



Earth Systems

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LETTER OF TRANSMITTAL

Date: December 20, 2018

ESP File No.: 302165-002

To: Ms. Barbara Thompson, County Counsel
County of San Benito
481 4th Street, 2nd Floor
Hollister, California 95023

PROJECT: SOUTHSIDE ROAD LANDSLIDE INVESTIGATION

SUBJECT: GEOLOGIC AND GEOTECHNICAL ENGINEERING INVESTIGATION

We are sending you the following items:

☐ Daily Inspection Report ☐ Samples ☐ Drawings/Plans ☐ Laboratory Test Results
☒ Report

These are transmitted as indicated below:

☐ For approval ☐ For review and comment
☒ For your records ☐ As requested

Comments:

From: Brett Faust, Senior Geologist

**GEOLOGIC AND GEOTECHNICAL
LANDSLIDE INVESTIGATION**

**SOUTHSIDE ROAD LANDSLIDE
AT BLOSSOM LANE
HOLLISTER, SAN BENITO COUNTY, CALIFORNIA**

December 20, 2018

Prepared for

San Benito County Counsel

Produced Pursuant to Settlement Discussions
Protected by Evidence Code § 1152

Prepared by

Earth Systems Pacific
500 Park Center Drive, Suite 1
Hollister, CA 95023

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Hollister, CA 95023

PROJECT: SOUTHSIDE ROAD LANDSLIDE INVESTIGATION
SOUTHSIDE ROAD AT BLOSSOM LANE
HOLLISTER, CALIFORNIA

SUBJECT: Geologic and Geotechnical Engineering Investigation
Produced Pursuant to Settlement Discussions –
Protected by Evidence Code § 1152

REF.: Proposal to Perform a Post-Emergency Landslide Removal Geotechnical
and Engineering Geologic Investigation, Southside Road Landslide
Investigation, Southside Road at Blossom Lane, Hollister, California, by
Earth Systems Pacific, dated June 13, 2018

Dear San Benito County Counsel:

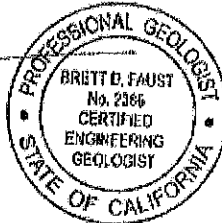
Per the County's authorization of the above referenced proposal, this Geotechnical and Engineering Geologic Investigation has been prepared for the Southside Road Landslide in Hollister, California. This report addresses current landslide conditions and possible causes. This report supersedes any prior reports.

We appreciate the opportunity to provide these services for this project and look forward to working with you again in the future. Please do not hesitate to contact this office if there are any questions concerning this report.

Sincerely,

Earth Systems Pacific

Brett Faust, CEG 2386
Senior Geologist



Ajay Singh, GE 3057
Principal Engineer



Doc. No.: 1812-008.SGR.REV1/ev

Attorney-Client Privilege / Attorney-Work Product



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1.0 INTRODUCTION

1.1 Site Setting

The Southside Road Landslide (SRL) is located on the north side of Southside and directly northeast of Blossom Lane in Hollister area of San Benito County, California and approximately centered at 36.8105°N latitude and 121.3780°W longitude on the United States Geological Survey's Hollister 7.5-Minute Quadrangle (see Figure 1). The SRL is present on steeply inclined slopes that ascend northward from Southside Road at an elevation of about 355 feet to the slope crest at an elevation of about 500 feet. Slopes are uneven in this area consisting of several subdued ridges and swales. At its near point situated about 80 feet north of the slope crest, is Pond #5 of the Sunnyslope County Water District Wastewater Treatment Plant (SCWDWWTP). The Ridgemark residential development is located northeast and east of the SCWDWWTP.

There are no structures other than Pond #5 mentioned above in the immediate area of the SRL. We understand that the areas east of the SRL, where there is large natural mid-slope terrace, have been used as a shooting range and livestock grazing by the property owner Mr. Lynn Hilden. This area was accessed by a dirt path about 6 to 7 feet in width that crossed the area of the SRL.

1.2 Landslide Timeline

The following is a timeline of events associated with the landslide documented by the County and provided to Earth Systems.

1. On Friday, May 18, 2018, Lynn Hilden, the property owner, noticed a rift of couple inches on his property along the slope with Southside Road and contacted Don Ridenhour, General Manager, Sunnyslope County Water District, of his concerns.
2. On Monday, May 21, 2018, Don Ridenhour replied to meet and review Lynn's concerns. On this date, Lynn did contact Jason DeRoza, Public Works Maintenance Supervisor, on his concerns and Jason proceeded to clear the Southside Road shoulder of the soil material sloughing onto the roadway.
3. On Wednesday, May 23, 2018, Lynn Hilden and Don Ridenhour met at the site to review and discuss the concerns of the situation.



