

**GEOTECHNICAL INVESTIGATION  
For  
LOST ACRES ALTERNATE WATER TANK SITE  
APN 064-201-37  
Felton, California**

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

**Prepared By  
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Geotechnical & Coastal Engineers  
Project No. SC11032  
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SAN LORENZO VALLEY WATER DISTRICT  
13060 Highway 9  
Boulder Creek, California 95006

Attention: Mr. Josh Wolff

Subject: Geotechnical Investigation

Reference: Lost Acres Water Tank Replacement Project  
APN 064-201-37  
Lost Acres Drive  
Felton, California

Dear Mr. Wolff:

In accordance with your authorization, we have performed a Geotechnical Investigation for the referenced project in Felton, 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.**

Christopher A. George  
C.E. 50871



CAG/sr

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## **GEOTECHNICAL INVESTIGATION**

### **Introduction**

This report presents the findings, conclusions, and recommendations of our Geotechnical Investigation for the proposed Lost Acres Alternate Water Tank Project site, located at the end of Lost Acres Drive in Felton, California (see Site Vicinity Map, Figure 1 in Appendix A). The site is proposed as an alternate site for replacement of the existing water tank at the end of nearby Valhalla Drive.

A Site Map for the proposed tank site, prepared by Paul Jensen, was provided for our use. The map, dated March 2016, was used as a base for our Boring Site Plan (see Figure 3 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 had 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 alternate 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 (CBC) edition design considerations, specifically the seismic factors and coefficients from Chapter 16, Volume II, 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 drilled to depths of 16.5 to 26.5 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 of select samples obtained. Moisture content and dry density tests were performed to evaluate the consistency of the in-situ soils. Gradation analysis was performed to aid in soil classification. Atterberg Limits tests were

performed to evaluate the expansion potential of clay soil encountered in the course of our exploration. Unconfined compression tests were performed on selected samples to determine the in-situ strength properties of site soils.

4. Engineering analysis and evaluation of the resulting data. 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 investigation.

### **Site Locations and Conditions**

The Lost Acres Alternate Tank Site is a 50-foot by 50-foot easement on APN 064-201-37, a 63.55-acre undeveloped parcel on Lost Acres Drive in Felton, California. The easement is located at the end of the paved portion of Lost Acres Drive. The tank site lies in a “Y” formed at the intersection of the 10 foot wide unpaved extension of Lost Acres Drive and a private paved driveway to an existing residence on APN 064-351-18. Lost Acres Drive intersects with Shingle Springs Road about 500 feet northwest of the tank site.

A review of the Site Map and our field observations indicates the tank site slopes to the east at gradients of 8 to 10 percent. The east perimeter of the site has a cut slope which

descends about 4 feet to the adjacent paved driveway. The tank site was cleared of brush and trees prior to our field investigation but the area north and northwest is heavily wooded. A grove of redwood trees lies about 25 feet west northwest of the tank site.

### **Project Description**

A replacement water tank is proposed for the Lost Acres Alternate tank site. The new water tank will replace the existing redwood water tank at the end of nearby Valhalla Drive. We understand the proposed new tank will be 32-foot high and 30-foot diameter bolted steel tank, which will hold about 120,000 gallons of water. The new tank will have reinforced concrete ring foundation and will be situated in the approximate center of the tank site easement. A base rock surfaced or paved 12' wide apron around the tank is also planned.

Grading for the project will consist of cut and fill grading to construct a level pad for the tank and apron and re-densification of near surface soil under the tank pad, excavations for ring footings, and compaction of subgrade soil and baserock on the tank apron.

### **Field Exploration**

Subsurface conditions were investigated on 15 April 2016 by drilling three (3) exploratory borings to depths of 16.5 to 26.5 feet. The boring locations were not surveyed and should be considered approximate only. The borings were drilled with 4-inch diameter, continuous flight auger equipment mounted on a truck or a limited access 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.

### **Subsurface Conditions**

Based on the results of our subsurface exploration, the Lost Acres Alternate Tank site is



underlain by top 6 to 12 inches of clayey sand topsoil, underlain by medium dense clayey sand and stiff to very stiff sandy clay to depths of 7 to 9 feet. From 9 feet to the depths explored (16.5 to 26.5 feet), dense to very dense silty sand was encountered.

A review of "The Geologic Map of Santa Cruz County, California" (Brabb, 1989) indicates that the site is mapped as sch: Metasedimentary rocks (Mesozoic or Paleozoic) Pelitic schist and quartzite.

The medium dense clayey sand, very stiff lean sandy clay and dense to very dense silty sand encountered in our borings is typical of the Metasedimentary rocks.

### **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. The evaluation of such factors is beyond the scope of our study.

### **Laboratory Testing**

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

Atterberg Limits tests 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 Limits tests and grain size analysis tests indicate the near surface soils at the Lost Acres Tank Site are classified as clayey sand (SC), sandy lean clay (CL) with moderate to high expansion potential ( $PI = 29$  to  $32$ ). The clayey sand and sandy clay extended to depths of 7 to 9 feet and was underlain by very dense silty sand bedrock.

The strength parameters of the underlying earth materials were determined from unconfined compression tests 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 Lost Acres Alternate Tank Site is located at Latitude 37.044528° North and Longitude 122.091083° West (Google Earth). The active San Andreas Fault and the potentially active Zayante Fault are located about 8.57 miles (13.79 km) and 4.88 miles (7.85 km) 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 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 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 very stiff and dense to very dense condition of the sandy clay and silty sand bedrock underlying the Lost Acres Alternate Tank site, the potential for seismic induced liquefaction is very low.

### **Slope Stability**

During our field investigation and site reconnaissance, we did not observe any visual indications of slope instability at the gently sloping tank site. A review of the Preliminary Map of Landslide Deposits in Santa Cruz County (Cooper-Clark, 1974) indicates the closest mapped landslide deposit is 0.40 miles south of the site tank site. The potential for seismic

induced landsliding on the gentle natural slopes at the Felton Heights tank sites to negatively impact the water tank and improvements is very low. However, due to the proximity of earthquakes faults, during a major earthquake there is a potential for severe ground shaking at the site. Structures designed in accordance with the most current California Building Code (2013 CBC) should perform adequately during strong seismic shaking.

## **DISCUSSIONS, CONCLUSIONS AND RECOMMENDATIONS**

Based on the results of our investigation, the proposed construction of a replacement 120,000-gallon water tank on the Lost Acres Alternate 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 Lost Acres Alternate Tank Site include providing firm uniform bearing support for the tank foundation, the potential for strong seismic shaking, and providing adequate site drainage.

