# GEOTECHNICAL EVALUATION REPORT

**ALTA VIA PIPELINE CONNECTION**
STATE ROUTE 9 AND PROSPECT AVENUE
BOULDER CREEK, CALIFORNIA

FOR
**SAN LORENZO VALLEY WATER DISTRICT**
BOULDER CREEK, CALIFORNIA


Pacific Crest
ENGINEERING INC

CONSULTING GEOTECHNICAL ENGINEERS



2154-SZ24-C31
NOVEMBER 2021
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Pacific Crest
ENGINEERING INC

GEOTECHNICAL | ENVIRONMENTAL | CHEMICAL | MATERIAL TESTING | SPECIAL INSPECTIONS

November 2, 2021 Project No. 2154-SZ24-C31

Mr. Josh Wolff, District Engineer
San Lorenzo Valley Water District
13060 Highway 9
Boulder Creek, CA 95006

Subject: **Geotechnical Evaluation Report**
Alta Via Pipeline Connection
State Route 9 and Prospect Avenue
Boulder Creek, CA 95006

Dear Mr. Wolff,

In accordance with your authorization, we have developed a geotechnical evaluation report for the proposed upgrade of the existing water main that provides water service to residents on Alta Via Drive and Monan Way in Boulder Creek, California.

The accompanying report presents our conclusions and recommendations as well as the results of the geotechnical study on which they are based.

Very truly yours,

**PACIFIC CREST ENGINEERING INC.**

REGISTERED PROFESSIONAL ENGINEER
ELIZABETH MAE MITCHELL
GE2718
Exp. 12/31/2022
GEOTECHNICAL
STATE OF CALIFORNIA

Elizabeth M. Mitchell, GE
President/Principal Engineer
GE 2718
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# I. INTRODUCTION

## PROJECT LOCATION

The subject site is located at the intersection of State Route 9 and Prospect Avenue in Boulder Creek, California. Please refer to the Regional Site Map, Figure No. 1, in Appendix A for the general vicinity of the project site, which is approximately located by the following coordinates:

Latitude = 37.112861 degrees
Longitude = -122.115646 degrees

## PROPOSED IMPROVEMENTS

It is our understanding that the San Lorenzo Valley Water District (the District) intends to upgrade their existing water main that provides water service to residents on Alta Via Drive and Monan Way. In conjunction with this work, the California Department of Transportation (Caltrans) is requiring a geotechnical evaluation report at the intersection of State Route 9 and Prospect Avenue prior to granting an encroachment permit to the District to allow hot tapping of their existing water main.

## PURPOSE AND SCOPE

The primary objective of this geotechnical evaluation report is to provide geotechnical recommendations required by Caltrans for utility trench backfill and flexible pavement design recommendations. The recommendations provided in this report are based upon the subsurface conditions within the vicinity of the existing water main that traverses Caltrans' Right-of-Way (ROW) at the intersection of State Route 9 and Prospect Avenue.

Our scope of services for this project consisted of:

1. Site reconnaissance to observe the existing conditions.
2. Review of the Geologic Map of Santa Cruz County, California, Brabb, 1997.
3. Review of Santa Cruz County GIS Geologic Hazards Map Application from the Santa Cruz County website at https://gis.santacruzcounty.us/gisweb/
4. The drilling and logging of 2 test borings.
5. Laboratory analysis of retrieved soil samples.
6. Preparation of this report documenting our investigation, findings, and conclusions.

# II. INVESTIGATION METHODS

## FIELD INVESTIGATION

Two, 8-inch diameter, test borings were drilled at the site on August 31, 2021. The approximate locations of the test borings are shown on Figure No. 2, in Appendix A. The drilling method used was hydraulically operated, continuous flight hollow stem augers on a truck mounted drill rig. A geologist from Pacific Crest Engineering Inc. was present during the drilling operations to log the soil encountered and to choose sampler type and locations.

Relatively undisturbed soil samples were obtained at various depths by driving a split spoon sampler 18 inches into the ground. This was achieved by dropping a 140-pound hammer a vertical height of 30 inches. The hammer was actuated with a wire winch. The number of blows required to drive the sampler each 6-inch increment and the total number of blows required to drive the last 12 inches was recorded by the field engineer. The outside diameter of the samplers used was 3-inch or 2-inch and is designated on the Boring Logs as “L” or “T”, respectively.

The field blow counts in 6-inch increments are reported on the boring logs adjacent to each sample as well as the Standard Penetration Test data (SPT). All SPT data has been normalized to a 2-inch O.D. sampler and is reported on the Boring Logs as SPT "N" values. The normalization method used was derived from the second edition of the Foundation Engineering Handbook (H.Y. Fang, 1991). The method utilizes a Sampler Hammer Ratio which is dependent on the weight of the hammer, height of hammer drop, outside diameter of sampler, and inside diameter of sample.

The Mobile B-61 (truck mounted) drilling rig is equipped with a downhole hammer. Based on a reported energy transfer ratio (ETR) of 54.2% provided by our drilling subconsultant Exploration Geoservices (EGI), a correction factor has been applied to the field measured blow counts. In this manner the standard penetration (SPT) N values have been normalized to a standard efficiency of 60% (N60).

The soils encountered in the boring were continuously logged in the field and visually described in accordance with the Unified Soil Classification System (ASTM D2488) as described in the Boring Log Explanation, Figures No. 3 and 4, in Appendix A. The soil classification was verified upon completion of laboratory testing in accordance with ASTM D2487.

Appendix A contains the site plan showing the locations of the test boring, our boring log and an explanation of the soil classification system used. Stratification lines on the boring logs are approximate as the actual transition between soil types may be gradual.

## LABORATORY TESTING

The laboratory testing program was developed to aid in evaluating the engineering properties of the materials encountered at the site. Laboratory tests performed include:

- Moisture Density relationships in accordance with ASTM D2937.
- Gradation testing in accordance with ASTM D1140.
- R-Value testing in accordance with California Test Method 301.
- Corrosivity testing in accordance with California Test Method 643 (Minimum Resistivity), California Test Method 422 (Chlorides), California Test Method 417 (Sulfates) and California Test Method 643 (pH).

The results of the laboratory testing are presented on the Log of Test Borings opposite the sample tested and/or presented graphically in Appendix A.

## III. FINDINGS AND ANALYSIS

### GEOLOGIC SETTING

The surficial geology in the area of the project site is mapped as Monterey Formation underlain by Lompico Sandstone at depth (Brabb, 1997). The Monterey Formation is described as "*medium to thickly bedded olive gray to light gray organic mudstone and sandy siltstone. It is semi-siliceous and typically includes a few thick dolomite interbeds*". The Lompico Sandstone is described as "*thick bedded to massive yellowish gray sandstone. It is fine to medium grained, calcareous, and arksoic*". We have inferred that the native soils encountered in the test borings are consistent with Lompico Sandstone overlain by residual soils derived from Lompico Sandstone.