4. On Wednesday, May 23, 2018 (Corrected date from Thursday, May 24, 2018 as noted in BAI Report), the property owner, Lynn Hilden, made contact with Jerry Muenzer, Board of Supervisors - District 4, County of San Benito.
5. On Thursday, May 24, 2018 Jerry (who proceeded to make – correction as noted in BAI Report) made contact with Gregory J. Bucknell, PE, Contract Civil Engineer, with the Public Works Division on this situation. Mr. Bucknell made contact with John Guertin, RMA Director, to apprise him on the situation.
6. On Thursday, May 24, 2018, Don Ridenhour made contact with Jason DeRoza, who proceeded to contact Public Works Engineering.
7. On Tuesday, May 29, 2018, AM, Public Works maintenance personnel cleared the soil material sloughing and encroaching onto the roadway shoulder and a site review was conducted by John Guertin, Jason DeRoza, and Gregory J. Bucknell, PE. It was determined later in the day to close Southside Road (Cross Street - Blossom Lane) at this location. John Guertin proceeded to instruct Mr. Bucknell to obtain Engineering Cost Estimates from contractors to response to the situation.
8. Don Chapin Company was determined to be the responsive and qualified contractor.
9. On June 7, 2018, the Board of Supervisors made CEQA findings and approved a contract for Construction and Repairs with Don Chapin Company not to exceed the amount of \$660,000 on Time and Materials Basis for Slope Stabilization on Southside Road at Blossom Lane, approved budget augmentation and transfer from contingencies, and authorize the CAO to execute any additional contracts and to approve modifications to the contract for Construction and Repairs Projects with Don Chapin Company as may be necessary to effectuate the Slope Stabilizations on Southside Road at Blossom Lane. Upon this action, Mr. Bucknell immediately made contact with the contractor to mobilize for the project.
10. On June 8, 2018, the contractor had construction personal, equipment, and material arriving on site.



11. On June 11, 2018, the contractor began the operation.
12. Mr. Bucknell made contact with an On-call Geotechnical Firm (Earth Systems) to respond to this situation. Three Tasks Orders were issued to Earth Systems: Task Order No. 1 to test the soil material for contaminants and monitor the progress of the removal of the Landslide soil material, Task Order No. 2 to provide Drone Topographic Work at 2 ft. contours, and Task Order No. 3 to perform a geotechnical and engineering geologic investigation of the Southside Road Landslide.

Earth Systems Pacific personnel first visited the site on May 31, 2018. Emergency landslide debris removal was initiated by the County on June 19, 2018 and monitored by Earth Systems Pacific (ESP) personnel through August 22, 2018, when removal operations stopped. During that period at least three subsequent shallow slope failures occurred in the area of the SRL, the last of which occurred the night of August 21, 2018. Subsequent to the emergency landslide debris removal, ESP was authorized by the County to perform the field investigation discussed herein, which commenced on August 30, 2018, with the drilling of the first of three borings. Prior to emergency landslide removal, a pre-landslide topographic map was developed based on existing LIDAR data and a site topographic survey of initial landslide conditions was performed by Kelley Engineering and Surveying. A post removal topographic survey was also performed by Kelley Engineering and Surveying. Based on the survey data, an estimated 38,500 cubic yards of soil were removed by the County's earthwork contractor from the site and stockpiled on County property off Southside Road, located approximately two-thirds mile to the northwest. The approximate area of landslide removal is shown on Figure 2. It should be noted that the elevations shown on the topographic surveys by Kelley Engineering are relative to an assumed elevation on Southside Road and are not relative to sea level.

1.3 Scope of Services

Earth Systems Pacific (ESP) performed this Geotechnical and Engineering Geologic Investigation to evaluate site geologic and current slope stability conditions and evaluate possible cause(s) of the Southside Road landslide.



The scope of our services included:

- a review of published and unpublished geologic literature, review of geologic mapping and aerial photography of the site and vicinity,
- a review of available documentation related to the Sunnyslope Wastewater Treatment Plant,
- discussion of observations during emergency landslide removal operations,
- subsurface investigation as described herein,
- evaluation of the information contained therein, and
- preparation of this report with supporting analysis and graphics.

The report is intended to comply with common geologic and geotechnical engineering practices in this area at this time under similar conditions.

Analysis of the soils for percolation rates, corrosion potential, mold or other microbial content, asbestos (either in building materials or naturally occurring), radioisotopes, hydrocarbons, or other chemical properties are beyond the scope of this report.

2.0 GEOLOGIC REVIEW

2.1 Regional Geologic Setting

The site is located in the seismically active central California Coast Ranges geomorphic province and is elevated above the southeast margin of the Hollister Valley floor. The valley is bounded by the Pajaro River on the north, the mountains of the Gabilan Range on the west, the Diablo Range on the east, and the juncture of the Gabilan and Diablo Ranges on the south. Structurally, the valley is divided into two structural blocks, with the San Justo block west of the Calaveras fault and the Diablo Block east of the fault (Rogers 1993) that underlies the site. These mountain ranges are a result of tectonic uplift that has been interpreted to have been occurring since Pliocene-Pleistocene time (beginning approximately 3 to 5 million years before present). The regional basins occupied by the Santa Clara and Hollister Valleys were formed by related tectonic processes during Pleistocene time.

The hillside where the SRL occurred is on the southwest edge of an approximate one-mile long ridge bounded by terraces of the San Benito River on the west and south, older alluvial fans on



the east, and the Hollister Valley floor on the north. In the area of the SRL, the western side of the ridgeline in the site vicinity is flanked by very steep natural slopes with inclinations of about 34 to 39 degrees.

