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Prepared for: Benchmark Resources
Project Title: Proposed Moody Flat Quarry
Project No: 140910

Technical Memorandum

Subject: Installation and Aquifer Test of Test Wells
Date: October 11, 2011
To: Andrew White, Benchmark Resources
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From:



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1. Introduction

This Technical Memorandum (TM) presents the results of the drilling, installation, and testing of groundwater test wells at two locations within the proposed 3M Hard Rock Aggregate Quarry located in Shasta County, California (Figures 1 and 2). The objective of the drilling program was to drill within areas that were readily accessible by the drill rig and had potential to produce significant groundwater within the region.

The proposed test wells were intended to assess potential water production rates for use as part of the water resources assessment related to permitting of the proposed quarry. A detailed discussion of the hydrogeology and rationale used to select the testing location is presented in our June 30, 2009 Field Investigation Report as addended February 9, 2010 and May 24, 2011. In summary, groundwater production wells have been sited in the vicinity of the site. In particular, a well located near Bass Mountain School in Mountain Gate is reportedly a good producing well (between 200 and 300 gallons per minute) and utilized for water supply in the Mountain Gate community. This well is completed within the Kennett Formation along a northwest trending mapped fracture / fault. Several similar fracture patterns have been recognized and mapped within the Moody Flat Property and have identified active seeps and springs. These locations are not currently accessible due to limitations associated with crossing the railroad tracks dissecting the property. The efforts described in this TM target other potential sites in the Bass Mountain Diabase and Copley Greenstone for PW-1/OW-1 and PW-2, respectively. Negotiations are currently in progress to provide access across the tracks and access drilling location at intersections of mapped fractures and faults within the Kennett Formation.

