Pacific Gas and Electric Company®

Yvonne J. Meeks
Site Remediation - Portfolio Manager
Environmental Affairs

6588 Ontario Road
San Luis Obispo, CA 93405
Mailing Address
4325 South Higuera Street
San Luis Obispo, CA 93401

805.546.5243
Internal: 664.5243
Fax: 805.546.5232
E-Mail: YJM1@pge.com

December 29, 2005

Mr. Norman Shopay
Project Manager
California Department of Toxic Substances Control
Geology and Corrective Action Branch
700 Heinz Avenue
Berkeley, California 94710

Subject: Groundwater Extraction Well TW-3D Installation Report
Pacific Gas and Electric Company, Topock Project

Dear Mr. Shopay:

This letter transmits the *Installation Report for Groundwater Extraction Well TW-3D* at the Pacific Gas and Electric Company (PG&E) Topock site. This summary report documents the installation, sampling, and testing of extraction well TW-3D between October 19, 2005 and December 12, 2005.

If you have any questions, please do not hesitate to contact me. I can be reached at (805) 546-5243.

Sincerely,

Julie Eakins for Yvonne Meeks

cc: Kate Burger/DTSC

Installation Report for Extraction Well TW-3D

Interim Measures No. 3 Groundwater Extraction and Treatment System

PG&E Topock Compressor Station Needles, California

Prepared for

California Department of Toxic Substances Control

on behalf of

Pacific Gas and Electric Company

December 29, 2005

Prepared by
CH2MHILL
155 Grand Avenue, Suite 100
Oakland, California 94612

Installation Report for Extraction Well TW-3D

Interim Measures No. 3
Groundwater Extraction and Treatment System
PG&E Topock Compressor Station
Needles, California

Prepared for
California Department of Toxic Substances Control

on behalf of
Pacific Gas and Electric Company

December 29, 2005

This report was prepared under supervision of a California-certified Engineering Geologist

Paul Bertucci, C.E.G.
Project Hydrogeologist

Contents

Tables

Figures

Appendix

Acronyms and Abbreviations

bgs	below ground surface
BLM	United States Bureau of Land Management
Cr(T)	total chromium
Cr(VI)	hexavalent chromium
DTSC	Department of Toxic Substances Control
gpm	gallons per minute
IM	Interim Measure
IM-3	Interim Measure No. 3
PG&E	Pacific Gas and Electric Company
PVC	polyvinyl chloride
TDS	total dissolved solids

1.0 Introduction

Pacific Gas and Electric Company (PG&E) is implementing an Interim Measure (IM) to address hexavalent chromium [Cr(VI)] concentrations in groundwater at the Topock Compressor Station near Needles, California. The IM consists of groundwater extraction for hydraulic control of the Cr(VI) plume in the Colorado River floodplain, and management of extracted groundwater. The groundwater extraction, treatment, and injection systems collectively are referred to as Interim Measure No. 3 (IM-3). Currently, the IM-3 facilities include a groundwater extraction system (two operational wells), conveyance piping, a groundwater treatment plant, and an injection well field for the discharge of the treated groundwater. Figure 1 shows the location of the IM-3 extraction, conveyance, treatment, and injection facilities.

In a letter dated June 30, 2005, the California Department of Toxic Substances Control (DTSC) requested PG&E to prepare and submit a work plan to install an additional extraction well for the IM groundwater extraction system. The purposes of the additional extraction well, as described in DTSC's letter, are to provide redundant pumping capacity for the currently operating extraction well and to allow for pumping and conveyance of groundwater at a maximum rate of 135 gallons per minute (gpm) from the lower interval of the aquifer in the floodplain area to the IM-3 treatment plant. The existing extraction system consists of one actively pumped deep well (TW-2D) with a pumping capacity of approximately 90 gpm, and one standby/inactive shallow well (TW-2S) with pumping capacity of approximately 40 gpm. The IM-3 treatment facilities were designed with a maximum capacity of 135 gpm (DTSC 2005a).

In response to the June 30 letter from DTSC, PG&E submitted a draft work plan for the installation of a supplemental extraction well for the IM (CH2M HILL 2005a). Six possible locations were screened, and two of those possible locations, identified as TW-3D and PE-3, were found to be viable and evaluated in the draft work plan. DTSC provided comments on the draft work plan in a letter dated September 16, 2005 (DTSC 2005b). That letter requested that a revised work plan for TW-3D, including 100 percent-design specification documents for the conveyance piping, be submitted by October 14, 2005. The final TW-3D work plan was submitted on October 7, 2005 (CH2M HILL 2005b). The revised work plan was approved in a letter from the DTSC dated October 17, 2005 (DTSC 2005c). This report documents the drilling, installation and initial sampling and testing of the new extraction well TW-3D.

1.1 Project Background

The Topock Compressor Station is located in San Bernardino County, approximately 15 miles southeast of Needles, California (Figure 1). The primary constituents of concern at the Topock site are Cr(VI) and total chromium [Cr(T)]. DTSC is the lead administering agency for the project.

In February 2004, DTSC directed PG&E to initiate an IM in the floodplain area of the site to prevent movement of the chromium plume toward the Colorado River. As directed by DTSC under IM No. 2, PG&E is currently pumping groundwater from one deep extraction well (TW-2D) located on a bench along the station access road and above the Colorado River floodplain. Well TW-2D and the newly-constructed extraction well TW-3D are both located on United States Bureau of Reclamation land that is managed by the United States Bureau of Land Management.

1.2 Purpose and Objective

The primary objective of well TW-3D is to extract groundwater from an additional location to maintain a landward gradient and hydraulic control of the lower zone of the Alluvial Aquifer. The siting and design for the new extraction well TW-3D was based on the performance and success of the TW-2D extraction well. The results of the review of possible drilling locations summarized in the draft work plan led to selection of TW-3D as the preferred location for a new extraction well. That conclusion was based on:

- The known favorable aquifer conditions near extraction well TW-2D, which has a relatively high specific capacity and has been a successful extraction well.
- The TW-3D well site is located in an area of higher chromium concentrations and, based on performance monitoring and groundwater modeling, would be capable of inducing stronger landward gradients on the plume area in the floodplain than other evaluated sites.
- The TW-3D well site is in a previously disturbed area (MW-20 bench) readily accessible to drilling equipment and the existing IM-3 extraction wells, piping and control facilities.
- The location of TW-3D adjacent to extraction well TW-2D minimizes adjustments to the gradient well pairs used for performance monitoring by maintaining a single pumping center.

The purpose of this report is to document the drilling, installation, and initial sampling and testing of the new extraction well TW-3D. This report provides the following:

- A summary of the methods used for well drilling, installation, and initial testing of well TW-3D
- The drilling and lithologic log for TW-3D, and the well completion diagram
- Documentation of TW-3D well development and specific capacity testing
- Results of the initial groundwater sampling and analysis
- Status of well completion.

2.0 Summary of Field Activities

This section summarizes the field activities and well completion information for IM extraction well TW-3D. The drilling and well installation activities were initiated on October 19, 2005 and completed by December 12, 2005. The specific activities described include drilling, core logging, well installation and development, step-drawdown (specific capacity) testing, and initial groundwater sampling and analysis.

Figure 2 shows the location of new well TW-3D and the other extraction and monitoring wells in the IM performance monitoring area. Well TW-3D is located approximately 12 feet south and 2.5 feet west of active IM extraction well TW-2D.

2.1 Drilling and Borehole Logging

The drilling was accomplished using the rotosonic drilling method, which involves advancing a rotating and vibrating core barrel or drive casing through the subsurface. This method was selected because it was capable of producing a continuous core from the land surface to approximately 157 feet below ground surface (bgs); generates minimal drilling wastes; and typically can drill through gravel, cobble, and competent bedrock formations. Rotosonic drilling requires no drilling mud. It could therefore be used in close proximity to the continuously pumping TW-2D well without the risk that drilling mud might be drawn into TW-2D. The continuous core obtained from the TW-3D boring was used to prepare a core log and to determine where to set the well screen. The core from TW-3D was subsequently added to the IM drilling program core archive.

The pilot boring for well TW-3D (approximately 7-inch diameter) was continuously cored from ground surface to a total depth of 157 feet bgs, for lithologic logging and well screen selection. The borehole was then drilled out to approximately 12.8 inches in diameter from the ground surface to a depth of 50 feet bgs. Because the drilling equipment was not capable of advancing the larger 12.8-inch casing much below 50 feet, the lower section of the borehole was drilled using 10.7-inch diameter tooling.