The predominant structural feature in the California Coast Ranges is the San Andreas fault zone, which is the structural boundary between two tectonic plates: the Pacific Plate to the west of the San Andreas fault zone and the North American Plate east of the zone. These two plates are moving past each other at approximately 5.1 cm/year at the mouth of the Gulf of California and 1 to 3 cm/year in the central and northern parts of California (Brown, 1990). The Calaveras fault is interpreted to be part of the San Andreas fault system.

2.2 Geologic Literature Review

USDA Soil Mapping

The soil where the SRL occurred is classified as Soper Gravelly Loam (U.S. Department of Agriculture, Web Soil Survey, 2018). These soils are described as occupying hill, mountain, and landslide areas with slopes of 30 to 50 percent (about 17 to 27 degrees). The soil is described as well drained with a moderately high hydraulic conductivity (0.2 to 0.57 in/hr).

Soil in the area of the wastewater treatment plant is classified as Pleasanton Gravelly Loam and occupies terraces and alluvial fans with 5 to 9 percent slopes. It is described as well drained with moderately low to moderately high hydraulic conductivity (0.06 to 0.57 in/hr).

Geologic Mapping

Authors of geologic maps published in the past 25 years covering the site and vicinity consist of Rogers, 1993; Majmundar, 1994; Rosenberg 1998; and Dibblee, 2006. Whereas these authors generally agree on the types and distribution of geologic materials, Majmundar shows the most detail with respect to geologic structure and landslide hazards.

Majmundar (1994), mapped older alluvium (Qoa), described as predominately flood plain deposits, overlying San Benito Formation (QTsb) rocks at the site. The San Benito Formation rocks are described as unconsolidated, light-gray to variegated maroon, purple gravel, sand, and silt that are prone to landsliding. Though he did not map landslides at or near the site, it appears



that there are several small older landslides nearby that we identified during our review of aerial photographs and images, and during our site reconnoitering. Majmundar also shows traces of the Calaveras fault 500 feet to the southwest and a trace on either side of the ridgeline at the SRL site, the western of which is shown to cross through the area of the SRL and very near the western end of the SCWDWWTP Pond #5. Subsidiary fault traces are also shown crossing between the faults bounding the ridgeline and crossing Southside Road. A Regional Geologic Map is present as Figure 3.

Faulting

Until recently, faults were historically described as "active" and "potentially active". Active faults were defined by the California Geologic Survey's Special Studies Zone as faults that are well defined and have experienced movement within the last 11,700 years (Hart and Bryant, 2018). The definition of "potentially active" varied, however, a generally accepted definition of "potentially active" was a fault showing evidence of displacement older than 11,700 years and younger than 2,000,000 years (i.e., Pleistocene age).

The California Geological Survey describes fault activity as "Holocene-active" for faults having activity within the last 11,700 years; "Pre-Holocene" for faults which have not been active within the last 11,700 years (Pre-Holocene faults may still have potential for rupture but are not regulated by the Alquist-Priolo Act); and "Age-undetermined" is used for faults where timing of last rupture is unknown.

The site is located within a State Earthquake Fault Zone associated with Holocene-active traces of the Calaveras fault as shown on the State of California Special Studies Zone Map of the Hollister Quadrangle (CGS, 1982). Although the locations of fault traces differ somewhat from those mapped by Majmundar (1994) they generally agree that the ridgeline is bounded by faults on the east and west and that faulting is present in the area of the SRL. A copy of the State map showing the Earthquake Fault Zone is presented as Figure 4.

Landsliding

In addition to his geologic map, Majmundar (1994) also prepared a landslide susceptibility map of the Hollister area. He deemed the steep slopes flanking the ridgeline most susceptible to landsliding and the top of the ridgeline as generally susceptible.



Majmundar (1994) did not map landslides on or near the SRL, whereas we identified small older landslides along Southside Road (see Figure 2). (Note: It is possible that he did not map any in this area because in his judgement they did not meet his criteria of greater than 10 feet in thickness or lacked certainty of clarity.)

Earthquake History

In evaluating possible conditions contributing to the SRL, we researched local seismicity during the two week period prior to and following initiation of the SRL on May 18, 2018. Specifically we searched the Northern California Earthquake Data Center Catalog for earthquakes of magnitudes 1 or greater within a 10 kilometer radius. During the period searched there were records for 4 earthquakes with magnitudes of 1.37 to 2.70 that occurred between 9 and 10 kilometers west-southwest from the site. The earthquake with magnitude 1.37 occurred on May 16 and the others occurred on May 13 (1.99M) and two on May 24 (2.70M and 2.11M). Because of the relative low magnitude of these earthquakes, their distance from the site, and because none occurred on or the day before initiation of the SRL, there was no apparent evidence that these earthquakes destabilized slopes at the subject site.

