Water Resources Addendum for the Petition to Amend

The California Energy Commission Final Decision on Bottle Rock Power Plant (79-AFC-4C)

February 2010

Prepared for:
Bottle Rock Power, LLC
7385 High Valley Road
Cobb, CA 95426

Prepared by:
RMT Inc.
4 West Fourth Avenue, Suite 303
San Mateo, California 94402

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1: Introduction

This report is an addendum to the Water Resources section, Section 4.17 of the Petition to Amend (PTA), submitted on September 30, 2009 to the California Energy Commission (RMT 2009). Up to 80 gallons per minute (gpm) of water are needed for the Bottle Rock Power (BRP) Steam Project during construction, for drilling, general dust control, and control of serpentinite dust. There were uncertainties in the PTA as to the potential effects of groundwater extraction because the source of water was not yet fully known at the time the PTA was submitted.

The uncertainties were specifically related to the following questions that are part of Section 4.17.2.1 CEQA Significance Criteria:

> *Would the project substantially deplete groundwater supplies or interfere with groundwater recharge such that there would be a net deficit in aquifer volume or a lowering of the local groundwater table level (e.g., the production rate of preexisting nearby wells would drop to a level that would not support existing land uses or planned uses for which permits have been granted)?*
>
> *Would the project cause substantial well interference with existing wells, and/or induced groundwater recharge where nearby streams begin to lose substantial water to the groundwater aquifer?*

Significant new information has recently been collected during recent testing of the groundwater aquifer by pumping of a test water supply well, PTW-1. The location of the test well is shown in Figure 1, and in more detail in Figure 1 of Appendix B. The new information, with details provided in Appendices A and B, helps to clarify water resources questions that arose during preparation of the PTA, with respect to the potential effects of pumping groundwater.

The following analysis clarifies the uncertainties that previously existed in the PTA regarding effects of groundwater pumping on water resources. Only the revised portions of the PTA are presented here.

1.1 Aquifer Test Location

Water for construction and drilling would be obtained from one or more water supply wells. A water supply well, based on information obtained from the test well, would be a 5-inch diameter PVC well with 0.020-inch slotted screen from 98.5 to 138.5 feet, encompassing a highly fractured permeable zone in the greywacke bedrock. The pump details have not yet been selected. A detailed geologic boring log and well construction details for the test well are presented in Appendix B.

A constant rate aquifer test was conducted for 49 hours at a rate of 80 gpm. The details of the aquifer test analysis are presented in Appendix B. The aquifer test results yielded values of 932 ft^2/day for transmissivity and 28 ft/day for hydraulic conductivity.

The aquifer test indicated that the fractured bedrock aquifer acts like a confined, permeable aquifer, capable of yielding 80 gpm or more. The upper 90 feet of bedrock is apparently not

fractured sufficiently to transmit drawdown effects during the pumping test. As a result, there is no evidence that drawdown is transmitted upward to shallow groundwater or the creek.

1.2 Environmental Impact Analysis

1.2.1 CONSTRUCTION IMPACTS

Dust Control

Future water usage for drilling and for well pad construction was summarized in Section 4.17.2.2 of the PTA (RMT, 2009). Recently obtained geologic data indicate that serpentine rock would not be uncovered during construction of the West Well Pad (EnvironStrategy 2009), and therefore, the pad area would not require misting for suppression of serpentine dust. Watering for dust control would still be needed but at a lower rate of water application. The East Well Pad would still require misting for serpentinite. Estimates of water needs for well pad construction activities have been revised downward, to be 115,000 gallons per day (80 gallons per minute [gpm]) or less for dust control for construction, traffic, and for serpentine rock misting, over a period of approximately 120 days during 2010 for the East Well Pad. Current plans are for the West Well Pad to be constructed in 2011. The West Well Pad construction will require only dust control for construction and traffic, not serpentine rock misting; the water requirements are estimated to be approximately 79,000 gallons per day for the West Pad construction.

Well Drilling

After well pad construction ends, well drilling will begin. Water use will decrease to an estimated 40,000 gallons per day. This number is a high estimate and would only be the case during mud drilling with lost circulation, and not for the entire 60 to 90 days per well, over a period of three to four years.

High Valley Creek

There is no indication that pumping at the depth of the water supply well would affect water levels in the shallow water table or creek. The water levels in the creek were closely monitored during the 2-day aquifer test and they showed no effect from pumping. As a result, no impacts to the water supply or to adjacent riparian vegetation are expected.

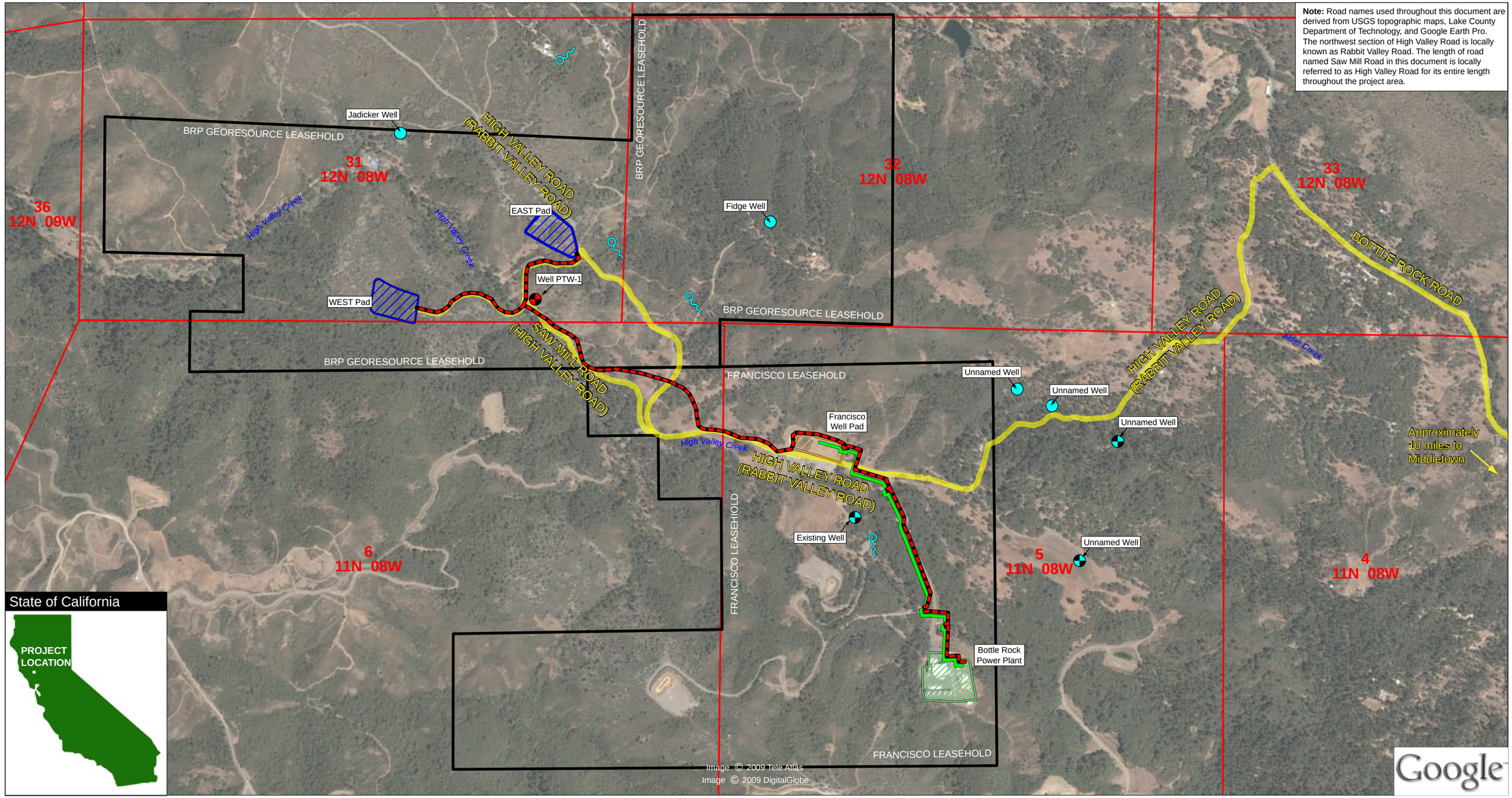
Springs

Springs located above the valley floor would not be expected to be affected by the pumping of a water supply well because there was no effect observed in water levels in shallow groundwater at the valley floor during the aquifer test at PTW-1. Springs located on the hillside are higher in elevation and more distant from the bedrock aquifer being pumped, and would be even further removed hydraulically. No impacts to springs are expected.

