GEOTECHNICAL INVESTIGATION
For
BLUE RIDGE TANK REPLACEMENT
APN 084-261-13, 14
Boulder Creek, California

Prepared For
SAN LORENZO VALLEY WATER DISTRICT
13060 Highway 9
Boulder Creek, California

Prepared By
HARO, KASUNICH AND ASSOCIATES, INC.
Geotechnical & Coastal Engineers
Project No. SC11988
August 2021

Project No. SC11988
20 August 2021

SAN LORENZO VALLEY WATER DISTRICT
13060 Highway 9
Boulder Creek, CA 95006

Attention: Mr. Josh Wolff

Subject: Geotechnical Investigation

Reference: Blue Ridge Tank Replacement Project
APN 084-261-13, 14
Blue Ridge Drive
Boulder Creek, California

Dear Mr. Wolff:

In accordance with your authorization, we have performed a Geotechnical Investigation for the referenced project in Boulder Creek, California.

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

If you have any questions concerning the data or conclusions presented in this report, please call our office.

Respectfully Submitted,

HARO, KASUNICH AND ASSOCIATES, INC.

Andrew Kasunich,
Staff Engineer

Christopher A. George
Senior Engineer

AK/CG/cg

Copies: 1 to Addressee + email (JWolff@slvwd.com)

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GEOTECHNICAL INVESTIGATION

Introduction

This report presents the findings, conclusions, and recommendations of our Geotechnical Investigation for the proposed Blue Ridge Tank Replacement Project site (see Site Vicinity Map, Figure 1 in Appendix A).

A Site Map for the proposed replacement water tank site, prepared by Paul Jensen, was provided for our use. The map, dated April 2021, was used as a base for our Boring Site Plan and Cross Section A-A' (see Figure 3 & 4 in Appendix A). Exploratory boring locations were not surveyed and should be considered approximate only. Ground surface elevations shown on Exploratory Boring Logs are based on contour elevations shown on the Site Map. Site descriptions, elevations, slope gradients and distances referred to in this report are based on review of the map and site reconnaissance by the engineer.

Foundation and grading plans for the replacement tank or improvements have not been developed at the time this report was prepared. Haro, Kasunich and Associates should be provided an opportunity to review the project plans prior to finalizing to evaluate if the criteria and recommendations presented were properly interpreted and implemented and determine if this report is adequate and complete for proposed project.

Purpose and Scope

The purpose of our investigation was to evaluate the soil and bedrock conditions at the referenced Blue Ridge Tank site and develop geotechnical design criteria and recommendations for proposed replacement water tank foundations and associated improvements. It is presumed the most current California Building Code (2019 CBC) edition design considerations will be followed during design and construction of the projects.

The specific scope of our services was as follows:

1. Site reconnaissance and review of available data in our files regarding the site and vicinity.
2. A field exploration program consisting of logging and interval sampling of soils encountered in three (3) exploratory borings with limited access, solid flight auger equipment drilled to depths of 5.5 feet. Standard Penetration Tests (SPT) were performed during sampling operations. The soil samples obtained were sealed and returned to the laboratory for testing.
3. Laboratory testing and classification of select samples was completed. Moisture content, dry density, grain size analysis, Atterberg Limits, and direct shear tests were performed to aid in soil classification and evaluate the soil engineering properties of onsite geomaterials.
4. Engineering analysis and evaluation of the resulting data was performed. We developed geotechnical design parameters for ring foundations, concrete

slabs-on-grade, retaining walls, and recommendations for site grading, drainage, and erosion control.

5. Preparation and submittal of this report presenting the results of our Geotechnical Investigation.

Site Location and Conditions

The Blue Ridge Tank site is located on APN 084-261-13 and APN 084-261-14. These parcels are contiguous and are 0.095 acres and 0.241-acres respectively. The site is on the top of a bedrock ridge spur with undisturbed natural slopes descending to the west, north and south of the ridge spur at gradients of between 3:1 and 2:1 (H: V). From the proposed tank location, slopes continue for roughly for horizontal distances of 60 to 120 feet, putting the tank site at 30 to 40 feet above Blue Ridge Road. The slopes are vegetated with scattered trees and brush.

Existing structures and improvements on the tank site parcel include a concrete pad below the redwood water storage tank to be replaced, a propane tank, electrical control panel and wiring, large water pipes and valves, and buried water lines. It is unknown if the concrete pad has footings or reinforcement. The existing concrete water tank pad is about 20 feet in diameter and is situated in the approximate middle of the ridge spur.

On the lower elevations of the ridge spur, adjacent to Blue Ridge Drive and Short Street, the slopes steepen to gradients of 100% to near vertical.

Project Description

A replacement water tank is proposed for Blue Ridge Tank site. We understand the existing concrete slab foundation will be removed. It is presumed the existing foundation will be demolished and removed so that a foundation for the new tank can be constructed.
The new water tank will be situated on a new ring spread footing foundation situated in the approximate location of the existing tank. We understand the replacement tank will be approximately the same size as the existing tank. Grading for the project is anticipated to consist of cut or cut and fill grading to construct a new level pad for the tank, and excavations for ring footings.

Field Exploration

Subsurface conditions were investigated on 2 July 2021 by drilling three (3) exploratory borings to depths of 5.5 feet each. The boring locations were not surveyed and should be considered approximate only. The borings were drilled with 3-inch diameter, minuteman equipment mounted on a tripod and a portable soil auger drill rig. The approximate locations of the borings are shown on the Boring Site Plan (see Figure 3 in Appendix A).

Representative soil samples were obtained from the exploratory borings at selected depths, or at major strata changes. These samples were recovered using a 3.0-inch outside diameter (O.D.) Modified California Sampler (L), or by a 2.0-inch O. D. Standard Terzaghi Sampler (T). The soils encountered in the borings were continuously logged in the field and visually described in accordance with the Unified Soil Classification System (ASTM

D2487).

The Logs of Test Borings are included in Appendix A of this report. The Logs depict subsurface conditions at the approximate locations shown on the Boring Site Plans. Subsurface conditions at other locations may differ from those encountered at the explored locations. Stratification lines shown on the logs represent the approximate boundaries between soil types; actual transitions may be gradual.

The penetration blow counts noted on the boring logs were obtained by driving a sampler into the soil with a 140-pound hammer dropping through a 30-inch fall. The sampler was driven up to 18 inches into the soil and the number of blows counted for each 6-inch penetration interval (Standard Penetration Test). The numbers indicated on the logs are the total number of blows that were recorded for the second and third 6-inch intervals, or the blows that were required to drive the penetration depth shown if high resistance was encountered.

<u>Subsurface Conditions</u>

Based on the results of our subsurface exploration, the top 12 to 24 inches of soil in our borings at the tank site consists of loose silty or clayey sand topsoil, underlain by medium dense clayey sand to depths of 2 to 3.5 feet. This layer is underlain by weathered to intact bedrock, which is likely the Vaqueros Formation Sandstone.

In B-1, loose silty sand topsoil with roots and sandstone fragments was encountered from the ground surface to a depth of 18 inches, which was underlain by medium dense weathered to un-weathered sandstone, which became very dense between 4 and 5 feet deep.

In B-2, firm sandy clay topsoil with roots and sandstone fragments was found from the ground surface to a depth of about 12 inches, underlain by stiff to very stiff weathered mudstone, which became hard at a depth of 5 feet.

In B-3, loose to medium dense clayey sand was encountered from the ground surface to a depth of 3.5 feet, which was underlain by medium dense to dense weathered fine sandstone to a depth of 5.5 feet.

A review of "The Geologic Map of Santa Cruz County, California" (Brabb, 1989) indicates that the site is mapped as Tvq: Vaqueros Sandstone (Oligocene). A contact between the Tvq and Tsr: Rices Mudstone Member (Oligocene and Eocene) is mapped about 180 northeast of the tank site.

Groundwater

Groundwater was not encountered in any of the borings. However, groundwater levels will fluctuate with time, being dependent upon seasonal precipitation, irrigation, land use, and climate conditions as well as other factors. Therefore, water observations at the time of the field investigation may vary from those encountered during the construction phase and/or post-construction of the project.

Laboratory Testing

The laboratory testing program was directed toward determining pertinent engineering and soil index properties.

