CITY OF BEVERLY HILLS

PUBLIC WORKS SERVICES DEPARTMENT

MEMORANDUM

TO: PUBLIC WORKS COMMISSION

FROM: Trish Rhay, Assistant Director of Public Works Services - Utilities

Michelle Tse, Senior Management Analyst

DATE: February 12, 2015

SUBJECT: Robertson Well Report

ATTACHMENT: Report Summary of Drilling and Testing Operations - Robertson Yard Exploratory Borehole dated February 2010

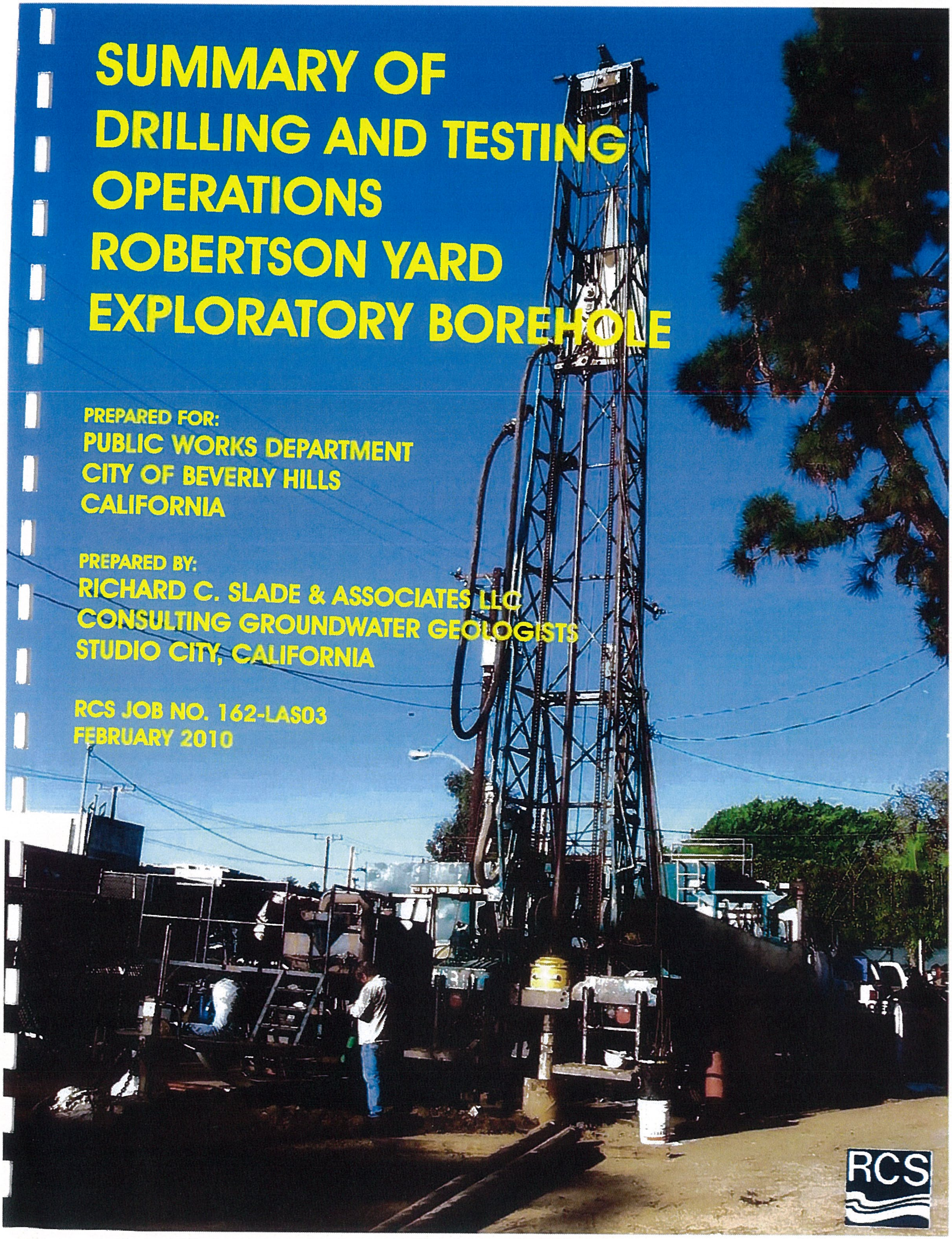
Attached is a copy of the report regarding the Robertson Yard Well as requested by the Public Works Commission. The report does not contain information that is contradictory to the Psomas report.

SUMMARY OF DRILLING AND TESTING OPERATIONS ROBERTSON YARD EXPLORATORY BOREHOLE

PREPARED FOR:
PUBLIC WORKS DEPARTMENT
CITY OF BEVERLY HILLS
CALIFORNIA

PREPARED BY:
RICHARD C. SLADE & ASSOCIATES LLC
CONSULTING GROUNDWATER GEOLOGISTS
STUDIO CITY, CALIFORNIA

RCS JOB NO. 162-LAS03
FEBRUARY 2010



RCS

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INTRODUCTION

This report has been prepared for the City of Beverly Hills (City) to provide a summary of operations performed during the drilling, testing and subsequent permanent destruction of an exploratory borehole (test hole) located at the City-owned Robertson Corporate Yard. In addition, a summary of the data collected during drilling and down-hole testing is presented along with recommendations for the possible future construction of a new municipal-supply water well at this property. The Corporate Yard property is located at 621 North Robertson Blvd, approximately 150 to 200 ft north-northwest of the intersection of Robertson Blvd and Melrose Ave in the City of West Hollywood, California. Figure 1, "Site Location Map," shows the location of this property and the approximate location of the test hole at the property. Also shown on Figure 1 are the locations of the four active City-owned wells (Well Nos. 2, 4, 5 and 6), the nearest of which (Well No. 2), lies approximately 1600 ft west of the subject test hole.

The subject test hole was drilled, tested, and destroyed by Southwest Pump and Drilling Company (Southwest) of Coachella, California. The Technical Specifications for the project were prepared by Richard C. Slade and Associates, LLC (RCS), Consulting Groundwater Geologists of Studio City, California. Geologists from RCS were also present to document Contractor activities during the drilling, testing, and destruction of the subject test hole.

The test hole was drilled, tested and destroyed between September 9 and December 29, 2009. Table 1, "Daily Record of Site Activities," presents a summary of test hole drilling, testing and destruction activities conducted for the test hole. Copies of the Los Angeles County Department of Health Services Drilling Permit and Destruction Permit, and the State Well Completion Report for the test hole, are also provided in the Appendix.

EXPLORATORY BOREHOLE (TEST HOLE) DRILLING

CONDUCTOR CASING

Prior to commencement of test hole drilling, a conductor casing was installed at the drill site for the purpose of preventing washouts of the borehole walls in the upper 50 ft of the test hole.

Installation of this conductor casing, which was performed between September 10 and 14, 2009, is summarized as follows:

- A 36-inch diameter borehole was drilled with a bucket auger drill rig to a depth of 50 ft below ground surface (bgs).
- A 16-inch outside diameter (O.D.) by 5/16-inch wall thickness, mild steel conductor casing was placed to a depth of approximately 50 ft bgs in the drilled borehole.
- Cement was placed in the annulus, outside the conductor casing, from a depth of 50 ft bgs up to 5.5 ft bgs. The cement ticket for the sealing material is provided in the appendix.

TEST HOLE DRILLING

Test hole drilling below the bottom of the conductor casing commenced on October 21, 2009, following mobilization and setup of the mud rotary drill rig, and was completed by October 29, 2009. Drilling of the test hole consisted of the following:

- Drilling was performed with a 12¼-inch diameter tricone drill bit, utilizing the mud rotary drilling method.
- The drilling fluid was water containing Quik-Gel® bentonite mud as the drilling additive. This drilling fluid was used to help stabilize the walls of the test hole and to help carry drill cuttings out of the borehole. Drispac® polymer was also used occasionally to help reduce the swelling of formation clays as drilling proceeded.
- The drilling fluid was circulated out of the test hole and through a small metal trough adjacent to the conductor casing where drill cuttings settled and were collected by the geologist. Drill cuttings were collected on 10-foot depth intervals.
- During drilling, the cuttings were occasionally removed with a backhoe and temporarily stockpiled onsite before being transported from the site by the Contractor for proper disposal.
- The drill cuttings were geologically logged by RCS geologists to help evaluate subsurface geologic conditions.
- Drilling of the test hole advanced to a total depth of 851 ft bgs.

DOWNHOLE GEOPHYSICAL SURVEYS

Downhole geophysical surveying (electric logging) was performed shortly following completion of drilling operations. The purpose of this electric logging was to provide semi-quantitative information regarding zones of relative permeability (potential aquifer zones) and possible water quality variations within potential aquifers with depth. Geophysical logging is accomplished basically by measuring the electrical resistance of the underlying earth materials with logging equipment that provides a plot of the various resistivity signatures of the earth materials encountered during drilling on a strip chart. The electric logging activities in the test hole generally entailed the following tasks:

- Upon completion of test hole drilling, the drilling fluid in the borehole was thinned with water and circulated for a period of a few hours prior to electric logging.
- Electric logging services were performed by Pacific Surveys of Claremont, CA.
- The electric logs consisted of short-normal (16-inch) and long-normal (64-inch) resistivity surveys, a spontaneous potential (SP) survey, a focused resistivity (guard) survey, a gamma-ray survey, a single point-resistivity survey, a temperature survey, and a sonic variable density survey.