Other Water Supply Wells

No water supply wells are expected to be affected by the pumping of the new water supply well, at the projected pumping rates because of the location of the wells and springs and the lack of

Figure 1: Waterways, Springs, and Wells in the Project Area



SOURCE: Google Earth Pro 2009, Lake County Department of Information Technology 2003, and RMT Inc. 2009

Aerial imagery flown in 2004

LEGEND

- Proposed Steam Pipeline
- Existing Bottle Rock Pipeline
- Primary Access Route
- Existing Drilled Well
- Resident Spring Well
- Test Well
- Spring
- Proposed Well Pad
- Existing Francisco Well Pad
- Existing Bottle Rock Power Plant
- USGS Section Boundary
- Leasehold Boundary

0 500 1,000 1,500 Feet

RMT ENVIRONMENT • ENERGY • ENGINEERING

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effect during the aquifer test. Only one water supply well, at the Jadicker residence, occurs within a reasonable (0.5 mile) radius of the Project well. The Jadicker well is located approximately 1,700 feet northwest of the Project water supply well (PTW-1). The "spring well" at this location is a spring with a water supply pipe inserted into the spring, located on a hillside more than 40 feet above High Valley Creek. The location of the Jadicker spring well on the hillside implies that the water flowing to the spring is derived from a higher elevation, and is not connected to the fractured bedrock aquifer the Project Well is utilizing. This lack of connection is evident because the water level in PTW-1 is below ground surface in the valley floor, and far beneath the elevation of the Jadicker spring well. This hydraulic condition also implies that water flowing to the Jadicker well would not be affected by pumping of the fractured bedrock aquifer below, at a depth of more than 100 feet below ground surface, because the aquifer test at PTW-1 showed no response to pumping in the shallow groundwater or the creek. The Jadicker spring well would be expected to be even farther removed hydraulically than the shallow groundwater near the test well, since the well is located more than 1,700 feet distant and is above the valley floor.

Other residences with wells that are beyond the 0.5 mile radius would be even more removed hydraulically from the Project's pumping than the Jadicker well. For example, the Fidge residence well is located across a ridge (drainage divide) from the test well and is more than 0.5 miles distant. The "Existing Well" shown just south of the Francisco Well Pad is a water supply well owned by BRP used for the existing BRP plant facility and is over 4,000 feet southeast of well PTW-1. Four other "Unnamed Wells" identified on Figure 1 are more than 5,000 feet southeast of PTW-1, and three of the four unnamed wells are separated from PTW-1 by a ridge and a drainage divide. No impacts to the BRP existing well or the four unnamed wells are expected, based on the long separation distance from well PTW-1, the presence of a hydraulic divide, and the limited, local drawdown experienced during the aquifer test.

No impacts to other water supply wells would occur.

No other portions of Section 4.17 of the PTA are affected by the new information.

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2: Conditions of Certification

2.1 Proposed Conditions of Certification

The COCs applicable to BRPP were originally adopted by the CEC in 1980. In April 1993, the CEC approved an amendment to the COCs that modified the monitoring and reporting requirements in consideration of BRPP's shut down status (Order 93-0426-02). The COCs were modified again in 2006 in conjunction with the refurbishment and restart of the facility (Order 06-1213-12).

The project owner proposes the existing COC Soil & Water-7 be updated to reflect current sampling locations. Previous sampling locations identified in the existing COC Soil & Water-7 have not been sampled due to access issues. Text proposed to be deleted is shown in ~~strikethrough~~ and added text is <u>underlined</u>.

SOIL & WATER-7 The project owner shall continue groundwater sampling at ~~Nance Spring, Union Oil Spring,~~ Coleman Well, ~~Jadiker Spring, and~~ Francisco Well, and <u>Barrett Spring</u>. Sampling shall be conducted in April, July, and October of each year. Protocol: Each groundwater sample shall be analyzed for boron, sodium, sulfate, calcium-magnesium hardness, pH, alkalinity, settlable solids, non-filterable residue, turbidity, specific electrical conductivity, magnesium, calcium, copper, iron, lead, manganese, and zinc.

<u>Verification</u>: The project owner shall include the results and a discussion of the year's monitoring in the BRMMSR.

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3: References

RMT, Inc. 2009. Petition to Amend, Bottle Rock Geothermal Plant. Prepared for California Energy Commission. September 2009.

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APPENDIX A:
Water Supply Test Well Construction and Aquifer Test Summary

WATER SUPPLY TEST WELL INSTALLATION

The test well (PTW-1) is located midway between the East and West Well Pads, in the lowland approximately 80 feet from High Valley Creek, along High Valley Road. The location of the well is shown in Figure 1, and in more detail in Figure 1 of Appendix B. The well is located in an area of thin gravelly loam alluvium, generally one to two feet thick but 12 feet thick at the well, overlying greywacke bedrock. No water was encountered during boring in the upper 70 feet of boring.

A substantially fractured greywacke bedrock zone was encountered from 101 to 134 feet bgs, which produced a high volume of water. A US Geological Survey report includes a geologic map of the area from McLaughlin (1978), which shows the location of well PTW-1 to be within approximately 100 feet of a known fault. The fault may be the cause of the highly fractured bedrock that occurs at the 101 to 134 foot depth.

The water supply test well is screened from 98.5 to 138.5 feet, encompassing the highly fractured and permeable zone in the greywacke bedrock. A detailed geologic boring log and well construction details are presented in Appendix B.

AQUIFER TESTING

A recently completed aquifer test has revealed important aquifer information regarding the hydraulic conductivity of the aquifer in the fractured bedrock, and information regarding the hydraulic isolation of the producing zone (at 101 to 134 feet bgs) from the surface. The aquifer test was conducted on the newly-installed water supply test well PTW-1, and it included a step drawdown test and a constant rate test. Details of the aquifer test are presented in Appendix B.

The step drawdown test was conducted first to identify a sustainable constant rate of pumping for the constant rate test. Discharge from the well was routed approximately 500 feet down gradient and approximately 100 feet on the far side (south) of High Valley Creek. Based on the results for the step drawdown test, a pumping rate of 80 gpm was selected for the constant rate test.

After an overnight recovery period during which the test well reached essentially full recovery, the constant rate test was started on December 15, 2009 and was monitored at three key locations:

- The pumped well (PTW-1)
- A shallow test well (PTW-2) located 80 feet southwest of the pumping well and screened from 5 to 10 feet bgs in the alluvium directly above bedrock
- High Valley Creek adjacent to (within 20 feet) of the shallow test well

A shallow test well (PTW-2) was installed at the water table near High Valley Creek, so that it could monitor shallow groundwater levels that are likely to be important for trees and riparian vegetation alongside the creek. Monitoring the water level in the shallow test well was intended to evaluate whether pumping well PTW-1, screened deeper in the bedrock, might have any effect on shallow groundwater levels.

The constant rate aquifer test was conducted for 49 hours at a rate of 80 gpm, and then for an additional 5 hours during the recovery phase after cessation of pumping. The pumping rate was

selected to match the water needs during the most water-intensive portion of well pad construction, when water use would be highest.

Aquifer Test Results

The water level in the pumping test well decreased rapidly within the first minute, and then continued to decline slowly over time, reaching a drawdown value of approximately 29 feet within about 5 hours after startup. Rapid water level decline in the first minute is typical in pumped wells, and is due to the removal of water stored in the well casing. The water level then continued to fall slowly during the remainder of the 49-hour test, to a maximum value of approximately 28 feet at the end of the test. Although the drawdown did not reach an equilibrium level during the 49-hour test, the rate of decline was approaching equilibrium, and it is expected that the total drawdown under equilibrium conditions would not exceed 35 feet in the pumping well.

There was no discernable response of the water level in the shallow well during the test. Similarly there was no apparent response in the level of the creek based on pressure transducer measurements taken every minute throughout the test. Small variations of approximately 0.1 to 0.2 feet occurred in the shallow well and the creek, following a short period of rain on December 16 (the second day of the test) when approximately 0.85 inch of rain fell. The water level in the shallow test well and the creek both rose and then slowly declined following the rain. Otherwise, the water levels in the shallow groundwater and the creek remained essentially constant.