The Hollister area has experienced several strong in the last approximate 40 years. Especially notable are the August 6, 1979 5.8M Coyote Lake earthquake, the April 24, 1984 6.2M Morgan Hill (Halls Valley) earthquake, and the October 17, 1989 7.1M (6.9Mw) Loma Prieta earthquake. It is expected that site will experience similar magnitude earthquakes in the future.

2.3 Aerial Photo Interpretations

Earth Systems reviewed aerial photographs of the site and vicinity, taken between 1939 and 2016 for the presence of terrain features indicative of landslides. Copies of the aerial photographs reviewed are presented in Appendix A.

1939 (B&W) – Southside Road, Blossom Lane and a ranch road (now Tyler Trail) leading to a building compound are present; The large bowl shaped feature, interpreted herein to be a natural terrace cut atop San Benito Formation, is present east of the SRL; subdued landslides are present on the northeast shoulder of Southside Road and about 200 and 700 feet northwest of Blossom Lane; the area currently occupied by the SCWDWWTP is used for dryland hay farming; there are no apparent landslides in the area of the SRL.



- 1949, 1953, and 1960 (B&W) – The SRL site and vicinity appear in similar use and condition as in 1939.
- 1959 and 1967 (Stereo B&W) – The SRL site and vicinity appear in use and condition as in 1939; Southside Road appears to have been constructed using mostly fill and lesser amounts of cut in the site vicinity.
- 1974 (Color) – Four original wastewater ponds (built in 1973) are present and the northeast pond contains water; the boundaries of the terrace cut east of the SRL has sharp boundaries and may have been in use as a gravel borrow pit. Ridgemark golf course and surrounding early residential development are present; there are no apparent landslides in the area of the SRL.
- 1981 (Color - Infrared) – The SRL site appears similar to the previous photographs and there are no obvious landslides at the SRL site; the northeast and northwest ponds of the SCWDWWTP contain water; Ridgemark residential areas are nearing complete development; there is no infrared evidence of water or active plant growth in the area of the SRL; there are no apparent landslides in the area of the SRL.
- 1998 (B&W) - Pond #5 (built in 1984) is present at the SCWDWWTP and contains water as do the other four ponds; there appears to be actively growing vegetation crossing in the mid-slope area of the SRL that appears to be associated with the dirt path that is first readily apparent in the 2009 photograph; there are no apparent landslides in the area of the SRL.
- 2006 (Color)– Pond #5 and original southeast pond of the SCWDWWTP are dry and the other three ponds contain water; a linear strip of green vegetation is present crossing the mid-slope area of the SRL; there are no apparent landslides in the area of the SRL.
- 2009 (Color)– The waste water plant appears similar to the 2006 photograph and Pond #5 is dry; the dirt trail leading to the natural terrace is present and there is faint green vegetation along its upslope edge; a narrow small landslide is now present in the area of the western margin of the future SRL.



2012 (Color) – At the SCWDWWTP facility, a portion of the original southwest wastewater pond has been replaced by the new treatment plant (operational in 2013) and the remaining four ponds including Pond #5 contain water; a linear strip of green vegetation is present along the dirt path and mid-slope west of the SRL; a string of faint, spotty green vegetation crosses the slope and down to Southside Road in the area of the SRL and has a similar trend as the western fault of Majmundar (1994); there are no apparent new landslides in the area of the SRL.

2016 (Color) – The SCWDWWTP facility appears the same as its current configuration with drying beds on the northwest corner, treatment plant on the west mid-area, and four ponds; three of the ponds contain water including Pond #5; a dark tonal lineament between Southside Road and a bend in the dirt path is present on the western edge of the narrow landslide present in the 2009 photograph and the SRL; there are no apparent new landslides in the area of the SRL.

3.0 SUNNYSLOPE COUNTY WASTEWATER TREATMENT PLANT

Because of the apparent probable impacts to slope stability resulting from percolation of treated wastewater directly above the SRL, we reviewed documentation pertinent to geologic evaluation of the Sunnyslope County Wastewater Treatment Plant, RM-1 available from the California Regional Water Quality Control Board and the Sunnyslope County Water District web page.

We reviewed the following documents:

- Transmittal of Waste Discharge Requirements Order No. R3-2004-0065 – Sunnyslope County Water District, Ridgemark Estates Subdivision, San Benito County, WDID 3 351000001, dated December 7, 2004, by California Regional Water Quality Control Board Central Coast Region.
- Construction Report for the Installation of Three New Monitoring Wells at the Sunnyslope County Water Treatment Facilities, by Todd Engineers, dated January 2006.
- Hollister Urban Area Water and Wastewater Master Plan and Coordinated Water Supply and Treatment Plan, Programmatic EIR, dated January 2011.



The Sunnyslope County Wastewater Treatment Plant is permitted by the California Regional Water Quality Control Board, Central Coast Region. The SCWDWWTP is permitted to treat up to 350,000 gallons per day.

These documents briefly discuss general geologic aspects of the Sunnyslope Waste Water. We are not aware of a detailed, site specific geologic study of the site.