A lithologic description of the boring was prepared under the supervision of a California-registered geologist, based on visual inspection of the retrieved core. The lithologic boring log is presented in Appendix A.

2.2 Extraction Well TW-3D Installation

Figure 3 summarizes the drilling and construction of extraction well TW-3D. The final screen interval for TW-3D was determined based on the sonic core log, in consultation with DTSC prior to well construction. The lithologic log for the pilot boring at well TW-3D is included in Appendix A.

Well TW-3D was constructed of 6-inch diameter, Schedule 80 polyvinyl chloride (PVC) well screen with 0.050-inch slot size. This screen has an open area of 27 square inches per foot of

screen length. Above the screen, well TW-3D is constructed with 8-inch diameter Schedule 80 PVC blank casing, which serves as a pump chamber for the 6-inch diameter submersible pump.

The extraction well was initially completed for development with a temporary above-ground surface completion, consisting of a locking stove-pipe well monument. Shortly after the well was installed, the surface completion was converted to a below-grade utility vault similar to those installed at extraction wells TW-2D and TW-2S.

2.3 Well Development

The installation of extraction well TW-3D was completed on October 24, 2005. On October 23, before setting the bentonite seal and grouting, the well was bailed to remove sediment from the casing and settle the filter pack. Approximately 125 gallons of water were removed from well TW-3D during this initial development.

After setting the bentonite seal and grouting on October 24, extraction well TW-3D was developed. The well screen was initially swabbed and bailed on November 2-3. On the afternoon of November 3, airlift methods were used for well development. This method involved use of a combined surge-block and airlift tool to develop 5- to 10-foot intervals of the screen. This development effort continued through November 4 and approximately 4,000 gallons of water were removed. A log of the well development activities is included in Appendix A.

On November 5, the first step-drawdown test of TW-3D was conducted, with the adjacent extraction well TW-2D shut down during the test. The first step-drawdown test indicated that the specific capacity was much lower than expected. This test was cut short, and additional development of well TW-3D was performed during November 14-17, 2005.

The first step of this additional development effort involved adding ½ gallon of dispersant (Johnson NW-220) for every 10 feet of well screen, in accordance with the manufacture's instructions, to further assist in the removal of clay and silt sediment from the well screen interval. After adding the dispersant, the well was swabbed for 50 minutes to ensure that the dispersant was thoroughly mixed throughout the well screen interval. The dispersant was then left to stand in the well overnight. On November 15, 4,200 gallons of water with dispersant were pumped from the extraction well via a tanker truck, for disposal at an offsite treatment facility. After the water with dispersant was removed from the well, the well was surged for approximately four hours. The well was surged for another three hours on November 16 and for three additional hours on November 17. Approximately 8,000 gallons of water were removed from the well during the second development effort. In total, approximately 16,000 gallons of water were removed during the two periods of well development.

2.4 Specific Capacity Testing

Initial hydraulic testing of extraction well TW-3D was conducted to determine the specific capacity of the well, and to obtain preliminary information on the well's radius of influence. An initial test was performed on November 5, 2005, comprised of a step-drawdown test with

three steps. Pumping rates ranged from 50 to 100 gpm for ten minutes each - except at the pumping rate of 100 gpm, which was conducted for only three minutes before the pump ran dry. Following the step test, two constant rate tests were run at a pumping rate of 60 gpm for durations of 30 minutes each. This testing removed approximately 6,500 gallons of water from TW-3D. Results from this initial set of pumping tests indicated a lower than expected specific capacity of less than two gpm per foot of drawdown, and additional development was recommended.

After completing the additional development, a second step-drawdown test was performed on November 17, 2005. Data from the step–drawdown test performed on November 17, 2005 is summarized in Figure 4. Unlike the November 5 tests, this test was conducted while adjacent well TW-2D was pumping at a rate of 97 gpm. TW-3D was pumped in steps of 70, 80, 90, and 110 gpm, with durations of 30 minutes for the first step and 20 minutes for subsequent steps. The pumping water level in TW-3D stabilized at steps up to 90 gpm. The last step, at 110 gpm, was stopped because the pumping water level in TW-3D was not stabilizing and was approaching the depth of the pump intake. As shown on Figure 4, the specific capacity for TW-3D measured by the step-test was approximately three gpm per foot of drawdown. It must be noted that this test was conducted while adjacent extraction well TW-2D was pumping at a rate of 97 gpm (less than 15 feet away), which could have affected the specific capacity measurements.

Following the November 17 pumping test, the permanent pump was installed in well TW-3D, and additional testing was performed. From December 15 to 19, 2005, TW-3D was pumped while adjacent well TW-2D was shut down. This test was conducted in accordance with procedures specified in a letter from DTSC dated December 12, 2005 (DTSC 2005d). The pumping rates for TW-3D ranged from 90 to 135 gpm, with a pumping rate of 120 gpm or higher for most of the test. Water levels and pumping rates from this short-term production test are provided on Figure 5.

Approximately 694,000 gallons were discharged from well TW-3D to the IM-3 treatment plant during this 4-day test. The sustainable yield of TW-3D during this test (which was conducted when TW-2D was not pumping) was approximately 120 gpm, with 35 to 37 feet of drawdown. This equates to a specific capacity of approximately 3.2 gpm per foot of drawdown which is generally consistent with the specific capacity results of the November 17, 2005 step-test. These results provide a baseline to gauge future performance of TW-3D.

2.5 Initial Groundwater Sampling and Analysis

On November 5, 2005, immediately after the first step-drawdown test, groundwater samples were collected from extraction well TW-3D for analyses of Cr(VI), Cr(T), specific conductance, total dissolved solids (TDS), barium, calcium, chloride, carbonate/bicarbonate, fluoride, magnesium, manganese, nitrate, potassium, sodium, sulfate, and iron. Groundwater samples for metals analyses [except Cr(VI) and Cr(T)] were field-filtered to obtain dissolved concentrations. Field water quality parameters (temperature, pH, specific conductance, oxidation-reduction potential, and turbidity) were also measured.

Table 1 presents the laboratory analytical results of the initial groundwater sampling of extraction well TW-3D. The results for Cr(T) and Cr(VI) of 4.04 and 4.36 milligrams per liter

(mg/L), respectively, are consistent with recent TW-2D monitoring results. The TDS concentration in this initial sampling was significantly lower than TDS levels measured for extraction operations in well TW-2D. However, during the three-day pumping test, the specific conductance of the extracted groundwater from well TW-3D increased to levels similar to extraction well TW-2D.

2.6 Well Completion

The TW-3D extraction well was initially completed with a temporary above-ground surface completion, consisting of a locking stove-pipe well monument. The surface completion was then converted to a below-grade utility vault similar to those installed at extraction wells TW-2D and TW-2S (Figure 3). The vault was constructed with provisions for connecting to the existing underground conveyance piping to the IM-3 treatment system.

TW-3D well vault piping and instrumentation installation was completed on December 6, 2005. A Grundfos 15-hp Model 150S-150-6 submersible pump was installed on December 1, 2005. The bottom of the well pump is set at approximately 100 feet bgs, with the intake of the pump at approximately 97 feet bgs. Refer to Figure 3 for a schematic diagram of the TW-3D well completion.

3.0 References

CH2M HILL. 2005a. *Draft Work Plan for Supplemental Extraction Well, Interim Measures Groundwater Extraction System, PG&E Topock Compressor Station, Needles, California.* July 29.

CH2M HILL. 2005b. *Final Work Plan for Installation of Extraction Well TW-3D, Interim Measures No. 3 Groundwater Extraction System, PG&E Topock Compressor Station, Needles, California.* October 7.

DTSC. 2005a. Letter to PG&E "Requirement for Workplan to Install Additional Extraction Well in the Vicinity of Extraction Well TW-2D". June 30.

DTSC. 2005b. Letter to PG&E "Requirement for Higher Capacity Groundwater Extraction Well on MW-20 Bench, Interim Measure Groundwater Extraction System". September 16.

DTSC. 2005c. Letter to PG&E "Conditional Approval of Final Installation Work Plan and Design Plan for Conveyance Piping and Power Supply for Extraction Well TW-3D". October 17.

DTSC. 2005d. Letter to PG&E "Requirement to Increase Pumping from Extraction Wells TW-2D and TW-3D". December 12.