Aquifer test analysis was conducted to obtain estimates of aquifer transmissivity, hydraulic conductivity, and storage coefficient. The details of the aquifer test analysis are presented in Appendix C. The aquifer test results yielded values of 932 ft^2/day for transmissivity and 28 ft/day for hydraulic conductivity.

In summary, there was no evidence of any effect of pumping on the water levels in the shallow groundwater or in the creek.

CONCEPTUAL MODEL OF RESPONSE TO PUMPING

A conceptual model of hydrogeologic conditions is includes the concepts that away from fault zones, low permeability greywacke, greenstone, and serpentenite bedrock of the Franciscan Formation yields small amounts of groundwater to wells, in the range of less than 2 gpm. Within the fault zone associated with the 101 - 134 foot deep fractured bedrock of the Project water supply well (PTW-1), permeability and water yield are high, yielding more than 80 gpm. The upper 90 feet of bedrock are apparently not fractured sufficiently to yield water or to transmit drawdown effects during the pumping test. As a result, there is no evidence that drawdown is transmitted upward to the surface or to higher elevations on the hillsides.

REFERENCE

McLaughlin, Robert J., 1978. Preliminary geologic map and structural sections of the central Mayacmas Mountains and The Geysers steam field, Sonoma, Lake, and Mendocino counties, California. USGS Open-File Report 78-389.

APPENDIX B:
Aquifer Test Letter Report

environ strategy consultants, inc.

One Technology Drive, Ste. B-123
Irvine, California 92618
tel 949.486.0884
fax 949.486.0885
environstrategy.com

January 18, 2009

Mr. Brian Harms
General Manager
BRP Steam Holdco, LLC
P.O. Box 1250
Cobb, California 95426

Project No. 484-I

Aquifer Test Letter Report
Bottle Rock Binkley Lease
7385 High Valley Road
Cobb, California 95426

Dear Mr. Harms:

Environ Strategy Consultants, Inc. (Environ Strategy), on behalf of Bottle Rock Power (BRP) is pleased to present this Aquifer Test Letter Report (Report) for the above-referenced site. The purpose of the aquifer test was to first determine the sustainable amount of groundwater available for construction, drilling, general dust control and serpentine dust control and second to evaluate whether alluvial groundwater was in hydraulic communication with the lower fractured bedrock aquifer.

The well installation activities and aquifer test were conducted in accordance with Lake County and the State of California Environmental Protection Agency Guidance Manual for Ground Water Investigations. This Report presents the results of the well installation and aquifer test procedures, test results and conclusions.

Well Locations and Construction

Well locations are shown on Figure 1. Geologic logs and well construction details are presented in the Attachment. A hydrogeologic section including the wells PTW-1, PTW-2, and High Valley Creek is shown in Figure 2.

Aquifer Testing

An aquifer test was conducted using PTW-1 as the pumping well, PTW-2 as an observation well, and High Valley Creek as an additional observation station. Continuously recording transducers were placed at 95 feet in PTW-1, 10 feet in PTW-2, and at the bed-level of the creek. All data from the test are summarized on Figure 3, where they are plotted against a common linear time axis.

Groundwater pumping test procedures

The test was conducted over five days, and included establishing pre-test static water levels in wells and the creek before pumping began. A continuous step drawdown test was then conducted at successive pumping rates of approximately 25, 50 and 80 gpm. The water level in the pumping well was allowed to return to the pre-test static level and a constant rate drawdown test was conducted at 80 gpm for approximately 49 hours.

Water level observations

Water levels (elevations) in both wells and the creek were recorded continuously by transducer and periodically by hand throughout the test period, and include five measurement intervals: static, step test, first recovery, constant rate test, and second recovery. These data are shown on Figure 3, along with the pumping test intervals and rates; and also on Figures 6, 7 and 8 in expanded format.

Barometric pressure, rainfall, and recharge

Significant rainfall occurred during the constant rate test, producing elevated creek levels, followed by recharge recorded in PTW-1 and PTW-2 during the test. Note the downward trend of water levels in PTW-2 until reversed by recharge at hour-16 of the test period. Rainfall and barometric pressure records from a regional monitoring station were obtained and are plotted for reference on Figure 3.

Time-drawdown data analysis

Semi-log time-drawdown and recovery analyses were performed for the pumping well PTW-1, and are shown in Figures 4 and 5, respectively. The pumping well was utilized for the analysis because no measurable drawdown was observed in the observation well, PTW-2. The drawdown analysis indicates that casing storage was overcome in the initial 3 minutes of pumping, and drawdown thereafter reflects aquifer transmissivity. The drawdown analysis yielded values of 933 ft^2/day for transmissivity and 28 ft/day for hydraulic conductivity. Analysis of the well recovery yielded a similar transmissivity value.

Pumping test discharge water quality

Water samples were collected for general minerals analysis at the beginning and end of the constant rate test. The results are presented in Table 1. No significant differences are apparent in the analyses, indicating a single groundwater source.

Summary of Test Results and Conclusions

Figure 2 summarizes our current understanding of the geology and groundwater relationships in the immediate vicinity of the wells. PTW-1 is a bedrock well, screened across a highly

fractured producing zone between depths 101 and 134 feet. Based on the test results, the producing zone acts like a confined aquifer with a potentiometric surface at about 7 to 8-feet bgs, capable of yielding 80 gpm or more. The rock above the zone produces little or no water. PTW-2 is a shallow well screened in alluvium, which communicates with High Valley Creek during periods of flow. It appears that the alluvial aquifer, including the creek, does not communicate with the confined aquifer encountered in the deeper well; no measurable drawdown was produced at the shallow observation well PTW-2 by pumping from PTW-1.

Respectfully submitted,

Margaret Patrick, PG 7620
Senior Geologist

Kevin O'Malley
Senior Project manager

Kent McMillan, PhD
CEG 1152; CHG 435
Consultant Hydrogeologist

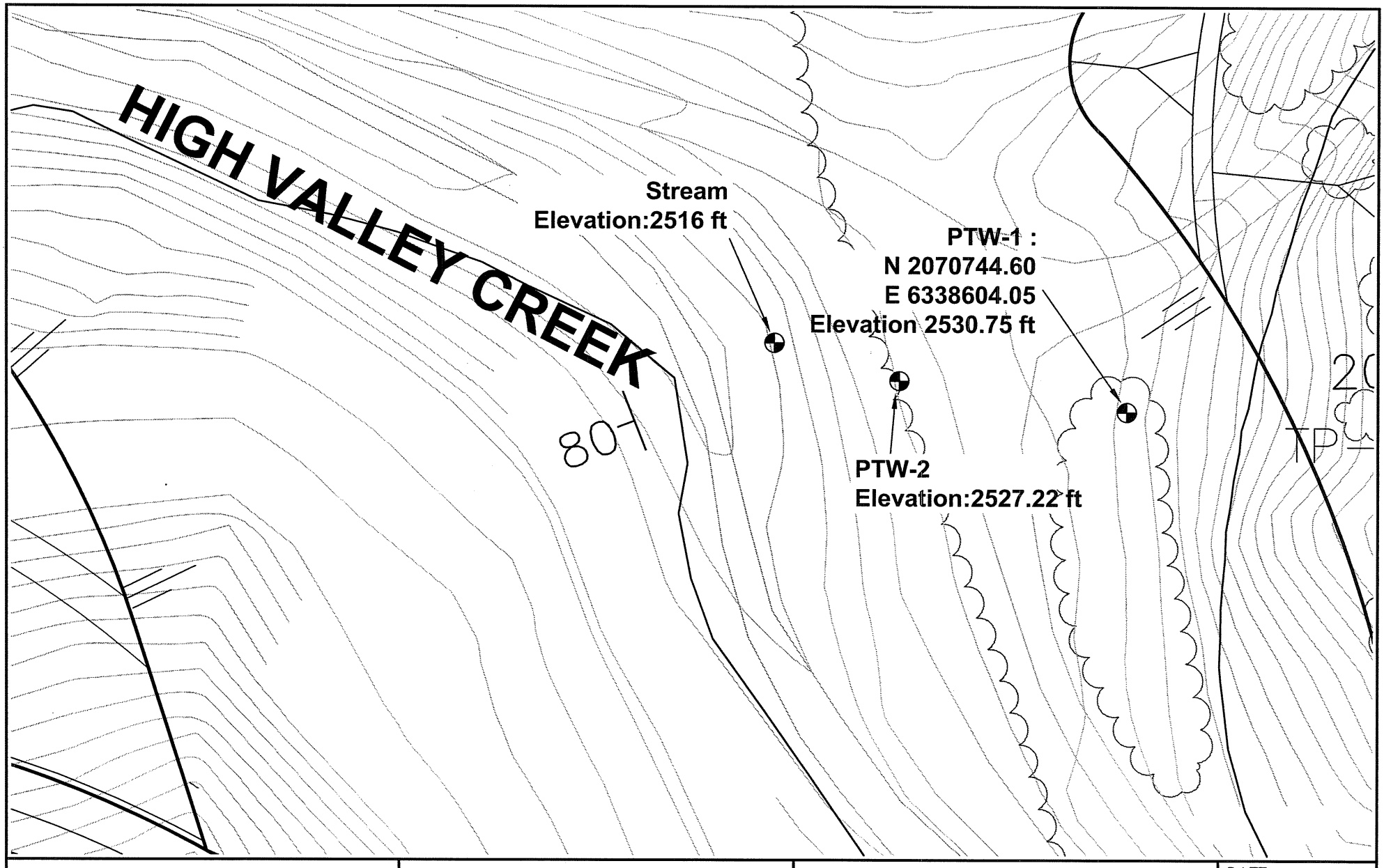
John McNamara
C.E.G. 1725
Principal Engineering Geologist