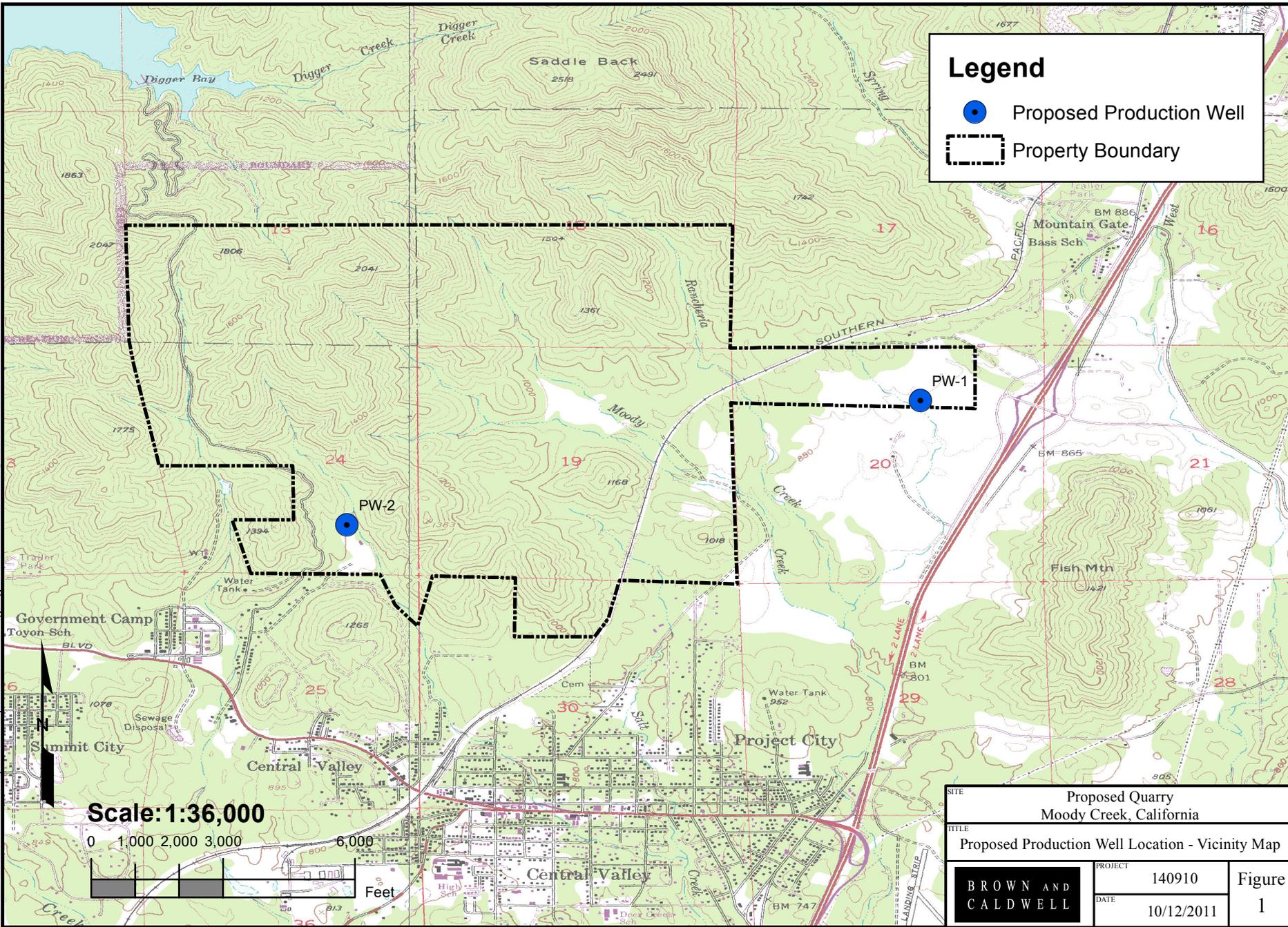
2. Test Boring Observations

Two locations were investigated for the potential for water production purposes, PW-1 and PW-2. The two boreholes were advanced under a C-57 licensed driller, Diamond Core Drilling. The drilling method used air rotary drilling techniques with a 6-inch diameter down hole hammer bit. Cuttings from both wells were spread around the site. Water produced during drilling was controlled and allowed to spread across land surface within vegetated areas. No water produced during drilling reached any surface water bodies or creeks.

2.1 PW-1/ OW-1

PW-1 was drilled on June 6, 2011 on the eastern side of the property, sited on a thin alluvium covering the Bass Mountain Diabase. The borehole was advanced under Shasta County Department of Environmental Health permit number WTR11-110 to a total depth of 407 feet below ground surface (bgs). The borehole was completed with a 2-inch diameter monitoring well. The well was renamed to OW-1 (formerly PW-1) due to poor water production potential. A thin unconsolidated alluvial soil cover was observed to a depth of approximately 7 feet bgs. At 7 feet bgs, weathered bedrock conditions were encountered down to approximately 12 feet bgs. Water production was strongest in the upper 20 feet within the weathered rock zone. Several fractures were encountered during drilling, but water production did not increase significantly with there occurrence. Table 1 summarizes the drilling and water production observations. A detailed drilling log is attached that includes well construction details.

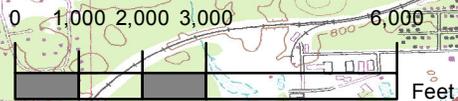
FILE: \\Bcsaco\1\GIS\MoodyCreek\Maps\TM PW Drilling\Fig. 1\Location.mxd