Based on our subsurface exploration and testing, the top 6 to 12 inches of soils at the tank site are loose and compressible. The underlying medium dense clayey sand, stiff lean sandy clay and very dense silty sand bedrock will provide firm uniform support for the larger replacement water tank provided the building pad is sub-excavated to a minimum depth of 2 feet below the bottom of the ring foundation and replaced with select Class II aggregate base engineered fill compacted to a minimum of 95% relative compaction. The soil at the bottom of the excavation should be moisture conditioned to 3% to 5% over optimum moisture prior to placement and compaction. The subexcavation should extend a minimum of 5 feet beyond the perimeter of the water tank foundation. There should be a minimum horizontal distance of 10 feet between the adjacent slope and the bottom of the ring foundation.

Concentrated surface runoff from the project site should not be allowed to flow onto the slopes at the site. The adjacent driveway has a moderately steep cut bank downslope of the proposed tank pad. We recommend roof and surface runoff be directed to collection facilities and conveyed to rock energy dissipater, trenches or pits located away from the driveway cut banks.

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 presented in 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 tank pad area to be graded should be cleared of all obstructions, including fill or loose soil, trees not designated to remain and other unsuitable material. Existing depressions or voids created during site clearing should be backfilled with engineered fill.
4. 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.
5. Following clearing and stripping, the soil at the tank pad should be sub-excavated to a minimum depth of 2 feet below the bottom of the ring foundation and removed. The sub-excavation should extend a minimum of 5 feet beyond the foundation perimeter. The soil at the bottom of the sub-excavation 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. The recommended depth of sub-excavation should be confirmed in the field by the geotechnical engineer during grading.



6. Engineered fill consisting of Class II aggregate base should then be moisture conditioned, placed in thin lifts (not exceeding 8 inches in loose thickness), and compacted to design pad grade at a minimum of 95 percent relative compaction.

7. The on-site silty and clayey sand should not be used as structural engineered fill. Engineered fill should consist of Class II aggregate base. Soil imported for use as engineered fill should consist of a granular soil conforming to the quality and gradation requirements as follows: Imported soil should be 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 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 2:1 (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 not steeper than 2:1 (horizontal to vertical). Fill slopes with these recommended gradients may require periodic maintenance to remove minor soil sloughing. All fills must be 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.

### **Spread Footing Foundations**

17. The design professional should determine the actual dimensions of the ring-type footings. However, as a minimum, footings should be 15 inches in width, penetrate loose soil and be embedded a minimum of 12 inches into engineered fill. 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 10 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, the water tank and foundations embedded in and underlain by redensified engineered fill and medium dense to dense decomposed granite may be designed for an allowable soil bearing pressure of 3000 psf for dead plus live loads. These values 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 foundations are expected 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 250 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 prior to placing forms and steel, to verify subsurface soil conditions are consistent with the anticipated soil conditions and the footings are in accordance with our recommendations.

#### **Geotechnical Related Seismicity**

25. The project should be designed in conformance with the most current California Building Code (2019 CBC). For seismic design, the soil properties at the site are conservatively classified as **Site Class “D” (default)** (per ASCE7-16 Section 11.4.3) based

on definitions presented in Section 1613.2.2 in the 2019 CBC that 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 = -122.091083°, Latitude = 37.044528°

26. The coordinates listed were used as inputs in the OSHPD Seismic Design Maps created by California's 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

$S_S = 1.691 \text{ g}$

$S_1 = 0.657 \text{ g}$

$S_{MS} = 2.030 \text{ g}$

$S_{M1} = 1.117 \text{ g}$

refer to section 11.4.8 ASCE7-16 for site specific ground motions and exceptions<sup>1</sup>

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<sup>1</sup> "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

$$S_{DS} = 1.353g$$

$$S_{D1} = 0.745g$$

refer to section 11.4.8 ASCE7-16 for site specific ground motions and exceptions<sup>1</sup>

A maximum considered earthquake geometric mean ( $MCE_G$ ) peak ground acceleration (PGA) was estimated using Figure 22-9 of the ASCE Standard 7-16. The mapped PGA was 0.716g and the site coefficient  $F_{PGA}$  for Site Class D (default) is 1.2. The  $MCE_G$  peak ground acceleration adjusted for Site Class effects is  $PGA_M = F_{PGA} * PGA$

$$PGA_M = 1.2 * 0.716g = 0.86g$$

### **Retaining Wall Lateral Pressures**

27. Where retaining walls are designed for support of the cut or fill slopes, the walls should be designed to resist both lateral earth pressures and any additional surcharge loads. Spread footings may be used for walls provided there is a minimum of 5 feet horizontally from the foundation to adjacent slopes. For design of fully drained retaining walls up to 8 feet high, the following design criteria may be used:

- A. Active earth pressure for walls allowed to yield (up to ½ percent of wall height) is that exerted by an equivalent fluid weight of 40 pcf for a level

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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  $T_L \geq T > 1.5 T_s$  or Eq. (12.8-4) for  $T > T_L$ ." ASCE7-16.

backslope gradient and 55 pcf for a 2:1 (horizontal to vertical) backslope gradient. **This assumes a fully drained condition.**

- B. Where walls are restrained from moving at the top, design for a uniform rectangular distribution equivalent to  $28H$  psf per foot of wall height for a level backslope, and  $38H$  psf per foot of wall height for a 2:1 backslope (where  $H$  is the height of the wall).
- C. In addition, the walls should be designed for any adjacent surcharge loads which will exert a force on the wall.
- D. Use a coefficient of friction = 0.30 between the base of foundations and native soil. Where retaining wall footings are poured neat against engineered fill, a passive resistance of 250 pcf (EFW) may be used. The top 12 inches of soil should be neglected when computing passive resistance.
- E. For seismic design of retaining walls, a dynamic surcharge load equal to  $10H^2$  per foot of wall, acting at  $0.6H$  from the top of the wall, where  $H$  is the height of the wall, should be added to the above active lateral earth pressures.

- F. Fully drained walls should be backfilled with drainage materials consisting of Class 1, Type A permeable material complying with Section 68-1.025 of Caltrans Standard Specifications, latest edition.
- G. The drainage material should be at least 12 inches thick. The drains should extend from the base of the walls to within 12 inches of the top of the backfill. A perforated, rigid pipe should be placed (holes down) about 4 inches above the bottom of the wall and be tied to a suitable drain outlet. Wall back drains should be capped at the surface with compacted clayey material to prevent infiltration of surface runoff into the back drains. A layer of filter fabric (Mirafi 140N or equivalent) should separate the subdrain material from the overlying soil cap.