Figure 1: Site Plan
Figure 2: Hydrogeologic Diagram
Figure 3: All-Data Plot
Figure 4: PTW-1 Drawdown Analysis
Figure 5: PTW-1 Recovery Analysis
Figure 6: PTW-2 and Stream Groundwater Elevations
Figure 7: PTW-1, PTW-2 and Stream Groundwater Elevations vs. Time
Figure 8: PTW-1 Step Pump Test Drawdown vs. Time

Table 1: General Minerals Chemistry

Attachment: Well Logs

FIGURES



N

40 0 40

SCALE: 1" = 40'

environ strategy consultants, inc.

One Technology Drive, Suite B-123
Irvine, California 92618

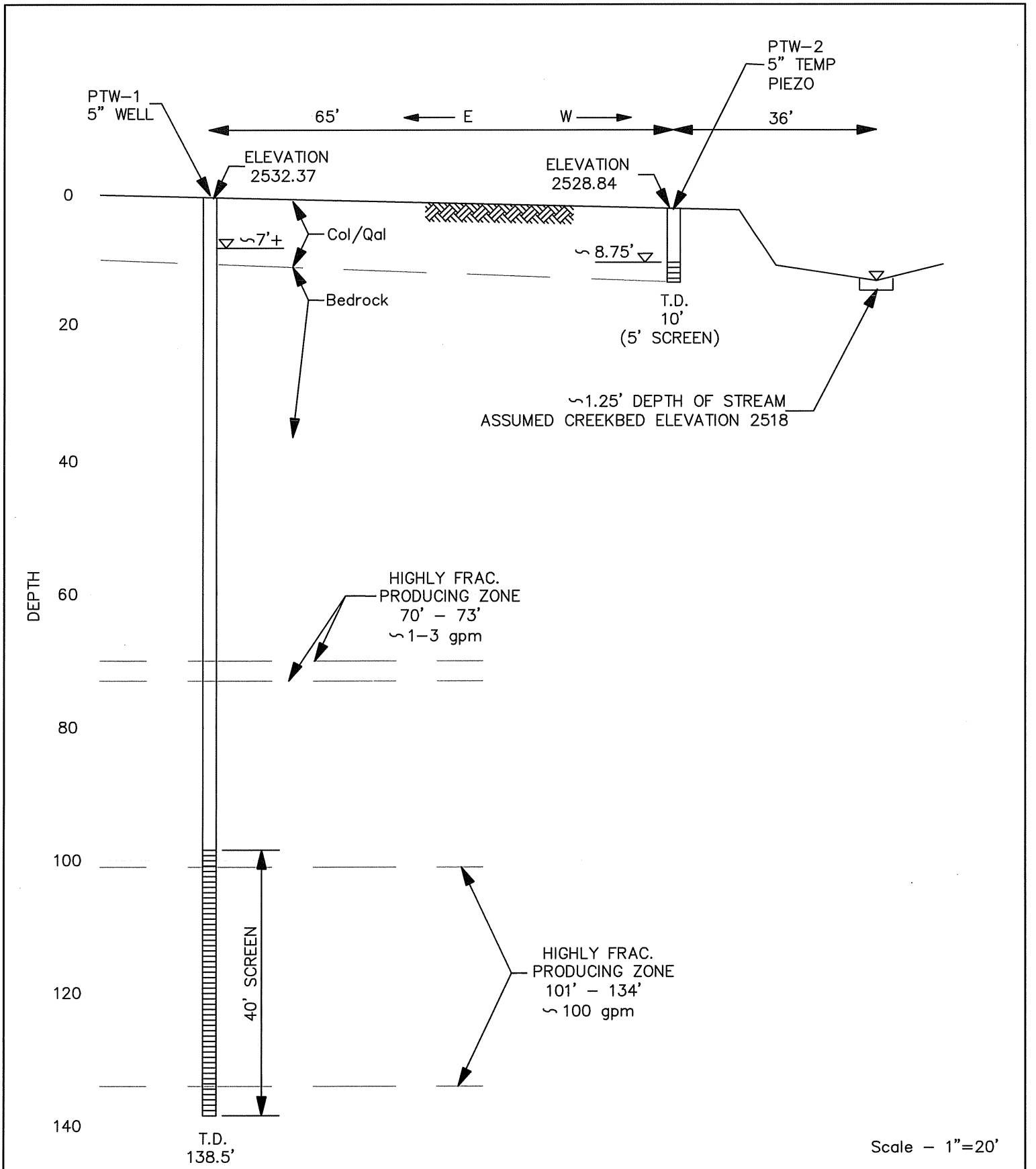
Figure 1
WELL LOCATIONS

BRP Binkley Lease
7385 High Valley Road
Cobb, CA 95426

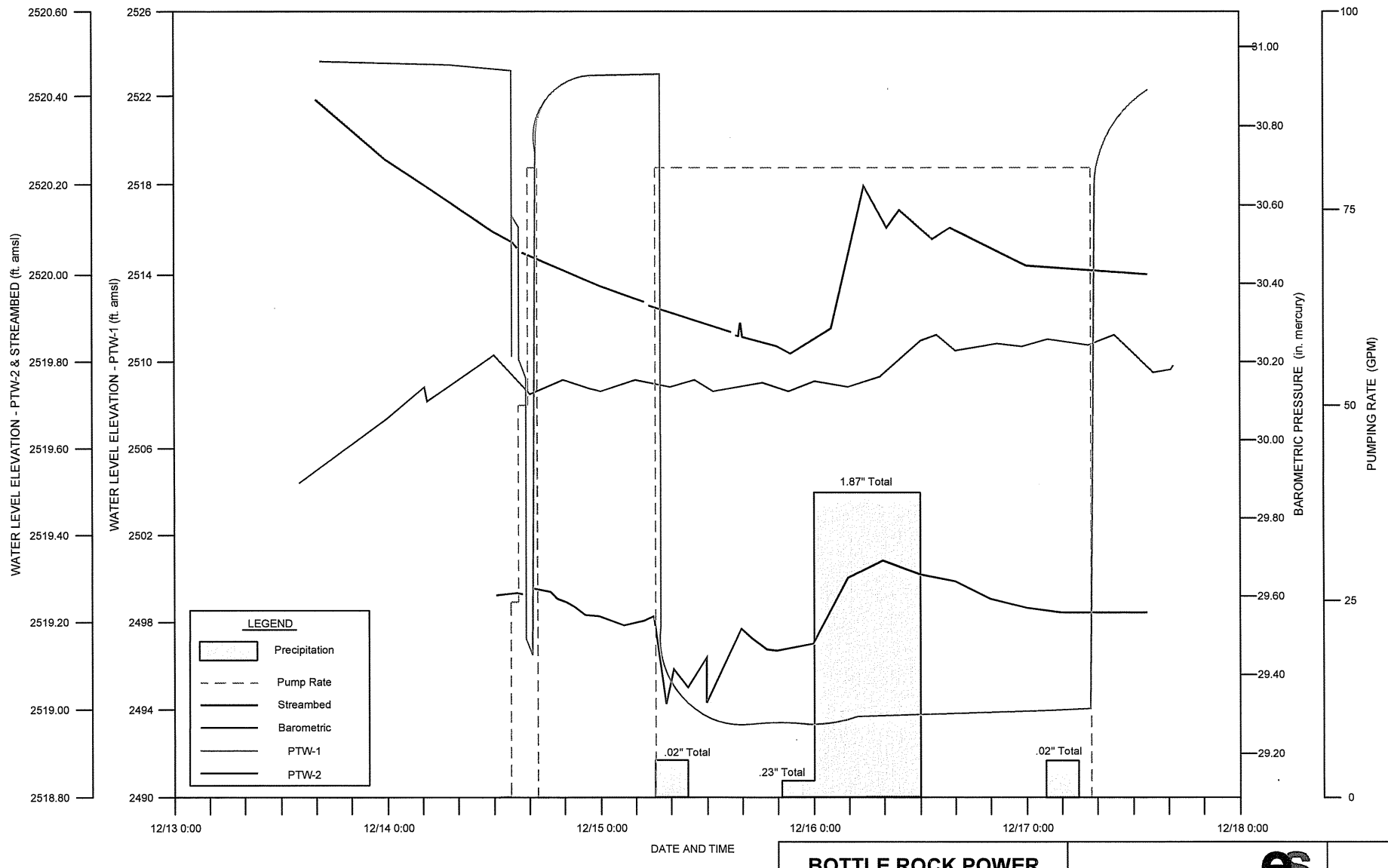
DATE
12/23/09

PROJECT NO.
484-I

FILE NO.
C-GEO-wells.dwg



environ strategy consultants, inc. One Technology Drive, Suite B–123 Irvine, California 92618	FIGURE 2 HYDROGEOLOGIC DIAGRAM Bottle Rock Power P O Box 1250 Cobb, California	DATE 12/07/09 PROJECT NO. 484 FILE NO. 484–HD



SEE FIGURES 6, 7 & 8

BOTTLE ROCK POWER
7385 High Valley Road
COBB, CA 95426

environ strategy consultants, inc.
One Technology Drive, Ste. B-123
Irvine, California 92618

