Topock Project Executive Abstract

Document Title: Upland Reductive Zone In-Situ Pilot Test Final Completion Report Submitting Agency/Authored by: PG&E Final Document? ☐ Yes ☒ No	Date of Document: March 3, 2009 Who Created this Document?: (i.e. PG&E, DTSC, DOI, Other) PG&E
Priority Status: ☐ **HIGH** ☐ **MED** ☒**LOW** Is this time critical? ☐ Yes ☒ No Type of Document: ☒ Draft ☐ Report ☐ Letter ☐ Memo ☐ Other / Explain:	Action Required: ☒ Information Only ☐ Review & Comment Return to: ______________________ By Date:_________________________ ☐ Other / Explain:
What does this information pertain to? ☐ Resource Conservation and Recovery Act (RCRA) Facility Assessment (RFA)/Preliminary Assessment (PA) ☐ RCRA Facility Investigation (RFI)/Remedial Investigation (RI) (including Risk Assessment) ☐ Corrective Measures Study (CMS)/Feasibility Study (FS) ☐ Corrective Measures Implementation (CMI)/Remedial Action ☐ California Environmental Quality Act (CEQA)/Environmental Impact Report (EIR) ☐ Interim Measures ☒ Other / Explain: Regional Water Quality Control Board (RWQCB)	Is this a Regulatory Requirement? ☒ Yes ☐ No If no, why is the document needed?
What is the consequence of NOT doing this item? What is the consequence of DOING this item? Permit required monitoring report	Other Justification/s: ☒ Permit ☐ Other / Explain:

Brief Summary of attached document:

The report summarizes the activities conducted during the Uplands In-Situ Pilot Test per the Waste Discharge Requirements (WDR). The report presents all data collected during the pilot test, details all operational changes to the pilot test as allowed by the WDR, and offers insight into the observed data trends.

Written by: ARCADIS on behalf of PG&E

Recommendations: None

How is this information related to the Final Remedy or Regulatory Requirements: The report is required under the Waste Discharge Requirement Permit Order No. R7-2007-0015

Other requirements of this information?
None.

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March 3, 2009

Mr. Robert Perdue
Executive Officer
California Regional Water Quality Control Board
Colorado River Basin Region
73-720 Fred Waring Drive, Suite 100
Palm Desert, California 92260

Subject: Board Order R7-2007-0015
PG&E Topock Compressor Station, Needles, California
Upland In-Situ Pilot Test
Final Completion Report

Dear Mr. Perdue:

Enclosed is the Board Order R7-2007-0015 Final Completion Report for the Pacific Gas and Electric Company (PG&E) Topock Compressor Station, upland reductive zone in situ pilot test. This report is being submitted in compliance with the Waste Discharge Requirements (WDRs) issued by the Colorado River Basin Regional Water Quality Control Board (Water Board) under Board Order R7-2007-0015. WDRs under Board Order R7-2009-0015 apply to the upland reductive zone in situ pilot test only.

If you have any questions regarding this report, please call me at (805) 234-2257.

Sincerely,

Yvonne Meeks

Yvonne Meeks
Topock Project Manager

Enclosures:
Board Order R7-2007-0015 Final Completion Report for the Upland Reductive Zone In Situ Pilot Test.

cc: Abdi Haile, Water Board
Aaron Yue, DTSC (2 copies)

Pacific Gas and Electric Company

Upland Reductive Zone In-Situ Pilot Test

Final Completion Report

Waste Discharge Requirements
Order No. R7-2007-0015
PG&E Topock Compressor Station
San Bernardino County, California

3 March 2009

ARCADIS

This report was prepared under the supervision of a California licensed Professional Geologist (PG)

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Upland Reductive Zone In-Situ Pilot Test Completion Report

Waste Discharge Requirements
Order No. R7-2007-0015
PG&E Topock Compressor Station
San Bernardino County, California

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RC000689.0004.00009

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Tables

Figures

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EMAX	EMAX Laboratories, Inc.
bgs	below ground surface
ft	feet
gpm	gallons per minute
gpd	gallons per day
ISPT	In-Situ Pilot Test
µg/L	micrograms per liter
mg/L	milligrams per liter
MRP	Monitoring and Reporting Program
OZARK	Ozark Underground Laboratories, Inc.
PG&E	Pacific Gas and Electric Company
RWQCB	California Regional Water Quality Control Board, Colorado River Basin Region
SAFPM	*Sampling, Analysis, and Field Procedures Manual, PG&E Topock Program, Revision 1*
S/M/D	Shallow/Middle/Deep
TOC	Total Organic Carbon
Truesdail	Truesdail Laboratories
USEPA	United States Environmental Protection Agency

Work Plan	*In-Situ Hexavalent Chromium Reduction Pilot Test Plan – Upland Plume Treatment* (September 2006)

1.0 Introduction

Pacific Gas and Electric (PG&E) has implemented an Upland reductive zone in-situ pilot test (ISPT) to address chromium concentrations in groundwater at the Topock Compressor Station (the Site) near Needles, California. The purpose of the Upland ISPT was to evaluate the efficacy of recirculation for distribution of ethanol for reduction of hexavalent chromium in groundwater. The Upland ISPT consisted of the recirculation of ethanol between two recirculation wells located approximately 140 feet apart (PTR-1 and PTR-2) and monitoring the results in surrounding groundwater monitoring wells (PT-7Shallow/Middle/Deep [S/M/D] through PT-9S/M/D, MW-11, MW-24A/B, and MW-38S/D). Figure 1 provides a map of the PG&E Topock Compressor Station and ISPT area. (All figures are provided at the end of the report).

California Regional Water Quality Control Board, Colorado River Basin Region (RWQCB), Order No. R7-2007-0015 authorized PG&E to inject a total of approximately 38,000 gallons of reagent through the duration of the test. An automated reagent dosing system metered the reagent injections daily for six months within the nine month timeframe of the pilot test. The pilot test was initiated on March 6, 2008 and concluded on December 3, 2008, at the end of the nine month period allowed in Order No. R7-2007-0015.

The Monitoring and Reporting Program (MRP) under Order No. R7-2007-0015 required monthly monitoring reports to be submitted by the 15th day of the following month. The final monthly report was submitted January 15, 2009. Following the completion of the pilot study, the MRP requires the submittal of a final report evaluating the effectiveness of the pilot study. This report fulfills that requirement and summarizes the activities and results related to the Upland ISPT from February 2008 through January 2009. As described in Section 6 of this report, while no more injections are planned, ongoing post-test monitoring of the Upland ISPT area will continue on a quarterly basis in 2009 to evaluate the long-term effectiveness of the test.

2.0 In-Situ Pilot Test Sampling Locations

Table 1 summarizes the well construction details of the recirculation wells (PTR-1 and PTR-2) and monitoring wells (PT-7S/M/D through PT-9S/M/D, MW-11, MW-24A/B, and MW-38S/D). Figure 2 provides a map of the sampling locations.

3.0 Description of Activities

The procedures of the Upland ISPT are outlined in the *In-Situ Hexavalent Chromium Reduction Pilot Test Work Plan – Upland Plume Treatment* (Work Plan; ARCADIS 2006) and all applicable permits, including, but not limited to: Mohave Desert Air Quality Management District, the San Bernardino County Fire Department Permit, Board Order R7-2007-0015, and the Caltrans encroachment permit.

3.1 Well Installation

From April 23, 2007 through July 18, 2007, WDC Exploration and Wells (WDC) of Montclair, California, installed three two-level monitoring well clusters (PT-7S/D, PT-8S/D, and PT-9S/D), three single-level monitoring wells (PT-7M, PT-8M and PT-9M) and two recirculation wells (PTR-1 and PTR-2). The monitoring wells were designated with S for the shallow interval well (approximately 130-150 feet below ground surface [ft bgs]), M for the middle interval well (approximately 165-185 ft bgs), and D for the deep interval well (approximately 190-210 ft bgs). The monitoring wells and recirculation wells were installed as outlined in the letter *Monitoring and Recirculation Well Design, In-situ Hexavalent Chromium Reduction Pilot Test, - Upland Plume Treatment* submitted to DTSC on April 6, 2007 (Well Design Letter).

Although the Well Design Letter planned for drilling 10-inch boreholes to 210 ft bgs with the rotosonic drilling technique, this proved infeasible in the field. The drilling approach was modified several times with approval from the DTSC, and the final drilling method was to complete a 4-inch boring with rotosonic drilling technique to acquire lithologic samples, followed by the use of mud rotary drilling technique to ream the 10-inch boreholes. During the advancement of the 4-inch borings, a field geologist, under the supervision of a California Professional Geologist, recorded the lithology of the subsurface state in accordance with Unified Soil Classification System (USCS) by observing continuous core samples retrieved from the boreholes and collected baseline soil samples (Section 3.4.1). Boring logs and well completion diagrams are presented in Appendix C.

3.2 Aquifer Test Activities

On February 4, 2008, ARCADIS began aquifer testing of the Uplands ISPT system. Per the Work Plan, ARCADIS completed extraction tests and injection tests at PTR-1 and PTR-2 as well as a recirculation test using both wells simultaneously.

Prior to the aquifer testing, 12 temporary pressure transducers and data loggers for water level monitoring were placed in wells PT-7S/M/D, PT-8S/M/D, PT-9S/M/D, MW-11, and MW-24A/B.

Permanent pressure transducers and data loggers were placed in PTR-1 and PTR-2 during construction of the system. Each pressure transducer was tested for potential drift prior to deploying in the wells and no drift was noted.

On February 6 and 7, 2008, ARCADIS completed extraction step tests on PTR-2 and PTR-1, respectively. Extraction was conducted from the shallow interval in PTR-1 and from the deep interval in PTR-2. The rate steps for the PTR-2 test were approximately 6 gallons per minute (gpm) (85 minutes), 13.25 gpm (75 minutes), 25 gpm (65 minutes), and 36 gpm (70 minutes). A total of 6,810 gallons of groundwater was extracted from PTR-2. Rate steps for the PTR-1 test were approximately 5 gpm (125 minutes), 10 gpm (94 minutes), 21 gpm (73 minutes), and 40 gpm (54 minutes). A total of 5,490 gallons of groundwater was extracted from PTR-1. Water levels were monitored throughout the tests, and drawdown did not exceed 10 feet in any of the wells during the extraction tests. The purge water from the extraction tests were transported to holding tanks at the IM-3 treatment plant for storage and off-site disposal.

On February 14 and 26, 2008, ARCADIS completed single well recirculation tests at PTR-2 and PTR-1, respectively. Recirculation was achieved in PTR-1 by extraction from the shallow interval and injection into the deep interval. Recirculation was achieved in PTR-2 by extraction from the deep interval and injection into the shallow interval. Rate steps for the PTR-2 test were approximately 7 gpm (130 minutes), 15 gpm (88 minutes), 30 gpm (142 minutes), and 40 gpm (110 minutes). Rate steps for the PTR-1 recirculation test were approximately 10 gpm (109 minutes), 25 gpm (98 minutes), and 38 gpm (71 minutes). Groundwater extracted during the extraction tests was re-injected for the injection tests. In compliance with the WDR, injected groundwater was first treated by amending with approximately 100 gallons of ethanol solution in both recirculation wells (40 percent ethanol in water). Water levels were monitored throughout the test.

A longer term constant-rate recirculation test was completed from February 27 through March 1, 2008, using both PTR-1 and PTR-2. The wells were operated simultaneously to create a recirculation cell to evaluate the optimal recirculation rate. A constant recirculation rate of approximately 30 gpm was sustained during the first 8 hours of this test. During the first overnight run of the system, the recirculation rate was lowered to 15 gpm. The recirculation rate was returned to 30 gpm the second day of the test and was maintained at 30 gpm for the remainder of the test. Groundwater recirculated in each well during this test was amended with approximately 50 gallons of the ethanol solution (40 percent ethanol). Water levels were monitored throughout the recirculation test and for three days following the test (through March 3, 2008) to monitor recovery of the water levels.

Following the completion of ISPT operations (Section 3.3), PTR-2 was reconfigured to allow extraction from the shallow interval. This short hydraulic extraction test was conducted to evaluate sustainable extraction rates from the shallow screen interval which had previously been used for injection on December 3. PG&E notified the Board of this activity in correspondence dated November 24, 2008 (Appendix A). The results of the extraction test are described in Appendix B.

3.3 Pilot System Operation

3.3.1 Tracer Injections

A 30-day tracer study was conducted concurrently with the pilot test start-up, from March 6 to April 4, 2008. The tracer study utilized two non-toxic fluorescent tracers for each recirculation well, fluorescein and Rhodamine WT, to evaluate groundwater movement in the pilot area emanating from each recirculation well. The system injected fluorescein into PTR-1 and Rhodamine WT into PTR-2. Sufficient tracer was injected to achieve concentrations of approximately 0.8 milligrams per liter (mg/L) of fluorescein and 0.5 mg/L of Rhodamine WT in groundwater recirculated over a 24 hour period (43,200 gallons). In total, approximately 9.0 pounds of fluorescein and 5.7 pounds of Rhodamine WT were injected for the 30-day tracer test. Tracers were injected as pulses over a 20 minute period each day throughout the month. Data collected from PTR-2 suggest that during startup activities, fluorescein was likely inadvertently introduced into PTR-2 for a brief period during the month of tracer injections because of a field error (at high concentrations, rhodamine and fluorescein look similar). This error was taken into consideration for interpretation of the tracer study. Results and interpretation of the tracer test is presented in Section 5.1.

3.3.2 Recirculation and Reagent Injections

On March 6, 2008, continuous operation of the Upland ISPT recirculation system began. Similar to the long-term constant rate hydraulic test, recirculation was achieved in PTR-1 by extraction from the shallow interval and injection into the deep interval. Recirculation was achieved in PTR-2 by extraction from the deep interval and injection into the shallow interval throughout the ISPT period. As discussed in the February Monitoring Report for the Upland Reductive Zone In-Situ Pilot Test (ARCADIS, 2008b), the aquifer test results demonstrated that the recirculation system could sustain recirculation at 30 gpm. Based on this, 30 gpm was the target recirculation flowrate throughout the ISPT, although the pump flow rates varied over time as detailed in Table 2.

The volume of 40 percent ethanol added to each recirculation well varied over the course of the test in response to performance data, as summarized below and presented in Table 3. For the first phase of operation from March 6 to June 2, 2008, approximately 95 gallons per day (gpd) of 40 percent ethanol were injected into each well (PTR-1 and PTR-2), as authorized by the RWQCB Order No. R7-2007-0015. This initial dosing was targeted to provide 400 mg/L of total organic carbon (TOC) delivered to the subsurface when mixed with recirculated groundwater at 30 gpm over the course of one day.

Changes were made in the ethanol dosing regime in order to evaluate the relationship between ethanol dosing, recirculation rates, and organic carbon distribution in the aquifer. The changes in operations are summarized as follows:

- June 3, 2008 - Ethanol dosing into the PTR-1 and PTR-2 was suspended to flush out the high concentrations of TOC that had accumulated close to the recirculation wells (Section 5.1.3).

- August 6, 2008 - After TOC concentrations near PTR-2 declined (Section 5.1), ethanol dosing resumed in PTR-2 on August 6, 2008 at a reduced rate of approximately 25 gpd.

- October 14, 2008 - The dosing rate in PTR-2 was increased to approximately 45 gpd. The recirculation rate in this well had declined over time (Table 3) and was increased to 25 gpm to improve horizontal distribution through the system (Section 5.1).

- October 28, 2008 - The dosing rate into PTR-2 was increased to approximately 70 gpd and dosing was resumed in PTR-1 at approximately 70 gpd in order to consume the remainder of ethanol stored on-site.

- November 1, 2008 - Ethanol injections into PTR-1 and PTR-2 ended.

- December 1, 2008 - Recirculation in PTR-1 and PTR-2 ended.

- December 3, 2008 - Extraction testing in PTR-2 (Section 3.2). ISPT operations were completed.

PG&E notified the Water Board of the operational changes listed above in correspondence dated May 29, August 4, and October 23, 2008. Copies of the notifications and approval letters are provided in Appendix A.

Following the end of ethanol injections on November 1, 2008, the ethanol storage tank was decommissioned. Residual ethanol solution was removed from the tank and injected into PTR-1 and PTR-2 and the tank and fill lines were triple-rinsed. The residual ethanol solution and the triple-rinse solution were within the required concentration limits for ethanol and were injected into the subsurface within the operational timeframe of the pilot. The rinse procedure was completed on November 6, 2008, and the tank remains empty onsite. On December 3, 2008, following the end of the ISPT, the recirculation system was decommissioned by removing down-well equipment from the recirculation wells, decontaminating the equipment and storing onsite.

3.4 Sampling Activities

The MRP required baseline sampling prior to the initiation of the ISPT, weekly sampling for the first month of operation (March 2008), bi-weekly sampling for the next two months (April and May 2008), and monthly sampling through the ninth month of operation (November 2008).

All samples were collected, labeled, and packaged according to the SAFPM, as summarized in Section 4.0. Table 4 presents a summary of field parameters, and tables 5 and 6 present the groundwater analytical results.

In accordance with the MRP, groundwater samples from the sampling events were analyzed for hexavalent chromium (United States Environmental Protection Agency [USEPA] Method 218.6 SM 2500-Cr) by Truesdail Laboratories (Truesdail); for dissolved iron, total dissolved chromium (USEPA 200.7), total iron (USEPA 200.8), sulfate (USEPA 300), total organic carbon (TOC) (USEPA Method 5310B), and sulfide (USEPA Method 4500-S^{2-}) by EMAX Laboratories, Inc. (EMAX); and for fluorescein and rhodamine by Ozark Underground Laboratories, Inc. (OZARK). Groundwater samples from monthly events were analyzed for all of the above as well as dissolved calcium, dissolved potassium, dissolved sodium and dissolved manganese (USEPA 200.7), total arsenic and total manganese (USEPA 200.8), and anions chloride, nitrate, nitrite and phosphorous (as phosphate) (USEPA 300). In addition, groundwater samples were analyzed for dissolved arsenic during the monthly event (USEPA 200.7). Hexavalent chromium was also analyzed in the field at the Interim Measures 3 facility using HACH Method 8023 - program 1560, during the monthly sampling events.

3.4.1 Baseline Sampling

Groundwater

Prior to injection activities, two baseline groundwater sampling events were performed. The first event was performed from July 16 through 18, 2007. The second baseline sampling event was performed from January 22 through 25, 2008.

In addition to the parameters required by the MRP, the samples collected during the July 16 through 18, 2007 baseline event were also analyzed for Title 22 Metals, results are presented in Table 7.

Soil

Soil samples were collected during well installation activities from April 27, 2007 to June 5, 2007. Two soil samples were collected from each recirculation well location and three soil samples were collected in each monitoring well location. The locations of these samples were in the saturated zone, but depths varied in each pilot hole; Table 8 presents the soil sample depths and results. The purpose of the soil samples was to provide a baseline of the soil chemistry in the Upland ISPT area.

All the samples were sent to EMAX Laboratories, Inc. (EMAX) in Torrance, California, a California-certified analytical laboratory. The samples were analyzed for hexavalent chromium (United States Environmental Protection Agency [USEPA] Method 3060A/7199), total chromium, total iron, total manganese, aluminum, arsenic, calcium, magnesium, sodium (USEPA Method 6020), nitrate, sulfate, phosphate (USEPA Method 300), sulfide (USEPA 376.1), alkalinity (USEPA Method 310.1), acidity (USEPA Method 305.1), pH (USEPA Method 9045), and cation-exchange–capacity (Method SW-9080).

The samples were also sent to an ARCADIS laboratory, located in Durham, South Carolina for selective chemical extractions for iron, chromium, and manganese. The selective extractions included a hydrochloric acid (H-H) extraction to target metals sorbed to soil particle surfaces, a hydroxylamine hydrochloride (H-H hydroxy) extraction to target easily reducible metals, a citrate-dithionite-bicarbonate (CBD) extraction to target all reducible metals, and a strong nitric acid digestion (this was USEPA Method 6020 performed by EMAX laboratories) targeting the total metals within the samples. The CBD extraction is based upon methods developed by Mehra et al, 1960. The hydrochloric acid and hydroxylamine extraction is based upon methods developed by Lovely et al. (1986, 1987).

3.4.2. Monthly sampling

Monthly groundwater samples were collected from March 2008 through November 2008.

The ninth and final monthly sampling event was conducted November 11 through 13, 2008. All sampling events were performed in accordance with the Work Plan and the applicable procedures contained within the SAFPM (CH2M Hill, 2005) and the MRP. The data from the November 11 through 13, 2008 sampling event is included in this report.

3.4.3. Post-Pilot Sampling

Groundwater

The groundwater will continue to be monitored on a quarterly basis in 2009 (Section 6) in order to monitor the long-term effects of the Upland ISPT. The first quarterly event took place on February 10 through 12, 2009. The results will be reported in the April 15th quarterly report.

Soils

The post-pilot soil sampling event was conducted January 14 through 16, 2009. The location of the soil boring from which all samples were collected is approximately 10 ft southeast of PTR-1 (Figure 2). A total of six samples were collected from different depth intervals: 140-142 ft, 142-144 ft, 175-177 ft, 177-179 ft, 199-201 ft, and 201-203 ft. The purpose of the sampling event was to compare post-pilot results to baseline conditions, thereby evaluating the effect of the Upland ISPT on the aquifer mineralogy of the area affected by the pilot test.