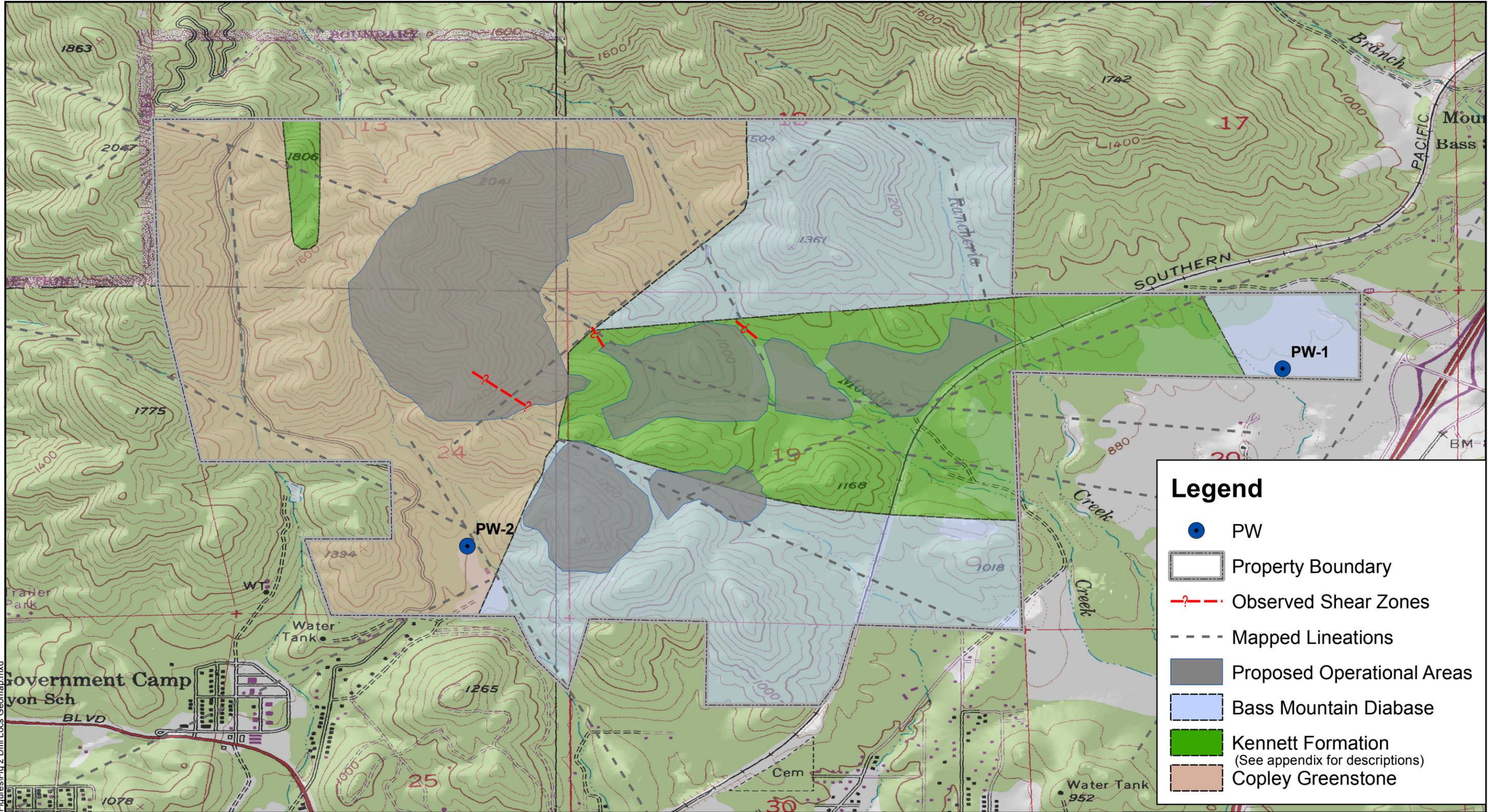
Legend

- Proposed Production Well
- Property Boundary

Scale: 1:36,000



SITE		Proposed Quarry Moody Creek, California	
TITLE		Proposed Production Well Location - Vicinity Map	
BROWN AND CALDWELL	PROJECT	140910	Figure 1
	DATE	10/12/2011	

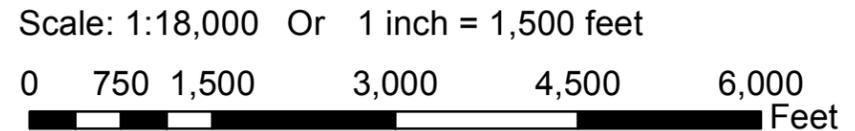


Legend

- PW
- Property Boundary
- Observed Shear Zones
- Mapped Lineations
- Proposed Operational Areas
- Bass Mountain Diabase
- Kennett Formation
(See appendix for descriptions)
- Copley Greenstone

FILE: S:\MoodyCreek\Maps\TM PW Figures\Fig 2 Drill Locs Geomap.mxd

Note:
Base map adapted from USGS 1:24000 Scale Topographic Map.



SITE	Proposed 3M Quarry Moody Creek, CA	
TITLE	Geologic Map and Lineation Assessment	
BROWN AND CALDWELL	PROJECT	140910
	DATE	10/12/2011
		Figure 2

2.2 PW-2

PW-2 was drilled on June 21, 2011 on the western side of the property, sited on the Copley Greenstone (meta-andesite). The borehole was advanced under Shasta County Department of Environmental Health permit number WTR11-131 to a total depth of 405 feet below ground surface. The borehole was abandoned by backfilling with a high solid bentonite slurry. A thin unconsolidated alluvial soil cover was observed to a depth of approximately 7 feet bgs. At 7 feet bgs weathered bedrock conditions were encountered down to approximately 12 feet bgs. Water production was strongest in the upper 20 feet within the weathered rock zone. Several fractures were encountered during drilling, but water production did not increase significantly with their occurrence. Table 1 summarizes the drilling and water production observations. A detailed drilling log is attached.