FIG. 3

Figure 4

PTW-1 Drawdown vs. Time (Semi-Log)
BRP Binkley Lease
Cobb, CA

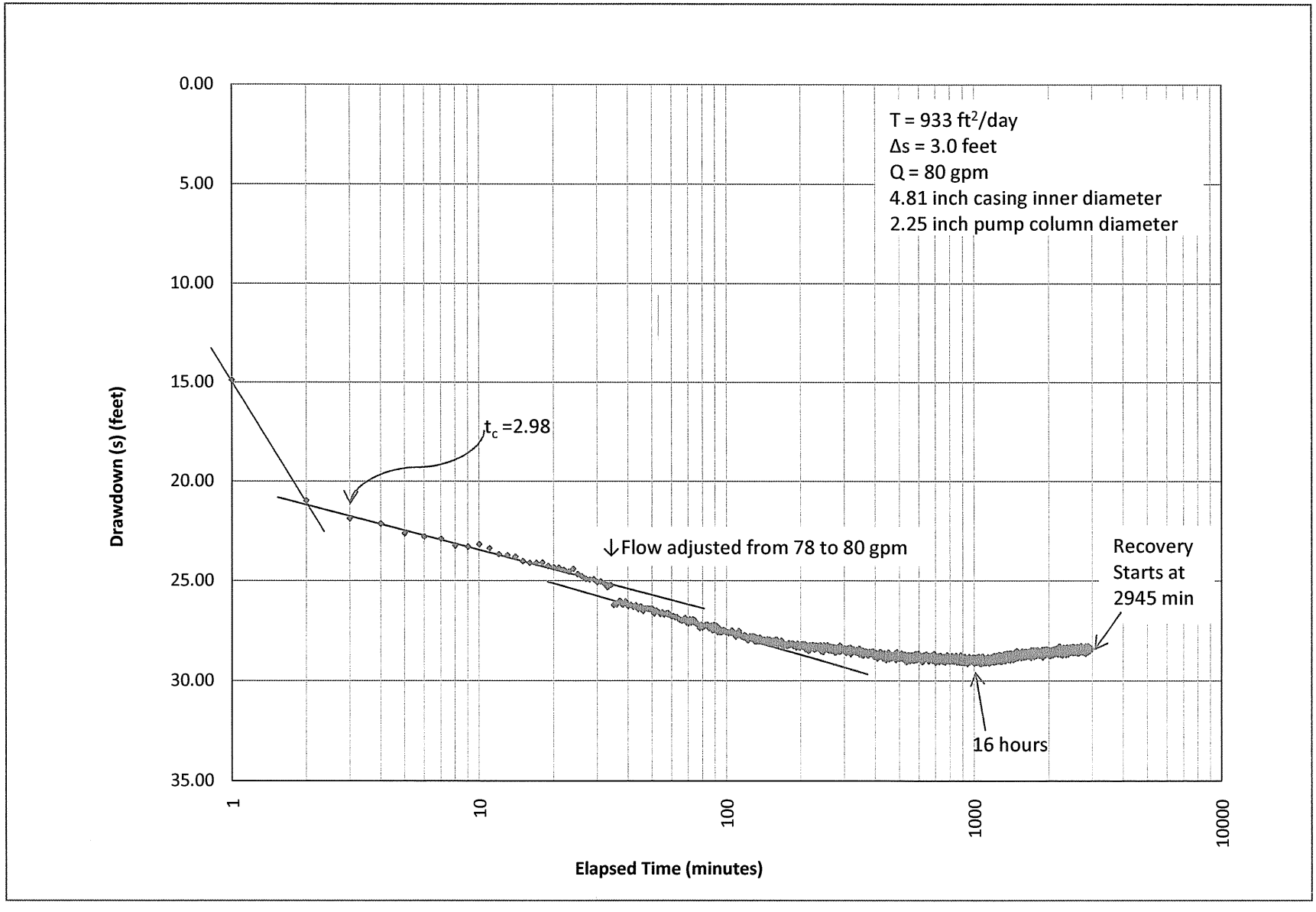


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Figure 5

PTW-1 Recovery Curve
BRP Binkley Lease
Cobb, California

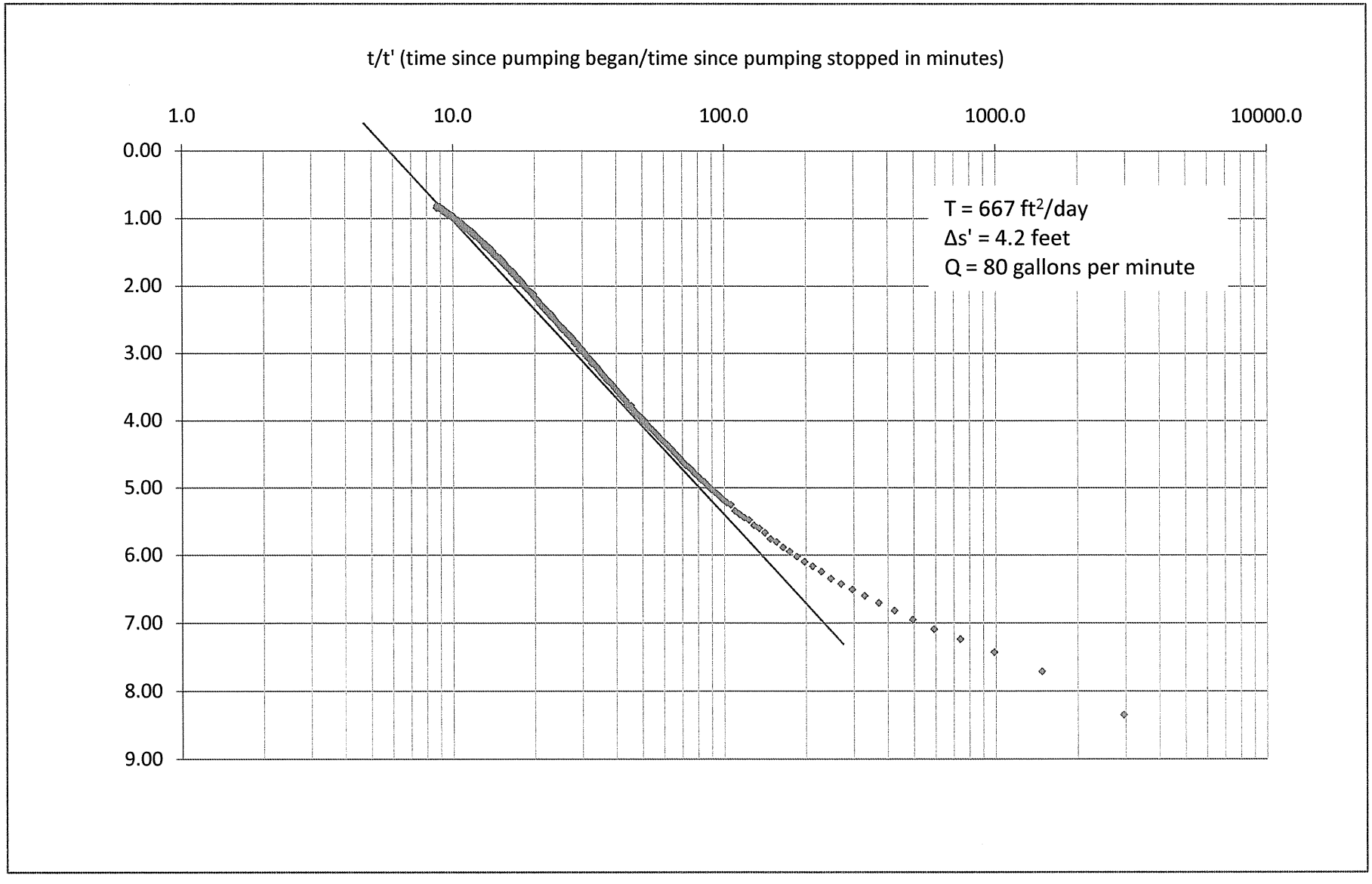