3.4.4 Additional Performance Sampling

In addition to the sampling frequency required by the MRP, additional TOC samples were collected throughout the ISPT operation to evaluate the affects of operational changes. As discussed in Section 3.3, ethanol dosing was temporarily halted on June 3, 2008 due to increased levels of TOC. Monthly sampling frequency began in June, and therefore in order to evaluate the natural attenuation of TOC, additional sampling events were conducted. Total organic carbon was the only parameter analyzed during the additional sampling events, supplementing the monthly sampling events. Additional TOC samples were collected from wells PT-7M/D, PT-8S/M/D, and MW-24A on the dates listed below, and are presented in Table 5.

- PT-7M and PT-7D: June 19; July 1, 8, 15, 28; and September 3
- PT-8S and PT-8D: June 19, July 1, 8, 15, and 28
- PT-8M and MW-24A: June 19 and July 1

4.0 Sampling and Analytical Procedures

Groundwater sampling and associated tasks were performed in accordance with the applicable procedures contained in the SAFPM (CH2M Hill, 2005) and as summarized below.

Monitoring wells were purged and sampled. Prior to groundwater sampling, the depth to water was recorded for each well. These data were used to evaluate the volume of standing water in the well. The monitoring wells were purged using a WaTerra® purge pump with dedicated polyethylene tubing. Purging continued until three casing volumes had been removed. The field parameters, such as pH, specific conductance, and temperature were recorded (Table 4). After completion of purging, the groundwater samples were collected into the appropriate containers.

Recirculation well (PTR-1 and PTR-2) samples were collected from dedicated sampling ports. Water was purged from the sample port prior to sampling the recirculation well to remove any stagnant water from the port.

The samples were stored in coolers at 4 degrees Celsius and transported to Truesdail and EMAX (and then from EMAX to Ozark) via a courier service under chain-of-custody documentation. Truesdail and EMAX are certified by the California Department of Health Services (Certification #1247 and #02116CA, respectively) under the State of California's Environmental Laboratory Accreditation Program.

Analyses were performed in accordance with the latest edition of the "Guidelines Establishing Test Procedures for Analysis of Pollutants" (40 CFR Part 136), or equivalent methods promulgated by the USEPA.

Sampling was conducted in accordance with the sampling frequency required by the MRP, and all required monitoring information was collected (sample location, date and time, sample identification, sampler name, laboratory performing the analysis, analysis method, analysis date, and the laboratory technician performing the analysis). Sample results are summarized in Tables 4 and 5. Copies of laboratory analytical results were presented in the monthly compliance reports submitted from March 2008 through January 2009 (ARCADIS, 2008b – 2008k; ARCADIS, 2009a).

5.0 In-Situ Pilot Test Results

5.1 Recirculation Hydraulics

The Upland ISPT was used to evaluate the effectiveness of dual-screened recirculation wells for the distribution of reagents for in situ hexavalent chromium treatment, as detailed in the following subsections.

5.1.1 Hydraulic Testing Results

Aquifer testing was conducted at the beginning of the ISPT. The purpose of the aquifer testing was to:

- Better define the sustainable extraction rates of PTR-1 and PTR-2 in order to optimize well performance;
- Identify appropriate sustainable recirculation rates for subsequent tracer and carbon substrate recirculation tests; and
- Determine hydraulic parameters (transmissivity, hydraulic conductivity, storage coefficient) and calibrate the numeric model for the Upland ISPT.

During step extraction testing, extraction rates up to 40 and 36 gpm were achieved in PTR-1 and PTR-2, respectively. During single well recirculation testing, maximum recirculation flow rates of 40 and 36 gpm were achieved in PTR-1 and PTR-2, respectively. Recirculation rates were sustained between 15.5 and 30 gpm during the 72-hour dual well recirculation test. Based on the aquifer testing results, 30 gpm was used for the start up of the system.

The complete set of results and a more comprehensive analysis of the hydraulic tests, including hydraulic parameter estimation and numerical model calibration, are presented in Appendix B.

5.1.2 Recirculation and Reagent Injection Results

Continuous recirculation and reagent dosing began on March 3, 2008. Modeled groundwater water elevations during operation of the recirculation wells are presented in Figure 3. Organic carbon substrate (ethanol) was injected into both recirculation wells (PTR-1 and PTR-2) for the first 90 days of the ISPT. Tracers were also injected into PTR-1 (fluorescein) and PTR-2 (Rhodamine WT) for the first 30 days of the ISPT. Recirculation hydraulics at the two recirculation wells, PTR-1 and PTR-2, were evaluated through analysis of the tracer and TOC concentration trends in monitoring wells (summarized in the cross section in Figure 4 and detailed in Figures 5 through 20 and Table 5) and through quantitative numerical flow and transport modeling (Appendix B). An evaluation of the recirculation hydraulics observed in the ISPT based on the TOC and tracer concentration trends is presented in the next subsections.

5.1.2.1 Distribution of Tracer and TOC by Recirculation at PTR-2

Near recirculation well PTR-2, Rhodamine WT tracer concentrations increased at MW-24A over the first month of operation, followed by decreasing concentrations (Figure 15). Groundwater from PTR-2 flowed laterally in the shallow zone toward PTR-1. Arrival of Rhodamine WT was detected halfway between PTR-2 and PTR-1 at PT-8S in the middle of March (Figure 8 and close to PTR-1 at PT-7S in July (Figure 5). Similarly, TOC was distributed throughout the shallow aquifer unit to MW-24A, PT-8S, and PT-7S. The conceptual groundwater flow from PTR-2 to MW-24A, PT-8S, and PT-7S based on the observed TOC and Rhodamine WT tracer distribution and hydraulic modeling is presented in Figure 4 and Figure B-15 in Appendix B.

The concentration of TOC measured at MW-24A (maximum concentration of 12,900 mg/L) was much greater than the target concentration of 400 mg/L. Because TOC concentrations exceeded the target concentrations at MW-24A near the recirculation wells, ethanol dosing was suspended on June 3, 2008. Recirculation continued in order to allow the accumulated organic carbon to flush out of the area. TOC concentrations at MW-24A decreased to baseline concentrations shortly after the first period of ethanol injections ended.

A second phase of ethanol injections was conducted in PTR-2 to test distribution with lower volumes of ethanol (25 gpd), beginning on August 6, 2008. The lower dose of ethanol was successfully distributed to MW-24A, as indicated by elevated concentrations of TOC and decreased concentrations of nitrate and sulfate at MW-24A in September through November.

5.1.2.2 Distribution of Tracer and TOC by Recirculation at PTR-1

Near recirculation well PTR-1, fluorescein tracer and TOC arrived at PT-7M and PT-7D within approximately one week of start-up and increased over the course of the first month of operation. Groundwater from PTR-1 flowed laterally in the deep zone toward PTR-2. Arrival of fluorescein and TOC was detected halfway between PTR-1 and PTR-2 at PT-8D starting in April and May (Table 5). TOC distribution to PT-8 was less consistent and at lower concentrations in the deep zone than in the shallow zone (Figures 8 and 10). Low concentrations of fluorescein were detected at PT-8M starting in June. The conceptual groundwater flow from PTR-1 to PT-7M/D and PT-8D based on the observed TOC and fluorescein tracer distribution and hydraulic modeling is presented in Figure 4 and Figure B-14 in Appendix B.

During the second month of operation, TOC and fluorescein tracer concentrations continued increasing at PT-7M and PT-7D. Fluorescein tracer concentrations remained elevated for several months after the injection of tracer ended at the beginning of April. As in MW-24A, TOC concentrations measured at PT-7M and PT-7D (up to approximately 10,000 mg/L and 5,600 mg/L, respectively) also exceeded the target concentrations during the first three months of reagent injections and ethanol dosing was consequently stopped on June 3. TOC concentrations declined much more slowly after ethanol injections stopped in PT-7M/D than in MW-24A and remained elevated above 100 mg/L through the end of the pilot study in November.

5.1.2.3 Conceptual Model of Recirculation Hydraulics

Key observations made from the distribution of tracer and TOC during the ISPT include (Figure 4):

- Distribution of reagent across approximately 140 feet by recirculation in dual-screened wells.
- Greater reagent distribution across shallow zone than across the deep zone, with little reagent distribution across the middle zone.
- Higher concentrations of TOC than designed accumulated within the aquifer in the immediate vicinity of the recirculation wells.

To better understand the recirculation hydraulics of the pilot test system and the design parameters governing reagent distribution, numerical modeling was conducted (Appendix B, Sections 3 and 4). In general, the numerical modeling indicated that there was a significant vertical component of groundwater flow between the injection and extraction intervals of each recirculation well, as shown in Figures B-15 and B-16 of Appendix B. The majority of groundwater at each injection interval traveled vertically, was extracted, was re-dosed with ethanol and tracer and was re-injected back into the aquifer, partially accounting for the higher than targeted concentrations of TOC and tracer at monitoring wells PT-7M/D and MW-24A near the recirculation wells. Incomplete mixing of the high concentration ethanol pulses is a second contribution to the high observed tracer and TOC concentrations.

The affect of vertical recirculation was more pronounced at PTR-1 than at PTR-2. A greater portion of water traveled vertically from the injection interval to the extraction interval in PTR-1 than in PTR-2, resulting in less horizontal groundwater flow from PTR-1, less reagent distribution in the deep zone (i.e. to PT-8D), and higher sustained TOC and tracer concentrations at PT-7M/D than at MW-24A. The modeling results also indicated that PT-8M and PT-8D were in stagnant zones during operation from March 3 to October 13, 2008, explaining the lower distribution of reagents to these zones in comparison to the shallow aquifer unit over this period.

5.1.3 Optimization of Recirculation Hydraulics

After analysis of the tracer and TOC distribution data and the model simulations, the model was used to assess whether distribution in the deep zone could be improved through changes in operational conditions (Appendix B, Section 6). The analysis indicated that the best option for improving distribution to the deep and middle aquifer unit was to increase the recirculation rate at PTR-2 to increase the hydraulic gradient between the recirculation wells in the deep aquifer unit. Accordingly, the recirculation rate at PTR-2 was increased on October 14, 2008 from 23 to 27 gpm (Table 3).

Following this operational change, increased distribution was observed at both PT-8M and PT-8D. At PT-8D, evidence of improved distribution included maximum concentrations of fluorescein and TOC in conjunction with decreases in Cr(VI) concentrations (Section 5.2.1) and nitrate in November. In PT-8M, evidence of improved distribution included arrival of low concentrations of both tracers, and declining Cr(IV), nitrate, and sulfate concentrations. While these concentration trends indicate that distribution in the middle and deep aquifer units at the mid-point monitoring well was achieved, they cannot definitively be linked to the operational change made in mid-October given that similar evidence of arrival was also observed prior to or simultaneously with the operational change.

These results demonstrate the utility of the model developed in the pilot test to optimize recirculation system design and operation.

5.1.4 Distribution to PT-9

Monitoring well cluster PT-9 is located approximately 120 feet downgradient from PTR-1 and approximately 180 feet downgradient from PTR-2; this well is outside of the immediate influence of the recirculation system. Arrival of groundwater amended with reagents was observed at PT-9S in August through November 2008. The arrival of 146 mg/L of TOC at PT-9S in November, demonstrates that with sufficiently high injection concentrations, even a rapidly degrading substrate such as ethanol can persist in the aquifer at reagent-strength concentrations for at least approximately 250 days.

5.2 Ethanol as Organic Carbon Substrate

5.2.1 Reduction and Precipitation of Hexavalent Chromium (Cr[VI])

The results of the Upland ISPT demonstrated that ethanol is an effective organic carbon substrate for in situ treatment of hexavalent chromium. The reductions of hexavalent chromium measured at key monitoring wells within the IRZ are presented in Table 9; pre- and post- ISPT chromium distribution is presented in Figures 21 and 22.

Prior to reagent delivery, total chromium (Cr[T]) concentrations ranged from 1,260 µg/L to 7,890 µg/L and hexavalent chromium (Cr[VI]) concentrations ranged from 1,200 µg/L to 7,260 µg/L in monitoring wells located within the direct influence of the recirculation wells (PT-7S/M/D, PT-8S/M/D, and MW24A, Table 4). The decrease in hexavalent chromium concentrations at these monitoring locations over the course of the ISPT, demonstrated that hexavalent chromium reduction was stimulated through the distribution of organic carbon substrate. The decrease in total chromium concentrations demonstrated the precipitation of reduced chromium. Table 8 summarizes the reduction in Cr(VI) concentrations measured during the pilot test. The data demonstrates the complete reduction of Cr(VI) where TOC distribution was the greatest (PT-7M, PT-7D, and PT-8S). Significant reduction was also achieved at PT-7S, the shallow monitoring well 135 feet from the shallow injection location, and at PT-8D, the deep monitoring well located 75 feet from the deep injection location. The weakest reduction was observed at well PT-8M, where little recirculation and TOC distribution was achieved during the pilot.

5.2.2 Secondary Byproducts

When anaerobic treatment processes are applied in situ, chemical reduction of native minerals occurs resulting in the dissolution of certain metals, including arsenic, manganese and iron. As discussed in the following section, data collected during the Uplands pilot test demonstrated that the extent of metals liberation correlates with the strength of the reducing environment that is created by injection of an organic carbon substrate, ethanol in this instance. The data collected in this pilot test provides information on how to control the dissolution of metals through the control of organic carbon dosing.

Arsenic

Arsenic was temporarily mobilized during the Upland ISPT and the extent and persistence of mobilization was dependent upon the amount of organic carbon distributed in the aquifer and the resulting strength of reducing conditions created. At monitoring wells close to the injection locations (i.e. PT-7M, PT-7D, and MW-24A), the maximum concentrations of arsenic during the ISPT ranged from 54.8 to 97.4 µg/L. Maximum TOC concentrations at these locations ranged from 8,580 to 12,900 mg/L and metal and sulfate reducing conditions were established as indicated by increased dissolved iron and manganese concentrations (discussed below) and decreased sulfate concentrations. As discussed above in Section 5.1.2, more organic carbon accumulated within the aquifer during the ISPT than had been targeted due to additional recirculation at the well, resulting in stronger reducing conditions than necessary to treat Cr(VI); this also resulted in more arsenic dissolution than if target TOC concentrations had been met.

By comparison, lower concentrations of arsenic were generated in the Floodplain ISPT (ARCADIS, 2008a) where lower concentrations of organic carbon were used (the maximum concentrations of arsenic and total organic carbon in the Floodplain ISPT were 20.8 µg/L and 1,835 mg/L, respectively). This effect was also observed in upland pilot test wells where less organic carbon was delivered (PT-7S, PT-8M and PT-8D (in these wells maximum TOC was 896 mg/L and maximum arsenic was 12.1 µg/L). With less organic carbon, the reducing conditions established in the Floodplain ISPT were not as strongly sulfate reducing, as evidenced by residual sulfate concentrations throughout the Floodplain ISPT. Together, the Floodplain and Upland ISPT results demonstrate that arsenic dissolution can be controlled by the control of organic carbon distribution in the aquifer. As discussed in Section 5.1, the hydraulic parameters and understanding of recirculation hydraulics developed in the Upland ISPT can be used to design recirculation systems and organic carbon dosing strategies to limit the dissolution of secondary byproducts in full-scale implementation and maintain concentrations comparable to what naturally occurs in the reducing fluvial sediments surrounding the Colorado River (2.6 to 49.9 µg/L, ARCADIS, 2009b).

The Upland ISPT arsenic data also indicates that the dissolution of arsenic is temporary and that concentrations within the IRZ return to baseline after consumption of the injected organic carbon. The highest concentrations of arsenic observed (82.8 µg/L in MW-24A and 97.4 µg/L in PT-7D) do not represent the concentrations of arsenic that would be continuously generated in an IRZ. Rather, these concentrations were transient occurrences associated with the initial arrival of organic carbon at those locations and concentrations decreased following this initial arrival (Figures 7 and 15). Furthermore, following the injection of organic carbon into an IRZ, arsenic concentrations return to baseline. Through the end of the test in November 2008, elevated concentrations at PT-7M, PT-7D, and PT-8S (54.8, 46.6, and 43.8 µg/L, respectively) correlate with the persistence of several hundred mg/L of organic carbon, whereas arsenic concentrations decreased to less than 25 µg/L in November in MW-24A, concurrent with the return of TOC concentrations to less than 100 mg/L..

Iron and Manganese

Similar to arsenic, iron and manganese were dissolved into groundwater in locations where significant organic carbon was distributed and maintained within the hydraulic influence of the recirculation wells (PT-7S/M/D, PT-8S, and MW-24A) and downgradient of the influence of the recirculation wells (PT-9S). As with arsenic, higher maximum concentrations of manganese (21,400 µg/L at PT-7M) and iron (11,200 µg/L) were observed in the Upland ISPT than maximum concentrations of manganese (10,600 µg/L) and iron (2,260 µg/L) that were observed in the deep aquifer zone in the Floodplain ISPT. The higher concentrations in the Upland ISPT were due to the accumulation of higher concentrations of TOC in the aquifer than targeted. As with arsenic, control of organic carbon dosing can be used to limit the dissolution of manganese and iron in full-scale implementation and maintain concentrations comparable to what naturally occurs in the reducing fluvial sediments surrounding the Colorado River (manganese ranges from <1 to 9,260 µg/L and iron from less than 20 to 30,000 µg/L, ARCADIS 2009b).

The Upland ISPT concentration trends indicate that the dissolution of manganese and iron is temporary and that concentrations within the IRZ return to baseline after consumption of the injected organic carbon. In monitoring wells PT-7S/M/D, PT-8S, and MW-24A, decreasing manganese concentrations correlated with decreasing organic carbon concentrations. Iron concentrations also exhibited decreasing concentration trends (Figure 5, 6, 7, 8, and 15).

5.3 Formation of Reducing Conditions and Residual Cr(VI)-Reducing Capacity

5.3.1 Evidence of Formation of Reducing Capacity from Groundwater Data

In addition to testing the reduction of Cr(VI) during operations, the pilot program will provide further data related to residual reducing capacity associated with reduced mineral formation. Long term monitoring of the ISPT will be used to evaluate the degree to which Cr(VI)-reducing capacity was formed during the ISPT. Reducing capacity refers to solid phases that remain in place and reduce Cr(VI) as groundwater flushes through the area; and the solid phase may include reduced iron and sulfide minerals and/or biomass.

Increases in concentrations of dissolved iron, particularly in the wells where TOC distribution was greatest (PT-7M, PT-7D, PT-8S and MW-24A), indicate that iron reduction was stimulated by ISPT operation and that this form of reducing capacity was generated. As observed with the dissolution of iron, sulfate reduction was highly pronounced in the areas closest to the recirculation wells (PT-7M, PT-7D, PT-8S and MW-24A) where TOC distribution was the greatest and to a lesser extent in areas where TOC distribution was not as strong (PT-7S, PT-8S, PT-9S, PT-8D). Greater longevity of chromium reduction is expected in locations where the greater distribution of organic carbon stimulated more iron and sulfate reduction. This expectation will be evaluated through post-pilot test monitoring.

5.3.2 Evidence of Formation of Reducing Capacity from Soil Data

Baseline soil data is presented in Table 8. The analysis of post-test samples is on-going. Results and interpretation will be presented in the next quarterly report for the post-pilot test monitoring program.

6.0 Future Groundwater Sampling and Reporting Plan

The Monitoring and Reporting Program (MRP) under Order No. R7-2007-0015 requires quarterly post-pilot monitoring and reporting for one year. The first quarterly event in 2009 occurred the week of February 2 through 6. The results of this event and all subsequent quarterly events will be submitted on the following dates: April 15th, July 15th, October 15th, and January 15th.

The proposed quarterly monitoring plan for 2009 is presented in Table 10.

7.0 Data Gaps

There were no data gaps or deficiencies in the monitoring system or reporting program.

On July 16, 2008, a system alarm went off notifying ARCADIS that the system was not operating. On July 17, 2008, the system was inspected, but the alarm could not be turned off. It is suspected that the alarm was triggered after a heavy rain storm in the area produced standing water in the well vault, submerging a water level switch which resulted in a malfunction and system shutdown. As a result, groundwater was not recirculated from July 16 through July 22, when the system was brought back on-line. The water level switches were also replaced to reduce the potential for another malfunction.

On August 11, 2008, a system alarm was activated indicating the system was not operating; system operation resumed on August 13, 2008. It is suspected a power failure at the Site caused the system to shutdown.

A list of unexpected occurrences during sampling or sample analysis is described below:

- For a period during tracer testing, fluorescein was injected into PTR-2 rather than Rhodamine WT.
- On April 29, 2008, the sample IDs for wells PT-7S and PT-7M were mistakenly switched in the field.
- On October 16, 2008, samples collected at PT-7M and PT-7D were collected as grab samples because field staff was unable to effectively purge the wells.
- The dilution-run for sample PT-9S collected on October 15, 2008, was analyzed two days past the holding time for Nitrate-N.

8.0 Conclusions

This report summarizes the results of the Upland ISPT, and presents the primary evaluation of the effectiveness of the pilot study as required by the WDR.