Table 1. Well Construction Summary

Well	Latitude	Longitude	Est. Elevation (ft msl)	Primary Rock Encountered	Final Completion / Construction	Total Depth (ft bgs)	Water Production
PW-1 / OW-1	40.705952° N	122.343336° W	875	Bass Mountain Diabase	Observation Well - 2in. dia. PVC, 0.020 in. Screen from 100 to 400 ft bgs.	407	2 gpm
PW-2	40.698077° N	122.380248° W	1010	Copley Greenstone	Abandoned	405	<5 gpm

3. Aquifer Testing Results

Production testing was performed at PW-1/OW-1 in an open borehole following reaching total depth of 407 ft bgs. Testing was not performed in PW-2 due to groundwater production observed during drilling of less than 5 gallons per minute (gpm).

Testing on PW-1/OW-1 was conducted using a 3-inch Grunfos® submersible pump installed in the open borehole. The test was conducted on June 7, 2011 and consisted of a step draw down test to evaluate an appropriate pumping rate for a potential longer duration test. However, as discussed below, the results of the step test indicated that flow rates for a long term test would be 2 gpm or less and was not conducted.

A pressure transducer was installed to observe drawdown within the borehole on a rapid frequency with accuracy to the nearest 1/100th of a foot. Figure 3 illustrates data collected for drawdown and recovery of the step draw down test.

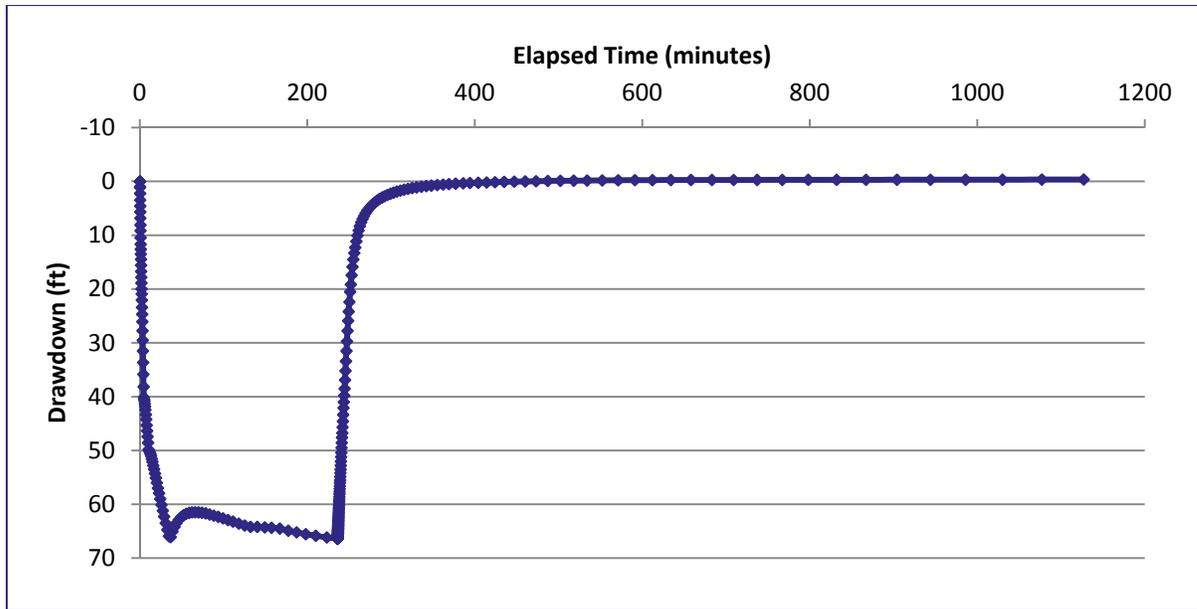


Figure 3. Drawdown and Recovery Curve for PW-1 / OW-1.

The test was initiated with the plan on running 3 increasing flow rates (Step Test) and run for a total of 4-hours. The test was started at a flow rate of 30 gpm; however, drawdown at this rate was very rapid and not sustainable. The flow rate was reduced until a rate was found that appeared to be sustainable. Table 2 provides the pumping schedule used.