The natural moisture contents and dry densities were determined on selected samples and are recorded on the boring logs at the appropriate depths. Since the engineering behavior of soil is affected by changes in moisture content, the natural moisture content will aid in evaluation of soil compressibility, strength, and potential expansion characteristics. Soil dry density and moisture content are index properties necessary for calculation of earth pressures on engineering structures. The soil dry density is also related to soil strength and permeability.

An Atterberg Limits test and grain size analysis tests were performed on selected soil samples to evaluate the range of moisture contents over which the soil exhibits plasticity, and to classify the soil according to the Unified Soil Classification System. The plasticity characteristics of a soil give an indication of the soil's compressibility and expansion potential. The results of the Atterberg Limit test indicate soil sample 2-1-2 located at a depth of 2 feet is classified as sandy clay (CH) with moderate to high expansion potential (PI = 34). The grain size analysis for this sample indicates silt and clay fines = 57 percent and sand = 43 percent. The grain size analysis for soil sample 2-2, in mudstone bedrock indicates silt and clay fines = 99.5 percent. In borings B-1 and B-3, we found two to three feet of medium dense silty and clayey sand underlain by dense to very dense fine sandstone bedrock.

The strength parameters of the underlying earth materials were determined from a direct shear test performed in the laboratory and from Standard Penetration Test (SPT) blow count measurements obtained in the field during sampling of in-situ soil. The results of the field and laboratory testing appear on the "Logs of Test Boring" opposite the sample tested.

Seismicity

The following is a general discussion of seismic considerations affecting the project area. Detailed studies of seismicity, faulting and other geologic hazards are beyond the scope of this study.

The Blue Ridge Tank Site is located at Latitude 37.151488° North and Longitude 122.129767° West (USGS). The active San Andreas Fault one and Zayante Fault zones are located about 3.22 miles and 0.82 miles from the project site, respectively.

The San Andreas Fault zone is a major fault zone of active displacement which extends from the Gulf of California to the vicinity of Point Arena, where the fault leaves the California coastline. Between these points, the fault is about 700 miles long. The fault zone is a break or series of breaks along the earth's crust, where shearing movement has taken place. This fault movement is primarily horizontal.

The largest historic earthquake in Northern California occurred on 18 April 1906 (M8.3+).

The 17 October 1989 Loma Prieta earthquake (M6.9) is also considered to have been associated with the San Andreas Fault system. This event was the second largest earthquake in Northern California this century. Strong ground shaking was experienced throughout Santa Cruz County during both of these seismic events.

Although research on earthquake prediction has greatly increased in recent years, seismologists have not yet reached the point where they can predict when and where another large earthquake will occur. Nevertheless, on the basis of current technology, it is reasonable to assume that the proposed development will be subject to at least one moderate to severe earthquake during the fifty-year period following construction.

Potential seismic hazards at the site and vicinity include surface ground rupture, liquefaction effects, land sliding, and damage from strong seismic shaking.

Since no known faults cross the project site, the potential for surface ground rupture is low. Because of the shallow very dense bedrock underlying the Blue Ridge Tank site, the potential for seismic induced liquefaction is nil.

Slope Stability

During our field investigation and site reconnaissance, we did not observe evidence of recent land sliding in the slopes descending from the tank site. The potential for deep seated land sliding in the shallow bedrock at the tank site to negatively impact the replacement tank is relatively low. However, there is potential for shallow land sliding on steeper slopes descending from the tank site when saturated. It is critical that concentrated runoff from the replacement tank and improvements be collected and conveyed to the roadways below the site.

California Building Code (2019) Seismic Design Parameters

The improvements should be designed in conformance with the most current California Building Code (2019 CBC). For seismic design, the soil properties at the site are classified as **Site Class "D"** based on definitions presented in Section 1613.2.2 in the 2019 CBC which refers to Chapter 20 of ASCE 7. The longitude and latitude were determined using a satellite image generated by Google Earth. These coordinates were taken from the approximate middle of the area of the proposed improvements:

Longitude = - 122.129767°, Latitude = 37.151488°.

The coordinates listed above were used as inputs in the OSHPD seismic design maps created by California Office of Statewide Health Planning and Development (OSHPD) to determine the ground motion associated with the maximum considered earthquake (MCE) S_M and the reduced ground motion for design S_D. The results are as follows:

Site Class D

S_S= 1.956 g

S_1= 0.741 g

S_{MS}= 2.348 g

S_{M1}= 1.260 g

refer to section 11.4.8 ASCE7-16 for site specific ground motions and exceptions[1]

S_{DS}= 1.565 g

S_{D1}= 0.840 g

refer to section 11.4.8 ASCE7-16 for site specific ground motions and exceptions[1]

A maximum considered earthquake geometric mean (MCE_G) peak ground acceleration (PGA) was estimated using the Figure 22-9 of the ASCE Standard 7-16. The mapped PGA was 0.819g and the site coefficient F_{PGA} for Site Class D is 1.2. The MCE_G peak ground acceleration adjusted for Site Class effects is $PGA_M = F_{PGA} * PGA$.

PGA_M = 1.2 * 0.819 g = 0.983 g

Building Codes

Project design and construction should conform to the following current building codes:

-2019 California Building Code (CBC); and

-2019 Green Building Standards Code (CALGreen)

1 "EXCEPTION: A ground motion hazard analysis is not required for structures other than seismically isolated structures and structures with damping systems where: … [Exception] 2. Structures on Site Class D sites with S_1 greater than or equal to 0.2 provided the value of the seismic response coefficient C_S is determined by Eq. (12.8-2) for values of $T \leq 1.5\ T_S$ and taken as equal to 1.5 times the value computed in accordance with either Eq. (12.8-3) for $T_L \geq T > 1.5T_S$ or Eq. (12.8-4) for $T > T_L$." ASCE7-16.

DISCUSSIONS, CONCLUSIONS AND RECOMMENDATIONS

Based on the results of our investigation, the proposed construction of a replacement water tank on the Blue Ridge Tank Site is acceptable from a geotechnical standpoint, provided the following geotechnical criteria and recommendations are incorporated into the design and construction of the project.

Geotechnical considerations at the Blue Ridge Tank Site include providing firm uniform bearing support for the water tank foundation, collecting, and directing water away from the slopes below the site, and the potential for strong seismic shaking.

There is a potential for total and differential settlement if the water tank foundation is founded on soil with variable compressibility. The top 12 to 24 inches of soil in our soil borings was loose. We recommend loose soil be removed and the bottom of the excavation be compacted to a minimum of 90 percent relative compaction or loose soil removed and replaced as engineered fill to provide firm uniform support for the replacement water tank. The depth of loose soil below the tank foundation is uncertain. Once the foundation is removed, the slab subgrade soil should be inspected by the geotechnical engineer. If loose soil is found within the replacement tank foundation zone, the soil should be removed entirely, and the bottom compacted as engineered fill or loose soil sub-excavated, stockpiled, and reused as engineered fill after compaction of the bottom of the excavation is completed. The sub-excavation should extend 5 feet beyond the tank perimeter.

Provided our recommendations are incorporated into the design and construction of the project, post-construction total and differential settlement of foundations due to static loading are considered to be low. Potential total and differential immediate foundation settlements are expected to be less than 1 inch and ½ inch, respectively, provided the entire structure is properly founded in similarly prepared subgrade soil.

Based on our subsurface exploration and testing, the soil below a depth of 2 feet in our borings along with the underlying weathered and un-weathered sedimentary bedrock will provide firm uniform support for the replacement water tank. The proposed ring-type replacement foundation should be uniformly embedded a minimum of 18 inches into the medium dense silty and clayey sand or very stiff clay under the tank site. There should be a minimum horizontal distance of 7 feet between the adjacent slope and the bottom of the ring foundation.

Concentrated surface and roof stormwater runoff from the project site **should not** be allowed to flow onto the slopes below the tank site. We recommend runoff from the site be collected and discharged in several locations on Blue Ridge Drive or an existing storm drain system.

The project site is located within a seismically active area. The proposed replacement water tank should be designed in accordance with the most current CBC seismic design standards.

The following recommendations should be used as guidelines for preparing project plans and specifications.