The results of the Upland ISPT demonstrated that ethanol injections can successfully reduce dissolved chromium concentrations by precipitating chromium. Secondary byproduct data was collected and indicated that the generation of secondary byproducts within IRZs can be managed through control of the distribution of the organic carbon substrate.

In addition, the ISPT results demonstrated that dual-screen recirculation wells can successfully distribute reagents between adjacent recirculation wells spaced approximately 140 feet apart. Quantitative modeling based on the recirculation hydraulics observed during the ISPT indicated that reagent distribution can be further improved by modifying recirculation rates, minor changes in well construction, and by optimizing recirculation well spacing. The modeling also demonstrated its usefulness as a tool for testing hypotheses and then optimizing operations of the field system. The recirculation well design for full-scale application should be flexible to allow for optimization of operation based on conditions likely to be encountered in new locations. For instance, the use of wells with multiple screens would allow for flexibility in the vertical spacing of screens and control of vertical recirculation by packering off specific sections after testing hydraulic characteristics of the new location. The understanding of recirculation hydraulics developed during the ISPT and the improved modeling capability resulting from analysis of the ISPT data can be used to optimize any full-scale system designs that incorporate recirculation wells for carbon distribution in an IRZ.

9.0 References

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March 31, 2005.

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10.0 Certification

PG&E submitted a signature delegation letter to the RWQCB on July 5, 2006. The letter delegated PG&E's signature authority to Mr. Curt Russell and Ms. Yvonne Meeks.

Certification Statement:

I declare under the penalty of law that I have personally examined and am familiar with the information submitted in this document, and that based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of a fine and imprisonment for knowing violations.

Signature:

Yvonne Meeks

Name: Yvonne Meeks
Company: PG&E
Title: Project Manager
Date: March 3, 2009

Table 1
Boring and Well Construction Detail Summary
PG&E Topock
Needles, California
Upland Reductive Zone In-Situ Pilot Test Final Completion Report

Well or Boring Designation	Date Completed	Aquifer Zone	Ground Elevation* (feet msl)	TOC Elevation** (feet msl)	Total Depth of Boring (feet bgs)	Casing Diameter (inches)	Boring Diameter (inches)	Well Completion Depth (feet bgs)	Well Completion Elevation (feet msl)	Screen Depth Interval (feet bgs)	Screen Elevation Interval (feet msl)	Sand Pack Depth Interval (feet bgs)	Sand Pack Elevation Interval (feet msl)	Bentonite Depth Interval (feet bgs)	Bentonite Elevation Interval (feet msl)	Well Permit Number	Distance From PTR-1 (feet)	Distance From PTR-2 (feet)	Latitude	Longitude
PT-7S	11-May-07	S	-	561.04	155	2	6	230	330.54	130-150	411-431	129-155	432-406	127-129	434-432	2007040400	17	122	34.71663	-114.49390
PT-7M	11-May-07	M	-	560.66***	187.5	2	6	187.5	373.66	165-185	376-396	164-187	397-374	162-164	399-397	2007040401	20	118	34.71662	-114.49391
PT-7D	11-May-07	D	-	560.46	221.5	2	6	230	330.42	197-217	343-363	196-221.5	364-338.5	194-196	366-364	2007040402	17	122	34.71663	-114.49390
PT-8S	21-May-07	S	-	562.60	152	2	6	225	337.60	127-147	416-436	126-152	437-411	124-126	439-437	2007040403	68	70	34.71650	-114.49382
PT-8M	21-May-07	M	562.47	562.59	184.5	2	6	184.5	378.09	162-182	381-401	161-184.5	402-378.5	159-161	404-402	2007040404	67	71	34.71651	-114.49381
PT-8D	21-May-07	D	-	562.07	212.5	2	6	225	337.07	190-210	353-373	189-212.5	374-350.5	187-189	376-374	2007040405	68	70	34.71650	-114.49382
PT-9S	6-Jun-07	S	-	559.68	153	2	6	218	341.67	128-148	412-432	126-153	434-407	120-126	440-434	2007040406	119	180	34.71684	-114.49362
PT-9M	6-Jun-07	M	559.50	559.67	187	2	6	187	372.67	162-182	378-398	158-187	402-373	155-158	405-402	2007040407	116	181	34.71684	-114.49364
PT-9D	6-Jun-07	D	559.56	559.66	212.5	2	6	218	341.66	190-210	350-370	188-212.5	372-347.5	156-188	404-372	2007040408	120	181	34.71684	-114.49362
MW-11	30-Jun-97	S	-	522.19	86.5	4	6	84	438.19	62-82	460-480	59-83	522.83-509.83	55-59	467.19-463.19	-	179	282	-	-
MW-24A	13-May-96	S	-	567.44	124.5	4	-	124.5	441.50	104-124	443-463	99-124.5	441.5-416.5	91-99	475-467	-	131	12	-	-
MW-24B	16-May-98	D	-	565.18	217.5	4	-	217.5	348.50	193-213	373-393	188-217.5	378-348.5	182.5-188	383.5-378	-	127	59	-	-
MW-38S	11-Apr-04	S	522.8	526.66	130	2	-	130	400.00	75-95	432-452	70-95.3	460-434.7	65-70	465-460	-	308	270	34.718640	-114.494285
MW-38D	10-Apr-04	D	523.0	526.74	195	2	-	195	335.00	166-188	364-384	152.8 - 188.3	377.2-341.7	147-152.8	383-377.2	-	323	280	34.715851	-114.494402
PTR-1	2-May-07	S/D	554***	560.21	225	6	10	225	335.21	125-160 175-220	435-470 340-385	123-162 173-225	442-403 392-340	118-123 162-173	442-437 398-387	2007040409	0	138	34.71666	-114.49395
PTR-2	2-May-07	S/D	554***	564.94	223	6	10	223	341.94	118-158 173-218	407-447 347-392	117-159 172-223	448-406 393-218	115-117 159-172	450-448 406-393	2007040410	138	0	34.71634	-114.49369

NOTES

feet bgs	Feet below ground surface
feet msl	Feet mean sea level
PTI-	Pilot test injection well
PT-	Pilot test monitoring well
S	Shallow
M	Middle
D	Deep
TOC	Top of casing
*	Elevations are in feet, North American Vertical Datum of 1988 (NAVD 88), NGS data sheet EU0763.
**	Reference elevation
***	Elevations are approximate, resurvey in progress
-	Not available

Table 2
Recirculation Flowrates
PG&E Topock
Needles, California
Upland Reductive Zone In-Situ Pilot Test Final Completion Report

Date	PTR-1 Recirculation Rate (gpm)	PTR-2 Recirculation Rate (gpm)
3/1/2008	0.0	0.0
3/5/2008	26.2	29.8
3/6/2008	27.8	29.2
3/10/2008	27.3	29.2
3/11/2008	27.3	29.6
3/12/2008	30.4	28.8
3/18/2008	--	--
3/19/2008	29.8	--
3/20/2008	28.7	27.3
3/25/2008	28.1	30.4
3/27/2008	28.0	30.8
4/1/2008	30.1	31.8
4/3/2008	30.3	31.6
4/4/2008	30.4	29.2
5/13/2008	22.2	28.8
5/14/2008	22.6	28.8
5/15/2008	22.3	25.9
5/19/2008	22.8	24.9
5/27/2008	21.8	25.7
5/29/2008	25.1	28.9
6/3/2008	24.9	27.5
6/10/2008	24.6	26.2
6/19/2008	24.6	25.5
6/24/2008	22.7	21.0
6/25/2008	22.9	23.1
6/26/2008	23.0	23.0
7/1/2008	23.7	23.2
7/24/2008	19.2	22.3
8/19/2008	20.2	22.8
8/21/2008	21.1	22.8
8/25/2008	19.8	21.9
9/3/2008	20.3	24.6
9/11/2008	21.1	21.1
9/23/2008	22.2	25.1
9/30/2008	23.3	17.7
10/8/2008	22.3	24.4
10/14/2008	20.2	19.5
10/15/2008	22.2	19.5
10/16/2008	24.7	25.8
10/22/2008	27.0	27.2
10/23/2008	23.1	20.1
10/28/2008	19.7	14.9
10/29/2008	24.2	16.1
10/30/2008	24.2	14.7
11/4/2008	23.1	18.5
11/6/2008	27.1	20.2
11/11/2008	6.8	23.0
11/13/2008	22.7	21.7
11/20/2008	23.9	22.2
11/25/2008	23.4	16.3
12/1/2008	0.0	0.0

Notes	
gpm	gallons per minute
--	flowrate not recorded

Table 3

Injection of 40 Percent Ethanol Detail Summary

PG&E Topock

Needles, California

Upland Reductive Zone In-Situ Pilot Test Final Completion Report

Date Range	PTR-1		PTR-2	
	Total Volume Injected (gal)	Average Injection Rate (gpd)	Total Volume Injected (gal)	Average Injection Rate (gpd)
March 1 - June 2	8,912	95	8,912	95
June 3 - August 5	0	0	0	0
August 6 - October 13	0	0	1,698	25
October 14 - October 27	0	0	751	54
October 28 - November 6	336	67	336	67

Totals	PTR-1 Total Volume Injected (gal)	PTR-2 Total Volume Injected (gal)
	9,247	11,696

NOTES	
gpd	gallons per day
gal	gallons

Table 4
Summary of Field Parameters
PG&E Topock
Needles, California
Upland Reductive Zone In-Situ Pilot Test Final Completion Report

Location Name	Sample Date	Sample Type	Screen Interval (ft bgs)	ORP (mV)	pH	Specific Conductance (µS/cm)	Temperature (ºC)	DO (mg/L)	Depth to Water (feet below TOC)	Hexavalent Chromium Field (µg/L)
PT-7S	18-Jul-07	N	130-150	-62.7	7.67	5,697	31.25	4.13	103.58	920
	22-Jan-08	N		132	7.60	4,369	23.5	4.12	105.75	1,760
	06-Mar-08	N		-70.4	7.26	5,514	29.47	0.54	105.11	1,800
	13-Mar-08	N		-112.4	7.32	4,860	29.6	0.15	104.98	1,400
	18-Mar-08	N		-114.1	7.42	5,328	29.6	0.075	104.89	1,280
	25-Mar-08	N		-55.9	7.43	5,235	29.69	0.87	104.66	1,680
	02-Apr-08	N		-179.1	7.50	5,577	29.68	0.41	104.78	1,700
	17-Apr-08	N		-161.8	7.37	5,682	27.01	0.66	104.26	1,340
	29-Apr-08	N		-210.6	7.37	4,804	29.75	0.35	103.33	220
	15-May-08	N		-155.6	7.35	5,090	30.1	0.38	103.72	1,040
	29-May-08	N		-143	7.33	5,781	29.88	0.33	103.77	1,440
	11-Jun-08	N		41.6	7.27	5,694	29.95	0.72	103.64	1,800
	24-Jun-08	N		0.2	6.83	5,044	30.11	0.16	103.55	1,060
	23-Jul-08	N		22.8	7.47	5,503	30.13	0.18	103.59	201
	21-Aug-08	N		-92.0	7.39	6,500	30.15	0.67	103.53	820
	18-Sep-08	N		-165.8	7.54	5,479	28.63	0.79	104.22	489
	15-Oct-08	N		5363.0	7.20	5,362	29.97	0.32	104.48	<10
	12-Nov-08	N		-109.4	7.60	5,897	29.93	0.17	104.78	280
PT-7M	19-Jul-07	N	165-185	-40.2	7.76	7,224	33.99	3.75	103.90	1,480
	24-Jan-08	N		10.6	7.17	9,257	30.06	0.85	105.79	2,840
	06-Mar-08	N		-487	7.34	6,818	29.91	0.07	105.48	22
	13-Mar-08	N		-280.12	6.99	6,650	29.99	0.08	105.06	240
	18-Mar-08	N		-324.9	6.85	6,870	30.21	0.057	105.07	86
	25-Mar-08	N		-320.6	6.75	6,806	30.25	0.46	104.67	37
	02-Apr-08	N		-338.3	7.01	7,208	30.20	0.13	104.83	220
	17-Apr-08	N		-231.4	6.85	6,980	28.00	0.55	104.31	80
	29-Apr-08	N		-278.6	6.89	6,610	30.55	0.36	101.26	1,020
	14-May-08	N		-254.3	6.72	7,802	30.82	0.13	103.80	80
	29-May-08	N		-213.9	6.76	7,526	30.81	0.22	103.72	60
	11-Jun-08	N		-199.3	6.77	6,879	31.07	0.27	83.83	27
	19-Jun-08	N		-239.1	6.74	8,241	31.02	0.08	102.84	---
	25-Jun-08	N		-161.8	6.66	7,973	31.11	0.13	79.51	35
	01-Jul-08	N		-217.2	6.61	7,604	31.41	0.04	97.30	---
	23-Jul-08	N		-187.9	6.68	7,417	31.48	0.13	88.72	14
	21-Aug-08	N		-189.2	6.72	8,498	31.49	0.32	103.48	160
	18-Sep-08	N		-231.0	6.78	7,506	31.57	0.57	104.51	37
	15-Oct-08	N		-199.3	7.29	7,931	25.91	1.05	103.89	419
	12-Nov-08	N		-35.9	6.82	5,974	22.76	0.94	104.77	<10

Table 4
Summary of Field Parameters
PG&E Topock
Needles, California
Upland Reductive Zone In-Situ Pilot Test Final Completion Report

Location Name	Sample Date	Sample Type	Screen Interval (ft bgs)	ORP (mV)	pH	Specific Conductance (µS/cm)	Temperature (ºC)	DO (mg/L)	Depth to Water (feet below TOC)	Hexavalent Chromium Field (µg/L)
PT-7D	18-Jul-07	N	197-217	-76.7	7.91	16,327	31.46	1.9	103.65	6,240
	24-Jan-08	N		10.9	7.86	19,260	30.35	0.58	105.90	9,280
	06-Mar-08	N		-322.8	7.97	12,840	30.3	0.05	105.53	568
	13-Mar-08	N		-189.4	7.76	1,138	30.43	0.07	105.04	360
	18-Mar-08	N		-379.8	7.28	12,933	30.46	0.58	105.00	58
	25-Mar-08	N		-320.4	7.19	13,090	30.53	0.74	104.75	35
	02-Apr-08	N		-313	7.50	13,818	30.53	0.05	104.83	140
	17-Apr-08	N		-310.1	7.01	10,406	28.2	0.42	104.11	360
	29-Apr-08	N		-311.3	7.05	9,035	30.79	0.63	94.86	260
	15-May-08	N		-424.7	6.68	10,224	31.02	0.36	103.76	100
	29-May-08	N		-330.7	6.68	10,985	31.03	0.32	101.80	100
	11-Jun-08	N		-274.9	6.78	8,920	31.38	0.29	84.54	23
	19-Jun-08	N		-372.1	6.70	10,173	31.44	0.09	102.18	---
	24-Jun-08	N		-248.9	6.51	8,952	31.2	0.1	86.30	54
	01-Jul-08	N		-290.4	6.65	9,071	31.44	0.05	102.94	---
	23-Jul-08	N		-189.2	6.67	8,509	31.72	0.12	80.54	18
	21-Aug-08	N		-256.3	7.00	8,647	32.01	0.15	103.69	180
	18-Sep-08	N		-258.8	6.65	9,188	30.00	0.28	103.66	<10
	14-Oct-08	N		-205.6	6.14	8,508	28.54	0.45	103.64	78
	12-Nov-08	N		-195.0	7.71	8,290	21.15	0.33	104.58	18
PT-8S	16-Jul-07	N	127-147	-66.4	7.90	5,389	31.07	7.02	105.29	1,670
	23-Jan-08	N		109.1	7.49	5,890	29.44	5.68	107.38	1,980
	05-Mar-08	N		-68.6	7.71	5,440	29.61	2.77	107.00	1,040
	13-Mar-08	N		131	7.34	4,969	29.72	0.26	106.61	390
	18-Mar-08	N		-145.9	7.64	5,024	29.61	0.48	106.47	162
	25-Mar-08	N		-43	7.51	4,795	29.54	0.49	106.39	306
	02-Apr-08	N		-176.3	7.53	5,101	29.57	0.08	106.31	1,080
	16-Apr-08	N		44.8	7.48	5,251	27.89	0.56	105.91	667
	29-Apr-08	N		-132.9	7.19	6,017	29.58	0.26	106.87	180
	14-May-08	N		-204.5	7.11	6,480	29.78	0.21	105.41	60
	28-May-08	N		-276.3	7.72	6,949	29.58	0.46	105.45	32
	11-Jun-08	N		-252.7	6.61	9,212	29.63	0.36	105.41	18
	19-Jun-08	N		-296.4	6.90	9,079	29.68	0.11	105.41	---
	25-Jun-08	N		-217.8	6.66	10,733	30.1	0.14	105.29	46
	01-Jul-08	N		-178.9	6.85	9,835	29.97	0.09	105.33	---
	23-Jul-08	N		-204.0	6.99	10,853	30	0.13	105.16	500
	20-Aug-08	N		-188.9	6.94	9,860	30	1.89	105.41	12
	17-Sep-08	N		-165.6	6.79	9,114	30	6.79	103.60	<10
	15-Oct-08	N		-145.7	6.92	9,055	28	0.49	106.10	28
	12-Nov-08	N		-82.3	7.08	9,443	25	0.99	106.44	11

Table 4
Summary of Field Parameters
PG&E Topock
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Location Name	Sample Date	Sample Type	Screen Interval (ft bgs)	ORP (mV)	pH	Specific Conductance (µS/cm)	Temperature (ºC)	DO (mg/L)	Depth to Water (feet below TOC)	Hexavalent Chromium Field (µg/L)
PT-8M	18-Jul-07	N	162-182	54.9	7.18	6,698	29.67	2.9	105.18	3,740
	23-Jan-08	N		36.1	7.17	8,047	29.95	1.72	107.30	4,660
	05-Mar-08	N		-96.4	7.40	7,930	29.89	1.68	107.10	3,680
	13-Mar-08	N		145.3	7.14	6,886	29.84	2.52	106.72	4,060
	19-Mar-08	N		164.5	7.34	7,238	29.87	3.64	106.65	3,340
	25-Mar-08	N		-6.1	7.19	6,955	29.99	2.77	106.30	4,100
	02-Apr-08	N		-129.7	7.23	7,308	29.81	1.47	106.24	4,100
	16-Apr-08	N		8.7	7.14	7,230	28.4	1.55	105.98	4,080
	29-Apr-08	N		-49.6	7.04	6,453	29.81	3.02	103.26	4,120
	14-May-08	N		-35.1	6.98	6,939	30.00	2.90	105.59	3,820
	28-May-08	N		-69.4	7.13	7,094	29.93	3.95	105.37	4,220
	11-Jun-08	N		-38.0	7.06	6,769	29.95	2.23	105.35	3,860
	19-Jun-08	N		-75.5	7.02	7,437	29.99	0.15	105.73	---
	25-Jun-08	N		23	6.89	6,634	30.19	0.85	76.50	4,140
	01-Jul-08	N		-22.2	6.98	6,438	30.03	0.07	105.30	---
	23-Jul-08	N		-0.6	7.13	6,511	29.93	0.31	105.47	4,000
	20-Aug-08	N		-37.0	7.22	6,769	29.97	0.32	105.71	3,140
	17-Sep-08	N		-80.1	7.01	6,884	29.87	1.11	105.93	2,460
	15-Oct-08	N		-101.0	6.99	6,277	29.99	0.24	106.19	2,940
	12-Nov-08	N		15.6	6.93	6,507	29.77	0.16	106.46	2,200
PT-8D	16-Jul-07	N	190-210	-54.6	7.99	16,042	33.76	6.39	105.09	6,120
	23-Jan-08	N		24.1	7.86	17,790	30.23	0.97	107.34	6,980
	05-Mar-08	N		-128.4	8.13	18,118	30.18	0.78	107.09	6,220
	13-Mar-08	N		195	7.85	1,589	30.3	1.21	106.80	5,740
	18-Mar-08	N		-57.3	7.93	17,392	30.28	1.34	106.77	5,460
	25-Mar-08	N		-34	7.87	16,250	30.32	0.77	106.45	5,700
	02-Apr-08	N		-169.2	7.90	16,964	30.15	0.29	107.17	4,800
	16-Apr-08	N		-39.1	7.85	17,458	28.44	0.90	106.13	6,480
	29-Apr-08	N		-108.1	7.74	15,000	30.39	0.71	105.91	4,940
	14-May-08	N		-99.5	7.57	14,622	30.37	0.32	105.89	3,800
	28-May-08	N		-52.9	7.79	16,139	30.24	0.39	105.50	1,220
	11-Jun-08	N		-89.7	7.75	15,420	30.36	0.43	106.56	3,960
	19-Jun-08	N		-129.8	7.76	16,400	30.4	0.26	105.63	---
	25-Jun-08	N		-163.9	7.49	14,750	30.38	0.23	104.57	2,920
	01-Jul-08	N		-155.5	7.71	15,337	30.47	0.18	105.20	
	23-Jul-08	N		-110.3	7.93	15,325	30.41	0.20	104.97	3,660
	20-Aug-08	N		-156.0	8.04	16,099	30.35	0.38	105.69	4,100
	17-Sep-08	N		-192.7	7.86	15,196	30.24	0.42	106.06	3,820
	15-Oct-08	N		-244.3	7.25	13,194	30.10	0.73	106.76	512
	12-Nov-08	N		-109.4	7.44	15,128	30.13	0.16	106.34	596