Table 2. PW-1 / OW-1 Pumping Rate Schedule			
Period	Flow Rate (gpm)	Duration (minutes)	Total Drawdown (ft)
1	30	5	40.12
2	15	6	49.82
3	10	25	65.89
4	7.5	205	66.39
5	0	922	0

The drawdown and recovery data was analyzed using AqteSolv[®] in an attempt to develop some general groundwater flow properties. However, due to the uncertainties of the fracture orientation, aperture, and density these values could not be developed. The diagnostic plots within Aqtesolv[®] did support that flow was consistent with a finite-conductivity fracture in a slab reservoir. Further analysis was not performed for production purposes following the observations made during pumping. After completion of the step draw down test, the boring was converted to a 2-inch diameter monitoring well as discussed in Section 2.1.

A significant component of flow (approximately 5 gpm) was observed at the weathered / solid rock interface within the upper approximately 30 feet. This zone was sealed off during the placement of the well casing and subsequent sanitary seal. Testing performed following the final development of the monitoring well indicated that the well would produce approximately 2 gpm from the screened interval (see Attached Geologic Boring Log for well construction details).

4. Summary and Recommendations

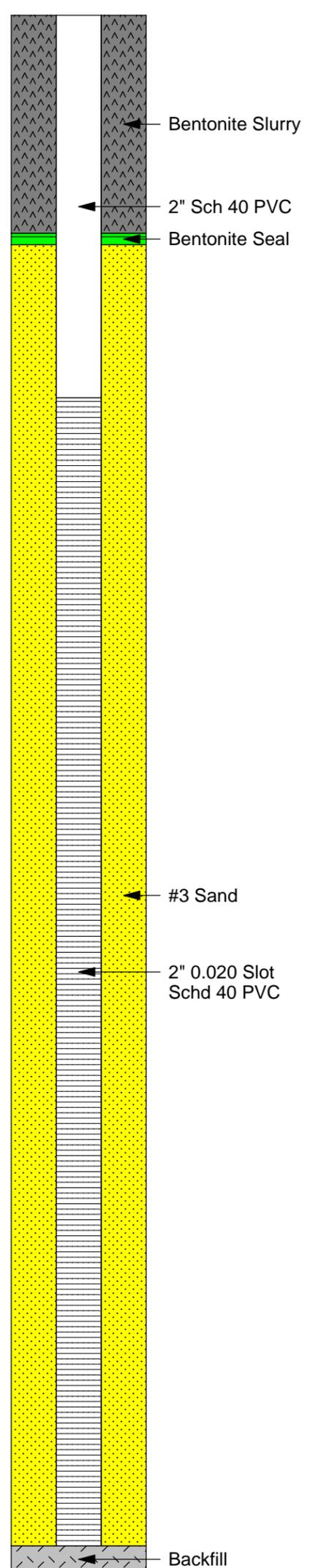
The test production wells drilled and tested as described above targeted shallow alluvium areas over fractured Bass Mountain Diabase and mapped fracture intersections within the Copley greenstone. Both of these boreholes did have minor groundwater present, but did not yield significant production (less than 5 gpm).

Continued investigation in locations similar to those of existing regional groundwater production wells should focus on mapped shear and fracture zones within the Kennett Formation near the planned operation areas of the proposed quarry. However, given the observations made during drilling of these two test boreholes, the limited nature and fracture opening and distribution will control the groundwater flow in the vicinity of the site. No boreholes have been advanced within the Kennett Formation within the Site boundaries to provide any preliminary information and future work should be considered exploratory.

Attachment A: Drilling Logs

PROJECT INFORMATION		DRILLING INFORMATION	
SITE LOCATION: Old Oregon Trail At Wonderland Blvd, Mountain Gate		DRILLING CO.: Diamond Core Drilling, Inc	
JOB NO.: 140910		DRILLER: Ted Ogilvie	
LOGGED BY: Tim Godwin		RIG TYPE:	
PROJECT MANAGER: Joe Turner		METHOD OF DRILLING: Air Rotary	
CHECKED BY:		SAMPLING METHODS: Grab samples	
DATES DRILLED: 6-6-11		HAMMER WT./DROP	
BOREHOLE INFORMATION		LATITUDE:	
TOTAL DEPTH: 407'		LONGITUDE:	
BOREHOLE DIA: 6 1/8"		APPROX. ELEV.:	
☞ Water level during drilling		☛ Water level in completed well	

