ 9 _		
				X	SC2	grades to olive broj n clayey find SAN: to sandy CLAR, soft2 medium dense
0	1440	SB-3-10	025050	X_10	CL	damp to moist, no odor
				X		
				_11_		
				_1D_		
				_13_		
				_14		
				X		
0	1445	SB-3-15	020100	X_15	CL	wlive broj n CLAR, medium stiff, damp, no odor (sampler j et)
				X		
				_ 1/		
				_17		
				_18		
				_19		
				X		
0	1450	SB-3-D0	020100	X_ D0		

Boring/Well Number: **SB-3**

PID reading (ppb)	Time	Sample ID	% gvl/sand/fines	Depth (ft BGS)	USCS	Lithologic Description
				X 20	CL	
				_21_		
				_22_		
				23		
				24		
				X		
	1500	NR		X_25		No Recovery
				X		
				26		
				27		
				28		
				29		
				30		
				31		
				32		
				33		
				34		
				35		
				36		
				37		
				38		
				39		

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Boring/Well Number: **SB-4**

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Project Number: 16-3985	Date Started: 6/1/17
Project Name: Corona Station	Date Completed: 6/1/17
Site Location: 320 Corona Rd, Petaluma	Casing Type/Diameter: N/A
Drilling Rig: CME-75	Screen Type/Slot: N/A
Drilling Method: Hollow Stem Auguer	Gravel/Sand Pack Type: N/A
Sampling Method: CA Split Spoon	Grout Type/Quantity: Neat Portland Cement
Boring Diameter: 8"	Depth to Water: 16'
Logged by: Francois Bush	Elevation of Top of PVC Casing:
Drilling Contractor: Cascade Drilling	Casing Stickup

Remarks: Groundwater Sample Collected @13:45 between bgs

PID reading (ppb)	Time	Sample ID	% gvl/sand/fines	Depth (ft BGS)	USCS	Lithologic Description
			2/2/96	_ _	CL	Very dark gray CLAY with trace fine gravel and sand, soft, dry, no odor
				_ 1 _		
				_ 2 _		
				_ 3 _		
				_ 4 _		
				X		becomes bluish gray CLAY (no gravel or sand), stiff
0	1310	SB-4-5	0/0/100	X 5		
				X		
				_ 6 _		
				_ 7 _		
				_ 8 _		
				_ 9 _		
				X		becomes olive brown with some fine sand, stiff, dry
0	1317	SB-4-10	0/15/85	X_10		
				X		
				_11_		
				_12_		
				_13_		
				_ 14		
				X		
0	1321	SB-4-15	0/0/100	X_15		becomes olive brown with some blue-gray motteling, very stiff no odor
				X		
				_ 16		
				_17		
				_18		
				X_19		
				X	SC	Olive brown clayey fine SAND, dense, moist to wet, no odor
0	1327	SB-2-20	0/60/40	X_ 20		

Pinnacle Environmental Inc.

Boring/Well Number: **SB-5**

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ProMct NumberD1: -3985	2 ate StartedD: 6 6 17
ProMct NameDCorona Station	2 ate CompletedD: 6 6 17
Site LocationD3/ 0 Corona Hd, Petaluma	Casing Type62 iameterD N6A
2 rilling HigDCj E-75	Screen Type6SlotD N6A
2 rilling j ethodD wolloR Stem Auguer	Gravel6Sand Pack TypeD N6A
Sampling j ethodDCA Split Spoon	Grout Type6QuantityD Neat Portland Cement
Boring 2 iameterD 8"	2 epth to WaterD1: .5'
Logged byD Francois Bush	Elevation of Top of PVC CasingD
2 rilling ContractorDCascade 2 rilling	Casing Stickup

HemarksD GroundRater Sample Collected Y 08D30 betReen bgs

PI2 reading (ppb)	Time	Sample I2	% gvl6sand6fines	2 epth (ft BGS)	USCS	Lithologic 2 escription
				_ _	GP	Gray sandy GHAVEL, dense
				_ 1 _		
			06 06 100		CL	Very dark gray CLA@ soft, dry, no odro
				_ / _		
				_ 3 _		
				_ 4 _		
				X		becomes medium stiff
0	758	SB-5-5	06 06 100	X 5		
				X		
				_ : _		
				_ 7 _		
				_ 8 _		
				_ 9 _		
				X		becomes light olive gray Rith some fine sand, damp
0	807	SB-5-10	06 15 85	X_10		
				X		
				_11_		
				_1/ _		
				_13_		
				_ 14		
				X		
0.3	81/	SB-5-15	06 70 30	X_15	SC	j ottled olive broRn 6bluish gray clayey fine to medium SAN2 dense, moist, no
				X		odor (sampler Ret)
				_ 1:		
				_17		
						becomes Ret
				_18		
				X_19		
				X	SC	slight odor
1.9	819	SB-5-/ 0	06 70 30	X_ / 0		