A copy of this log is provided in an electronic copy of the report in an Adobe Portable Document Format (PDF) on a CD in the Appendix.

RESULTS OF GEOLOGIC AND ELECTRIC LOGGING

The geologic log and the electric logs of the test hole were then reviewed by RCS geologists gain an understanding of subsurface geologic conditions at the drill site. The data reviewed yielded the following observations:

- Generally, the subsurface earth materials were interbedded sediments comprised of layers and lenses of gravel, sand, silt and clay to a depth of 735 ft bgs. These materials are interpreted to consist of geologically young alluvial-type sediments and underlying Pleistocene-aged marine sediments. The contact between these two geologic deposits is very difficult to discern.
- From 735 ft to 851 ft bgs, dark gray and olive gray sediments composed of silty sands, clayey silts, and sandy silts were observed. These materials are interpreted to be part of the upper Pico Formation.
- Shell fragments and marine fossils were observed by the logging geologist from an initial depth of 500 ft bgs to the total drilled depth of 851 ft bgs. These fossils are also indicative of a shallow marine environment of deposition for these sediments.

These observations, along with other data obtained during test hole drilling, were utilized by RCS to select potential aquifer zones for isolated aquifer zone testing in the open borehole. Table 2, "Geologic Log of the Test Hole," presents a summary of the RCS logging of the drill cuttings samples from the test hole.

Correlation of Electric Log with Nearby City-Owned Wells

RCS used the electric log from this test hole to correlate with additional electric logs that are available for nearby City-owned wells. This correlation was accomplished by selecting marker beds of sand or clay in the nearby wells that could be interpreted to be the same sand or clay deposits as are revealed on the electric log of the Robertson Yard test hole. Using the electric log data from the nearby wells (the nearest of which is City Well No. 2), RCS also noted subsurface materials that correlated well with similar materials in the test hole. For example, in the test hole, the RCS geologist reported broken, fossil shell fragments at a depth of around 500 ft bgs. In nearby City Well No. 2, the consultant for the City at that time reported that similar shell fragments were first observed at a depth of 400 ft bgs. Also, the base of Pleistocene-aged sediments is identified to be at a depth of about 735 ft bgs in the subject test hole whereas, by comparison in nearby Well No. 2, this same base boundary is preliminarily interpreted to be at a depth of 745 ft bgs. These types of correlations provide information that can be useful for future well construction at the Robertson Corporate Yard property.

METHANE AND HYDROGEN SULFIDE GAS MONITORING

During the drilling and testing operations of the test hole, RCS geologists monitored for the possible presence of methane gas (CH_4) and hydrogen sulfide (H_2S) gas using a portable probe. As discussed previously with the City, it was expected that these gases may exist in the subsurface in the region and that these gases could be detected during the drilling of the test hole. Because of the hazardous conditions that these gases can create, including inhalation hazards and combustion, RCS considered the monitoring of these gases to be important for the safety and security of the drilling and field personnel during operation activities. In addition, any information relating to the existence of these gasses at specific depths and/or geologic formation during drilling would be useful for future onsite well construction. An RCS geologist was onsite full-time during the drilling process. The portable gas monitoring probe was placed adjacent to the drill rig where the cuttings were coming up the borehole and out of the conductor casing during drilling. As drilling continued, the portable probe measured methane (%) and hydrogen sulfide (parts per million, ppm) gas concentrations continuously while the device was in use.

Results of Gas Monitoring During Test Hole Drilling

Figure 2, "Gas Concentrations During Drilling and Testing," illustrates methane and hydrogen sulfide gas recordings collected by the gas monitoring device during the period of the test hole drilling and isolated aquifer zone testing. Basic results of the monitoring included: there were no detected concentrations of methane during the drilling process; and hydrogen sulfide was detected but the concentrations remained relatively low, ranging from not detected to 0.3 ppm. It should be noted that, even in our offices, detected hydrogen sulfide concentrations ranged between 0.2 and 0.3 ppm, hence the measurements collected during drilling appear to be normal, or is a result due to the calibration of the device. However, while drilling at a depth of 726 ft bgs, a slightly higher concentration of hydrogen sulfide of 0.9 ppm was recorded.

ISOLATED AQUIFER ZONE TESTING

PURPOSES

Isolated aquifer zone testing is a method of collecting depth-discrete groundwater samples from potential aquifer zones in the open borehole under very short-term pumping conditions and subsequently allowing water quality laboratory tests to be performed on those groundwater samples. Thus, the zone testing is performed to assess water quality conditions in potential, depth-discrete aquifer zones, and to serve as an aid in evaluating potential impacts of the quality from those selected zones on the water quality of the final wellblend from a possible water-supply well at the site in the future.

However, data on water levels, pumping rates and the quality of the groundwater obtained from each tested zone are considered to be representative of only very short-term and relatively low, pumping rate testing of each selected aquifer zone. Thus, the results of zone testing may not be representative of the final pumping rates, water levels or wellblend water quality in a future water well. As such, isolated aquifer zone testing provides only an indication of possible water quality and flow conditions of each tested zone.

Also, the concentrations of specific "target" constituents in these discreetly sampled aquifer zones may change over time as pumping from a new well in the future begins to introduce changes in local groundwater flow conditions (both laterally and vertically). Thus, the water level and water quality data obtained from each isolated aquifer zone test function solely as a semi-quantitative tool to assess potential groundwater quality in a future well. Consequently, any data obtained from each zone must be evaluated to help provide judgment on whether or not a specific aquifer zone is to be perforated in the design of a future water well. Ultimately, however, representative wellblend groundwater samples for laboratory testing can only be obtained from the well under actual operational pumping rates.

ZONE-BUILDING PROCEDURES

Utilizing the geologic log and the electric logs of the new test hole, a total of five potential aquifer zones were selected by RCS geologists for isolated aquifer zone testing in the open test hole. Setup of each isolated aquifer test zone was performed by Southwest personnel and generally consisted of the following tasks:

- Installing a bentonite seal to just below the depth of the initial (and lowermost) aquifer zone to be tested and sampled.
- Placing an approximately 20-foot length of perforated pipe on the bottom of the drill string and then installing that perforated tool to the depth of the initial depth-discrete aquifer zone to be tested and sampled.
- Installing a gravel pack above the bottom seal, and also below, around, and above the 20-foot long perforated sampling tool.
- Sealing the top of the gravel pack with bentonite to create an upper seal and to help isolate the perforated interval of the sampling tool.
- Allowing the upper and lower bentonite seals to set for a minimum period of two hours before initiating development of the aquifer zone to be tested.
- Conducting zone development and groundwater sampling of each zone.
- Following completion of testing activities in the initial (deepest) zone, the entire sampling tool assembly was pulled up to the next overlying (and more shallow) aquifer zone to test, and the above procedures were repeated for each successive zone to be tested. For the subject test hole, a total of five isolated aquifer zone tests were performed.

Figure 3, "Construction Diagram, Isolated Aquifer Zone Testing," illustrates the general construction of each of the five isolated aquifer zone tests. Table 3, "Construction Details, Isolated Aquifer Zone Testing," provides the actual placement depth of the perforated tool, the gravel pack interval, and the depths of the bentonite seals utilized for each of the five isolated aquifer zones tested in the open borehole for the subject test hole. Figure 4, "Graphical Presentation of Isolated Aquifer Zone Testing Construction," illustrates the five selected isolated aquifer test depth zones and their placement relative to depth on the Pacific Surveys geophysical (electric) log. Each tested zone was constructed at a depth that was interpreted to contain relatively permeable sediments (potential aquifer zones) as observed on the electric log.

ISOLATED AQUIFER ZONE DEVELOPMENT

After the specified time had elapsed for the upper and lower bentonite seals to set, airlift development of each zone was performed. This development procedure in each zone generally entailed the following:

- Airlifting was conducted for approximately 2 to 6 hours depending on how quickly the turbidity of the discharge water was observed to decrease. Airlifting was conducted until the zone was considered to be free of heavy muds and sediments. Airlifting rates in the zones ranged from approximately 10 to 50 gpm.
- After the airline was removed from the drill string, a submersible pump was placed inside the drill string to a depth that was below the perforated zone tool in each zone. Each zone was pumped for periods ranging from 4½ to 8½ hours. During the pumping period, the discharge water was measured by an RCS geologist for the field water quality parameters of temperature (T), electrical conductivity (EC), pH, and turbidity.
- Measurements of methane, CH_4, and hydrogen sulfide, H_2S, gas were also taken during isolated aquifer zone testing; both as a safety measure and to determine if water produced from each of the tested zones contained these gases.

ISOLATED AQUIFER ZONE GROUNDWATER SAMPLING

When it was determined by the geologist that each zone had been sufficiently developed by submersible pumping, and that the field water quality parameters had become relatively stable, a groundwater sample was collected by the onsite RCS geologist in order to conduct laboratory testing. The samples were collected just prior to cessation of pumping in each zone by RCS geologists and were then delivered by Southwest personnel to E.S. Babcock and Sons, Inc (Babcock) Environmental Laboratories, of Riverside, California, the laboratory that performed the analyses.