### **Concrete Slabs-on-Grade**

28. 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".

29. 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.

30. 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**

31. 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.

32. 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.

33. 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.

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

#### **Site Drainage**

35. 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 energy dissipaters, rock filled trenches, or pits at the tank site. The pipe outlet facilities should be designed so that instability and/or erosion does not occur at the outlet. Concentrated surface runoff should not be allowed to flow on the cut slopes below the tank site.

#### **Erosion Control**

36. 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 properly installed erosion control blankets.

37. 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**

38. 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 Vicinity Map**

**Regional Geologic Map**

**Boring Site Plan**

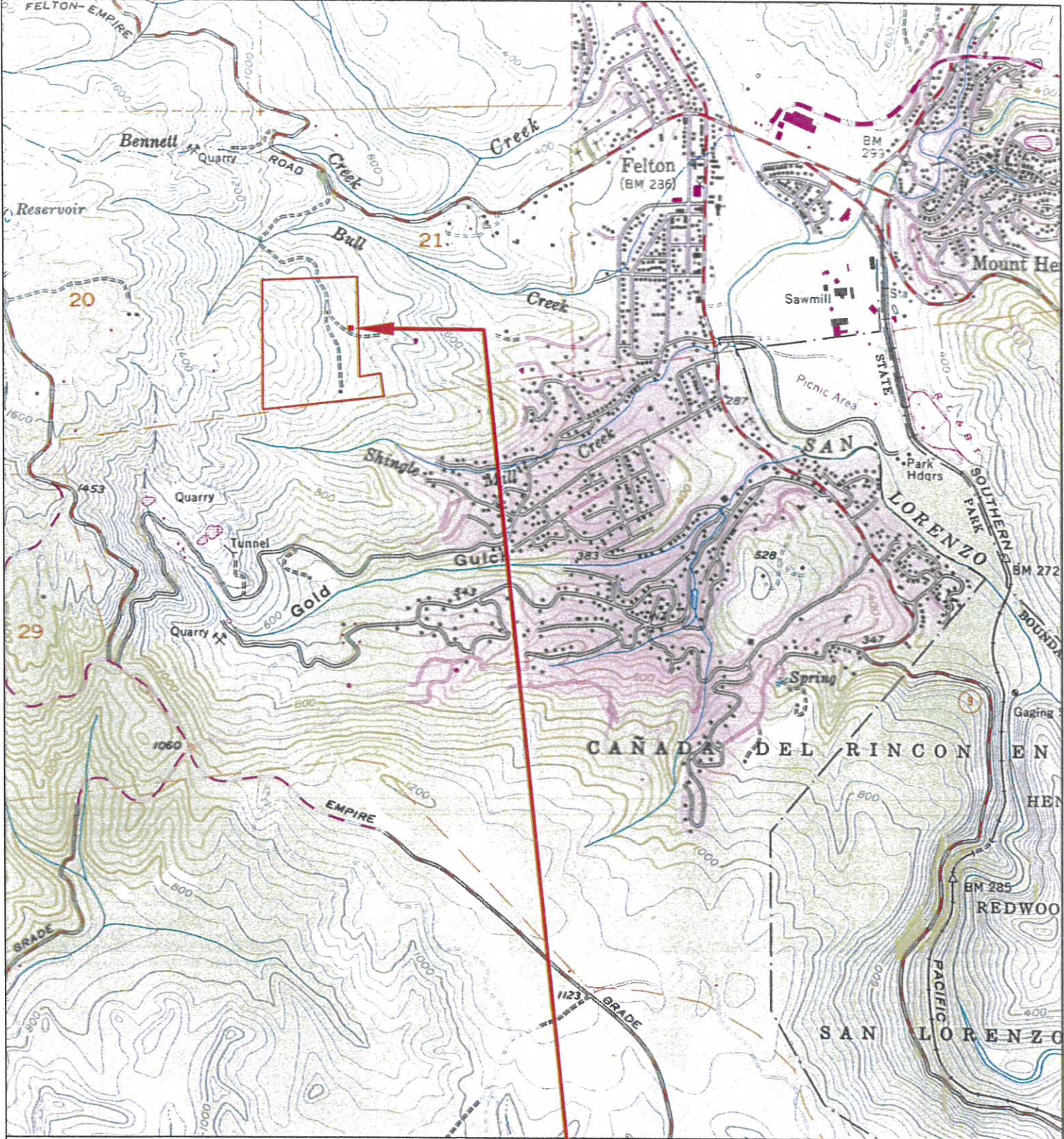
**Key to Logs**

**Logs of Test Borings**

**Grain Size Analysis Tests**

**Atterberg Limits Tests**





SLVWD LOST ACRE TANK SITE

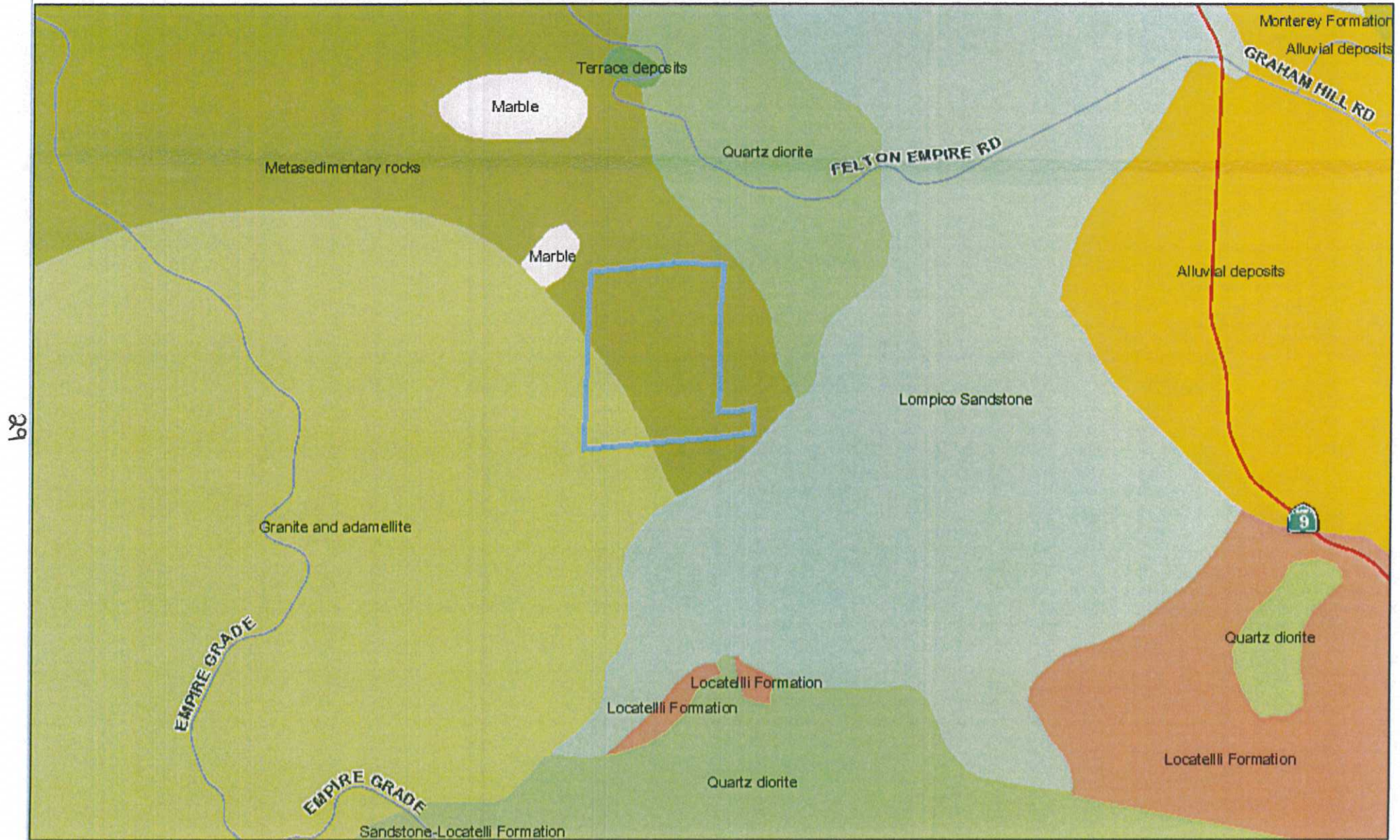


FROM:  
USGS Felton Topographic Quadrangle, 1955, photorevised 1980. 40 ft. contour interval

| SITE VICINITY MAP                                       |                                                                                                                                                   |              |
|---------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| San Lorenzo Valley Water District - Lost Acre Tank Site |                                                                                                                                                   |              |
