NOTICE OF ENGINEERING COMMITTEE MEETING

Covering Design, Construction, Capital Improvement, Master Plan and other Engineering, Operational and Planning Related Matters

NOTICE IS HEREBY GIVEN that the San Lorenzo Valley Water District has called a meeting of the Engineering Committee to be held Monday, March 18, 2019 at 9:00 am at the Operations Building, 13057 Highway 9, Boulder Creek, California.

AGENDA

1. Convene Meeting/Roll Call

2. Oral Communications
This portion of the agenda is reserved for Oral Communications by the public for items which are not on the Agenda. Please understand that California law (The Brown Act) limits what the Board can do regarding issues raised during Oral Communication. No action or discussion may occur on issues outside of those already listed on today's agenda. Any person may address the Committee at this time, on any subject that lies within the jurisdiction of this committee. Normally, presentations must not exceed five (5) minutes in length, and individuals may only speak once during Oral Communications. Any Director may request that the matter be placed on a future agenda or staff may be directed to provide a brief response.

3. New Business:
Members of the public will be given the opportunity to address each scheduled item prior to Committee action. The Chairperson of the Committee may establish a time limit for members of the public to address the Committee on agendized items.

   A. ELECTION OF COMMITTEE CHAIR
   Discussion and possible action by the Committee regarding Committee Chair.

   B. SET DAY AND TIME FOR COMMITTEE REGULARLY SCHEDULED MEETINGS
   Discussion and possible action by the Committee regarding regularly scheduled meeting time and day.

   C. PROJECT UPDATES
   Discussion by the Committee regarding the following projects:
   1. Lompico Tanks
   2. Lyon Tank Access Road
   3. Glen Arbor Bridge Pipeline
   4. Engineering Department staffing

   D. USDA LOAN PROJECT UPDATES
   Discussion by the Committee regarding the status of USDA Loan projects.

   E. WATER MASTER PLAN
   Discussion by the Committee regarding the Water Master Plan.

   F. BEAR CREEK ESTATES WASTEWATER TREATMENT FACILITY REQUEST FOR PROPOSAL AND PUBLIC MEETING DATE
   Discussion and possible action by the Committee regarding the Bear Creek Estates Wastewater RFP and public meeting date.

4. Old Business: None
Members of the public will be given the opportunity to address each scheduled item prior to Committee action. The Chairperson of the Committee may establish a time limit for members of the public to address the Committee on agendized items.

5. Informational Material: None

6. Adjournment

In compliance with the requirements of Title II of the American Disabilities Act of 1990, the San Lorenzo Valley Water District requires that any person in need of any type of special equipment, assistance or accommodation(s) in order to communicate at the District's Public Meeting can contact the District Office at (831) 338-2153 a minimum of 72 hours prior to the scheduled meeting.

Agenda documents, including materials related to an item on this agenda submitted to the Committee after distribution of the agenda packet, are available for public inspection and may be reviewed at the office of the District Secretary, 13060 Highway 9, Boulder Creek, CA 95006 during normal business hours. Such documents may also be available on the District website at www.slvwd.com subject to staff's ability to post the documents before the meeting.

Certification of Posting

I hereby certify that on March 14, 2019, I posted a copy of the foregoing agenda in the outside display case at the District Office, 13060 Highway 9, Boulder Creek, California, said time being at least 72 hours in advance of the meeting of the Engineering Committee of the San Lorenzo Valley Water District in compliance with California Government Code Section 54956.

Executed at Boulder Creek, California, on March 14, 2019.

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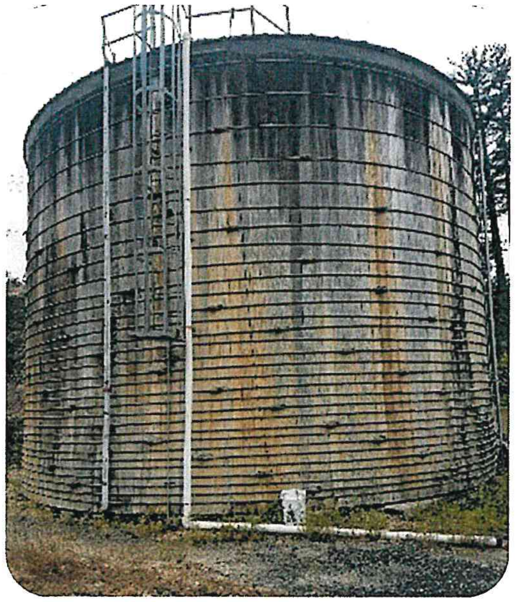
Holly B. Hossack, District Secretary
San Lorenzo Valley Water District



GEOTECHNICAL INVESTIGATION

KASKI, MADRONE & LEWIS TANK SITES
SANTA CRUZ COUNTY, CALIFORNIA

FOR
SCHAAF AND WHEELER CONSULTING CIVIL ENGINEERS
SALINAS, CALIFORNIA

Pacific Crest
ENGINEERING INC

CONSULTING GEOTECHNICAL ENGINEERS

Project No. 1886-SZ25-D61
DECEMBER 2018
www.4pacific-crest.com

December 10, 2018

Project No. 1886-SZ25-D61

Andrew A. Sterbenz, PE
Senior Project Manager
Schaaf and Wheeler Consulting Civil Engineers
3 Quail Run Circle, Ste. 101
Salinas, CA 93907

Subject: **Geotechnical Investigation – Design Phase**
Kaski, Madrone and Lewis Tank Sites
Santa Cruz County, California

Dear Mr. Sterbenz,

In accordance with your authorization, we have performed a geotechnical investigation for the Kaski, Madrone and Lewis tank sites in Santa Cruz County, California.

The accompanying report presents our findings, conclusions and recommendations for the subject sites. If you have any questions concerning the information presented in this report, please contact our office.

Very truly yours,

PACIFIC CREST ENGINEERING INC.

Prepared by:

Michael Luciano
Staff Geologist

Reviewed by:

Soma Goresky
Associate Engineer
GE 2252
Expires 6/30/19

Copies: 3 to Client

TABLE OF CONTENTS

GEOTECHNICAL INVESTIGATION REPORT
Kaski, Madrone and Lewis Tank Sites
Santa Cruz County, California

I. INTRODUCTION

PURPOSE AND SCOPE

This report describes the geotechnical investigation and presents our conclusions and recommendations for the Kaski, Madrone and Lewis tank sites located in Santa Cruz County, California.

Our scope of services for this project has consisted of:

1. Site reconnaissance to observe the existing conditions.

2. Review of the following published maps:
   - Geologic Map of Santa Cruz County, California, Brabb, 1997.
   - Preliminary Map of Landslide Deposits in Santa Cruz County, California, Cooper-Clark and Associates, 1975.
   - Map Showing Geology and Liquefaction Potential of Quaternary Deposits in Santa Cruz County, California, Dupré, 1975.
   - Map Showing Faults and Their Potential Hazards in Santa Cruz County, California, Hall, Sarna-Wojcicki, Dupré, 1974.
   - U.S. Geological Survey (and the California Geologic Survey), 2018, Quaternary fault and fold database for the United States, accessed July 2018, from USGS web site: http//earthquake.usgs.gov/hazards/qfaults/.

3. The drilling and logging of 4 test borings.

4. Laboratory analysis of retrieved soil samples.

5. Engineering analysis of the field and laboratory test results.

6. Preparation of this report documenting our investigation and presenting geotechnical recommendations for the design and construction of the project.

PROJECT LOCATION

The Kaski tank site is located approximately 750 feet northwest of the terminus of Tromba Road in Santa Cruz County, California. Please refer to the Regional Site Map, Figure No. 1, in Appendix A for the general vicinity of the project site, which is located by the following coordinates:

Latitude = 37.100815 degrees
Longitude = -122.048085 degrees

The Madrone tank site is located approximately 650 feet northeast of the intersection of Madrone Avenue and Whilaway Avenue in Santa Cruz County, California. Please refer to the Regional Site Map, Figure No. 1, in Appendix A for the general vicinity of the project site, which is located by the following coordinates:

Latitude = 37.107335 degrees
Longitude = -122.041717 degrees

The Lewis tank site is located approximately 1200 feet southwest of the intersection of Vera Ave and West Drive in Santa Cruz County, California. Please refer to the Regional Site Map, Figure No. 1, in Appendix A for the general vicinity of the project site, which is located by the following coordinates:

Latitude = 37.098421 degrees
Longitude = -122.059068 degrees

PROPOSED IMPROVEMENTS

The Kaski and Madrone sites are currently occupied by two 60,000-gallon redwood water storage tanks. The Lewis site is currently occupied by one 100,000-gallon water storage tank. It is our understanding that all of these tanks are to be replaced by steel bolted tanks of similar volume, over essentially the same footprints. The Lewis site will likely install two tanks as part of the upgrade.

The purpose of our investigation was to characterize the subsurface conditions around the tank sites, in order to assess geotechnical impacts and develop geotechnical recommendations for the design and construction of the new tanks.

A previous geotechnical investigation was performed for the three sites by Haro Kasunich & Associates (Project SC10325, dated 9/27/12). Our present work is intended to supplement the data obtained in that report and provide revised geotechnical recommendations for the proposed project.

II. INVESTIGATION METHODS

FIELD INVESTIGATION

Four, 6-inch diameter test borings were drilled at the tank sites on October 10, 2018. The approximate locations of the test borings are shown, for each tank site, on Figures No. 2, 3 and 4, in Appendix A. The drilling method used was a limited access "minuteman" drilling rig. A geologist from Pacific Crest Engineering Inc. was present during the drilling operations to log the soil encountered and to choose sampler type and locations.

Relatively undisturbed soil samples were obtained at various depths by driving a split spoon sampler 24 inches into the ground. This was achieved by dropping a 140 pound hammer a vertical height of 30 inches. The number of blows required to drive the sampler each 6-inch increment and the total number of blows required to drive the last 12 inches was recorded by the geologist. The outside diameter of the samplers was 3, 2½ or 2 inches and is designated on the Boring Logs as "L", "M" or "T", respectively.

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

The limited access drill is equipped with a 140-pound safety hammer on a cathead and a rope and pully system which has an energy efficiency roughly equivalent to the 60% standard (the N_{60} standard is based on a cathead and rope system). Therefore, we did not apply an energy correction to the field measured blow counts performed. We note that no drilling was performed between samples, so the second drive of the same sampler does not represent standard penetration blow count.

The soils encountered in the borings were continuously logged in the field and visually described in accordance with the Unified Soil Classification System (ASTM D2488) as described in the Boring Log Explanation, Figures No. 6 and 7, in Appendix A. The soil classification was verified upon completion of laboratory testing in accordance with ASTM D2487.

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

HKA (2012) drilled eight borings spread over the three tanks sites, using both a limited access and a truck mounted rig. Consequently, their borings penetrated deeper into bedrock materials and extended a maximum 36½ feet below ground surface. Appendix B presents the borings HKA drilled for this project.

LABORATORY TESTING

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

- Moisture Density relationships in accordance with ASTM D2937.
- Gradation testing in accordance with ASTM D1140
- Field penetrometer testing to approximate unconfined compressive strength.

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

III. FINDINGS AND ANALYSIS

GEOLOGIC SETTING

The surficial geology in the area of the Kaski site is mapped as Monterey Formation (Brabb 1997). The deposits locally are described as "medium- to thick-bedded and laminated olive gray to light gray semisiliceous organic mudstone and sandy siltstone and includes a few thick dolomite interbeds."

The surficial geology in the area of the Madrone site is mapped as Butano Formation- upper sandstone member (Brabb 1997). The deposits locally are described as "thin bedded to very thick bedded medium-gray, fine to medium grained arkosic sandstone containing thin interbeds of medium gray siltstone."

The surficial geology in the area of the Lewis site is mapped as Santa Margarita Sandstone (Brabb 1997). The deposits locally are described as "very thick bedded to massive thickly cross-bedded yellowish-gray to white friable granular medium- to fine-grained arkosic sandstone; locally calcareous and locally bituminous."

The native soil and bedrock encountered at each location during our field investigations are consistent with these bedrock descriptions.

Although much of the Santa Cruz County area is mapped as landslide deposits, our site observations and review of the Santa Cruz County Geologic Hazard map indicate that there is a low hazard of landsliding at the tank sites. We did not observe any features indicative of large or moderate scale landsliding in the immediate vicinity of each site.

SURFACE CONDITIONS

The Kaski tank site currently supports two approximately 24-foot diameter tanks founded on roughly 26-foot diameter concrete foundations. The site is located on a level to gently sloping pad that has been graded by cutting on the east side and filling on the west side. Natural slopes above and below the pad range in inclination between 15 and 25 degrees. The 10 to 12-foot cut east and northeast of the tank site stands at an approximately 1:1 slope. Fills have been placed on the west side of the tank pad (See Figure 2). The pad slopes gently to the west. Fill slopes on the west side of the pad, descend to the west at approximately a 2:1 inclination (horizontal:vertical). Significant pooling of water was observed leaking from the existing tanks and the water has begun to scour the ground surface (see Figure 2).

The Madrone tank site is located near a ridgetop and currently supports two approximately 26-foot diameter tanks founded on roughly 29-foot diameter concrete foundations. The site is located on a level graded pad. Previous grading appears to consist of minor cutting on the east side of the ridgetop and filling on the west and north sides of the tanks (see Figure 3). The ridge slopes away from the site to the north, west and south at approximately a 3:1 slope (horizontal:vertical).

The Lewis tank site currently supports one approximaltey 30-foot diameter tank, a well, and a water treatment building, pond and tower. The tank site was cut into a gently south and east slope with level pads graded for the tank site and water treatment improvements (See Figure 4). Past grading appears to consist of maximum 1 to 2-foot cuts and fills in order to accommodate site improvements.

SUBSURFACE CONDITIONS

Our borings were focused on characterizing fill and soil at the sites and confirming depth to bearing material. Bedrock characteristics were previously explored by HKA (2012). Our subsurface exploration consisted of four test borings drilled on the tank pads. The borings extended 10 to 12 feet below existing grade. The soil profiles and classifications, laboratory test results and groundwater conditions encountered for each test boring are presented in the Log of Test Borings, in Appendix A. The general subsurface conditions are described below.

Previous borings were performed by Haro Kasunich & Associates in 2012. These borings are presented in Appendix B. We note that boring B-7 was missing from the report copy we received.

The subsurface profile at the Kaski site, encountered within B-1K, consisted of about 3½ feet of fill overlying native soil and Monterey Formation bedrock. The fill consisted of sandy lean clay with scattered weathered siltstone clasts up to ½" in diameter. Native Monterey Formation consisted of severely to completely weathered siltstone bedrock. The upper two feet of bedrock has weathered to a sandy silt. The fill within B-1K was very stiff in density. The weathered Monterey Formation was generally soft to moderately hard in rock hardness. B-1, B-2, and B-3 were drilled by HKA (2012) at the Kaski site. Siltstone bedrock was explored to a maximum depth of 21½ feet and found to be similar in strength to the bedrock encountered in our B-1K boring.

The subsurface profile at the Madrone site, encountered within B-1M, consisted of native, moderately weathered, very soft to moderately hard Butano Sandstone. No fill was encountered at our boring location. Up to 5 feet of fill and native soils were encountered in HKA's borings and these materials were found to be loose and compressible.

The subsurface profile at the Lewis site, encountered within B-1L and B-2L, consisted of 4 to 6 feet of colluvium overlying native Santa Margarita Formation bedrock. In boring B-1L the soil is overlain by 4 feet of fill material. Both fill and native material consisted of loose to medium dense silty sand and sand with silt. Native Santa Margarita Formation consisted of very soft sandstone bedrock, with the upper few feet weathered to a sandy silt or silty sand. We interpret the material below about 7 feet in the HKA borings (B-7 and B-8) to be completely weathered sandstone bedrock.

Groundwater was not encountered in any of our borings or the HKA (2012) borings and no evidence of shallow ground water was observed at the site. Water observed at the Kaski and Lewis sites is associated with long term leakage from the tanks. The groundwater conditions described in this report reflect the conditions encountered during our drilling investigation in October 2018 at the specific locations drilled. It must be anticipated that the perched and regional groundwater tables may vary with location and could fluctuate with variations in rainfall, runoff, irrigation and other changes to the conditions existing at the time our measurements were made.

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

FAULTING AND SEISMICITY

Faulting

Mapped faults which have the potential to generate earthquakes that could significantly affect the subject site are listed in Table No. 1. The fault distances are approximate distances based the U.S. Geological Survey and California Geological Survey, Quaternary fault and fold database, accessed on October 2018 from the USGS website (http//earthquake.usgs.gov/hazards/qfaults/) and overlaid onto Google Earth.

Kaski Site- Table No. 1 - Distance to Significant Faults

Fault Name	Distance (miles)	Direction
Zayante	½	Northeast
Butano	4	Northeast
San Andreas	5½	Northeast
Sargeant	6	Northeast
Lexington	6	Northeast

Madrone Site- Table No. 2 - Distance to Significant Faults

Fault Name	Distance (miles)	Direction
Zayante	500 feet	Northeast
Butano	3½	Northeast
San Andreas	5	Northeast
Sargeant	5½	Northeast
Lexington	5½	Northeast

Lewis Site- Table No. 3 - Distance to Significant Faults

Fault Name	Distance (miles)	Direction
Zayante	¾	Northeast
Butano	4½	Northeast
San Andreas	6	Northeast
Sargeant	6½	Northeast
Lexington	6½	Northeast

Seismic Shaking and CBC Design Parameters

Due to the proximity of the site to active and potentially active faults, it is reasonable to assume the site will experience high intensity ground shaking during the lifetime of the project. Structures founded on thick soft soil deposits are more likely to experience more destructive shaking, with higher amplitude and lower frequency, than structures founded on bedrock. Generally, shaking will be more intense closer to earthquake epicenters. Thick soft soil deposits large distances from earthquake epicenters, however, may result in seismic accelerations significantly greater than expected in bedrock.

Selection of seismic design parameters should be determined by the project structural designer. The site coefficients and seismic ground motion values shown in the table below were developed based on CBC 2016 incorporating the ASCE 7-10 standard, and the project site location.

Kaski Site- Table No. 4 - 2016 CBC Seismic Design Parameters [1]

Seismic Design Parameter	ASCE 7-10 Value
Site Class	D
Spectral Acceleration for Short Periods	$S_S = 1.55g$
Spectral Acceleration for 1-second Period	$S_1 = 0.71g$
Short Period Site Coefficient	$F_a = 1.0$
1-Second Period Site Coefficient	$F_v = 1.3$
Design Spectral Response Acceleration for Short Period	$S_{DS} = 1.03g$
Design Spectral Response Acceleration for 1-Second Period	$S_{D1} = 0.62g$

Madrone Site- Table No. 5 - 2016 CBC Seismic Design Parameters [1]

Seismic Design Parameter	ASCE 7-10 Value
Site Class	D
Spectral Acceleration for Short Periods	S_s = 1.62g
Spectral Acceleration for 1-second Period	S_1 = 0.74g
Short Period Site Coefficient	Fa = 1.0
1-Second Period Site Coefficient	Fv = 1.5
Design Spectral Response Acceleration for Short Period	S_{DS} = 1.08g
Design Spectral Response Acceleration for 1-Second Period	S_{D1} = 0.74g

Lewis Site- Table No. 6 - 2016 CBC Seismic Design Parameters [1]

Seismic Design Parameter	ASCE 7-10 Value
Site Class	D
Spectral Acceleration for Short Periods	S_s = 1.5g
Spectral Acceleration for 1-second Period	S_1 = 0.67g
Short Period Site Coefficient	Fa = 1.0
1-Second Period Site Coefficient	Fv = 1.5
Design Spectral Response Acceleration for Short Period	S_{DS} = 1.00g
Design Spectral Response Acceleration for 1-Second Period	S_{D1} = 0.67g

Note 1: Design values have been obtained by using the SEAOC/OSHPD Seismic Design Maps Tool.
Note 2: The Seismic Design Category assumes a structure with Risk Category IV. Pacific Crest Engineering Inc. should be contacted for revised seismic design parameters if the proposed structure has a different occupancy rating than that assumed.

The recommendations of this report are intended to reduce the potential for structural damage to an acceptable risk level, however strong seismic shaking could result in minor damage and the need for post-earthquake repairs. It should be assumed that exterior improvements such as pavements or sidewalks may need to be repaired or replaced following strong seismic shaking.

GEOTECHNICAL HAZARDS

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

Ground Surface Fault Rupture

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

Ground surface fault rupture typically occurs along the surficial traces of active faults during significant seismic events. Since the nearest known active, or potentially active fault trace is mapped approximately 0.1 miles from the site, it is our opinion that the potential for ground surface fault rupture to occur at the site should be considered low.

Liquefaction and Lateral Spreading

A quantitative liquefaction analysis was not within our scope for this project. Based upon our review of the Santa Cruz County GIS Hazard Maps, the project site is not mapped within a liquefaction hazard zone.

Liquefaction tends to occur in loose, saturated fine-grained sands and coarse silt, or clays with low plasticity. At the Kaski and Madrone sites, we did not encounter potentially liquefiable soils, nor did we encounter groundwater during our field investigation. Consequently, it is our opinion that the potential for liquefaction to occur at these sites should be considered low.

At the Lewis site, the loose upper 6 to 8 feet of soils have some potential for seismically induced soil densification. However, due to the lack of groundwater, the potential for liquefaction is considered to be low.

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

Landsliding

No landslide deposits are mapped within the subject sites. (Cooper-Clark 1975) An investigation to determine whether the proposed project is located on an existing landslide or the potential for a deep-seated landslide to occur and adversely affect the project was beyond our scope of services and was not performed.

Although a large portion of the Santa Cruz County area consists of landslide deposits, the subject sites are located some distance from these mapped areas. It is our opinion that the potential for landsliding to occur and adversely affect the proposed development should be considered low.

IV. DISCUSSION AND CONCLUSIONS

GENERAL

1. The results of our investigation indicate that proposed improvements to the tank pads are feasible from a geotechnical engineering standpoint, provided our recommendations are included in the design and construction of the project.

2. Grading and foundation plans should be reviewed by Pacific Crest Engineering Inc. during their preparation and prior to contract bidding.

3. Pacific Crest Engineering Inc. should be notified at least four (4) working days prior to any site clearing and grading operations on the property in order to observe the stripping and disposal of unsuitable materials, and to coordinate this work with the grading contractor. During this period, a pre-construction conference should be held on the site, with at least the client or their representative, the grading contractor and one of our engineers present. At this meeting, the project specifications and the testing and inspection responsibilities will be outlined and discussed.

4. Field observation and testing must be provided by a representative of Pacific Crest Engineering Inc., to enable them to form an opinion as to the degree of conformance of the exposed site conditions to those foreseen in this report, the adequacy of the site preparation, the acceptability of fill materials, and the extent to which the earthwork construction and the degree of compaction comply with the specification requirements. Any work related to grading or foundation excavation that is performed without the full knowledge and direct observation of Pacific Crest Engineering Inc., the Geotechnical Engineer of Record, will render the recommendations of this report invalid, unless the Client hires a new Geotechnical Engineer who agrees to take over complete responsibility for this report's findings, conclusions and recommendations. The new Geotechnical Engineer must agree to prepare a Transfer of Responsibility letter. This may require additional test borings and laboratory analysis if the new Geotechnical Engineer does not completely agree with our prior findings, conclusions and recommendations.

PRIMARY GEOTECHNICAL CONSIDERATIONS

5. Based upon the results of our investigation, it is our opinion that the primary geotechnical issues associated with the design and construction of the proposed project are the following:

  a. *Non-Engineered Fills:* At each of the tank sites, areas of non-engineered fill were encountered in borings and observations. It should be anticipated that other areas of non-engineered fills may be encountered during construction. To mitigate the potential for adverse settlement to occur beneath the proposed improvements, we recommend subexcavation and recompaction of existing fill be performed where such fills underlie proposed tank foundations, slabs-on-grade and pavements. Refer to the Earthwork section of this report for recommendations.

b. *Divergent Bearing Conditions And Differential Settlement:* The western portions of the tanks at the Kaski site appear to be underlain by fill while the rest of the tanks are bearing on the cut native material. It also appears that some fill material underlies the northern edge of the Madrone tanks. Generally, spanning a cut/fill transition can lead to differential settlement. Additionally, loose surficial soils may compress under the proposed loads resulting in adverse settlement. To reduce the potential for adverse settlement to occur beneath the proposed improvements, we recommend subexcavation of the tank subgrades to a depth 2 feet below the base of the footing or until competent bedrock is exposed. Refer to the Earthwork section of this report for recommendations.

c. *Excavations and Existing Improvements:* We understand that the existing tanks will be relocated during grading. If this construction plan changes and some tanks are to remain in place during earthwork, it will be difficult to excavate the tank pads. Temporary shoring and other measures will be required. We request the opportunity to review construction plans if the existing tanks cannot be relocated during construction.

d. *Strong Seismic Shaking:* The project site is located within a seismically active area and strong seismic shaking is expected to occur within the design lifetime of the project. Improvements should be designed and constructed in accordance with the most current CBC and the recommendations of this report to minimize reaction to seismic shaking. Structures built in accordance with the latest edition of the California Building Code have an increased potential for experiencing relatively minor damage which should be repairable, however strong seismic shaking could result in architectural damage and the need for post-earthquake repairs.