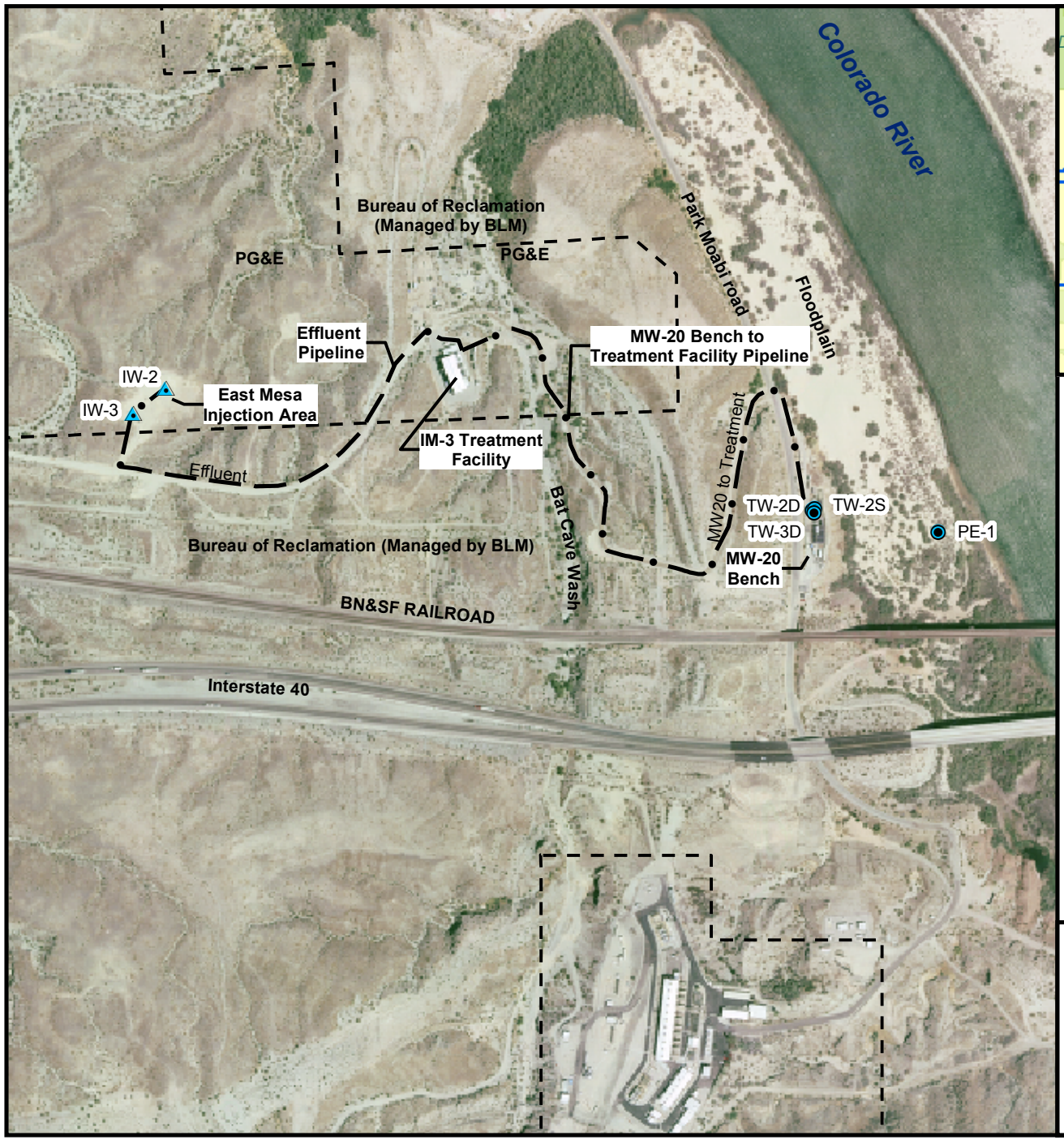
Tables

TABLE 1
Groundwater Analytical Results for TW-3D Extraction Well
Installation Report for Extraction Well TW-3D
PG&E Topock Compressor Station

Location ID	Sample Date	Analyte	Method	Results	Units
TW-03D	11/5/2005	Alkalinity, total as caco3	3101	78	mg/L
		Aluminum	6010B	ND (0.052)	mg/L
		Ammonia as nitrogen	3502	0.61	mg/L
		Antimony	6020A	ND (0.003)	mg/L
		Arsenic	6020A	ND (0.005)	mg/L
		Barium	6010B	ND (0.3)	mg/L
		Bicarbonate	3101	95.2	mg/L
		Boron	6010B	1.12	mg/L
		Calcium	6010B	182	mg/L
		Carbonate	3101	ND (5)	mg/L
		Chloride	300	1670	mg/L
		Chromium	6010B	4.04	mg/L
		Copper	6020A	ND (0.01)	mg/L
		Fluoride	300	3.04	mg/L
		Hexavalent chromium	7199	4.36	mg/L
		Iron	6010B	ND (0.3)	mg/L
		Lead	6020A	ND (0.002)	mg/L
		Magnesium	6010B	16	mg/L
		Manganese	6010B	ND (0.5)	mg/L
		Molybdenum	6020A	0.0169	mg/L
		Nickel	6010B	ND (0.02)	mg/L
		Nitrate as Nitrogen	300	7.79	mg/L
		Nitrite as Nitrogen	3541	0.025	mg/L
		Orthophosphate	3652	ND (0.02)	mg/L
		pH	1501	7.68	pH units
		Potassium	6010B	23.8	mg/L
		Sodium	6010B	869	mg/L
		Soluble silica	3701	22	mg/L
		Specific conductance	1201	6950	µS/cm
		Strontium	6020A	3.69	mg/L
		Sulfate	300	624	mg/L
		Total dissolved solids	1601	3820	mg/L
		Total organic carbon	4152	ND (0.5)	mg/L
		Total phosphorus as p	3653	ND (0.02)	mg/L
		Total suspended solids	1602	ND (2.5)	mg/L
		Turbidity	1801	1.25 J	NTU
		Zinc	6010B	0.046	mg/L

Notes: ND - parameter not detected at the listed reporting limit
J - concentration or reporting limits estimated by laboratory or validation
mg/L - milligrams per liter
µS/cm - micro Seimens per centimeter
NTU - nephelometric turbidity units

Figures



N

0 600 1,200 Feet

1 inch equals 600 feet

LEGEND

PG&E Property Line

IM Extraction Well

IM Injection Well

Notes: Location map shows Interim Measures No.3 (IM-3) wells as of of November 2005. Aerial photography taken May 2005.

FIGURE 1
LOCATIONS OF IM GROUNDWATER EXTRACTION, CONVEYANCE, AND TREATMENT FACILITIES

INTERIM MEASURES NO. 3
PG&E TOPOCK COMPRESSOR STATION
NEEDLES, CALIFORNIA

CH2MHILL

BAO \\ZINFANDEL\PROJ\PACIFICGASELECTRICCO\TOPOCKPROGRAM\GIS\MXD\2005\IMPM_JULY05_LOCS_IM3_FACILITIES8X11.MXD
IMPM_JULY05_LOCS_IM3_FACILITIES8X11.PDF 12/21/2005 18:54:03