4.0 FIELD INVESTIGATION

4.1 Site Reconnaissance and Emergency Landslide Removal

During emergency landslide removal operations, Earth Systems Pacific geologists visited the site daily to note removal progress and observe geologic conditions exposed within and beneath landslide debris. The mode of landsliding is principally translation with movement parallel to ground surface with a relatively shallow slide plane rather than rotational slip with a deep slide plane. Landslide debris largely consisted of San Benito Formation materials consisting of cemented fine-grained materials, sand and small amounts of gravel. Older alluvial sands and gravels were also part of the debris. The orientation of San Benito Formation bedding was generally consistent with Majmundar's (1994) mapping, and sheared and striated surfaces were common and indicated the presence of vertical faulting with horizontal movement. The shearing was most prevalent in the central and western portions of the debris removal area and their orientation correlated well with the trend of faulting mapped by Majmundar (1994). Hand driven samples of the landslide debris and underlying materials in the mid-slope areas were taken over a period of several days as debris removal progressed through this zone and tested for moisture and density the same day. Two of the samples were also tested for specific gravity and the results averaged for calculating degree of saturation. The hand samples locations are shown on Figure 5, and test results are presented in Appendix C. Additionally, photographs taken in the mid-slope areas where wet conditions encountered are shown on Figure 6.

4.2 Subsurface Exploration and Laboratory Testing

An Earth Systems Pacific geologist logged subsurface conditions in three exploratory borings. Two borings were located between the SRL slope crest and SCWDWWTP western fenceline and one was drilled on the shoulder of Southside Road nearest the slope of the SRL. The borings were drilled to depths of between 34 and 100 feet. Boring 1 was drilled using a Mobile B-53 rig and



boring B3 was drilled using a Mobile B-61 rig. Both rigs were equipped with 8-inch (outside diameter) hollow-stem augers. Boring B2 was drilled using a Geoprobe 7822DT equipped with 6-inch diameter hollow stem augers. The Geoprobe rig was also used to push small diameter acetate liners adjacent to boring B2 and through the zone where groundwater was encountered. Soils encountered in the borings were categorized and logged in general accordance with the Unified Soil Classification System and rock was characterized with regard to type, degree of weathering, discontinuities, and cementation. Copies of the boring logs are included in Appendix B. The locations of the borings are shown on Figure 2.

Geotechnical Laboratory Testing

The hand driven samples (13 total) were tested for moisture content and dry density. Two of these samples were also tested for specific gravity for calculation of degree of saturation. Additionally, samples from Boring B1 at depths of 27 to 31.5 were tested for triaxial compression under unconsolidated-undrained conditions and one sample from Boring B3 at a depth of 5 feet was tested for direct-shear strength. Results of laboratory testing are presented in Appendix C.

Analytical Laboratory Testing

In an attempt to evaluate for the presence of subsurface water that originated from the wastewater ponds, a sample of saturated soil collected in one of the acetate liners advanced adjacent to Boring B2 was submitted to McCampbell Analytical Laboratory for fecal coliform, pH, total organic carbon, and dissolved solids testing. Results of analytical testing are presented in Appendix E.

4.3 Geologic Profile

Based on a review of the subsurface drilling data and our observations during emergency landslide removal, the site is underlain by San Benito Formation rocks that are capped by older alluvial deposits at the top of slope and in the vicinity of the SCWDWWTP. The San Benito Formation rocks encountered in the borings generally consisted of thickly bedded claystone that locally contained thin interbeds of fine sand. The vast majority of claystone was cemented with calcium carbonate, though in places it was decomposed to sandy lean clay. Lesser components of the San Benito Formation encountered in the borings consisted of thin to medium thick beds of poorly to well graded sands, clayey sands and sandy lean clay. The claystone was generally



soft in terms of rock hardness, and the sands were medium dense to very dense. The cap of older alluvium generally consisted of stiff lean clay with sand. Pockets of coarse gravel and cobbles were also present and exposed at the top of slope above the SRL. Moisture conditions were described as moist to locally very moist to wet. During removal of landslide debris, we observed locally wet soil and rock conditions in the mid-slope areas of the SRL. Hand driven samples of the landslide debris and underlying materials in the mid-slope areas were taken over a period of several days as debris removal progressed through this zone and tested for moisture and density the same day.

Cross-sections showing our interpretation of geologic conditions and recommended geotechnical grading are shown on Cross Section Figures A-A' through D-D'.

Groundwater

Water was initially encountered in boring B2 at depth of about 16 ft and stabilized after drilling at a depth of about 23 feet. Free water was not encountered in Boring B1 or B3. According to San Benito County Water District records (2017), depth to groundwater in the site vicinity is about 40 feet below Southside Road. Additionally, depth to groundwater was reported at a depth of about 190 feet in SCWDWWTP monitoring well MW 5 constructed in the area of the wastewater treatment plant by Todd Engineers (2006). This depth corresponds to an elevation consistent with San Benito County Water District records.

5.0 DATA ANALYSIS

5.1 Quantitative Slope Stability Analysis

To evaluate the stability of the slopes at the site, Earth Systems performed computer-aided analysis of the slope profile represented by cross section A-A' (See Figures 2 and Cross Section A-A') The stability analyses were performed using Bishop's simplified, Janbu's simplified, and Spencer's Methods with the aid of the computer program SLIDE version 8.018 (RocScience, 2018) with a translational failure surface. Slopes are considered to be stable if the stability analysis results in a calculated static factor of safety of 1.0 or higher.