Table 4
Summary of Field Parameters
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Location Name	Sample Date	Sample Type	Screen Interval (ft bgs)	ORP (mV)	pH	Specific Conductance (µS/cm)	Temperature (ºC)	DO (mg/L)	Depth to Water (feet below TOC)	Hexavalent Chromium Field (µg/L)
PT-9S	17-Jul-07	N	128-148	-61.5	7.86	4,919	33.28	4.97	102.33	2,620
	22-Jan-08	N		157.1	7.53	4,784	27.16	3.97	104.50	1,580
	05-Mar-08	N		41.8	7.71	4,942	25.95	4.21	104.08	1,360
	12-Mar-08	N		144.6	7.62	4,280	27.81	3.12	103.80	1,480
	19-Mar-08	N		125.6	7.73	4,819	27.07	2.68	103.71	1,200
	26-Mar-08	N		25.1	7.54	4,106	27.92	3.1	103.47	1,580
	02-Apr-08	N		-34.4	7.60	4,822	27.91	3.2	103.38	1,540
	16-Apr-08	N		149.3	7.50	4,800	27.79	2.79	103.09	1,640
	29-Apr-08	N		180.4	7.44	4,350	28.55	5.99	107.00	1,360
	14-May-08	N		-57.5	7.44	4,369	28.23	2.91	102.56	1,240
	28-May-08	N		2.0	7.52	4,840	28.61	2.78	102.48	1,540
	11-Jun-08	N		146.1	7.50	4,511	26.51	4.74	102.50	1,540
	25-Jun-08	N		21.4	7.30	4,778	28.86	3.91	102.27	1,420
	24-Jul-08	N		123.4	7.63	4,490	29.7	4.79	102.54	1,740
	20-Aug-08	N		-9.6	7.74	4,499	29.97	4.54	102.87	1,760
	17-Sep-08	N		154.4	7.43	4,908	27.72	2.86	103.00	1,880
	15-Oct-08	N		114.0	7.47	4,660	28.37	4.94	103.32	1,100
	12-Nov-08	N		-2.3	7.37	5,912	25.66	3.15	103.53	760
PT-9M	17-Jul-07	N	162-182	-57.0	7.34	6,605	31.74	4.09	102.34	3,460
	22-Jan-08	N		58.8	7.03	7,963	30.05	3.34	104.49	3,000
	05-Mar-08	N		-41.7	7.37	7,982	29.99	3.06	104.10	2,100
	12-Mar-08	N		120.5	7.14	7,080	29.87	3.46	103.86	2,740
	19-Mar-08	N		48.9	7.28	7,710	30.08	3.03	103.69	2,420
	26-Mar-08	N		110.2	7.10	6,572	29.88	3.56	103.48	2,480
	02-Apr-08	N		55.7	7.08	7,798	29.81	2.34	77.22	2,800
	16-Apr-08	N		40.3	7.09	7,653	29.28	2.07	78.96	2,940
	29-Apr-08	N		-1.2	7.04	6,791	29.96	3.95	98.07	2,760
	14-May-08	N		-17.0	6.94	7,633	30.13	3.59	102.80	2,760
	28-May-08	N		-6.8	7.09	7,593	29.99	3.65	102.40	2,640
	11-Jun-08	N		70.1	7.00	7,238	30.13	4	90.56	2,980
	25-Jun-08	N		23.1	6.91	6,977	30.08	4.1	102.75	2,800
	24-Jul-08	N		198.7	7.27	6,706	30.01	4.57	102.47	2,800
	20-Aug-08	N		6.3	7.20	7,282	30.02	3.83	102.82	2,800
	17-Sep-08	N		111.3	7.07	7,304	29.85	4.04	103.06	2,860
	15-Oct-08	N		66.9	7.11	6,726	29.73	3.73	103.27	3,280
	12-Nov-08	N		71.3	7.14	7,152	29.85	2.95	103.36	3,180

Table 4
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Location Name	Sample Date	Sample Type	Screen Interval (ft bgs)	ORP (mV)	pH	Specific Conductance (µS/cm)	Temperature (ºC)	DO (mg/L)	Depth to Water (feet below TOC)	Hexavalent Chromium Field (µg/L)
PT-9D	17-Jul-07	N	190-210	-74.8	7.87	14,027	31.46	1.14	102.18	10,050
	22-Jan-07	N		47.9	7.76	17,070	30.4	1.23	104.38	17,080
	05-Mar-08	N		-85.7	8.05	17,396	30.44	0.98	104.12	15,820
	12-Mar-08	N		198.4	7.78	1,541	30.16	1.52	103.89	14,060
	19-Mar-08	N		71.3	7.94	16,747	30.35	0.97	103.80	13,580
	26-Mar-08	N		35.2	7.81	13,975	30.39	0.98	103.50	12,220
	02-Apr-08	N		-93	7.83	16,109	30.41	0.51	105.17	13,980
	16-Apr-08	N		44.1	7.76	12,223	29.4	1.25	103.31	14,130
	29-Apr-08	N		-53.9	7.60	14,014	30.31	0.96	102.82	10,790
	14-May-08	N		-89.2	7.56	15,231	30.44	0.7	102.92	10,850
	28-May-08	N		101.2	7.68	15,667	30.34	0.8	102.51	14,450
	11-Jun-08	N		107.6	7.62	15,590	30.11	1.15	85.69	13,660
	25-Jun-08	N		14.2	7.45	14,474	30.46	0.68	102.49	10,400
	24-Jul-08	N		162.4	7.65	14,681	30.34	0.77	102.05	10,780
	20-Aug-08	N		17.7	7.84	16,555	30.46	1.15	102.87	14,400
	17-Sep-08	N		136.6	7.73	15,588	30.32	1.2	103.11	15,180
	15-Oct-08	N		80.0	7.52	13,691	30.06	2.56	103.36	9,300
	12-Nov-08	N		80.7	7.64	16,534	30.19	0.69	103.42	13,900
MW-11	17-Jul-07	N	63-88	-23.7	7.56	2,176	30.15	8.81	65.60	260
	24-Jan-08	N		137.3	7.40	2,312	28710	7.61	67.67	342
	04-Mar-08	N		51.6	7.47	2,262	28.79	0.93	67.09	350
	11-Mar-08	N		149.2	7.44	2,169	29.81	7.1	66.97	319
	19-Mar-08	N		29.5	7.61	2,279	29.27	5.59	66.85	340
	26-Mar-08	N		110.2	7.37	2,205	29.52	7.91	66.62	360
	01-Apr-08	N		-48.8	7.47	4,194	29.17	6.44	66.60	334
	15-Apr-08	N		66.5	7.24	2,097	30.06	5.66	66.06	326
	28-Apr-08	N		-23.2	7.41	20	29.86	9.03	65.82	322
	13-May-08	N		-35.9	7.24	2,351	30.04	6.76	65.83	420
	27-May-08	N		32.1	7.24	2,208	29.87	9.66	65.64	380
	10-Jun-08	N		-11.3	7.20	2,196	30.73	8.14	65.49	302
	24-Jun-08	N		54.6	7.01	2,287	29.17	8.96	65.54	252
	22-Jul-08	N		125.8	7.40	2,370	29.35	6.71	65.63	299
	21-Aug-08	N		151.7	7.43	2,210	29.49	8.68	65.84	285
	16-Sep-08	N		-43.3	7.32	2,203	29.37	7.51	66.10	269
	14-Oct-08	N		43.0	7.42	2,120	29.37	6.43	66.36	337
	11-Nov-08	N		144.3	7.69	2,161	29.21	5.87	66.78	343

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Location Name	Sample Date	Sample Type	Screen Interval (ft bgs)	ORP (mV)	pH	Specific Conductance (µS/cm)	Temperature (ºC)	DO (mg/L)	Depth to Water (feet below TOC)	Hexavalent Chromium Field (µg/L)
MW-24A	18-Jul-07	N	104-124	-43.9	7.67	2,707	32.20	2.89	110.05	1,100
	24-Jan-08	N		79.8	7.51	3,090	28.51	1.95	112.20	2,980
	06-Mar-08	N		-119.7	7.45	10,486	29.02	0.61	111.33	325
	12-Mar-08	N		-201.4	7.44	9,758	31.2	0.2	111.50	14,060
	19-Mar-08	N		-250.7	7.04	9,950	30.13	0.16	111.48	111
	26-Mar-08	N		-299.6	6.54	8,402	30.7	0.39	111.25	173
	01-Apr-08	N		-299.1	7.06	1,638	30.6	0.04	---	440
	17-Apr-08	N		-285.9	6.62	10,291	30.9	1.39	110.85	160
	30-Apr-08	N		-315.7	6.45	10,294	32.03	1.46	110.15	220
	30-Apr-08	FD		-315.7	6.45	10,294	32.03	1.46	110.15	220
	15-May-08	N		-350.1	6.54	10,940	33.47	0.44	109.82	120
	27-May-08	N		-278.1	6.33	10,759	32.8	1.29	110.20	<10
	12-Jun-08	N		-259.9	6.70	10,910	32.6	0.8	111.66	<10
	19-Jun-08	N		-222.4	6.49	11,469	32.81	1.28	110.28	---
	26-Jun-08	N		-228.5	7.20	107	30.84	0.17	110.13	18
	01-Jul-08	N		-320.4	6.82	10,282	31.3	0.07	109.73	---
	24-Jul-08	N		-224.9	7.57	10,670	32.38	0.32	110.26	180
	19-Aug-08	N		-302.5	7.20	10,311	33.74	2.06	110.53	17
	16-Sep-08	N		-343.8	6.54	9,799	30.03	0.31	110.78	50
	16-Oct-08	N		-259.4	7.01	10,626	30.91	0.70	111.11	123
	13-Nov-08	N		-284.9	7.57	10,952	27.05	0.44	111.33	<10
MW-24B	18-Jul-07	N	193-213	-57.9	7.86	15,371	31.40	3.02	107.92	2,340
	24-Jan-08	N		-9.7	7.74	17,450	29.91	0.85	109.75	5,400
	06-Mar-08	N		28.1	7.73	17,751	28.05	1.49	110.20	4,400
	12-Mar-08	N		-19.4	7.78	1,669	30.62	1.11	109.47	4,800
	19-Mar-08	N		-32.7	7.90	17,369	30.16	0.78	109.22	4,460
	26-Mar-08	N		-28	7.77	14,547	30.91	88	109.23	4,700
	02-Apr-08	N		-292.2	7.77	17,340	30.13	0.54	109.00	4,420
	17-Apr-08	N		-141.4	7.77	16,429	30.42	1.09	108.60	4,640
	30-Apr-08	N		-222.7	7.79	15,539	30.45	0.85	105.82	3,800
	15-May-08	N		-82.0	7.65	17,017	30.36	0.80	108.57	3,860
	28-May-08	N		-105.4	7.76	16,854	30.25	2.54	108.14	3,940
	12-Jun-08	N		-66.6	7.72	16,160	30.23		111.23	3,980
	26-Jun-08	N		24.7	7.68	10,275	30.09	0.49	108.06	3,400
	24-Jul-08	N		-22.0	7.82	16,374	30.19	0.39	108.29	3,240
	19-Aug-08	N		-25.7	7.61	16,302	30.51	0.48	108.31	3,400
	17-Sep-08	N		-64.4	7.76	15,433	29.49	0.79	108.56	3,360
	16-Oct-08	N		88.6	7.60	15,816	31.18	1.18	109.03	3,380
	13-Nov-08	N		9.3	7.66	16,049	31.12	0.47	109.14	3,000

Table 4
Summary of Field Parameters
PG&E Topock
Needles, California
Upland Reductive Zone In-Situ Pilot Test Final Completion Report

Location Name	Sample Date	Sample Type	Screen Interval (ft bgs)	ORP (mV)	pH	Specific Conductance (µS/cm)	Temperature (ºC)	DO (mg/L)	Depth to Water (feet below TOC)	Hexavalent Chromium Field (µg/L)
MW-38S	17-Jul-07	N	75-95	27.2	7.52	3,306	29.00	6.02	69.04	720
	23-Jan-08	N		36.6	7.56	3,175	27.08	5.33	71.05	1,140
	04-Mar-08	N		150	7.59	3,194	27.72	0.57	70.71	1,200
	11-Mar-08	N		56	7.70	3,094	28.37	2.95	70.40	1,300
	20-Mar-08	N		117.6	7.71	3,218	27.3	5.31	70.43	1,140
	26-Mar-08	N		24.1	7.39	2,687	28.36	4.2	70.18	1,260
	01-Apr-08	N		-16.4	7.57	5,892	28.48	4.6	70.10	1,280
	15-Apr-08	N		116.4	7.41	2,958	28.64	3.89	69.66	1,180
	28-Apr-08	N		-88.8	7.70	2,875	29.05	5.22	69.45	1,340
	13-May-08	N		-41.3	7.38	3,213	28.62	4.18	69.27	1,120
	27-May-08	N		-20.0	7.43	3,035	28.39	4.82	69.17	1,180
	10-Jun-08	N		-14.1	7.50	2,569	28.8	1.59	66.62	1,320
	24-Jun-08	N		10.7	7.20	3,041	28.65	4.82	69.12	1,140
	22-Jul-08	N		185.1	7.54	3,045	29.33	2.85	69.10	1,280
	20-Aug-08	N		7.2	7.71	2,832	28.88	1.49	65.66	1,340
	16-Sep-08	N		80.9	7.46	2,811	29.00	1.54	69.50	1,360
	14-Oct-08	N		141.6	7.43	2,684	28.63	0.67	69.94	1,540
	11-Nov-08	N		136.7	7.77	2,701	27.87	3.71	70.18	1,440
MW-38D	17-Jul-07	N	166-188	-62.9	7.81	20,894	30.63	1.2	69.37	1,410
	23-Jan-08	N		-32.8	7.78	23,020	30.28	0.14	71.29	69
	04-Mar-08	N		-39	7.86	23,367	30.09	0.11	71.01	77
	11-Mar-08	N		-54.0	7.80	2,260	30.28	0.3	70.86	72
	20-Mar-08	N		174.8	7.95	234	30.18	0.14	70.79	54
	26-Mar-08	N		-47.9	7.77	19,673	30.4	0.18	70.53	54
	01-Apr-08	N		-79.7	8.10	42,680	30.22	0.10	67.43	53
	15-Apr-08	N		-56.2	7.65	21,852	30.06	0.50	70.83	62
	15-Apr-08	FD		-56.2	7.65	21,852	30.06	0.50	70.83	62
	28-Apr-08	N		-2.1	7.79	21,005	30.26	0.45	69.96	62
	13-May-08	N		-106.5	7.62	23,691	30.27	0.18	188.30	<10
	27-May-08	N		10.2	7.68	2,246	30.27	0.57	69.63	189
	10-Jun-08	N		36.9	7.74	21,879	30.49	0.5	69.22	64
	24-Jun-08	N		-80.4	7.80	22,824	30.32	0.17	69.58	53
	22-Jul-08	N		110.6	7.81	23,605	30.41	0.15	69.50	69
	20-Aug-08	N		89.0	7.93	22,069	30.33	0.20	69.81	66
	16-Sep-08	N		-118.3	7.73	21,191	29.29	0.39	70.07	70
	14-Oct-08	N		86.3	7.72	21,347	30.19	2.56	70.38	87
	11-Nov-08	N		159.3	7.82	21,866	30.24	0.33	68.70	71

Table 4
Summary of Field Parameters
PG&E Topock
Needles, California
Upland Reductive Zone In-Situ Pilot Test Final Completion Report

Location Name	Sample Date	Sample Type	Screen Interval (ft bgs)	ORP (mV)	pH	Specific Conductance (µS/cm)	Temperature (ºC)	DO (mg/L)	Depth to Water (feet below TOC)	Hexavalent Chromium Field (µg/L)
PTR-1	19-Jul-07	N	*	-50.9	7.91	8,927	31.2	1.6	102.65	201
	25-Jan-08	N		228.7	7.48	7,093	22.52	2.09	---	920
	06-Mar-08	N		23.2	7.77	4,750	26.9	1.2	---	641
	11-Mar-08	N		114.3	6.74	4,453	32.84	1.99	---	380
	20-Mar-08	N		-139.7	7.97	3,105	37.50	1.54	---	62
	27-Mar-08	N		185.1	7.46	1,489	31.28	3.7	---	654
	01-Apr-08	N		-215.3	7.97	10,980	33.58	1.39	---	240
	16-Apr-08	N		-42.4	7.63	4,019	33.01	0.92	---	52
	29-Apr-08	N		-232.9	7.23	4,479	28.91	0.54	---	22
	15-May-08	N		-221.6	6.98	5,158	32.1	0.60	---	120
	29-May-08	N		-107.5	7.34	4,640	36.35	0.80	---	25
	12-Jun-08	N		-159.4	7.69	5,661	33.60	1.34	---	1
	19-Jun-08	N		-119.7	7.79	6,231	38.28	0.78	---	---
	26-Jun-08	N		-113.6	7.58	5,640	38.43	1.10	---	<10
	01-Jul-08	N		-1115	7.62	5,868	39.84	1.24	---	---
	24-Jul-08	N		90.5	7.46	5,365	37.00	1.24	---	480
	19-Aug-08	N		40.8	7.44	5,752	36.86	1.60	---	<10
	18-Sep-08	N		-33.3	7.57	5,804	31.94	0.96	---	<10
	16-Oct-08	N		-74.8	7.28	6,139	38.5	1.35	---	11
	13-Nov-08	N		-23.3	7.33	4,410	33.2	1.09	---	<10
PTR-2	18-Jul-07	N	*	-56.7	7.40	9,367	30.52	1.01	110.34	2,020
	25-Jan-08	N		167.8	7.31	9,122	28.41	2.37	---	4,920
	06-Mar-08	N		33.8	7.31	1,007	28.7	1.27	---	4,800
	11-Mar-08	N		125	6.92	9,837	28.21	1.59	---	5,660
	20-Mar-08	N		-27.2	7.70	4,116	37.18	3.66	---	19,500
	27-Mar-08	N		52.8	7.76	2,146	32.21	4.4	---	8,700
	01-Apr-08	N		-46.9	7.45	1,953	36.75	1.56	---	4,240
	15-Apr-08	N		-79.1	7.42	50	33.21	2.24	---	552
	29-Apr-08	N		-82.4	7.20	10,168	26.61	2.07	---	5,320
	15-May-08	N		45.0	7.30	11,203	29.69	1.43	---	5,060
	28-May-08	N		-60.0	7.73	8,988	32.73	1.95	---	4,280
	10-Jun-08	N		69.0	7.54	10,684	37.77	1.46	---	196
	19-Jun-08	N		170.6	7.55	9,106	38.22	1.4	---	---
	26-Jun-08	N		20.9	7.32	10,484	31.34	0.79	---	4,280
	01-Jul-08	N		-54.3	7.20	10,163	37.45	0.81	---	---
	24-Jul-08	N		281.5	7.26	10,747	33.07	1.18	---	4,900
	19-Aug-08			-19.6	7.30	5,956	37.04	---	---	2,000
	18-Sep-08	N		128.9	7.37	5,782	30.6	1.49	---	2,160
	16-Oct-08	N		-154.8	7.14	10,131	28.5	0.85	---	4,440
	13-Nov-08	N		16.5	7.09	11,109	33.11	0.88	---	4,360

Table 4
Summary of Field Parameters
PG&E Topock
Needles, California
Upland Reductive Zone In-Situ Pilot Test Final Completion Report

Location Name	Sample Date	Sample Type	Screen Interval (ft bgs)	ORP (mV)	pH	Specific Conductance (µS/cm)	Temperature (ºC)	DO (mg/L)	Depth to Water (feet below TOC)	Hexavalent Chromium Field (µg/L)

NOTES

Most recent data indicated in **BOLD**

Depth to water recorded prior to any sampling activities. Recirculation wells PTR-1 and PTR-2 cannot be gauged post-construction due to necessary piping and well caps

ft bgs	Feet below ground surface
mV	Millivolts
µS/cm	Microsiemens per centimeter
ºC	Degrees Celsius
µg/L	Micrograms per liter
mg/L	Milligrams per liter
ORP	Oxidation Reduction Potential
N	Normal
DO	Dissolved oxygen
TOC	Top of Casing
---	Not analyzed/Not available
*	PTR-1 Screen: 125-160 and 175-220 ft bgs. PTR-2 Screen: 118-158 and 173-218 ft bgs.