V. RECOMMENDATIONS

EARTHWORK

Clearing and Stripping

1. The initial preparation of the site may consist of demolition of existing structures and their foundations and removal of designated trees and debris. For all the tank replacements we understand that the existing tanks can be removed so that the earth work can be completed across the entire tank pad as recommended in this section. All foundation elements from existing structures must be completely removed from the building areas. Tree removal should include the entire stump and root ball. The extent of this soil removal will be designated by a representative of Pacific Crest Engineering Inc. in the field. This material must be removed from the site.

2. Any voids created by the removal of old structures and their foundations, tree and root balls, septic tanks, and leach lines must be backfilled with properly compacted engineered fill which meets the requirements of this report.

3. Any wells encountered shall be capped in accordance with the requirements and approval of the County Health Department. The strength of the cap shall be equal to the adjacent soil and shall not be located within 5 feet of a structural footing.

4. Surface vegetation, tree roots and organically contaminated topsoil should then be removed ("stripped") from the area to be graded. In addition, any remaining debris or large rocks must also be removed (this includes asphalt or rocks greater than 2 inches in greatest dimension). This material may be stockpiled for future landscaping.

5. It is anticipated that the depth of stripping may be 2 to 4 inches. Final required depth of stripping must be based upon visual observations by a representative of Pacific Crest Engineering Inc., in the field. The required depth of stripping will vary based upon the type and density of vegetation across the project site and with the time of year.

<u>Subgrade Preparation</u>

6. All existing fill within the tank pad areas should be subexcavated and removed. Fill depth is anticipated to be as much as 4 feet at the Kaski tank site, 4 feet at the Lewis site and 1 to 2 feet at the Madrone site. The approximate lateral extents of existing fills are shown on Figure 2, 3 and 4. Additionally, loose surficial soils should be subexcavated to a depth 2 feet below base of footing or until competent bedrock is exposed, whichever depth is less. The excavation process should be observed and the extent designated by a representative of Pacific Crest Engineering Inc., in the field. Any voids created by fill removal must be backfilled with properly compacted engineered fill.

7. Subexcavations should extend at least 5 feet horizontally beyond foundations and at least 2 feet horizontally beyond pavements and flatwork.

8. Final depth of subexcavation should be determined by a representative of Pacific Crest Engineering Inc., in the field.

9. We understand that the existing tanks will be removed, and the pads rebuilt. In general, care must be taken not to undermine the foundation system beneath any existing structures. Excavations made adjacent to existing footings must not extend below a line drawn outward at a gradient of 2:1 (H:V) from the bottom outside edge of the footing.

10. Wet and soft soils will likely be encountered at the bottom of the excavations. If wet or unstable subgrades are encountered they may need to further subexcavated and replaced with stabilization fabric, crushed rock or other materials to create a stable working surface. The depth of over-excavations and method used should be determined in the field at the time of construction.

11. Following clearing, stripping and any necessary subexcavations, the exposed subgrade soil that is to support concrete slabs-on-grade, foundations, pavements or engineered fill should then be scarified 8 inches, and the soil moisture conditioned and compacted as outlined below. The moisture

conditioning procedure will depend upon the time of year that the work is done, but it should result in the soils being 1 to 3 percent over optimum moisture content at the time of compaction.

Material for Engineered Fill

12. Native or imported soil proposed for use as engineered fill should meet the following requirements:

a. free of organics, debris, and other deleterious materials,
b. free of "recycled" materials such as asphaltic concrete, concrete, brick, etc.,
c. granular in nature, well graded, and contain sufficient binder to allow utility trenches to stand open,
d. free of rocks in excess of 2 inches in size.

13. In addition to the above requirements, import fill should have a Plasticity Index between 4 and 12, have a minimum Resistance "R" Value of 30, and be non-expansive.

14. Samples of any proposed imported fill planned for use on this project should be submitted to Pacific Crest Engineering Inc. for appropriate testing and approval not less than ten (10) working days before the anticipated jobsite delivery. This includes proposed import trench sand, drain rock and aggregate base materials. Imported fill material delivered to the project site without prior submittal of samples for appropriate testing and approval must be removed from the project site.

Engineered Fill Placement and Compaction

15. Following the subexcavation and subgrade preparation, the tank pad should be brought up to design grades with engineered fill that is moisture conditioned and compacted according to the recommendations of this report. Recompacted sections should extend at least 5 feet horizontally beyond all footings, slabs and pavement areas.

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

17. All soil on the project should be compacted to a minimum of 90% of its maximum dry density. The upper 8 inches of the soil subgrade within the tank pad areas, pavement areas, and all aggregate subbase and aggregate base should be compacted to a minimum of 95% of its maximum dry density.

18. The maximum dry density will be obtained from a laboratory compaction curve run in accordance with ASTM Procedure #D1557. This test will also establish the optimum moisture content of the material. Field density testing will be performed in accordance with ASTM Test #D6938 (nuclear method).

19. We recommend field density testing be performed in maximum 2-foot elevation differences. In general terms, we recommend at least one compaction test per 200 linear feet of utility trench or

retaining wall backfill, and at least one compaction test per 2,000 square feet of building or structure area. This is a subjective value and may be changed by the geotechnical engineer based on a review of the final project layout and exposed field conditions.

20. We anticipate that the fill slope at the Kaski site will need to be rebuilt. In general, engineered fill placed on existing slopes that are steeper than 5:1 (horizontal:vertical) should be keyed and benched into competent native material. Toe keys should be constructed at the base of the fill slope with a minimum 10-foot-wide width and sloped negatively at least 2% into the bank. The depth of the keyways will vary, depending on the materials encountered. It is anticipated that the depth of the keyways may be 2 to 4 feet, but at all locations shall be at least 2 feet into firm material.

21. Subsequent benches may be required as the fill section progresses upslope. Benches and keys will be designated in the field by a representative of Pacific Crest Engineering Inc.

Cut and Fill Slopes

22. Fill slopes should be constructed with engineered fill meeting the minimum density requirements of this report and have a gradient no steeper than 2:1 (horizontal:vertical). Fill slopes should not exceed 15 feet in vertical height unless specifically reviewed by Pacific Crest Engineering Inc. Where the vertical height exceeds 15 feet, intermediate benches must be provided. These benches should be at least 6 feet wide and sloped to control surface drainage. A lined ditch should be used on the bench.

23. Permanent cut slopes in soil shall not exceed a 2:1 (horizontal:vertical) gradient. Permanent cut slopes in bedrock shall not exceed a 1½:1 gradient. If sloughing of soil and increased maintenance is to be avoided, then we recommend the existing cut slope behind the tank be flattened to a maximum inclination of 1½:1. A lined ditch should be installed at the top of all cut slopes.

24. The above slope gradients are based on the strength characteristics of the materials under conditions of normal moisture content that would result from rainfall falling directly on the slope, and do not take into account the additional activating forces applied by seepage from spring areas or subsurface groundwater. Therefore, in order to maintain stable slopes at the recommended gradients, it is important that any seepage forces and accompanying hydrostatic pressure (if encountered) be relieved by adequate drainage. Drainage facilities may include subdrains, gravel blankets, rock fill surface trenches or horizontally drilled drains. Configurations and type of drainage will be determined by a representative of Pacific Crest Engineering Inc. during the grading operations.

25. The surfaces of all cut and fill slopes should be prepared and maintained to reduce erosion. This work, at a minimum, should include track rolling of the slope and effective planting. The protection of the slopes should be installed as soon as practicable so that a sufficient growth will be established prior to inclement weather conditions. It is vital that no slope be left standing through a winter season without the erosion control measures having been provided.

26. The above recommended gradients do not preclude periodic maintenance of the slopes, as minor sloughing and erosion may take place.

27. If a fill slope is to be placed above a cut slope, the toe of the fill slope should be set back at least 8 feet horizontally from the top of the cut slope. A lateral surface drain should be placed in the area between the cut and fill slopes.

28. All pavements and flatwork should be set back at least 5 feet horizontally from the top of cut and fill slopes. All foundations should be set back at least 8 feet horizontally from the top of cut and fill slopes.

Soil Moisture and Weather Conditions

29. Surface water associated with long term leakage from the tanks was observed at the Kaski and Lewis sites. Additionally, if earthwork activities are done during or soon after the rainy season, the on-site soils and other materials may be too wet in their existing condition to be used as engineered fill. These materials may require a diligent and active drying and/or mixing operation to reduce the moisture content to the levels required to obtain adequate compaction as an engineered fill. If the on-site soils or other materials are too dry, water may need to be added. In some cases, the time and effort to dry the on-site soil may be considered excessive, and the import of aggregate base may be required.

Utility Trench Backfill

30. Utility trenches that are parallel to the sides of the building should be placed so that they do not extend below a line sloping down and away at a 2:1 (horizontal:vertical) slope from the bottom outside edge of all footings.

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

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

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

34. Approved imported clean sand or native soil should be used as utility trench backfill. Backfill in trenches located under and adjacent to structural fill, foundations, concrete slabs and pavements should be placed in horizontal layers no more than 8 inches thick. This includes areas such as sidewalks, patios, and other hardscape areas. Each layer of trench backfill should be water conditioned and compacted to at least 95 percent relative compaction

35. All utility trenches beneath perimeter footing or grade beams should be backfilled with controlled density fill (such as 2-sack sand\cement slurry) to help minimize potential moisture intrusion below interior floors. The length of the plug should be at least three times the width of the footing or grade beam at the building perimeter, but not less than 36 inches. A representative from Pacific Crest Engineering Inc. should be contacted to observe the placement of slurry plugs. In addition, all utility pipes which penetrate through the footings, stemwalls or grade beams (below the exterior soil grade) should also be sealed water-tight, as determined by the project civil engineer or architect.

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

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

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

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

<u>Excavations and Shoring</u>

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

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

42. The "top" of any temporary cut slope and excavations should be set-back at least ten feet (measured horizontally) from any nearby structure or property line. Any excavations which cannot meet this requirement will need to have a shoring system designed to support steeper sidewall gradients.

43. Temporary shoring is not currently anticipated for this project. Should these requirements change, please contact our office for additional recommendations.

FOUNDATIONS

44. The following foundation recommendations are based on the assumption that the current tanks will be replaced, and the entire tank pad will be rebuilt as recommended in the Earthwork section of this report.

45. At the time we prepared this report, plans had not been completed and the location and details of proposed tank(s) and grading had not been finalized. We request an opportunity to review these items during the design stages to verify that the following recommendations apply.

46. We recommend that proposed tank(s) be founded on reinforced concrete spread footings or ringwalls. Geotechnical design parameters for this system is provided below.

47. All footings must be trenched at least 24 inches below final pad grade.

48. Footings should be designed for the following allowable bearing capacities:
   a. 2,500 psf for Dead plus Live Load
   b. a 1/3rd increase for Seismic or Wind Load

49. In computing the pressures transmitted to the soil by the footings, the embedded weight of the footing may be neglected.

50. No footing should be placed closer than 8 feet from the top of adjacent cut or fill slopes.

51. No footings shall be constructed with the intent of placing engineered fill against the footing after the footing is poured, and counting that engineered fill as part of the embedment depth of the footing.

52. Footings may be assumed to have a resistance to lateral sliding coefficient of 0.30.

53. Footings may be assumed to have a lateral bearing pressure resistance value of 350 psf/foot. The upper one foot of soil should be ignored when calculating lateral resistance.

54. The footing excavations must be free of loose material prior to placing concrete. The footing excavations should be thoroughly saturated prior to placing concrete.

55. Provided our recommendations are followed, under static loading conditions, we estimate that total post-construction foundation settlement will be less than 1 inch, and post-construction differential foundation settlement will be less than 1/2 inch.

56. Footing excavations must be observed by a representative of Pacific Crest Engineering Inc. before placement of formwork, steel and concrete to ensure bedding into proper material.

57. The footings should contain steel reinforcement as determined by the project civil or structural engineer in accordance with applicable CBC or ACI Standards.

RETAINING WALLS

58. We anticipate that a retaining wall may be proposed at one or more tank sites. The following parameters may be used for preliminary planning purposes. We request the opportunity to review any proposed retaining wall locations to verify that these parameters apply.

59. Retaining walls with full drainage should be designed using the following criteria:

a. The following lateral earth pressure values should be used for design:

Table No. 7, Active Earth Pressure Values

Maximum Backfill Slope (H:V)	Active Earth Pressure (psf/ft of depth)
Level	40
2:1	55
1½:1	65

b. Should the slope behind the retaining walls be other than shown in Table 7, supplemental design criteria will be provided for the active earth or at rest pressures for the particular slope angle.

c. Active earth pressure values may be used when walls are free to yield an amount sufficient to develop the active earth pressure condition (about ½% of height). The effect of wall rotation should be considered for areas behind the planned retaining wall (pavements, foundations, slabs, etc.).

d. Retaining walls should be supported on shallow foundation designed using an allowable bearing capacity of 2000 psf for dead plus live load, with a 1/3rd increase for short term loads.

e. Retaining wall footings should be embedded a minimum of 18 inches below the lowest adjacent compacted pad grade. There should be a minimum of 5 feet of horizontal cover as measured from the outside edge of the footing.

f. For resisting lateral forces a passive earth pressure of 350 psf/ft of depth should be used. The upper 12 inches should be ignored.

g. The mechanics of soil pressure on the footing keyway intended to enhance sliding stability has been considered. The active pressure on the keyway, acting opposite the passive pressure, may be taken as zero.

h. A "coefficient of friction" between base of foundation and soil of 0.30

i. If the structural designer wishes to include seismic forces in their design, the wall may be designed using the above active soil pressures plus a horizontal seismic force of $13H^2$ pounds per lineal foot (where H is the height of retained material). The resultant seismic force should be applied at a point 1/3rd above the base of the wall. This force has been estimated using the Mononobe-Okabe method of analysis as modified by Whitman (1990) and Lew and Sitar (2010). A reduced factor of safety for overturning and sliding may be used in seismic design as determined by the structural designer.

Retaining Wall Drainage

60. The above design criteria are based on fully drained conditions. Therefore, we recommend that permeable material meeting the State of California Standard Specification Section 68-2.02F, Class 1, Type A, be placed behind the wall, with a minimum width of 12 inches and extending for the full height of the wall to within 1 foot of the ground surface. The top of the permeable material should be covered with Mirafi 140N filter fabric or equivalent and then compacted native soil placed to the ground surface. A 4-inch diameter perforated rigid plastic drain pipe should be installed within 3 inches of the bottom of the permeable material and be discharged to a suitable, approved location. The perforations should be placed downward; oriented along the lower half of the pipe. Neither the pipe nor the permeable material should be wrapped in filter fabric. Please refer to the Typical Retaining Wall Drain Detail, Figure 13, in Appendix A for details.

61. The area behind the wall and beyond the permeable material should be compacted with approved material to a minimum relative compaction of 90%.

PAVEMENT DESIGN

62. The design of the pavement section was beyond our scope of services for this project. To have the selected pavement sections perform to their greatest efficiency, it is very important that the following items be considered:

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

b. Provide sufficient gradient to prevent ponding of water.

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

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

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

f. **Porous pavement systems which consist of porous paving blocks, asphaltic concrete or concrete are generally not recommended due to the potential for saturation of the subgrade soils and resulting increased potential for a shorter pavement life. At a minimum, porous pavement systems should include a layer of Mirafi HP370 geotextile fabric placed on the subgrade soil beneath the porous paving section. These pavement systems should only be used with the understanding by the Owner of the increased potential for pavement cracking, rutting, potholes, etc.**

g. Maintenance should be undertaken on a routine basis.

<u>SURFACE DRAINAGE</u>

63. Surface water drainage is the responsibility of the project civil engineer. The following should be considered by the civil engineer in design of the project.

64. Slope failures can occur where surface drainage is allowed to concentrate onto unprotected slopes. Improvements to the surface drainage around the project area is important to reduce potential for shallow slumping of slopes. Erosion control measures should be implemented and maintained. Under no circumstances should surface runoff be directed toward, or discharged upon, any topographic slopes.

65. Surface water must not be allowed to pond or be trapped adjacent to foundations, or on tank pads and surrounding areas.

66. Final grades should be provided with positive gradient away from all foundation elements. Soil grades should slope away from foundations at least 5 percent for the first 10 feet. Impervious surfaces should slope away from foundations at least 2 percent for the first 10 feet. Concentrations of surface runoff should be handled by providing structures, such as paved or lined ditches, catch basins, etc.

67. Following completion of the project we recommend that storm drainage provisions and performance of permanent erosion control measures be closely observed through the first season of significant rainfall, to determine if these systems are performing adequately and, if necessary, resolve any unforeseen issues.

68. Surface drainage facilities must not be altered, nor any filling or excavation work performed in the area without first consulting Pacific Crest Engineering Inc. Surface drainage improvements developed

by the project civil engineer must be maintained by the property owner at all times, as improper drainage provisions can produce undesirable affects.

EROSION CONTROL

69. The surface soils are classified as having a moderate to high potential for erosion. Therefore, the finished ground surface should be planted with ground cover and continually maintained to minimize surface erosion. For specific and detailed recommendations regarding erosion control on and surrounding the project site, the project civil engineer or an erosion control specialist should be consulted.

PLAN REVIEW

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

VI. LIMITATIONS AND UNIFORMITY OF CONDITIONS

1. This Geotechnical Investigation was prepared specifically for the Schaaf and Wheeler Consulting Civil Engineers and for the specific project and location described in the body of this report. This report and the recommendations included herein should be utilized for this specific project and location exclusively. This Geotechnical Investigation should not be applied to nor utilized on any other project or project site. Please refer to the ASFE "Important Information about Your Geotechnical Engineering Report" attached with this report.

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

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

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

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

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

Important Information About Your

Geotechnical Engineering Report

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

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

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

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

Read the Full Report

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

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

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

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

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

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

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

Subsurface Conditions Can Change

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

Most Geotechnical Findings Are Professional Opinions

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

A Report's Recommendations Are *Not* Final

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

A Geotechnical Engineering Report Is Subject to Misinterpretation

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

Do Not Redraw the Engineer's Logs

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

Give Contractors a Complete Report and Guidance

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

Read Responsibility Provisions Closely

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

Geoenvironmental Concerns Are Not Covered

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

Obtain Professional Assistance To Deal with Mold

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

Rely, on Your ASFE-Member Geotechncial Engineer for Additional Assistance

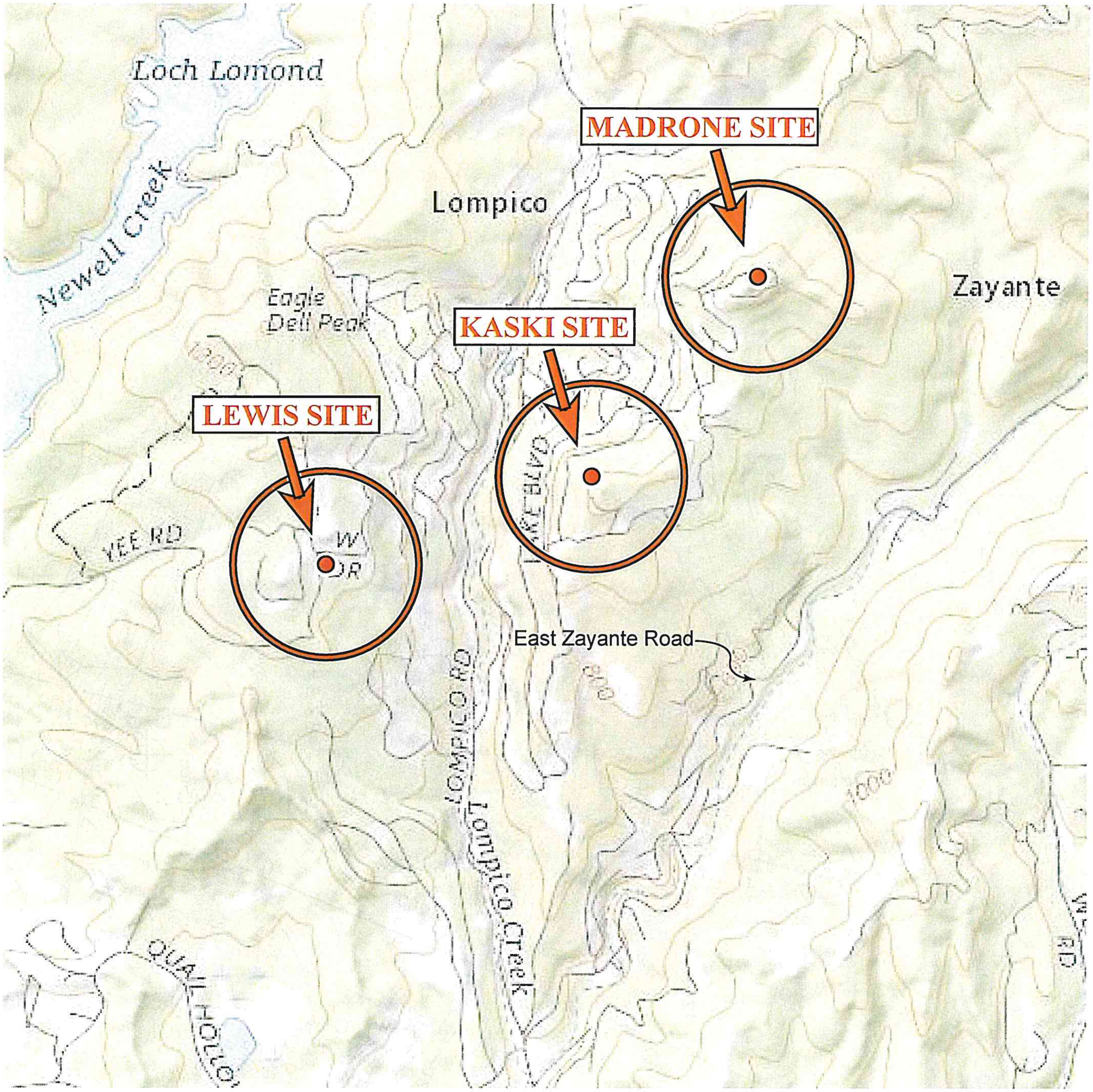
Membership in ASFE/The Best People on Earth exposes geotechnical engineers to a wide array of risk management techniques that can be of genuine benefit for everyone involved with a construction project. Confer with you ASFE-member geotechnical engineer for more information.

ASFE
The Best People on Earth

8811 Colesville Road/Suite G106, Silver Spring, MD 20910
Telephone: 301/565-2733 Facsimile: 301/589-2017
e-mail: info@asfe.org www.asfe.org

APPENDIX A

Regional Site Map
Site Map Showing Test Borings (3)
Cross Section A-A'
Key to Soil Classification
Log of Test Borings



0 2000 ft.