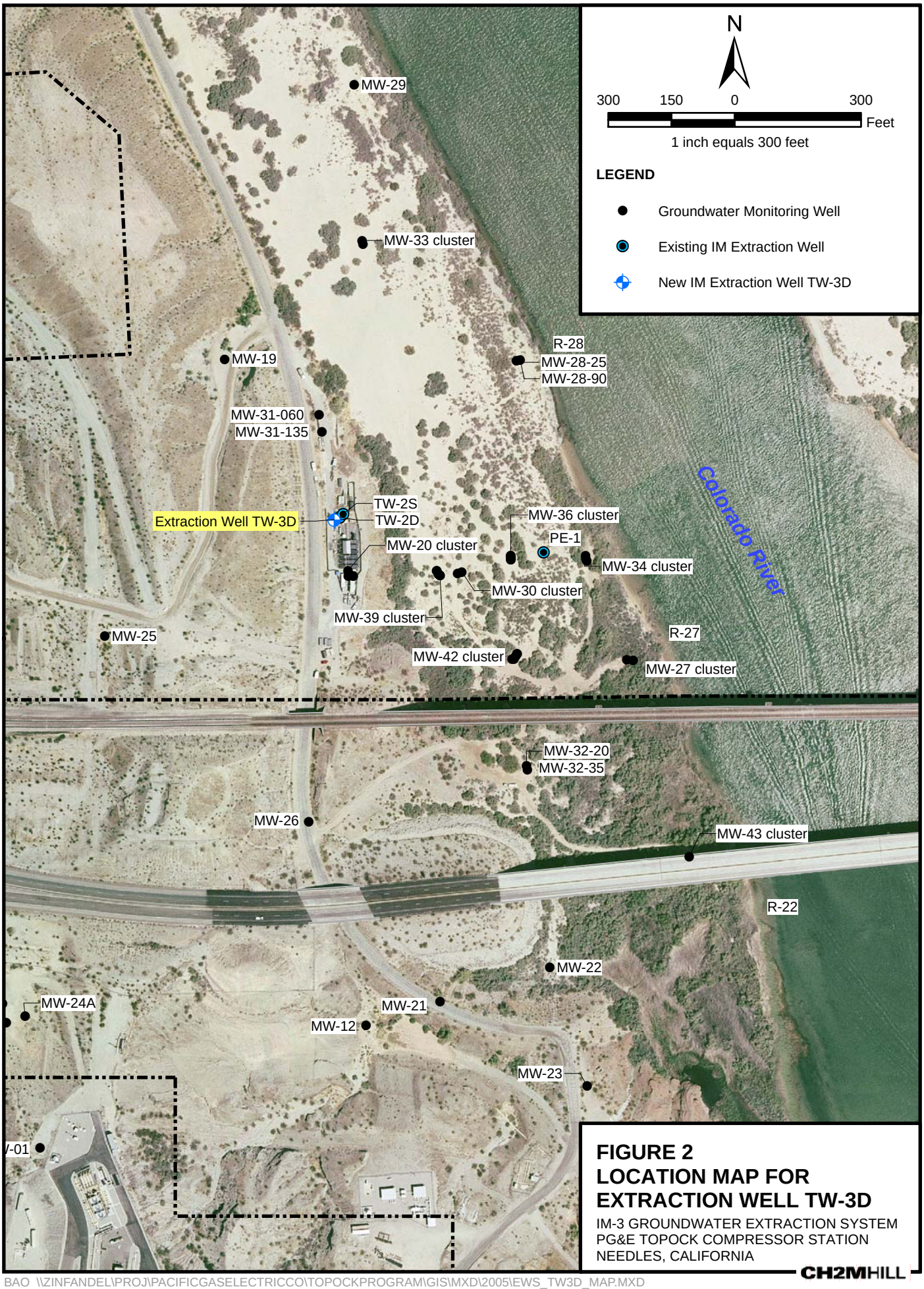


FIGURE 2
LOCATION MAP FOR EXTRACTION WELL TW-3D
IM-3 GROUNDWATER EXTRACTION SYSTEM
PG&E TOPOCK COMPRESSOR STATION
NEEDLES, CALIFORNIA

CH2MHILL

BAO \\ZINFANDEL\PROJ\PACIFICGASELECTRICCO\TOPOCKPROGRAM\GIS\MXD\2005\EWS_TW3D_MAP.MXD
EWS_TW3D_MAP.PDF 12/21/2005 19:10:16

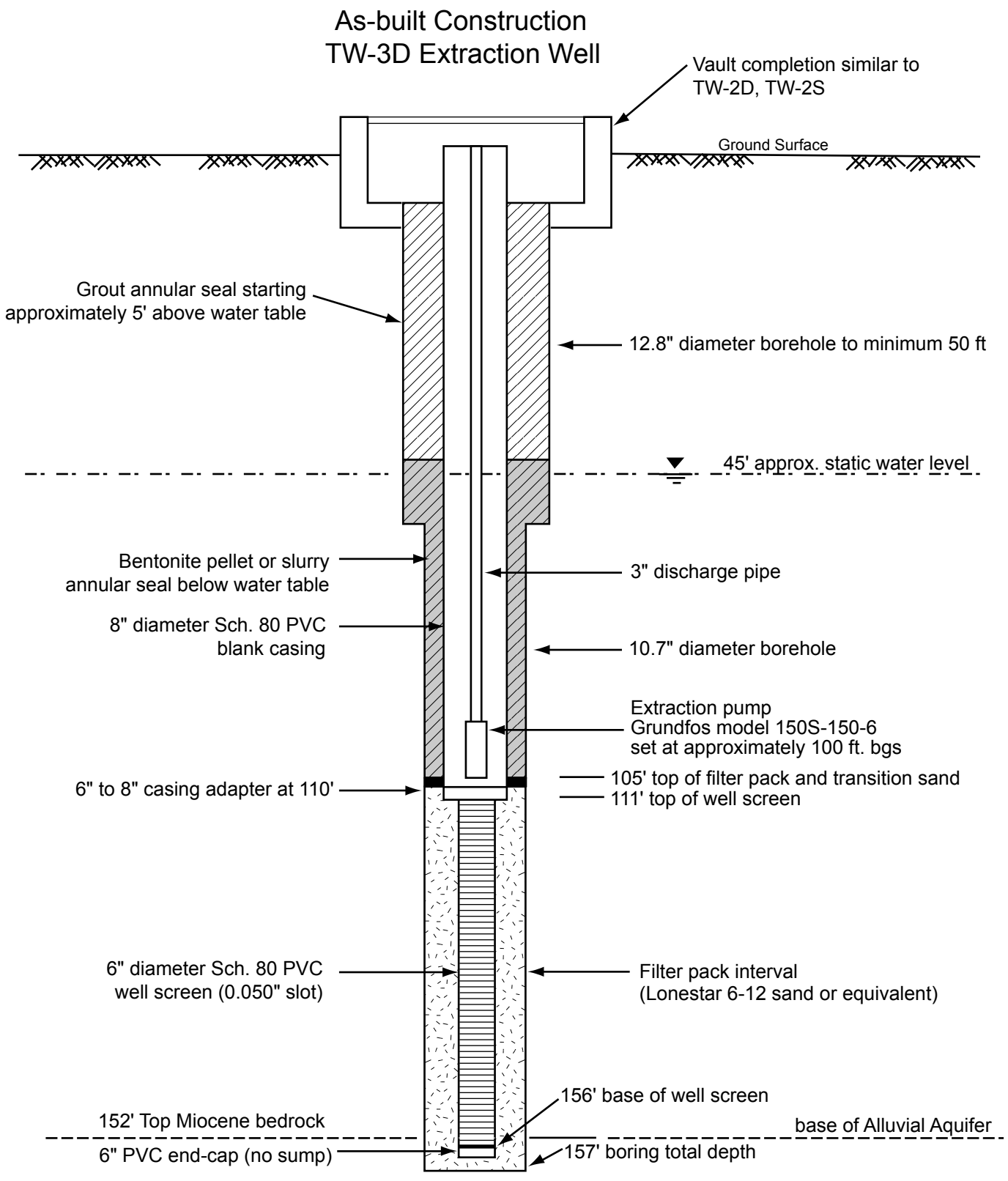


DIAGRAM NOT TO SCALE

Well screen selection reviewed with DTSC 10/21/05

Well TW-3D installed 10/26-27/05

FIGURE 3
WELL CONSTRUCTION DIAGRAM
TW-3D EXTRACTION WELL
IM NO. 3 GROUNDWATER EXTRACTION SYSTEM
PG&E TOPOCK COMPRESSOR STATION