Site Grading

1. The geotechnical engineer should be notified **at least four (4) working days prior to any grading or foundation excavating** so the work in the field can be coordinated with the grading contractor and arrangements for testing and observation can be made. The recommendations of this report assume that the geotechnical engineer or representative will perform the required testing and observation during grading and construction. It is the owner's responsibility to make the necessary arrangements for these required services.

2. Where referenced in this report, Percent Relative Compaction and Optimum Moisture Content shall be based on ASTM Test Designation D1557-10.

3. The bottom of the ring foundation should be uniformly embedded a minimum of 18 inches into medium dense native clayey sand or weathered sedimentary rock. Loose, near surface soil on the tank site should be removed entirely and the bottom of the excavation compacted to a minimum of 90 percent relative compaction or removed, stockpiled, the bottom of the excavation compacted to a minimum of 90 percent relative compaction.

4. The tank pad area to be graded should be cleared of all obstructions, including concrete, fill or loose soil, trees not designated to remain, and other unsuitable material. Loose disturbed soil resulting from demolition and clearing operations may be stockpiled for

use as engineered fill provided the fill is clean of organic material, debris, or other unsuitable material. Existing depressions or voids created during site clearing should be backfilled with engineered fill. The geotechnical engineer or representative should observe the bottom of the excavation to confirm loose soil has been removed,

5. The remaining cleared areas should then be stripped of organic-laden topsoil. Stripping depth is anticipated to be from 4 to 6 inches. Actual depth of stripping should be determined in the field by the geotechnical engineer. Strippings should be wasted off-site or stockpiled for use in landscaped areas if desired.

6. Following clearing and stripping, the bottom of the subexcavation and all areas to receive fill should be scarified, moisture conditioned (or allowed to dry as necessary) to produce a moisture content 3 to 5 percent over laboratory optimum value, and uniformly compacted to a minimum of 90 percent relative compaction based on ASTM Test D1557-10.

7. If grading is performed during or shortly after the rainy season, the grading contractor may encounter compaction difficulty, such as pumping or bringing free water to the surface in the near surface soils. If compaction cannot be achieved after reducing the soil moisture content, it may be necessary to overexcavate the subgrade soil and replace it with angular crushed rock to stabilize the subgrade. The need for ground stabilization measures to complete grading effectively should be determined in the field at the time of grading, based on exposed soil conditions.

9. Engineered fill should be placed in thin lifts not exceeding 8 inches in loose thickness, moisture conditioned, and compacted to a minimum of 90 percent relative compaction. The upper 6 inches of slab or pavement subgrade and aggregate base below pavements should be compacted to a minimum of 95 percent relative compaction.

10. The on-site silty and clayey sand is acceptable for use as engineered fill. Highly expansive clay soil should be removed off site. Soil imported for use as engineered fill should consist of a predominantly granular soil conforming to the quality and gradation requirements as follows: Imported soil should be relatively free of organic material and contain no rocks or clods greater than 4 inches in diameter, with no more than 15 percent larger than 2½ inches. The material should be predominately granular with a plasticity index < 15, a liquid limit less than 35 and not more than 35 percent passing the No. 200 sieve. Engineered fill should also have sufficient binder so that footing and utility trenches will not collapse.

11. We estimate shrinkage factors of 15 to 25 percent for the on-site materials when used in engineered fills.

Cut and Fill Slopes

12. Temporary excavations should be properly shored and braced during construction to prevent sloughing and caving at sidewalls. The contractor should be aware of all CAL OSHA and local safety requirements and codes dealing with excavations and trenches.

13 Permanent cut slopes in bedrock should be inclined no steeper than 1:1 (horizontal to vertical). The top of all cut slopes should be rounded off to reduce soil sloughing. If seepage is observed, the geotechnical engineer should provide additional recommendations. Cut slopes with these recommended gradients may require periodic maintenance to remove minor soil sloughing.

14. Compacted fill slopes should be constructed at a slope inclination no steeper than 3:1 (horizontal to vertical). Fill slopes with these recommended gradients may require periodic maintenance to remove minor soil sloughing. All fills must be adequately benched into competent material, and keys for stability will be required at the toe of fill embankments. Toe keys should be at least 6 feet wide and should extend at least 1½ feet into competent soil or bedrock. The bottom of the toe key should be sloped downward at about 2 percent toward the back of the key. Where seepage is observed, keyways should have subdrains. The location of subdrains and outlets should be determined by the geotechnical engineer in the field during grading.

15. Following grading, exposed soil should be planted as soon as possible with erosion-resistant vegetation.

16. After the earthwork operations have been completed and the geotechnical engineer has finished his observation of the work, no further earthwork operations shall be performed without the direct observation and approval of the geotechnical engineer.

Ring Foundation

17. The actual dimensions of the ring-type foundation should be determined by the design professional. However, as a minimum, footings should be 15 inches in width, penetrate loose soil and be embedded a minimum of 18 inches into medium dense to very dense native soils. The footings should be reinforced as required by the structural designer based on the actual loads transmitted to the foundations.

18. The bottom of all foundation elements should have a minimum setback of 7 feet horizontally from adjacent slopes.

19. The foundation trenches should be kept moist and be thoroughly cleaned of all slough or loose materials prior to pouring concrete. In addition, all footings located adjacent to other footings should have their bearing surfaces founded below an imaginary 1½:1 plane projected upward from the bottom edge of the adjacent footings or utility trenches.

20. Provided the water tank pad is redensified as recommended in the grading section of this report and footings are embedded a minimum of 18 inches in medium dense silty or clayey sand or very stiff mudstone, the water tank and foundations may be designed for an allowable soil bearing pressure of 1500 psf for dead plus live loads. This value may be increased by one-third to include short-term seismic and wind loads.

21. Provided our recommendations are followed during design and construction of the

project, post-construction total and differential settlement of the proposed tank foundation is anticipated to be less than 1 inch and ½ inch, respectively.

22. Lateral load resistance for the tank footings may be developed in friction between the foundation bottom and the supporting subgrade. A friction coefficient of 0.30 is considered applicable. A passive resistance of 300 pcf may be used below a depth of 12 inches.

23. All footings should be reinforced in accordance with applicable CBC and/or ACI standards. We recommend the footings contain a minimum steel reinforcement of four (4) No. 4 bars, i.e., two near the top and two near the bottom of the footing.

24. The footing excavations should be thoroughly cleaned and observed by the geotechnical engineer <u>prior to placing forms and steel</u>, to verify subsurface soil conditions are consistent with the anticipated soil conditions and the footings are in accordance with our recommendations.

<u>Concrete Slabs-On-Grade</u>

25. Concrete slabs should be constructed on properly moisture conditioned and compacted subgrade soil. Soil subgrade should be prepared and compacted as recommended in the section entitled "Site Grading".

26. Slab reinforcing should be provided in accordance with the anticipated use and

loading of the slab, however we recommend a minimum reinforcement of #4 bars spaced 18 inches on-center in both directions. The steel reinforcement should be held firmly in the vertical center of the slab during placement and finishing of the concrete with pre-cast concrete dobies.

27. The project design professional should determine the appropriate slab reinforcing and thickness, in accordance with the anticipated use and loading of the slab. However, we recommend a minimum reinforcement of #4 bars spaced 18 inches on-center in both directions. The steel reinforcement should be held firmly in the vertical center of the slab during placement and finishing of the concrete with pre-cast concrete dobies. In addition, we recommend that consideration be given to a minimum slab thickness of 5 inches and steel reinforcement necessary to address temperature and shrinkage considerations.

Utility Trenches

28. Trenches must be properly shored and braced during construction or laid back at an appropriate angle to prevent sloughing and caving at sidewalls. The project plans and specifications should direct the attention of the contractor to all CAL OSHA and local safety requirements and codes dealing with excavations and trenches.

29. Utility trenches should be placed so that they do not extend below an imaginary line sloping down and away at a 1½:1 (horizontal to vertical) slope from the bottom outside edge of all footings. The structural design professional should coordinate this requirement with the utility layout plans for the project.

30. Trenches should be backfilled with granular-type material and uniformly compacted by mechanical means to the relative compaction as required by county specifications, but not less than 95 percent under paved areas and 90 percent elsewhere. The relative compaction will be based on the maximum dry density obtained from a laboratory compaction curve run in accordance with ASTM Procedure D1557-07.