| APN 064-201-37 Lost Acre Drive                          |                                                                                                                                                   |              |
| Felton, California                                      |                                                                                                                                                   |              |
| SCALE: 1:24,000 (1" = 2,000')                           | <b>HARO, KASUNICH &amp; ASSOCIATES, INC.</b><br>GEOTECHNICAL AND COASTAL ENGINEERS<br>116 E. LAKE AVENUE, WATSONVILLE, CA 95076<br>(831) 722-4175 |              |
| DRAWN BY: JD                                            |                                                                                                                                                   |              |
| DATE: May 2016                                          |                                                                                                                                                   |              |
| REVISID:                                                |                                                                                                                                                   |              |
| JOB NO: SC11032                                         | <b>FIGURE NO. 1</b>                                                                                                                               |              |
|                                                         |                                                                                                                                                   | SHEET NO. 28 |



# APN 064-201-37 Lost Acres Alternate Tank Site GISWeb Geologic Map



June 3, 2016

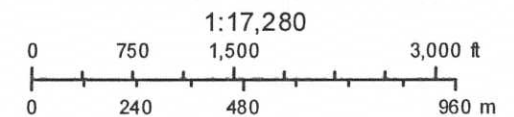
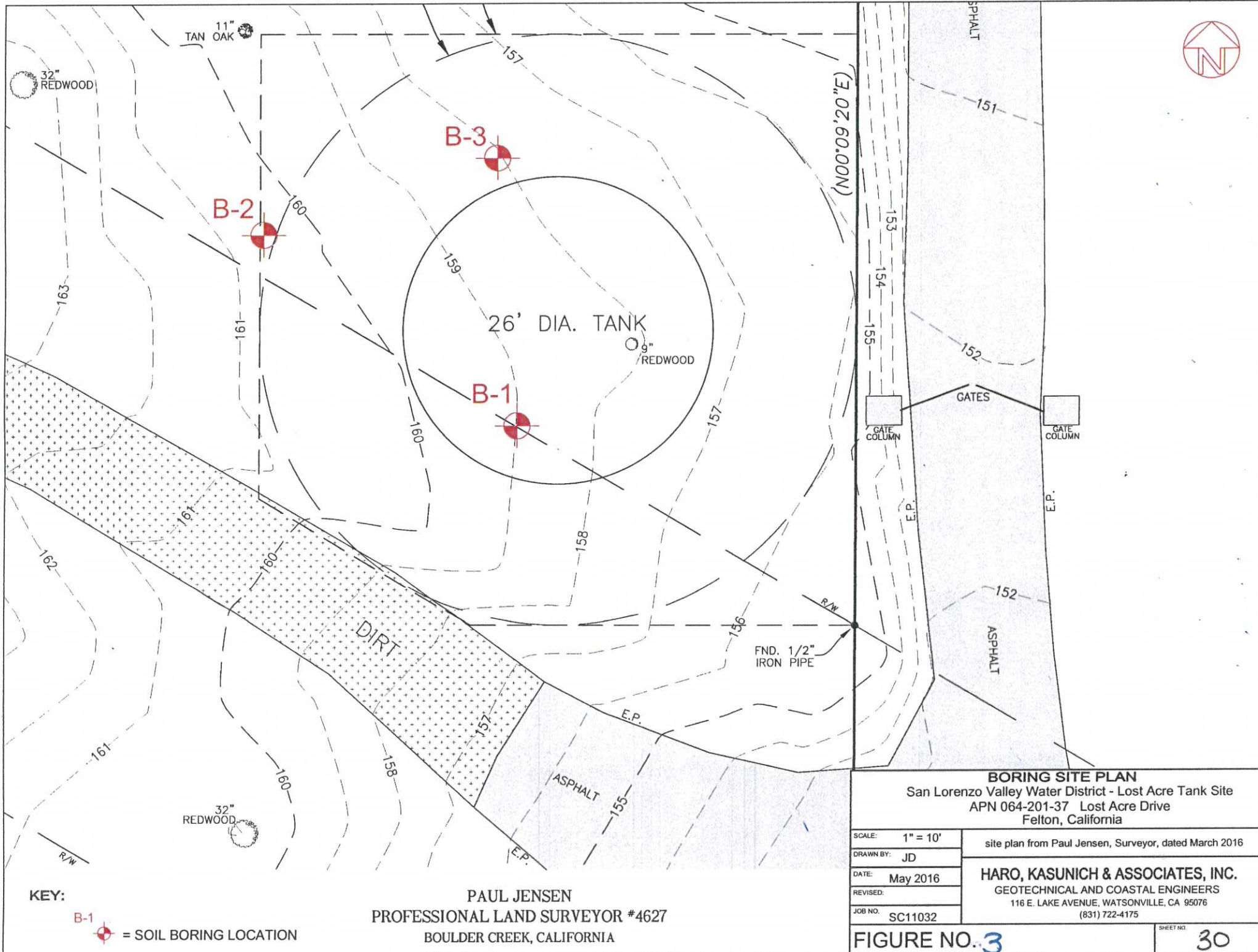