CH2MHILL

326128.01.19.EW_Diagram Extraction Well_12/29/05_ccc_sfo

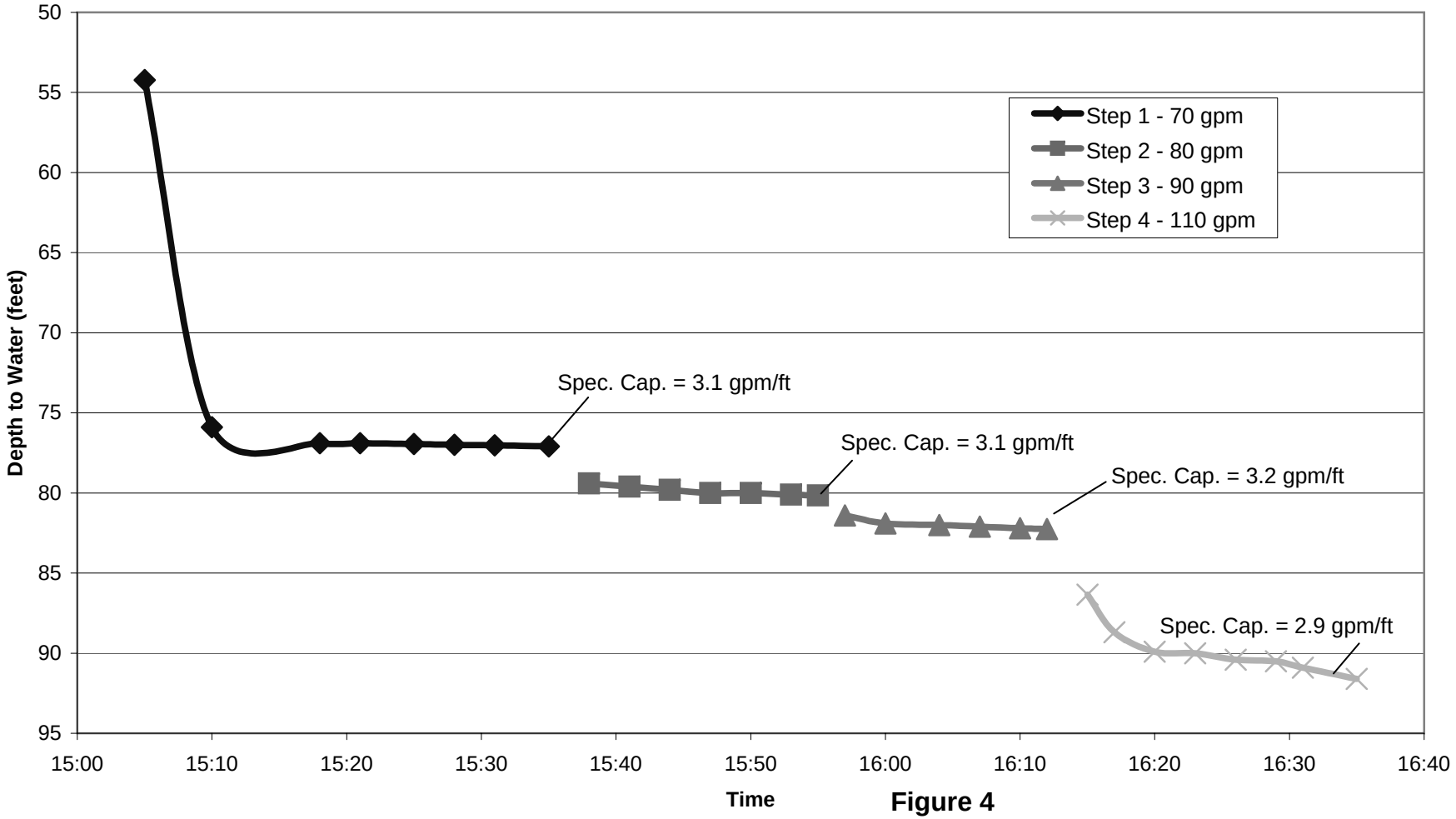


Figure 4
Extraction Well TW-3D Step-Drawdown Test
November 17, 2005
IM-3 GROUNDWATER EXTRACTION SYSTEM
PG&E TOPOCK COMPRESSOR STATION
NEEDLES, CALIFORNIA

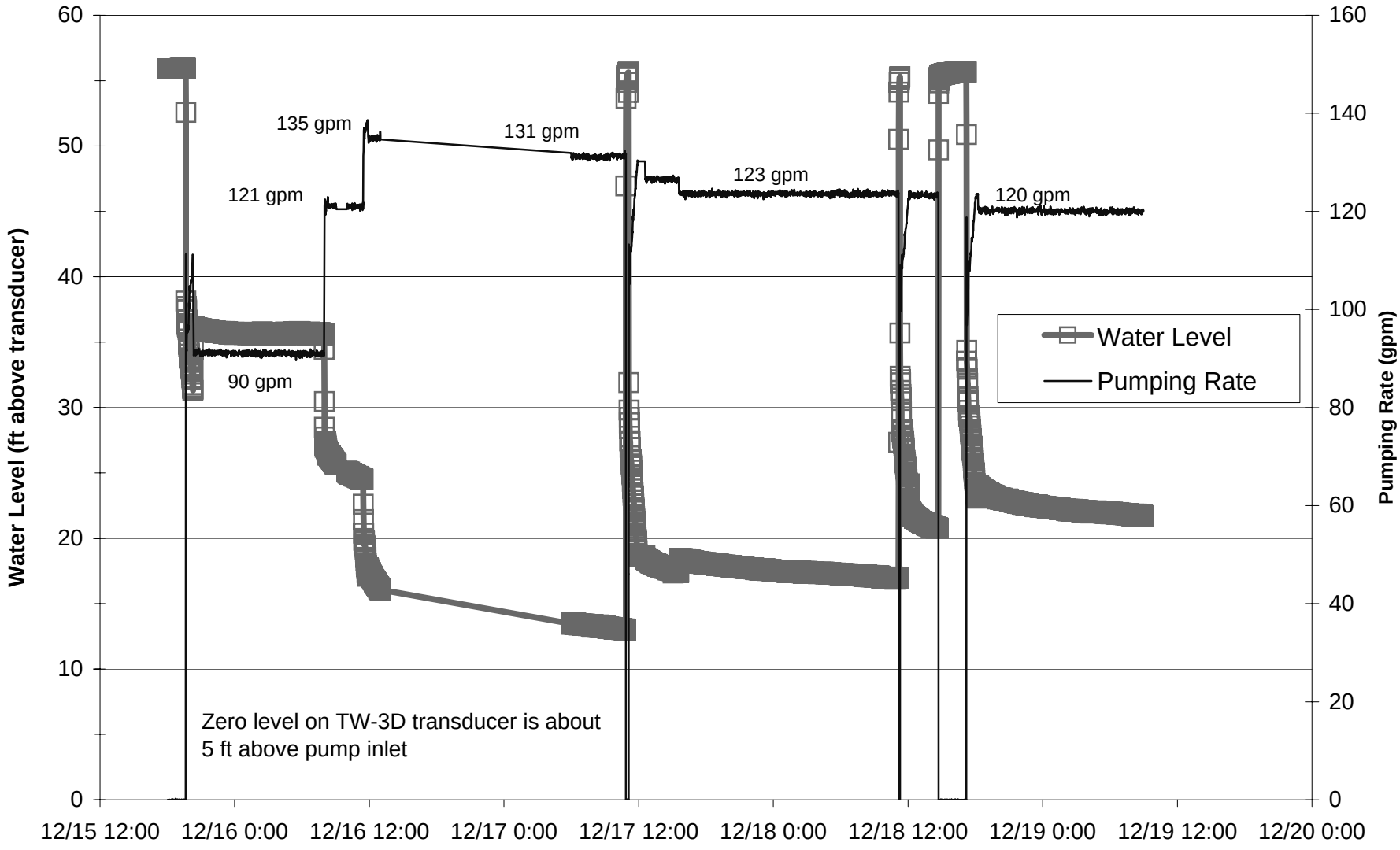


Figure 5
Pumping Rate and Water Level in TW-3D During Short Term Test
IM-3 GROUNDWATER EXTRACTION SYSTEM
PG&E TOPOCK COMPRESSOR STATION
NEEDLES, CALIFORNIA

Appendix A
Drilling and Well Construction Records

PROJECT NUMBER:	BORING NUMBER:
326128.01.19.EW	*TW-3D*

SOIL BORING LOG

PROJECT NAME: PG&E Topock Interim Measures Extraction Well		**HOLE DEPTH (ft):** 157.0	**DRILLING CONTRACTOR:** Prosonic Corp., Phoenix, AZ	
SURFACE ELEVATION: 497.0 ft. MSL	**NORTHING (CCS NAD 83):** Approx. 2,102,627.34	**EASTING (CCS NAD 83):** Approx. 7,615,874.57	**DATE STARTED:** 10/20/2005 09:00	**DATE COMPLETED:** 10/24/2005 14:15
DRILLING METHOD: Rotosonic		**DRILLING EQUIPMENT:** Standard Rotosonic Rig		
LOCATION: MW-20 bench, approx. 13 ft. west and 6 ft. south of TW-2D		**LOGGED BY:** J. Piper		