### SURFACE CONDITIONS

The subject portion of State Route 9 is relatively flat to gently sloping to the inboard (southbound) side of the highway as it winds through the subject site. Prospect Avenue slopes down to the northeast at a grade of up to 30% as it truncates into the southbound lane of State Route 9. The outboard, northbound side of State Route 9 continues to slope down towards the northeast at a grade of up to 30%. Mature trees and residences line the inboard and outboard sides of State Route 9. Prospect Avenue is well developed a residential street that is also lined with mature trees. Based on information provided by the District, it is our understanding that the District's water main is aligned along the northbound lane of the highway. PG&E's gas main is also aligned along the northbound lane of State Route 9; however, a lateral exists perpendicular to State Route 9 and traverses up Prospect Avenue. Electricity is provided via overhead utility lines and poles.

### SUBSURFACE SOIL CONDITIONS

Our subsurface exploration consisted of the advancement of two borings drilled within the Caltrans ROW on State Route 9 at the intersection with Prospect Avenue. The depths of the borings ranged from 16 feet to 16½ feet below ground surface. The thickness of the pavement and aggregate base course sections were measured at each test boring location. The site map showing boring locations, the soil profiles and classifications, laboratory test results and groundwater conditions encountered for each test boring are presented in Appendix A.

Boring B-1 encountered 6 inches of asphalt underlain by 8 inches of concrete. Approximately two feet of silty sand fill was encountered below the concrete section. Native silty sand, sandy lean clay/clayey sand, and poorly graded sand with silt was encountered beneath the fill. The soils were generally fine to medium grained with few coarse grains, moist, and weakly cemented. The native soil densities were described as medium dense.

Within boring B-2, native soils described as sandy lean clay were encountered below the aggregate base section. Some very fine to fine grained sand and trace subrounded to well-rounded fine gravel was noted. The medium dense native soil was also described as moist and weakly cemented.

Poorly indurated Lompico Sandstone bedrock was encountered beneath the native soils. Bedrock was encountered at 14½ and 3½ feet below road grade within B-1 and B-2, respectively. The poorly indurated sandstone was very dense, weakly cemented, and described as silty sand with gravel, silty sand, or sand with silt and gravel.

No groundwater was encountered in either of our borings to the maximum depths explored. A summary of the conditions encountered within each test boring is listed below:

**Table No. 1 – Summary of Test Borings**

| Boring Number | AC Pavement Thickness (Inches) | Aggregate Base Course (Inches) | Concrete (Inches) | Subgrade Material | Total Boring Depth (Feet) |
|---|---|---|---|---|---|
| B-1 | 6 | 0 | 8 | Silty Sand | 16 |
| B-2 | 4 | 4 | 0 | Sandy Lean Clay | 16½ |

Please refer the Log of Test Borings in Appendix A for a more detailed description of the subsurface conditions encountered in each of our test borings at the subject site.

## SOIL CORROSIVITY

To address the corrosivity potential at the subject site, testing was performed on a sample of the on-site soils likely to come in contact with the water line. The results are summarized as follows:

**Table No. 2 - Corrosivity Test Summary**

| Sample | Approximate Sample Depth (ft) | Soil Resistivity | Chloride | Sulfate (water soluble) | pH |
|---|---|---|---|---|---|
| | | Ohm-cm | mg/kg | mg/kg | |
| B-1 | 3.0 | 3,648 | 35 | 13 | 4.4 |
| B-2 | 3.0 | 3,386 | 24 | 186 | 5.6 |

According to the Caltrans Corrosion Guidelines, Version 3.0 (March 2018), a site may be considered corrosive if one or more of the following conditions exist:

- The soil resistivity is *less than* 1,100 ohm-cm
- Chloride concentration is *greater than* or equal to 500 mg/Kg (ppm)
- Sulfate concentration is *greater than* or equal to 1500 mg/Kg (ppm)
- The soil pH is 5.5 *or less*

In comparing the test results to the threshold values, we have determined that the low pH native soils encountered in boring B-2 have the potential to be corrosive. The corrosion potential for any imported select fill should also be tested for corrosivity. Please refer to Appendix A for specific results of the corrosivity testing by the analytical laboratory (Figure 6).

## FAULTING AND SEISMIC CONSIDERATIONS

A quantitative analysis of seismic hazards was beyond our scope of services for this project. In general however, the seismic hazards associated with the project site include faulting, seismic shaking, ground surface fault rupture, liquefaction, lateral spreading and landsliding. A qualitative discussion of these hazards is presented below.

### Faulting

Mapped faults which have the potential to generate earthquakes that could significantly affect the subject site are listed in Table No. 3. The fault distances are approximate distances based the U.S. Geological Survey and California Geological Survey, Quaternary fault and fold database, accessed October 2021 from the USGS website https://www.usgs.gov/natural-hazards/earthquake-hazards/faults and overlaid onto Google Earth.

**Table No. 3 - Distance to Significant Faults**

| Fault Name | Fault ID | Distance (km) | Direction |
|---|---|---|---|
| San Andreas | 1 | 12.6 | East |
| Butano | 236 | 11.7 | Southeast |
| Sargent | 58 | 15.6 | Southeast |
| Zayante-Vergeles | 59 | 23.2 | Southeast |
| San Gregorio | 60 | 14.1 | West |

### Seismic Shaking

Due to the proximity of the site to active and potentially active faults, it is reasonable to assume the site will experience high intensity ground shaking during the lifetime of the project. Structures founded on thick, soft soil deposits are more likely to experience more destructive shaking, with higher amplitude and lower frequency, than structures founded on bedrock. Generally, shaking will be more intense closer to earthquake epicenters. Thick, soft soil deposits large distances from earthquake epicenters, however, may result in seismic accelerations significantly greater than expected in bedrock. There are no structural components to this project, therefore spectral acceleration design values have not been developed. The following peak ground accelerations (PGA) were obtained for the project site from the online California Geologic Survey – PSHA Ground Motion Interpolator.

**Table No. 4 – Site Specific Peak Ground Accelerations**

| Probability of Exceedance | PGA |
|---|---|
| 2% in 50 Years | 0.86g |
| 5% in 50 Years | 0.66g |
| 10% in 50 Years | 0.51g |

Ground Surface Fault Rupture

Pacific Crest Engineering Inc. has not performed a specific investigation for the presence of active faults at the project site. Based upon our review of the Santa Cruz County GIS Hazard Maps, the project site is not mapped within a fault hazard zone.

Ground surface fault rupture typically occurs along the surficial traces of active faults during significant seismic events. Since the nearest known active, or potentially active fault trace is mapped approximately 12 kilometers from the site, it is our opinion that the potential for ground surface fault rupture to occur at the site may be considered low.

Liquefaction and Lateral Spreading

Based upon our review of the Santa Cruz County GIS Maps, the project site is not mapped within a liquefaction hazard zone.

Liquefaction tends to occur in loose, saturated fine grained sands and coarse silt, or clays with low plasticity. Given the relatively shallow depth to bedrock and the lack of a groundwater table it is our opinion that the subsurface conditions encountered in our borings corroborate the mapping of the project site as having a low potential for liquefaction.

Liquefaction induced lateral spreading occurs when a liquefied soil mass fails toward an open slope face or fails on an inclined topographic slope. Our analysis indicates that the site has a low potential for liquefaction, consequently the potential for lateral spreading is also considered low.

