GEOTECHNICAL INVESTIGATION

SONOMA VALLEY COUNTY SANITATION DISTRICT
AGUA CALIENTE CREEK
BORE AND JACK CROSSING
EL VERANO, SONOMA COUNTY, CALIFORNIA

Project Number 11027.04

August 30, 2012

Brunsing Associates, Inc.

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prepared for

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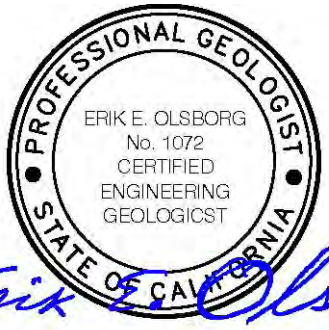

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1.0 INTRODUCTION

This report presents the results of our geotechnical investigation performed by Brunsing Associates, Inc. (BAI) for the planned Bore and Jack operation under Agua Caliente Creek near El Verano, Sonoma County, California. The site is situated west of Highway 12, in the community of El Verano, as shown on the Vicinity Map, Plate 1.

BAI reviewed Sheet 1 of Trunk Main Replacement, Siphon Under Agua Caliente Creek, Alternate 2, prepared by Sonoma Valley County Sanitation District (SVCSD), dated August 3, 2011. We understand that the existing 21-inch sewer trunk line is exposed within the approximately 20-feet deep creek channel approximately two-thirds of the way up the channel banks. Creek bank erosion has exposed a portion of a nearby manhole structures. According to the drawings, the existing pipe will be replaced by two siphon pipes, 12 and 24 inches in diameter, installed in steel casings 24 and 36 inches in diameter, respectively, and placed under the creek channel using bore and jack installation methods. The improvements will also include two junction structures, two siphon structures, and two 6 foot diameter manholes, ranging in depth from 7.5 feet to 12 feet. The existing and planned new structures are shown on Plate 2.

The purpose of our geotechnical investigation was to evaluate the soil, rock and groundwater conditions at the site in order to provide conclusions regarding anticipated jack and boring conditions and recommendations regarding protective shoring for the bore and receiving pits. Our services included document review and research, subsurface exploration, laboratory testing, and engineering and geologic analyses, to provide conclusions and recommendations regarding:

- Excavation characteristics
- Caving potential within the site soils
- Shoring design criteria for deep excavations
- Depth of creek channel scour in the planned pipeline areas
- Pipe cover depth beneath the creek channel
- Pavement section thicknesses for the planned driveway extension
- Dewatering
- Additional geotechnical services.

BAI's services have expanded under Change/Extra Service Order No.1 to include bearing pressure and estimated settlement for the new structures, based on our existing boring data.

2.0 INVESTIGATION

2.1 Document Review and Research

Our investigation was initiated by reviewing the following resources and published references:

- California Division of Mines and Geology (CDMG), 1998, Uniform Building Code, Maps of Known Active Fault Near-Source Zones in California and Adjacent Portions of Nevada: International Conference of Building Officials (ICBO).

- California State Water Resources Control Board (SWRCB), 2011, GeoTracker website, http://geotracker.swrcb.ca.gov/.
- Fox Jr., K.F., Sims, J.D., Bartow, J.A., and Helley, E.J., 1973, Basic Data Contribution 56 – Preliminary Geologic Map of Eastern Sonoma County and Western Napa County, California, California Division of Mines and Geology, Miscellaneous Field Studies Map MF-483, scale 1:62,500.
- Huffman, M.E., and Armstrong, C.F., 1980, Geology for Planning in Sonoma County: California Division of Mines and Geology Special Report 120.
- Jennings, C.W., and Bryant, W.A., 2010, Fault Activity Map: California Geologic Survey, California Geologic Data Map Series, Map No. 6, Scale 1:750,000.
- Wagner, D.L., Clahan, K.B., Randolph-Loar, and Sowers, J.T., 2004, Geologic Map of the Sonoma 7.5' Quadrangle Sonoma and Napa Counties, California – A Digital Database: California Geological Survey Preliminary Geologic Map – Version 1.0, website, http://conservation.ca.gov/cgs/rghm/rgm/preliminary_geologic_maps.htm.

2.2 Field Reconnaissance and Exploration

Our Principal Engineering Geologist, Erik Olsborg, conducted a site reconnaissance on November 17, 2011. It consisted of photography and drill rig access observations. Our Professional Geologist, Sarah Lockwood, explored subsurface conditions on December 15 and 16, 2011, and on January 9, 2012, by drilling, logging, and sampling three exploratory test borings. The approximate boring locations are shown on Plate 2. Borings B-1 and B-3 were drilled 47 and 41.5 feet below the ground surface (bgs), respectively, with a track-mounted drill rig (DR8-K) utilizing 10-inch and 8-inch hollow stem auger equipment. Boring B-2 in the creek channel was advanced approximately 7.5 feet bgs using light, portable equipment (Little Beaver) and 4-inch solid stem auger.

Our Professional Geologist logged the test borings and obtained relatively undisturbed tube samples and bulk samples of the soil and rock materials encountered for visual classification and laboratory testing. The relatively undisturbed samples were obtained from the test borings using a 3-inch outside diameter Modified California split-barrel sampler, driven by a 140-pound drop hammer falling 30 inches per blow. The sampler barrel contained liners for retaining the soil and rock materials. Hammer blows required to drive the sampler were converted to Standard Penetration Test (SPT) blow counts for correlation with empirical test data, using a conversion factor of 0.64. A 2.0-inch outside diameter, SPT sampler was also used to collect selected samples. SPT blow counts provide a relative measure of soil consistency and strength, and are utilized in our engineering analyses.

At the conclusion of drilling, 4-inch diameter piezometers (groundwater monitoring wells) were installed in Borings B-1 and B-3. For well construction details, including screen intervals and seal depth, see the boring logs. A bulk sample of subgrade soils was obtained from the planned driveway turn-around area in the back of the property on the north side of Agua Caliente Creek.

Graphic logs of the borings showing the materials encountered are presented on Plates 3 through 5. The soils were classified in accordance with the Unified Soil Classification System outlined on Plate 6. The various soil and rock descriptive properties used to describe the materials encountered are listed on Plates 7 and 8, respectively.

2.3 Laboratory Testing

Soil and rock samples obtained during our subsurface exploration were transported to our laboratory and examined to confirm field classifications. Laboratory tests were performed on selected samples to estimate their pertinent geotechnical engineering characteristics. Laboratory testing consisted of moisture content-dry density, classification (grain-size), unconsolidated-undrained triaxial compression, resistance (R-) value, and corrosivity tests (see Section 5.6).

The test results are presented opposite the samples tested on the boring logs. A Key to Test Data is provided on Plate 6. In addition, grain size classification and triaxial compression tests are presented on Plates 9 and 10, respectively. Resistance value is presented on Plate 11. Soil was sent to JDH Corrosion Consultants, Inc. for corrosivity potential testing consisting of resistivity, pH, chloride, sulfate and redox. Corrosivity test results are presented in Appendix A.

2.4 Groundwater Well Testing

On January 12 and 13, 2012, our Project Geologist and Senior Engineer performed slug testing and pump testing of the wells at Borings B-1 and B-3. Slug testing measures the ability of the groundwater table to recover equilibrium under falling and rising head conditions. A weighted cylinder of discrete volume (slug) is first submerged in the well, with a responding rise in water level. As the water level recovers to equilibrium, water levels are measured over time. The slug is then removed quickly and the return to equilibrium is again measured. In Boring B-1, head recovery time during slug testing was approximately 45 to 55 minutes. In B-3, recovery time during slug testing was instantaneous.

For our pump tests we operated a clean, 12 gallon per minute (gpm) pump in each well with the intake at approximately the level of the planned base of the respective bore/receiving pit, and measured each well's response. Our 12 gpm pump was able to dewater Boring B-1 at the pit working level in less than one minute. In Boring B-3 the pump was only able to lower the water level by 0.5 feet in at two-hour period. John Mendoza, an Engineer from the Sonoma County Water Agency, was present to record the data for both slug and pump tests using a transducer. He then reduced the data and produced graphic plots, presented in Appendix B.

3.0 SITE CONDITIONS

The portion of Agua Caliente Creek under which the new pipeline will run flows generally west-southwest in a narrow, steeply incised channel. Its confluence with Sonoma Creek is approximately 400 feet west of the site, as shown on Plate 1. The creek channel is approximately 20 feet in depth with very steep banks, varying from approximately one horizontal to one vertical (1H:1V) to near vertical. In the vicinity of the proposed jack and bore pits, the channel banks are near vertical. There were pools and a slight flow of water in the creek channel at the time of our field exploration. The creek banks are heavily vegetated in most places. However, large areas of exposed soils and/or weathered bedrock are present on both banks. The planned jacking pit is located on the property of the Finnish American Home, on the south creek terrace, at an elevation of approximately 103 feet above Mean Sea Level (MSL). The planned receiving pit is located on the northern creek terrace, in the rear yard of a private residence, at an

elevation of approximately 100 feet above MSL. The terraces on either side of the creek are very gently sloping to near level.

An existing, 21-inch diameter sanitary sewer trunk line crosses the properties and is exposed where it spans the creek channel about two-thirds up the banks (Plate 2).

4.0 SITE GEOLOGY AND SOIL CONDITIONS

4.1 Regional Geologic and Seismic Setting

The project site is located along a generally southwest-trending stream channel of Agua Caliente Creek, which drains the northwest-trending Sugarloaf Ridge located northeast of the site. Sugarloaf Ridge is comprised of volcanic deposits of the Tertiary Sonoma Volcanics group. Holocene alluvium and other sedimentary units present in the creek channel and on its terraces contain clasts originating from the Sonoma Volcanics. The Tertiary-Quaternary Glen Ellen Formation, comprised of tuff, conglomerate, sandstone and siltstone, also occurs in the general area. At depth, the area is underlain by Cretaceous-Jurassic Franciscan Complex sedimentary rocks.

According to the published geologic references we reviewed, no active faults are shown at or trending towards the site. The active Rodgers Creek Fault is located approximately 5.27 miles west of the site, as shown on the Regional Fault Map, Plate 12. The Rodgers Creek Fault is part of a network of generally northwest-trending strike-slip faults of the San Andreas Fault system, which controls the seismicity and tectonics of the Sonoma County region. The San Andreas Fault is located along the coast, approximately 24.27 miles to the southwest. A Pre-Quaternary fault is shown on Plate 12 in the site vicinity; however, this ancient inactive fault does not appear to be of significance. Future, large-magnitude earthquakes originating on these or other nearby faults are expected to cause strong ground shaking at the site.

4.2 Site Geology and Soils

The channel of Agua Caliente Creek contains three geologic units; the Pliocene-Pleistocene Glen Ellen Formation sedimentary rocks on the south bank and channel bottom; the Holocene alluvium on the northerly creek bank, and the recent Holocene alluvium (channel deposits) within the creek channel.

The two sides of the creek channel are markedly different geologically. In the southern creek bank and channel bottom, tuff, conglomerate, sandstone and siltstone of the Glen Ellen Formation are exposed. The siltstone extends across much of the channel, where not scoured and covered by Holocene alluvium.

We encountered the same materials in Boring B-1 on the south bank as were observed in the lower creek channel. In Boring B-1, Glen Ellen Formation volcanic and sedimentary rocks were observed down to about 47 feet bgs, the maximum depth explore. The Glen Ellen Formation consists of brownish red tuff breccia, brownish red and gray tuff; reddish brown conglomerate, gray, yellow and tan siltstone; tan, red and blue gray sandstone; and blue gray siltstone and shale. These rocks are generally little fractured, moderate in hardness and little weathered. The tuff

between about 3 and 14 feet bgs was moderately hard to hard and difficult to drill with the 10-inch auger. The siltstone-shale below 41 feet in depth is low to moderate in hardness.

Test boring B-2 was drilled within the creek channel. The light, portable drill rig encountered drilling and sampling refusal and caving at 7.5 feet in sandy, gravelly alluvium. The alluvium (channel deposits) contained cobbles up to 8 inches in largest dimension.

In Test Boring B-3, on the north bank, we encountered Holocene alluvium down to approximately 37 feet in depth. The upper 29 feet of alluvium consists of loose silty sands and gravels. The alluvium was very loose between 25 to 29 feet bgs. The lower alluvium consists of medium stiff, blue-gray clay from 29 to approximately 38 feet bgs. Glen Ellen Formation sedimentary rocks were encountered from approximately 38 to 41.5 feet, the maximum depth explored. The Glen Ellen rocks consist of bluish-green to olive-colored siltstone. Our interpretation of the subsurface geology is shown on the Geologic Cross Section, Plate 13.

A small slump was observed on the upper part of the northern creek bank, and is shown on Plate 2. No other landslides were observed in the immediate vicinity of the site.

Site Photograph A, Plate 14, shows the exposed soil and weathered rock conditions within the creek channel upstream of the existing sewer trunk line. As observed in Site Photograph A the channel deposits (sand, gravel and cobbles) are within the incised channel within the Glen Ellen Formation bedrock. Holocene alluvium (gray-brown silty sands at this location) overlies the Glen Ellen Formation sedimentary rock on the north bank, but is not present on the south bank. The alluvium/Glen Ellen Formation contact is relatively flat on the north channel bank, but apparently dips steeply to the north toward Boring B-3 just beyond the creek channel. We were not able to determine the nature of the contact between the Holocene alluvium and the Glen Ellen Formation bedrock beyond the northerly creek bank. There appears to be an offset between the southerly bank where Glen Ellen bedrock (Boring B-1) starts at 3 feet bgs and the northerly bank (Boring B-3) where Glen Ellen bedrock starts at 37 feet bgs. The offset may be due to a steeply-dipping, east-west trending normal fault (hanging wall down to the north), or to an erosional and subsequent depositional unconformity.

4.3 Site Hydrology

Groundwater was measured in each of our borings, as summarized in Table 1.