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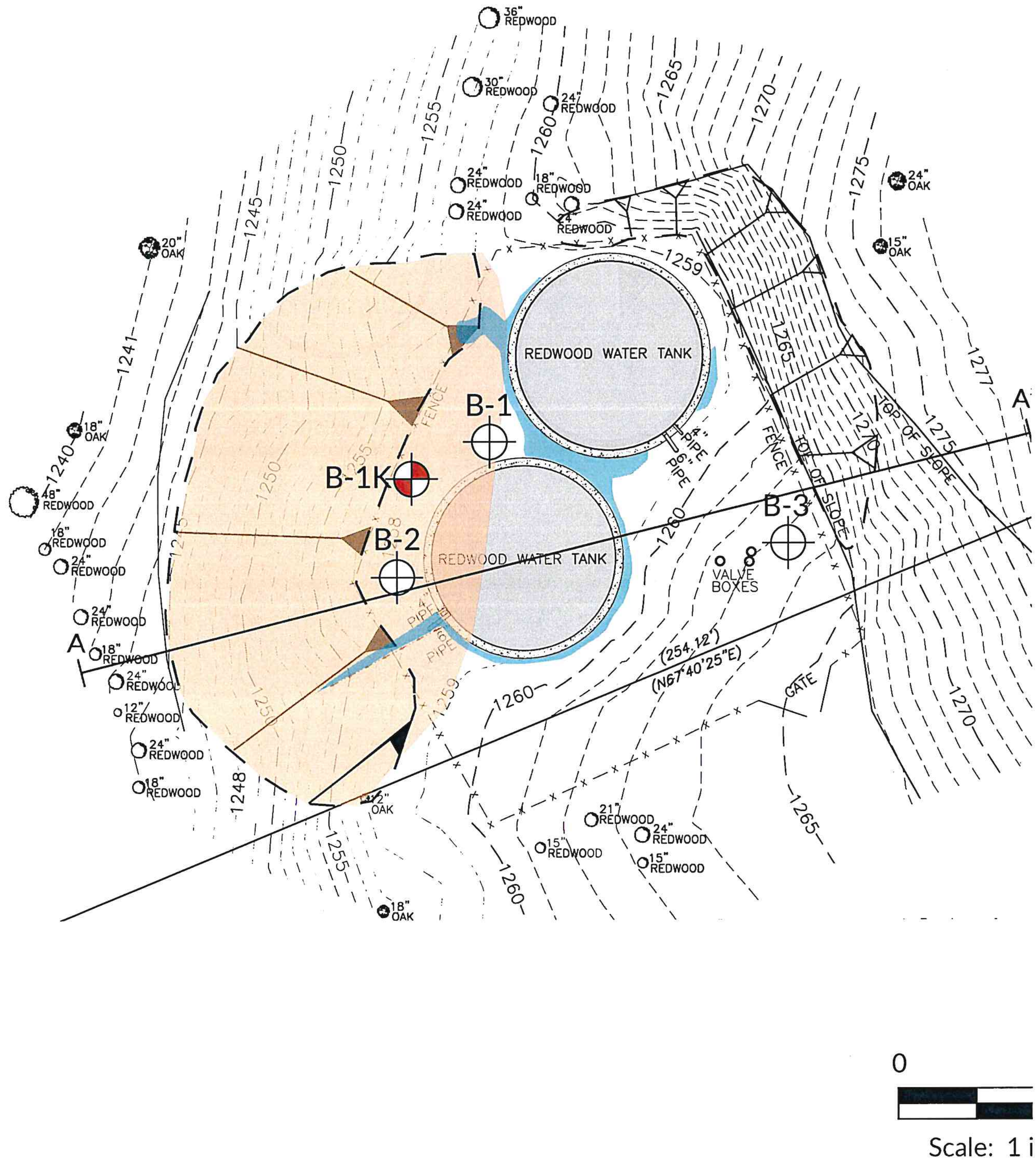
Base Map: United States Geological Survey
Felton Quadrangle, California
Santa Cruz County, 7.5 Minute Series, 2018

Pacific Crest ENGINEERING INC	**Regional Site Map** Kaski, Madrone and Lewis Tank Sites Santa Cruz County, California	Figure No. 1 Project No. 1886 Date: 12/10/18

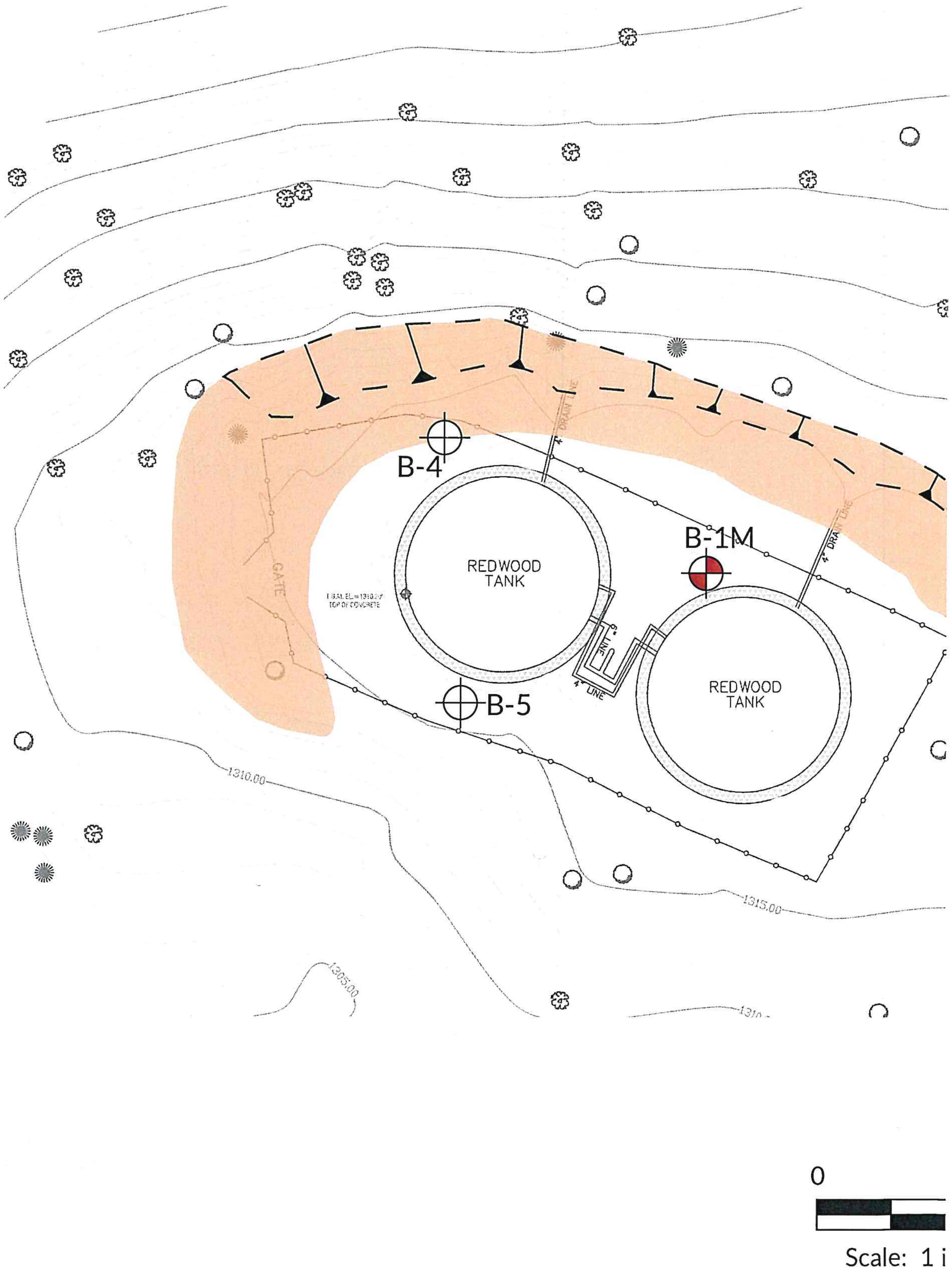


Pacific Crest ENGINEERING INC

Site Map Showing Test B

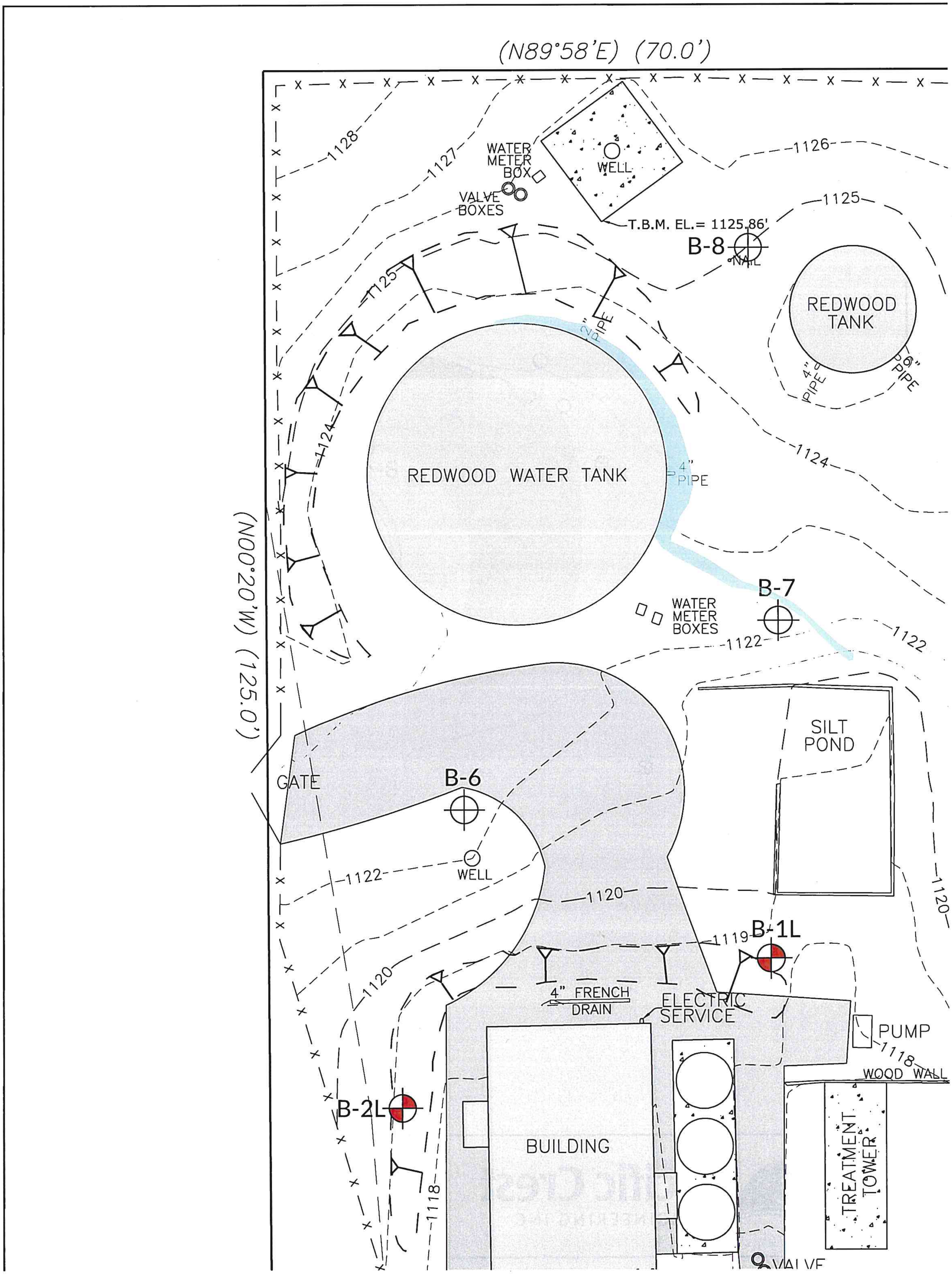
Kaski, Madrone a

Santa Cruz Co

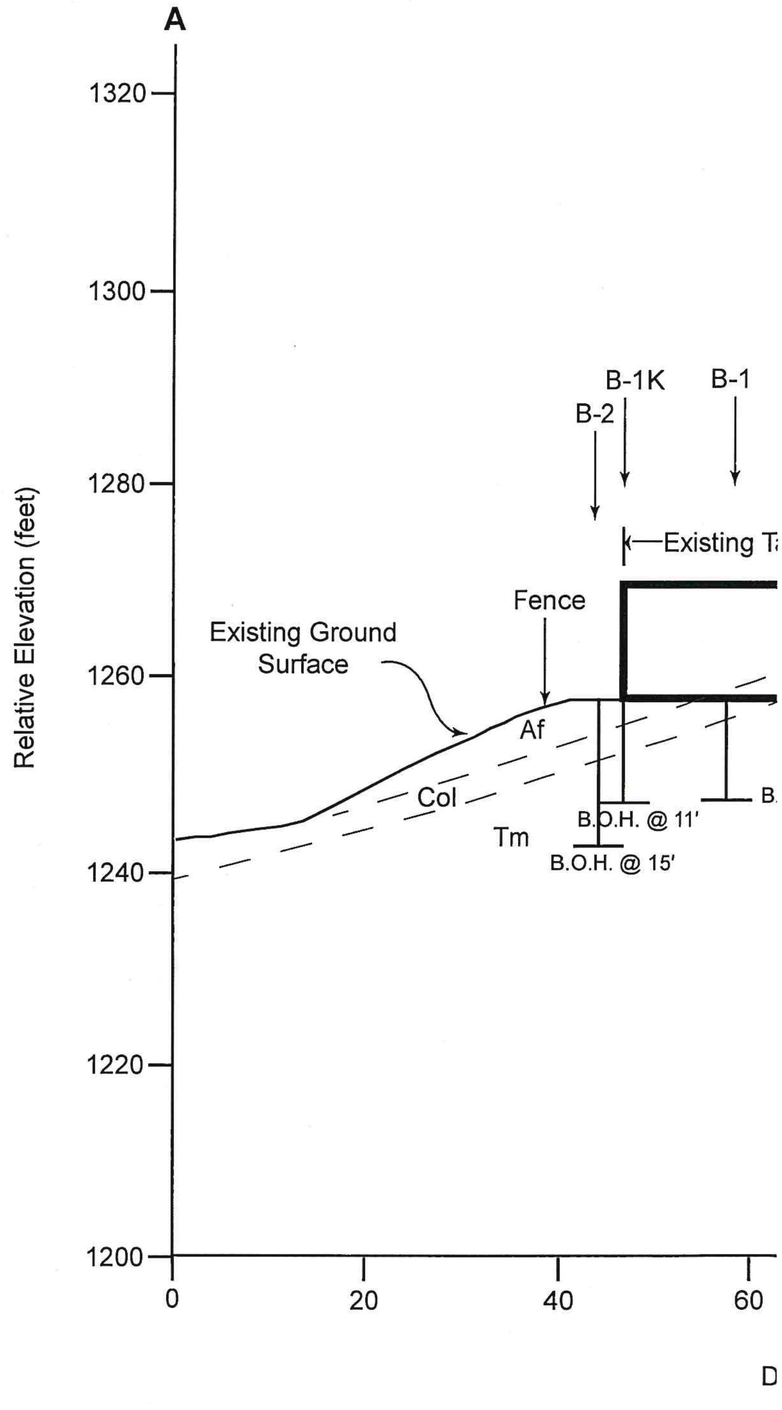


Pacific Crest
ENGINEERING INC

Site Map Showing Test Bo
Kaski, Madrone a
Santa Cruz Co



(N89°58'E) (70.0')
(N00°20'W) (125.0')
WATER METER BOX
VALVE BOXES
WELL
T.B.M. EL.= 1125.86'
B-8
NAIL
REDWOOD TANK
REDWOOD WATER TANK
2" PIPE
4" PIPE
6" PIPE
B-7
WATER METER BOXES
SILT POND
GATE
B-6
WELL
B-1L
B-2L
4" FRENCH DRAIN
ELECTRIC SERVICE
PUMP
WOOD WALL
BUILDING
TREATMENT TOWER
VALVE
1128
1127
1126
1125
1124
1122
1120
1119
1118



Note: Cross section prepared with handheld tape and inclinometer
and only as accurate as the method implies

Pacific Crest ENGINEERING INC

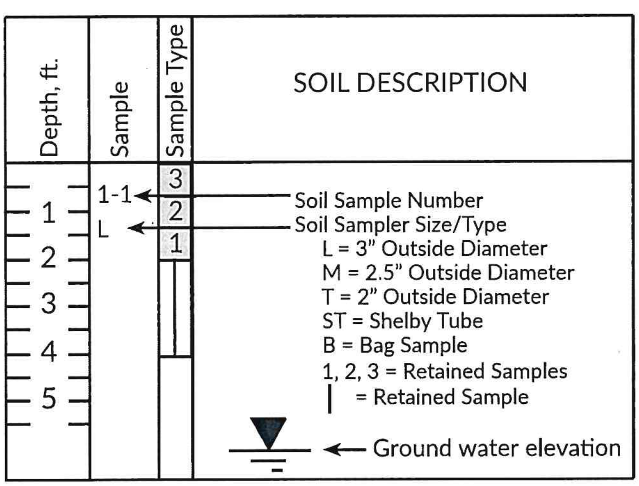
Cross Section
Lompic
Santa Cruz C

KEY TO SOIL CLASSIFICATION - FINE GRAINED SOILS (FGS)
UNIFIED SOIL CLASSIFICATION SYSTEM - ASTM D2487 (Modified)

MAJOR DIVISIONS		SYMBOL	FINES	COARSENESS	SAND/GRAVEL	GROUP NAME
SILT AND CLAY	*LL < 35% Low Plasticity	**CL** Lean Clay PI > 7 Plots Above A Line -OR- **ML** Silt PI > 4 Plots Below A Line	<30% plus No. 200	<15% plus No. 200		Lean Clay / Silt
				15-30% plus No. 200	% sand ≥ % gravel	Lean Clay with Sand / Silt with Sand
					% sand < % gravel	Lean Clay with Gravel / Silt with Gravel
			≥30% plus No. 200	% sand ≥ % gravel	< 15% gravel	Sandy Lean Clay / Sandy Silt
					≥ 15% gravel	Sandy Lean Clay with Gravel / Sandy Silt with Gravel
				% sand < % gravel	< 15% sand	Gravelly Lean Clay / Gravelly Silt
					≥ 15% sand	Gravelly Lean Clay with Sand / Gravelly Silt with Sand
		CL - ML 4 < PI < 7	<30% plus No. 200	<15% plus No. 200		Silty Clay
				15-30% plus No. 200	% sand ≥ % gravel	Silty Clay with Sand
					% sand < % gravel	Silty Clay with Gravel
			≥30% plus No. 200	% sand ≥ % gravel	< 15% gravel	Sandy Silty Clay
					≥15% gravel	Sandy Silty Clay with Gravel
				% sand < % gravel	< 15% sand	Gravelly Silty Clay
					≥15% sand	Gravelly Silty Clay with Sand
	35% ≤ *LL < 50% Intermediate Plasticity	**CI**	<30% plus No. 200	<15% plus No. 200		Clay
				15-30% plus No. 200	% sand ≥ % gravel	Clay with Sand
					% sand < % gravel	Clay with Gravel
			≥30% plus No. 200	% sand ≥ % gravel	< 15% gravel	Sandy Clay
					≥ 15% gravel	Sandy Clay with Gravel
				% sand < % gravel	< 15% sand	Gravelly Clay
					≥ 15% sand	Gravelly Clay with Sand
	*LL > 50% High Plasticity	**CH** Fat Clay Plots Above A Line -OR- **MH** Elastic Silt Plots Below A Line	<30% plus No. 200	<15% plus No. 200		Fat Clay or Elastic Silt
				15-30% plus No. 200	% sand ≥ % gravel	Fat Clay with Sand Elastic Silt with Sand
					% sand < % gravel	Fat Clay with Gravel / Elastic Silt with Gravel
			≥30% plus No. 200	% sand ≥ % gravel	< 15% gravel	Sandy Fat Clay / Sandy Elastic Silt
					≥ 15% gravel	Sandy Fat Clay with Gravel / Sandy Elastic Silt with Gravel
				% sand < % gravel	< 15% sand	Gravelly Fat Clay / Gravelly Elastic Silt
					≥ 15% sand	Gravelly Fat Clay with Sand / Gravelly Elastic Silt with Sand

* LL = Liquid Limit
* PI = Plasticity Index

BORING LOG EXPLANATION



MOISTURE

DESCRIPTION	CRITERIA
DRY	Absence of moisture, dusty, dry to the touch
MOIST	Damp, but no visible water
WET	Visible free water, usually soil is below the water table

CONSISTENCY

DESCRIPTION	UNCONFINED SHEAR STRENGTH (KSF)	STANDARD PENETRATION (BLOWS/FOOT)
VERY SOFT	< 0.25	< 2
SOFT	0.25 - 0.5	2 - 4
FIRM	0.5 - 1.0	5 - 8
STIFF	1.0 - 2.0	9 - 15
VERY STIFF	2.0 - 4.0	16 - 30
HARD	> 4.0	> 30

Pacific Crest ENGINEERING INC	**Log of Test Borings** Lompico Tank Sites Santa Cruz County, California	Figure No. 6 Project No. 1886 Date: 12/10/18

KEY TO SOIL CLASSIFICATION - COARSE GRAINED SOILS
UNIFIED SOIL CLASSIFICATION SYSTEM - ASTM D2487 (Modified)

MAJOR DIVISIONS		FINES	GRADE/TYPE OF FINES	SYMBOL	GROUP NAME *
GRAVEL	More than 50% of coarse fraction is larger than No. 4 sieve size	<5%	Cu ≥ 4 and 1 ≤ Cc ≤ 3	**GW**	Well-Graded Gravel / Well-Graded Gravel with Sand
			Cu < 4 and/or 1 > Cc > 3	**GP**	Poorly Graded Gravel/Poorly Graded Gravel with Sand
		5-12%	ML or MH	**GW - GM**	Well-Graded Gravel with Silt / Well- Graded Gravel with Silt and Sand
				GP - GM	Poorly Graded Gravel with Silt / Poorly Graded Gravel with Silt and Sand
			CL, CI or CH	**GW - GC**	Well-Graded Gravel with Clay / Well-Graded Gravel with Clay and Sand
				GP - GC	Poorly Graded Gravel with Clay / Poorly Graded Gravel with Clay and Sand
		>12%	ML or MH	**GM**	Silty Gravel / Silty Gravel with Sand
			CL, CI or CH	**GC**	Clayey Gravel/ Clayey Gravel with Sand
			CL - ML	**GC - GM**	Silty, Clayey Gravel/ Silty, Clayey Gravel with Sand
SAND	50% or more of coarse fraction is smaller than No. 4 sieve size	<5%	Cu ≥ 6 and 1 ≤ Cc ≤ 3	**SW**	Well-Graded Sand / Well-Graded Sand with Gravel
			Cu < 6 and/or 1 > Cc > 3	**SP**	Poorly Graded Sand / Poorly Graded Sand with Gravel
		5-12%	ML or MH	**SW - SM**	Well-Graded Sand with Silt / Well- Graded Sand with Silt and Gravel
				SP - SM	Poorly Graded Sand with Silt / Poorly Graded Sand with Silt and Gravel
			CL, CI or CH	**SW - SC**	Well-Graded Sand with Clay / Well-Graded Sand with Clay and Gravel
				SP - SC	Poorly Graded Sand with Clay / Poorly Graded Sand with Clay and Gravel
		>12%	ML or MH	**SM**	Silty Sand / Silty Sand with Gravel
			CL, CI or CH	**SC**	Clayey Sand / Clayey Sand with Gravel
			CL - ML	**SC - SM**	Silty, Clayey Sand / Silty, Clayey Sand with Gravel

* The term "with sand" refers to materials containing 15% or greater sand particles within a gravel soil, while the term "with gravel" refers to materials containing 15% or greater gravel particles within a sand soil.

US STANDARD SIEVE SIZE:

	3 inch	¾ inch	No. 4	No. 10	No. 40	No. 200	0.002 µm
	COARSE	FINE	COARSE	MEDIUM	FINE		
COBBLES AND BOULDERS	GRAVEL		SAND			SILT	CLAY

RELATIVE DENSITY

DESCRIPTION	STANDARD PENETRATION (BLOWS/FOOT)
VERY LOOSE	0 - 4
LOOSE	5 - 10
MEDIUM DENSE	11 - 30
DENSE	31 - 50
VERY DENSE	> 50

MOISTURE

DESCRIPTION	CRITERIA
DRY	Absence of moisture, dusty, dry to the touch
MOIST	Damp, but no visible water
WET	Visible free water, usually soil is below the water table

LOGGED BY CLA　　DATE DRILLED 10/10/2018　　BORING DIAMETER 3½" SS　　BORING NO. 1K

DRILL RIG Minuteman with Tripod　　HAMMER TYPE 140 lb Hammer & Cat Head

Depth (feet)	Sample	Sample Type	Soil Description	USCS	Field Blow Counts	SPT "N" Value	Pocket Pen. (tsf)	% Passing #200 Sieve	Dry Density (pcf)	Moisture Content (%)	Additional Lab Results
1	1K-1 L	2, 1	**FILL: SANDY LEAN CLAY:** Black (10YR 2/1), very fine-grained sand, clay appears to exhibit low plasticity, trace rootlets, scattered completely weathered siltstone clasts up to ½" sliightly moist, very stiff	CL	8, 8, 12, 12	18	4.3	78	57	37	0.0% Gravel 90.1% Sand 9.9% Fines
2, 3	1K-2 L	2, 1			13, 12, 15, 17	24	4.5	53	67	37	0.0% Gravel 90.1% Sand 9.9% Fines
4, 5	1K-3 M	2, 1	**NATIVE: SANDY SILT:** Light yellowish-brown (10YR 6/4) and brownish-yellow (10YR 6/8), very fine-grained sand, thinly laminated, trace subvertical clay veins, completely weathered bedrock, slightly moist, very stiff	ML	9, 11, 19, 34	44	4.5		58	38	
6, 7	1K-4 M	2, 1	**BEDROCK: MONTEREY FORMATION SILTSTONE:** Light yellowish-brown (10YR 6/4) and brownish-yellow (10YR 6/8), very fine-grained sand, thinly laminated, trace subvertical clay veins, moderately severely weathered, slightly moist, very soft rock hardness At 6' Lack of clay veins, closely fractured At 7' Yellowish-brown (10YR 5/4) and dark gray (10YR 4/1) and white (2.5Y 8/1), moderately hard At 8' Trace subvertical dark gray clay veins, severely to very severely weathered		18, 49, 40, 50/3"	50/3"	4.3	32	64	48	0.0% Gravel 90.1% Sand 9.9% Fines
8, 9	1K-5 T				34, 29, 31, 24	55					
10, 11	1K-6 T				42, 50/6"	50/6"		12		40	0.0% Gravel 90.1% Sand 9.9% Fines
12–23			Boring terminated at 11 feet. No groundwater encountered. NOTE: Sampling was performed in 24 inch long drives. No drilling was performed between samples.								