Landsliding

The ground within the Caltrans ROW is relatively flat to gently sloping and not subject to landsliding hazards. In our opinion the proposed pipeline upgrade not likely to pose an increased risk to slope stability.

# IV. DISCUSSION, CONCLUSIONS & RECOMMENDATIONS

## GENERAL

1. Based on our subsurface boring information the existing pavement sections overlie native subgrade comprised of predominately sandy materials with varying fractions of silt and clay. Laboratory testing indicates an R-Value of 27 for the native subgrade materials.

## EARTHWORK

### Engineered Fill Placement and Compaction

2. Engineered fill should be placed in maximum 8-inch lifts, before compaction, at a water content which is within 1 to 3 percent of the laboratory optimum value.

3. All engineered fill should be compacted to a minimum of 95% of its maximum dry density. This includes pipe bedding, trench backfill and aggregate baserock.

4. The maximum dry density will be obtained from a laboratory compaction curve run in accordance with California Test Method CT 216. This test will also establish the optimum moisture content of the material. Field density testing shall be performed in accordance with California Test Method CT 231 (nuclear method).

5. A representative from our office should be present to provide field observation and testing during construction, in order to form an opinion as to the degree of conformance of the exposed site conditions to those foreseen in this report, the adequacy of the site preparation, the acceptability of fill materials, and the extent to which the earthwork construction and the degree of compaction comply with the specification requirements.

### Utility Trench Backfill

6. Utility pipes should be designed and constructed so that the top of pipe is a minimum of 24 inches below the finish subgrade elevation of any road or pavement areas. Any pipes within the top 24 inches of finish subgrade should be concrete encased, per design by the project civil engineer.

7. For the purpose of this section of the report, backfill is defined as material placed in a trench starting one foot above the pipe, and bedding is all material placed in a trench below the backfill.

8. Unless concrete bedding is required around utility pipes, free-draining clean sand should be used as bedding. Sand bedding should be compacted to at least 95 percent relative compaction. Clean sand is defined as 100 percent passing the #4 sieve, and less than 5 percent passing the #200 sieve.

9. Approved imported clean sand or native soil should be used as utility trench backfill. Backfill in trenches located under and adjacent to structural fill, foundations, concrete slabs, and pavements should be placed in horizontal layers no more than 8 inches thick.

10. Utility trenches which carry "nested" conduits (stacked vertically) should be backfilled with a control density fill (such as 2-sack sand\cement slurry) to an elevation one foot above the nested conduit stack. The use of pea gravel or clean sand as backfill within a zone of nested conduits is not recommended.

11. A representative from our firm should be present to observe the bottom of all trench excavations, prior to placement of utility pipes and conduits. In addition, we should observe the condition of the trench prior to placement of sand bedding, and to observe compaction of the sand bedding, in addition to any backfill planned above the bedding zone.

12. Jetting of the trench backfill is not recommended as it may result in an unsatisfactory degree of compaction.

Excavations and Shoring

13. Trenches must be shored as required by the local agency and the State of California Division of Industrial Safety construction safety orders.

14. It should be understood that on-site safety is the *sole responsibility* of the Contractor, and that the Contractor shall designate a *competent person* (as defined by CAL-OSHA) to monitor the slope excavation prior to the start of each workday, and throughout the work day as conditions change. The competent person designated by the Contractor shall determine if flatter slope gradients are more appropriate, or if shoring should be installed to protect workers in the vicinity of the slope excavation. Refer to Title 8, California Code of Regulations, Sections 1539-1543.

15. All excavations must meet the requirements of 29 CFR 1926.651 and 1926.652 or comparable OSHA approved state plan requirements.

## PAVEMENT RESTORATION

16. The table below provides minimum flexible pavement sections for traffic indices of 7.0 to 10.0*. This procedure is based on the 6th Edition of the Caltrans Highway Design Manual – Chapter 630 (last updated December 31, 2016), and assumes a 20-year design life and a minimum soil subgrade R-value of 27:

**Table No. 3, Recommended Pavement Sections**

| Material | Traffic Index | | | |
|---|---|---|---|---|
| | 7* | 8* | 9* | 10* |
| Asphalt Concrete | 4.0 inches | 5.0 inches | 5.5 inches | 6.5 inches |
| Class 2 Aggregate Base, R=78 min. | 11.0 inches | 12.0 inches | 14.0 inches | 15.0 inches |

** Pacific Crest Engineering Inc. has not performed a site-specific traffic study to determine the actual traffic indices associated with this project. These values are for general design purposes only and the values may need modification. Traffic* *volume and equivalent axle loads that exceed the assumed TI could be destructive to the pavement, resulting in an accelerated rate of deterioration and the need for increased maintenance. Final pavement section and design traffic index should be determined by the project civil engineer.*

17. To have the selected pavement sections perform to their greatest efficiency, it is very important that the following items be considered:

a. Properly scarify and moisture condition the upper 8 inches of the subgrade soil and compact it to a minimum of 95% of its maximum dry density, at a moisture content of 1 to 3% over the optimum moisture content for the soil.

b. Provide sufficient gradient to prevent ponding of water.

c. Use only quality materials of the type and thickness (minimum) specified. All aggregate base and subbase must meet Caltrans Standard Specifications for Class 2 materials, and be angular in shape. All Class 2 aggregate base should be ¾ inch maximum in aggregate size.

d. Compact the base and subbase uniformly to a minimum of 95% of its maximum dry density.

e. Use ½ inch maximum, Type "A" medium graded asphaltic concrete. Place the asphaltic concrete only during periods of fair weather when the free air temperature is within prescribed limits by Cal Trans Specifications.

f. Maintenance should be undertaken on a routine basis.

PLAN REVIEW

18. We respectfully request an opportunity to review the project plans and specifications during preparation and before bidding to verify that the recommendations of this report have been included and to provide additional recommendations, if needed. These plan review services are also typically required by the reviewing agency. Misinterpretation of our recommendations or omission of our requirements from the project plans and specifications may result in changes to the project design during the construction phase, with the potential for additional costs and delays in order to bring the project into conformance with the requirements outlined within this report. Services performed for review of the project plans and specifications are considered "post-report" services and billed on a "time and materials" fee basis in accordance with our latest Standard Fee Schedule.

## V. LIMITATIONS AND UNIFORMITY OF CONDITIONS

1. This Geotechnical Evaluation Report was prepared specifically for San Lorenzo Valley Water District and for the specific project and location described in the body of this report. This report and the recommendations included herein should be utilized for this specific project and location

exclusively. This Geotechnical Data Report should not be applied to nor utilized on any other project or project site. Please refer to the ASFE "Important Information about Your Geotechnical Engineering Report" attached with this report.

2. The recommendations of this report are based upon the assumption that the soil conditions do not deviate from those disclosed in the boring. If any variations or undesirable conditions are encountered during construction, or if the proposed construction will differ from that planned at the time, our firm should be notified so that supplemental recommendations can be provided.

3. This report is issued with the understanding that it is the responsibility of the owner, or his representative, to ensure that the information and recommendations contained herein are called to the attention of the Architects and Engineers for the project and incorporated into the plans, and that the necessary steps are taken to ensure that the Contractors and Subcontractors carry out such recommendations in the field.