Table 1. Groundwater Elevation Data 1/12/12

Well/Boring I.D.	Top of Casing Elevation (feet above MSL)*	Depth to water	Groundwater Elevation
B-1 (Glen Ellen Fmn.)	103.7	19.0	84.7
B-2 (channel deposits)	83.0**	0.8	82.2
B-3 (older alluvium)	100.5	22.8	77.7

*Elevations are based on surveyed topographic contours on SVCSD plans, See Plate 2.
**Ground elevation

Regionally, the wells are situated to receive down-gradient head pressure from the north and northeast. Data from our slug tests and pumping tests of the piezometers in borings B-1 (south

bank) and B-3 (north bank) indicate that the Glen Ellen Formation is a much less permeable unit than the Holocene alluvium. Table 1 data indicate a steep hydraulic gradient on the north side of the creek. This is illustrated on Plate 13. Additional subsurface data may be necessary if the client wished to further define the respective aquifer properties, and what outside influences may be responsible for the unusual shape of the water table across the site.

A rain storm on January 20 through 22, 2012 raised the creek water elevation by several feet (not measured). This rain event raised the water level in Boring B-1 by approximately 2.5 feet and the water level in Boring B-3 by almost 7 feet. The water level rise in Boring B-3 appears to be the result of the creek water rising to be in contact with the permeable alluvium overlying the Glen Ellen bedrock (see Site Photograph A, Plate 14).

As previously mentioned, the creek channel is incised within the low-permeability Glen Ellen Formation bedrock. During low water periods, the creek water is confined within the channel. When the creek water rises, the water comes into contact with the permeable alluvium, resulting in groundwater recharge within the alluvial soils. As shown in Table 1, the groundwater elevation in boring B-1 during our investigation (1/12/12) was 2.5 feet higher than the creek water elevation at the casing crossing location. The groundwater elevation in boring B-3 at that time was 4.5 feet lower than the nearby creek water.

5.0 DISCUSSION AND CONCLUSIONS

5.1 General

Based on the results of our reconnaissance and subsurface exploration, we conclude that the site is marginally suitable from a geotechnical standpoint for the planned jack and bore operation and suitable for the improvement junction, siphon and manhole structures. The main geotechnical constraints at the site include difficult excavation in moderately hard to hard rock on the south bank; difficult drilling in gravel and cobbles with flowing water in the creek channel; and potential caving and groundwater conditions within excavations into the loose to very loose alluvium on the north bank. There is also a potential for encountering “flowing sands” in the alluvium on the north bank. These concerns and their potential mitigation measures are discussed in the following sections.

5.2 Soil and Rock Unit Characteristics and Excavatibility

5.2.1 Southern Bank (Bore Pit)

As observed in the southern creek bank and in Boring B-1, the subsurface materials in the area of the planned bore pit are comprised of volcanic and sedimentary rocks of the Glen Ellen Formation. Difficult drilling was encountered in the tuff extending from about 3 to 14 feet bgs in B-1. High blow counts were recorded in this unit. Heavy-duty excavation equipment will likely be necessary to penetrate this, and the underlying conglomerate. The base of the bore pit will likely bear on moderately hard siltstone. Walls of the excavation should be relatively stable. The bore pit should be relatively easy to dewater during the dry season using heavy-duty trash pumps.

5.2.2 Northern Bank (Receiving Pit)

As observed in the upper creek bank and in Boring B-3, the subsurface materials in the area of the planned receiving pit are comprised of sandy, gravelly, and clay alluvium to a depth to about 37 feet bgs. The alluvium is underlain at depth by moderately hard siltstone. Blow counts in the alluvium were relatively low. The entirety of the receiving pit is expected to be in the alluvium. Standard excavation equipment should be sufficient to penetrate these units. However, walls of the excavation, especially below the groundwater table which was at 22 feet bgs during our investigation, may be unstable, especially in saturated conditions. The receiving pit area will need to be thoroughly dewatered for a period of time before the excavation commences and maintained until the pits are backfilled. If the water in the creek channel is higher than approximately 80 feet in elevation, the creek water will be recharging the groundwater in the north bank alluvium. Operations should not take place when the creek water is higher than elevation 80 feet at the casing crossing location.

5.2.3 Creek Channel Alluvium (Bore Path)

We understand that the bore path alignment and elevations have already been determined. The planned depth of cover for the bore path below the creek channel is approximately 5 feet. As observed in Boring B-2, the depth of potential scour within the creek channel is greater than 7 feet. We were not able to determine the depth of the alluvium with our light drilling and sampling equipment. It is likely that the jack and bore equipment will penetrate alluvium in the center of the channel, however, it should not be laterally extensive.

The bore and jack operations will encounter clean (less than 5 percent fines) sands, gravels and cobbles, up to 8-inches in largest dimension. Drilling in the lean gravel and cobbles will be difficult. Drilling within the unconsolidated alluvium could create instability (caving) within the creek channel. It is likely that creek water will flow into the bore pit if the creek water is not first controlled.

With only five feet of cover, there is a possibility of creating a “glory hole” within the creek channel during the bore and jack operations. Ideally, the bore path should be lowered into bedrock with at least 5 feet of bedrock cover. However, lowering the bore path does not appear practical; the greater pit depths would encounter worsening stability issues and groundwater concerns.

5.3 Faulting and Seismicity

No active faults are shown on, or trending toward the site on the published geologic maps we reviewed. The site is not in a Fault Rupture Hazard Zone as defined by the Alquist-Priolo Earthquake Fault Zoning Act and associated maps (Hart and Bryant, 1997). The active Rodgers Creek fault is located approximately 5.27 miles west of the site. The active San Andreas Fault is located along the coast, approximately 24.27 miles to the southwest. Due to the site’s proximity to major active faults, future large magnitude earthquakes are expected to cause strong ground shaking at the site.

Although we did not observe direct evidence of faulting, active or inactive, at the site, one explanation for the lack of continuity in geologic units across the creek channel could be fault offset. In this scenario, the most likely orientation would be an east-west-trending, steeply northward-dipping normal fault, resulting in the northern bank moving down relative to the southern bank. This would make the age of the fault younger than the Glen Ellen Formation which it offsets, indicating possible late Quaternary movement. Such a fault could be considered "potentially active"; however, it is unlikely to be capable of generating an earthquake with surface rupture. More likely, fault movement could occur as a response to a large magnitude earthquake on a nearby active fault.

5.4 Stability of Creek Banks

As mentioned above, a small slump was observed within the older alluvium on the upper part of the northern bank. According to the SVCSD plans we reviewed, the receiving pit is set back about 10 feet from the top of bank in this area. The jacking pit is set back about 15 feet from the top of the southern bank. There is a potential for caving within the pit excavations, primarily on the north bank. Such caving could involve a creek bank failure into the excavation. To maintain stability during excavation and boring, the upper part of the banks should not be subjected to surcharge loads between the pit and the channel.

5.5 Groundwater

Depending on the time of year of construction, the lower at least 17 feet of the jacking pit, and the lower at least 8 feet of the receiving pit, as well as the entire bore path, could be below the water table. Efficient dewatering of the excavations will be of critical importance to maintaining pit stability and workable conditions. Due to the lower permeability, and slower well recharge time observed on the southern bank, groundwater management on that side is anticipated to be straightforward. Management of in-stream and northern bank groundwater will require more aggressive measures. Dewatering options are discussed below in section 6.3.

BAI evaluated our slug test data to estimate the hydraulic conductivity of materials in the immediate vicinity of Borings B-1 and B-3. Our evaluations utilized methods developed by Bouwer and Rice (1976)[1]. The results of our evaluations are summarized in Table 1.

Table 2. Hydraulic Conductivity Estimates

Boring	Hydraulic Conductivity (gpm/ft^2)
B-1	0.053
B-3	1.98

5.6 Settlement

Assuming foundations are designed and constructed in accordance with our recommendations, we estimate that the maximum post-construction settlement due to foundation loads will be 1 inch or less, see Table 1 below.

[1]A Slug Test for Determining Hydraulic Conductivity of Unconfined aquifers With Completely or Partially Penetrating Wells", Bouwer, H. and R. C. Rice, Water Resources Research, Volume 12, No. 3

Table 3 – Estimated Settlement

Structure	Station	Settlement (inches)
Junction 1	0+00	1.0
6' Dia. Manhole	1+11.07	0.5
Siphon "A"	1+37.40	0.1
Siphon "B"	4+46	0.6
6' Dia. Manhole	4+91.76	0.7
Junction 2	5+24	0.3

5.7 Soil Corrosivity

In order to assess the potential of the soil chemistry to corrode subsurface utility casing, conduits and other subsurface structures, we submitted samples of subsurface soils we considered most pertinent to the structures addressed in this report to our sub-consultant, JDH Corrosion Consultants, Inc. for basic soil corrosivity testing. The laboratory test results, interpretation of the raw data and associated recommendations for corrosion control are presented in Appendix A.

6.0 RECOMMENDATIONS

6.1 Bore and Jack in the Creek Channel

As much as practical, the bore and jack pipe in the creek channel should be advanced by jacking through the gravels and cobbles. Augering should be kept to a practical minimum within the creek channel alluvium. The pipe should be advanced by jacking to minimize the potential for water, gravel and cobble intrusion into the bore pit and for creating a "glory hole" in the creek channel gravels.

6.2 Pit Wall Shoring Design Criteria

During construction, the bore pits will need temporary shoring in pits greater than about 4 feet in depth, and in accordance with the State of California Safety Regulations and/or OSHA requirements. The design of the shoring is the responsibility of the Contractor or shoring designer. The design of the temporary shoring should take into account lateral pressures exerted by the adjacent soil, surcharge loads due to construction equipment and traffic alongside the excavation. A heavy-duty steel shield will be needed for the receiving pit on the north bank. While the design and maintenance of the shoring system is the responsibility of the Contractor and/or shoring designer, we recommend that shoring be designed to resists an equivalent fluid pressure of 70 pounds per cubic foot (pcf) on the south side (B-1) and 90 pcf on the north side (B-3). Allowable bearing loads for structures are discussed in Section 6.4.

6.3 Dewatering

There is a strong probability that creek water will be entering the bore and jack pipe when the creek channel deposits are encountered. The creek channel gravels and cobbles along the bore path may need to be dewatered by means such as an upstream cofferdam.

The cofferdam, if needed, should be constructed by excavating the creek channel gravels at the dam location, then placing 15-mil (minimum) plastic sheeting. Fill soils, as much as practical, should be placed in thin lifts and compacted. The completed cofferdam should be two feet higher than the adjacent channel gravels. When the bore and jack operations through the creek channel are completed, the fill soils and underlying plastic sheeting be removed and the previously-excavated gravels replaced.

On the southern bank (jacking pit), dewatering of the bore pit can likely be accomplished with heavy duty trash pumps and sump within the excavation. On the northern bank, the water table surrounding the receiving pit may need to be lowered by means of a ring of nearby dewatering wells ("point wells"). A sump and pump within the receiving pit will also be needed.

Actual size and capacity of the sump pumps at either pit will need to be determined by the contractor. Discharge of the pumped water should be well downstream from the construction area and immediate recharge zones, or stored and discharged into the trunk sewer.

6.4 Foundation Support

The proposed improvement structures can be supported on reinforced concrete footings founded in supporting material. Footings can be designed using an allowable soil bearing pressure of 1000 pounds per square foot (psf) for dead plus live loads. A 33 percent increase in bearing pressure is allowable for total loads, including wind or seismic loads.

Resistance to lateral loads can be obtained using passive earth pressure against the face of the foundations. An allowable passive pressure of 500 psf plus 40 psf per foot of depth below subgrade and frictional resistance of 0.30 times net vertical dead load, are appropriate for footing elements poured neat against supporting natural soils. Passive pressure should be neglected within the upper three feet in Boring B-1 and seven feet in Boring B-3 where porous and weak soils are not removed.

The above bearing pressures are based on data obtained from boring B-3, soil conditions at each improvement structure could be significantly different than the data used. During construction BAI should observed the completed foundation excavations to ensure that design criteria is appropriate for the structure.

6.5 Pavement Section Design

We understand that the SVCSD would like to use Turfstone by Interlock Paving Systems, Inc., concrete paving system for trench resurfacing and the driveway. Our laboratory test indicates near surface soils have an R-value of 28. Using this value and the design information from the Interlock Paving Systems, we recommend the following minimum pavement section:

Table 4 – Pavement Section

Assumed Traffic Index (T.I.)	Thickness (inches)	
	Leveling Course (sand)	Crushed Stone (1/2" to ¾")
4.0	1.5	6

Section should conform to the above minimum section and the manufacturer's recommendations. The crushed stone should conform to the manufacturer's recommendations. A filter fabric, such as Mirafi 140N, or equivalent, should be placed over the crushed stone, prior to sand placement.

Prior to placing crushed stone, BAI should observe the soils exposed by the required site grading. The exposed soils should be scarified to at least six inches deep, moisture conditioned to at least 2 percent over optimum moisture content and compacted to at least 90 percent relative compaction as determined by the ASTM D 1557 test procedure, latest edition, to provide a smooth unyielding surface. Weak soils within pavement areas should be removed and compacted to at least 90 percent relative compaction, as described in Appendix C of this report.

7.0 ADDITIONAL SERVICES

To complete the geotechnical program, BAI should review the final grading and shoring plans, and soil related specifications. This important step will allow us to check that the recommended design criteria were applied as we intended. During construction, BAI should observe soil conditions exposed during excavation activities to check that the conditions exposed are as anticipated during our investigation. In addition, we should observe Agency personnel performing the appropriate field and laboratory testing during site preparation, grading and trench resurfacing and driveway surfacing activities. Our observations and tests would allow us to check that the work is being performed in accordance with project guidelines, confirm that the soil and rock conditions are as anticipated, and to modify our recommendations, if necessary.