Just prior to the cessation of pumping, following the collection of the groundwater samples, a pumping water level measurement was obtained for each zone, when possible. In addition, a static water level measurement was collected after the submersible pump had been raised up from each successive zone being sampled.

RESULTS OF ISOLATED AQUIFER ZONE SAMPLING

Table 4, "Summary of Field Measurements, Isolated Aquifer Zone Testing," shows the dates the samples were collected and provides the results of the monitoring of the field water quality parameters by the RCS geologist for each tested zone. From Table 4, the field results for five zone test were as follows:

Water Levels and Pumping Rates

1. Static water levels (SWLs) ranged in depth from a high of 58 ft bgs in Zone No. 5, to a low of 236 ft bgs in Zone No. 2.
2. Submersible pump flow rates from the five tested zones were between a low of 30 gallons per minute (gpm) in Zone No. 1 and a high of 50 gpm in Zone No. 4.
3. Pumping water levels (PWLs) ranged from the deepest measurements of 252 ft bgs in Zone No. 2 to the shallowest measurement of 122 ft bgs in Zone No. 5. PWLs were not recorded in Zone Nos. 1 and 3 because the electronic sounder continued to become lodged in the annular space between the drill string and the pump column.
4. Specific capacities were between 0.75 gallons per minute per foot of water level drawdown (gpm/ft ddn) in Zone No. 5 and 2.69 gpm/ft ddn in Zone No. 2. Specific capacities for Zone Nos. 1 and 3 could not be calculated because PWLs could not be collected in those zones.
5. Water levels recovered within 2 to 8 ft of the static water level in periods of ±60 to 90 minutes after pumping ceased in each zone (see Table 4).

Field Water Quality Parameters

1. Temperatures of the groundwater in each zone ranged from a low of 76.5 °F in Zone No. 5 to a high of 84.9 °F in Zone No. 2. In general, Zone Nos. 1 and 2 (the deeper zones) had higher temperatures (greater than 80 °F), whereas the shallower zones (Nos. 3, 4, and 5) had lower temperatures.
2. The field pH of each zone was between 7.65 in Zone No. 1 and 8.21 in Zone No. 3. No measurement was recorded for Zone No. 1.
3. Electrical conductivity (EC) measurements ranged between 3010 micromhos per centimeter (µmhos/cm) in Zone No. 1 and 837 µmhos/cm in Zone No. 4. The deeper zones (Nos. 1 and 2) had much higher EC measurements than Zone Nos. 3, 4 and 5 (see Table 4).
4. Just before the groundwater samples were collected by the geologist, the field turbidity in the water ranged from 4.5 nephlometric turbidity units (NTU) in Zone No. 5, to 58.3 NTU in Zone No. 2.

Results of Gas Monitoring During Isolated Aquifer Zone Testing

An RCS geologist was onsite during the pumping portion of the isolated aquifer zone testing to monitor methane and hydrogen sulfide gases using the portable probe device. Peak measurements were logged by the device for every 10-minute time interval, and also manually recorded by the geologist while onsite. The geologist selected four separate ground surface locations at and near the drill rig at which to measure concentrations of the two monitored gases: at the top of the borehole, near where water quality samples were collected; near the top of the conductor casing; underneath the drill rig; and at the top of the discharge tank (Baker tank) where fluids from pumping were being discharged. These monitored gases are considered to represent a safety hazard when they accumulate in confining locations such as small unventilated spaces. Each time the gases were detected, the geologist notified the onsite drillers so approximate action could be taken if necessary.

During the zone test pumping of Zone Nos. 1 and 2, methane gas was detected by the device in concentrations that could be considered hazardous (see Figure 2). Table 4 lists the peak measurements for hydrogen sulfide recorded by the portable device during isolated aquifer zone testing for each zone, and notes whether methane was detected or not. It was observed that during the pumping of Zone No. 1, the highest concentration of methane was reported to be 59% and during the pumping of Zone No. 2, methane had reached a peak measurement of 100%. Both of these measurements were recorded when the geologist had moved the device to the end of the discharge pipe where it entered the Baker tanks. Because the device is measuring the percentage of gas within a fixed volume of air, the detected measurements represent "pockets" of methane gas that were being discharged while pumping each zone and not necessarily the concentration of methane gas in each depth-discrete, tested aquifer zone. Once the device was moved away from the end of the discharge pipe, the methane concentration measurements rapidly decreased to almost zero. Hydrogen sulfide gas was reported to be between not detected and 0.3 ppm while pumping each zone for the entire isolated zone testing period and thus was never detected at concentrations considered to be hazardous. As noted previously, no methane and only minor concentrations of hydrogen sulfide were detected during drilling using direct mud rotary methods.

RESULTS OF LABORATORY ANALYSES

Table 5, "Summary of Laboratory Test Results," shows the results of laboratory analysis of groundwater samples from the five isolated aquifer zones from which groundwater samples were successfully obtained in the open borehole. Table 5 shows that the general mineral analytes in groundwater samples from the shallowest three zones (Zone Nos. 3 to 5) appear to be within their respective California Department of Public Health (CDPH) Maximum Contaminant Level (MCL), with the exception of turbidity (NTU) in each of those zones; NTU values were above their Secondary MCL of 5 NTU. Turbidity is higher than the MCL in these zones because each of these zones had been subjected to only limited development (pumping and air-lifting) before sampling. It is expected that over a longer period of pumping in a newly-constructed well in the future, turbidity would be reduced to levels below the State MCL. All other general mineral analytes for these three shallow zones are below their respective MCLs.

The two deepest zones sampled during isolated aquifer zone testing (Zone Nos. 1 and 2) had several general mineral analytes that were detected at concentrations above their respective MCLs. Also, due to safety concerns regarding methane gas, Zone No. 1 had minimal pumping time before samples were collected by the geologist, and this may be part of the reason for the increased concentration of analytes from this zone.

Trace metals (i.e., inorganic chemicals) were also detected in groundwater samples collected from each of the five zones, as shown on Table 5. It should be noted that all samples from zone testing, with the exception of Zone No. 1, were filtered in the field with a 0.45 micron pore size filter, to help remove undissolved solids (turbidity) from the samples. Nonetheless, the results of laboratory analysis of the trace elements reveal: aluminum (Al) was above its State MCL of 100 µg/l, in Zone No. 2 (measured at a concentration of 190 micrograms per liter, µg/l); and boron (B) was detected in Zone Nos. 1 and 2 (reported to be 2200 and 1600 µg/l, respectively, relative to its MCL is 1000 µg/l). Arsenic was detected in three zones (Zone Nos. 1, 2, and 5) but was only found to be above its Primary MCL of 10 µg/l in Zone No. 5, where a concentration of 11 µg/l was reported. Also, manganese (Mn) was detected in Zone Nos. 3 and 5, but was only above its Secondary MCL of 100 µg/l in Zone No. 5. All other detected trace metals are in concentrations that are below their respective State MCLs or Notification Limits (NL). The final laboratory analytical reports are included in the Appendix.

To further evaluate and compare groundwater quality from each of the isolated aquifer test zones, RCS has prepared Figure 5, "Stiff Water Quality Pattern Diagrams." For this figure, all available water quality data for each zone have been assessed using a method developed by Mr. H. Stiff in the early-1950s. The plots, known as Stiff water quality pattern diagrams, equalize the concentrations of each cation and anion (on the "X" axis of each diagram) by using the concentration of each constituent in terms of its equivalents per million (epm), and not in milligrams per liter (mg/L). Stiff pattern diagrams are useful for identifying the groundwater character of the isolated aquifer test zones and readily permits comparison of the quality between these test zones in the same or different geologic environments. Below each Stiff pattern diagram, the concentrations of total dissolved solids (TDS) concentration, and total hardness (TH) are listed in units of mg/L, whereas iron, manganese, and arsenic is listed in units of µg/L; the sampling date is also provided.. Key test results include:

1. In general, the water quality changes from a sodium-chloride (Na-Cl) character in the two deepest zones (Zone Nos. 1 and 2) to a sodium-bicarbonate ($Na\text{-}HCO_3$) water character in the three shallowest zones (Zone Nos. 3, 4, and 5).
2. TDS values change from a range of 1300 mg/L to 1800 mg/L in the two deepest zones, to a much lower range of 490 mg/L to 700 mg/L in the three shallowest zones.
3. TH values range from 53 mg/L to 340 mg/L, but the values do not have any particular trend relating to zone depth.

EXPLORATORY BOREHOLE (TEST HOLE) DESTRUCTION

On December 7, 2009, Southwest began to demobilize the drill rig and other equipment that had been used to drill and zone sample the test hole. On December 9, following demobilization and site cleanup activities, the contractor excavated around the top of the conductor casing using a backhoe. This excavated pit was approximately 6 ft deep and an estimated 8 ft in diameter. On December 29, the top of the conductor casing was cut down to a depth of 6.2 ft bgs and removed from the drill site; the top of the exposed conductor casing was then temporarily secured.