4. The findings of this report are valid as of the present date. However, changes in the conditions of a property can occur with the passage of time, whether they are due to natural process or the works of man, on this or adjacent properties. In addition, changes in applicable or appropriate standards occur, whether they result from legislation or the broadening of knowledge. Accordingly, the findings of this report may be invalidated, wholly or partially, by changes outside of our control. This report should therefore be reviewed in light of future planned construction and then current applicable codes. This report should not be considered valid after a period of two (2) years without our review.

5. This report was prepared upon your request for our services in accordance with currently accepted standards of professional geotechnical engineering practice. No warranty as to the contents of this report is intended, and none shall be inferred from the statements or opinions expressed.

6. The scope of our services mutually agreed upon for this project did not include any environmental assessment or study for the presence of hazardous or toxic materials in the soil, surface water, groundwater, or air, on or below or around this site.

# Important Information About Your

# Geotechnical Engineering Report

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

*The following information is provided to help you manage your risks.*

## 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 Geotechncial Engineer for Additional Assistance

Membership in ASFE/The Best People on Earth 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 you ASFE-member geotechnical engineer for more information.

ASFE
The Best People on Earth

8811 Colesville Road/Suite G106, Silver Spring, MD 20910
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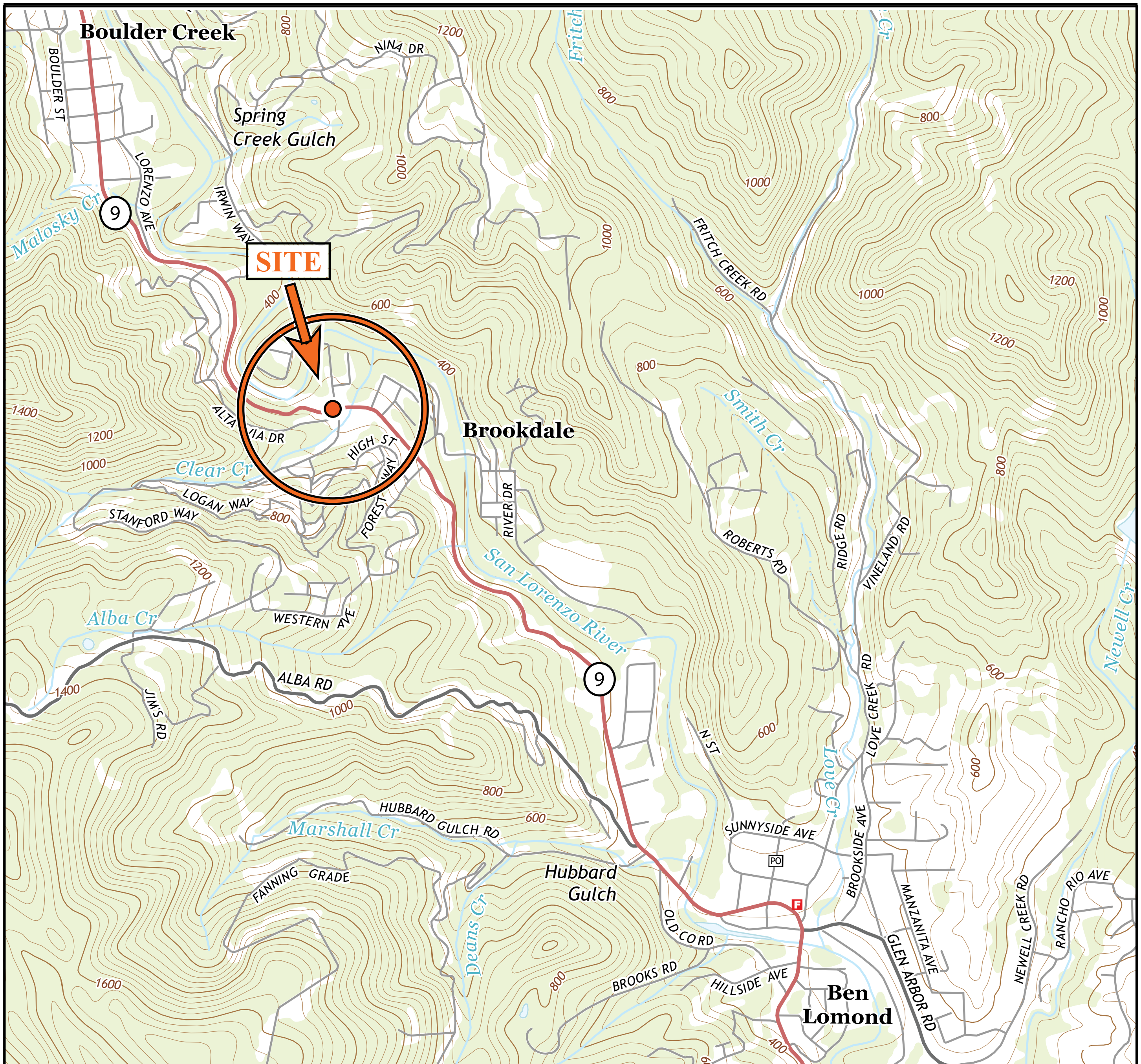
# APPENDIX A

Regional Site Map
Site Map Showing Test Borings
Key to Log of Test Borings
Key to Soil Classification
Log of Test Borings
Corrosivity Test Results
R-Value Test Results