8.0 LIMITATIONS

This geotechnical investigation was performed in accordance with the usual and current standards of the profession, as they relate to this and similar localities. No other warranty, either expressed or implied, is provided as to the conclusions and professional advice presented in this report. Our conclusions are based upon reasonable geologic and engineering interpretation of available data.

The samples taken and tested, and the observations made, are considered to be representative of the site; however, soil and geologic conditions may vary significantly between test borings and across the site. As in most projects, conditions revealed during construction excavation may be at variance with preliminary findings. If this occurs, the changed conditions must be evaluated by BAI, and revised recommendations be provided as required.

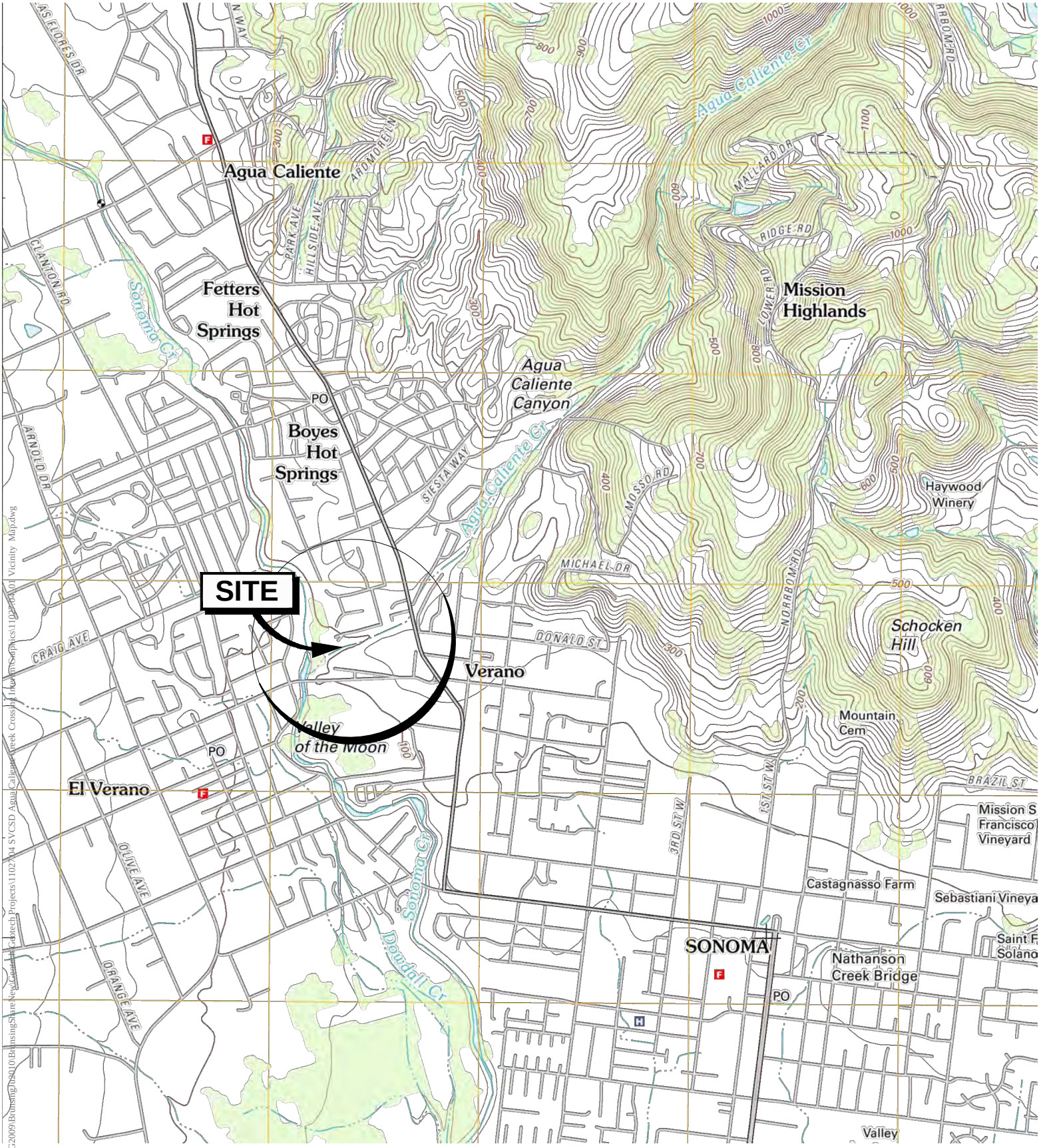
This report is issued with the understanding that it is the responsibility of the Owner, or his/her representative, to insure that the information and recommendations contained herein are brought to the attention of all other design professionals for the project, and incorporated into the plans,

and that the Contractor and Subcontractors implement such recommendations in the field. The safety of others is the responsibility of the Contractor. The Contractor should notify the owner and BAI if he/she considers any of the recommended actions presented herein to be unsafe or otherwise impractical.

Changes in the conditions of a site can occur with the passage of time, whether they are due to natural events or to human activities on this, or adjacent sites. In addition, changes in applicable or appropriate codes and standards may occur, whether they result from legislation or the broadening of knowledge. Accordingly, this report may become invalidated wholly or partially by changes outside our control. Therefore, this report is subject to review and revision as changed conditions are identified.

The recommendations contained in this report are based on certain specific project information regarding type of construction and improvement location, which have been made available to us. If conceptual changes are undertaken during final project design, we should be allowed to review them in light of this report to determine if our recommendations are still applicable.

ILLUSTRATIONS



REFERENCE:
Sonoma Quadrangle, 2012
7.5-Minute Series, USGS

NORTH

APPROXIMATE SCALE (FEET)
0 1000 2000 4000

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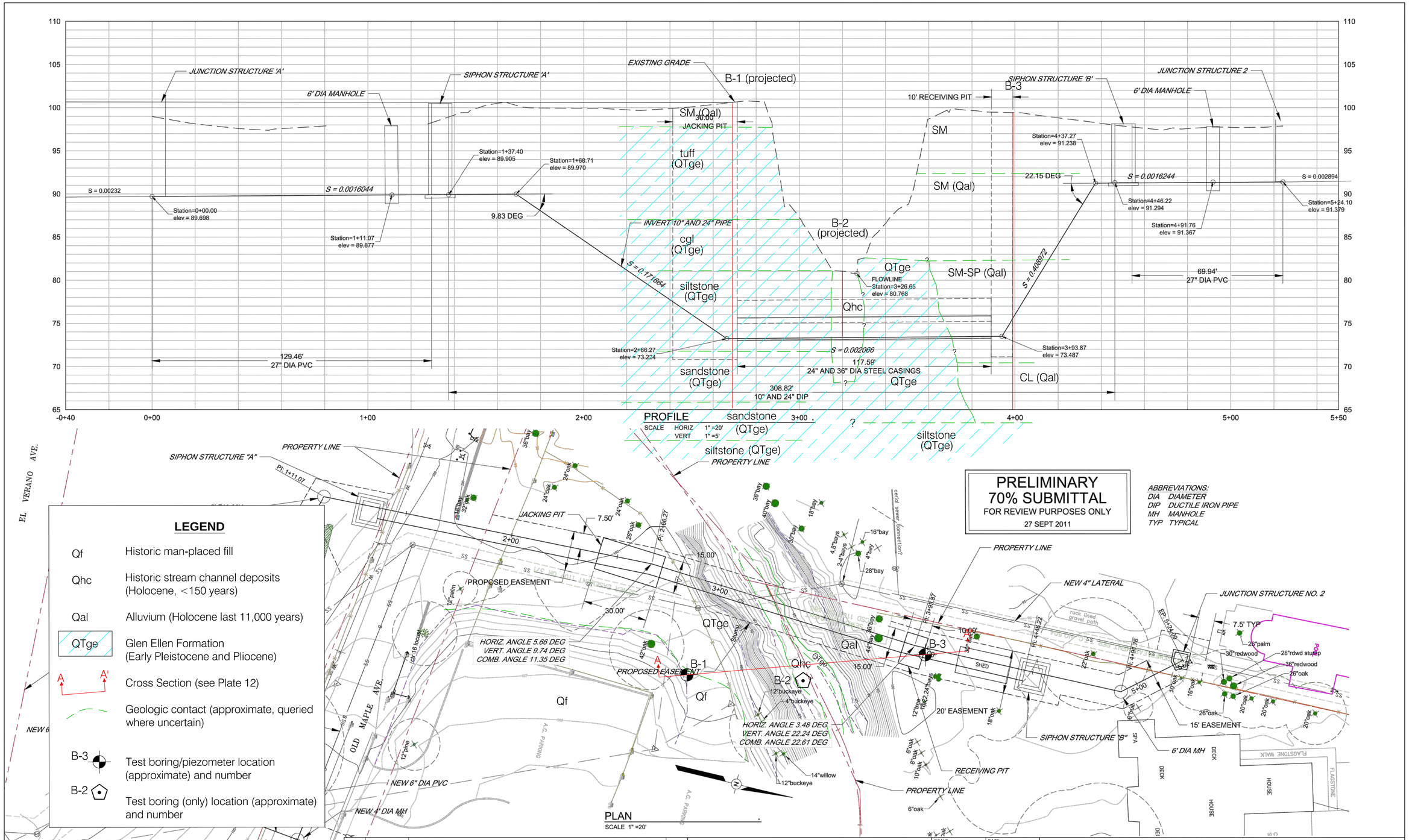
Santa Rosa, California 95403
(707) 838-3027

Job No.: 11027.04
Appr.: KAC
Date: 08/30/12

VICINITY MAP
SVCSD AGUA CALIENTE CREEK
BORE AND JACK CROSSING
Agua Caliente Creek
El Verano, Sonoma County, California

PLATE
1

\\BRUNSING2009\Brunsing\2010\BrunsingShareNew\Geotech Projects\11027.04 SVCSD Agua Caliente Creek Crossing Interim\Graphics\11027.04\01 Vicinity Map.dwg
8/30/2012 12:49:12 PM save date
8/30/2012 12:49:25 PM plot date



LEGEND

Qf	Historic man-placed fill
Qhc	Historic stream channel deposits (Holocene, <150 years)
Qal	Alluvium (Holocene last 11,000 years)
QTge	Glen Ellen Formation (Early Pleistocene and Pliocene)
A A'	Cross Section (see Plate 12)
	Geologic contact (approximate, queried where uncertain)
B-3	Test boring/piezometer location (approximate) and number
B-2	Test boring (only) location (approximate) and number

NO.	DATE	REVISION	BY

SONOMA VALLEY COUNTY SANITATION DISTRICT

SCALE : | DATE : 3-Aug-11
DRAWN : ADF
REVIEWED :

TRUNK MAIN REPLACEMENT
SIPHON UNDER AGUA CALIENTE CREEK
ALTERNATE 2

FILE NAME: ALTERNATE-2.dwg
CONTRACT NUMBER:
DRAWING NUMBER: C-1
SHEET 1 OF 1

REFERENCE: Trunk Main Replacement Siphon Under Agua Caliente Creek Alternate 2, prepared by Sonoma Valley County Sanitation District, Drawing Number C-1, Sheet 1 of 1, dated 3-Aug-11

APPROXIMATE SCALE (FEET)
0 10 20 40

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Job No.: 11027.04
Appr.: EEO
Date: 08/30/12

SITE PLAN, PROFILE and GEOLOGIC MAP
SVCSD AGUA CALIENTE CREEK
BORE AND JACK CROSSING
Agua Caliente Creek
El Verano, Sonoma County, California

PLATE 2

Log of Boring B-1

Equipment: Deeprock DR8K

Date: 12/15/11

Logged By: SCL **Elevation:** 102.9 feet ***

Laboratory Tests	Sampler Type*	Moisture Content (%)	Dry Density (pcf)	Blows/foot	Depth (ft.)	Description
					1	BROWN SILTY GRAVELLY SAND (SM) medium dense, damp to moist large cobbles of rhyolite, andesite
					2	
					3	BROWNISH-RED TUFF BRECCIA little fracturing,moderately hard to hard, little weathering
					4	
					5	
	CA	12.4	94	51**	6	
					7	BROWNISH-RED TUFF little fracturing, moderately hard, deep weathering
					8	
					9	
		17.5	102		10	
Tx 5488 (1440)		15.8	103			
	CA			37**	11	GRAY TUFF little fracturing, moderately hard to hard, moderate weathering
					12	
					13	
					14	REDDISH BROWN CONGLOMERATE little fracturing, moderate hardness, little weathering cobbles of volcanics, clast-supported in a sandy-clayey matrix
Tx 1112 (2160)		16.6	101		15	
	CA			42**		
					16	
					17	
					18	
					19	
					20	
	CA			38**		GRAY AND YELLOW SILTSTONE little fracturing, moderate hardness, little weathering
Tx 5896 (3600)		31.1	91		21	
					22	

Fill

*CA - California Modified Split Barrel Sampler 3.0-inch O.D.
CM - California Modified Split Barrel Sampler 2.5-inch O.D.
SPT - California Split Barrel Sampler 2.0-inch O.D.
** Equivalent "Standard Penetration" Blow Counts.
*** Elevations interpolated from Sheet C-1, Alternate 2, dated 8-3-11 by SCVSD, See Plate 2

Scale: 1" = 3'

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Date: 08/30/12

LOG OF BORING B-1
SVCSD AGUA CALIENTE CREEK
BORE AND JACK CROSSING
Agua Caliente Creek
El Verano, Sonoma County, California

PLATE 3

Log of Boring B-1

Equipment: Deeprock DR8K
Date: 12/15/11
Logged By: SCL **Elevation:** 102.9 feet ***