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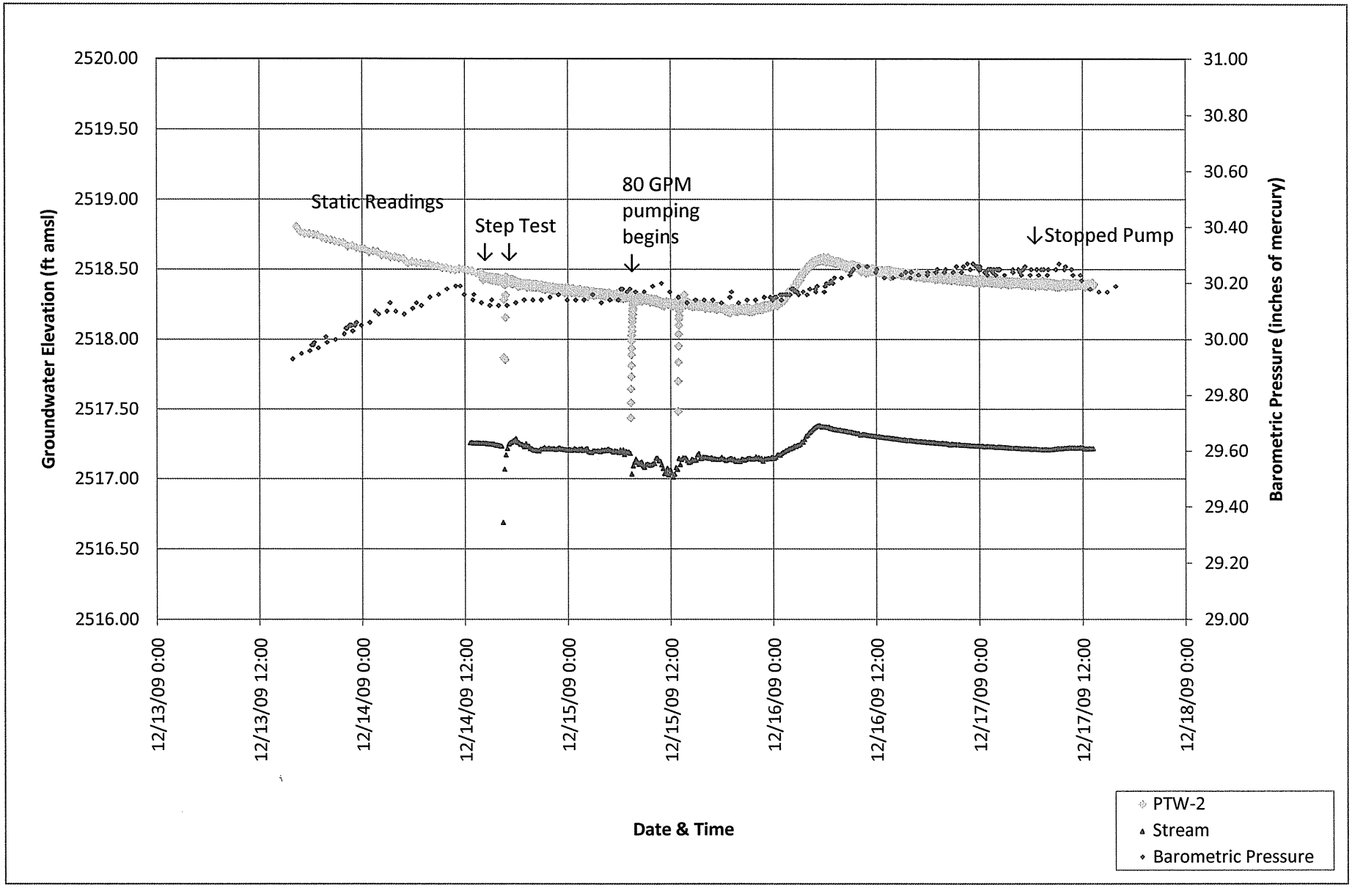
Figure 6

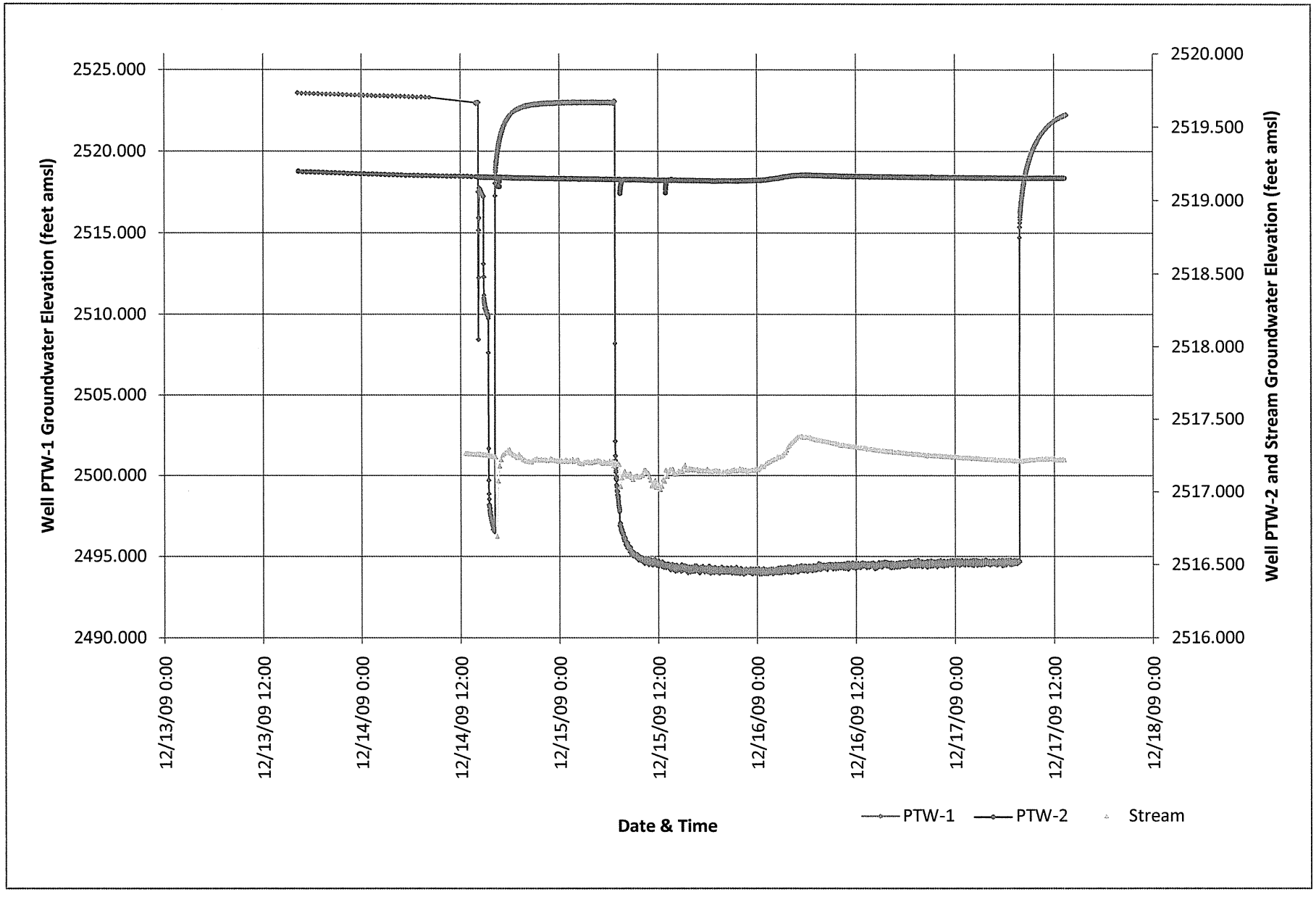
PTW-2 and Stream Groundwater Elevations
BRP Binkley Lease
Cobb, CA



environ strategy consultants, inc.