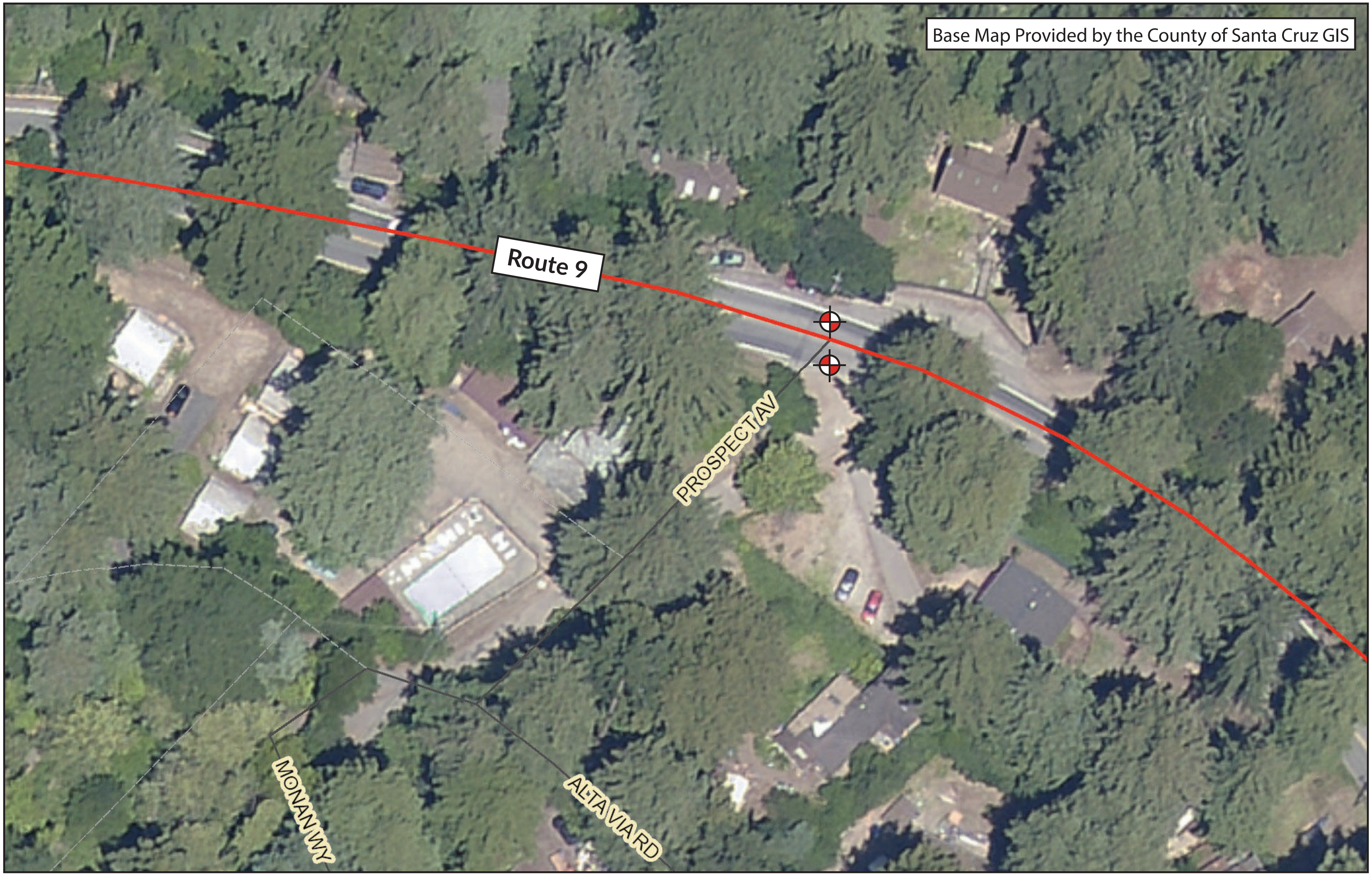



0 2000 ft.

N

Base Map: United States Geological Survey
Felton Quadrangle, California
Santa Cruz County, 7.5 Minute Series, 2015

| | | |
|---|---|---|
| Pacific Crest ENGINEERING INC | **Regional Site Map**<br>Alta Via Pipeline Connection<br>Boulder Creek, Santa Cruz County, California | Figure No. 1<br>Project No. 2154<br>Date: 11/2/21 |




Proposed Boring Location

N

0 60.25

Scale: 1 inch = 60.25 feet

Pacific Crest
ENGINEERING INC

**Site Map Showing Proposed Boring Locations**
Alta Via Pipeline Connection
Boulder Creek, Santa Cruz County, California

Figure No. 2
Project No. 2154
Date: 11/2/21

REFERENCE: CALTRANS SOIL & ROCK LOGGING, CLASSIFICATION, AND PRESENTATION MANUAL (2010)

THE STATE OF CALIFORNIA OR ITS OFFICERS OR AGENTS SHALL NOT BE RESPONSIBLE FOR THE ACCURACY OR COMPLETENESS OF SCANNED COPIES OF THIS PLAN SHEET.

**ABBREVIATION:**

GWS = Ground Water Surface

CEMENTATION

| DESCRIPTION | CRITERIA |
|---|---|
| WEAK | CRUMBLES OR BREAKS WITH HANDLING OR LITTLE FINGER PRESSURE. |
| MODERATE | CRUMBLES OR BREAKS WITH CONSIDERABLE FINGER PRESSURE. |
| STRONG | WILL NOT CRUMBLE OR BREAK WITH FINGER PRESSURE. |

BOREHOLE IDENTIFICATION

| SYMBOL | HOLE TYPE | DESCRIPTION |
|---|---|---|
| Size | A | AUGER BORING (HOLLOW OR SOLID STEM BUCKET) |
| Size | R<br>RW<br>RC<br>P | ROTARY DRILLED BORING (CONVENTIONAL)<br>ROTARY DRILLED WITH SELF-CASING WIRE-LINE<br>ROTARY CORE WITH CONTINUOUSLY-SAMPLED, SELF-CASING WIRE-LINE<br>ROTARY PERCUSSION BORING (AIR) |
| Size | R<br>RC | ROTARY DRILLED DIAMOND CORE<br>ROTARY DRILLED DIAMOND CORE, CONTINUOUSLY SAMPLED |
| Size | HD<br>HA | HAND DRIVEN (1-INCH SOIL TUBE)<br>HAND AUGER |
| ● | D | DYNAMIC CONE PENETRATION BORING |
| ▲ | CPT | CONE PENETRATION TEST (ASTM D 5778) |
| | O | OTHER (NOTE ON LOTB) |

Note: Size in inches.

CONSISTENCY OF COHESIVE SOILS

| DESCRIPTION | SHEAR STRENGTH (tsf) | POCKET PENETROMETER MEASUREMENT, PP, (tsf) | TORVANE MEASUREMENT, TV, (tsf) | VANE SHEAR MEASUREMENT, VS, (tsf) |
|---|---|---|---|---|
| VERY SOFT | LESS THAN 0.12 | LESS THAN 0.25 | LESS THAN 0.12 | LESS THAN 0.12 |
| SOFT | 0.12 - 0.25 | 0.25 - 0.5 | 0.12 - 0.25 | 0.12 - 0.25 |
| MEDIUM STIFF | 0.25 - 0.5 | 0.5 - 1 | 0.25 - 0.5 | 0.25 - 0.5 |
| STIFF | 0.5 - 1 | 1 - 2 | 0.5 - 1 | 0.5 - 1 |
| VERY STIFF | 1 - 2 | 2 - 4 | 1 - 2 | 1 - 2 |
| HARD | GREATER THAN 2 | GREATER THAN 4 | GREATER THAN 2 | GREATER THAN 2 |

2018 STANDARD PLAN A10F

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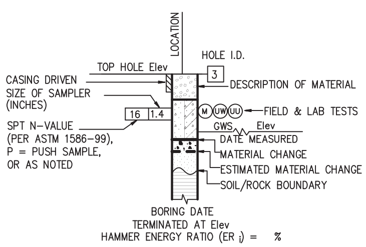
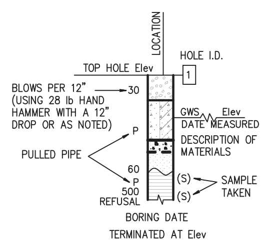
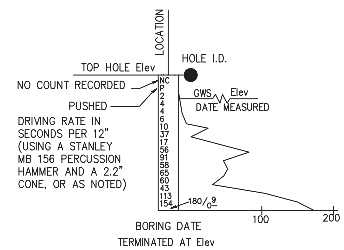