Pacific Crest ENGINEERING INC

Log of Test Borings
Lompico Tank Sites
Santa Cruz County, California

Figure No. 8
Project No. 1886
Date: 12/10/18

LOGGED BY CLA	DATE DRILLED 10/10/2018	BORING DIAMETER 3½" SS	BORING NO. 1M
DRILL RIG Minuteman with Tripod		HAMMER TYPE 140 lb Hammer & Cat Head	

Depth (feet)	Sample	Sample Type	Soil Description	USCS	Field Blow Counts	SPT "N" Value	Pocket Pen. (tsf)	% Passing #200 Sieve	Dry Density (pcf)	Moisture Content (%)	Additional Lab Results
	1M-1 L		**BEDROCK: BUTANO SANDSTONE:** Pink (7.5YR 7/4), very fine- to fine-grained with trace medium grains, poorly-graded, quartz rich, trace thin subvertical siltstone, very fine-grained sandstone beds, slightly moist, very soft rock hardness (friable), upper two feet weathered to a medium dense, silty sand		14						
1					23						
		2			26						
2		1			22	25		24	113	6	
	1M-2 L				20						
3					26						
		2	Moderately weathered, scattered mica flakes		29						
4		1			34	32			110	9	
	1M-3 M				31						
5					37						
		2			47						
6		1			60/5"	60/5"			113	9	
	1M-4 T		Light brown (7.5YR 6/4) and pink (7.5YR 7/4), very friable, lack of subvertical bedding, moderate rock hardness		54						
7					34						
					25						
8					27	52					
	1M-5 T		Variegated white (WHITE 9/N2) and redish-yellow (7.5YR 6/8), slightly cemented, slightly moist to dry		26						
9					22						
					21						
10					19	40		42		10	
11			Boring terminated at 10 feet. No groundwater encountered. NOTE: Sampling was performed in 24 inch long drives. No drilling was performed between samples.								
12											
13											
14											
15											
16											
17											
18											
19											
20											
21											
22											
23											

LOGGED BY CLA	DATE DRILLED 10/10/2018	BORING DIAMETER 3½" SS	BORING NO. 1L
DRILL RIG Minuteman with Tripod		HAMMER TYPE 140 lb Hammer & Cat Head	

Depth (feet)	Sample	Sample Type	Soil Description	USCS	Field Blow Counts	SPT "N" Value	Pocket Pen. (tsf)	% Passing #200 Sieve	Dry Density (pcf)	Moisture Content (%)	Additional Lab Results
0–2	1L-1 L	2, 1	**FILL: SAND WITH SILT:** Light yellowish-brown (2.5Y 6/3), fine- to medium-grained, sub-rounded shaped, poorly-graded, quartz rich, poorly indurated, few rootlets, dry, loose	SP-SM	3, 3, 3, 4	4		10	89	5	
2–4	1L-2 L	2, 1	Sand fines slightly with depth, sub-rounded sandstone gravel up to ½" in diameter at 3½'		3, 5, 7, 10	9		10	92	4	
4–6	1L-3 L	2, 1	**NATIVE: SILTY SAND:** Light yellowish-brown (2.5Y 6/3), fine- to medium-grained, sub-rounded shaped, poorly-graded, quartz rich, poorly indurated, slightly moist to dry, medium dense	SM	7, 7, 10, 11	17					
6–8	1L-4 L	2, 1	Light yellowish-brown (2.5Y 6/3) and yellowish-brown (10YR 5/4), fine-grained		12, 12, 14, 15	23		16		6	
8–10	1L-5 L	2, 1	**BEDROCK: SANTA MARGARITA SANDSTONE:** Pale brown (2.5Y 7/4 & 7/3), fine-grained, poorly-graded, quartz rich, massive, friable, moderately to slightly weathered, slightly moist, very soft rock hardness		12, 12, 15, 15	30					
10–12	1L-6 L	2, 1	Pale brown (2.5Y 7/4 & 7/3) and white (2.5Y 8/1), dense		21, 22, 24, 26	50					
12–23			Boring terminated at 12 feet. No groundwater encountered. NOTE: Sampling was performed in 24 inch long drives. No drilling was performed between samples.								

Pacific Crest ENGINEERING INC

Log of Test Borings
Lompico Tank Sites
Santa Cruz County, California

Figure No. 10
Project No. 1886
Date: 12/10/18

LOGGED BY CLA | DATE DRILLED 10/10/2018 | BORING DIAMETER 3½" SS | BORING NO. 2L

DRILL RIG Minuteman with Tripod | HAMMER TYPE 140 lb Hammer & Cat Head

Depth (feet)	Sample	Sample Type	Soil Description	USCS	Field Blow Counts	SPT "N" Value	Pocket Pen. (tsf)	% Passing #200 Sieve	Dry Density (pcf)	Moisture Content (%)	Additional Lab Results
	2L-1 L		**NATIVE: SAND WITH SILT:** Brown (10YR 4/3), light yellowish-brown (2.5Y6/4) and brownish-yellow (10YR 6/8), fine- to medium-grained, sub-rounded shaped, poorly-graded, quartz rich, poorly indurated, slightly moist to dry, loose	SP-SM	2						
1					4						
		2			6						
2		1			11	9		6	96	4	
	2L-2 L		Light yellowish-brown (2.5Y6/4), medium dense		10						
3					11						
		2			15						
4		1			16	16			97	3	
	2L-3 L		No sample recovered. Recovered sample using sand catcher, highly disturbed. (Tsm?)		21						
5					21						
		2			22						
6		1			25	38					
	2L-4 L		**BEDROCK: SANTA MARGARITA SANDSTONE:** Pale brown (2.5Y 8/3), fine-grained, poorly-graded, quartz rich, massive, manganese oxide staining, slightly moist to dry, very soft rock hardness		21						
7					21						
		2			22						
8		1			25	43			98	7	
	2L-5 L				18						
9					17						
		2			19						
10		1			19	38		14		8	
	2L-6 L				19						
11					18						
		2			19						
12		1			25	44					

Boring terminated at 12 feet. No groundwater encountered.

NOTE: Sampling was performed in 24 inch long drives. No drilling was performed between samples.

13 14 15 16 17 18 19 20 21 22 23

APPENDIX B

Haro Kasunich & Associates (2012) Log of Test Borings

PRIMARY DIVISIONS			GROUP SYMBOL	SECONDARY DIVISIONS
COARSE GRAINED SOILS MORE THAN HALF OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	GRAVELS 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.
	SANDS 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 mixtures, non-plastic fines.
			SC	Clayey sands, sand-clay mixtures, plastic fines.
FINE GRAINED SOILS MORE THAN HALF OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE	SILTS AND CLAYS LIQUID LIMIT IS 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 LIQUID LIMIT IS 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.

GRAIN SIZES

U.S STANDARD SERIES SIEVE — CLEAR SQUARE SIEVE OPENINGS

	200	40	10	4	3/4"	3"	12"
SILTS AND CLAYS	SAND			GRAVEL		COBBLES	BOULDERS
	FINE	MEDIUM	COARSE	FINE	COARSE		

RELATIVE DENSITY

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

CONSISTENCY

SILTS AND CLAYS	STRENGTH**	BLOWS/FT*
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

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

**Unconfined compressive strength in tons/ft² as determined by laboratory testing or approximated by the standard penetration test (ASTM D-1586), pocket penetrometer, torvane, or visual observation

HARO, KASUNICH & ASSOCIATES	FIGURE NO. 6	KEY TO LOGS

Lompico-Kaski Tank Site

Haro, Kasunich & Associates, Inc.

PROJECT NO. SC10325

LOGGED BY CG | DATE DRILLED May 15, 2012 | BORING DIAMETER 4" | BORING NO. B-1

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	1-1 (L)		Dark brown black SILT with Clay (loam), roots, very moist, fim	MH	16		61	51.4	(1-1) Atterberg Limits LL = 61.6% PI = 19 (1-1) Qu = 1.85 ksf
	1-2 (T)		Yellow brown fine SILTSTONE (blocky) moist, hard	ML	31			49.1	
5									
10	1-3 (T)		Tan brown Sandy SILTSTONE, moist, very hard	ML	52/6"			39.1	
			Boring terminated at 10 feet						
15									
20									
25									
30									
35									

HARO, KASUNICH AND ASSOCIATES, INC.

BY: dk | FIGURE NO. 7

Haro, Kasunich & Associates, Inc.

Lompico-Kaski Tank Site

PROJECT NO. SC10325

LOGGED BY CG | DATE DRILLED May 15, 2012 | BORING DIAMETER 4" | BORING NO. B-2

Depth, ft.	Sample No. and type	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		Fill, Black brown SILT with Clay & roots very moist, stiff	MH					
	2-1 (L)			17		62	56.9	(2-1) GSA % Gravel = 10.5 % Sand = 14.9 % Silt = 49.4% Clay = 25.3 (2-1) Atterberg Limits LL = 69.7% PI = 24
	2-2 (T)	Mixed yellow brown SILTSTONE and dark brown Sandy SILT, very moist, stiff		13				
5	2-3 (L)	Mixed dark brown SILT with Clay and Siltstone clasts, very moist, stiff	ML	39			47.6	
	2-4 (T)	Native, Yellow brown weathered SILTSTONE, very moist, stiff	ML	15				
10	2-5 (T)	Yellow brown weathered SILTSTONE with trace of Clay, very moist, stiff	ML	16			50.8	
	2-6 (L)			31		67	39.3	(2-6) Qu = 2.29 ksf
	2-7 (T)	Brown blocky SILTSTONE with orange stains, very moist, hard	ML	39			42.7	
15		Boring terminated at 15 feet						
20								
25								
30								
35								

HARO, KASUNICH AND ASSOCIATES, INC.

BY: dk | FIGURE NO. 8

Haro, Kasunich & Associates, Inc.

Lompico-Kaski Tank Site

PROJECT NO. SC10325

LOGGED BY CG | DATE DRILLED May 15, 2012 | BORING DIAMETER 4" | BORING NO. B-3

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	3-1 (T)		Native, Dark brown Clayey SILT with Siltstone clasts, moist, medium dense	MH	17			49.6	
5	3-2 (T)		Mottled light and dark brown Clayey SILT with Siltstone clasts (very weathered bedrock) very moist, very stiff	ML	25			61.1	
	3-3 (T)		Light brown fractured SILTSTONE, moist, very stiff	ML	27			32.1	
10									
	3-4 (T)		Light brown fractured Sandy SILTSTONE, moist, very hard	ML	55			45.2	
15			Harder drilling from 15' - 17'						
			Light brown Sandy SILTSTONE, moist, hard	ML					
20	3-5 (T)		Light brown rust stained, lightly cemented SILTSTONE, moist-very moist, hard	ML	33				
			Boring terminated at 21.5 feet						
25									
30									
35									

HARO, KASUNICH AND ASSOCIATES, INC.

BY: dk | FIGURE NO. 9

Lompico-Madrone Tank Site

Haro, Kasunich & Associates, Inc.

PROJECT NO. SC10325

LOGGED BY CG   DATE DRILLED May 15, 2012   BORING DIAMETER 4"   BORING NO. B-4

Depth, ft.	Sample No. and type	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		Fill, brown and yellow Silty SAND with trace of Clay, very moist, loose	SM					
	4-1 (L)			9				(4-1) Atterberg Limits Non Plastic
	4-2 (T)			6			14.4	(4-1) GSA
		Brown uncemented Silty SAND with Sandstone clasts, very moist, loose	SM					% Sand = 69.0
5								% Silt = 24.2
	4-3 (T)	Native, Orange brown uncemented medium to coarse SAND with Silt, very moist, loose-medium dense	SM	8			13.7	% Clay = 6.7
	4-4 (L)			23		112	15.7	(4-4) Qu = 2.16 ksf
	4-5 (T)	Orange and light brown uncemented Silty SAND with trace Clay (weathered Sandstone) very moist, dense	SM	31			14.7	
10								
	4-6 (T)	White and orange weathered SANDSTONE and Siltstone, very moist, very dense	SM	50/3"				
15								
20		Light brown & orange SANDSTONE, moist, very dense	SM					
	4-7 (T)			50/6"			9.7	
		Boring terminated at 21.5 feet						
25								
30								
35								

HARO, KASUNICH AND ASSOCIATES, INC.

BY: dk   FIGURE NO. 10

Lompico-Madrone Tank Site

Haro, Kasunich & Associates, Inc.

PROJECT NO. SC10325

LOGGED BY CG | DATE DRILLED May 15, 2012 | BORING DIAMETER 4" | BORING NO. B-5

Depth, ft.	Sample No. and type	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		Fill, brown SAND with SILT, very moist, loose	SM					
	5-1 (L)			11		109	16.1	(5-1) GSA % Sand = 60.0 % Silt = 29.4 % Clay = 10.6
	5-2 (T)	Native, Orange uncemented Silty SAND (weathered Sandstone) very moist, loose	SM	8			16.4	
5								
	5-3 (T)	Orange, uncemented Silty SAND (weathered Sandstone) very moist, medium dense	SM	15			9.2	
10	5-4 (T)	Orange & light brown slightly cemented SAND, (less weathered Sandstone), very moist, medium dense	SM	24			13.0	
15	5-5 (T)	Orange brown slightly cemented SAND, very moist, dense		36			9.4	
		Boring terminated at 16.5 feet						
20								
25								
30								
35								

HARO, KASUNICH AND ASSOCIATES, INC.

BY: dk | FIGURE NO. 11

Haro, Kasunich & Associates, Inc.

Lompico-Lewis Tank Site

PROJECT NO. SC10325

LOGGED BY CG | DATE DRILLED May 16, 2012 | BORING DIAMETER 6" | BORING NO. B-6

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			Brown Silty SAND (colluvium), damp, loose	SM					
	6-1 (L)				10		106	4.3	(6-1) GSA% Sand = 90.7 % Fines = 9.3
	6-2 (T)		Brown Silty SAND, moist, loose	SP-SM	7				
5			Yellow brown SAND with Silt (colluvium) moist, loose	SM					
	6-3 (L)				16		105	7.3	
	6-4 (T)		Medium dense at 7 feet		15				
10	6-5 (T)		Very light brown Silty SAND with slight orange stains, moist, medium dense	SM	22			8.4	
15	6-6 (T)		Very light brown (white) with orange stains, moist, dense	SM	35			9.2	(6-6) GSA % Sand = 85.5 % Fines = 14.5
20	6-7 (T)		Very light brown Silty SAND with orange stains, moist, dense	SM	30			8.6	
25	6-8 (T)		Very light brown Silty SAND with orange stains with angular 1/2" to 1" diameter Gravels, moist, very loose	SM	1			8.9	
	6-9 (T)				1			9.3	
30	6-10 (T)		Very light brown SAND with orange stains, moist, dense	SM	28			9.8	
	6-11 (T)				31				
			Boring terminated at 31.0 feet						
35									

HARO, KASUNICH AND ASSOCIATES, INC.

BY: dk | FIGURE NO. 12

Lompico-Lewis Tank Site

PROJECT NO. SC10325

LOGGED BY CG | DATE DRILLED May 16, 2012 | BORING DIAMETER 4" | BORING NO. B-8

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			Brown Silty SAND with roots (colluvium), damp, very loose	SM					
5	B-1 (T)				5		6.4		
			Color change to yellow brown						
	B-2 (T)		Yellow brown SAND with Silt, moist, medium dense (Santa Margarita Formation)	SM	24				
10									
15	B-3 (T)		Very light brown Silty SAND with orange stains, moist, dense		35		10.5		
20			Same						
25	B-4 (T)		Very light brown Silty SAND orange stains, moist, very dense	SM	48		9.0		
30			Same						
35									

HARO, KASUNICH AND ASSOCIATES, INC.

BY: dk | FIGURE NO. 14

Haro, Kasunich & Associates, Inc.

Lompico-Lewis Tank Site

PROJECT NO. SC10325

LOGGED BY CG DATE DRILLED May 16, 2012 BORING DIAMETER 4" BORING NO. B-8

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
35	8-5 (T)		Very light brown Silty SAND with orange stains and pockets of orange Sand, moist, very dense	SM	60		16.8		
			Boring terminated at 36.5 feet						
40									
45									
50									
55									
60									
65									
70									

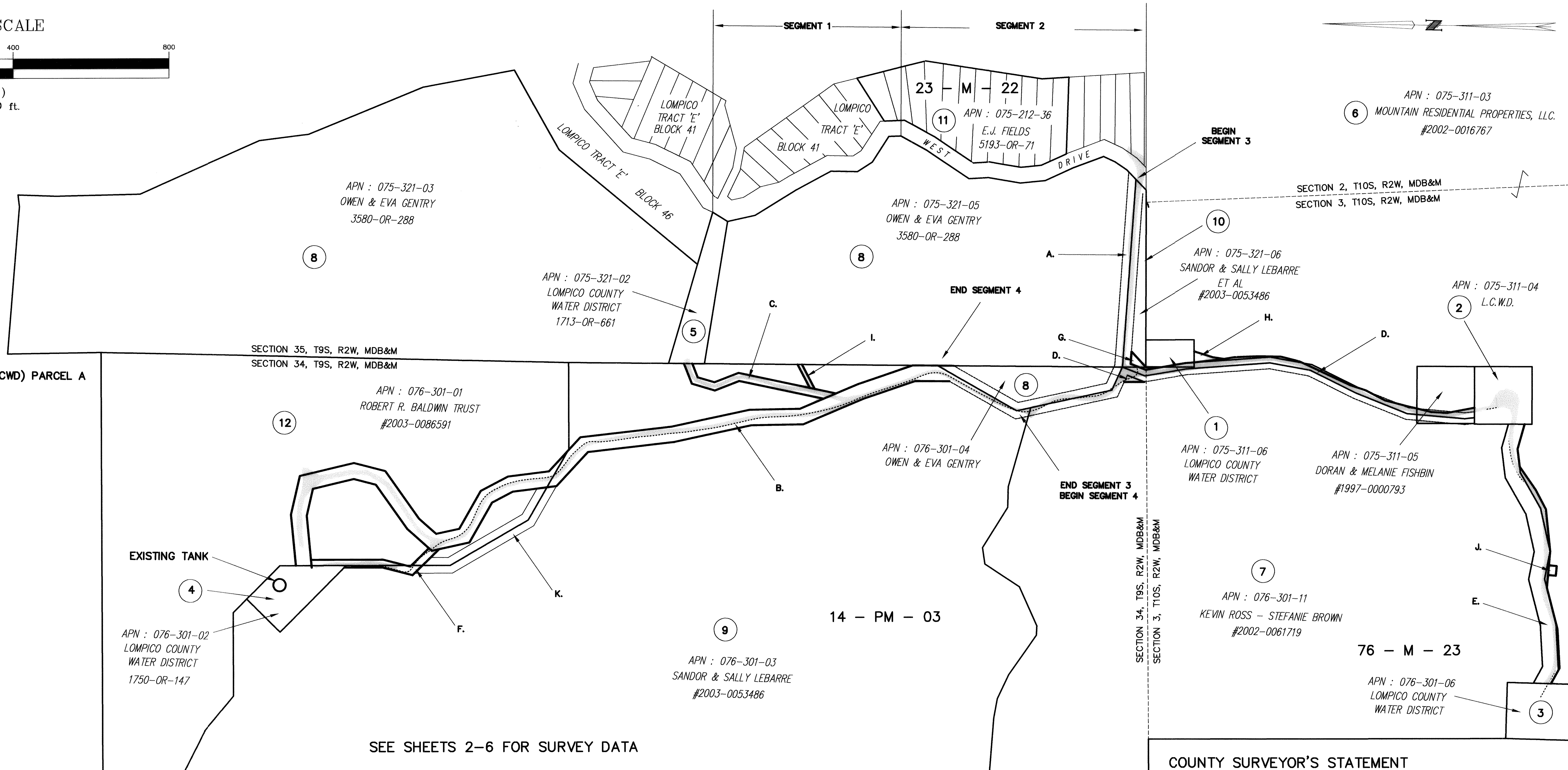
HARO, KASUNICH AND ASSOCIATES, INC.

BY: dk FIGURE NO. 15

GRAPHIC SCALE

200 0 100 200 400 800

(IN FEET)
1 inch = 200 ft.



SEE SHEETS 2–6 FOR SURVEY DATA

BASIS OF BEARINGS

BEARINGS ARE BASED UPON THE WESTERN BOUNDARY OF PARCEL 'B' AS SHOWN ON THAT MAP FILED IN VOLUME 14 OF PARCEL MAPS AT PAGE 3, SANTA CRUZ COUNTY RECORDS AND ESTABLISHED BETWEEN MONUMENTS FOUND AS SHOWN

= SOUTH 0°00'00" WEST

PARCEL DEFINITIONS AS DESIGNATED IN SETTLEMENT AGREEMENT

1 = LOMPICO COUNTY WATER DISTRICT (LCWD) PARCEL A
2 = LCWD PARCEL B
3 = LCWD PARCEL C
4 = LCWD UPPER TANK SITE
5 = LCWD FORMER TANK SITE
6 = MRP PROPERTY
7 = ROSS–BROWN PROPERTY
8 = GENTRY PROPERTY
9 = LeBARRE PROPERTY
10 = PARCEL 06
11 = FIELDS PROPERTY
12 = BALDWIN PROPERTY

EASEMENT DEFINITIONS AS DESIGNATED IN SETTLEMENT AGREEMENT

A. = GENTRY/06 RIGHT OF WAY
B. = UPPER ROADWAY EASEMENT
C. = FORMER TANK SITE EASEMENT
D. = PARCEL B TO PARCEL 06/GENTRY ACCESS AND UTILITY EASEMENT
E. = PARCEL C TO PARCEL B ACCESS AND UTILITY EASEMENT
F. = WATER LINE/UTILITY EASEMENT TO UPPER TANK SITE
G. = UTILITY EASEMENT TO NORTHERN BOUNDARY OF PARCEL A
H. = ELECTRIC LINE EASEMENT APPURTENANT TO PARCEL A
I. = TELEMETRY LINE EASEMENT
J. = DROP POLE/WATER METER EASEMENT
K. = NORTHERLY SEGMENT OF UPPER TANK SITE RIGHT OF WAY

ROAD SEGMENT DEFINITIONS AS DESIGNATED IN ROAD MAINTENANCE AGREEMENT

I = SEGMENT 1
II = SEGMENT 2
III = SEGMENT 3
IV = SEGMENT 4

SURVEYOR'S STATEMENT

THIS MAP CORRECTLY REPRESENTS A SURVEY MADE BY ME OR UNDER MY DIRECTION IN CONFORMANCE WITH THE REQUIREMENTS OF THE PROFESSIONAL LAND SURVEYORS' ACT AT THE REQUEST OF LOMPICO COUNTY WATER DISTRICT IN MAY 2003.

(SIGNED AND SEALED) DATE: JUNE 8, 2004
CURT G. DUNBAR
PLS NO. 5615
RENEWAL DATE 9/30/2006

LICENSED LAND SURVEYOR CURT G. DUNBAR 5615 LICENSE RENEWAL DATE 30 SEPT 2006 STATE OF CALIFORNIA

COUNTY RECORDER'S STATEMENT

FILED THIS 14th DAY OF June, 2004, AT 8:50 AM.