Laboratory Tests	Sampler Type*	Moisture Content (%)	Dry Density (pcf)	Blows/foot	Depth (ft.)	Sample	
					23		
					24		TAN SILTSTONE little fracturing, moderate hardness, little weathering
54% Passing #200		29.6	90		25		
	CA			51/10"**	26	Casing	
					27		
					28		
					29		TAN TO RED SILTY SANDSTONE little fracturing, moderate hardness, little weathering, coarse, rounded sands
Bottom Elev. of Jacking Pit					30		
22% Passing #200 97% Passing #4		33.2	88				
	CA	19.6	107	53/10"**	31		
					32		
					33		
					34		
					35		BLUE-GRAY SANDSTONE little fracturing,moderate hardness, little weathering coarse rounded sands entrained
	CA			51/11"**	36		
					37		
					38		
					39		
					40		
	SPT			71	41		BLUE-GRAY SILTSTONE-SHALE little fracturing, low to moderate hardness, little weathering contains coarse rounded sands
					42		
					43		
					44		

*CA - California Modified Split Barrel Sampler 3.0-inch O.D.
CM - California Modified Split Barrel Sampler 2.5-inch O.D.
SPT - California Split Barrel Sampler 2.0-inch O.D.
** Equivalent "Standard Penetration" Blow Counts.
*** Elevations interpolated from Sheet C-1, Alternate 2, dated 8-3-11 by SCVSD, See Plate 2

Scale: 1" = 3'

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LOG OF BORING B-1
SVCSD AGUA CALIENTE CREEK
BORE AND JACK CROSSING
Agua Caliente Creek
El Verano, Sonoma County, California

PLATE 3

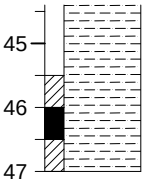
Log of Boring B-1

Equipment: Deeprock DR8K

Date: 12/15/11

Logged By: SCL **Elevation:** 102.9 feet ***

Laboratory Tests	Sampler Type*	Moisture Content (%)	Dry Density (pcf)	Blows/foot	Depth (ft.)	Sample
					45	
	SPT			31	46	
					47	



Notes:
1. Water encountered at about 30 feet during drilling
2. 4-inch diameter well installed to 45.3 feet, see well construction detail

*CA - California Modified Split Barrel Sampler 3.0-inch O.D.
CM - California Modified Split Barrel Sampler 2.5-inch O.D.
SPT - California Split Barrel Sampler 2.0-inch O.D.
** Equivalent "Standard Penetration" Blow Counts.
*** Elevations interpolated from Sheet C-1, Alternate 2, dated 8-3-11 by SCVSD, See Plate 2

Scale: 1" = 3'

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Job No.: 11027.04
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LOG OF BORING B-1
SVCSD AGUA CALIENTE CREEK
BORE AND JACK CROSSING
Agua Caliente Creek
El Verano, Sonoma County, California

PLATE 3

Log of Boring B-2

Equipment: Light Portable Drill Rig (Little Beaver)

Date: 12/16/11

Logged By: SCL **Elevation:** 83 feet ***

Sampler Type*	Blows/foot	Depth (ft.)	Sample
		1	COBBLES, 6-inch diameter BROWN SILTY SANDY GRAVEL (GP-GM) medium dense, saturated
		2	COBBLES & SILTY SANDY GRAVEL (SP-GP) medium dense to dense, saturated
SPT	23**	3	
		4	
SPT	15**	5	
		6	BROWN GRAVELLY SILTY SAND (SM) dense, saturated
SPT	78**	7	

Casings

Notes:
1. Water encountered at 0.8 feet during drilling.
2. Material "glory holed" during drilling, hole would not stay open. Hole was hand dug to 2 feet.

*CA - California Modified Split Barrel Sampler 3.0-inch O.D.
CM - California Modified Split Barrel Sampler 2.5-inch O.D.
SPT - California Split Barrel Sampler 2.0-inch O.D.
** Equivalent "Standard Penetration" Blow Counts.
*** Elevations interpolated from Sheet C-1, Alternate 2, dated 8-3-11 by SCVSD, See Plate 2

Scale: 1" = 3'

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Job No.: 11027.04
Appr.: EEO
Date: 08/30/12

LOG OF BORING B-2
SVCSD AGUA CALIENTE CREEK
BORE AND JACK CROSSING
Agua Caliente Creek
El Verano, Sonoma County, California

PLATE 4

Log of Boring B-3

Equipment: Deeprock DR8K
Date: 1/9/12
Logged By: SCL **Elevation:** 99.5 feet ***

Laboratory Tests	Sampler Type*	Moisture Content (%)	Dry Density (pcf)	Blows/foot	Depth (ft.)	Sample	
					1		BROWN SILTY SAND (SM) loose, porous, dry to damp (fill)
					2		
					3		
					4		BROWN SILTY SAND (SM) loose, porous, dry to damp with rootlets (topsoil)
	CA			7**	5		
					6		
					7		BROWN WITH GRAY SILTY SAND (SM) loose, porous, dry with roots
					8		
					9		
	CA			9**	10		
Tx 2168 (1440)		15.1	69		11		
					12		
					13		
					14		
	CA			10**	15		
Tx 2690 (2160)		11.9	71		16		REDDISH BROWN SILTY COARSE SAND (SM) with rounded gravels loose, dry
					17		
					18		REDDISH-BROWN SILTY SANDY GRAVEL (GM) loose to very loose, wet to saturated large gravels to small cobbles
					19		
	CA			10**	20		
11% Passing #200 49% Passing #4					21		
					22		

*CA - California Modified Split Barrel Sampler 3.0-inch O.D.
CM - California Modified Split Barrel Sampler 2.5-inch O.D.
SPT - California Split Barrel Sampler 2.0-inch O.D.
** Equivalent "Standard Penetration" Blow Counts.
*** Elevations interpolated from Sheet C-1, Alternate 2, dated 8-3-11 by SCVSD, See Plate 2

Scale: 1" = 3'

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Job No.: 11027.04
Appr.: EEO
Date: 08/30/12

LOG OF BORING B-3
SVCSD AGUA CALIENTE CREEK
BORE AND JACK CROSSING
Agua Caliente Creek
El Verano, Sonoma County, California

PLATE 5
SHEET 1 of 2

Log of Boring B-3

Equipment: Deeprock DR8K
Date: 1/9/12
Logged By: SCL **Elevation:** 99.5 feet ***

Laboratory Tests	Sampler Type*	Moisture Content (%)	Dry Density (pcf)	Blows/foot	Depth (ft.)	Sample	
					23		
					24		
15% Passing #200 47% Passing #4	CA			5**	25		BROWN SILTY FINE SAND (SM) very loose, saturated
					26		
					27		
Bottom Elev. of Receiving Pit					28		
					29		BLUE-GRAY CLAY (CL) medium stiff, saturated
					30		
	CA			14**	31		
					32		
					33		
					34		
					35		
					36		
					37		
					38		BLUE-GREEN TO OLIVE-TAN SILTSTONE little fracturing, weakly indurated, low to moderate hardness, little weathering contains coarse rounded sands
					39		
					40		
	CA			28**	41		

Casing

Notes:
1. Water encountered at about 23 feet bgs during drilling
2. 4-inch diameter well installed to 40 feet, see well construction detail

*CA - California Modified Split Barrel Sampler 3.0-inch O.D.
CM - California Modified Split Barrel Sampler 2.5-inch O.D.
SPT - California Split Barrel Sampler 2.0-inch O.D.
** Equivalent "Standard Penetration" Blow Counts.
*** Elevations interpolated from Sheet C-1, Alternate 2, dated 8-3-11 by SCVSD, See Plate 2

Scale: 1" = 3'

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LOG OF BORING B-3
SVCSD AGUA CALIENTE CREEK
BORE AND JACK CROSSING
Agua Caliente Creek
El Verano, Sonoma County, California

PLATE 5
SHEET 2 of 2

UNIFIED SOIL CLASSIFICATION SYSTEM (USCS)

MAJOR DIVISIONS			SYMBOLS GRAPH	SYMBOLS LETTER	TYPICAL DESCRIPTIONS
COARSE-GRAINED SOILS	GRAVELS AND GRAVELLY SOILS	CLEAN GRAVELS (Less than 5% fines)		GW	WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
				GP	POORLY-GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
	MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	GRAVELS WITH FINES (Greater than 12% fines)		GM	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES
				GC	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES
MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	SAND AND SANDY SOILS	CLEAN SANDS (Less than 5% fines)		SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
				SP	POORLY-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
	50% OR MORE OF COARSE FRACTION PASSING THROUGH NO. 4 SIEVE	SANDS WITH FINES (Greater than 12% fines)		SM	SILTY SANDS, SAND-SILT MIXTURES
				SC	CLAYEY SANDS, SAND-CLAY MIXTURES
FINE-GRAINED SOILS	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
				CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
				OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILT, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS
				CH	INORGANIC CLAYS OF HIGH PLASTICITY
				OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS				PT	PEAT, HUMOUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS

KEY TO TEST DATA

Consol - Consolidation
LL - Liquid Limit
PI - Plasticity Index
EI - Expansion Index
SA - Sieve Analysis
■ Sample Retained
▨ Sample Recovered, Not Retained
⊠ Bulk Sample
◯ Sample Not Recovered
▽ Groundwater Level Reading

	Shear Strength, psf	Confining Pressure, psf	
Tx	320	(2600)	- Unconsolidated Undrained Triaxial
TxCU	320	(2600)	- Consolidated Undrained Triaxial
DS	2750	(2600)	- Consolidated Drained Direct Shear
FVS	470		- Field Vane Shear
UC	2000		- Unconfined Compression
PP	2000		- Field Pocket Penetrometer
Sat			- Sample saturated prior to test

▼ Second Groundwater Level Reading

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SOIL CLASSIFICATION CHART & KEY TO TEST DATA

SVCSD AGUA CALIENTE CREEK
BORE AND JACK CROSSING
Agua Caliente Creek
El Verano, Sonoma County, California

PLATE 6

RELATIVE DENSITY OF COARSE-GRAINED SOILS

Relative Density	Standard Penetration Test Blow Count (blows per foot)
Very loose	4 or less
Loose	5 to 10
Medium dense	11 to 30
Dense	31 to 50
Very dense	More than 50

CONSISTENCY OF FINE-GRAINED SOILS

Consistency	Identification Procedure	Approximate Shear Strength (psf)
Very soft	Easily penetrated several inches with fist	Less than 250
Soft	Easily penetrated several inches with thumb	250 to 500
Medium stiff	Penetrated several inches by thumb with moderate effort	500 to 1000
Stiff	Readily indented by thumb, but penetrated only with great effort	1000 to 2000
Very stiff	Readily indented by thumb nail	2000 to 4000
Hard	indented with difficulty by thumb nail	More than 4000

NATURAL MOISTURE CONTENT

Dry	No noticeable moisture content. Requires considerable moisture to obtain optimum moisture content* for compaction.
Damp	Contains some moisture, but is on the dry side of optimum.
Moist	Near optimum moisture content for compaction.
Wet	Requires drying to obtain optimum moisture content for compaction.
Saturated	Near or below the water table, from capillarity, or from perched or ponded water. All void spaces filled with water.

* Optimum moisture content as determined in accordance with ASTM Test Method D1557, latest edition.

Where laboratory test data are not available, the above field classifications provide a general indication of material properties; the classifications may require modification based upon laboratory tests.

Generalized Graphic Rock Symbols

Claystone	Siltstone	Tuff (Volcanic Ash)
Shale	Chert	Andesite
Sandstone	Serpentine	Basalt
Conglomerate	Metamorphic Rock	Granite

Stratification

Bedding of Sedimentary Rocks	Thickness of Beds
Massive	No apparent bedding
Very thick bedded	Greater than 4 feet
Thick bedded	2 feet to 4 feet
Thin bedded	2 inches to 2 feet
Very thin bedded	0.5 inches to 2 inches
Laminated	0.125 inches to 0.5 inches
Thinly laminated	less than 0.125 inches

Fracturing

Fracturing Intensity	Fracture Spacing
Little	Greater than 4 feet
Occasional	1 foot to 4 feet
Moderate	6 inches to 1 foot
Close	1 inch to 6 inches
Intense	0.5 inches to 1 inch
Crushed	less than 0.5 inches

Strength

Soft	Plastic or very low strength.
Friable	Crumbles by hand.
Low hardness	Crumbles under light hammer blows.
Moderate hardness	Crumbles under a few heavy hammer blows.
Hard	Breaks into large pieces under heavy, ringing hammer blows.
Very hard	Resists heavy, ringing hammer blows and will yield with difficulty only dust and small flying fragments.

Weathering

Deep	Moderate to complete mineral decomposition, extensive disintegration, deep and thorough discoloration, many extensively coated fractures.
Moderate	Slight decomposition of minerals, little disintegration, moderate discoloration, moderately coated fractures.
Little	No megascopic decomposition of minerals, slight to no effect on cementation, slight and intermittent, or localized discoloration, few stains on fracture surfaces.
Fresh	Unaffected by weathering agents, no disintegration or discoloration, fractures usually less numerous than joints.