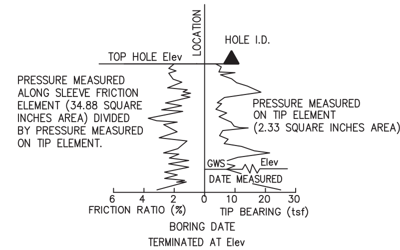
ROTARY BORING



HAND BORING



DYNAMIC CONE PENETRATION BORING



CONE PENETRATION TEST (CPT) BORING

STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION

LEGEND - SOIL
(SHEET 1 OF 2)

**NO SCALE**

A10F

Base Map Provided by Caltrans

Pacific Crest ENGINEERING INC

**Key to Log of Test Borings**
Alta Via Pipeline Connection
Boulder Creek, Santa Cruz County, California

Figure No. 3
Project No. 2154
Date: 11/2/21

REFERENCE: CALTRANS SOIL & ROCK LOGGING, CLASSIFICATION, AND PRESENTATION MANUAL (2010)

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## GROUP SYMBOLS AND NAMES

| GRAPHIC/SYMBOL | GROUP NAMES |
|---|---|
| GW | WELL-GRADED GRAVEL<br>WELL-GRADED GRAVEL WITH SAND |
| GP | POORLY-GRADED GRAVEL<br>POORLY-GRADED GRAVEL WITH SAND |
| GW-GM | WELL-GRADED GRAVEL WITH SILT<br>WELL-GRADED GRAVEL WITH SILT AND SAND |
| GW-GC | WELL-GRADED GRAVEL WITH CLAY (OR SILTY CLAY)<br>WELL-GRADED GRAVEL WITH CLAY AND SAND (OR SILTY CLAY AND SAND) |
| GP-GM | POORLY-GRADED GRAVEL WITH SILT<br>POORLY-GRADED GRAVEL WITH SILT AND SAND |
| GP-GC | POORLY-GRADED GRAVEL WITH CLAY (OR SILTY CLAY)<br>POORLY-GRADED GRAVEL WITH CLAY AND SAND (OR SILTY CLAY AND SAND) |
| GM | SILTY GRAVEL<br>SILTY GRAVEL WITH SAND |
| GC | CLAYEY GRAVEL<br>CLAYEY GRAVEL WITH SAND |
| GC-GM | SILTY, CLAYEY GRAVEL<br>SILTY, CLAYEY GRAVEL WITH SAND |
| SW | WELL-GRADED SAND<br>WELL-GRADED SAND WITH GRAVEL |
| SP | POORLY-GRADED SAND<br>POORLY-GRADED SAND WITH GRAVEL |
| SW-SM | WELL-GRADED SAND WITH SILT<br>WELL-GRADED SAND WITH SILT AND GRAVEL |
| SW-SC | WELL-GRADED SAND WITH CLAY (OR SILTY CLAY)<br>WELL-GRADED SAND WITH CLAY AND GRAVEL (OR SILTY CLAY AND GRAVEL) |
| SP-SM | POORLY-GRADED SAND WITH SILT<br>POORLY-GRADED SAND WITH SILT AND GRAVEL |
| SP-SC | POORLY-GRADED SAND WITH CLAY (OR SILTY CLAY)<br>POORLY-GRADED SAND WITH CLAY AND GRAVEL (OR SILTY CLAY AND GRAVEL) |
| SM | SILTY SAND<br>SILTY SAND WITH GRAVEL |
| SC | CLAYEY SAND<br>CLAYEY SAND WITH GRAVEL |
| SC-SM | SILTY, CLAYEY SAND<br>SILTY, CLAYEY SAND WITH GRAVEL |
| PT | PEAT |
| | COBBLES<br>COBBLES AND BOULDERS<br>BOULDERS |

| GRAPHIC/SYMBOL | GROUP NAMES |
|---|---|
| CL | LEAN CLAY<br>LEAN CLAY WITH SAND<br>LEAN CLAY WITH GRAVEL<br>SANDY LEAN CLAY<br>SANDY LEAN CLAY WITH GRAVEL<br>GRAVELLY LEAN CLAY<br>GRAVELLY LEAN CLAY WITH SAND |
| CL-ML | SILTY CLAY<br>SILTY CLAY WITH SAND<br>SILTY CLAY WITH GRAVEL<br>SANDY SILTY CLAY<br>SANDY SILTY CLAY WITH GRAVEL<br>GRAVELLY SILTY CLAY<br>GRAVELLY SILTY CLAY WITH SAND |
| ML | SILT<br>SILT WITH SAND<br>SILT WITH GRAVEL<br>SANDY SILT<br>SANDY SILT WITH GRAVEL<br>GRAVELLY SILT<br>GRAVELLY SILT WITH SAND |
| OL | ORGANIC LEAN CLAY<br>ORGANIC LEAN CLAY WITH SAND<br>ORGANIC LEAN CLAY WITH GRAVEL<br>SANDY ORGANIC LEAN CLAY<br>SANDY ORGANIC LEAN CLAY WITH GRAVEL<br>GRAVELLY ORGANIC LEAN CLAY<br>GRAVELLY ORGANIC LEAN CLAY WITH SAND |
| OL | ORGANIC SILT<br>ORGANIC SILT WITH SAND<br>ORGANIC SILT WITH GRAVEL<br>SANDY ORGANIC SILT<br>SANDY ORGANIC SILT WITH GRAVEL<br>GRAVELLY ORGANIC SILT<br>GRAVELLY ORGANIC SILT WITH SAND |
| CH | FAT CLAY<br>FAT CLAY WITH SAND<br>FAT CLAY WITH GRAVEL<br>SANDY FAT CLAY<br>SANDY FAT CLAY WITH GRAVEL<br>GRAVELLY FAT CLAY<br>GRAVELLY FAT CLAY WITH SAND |
| MH | ELASTIC SILT<br>ELASTIC SILT WITH SAND<br>ELASTIC SILT WITH GRAVEL<br>SANDY ELASTIC SILT<br>SANDY ELASTIC SILT WITH GRAVEL<br>GRAVELLY ELASTIC SILT<br>GRAVELLY ELASTIC SILT WITH SAND |
| OH | ORGANIC FAT CLAY<br>ORGANIC FAT CLAY WITH SAND<br>ORGANIC FAT CLAY WITH GRAVEL<br>SANDY ORGANIC FAT CLAY<br>SANDY ORGANIC FAT CLAY WITH GRAVEL<br>GRAVELLY ORGANIC FAT CLAY<br>GRAVELLY ORGANIC FAT CLAY WITH SAND |
| OH | ORGANIC ELASTIC SILT<br>ORGANIC ELASTIC SILT WITH SAND<br>ORGANIC ELASTIC SILT WITH GRAVEL<br>SANDY ORGANIC ELASTIC SILT<br>SANDY ORGANIC ELASTIC SILT WITH GRAVEL<br>GRAVELLY ORGANIC ELASTIC SILT<br>GRAVELLY ORGANIC ELASTIC SILT WITH SAND |
| OL/OH | ORGANIC SOIL<br>ORGANIC SOIL WITH SAND<br>ORGANIC SOIL WITH GRAVEL<br>SANDY ORGANIC SOIL<br>SANDY ORGANIC SOIL WITH GRAVEL<br>GRAVELLY ORGANIC SOIL<br>GRAVELLY ORGANIC SOIL WITH SAND |