DEPTH BGS (feet)	SAMPLE: INTERVAL	SAMPLE: RECOVERY (ft)	SAMPLE: PID (PPM)	SAMPLE: SOIL SAMPLE	USCS CODE	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY
						- start coring at 9:00 AM 10/20/05 **Note:** TW-3D pilot boring (7") diameter) continuously cored using sonic core barrel system. No analytical sampling conducted during drilling.
5					SW	**GRAVELLY SAND WITH SILT (SW)** - dk yellowish brn (10YR4/2 to 5/4), 65% poorly sorted f-m sand, 30% rnd quartz, limestone, and vesicular basaltic gravel up to 15 cm (minor portion reworked? subang mm clasts), 5% silt, moist.
10					SP	- dry **POORLY GRADED SAND (SP)** - dk yellowish orange (10YR7/4 to 6/6), 95% well sorted f sand, 5% gravel up to 1 cm, loose, moist
15					SW	**GRAVELLY SAND (SW)** - dk yellowish brn (10YR4/2), 55% sand, 40% rnd qtz, limestone, and jasper gravel up to 4-5 cm, 5% fines
20						- 60% sand, no fines (coarsening downwards), rounded chert and limestone clasts up to 12 cm
25					GW	**WELL GRADED SANDY GRAVEL (GW)** - 10YR4/2, 60% rnd (fluvial) gravel up to 15 cm (diverse rock types), 40% sand
30					SW/GW	**GRAVELLY SILTY SAND (SW/GW)** - med brn (5YR4/4), 50% sand, 40% subang mm gravel with weathered rinds, 10% fines, weakly cemented
35						

CH2MHILL

PROJECT NUMBER: 326128.01.19.EW

BORING NUMBER: *TW-3D*

SOIL BORING LOG

PROJECT NAME: PG&E Topock Interim Measures Extraction Well		**HOLE DEPTH (ft):** 157.0	**DRILLING CONTRACTOR:** Prosonic Corp., Phoenix, AZ	
SURFACE ELEVATION: 497.0 ft. MSL	**NORTHING (CCS NAD 83):** Approx. 2,102,627.34	**EASTING (CCS NAD 83):** Approx. 7,615,874.57	**DATE STARTED:** 10/20/2005 09:00	**DATE COMPLETED:** 10/24/2005 14:15
DRILLING METHOD: Rotosonic		**DRILLING EQUIPMENT:** Standard Rotosonic Rig		
LOCATION: MW-20 bench, approx. 13 ft. west and 6 ft. south of TW-2D		**LOGGED BY:** J. Piper		

DEPTH BGS (feet)	SAMPLE: INTERVAL	SAMPLE: RECOVERY (ft)	SAMPLE: PID (PPM)	SAMPLE: SOIL SAMPLE	USCS CODE	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY
					SW/GW	**GRAVELLY SILTY SAND (SW/GW)** - med brn (5YR4/4), 50% sand, 40% subang mm gravel with weathered rinds, 10% fines, weakly cemented
					SW/SM	**GRAVELLY SILTY SAND (SW/SM)** - med brn (5YR4/4), 45% sand, 40% gravel up to 5 cm, 15% fines, slightly cohesive - weakly cemented, dry to moist
40						
					SM/GM	**SILTY GRAVEL WITH SAND (SM/GM)** - 45% gravel up to 9 cm, 40% sand, 20% fines
45						
					SM	- saturated conditions encountered at 47 ft. **GRAVELLY SILTY SAND (SM)** - med brn (5YR4/4), 55% sand, 30% fines, 15% gravel up to 3 cm, slightly plastic
50						
						- 55% sand, 25% gravel up to 5 cm, 20% fines, coarsening downwards
55						
60						
					SW	**GRAVELLY SAND (SW)** - 5YR4/4-3/4, 55% poorly sorted sand, 40% subang weathered mm gravel up to 15 cm, 5% fines
						- increasing sand and less fines, gravel up to 4 cm
65						
					SM	**GRAVELLY SILTY SAND (SM)** - 45% sand, 30% gravel up to 7 cm, 25% clayey fines
					SW	**SAND WITH GRAVEL AND SILT (SW)** - 60% poorly sorted f-c sand, 25% mm gravel, 15% fines
					GW	**SANDY GRAVEL (GW)** - 5YR5/2 - 10YR6/2, 70% fluvial (and some reworked? mm) gravel up to 8 cm, 27% sand, 3% fines
70						

CH2MHILL

PROJECT NUMBER: 326128.01.19.EW

BORING NUMBER: *TW-3D*

SOIL BORING LOG

PROJECT NAME: PG&E Topock Interim Measures Extraction Well		**HOLE DEPTH (ft):** 157.0	**DRILLING CONTRACTOR:** Prosonic Corp., Phoenix, AZ
SURFACE ELEVATION: 497.0 ft. MSL	**NORTHING (CCS NAD 83):** Approx. 2,102,627.34	**EASTING (CCS NAD 83):** Approx. 7,615,874.57	**DATE STARTED:** 10/20/2005 09:00 / **DATE COMPLETED:** 10/24/2005 14:15
DRILLING METHOD: Rotosonic		**DRILLING EQUIPMENT:** Standard Rotosonic Rig	
LOCATION: MW-20 bench, approx. 13 ft. west and 6 ft. south of TW-2D		**LOGGED BY:** J. Piper	

DEPTH BGS (feet)	SAMPLE: INTERVAL	SAMPLE: RECOVERY (ft)	SAMPLE: PID (PPM)	SAMPLE: SOIL SAMPLE	USCS CODE	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY
75					GW	**SANDY GRAVEL (GW)** - 5YR5/2 - 10YR6/2, 70% fluvial (and some reworked? mm) gravel up to 8 cm, 27% sand, 3% fines - 65% ang to subang mm gravel up to 3 cm, 35% sand - 5YR4/4, 65% gravel up to 3 cm, 25% sand, 10% fines
80					SW	- end of drilling on 10/20/05 **SAND (SW)** - 60% sand, 30% gravel up to 9 cm, 10% fines, gradational contact (grades finer) - start of drilling at 8:45 10/21/05
85					SM	**GRAVELLY SAND WITH SILT AND CLAY (SM)** - 55% sand, 25% gravel up to 5 cm, 20% fines
90					SW	**SAND (SW)** - 55% m-c sand, 25% gravel up to 13 cm, 20% fines (clay increasing with depth), becoming slightly plastic - 50% sand, 35% gravel, 15% fines
95					GW	**SANDY GRAVEL (GW)** - 65% gravel up to 3 cm, 35% sand, 5% fines
100					GM/SM	**SILTY SAND AND GRAVEL (GM/SM)** - 5YR4/4, 40% sand, 40% mm gravel up to 13 cm, 20% fines
105					SW	**GRAVELLY SAND (SW)** - 52% well sorted m-c sand, 45% f gravel up to 2 cm, 3% fines - 62% gravel up to 15 cm, 35% sand, 3% fines
					GW	**GRAVEL WITH SAND (GW)** - 50% sand, 45% gravel up to 4 cm (90% of gravel is subang mm clasts, 10% is reworked? subrnd mm clasts), 5% fines

CH2MHILL

PROJECT NUMBER:	BORING NUMBER:
326128.01.19.EW	*TW-3D*

SOIL BORING LOG

PROJECT NAME: PG&E Topock Interim Measures Extraction Well		**HOLE DEPTH (ft):** 157.0	**DRILLING CONTRACTOR:** Prosonic Corp., Phoenix, AZ	
SURFACE ELEVATION: 497.0 ft. MSL	**NORTHING (CCS NAD 83):** Approx. 2,102,627.34	**EASTING (CCS NAD 83):** Approx. 7,615,874.57	**DATE STARTED:** 10/20/2005 09:00	**DATE COMPLETED:** 10/24/2005 14:15
DRILLING METHOD: Rotosonic		**DRILLING EQUIPMENT:** Standard Rotosonic Rig		
LOCATION: MW-20 bench, approx. 13 ft. west and 6 ft. south of TW-2D		**LOGGED BY:** J. Piper		

DEPTH BGS (feet)	SAMPLE: INTERVAL	SAMPLE: RECOVERY (ft)	SAMPLE: PID (PPM)	SAMPLE: SOIL SAMPLE	USCS CODE	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY
110					GW	**GRAVEL WITH SAND (GW)** - 50% sand, 45% gravel up to 4 cm (90% of gravel is subang mm clasts, 10% is reworked? subrnd mm clasts), 5% fines - 57% gravel up to 4 cm, 40% sand, 3% fines - 50% sand, 40% gravel, 10% fines
115					SW/SM	**GRAVELLY SILTY SAND (SW/SM)** - 5YR3/4, 55% sand, 25% gravel up to 3 cm, 20% fines
120					SM	**SILTY SAND (SM)** - 65% sand, 25% fines (clayey), 10% gravel, slightly plastic - clayey - clayey
125					SW	**GRAVELLY SAND (SW)** - 60% gravel up to 4 cm, 25% well sorted m-c sand, 15% fines
130					GW	**GRAVEL WITH SAND AND SILT (GW)** - 50% sand, 40% gravel up to 15 cm, 10% fines
					SM	**SILTY SAND (SM)** - 55% sand, 25% gravel (mm cobble), 20% fines
135					SW	**SAND WITH GRAVEL AND SILT (SW)** - 5YR4/4, 60% sand, 25% gravel up to 4 cm, 15% silty fines - maximum clast size decreasing
140					SM	**GRAVELLY SILTY SAND (SM)** - 50% sand, 40% gravel up to 3 cm, 10% fines
					SW	**GRAVELLY SAND (SW)** - 45% sand, 40% gravel up to 3 cm, 15% fines