On December 29, the test hole was permanently sealed and destroyed by pouring 23-sack neat cement into the open borehole, via a tremie pipe set to a depth of 240 ft bgs. A total of 10 cubic yards (yd^3) of cement were emplaced. A "mushroom cap" of cement was then placed over the top of the conductor and into the surrounding excavation. These destruction activities were completed in accordance with the current guidelines of the Department of Water Resources (DWR) and the Los Angeles County Department of Health Services (LACDHS). The County inspector and a RCS geologist were present to observe the placement of this cement. Copies of the cement delivery ticket for the neat cement are included in the Appendix.

CONCLUSIONS

The results of isolated aquifer zone testing with regard to potential pumping rates, drawdowns and specific capacities of the tested aquifer zones provide a general indication of potential permeability conditions of the sediments encountered in the test hole. The results indicate that the sedimentary section that might be screened in a new well would likely have sufficient permeability to support moderate pumping rates in the new onsite water-supply well. Key factors that were found to be beneficial in determining the feasibility for a new well at Robertson Yard include:

1. Each tested zone cleared up relatively quickly after pumping began.
2. Turbidity in the collected samples was relatively low at the time of zone sampling in Zone Nos. 3 through 5 after only limited development. However, turbidity measurements of all five tested zones were still above the Secondary MCL of 5 NTU.
3. Specific capacities were relatively high in Zone Nos. 2 and 4. No pumping water level data were collected for Zone Nos. 1 and 3, thus a specific capacity could not be calculated for these zones.
4. Hydrogen sulfide concentrations were relatively low (less than 0.3 ppm) for each of the tested zones, and may represent baseline conditions.
5. Methane concentrations were detected in relatively high concentrations in only the two deep zones, Zone Nos. 1 and 2, at depths of 756 to 776 ft and 642 to 662 ft, respectively.
6. Water levels recovered close to pre-test static water levels in relatively short time periods after each zone was pumped.
7. Results of laboratory analyses for the five tested zones revealed that the all detected analytes of the three shallowest zones (Zone Nos. 3 through 5) were below their respective MCLs, with the exception of arsenic and manganese in Zone No. 5. The two deeper zones (Zone Nos. 1 and 2) had high concentrations of EC, TDS, and boron. Aluminum was detected only in Zone No. 2, and its concentration was above its respective MCL.
8. The field temperature of the groundwater pumped from the isolated aquifer test zones ranged from 76.5°F in Zone No. 5 (the shallowest zone, at 287-307 ft), to 84.9°F in Zone No. 2 (the second deepest zone, at 642-662 ft).

It is considered hydrogeologically feasible for the City to attempt to drill and construct a new municipal-supply well having an acceptable pumping capacity and an acceptable water quality at the subject Robertson Corporate Yard property. Based on preliminary data acquired from test hole drilling and isolated zone aquifer testing, the following summary provides anticipated conditions for a possible new onsite municipal-supply water well in the future:

1. Groundwater is expected to occur under semi-confined to confined conditions.
2. A current static water level depth on the order of 50 to 100 ft bgs is anticipated.
3. A pumping rate in the range of 300 to perhaps 500 gpm might be achievable. Hence, a new well at the subject property would tend to be capable of supplying the same annual volume of groundwater (in acre-feet per year) to the City's treatment plant as does each of the City's other existing municipal-supply water wells.
4. An estimated current specific capacity for the new well of 2 to 5 gpm/ft ddn.
5. Current pumping water levels could be at depths on the order of 200 to 350 ft bgs at an estimated maximum pumping rate of 500 gpm, and using a maximum specific capacity of 5 gpm/ft ddn.
6. Because of the relatively large drawdowns and deep pumping water levels expected in the new well, cascading water conditions could occur when the well is being actively pumped depending on the depth to the top of the uppermost perforations in the new well.
7. Because of poor water quality at depth, including high EC and TDS, as well as elevated concentrations of methane and hydrogen sulfide gases, drilling operations and/or casing emplacement should not occur in a future onsite well to depths below ±560 ft.
8. The pumped groundwater wellblend is anticipated to have the following characteristics:
   a. a calcium-sodium-bicarbonate character.
   b. detectable amounts of hydrogen sulfide odors, but likely no methane.
   c. a field water temperature of 76° to 82°F.
   d. TDS and TH values on the order of 500 to 700 mg/L, and 100 to 350 mg/L, respectively.

PRELIMINARY DESIGN FOR FUTURE ONSITE WATER WELL

Table 6, "Preliminary Design for Future Onsite Water Well," and Figure 6, "Preliminary Design for Future Onsite Water Well," provide examples of a preliminary RCS-recommended well design for the future well at the subject site. It should be noted that these details are based on the current test hole drilling results and isolated aquifer zone testing data, as well as from data from current and former City-owned wells in the area. Changes to the final well design may be necessary at the time of well construction. The Technical Specifications for the new well will include provisions for conducting at least two isolated aquifer zone tests between the depths of ±175 and ±250 ft. Data generated during these test in the open pilot borehole for the future well will help define the viability of also placing perforations in these relatively shallow aquifer zones.

Below is a summary of the possible future construction methods for a new well constructed at the subject property.

1. Casing diameter should be on the order of 12 inches; the recommended casing material is Type 304L stainless steel.

2. The well casing should be placed no deeper than approximately 540 ft bgs including a 20-foot section of cellar pipe with end cap.

3. Based upon the current test hole geophysical log, well perforations could be placed in selected depth zones between the depths of 145 ft and 520 ft bgs, and these perforated casing sections should be interspersed with blank (unperforated) sections of casing.

4. Accessory tube casing such as sounding tubes and gravel feed tube should be installed with the new well. A sounding tube allows for the collection of water levels (via manually or use of a pressure transducer) as well as the collection groundwater samples without having to remove the permanent pump from the wellhead.

5. A cement sanitary seal can be placed from ground surface to a depth of at least 110 ft bgs; such a depth readily meets State and County standards for domestic use.

PRELIMINARY COST OF WELL CONSTRUCTION

For the tentative well design that is provided in Table 6 and shown on Figure 6, RCS estimates, for your general budgetary consideration, that the cost will be on the order of $465,000 (in current dollars). This estimate includes drill rig mobilization/demobilization, noise control walls, pilot hole drilling to 580 ft, conducting electric logs, conducting two isolated aquifer zone tests, reaming the pilot borehole, installing 12-inch diameter by ¼-inch wall thickness type 304L stainless steel casing, installing casing to a depth of ±560 ft, performing mechanical and chemical development, providing a test pump and performing all pumping development and final pumping tests, performing a final spinner log and depth-discrete water quality sampling in four zones under pumping conditions in the new well, and final site cleanup.

Excluded from the above cost estimate for well construction and testing are any and all costs for such items as: the permanent pump and wellhead; providing all discharge piping and hookups to City raw water pipelines, constructing new raw water pipelines, water treatment, a new building to house the well, and hydrogeologic and engineering services during all construction activities.

TABLE 1
DAILY RECORD OF SITE ACTIVITIES
BEVERLY HILLS ROBERTSON YARD

DATE(S)-2009	SITE ACTIVITY
CONDUCTOR CASING INSTALLATION & MOBILIZATION	
9/9	Crew mobilizes bucket rig to site. Cleans site.
9/10	Rig up bucket rig, Drill 36-inch broehole with bucket. First water at 20 ft bgs.
9/11	Continue bucket rig drilling.
9/12-9/13	No work onsite.
9/14	TD bucket hole, pour cement. County inspector onsite. 10 yds concrete used, cement tagged at 8 ft bgs when wet. Inspector wants cement 5 ft below grade for future destruction.
9/15	Cement tagged at 5.5 ft bgs this morning. Mud rotary drill rig being mobilized to the site.
9/16	Problem mobilizing drill rig to site; rig engine blew up. Plate over the hole, and backhoe holding it in place.
9/17-10/13	No work onsite.
10/14	Crew mobilzes drill rig and equipment to site.
10/15-10/16	Rig Up.
10/17-10/18	No work onsite.
10/19-10/20	Rig Up. RCS onsite for 1 hour each Day
TEST HOLE DRILLING	
10/21	Commence drilling. RCS onsite. Depth @ end of day = 246 ft.
10/22	Continue pilot hole drilling. RCS onsite. Depth @ end of day = 390 ft.
10/23	Continue pilot hole drilling. RCS onsite. Depth @ end of day = 486 ft.
10/26	Continue pilot hole drilling. RCS onsite. Depth @ end of day = 616 ft. Sound panels delivered but no crane onsite.
10/27	Continue pilot hole drilling. RCS onsite. Depth @ end of day = 750 ft. 120 ft of soundwalls installed.
10/28	Continue pilot hole drilling. RCS onsite. Depth @ end of day = 821 ft.
10/29	Continue pilot hole drilling. RCS onsite. TD = 851' @ 12 Noon. Begin Elog at 4 pm; end at 7 pm.
10/30-11/3	No work on site.
11/4	Wiper Pass (borehole ream). Chris Wick onsite to observe zone tool.
11/5	Call from Brian Jeffers; mud too heavy, crew cannot tag. Need to remove mud, tanker to be onsite Monday.
11/6-11/8	No work on site.
11/9	Crew is reaming borehole.
11/10	Reamed to 820 ft. Set bottom seal today; start tripping in zone tool.