Earth Systems quantitatively analyzed the stability of the site slopes with the SRL present and following landslide removal. Modeling of the slope stability with the SRL present was performed



in order to derive strength values consistent with observed SRL failure conditions and geometry. Laboratory measured strength values were also incorporated in our model using engineering judgement. Model parameters with the SRL present were adjusted to simulate conditions leading up to the SRL. These values were then applied to the post-removal slope stability analysis. The post-removal minimum static factor of safety for the slope is 1.83 indicating that the slopes, as they exist following removal, are stable.

Plots showing results of slope stability analyses are presented in Appendix D.

5.2 Groundwater

A review of available groundwater data was performed as part of our investigation at the subject site. Reports of groundwater level and quality data from several sources, including the San Benito County Water District, Sunnyslope County Water District, and California Regional Water Quality Control Board, were reviewed to gain an understanding of groundwater in the vicinity of the site.

Overview

San Benito County's agricultural and urban water supply comes from 16 groundwater basins. Water management is the responsibility of the San Benito County Water District, including monitoring of basin water levels and water quality, management of salts and nutrients in the water, recharge into the basins, and annual reporting on the status of groundwater (SBCWD, 2017).

The project area overlies the San Benito County portion of the Gilroy-Hollister groundwater basin (Basin). The basin, bounded by the Pajaro River in the north, the Diablo Range on the east and the Gabilan Range to the southwest, lies within a portion of the Pajaro River watershed. The project area is situated in the Tres Pinos subbasin, one of eight subbasins of the Gilroy-Hollister groundwater basin. The subbasins are hydrologically connected and pumping in these subbasins affects the entire groundwater basin (SBCWD et al. 2017).

Groundwater Levels

The groundwater elevation contours in the Tres Pinos subbasin are significantly impacted by the presence of the Calaveras Fault, and requires that the groundwater elevation contours on the



western side of the fault be developed separately from the groundwater elevation contours on the eastern side of the fault, with little if any continuity between two sides. (SBCWD, 2017).

Generally, groundwater levels in the vicinity of the subject site have declined from the early 1900's to the 1970's but reportedly have since stabilized due to successful water management efforts, which have included recharge to the groundwater basins and imported surface water, as well as increased precipitation. In the area of the project, groundwater levels in the Tres Pino subbasin have experienced slight declines and in some areas remained steady. (SBCWD et al. 2016).

Based on depths to groundwater maps published by the SBCWD, depth to water in the project area, generally the area east of the Calaveras Fault along Southside Road, is between 40 and 60 feet below Southside Road.

Sunnyslope County Water District Wells

Wells in the vicinity of the subject site include Sunnyslope County Water District's (SSCWD) Wastewater Monitoring wells #2 and #5. According to information in SSCWD's 2017 Monitoring Report to the State Regional Water Quality Control Board (RWQCB), and the Construction Report for the Installation of Three New Monitoring Wells (MW#4 and MW#5 at Ridgemark 2, and MW#6 at Ridgemark 1 by Todd Engineers, 2006) Wastewater Monitoring Well #2 is located along Southside Road approximately 1,400 feet southeast of the project site, and was installed in June 1991, at a completed depth of 80 feet and a surface elevation of 380.68 feet. Wastewater Monitoring Well #5 is located at the top of the slope (slope failure) at the project site, adjacent to the Wastewater Treatment Plant Ponds #4 and #5, was installed in October 2005 at a completed depth of 195 feet (with 5 feet of tailpipe) and a surface elevation of 528.9 feet.

In Wastewater MW#2, depth to water was measured at 49.5 feet (331.18 ft Elevation) in January 2006, and 56 feet (324.68 ft Elevation) in December 2016. In Wastewater MW#5, depth to water was reported as "DRY" at 192 feet (336.9 ft Elevation) in January 2006, and the well was reported as "DRY" at 192 ft (336.9 ft Elevation) in four quarters of monitoring in 2017.



Several important observations were documented in the Construction Report for the Installation of Three New Monitoring Wells (MW#4 and MW#5 at Ridgemark 2, and MW#6 at Ridgemark 1). It was noted that at the time the wells were drilled "a significant portion of the geologic log at MW#5 is missing due to intervals of lost circulation during drilling," specifically that no cuttings (no circulation) were retrieved from depths of 95 feet to 280 feet. Further, the report states that "It is notable that a significant volume of drilling mud was lost to the formation in these intervals. Lost drilling mud was not observed to re-surface along the face of the adjacent slope." (Todd 2006). It is also noted in the report that MW5 was screened from 110 feet to 150 feet and from 170 feet to 190 feet, with a five-foot length of tailpipe, and that upon completion of the well, water levels were suspect because they were at or below the lowest portion of the screen and likely represented water stored on the tailpipe portion of the casing.