PROJECT NUMBER: 326128.01.19.EW

BORING NUMBER: *TW-3D*

SOIL BORING LOG

PROJECT NAME: PG&E Topock Interim Measures Extraction Well		**HOLE DEPTH (ft):** 157.0	**DRILLING CONTRACTOR:** Prosonic Corp., Phoenix, AZ
SURFACE ELEVATION: 497.0 ft. MSL	**NORTHING (CCS NAD 83):** Approx. 2,102,627.34	**EASTING (CCS NAD 83):** Approx. 7,615,874.57	**DATE STARTED:** 10/20/2005 09:00 / **DATE COMPLETED:** 10/24/2005 14:15
DRILLING METHOD: Rotosonic		**DRILLING EQUIPMENT:** Standard Rotosonic Rig	
LOCATION: MW-20 bench, approx. 13 ft. west and 6 ft. south of TW-2D		**LOGGED BY:** J. Piper	

DEPTH BGS (feet)	SAMPLE: INTERVAL	SAMPLE: RECOVERY (ft)	SAMPLE: PID (PPM)	SAMPLE: SOIL SAMPLE	USCS CODE	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY
					GW	**SANDY GRAVEL (GW)** - 50% gravel up to 12 cm, 45% sand, 5% fines, grading finer downwards
145					SM	**GRAVEL WITH SAND AND SILT (SM)** - 60% gravel up to 15 cm, 35% sand, 5% fines - becoming stiff - transition to weathered bedrock
150					SM	- stronger white CO3 cemented zones, mm clasts very weathered - 45% sand, 45% gravel up to 12 cm, 10% fines, weathered bedrock with (mm clasts), stiff, competent, moist - drilling becomes harder below 150 ft.
155					BR	**BEDROCK (BR)** - consolidated Miocene conglomerate, 45% gravel up to 15 cm, 40% sand, 15% fines, competent, dry, dark reddish brown - shattered, moist - shattered, dry bedrock - End of boring 16:30 10/21/05 - Enlarged borehole to 10.7" for installing extraction well TW-3D. See TW-3D installation report.
						Total Depth = 157 ft bgs

ABBREVIATIONS

brn = brown
lt = light
dk = dark
vf = very fine-grained
f = fine-grained
m = medium-grained
c = coarse-grained
ang = angular
subang = subangular
subrnd = subrounded
rnd = rounded
mm = metamorphic

CH2MHILL

Well Development Record

Well ID: **Extraction Well TW-3D**

Sheet 1 of 6

Project Name: PG&E Topock Interim Measures	Project No: 326128.01.19.R1	Date: 10/23/2005 – 11/17/2005
Location: MW-20 Bench		Date Installed: 10/24/2005
Total Well Depth: 157.47 feet below TOC		Casing Diameter: 8 inch Screen Diameter: 6 inch
CH Field Team: Allan Erickson, Jennifer Claghorn		
Sub Field Team: WDC Exploration		

Methods of Development

☒ Swabbing ☒ Bailing ☒ Pumping ☒ Describe:

10/23/2005 – Bailed approximately 125 gallons before setting the bentonite seal and grouting.
11/2/2005 – Start well development: well screen was swabbed and bailed
11/3 and 11/4/2005 – Well swabbed, bailed, and airlifted: approximately 4,000 gallons removed 11/2-4.

11/5/2005 – Performed 1st step drawdown test. Approximately 6,,500 gallons removed

11/14/2005 – Added dispersant to well, swab well for 50 minutes, and let set over-night
11/15/2005 - Approximately 4,200 gallons of water and dispersant removed. Well then airlifted for 4 hours
11/16/2005 – Well airlifted for 3 hours
11/17/2005 – Well airlifted for 3 hours and performed 2nd step drawdown test.
Approximately 8,000 gallons removed during 11/14-17 development and testing.

Additional pumping test of TW-3D performed 12/15-19/2005 (see TW-3D Installation Report)

Equipment decontaminated prior to development? ☒ Yes ☐ No

Equipment Numbers

Horiba _____ Waterlevel meter _____ Hach _____ Thermometer _____

Casing Volume Information

Casing ID (inch)	1.0	1.5	2.0	2.2	3.0	4.0	4.3	5.0	6.0	7.0	8.0
Unit Casing Volume (A) (gal/ft)	0.04	0.09	0.16	0.2	0.37	0.65	0.75	1.0	1.5	2.0	2.6

Purging Information

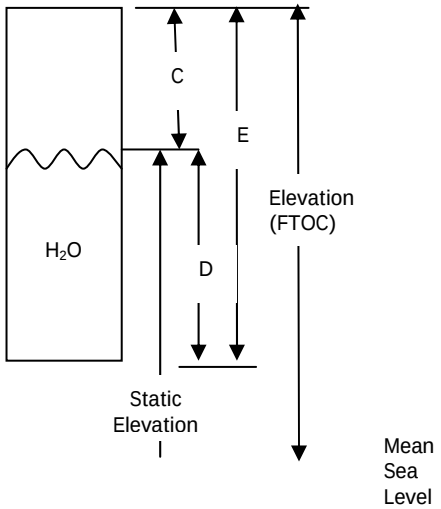
Measured Well Depth (B) 157.47 FTOC.

Measured Water Level Depth (C) 74.4ft (11/2/05 initial)

Length of Static Water Column(D) 157.5 (B) – 74.4 (C) = 83.1ft.

6" Casing Water Volume: 1.5 x 47.5 = 71.25 gal.
8" Casing Water Volume: ` 2.6 x 35.6 = 95.56 gal

Total 1-casing Volume = 166.8 (gal)



Well Development Record

Date	Time	Water Level (FTOC)	Volume Removed (gal)	pH	EC mS/cm	Temp °C	Dissolved Oxygen mg/l	Salinity %	TDS g/L	Eh/ORP mv	Turbidity (NTU)	Specific Capacity	Comments
10/23/2005	1602-1630	Initial: 41.90 Final: 52.73	125										Initial bailing of well prior to setting bentonite seal and grouting.
11/02/2005	1113 -1353												Swab screen and bail well
11/02/2005	1430	74.42	40	5.97	3.46	29.39	6.68				576		
11/02/2005	1445	74.36	40	6.90	3.99	29.57	5.76				680		
	1450	106.50	140	7.06	3.92	29.92	5.17				472		
	1520	150	440										
	1550	73.31	440	7.25	14	29.89	6.77				674		
	1555	83.27	490	7.31	14.1	29.39	5.33				227		
	1600	92.85	540	7.42	14.1	29.28	5.28				198		
	1605	100.13	590	7.44	14.1	29.05	5.09				70.3		
	1610	102.83	640	7.44	14.1	29.00	5.03				73.3		
	1615		650										
	1620	106.81	740	7.45	14.1	28.67	5.03				54.1		
	1630	110.22	790	7.45	14.1	28.40	4.57				53.7		790 gallon total volume is cumulative
11/03/2005	0700-0833												Swab screen
11/03/2005	0834-1040	Initial:45.92											Bail well. 30 mL/1000 gal of fines during bailing.
11/03/2005	1323-1510	Initial: 61.99 Final: 60.10									Initial: 43.9 Final: 18.7		Airlift and surge bottom 5' of screen (151'-156').
11/03/2005	1530-1630	Initial: 60.10 Final: 57.61									Initial: 1000 Final: 24.6		Airlift and swab 153'-143' screen interval
11/03/2005	1635-1655	Initial: 57.61 Final: 53.45											Airlift and swab 141'-147' screen interval