FIGURE 2







| PRIMARY DIVISIONS                                                                       |                                                                            |                                    | GROUP SYMBOL | SECONDARY DIVISIONS                                                                                                 |
|-----------------------------------------------------------------------------------------|----------------------------------------------------------------------------|------------------------------------|--------------|---------------------------------------------------------------------------------------------------------------------|
| COARSE GRADED SOILS<br><br>MORE THAN HALF OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE | GRAVEL<br><br>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<br><br>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<br><br>MORE THAN HALF OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE  | SILTS AND CLAYS<br><br>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 CLAYS<br><br>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                      |        |
|                            | FINE | MEDIUM      | COARSE | FINE                        | COARSE |
| COBBLES                    |      | BOULDERS    |        |                             |        |

| RELATIVE DENSITY  |                 | CONSISTENCY     |                  |                 | SAMPLING METHOD           |     |  | WATER                   |  |
|-------------------|-----------------|-----------------|------------------|-----------------|---------------------------|-----|--|-------------------------|--|
| SANDS AND GRAVELS | BLOWS PER FOOT* | SILTS AND CLAYS | STRENGTH (TSF)** | BLOWS PER FOOT* | STANDARD PENETRATION TEST | SPT |  | FINAL                   |  |
|                   |                 |                 |                  |                 | MODIFIED CALIFORNIA       | MC  |  | INITIAL                 |  |
|                   |                 |                 |                  |                 | PITCHER BARREL            | P   |  | WATER LEVEL DESIGNATION |  |
|                   |                 |                 |                  |                 | SHELBY TUBE               | S   |  |                         |  |
|                   |                 |                 |                  |                 | BULK                      | B   |  |                         |  |
| VERY LOOSE        | 0 - 4           | VERY SOFT       | 0 - 1/4          | 0 - 2           |                           |     |  |                         |  |
| LOOSE             | 4 - 10          | SOFT            | 1/4 - 1/2        | 2 - 4           |                           |     |  |                         |  |
| MEDIUM DENSE      | 10 - 30         | FIRM            | 1/2 - 1          | 4 - 8           |                           |     |  |                         |  |
| DENSE             | 30 - 50         | STIFF           | 1 - 2            | 8 - 16          |                           |     |  |                         |  |
| VERY DENSE        | OVER 50         | VERY STIFF      | 2 - 4            | 16 - 32         |                           |     |  |                         |  |
|                   |                 | HARD            | OVER 4           | OVER 32         |                           |     |  |                         |  |

\*Number of blows of 140 lb hammer falling 30 inches to drive a 2" O.D. (1 3/8" I.D.) split spoon sampler (ASTM D-1586).

\*\*Unconfined compressive strength in tons/ft<sup>2</sup> as determined by laboratory testing or approximated by the Standard Penetration Test (ASTM D-1586), pocket penetrometer, torvane, or visual observation.

**KEY TO LOGS**  
Lost Acres Alternate Water Tank Site  
Felton, CALIFORNIA  
APN: 064-201-37

SCALE: NTS  
DRAWN BY: CAG  
DATE: November 2022  
REVISED:  
JOB NO. SC11032

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

**FIGURE NO. 4**

SHEET NO.

LOGGED BY CAG DATE DRILLED 4-15-16 BORING DIAMETER 6" BORING NO. B-1

Date: 6/13/2016 File: C:\superlog4\HKALOGS\SC11032 Lost Acres Tank Site.log SuperLog CivilTech Software, USA www.civiltech.com

| Depth, ft. | Sample No. and type | Symbol | SOIL DESCRIPTION                                                                        | Unified Soil Classification | Blows/foot 350 ft - lbs. | Qu - t.s.f. Penetrometer | Dry Density p.c.f. | Moisture % dry wt. | MISC. LAB RESULTS                                                        |
|------------|---------------------|--------|-----------------------------------------------------------------------------------------|-----------------------------|--------------------------|--------------------------|--------------------|--------------------|--------------------------------------------------------------------------|
| 0          |                     |        | G.S. = 159.0'                                                                           |                             |                          |                          |                    |                    |                                                                          |
|            |                     |        | Roots and organic material (top 6") Brown sandy Lean CLAY, moist, stiff                 | CL                          | 32                       |                          |                    |                    |                                                                          |
| 1-1 (L)    |                     |        | Mottled olive gray orange very sandy Lean CLAY, very moist, very stiff                  | SC                          | 27                       |                          | 98                 | 22.2               | (1-1-2) Atterberg Limits<br>LL = 45.9%<br>PI = 29                        |
| 1-2 (T)    |                     |        | Mottled olive orange brown Clayey SAND, moist, medium dense                             |                             | 50/6"                    |                          | 111                | 17.6               | (1-1-2) GSA<br>% Gravel = 0.3<br>% Sand = 39.4<br>% Silt and Clay = 60.3 |
| 1-3 (L)    |                     |        |                                                                                         |                             |                          |                          |                    |                    |                                                                          |
| 10         |                     |        | Light brown Silty SAND with CLAY and angular coarse SAND, moist, dense                  | SM                          | 48                       |                          |                    | 12.7               |                                                                          |
| 1-4 (T)    |                     |        |                                                                                         |                             |                          |                          |                    |                    |                                                                          |
| 15         |                     |        | Olive orange Silty SAND with mica and angular small gravels, moist, very dense          | SM                          | 50/4"                    |                          |                    | 12.0               |                                                                          |
| 1-5 (T)    |                     |        |                                                                                         |                             |                          |                          |                    |                    |                                                                          |
| 20         |                     |        | Interbedded thin layers of orange and brown fine to medium SAND, very moist, very dense |                             | 50/3"                    |                          |                    | 13.0               |                                                                          |
| 1-6 (T)    |                     |        |                                                                                         |                             |                          |                          |                    |                    |                                                                          |
| 25         |                     |        | Gray, orange brown Silty SAND, very moist, very dense                                   | SM                          | 50/4"                    |                          |                    | 15.0               |                                                                          |
| 1-7 (T)    |                     |        | Boring terminated at 26.5 feet                                                          |                             |                          |                          |                    |                    |                                                                          |
| 30         |                     |        |                                                                                         |                             |                          |                          |                    |                    |                                                                          |
| 35         |                     |        |                                                                                         |                             |                          |                          |                    |                    |                                                                          |