Table 5
Summary of Primary Analytical Parameters
PG&E Topock
Needles, California
Upland Reductive Zone In-Situ Pilot Test Final Completion Report

Location Name	Sample Date	Sample Type	Hexavalent Chromium (µg/L)	Total Dissolved Chromium (µg/L)	Total Chromium (µg/L)	Fluorescein (ppb dye)	Rhodamine (ppb dye)	Nitrate-N (mg/L)	Nitrite-N (mg/L)	Total Iron (µg/L)	Dissolved Iron (µg/L)	Dissolved Manganese (µg/L)	Total Manganese (µg/L)	Sulfate (mg/L)	Total Organic Carbon (mg/L)
PT-7S	18-Jul-07	N	1,200	1,260	1,080	---	---	22.0	<0.1	6,160	<500	55.6	1,050	674	1.18
	23-Jan-08	N	1,400	1,390	---	---	---	18.7	<0.1	558	<2,500	<2,500	462	608	2.99
	06-Mar-08	N	1,420	1,270	---	---	ND	18.6	<0.1	<500	<500	<500	34	637	<1
	13-Mar-08	N	1,100	1,070	---	0.02	ND	15.4	<0.1	<500	<2,500	<2,500	<10	588	1.25
	18-Mar-08	N	1,300	1,280	---	0.64	ND	17.7	<0.1	<500	<2,500	---	11	606	1.17
	25-Mar-08	N	1,420	1,410	---	0.96	ND	19.3	<0.2	<500	<2,500	<2,500	23	630	1.88
	02-Apr-08	N	1,490	1,510	---	0.24	ND	---	---	<500	<2,500	---	---	665	<1
	17-Apr-08	N	1,320	1,280	---	2.42	ND	---	---	<500	<2,500	---	---	737	<1
	29-Apr-08	N	812	855	---	5.71	ND	13.5	0.95	<500	<500	<500	189	567	1.84
	15-May-08	N	876	868	---	2.89	ND	---	---	<500	<500	---	---	563	<1
	29-May-08	N	1,230	1,190	---	0.07	ND	18.9	<0.5	<500	<500	<500	47.9	675	<1
	11-Jun-08	N	1,580	1,350	---	0.17	ND	---	---	<500	<500	---	---	764	---
	24-Jun-08	N	927	801	---	1.04	ND	13.2	<0.5	<500	<500	<500	134	599	1.88
	23-Jul-08	N	182	190	---	25.28	3.00	4.38	<1	<500	<500	1,450	1,650	547	14.3
	21-Aug-08	N	401	398	---	338.25	0.37	9.00	<1	<500	<500	2,230	2,620	486	896
	18-Sep-08	N	429	502	---	2.18	0.12	15.00	<0.5	<500	<500	690	855	629	3.21
	15-Oct-08	N	<0.2	39	---	31.73	2.80	2.93	<0.5	604	<500	1,470	1,710	381	47.8
	12-Nov-08	N	152	316	---	15.30	1.71	11.30	<0.5	<500	<500	945	1,380	543	15.9
PT-7M	19-Jul-07	N	2,320	2,240	2,110	---	---	25.2	<0.1	6,260	<500	31.6	1,150	1,250	1.02
	24-Jan-08	N	2,440	2,340	---	---	---	30.4	<0.5	<500	<1,000	<1,000	<10	1,280	<1
	06-Mar-08	N	30	16.5	---	ND	ND	<0.5	<0.1	<500	<500	702	711	846	216
	06-Mar-08	FD	33.3	18.0	---	0.03	ND	<0.5	<0.1	<500	<500	703	714	832	213
	13-Mar-08	N	<0.2	<5	---	1,193	ND	<0.5	<0.1	<500	<2,500	3,320	3,540	656	446
	18-Mar-08	N	<0.2	<5	---	3,390	ND	<5	<1	1,040	<2,500	---	6,290	205	1,550
	25-Mar-08	N	6.9	<5	---	3,030	ND	<2.5	<0.5	1,740	<2,500	8,690	9,500	144	1,500
	02-Apr-08	N	2	<5	---	2,820	ND	---	---	2,660	<2,500	---	---	105	1,270
	17-Apr-08	N	<1	<5	---	7,650	ND	---	---	6,320	3,700	---	---	<10	4,640
	29-Apr-08	N	<1	1.08	---	8,175	ND	<10	<2	1,680	1,300	11,300	14,100	<10	8,050
	14-May-08	N	<1.1	1.52	---	7,725	ND	---	---	9,070	6,900	---	---	<20	8,040
	29-May-08	N	<1	1.34	---	4,163	ND	<10	<10	12,400	11,000	18,600	18,400	<10	10,700
	11-Jun-08	N	1.4	1.98	---	3,000	ND	---	---	15,100	10,900	---	---	11.2	8,530
	19-Jun-08	N	---	---	---	---	---	---	---	---	---	---	---	---	9,340
	25-Jun-08	N	<1	1.02	---	1,898	ND	<2.5	<2.5	18,500	13,200	21,900	26,300	<2.5	8,630
	01-Jul-08	N	---	---	---	---	---	---	---	---	---	---	---	---	8,180
	08-Jul-08	N	---	---	---	---	---	---	---	---	---	---	---	---	6,980
	15-Jul-08	N	---	---	---	---	---	---	---	---	---	---	---	---	1,810
	23-Jul-08	N	<0.2	<1	---	12.375	ND	<2.5	<2.5	27,100	19,100	24,400	26,500	3.11	5,180
	28-Jul-08	N	---	---	---	---	---	---	---	---	---	---	---	---	4,930
	21-Aug-08	N	<0.2	<1	---	1,088	ND	<2.5	<2.5	38,600	34,400	31,400	31,300	11.8	5,530
	03-Sep-08	N	---	---	---	---	---	---	---	---	---	---	---	---	2,870
	18-Sep-08	N	<0.2	<1	---	1,088	ND	<1	<1	13,600	25,100	22,900	29,200	6.65	2,930
	15-Oct-08	N	<0.2	<1	---	990	ND	<2.5	<2.5	33,600	27,800	16,100	16,300	57.8	2,210
	12-Nov-08	N	<0.2	<1	---	404	ND	<1	<1	4,090	2,690	1,100	1,190	17.5	395

Table 5
Summary of Primary Analytical Parameters
PG&E Topock
Needles, California
Upland Reductive Zone In-Situ Pilot Test Final Completion Report

Location Name	Sample Date	Sample Type	Hexavalent Chromium (µg/L)	Total Dissolved Chromium (µg/L)	Total Chromium (µg/L)	Fluorescein (ppb dye)	Rhodamine (ppb dye)	Nitrate-N (mg/L)	Nitrite-N (mg/L)	Total Iron (µg/L)	Dissolved Iron (µg/L)	Dissolved Manganese (µg/L)	Total Manganese (µg/L)	Sulfate (mg/L)	Total Organic Carbon (mg/L)
PT-7D	18-Jul-07	N	7,260	7,890	7,750	---	---	7.4	<0.1	<500	<500	48.3	54	1,140	<1
	24-Jan-08	N	8,010	7,920	---	---	---	9.9	<0.5	<500	<1,000	<1,000	14	1,150	<1
	06-Mar-08	N	506	499	---	ND	ND	<0.5	<0.1	<500	<500	<500	193	903	234
	13-Mar-08	N	80.6	160	---	1,185	ND	<0.5	<0.2	<500	<2,500	<2,500	1,050	903	313
	18-Mar-08	N	<2.1	69.3	---	780	ND	<1	<0.2	<500	<2,500	---	2,220	621	309
	25-Mar-08	N	4	17.8	---	645	ND	<1	<0.5	<500	<2,500	4,080	4,320	612	313
	02-Apr-08	N	<0.2	<5	---	578	ND	---	---	<500	<2,500	---	---	633	256
	17-Apr-08	N	22.6	7.64	---	4,163	ND	---	---	<500	<2,500	---	---	179	1,410
	29-Apr-08	N	<0.2	17.2	---	5,010	ND	<10	<2	<500	<500	2,960	3,380	98	2,920
	15-May-08	N	<1.1	1.48	---	4,088	ND	---	---	2,280	1,730	---	---	96	2,780
	29-May-08	N	<1	1.14	---	3,945	ND	<10	<10	2,660	2,000	8,860	8,850	100	1,690
	11-Jun-08	N	1.5	1.48	---	6,293	ND	---	---	4,920	2,740	---	---	50.5	4,620
	19-Jun-08	N	---	---	---	---	---	---	---	---	---	---	---	---	4,520
	24-Jun-08	N	<1	49.2	---	5,250	ND	<10	<10	10,600	1,280	9,700	11,400	12.7	4,450
	01-Jul-08	N	---	---	---	---	---	---	---	---	---	---	---	---	5,850
	08-Jul-08	N	---	---	---	---	---	---	---	---	---	---	---	---	4,580
	15-Jul-08	N	---	---	---	---	---	---	---	---	---	---	---	---	5,430
	23-Jul-08	N	<0.2	2.18	---	2,048	ND	<5	<5	7,870	5,380	18,100	19,900	<5	5,140
	28-Jul-08	N	---	---	---	---	---	---	---	---	---	---	---	---	5,140
	21-Aug-08	N	<0.2	1.13	---	1,658	ND	<2.5	<2.5	7,130	6,140	19,100	20,300	30.1	4,500
	03-Sep-08	N	---	---	---	---	---	---	---	---	---	---	---	---	5,110
	18-Sep-08	N	<0.2	3.07	---	758	ND	<1	<1	25,900	10,000	27,000	20,100	11.3	2,890
	15-Oct-08	N	<0.2	7.37	---	528	ND	<1	<1	14,300	6,150	23,700	25,400	17.0	1,640
	12-Nov-08	N	<0.2	2.8	---	318	ND	<2.5	<2.5	4,460	<500	18,200	22,100	7.8	791

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PG&E Topock
Needles, California
Upland Reductive Zone In-Situ Pilot Test Final Completion Report

Location Name	Sample Date	Sample Type	Hexavalent Chromium (µg/L)	Total Dissolved Chromium (µg/L)	Total Chromium (µg/L)	Fluorescein (ppb dye)	Rhodamine (ppb dye)	Nitrate-N (mg/L)	Nitrite-N (mg/L)	Total Iron (µg/L)	Dissolved Iron (µg/L)	Dissolved Manganese (µg/L)	Total Manganese (µg/L)	Sulfate (mg/L)	Total Organic Carbon (mg/L)
PT-8S	16-Jul-07	N	1,750	1,660	1,620	---	---	25.1	<0.1	2,670	<500	25.1	269	869	1.35
	23-Jan-08	N	1,620	1,680	---	---	---	24.9	<0.1	<500	<2,500	<2,500	<10	734	1.03
	05-Mar-08	N	1,430	1,340	---	ND	ND	22.6	<0.1	<500	<500	<500	<10	727	1.10
	13-Mar-08	N	657	657	---	ND	ND	8.4	1.61	<500	<2,500	<2,500	333	618	12.5
	18-Mar-08	N	160	164	---	ND	ND	1.7	0.82	<500	<2,500	---	1,050	561	7.18
	25-Mar-08	N	455	438	---	0.07	ND	6.2	2.42	<500	<2,500	<2,500	973	591	4.16
	02-Apr-08	N	877	884	---	ND	ND	---	---	<500	<2,500	---	---	634	1.39
	16-Apr-08	N	775	747	---	0.15	ND	---	---	<500	<2,500	---	---	408	<1
	29-Apr-08	N	76.7	95.7	---	18.60	ND	1.4	<0.2	<500	<500	2,300	2,910	560	74.3
	14-May-08	N	<0.2	18.1	---	9.60	0.35	---	---	<500	<500	---	---	481	36.0
	28-May-08	N	<0.2	2.68	---	60.00	6.92	<0.5	<2.5	532	<500	3,560	3,930	161	49.6
	28-May-08	FD	<0.2	3.05	---	62.10	6.72	<0.5	<2.5	544	<500	3,520	3,950	162	91.6
	11-Jun-08	N	1.8	4.97	---	322.5	42.6	---	---	5,530	4,210	---	---	12.7	1,100
	19-Jun-08	N	---	---	---	---	---	---	---	---	---	---	---	---	842
	25-Jun-08	N	<1	1.8	---	123	97.4	<1	<1	6,600	5,540	15,600	17,600	2.6	1,710
	01-Jul-08	N	---	---	---	---	---	---	---	---	---	---	---	---	1,740
	08-Jul-08	N	---	---	---	---	---	---	---	---	---	---	---	---	1,090
	15-Jul-08	N	---	---	---	---	---	---	---	---	---	---	---	---	1,230
	23-Jul-08	N	<0.2	<1	---	83.25	97.20	<5	<5	6,380	5,050	17,200	18,100	<5	1,210
	28-Jul-08	N	---	---	---	---	---	---	---	---	---	---	---	---	1,020
	20-Aug-08	N	<0.2	16.0	---	89.25	69.20	<1	<2.5	13,600	11,200	9,560	10,700	3.9	439
	17-Sep-08	N	<0.2	3.7	---	72.83	51.40	<1	<1	12,800	10,300	4,700	5,380	4.1	189
	15-Oct-08	N	<0.2	1.0	---	135.75	69.00	<1	<2.5	9,240	8,200	2,720	3,040	5.5	164
	12-Nov-08	N	<0.2	<1	---	83.25	49.60	<1	<1	19,700	8,090	1,640	3,030	5.2	5.41
PT-8M	18-Jul-07	N	3,960	4,120	4,140	---	---	31.8	<0.5	<500	<500	15.5	22.7	1,330	1.40
	23-Jan-08	N	4,050	4,030	---	---	---	34.9	<0.1	<500	<2,500	<2,500	<10	1,210	1.31
	05-Mar-08	N	3,820	3,910	---	ND	ND	33.9	<0.1	<500	<500	<500	<10	1,290	1.39
	13-Mar-08	N	3,870	3,870	---	ND	ND	32.4	<0.1	<500	<2,500	<2,500	<10	1,250	1.34
	19-Mar-08	N	4,030	3,850	---	ND	ND	32.6	<0.2	<500	<2,500	---	<10	1,230	1.15
	25-Mar-08	N	3,890	3,820	---	ND	ND	32.8	<0.2	<500	<2,500	<2,500	<10	1,230	1.02
	02-Apr-08	N	3,880	3,810	---	ND	ND	---	---	<500	<2,500	---	---	1,290	1.11
	16-Apr-08	N	3,670	3,730	---	ND	ND	---	---	<500	<2,500	---	---	1,280	<1
	29-Apr-08	N	3,570	3,760	---	ND	ND	31.5	<0.2	<500	<500	<500	<10	1,250	<1
	14-May-08	N	3,880	3,760	---	ND	ND	---	---	<500	<500	---	---	1,220	1.42
	28-May-08	N	3,830	3,660	---	ND	ND	12.6	<2.5	<500	<500	<500	12.8	1,010	<1
	11-Jun-08	N	2,720	3,500	---	0.32	ND	---	---	<500	<500	---	---	1,220	1.38
	19-Jun-08	N	---	---	---	---	---	---	---	---	---	---	---	---	<2
	25-Jun-08	N	3,710	3,540	---	0.02	ND	30.2	<1	<500	<500	<500	<10	1,190	1.53
	25-Jun-08	FD	3,550	3,470	---	0.02	ND	30.9	<1	<500	<500	<500	<10	1,190	1.46
	01-Jul-08	N	---	---	---	---	---	---	---	---	---	---	---	---	1.58
	23-Jul-08	N	3,620	3,480	---	0.027	ND	29.4	<1	<500	<500	<500	<10	1,130	1.55
	20-Aug-08	N	2,770	2,740	---	1.92	ND	21.8	<1	<500	<500	<500	80	1,090	2.21
	17-Sep-08	N	1,950	2,310	---	0.49	0.07	18.5	<1	<500	<500	<500	231	1,040	2.40
	15-Oct-08	N	2,900	2,780	---	0.50	0.99	26.5	<1	<500	<500	<500	16	1,110	1.64
	12-Nov-08	N	1,660	1,650	---	2.05	2.82	12.0	1.21	<500	<500	<500	314	878	2.34

Table 5
Summary of Primary Analytical Parameters
PG&E Topock
Needles, California
Upland Reductive Zone In-Situ Pilot Test Final Completion Report

Location Name	Sample Date	Sample Type	Hexavalent Chromium (µg/L)	Total Dissolved Chromium (µg/L)	Total Chromium (µg/L)	Fluorescein (ppb dye)	Rhodamine (ppb dye)	Nitrate-N (mg/L)	Nitrite-N (mg/L)	Total Iron (µg/L)	Dissolved Iron (µg/L)	Dissolved Manganese (µg/L)	Total Manganese (µg/L)	Sulfate (mg/L)	Total Organic Carbon (mg/L)
PT-8D	16-Jul-07	N	6,540	7,260	7,290	---	---	9.72	<0.2	2,620	<500	23.5	186	1,110	<1
	23-Jan-08	N	6,210	6,340	---	---	---	11.4	<0.5	<500	<5,000	<5,000	<10	1,080	<1
	05-Mar-08	N	6,510	6,600	---	ND	ND	10.7	<0.2	<500	<2,500	<2,500	<10	1,110	<1
	13-Mar-08	N	6,560	5,030	---	ND	ND	12.7	<0.5	<500	<2,500	<2,500	<10	1,270	<1
	18-Mar-08	N	5,750	5,280	---	ND	ND	11.8	<0.5	<500	<2,500	---	<10	1,130	<1
	25-Mar-08	N	5,380	5,310	---	ND	ND	12.3	<0.5	<500	<2,500	<2,500	<10	1,160	<1
	02-Apr-08	N	2,640	5,180	---	ND	ND	---	---	<500	<2,500	---	---	1,180	<1
	16-Apr-08	N	6,340	6,270	---	ND	ND	---	---	<500	<2,500	---	---	1,100	<1
	29-Apr-08	N	4,570	4,380	---	2.20	ND	12.9	<0.5	<500	<500	<500	<10	1,240	<1
	14-May-08	N	2,300	3,470	---	10.58	ND	---	---	<500	<500	---	---	1,210	8.24
	28-May-08	N	3,940	3,790	---	4.52	ND	11.2	<2.5	<500	<500	<500	82.1	1,170	<1
	11-Jun-08	N	3,310	3,530	---	6.92	ND	---	---	<500	<500	---	---	1,190	1.5
	19-Jun-08	N	---	---	---	---	---	---	---	---	---	---	---	---	2.26
	25-Jun-08	N	2,120	2,550	---	48.68	ND	7.2	<2.5	<500	<500	929	975	1,140	91.1
	01-Jul-08	N	---	---	---	---	---	---	---	---	---	---	---	---	4.17
	08-Jul-08	N	---	---	---	---	---	---	---	---	---	---	---	---	50.9
	15-Jul-08	N	---	---	---	---	---	---	---	---	---	---	---	---	1.67
	23-Jul-08	N	3,000	2,700	---	8.78	ND	9.6	<2.5	<500	<500	<500	72.4	1,170	2.42
	28-Jul-08	N	---	---	---	---	---	---	---	---	---	---	---	---	24.6
	20-Aug-08	N	3,710	3,550	---	4.67	ND	9.3	<2.5	<500	<500	<500	107.0	1,130	1.39
	17-Sep-08	N	3,130	3,430	---	ND	ND	10.1	<2.5	<500	<2,500	<2,500	45.0	1,180	<1
	15-Oct-08	N	18	1,420	---	65.48	ND	7.0	<2.5	<500	<2,500	<2,500	1,410	1,120	58.1
	12-Nov-08	N	714	802	---	33.23	ND	5.5	<1	<500	<2,500	<2,500	952	1,120	1.64
PT-9S	17-Jul-07	N	1,180	1,150	1,170	---	---	16.4	<0.1	1,080	<500	29.0	125	689	1.24
	22-Jan-08	N	1,380	1,250	---	---	---	17.3	<0.5	917	1,000	<500	36.7	644	<1
	05-Mar-08	N	1,380	1,340	---	0.01	ND	17.7	<0.1	1,060	<500	<500	145	718	<1
	12-Mar-08	N	1,140	1,010	---	ND	ND	16.3	<0.1	<500	<500	<500	12.5	525	<1
	19-Mar-08	N	1,390	1,380	---	ND	ND	17.6	<0.1	<500	<2,500	---	21.7	633	<1
	26-Mar-08	N	1,350	1,310	---	ND	ND	17.5	<0.1	<500	<2,500	<2,500	16.5	668	<1
	02-Apr-08	N	1,340	1,300	---	ND	ND	---	---	<500	<2,500	---	---	670	<1
	16-Apr-08	N	1,410	1,350	---	0.04	ND	---	---	<500	<2,500	---	---	424	<1
	29-Apr-08	N	1,050	1,080	---	ND	ND	17.3	<0.1	<500	<500	<500	16.6	559	<1
	14-May-08	N	1,060	1,030	---	ND	ND	---	---	<500	<500	---	---	563	<1
	28-May-08	N	1,280	1,210	---	ND	ND	17.5	<0.5	635	<500	<500	52.1	643	<1
	11-Jun-08	N	1,270	1,180	---	ND	ND	---	---	719	<500	---	---	678	---
	25-Jun-08	N	1,030	1,060	---	0.02	ND	15.9	<0.5	<500	<500	<500	33.3	595	<1
	24-Jul-08	N	1,450	1,240	---	ND	ND	16.6	<1	1,310	<500	<500	194.0	627	1.25
	20-Aug-08	N	1,460	1,390	---	1.55	2.2	17.0	<1	1,240	<500	<500	164.0	667	1.25
	17-Sep-08	N	1,290	1,400	---	4.36	ND	16.0	<0.5	<500	<500	<500	22.2	689	1.22
	15-Oct-08	N	929	889	---	2.93	0.81	11.4	<0.5	<500	<500	<500	28.3	558	1.15
	12-Nov-08	N	530	484	---	56.33	1.84	8.9	<0.5	1,480	<500	1,280	1,820	377	146