31. Trenches should be capped with a minimum of 12 inches of compacted relatively impermeable soil.

Site Drainage

32. Surface drainage should include provisions for positive gradients so that surface runoff is not permitted to pond adjacent to tank foundations, pavement, or other improvements. Roof and surface runoff should be directed away from foundations to collection facilities and conveyed via buried plastic pipes to Blue Ridge Road or Short Street or an existing storm drain system. The pipe outlet facilities should be designed so that instability and/or erosion does not occur at the outlet. Concentrated roof surface runoff **must not** be allowed to flow on the slopes below the tank site.

Erosion Control

33. The soil at the project site has potential for erosion where unvegetated. We recommend the following provisions be incorporated into the project plans:

A. All grading and soil disturbance shall be kept to a minimum.

B. No eroded soil shall be allowed to leave the site.

C. All bare soil should be seeded and mulched immediately after grading with barley, rye, grass, and crimson clover and covered with straw.

D. Prior to the rainy season bare soil should be well vegetated or protected from erosion by installation of ground cover or erosion control blankets.

34. The migration of water or spread of extensive root systems below foundations, slabs, or pavements may cause undesirable differential movements and subsequent damage to these structures. Landscaping should be planned accordingly.

Plan Review, Construction Observation and Testing

35. Haro, Kasunich and Associates must be provided an opportunity to review project plans prior to construction to evaluate if our recommendations have been properly interpreted and implemented. We should also provide foundation excavation observations and earthwork observations and testing during construction. This allows us to confirm anticipated soil conditions and evaluate conformance with our recommendations and project plans. If we do not review the plans or provide observation and testing services during the earthwork phase of the project, we assume no responsibility for misinterpretation of our recommendations.

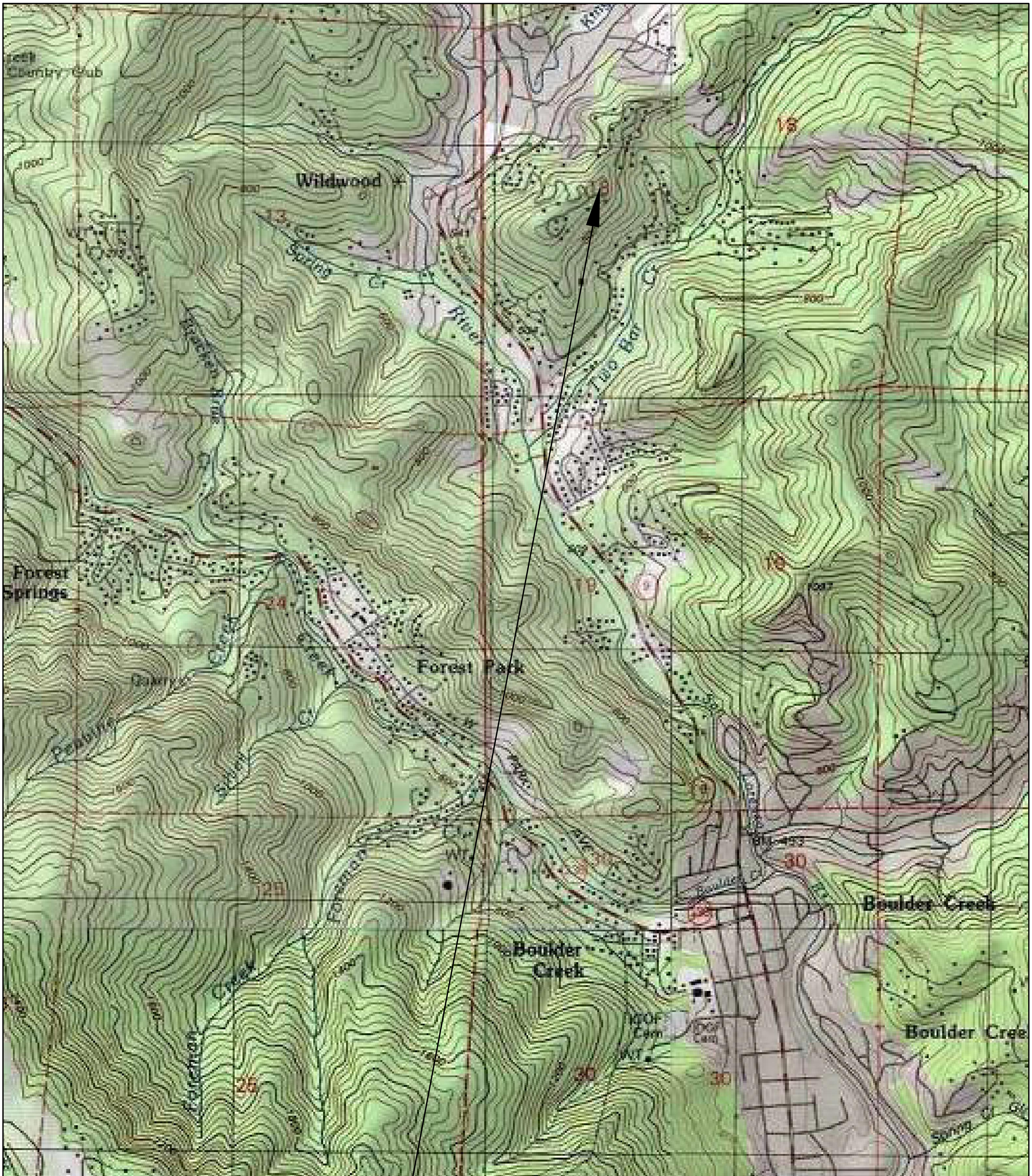
LIMITATIONS AND UNIFORMITY OF CONDITIONS

1. The recommendations of this report are based upon the assumption that the soil conditions do not deviate from those disclosed in the borings. 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 given.

2. 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. The conclusions and recommendations contained herein are professional opinions derived in accordance with current standards of professional practice. No other warranty expressed or implied is made.

3. 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 be due to natural processes or to 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 our control. Therefore, this report should not be relied upon after a period of three years without being reviewed by a geotechnical engineer.

APPENDIX A



SITE LOCATION

FROM:
TopoZone.com

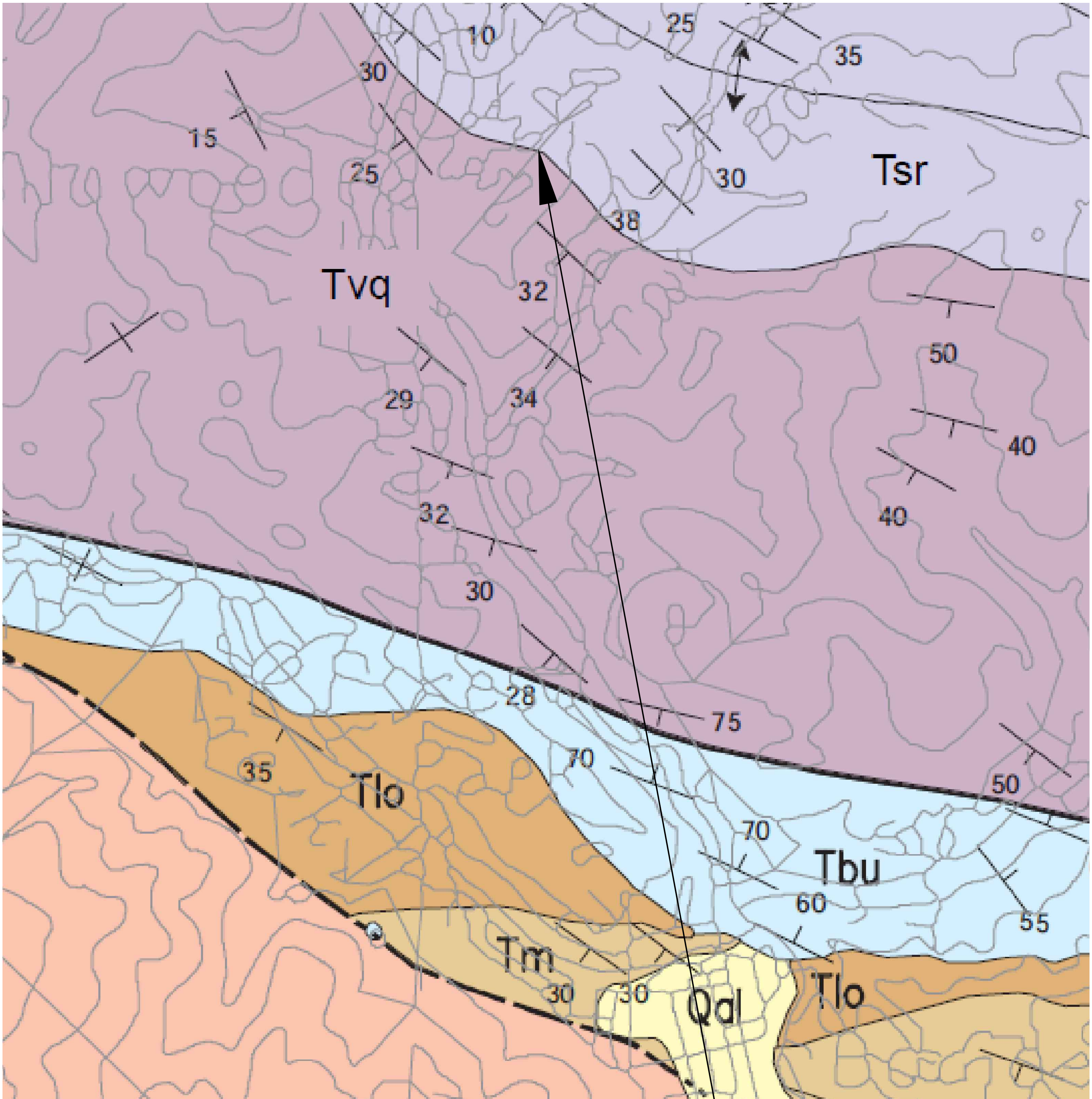
SITE VICINITY MAP
Blue Ridge Tank Replacement
APN 084-261-13, 14
Boulder Creek, Santa Cruz County