DEPTH	SOIL SYMBOLS	USCS	SOIL DESCRIPTION	BORING COMPLETION	WELL DESCRIPTION
0					
5		ML	ML: Silt		
10			Meta-sedimentary: Weathered metasedimentary rock		
15					
20					
25					
30					
35					
40					
45					
50					
55			Meta-sedimentary: Solid Slate and metasedimentary rock with pyrite, black pelitic slate, and green recrystallized fine sand		
60					
65					
70					
75					
80					
85					
90					
95			Meta-sedimentary: Greenstone		
100					
105			Andesite: Meta-andesite, no pyrite		
110					
115			Meta-sedimentary: Metasedimentary rock, black pelitic slate		
120					
125					
130			Meta-sedimentary: Slate/metasedimentary rocks with black pelitic slate, pyrite veining		
135			@229/230' - fracturing		
140					
145					
150					
155					
160					
165					
170					
175					
180					
185					
190					
195					
200					
205					
210					
215					
220					
225					
230					
235					
240					
245					
250					
255					
260					
265					
270			Basalt: Basalt lava flow, with olivine		
275			Meta-sedimentary: Slate/metasedimentary rock, quartz-dominated, green.		
280					
285					
290					
295					
300					
305					
310					
315					
320					
325					
330					
335					
340					
345					
350			Meta-sedimentary: Slate/metasedimentary rock, black pelitic slate		
355			@390' - fracture, iron oxide staining		
360					
365					
370					
375					
380					
385					
390					
395					
400					
405					





10540 White Rock Rd., Suite 180
Rancho Cordova, CA 95670

Boring / Well Log

PROJECT: **Moody Flats Quarry**

Boring/Well No.:

OW-1 (PW-1)

PROJECT INFORMATION		DRILLING INFORMATION	
SITE LOCATION: Old Oregon Trail At Wonderland Blvd, Mountain Gate		DRILLING CO.: Diamond Core Drilling, Inc	
JOB NO.: 140910		DRILLER: Ted Ogilvie	
LOGGED BY: Tim Godwin		RIG TYPE:	
PROJECT MANAGER: Joe Turner		METHOD OF DRILLING: Air Rotary	
CHECKED BY:		SAMPLING METHODS: Grab samples	
DATES DRILLED: 6-6-11		HAMMER WT./DROP	
BOREHOLE INFORMATION		LATITUDE:	
TOTAL DEPTH: 407'		LONGITUDE:	
BOREHOLE DIA: 6 1/8"		APPROX. ELEV.:	
☺ Water level during drilling		▼ Water level in completed well	

DEPTH	SOIL SYMBOLS	USCS	SOIL DESCRIPTION	BORING COMPLETION	WELL DESCRIPTION
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405 _____

PROJECT INFORMATION		DRILLING INFORMATION	
SITE LOCATION: Old Oregon Trail At Wonderland Blvd, Mountain Gate		DRILLING CO.: Diamond Core Drilling, Inc	
JOB NO.: 140910		DRILLER: Ted Ogilvie	
LOGGED BY: Tim Godwin		RIG TYPE:	
PROJECT MANAGER: Joe Turner		METHOD OF DRILLING: Air Rotary	
CHECKED BY:		SAMPLING METHODS: Grab Samples	
DATES DRILLED: 6-21-11		HAMMER WT./DROP	
BOREHOLE INFORMATION		LATITUDE:	
TOTAL DEPTH: 405'		LONGITUDE:	
BOREHOLE DIA: 6 1/8"		APPROX. ELEV.:	
☞ Water level during drilling		☛ Water level in completed well	

DEPTH	SOIL SYMBOLS	USCS	SOIL DESCRIPTION	BORING COMPLETION	WELL DESCRIPTION
0	ML	ML	ML: Sandy silt	[Green Hatched]	
5					
10			Meta-andesite: Weathered meta-andesitic rock. Greenstone.	[Green Hatched]	
15					
20					
25					
30					
35					
40					
45					
50					
55					
60			Meta-andesite: Meta-andesite greenstone. Multiple annealed fractures. Poor water production <5 gpm below weathered rock interface.	[Green Hatched]	
65					
70					
75			@74' - Open fracture no increase in water production.		
80					
85					
90					
95					
100					
105					
110					
115					
120					
125					
130					
135					
140					
145			@145' - Increase in calcite veining		
150					
155					
160					
165					
170					
175					
180					
185					
190					
195					
200					
205					
210					
215					
220					
225					
230					
235					
240					
245					
250					
255					
260					
265					
270					
275					
280					
285					
290					
295					
300					
305					
310					
315					
320					
325					
330					
335					
340					
345					
350					
355					
360					
365					
370					
375					
380			@375' - Decrease in veining		
385					
390					
395					
400					
405			TD = 405 ft bgs		

← Bentonite Slurry