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PG&E Topock
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Upland Reductive Zone In-Situ Pilot Test Final Completion Report

Location Name	Sample Date	Sample Type	Hexavalent Chromium (µg/L)	Total Dissolved Chromium (µg/L)	Total Chromium (µg/L)	Fluorescein (ppb dye)	Rhodamine (ppb dye)	Nitrate-N (mg/L)	Nitrite-N (mg/L)	Total Iron (µg/L)	Dissolved Iron (µg/L)	Dissolved Manganese (µg/L)	Total Manganese (µg/L)	Sulfate (mg/L)	Total Organic Carbon (mg/L)
PT-9M	17-Jul-07	N	2,340	2,270	2,250	---	---	24.4	<0.1	<500	<500	18.7	27.2	1,410	1.17
	17-Jul-07	FD	2,240	2,270	2,220	---	---	24.6	<0.1	<500	<500	18.2	32.3	1,410	1.21
	22-Jan-08	N	2,940	2,400	---	---	---	24.3	<0.5	<500	<500	<500	<10	1,390	1.02
	05-Mar-08	N	2,310	2,400	---	ND	ND	24.5	<0.1	<500	<500	<500	<10	1,460	<1
	12-Mar-08	N	2,590	2,360	---	ND	ND	22.3	<0.1	<500	<500	<500	<10	1,370	<1
	19-Mar-08	N	2,660	2,570	---	0.06	ND	23.0	<0.2	<500	<2,500	---	<10	1,430	<1
	26-Mar-08	N	2,610	2,490	---	0.13	ND	23.5	<0.2	<500	<2,500	<2,500	<10	1,340	<1
	26-Mar-08	FD	2,500	2,500	---	ND	ND	23.5	<0.2	<500	<2,500	<2,500	<10	1,340	<1
	02-Apr-08	N	2,520	2,510	---	ND	ND	---	---	1,260	<2,500	---	---	1,510	<1
	16-Apr-08	N	2,550	2,570	---	ND	ND	---	---	<500	<2,500	---	---	908	<1
	29-Apr-08	N	2,370	2,360	---	ND	ND	22.2	<0.2	<500	<500	<500	<10	1,460	<1
	14-May-08	N	2,550	2,430	---	ND	ND	---	---	<500	<500	---	---	1,450	<1
	28-May-08	N	2,500	2,300	---	0.05	ND	23.6	<1	<500	<500	<500	<10	1,410	<1
	11-Jun-08	N	2,500	2,330	---	ND	ND	---	---	<500	<500	---	---	1,460	---
	25-Jun-08	N	2,460	2,260	---	ND	ND	21.3	<1	<500	<500	<500	<10	1,450	1.28
	24-Jul-08	N	2,620	2,230	---	ND	ND	20.7	<1	<500	<500	<500	<10	1,400	1.47
	20-Aug-08	N	2,500	2,400	---	0.06	ND	21.5	<1	<500	<500	<500	<10	1,420	1.38
	17-Sep-08	N	2,260	2,590	---	ND	0.04	22.1	<1	<500	<2,500	<2,500	<10	1,480	<1
	15-Oct-08	N	2,660	2,630	---	ND	ND	26.1	<1	<500	<500	<500	<10	1,490	1.07
	12-Nov-08	N	2,590	2,800	---	ND	ND	23.6	<0.5	<500	<2,500	<2,500	<10	1,450	1.00
PT-9D	17-Jul-07	N	15,700	15,600	<1	---	---	9.3	<0.2	<500	<500	29.4	33.8	1,260	1.14
	22-Jan-08	N	17,400	15,300	---	---	---	11.8	<0.5	<500	<5,000	<5,000	<10	1,390	<1
	22-Jan-08	FD	16,400	15,500	---	---	---	10.9	<0.5	<500	<5,000	<5,000	<10	1,310	<1
	05-Mar-08	N	16,000	15,600	---	ND	ND	9.9	<0.2	<500	<2,500	<2,500	15.8	1,470	<1
	12-Mar-08	N	13,500	12,500	---	ND	ND	12.5	<0.5	<500	<2,500	<2,500	<10	1,390	<1
	19-Mar-08	N	14,800	14,300	---	ND	ND	12.4	<0.5	<500	<2,500	---	<10	1,370	<1
	26-Mar-08	N	14,600	14,100	---	ND	ND	12.4	<0.5	<500	<2,500	<2,500	<10	1,320	<1
	02-Apr-08	N	13,900	14,400	---	ND	ND	---	---	<500	<2,500	---	---	1,430	<1
	16-Apr-08	N	14,900	15,400	---	ND	ND	---	---	<500	<2,500	---	---	1,350	<1
	29-Apr-08	N	11,000	10,600	---	ND	ND	12.9	<1	<500	<500	<500	<10	1,400	<1
	14-May-08	N	10,600	10,700	---	ND	ND	---	---	<500	<500	---	---	1,340	<1
	28-May-08	N	12,000	11,700	---	ND	ND	12.9	<2.5	<500	<500	<500	<10	1,330	<10
	11-Jun-08	N	13,600	12,300	---	ND	ND	---	---	<500	<500	---	---	1,400	<2
	11-Jun-08	FD	14,500	12,200	---	0.29	ND	---	---	<500	<500	---	---	1,380	<2
	25-Jun-08	N	10,500	9,680	---	ND	ND	13.6	<2.5	<500	<500	<500	<10	1,330	<5
	24-Jul-08	N	10,900	9,920	---	ND	ND	13.1	<2.5	<500	<500	<500	<10	1,320	11.9
	20-Aug-08	N	13,000	14,900	---	0.02	ND	10.7	<2.5	<500	<500	<500	<10	1,320	1.15
	20-Aug-08	FD	7,090	14,800	---	---	---	10.8	<2.5	<500	<500	<500	<10	1,310	1.17
	17-Sep-08	N	12,100	14,000	---	ND	ND	11.4	<2.5	<500	<2,500	<2,500	<10	1,440	<1
	15-Oct-08	N	9,920	9,650	---	ND	ND	14.6	<1	<500	<2,500	<2,500	<10	1,440	<2
	12-Nov-08	N	13,500	13,400	---	ND	ND	12.5	<2.5	<500	<2,500	<2,500	<10	1,380	1.82

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PG&E Topock
Needles, California
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Location Name	Sample Date	Sample Type	Hexavalent Chromium (µg/L)	Total Dissolved Chromium (µg/L)	Total Chromium (µg/L)	Fluorescein (ppb dye)	Rhodamine (ppb dye)	Nitrate-N (mg/L)	Nitrite-N (mg/L)	Total Iron (µg/L)	Dissolved Iron (µg/L)	Dissolved Manganese (µg/L)	Total Manganese (µg/L)	Sulfate (mg/L)	Total Organic Carbon (mg/L)
MW-11	17-Jul-07	N	321	314	339	---	---	8.4	<0.1	<500	<500	<5	<10	251	1.06
	24-Jan-08	N	321	310	---	---	---	8.7	<0.1	<500	<500	<500	<10	241	<1
	04-Mar-08	N	299	290	---	ND	---	9.7	<0.1	<500	<500	<500	<10	236	<1
	11-Mar-08	N	289	288	---	ND	ND	8.9	<0.1	<500	<500	<500	<10	240	<1
	11-Mar-08	FD	286	285	---	ND	ND	9.0	<0.1	<500	<500	<500	<10	248	<1
	19-Mar-08	N	340	332	---	ND	ND	9.3	<0.1	<500	<2,500	---	<10	231	<1
	27-Mar-08	N	331	308	---	0.04	ND	8.9	<0.1	<500	<500	<500	<10	238	<1
	01-Apr-08	N	316	306	---	0.03	ND	---	---	<500	<500	---	---	237	<1
	15-Apr-08	N	311	319	---	ND	ND	---	---	<500	<500	---	---	222	<1
	28-Apr-08	N	284	266	---	ND	ND	8.6	<0.1	<500	<500	<500	<10	226	<1
	13-May-08	N	280	281	---	ND	ND	---	---	<500	<500	---	---	229	<1
	27-May-08	N	286	238	---	ND	ND	8.6	<0.5	<500	<500	<500	<10	220	<1
	10-Jun-08	N	275	265	---	ND	ND	---	---	---	<500	---	---	227	<1
	24-Jun-08	N	286	244	---	0.02	ND	8.7	<0.5	<500	<500	<500	<10	226	<1
	22-Jul-08	N	296	256	---	ND	ND	8.6	<0.5	<500	<500	<500	<10	220	<1
	21-Aug-08	N	281	240	---	ND	ND	8.3	<0.5	<500	<500	<500	<10	223	<1
	16-Sep-08	N	262	256	---	ND	ND	8.5	<0.5	<500	<500	<500	<10	227	<1
	14-Oct-08	N	264	312	---	ND	ND	8.4	<0.5	<500	<500	<500	<10	217	<1
	11-Nov-08	N	305	303	---	ND	ND	8.6	<0.5	<500	<500	<500	<10	266	<1
MW-24A	18-Jul-07	N	2,480	2,550	2,600	---	---	18.3	<0.1	<500	<500	<5	<10	372	3.82
	24-Jan-08	N	2,620	2,570	---	---	---	18.5	<0.1	<500	<500	<500	<10	380	3.79
	06-Mar-08	N	3,890	4,190	---	ND	ND	13.5	<1	<500	<500	<500	401	1,210	367
	12-Mar-08	N	1,650	2,510	---	8.55	458	<10	<2	<500	<2,500	<2,500	417	1,170	1,160
	19-Mar-08	N	1.6	5.76	---	1,320	296	<2.5	<0.5	<500	<2,500	---	1,280	854	2,460
	26-Mar-08	N	10.6	12.90	---	9,450	776	<5	<1	1,030	<2,500	<2,500	2,380	347	4,890
	01-Apr-08	N	<1	5.46	---	10,650	1,994	---	---	2,080	<2,500	---	---	129	12,900
	17-Apr-08	N	15.7	9.79	---	190.5	496	---	---	1,820	<2,500	---	---	46.1	3,690
	30-Apr-08	N	<1	7.18	---	21.5	38.80	<5	<1	670	<500	1,320	1,360	624	1,160
	30-Apr-08	FD	<1	8.19	---	21.5	53	<5	<1	680	<500	1,330	1,350	624	1,160
	15-May-08	N	<0.2	5.04	---	41.0	42.80	---	---	1,520	853	---	---	831	1,650
	15-May-08	FD	<0.2	4.88	---	42	39	---	---	1,540	861	---	---	821	1,660
	27-May-08	N	<2.1	5.42	---	14	70.60	<1	<2.5	2,160	1,560	3,550	3,740	21	1,350
	12-Jun-08	N	2.3	4.56	---	21.23	65.20	---	---	2,440	671	---	---	267	1,130
	19-Jun-08	N	---	---	---	---	---	---	---	---	---	---	---	---	1,500
	26-Jun-08	N	<0.2	26.00	---	2.41	2.98	5.4	<2.5	1,890	758	1,550	1,630	1,110	42.6
	01-Jul-08	N	---	---	---	---	---	---	---	---	---	---	---	---	<400
	24-Jul-08	N	<1.0	39.10	---	2.74	4.08	4.2	<2.5	2,370	527	647	653	1,230	<1
	24-Jul-08	FD	<1.0	43.40	---	2.55	4.66	3.2	<2.5	2,350	560	672	768	1,190	12.1
	19-Aug-08	N	1.5	1.46	---	5.38	73.0	<1	<1	548	<500	1,430	1,670	982	9.4
	16-Sep-08	N	<0.2	4.38	---	2.62	41.6	<1	<1	<500	<500	1,510	1,720	16	800.0
	16-Oct-08	N	5.8	6.72	---	1.61	0.7	<0.5	<1	2,380	519	1,100	1,330	868	89.5
	13-Nov-08	N	<0.2	9.10	---	1.57	3.8	<0.5	<1	2,010	<2,500	<2,500	1,140	644	51.6
	13-Nov-08	FD	<0.2	7.19	---	1.48	2.8	<2.5	<2.5	3,490	<2,500	<2,500	1,020	690	79.7

Table 5
Summary of Primary Analytical Parameters
PG&E Topock
Needles, California
Upland Reductive Zone In-Situ Pilot Test Final Completion Report

Location Name	Sample Date	Sample Type	Hexavalent Chromium (µg/L)	Total Dissolved Chromium (µg/L)	Total Chromium (µg/L)	Fluorescein (ppb dye)	Rhodamine (ppb dye)	Nitrate-N (mg/L)	Nitrite-N (mg/L)	Total Iron (µg/L)	Dissolved Iron (µg/L)	Dissolved Manganese (µg/L)	Total Manganese (µg/L)	Sulfate (mg/L)	Total Organic Carbon (mg/L)
MW-24B	18-Jul-07	N	5,540	6,020	5,680	---	---	12.1	<0.1	<500	<500	22.7	25.1	1,060	<1
	24-Jan-08	N	4,870	4,760	---	---	---	11.3	<0.5	<500	<1,000	<1,000	20.3	1,050	<1
	06-Mar-08	N	4,510	4,110	---	ND	ND	11.2	<0.2	<500	<500	<500	15.4	1,030	<1
	12-Mar-08	N	4,530	4,310	---	ND	ND	12.0	<0.2	<500	<2,500	<2,500	12.9	996	<1
	19-Mar-08	N	4,690	4,470	---	ND	ND	12.6	<0.5	<500	<2,500	---	15.7	1,010	<1
	26-Mar-08	N	4,160	4,220	---	ND	ND	12.0	<0.5	<500	<2,500	<2,500	13.6	1,020	<1
	03-Apr-08	N	4,310	4,240	---	0.15	ND	---	---	<500	<2,500	---	15	1,040	<1
	17-Apr-08	N	4,180	4,260	---	0.02	ND	---	---	<500	<2,500	---	---	1,120	<1
	30-Apr-08	N	3,400	3,790	---	ND	ND	9.96	<0.2	<500	<500	<500	14.2	1,050	4.42
	15-May-08	N	3,580	3,780	---	ND	ND	---	---	<500	<500	---	---	1,050	<1
	28-May-08	N	3,620	3,530	---	0.07	ND	31.0	<1	<500	<500	<500	<10	1,180	1.02
	12-Jun-08	N	3,690	3,730	---	ND	ND	---	---	<500	<500	---	---	1,080	<1
	26-Jun-08	N	3,720	3,280	---	0.03	ND	12.5	<2.5	<500	<500	<500	14.7	995	<1
	24-Jul-08	N	3,180	2,690	---	ND	ND	12.2	<5	<500	<500	<500	13.5	1,010	1.03
	19-Aug-08	N	3,200	2,730	---	ND	ND	11.9	<1	<500	<500	<500	11.3	1,020	1.21
	17-Sep-08	N	2,680	2,820	---	ND	ND	11.8	<2.5	<500	<2,500	<2,500	19.5	1,070	1.09
	16-Oct-08	N	2,700	2,640	---	ND	ND	13.0	<2.5	<500	<2,500	<2,500	13.4	1,060	<1
	16-Oct-08	FD	2,560	2,610	---	ND	ND	13.0	<2.5	<500	<2,500	<2,500	13.9	1,060	<1
	13-Nov-08	N	2,470	2,540	---	ND	ND	13.2	<2.5	<500	<2,500	<2,500	17.4	1,120	2.56
MW-38S	17-Jul-07	N	911	920	948	---	---	10.5	<0.1	1,910	<500	<5	234	465	1.07
	23-Jan-08	N	899	885	---	---	---	10.7	<0.1	<500	<500	<500	<10	366	<1
	04-Mar-08	N	900	912	---	ND	ND	11.5	<0.1	<500	<500	<500	14.7	399	<1
	11-Mar-08	N	948	942	---	ND	ND	11.2	<0.1	<500	<500	<500	12.6	429	<1
	20-Mar-08	N	993	1,040	---	0.05	0.05	10.9	<0.1	<500	<2,500	---	<10	404	<1
	26-Mar-08	N	958	984	---	ND	ND	10.9	<0.1	<500	<2,500	<2,500	<10	404	<1
	01-Apr-08	N	999	852	---	0.08	ND	---	---	<500	<500	---	---	419	<1
	15-Apr-08	N	995	987	---	ND	ND	---	---	<500	<500	---	---	396	<1
	28-Apr-08	N	1,020	956	---	0.17	ND	10.7	<0.1	<500	<500	<500	<10	414	<1
	13-May-08	N	1,000	977	---	ND	ND	---	---	<500	<500	---	---	404	<1
	27-May-08	N	984	895	---	ND	ND	10.7	<0.5	<500	<500	<500	<10	399	<1
	10-Jun-08	N	992	959	---	ND	ND	---	---	1,140	<500	---	---	410	<1
	24-Jun-08	N	1,040	942	---	0.02	ND	10.4	<0.5	<500	<500	<500	<10	396	<1
	22-Jul-08	N	1,020	945	---	ND	ND	10.1	<0.5	<500	<500	<500	<10	390	<1
	20-Aug-08	N	1,020	1,020	---	0.02	ND	9.9	<0.5	<500	<500	<500	<10	371	<1
	16-Sep-08	N	987	999	---	ND	ND	9.9	<0.5	<500	<500	<500	<10	391	<1
	14-Oct-08	N	1,100	1,090	---	ND	ND	9.6	0.60	<500	<500	<500	<10	383	<1
	11-Nov-08	N	1,050	1,000	---	0.13	ND	10.1	<0.5	566	<500	<500	45.5	381	<1

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Needles, California
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Location Name	Sample Date	Sample Type	Hexavalent Chromium (µg/L)	Total Dissolved Chromium (µg/L)	Total Chromium (µg/L)	Fluorescein (ppb dye)	Rhodamine (ppb dye)	Nitrate-N (mg/L)	Nitrite-N (mg/L)	Total Iron (µg/L)	Dissolved Iron (µg/L)	Dissolved Manganese (µg/L)	Total Manganese (µg/L)	Sulfate (mg/L)	Total Organic Carbon (mg/L)
MW-38D	17-Jul-07	N	104	72.1	66.2	---	---	0.70	<0.5	<500	<500	10.4	20.4	724	<1
	23-Jan-08	N	58.8	67.7	---	---	---	<2.5	<0.5	<500	<10,000	<10,000	<10	723	<1
	04-Mar-08	N	49.8	47.0	---	ND	ND	0.56	<0.5	<500	<500	<500	<10	735	<1
	11-Mar-08	N	50.4	53.8	---	ND	ND	0.58	<0.5	<500	<2,500	<2,500	<10	734	<1
	20-Mar-08	N	49.6	50.7	---	ND	ND	<2.5	<0.5	<500	<2,500	---	13	724	<1
	20-Mar-08	FD	51	50.9	---	ND	ND	<2.5	<0.5	<500	<2,500	---	11.9	711	<1
	26-Mar-08	N	48.7	50.1	---	ND	ND	<1	<0.5	<500	<2,500	<2,500	12.5	723	<1
	01-Apr-08	N	45.6	42.4	---	ND	ND	---	---	<500	<500	---	---	746	<1
	01-Apr-08	FD	47.6	41.8	---	0.02	ND	---	---	<500	<500	---	---	746	<1
	15-Apr-08	N	43.8	45.8	---	ND	ND	---	---	<500	<500	---	---	738	<1
	15-Apr-08	FD	46.1	45.8	---	0.04	ND	---	---	<500	<500	---	---	748	<1
	28-Apr-08	N	48	46.2	---	ND	ND	0.54	<0.5	<500	<2,500	<2,500	16.6	734	<1
	13-May-08	N	53	50.1	---	ND	ND	---	---	<500	<500	---	---	743	<1
	27-May-08	N	53	48.3	---	ND	ND	0.59	<5	<500	<500	<500	12.7	748	<1
	10-Jun-08	N	50.9	47.7	---	0.05	ND	---	---	<500	<500	---	---	741	<1
	24-Jun-08	N	55.5	48.3	---	ND	ND	0.57	<0.5	<500	<500	<500	13.3	737	<1
	22-Jul-08	N	56.3	52.3	---	ND	ND	<0.5	<5	<500	<500	<500	<10	734	<1
	20-Aug-08	N	54.1	47.2	---	ND	ND	<2.5	<2.5	<500	<500	6,950	<10	721	<1
	16-Sep-08	N	48.8	52.5	---	ND	ND	<0.5	<2.5	<500	<500	<500	<10	763	<1
	16-Sep-08	FD	50.5	57.0	---	ND	ND	0.54	<2.5	<500	<2,500	<2,500	<10	760	<1
	14-Oct-08	N	71.7	70.2	---	ND	ND	0.68	<2.5	<500	<2,500	<2,500	<10	672	<1
	11-Nov-08	N	55.8	53.4	---	ND	ND	0.77	<2.5	<500	<500	<500	<10	655	<1
PTR-1	19-Jul-07	N	538	713	1,240	---	---	18.4	<0.1	6,010	<500	92.2	119	983	<1
	25-Jan-08	N	904	991	---	---	---	20.4	<0.1	2,920	<500	<500	25.8	742	3.82
	06-Mar-08	N	356	334	---	333,750	ND	<500	<100	<500	<2,500	<2,500	1,070	1,460	11,200
	11-Mar-08	N	945	846	---	2,070	ND	11.4	<1	<500	<2,500	<2,500	633	671	29,700
	20-Mar-08	N	76.8	125	---	30,375	ND	<50	<10	540	<2,500	---	437	440	63,400
	27-Mar-08	N	<1	<5	---	8,700	ND	<20	<4	1,660	<2,500	<2,500	867	122	122,000
	01-Apr-08	N	<1	<5	---	12,525	ND	---	---	2,160	<2,500	---	---	356	2,890
	16-Apr-08	N	20.2	99.2	---	84	ND	---	---	750	<2,500	---	---	386	37,200
	28-Apr-08	N	---	---	---	---	---	---	---	---	---	---	---	---	208,000
	29-Apr-08	N	<0.2	93.9	---	1,320	ND	5.9	<1	<500	<500	5,350	5,890	359	205,000
	15-May-08	N	<2.1	170	---	364	ND	---	---	524	<500	---	---	428	2,360
	29-May-08	N	<2	3.1	---	24	ND	1.5	<0.5	2,670	<500	708	919	520	27,900
	12-Jun-08	N	<2	1.8	---	31.8	---	---	---	2,310	1,040	---	---	644	80.30
	19-Jun-08	N	---	---	---	---	---	---	---	---	---	---	---	---	107
	26-Jun-08	N	<0.2	5.2	---	25.95	ND	5.3	6.04	718	<500	1,050	1,200	658	28.20
	01-Jul-08	N	---	---	---	---	---	---	---	---	---	---	---	---	12.30
	24-Jul-08	N	<1.0	49.3	---	29.55	ND	3.5	7.44	998	<500	1,770	2,200	586	18.70
	19-Aug-08	N	<0.2	30.9	---	8.33	ND	2.0	0.72	5,210	<500	507	623	659	968.0
	18-Sep-08	N	1.2	96.0	---	4.66	ND	9.3	0.71	8,970	<500	<500	519	731	6.46
	16-Oct-08	N	0.3	16.5	---	4.75	ND	11.1	<1	15,400	<500	<500	322	713	3.45
	13-Nov-08	N	0.4	16.0	---	12.08	ND	<0.5	<0.5	7,530	<500	528	764	161	12,400