Boring/Well Number: SB-6

Page 1 of 1

ProRct Number: 16-3985	Date Started: 6/2/17
ProRct Name: Corona Station	Date Completed: 6/2/17
Site Location: 320 Corona Md, Petaluma	Casing Type/Diameter: N/A
Drilling Mig: CHE-75	Screen Type/Slot: N/A
Drilling Hethod: " ollow Stem Auguer	Gravel/Sand Pack Type: N/A
Sampling Hethod: CA Split Spoon	Grout Type/Quantity: Neat Portland Cement
Boring Diameter: 8@	Depth to Water: 15.5'
Logged by: Francois Bush	Elevation of Top of PVC Casing:
Drilling Contractor: Cascade Drilling	Casing Stickup

Memarks: Groundwater Sample Collected Y 09:40 between bgs

PID reading (ppb)	Time	Sample ID	% gvl/sand/fines	Depth (ft BGS)	USCS	Lithologic Description
			0/0/100	_ _	CL	Very dark gray CLAj , soft, dry, no odor
				_ 1 _		
				_ 2 _		
				_ 3 _		
			0/10/90			becomes light olive gray with some fine sand, medium stiff
				_ 4 _		
				X		
0	918	SB-6-5	0/10/90	X 5		
				X		
				_ 6 _		
				_ 7 _		
				_ 8 _		
				_ 9 _		
				X	SC/	Olive brown clayey fine SAND to sandy CLAj , dense, medium stiff, moist to wet
0	922	SB-6-10	0/50/50	X_10	CL	no odor
				X		
				_11_		
				_12_		
				_13_		
				_ 14		
				X		
0	926	SB-6-15	0/0/100	X_15	CL	olive brown CLAj , soft, moist, no odor
				X		(sampler wet)
				_ 16		
				_17		
				_18		
				X_19		
				X		becomes very stiff, damp to dry
0	930	SB-6-20	0/0/100	X_ 20		

APPENDIX D

ASFE Guidelines

Important Information about Your

Geotechnical Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

While you cannot eliminate all such risks, you can manage them. The following information is provided to help.

Geotechnical Services Are Performed for Specific Purposes, Persons, and Projects

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical engineering study conducted for a civil engineer may not fulfill the needs of a construction contractor or even another civil engineer. Because each geotechnical engineering study is unique, each geotechnical engineering report is unique, prepared *solely* for the client. No one except you should rely on your geotechnical engineering report without first conferring with the geotechnical engineer who prepared it. *And no one — not even you* — should apply the report for any purpose or project except the one originally contemplated.

Read the Full Report

Serious problems have occurred because those relying on a geotechnical engineering report did not read it all. Do not rely on an executive summary. Do not read selected elements only.

A Geotechnical Engineering Report Is Based on A Unique Set of Project-Specific Factors

Geotechnical engineers consider a number of unique, project-specific factors when establishing the scope of a study. Typical factors include: the client's goals, objectives, and risk management preferences; the general nature of the structure involved, its size, and configuration; the location of the structure on the site; and other planned or existing site improvements, such as access roads, parking lots, and underground utilities. Unless the geotechnical engineer who conducted the study specifically indicates otherwise, do not rely on a geotechnical engineering report that was:

- not prepared for you,
- not prepared for your project,
- not prepared for the specific site explored, or
- completed before important project changes were made.

Typical changes that can erode the reliability of an existing geotechnical engineering report include those that affect:

- the function of the proposed structure, as when it's changed from a parking garage to an office building, or from a light industrial plant to a refrigerated warehouse,
- elevation, configuration, location, orientation, or weight of the proposed structure,
- composition of the design team, or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project changes—even minor ones—and request an assessment of their impact. *Geotechnical engineers cannot accept responsibility or liability for problems that occur because their reports do not consider developments of which they were not informed.*

Subsurface Conditions Can Change

A geotechnical engineering report is based on conditions that existed at the time the study was performed. *Do not rely on a geotechnical engineering report* whose adequacy may have been affected by: the passage of time; by man-made events, such as construction on or adjacent to the site; or by natural events, such as floods, earthquakes, or groundwater fluctuations. *Always* contact the geotechnical engineer before applying the report to determine if it is still reliable. A minor amount of additional testing or analysis could prevent major problems.