Figure 7

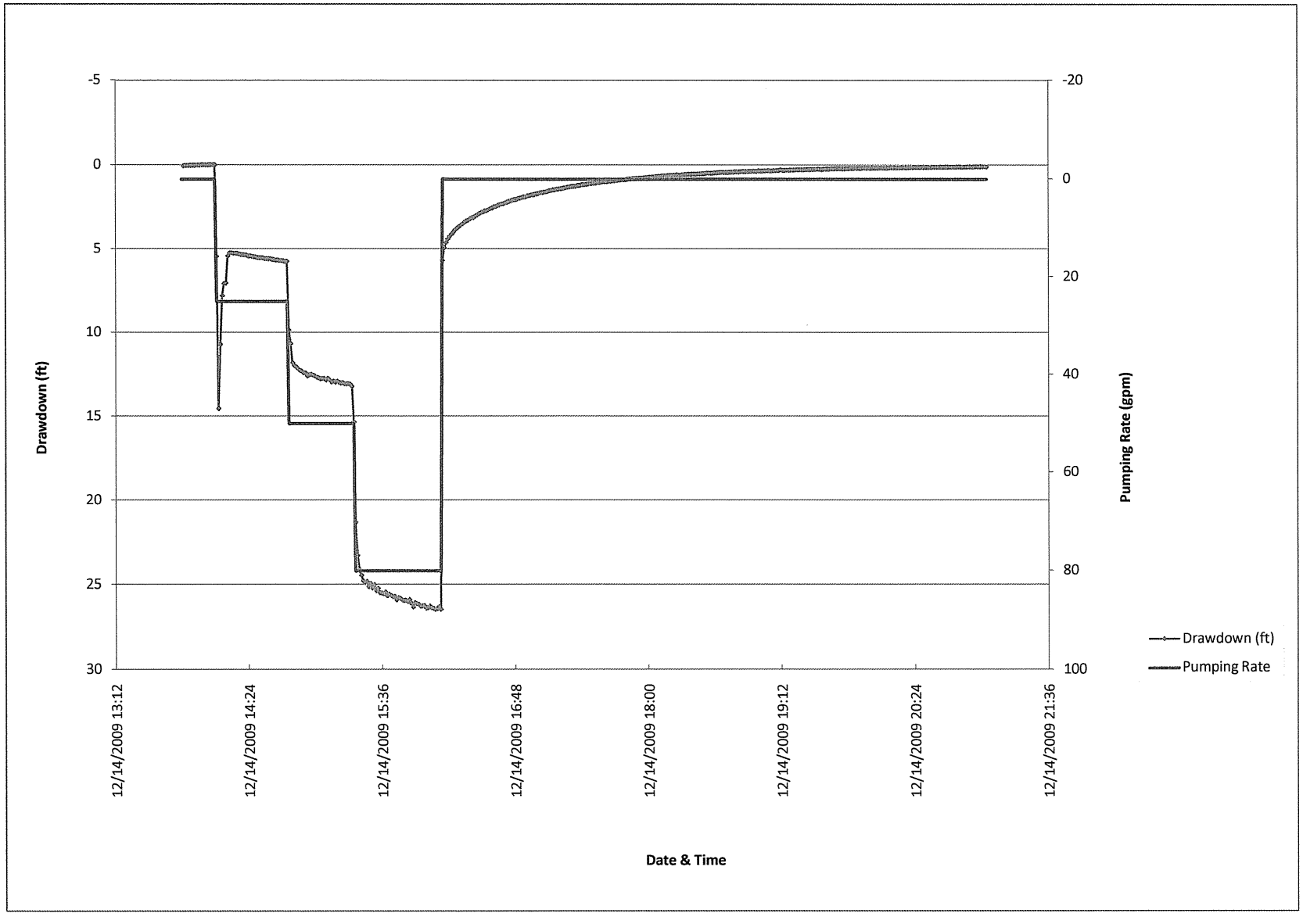
Groundwater Elevation vs. Time (PTW-1, PTW-2, and Stream)
BRP Binkley Lease
Cobb, CA



environ strategy consultants, inc.

Figure 8

PTW-1 Step Rate Test (Drawdown vs. Time)
BRP Binkely Lease
Cobb, CA



environ strategy consultants, inc.

TABLE

Table 1
Summary of Groundwater General Minerals Analyses Well PTW-1
Bottlerock Power LLC
Cobb, California

Sample ID	Date Sampled	Time Collected	General Minerals (mg/l)											
			Calcium	Magnesium	Chloride	Fluoride	Nitrate as N	Sulfate	Hardness as $CaCO_3$	Total Dissolved Solids (Glass Fiber)	Total Suspended Solids (Glass Fiber)	Total Nitrogen	Total Kjeldahl Nitrogen	Nitrite as N
PTW-1 Initial	12/15/2009	7:00 AM	26	24	3.5	0.18	<0.1	4.0	160	240	1.8	<0.3	<0.2	<0.05
PTW-1 Final	12/17/2009	7:47 AM	27	25	2.9	0.21	<0.1	5.5	170	240	<1.1	<0.3	<0.2	<0.05

Notes:

Chloride, Fluoride, Nitrate as N and Sulfate by U.S. EPA Method 300.0
Calcium and Magnesium by U.S. EPA method 6010B
Total Suspended Solids by U.S. EPA method 160.2
Total Kjeldahl Nitrogen by U.S. EPA method 351.2
Nitrite as N by U.S. EPA method 353.2
Total Nitrogen (Calculated)
Hardness by CaCO3 (Calculated)
mg/l = milligrams per liter or parts per million

ATTACHMENT

WATER SUPPLY WELL: PTW-1

LOGGED BY:John Cook, P.G. CHECKED BY: John Cook, P.G. DATE STARTED: 12/02/09 DATE FINISHED: 12/02/09	DRILLING COMPANY: Weeks Drilling & Pump DRILLING FOREMAN: TIM DRILLING RIG: ATLAS-COPCO AIR ROTARY DRILLING METHOD: Downhole Air Rotary BORING DEPTH: 138.5 Feet	BORING NO: PTW-1 PROJECT NAME:BRP Water Supply Well PROJECT NO: 484-I SITE LOCATION: Int. High Valley Rd. / Lee Rd. SURFACE ELEVATION: 2528

Depth	Sample Number	Blow Count	OVM (ppm)	Well Details	Soil Class (USCS)	Description
0		No Samples Collected (Boring logged by drill cuttings)		Neat Cement Grout		**COLLUVIUM:** fine silty SAND (SP–SM), Brown–Yellowish brown, moist, dense, weathered J–kf (Greywacke), sandstone fragments that are very angular and friable, some rootholes and rootlets noted
5				Neat Cement Grout		**ALLUVIUM:** coarse gravelly SAND (SP–GP), light grayish green – dark gray, moist, very dense, gravels are weathered J–kf (Graywacke), sandstone that are sub rounded with white quartz veins.
▽						Note after completion of well static water level was gauged to approximately 8 feet.
10						J–kf (Graywacke) sandstone, gray to light gray, well indurated, slightly fractured, massive beds, old fractures filled with white quartz viens 1/4"–1/2" thick, dry
15						
20				Bentonite Chips		Gray to dark gray, well indurated, massive beds, white to reddish brown chert and quartz veins, dry
25						