ISOLATED AQUFIER ZONE TESTING	
11/11	Zone 1 built; begin airlifting. 6 hours total airlifting performed.
11/12	Installed submersible pump at 310 ft and began pumping. Static water level (SWL) at roughly 200 ft. Pump from 11 am to 5 pm. Breaking suction. Need to deepen the pump.
11/13	Move pump to 350 ft and resumed pumping and adding hydrant water. Without hydrant water, zone pumps for 3 minutes. Get eventual breakthrough and zone is making water. Abundant methane, peak was 58%, usually around 40%. Grabbed sample and shutdown. Pulled tool and added bentonite to 707 ft. Mr. Wick onsite all day to measure methane.
11/14-11/15	No work on site.
11/16	Zone 2 built; begin airlifting. 4 hours total airlifting.
11/17	Installed pump to 350 ft. Pumped from 7:30 am to 1:30 pm. SWL at roughly 236 ft bgs. PWL at roughly at 252 ft bgs. Grabbed sample and shutdown. Begin building Zone 3.
11/18	Zone 3 built. Airlifting from 7:30 am to 9:30 am (2 hours total). Install pump at 307 ft. Pump from 12:00 pm to 3:30 pm (3.5 hours total). Grabbed sample and shutdown.
11/19	Zone 4 built. Airlifting from 1:30 pm to 3:00 pm and 4:30 pm to 5:30 pm (3.5 hours total).
11/20	Installed pump to 249 ft. Pumped from 8:00 am to 1:30 pm (5.5 hours total). Grabbed sample and shutdown.
11/21-11/22	No work on site.
11/23	Built Zone 5 and airlifted for 2 hours.
11/24	Installed pump to 182 ft. Pumped from 07:30 am to 13:30 pm (6 hours total). Grabbed sample. Remove remaining column pipe and zone tool. Shut down for the week.
11/25-12/6	No work on site, except for occasional vaccuum truck visits to empty Baker Tanks.
TEST HOLE DESTRUCTION & DEMOBILIZATION	
12/7	Removed drill rig from site.
12/8	No work onsite.
12/9	Excavate pit around conductor casing to a depth of 6 ft bgs.
12/29	Pump 23-sack neat cement into borehole from a depth of 5 ft to 240 ft bgs. Complete test hole destruction.

Table 2
Geologic Log of the Test Hole
Robertson Yard Test Hole
City of Beverly Hills

Pilot Hole Data

Location:
GPS Location: Lat: 34.081111°N Long: 118.385555°W
State Well Location: Township 1 South, Range 14 West, San Bernardino Baseline & Meridian
Dates of Drilling: 10/21-10/29/2009
Drilling Company: Southwest Pump Company
Drilling Supervisor: Brian Jeffers
Geologic Manager: Richard C. Slade & Associates LLC
Logging Geologist: Chris Wick
Total Depth: 851 ft bgs
Approximate Ground Elevation: 240 ft above mean sea level

Depth (below ground surface)	General Geologic Description	Interpreted Geologic Unit
0 - 50	Conductor Borehole; sand and silt	
50 - 90	Sand: brown to gray, fine- to very coarse-grained, subangular to subrounded, moderately to poorly sorted, small gravels increased from 80 ft to 90 ft.	Recent alluvium to undifferentiated Pleistocene-aged sediments
90 - 120	Clayey Silty Gravel: brownish gray, gravel chips up to 1cm, poorly sorted	
120 - 180	Sandy Gravelly Silt: brown, fine- to very coarse-grained sand, gravel chips up to 1.5cm; minor soft, sticky clay	
180 - 280	Gravelly Clayey Silt: gray to dark gray, gravel chips up to 1.5 cm; soft, sticky clay and silt, some sandy interbeds	
280 - 370	Silty Sandy Gravel: olive brown, fine- to very coarse-grained sand, subangular to subrounded, silt is mostly "balled" up	
370 - 420	Clay: gray, soft, sticky, low to moderate plasticity; with minor gravels and sands	
420 - 460	Sandy Gravel: gray, fine- to very coarse-grained sands, poorly sorted, angular to subangular, gravels up to 5mm, increasing silts towards 460 ft	
460 - 480	Sandy Silty Gravel: gray, fine- to very coarse-grained sands, gravel chips up to 5 mm, silts have low to moderate plasticity	
480 - 490	Gravelly Clay: gray, soft, sticky, low plasticity, gravel chips up to 5mm, angular to subangular	
490 - 510	Sandy Gravel: olive gray, gravel chips up to 1 cm, angular to rounded, fine- to very-coarse-grained sands	
510 - 540	Sandy Gravel: blue gray, gravel chips up to 5mm, subrounded, fine- to very-coarse-grained sands, subrounded, shell fragments/fossils	
540 - 580	Silty Sand: gray, very fine- to very coarse-grained, subangular to subrounded, moderately sorted, soft, sticky clay, trace clay, shell/fossil fragments	
580 - 610	Silty Clayey Sand: blue gray, very fine- to very coarse-grained sands, subangular to subrounded; soft, sticky, low to moderate plasticity clays and silts	
610 - 700	Silty Gravelly Sand: gray, very fine- to very coarse-grained sand, subangular to subrounded, poorly sorted; gravel chips up to 5mm, shell/fossil fragments	
700 - 730	Sandy Silt: gray, soft, sticky, low to moderate plasticity, mostly "balled" silts, sand is very fine- to medium-grained, trace gravels and clays	
730 - 750	Silty Sand: dark olive gray, very fine- to very coarse-grained, subangular to subrounded, moderately to poorly sorted	? ? ? ?
750 - 800	Clayey Silt: dark olive gray, low to moderate plasticity, "balled", interbeds of sands, clasts of metamorphics, volcanics, shell/fossil fragments, fizzes with HCL	Upper Pico Formation
800 - 820	Silt: dark gray, minor fine- to coarse-grained sands	
820 - 851	Clay: dark olive gray, low to moderate plasticity, "balled", trace silts, sands and gravels; fizzes with HCL	

TABLE 3
CONSTRUCTION DETAILS FOR
ISOLATED AQUIFER ZONE TESTING
ROBERTSON YARD TEST HOLE
CITY OF BEVERLY HILLS

ZONE TEST NO.	TOOL DEPTH (ft bgs)	GRAVEL PACKED INTERVAL (ft bgs)	UPPER BENTONITE SEAL (ft bgs)	LOWER BENTONITE SEAL (ft bgs)
1	756 to 776	746 to 790	727 to 746	790 to 806
2	642 to 662	629 to 678	609 to 629	678 to 698
3	484 to 504	465 to 520	448 to 465	520 to 538
4	391 to 411	380 to 422	353 to 380	422 to 440
5	287 to 307	277 to 330	256 to 277	330 to 350

TABLE 4
SUMMARY OF FIELD MEASUREMENTS
ISOLATED AQUIFER ZONE TESTING
ROBERTSON YARD TEST HOLE

Aquifer Zone No.	Zone Depth (ft, bgs)	Date of Sample Collection	Zone Development Measurements					Field Water Quality					Gas Readings	
			Static Water Level (ft, bgs)	Submersible Pumping Rate (gpm)	Pumping Water Level (ft, bgs)	Water Level Drawdown (ft)	Specific Capacity of Zone (gpm/ft ddn)	Temperature (^oC)		pH	Electrical Conductivity (µmhos/cm)	Turbidity (NTU)	Methane Detected (Y/N)	H_2S (ppm)
								(^oC)	(^oF)					
1	756 to 776	11/13/09	204	30	NA	-	-	28.3	82.9	-	3010	40.1	Yes	0.3
2	642 to 662	11/17/09	236	43	252	16	2.69	29.4	84.9	8.01	2330	58.3	Yes	0.4
3	484 to 504	11/18/09	196	38	NA	-	-	24.9	76.8	7.97	985	11.1	No	0.3
4	391 to 411	11/20/09	158	50	186	28	1.79	25.8	78.4	8.21	837	9.0	No	0.3
5	287 to 307	11/24/09	58	48	122	64	0.75	24.7	76.5	7.65	1106	4.5	No	0.3

NOTES: All water levels taken by Southwest Pump using an airline with the exception of the pumping water level recorded in Zone No. 5, which was recorded by RCS using an electric tape sounder