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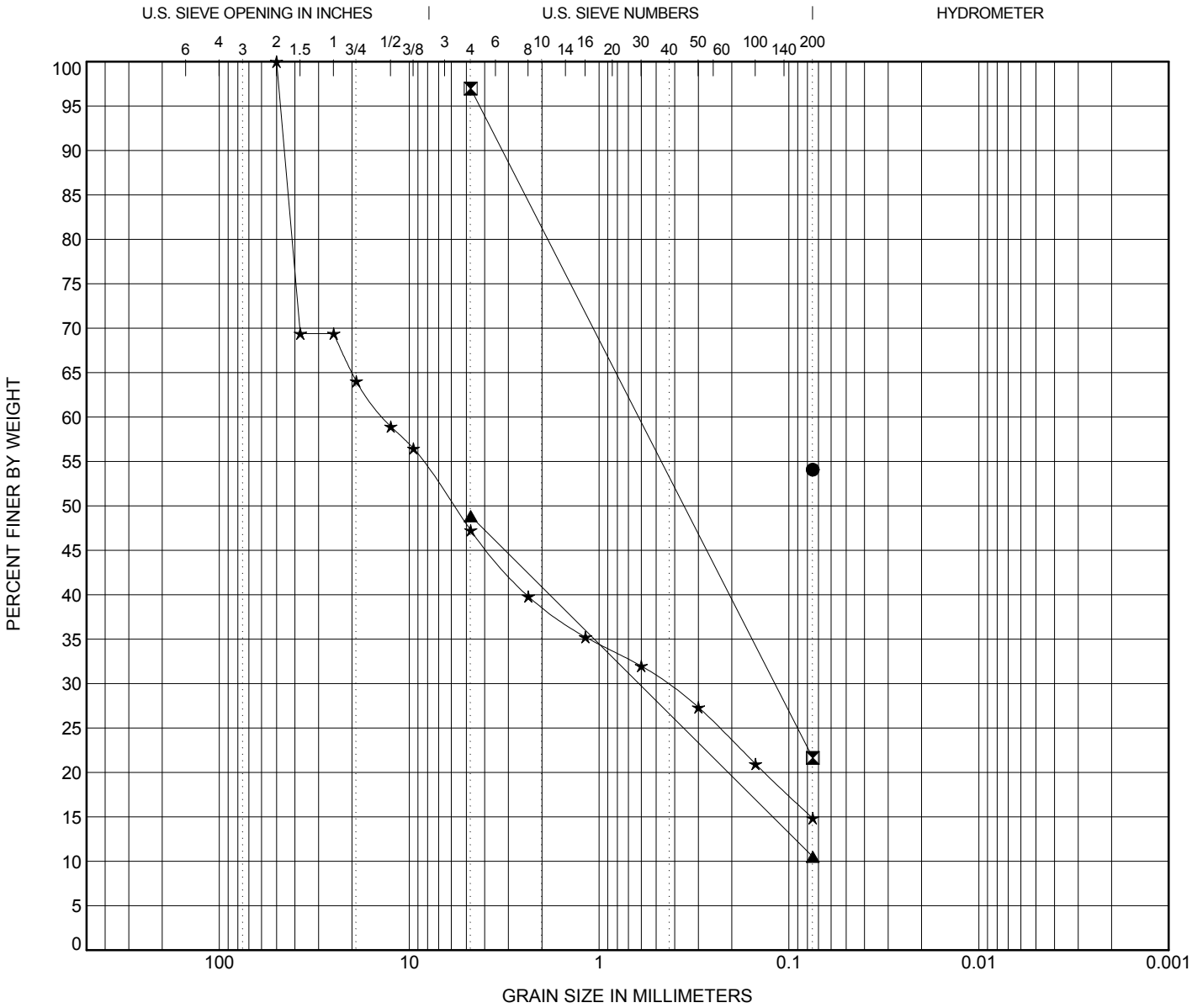
Date: 08/30/12

ROCK DESCRIPTIVE PROPERTIES
SVCSD AGUA CALIENTE CREEK
BORE AND JACK CROSSING
Agua Caliente Creek
El Verano, Sonoma County, California

PLATE 8



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	B-1	25.5 ft	TAN SILTSTONE					
⧗	B-1	30.5 ft	TAN TO RED SILTY SANDSTONE					
▲	B-3	21.0 ft	REDDISH-BROWN SILTY SANDY GRAVEL (GM)					
★	B-3	25.0 ft	REDDISH-BROWN SILTY SANDY GRAVEL (GM)					

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B-1	25.5 ft	0.075						54.1	
⧗	B-1	30.5 ft	4.75	0.62	0.119			75.3	21.6	
▲	B-3	21.0 ft	4.75		0.618			38.4	10.5	
★	B-3	25.0 ft	50	13.645	0.447		52.7	32.4	14.9	

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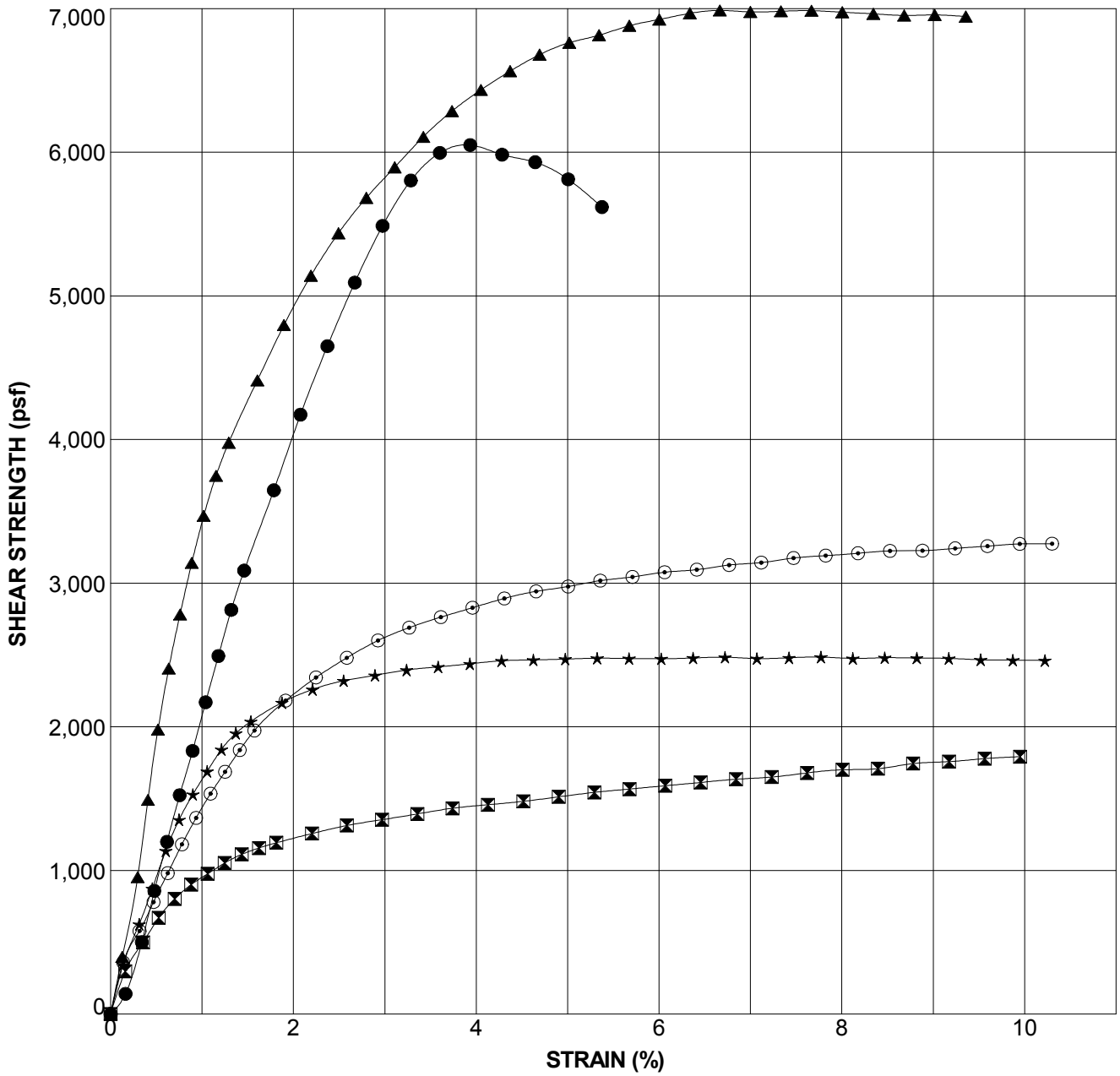
Job No.: 11027.04
Appr.: EEO
Date: 08/30/12

GRAIN SIZE DISTRIBUTION
SVCSD AGUA CALIENTE CREEK
BORE AND JACK CROSSING
Agua Caliente Creek
El Verano, Sonoma County, California

PLATE
9



Sample Source	Classification	Confining Pressure (psf)	Yield Strength (psf)	Strain (%)	Dry Density (pcf)	Moisture Content (%)
● B-1 at 10.25 ft	BROWNISH-RED TUFF	1440	5488	3.0	103	15.8
⊠ B-1 at 15 ft	REDDISH BROWN CONGLOMERATE	2160	1112	14.0	101	16.6
▲ B-1 at 21 ft	GRAY AND YELLOW SILTSTONE	3600	5896	3.1	91	31.1
★ B-3 at 11 ft	BROWN WITH GRAY SILTY SAND (SM)	1440	2168	1.9	69	15.1
⊙ B-3 at 16 ft	REDDISH BROWN SILTY COARSE SAND (SM)	2160	2690	3.3	71	11.9

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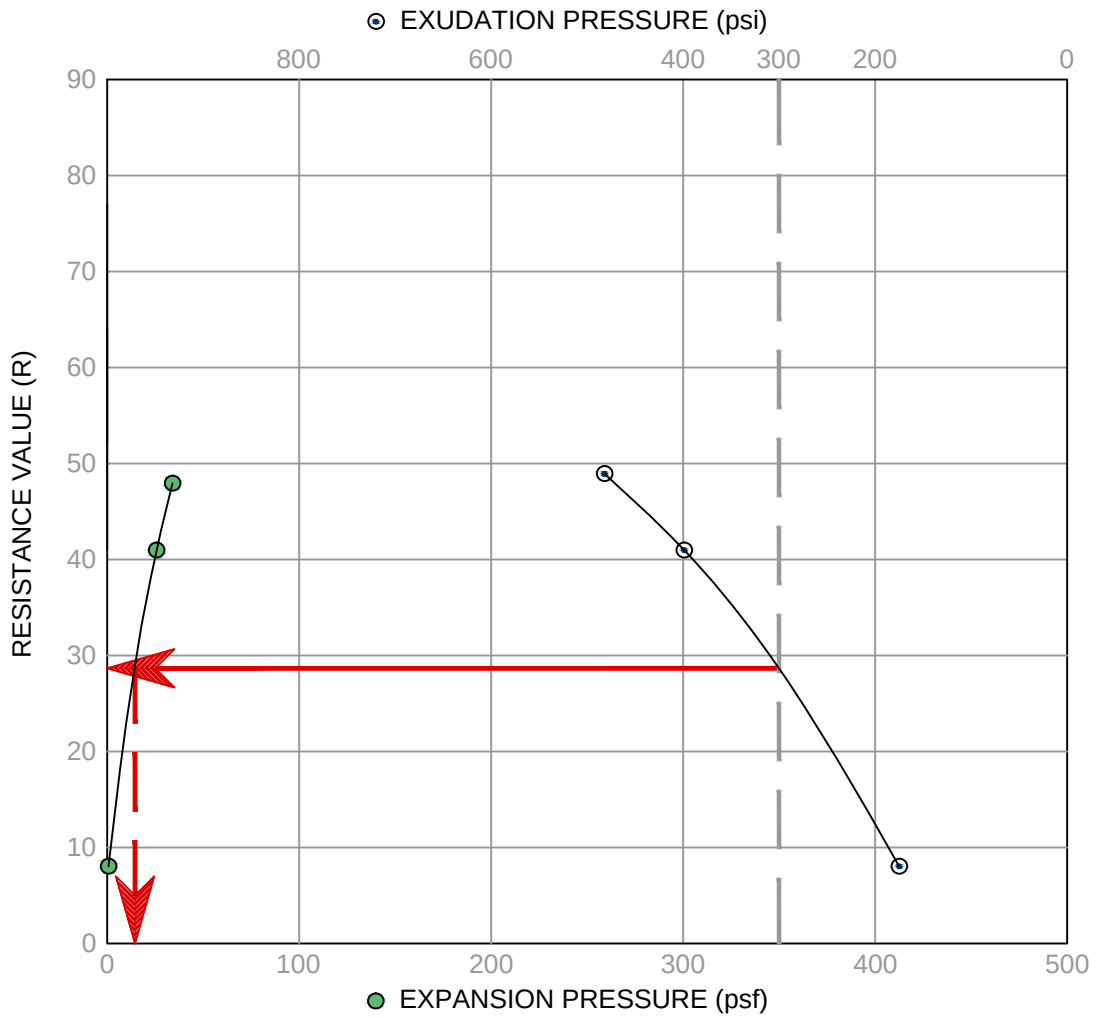
Santa Rosa, California 95403
Tel: (707) 838-3027

Job No.: 11027.04
Appr.: EEO
Date: 08/30/12

UNCONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST RESULTS
SVCSD AGUA CALIENTE CREEK
BORE AND JACK CROSSING
Agua Caliente Creek
El Verano, Sonoma County, California

PLATE 10



Specimen Number	A	B	C	D
Exudation Pressure (psi)	175	401	481	--
Moisture Content (%)	23.3	19.4	18.9	--
Dry Density (pcf)	94	101	104	--
Expansion Pressure (psf)	0.0	25.8	34.4	--
Resistance Value (R)	8	41	49	--

			Values at 300 psi Exudation	
Sample Source	Classification	Sand Equivalent	Expansion Pressure (psf)	**R-Value**
Hand Auger in Driveway Area	DARK OLIVE-BROWN SILTY SAND (SM)	--	20	28