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Location Name	Sample Date	Sample Type	Hexavalent Chromium (µg/L)	Total Dissolved Chromium (µg/L)	Total Chromium (µg/L)	Fluorescein (ppb dye)	Rhodamine (ppb dye)	Nitrate-N (mg/L)	Nitrite-N (mg/L)	Total Iron (µg/L)	Dissolved Iron (µg/L)	Dissolved Manganese (µg/L)	Total Manganese (µg/L)	Sulfate (mg/L)	Total Organic Carbon (mg/L)
PTR-2	18-Jul-07	N	3,190	3,380	4,020	---	---	25.8	<0.1	3,720	<500	68.7	73.6	1,200	1.63
	25-Jan-08	N	4,240	4,310	---	---	---	32.8	<0.1	6,920	<1,000	<1,000	29.4	1,280	6.35
	06-Mar-08	N	4,960	5,120	---	4,118	ND	29.1	<0.2	<500	<2,500	<2,500	<10	1,220	675
	11-Mar-08	N	5,120	5,150	---	0	0.16	29.6	<0.2	<500	<500	<500	<10	1,280	1,060
	20-Mar-08	N	3,170	3,160	---	2,228	96,400	<250	<50	<500	<2,500	---	55.1	514	83,000
	27-Mar-08	N	1,800	1,720	---	1,403	39,000	<500	<100	<500	<2,500	<2,500	131	<500	117,000
	01-Apr-08	N	4,190	4,370	---	848	81.80	---	---	<500	<2,500	---	---	1,190	3,090
	15-Apr-08	N	2,030	2,080	---	20	39.00	---	---	<500	<2,500	---	---	762	31,900
	28-Apr-08	N	---	---	---	---	---	---	---	---	---	---	---	---	220,000
	29-Apr-08	N	4,900	4,870	---	3.49	21.40	26.9	<0.2	<500	<500	<500	95.3	1,250	206,000
	15-May-08	N	4,790	4,840	---	0.86	8.88	---	---	<500	<500	---	---	1,240	8.38
	28-May-08	N	3,870	3,920	---	0.33	16.98	10.7	<1	<500	<500	<500	183	1,010	25,200
	10-Jun-08	N	4,350	4,970	---	0.36	8.58	---	---	<500	<500	---	---	1,200	201
	19-Jun-08	N	---	---	---	---	---	---	---	---	---	---	---	---	39
	26-Jun-08	N	4,570	4,240	---	1.06	1.54	26.1	<2.5	<500	<500	<500	31.2	1,160	<20
	01-Jul-08	N	---	---	---	---	---	---	---	---	---	---	---	---	<10
	24-Jul-08	N	4,620	4,420	---	2.02	1.41	24.4	<2.5	<500	<500	<500	18.6	1,160	54
	19-Aug-08	N	1,620	1,900	---	ND	4.90	<0.5	<1	2,370	<5,000	<5,000	79.8	782	29,100
	18-Sep-08	N	719	2,070	---	0.87	3.44	8.9	0.83	1,110	<500	<500	145	654	47,400
	16-Oct-08	N	3,900	3,780	---	1.19	0.38	19.7	<2.5	<500	<2,500	<2,500	49.3	1,180	2,690
	13-Nov-08	N	3,900	4,220	---	0.11	0.60	14.9	5.25	<500	<2,500	<2,500	43.4	1,080	3.74
Equipment Balnks	17-Jul-07	EB	<0.2	<1	<1	---	---	<0.5	<0.1	<500	<500	<5	<10	<0.5	<1
	22-Jan-08	EB	<0.2	<1	---	---	---	<0.5	<0.1	<500	<500	<500	<10	<0.5	<1
	05-Mar-08	EB	<0.2	1.70	---	ND	ND	<0.5	<0.1	<500	<500	<500	<10	0.63	<1
	11-Mar-08	EB	<0.2	<1	---	ND	ND	<0.5	<0.1	<500	<500	<500	<10	0.69	<1
	18-Mar-08	EB	<1	<1	---	ND	ND	<0.5	<0.1	<500	<500	---	<10	<0.5	<1
	25-Mar-08	EB	<42	3.31	---	0.02	ND	<0.5	<0.1	<500	<500	<500	<10	<0.5	<1
	03-Apr-08	EB	<0.2	<1	---	ND	ND	---	---	<500	<500	---	<10	<0.5	<1
	15-Apr-08	EB	<0.2	<1	---	ND	ND	---	---	<500	<500	---	---	<0.5	1.40
	28-Apr-08	EB	<0.2	<1	---	ND	ND	<0.5	<0.1	<500	<500	<500	<10	<0.5	<1
	13-May-08	EB	<0.2	<1	---	ND	ND	---	---	<500	<500	---	---	<0.5	<1
	28-May-08	EB	<0.2	<1	---	ND	ND	<0.5	<0.5	<500	<500	<500	<10	<0.5	<1
	10-Jun-08	EB	<0.2	<1	---	---	---	---	---	<500	<500	---	---	<0.5	<1
	19-Jun-08	EB	---	---	---	---	---	---	---	---	---	---	---	---	<1
	24-Jun-08	EB	<0.2	<1	---	ND	ND	<0.5	<0.5	<500	<500	<500	<10	<0.5	<1
	01-Jul-08	EB	---	---	---	---	---	---	---	---	---	---	---	---	<1
	22-Jul-08	EB	<0.2	<1	---	ND	ND	<0.5	<0.5	<500	<500	<500	<10	<0.5	<1
	19-Aug-08	EB	<0.2	---	---	---	---	---	---	---	---	---	---	---	---
	20-Aug-08	EB	---	<1	---	ND	ND	1.13	<0.5	<500	<500	<500	<10	<0.5	<1
	16-Sep-08	EB	<0.2	<1	---	ND	ND	<0.5	<0.5	<500	<500	<500	<10	<0.5	<1
	14-Oct-08	EB	<0.2	<1	---	ND	ND	<0.5	<0.5	<500	<500	<500	<10	<0.5	<1
	11-Nov-08	EB	<0.2	<1	---	ND	ND	<0.5	<0.5	<500	<500	<500	<10	<0.5	<1

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Upland Reductive Zone In-Situ Pilot Test Final Completion Report

Location Name	Sample Date	Sample Type	Hexavalent Chromium (µg/L)	Total Dissolved Chromium (µg/L)	Total Chromium (µg/L)	Fluorescein (ppb dye)	Rhodamine (ppb dye)	Nitrate-N (mg/L)	Nitrite-N (mg/L)	Total Iron (µg/L)	Dissolved Iron (µg/L)	Dissolved Manganese (µg/L)	Total Manganese (µg/L)	Sulfate (mg/L)	Total Organic Carbon (mg/L)
Field Blanks	17-Jul-07	FB	<0.2	<1	<1	---	---	<0.5	<0.1	<500	<500	<5	<10	<0.5	<1
	22-Jan-08	FB	<0.2	<1	---	---	---	<0.5	<0.1	<500	<500	<500	<10	36.4	<1
	05-Mar-08	FB	<0.2	<1	---	ND	ND	<0.5	<0.1	<500	<500	<500	<10	0.63	<1
	11-Mar-08	FB	<0.2	1.15	---	ND	ND	<0.5	<0.1	<500	<500	<500	<10	<0.5	<1
	18-Mar-08	FB	<0.2	<1	---	ND	ND	<0.5	<0.1	<500	<500	---	<10	<0.5	<1
	25-Mar-08	FB	<0.2	<1	---	0.02	ND	<0.5	<0.1	<500	<500	<500	<10	<0.5	<1
	03-Apr-08	FB	<0.2	<1	---	0.03	ND	---	---	<500	<500	---	<10	<0.5	<1
	15-Apr-08	FB	<0.2	<1	---	ND	ND	---	---	<500	<500	---	---	<0.5	<1
	28-Apr-08	FB	<0.2	<1	---	ND	ND	<0.5	<0.1	<500	<500	<500	<10	<0.5	<1
	13-May-08	FB	<0.2	<1	---	ND	ND	---	---	<500	<500	---	---	<0.5	<1
	28-May-08	FB	<0.2	---	---	ND	ND	<0.5	<0.5	<500	<500	<500	<10	<0.5	<1
	10-Jun-08	FB	---	<1	---	---	---	---	---	<500	<500	---	---	<0.5	<1
	19-Jun-08	FB	---	---	---	---	---	---	---	---	---	---	---	---	<1
	24-Jun-08	FB	<0.2	<1	1	ND	ND	<0.5	<0.5	<500	<500	<500	<10	<0.5	<1
	01-Jul-08	FB	---	---	---	---	---	---	---	---	---	---	---	---	<1
	22-Jul-08	FB	<0.2	<1	---	0.34	ND	<0.5	<0.5	<500	<500	<500	<10	<0.5	<1
	19-Aug-08	FB	<.02	<1	---	0.024	ND	<0.5	<0.5	<500	<500	<500	<10	<0.5	1.03
	16-Sep-08	FB	<0.2	<1	---	ND	ND	<0.5	<0.5	<500	<500	<500	<10	<0.5	<1
	14-Oct-08	FB	<0.2	<1	---	ND	ND	<0.5	<0.5	<500	<500	<500	<10	<0.5	<1
	11-Nov-08	FB	<0.2	<1	---	ND	ND	0.517	<0.5	<500	<500	<500	<10	<0.5	<1

NOTES

Most recent data indicated in **BOLD**

a	Samples were diluted in the laboratory
Dissolved	Samples were field filtered with a 0.45 micron filter.
ft bgs	Feet below ground surface
mg/L	Milligrams per liter
µg/L	Micrograms per liter
<	Symbol indicates not detected at or above laboratory detection limit as noted
N	Normal
ND	Non-detect
EB	Equipment blank
FB	Field blank
FD	Field duplicate
Nitrate-N	Nitrate as Nitrogen
Nitrite-N	Nitrite as Nitrogen
---	Not analyzed/Not available
*	PTR-1 Screen: 125-160 and 175-220 ft bgs. PTR-2 Screen: 118-158 and 173-218 ft bgs.
**	Sample IDs were transcribed in the field. Data here are presented with the appropriate ID.

Table 6
Summary of Secondary Analytical Parameters
PG&E Topock
Needles, California
Upland Reductive Zone In-Situ Pilot Test Final Completion Report

Location Name	Sample Date	Sample Type	Dissolved Calcium (µg/L)	Dissolved Magnesium (µg/L)	Dissolved Arsenic (µg/L)	Total Arsenic (µg/L)	Dissolved Potassium (µg/L)	Dissolved Sodium (µg/L)	Alkalinity bicarbonate (mg/L)	Alkalinity carbonate (mg/L)	Chloride (mg/L)	Orthophosphate-p (mg/L)	Sulfide (mg/L)
PT-7S	18-Jul-07	N	159,000	---	<5	9.65	14,500	999,000	125	<5	1,250	<0.5	<2
	23-Jan-08	N	259,000	42,400	<25	---	13,600	942,000	135	---	1,060	<0.5	<2
	06-Mar-08	N	147,000	30,000	<5	---	12,300	931,000	153	---	1,170	<0.5	<2
	13-Mar-08	N	141,000	28,100	<25	---	11,900	844,000	153	---	1,110	<0.5	<2
	18-Mar-08	N	179,000	30,100	---	---	12,900	885,000	160	<5	1,230	<0.5	<2
	25-Mar-08	N	160,000	30,600	<25	---	12,900	903,000	153	---	1,240	<0.5	<2
	02-Apr-08	N	163,000	34,900	---	---	13,400	982,000	135	<5	---	---	<2
	17-Apr-08	N	172,000	35,400	---	---	13,900	1,010,000	140	<5	---	---	<2
	29-Apr-08	N	141,000	30,300	<5	---	12,800	897,000	170	<5	---	<0.5	<2
	15-May-08	N	140,000	28,900	---	---	12,300	873,000	175	<5	---	---	<2
	29-May-08	N	166,000	34,000	<5	---	13,600	1,010,000	145	---	1,270	<0.5	<2
	11-Jun-08	N	170,000	37,000	---	---	13,600	1,110,000	128	<5	---	---	<2
	24-Jun-08	N	139,000	27,100	<5	---	12,100	872,000	158	---	1,150	<0.5	<2
	23-Jul-08	N	154,000	36,200	<5	---	13,200	96,700	173	---	1,310	<0.5	<2
	21-Aug-08	N	221,000	42,800	5.61	---	15,400	1,330,000	580	---	1,310	<1	4.0
	18-Sep-08	N	149,000	31,400	<5	---	12,900	983,000	130	---	1,260	<0.5	<2
	15-Oct-08	N	151,000	33,100	12.1	---	11,900	918,000	352	---	1,420	<0.5	<2
	12-Nov-08	N	158,000	33,600	8.0	---	13,100	1,020,000	211	---	1,340	<0.5	<2
PT-7M	19-Jul-07	N	419,000	---	<5	7.01	23,900	1,350,000	97.5	<5	1,920	<0.5	<2
	24-Jan-08	N	434,000	58,100	<10	---	24,600	1,460,000	80.0	---	2,180	<0.5	<2
	06-Mar-08	N	236,000	32,200	10.1	---	19,200	1,170,000	138	---	1,520	<0.5	<2
	06-Mar-08	FD	236,000	32,500	10.8	---	19,200	1,170,000	145	<5	1,490	<0.5	<2
	13-Mar-08	N	275,000	37,500	53.0	---	18,600	1,150,000	360	---	1,530	<0.5	<2
	18-Mar-08	N	273,000	37,900	---	---	17,300	1,140,000	650	<5	1,570	<0.5	8.0
	25-Mar-08	N	333,000	42,400	<25	---	18,000	1,170,000	920	---	1,560	<2.5	<2
	02-Apr-08	N	340,000	47,500	---	---	17,200	1,210,000	1,010	<5	---	---	8.0
	17-Apr-08	N	457,000	59,500	---	---	19,500	1,310,000	1,380	<5	---	---	<2
	29-Apr-08	N	503,000	62,400	16.3	---	19,400	1,220,000	1,460	<5	---	<10	<2
	14-May-08	N	614,000	75,200	---	---	20,300	1,230,000	1,930	<5	---	---	<2
	29-May-08	N	697,000	71,200	28.6	---	19,900	1,180,000	1,720	---	1,090	<10	<2
	11-Jun-08	N	769,000	87,900	---	---	20,800	1,220,000	1,400	<5	---	---	<2
	19-Jun-08	N	---	---	---	---	---	---	---	---	---	---	---
	25-Jun-08	N	874,000	81,100	35.4	---	20,800	1,110,000	1,800	---	1,110	<2.5	<2
	01-Jul-08	N	---	---	---	---	---	---	---	---	---	---	---
	08-Jul-08	N	---	---	---	---	---	---	---	---	---	---	---
	15-Jul-08	N	---	---	---	---	---	---	---	---	---	---	---
	23-Jul-08	N	1,030,000	97,700	29.7	---	20,200	984,000	1,980	---	863	<2.5	<2
	21-Aug-08	N	1,380,000	133,000	31.4	---	22,900	1,290,000	2,780	---	1,020	<2.5	8.0
	18-Sep-08	N	994,000	82,600	46.9	---	20,600	1,100,000	2,160	---	1,080	<1	<2
	15-Oct-08	N	849,000	80,200	46.7	---	21,200	1,090,000	2,040	---	1,280	<2.5	<2
	12-Nov-08	N	225,000	52,800	54.8	---	16,800	1,020,000	1,010	---	1,230	<1	<2

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PG&E Topock
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Location Name	Sample Date	Sample Type	Dissolved Calcium (µg/L)	Dissolved Magnesium (µg/L)	Dissolved Arsenic (µg/L)	Total Arsenic (µg/L)	Dissolved Potassium (µg/L)	Dissolved Sodium (µg/L)	Alkalinity bicarbonate (mg/L)	Alkalinity carbonate (mg/L)	Chloride (mg/L)	Orthophosphate-p (mg/L)	Sulfide (mg/L)
PT-7D	18-Jul-07	N	321,000	---	8.0	8.12	38,600	3,630,000	52.5	<5	5,490	<0.5	<2
	24-Jan-08	N	339,000	9,350	<10	---	39,100	3,890,000	47.5	---	5,540	<1	<2
	06-Mar-08	N	153,000	4,530	18.8	---	25,200	2,660,000	85.0	---	3,480	<0.5	<2
	13-Mar-08	N	141,000	<5,000	<25	---	23,400	2,460,000	150	---	3,540	<0.5	<2
	18-Mar-08	N	174,000	5,650	---	---	24,100	2,620,000	280	<5	3,690	<1	10.4
	25-Mar-08	N	217,000	6,970	97.4	---	25,400	2,940,000	360	---	3,980	<1	17.6
	02-Apr-08	N	210,000	7,980	---	---	25,500	3,030,000	340	<5	---	---	6.8
	17-Apr-08	N	178,000	5,700	---	---	19,800	2,340,000	840	<5	---	---	20.8
	29-Apr-08	N	155,000	4,780	41.9	---	18,100	2,130,000	805	<5	---	<10	4.4
	15-May-08	N	188,000	6,370	---	---	19,300	2,110,000	920	<5	---	---	5.6
	29-May-08	N	215,000	6,640	27.7	---	20,400	2,280,000	1,040	---	2,670	<10	7.2
	11-Jun-08	N	286,000	7,090	---	---	19,300	2,170,000	1,330	<5	---	---	<2
	19-Jun-08	N	---	---	---	---	---	---	---	---	---	---	---
	24-Jun-08	N	257,000	6,700	17.5	---	21,400	2,110,000	1,370	---	2,030	<10	5.6
	01-Jul-08	N	---	---	---	---	---	---	---	---	---	---	---
	08-Jul-08	N	---	---	---	---	---	---	---	---	---	---	---
	15-Jul-08	N	---	---	---	---	---	---	---	---	---	---	---
	23-Jul-08	N	400,000	11,000	23.2	---	19,800	1,940,000	1,640	---	1,480	<5	<2
	21-Aug-08	N	472,000	14,300	33.0	---	21,200	2,270,000	2,080	---	1,480	<2.5	40.0
	18-Sep-08	N	433,000	11,400	23.3	---	21,600	198,000	1,960	---	1,460	<1	<2
	15-Oct-08	N	320,000	11,000	31.6	---	20,300	1,780,000	1,490	---	1,650	<1	6.4
	12-Nov-08	N	236,000	10,700	46.6	---	20,000	1,700,000	1,380	---	1,560	<2.5	26.0
PT-8S	16-Jul-07	N	132,000	---	<5	5.13	12,500	955,000	125	<5	1,190	<0.5	<2
	23-Jan-08	N	141,000	30,000	<25	---	12,600	1,040,000	128	---	1,220	<0.5	2.0
	05-Mar-08	N	120,000	26,000	<5	---	11,400	1,060,000	158	---	1,100	<0.5	<2
	13-Mar-08	N	114,000	23,900	<25	---	11,100	934,000	215	---	1,110	<0.5	<2
	18-Mar-08	N	97,500	21,500	---	---	10,600	894,000	225	<5	1,010	<0.5	<2
	25-Mar-08	N	101,000	21,300	<25	---	10,600	876,000	230	---	1,070	<0.5	<2
	02-Apr-08	N	110,000	25,200	---	---	11,400	965,000	200	<5	---	---	<2
	16-Apr-08	N	125,000	26,700	---	---	11,700	1,010,000	205	<5	---	---	<2
	29-Apr-08	N	160,000	35,500	10.4	---	13,000	1,130,000	283	<5	---	<0.5	<2
	14-May-08	N	148,000	34,100	---	---	12,300	1,140,000	323	<5	---	---	<2
	28-May-08	N	155,000	33,300	25.6	---	11,200	1,220,000	550	---	1,760	<0.5	2.0
	11-Jun-08	N	402,000	72,100	---	---	15,600	1,840,000	950	<5	---	---	<2
	19-Jun-08	N	---	---	---	---	---	---	---	---	---	---	---
	25-Jun-08	N	502,000	77,100	18.6	---	17,400	1,940,000	1,370	---	2,440	<1	<2
	01-Jul-08	N	---	---	---	---	---	---	---	---	---	---	---
	08-Jul-08	N	---	---	---	---	---	---	---	---	---	---	---
	15-Jul-08	N	---	---	---	---	---	---	---	---	---	---	---
	23-Jul-08	N	459,000	84,800	21.4	---	16,200	1,910,000	1,150	---	2,660	<5	<2
	20-Aug-08	N	358,000	62,500	27.9	---	14,500	1,780,000	1,000	---	2,640	<1	40.0
	17-Sep-08	N	264,000	58,600	30.7	---	14,500	1,750,000	830	---	2,580	<1	<2
	15-Oct-08	N	251,000	57,500	27.2	---	13,900	1,700,000	1,180	---	2,550	<1	<2
	12-Nov-08	N	212,000	49,200	43.8	---	14,200	1,740,000	914	---	2,510	<1	2.0