## FIELD AND LABORATORY TESTING

- C — CONSOLIDATION (ASTM D2435)
- CL — COLLAPSE POTENTIAL (ASTM D4546)
- CP — COMPACTION CURVE (CTM 216)
- CR — CORROSIVITY TESTING (CTM 643, CTM 422, CTM 417)
- CU — CONSOLIDATED UNDRAINED TRIAXIAL (ASTM D4767)
- DS — DIRECT SHEAR (ASTM D3080)
- EI — EXPANSION INDEX (ASTM D4829)
- M — MOISTURE CONTENT (ASTM D2216)
- OC — ORGANIC CONTENT-% (ASTM D2974)
- P — PERMEABILITY (CTM 220)
- PA — PARTICLE SIZE ANALYSIS (ASTM D422)
- PI — PLASTICITY INDEX (AASHTO T 90) LIQUID LIMIT (AASHTO T 89)
- PL — POINT LOAD INDEX (ASTM D5731)
- PM — PRESSURE METER
- R — R-VALUE (CTM 301)
- SE — SAND EQUIVALENT (CTM 217)
- SG — SPECIFIC GRAVITY (AASHTO T 100)
- SL — SHRINKAGE LIMIT (ASTM D4943)
- SW — SWELL POTENTIAL (ASTM D4546)
- UC — UNCONFINED COMPRESSION-SOIL (ASTM D2166) UNCONFINED COMPRESSION-ROCK (ASTM D7012 - METHOD C)
- UU — UNCONSOLIDATED UNDRAINED TRIAXIAL (ASTM D2850)
- UW — UNIT WEIGHT (ASTM D7263 - METHOD B)



## APPARENT DENSITY OF COHESIONLESS SOILS

| DESCRIPTION | SPT N 60 (BLOWS / 12 INCHES) |
|---|---|
| VERY LOOSE | 0 - 5 |
| LOOSE | 5 - 10 |
| MEDIUM DENSE | 10 - 30 |
| DENSE | 30 - 50 |
| VERY DENSE | GREATER THAN 50 |

## MOISTURE

| DESCRIPTION | CRITERIA |
|---|---|
| DRY | NO DISCERNABLE MOISTURE |
| MOIST | MOISTURE PRESENT, BUT NO FREE WATER |
| WET | VISIBLE FREE WATER |

## PERCENT OR PROPORTION OF SOILS

| DESCRIPTION | CRITERIA |
|---|---|
| TRACE | PARTICLES ARE PRESENT BUT ESTIMATED TO BE LESS THAN 5% |
| FEW | 5% - 10% |
| LITTLE | 15% - 25% |
| SOME | 30% - 45% |
| MOSTLY | 50% - 100% |

## PARTICLE SIZE

| DESCRIPTION | | SIZE |
|---|---|---|
| BOULDER | | GREATER THAN 12" |
| COBBLE | | 3" - 12" |
| GRAVEL | COARSE | 3/4" - 3" |
| | FINE | 1/5" - 3/4" |
| SAND | COARSE | 1/16" - 1/5" |
| | MEDIUM | 1/64" - 1/16" |
| | FINE | 1/300" - 1/64" |
| SILT AND CLAY | | LESS THAN 1/300" |

STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION

LEGEND - SOIL
(SHEET 2 OF 2)

**NO SCALE**

A10G

2018 STANDARD PLAN A10G

1-26-18

Base Map Provided by Caltrans

Pacific Crest ENGINEERING INC

**Key to Soil Classification**
Alta Via Pipeline Connection
Boulder Creek, Santa Cruz County, California

Figure No. 4
Project No. 2154
Date: 11/2/21

Base Map Provided by:
County of Santa Cruz GIS

N

PLAN
1" = 20'

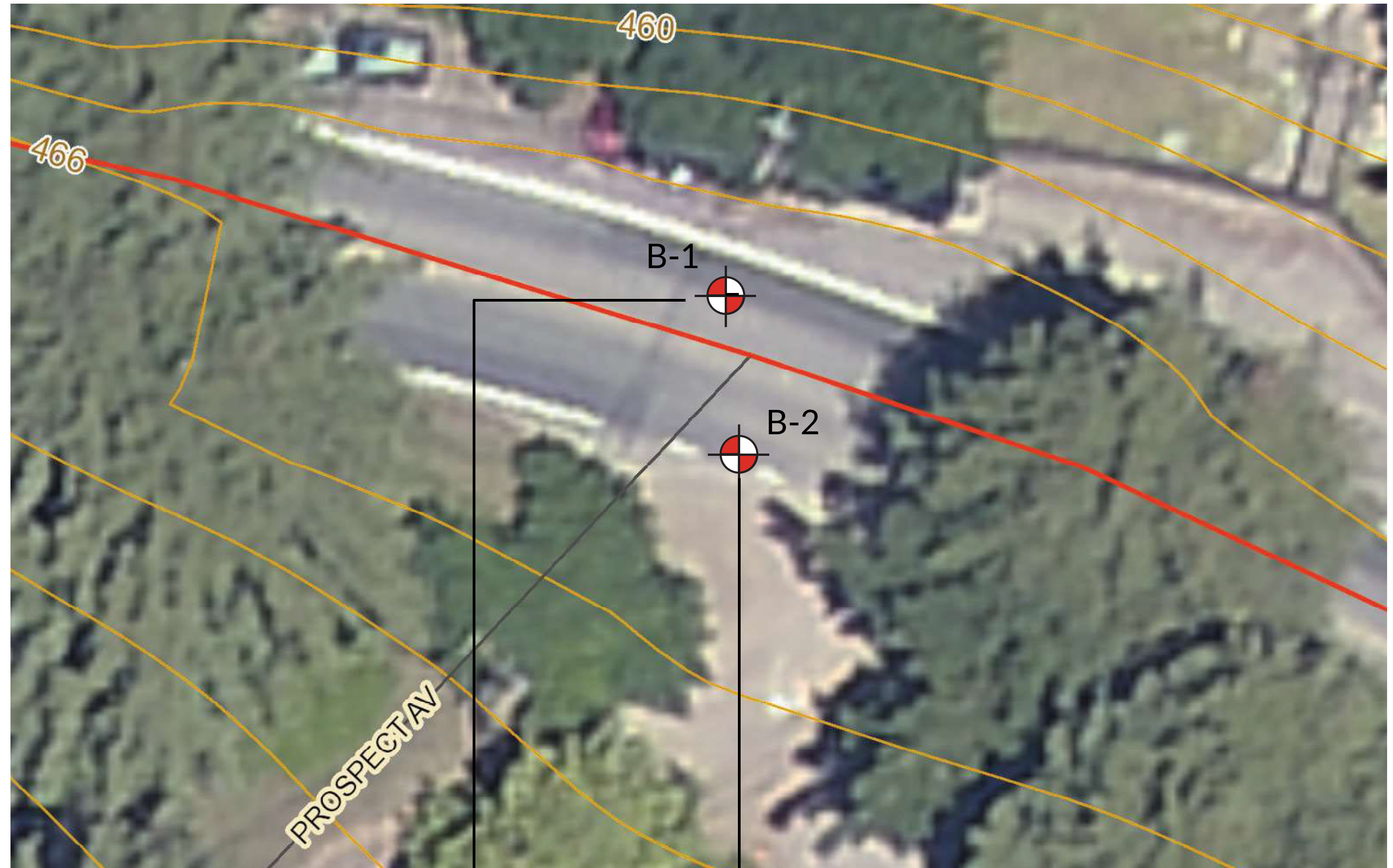
NOTES:

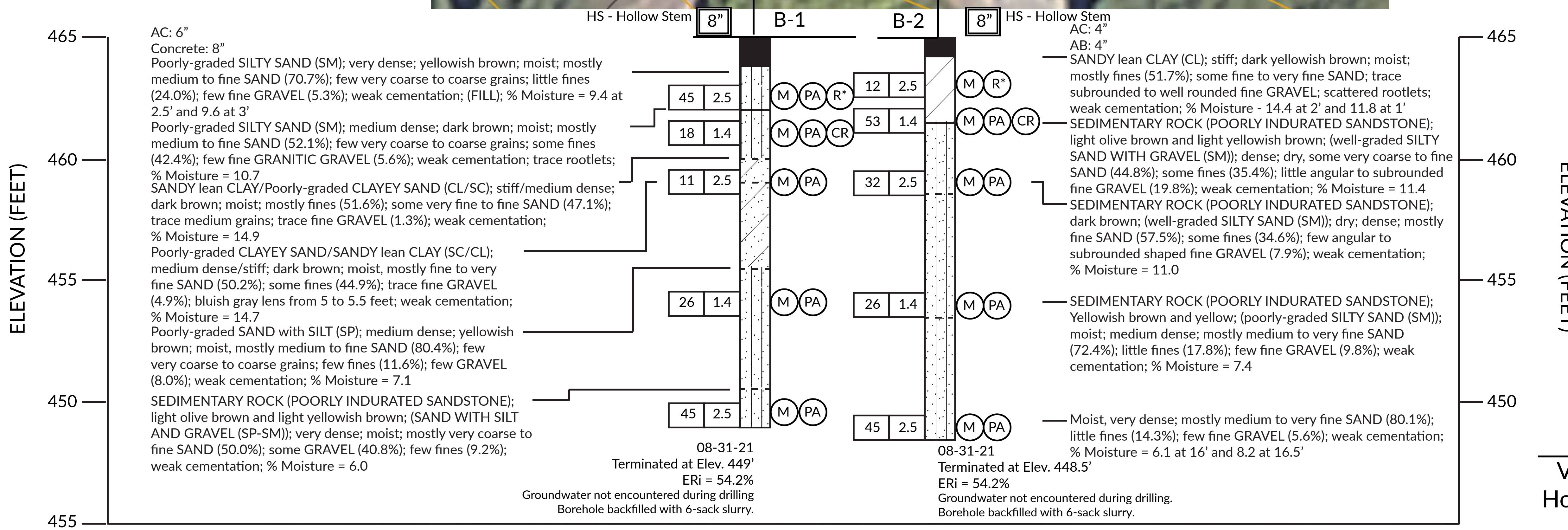
Standard penetration test sampler: I.D. = 1.4"; O.D. = 2"
Modified California Sampler: I.D. = 2.5"; O.D. = 3"
Hammer Assembly: A 140 lb hammer with a 30" drop

This Log of Test Boring Sheet was prepared in accordance with the Caltrans Soil and Rock, Logging, Classification, and Presentation Manual (2010)

See Caltrans 2018 Standard Plans A10F (Figure 3) , A10G (Figure 4) for soil legend.

All dimensions are in feet unless otherwise shown.




PROFILE
Vertical: 1" = 5'
Horizontal: 1" = 1'

San Lorenzo Valley
WATER DISTRICT

| | |
|---|---|
| DRAWN BY: C. AL-LAMI | |
| CHECKED BY: E. MITCHELL | |
| SCALE: AS SHOWN | |
| DATE: 11/2/2021 | |
| JOB NUMBER: 2154 | |

Pacific Crest
ENGINEERING INC

SANTA CRUZ COUNTY, CALIFORNIA
ALTA VIA PIPELINE CONNECTION
LOG OF TEST BORINGS
FOR: SAN LORENZO VALLEY WATER DISTRICT

Figure No. 5
Project No. 2154
Date: 11/2/21

COOPER TESTING LABORATORY

# Corrosivity Test Summary

**CTL #** 416-643 **Date:** 9/17/2021 **Tested By:** PJ **Checked:** PJ
**Client:** Pacific Crest Engineering **Project:** Prospect Ave & Highway 9 **Proj. No:** 2154
**Remarks:**

| Sample Location or ID | | | Resistivity @ 15.5 °C (Ohm-cm) | | | Chloride | Sulfate | | pH | ORP | Moisture | Soil Visual Description |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Boring | Sample, No. | Depth, ft. | As Rec. | Minimum | Saturated | mg/kg | mg/kg | % | | (Redox) | At Test | |
| | | | | | | Dry Wt. | Dry Wt. | Dry Wt. | | mv | % | |
| | | | ASTM G57 | Cal 643 | ASTM G57 | Cal 422-mod. | Cal 417-mod. | Cal 417-mod. | Cal 643 | SM 2580B | ASTM D2216 | |
| B-1 | - | - | - | 3648 | - | 35 | 13 | 0.0013 | 4.4 | - | 2.3 | Yellowish Brown Silty SAND w/ Gravel |
| B-2 | - | - | - | 3386 | - | 24 | 186 | 0.0186 | 5.6 | - | 2.2 | Yellowish Brown Silty SAND w/ Gravel |

COOPER TESTING LABORATORY

# R-Value
# CTM 301

| | | | | | |
|---|---|---|---|---|---|
| CTL Job No.: | 416-644 | Boring: | | Reduced By: | RU |
| Client: | Pacific Crest Engineering | Sample: | R-1 | Checked By: | PJ |
| Project Number: | 2154 | Depth: | | Date: | 9/20/2021 |
| Project Name: | Prospect Ave & Highway 9 | | | **R-Value** | **27** |
| Soil Description: | Olive Brown Clayey SAND | | | | |
| Remarks: | | | | **Expansion Pressure** | **0** |

| Specimen Designation | A | B | C | D | E |
|---|---|---|---|---|---|
| Compactor Foot Pressure (psi) | 180 | 50 | 350 | | |
| Exudation Pressure (psi) | 291 | 132 | 508 | | |
| Exudation Load (lbf) | 3657 | 1659 | 6384 | | |
| Height After Compaction (in) | 2.48 | 2.55 | 2.50 | | |
| Expansion Pressure (psf) | 0 | 0 | 43 | | |
| Stabilometer @ 2000 | 108 | 132 | 58 | | |
| Turns Displacement | 3.42 | 3.10 | 3.66 | | |
| R-value | 26 | 15 | 55 | | |
| Corrected R-Value | 26 | 15 | 55 | | |
| Moisture Content (%) | 13.3 | 14.7 | 11.9 | | |
| Wet Density (pcf) | 129.6 | 130.3 | 131.8 | | |
| Dry Density (pcf) | 114.3 | 113.6 | 117.8 | | |