NA = Not Available

TABLE 5
SUMMARY OF LABORATORY TEST RESULTS
ISOLATED AQUIFER ZONE TESTING
ROBERTSON YARD TEST HOLE

Constituent Analyzed	Units	Maximum Contaminant Level (MCL)	Zone No. 1 756 to 776 ft Nov-13-2009	Zone No. 2 642 to 662 ft Nov-17-2009	Zone No. 3 484 to 504 ft Nov-18-2009	Zone No. 4 391 to 411 ft Nov-20-2009	Zone No. 5 287 to 307 ft Nov-24-2009
General Physical Constituents							
Electrical Conductance	µmhos/cm	900, 1600, 2200(1)	3200	2300	860	850	1100
pH	units	6.5 to 8.5	8.3	8.1	8	8.2	7.5
Color	CU	15	60	40	15	5	ND
Odor	units	3	ND	ND	ND	ND	ND
Turbidity	NTU	5	90	82	11	8.4	4.2
General Mineral Constituents							
Total Dissolved Solids	mg/L	500, 1000, 1500(1)	1800	1300	540	490	700
Hardness	mg/L	None	81	97	140	53	340
Calcium	mg/L	None	11	13	28	9.8	89
Magnesium	mg/L	None	13	15	18	6.8	29
Potassium	mg/L	None	12	7.2	4.2	1.7	2.2
Sodium	mg/L	None	670	480	150	170	100
Alkalinity as $CaCO_3$	mg/L	None	400	430	330	320	320
Bicarbonate (HCO_3)	mg/L	None	490	530	400	390	300
Sulfate	mg/L	250, 500, 600(1)	3.1	2.1	16	18	120
Chloride	mg/L	250, 500, 600(1)	770	490	130	54	85
Nitrate as NO_3	mg/L	45	ND	ND	ND	ND	1.1
Fluoride	mg/L	2	0.6	0.8	0.4	1.7	0.4
Inorganic Chemicals							
Aluminum	µg/L	100	ND	190	ND	ND	ND
Arsenic	µg/L	10	5	2.7	ND	ND	11
Barium	µg/L	1000	ND	ND	ND	ND	ND
Boron	µg/L	1000 (NL)	2200	1600	480	630	230
Total Chromium	µg/L	50	ND	17	6.3	5.4	9.7
Copper	µg/L	1300	ND	ND	ND	ND	ND
Iron	µg/L	300	280	250	ND	ND	ND
Manganese	µg/L	50	ND	ND	36	ND	150
Nickel	µg/L	100	ND	ND	ND	ND	ND
Selenium	µg/L	50	20	7.6	ND	ND	ND
Vanadium	µg/L	50 (NL)	ND	6.2	ND	ND	6.9
Zinc	µg/L	5000	51	64	ND	ND	85
Volatile Organic Compunds (VOCs)							
Toluene(2)	ug/L	150	0.73	2.7	ND	1.2	1.4

(1) The three listed numbers represent the recommended, upper and short-term State Maximum Contaminant Levels for the constituent.
(2) Toluene was detected in Zone Nos. 1, 2, 4 and 5 at concentrations ranging from 0.73 to 2.7 µg/L. This constituent was detected because electrical tape was used by the Contractor in attaching wires to the pump column for aquifer zone testing.

NL = Notification Level
ND = Not Detected

TABLE 6
PRELIMINARY DESIGN DETAILS
FOR FUTURE ONSITE WATER WELL
CITY OF BEVERLY HILLS

Depth of Casing Sections (ft bgs)		Specified Depths and Diameters for the Stainless Steel Well Casing	Length of Casing (ft bgs)	
Top of Section	Bottom of Section		Blank	Screen
2 ft above ground surface	145	12-in. I.D. X 5/16-in. thick wall, Type 304L Stainless Steel, blank pump house casing. Also add 2 ft of stickup above ground surface.	147	---
145	260	12-in. I.D. X 5/16-in. thick wall, Type 304L Stainless Steel, louvered well casing	---	115
260	280	12-in. I.D. X 5/16-in. thick wall, Type 304L Stainless Steel, blank pump house casing.	20	---
280	370	12-in. I.D. X 5/16-in. thick wall, Type 304L Stainless Steel, louvered well casing	---	90
370	390	12-in. I.D. X 5/16-in. thick wall, Type 304L Stainless Steel, blank pump house casing.	20	---
390	520	12-in. I.D. X 5/16-in. thick wall, Type 304L Stainless Steel, louvered well casing	---	130
520	540	12-in. I.D. X 5/16-in. thick wall, Type 304L Stainless Steel, blank well casing and end cap.	20	---
Note: bgs = below ground surface		**Total Blank Casing:**	**207**	
		Total Screened Casing:	**335**	
		Total Casing Length:	**542**	

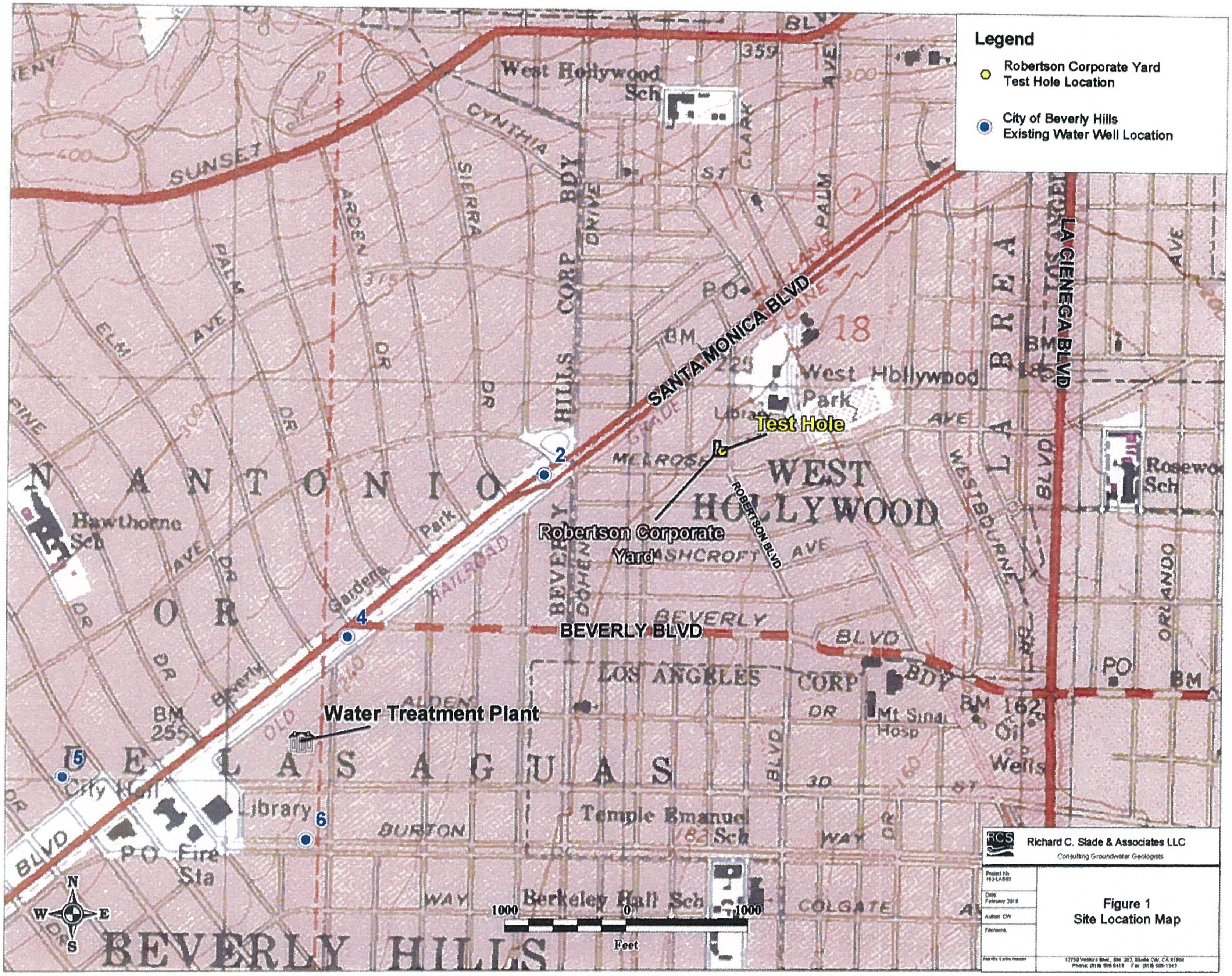
Accessory Tubes, Air Vent, Gravel Feed & Sounding Tubes (Type 304L Stainless Steel):
1. Gravel feed tube: 4-inches I.D.
2. Sounding tubes: Two, 2-in. I.D. tubes
3. Air Vent Tube: 3-in. I.D. tube

Ream Diameters and Depths:
22-inch diameter ream from 50 ft ft to 580 ft bgs; total length of ream is 530 ft.

Gravel Pack/Bentonite Seal:
1. Gradation: 6 x 8 gradation.
2. Depth Settings: from 100 to 560 ft bgs.
3. Bentonite Seal: a bottom plug shall be placed from 560 ft to 580 ft bgs.

Annular Cement Seal:
1. Type: 10.3-sack sand-cement mixture
2. Depth Setting: ground surface to 110 ft bgs; total length of annulus to be cemented is 110 ft.

Note: Based on preliminary test hole data. Changes to the well design may be necessary. Actual lengths, depths, footages, and diameters will be provided at a later date to be determined.