SCALE:	NTS
DRAWN BY:	AK
DATE:	JULY 2021
REVISED:	
JOB NO.	M11988

HARO, KASUNICH & ASSOCIATES, INC.
GEOTECHNICAL AND COASTAL ENGINEERS
116 E. LAKE AVENUE, WATSONVILLE, CA 95076
(831) 722-4175

FIGURE NO. 1

SHEET NO.



KEY:

Tsr	Rices Mudstone Member (Oligocene and Eocene)
Tvq	Vaqueros Sandstone (lower Miocene and Oligocene)

FROM:

GEOLOGIC MAP OF SANTA CRUZ COUNTY, CALIFORNIA
Compiled by
Earl E. Brabb
Digital Database Prepared by S. Graham, C. Wentworth, D. Knifong, R. Graymer and J. Blissenbach
1997

REGIONAL GEOLOGIC MAP
Blue Ridge Tank Replacement
APN 084-261-13, 14
Boulder Creek, Santa Cruz County

SCALE:	NTS
DRAWN BY:	AK
DATE:	JULY 2021
REVISED:	
JOB NO.	M11988

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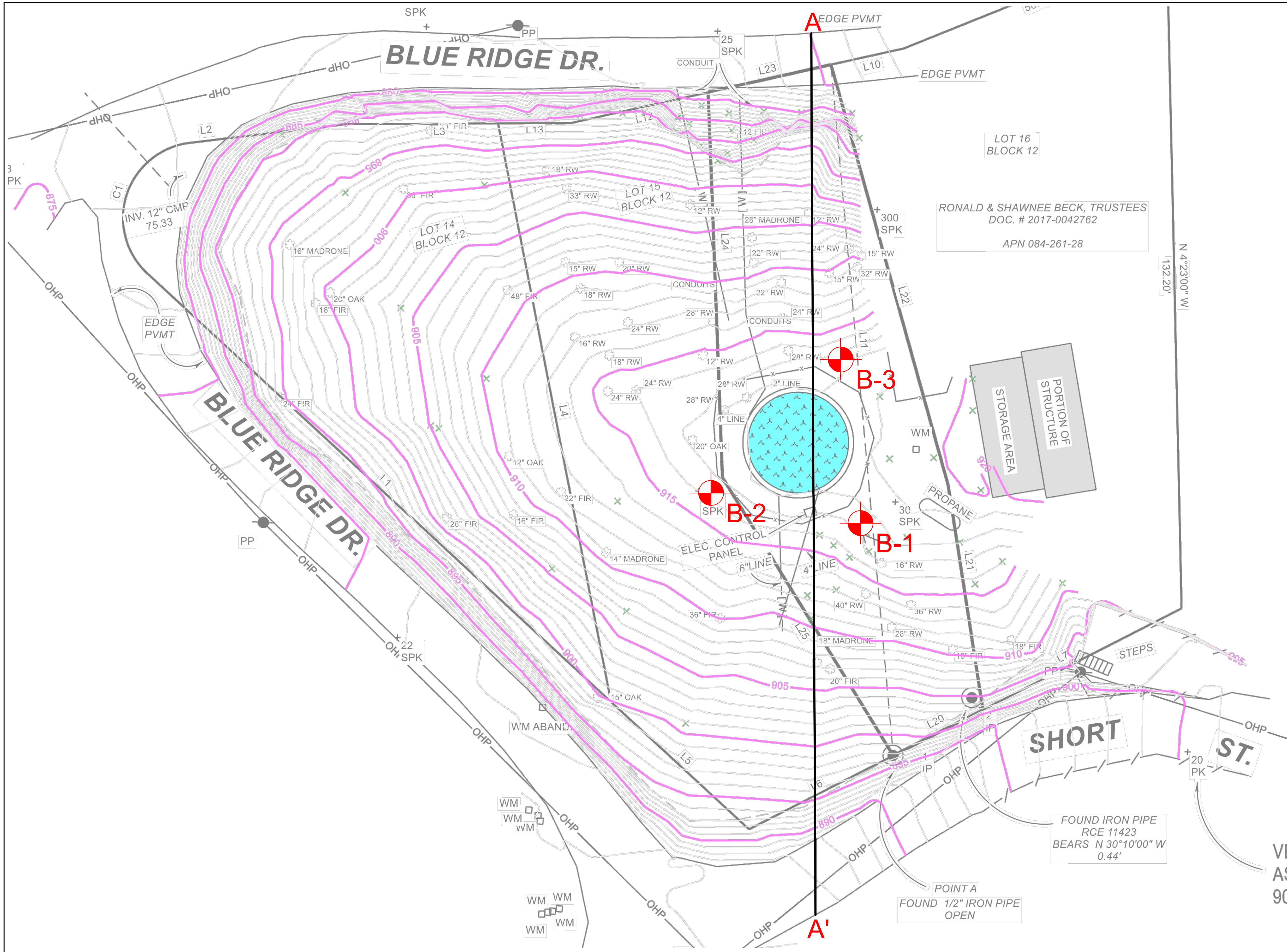
FIGURE NO. 2

SHEET NO.



NOTES:

1. TOPOGRAPHIC MAP PREPARED BY PAUL JENSEN PROFESSIONAL LAND SURVEYOR, DATED APRIL 2021

KEY: = SOIL BORING LOCATION

0 20' 40'