IN VOLUME 106 OF MAPS AT PAGE 3, AT THE REQUEST OF LOMPICO COUNTY WATER DISTRICT
#2004-0042762

COUNTY RECORDER RICHARD W BEDAL

BY DEPUTY DARI AGNONE

COUNTY RECORDER OF SANTA CRUZ COUNTY CALIFORNIA

COUNTY SURVEYOR'S STATEMENT

THIS MAP HAS BEEN EXAMINED IN ACCORDANCE WITH SECTION 8766 OF THE PROFESSIONAL LAND SURVEYORS' ACT THIS 11th DAY OF JUNE 2004.

(SIGNED AND SEALED)
THOMAS L. BOLICH
COUNTY SURVEYOR LICENSE NO. 26862
MY LICENSE EXPIRES 03-31-05

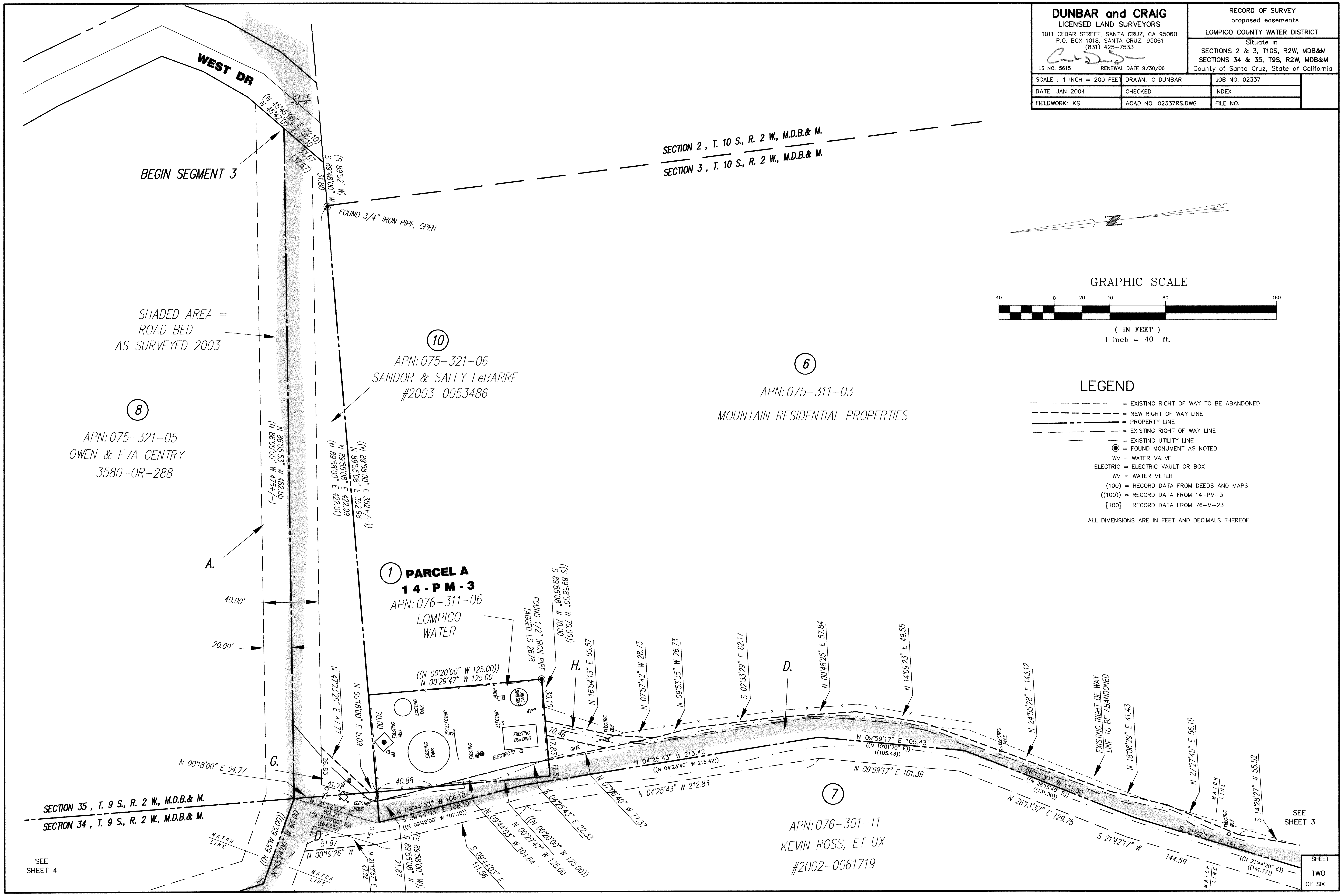
REGISTERED PROFESSIONAL ENGINEER THOMAS LeROY BOLICH No. 26862 CIVIL STATE OF CALIFORNIA

SURVEYOR'S NOTE

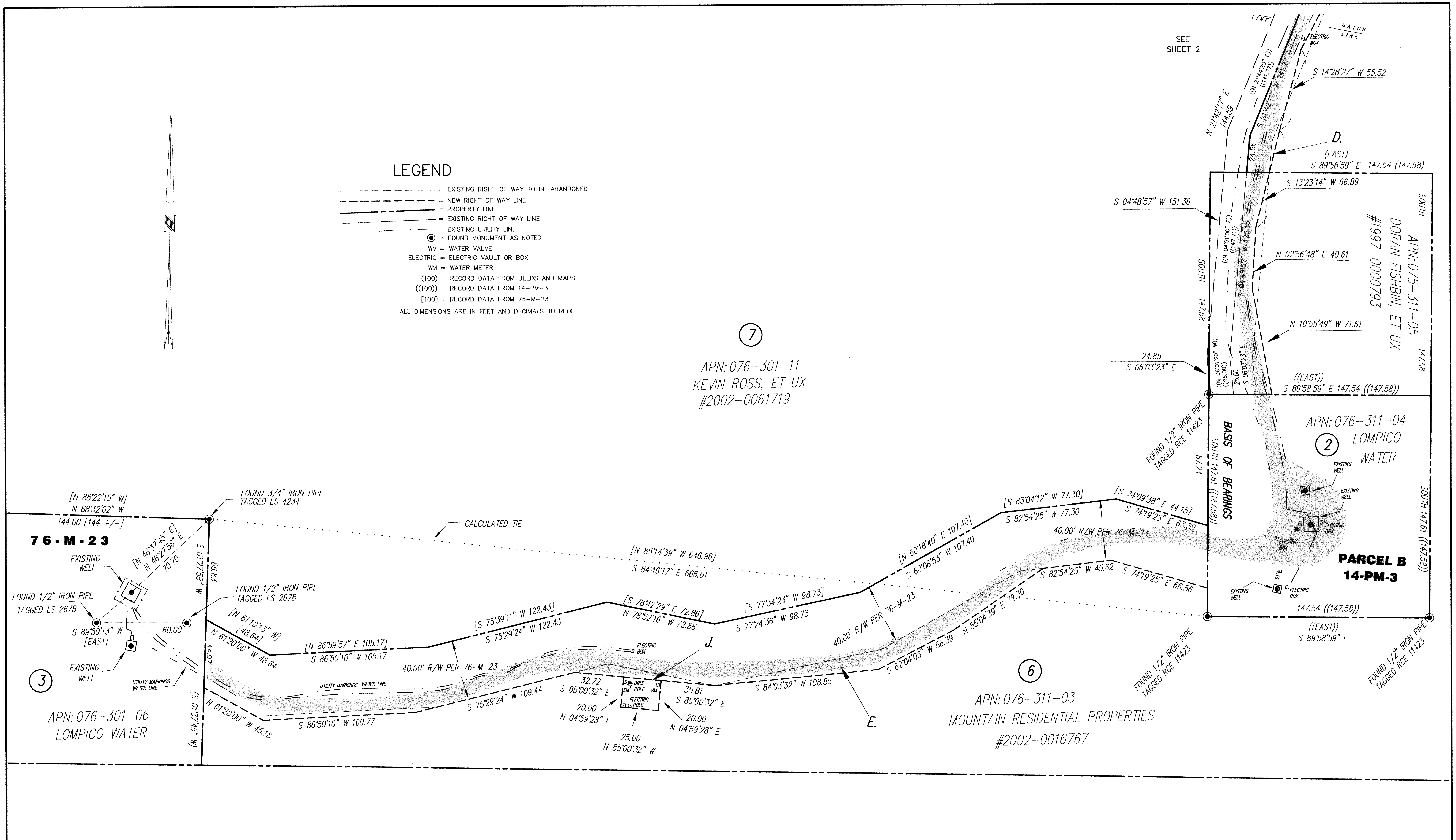
THIS MAP IS REFLECTIVE OF A SETTLEMENT AGREEMENT AND ROAD MAINTENANCE AGREEMENT ARRIVED AT THROUGH ARBITRATION. THE SETTLEMENT AGREEMENT AND ROAD MAINTENANCE AGREEMENT SHALL BE RECORDED IN SANTA CRUZ COUNTY OFFICIAL RECORDS AND WILL REFERENCE THIS MAP.

DUNBAR and CRAIG LICENSED LAND SURVEYORS 1011 CEDAR STREET, SANTA CRUZ, CA 95060 P.O. BOX 1018, SANTA CRUZ, 95061 (831) 425-7533 LS NO. 5615 RENEWAL DATE 9/30/06	RECORD OF SURVEY proposed easements LOMPICO COUNTY WATER DISTRICT Situate in SECTIONS 2 & 3, T10S, R2W, MDB&M SECTIONS 34 & 35, T9S, R2W, MDB&M County of Santa Cruz, State of California		
SCALE : 1 INCH = 200 FEET	DRAWN: C DUNBAR	JOB NO. 02337	SHEET
DATE: JAN 2004	CHECKED	INDEX	ONE
FIELDWORK: KS	ACAD NO. 02337RS.DWG	FILE NO.	OF SIX

BM 38 & 49


DUNBAR and CRAIG
LICENSED LAND SURVEYORS
1011 CEDAR STREET, SANTA CRUZ, CA 95060
P.O. BOX 1018, SANTA CRUZ, 95061
(831) 425-7533
LS NO. 5615
RENEWAL DATE 9/30/06
RECORD OF SURVEY
proposed easements
LOMPICO COUNTY WATER DISTRICT
Situate in
SECTIONS 2 & 3, T10S, R2W, MDB&M
SECTIONS 34 & 35, T9S, R2W, MDB&M
County of Santa Cruz, State of California
SCALE : 1 INCH = 200 FEET
DRAWN: C DUNBAR
JOB NO. 02337
DATE: JAN 2004
CHECKED
INDEX
FIELDWORK: KS
ACAD NO. 02337RS.DWG
FILE NO.
GRAPHIC SCALE
(IN FEET)
1 inch = 40 ft.
LEGEND
= EXISTING RIGHT OF WAY TO BE ABANDONED
= NEW RIGHT OF WAY LINE
= PROPERTY LINE
= EXISTING RIGHT OF WAY LINE
= EXISTING UTILITY LINE
= FOUND MONUMENT AS NOTED
WV = WATER VALVE
ELECTRIC = ELECTRIC VAULT OR BOX
WM = WATER METER
(100) = RECORD DATA FROM DEEDS AND MAPS
((100)) = RECORD DATA FROM 14-PM-3
[100] = RECORD DATA FROM 76-M-23
ALL DIMENSIONS ARE IN FEET AND DECIMALS THEREOF
WEST DR
BEGIN SEGMENT 3
SECTION 2, T. 10 S., R. 2 W., M.D.B.& M.
SECTION 3, T. 10 S., R. 2 W., M.D.B.& M.
FOUND 3/4" IRON PIPE, OPEN
SHADED AREA = ROAD BED AS SURVEYED 2003
10
APN: 075-321-06
SANDOR & SALLY LeBARRE
#2003-0053486
6
APN: 075-311-03
MOUNTAIN RESIDENTIAL PROPERTIES
8
APN: 075-321-05
OWEN & EVA GENTRY
3580-OR-288
1 PARCEL A
14-PM-3
APN: 076-311-06
LOMPICO WATER
FOUND 1/2" IRON PIPE TAGGED LS 2678
EXISTING TANK
EXISTING WELL
EXISTING BUILDING
7
APN: 076-301-11
KEVIN ROSS, ET UX
#2002-0061719
EXISTING RIGHT OF WAY LINE TO BE ABANDONED
SECTION 35, T. 9 S., R. 2 W., M.D.B.& M.
SECTION 34, T. 9 S., R. 2 W., M.D.B.& M.
SEE SHEET 4
SEE SHEET 3
MATCH LINE
SHEET TWO OF SIX

BM 38 & 49



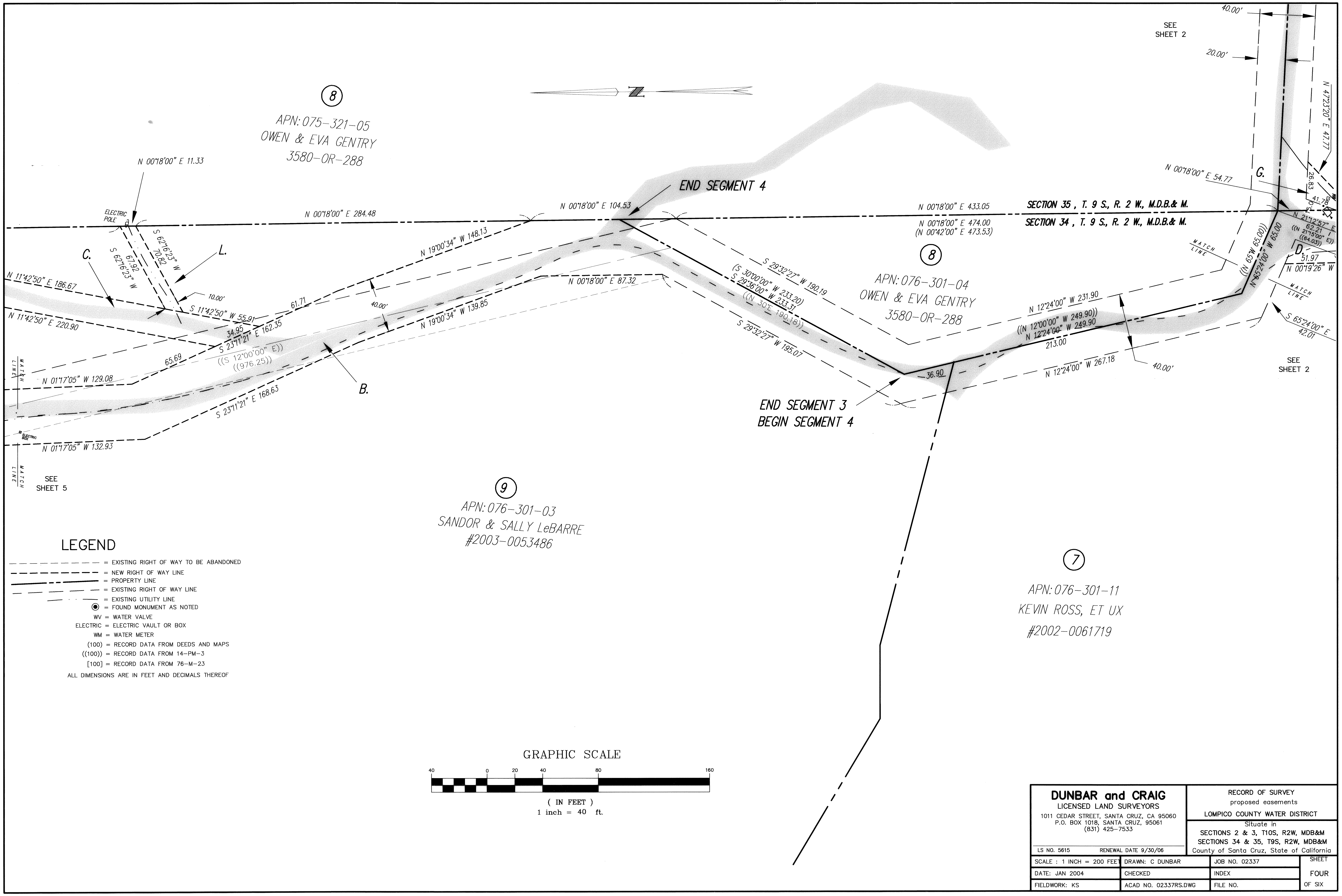
GRAPHIC SCALE

40 0 20 40 80 160

(IN FEET)
1 inch = 40 ft.

DUNBAR and CRAIG LICENSED LAND SURVEYORS 1011 CEDAR STREET, SANTA CRUZ, CA 95060 P.O. BOX 1018, SANTA CRUZ, 95061 (831) 425-7533 LS NO. 5615 RENEWAL DATE 9/30/06		RECORD OF SURVEY proposed easements LOMPICO COUNTY WATER DISTRICT Situate in SECTIONS 2 & 3, T10S, R2W, MDB&M SECTIONS 34 & 35, T9S, R2W, MDB&M County of Santa Cruz, State of California	
SCALE : 1 INCH = 200 FEET	DRAWN: C DUNBAR	JOB NO. 02337	SHEET
DATE: JAN 2004	CHECKED	INDEX	THREE
FIELDWORK: KS	ACAD NO. 02337RS.DWG	FILE NO.	OF SIX

BM 38 & 49



SEE SHEET 2
40.00'
20.00'
N 47°23'20" E 47.77
N
8
APN: 075-321-05
OWEN & EVA GENTRY
3580-OR-288
N 00°18'00" E 11.33
ELECTRIC POLE
N 00°18'00" E 284.48
N 00°18'00" E 104.53
END SEGMENT 4
N 00°18'00" E 433.05
N 00°18'00" E 474.00
(N 00°42'00" E 473.53)
N 00°18'00" E 54.77
G.
SECTION 35 , T. 9 S., R. 2 W., M.D.B.& M.
SECTION 34 , T. 9 S., R. 2 W., M.D.B.& M.
26.83
41.78
N 21°12'57" E
62.21
((N 21°15'00" E))
((64.03))
D.
51.97
N 00°19'26" W
MATCH LINE
((N 65°W 65.00))
N 65°24'00" W 65.00
S 65°24'00" E
42.01
SEE SHEET 2
C.
L.
S 62°16'23" W
67.92
S 62°16'23" W
70.82
10.00'
N 11°42'50" E 186.67
N 11°42'50" E 220.90
S 11°42'50" W 55.91
61.71
34.95
S 23°11'21" E 162.35
((S 12°00'00" E))
((976.25))
65.69
N 19°00'34" W 148.13
40.00'
N 19°00'34" W 139.85
N 00°18'00" E 87.32
S 29°32'27" W 190.19
(S 30°00'00" W 233.20)
S 29°36'00" W 233.31
((N 30°E 190.18))
S 29°32'27" W 195.07
8
APN: 076-301-04
OWEN & EVA GENTRY
3580-OR-288
N 12°24'00" W 231.90
((N 12°00'00" W 249.90))
N 12°24'00" W 249.90
213.00
40.00'
N 12°24'00" W 267.18
36.90
END SEGMENT 3
BEGIN SEGMENT 4
B.
MATCH LINE
N 01°17'05" W 129.08
S 23°11'21" E 168.63
ELECTRIC BOX
N 01°17'05" W 132.93
MATCH LINE
SEE SHEET 5
9
APN: 076-301-03
SANDOR & SALLY LeBARRE
#2003-0053486
7
APN: 076-301-11
KEVIN ROSS, ET UX
#2002-0061719
LEGEND
= EXISTING RIGHT OF WAY TO BE ABANDONED
= NEW RIGHT OF WAY LINE
= PROPERTY LINE
= EXISTING RIGHT OF WAY LINE
= EXISTING UTILITY LINE
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((100)) = RECORD DATA FROM 14-PM-3
[100] = RECORD DATA FROM 76-M-23
ALL DIMENSIONS ARE IN FEET AND DECIMALS THEREOF
GRAPHIC SCALE
40 0 20 40 80 160
(IN FEET)
1 inch = 40 ft.
DUNBAR and CRAIG
LICENSED LAND SURVEYORS
1011 CEDAR STREET, SANTA CRUZ, CA 95060
P.O. BOX 1018, SANTA CRUZ, 95061
(831) 425-7533
LS NO. 5615 RENEWAL DATE 9/30/06
RECORD OF SURVEY
proposed easements
LOMPICO COUNTY WATER DISTRICT
Situate in
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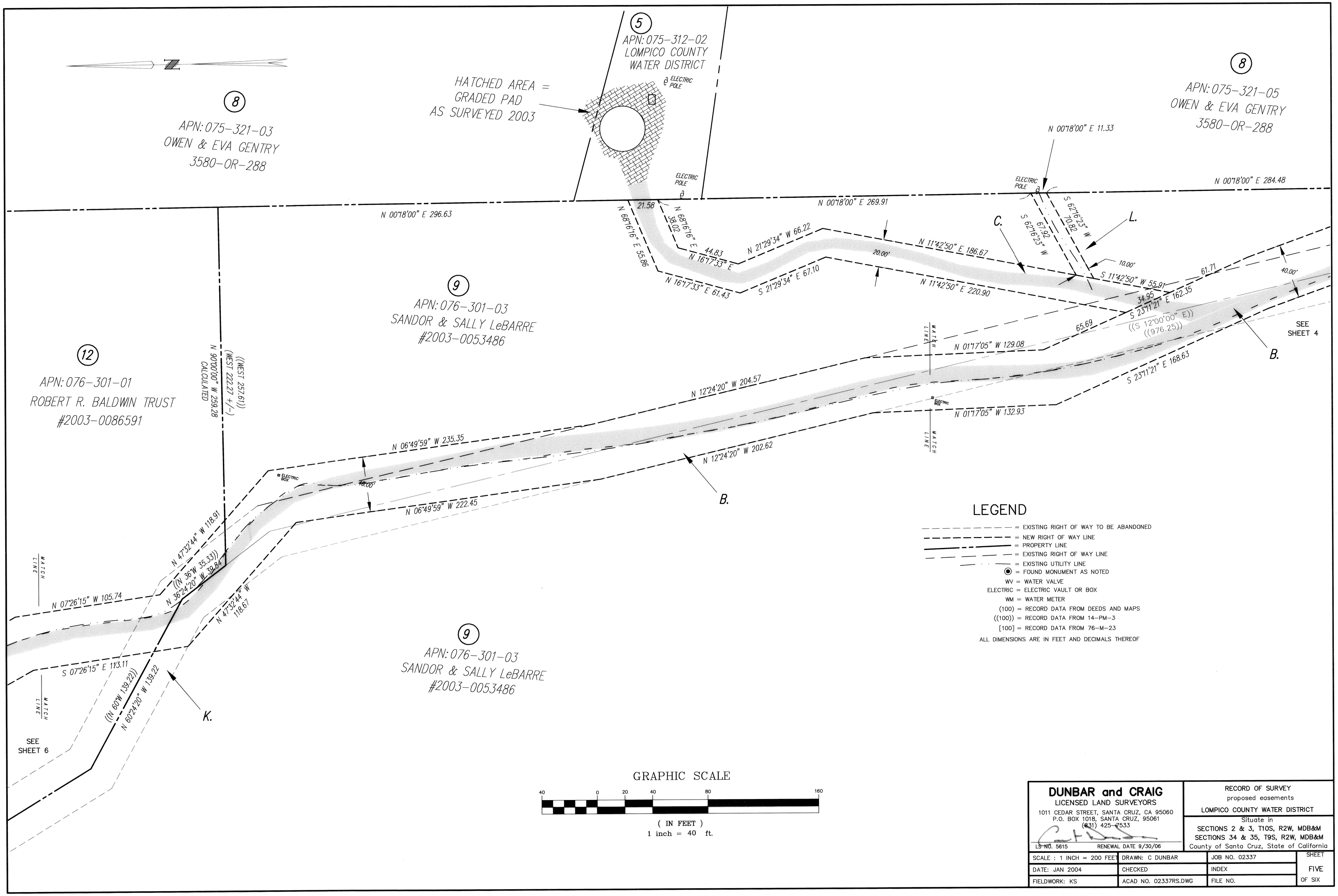
SECTIONS 34 & 35, T9S, R2W, MDB&M
County of Santa Cruz, State of California
SCALE : 1 INCH = 200 FEET
DRAWN: C DUNBAR
JOB NO. 02337
SHEET
DATE: JAN 2004
CHECKED
INDEX
FOUR
FIELDWORK: KS
ACAD NO. 02337RS.DWG
FILE NO.
OF SIX