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BY: sr

FIGURE NO. 5

LOGGED BY CAG DATE DRILLED 4-15-16 BORING DIAMETER 6" BORING NO. B-2

Date: 6/13/2016 File: C:\superlog4\HKALOGS\SC11032 Lost Acres Tank Site.log SuperLog CivilTech Software, USA www.civiltech.com

| Depth, ft. | Sample No. and type | Symbol | SOIL DESCRIPTION                                                                                        | Unified Soil Classification | Blows/foot<br>350 ft - lbs. | Qu - t.s.f.<br>Penetrometer | Dry Density<br>p.c.f. | Moisture<br>% dry wt. | MISC.<br>LAB<br>RESULTS                                                                 |
|------------|---------------------|--------|---------------------------------------------------------------------------------------------------------|-----------------------------|-----------------------------|-----------------------------|-----------------------|-----------------------|-----------------------------------------------------------------------------------------|
| 0          |                     |        | G.S. = 160.5'                                                                                           |                             |                             |                             |                       |                       |                                                                                         |
| 2-1-1 (L)  |                     |        | Top 4 inches dark brown gray, Clayey SAND, very moist, firm                                             | SC                          | 21                          |                             | 105                   | 21.0                  | (2-1-1) Atterberg Limits<br>LL = 47.6%<br>PI = 32<br>(2-1-1) Unconfined<br>Qu = 3.7 ksf |
| 2-2 (T)    |                     |        | Orange olive SAND and CLAY with roots, very moist, very stiff                                           | CL                          | 33                          |                             |                       | 21.2                  |                                                                                         |
| 2-3 (L)    |                     |        | Mottled orange olive Sandy CLAY, moist, stiff                                                           | CL                          | 37                          |                             |                       | 19.2                  |                                                                                         |
| 2-4 (T)    |                     |        | Interbedded layers of light brown medium SAND with thin layers of SILT and CLAY, moist with mica, dense | SM                          | 35                          |                             |                       | 15.7                  |                                                                                         |
| 2-5 (T)    |                     |        | Mottled orange olive Silty SAND with CLAY and mica, very moist, dense                                   | SM                          | 36                          |                             |                       | 18.4                  |                                                                                         |
|            |                     |        | Boring terminated at 16.5 feet                                                                          |                             |                             |                             |                       |                       |                                                                                         |

HARO, KASUNICH AND ASSOCIATES, INC.

BY: sr

FIGURE NO. 6

LOGGED BY CAG DATE DRILLED 4-15-16 BORING DIAMETER 6" BORING NO. B-3

Date: 6/13/2016

File: C:\superlog4\HKA\LOGS\SC11032 Lost Acres Tank Site.log

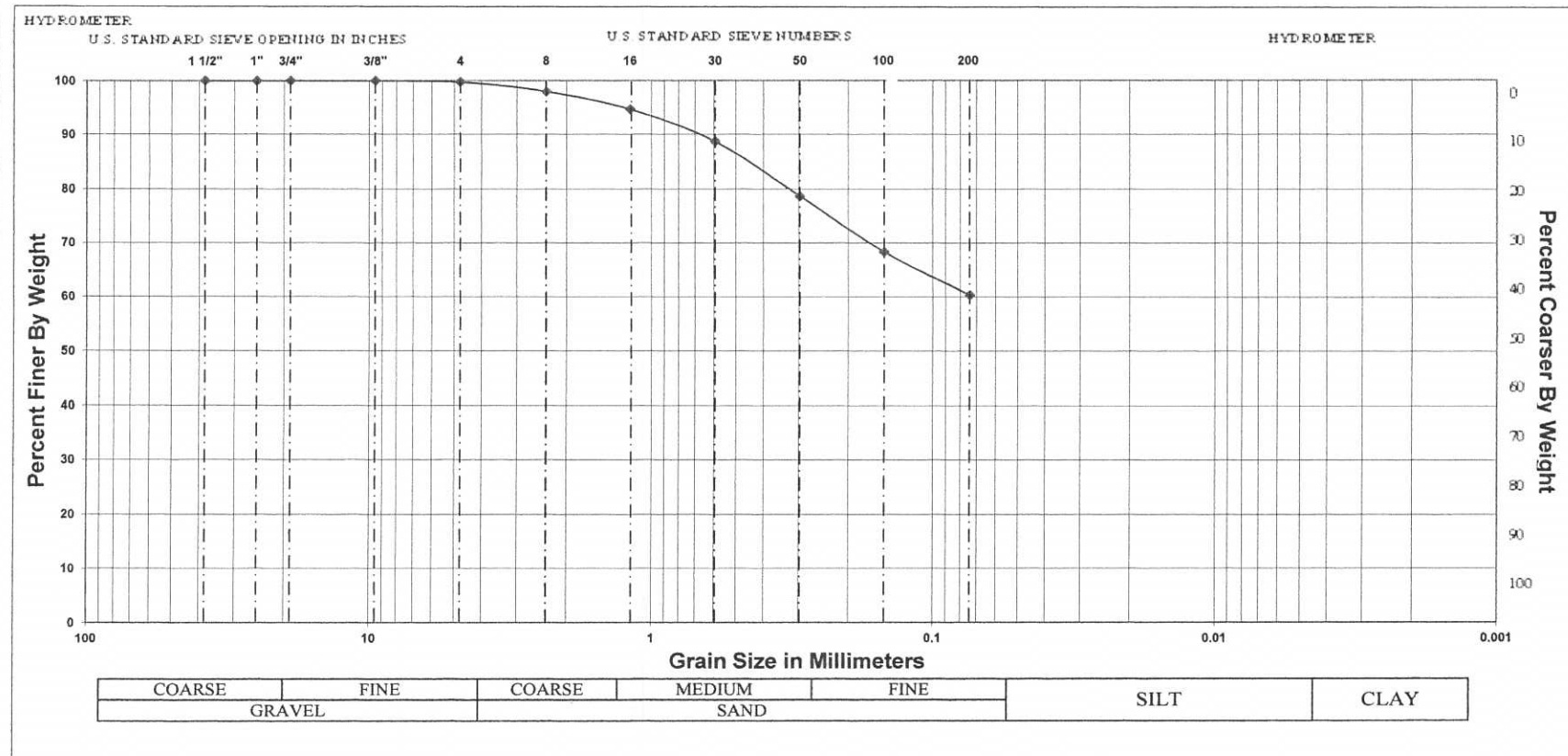
SuperLog CivilTech Software, USA www.civiltech.com