BORING SITE PLAN

Blue Ridge Tank Replacement
APN 084-261-13, 14
Boulder Creek, Santa Cruz County

SCALE:	AS SHOWN
DRAWN BY:	AK
DATE:	JULY 2021
REVISED:	
JOB NO.	M11988

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116 E. LAKE AVENUE, WATSONVILLE, CA 95076
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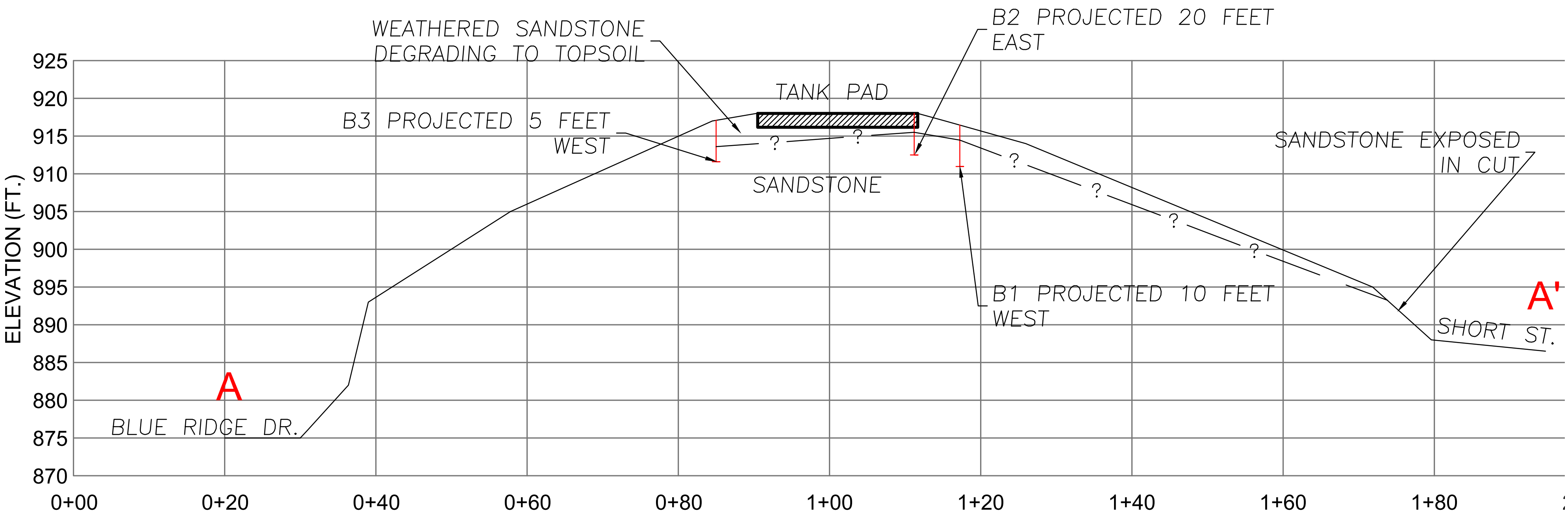
FIGURE NO. 3

SHEET NO.



CROSS SECTION A—A'

SCALE: 1" = 20'

NOTES:
CROSS SECTION DEVELOPED FROM TOPOGRAPHIC MAP PREPARED BY
PAUL JENSEN PROFESSIONAL LAND SURVEYOR, DATED APRIL 2021

SECTION AA'
Blue Ridge Tank Replacement
APN 084-261-13, 14
Boulder Creek, Santa Cruz County

SCALE:	1" = 20'
DRAWN BY:	AK AK
DATE:	JULY 2021
REVISED:	
JOB NO.	M11988

HARO, KASUNICH & ASSOCIATES, INC.
GEOTECHNICAL AND COASTAL ENGINEERS
116 E. LAKE AVENUE, WATSONVILLE, CA 95076
(831) 722-4175

SHEET NO.

FIGURE NO. 4

PRIMARY DIVISIONS				GROUP SYMBOL	SECONDARY DIVISIONS
COARSE GRADED SOILS	MORE THAN HALF OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	GRAVEL MORE THAN HALF OF COARSE FRACTION IS LARGER THAN NO. 4 SIEVE	CLEAN GRAVELS (LESS THAN 5% FINES)	GW	WELL GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES.
				GP	POORLY GRADED GRAVELS OR GRAVEL-SAND MIXTURES, LITTLE OR NO FINES.
			GRAVEL WITH FINES	GM	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES, NON-PLASTIC FINES
				GC	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES, PLASTIC FINES.
		SAND MORE THAN HALF OF COARSE FRACTION IS SMALLER THAN NO. 4 SIEVE	CLEAN SANDS (LESS THAN 5% FINES)	SW	WELL GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES.
				SP	POORLY GRADED SANDS OR GRAVELLY SANDS, LITTLE OR NO FINES.
			SANDS WITH FINES	SM	SILTY SANDS, SAND-SILT MIXTYRES, NON-PLASTIC FINES.
				SC	CLAYEY SANDS, SAND-CLAY MIXTYRES, PLASTIC FINES.
FINE GRADED SOILS	MORE THAN HALF OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE	SILTS AND CLAYES LIQUID LIMIT LESS THAN 50%		ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY.
				CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS.
				OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY.
		SILTS AND CLAYES LIQUID LIMIT GREATER THAN 50%		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SANDY OR SILTY SOILS, ELASTIC SILTS.
				CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS.
				OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS.
HIGHLY ORGANIC SOILS				Pt	PEAT AND OTHER HIGHLY ORGANIC SOILS.

U.S. STANDARD SERIES SIEVE **GRAIN SIZES** CLEAR SQUARE SIEVE OPENINGS

200 40 10 4 3/4" 2" 12"

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

RELATIVE DENSITY

SANDS AND GRAVELS	BLOWS PER FOOT*
VERY LOOSE	0 - 4
LOOSE	4 - 10
MEDIUM DENSE	10 - 30
DENSE	30 - 50
VERY DENSE	OVER 50

CONSISTENCY

SILTS AND CLAYS	STRENGTH (TSF)**	BLOWS PER FOOT*
VERY SOFT	0 - 1/4	0 - 2
SOFT	1/4 - 1/2	2 - 4
FIRM	1/2 - 1	4 - 8
STIFF	1 - 2	8 - 16
VERY STIFF	2 - 4	16 - 32
HARD	OVER 4	OVER 32

SAMPLING METHOD

STANDARD PENETRATION TEST	T	
MODIFIED CALIFORNIA	MC	
PITCHER BARREL	P	
SHELBY TUBE	S	
BULK	B	

WATER

FINAL	▽
INITIAL	▼
WATER LEVEL DESIGNATION	

KEY TO LOGS
Blue Ridge Tank Replacement
APN 084-261-13, 14
Boulder Creek, Santa Cruz County

SCALE:	NTS
DRAWN BY:	AK
DATE:	JULY 2021
REVISED:	
JOB NO.	M11988

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FIGURE NO. 5

SHEET NO.

Haro, Kasunich and Associates, Inc.
116 East Lake Avenue
Watsonville, CA
Telephone: (831) 722-4175
Fax: (831) 722-3202

BORING NUMBER 1

Figure No.: 6

CLIENT San Lorenzo Valley Water District

PROJECT NAME Blue Ridge Tank Replacement

PROJECT NUMBER SC11988

PROJECT LOCATION Boulder Creek, Ca

DATE STARTED 7/2/21 **COMPLETED** 7/2/21

GROUND ELEVATION **HOLE SIZE** 4"

DRILLING CONTRACTOR Exploration Geo Services

GROUND WATER LEVELS:

DRILLING METHOD MMK - Solid Flight

AT TIME OF DRILLING ---

LOGGED BY AK **CHECKED BY** CG

AT END OF DRILLING ---

NOTES

AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	USCS	SAMPLE TYPE NUMBER	BLOW COUNTS	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	SIEVE ANALYSIS GRAVEL %	SIEVE ANALYSIS SAND %	SIEVE ANALYSIS FINES %	ATTERBERG LIMITS LIQUID LIMIT	ATTERBERG LIMITS PLASTIC LIMIT	ATTERBERG LIMITS PLASTICITY INDEX	Phi (deg)	COHESION (psf)
0		Dark brown Silty Sand topsoil intermixed with SANDSTONE fragments		MC 1-1-1	6-11-11 (22)										
		Light brown weathered Fine SANDSTONE, damp, medium dense													
5		Intact Fine SANDSTONE Bedrock, decrease in moisture, very dense		SPT 1-2	26-38-50/6"										

Bottom of borehole at 5.5 feet.

Haro, Kasunich and Associates, Inc.
116 East Lake Avenue
Watsonville, CA
Telephone: (831) 722-4175
Fax: (831) 722-3202

BORING NUMBER 2

Figure No.: 7

CLIENT San Lorenzo Valley Water District

PROJECT NAME Blue Ridge Tank Replacement

PROJECT NUMBER SC11988

PROJECT LOCATION Boulder Creek, Ca

DATE STARTED 7/2/21 **COMPLETED** 7/2/21

GROUND ELEVATION **HOLE SIZE** 4"

DRILLING CONTRACTOR Exploration Geo Services

GROUND WATER LEVELS:

DRILLING METHOD MMK - Solid Flight

AT TIME OF DRILLING ---

LOGGED BY AK **CHECKED BY** CG

AT END OF DRILLING ---

NOTES

AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	USCS	SAMPLE TYPE NUMBER	BLOW COUNTS	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	SIEVE ANALYSIS GRAVEL %	SIEVE ANALYSIS SAND %	SIEVE ANALYSIS FINES %	ATTERBERG LIMITS LIQUID LIMIT	ATTERBERG LIMITS PLASTIC LIMIT	ATTERBERG LIMITS PLASTICITY INDEX	Phi (deg)	COHESION (psf)
0		Brown Sandy Clay topsoil with decomposed SANDSTONE and roots, firm to stiff	CH												
				MC 2-1-2	11-12-24 (36)	89	15	0	43.0	57	54	20	34		
		Highly weathered mudstone bedrock at shoe													
5		Brown mudstone bedrock, damp, hard		SPT 2-2	14-22-26 (48)		27		0.5	99.5					

Bottom of borehole at 5.5 feet.