BM 38 & 49


N
5
APN: 075-312-02
LOMPICO COUNTY
WATER DISTRICT
ELECTRIC POLE
HATCHED AREA =
GRADED PAD
AS SURVEYED 2003
8
APN: 075-321-03
OWEN & EVA GENTRY
3580-OR-288
8
APN: 075-321-05
OWEN & EVA GENTRY
3580-OR-288
N 00°18'00" E 11.33
N 00°18'00" E 284.48
N 00°18'00" E 269.91
N 00°18'00" E 296.63
21.58
N 68°16'16" E 55.86
N 68°16'16" E 38.02
44.83
N 16°17'33" E
N 16°17'33" E 61.43
N 21°29'34" W 66.22
S 21°29'34" E 67.10
N 11°42'50" E 186.67
N 11°42'50" E 220.90
20.00'
C.
L.
S 62°16'23" W 67.92
S 62°16'23" W 70.82
10.00'
S 11°42'50" W 55.91
61.71
40.00'
34.95
S 23°11'21" E 162.35
((S 12°00'00" E))
((976.25))
65.69
SEE SHEET 4
B.
S 23°11'21" E 168.63
9
APN: 076-301-03
SANDOR & SALLY LeBARRE
#2003-0053486
12
APN: 076-301-01
ROBERT R. BALDWIN TRUST
#2003-0086591
((WEST 257.61))
(WEST 222.27 +/-)
N 90°00'00" W 259.28
CALCULATED
N 01°17'05" W 129.08
N 01°17'05" W 132.93
MATCH LINE
N 12°24'20" W 204.57
N 12°24'20" W 202.62
N 06°49'59" W 235.35
N 06°49'59" W 222.45
ELECTRIC BOX
16.00'
B.
N 47°32'44" W 118.91
((N 36°W 35.33))
N 36°24'20" W 39.84
N 47°32'44" W 118.67
N 07°26'15" W 105.74
S 07°26'15" E 113.11
MATCH LINE
((N 60°W 139.22))
N 60°24'20" W 139.22
K.
SEE SHEET 6
9
APN: 076-301-03
SANDOR & SALLY LeBARRE
#2003-0053486
LEGEND
= EXISTING RIGHT OF WAY TO BE ABANDONED
= NEW RIGHT OF WAY LINE
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County of Santa Cruz, State of California
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DRAWN: C DUNBAR
JOB NO. 02337
SHEET
DATE: JAN 2004
CHECKED
INDEX
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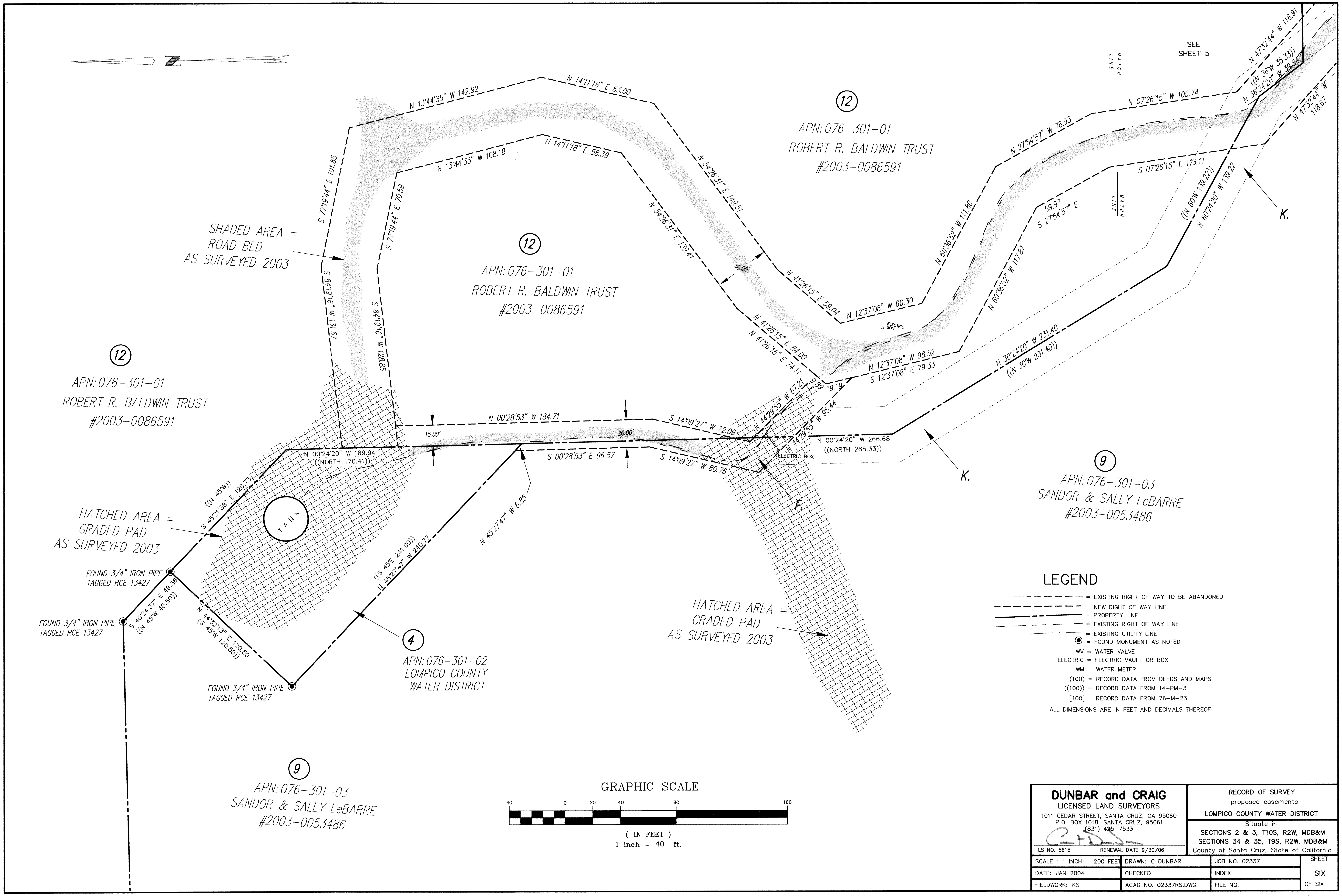
FIELDWORK: KS
ACAD NO. 02337RS.DWG
FILE NO.
OF SIX

Bm 38 & 49



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LS NO. 5615 RENEWAL DATE 9/30/06

RECORD OF SURVEY
proposed easements
LOMPICO COUNTY WATER DISTRICT
Situate in
SECTIONS 2 & 3, T10S, R2W, MDB&M
SECTIONS 34 & 35, T9S, R2W, MDB&M
County of Santa Cruz, State of California

SCALE : 1 INCH = 200 FEET	DRAWN: C DUNBAR	JOB NO. 02337	SHEET
DATE: JAN 2004	CHECKED	INDEX	SIX
FIELDWORK: KS	ACAD NO. 02337RS.DWG	FILE NO.	OF SIX

Bm 38 & 49

Schaaf & Wheeler
CONSULTING CIVIL ENGINEERS

1171 Homestead Rd., Suite 255
Santa Clara, CA 95050-5485
t. 408-246-4848
f. 408-246-5624
s&w@swsv.com

DRAFT BASIS OF DESIGN MEMORANDUM

TO:	Rick Rogers San Lorenzo Valley Water District 13060 Highway 9 Boulder Creek, CA 95006	DATE:	January 11, 2018
FROM:	Logan Fox, PE, and Andrew Sterbenz, PE	JOB#:	SLVW.01.18
SUBJECT:	Lompico Water Tanks Replacement Project		

This memorandum has been prepared for the San Lorenzo Valley Water District (SLVWD) to document the considerations used as a basis of design for the Lompico Water Tanks Replacement Project. The main objective of this project is to replace existing redwood, potable water storage tanks which are nearing the end of their service lives with new storage tanks built to current standards. Existing site infrastructure will be removed and site improvements will be made to provide SLVWD with functional tank sites.

Project Summary

The San Lorenzo Valley Water District serves the Lompico community in Santa Cruz County with approximately 498 residential services. The Lompico water system is supplied from the SLVWD's Quail Zone via the Lompico Booster Pump Station. The Lompico water system consists of a network of 4-inch and 6-inch water mains, three water tank sites, a booster pump station, and six PRV (pressure reducing valve) stations. The work of the Lompico Water Tanks Replacement Project will occur at the three water tank sites: Lewis, Kaski, and Madrone.

Lewis Tank Site

The site currently contains one 100,000 gallon (nominal) redwood tank that is approximately 30 feet in diameter and 20 feet tall. The tank sits on mudsill beams placed on a compacted aggregate foundation (per the 1977 design drawings). The site also includes facilities that are no longer in use, including a water well, a building containing a water treatment system and associated electrical equipment, three approximately 5.5-foot diameter steel pressure vessels and an aeration tower from the old treatment system. SLVWD would like to increase the storage at this site from 100,000 gallons to 200,000 gallons.

The Lewis site is located on a ridgeline, but not on a narrow ridge crest. The on-site soils are 6 to 8 feet of loose sand over sandstone bedrock. The current fence is on the property boundary (70' x 125' lot, APN 076-311-06), and the west parcel boundary abuts an existing access and utility easement. A temporary construction easement may be required for the adjacent parcel along the north boundary, which sits between the District parcel and the West Drive right-of-way.

The site is in the Sandhills habitat zone.

Kaski Tank Site

The site currently contains two 60,000 gallon (nominal) redwood tanks that are about 24 feet in diameter and about 18 feet tall. The tanks sit on concrete ringwall foundations. The Kaski site is a shelf cut into the hillside with limited work area around the tanks. The on-site soils are 3 to 5 feet of silty clay over siltstone bedrock. The site sits on the southeast edge of a 1.05 acre District-owned parcel (APN 074-261-09). The parcel slopes downhill to the northwest.

The site has redwood trees on three sides, some overhanging the fence. If any of these were to fall, they could destroy the current wooden tanks and damage the future steel tanks. It is recommended that an arborist assess the trees along the project limits and determine if any should be removed a part of the work.

Madrone Tank Site

The site currently contains two 60,000 gallon (nominal) redwood tanks that are about 26 feet in diameter and about 19 feet tall. The tanks sit on concrete ringwall foundations. The Madrone site is on the crest of a ridge, sloping away on three sides. The site sits within a 0.52 acre District-owned parcel (APN 075-072-14), so there is available space outside the fence for staging and temporary tanks. The on-site soils are 0 to 6 feet of silty sand over sandstone bedrock.

Access Limitations

All of the Lomipco sites have limited access due to steep, single-lane roads with low overhead clearances. The private paved roads have posted weight limits of 10 tons. The tank sites have unpaved access roads which are susceptible to erosion in wet weather. The roadway conditions will be highlighted in the construction documents, and pre-bid site visits should be mandatory to prevent claims for difficult conditions during the construction.

Tank Type

The majority of new tanks constructed for public potable water storage in the region are made of steel. The steel tanks are constructed of welded steel plates or bolted steel plates according to the relevant AWWA (American Water Works Association) standards. Bolted steel tanks are SLVWD's preference for the Lompico tanks due to the lower cost compared to welded steel tanks for the sizes of the tanks included in this project. Tanks will be specified to meet the AWWA D103-09 Standard for Factory-Coated Bolted Carbon Steel Tanks for Water Storage.

Tank Foundation

There are multiple options for foundations for bolted steel water storage tanks. Concrete ringwall foundations are normally specified for public water tanks in the area. This foundation type is referred to as Type 1 "steel-bottom tanks supported on ringwalls" per AWWA D103-09 Section 13.4.1. Within the ringwall, the tank bottom sits on sand with a base rock subgrade. The concrete ringwall design will be prepared by the tank supplier. Based on the tank dimensions, anchoring of the tank to the concrete foundation will likely be required. Anchorage design will be determined by the tank supplier according to the requirements of AWWA D103-09.

Tank Sizing

Tanks must be sized to balance the need to have sufficient storage volume with the need to have sufficient turnover within the tank to ensure water quality is maintained. It is understood from SLVWD that the existing tank sizes have generally been sufficient to meet the domestic water demands of the service area. SLVWD has expressed that they would like to keep the existing storage capacity of two approximately 60,000 gallon tanks at each of the Kaski and Madrone sites. The Lewis zone has the highest water demand of the three Lompico system zones. SLVWD would like to increase the storage at this site from one 100,000 gallon tank to two 100,000 gallon tanks. The replacement of the tanks provides an opportune time to evaluate the tank sizes. The replacement tanks will be sized to provide storage for domestic uses and fire-suppression as well as additional storage as required by the operation and configuration of the tanks.

Fire Flow Storage

For each tank site, a fire storage volume of 60,000 gallons is planned. This corresponds to a fire-flow of 1,000 gpm for one hour as required for 0-3,600 square-feet one and two family dwellings. (2016 California Fire Code, Appendix B, Table B105.1(1)) The Lompico Water System is within the Zayante Fire Protection District service area. Schaaf & Wheeler contacted the district Fire Chief via telephone and confirmed that this fire flow is applicable to the system.

Domestic Storage

Domestic water storage will be provided for supply and domestic demand equalization as well as an allowance for emergency conditions. Equalization storage is required for any deficit of the reliable supply capacity to meet the maximum domestic demand of the service area (i.e., peak hour demand minus the supply rate from the Lompico booster pump station). Emergency storage is provided in the case there is a condition, such as a pipe break or supply pump failure, in which the normal water supply is not available to the system.

California Waterworks Standards require public water system's to have sufficient source capacity to meet the system's maximum day demand (MDD) at all times. The standard requires systems with less than 1,000 service connections to "have storage capacity equal to or greater than MDD, unless the system can demonstrate that it has an additional source of supply or has an emergency source connection that can meet the MDD requirement." (California Waterworks Standards per CCR Title 22, Division 4, Chapter 16, Section 64554). The calculation of MDD is included in the Tank Sizing Calculations which is attached to this memorandum as Appendix A.

Daily water usage data is not collected by SLVWD, so the MDD was calculated based on monthly water usage data. SLVWD provided the monthly water usage data from June 2016 to September 2018 in the service areas of the three Lompico tanks, which are included as Appendix B. The month of maximum usage during this period was multiplied by a peaking factor of 1.5 to determine the MDD in accordance with California Waterworks Standards as shown in Appendix A.

In areas where development is projected, additional storage capacity can be provided to meet projected future demand. Since significant development is not anticipated within the service area, no additional capacity has been included for this.

Additional Storage

Some additional storage above the normal fill level will be provided. This will allow the tank filling operational protocol to limit cycling of supply pumps and to provide an operating band that is sufficiently wide to prevent errors in controls due to any imprecise level measurement. The operating band will also be sized to achieve complete mixing within the tank if a hydrodynamic mixing system is used. (The use of hydrodynamic mixing systems is discussed later in this memorandum.)

A few inches of cushion between the design high water level and the tank overflow is included, so there is no overflow of water caused by fluctuations at the water surface due to turbulence of the tank filling or imprecise level measurement.

Tank sizing also considers the volume of water which is below the level that water can be drawn through the tank outlet. The total height of the tank includes the required freeboard to prevent water that sloshes during a seismic event from damaging the roof of the tank. The minimum freeboard requirement is calculated according to the AWWA D103-09 standard and accounts for site specific seismic and soil conditions. The freeboard calculation (provided in Appendix A) is based on design values from the Geotechnical Investigation report, which is provided as an attachment to this report.

Bolted steel tanks are available in a wide variety of diameters and heights within the capacity range of the Lompico Tanks. Tank dimensions were selected based on the available site area and the required storage volumes. Detailed tank sizing calculations are included in Appendix A. Tank sizes are summarized in the table below. The calculated storage volumes of 51,816 and 50,758 gallons for the Kaski and Madrone tanks respectively is smaller than the nominal capacity of the existing 60,000 gallon tanks. If SLVWD would like to maintain the use of two 60,000 gallons at each site, the tanks would be a few feet taller than shown in the table.

Tank Sizes

	Lewis	Kaski	Madrone
Tank Diameter (ft)	32.00	21.00	24.00
Tank Overflow Height (ft)	16.75	20.00	15.50
Nominal Tank Height (ft)	24.00	26.00	22.00
Single Tank Volume at Overflow (gal)	100,764	51,816	50,758
Normal Low Tank Level (ft)	14.50	17.75	12.75
Normal High Tank Level (ft)	16.50	19.75	14.75
Operating Range (ft)	2.00	2.00	2.00
Two Tank Operating Range (gal)	24,063	10,363	13,535
Tank Bottom Elevation	1,123.00	1,259.00	1,316.00
Normal Tank Low Level Elevation	1,137.50	1,276.75	1,328.75
Normal Tank High Level Elevation	1,139.50	1,278.75	1,330.75
Existing Tank High Water Elevation	1,141.50	1,277.00	1,331.20
Winter Residence Time (days)	12.1	20.1	57.6
Summer Residence Time (days)	3.5	7.5	13.0

SLVWD has indicated their preference to have two tanks at each site. Having two tanks allows one tank to remain in service when the other tank is taken out service for inspection or maintenance. However, a single, larger tank at each site was also considered due to the lower cost of construction compared with two, smaller tanks.

At the Kaski and Madrone sites, the existing site areas are roughly rectangular to accommodate the existing two-tank arrangement. Replacing the two existing tanks with a single, larger tank of similar height would require a diameter increase of approximately 10-feet. These sites are already have limited work space between the tanks and the fence, so increasing the diameter would require widening the site to allow a minimum of 8-feet between the tank and the fence. This would be an inefficient use of the available area, not fully utilizing the relatively flat area that has already been created and requiring additional earthwork.

The Lewis site is wider than the other sites, so a single 200,000 gallon tank with a nominal diameter of 46-feet could be accommodated. One or more short retaining walls would be required to provide a level work area around the tanks, due to the 10-ft change in elevation across the property.

Water storage tank sizing can have an impact on water quality. The influence of water age on water quality depends on the particular chemistry of the water, disinfectants used, and any constituents that may be present in the water system. The calculation of water age should consider the time from when water leaves a treated water source (such as a water treatment plant, or well head treatment system) to when it flows through customer services. Water systems, such as the Lompico system, that have a supply source that goes through multiple storage tanks can result in higher water ages in downstream portions of the system than in systems where the supply is located closer to the end users. In order to maintain water quality, systems should generally be operated to minimize water age while considering other operational constraints and priorities.

While the tanks sizes have been determined based on the demand during maximum water use periods (dry weather), it is also necessary to consider operation during low water use periods (wet weather). SLVWD should analyze the expected water age and any impacts on water quality in the Lompico system based on how the system operates during all seasons.

Site Demolition

At each of the three tank sites, all existing infrastructure will be removed. This includes the redwood tanks, chain-link fencing surrounding the sites, onsite water piping, and onsite tank drain piping. At the Kaski and Madrone sites, the existing tank concrete foundations will be removed. At the Lewis tank site, all facilities will be removed, including the tank, the existing well, and the treatment building.

Site Improvements

At all three sites, galvanized chain-link fence with three-strand barbed wire will be installed around the site perimeter. Within the fenced-in area, asphalt concrete pavement will be installed and sloped to drain away from the tank foundations. As required by the site topography, drainage swales will be installed outside of the fence to convey surface runoff to percolation areas. Preliminary site layouts are included as Appendix C to this memorandum.

Since tanks with larger diameter to height ratios are generally more economical in areas with relatively high seismic design parameters, tank diameters were maximized given the available site area and the desired clearances around each tank. SLVWD has expressed the desire to have eight feet of working area around each tank.

This working area of eight feet can be provided for the Lewis and Madrone utilizing tanks with a diameter to height ratio of greater than one to one. At these two sites, the required flat site area can be created with 2:1 slopes as shown in the Appendix C preliminary site layouts. However, the Kaski tanks would need to be limited to about 16 feet in diameter to have eight foot working clearances. This would result in the need for the Kaski tanks to be about 30 feet tall. In order to avoid the low tank diameter to height ratios, the working area was reduced to four feet in the Kaski Tank Option 1 preliminary site plan shown in Appendix C.

The Kaski tank site is a bench cut into the hillside, which could be extended within SLVWD's property to increase the available workspace. A conceptual site plan is shown as Kaski Option 2 in Appendix C. Widening the site as shown would require approximately 700 CY of cut, which would need to be off-hauled. This would accommodate the tanks with 8-ft clearance on all sides. It would also place both tank foundations over siltstone bedrock. The current southern tank is partially bedded on fill material.

A catch basin will be located adjacent to each tank to collect any water from the tank overflow. A tank drain connection with an isolation valve will also be provided near the catch basin to allow SLVWD to drain the tank if needed. There will be drain pipes exiting the catch basins and routed underground to daylight downhill of the tank sites. Drain pipes will discharge near the discharge locations of the existing drain pipes or as determined to be appropriate. Other drain inlets and drain pipes may be determined to be needed as the site layouts and grading design are developed.

Tank Level Controls

It is understood that the design of the controls and telemetry system for conveying water level signals from the tank is being prepared by SLVWD under a separate contract, and may be installed under a different construction contract than the Lompico Tanks Replacement Project. Information on all equipment to be mounted on the tank should be provided to Schaaf & Wheeler during the design so the tank can be equipped with appropriate appurtenances for the future installation. SLVWD should also provide Schaaf & Wheeler with information on any panels or other equipment to be installed at the tank sites for appropriate consideration in the site layouts.

It is understood that a single pressure transducer will provide level measurement at each tank. As the two tanks at each site will normally be operated together, the controls may be configured so that one transducer at each site will be used for control during normal operation. The level signal will be transmitted to control the filling of the tanks. For the Kaski and Madrone tanks, it is expected that the level signals will control the starting and stopping of the respective booster pump stations supplying these zones.

The Lompico system is supplied from the Zayante system via a booster pump feeding the Kaski zone. Water is boosted to the Madrone zone via a separate booster pump station. Water is fed into the Lewis zone through pressure reducing valves (PRVs). Under this arrangement, the Kaski tanks will drain first unless the system controls are configured to balance use across the zones. The PRVs feeding the Lewis zone should be configured as altitude valves, remaining closed until the Lewis zone pressure reflects the tanks at their low water setting, then opening to refill the tanks. The Madrone booster should operate on a similar two-limit pressure band, allowing the tank to drain by 2-feet and then refill.

Tank Mixing

California Waterworks Standards and proper potable water tank design require minimizing the short-circuiting of flow and stagnation of water in the tank. A level of protection from short-circuiting and stagnation can be achieved by locating the tank inlet towards the top of the tank and the tank outlet towards the bottom of the tank near the opposite side of the tank.

A higher level of protection can be achieved by utilizing a mechanical mixer or a hydrodynamic mixing system. Mechanical mixers, as the name implies, utilize electricity to mechanically mix tanks. (Options for mechanical mixers include a GridBee or SolarBee by Medora Corp or an Active Jet Mixer by PAX Water Technologies.) Hydrodynamic mixing systems are designed to utilize the energy from the tank inlet supply flow by concentrating the inflowing water in specific locations of the tank. The designers of hydrodynamic mixing systems conduct hydraulic analyses to determine the optimal system configuration to completely mix the tank on each fill cycle. SLVWD has indicated a preference for a hydrodynamic mixing system to avoid the need for electricity on the site. A conceptual piping layout for a hydrodynamic mixing system is included in Appendix D.

Onsite Water System Piping

At the exit from the each tank, an isolation valve and a force-balanced flexible expansion joint fitting will be installed above grade. From the expansion joint fitting, piping will be routed below grade to connect with the existing water main near the perimeter of the tank sites. The planned piping material is cement-lined ductile iron pipe (AWWA C151). If a hydrodynamic mixing system is used, fusion bonded epoxy lined and coated carbon steel pipe will be specified for the pipe internal to the tank.

Tank Hydraulics

The tank replacements will have minimal impacts on the system hydraulics. Based on the preliminary tank layouts, the new tank water levels will be within 2 feet of the existing tank water levels, or less than a 1 psi difference. New hydrodynamic mixing systems may 2 psi of pressure losses during tank filling and withdrawal. Actual losses through the hydrodynamic mixing system will be calculated by the system designer. The existing site piping will be replaced with pipe of the same diameter (6-inch ductile iron or 6-inch PVC), so there will be no significant hydraulic change due to site piping modifications.

Coating

AWWA D103-09 Section 12 includes the following generic coating systems: galvanized coatings, glass coatings, thermoset liquid suspension coatings, thermoset powder coatings. Thermoset powder coatings have mostly replaced the use of thermoset liquid suspension coatings and are the most common for public potable water systems. Glass coatings have been known to provide a longer service life. However, glass coated tanks are provided by a more limited number of tank manufacturers and the cost of the tanks are about 10% to 20% percent higher than for thermoset powder coated tanks. Another drawback of glass-coated tanks is that spot repair of coatings is not feasible, so entire tank panels need to be replaced in the event of coating damage. Thermoset powder coating can be spot-repaired if required. Schaaf & Wheeler recommends using thermoset powder coatings per AWWA D103-09 unless SLVWD has another preference.