Legend
Robertson Corporate Yard Test Hole Location
City of Beverly Hills Existing Water Well Location
SANTA MONICA BLVD
LA CIENEGA BLVD
BEVERLY BLVD
ROBERTSON BLVD
Test Hole
Robertson Corporate Yard
Water Treatment Plant
2
4
5
6
WEST HOLLYWOOD
BEVERLY HILLS
LOS ANGELES
West Hollywood Park
West Hollywood Sch
Hawthorne Sch
Temple Emanuel Sch
Berkeley Hall Sch
Mt Sinai Hosp
Library
City Hall
Fire Sta
SUNSET
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W
Richard C. Slade & Associates LLC
Consulting Groundwater Geologists
Figure 1
Site Location Map

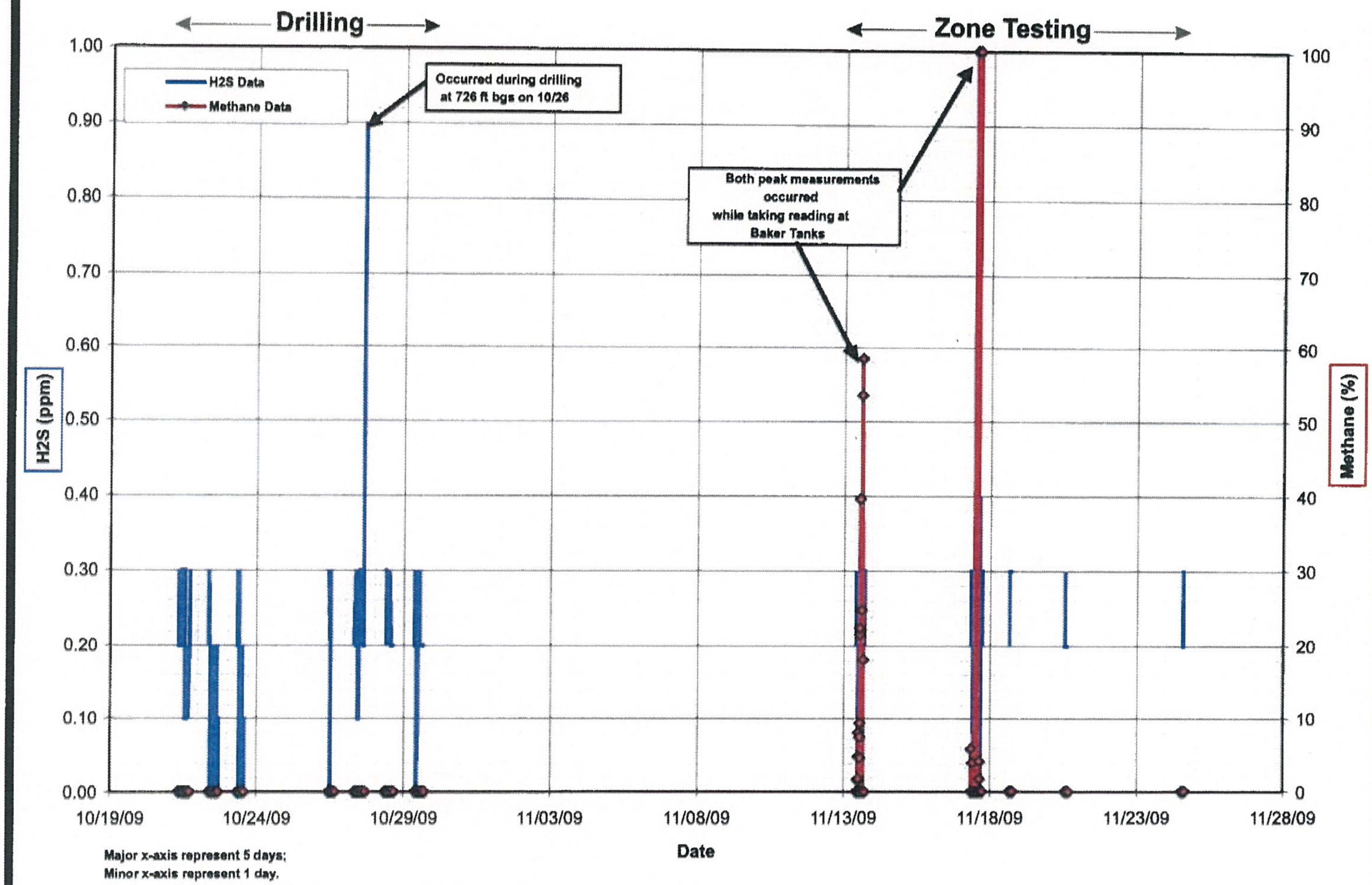

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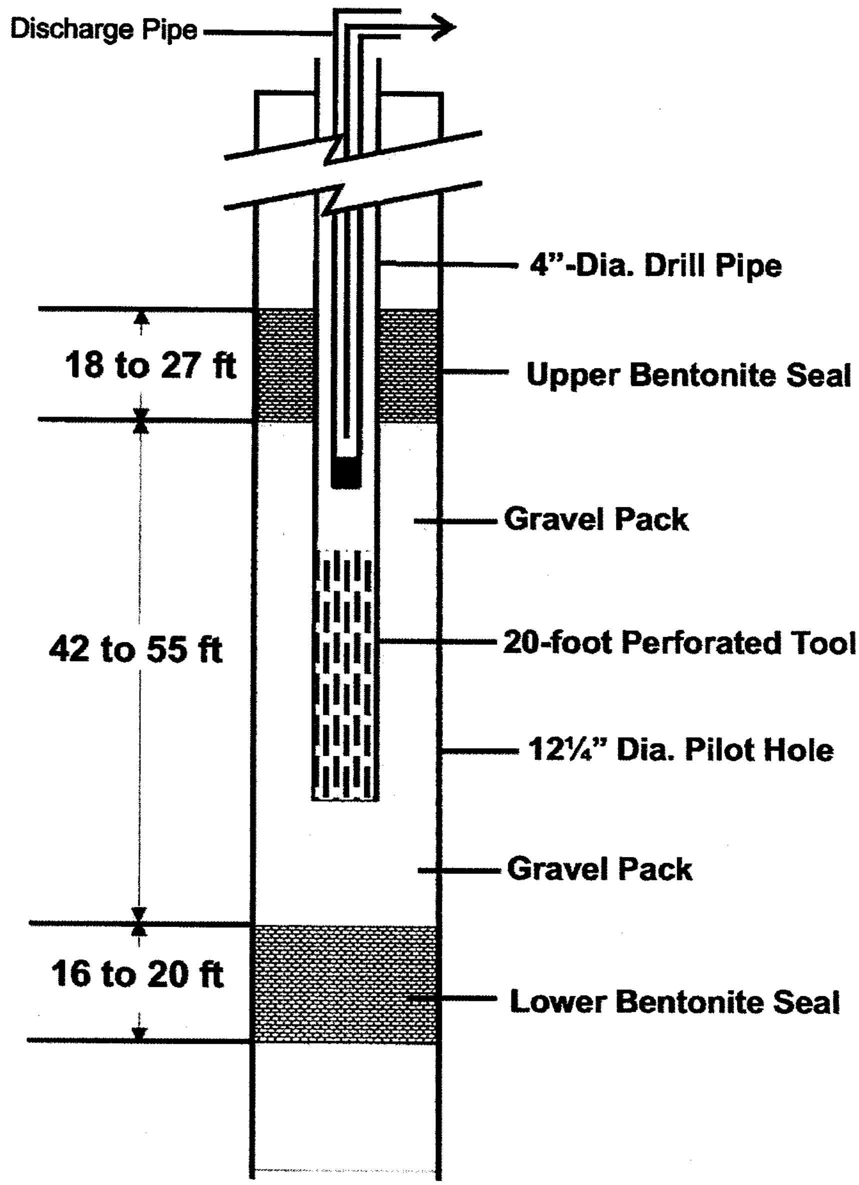
FIGURE 2
GAS CONCENTRATIONS DURING DRILLING AND ZONE TESTING ROBERTSON YARD TEST HOLE

Job No. 162-LAS03 **February 2010**



Note: Diagram not to scale

See Table 3 for actual lengths and depths of the gravel pack and seal for each zone

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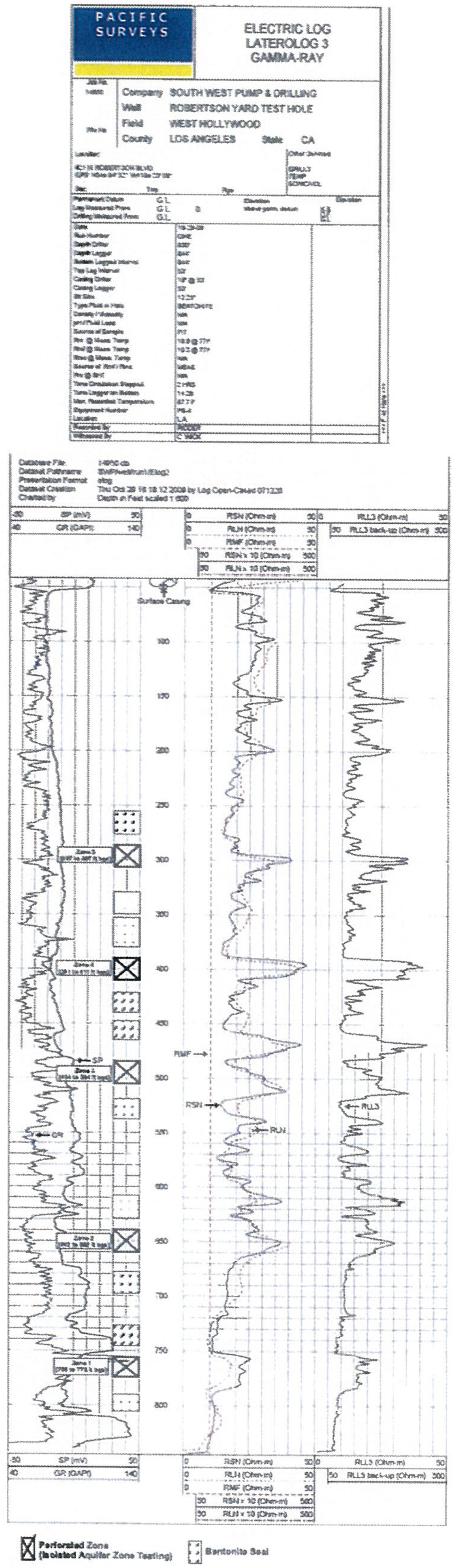
FIGURE 3
CONSTRUCTION DIAGRAM
ISOLATED AQUIFER ZONE TESTING
ROBERTSON YARD TEST HOLE