Haro, Kasunich and Associates, Inc.
116 East Lake Avenue
Watsonville, CA
Telephone: (831) 722-4175
Fax: (831) 722-3202

BORING NUMBER 3

Figure No.: 8

CLIENT San Lorenzo Valley Water District

PROJECT NAME Blue Ridge Tank Replacement

PROJECT NUMBER SC11988

PROJECT LOCATION Boulder Creek, Ca

DATE STARTED 7/2/21 **COMPLETED** 7/2/21

GROUND ELEVATION **HOLE SIZE** 4"

DRILLING CONTRACTOR Exploration Geo Services

GROUND WATER LEVELS:

DRILLING METHOD MMK - Solid Flight

AT TIME OF DRILLING ---

LOGGED BY AK **CHECKED BY** CG

AT END OF DRILLING ---

NOTES

AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	USCS	SAMPLE TYPE NUMBER	BLOW COUNTS	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	SIEVE ANALYSIS GRAVEL %	SIEVE ANALYSIS SAND %	SIEVE ANALYSIS FINES %	ATTERBERG LIMITS LIQUID LIMIT	ATTERBERG LIMITS PLASTIC LIMIT	ATTERBERG LIMITS PLASTICITY INDEX	Phi (deg)	COHESION (psf)
0		(SC) Brown Clayey SAND, trace CLAY, moist, loose - medium dense at 2.5 feet Moisture at Saturation = 30.6%	SC	MC 3-1-1	7-8-14 (22)	87	12							31	69
5		Weathered Fine SANDSTONE Bedrock, damp medium dense to dense		SPT 3-2	9-13-13 (26)										

Bottom of borehole at 5.5 feet.

Liquid Limit:	53.49	
Plastic Limit:	20.31	
Plasticity Index:	33.2	

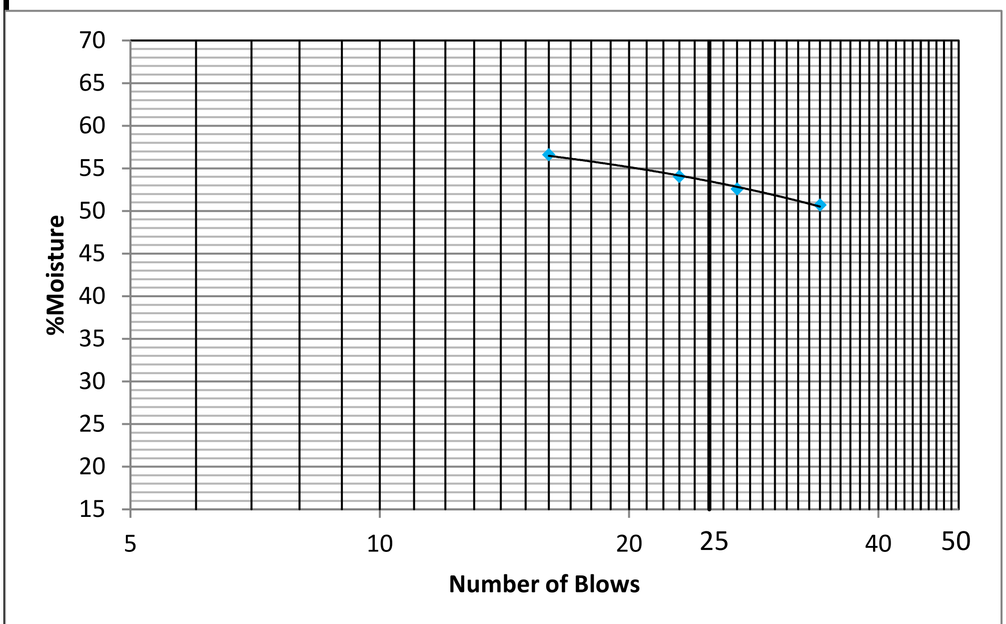
HARO, KASUNICH AND ASSOCIATES, INC.
CONSULTING GEOTECHNICAL & COASTAL ENGINEERS

File N◦	11988
Sample N◦	2-1-2
Date:	7/12/2021
By:	MA

34

Job Name:	Blue Ridge Tank Replacement

	PLASTIC LIMIT				LIQUID LIMIT NUMBER OF BLOWS			
Determination	1	2	3	4	16	23	27	34
Tare N◦	P3	P12			F4	F3	D3	D1
Gross Wet WT.	20.92	20.32			16.70	17.00	16.47	17.87
GrossDry WT.	19.71	19.21			13.28	13.61	13.30	14.30
Tare WT.	13.70	13.79			7.24	7.34	7.27	7.26
NET DRY WT.	6.01	5.42	0.00	0.00	6.04	6.27	6.03	7.04
WT. OF Water	1.21	1.11	0.00	0.00	3.42	3.39	3.17	3.57
% Moisture	20.13	20.48	#DIV/0!	#DIV/0!	56.62	54.07	52.57	50.71

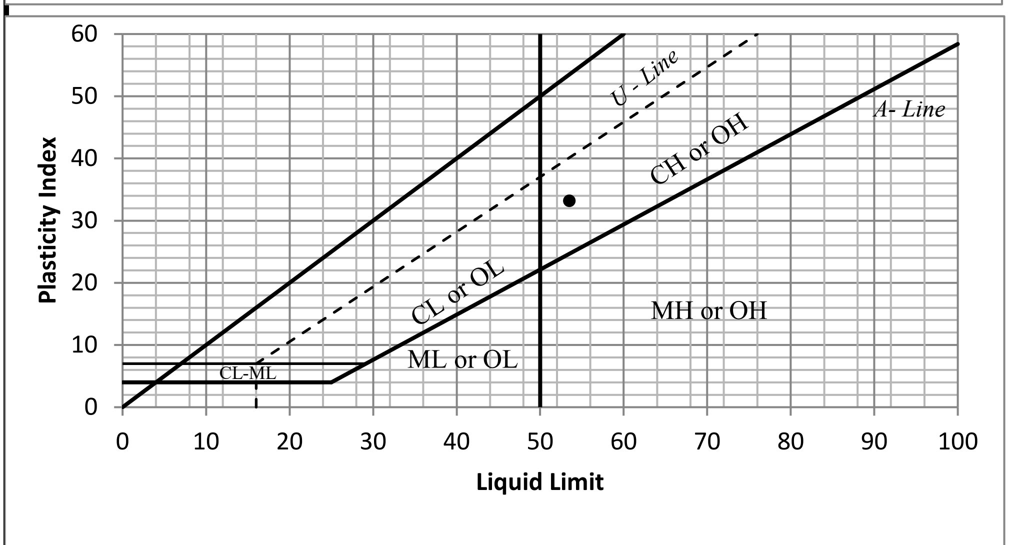


Sample #	2-1-2
Ht. of Sample	6/split
Tare	440
Gross Wet Wt	774.4
Gross Dry Wt.	721.8
Tare Wt.	414.6
Net Dry Wt.	307.2
Wt. Of Water	52.6
% Moisture	17.1%
Dry Density	88.5

SOIL DESCRIPTION

Mottled Dk Brown Sandy CLAY

Group Symbol	**CH**



Note:
Density calced using total weights from PI & FG. Total sample Moisture= 16.2%

Saturated Direct Shear

Project Name:	Blue Ridge Tank Replacment
Project #:	11988
Sample #:	3-1-1
Description:	Mottled Orange/Gray/Brown Clayey SAND
Tested By:	MA
Date Tested:	7/12/21

Test Number	1	2	3	4
Normal Pressure (PSF)	200	350	500	-
Max Shear Stress	6.2	8.9	12.0	#VALUE!
Shear Stress (PSF)	192.5	276.9	374.2	#VALUE!