WATER SUPPLY WELL: PTW-1

LOGGED BY:John Cook, P.G. CHECKED BY: John Cook, P.G. DATE STARTED: 12/02/09 DATE FINISHED: 12/02/09	DRILLING COMPANY: Weeks Drilling & Pump DRILLING FOREMAN: TIM DRILLING RIG: ATLAS-COPCO AIR ROTARY DRILLING METHOD: Downhole Air Rotary BORING DEPTH: 138.5 Feet	BORING NO: PTW-1 PROJECT NAME:BRP Water Supply Well PROJECT NO: 484-I SITE LOCATION: Int. High Valley Rd. / Lee Rd. SURFACE ELEVATION: 2528

Depth	Sample Number	Blow Count	OVM (ppm)	Well Details	Soil Class (USCS)	Description
25						
30						Red chert veins 1' thick @ 32'
35				Bentonite Chips		
40						White to light green Quartz fragments, fractured and dry at 43'
45						
50						

WATER SUPPLY WELL: PTW-1

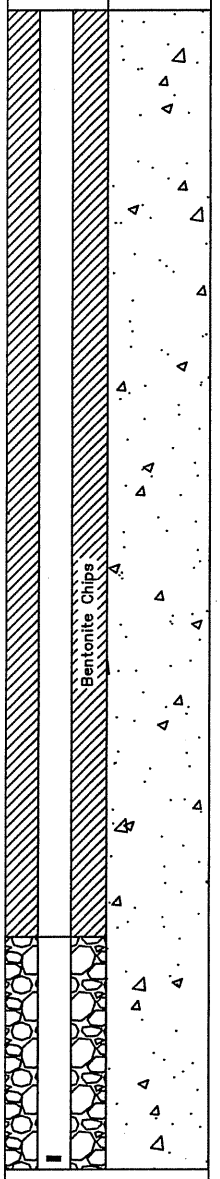
LOGGED BY:John Cook, P.G. CHECKED BY: John Cook, P.G. DATE STARTED: 12/02/09 DATE FINISHED: 12/02/09	DRILLING COMPANY: Weeks Drilling & Pump DRILLING FOREMAN: TIM DRILLING RIG: ATLAS-COPCO AIR ROTARY DRILLING METHOD: Downhole Air Rotary BORING DEPTH: 138.5 Feet	BORING NO: PTW-1 PROJECT NAME:BRP Water Supply Well PROJECT NO: 484-I SITE LOCATION: Int. High Valley Rd. / Lee Rd. SURFACE ELEVATION: 2528

Depth	Sample Number	Blow Count	OVM (ppm)	Well Details	Soil Class (USCS)	Description
50						
55						Brown to red brown chert seams 1'-3' thick, fractured
60				Bentonite Chips		
65						
70						highly fractured zone of J-kf (Graywacke) sandstone, wet, gray - dark gray with secondary white quartz veins, water entering boring @ appoximately 1-3 gpm
						Gray to greenish gray, dry, well indurated, massive beds, with greenish gray quartz veins with iron pyrite noted
75						

WATER SUPPLY WELL: PTW-1

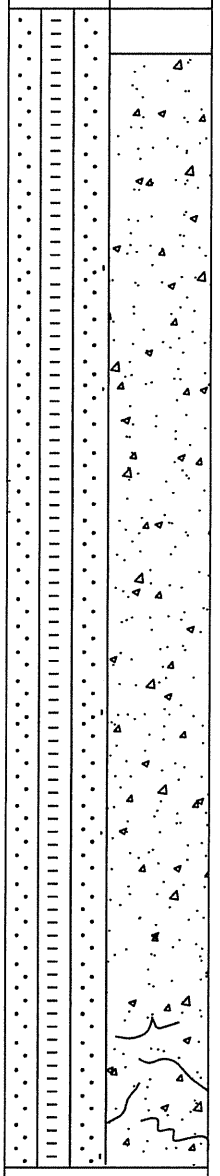
LOGGED BY:John Cook, P.G. CHECKED BY: John Cook, P.G. DATE STARTED: 12/02/09 DATE FINISHED: 12/02/09	DRILLING COMPANY: Weeks Drilling & Pump DRILLING FOREMAN: TIM DRILLING RIG: ATLAS-COPCO AIR ROTARY DRILLING METHOD: Downhole Air Rotary BORING DEPTH: 138.5 Feet	BORING NO: PTW-1 PROJECT NAME:BRP Water Supply Well PROJECT NO: 484-I SITE LOCATION: Int. High Valley Rd. / Lee Rd. SURFACE ELEVATION: 2528

Depth	Sample Number	Blow Count	OVM (ppm)	Well Details	Soil Class (USCS)	Description
75						
80						Gray to greenish gray, dry, well indurated, massive beds, with greenish gray quartz veins and iron pyrite
85						
90				Bentonite Chips		
95						White chert veins at 97'
100						



WATER SUPPLY WELL: PTW-1

LOGGED BY:John Cook, P.G. CHECKED BY: John Cook, P.G. DATE STARTED: 12/02/09 DATE FINISHED: 12/02/09	DRILLING COMPANY: Weeks Drilling & Pump DRILLING FOREMAN: TIM DRILLING RIG: ATLAS-COPCO AIR ROTARY DRILLING METHOD: Downhole Air Rotary BORING DEPTH: 138.5 Feet	BORING NO: PTW-1 PROJECT NAME:BRP Water Supply Well PROJECT NO: 484-I SITE LOCATION: Int. High Valley Rd. / Lee Rd. SURFACE ELEVATION: 2528

Depth	Sample Number	Blow Count	OVM (ppm)	Well Details	Soil Class (USCS)	Description
100						Gray to greenish gray, dry, well indurated, massive beds, with greenish gray secondary quartz veins and iron pyrite
105						
						Dark gray to black, highly fractured with smooth polished sandstone fracture planes by water flow, water gushing out at 100 gpm from below 100' (J-kf) graywacke fragments 1" - 8" long caving into borehole were flushed to surface
110						
115						
120						Some (J-kf) graywacke with minor serpentine melange at 122', highly fractured with mottled appearance, dark green-black wet
125						

WATER SUPPLY WELL: PTW-1

LOGGED BY:John Cook, P.G. CHECKED BY: John Cook, P.G. DATE STARTED: 12/02/09 DATE FINISHED: 12/02/09	DRILLING COMPANY: Weeks Drilling & Pump DRILLING FOREMAN: TIM DRILLING RIG: ATLAS-COPCO AIR ROTARY DRILLING METHOD: Downhole Air Rotary BORING DEPTH: 138.5 Feet	BORING NO: PTW-1 PROJECT NAME:BRP Water Supply Well PROJECT NO: 484-I SITE LOCATION: Int. High Valley Rd. / Lee Rd. SURFACE ELEVATION: 2528

Depth	Sample Number	Blow Count	OVM (ppm)	Well Details	Soil Class (USCS)	Description
125						
130						
135						Greenish gray, well indurated, wet, massive beds, with quartz veins and chert seams
						End of Boring @ 138.5'
140						

WATER SUPPLY WELL: PTW-2

LOGGED BY:John Cook, P.G. CHECKED BY: John Cook, P.G. DATE STARTED: 12/02/09 DATE FINISHED: 12/02/09	DRILLING COMPANY: Weeks Drilling DRILLING FOREMAN: TIM DRILLING RIG: ATLAS-COPCO AIR ROTARY DRILLING METHOD: Backhoe Excavation BORING DEPTH: 138.5 Feet	BORING NO: PTW-2 PROJECT NAME:BRP Water Supply Well PROJECT NO: 484-I SITE LOCATION: Int. High Valley Rd. / Lee Rd. SURFACE ELEVATION: 2526

Depth	Sample Number	Blow Count	OVM (ppm)	Well Details	Soil Class (USCS)	Description
0	No Samples Collected					**COLLUVIUM:** Brown – Yellowish Brown fine clayey SAND (SC–ML), with weathered J–kf (Greywacke) sandstone fragments that are very angular and friable, very moist, loose, poorly graded, rootholes with < ¼" dia. roots
5						**ALLUVIUM:** Brown – light Brown gravelly medium SAND (SP–GP), dense, very moist to wet, with 8' dia. gravels ½"– 4" dia. of J–kgw graywake sandstone that are well rounded, some decayed wood fragments noted
10						Graywacke Sandstone (J-kgw), gray - dark gray, dense, well indurated with secondary white quartz seams ¼" thick, dry - damp
15						
20						
25						