| Depth, ft. | Sample No. and type | Symbol | SOIL DESCRIPTION                                                                   | Unified Soil Classification | Blows/foot<br>350 ft - lbs. | Qu - t.s.f.<br>Penetrometer | Dry Density<br>p.c.f. | Moisture<br>% dry wt. | MISC.<br>LAB<br>RESULTS                           |
|------------|---------------------|--------|------------------------------------------------------------------------------------|-----------------------------|-----------------------------|-----------------------------|-----------------------|-----------------------|---------------------------------------------------|
| 0          |                     |        | G.S. = 158.0'                                                                      |                             |                             |                             |                       |                       |                                                   |
| 0          | 3-1 (B)             |        | Dark orange brown Clayey SAND, very moist, loose                                   | SC                          | 34                          |                             | 94                    | 22.1                  | (3-2-2) Atterberg Limits<br>LL = 45.6%<br>PI = 29 |
|            | 3-2 (L)             |        |                                                                                    |                             |                             |                             | 108                   | 16.1                  |                                                   |
| 5          | 3-3 (T)             |        | Light brown Sandy CLAY, moist, very stiff                                          | CL                          | 20                          |                             |                       | 14.8                  | (3-2-1) Unconfined<br>Qu = 3.09 ksf               |
|            |                     |        | Light brown medium to coarse SAND with SILT and angular gravels, very moist, dense | SM                          |                             |                             |                       |                       |                                                   |
| 10         | 3-4 (T)             |        |                                                                                    |                             | 30                          |                             |                       | 13.2                  |                                                   |
| 15         | 3-5 (T)             |        | Same                                                                               |                             | 33                          |                             |                       | 13.1                  |                                                   |
|            |                     |        | Boring terminated at 16.5 feet                                                     |                             |                             |                             |                       |                       |                                                   |

**HARO, KASUNICH AND ASSOCIATES, INC.**

BY: sr

FIGURE NO. 7



Gravel Content: 0.3%  
 Sand Content: 39.4%  
 Fines Content: 60.3%  
 Cumulative Sum: 100.0%



116 East Lake Avenue, Watsonville, California  
 (831) 722-4175 ~ Fax (831) 722-3202

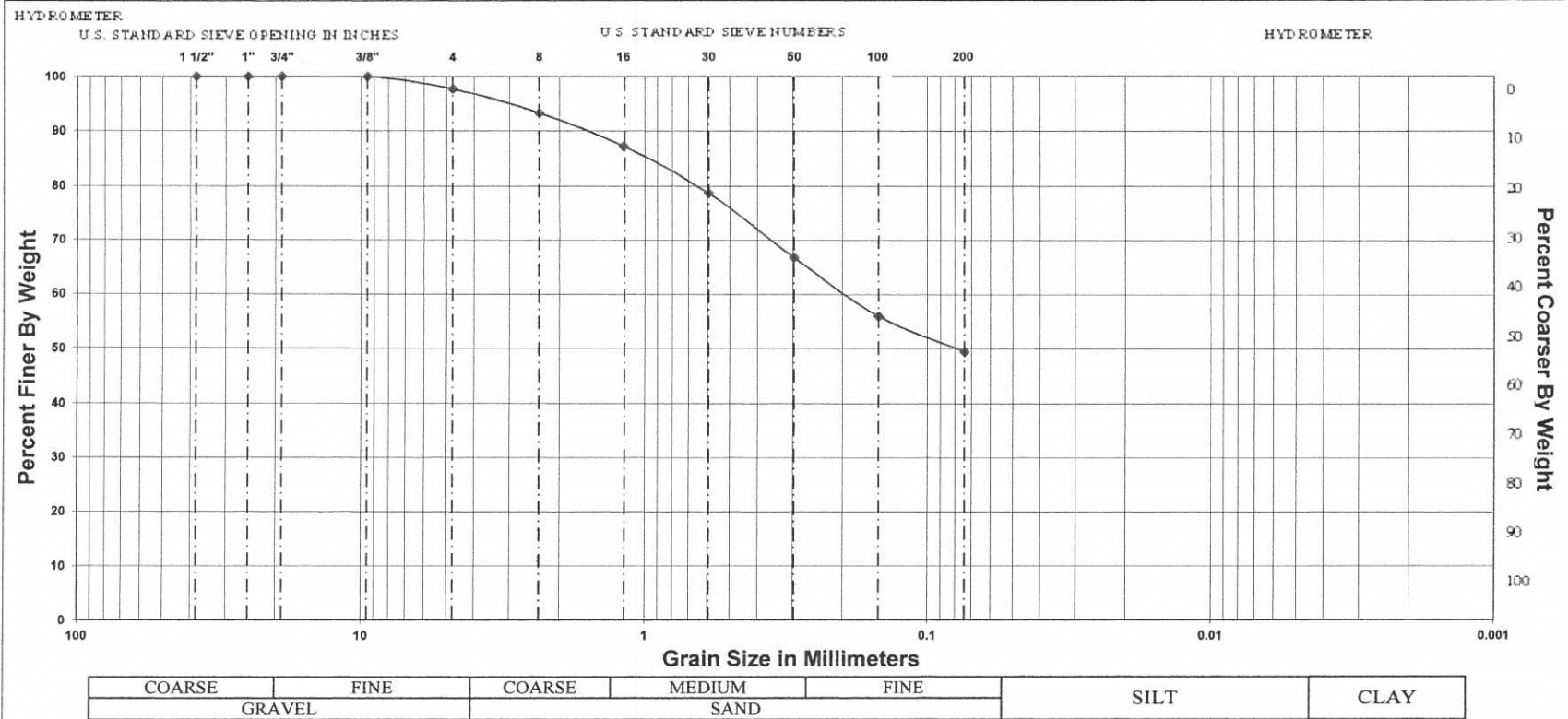
Sample Description: Orange Brown Sandy CL- Lean Clay  
 Group Symbol: CL