Job No. 162-LAS03 February 2010

FIGURE 4
GRAPHICAL PRESENTATION OF ISOLATED AQUIFER ZONE TESTING CONSTRUCTION ROBERTSON YARD EXPLORATORY BOREHOLE CITY OF BEVERLY HILLS



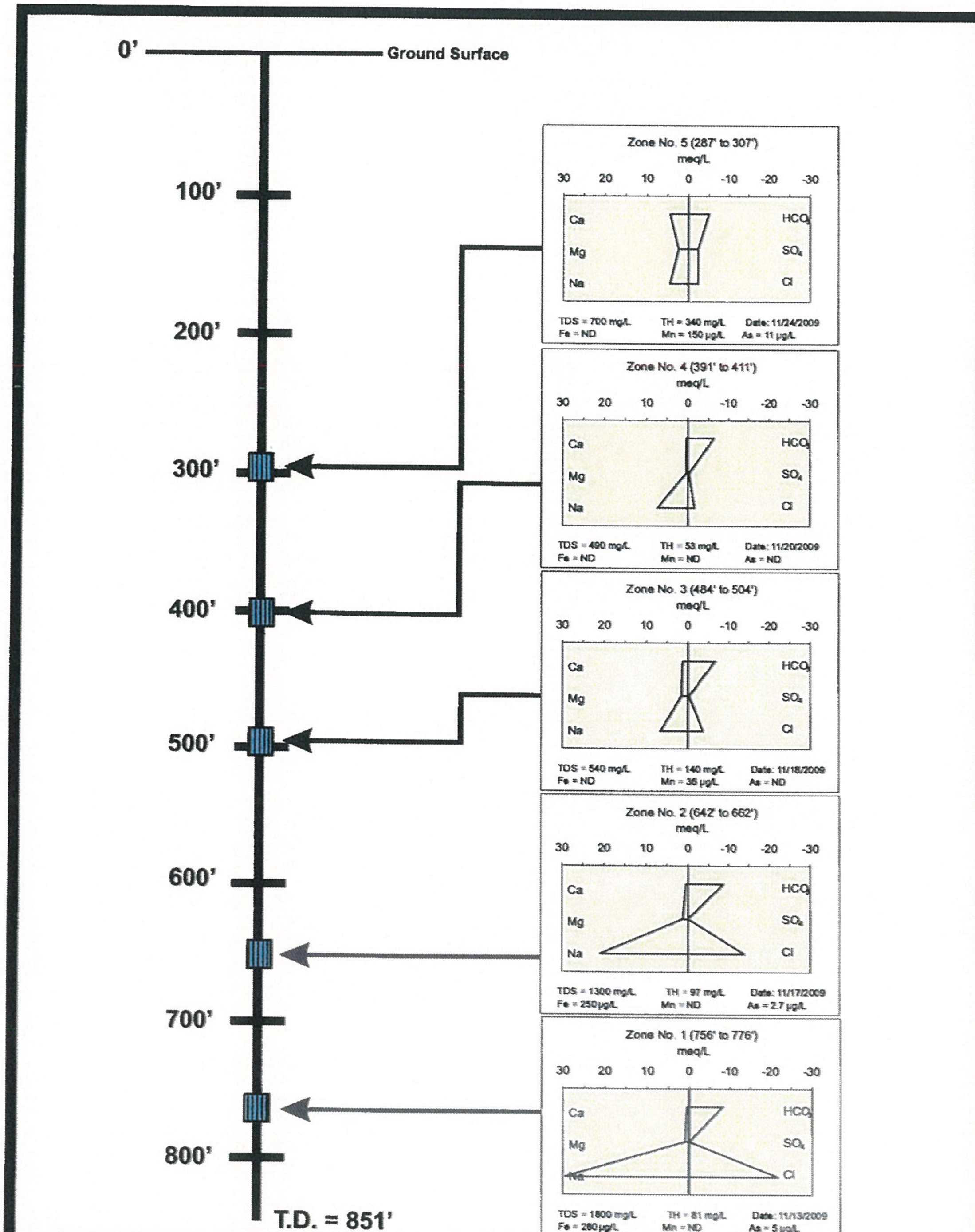


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FIGURE 5
STIFF WATER QUALITY PATTERN DIAGRAMS
AQUIFER ZONE TEST RESULTS
ROBERTSON YARD TEST HOLE

Job No. 162-LAS03 **February 2010**

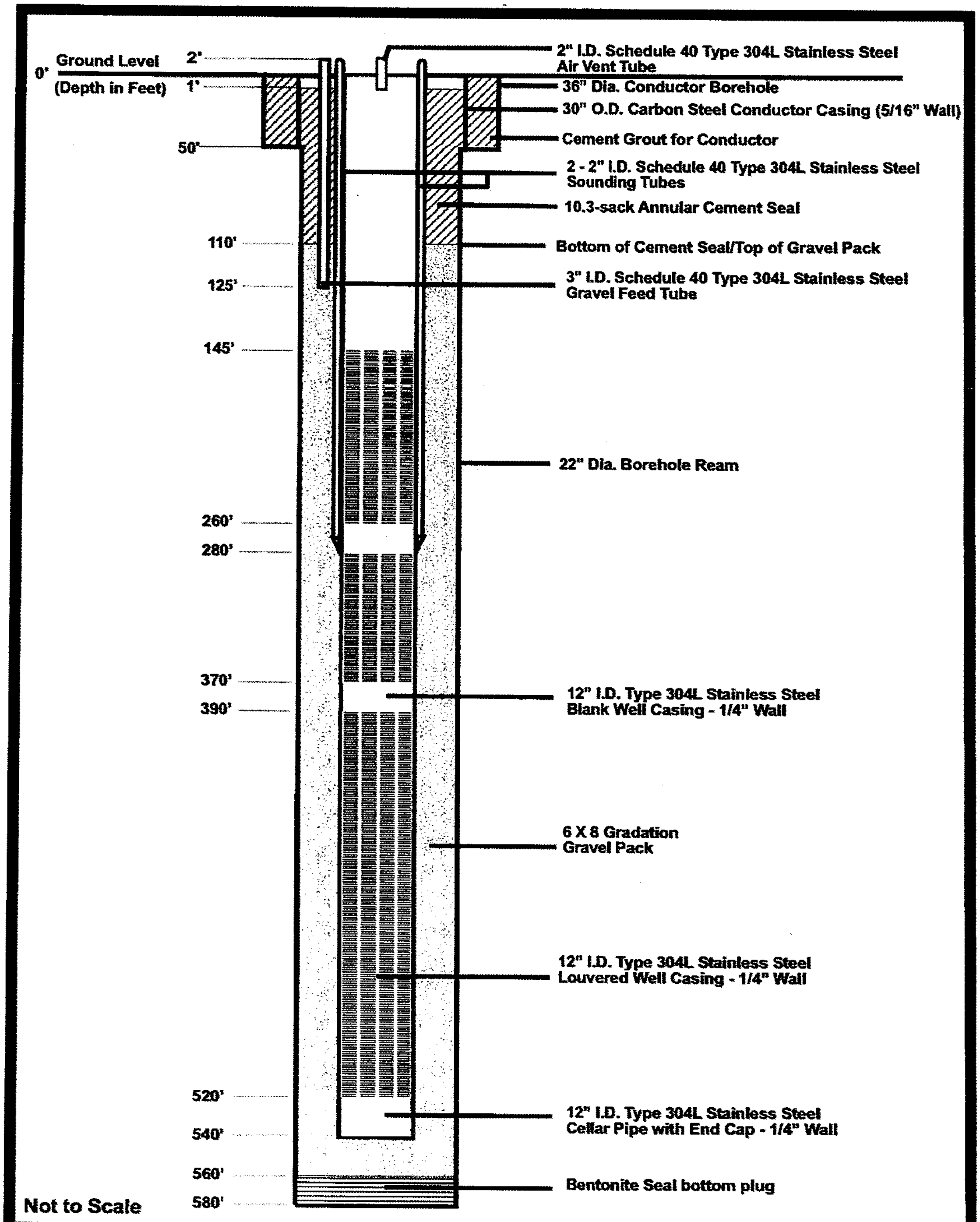

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FIGURE 6
PRELIMINARY DESIGN DIAGRAM FOR FUTURE ONSITE WATER WELL CITY OF BEVERLY HILLS

Job No. 162-LAS03 February 2010