Most Geotechnical Findings Are Professional Opinions

Site exploration identifies subsurface conditions only at those points where subsurface tests are conducted or samples are taken. Geotechnical engineers review field and laboratory data and then apply their professional judgment to render an opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ—sometimes significantly—from those indicated in your report. Retaining the geotechnical engineer who developed your report to provide construction observation is the most effective method of managing the risks associated with unanticipated conditions.

A Report's Recommendations Are *Not* Final

Do not overrely on the construction recommendations included in your report. *Those recommendations are not final,* because geotechnical engineers develop them principally from judgment and opinion. Geotechnical engineers can finalize their recommendations only by observing actual subsurface conditions revealed during construction. *The geotechnical engineer who developed your report cannot assume responsibility or liability for the report's recommendations if that engineer does not perform construction observation.*

A Geotechnical Engineering Report Is Subject to Misinterpretation

Other design team members' misinterpretation of geotechnical engineering reports has resulted in costly problems. Lower that risk by having your geotechnical engineer confer with appropriate members of the design team after submitting the report. Also retain your geotechnical engineer to review pertinent elements of the design team's plans and specifications. Contractors can also misinterpret a geotechnical engineering report. Reduce that risk by having your geotechnical engineer participate in prebid and preconstruction conferences, and by providing construction observation.

Do Not Redraw the Engineer's Logs

Geotechnical engineers prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors or omissions, the logs included in a geotechnical engineering report should *never* be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable, *but recognize that separating logs from the report can elevate risk.*

Give Contractors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can make contractors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give contractors the complete geotechnical engineering report, *but* preface it with a clearly written letter of transmittal. In that letter, advise contractors that the report was not prepared for purposes of bid development and that the report's accuracy is limited; encourage them to confer with the geotechnical engineer who prepared the report (a modest fee may be required) and/or to conduct additional study to obtain the specific types of information they need or prefer. A prebid conference can also be valuable. *Be sure contractors have sufficient time* to perform additional study. Only then might you be in a position to give contractors the best information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions.

Read Responsibility Provisions Closely

Some clients, design professionals, and contractors do not recognize that geotechnical engineering is far less exact than other engineering disciplines. This lack of understanding has created unrealistic expectations that have led to disappointments, claims, and disputes. To help reduce the risk of such outcomes, geotechnical engineers commonly include a variety of explanatory provisions in their reports. Sometimes labeled "limitations" many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

Geoenvironmental Concerns Are Not Covered

The equipment, techniques, and personnel used to perform a *geoenvironmental* study differ significantly from those used to perform a *geotechnical* study. For that reason, a geotechnical engineering report does not usually relate any geoenvironmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated environmental problems have led to numerous project failures.* If you have not yet obtained your own geoenvironmental information, ask your geotechnical consultant for risk management guidance. *Do not rely on an environmental report prepared for someone else.*

Obtain Professional Assistance To Deal with Mold

Diverse strategies can be applied during building design, construction, operation, and maintenance to prevent significant amounts of mold from growing on indoor surfaces. To be effective, all such strategies should be devised for the *express purpose* of mold prevention, integrated into a comprehensive plan, and executed with diligent oversight by a professional mold prevention consultant. Because just a small amount of water or moisture can lead to the development of severe mold infestations, a number of mold prevention strategies focus on keeping building surfaces dry. While groundwater, water infiltration, and similar issues may have been addressed as part of the geotechnical engineering study whose findings are conveyed in this report, the geotechnical engineer in charge of this project is not a mold prevention consultant; ***none of the services performed in connection with the geotechnical engineer's study were designed or conducted for the purpose of mold prevention. Proper implementation of the recommendations conveyed in this report will not of itself be sufficient to prevent mold from growing in or on the structure involved.***

Rely on Your ASFE-Member Geotechnical Engineer for Additional Assistance

Membership in ASFE/The Geoprofessional Business Association exposes geotechnical engineers to a wide array of risk management techniques that can be of genuine benefit for everyone involved with a construction project. Confer with your ASFE-member geotechnical engineer for more information.

ASFE THE GEOPROFESSIONAL BUSINESS ASSOCIATION

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