HKA Project No: SC 11032  
 Sample No: 1-1-2  
 Date: April 25, 2016

**GRAIN SIZE ANALYSIS**

**Lost Acres Tank Site**

Figure No. 8



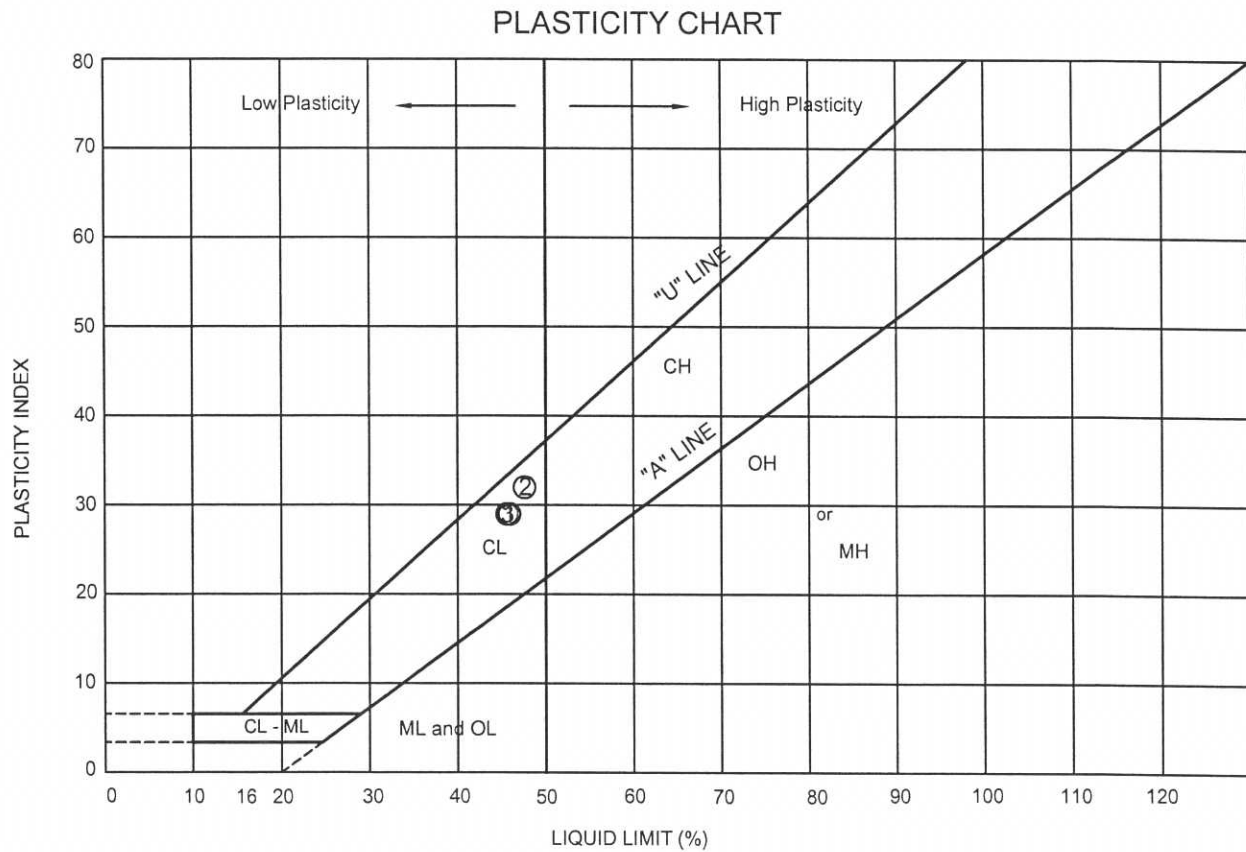
Gravel Content: 2.3%  
 Sand Content: 48.3%  
 Fines Content: 49.4%  
 Cumulative Sum: 100.0%

Sample Description: Orange Brown CL-Lean Clayey Sand  
 Group Symbol: SC



116 East Lake Avenue, Watsonville, California  
 (831) 722-4175 ~ Fax (831) 722-3202

|                          |                                                                                          |
|--------------------------|------------------------------------------------------------------------------------------|
| HKA Project No: SC 11032 | <b>GRAIN SIZE ANALYSIS</b><br><br><b>Lost Acres Tank Site</b><br><br>Figure No. <b>9</b> |
| Sample No: 3-2-2         |                                                                                          |
| Date: April 25, 2016     |                                                                                          |



**PLASTICITY DATA**

| Key Symbol | Sample Number | Depth (feet) | Natural Water Content W(%) | Plastic Limit (%) | Liquid Limit (%) | Plasticity Index | Liquidity Index $\frac{W - PL}{LL - PL}$ | Unified Soil Classification Symbol |
|------------|---------------|--------------|----------------------------|-------------------|------------------|------------------|------------------------------------------|------------------------------------|
| ①          | 1-1-1         | 2.0          | 22.2                       | 17.4              | 45.9             | 29               | +0.168                                   | CL                                 |
| ②          | 2-1-1         | 2.0          | 21.0                       | 16.2              | 47.6             | 32               | +0.153                                   | CL                                 |
| ③          | 3-2-2         | 1.5          | 22.1                       | 16.7              | 45.6             | 29               | +0.187                                   | CL                                 |

| ATTERBERG LIMITS TEST RESULTS                    |                                                                                                                                                   |
|--------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------|
| SLVWD LOST ACRES TANK SITE<br>FELTON, CALIFORNIA |                                                                                                                                                   |
| SCALE: No Scale                                  | <b>HARO, KASUNICH &amp; ASSOCIATES, INC.</b><br>GEOTECHNICAL AND COASTAL ENGINEERS<br>116 E. LAKE AVENUE, WATSONVILLE, CA 95076<br>(831) 722-1475 |
| DRAWN BY: MC                                     |                                                                                                                                                   |
| DATE: JUNE 2016                                  |                                                                                                                                                   |
| REVISED:                                         |                                                                                                                                                   |
| JOB NO: SC11032                                  | <b>FIGURE NO. 10</b>                                                                                                                              |