In the 2006 Monitoring Well report, Todd Engineers concluded that "Due to the complex local hydrogeologic framework (specifically the proximity to major faults and nearby steep slopes) more than three monitoring wells per facility may be required to characterize the site. Also, because percolating water at each of the three sites is likely to create a localized mound in the water table, multiple monitoring wells may be needed to accurately ascertain the shape and nature of the local water table at these sites. The monitoring well network may be developed in phases, with an evaluation of the effectiveness of the network to monitor local groundwater conditions conducted after each phase of monitoring well installation. If gaps are recognized in the network, well installations may be needed to amend the network." The report goes on to conclude that the "number of groundwater monitoring wells per site does not allow for effective characterization of groundwater flow patterns. Given the presumably nonplanar nature of the local water table at these facilities, it is likely that a minimum of four monitoring wells per site will be necessary for preliminary characterization of groundwater flow patterns." (Todd 2016)

Groundwater During ESP 2018 Investigation

Groundwater was not encountered in either of the two borings drilled at or near the top of the slope, Boring #1 and #3, were drilled to depths of 43.5 feet and 100 feet, respectively. Groundwater was encountered at the time of drilling in Boring #2, which was drilled at a location on Southside Road at the base of the slope failure. Ground surface elevation at the boring location is about 356 ft. Boring #2 was drilled to a depth of 34 feet, and groundwater was first



encountered at a depth of approximately 16 feet below the ground surface (estimated to be about 340 ft elevation) at the time of drilling, and at the time the boring was completed, at a depth of 23 feet below the ground surface (approximately 333 feet elevation). Groundwater elevation encountered was within the range of what would be expected based on published groundwater elevations from SSWD Wastewater MW#2.

Groundwater Water Quality

The quality of groundwater for the subbasins that serve the Hollister urban area, including the project site, is characterized as highly mineralized and of marginal quality for drinking and agricultural purposes (SBCWD 2016) and is considered typical of small Coast Range groundwater basins. Generally, measure of groundwater quality is total dissolved solids (TDS) in the range of 500 milligrams per liter (mg/L) to 1,000 mg/L are considered acceptable for drinking water purposes.

Chemicals of concern (COCs) for the Gilroy-Hollister groundwater basin include boron, chloride, hardness, nitrate, and TDS. In some parts of the basin, groundwater does not meet water quality standards. However, in most areas of the Gilroy-Hollister basin, water quality has remained stable in recent years (2004-2015).

Analytical groundwater quality data of water samples collected in 2017 during four quarterly groundwater monitoring events from SSCWD Wastewater Monitoring Well MW-2 (located approximately 1,400 feet southeast of the project site), is included as Table 1.



Table 1
Sunnyslope County Water District Wastewater Treatment Plant
Wastewater Monitoring Well MW-2
2017 Water Quality Monitoring Results

Date	Nitrate as Nitrogen	Chloride	Residual Filterable TDS	Sodium	pH	Boron	Sulfate	Nitrite	Total Nitrogen	TKN	Depth to Water
3/7/17	0.79	36	600	59	7.16	0.2	20	ND	ND	ND	55
6/6/17	0.6	64	650	69	7.11			ND	ND	ND	53
9/6/17	3.9	160	800	110	7.27	0.46	34	0.15	4.1	ND	52
12/5/17	6	190	760	100	7.39			ND	6	ND	56
Average	2.8	113	703	85	7.23	.33	27	0.04	2.5		54

Units -mg/L

5.3 ESP Water Sampling

Saturated soil samples collected in sealed acetate liners from Boring B-2 were submitted to McCampbell Analytical, Inc. for analyses. Due to the limited amount of liquid sample that could be extracted from the soil sample, and the exceedance of the holding time for several analytes, the results are inconclusive and could not be compared to published groundwater quality data collected from wells near the site. Results of these analyses are summarized in Table 2 and analytical laboratory reports included in Appendix E.

Table 2
Results of Analytical Laboratory Testing

Sample	Fecal Coliform	pH	TOC	TDS
B2@32.5 -34ft	ND (MPN/g)	8.60	1000 (mg/kg)	195 (mg/l)

Notes:

TOC – Total Organic Carbon

TDS – Total Dissolved Solids



6.0 GEOLOGIC ANALYSIS AND CONCLUSIONS

Several small to moderate size landslides were present along Southside Road prior to the SRL including a narrow landslide on the western margin of the SRL that occurred sometime between 2006 and 2009. Between at least 1939 and 2006 there was no apparent evidence of landsliding in the area of the SRL. The dirt path crossing the midslope area was first readily apparent in the 2009 photograph and may have been present as early as 1998. A dark tonal lineament between Southside Road and a bend in the dirt path present in the 2016 photograph may indicate the presence of a drainage pathway off the dirt path and along the margin of the earlier landslide. During emergency landslide removal, a fissure previously concealed by vegetation and about 1 to 2 feet in depth was observed in this area for the first time, though there were no obvious indications that it was due to water runoff and erosion.