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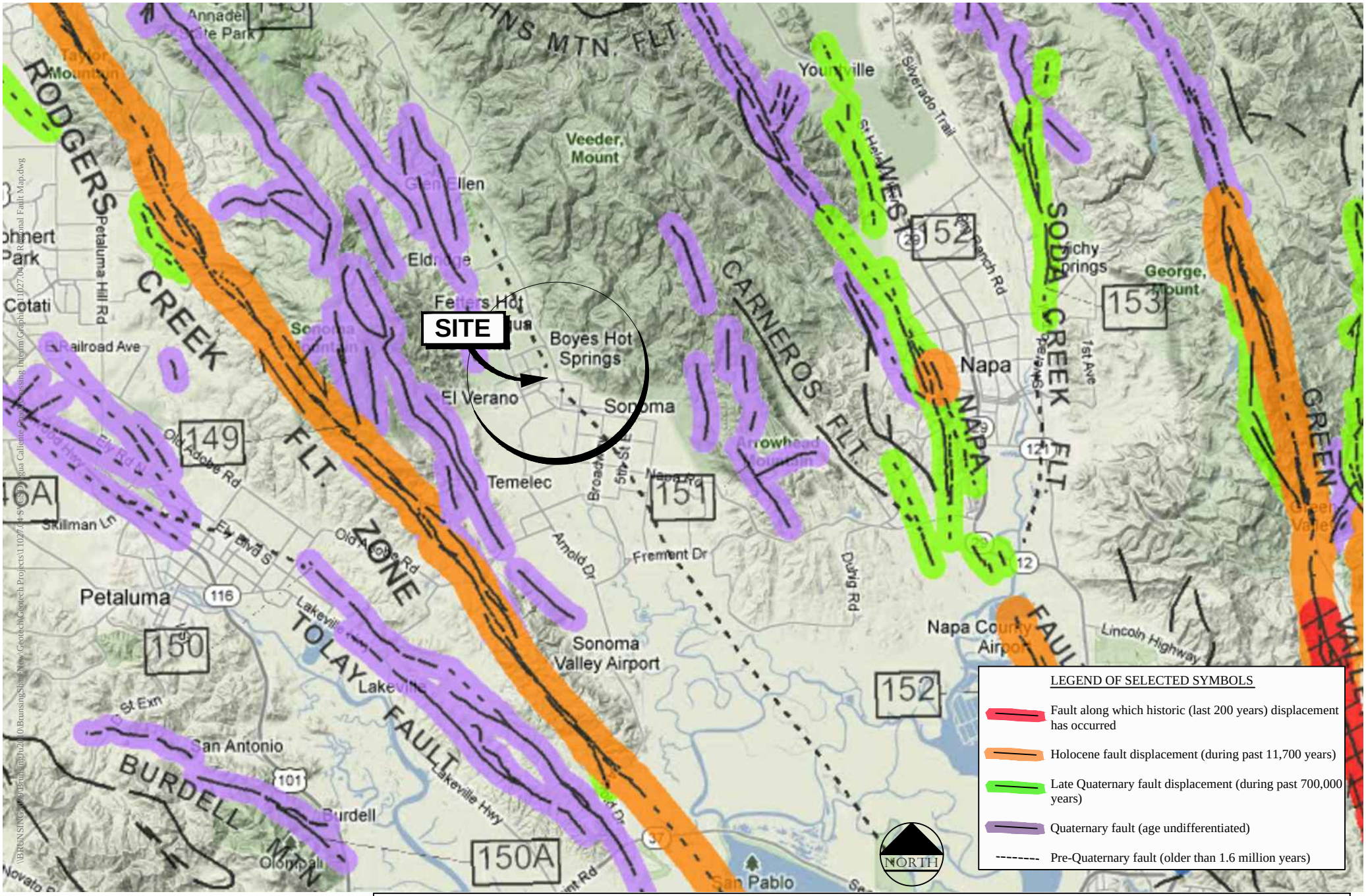
Job No.: 11027.04
Appr.: KAC
Date: 08/30/12

RESISTANCE VALUE TEST DATA
SVCSD AGUA CALIENTE CREEK
BORE AND JACK CROSSING
Auga Caliente Creek
El Verano, Sonoma County, California

PLATE
11

\\BRUNSING2009\Brunsing\n2010\BrunsingShareNew\Geotech\Geotech Projects\11027.04 SVCSD Agua Caliente Creek Crossing Interim\Graphics\11027.04_11 RESISTANCE (R-) VALUE TEST DATA.dwg
8/30/2012 1:05:51 PM save date
8/30/2012 1:06:23 PM plot date



REFERENCE:
2010 Fault Activity Map of California
http://www.quake.ca.gov/gmaps/FAM/faultactivitymap.html

APPROXIMATE SCALE (FEET)

0 7500 15000 30000

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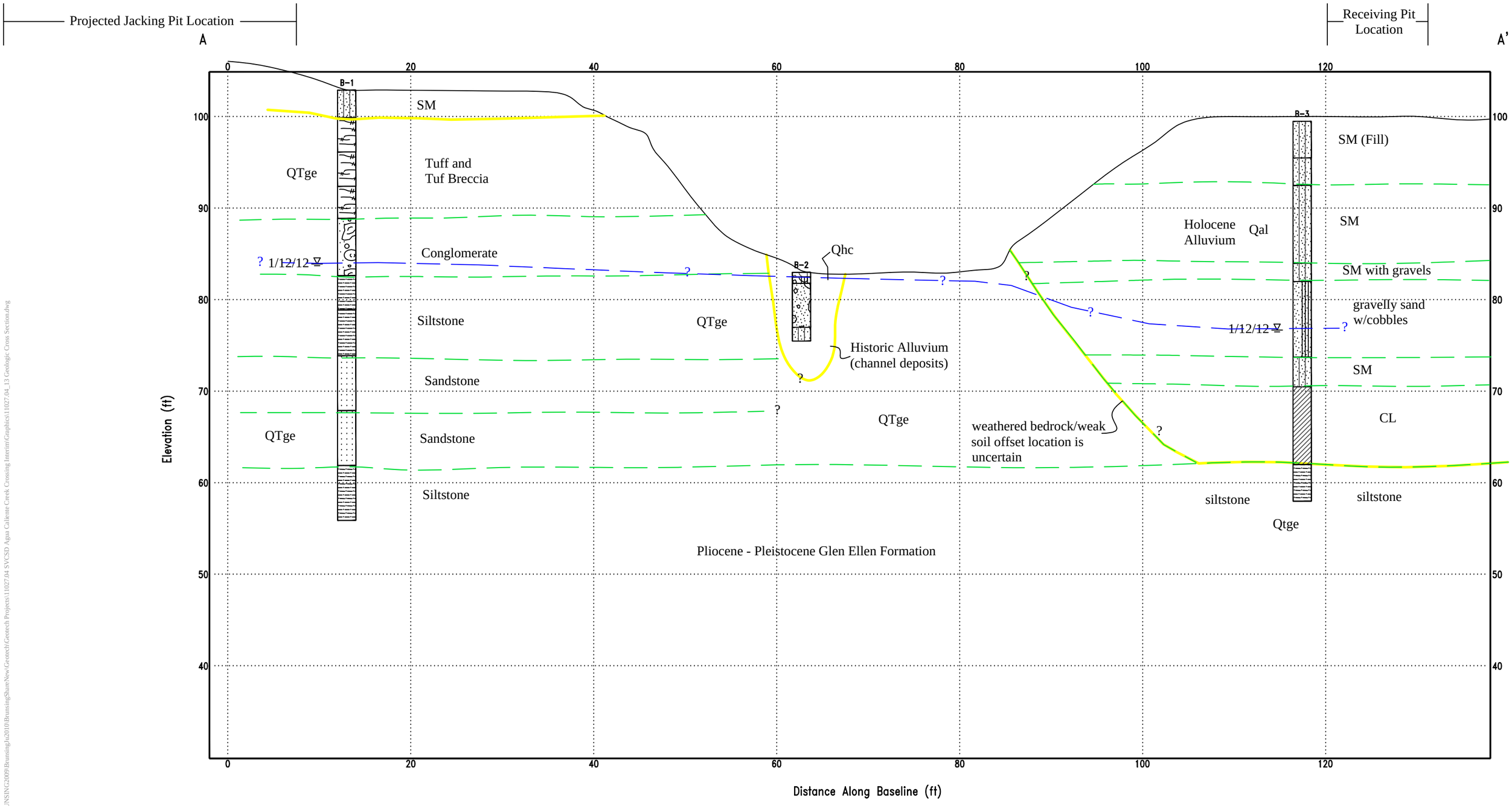
Appr.: EEO
Date: 08/30/12

REGIONAL FAULT MAP

SVCSD AGUA CALIENTE CREEK
BORE AND JACK CROSSING
Agua Caliente Creek
El Verano, Sonoma County, California

PLATE
12

8/30/2012 1:07:32 PM save date
8/30/2012 1:08:10 PM plot date
\\BRUNSINGSERVER\brunsing\n2010\BrunsingShare2\New\Geotech\Geotech Projects\11027.04 SVCSD Agua Caliente Creek Crossing Interim\Graphics\11027.04 Regional Fault Map.dwg



\\BRUNSING2009\BrunsingJu2010\BrunsingShareNew\Geotech\Geotech Projects\11027.04 SVCSD Agua Caliente Creek Crossing Interim\Graphics\11027.04_13 Geologic Cross Section.dwg

8/30/2012 12:10:51 PM save date
8/30/2012 1:09:30 PM plot date

REFERENCE: Topgraphic profile data, See Plate 2

NORTH

APPROXIMATE SCALE (FEET) VERTICAL AND HORIZONTAL

0 5 10 20

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Appr.: EEO
Date: 08/30/12

GEOLOGIC CROSS SECTION
SVCSD AGUA CALIENTE CREEK
BORE AND JACK CROSSING
Agua Caliente Creek
El Verano, Sonoma County, California

PLATE 13

Site Photograph A
Looking West (downstream)
January 31, 2012

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Santa Rosa, California 95403
Tel: (707) 838-3027

Job No.: 11027.04
Appr.: EEO
Date: 08/30/12

SITE PHOTOGRAPH A
SVCSD AGUA CALIENTE CREEK
BORE AND JACK CROSSING
Agua Caliente Creek
El Verano, Sonoma County, California

PLATE
14

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8/30/2012 1:09:56 PM save date
8/30/2012 1:10:27 PM plot date

APPENDIX A

Corrosion Testing and Recommendations for Corrosion Control

February 3, 2012

BACE Geotechnical
5468 Skylane Blvd., Suite 201
Santa Rosa, CA 95403

Attention: **Mr. Keith A. Colorado**
Civil Engineer- 69011

Subject: **Site Corrosivity Evaluation**
SVCSD Aqua Caliente Creek Crossing Interim
11027.04

Dear Keith,

In accordance with your request, we have reviewed the laboratory soils data for the above referenced project site. Our evaluation of these results and our corresponding recommendations for corrosion control for the above referenced project foundations and buried site utilities are presented herein for your consideration.

SOIL TESTING & ANALYSIS

Soil Chemical Analysis

One (1) soil sample from the site was transported to a state certified testing laboratory, **CERCO Analytical, Inc.** (certificate no. 2153) located in Concord, CA for chemical analysis. This sample was analyzed for pH, chlorides, resistivity (@ 100% saturation), sulfates and Redox potential using ASTM test methods as detailed in the table below. The preparation of the soil sample for chemical analysis was in accordance with the applicable specifications.

Soil Analysis Test Methods

Chemical Analysis	ASTM Method
Chlorides	D4327
pH	D4972
Resistivity (100% Saturation)	G57
Sulfate	D4327
Redox Potential	D1498

The results of the chemical analysis are provided in CERCO Analytical, Inc. report dated January 30, 2012. The results are summarized as follows:

CERCO Analytical, Inc.
Soil Laboratory Analysis

Chemical Analysis	Range of Results	Corrosion Classification*
Chlorides	17 (mg/kg)	Non-corrosive*
pH	7.0	Non corrosive*
Resistivity	1,900 Ohms-cm	Corrosive *
Sulfate	Non Detected	Non-corrosive**
Redox Potential	500 mV	Non-corrosive*

* With respect to bare steel or ductile iron.
** With respect to mortar coated steel

DISCUSSION

Reinforced Concrete Foundations

Due to the low level of water-soluble sulfates and chlorides in these soils, special requirements for sulfate resistant cement are not required. However, the minimum depth of cover for the reinforcing steel should be as specified in the California Building Code (CBC Section 1907) and the America Concrete Institute (ACI 318-08 Section 7.7)

Underground Metallic Pipelines

The soils at the project site are generally considered to be “corrosive” to ductile/cast iron, steel and dielectric coated steel based on the saturated resistivity measurements. Therefore, corrosion control in the form of coatings and cathodic protection should be considered for any metal structure placed in these soils. Pressure piping systems such as domestic and fire water should be provided with appropriate electrical isolation from dissimilar metals and grounding systems along with pipe bonding, cathodic protection and polyethylene encasement. In addition, all underground pipelines should be electrically isolated from above grade structures, reinforced concrete structures and copper lines in order to avoid potential galvanic corrosion problems.

LIMITATIONS

The conclusions and recommendations contained in this report are based on the information and assumptions referenced herein. All services provided herein were performed by persons who are experienced and skilled in providing these types of services and in accordance with the standards of workmanship in this profession. No other warrantees or guarantees, expressed or implied, are provided.

We thank you form the opportunity to be of service to ***BACE Geotechnical*** on this project and trust that you find the enclosed information satisfactory. If you have any questions, or if we can be of any additional assistance, please feel free to contact us at (925) 927-6630.

Respectfully submitted,

J. Darby Howard, Jr.

Darby Howard, Jr., P.E.
JDH CORROSION CONSULTANTS, INC.
Principal

Brendon Hurley

Brendon Hurley
JDH CORROSION CONSULTANTS, INC.
Field Technician

Cc: File 12007

California State Certified Laboratory No. 2153

CERCO analytical
1100 Willow Pass Court, Suite A
Concord, CA 94520-1006
925 462 2771 Fax. 925 462 2775
www.cercoanalytical.com

Client: JDH Corrosion Consultants, Inc.
Client's Project No.: 12007
Client's Project Name: SVCSD Aqua Caliente Creek Crossing Interim
Date Sampled: 23-Jan-12
Date Received: 23-Jan-12
Matrix: Soil
Authorization: Signed Chain of Custody

Date of Report: 30-Jan-2012

Job/Sample No.	Sample I.D.	Redox (mV)	pH	Conductivity (umhos/cm)*	Resistivity (100% Saturation) (ohms-cm)	Sulfide (mg/kg)*	Chloride (mg/kg)*	Sulfate (mg/kg)*
1201167-001	B-1 @ 26.0'	500	7.0	-	1,900	-	17	N.D.