Equation of Trendline	
Intercept	Slope
69.218	0.6057

*Manually Enter from Trendline Equation

C (PSF)	PHI
69	31

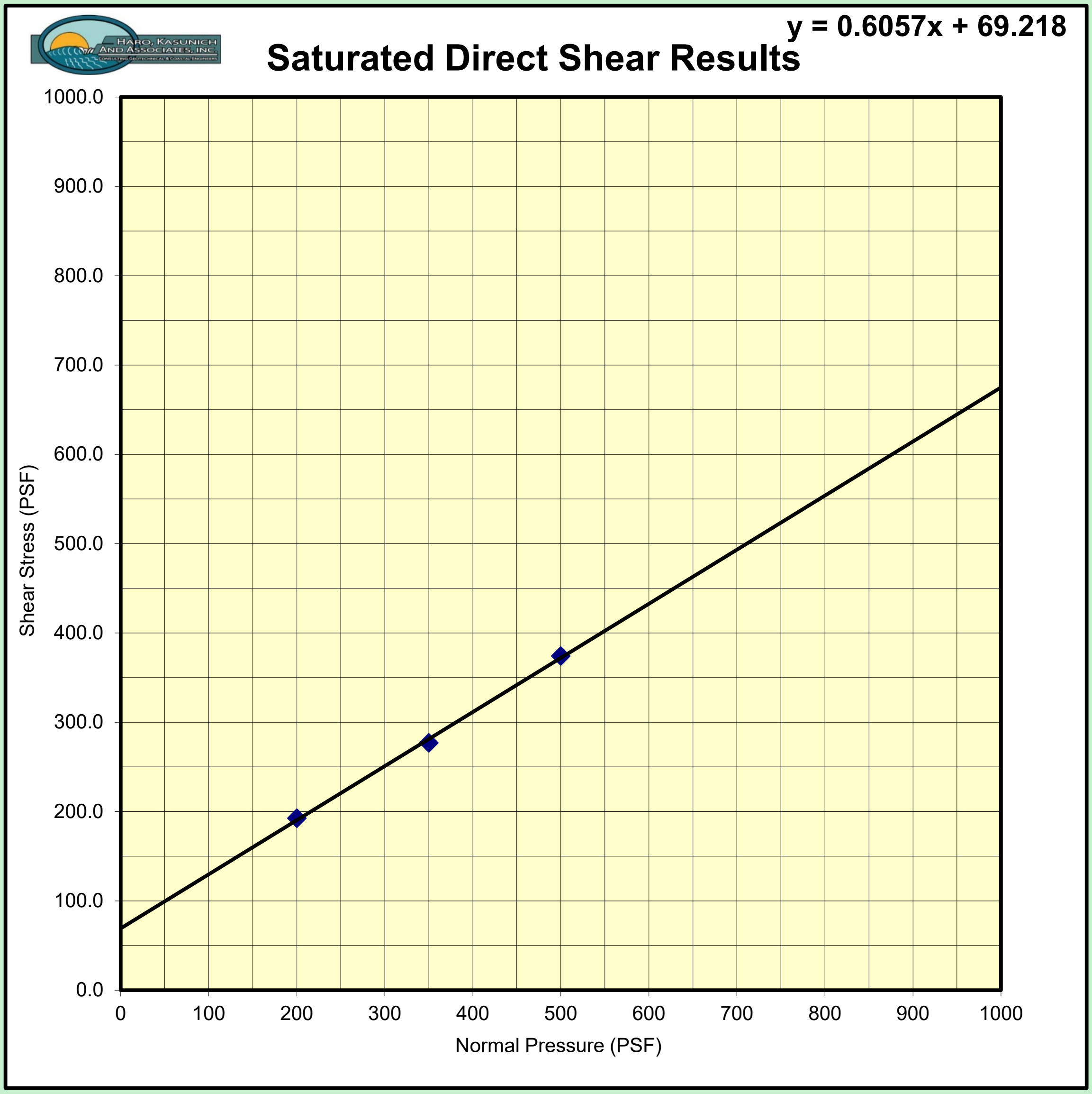


Figure No. 10

Percent Passing #200 Sieve

Project Name:	Blue Ridge Tank Replacement		
File No.:	11988		
Sample No.:	2-1-2		
Date:	July 12, 2021		
By:	MA		

Moisture Density		
Height Of Sample (in) or Enter "Bag"		6.0
Tare No.	Total (NET)	PSF
Gross Wet Weight	717.8	436.2
Gross Dry Weight		388.6
Tare Weight		78.2
Net Dry Weight	617.6	310.4
Weight of Water	100.2	47.6
%Moisture	16.2%	15.3%
Dry Density		88.5

Sample Description:

Mottled Dk Brown Sandy CLAY

Group Symbol:	CH
Gravel Content:	0.0%
Sand Content:	43.0%
Fines Content:	57.0%

Note: Density calced using total weights of PI & 200W. Total sample moisture = 16.2%

Sieve	Weight Retained	% Retained	Cumulative Percent		Specs
			Retained	Passing	
2"	0.0	0.0%	0.0%	100.0%	
1½"	0.0	0.0%	0.0%	100.0%	
1"	0.0	0.0%	0.0%	100.0%	
¾"	0.0	0.0%	0.0%	100.0%	
½"	0.0	0.0%	0.0%	100.0%	
3/8"	0.0	0.0%	0.0%	100.0%	
No. 4	0.0	0.0%	0.0%	100.0%	
No. 8	0.0	0.0%	0.0%	100.0%	
No. 10	0.0	0.0%	0.0%	100.0%	
No. 16	0.0	0.0%	0.0%	100.0%	
No. 30	0.0	0.0%	0.0%	100.0%	
No. 40	0.0	0.0%	0.0%	100.0%	
No. 50	0.0	0.0%	0.0%	100.0%	
No. 100	0.0	0.0%	0.0%	100.0%	
No. 200	133.5	43.0%	43.0%	57.0%	
Pan	176.9	57.0%	100.0%	0.0%	
Total	310.4	100.0%		100.0%	

Before	310.4	After Wash	
Dry Wt.		Gross Dry Wt.	211.7
Tare		Tare	78.2
			133.5

Percent Passing #200 Sieve

Project Name:	Blue Ridge Tank Replacement		
File No.:	11988		
Sample No.:	2-2		
Date:	July 12, 2021		
By:	MA		

Moisture Density	
Height Of Sample (in) or Enter "Bag"	Bag
Tare No.	6
Gross Wet Weight	400.3
Gross Dry Weight	336.9
Tare Weight	100.2
Net Dry Weight	236.7
Weight of Water	63.4
%Moisture	26.8%
Dry Density	#VALUE!

Sample Description:

Lt Brown CLAY

Group Symbol:	CL-CH	Notes:
Gravel Content:	0.0%	
Sand Content:	0.5%	
Fines Content:	99.5%	

Sieve	Weight Retained	% Retained	Cumulative Percent Retained	Cumulative Percent Passing	Specs
2"	0.0	0.0%	0.0%	100.0%	
1½"	0.0	0.0%	0.0%	100.0%	
1"	0.0	0.0%	0.0%	100.0%	
¾"	0.0	0.0%	0.0%	100.0%	
½"	0.0	0.0%	0.0%	100.0%	
3/8"	0.0	0.0%	0.0%	100.0%	
No. 4	0.0	0.0%	0.0%	100.0%	
No. 8	0.0	0.0%	0.0%	100.0%	
No. 10	0.0	0.0%	0.0%	100.0%	
No. 16	0.0	0.0%	0.0%	100.0%	
No. 30	0.0	0.0%	0.0%	100.0%	
No. 40	0.0	0.0%	0.0%	100.0%	
No. 50	0.0	0.0%	0.0%	100.0%	
No. 100	0.0	0.0%	0.0%	100.0%	
No. 200	1.2	0.5%	0.5%	99.5%	
Pan	235.5	99.5%	100.0%	0.0%	
Total	236.7	100.0%		100.0%	

Before	236.7	After Wash	
Dry Wt.		Gross Dry Wt.	101.4
Tare		Tare	100.2
		1.2	