Between 1984, when Pond #5 of the SCWDWWTP was constructed, and at least 2006, there was no evidence of landsliding in the area of the SRL. However, beginning in the 1998 photograph green vegetation lineaments within otherwise dry surroundings were present across the mid-slope areas and crossing down slope to Southside Road coinciding with the trend of a fault here. This strongly indicates the presence of subsurface water that is migrating preferentially along fault and lithologic discontinuities, and the more permeable strata of the San Benito Formation. During landslide debris removal, very moist to saturated conditions were observed in these areas and additionally documented through moisture and density testing of hand driven samples. Because there are no apparent sources of subsurface water in the site vicinity other than the adjacent SCWDWWTP, and depth to groundwater is currently estimated at about 23 feet below Southside Road, the observed and tested moisture conditions can be directly attributable to the SCWDWWTP.

The general geologic setting of the SCWDWWTP RM-1 is discussed in the waste discharge requirements and report of monitoring well construction obtained from the Regional Water Quality Control Board, as well as in the Hollister Urban Area Water and Waste Water Master plan obtained from the Sunnyslope County Water District internet web page. However, we are not aware of a site-specific geologic hazards investigation in connection with siting the plant adjacent to the steep slopes where the SRL occurred.



Conclusions

In evaluating possible causes of the SRL, we assessed geologic conditions, local seismic activity, groundwater conditions, past grading activities, and nearby land use changes that may have contributed to destabilizing the SRL slopes.

In general, it appears that tectonic uplift has oversteepened the slopes beyond the intrinsic strength characteristics of the San Benito Formation materials, but natural calcium carbonate cementation has contributed significantly to cohesion of the materials allowing the slopes to remain relatively stable. From at least 1974 when the wastewater plant was first constructed and in use, to the time of the narrow landslide that occurred sometime between 2006 and 2009, there was no apparent slope instability at the site, suggesting that the addition of Pond #5 in 1984 likely accelerated the process of dissolving cementation.

Based on our review of the limited available data, groundwater in the area of the site is highly variable and is significantly affected by the complex geologic environment, including faulting and inhomogeneous subsurface geology. Measured depths to groundwater, both published (SSCWD Wastewater MW-2) and measured in boring advanced during our investigation, appears consistent, groundwater in the immediate vicinity of the slope failure appears to be less predictable and, currently unknown. For unknown reasons, despite its relative proximity to the SSCWD Wastewater Treatment Plants active disposal Ponds #4 and #5, SSCWD Wastewater MW-5 does not appear to intercept percolating water from the SSCWD Wastewater treatment ponds. It is not clear, either from the previously published data reviewed as part of our study or from the results of our limited field investigation, the pathway, or eventual disposition of percolating water, from the SSCWD Wastewater treatment ponds. As recommended by others and reiterated herein, further assessment of the hydrogeology and areal geology would be necessary to determine where the water from the Water Treatment Plant is going.

Earth Systems concludes that, primarily with respect to Pond #5 of the SCWDWWTP where a fault is present very near its western end, water migrating through discontinuities such as this fault as well as within more permeable beds of the San Benito Formation has likely led to dissolution of cementation leading to destabilization of the slopes. Continued loading of Pond #5 will likely continue to weaken slopes adjacent to the plant. Additionally changes to drainage patterns



associated with the dirt path, and road maintenance that has removed soil from the toe of slopes, may have contributed to the SRL. There was no obvious correlation of the SRL with local seismicity at the time of its initiation in May 2018.

Summary of Conclusions

- San Benito Formation rocks are heavily cemented at the site. The calcium carbonate cement has been dissolved by subsurface water decreasing slope stability in the area of the SRL.
- Subsurface water appears to be migrating preferential along a fault trace that passes very close to the west end of SCWDWWTP Pond #5. This trace daylights on the slopes at the SRL.
- A lineament of green vegetation in otherwise dry surroundings where the fault daylights on the slopes is visible in historic aerial photographs taken after construction of SCWDWWTP Pond #5.
- Wet soil conditions were observed in the central portions of the SRL during emergency landslide removal. Observations and testing of soil samples taken in this area indicate wet to near-saturated conditions.
- Groundwater monitoring well MW#5 at the SCWDWWTP has been dry since its construction. Also, Todd Engineers (2006) noted that "a significant portion of the log MW#5 is missing due to intervals of lost circulation during drilling". The hydrologic effects of percolating waste water on groundwater is uncertain.
- In their 2006 well construction report for the SCWDWWTP, Todd Engineers noted that due to complex local hydrogeologic framework, more than three monitoring wells may be required to characterize the site. We are only aware of monitoring wells MW#2 and MW#5 at the site.



- Groundwater testing by Earth Systems was inconclusive and could not be compared to published groundwater quality data collected from SCWDWWTP monitoring wells.
- There was no significant nearby seismic activity in the period leading up to initiation of the SRL.

CLOSURE

This report is valid for conditions as they exist at this time for the type of project described herein. Our intent was to perform the investigation in a manner consistent with the level of care and skill ordinarily exercised by members of the profession currently practicing in the locality of this project under similar conditions. No representation, warranty, or guarantee is either expressed or implied. This report is intended for the exclusive use by the client as discussed in the Scope of Services section. Application beyond the stated intent is strictly at the user's risk.

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