Well Development Record

Date	Time	Water Level (FTOC)	Volume Removed (gal)	pH	EC mS/cm	Temp °C	Dissolved Oxygen mg/l	Salinity %	TDS g/L	Eh/ORP mv	Turbidity (NTU)	Specific Capacity	Comments
11/04/2005	0710-0750	Initial: 45.55 Final: 49.32									Initial: 85.3 Final: 30.3		Airlift and swab 141'-147' screen interval
11/04/2005	0757-0944	Initial: 52.25 Final: 51.43									Initial: 234 Final: 41.0		Airlift and swab 136'-141' screen interval
11/04/2005	0952-1045	Initial: 47.5 Final: 47.61									Initial: 487 Final: 35.2		Airlift and swab 126'-131' screen interval
11/04/2005	1045-1431	Initial: 48.89 Final: 47.26									Initial: 954 Final: 44.3		Airlift and swab 126'-121' screen interval
11/04/2005	1447-1615	Initial: 47.26 Final: 45.73									Initial: High Final: 17.7		Airlift and swab 126'-111' screen interval. Airlift discharge rates were 6 to 20 gpm from 0834 to 1615. Approx. 3,200 gallons removed by airlift
11/05/2005	0813 0814	45.49 (TOC) 46.46 (Sound tube)											Start step test at 0915 MW-20-70 DTW: 45.55 MW-20-130 DTW: 45.76 MW-20-100 DTW: 45.65 MW-31-135 DTW: 43.10 MW-31-60 DTW: 41.91 TW-2D DTW: 38.58
11/05/2005	0918	85.01	150	6.29	5.85	29.65	7.77	0.31	3.7	138	304		Step 1 Flow – 50gpm
11/05/2005	0920	86.31	100										Step 1 Flow – 50 gpm
11/05/2005	0921	86.72	50	6.52	5.84	29.45	4.83	0.31	3.7		11.2		Step 1 Flow – 50 gpm
11/05/2005	0924	87.28	150									1.22	Step 1 Flow – 50 gpm
11/05/2005	0925	89.98	70	6.69	5.84	29.57	4.22	0.31	3.7	121	6.0		Step 2 Flow – 70 gpm
11/05/2005	0928	93.96	210										Step 2 Flow – 70 gpm

Well Development Record

Date	Time	Water Level (FTOC)	Volume Removed (gal)	pH	EC mS/cm	Temp °C	Dissolved Oxygen mg/l	Salinity %	TDS g/L	Eh/ORP mv	Turbidity (NTU)	Specific Capacity	Comments
11/05/2005	0930	95.45	140	6.78	5.83	30.10	3.96	0.31	3.7	116	8.2		Step 2 Flow – 70 gpm
11/05/2005	0933	95.86	210									1.41	Step 2 Flow – 70 gpm
11/05/2005	0935	104.03	200										Step 3 Flow – 100 gpm
11/05/2005	0938	108.25	300									1.62	Step 3 Flow – 100 gpm Shutdown at 0940
11/05/2005	956	46.52											Start Constant rate test at 60 gpm
11/05/2005	1006	98.66	600										
11/05/2005	1010			6.74	5.68	30.10	3.98	0.31	3.7	118	8.1		
11/05/2005	1015	99.23	540										
11/05/2005	1025	99.28	600										
11/05/2005	1031	99.55	360										
11/05/2005	1044	100.29	780										
11/05/2005	1051	86.50	420										Shutdown at 1051 and then restarted at 1051
11/05/2005	1056	95.44	300										
11/05/2005	1101	95.83	300										
11/05/2005	1107	96.03	360										
11/05/2005	1111	97.66	240										
11/05/2005	1116	98.72	300										
11/05/2005	1121	99.56	300										
11/05/2005	1127	100.08	360										Shutdown at 1128 Shock well from 1141 to 1159 at 210 gpm
11/05/2005	1210												TW-3D DTW: 46.44 MW-20-100 DTW: 45.73 MW-20-130 DTW: 45.88 MW-20-70 DTW: 45.57

Well Development Record

Date	Time	Water Level (FTOC)	Volume Removed (gal)	pH	EC mS/cm	Temp °C	Dissolved Oxygen mg/l	Salinity %	TDS g/L	Eh/ORP mv	Turbidity (NTU)	Specific Capacity	Comments
													MW-31-135 DTW: 43.22 MW-31-60 DTW: 41.91
11/14/2005	1610-1700												Added dispersant at 1605. Swabbed well screen to thoroughly disperse dispersant.
11/15/2005	733-1107		4,200										Pumped dispersant and water into tanker truck for offsite disposal.
11/15/2005	1507-1543		1,210								Initial: 221 Final; 127		Airlifted well interval 156'-146'
11/16/2005	0750-0816		573								Initial: 45.9 Final; 94.9		Airlifted well interval 156'-146'
11/16/2005	0822-0946		2,464								Initial: 37.4 Final: 126		Airlifted well interval 146'-136'
11/16/2005	1033-1116		1,388								Initial: 126 Final: 175		Airlifted well interval 126'-136'
11/17/2005	0740-0853		1,919								Initial: 199 Final: 133		Airlifted well interval 126'-136'
11/17/2005	0857-1048		2,722								Initial: 232 Final: 25.4		Airlifted well interval 116'-126'
11/17/2005	1305	54.23											Start pump test at 70 gpm
11/17/2005	1310	75.90	350	7.07	5.38	29.40	5.45	0.28	3.4	168	301		
11/17/2005	1318	76.90	560	7.05	5.38	29.22	4.30	0.28	3.4	165	93.7		
11/17/2005	1321	76.90	210	7.15	5.42	28.77	3.96	0.29	3.4	160	11.3		
11/17/2005	1325	76.95	280	7.17	5.49	27.46	4.02	0.29	3.5	159	13.3		
11/17/2005	1328	77.0	210	7.21	5.59	26.61	4.03	0.30	3.5	158	8.3		
11/17/2005	1331	77.03	210	7.23	5.61	26.19	4.01	0.30	3.5	157	6.7		

Well Development Record

Date	Time	Water Level (FTOC)	Volume Removed (gal)	pH	EC mS/cm	Temp °C	Dissolved Oxygen mg/l	Salinity %	TDS g/L	Eh/ORP mv	Turbidity (NTU)	Specific Capacity	Comments
11/17/2005	1335	77.10	280	7.23	5.96	29.37	3.51	0.32	3.8	149	26.9		
11/17/2005	1338	79.40	210	7.25	5.98	29.17	3.47	0.32	3.8	144	133		Start pumping at 80 gpm
11/17/2005	1341	79.60	240	7.27	5.99	28.58	3.52	0.32	3.8	143	45.2		
11/17/2005	1344	79.80	240	70.0	6.21	29.50	3.39	0.33	3.9	137	107.0		
11/17/2005	1347	80.00	240	7.30	6.24	29.54	3.35	0.33	3.9	119	133		
11/17/2005	1350	80.00	240	7.32	6.30	29.54	3.38	0.34	4.0	104	115		
11/17/2005	1353	80.1	240	7.34	6.38	29.51	3.39	0.34	4.0	94	121		
11/17/2005	1355	80.15	160	7.35	6.44	29.50	3.37	0.34	4.1	86	133		Start pumping at 90 gpm
11/17/2005	1357	81.40	180	7.36	6.49	29.47	3.34	0.35	4.0	82	120		
11/17/2005	1400	81.90	270	7.36	6.57	29.47	3.38	0.35	4.1	72	146		
11/17/2005	1404	82.00	360	7.37	6.60	29.45	3.35	0.35	4.2	71	143		
11/17/2005	1407	82.10	270	7.37	6.61	29.45	3.36	0.35	4.2	68	160		
11/17/2005	1410	82.20	270	7.30	6.65	29.44	3.33	0.36	4.2	65	139		
11/17/2005	1412	82.25	180	7.38	6.75	29.44	3.35	0.36	4.3	63	143		
11/17/2005	1415	86.35	270	7.40	6.60	29.41	3.35	0.36	4.2	62	160		Start pumping at 110 gpm
11/17/2005	1417	88.70	220	7.30	6.89	29.39	3.33	0.37	4.3	61	162		
11/17/2005	1420	89.90	330	7.38	6.99	29.37	3.26	0.38	4.4	59	165		
11/17/2005	1423	90.00	330	7.38	7.08	29.31	3.24	0.38	4.4	58	215		
11/17/2005	1426	90.40	330	7.38	7.08	29.30	3.21	0.38	4.5	59	199		
11/17/2005	1429	90.51	330	7.38	7.16	29.29	3.20	0.39	4.5	58	168		
11/17/2005	1431	90.90	330	7.38	7.22	29.29	3.19	0.39	4.5	56	189		
11/17/2005	1435	91. 60	440	7.38	7.23	29.29	3.18	0.39	4.6	56	165		
12/15/2005 – 12/19/2005			694,000 approx. total									3.2	Pumping of TW-3D with TW-2D pump turned off