Method:	ASTM D1498	ASTM D4972	ASTM D1125M	ASTM G57	ASTM D4658M	ASTM D4327	ASTM D4327
Detection Limit:	-	-	10	-	50	15	15
Date Analyzed:	26-Jan-2012	26-Jan-2012	-	24-Jan-2012	-	27-Jan-2012	27-Jan-2012

* Results Reported on "As Received" Basis

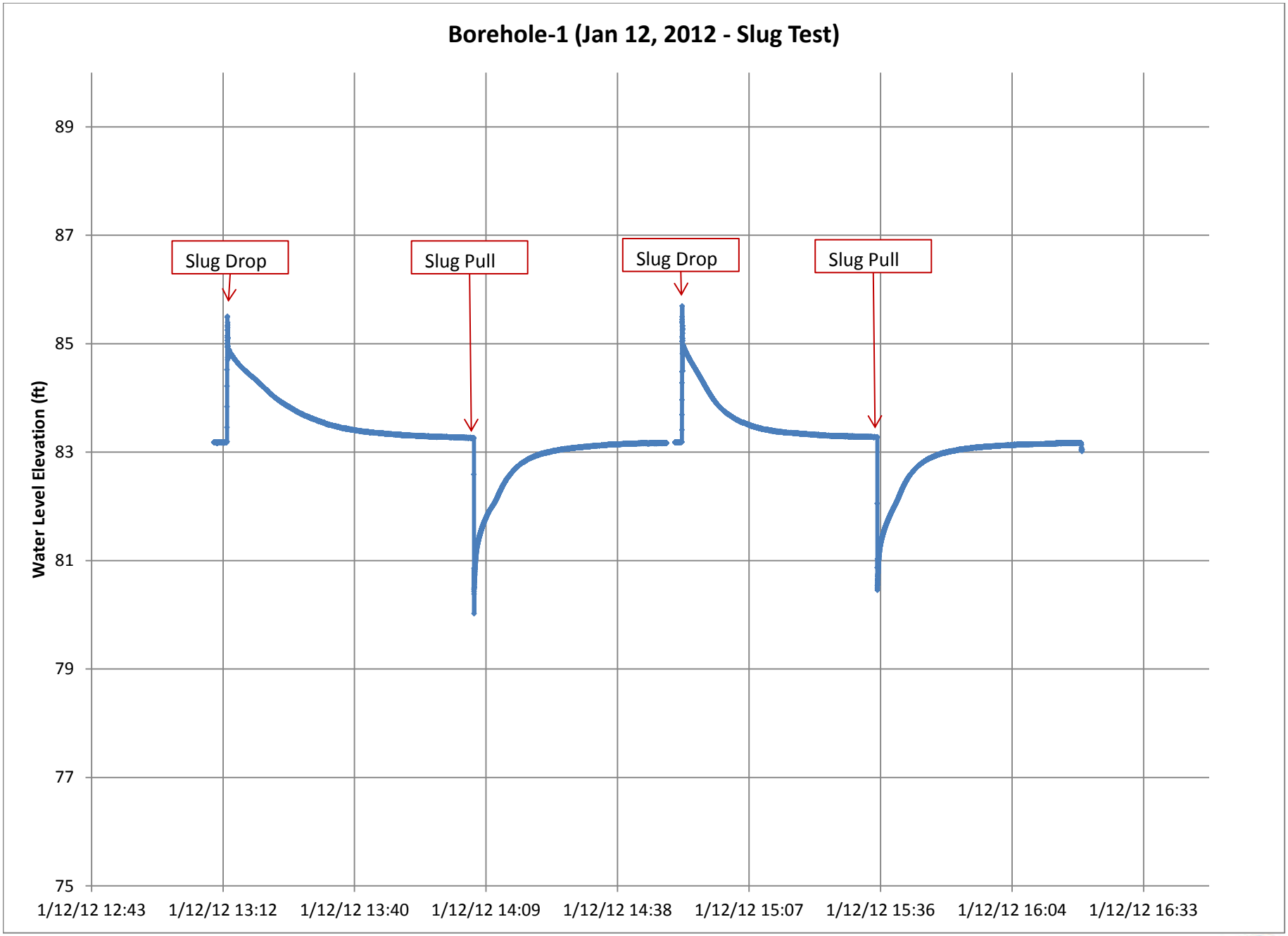
N.D. - None Detected

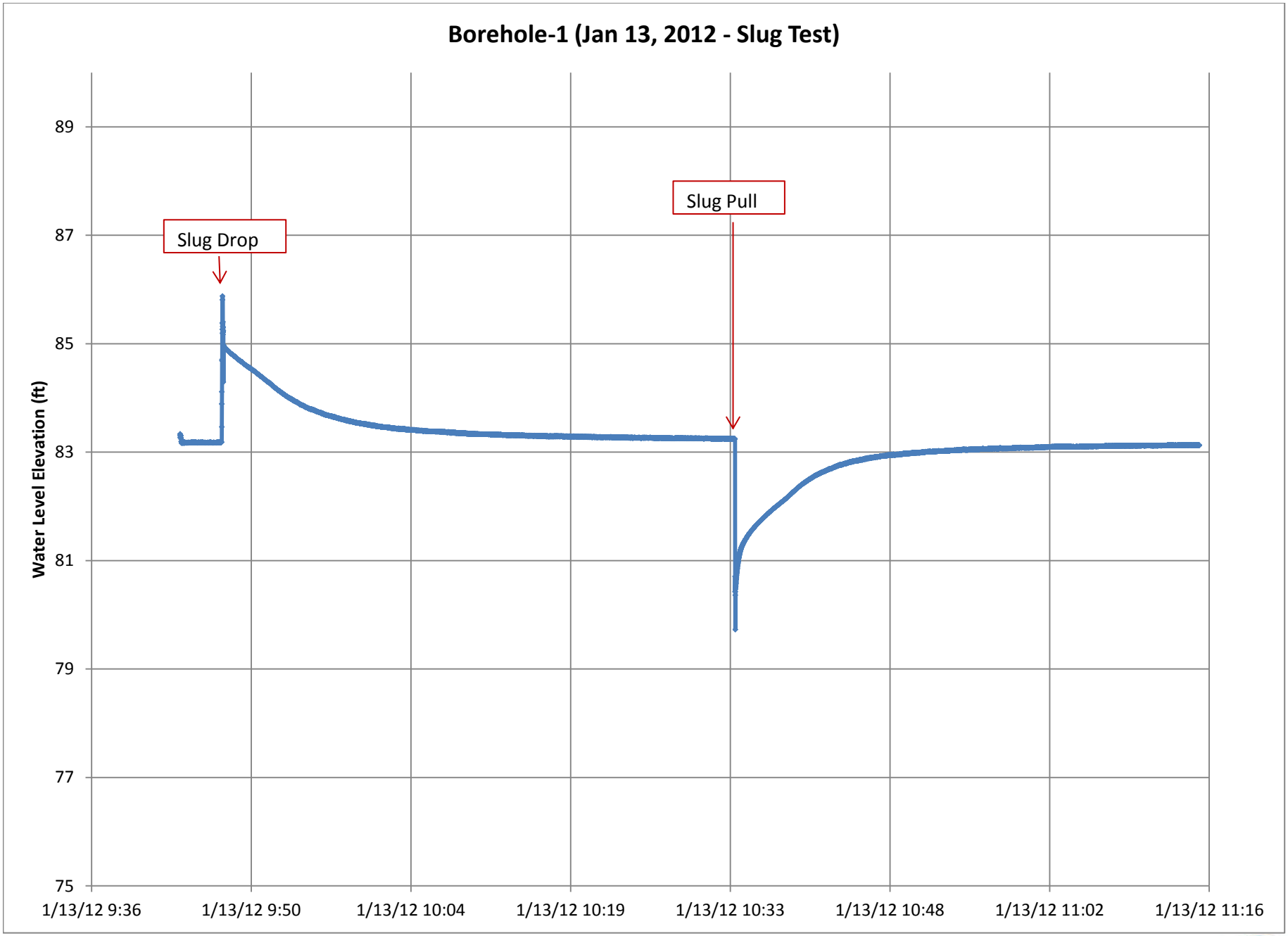
Cheryl McMillen
Laboratory Director

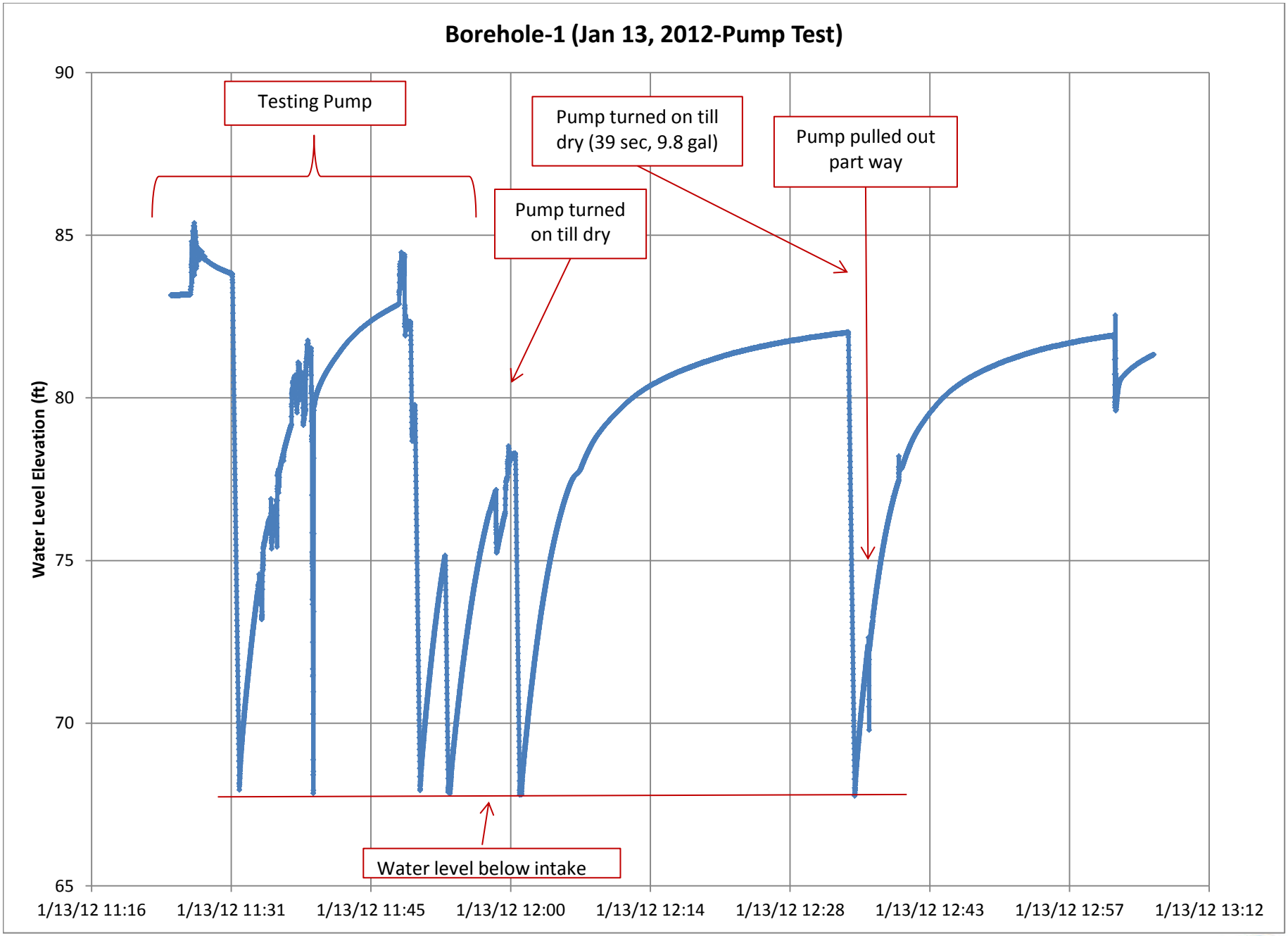
Quality Control Summary - All laboratory quality control parameters were found to be within established limits