Normally white color is used on the tank interior for ease of visual inspection. The exterior coating color may be a tan, green or other color preferred by SLVWD. Generally, in areas exposed to the sun, lighter colors are preferred to limit the heating of tanks and the associated potential for water stagnation within the tank.

Cathodic Protection

While the coating will provide protection against the corrosion of the steel tanks, sacrificial anode cathodic protection systems will be specified to provide additional protection of the interior submerged surfaces of each tank. Cathodic protection systems will be specified to conform to the requirements of the AWWA D106-16 Standard for Sacrificial Anode Cathodic Protection Systems for the Interior Submerged Surfaces of Steel Water Storage Tanks.

Tanks Accessories

The tanks will be designed to adhere to the California Code of Regulations (Title 22, Section 64585, Division 4, Chapter 16). Tanks will include the following accessories:

- Inlet and outlet pipe connections
- Overflow sized for the largest possible inflow
- Drain connection with valve
- Sampling ports at desired locations
- Port for pressure transducer
- Water level indicator for visual indication of level
- Roof vent
- Exterior ladder with safety cage
- Roof manway hatch with nearby safety railings
- Two shell manways

Well Destruction

SLVWD desires to destroy Well No. 5 at the Lewis Tank Site that is no longer being used. The driller's log for Well 5 was obtained from the DWR Well Completion Report Map Application, and is provided at Appendix E. The well is approximately 400-feet deep with an 8-inch screen and casing.

Wells fall under the jurisdiction of the California State Water Resources Control Board's Division of Drinking Water (DDW) through the Central Coast Regional Water Quality Control Board and locally under the Environmental Health Division of the Santa Cruz County Health Services Agency. As required by Santa Cruz County Code Ordinance 7.70.100, well destruction shall be under permit and by methods described in California water well standards Bulletin 74-81 and the supplemental Bulletin 74-90. Well destruction requires filling the well with concrete grout of neat cement and the removal of the well casing to about five feet below the surface. The annular space outside the well casing may also need to be sealed at certain depths by perforating solid portions of the casing and filling with neat cement grout.

The County Environmental Health Division along with the State DDW should be engaged to determine exact requirements for the destruction of the well. An Application for Well Permit will need to be submitted to the County Environmental Health Division. Well destruction will be by a licensed Well Drilling Contractor (California Contractor License Class C-57).

SLVWD records indicate that there was an additional well on the Lewis site, known as Well No. 3, which was identified as "to be abandoned" in the 1977 Water System Improvements plans by Barrett & Associates. This well is located within the footprint of one proposed new tanks as shown in the preliminary site layout in Appendix C, Sheet 1 and 2. A record of the well destruction was not found in the DWR Map Application. We will inquire with the County Department of Health for destruction records during the next phase of design.

Project Construction Phasing

Storage for each pressure zone must be maintained throughout the duration of construction. The storage required during construction will need to be assessed. Phasing requirements will be incorporated into the project construction documents.

The Madrone and Kaski Tank sites have two existing tanks. Although it would be desirable to keep one tank in operation while replacing the other, the limited work space and saturated soil conditions would make this very difficult. These tanks occupy only a small portion of the overall parcels owned by the District, so it is possible to stage temporary high-density polyethylene (HDPE) tanks for water storage during construction. For the Lewis Tank site, the proposed earthwork requires all of the space within the District's parcel, but there is sufficient space between the site and West Road to stage temporary HDPE tanks (a temporary construction easement will be required). The Assessor Map also shows a Lompico County Water District parcel, APN 075-321-02, approximately 1400 feet north of the Lewis site, where the original Lewis 1 tank was located. If the water main to that site is still intact, it may be possible to stage temporary tanks there. The elevation of that parcel is about 30-ft higher than the current Lewis site, which would compensate for the shorter temporary tanks.

The temporary tank option is preferred for Lewis and Madrone, where there is available space to install temporary tanks and above-grade temporary piping. The Kaski site is very constrained, but a single temporary HDPE tank might be sited there for operational storage, so that the Lompico booster pump station is not pumping into a closed system. The Kaski zone is supplied through pressure reducing valves from the Madrone zone, so additional temporary HDPE tanks at the Madrone site could provide additional operational and fire storage.

Sequentially, the Madrone site should be constructed first, since that site requires the least earthwork, and should therefore be the fastest to complete. Kaski would follow Madrone, allowing for the continued use of the temporary tanks staged at Madrone. The Lewis site may precede Madrone or follow Kaski, which would allow for relocating the temporary tanks rather than staging tanks at two sites concurrently.

Construction Costs

Construction cost estimates for the project are presented in Appendix F. For each site, the cost was estimated for the recommended 2-tank option and the alternative single-tank option. Tank prices are based upon a preliminary quote provided by a tank manufacturer, which ranged from $1.38 per gallon (gross volume) for the larger tanks to $2.16 per gallon (gross volume) for the smallest tank. Site civil costs are based on the 2018 RSMeans Construction Cost Estimating Guide. All costs are scaled to December 2018 using the Engineering News Record Construction Cost Index, which is 11186 for December 2018. A 30% contingency is included to account for future refinements in the design.

The estimates include costs for purchasing and installing temporary tanks to serve the system during construction. The estimated cost for four 10,000 gallon plastic tanks with valves and piping is approximately $42,000. If the Lewis site is constructed sequentially with the other sites, and not concurrently, only one set of temporary tanks would be required, and they could be relocated from Madrone to Lewis.

The estimates assume all valves and piping will be new. The District may determine that certain items may be retained and reused, such as the existing Flex-Tend Fittings.

Permitting

Domestic Water Supply Permit Amendment

The regional office of the State DDW may direct SLVWD to submit an Application for Domestic Water Supply Permit Amendment with the California State Water Resources Control Board - Division of Drinking Water. The requirements for this application are described in the California Health and Safety Code, Division 104, Part 12, Chapter 4 (California Safe Drinking Water Act), Article 7, Section 116550. The regional office should be contacted to determine if the application will be required.

CEQA

Denise Duffy & Associates is preparing a CEQA Initial Study/Mitigated Negative Declaration for the project. Based upon their site reconnaissance and review of the conceptual designs, the following mitigations have been identified. Additional mitigations may also be required, based upon the final design.

- The Lewis Site is habitat for Mount Herman June Beetle (Sand Hills habitat). Designation of a mitigation habitat parcel and monitoring during construction will be required.

- All sites have nearby trees which may provide nesting habitat for protected bird species. Pre-construction bird surveys will be required. Mitigations for sensitive noise receptors may be required.

- All sites have nearby habitat which may contain California wood rat. Pre-construction surveys to identify and relocated nests will be required. A skunk nest was identified at the Kaski site, which would require similar relocation.

- Despite the constant water leakage at all sites, wetland species have not established in the saturated soils.
- Seasonal surveys for special-status plant species should be conducted before the construction.

References:

AWWA Standard D103-09, Factory Coated Bolted Carbon Steel Tanks for Water Storage.

Biological Assessment for Lewis Tank #1, near 10011 West Drive Felton, CA (APNs: 075-311-06), prepared by Jodi Mcgraw Consulting, December 2016

Geotechnical Investigation for APN 074-261-09, APN 075-072-14, APN 075-311-06, Kaski Tank Site, Madrone Tank Site and Lewis Tank Site, Lompico, CA, prepared by Haro, Kasunich and Associates, September 2012

Lompico County Water District, System Atlas Map, prepared by Wy'East Engineers, April 1999

Lompico County Water District, Water System Improvements, prepared by Barrett & Associates, August 1977

Site Topographic Surveys, prepared by Paul Jensen, PLS, May 2012

Santa Cruz County, Assessor Parcel Maps 74-26, 75-07 and 75-31

Santa Cruz County, GIS Web Portal, https://gis.co.santa-cruz.ca.us/PublicGISWeb/

Attachments:

Appendix A, Tank Sizing Tables

Appendix B, Water Use Data

Appendix C, Conceptual Site Plans

Appendix D, Tank Details

Appendix E, Well Driller's Report, Lompico Well #5

Appendix F, Cost Estimates

Geotechnical Investigation, Kaski, Madrone and Lewis Tank Sites, Santa Cruz County, CA, prepared by Pacific Crest Engineering, December 10, 2018

Appendix A, Tank Sizing Tables

Appendix A – Tank Sizing

	Parameter	Lewis	Kaski	Madrone	Units	Notes
Tank Plan Dimensions	tank diameter	**32.00**	**21.00**	**24.00**	**ft**	tank Diameter Selected based on available site area
	plan area of tank	804	346	452	ft^2	π x (tank diameter/2)^2
	number of tanks	2	2	2		two tanks, so one can be taken offline for maintenance
	total plan area of tanks	1,608	693	905	ft^2	(plan area of tank) x (number of tanks)
Demand	Maximum Month	June 2016	July 2016	July 2016		per SLVWD monthly usage data
	Maximum Month usage	1,386	563	293	HCF	per SLVWD monthly usage data. California Waterworks Standards per CCR Title 22, Division 4, Chapter 16, Section 64554 (b) (2) (A)
	days in Maximum Month	30	31	31	days	days in Maximum Month
	average daily usage during Maximum Month	46.2	18.2	9.5	HCF/day	(days in Maximum Month) / (average daily usage during Maximum Month). California Waterworks Standards per CCR Title 22, Division 4, Chapter 16, Section 64554 (b) (2) (B)
	average daily usage during Maximum Month	34,558	13,585	7,070	gpd	unit conversion
	Maximum Day Demand	51,836	20,377	10,605	gpd	(average daily usage during Maximum Month) x 1.5. California Waterworks Standards per CCR Title 22, Division 4, Chapter 16, Section 64554 (b) (2) (C)
Useable Storage	domestic storage	51,836	20,377	10,605	gal	Maximum Day Demand. California Waterworks Standards per CCR Title 22, Division 4, Chapter 16, Section 64554 (a) (2)
	fire storage	60,000	60,000	60,000	gal	1,000 gpm for 1 hour
	design useable storage	111,836	80,377	70,605	gal	(domestic storage) + (fire storage)
	useable storage height in tanks required	9.29	15.51	10.43	ft	(design useable storage) / (total plan area of tanks)
	useable storage height in tanks selected	12.50	15.75	10.75	ft	rounded up
	useable storage in tanks selected	150,394	81,609	72,753	gal	7.48 x (total plan area of tanks) x (useable storage height in tanks selected)
Total Storage	water below tank outlet	2.00	2.00	2.00	ft	approximate height of tank outlet
	height where tank filling is turned on	14.50	17.75	12.75	ft	(useable storage height in tanks selected) + (water below tank outlet)
	operation depth	2.00	2.00	2.00	ft	Estimated fill depth required to achieve complete mixing. (Mixing depth to be adjusted during design based on input from mixing system designer.)
	height where tank filling is turned off	16.50	19.75	14.75	ft	(height where tank filling is turned on) + (operation depth)
	tank filling off level to overflow elevation	0.25	0.25	0.25	ft	to avoid overflow
	overflow height	**16.75**	**20.00**	**15.00**	**ft**	(height where tank filling is turned off) + (tank filling off level to overflow elevation)
	total volume at overflow	**201,528**	**103,631**	**101,516**	**gal**	7.48 x (total plan area of tanks) x (overflow height)
	volume at overflow per tank	**100,764**	**51,816**	**50,758**	**gal**	(total volume at overflow) / (number of tanks)
Tank Height	overflow to lowest level of roof framing	4.84	4.19	4.68	ft	Freeboard required calculation per AWWA D103-09 based on the default soil site class. (Final calculation will be by the tank manufacturer per parameters from the geotechnical report.)
	roof framing depth below tank nominal tank height	0.67	0.67	0.67	ft	Approximate. Final roof framing will be per the tank manufacturer.
	required minimum nominal tank height from top of foundation	22.25	24.85	20.35	ft	(overflow height) + (overflow to lowest level of roof framing) + (roof framing depth below tank nominal tank height)
	selected nominal tank height from top of foundation	**24.00**	**26.00**	**22.00**	**ft**	rounded up to an even dimension

Lompico Tanks Freeboard

Freeboard Requirement per AWWA D103-09 with Errata (Factory-Coated Bolted Carbon Steel Tanks for Water Storage)

Parameter	Lewis Tanks	Kaski Tanks	Madrone Tanks	Unit	D103-09 Source	Parameter Description/Notes
Latitude, Longitude	37.0985°N, 122.05911°W	37.100816°N, 122.04804°W	37.10727°N, 122.04173°W			
Seismic Use Group	III	III	III		§14.2.1	based on intended use and expected performance
g	32.2	32.2	32.2	ft/s^2		
I_E	1.5	1.5	1.5		Table 2	Seismic Importance Factor, function of Seismic Use Group
S_S	1.502	1.536	1.616	g	Figure 5	Mapped Spectral Response Acceleration at 5% Damping and 0.2 Second Period for Site Class B (value from online U.S. Seismic Design Maps)
S_1	0.672	0.704	0.743	g	Figure 6	Mapped Spectral Response Acceleration at 5% Damping and 1 Second Period for Site Class B (value from online U.S. Seismic Design Maps)
Site Class	D	D	D		§14.2.4	Geotechnical Investigation report
F_a	1.0	1.0	1.0		Table 4	Short-period site coefficient, function of S_S and Site Class
F_v	1.5	1.5	1.5		Table 5	Long-period site coefficient, function of S_1 and Site Class
S_{MS}	1.502	1.536	1.616	g	Eq 14-5	MCE Spectral Response Acceleration, $S_{MS} = F_aS_S$ (adjustment for Site Class effects)
S_{M1}	1.008	1.056	1.115	g	Eq 14-6	MCE Spectral Response Acceleration, $S_{M1} = F_vS_1$ (adjustment for Site Class effects)
T_L	12	12	12		Figure 17	Region-dependent transition period for longer-period ground motion
U	2/3	2/3	2/3		page 71	scaling factor to scale the MCE (Maximum Considered Earthquake) to design earthquake
S_{DS}	1.001	1.024	1.077	g	Eq 14-7	$S_{DS} = US_{MS}$ (adjustment to design earthquake)
S_{D1}	0.672	0.704	0.743	g	Eq 14-8	$S_{D1} = US_{M1}$ (adjustment to design earthquake)
D	32.00	21.00	24.00	ft	page 77	tank diameter
H	16.75	20.00	15.00	ft	page 77	distance from bottom of the shell to MOL (Maximum Operating Level)
T_c	3.335	2.647	2.856	s	Eq 14-18	first mode sloshing wave period
K	1.5	1.5	1.5		§14.3.4.4	damping scaling factor to convert from 5% dampening to 0.5% dampening
A_f Equation	Eq 14-51	Eq 14-51	Eq 14-51			equation selection depends on Seismic Use Group and T_c and/or T_L
A_f	0.302	0.399	0.390	g	Eq 14-51	convective design acceleration for sloshing
d	4.84	4.19	4.68	ft	Eq 14-48	sloshing wave height
Minimum Freeboard Requirement Equation	d	d	d		Table 7	equation selection depends on Seismic Use Group and S_{DS}
Minimum Freeboard Requirement	4.84	4.19	4.68	ft		distance from the MOL to the lowest level of the roof framing
height to the lowest level of the roof framing	21.59	24.19	19.68	ft		H+d, distance from bottom of the shell to the lowest level of the roof framing
Roof Framing Below Tank Stave	0.67	0.67	0.67	ft		assumed/estimated, distance from the lowest level of the roof framing to nominal height
nominal height required	22.25	24.85	20.35	ft		distance from bottom of the shell

Appendix B, Water Use Data

Appendix B – Water Usage Data

	Lewis Zone Monthly Usage (HCF/month)											
Year	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
2016	-	-	-	-	-	***2324**	1,292	690	840	1,017	979	1,148
2017	1,028	931	797	1,088	1,040	1,148	1,228	1,190	1,386	1,047	1,094	931
2018	1,013	1,006	916	1,072	967	1,114	1,125	1,379	1,192	-	-	-
Average	1,021	969	857	1,080	1,004	1,131	1,215	1,086	1,139	1,032	1,037	1,040

	Kaski Zone Monthly Usage (HCF/month)											
Year	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
2016	-	-	-	-	-	473	***570**	260	207	345	255	378
2017	253	260	237	300	296	459	519	519	563	407	466	360
2018	335	302	291	307	338	392	423	505	438	-	-	-
Average	294	281	264	304	317	441	471	428	403	376	361	369

	Madrone Zone Monthly Usage (HCF/month)											
Year	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
2016	-	-	-	-	-	293	***323**	73	151	201	193	257
2017	175	164	230	243	205	239	268	256	291	240	237	197
2018	218	198	200	209	202	243	261	291	247	-	-	-
Average	197	181	215	226	204	258	265	207	230	221	215	227

Notes: Data provided by San Lorenzo Valley Water District.
HCF = Hundred Cubic Feet
***** denotes Maximum Month
\- denotes data not provided

Appendix C, Conceptual Site Plans

Appendix C - Conceptual Site Plans

Appendix C - Conceptual Site Plans

Appendix C - Conceptual Site Plans

Appendix C - Conceptual Site Plans

Appendix C - Conceptual Site Plans

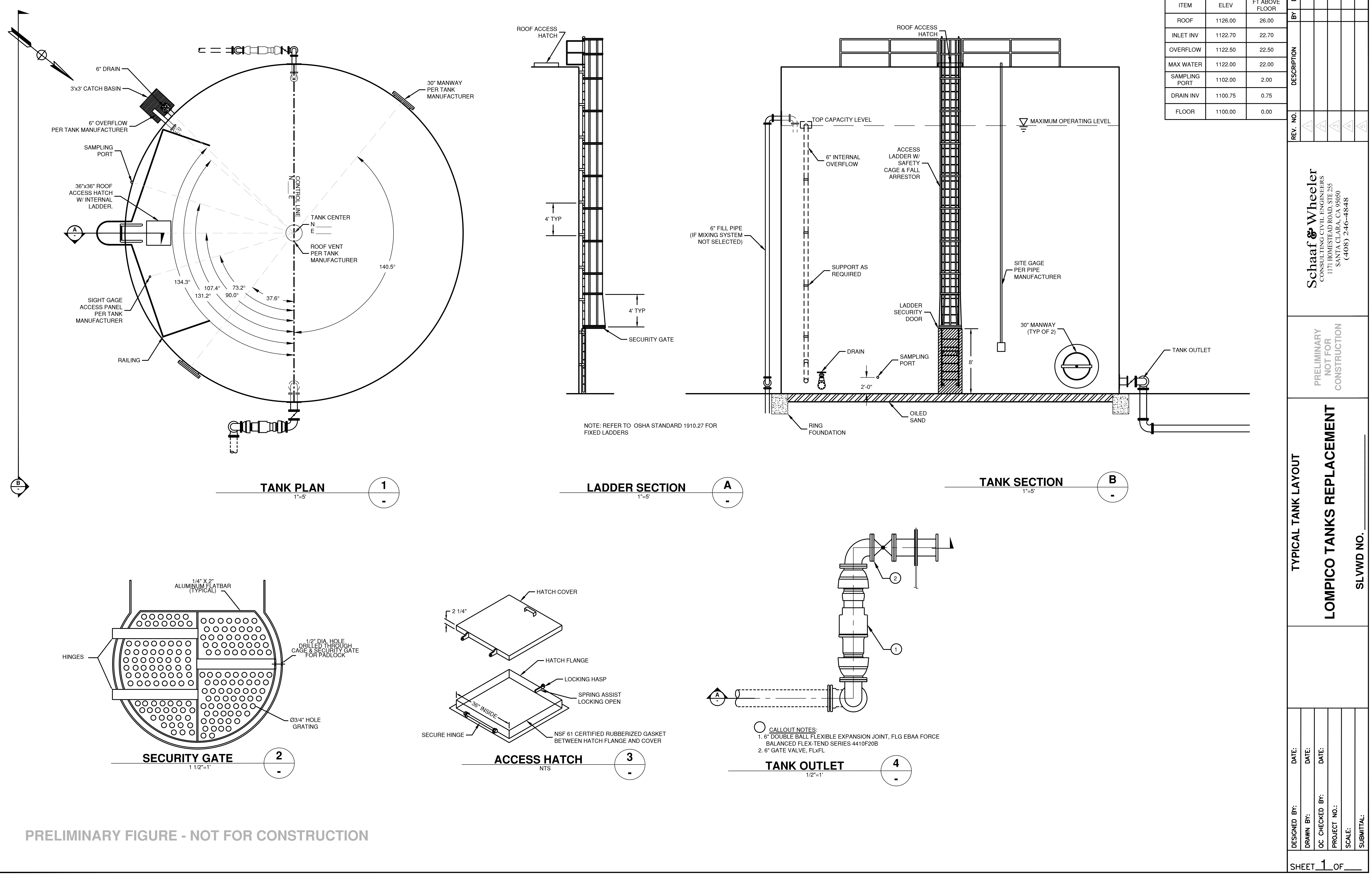
Appendix C - Conceptual Site Plans

Appendix C - Conceptual Site Plans

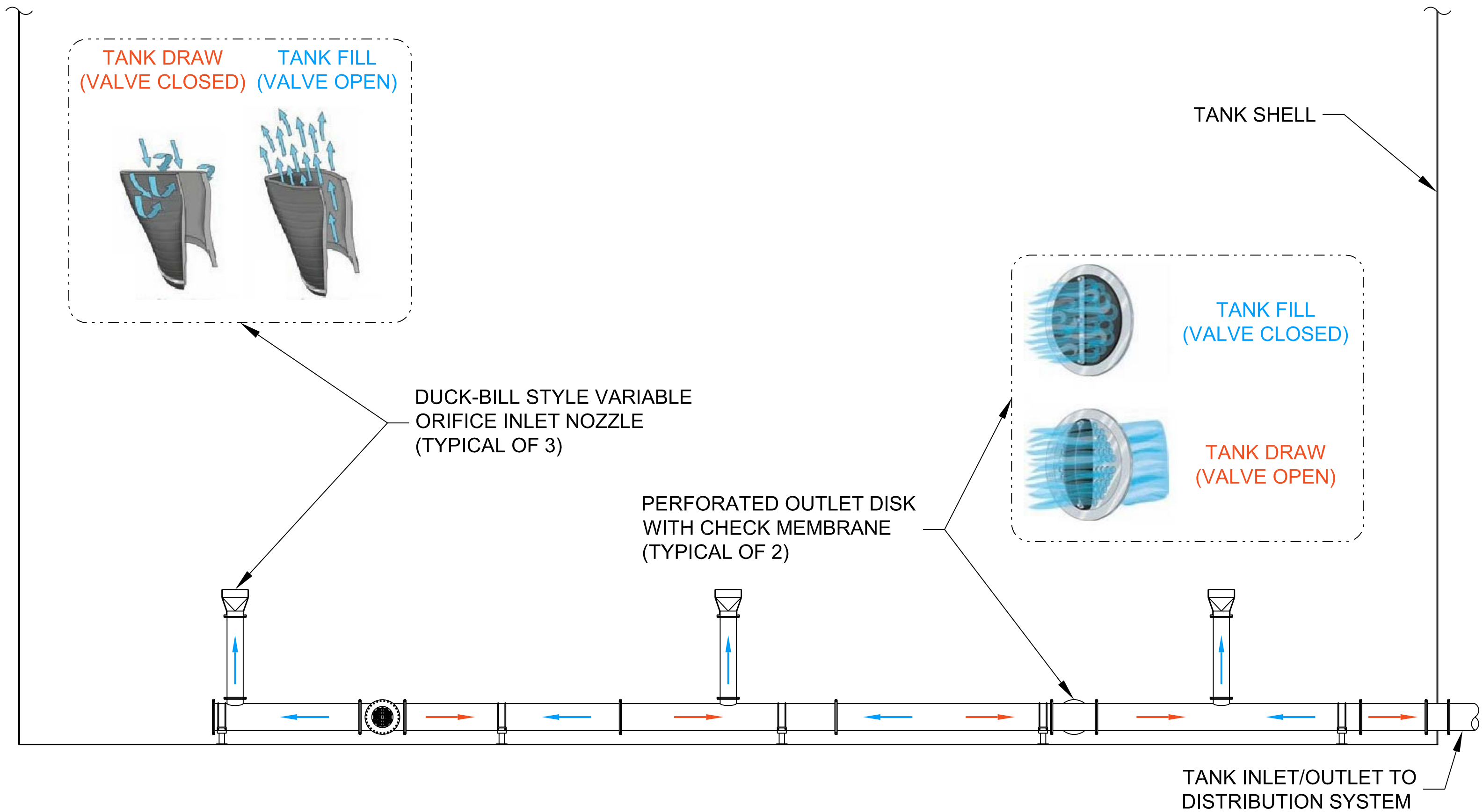
Appendix D, Tank Details

Appendix D - TANK DETAILS

TANK ELEVATIONS		
ITEM	ELEV	FT ABOVE FLOOR
ROOF	1126.00	26.00
INLET INV	1122.70	22.70
OVERFLOW	1122.50	22.50
MAX WATER	1122.00	22.00
SAMPLING PORT	1102.00	2.00
DRAIN INV	1100.75	0.75
FLOOR	1100.00	0.00



Appendix D - Hydrodynamic Mixing System Typical General Arrangement Drawing



Appendix E, Well Driller's Report, Lompico Well #5

CONFIDENTIAL LOG Water Code Sec. 13752

CONFIDENTIAL LOG Water Code Sec. 13752

ORIGINAL
File with DWR

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES

WATER WELL DRILLERS REPORT

Do Not Fill In

№ 74341

State Well No. 10S/2W-3A5

Other Well No.