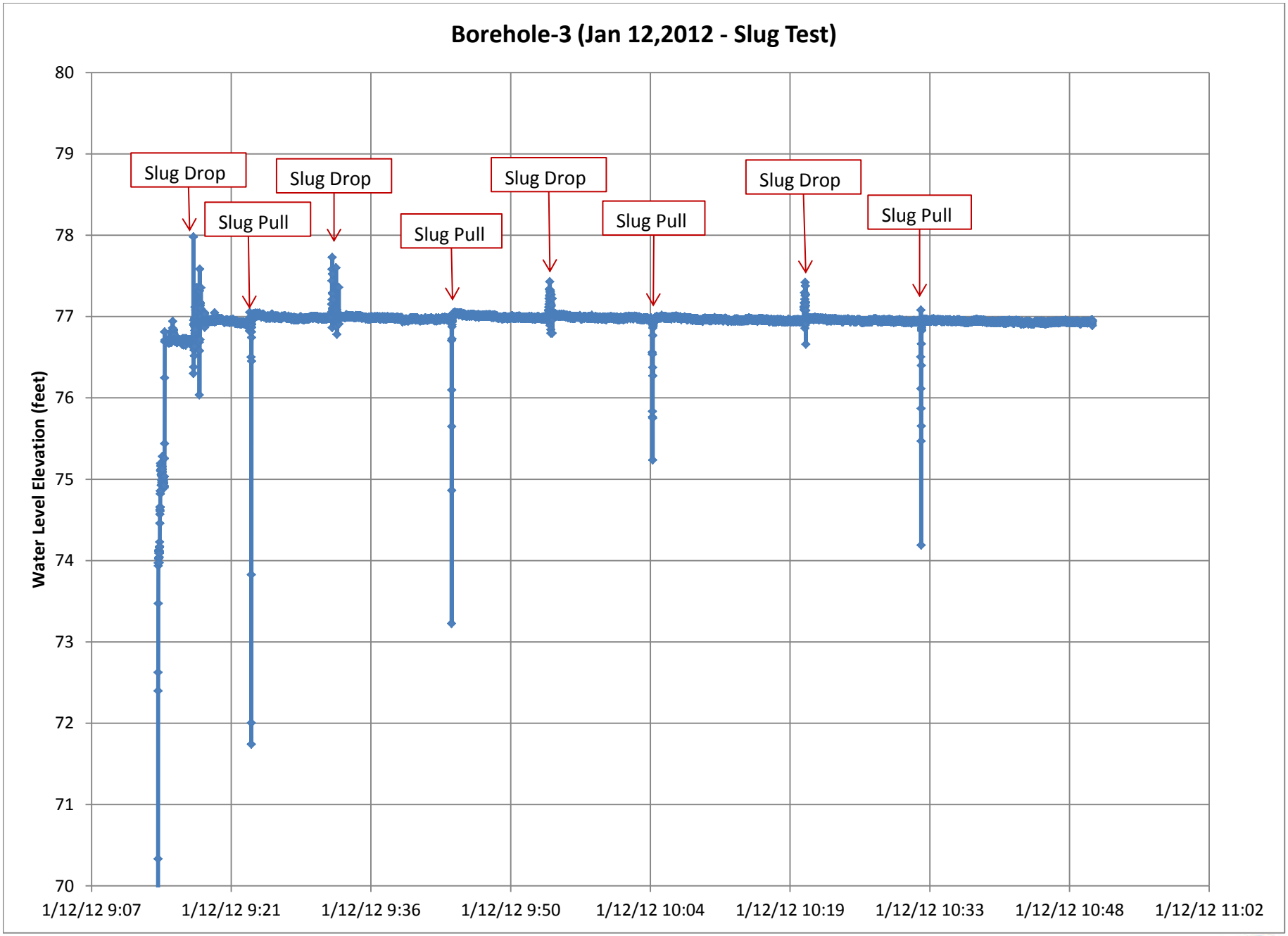
APPENDIX B

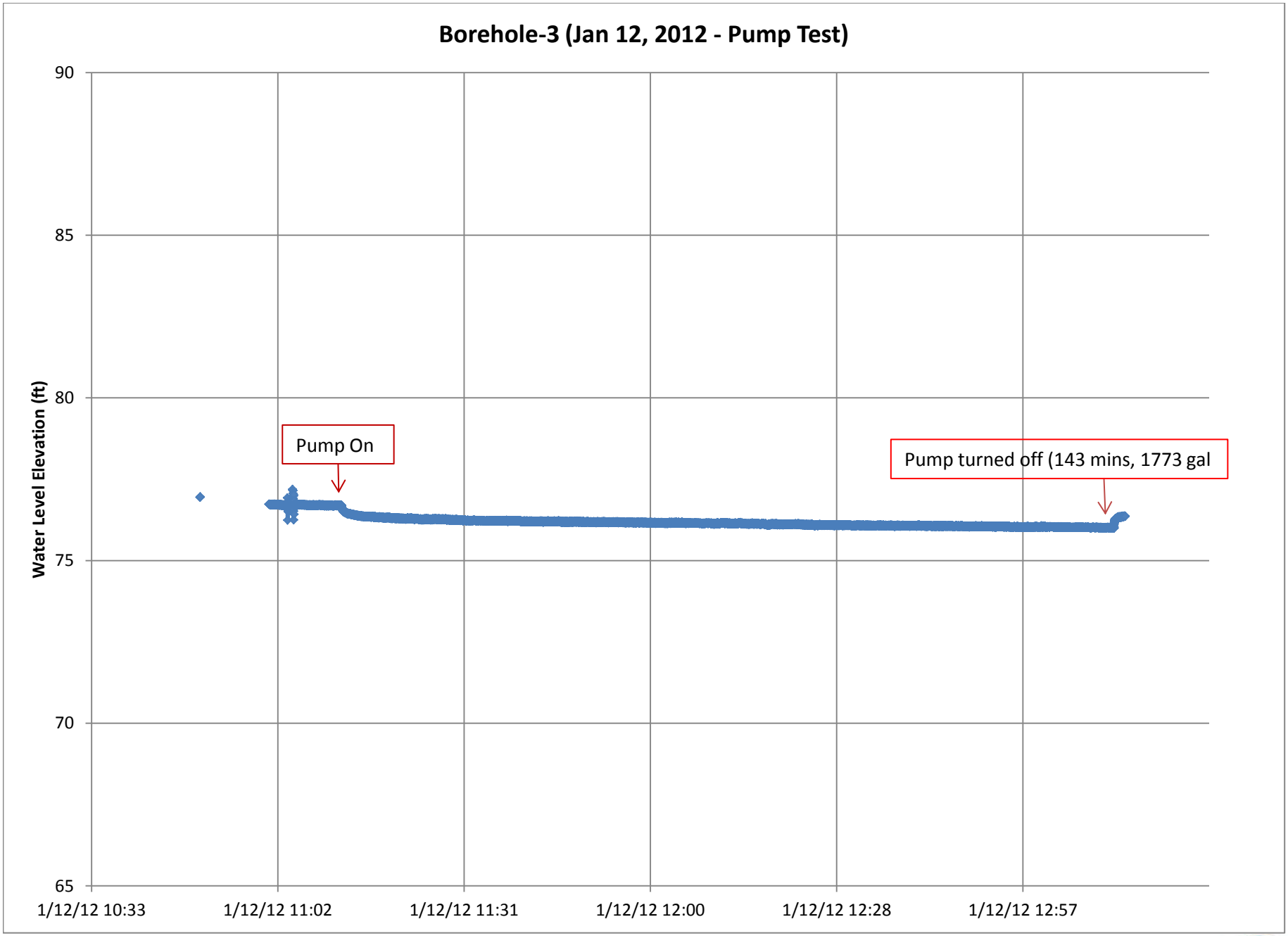
Well Slug and Pump Test Data Plots

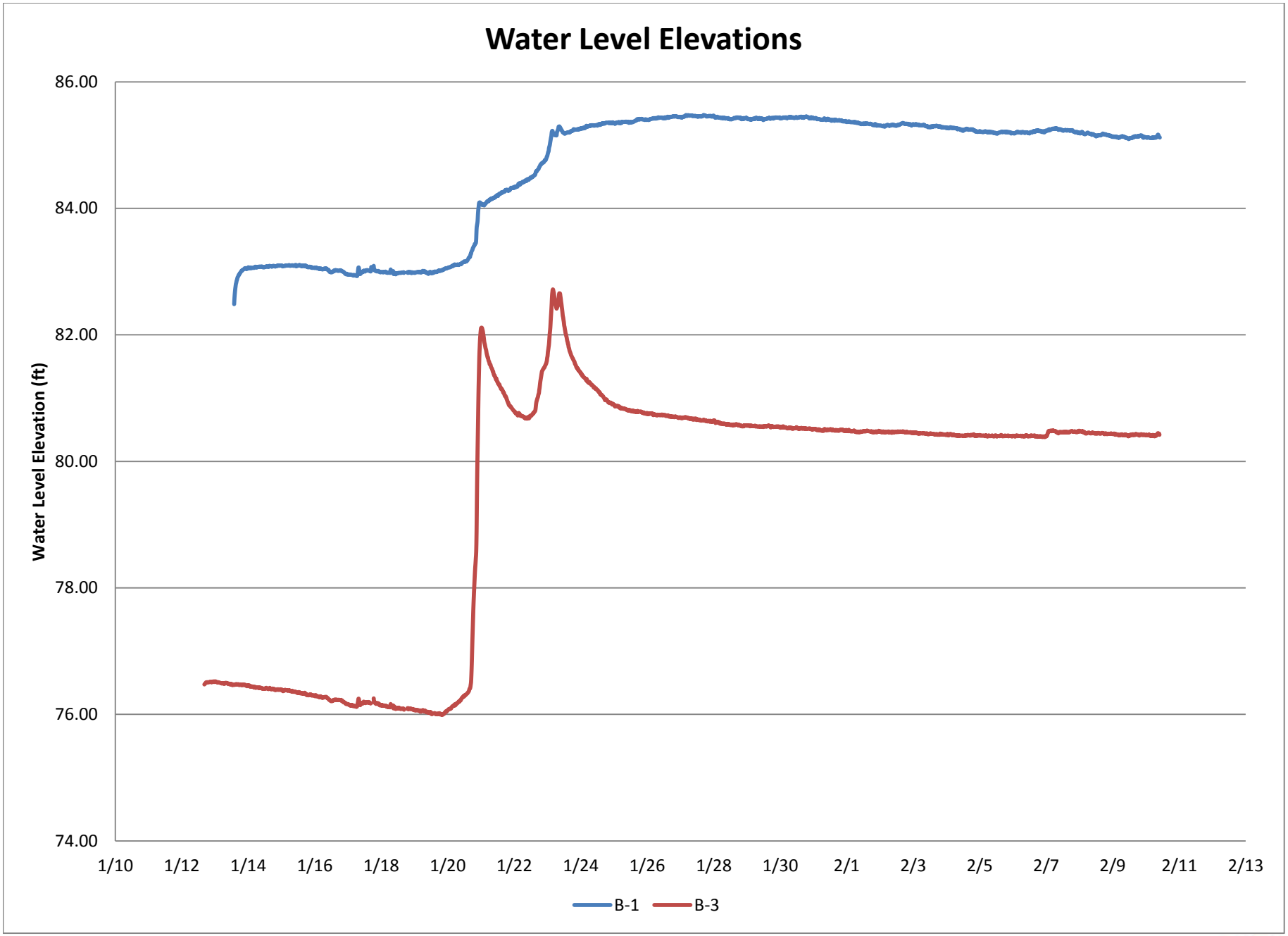

Borehole-1 (Jan 12, 2012 - Slug Test)
Water Level Elevation (ft)
89
87
85
83
81
79
77
75
Slug Drop
Slug Pull
Slug Drop
Slug Pull
1/12/12 12:43
1/12/12 13:12
1/12/12 13:40
1/12/12 14:09
1/12/12 14:38
1/12/12 15:07
1/12/12 15:36
1/12/12 16:04
1/12/12 16:33


Borehole-1 (Jan 13, 2012 - Slug Test)
Water Level Elevation (ft)
89
87
85
83
81
79
77
75
Slug Drop
Slug Pull
1/13/12 9:36
1/13/12 9:50
1/13/12 10:04
1/13/12 10:19
1/13/12 10:33
1/13/12 10:48
1/13/12 11:02
1/13/12 11:16


Borehole-1 (Jan 13, 2012-Pump Test)
Water Level Elevation (ft)
90
85
80
75
70
65
1/13/12 11:16
1/13/12 11:31
1/13/12 11:45
1/13/12 12:00
1/13/12 12:14
1/13/12 12:28
1/13/12 12:43
1/13/12 12:57
1/13/12 13:12
Testing Pump
Pump turned on till dry (39 sec, 9.8 gal)
Pump pulled out part way
Pump turned on till dry
Water level below intake


Borehole-3 (Jan 12,2012 - Slug Test)
Water Level Elevation (feet)
80
79
78
77
76
75
74
73
72
71
70
Slug Drop
Slug Pull
Slug Drop
Slug Pull
Slug Drop
Slug Pull
Slug Drop
Slug Pull
1/12/12 9:07
1/12/12 9:21
1/12/12 9:36
1/12/12 9:50
1/12/12 10:04
1/12/12 10:19
1/12/12 10:33
1/12/12 10:48
1/12/12 11:02


Borehole-3 (Jan 12, 2012 - Pump Test)
Water Level Elevation (ft)
90
85
80
75
70
65
1/12/12 10:33
1/12/12 11:02
1/12/12 11:31
1/12/12 12:00
1/12/12 12:28
1/12/12 12:57
Pump On
Pump turned off (143 mins, 1773 gal


Water Level Elevations
Water Level Elevation (ft)
86.00
84.00
82.00
80.00
78.00
76.00
74.00
1/10
1/12
1/14
1/16
1/18
1/20
1/22
1/24
1/26
1/28
1/30
2/1
2/3
2/5
2/7
2/9
2/11
2/13
B-1
B-3

APPENDIX C

Site Preparation and Grading Recommendations

1. Clearing and Stripping

Areas to be graded should be cleared of existing vegetation, rubbish, and debris. After clearing, surface soils that contain organic matter should be stripped. In general, the depth of required stripping will be about 2 to 4 inches; deeper stripping and grubbing may be required to remove isolated concentrations of organic matter or roots. The cleared materials should be removed from the site or stockpiled for later use in landscape areas, as appropriate.

2. Structural Area Preparation

As used in this report, "Structural Areas" refers to paved areas and the areas extending three feet beyond their edges.

Within structural areas of the driveway extension, existing weak soils should be removed for a depth of at least 2 feet below soil subgrade. In some areas, deeper excavations may be necessary to remove very weak soils, if encountered.

After the recommended excavations, BAI should observe the exposed soils to confirm suitable materials are exposed. These soils should then be scarified to about six inches deep, moisture conditioned to at least two percent over optimum moisture content and compacted to at least 90 percent relative compaction as determined by the ASTM D 1557 test procedure, latest edition. These moisture conditioning and compaction procedures should be periodically observed by BAI to check that the soil is properly moisture conditioned and the recommended compaction is achieved.

Fill material, either imported or on-site, should be free of perishable matter and rocks greater than six inches in largest dimension, and be approved by BAI before fill placement. We anticipate that most of the existing on-site soils to be excavated, in a "cleaned" condition (i.e., less any organics and debris) are satisfactory for reuse as compacted fill. Some of on-site clays may have an Expansion Index over 30. These materials will not be suitable for fill within 30 inches of soil subgrade. Imported fill for use in structural areas should be of relatively low expansion potential (i.e., Expansion Index of 30 or less).

Low-expansive engineered fill, on-site or imported, should be placed in thin lifts (six to eight inches depending on compaction equipment), moisture conditioned to near optimum moisture content, and compacted to at least 90 percent relative compaction, to achieve planned grades.

DISTRIBUTION

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