(2) LOCATION OF WELL:

County Santa Cruz Owner's number, if any #5

Township, Range, and Section

Distance from cities, roads, railroads, etc. End of West Drive

(3) TYPE OF WORK (check):

New Well ☒ Deepening ☐ Reconditioning ☐ Destroying ☐

If destruction, describe material and procedure in Item 11.

(4) PROPOSED USE (check):

Domestic ☐ Industrial ☐ Municipal ☒ Irrigation ☐ Test Well ☐ Other ☐

(5) EQUIPMENT:

Rotary ☒ Cable ☐ Other ☐

(6) CASING INSTALLED:

STEEL: ✓ OTHER:

SINGLE ☒ DOUBLE ☐

If gravel packed

From ft.	To ft.	Diam.	Gage or Wall	Diameter of Bore	From ft.	To ft.
~~0~~	~~50~~	~~8¾~~		13½	50	400
0	50	14	¼	20		
0	400	8¾	¼			

Size of shoe or well ring: None Size of gravel: #8 sand

Describe joint Welded collar

(7) PERFORATIONS OR SCREEN:

Type of perforation or name of screen Johnson Type 304

From ft.	To ft.	Perf. per row	Rows per ft.	Size in. x in.
70	80			.040 slot
90	100			
225	235			
390	400			

(8) CONSTRUCTION:

Was a surface sanitary seal provided? Yes ☒ No ☐ To what depth 50 ft.

Were any strata sealed against pollution? Yes ☒ No ☐ If yes, note depth of strata

From 0 ft. to 50 ft.

From ft. to ft.

Method of sealing Cement

(9) WATER LEVELS:

Depth at which water was first found, if known 70 ft.

Standing level before perforating, if known 70 ft.

Standing level after perforating and developing 170 ft.

(10) WELL TESTS:

Was pump test made? Yes ☐ No ☒ If yes, by whom?

Yield: gal./min. with ft. drawdown after hrs.

Temperature of water Was a chemical analysis made? Yes ☐ No ☐

Was electric log made of well? Yes ☐ No ☒ If yes, attach copy

(11) WELL LOG:

Total depth 410 ft. Depth of completed well 400 ft.

Formation: *Describe by color, character, size of material, and structure*

ft. to ft.	
0 – 76'	White Sand
76 – 225	Brown shale
225 - 235	Fractured shale
235 - 320	Brown Shale
320 - 350	Fractured shale
350 - 410	Fractured shale

Work started 8/26 1975 Completed 9/18 1975

WELL DRILLER'S STATEMENT:

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

NAME LANDINO CONST & WELL DRILLING
(Person, firm, or corporation) (Typed or printed)

Address 5360 Coast Road
Santa Cruz, California 95060

[SIGNED] Tony Landino
(Well Driller)

License No. 201380 Dated 10/6, 1975

SKETCH LOCATION OF WELL ON REVERSE SIDE ✓

DWR 188 (REV. 9-68)

25179-950 9-68 50M TRIP OSP

Appendix F, Cost Estimates

San Lorenzo Valley Water District, Lewis Tank
30% Design Cost Estimate, Two Tank Option

January 11, 2019
By: AAS

Item of Work	Unit	Unit Cost	Quantity	Subtotal
Mobilization / Demobilization				
~ 5% of of project cost. This cost includes permits, fees, temporary structures, equipment rental and various misc. items				***$32,000***
Site Demo and Earthwork				
Tank Demo	LS	$1,000	1	$1,000
Building Demo, wood	CF	$0.50	3,900	$1,931
Building Demo, concrete foundation	SF	$1.40	600	$838
Demo 6-inch pipes	LF	$23	60	$1,386
Tipping fee	Ton	$103	200	$20,565
Demo wellhead	SF	$1.95	100	$195
Abandon Well (grout and cap)	VF	$51	400	$20,312
Over-excavate and recompact	CY	$9.50	340	$3,229
Piping and appurtenances				
4-inch DIP (overflow)	LF	$64	40	$2,564
4-inch gate valve	EA	$1,460	2	$2,920
6-inch DIP w/ Trenching and Backfill	LF	$93	40	$3,725
6-inch gate valve	EA	$1,999	5	$9,997
6-inch DIP Tee	EA	$1,143	1	$1,143
6-inch DIP Elbows and Bends	EA	$590	7	$4,132
Flex-Tend Fittings, 6-inch	EA	$6,000	2	$12,000
Thrust Blocks	EA	$197	3	$590
6-inch PVC, SDR-26 w/ Trenching and Backfill	LF	$30	75	$2,271
Catch Basin	EA	$1,263	2	$2,526
Tank and Foundation				
Bolted Steel Tank (gross volume) (2 tanks, D=32, H=24)	GAL	$1.38	288,700	$398,406
Ringwall Foundation (3-ft wide, 2-ft deep)	CY	$387	45	$17,423
Mixing System	LS	$7,084	2	$14,167
Temporary Tanks and Pipelines				
Hot Tap Connections	EA	$3,885	1	$3,885
6-inch DIP Cap	EA	$277	4	$1,107
10,000 Gallon Poly Tank	EA	$7,500	4	$30,000
6-inch PVC, SDR-26 w/ Trenching and Backfill	LF	$30	100	$3,028
6-inch Elbows and Bends	EA	$590	5	$2,952
4-inch gate valve	EA	$1,460	4	$5,840
Paving and Fencing				
AC Removal	SF	$12	1,000	$12,060
AC Resurfacing (4-inch AC over 8-inch AB)	SY	$81	256	$20,780
Site Fencing	LF	$74	270	$20,086
ESTIMATED CONSTRUCTION COST				**$653,056**
INSPECTION AND TESTING:	**10%**			**$65,000**
CONSTRUCTION CONTINGENCY:	**30%**			**$196,000**
ESTIMATED TOTAL CONSTRUCTION COST				**$914,000**

This estimate of construction cost is a professional opinion, based upon the engineer's experience with the design and construction of similar projects. It is prepared only as a guide and is subject to change. Schaaf & Wheeler and its subconsultants make no warranty, whether expressed or implied, that the actual costs will not vary from these estimated costs, and assumes no liability for such variances. This estimate specifically excludes any costs associated with designing for handling and disposal of hazardous wastes and contaminated materials. Costs associated with land, right-of-way, or easement purchase are not included in this estimate.

San Lorenzo Valley Water District, Lewis Tank
30% Design Cost Estimate, Single Tank Option

January 11, 2019
By: AAS

Item of Work	Unit	Unit Cost	Quantity	Subtotal
Mobilization / Demobilization				
~ 5% of of project cost. This cost includes permits, fees, temporary structures, equipment rental and various misc. items				***$30,000***
Site Demo and Earthwork				
Tank Demo	LS	$1,000	1	$1,000
Building Demo, wood	CF	$0.50	3,900	$1,931
Building Demo, concrete foundation	SF	$1.40	600	$838
Demo 6-inch pipes	LF	$23	60	$1,386
Tipping fee	Ton	$103	200	$20,565
Demo wellhead	SF	$1.95	100	$195
Abandon Well (grout and cap)	VF	$51	400	$20,312
Over-excavate and recompact	CY	$9.50	310	$2,944
Piping and appurtenances				
4-inch DIP (overflow)	LF	$64	20	$1,282
4-inch gate valve	EA	$1,460	1	$1,460
6-inch DIP w/ Trenching and Backfill	LF	$93	30	$2,793
6-inch gate valve	EA	$1,999	3	$5,998
6-inch DIP Tee	EA	$1,143	0	$0
6-inch DIP Elbows and Bends	EA	$590	4	$2,361
Flex-Tend Fittings, 6-inch	EA	$6,000	1	$6,000
Thrust Blocks	EA	$197	2	$394
6-inch PVC, SDR-26 w/ Trenching and Backfill	LF	$30	50	$1,514
Catch Basin	EA	$1,263	1	$1,263
Tank and Foundation				
Bolted Steel Tank (gross volume) (1 tank, D= 45.5, H=24)	GAL	$1.38	288,000	$397,440
Ringwall Foundation (3-ft wide, 2-ft deep)	CY	$387	32	$12,390
Mixing System	LS	$7,084	1	$7,084
Temporary Tanks and Pipelines				
Hot Tap Connections	EA	$3,885	1	$3,885
6-inch DIP Cap	EA	$277	4	$1,107
10,000 Gallon Poly Tank	EA	$7,500	4	$30,000
6-inch PVC, SDR-26 w/ Trenching and Backfill	LF	$30	100	$3,028
6-inch Elbows and Bends	EA	$590	5	$2,952
4-inch gate valve	EA	$1,460	4	$5,840
Paving and Fencing				
AC Removal	SF	$12	1,000	$12,060
AC Resurfacing (4-inch AC over 8-inch AB)	SY	$81	224	$18,182
Site Fencing	LF	$74	250	$18,598
ESTIMATED CONSTRUCTION COST				**$614,800**
INSPECTION AND TESTING:	**10%**			**$61,000**
CONSTRUCTION CONTINGENCY:	**30%**			**$184,000**
ESTIMATED TOTAL CONSTRUCTION COST				**$860,000**

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San Lorenzo Valley Water District, Kaski Tank
30% Design Cost Estimate, Two Tanks, Option 1

January 11, 2019
By: AAS

Item of Work	Unit	Unit Cost	Quantity	Subtotal
Mobilization / Demobilization				
~ 5% of of project cost. This cost includes permits, fees, temporary structures, equipment rental and various misc. items				***$19,000***
Site Demo and Earthwork				
Tank Demo	LS	$1,000	1	$1,000
Demo 6-inch pipes	LF	$23	140	$3,235
Tipping fee	Ton	$103	80	$8,226
Over-excavate and recompact	CY	$9.50	170	$1,614
Excavate and off-haul	CY	$16.21	0	$0
Piping and appurtenances				
4-inch DIP (overflow)	LF	$64	40	$2,564
4-inch gate valve	EA	$1,460	2	$2,920
6-inch DIP w/ Trenching and Backfill	LF	$93	60	$5,587
6-inch gate valve	EA	$1,999	5	$9,997
6-inch DIP Tee	EA	$1,143	1	$1,143
6-inch DIP Elbows and Bends	EA	$590	7	$4,132
Flex-Tend Fittings, 6-inch	EA	$6,000	2	$12,000
Thrust Blocks	EA	$197	3	$590
6-inch PVC, SDR-26 w/ Trenching and Backfill	LF	$30	40	$1,211
Catch Basin	EA	$1,263	2	$2,526
Tank and Foundation				
Bolted Steel Tank (gross volume) (2 tanks, D=21, H=26)	GAL	$1.90	134,700	$255,930
Ringwall Foundation (3-ft wide, 2-ft deep)	CY	$387	30	$11,616
Mixing System	LS	$7,084	2	$14,167
Temporary Tanks and Pipelines (requires added tanks at Madrone as well)				
Hot Tap Connections	EA	$3,885	1	$3,885
6-inch DIP Cap	EA	$277	3	$830
10,000 Gallon Poly Tank	EA	$7,500	1	$7,500
6-inch PVC, SDR-26 w/ Trenching and Backfill	LF	$30	50	$1,514
6-inch Elbows and Bends	EA	$590	2	$1,181
4-inch gate valve	EA	$1,460	1	$1,460
Paving and Fencing				
AC Removal	SF	$12	0	$0
AC Resurfacing (4-inch AC over 8-inch AB)	SY	$81	79	$6,412
Site Fencing	LF	$74	170	$12,646
ESTIMATED CONSTRUCTION COST				**$392,886**
INSPECTION AND TESTING:	**10%**			**$39,000**
CONSTRUCTION CONTINGENCY:	**30%**			**$118,000**
ESTIMATED TOTAL CONSTRUCTION COST				**$550,000**

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San Lorenzo Valley Water District, Kaski Tank
30% Design Cost Estimate, Two Tanks, Option 2

January 11, 2019
By: AAS

Item of Work	Unit	Unit Cost	Quantity	Subtotal
Mobilization / Demobilization				
~ 5% of of project cost. This cost includes permits, fees, temporary structures, equipment rental and various misc. items				***$20,000***
Site Demo and Earthwork				
Tank Demo	LS	$1,000	1	$1,000
Demo 6-inch pipes	LF	$23	140	$3,235
Tipping fee	Ton	$103	80	$8,226
Over-excavate and recompact	CY	$9.50	170	$1,614
Excavate and off-haul	CY	$16.21	700	$11,348
Piping and appurtenances				
4-inch DIP (overflow)	LF	$64	40	$2,564
4-inch gate valve	EA	$1,460	2	$2,920
6-inch DIP w/ Trenching and Backfill	LF	$93	60	$5,587
6-inch gate valve	EA	$1,999	5	$9,997
6-inch DIP Tee	EA	$1,143	1	$1,143
6-inch DIP Elbows and Bends	EA	$590	7	$4,132
Flex-Tend Fittings, 6-inch	EA	$6,000	2	$12,000
Thrust Blocks	EA	$197	3	$590
6-inch PVC, SDR-26 w/ Trenching and Backfill	LF	$30	40	$1,211
Catch Basin	EA	$1,263	2	$2,526
Tank and Foundation				
Bolted Steel Tank (gross volume) (2 tanks, D=21, H=26)	GAL	$1.90	134,700	$255,930
Ringwall Foundation (3-ft wide, 2-ft deep)	CY	$387	30	$11,616
Mixing System	LS	$7,084	2	$14,167
Temporary Tanks and Pipelines (requires added tanks at Madrone as well)				
Hot Tap Connections	EA	$3,885	1	$3,885
6-inch DIP Cap	EA	$277	3	$830
10,000 Gallon Poly Tank	EA	$7,500	1	$7,500
6-inch PVC, SDR-26 w/ Trenching and Backfill	LF	$30	50	$1,514
6-inch Elbows and Bends	EA	$590	2	$1,181
4-inch gate valve	EA	$1,460	1	$1,460
Paving and Fencing				
AC Removal	SF	$12	0	$0
AC Resurfacing (4-inch AC over 8-inch AB)	SY	$81	171	$13,880
Site Fencing	LF	$74	210	$15,622
ESTIMATED CONSTRUCTION COST				**$415,677**
INSPECTION AND TESTING:	**10%**			**$42,000**
CONSTRUCTION CONTINGENCY:	**30%**			**$125,000**
ESTIMATED TOTAL CONSTRUCTION COST				**$583,000**

This estimate of construction cost is a professional opinion, based upon the engineer's experience with the design and construction of similar projects. It is prepared only as a guide and is subject to change. Schaaf & Wheeler and its subconsultants make no warranty, whether expressed or implied, that the actual costs will not vary from these estimated costs, and assumes no liability for such variances. This estimate specifically excludes any costs associated with designing for handling and disposal of hazardous wastes and contaminated materials. Costs associated with land, right-of-way, or easement purchase are not included in this estimate.

San Lorenzo Valley Water District, Kaski Tank
30% Design Cost Estimate, Single Tank

Item of Work	Unit	Unit Cost	Quantity	January 11, 2019 By: AAS Subtotal
Mobilization / Demobilization				
~ 5% of of project cost. This cost includes permits, fees, temporary structures, equipment rental and various misc. items				***$14,000***
Site Demo and Earthwork				
Tank Demo	LS	$1,000	1	$1,000
Demo 6-inch pipes	LF	$23	140	$3,235
Tipping fee	Ton	$103	80	$8,226
Over-excavate and recompact	CY	$9.50	150	$1,424
Excavate and off-haul	CY	$16.21	0	$0
Piping and appurtenances				
4-inch DIP (overflow)	LF	$64	20	$1,282
4-inch gate valve	EA	$1,460	1	$1,460
6-inch DIP w/ Trenching and Backfill	LF	$93	40	$3,725
6-inch gate valve	EA	$1,999	3	$5,998
6-inch DIP Tee	EA	$1,143	0	$0
6-inch DIP Elbows and Bends	EA	$590	4	$2,361
Flex-Tend Fittings, 6-inch	EA	$6,000	1	$6,000
Thrust Blocks	EA	$197	2	$394
6-inch PVC, SDR-26 w/ Trenching and Backfill	LF	$30	25	$757
Catch Basin	EA	$1,263	1	$1,263
Tank and Foundation				
Bolted Steel Tank (gross volume) (1 tank, D=30, H=26)	GAL	$1.38	137,000	$189,060
Ringwall Foundation (3-ft wide, 2-ft deep)	CY	$387	21	$8,131
Mixing System	LS	$7,084	1	$7,084
Temporary Tanks and Pipelines (requires added tanks at Madrone as well)				
Hot Tap Connections	EA	$3,885	1	$3,885
6-inch DIP Cap	EA	$277	3	$830
10,000 Gallon Poly Tank	EA	$7,500	1	$7,500
6-inch PVC, SDR-26 w/ Trenching and Backfill	LF	$30	50	$1,514
6-inch Elbows and Bends	EA	$590	2	$1,181
4-inch gate valve	EA	$1,460	1	$1,460
Paving and Fencing				
AC Removal	SF	$12	0	$0
AC Resurfacing (4-inch AC over 8-inch AB)	SY	$81	83	$6,737
Site Fencing	LF	$74	160	$11,903
ESTIMATED CONSTRUCTION COST				**$290,408**
INSPECTION AND TESTING:	**10%**			**$29,000**
CONSTRUCTION CONTINGENCY:	**30%**			**$87,000**
ESTIMATED TOTAL CONSTRUCTION COST				**$406,000**

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San Lorenzo Valley Water District, Madrone Tank
30% Design Cost Estimate, Two Tank Option

January 11, 2019
By: AAS

Item of Work	Unit	Unit Cost	Quantity	Subtotal
Mobilization / Demobilization				
~ 5% of of project cost. This cost includes permits, fees, temporary structures, equipment rental and various misc. items				***$25,000***
Site Demo and Earthwork				
Tank Demo	LS	$1,000	1	$1,000
Demo 6-inch pipes	LF	$23	100	$2,310
Tipping fee	Ton	$103	88	$9,049
Over-excavate and recompact	CY	$9.50	210	$1,994
Excavate and off-haul	CY	$16.21	0	$0
Piping and appurtenances				
4-inch DIP (overflow)	LF	$64	40	$2,564
4-inch gate valve	EA	$1,460	2	$2,920
6-inch DIP w/ Trenching and Backfill	LF	$93	60	$5,587
6-inch gate valve	EA	$1,999	5	$9,997
6-inch DIP Tee	EA	$1,143	1	$1,143
6-inch DIP Elbows and Bends	EA	$590	7	$4,132
Flex-Tend Fittings, 6-inch	EA	$6,000	2	$12,000
Thrust Blocks	EA	$197	3	$590
6-inch PVC, SDR-26 w/ Trenching and Backfill	LF	$30	40	$1,211
Catch Basin	EA	$1,263	2	$2,526
Tank and Foundation				
Bolted Steel Tank (gross volume) (2 tanks, D=24, H=22)	GAL	$2.16	148,900	$321,624
Ringwall Foundation (3-ft wide, 2-ft deep)	CY	$387	34	$13,164
Mixing System	LS	$7,084	2	$14,167
Temporary Tanks and Pipelines				
Hot Tap Connections	EA	$3,885	1	$3,885
6-inch DIP Cap	EA	$277	2	$553
10,000 Gallon Poly Tank	EA	$7,500	4	$30,000
6-inch PVC, SDR-26 w/ Trenching and Backfill	LF	$30	100	$3,028
6-inch Elbows and Bends	EA	$590	5	$2,952
4-inch gate valve	EA	$1,460	4	$5,840
Paving and Fencing				
AC Removal	SF	$12	0	$0
AC Resurfacing (4-inch AC over 8-inch AB)	SY	$81	193	$15,666
Site Fencing	LF	$74	220	$16,366
ESTIMATED CONSTRUCTION COST				**$509,268**
INSPECTION AND TESTING:	**10%**			**$51,000**
CONSTRUCTION CONTINGENCY:	**30%**			**$153,000**
ESTIMATED TOTAL CONSTRUCTION COST				**$713,000**

This estimate of construction cost is a professional opinion, based upon the engineer's experience with the design and construction of similar projects. It is prepared only as a guide and is subject to change. Schaaf & Wheeler and its subconsultants make no warranty, whether expressed or implied, that the actual costs will not vary from these estimated costs, and assumes no liability for such variances. This estimate specifically excludes any costs associated with designing for handling and disposal of hazardous wastes and contaminated materials. Costs associated with land, right-of-way, or easement purchase are not included in this estimate.

San Lorenzo Valley Water District, Madrone Tank
30% Design Cost Estimate, Single Tank Option

January 11, 2019
By: AAS

Item of Work	Unit	Unit Cost	Quantity	Subtotal
Mobilization / Demobilization				
~ 5% of of project cost. This cost includes permits, fees, temporary structures, equipment rental and various misc. items				***$17,000***
Site Demo and Earthwork				
Tank Demo	LS	$1,000	1	$1,000
Demo 6-inch pipes	LF	$23	100	$2,310
Tipping fee	Ton	$103	88	$9,049
Over-excavate and recompact	CY	$9.50	186	$1,766
Excavate and off-haul	CY	$16.21	0	$0
Piping and appurtenances				
4-inch DIP (overflow)	LF	$64	20	$1,282
4-inch gate valve	EA	$1,460	1	$1,460
6-inch DIP w/ Trenching and Backfill	LF	$93	50	$4,656
6-inch gate valve	EA	$1,999	3	$5,998
6-inch DIP Tee	EA	$1,143	0	$0
6-inch DIP Elbows and Bends	EA	$590	4	$2,361
Flex-Tend Fittings, 6-inch	EA	$6,000	1	$6,000
Thrust Blocks	EA	$197	2	$394
6-inch PVC, SDR-26 w/ Trenching and Backfill	LF	$30	20	$606
Catch Basin	EA	$1,263	1	$1,263
Tank and Foundation				
Bolted Steel Tank (gross volume) (1 tank, D=34, H=22)	GAL	$1.38	149,400	$206,172
Ringwall Foundation (3-ft wide, 2-ft deep)	CY	$387	24	$9,293
Mixing System	LS	$7,084	1	$7,084
Temporary Tanks and Pipelines				
Hot Tap Connections	EA	$3,885	1	$3,885
6-inch DIP Cap	EA	$277	2	$553
10,000 Gallon Poly Tank	EA	$7,500	4	$30,000
6-inch PVC, SDR-26 w/ Trenching and Backfill	LF	$30	100	$3,028
6-inch Elbows and Bends	EA	$590	5	$2,952
4-inch gate valve	EA	$1,460	4	$5,840
Paving and Fencing				
AC Removal	SF	$12	0	$0
AC Resurfacing (4-inch AC over 8-inch AB)	SY	$81	58	$4,708
Site Fencing	LF	$74	160	$11,903
ESTIMATED CONSTRUCTION COST				**$340,560**
INSPECTION AND TESTING:	**10%**			**$34,000**
CONSTRUCTION CONTINGENCY:	**30%**			**$102,000**
ESTIMATED TOTAL CONSTRUCTION COST				**$477,000**

This estimate of construction cost is a professional opinion, based upon the engineer's experience with the design and construction of similar projects. It is prepared only as a guide and is subject to change. Schaaf & Wheeler and its subconsultants make no warranty, whether expressed or implied, that the actual costs will not vary from these estimated costs, and assumes no liability for such variances. This estimate specifically excludes any costs associated with designing for handling and disposal of hazardous wastes and contaminated materials. Costs associated with land, right-of-way, or easement purchase are not included in this estimate.