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Location Name	Sample Date	Sample Type	Dissolved Calcium (µg/L)	Dissolved Magnesium (µg/L)	Dissolved Arsenic (µg/L)	Total Arsenic (µg/L)	Dissolved Potassium (µg/L)	Dissolved Sodium (µg/L)	Alkalinity bicarbonate (mg/L)	Alkalinity carbonate (mg/L)	Chloride (mg/L)	Orthophosphate-p (mg/L)	Sulfide (mg/L)
PT-8M	18-Jul-07	N	353,000	---	<5	1.53	22,200	1,130,000	103	<5	1,510	<2.5	<2
	23-Jan-08	N	403,000	41,800	<25	---	24,100	1,230,000	100	---	1,700	<0.5	4.0
	05-Mar-08	N	422,000	42,200	<5	---	24,000	1,350,000	108	---	1,650	<0.5	<2
	13-Mar-08	N	364,000	44,100	<25	---	22,300	1,130,000	120	---	1,400	<0.5	<2
	19-Mar-08	N	362,000	43,000	---	---	22,400	1,120,000	123	<5	1,400	<0.5	<2
	25-Mar-08	N	376,000	41,500	<25	---	22,200	1,110,000	130	---	1,570	<0.5	4.0
	02-Apr-08	N	367,000	45,400	---	---	22,900	1,160,000	130	<5	---	---	<2
	16-Apr-08	N	392,000	45,100	---	---	23,200	1,190,000	125	<5	---	---	<2
	29-Apr-08	N	356,000	43,900	<5	---	22,000	1,070,000	145	<5	---	<1	<2
	14-May-08	N	350,000	42,900	---	---	21,800	1,040,000	135	<5	---	---	<2
	28-May-08	N	321,000	6,750	7.0	---	34,000	3,200,000	50	---	4,820	<1	<2
	11-Jun-08	N	381,000	48,900	---	---	21,400	1,160,000	110	<5	---	---	<2
	19-Jun-08	N	---	---	---	---	---	---	---	---	---	---	---
	25-Jun-08	N	362,000	42,600	<5	---	21,200	104,000	113	---	1,360	<0.5	<2
	01-Jul-08	N	---	---	---	---	---	---	---	---	---	---	---
	23-Jul-08	N	356,000	49,300	<5	---	20,100	1,020,000	115	---	1,300	<1	<2
	20-Aug-08	N	364,000	43,900	<5	---	20,000	1,050,000	155	---	1,510	<0.5	80.0
	17-Sep-08	N	371,000	47,400	<5	---	21,800	1,120,000	180	---	1,650	<0.5	<2
	15-Oct-08	N	357,000	45,000	<5	---	20,400	978,000	168	---	1,480	<1	<2
	12-Nov-08	N	338,000	44,500	<5	---	20,400	990,000	258	---	1,400	<0.5	<2
PT-8D	16-Jul-07	N	281,000	---	7.1	9.00	35,100	3,300,000	45.0	<5	5,360	<0.5	<2
	23-Jan-08	N	325,000	11,800	<50	---	35,200	3,420,000	50.0	---	5,190	<1	<2
	05-Mar-08	N	322,000	10,000	<25	---	37,700	3,850,000	50.0	---	5,240	<0.5	<2
	13-Mar-08	N	284,000	9,560	<25	---	32,900	3,340,000	55.0	---	5,090	<2.5	<2
	18-Mar-08	N	292,000	9,470	---	---	33,900	3,480,000	48.0	<5	5,480	<2.5	<2
	25-Mar-08	N	306,000	10,200	<25	---	34,300	3,550,000	50.0	---	5,010	<0.5	<2
	02-Apr-08	N	298,000	10,700	---	---	33,800	3,550,000	52.5	<5	---	---	<2
	16-Apr-08	N	312,000	9,020	---	---	36,000	3,840,000	50.0	<5	---	---	<2
	29-Apr-08	N	292,000	9,830	7.7	---	33,500	3,290,000	60.0	<5	---	<1	<2
	14-May-08	N	281,000	13,300	---	---	32,000	2,820,000	87.5	<5	---	---	<2
	28-May-08	N	267,000	9,020	6.8	---	32,100	3,050,000	57.5	---	4,530	<1	<2
	11-Jun-08	N	288,000	11,100	---	---	32,200	3,390,000	55.0	<5	---	---	<2
	19-Jun-08	N	---	---	---	---	---	---	---	---	---	---	---
	25-Jun-08	N	280,000	12,100	11.6	---	30,600	2,960,000	143	---	4,200	<0.5	<2
	01-Jul-08	N	---	---	---	---	---	---	---	---	---	---	---
	08-Jul-08	N	---	---	---	---	---	---	---	---	---	---	---
	15-Jul-08	N	---	---	---	---	---	---	---	---	---	---	---
	23-Jul-08	N	264,000	11,000	8.9	---	30,700	3,080,000	60	---	4,390	<1	<2
	20-Aug-08	N	284,000	10,500	7.2	---	31,400	3,220,000	46.3	---	4,870	<1	40.0
	17-Sep-08	N	286,000	10,000	<25	---	34,000	3,250,000	47.5	---	4,730	<1	<2
	15-Oct-08	N	333,000	24,200	<25	---	31,300	2,530,000	197	---	4,140	<0.5	<2
	12-Nov-08	N	312,000	17,400	<25	---	33,600	3,020,000	85.9	---	4,250	<0.5	<2

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PT-9S	17-Jul-07	N	108,000	---	<5	5.36	11,800	820,000	155	<5	895	<0.5	<2
	22-Jan-08	N	107,000	21,100	5.6	---	9,140	848,000	205	---	924	<0.5	<2
	05-Mar-08	N	120,000	24,500	5.2	---	9,990	962,000	168	---	977	<0.5	<2
	12-Mar-08	N	87,500	17,800	5.5	---	8,270	836,000	190	---	916	<0.5	<2
	19-Mar-08	N	115,000	23,100	---	---	9,930	884,000	163	<5	889	<0.5	<2
	26-Mar-08	N	116,000	23,000	<25	---	9,370	843,000	175	---	977	<0.5	<2
	02-Apr-08	N	118,000	25,100	---	---	9,570	871,000	178	<5	---	---	<2
	16-Apr-08	N	126,000	25,100	---	---	9,980	891,000	170	<5	---	---	<2
	29-Apr-08	N	113,000	24,900	5.3	---	9,590	837,000	185	<5	---	<0.5	<2
	14-May-08	N	101,000	21,000	---	---	8,940	821,000	168	<5	---	---	<2
	28-May-08	N	111,000	22,000	<5	---	9,420	825,000	158	---	917	<0.5	<2
	11-Jun-08	N	107,000	23,500	---	---	9,150	867,000	160	<5	---	---	<2
	25-Jun-08	N	102,000	20,000	<5	---	8,910	820,000	163	---	908	<0.5	<2
	24-Jul-08	N	105,000	22,600	5.1	---	9,070	855,000	165	---	890	<0.5	<2
	20-Aug-08	N	99,200	21,100	5.1	---	9,050	844,000	160	---	922	<0.5	320.0
	17-Sep-08	N	114,000	23,500	<5	---	9,930	920,000	155	---	989	<0.5	<2
	15-Oct-08	N	103,000	21,400	5.2	---	9,180	849,000	188	---	1,090	<0.5	<2
	12-Nov-08	N	127,000	27,100	13.2	---	9,840	993,000	427	---	1,290	<0.5	<2
PT-9M	17-Jul-07	N	485,000	---	<5	1.40	30,200	1,030,000	97.5	<5	1,400	<0.5	<2
	17-Jul-07	FD	476,000	---	<5	1.42	29,800	1,020,000	100	<5	1,400	<0.5	<2
	22-Jan-08	N	525,000	22,700	<5	---	29,800	1,140,000	97.5	---	1,640	<0.5	<2
	05-Mar-08	N	553,000	25,100	<5	---	32,100	1,220,000	100	---	1,650	<0.5	<2
	12-Mar-08	N	483,000	22,800	<5	---	30,700	1,140,000	113	---	1,520	<0.5	<2
	19-Mar-08	N	517,000	26,400	---	---	32,100	1,190,000	97.5	<5	1,510	<0.5	<2
	26-Mar-08	N	526,000	26,200	<25	---	31,900	1,160,000	100	---	1,610	<0.5	<2
	26-Mar-08	FD	543,000	26,400	<25	---	33,200	1,190,000	103	---	1,600	<0.5	<2
	02-Apr-08	N	513,000	27,700	---	---	31,800	1,150,000	105	<5	---	---	<2
	16-Apr-08	N	556,000	28,000	---	---	32,900	1,220,000	105	<5	---	---	<2
	29-Apr-08	N	475,000	23,900	<5	---	30,900	1,100,000	120	<5	---	<1	<2
	14-May-08	N	496,000	26,100	---	---	33,500	1,130,000	120	<5	---	---	<2
	28-May-08	N	479,000	22,800	<5	---	29,800	1,070,000	108	---	1,530	<0.5	<2
	11-Jun-08	N	492,000	25,900	---	---	31,200	1,150,000	97.5	<5	---	---	<2
	25-Jun-08	N	452,000	21,800	<5	---	29,900	1,090,000	103	---	1,380	<1	<2
	24-Jul-08	N	426,000	22,700	<5	---	26,600	1,050,000	108	---	1,240	<0.5	<2
	20-Aug-08	N	488,000	23,500	<5	---	28,900	1,100,000	97.5	---	1,530	<0.5	40.0
	17-Sep-08	N	504,000	26,100	<25	---	32,300	1,110,000	92.5	---	1,660	<0.5	<2
	15-Oct-08	N	431,000	22,300	<5	---	27,600	1,010,000	105	---	1,450	<1	<2
	12-Nov-08	N	468,000	24,700	<25	---	30,700	1,090,000	100	---	1,420	<0.5	<2

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Location Name	Sample Date	Sample Type	Dissolved Calcium (µg/L)	Dissolved Magnesium (µg/L)	Dissolved Arsenic (µg/L)	Total Arsenic (µg/L)	Dissolved Potassium (µg/L)	Dissolved Sodium (µg/L)	Alkalinity bicarbonate (mg/L)	Alkalinity carbonate (mg/L)	Chloride (mg/L)	Orthophosphate-p (mg/L)	Sulfide (mg/L)
PT-9D	17-Jul-07	N	368,000	---	6.3	6.11	34,200	2,840,000	52.5	<5	4,350	<1	<2
	22-Jan-08	N	399,000	8,380	<50	---	35,500	3,230,000	50.0	---	4,790	<1	<2
	22-Jan-08	FD	404,000	9,160	<50	---	35,400	3,260,000	55.0	---	4,940	<1	<2
	05-Mar-08	N	438,000	9,240	<25	---	37,000	3,540,000	41.0	---	4,890	<0.5	<2
	12-Mar-08	N	407,000	10,100	<25	---	35,000	3,210,000	52.5	---	4,920	<2.5	<2
	19-Mar-08	N	432,000	10,400	---	---	36,800	3,320,000	42.0	<5	4,650	<1	<2
	26-Mar-08	N	436,000	10,100	<25	---	36,700	3,300,000	52.5	---	4,810	<1	12.0
	02-Apr-08	N	419,000	10,400	---	---	36,000	3,320,000	50.0	<5	---	---	<2
	16-Apr-08	N	445,000	10,300	---	---	36,600	3,440,000	55.0	<5	---	---	<2
	29-Apr-08	N	431,000	11,900	7.3	---	35,500	2,940,000	57.5	<5	---	<5	<2
	14-May-08	N	408,000	12,400	---	---	35,800	2,750,000	65.0	<5	---	---	<2
	28-May-08	N	421,000	11,200	6.8	---	35,100	2,800,000	55.0	---	4,320	<1	<2
	11-Jun-08	N	460,000	12,800	---	---	37,300	3,270,000	47.5	<5	---	---	<2
	11-Jun-08	FD	466,000	13,200	---	---	37,100	3,340,000	47.5	<5	---	---	<2
	25-Jun-08	N	439,000	12,500	7.4	---	35,000	2,830,000	52.5	---	4,050	<1	<2
	24-Jul-08	N	452,000	15,200	6.5	---	33,600	2,910,000	53.8	---	4,090	<2.5	8
	20-Aug-08	N	451,000	11,900	7.3	---	36,700	3,250,000	47.5	---	4,810	<2.5	40.0
	20-Aug-08	FD	451,000	12,000	7.2	---	36,200	3,280,000	47.5	---	4,820	<2.5	160.0
	17-Sep-08	N	431,000	11,200	<25	---	36,900	3,250,000	47.5	---	4,880	<2.5	<2
	15-Oct-08	N	458,000	18,400	<25	---	36,300	2,640,000	55.5	---	3,990	<1	<2
	12-Nov-08	N	523,000	17,000	<25	---	40,300	3,110,000	47.9	---	4,680	<2.5	<2
MW-11	17-Jul-07	N	125,000	---	<5	1.54	8,330	280,000	87.5	<5	470	<0.5	<2
	24-Jan-08	N	122,000	16,100	<5	---	8,160	280,000	103	---	442	<0.5	<2
	04-Mar-08	N	123,000	17,700	<5	---	8,300	302,000	92.5	---	434	<0.5	<2
	11-Mar-08	N	116,000	16,100	<5	---	7,990	278,000	110	---	439	<0.5	<2
	11-Mar-08	FD	120,000	16,700	<5	---	8,160	296,000	105	---	453	<0.5	<2
	19-Mar-08	N	125,000	17,400	---	---	8,800	302,000	103	<5	427	<0.5	<2
	27-Mar-08	N	124,000	15,900	<5	---	8,480	295,000	110	---	467	<0.5	<2
	01-Apr-08	N	118,000	15,800	---	---	8,340	283,000	103	<5	---	---	<2
	15-Apr-08	N	122,000	16,400	---	---	8,260	299,000	108	<5	---	---	4.0
	28-Apr-08	N	116,000	16,100	<5	---	8,230	276,000	140	<5	---	<0.5	<2
	13-May-08	N	120,000	16,800	---	---	8,290	289,000	113	<5	---	---	2.4
	27-May-08	N	117,000	16,100	<5	---	8,220	272,000	100.0	---	466	<0.5	<2
	10-Jun-08	N	119,000	17,600	---	---	8,230	282,000	90.0	<5	---	---	<2
	24-Jun-08	N	120,000	16,700	<5	---	8,560	284,000	90.0	---	477	<0.5	<2
	22-Jul-08	N	114,000	17,900	<5	---	8,120	275,000	92.5	---	473	<0.5	<2
	21-Aug-08	N	116,000	19,000	<5	---	8,450	300,000	92.5	---	465	<0.5	<2
	16-Sep-08	N	114,000	16,500	<5	---	8,360	268,000	87.5	---	474	<0.5	<2
	14-Oct-08	N	120,000	16,300	<5	---	8,140	278,000	94.3	---	459	<0.5	<2
	11-Nov-08	N	116,000	15,100	<5	---	8,210	280,000	91.5	---	551	<0.5	<2

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Location Name	Sample Date	Sample Type	Dissolved Calcium (µg/L)	Dissolved Magnesium (µg/L)	Dissolved Arsenic (µg/L)	Total Arsenic (µg/L)	Dissolved Potassium (µg/L)	Dissolved Sodium (µg/L)	Alkalinity bicarbonate (mg/L)	Alkalinity carbonate (mg/L)	Chloride (mg/L)	Orthophosphate-p (mg/L)	Sulfide (mg/L)
MW-24A	18-Jul-07	N	42,000	---	5.4	5.58	5,610	565,000	310	<5	410	<0.5	<2
	24-Jan-08	N	46,300	8,660	5.1	---	5,860	585,000	365	---	452	<0.5	<2
	06-Mar-08	N	367,000	46,000	8.0	---	19,900	1,840,000	118	---	2,450	<5	<2
	12-Mar-08	N	387,000	39,900	<25	---	22,700	1,680,000	198	---	2,680	<10	<2
	19-Mar-08	N	407,000	46,200	---	---	21,200	1,710,000	423	<5	2,370	<2.5	<2
	26-Mar-08	N	491,000	50,500	82.8	---	18,900	1,690,000	970	---	2,380	<5	4.8
	01-Apr-08	N	423,000	47,700	---	---	18,100	1,620,000	1,020	<5	---	---	<2
	17-Apr-08	N	517,000	43,400	---	---	23,100	2,030,000	1,110	<5	---	---	10.4
	30-Apr-08	N	432,000	37,200	72.2	---	24,700	1,860,000	590	<5	---	<5	<2
	30-Apr-08	FD	437,000	35,800	70.4	---	23,700	1,860,000	570	<5	---	<5	<2
	15-May-08	N	494,000	59,900	---	---	24,000	1,750,000	450	<5	---	---	<2
	15-May-08	FD	502,000	59,100	---	---	24,800	1,780,000	480	<5	---	---	<2
	27-May-08	N	493,000	42,200	9.8	---	24,300	1,870,000	880	---	2,790	<1	11.2
	12-Jun-08	N	521,000	45,900	---	---	25,300	1,960,000	970	<5	---	---	4.0
	19-Jun-08	N	---	---	---	---	---	---	---	---	---	---	---
	26-Jun-08	N	398,000	29,700	23.7	---	23,700	192,000	153	---	2,780	<0.5	<2
	01-Jul-08	N	---	---	---	---	---	---	---	---	---	---	---
	24-Jul-08	N	384,000	27,800	24.5	---	24,000	1,980,000	115	---	2,730	<1	6.4
	24-Jul-08	FD	397,000	28,300	25.7	---	24,300	2,020,000	118	---	2,670	<1	<2
	19-Aug-08	N	376,000	34,500	21.0	---	22,400	1,800,000	288	---	2,690	<1	2.0
	16-Sep-08	N	355,000	29,100	8.1	---	23,100	1,930,000	670	---	2,720	<1	117.0
	16-Oct-08	N	353,000	30,400	25.9	---	24,300	1,940,000	353	---	2,870	<0.5	22.0
	13-Nov-08	N	348,000	26,500	<25	---	26,500	1,980,000	340	---	2,800	<0.5	102.0
	13-Nov-08	FD	349,000	27,400	<25	---	26,000	2,010,000	310	---	2,800	<2.5	94.4
MW-24B	18-Jul-07	N	329,000	---	7.1	7.08	34,500	3,270,000	50.0	<5	4,820	<0.5	<2
	24-Jan-08	N	341,000	8,050	<10	---	36,400	3,470,000	50.0	---	5,270	<1	2.0
	06-Mar-08	N	338,000	7,970	8.8	---	37,200	3,430,000	42.0	---	5,160	<1	<2
	12-Mar-08	N	332,000	7,610	<25	---	34,800	3,290,000	52.5	---	5,870	<1	<2
	19-Mar-08	N	351,000	8,410	---	---	37,100	3,650,000	44.0	<5	5,120	<0.5	<2
	26-Mar-08	N	358,000	8,240	<25	---	37,200	3,580,000	42.0	---	5,150	<0.5	<2
	03-Apr-08	N	345,000	8,130	---	---	36,200	3,470,000	44.0	<5	---	---	3.2
	17-Apr-08	N	345,000	8,280	---	---	36,700	3,530,000	50.0	<5	---	---	<2
	30-Apr-08	N	304,000	7,020	6.8	---	68,200	3,420,000	57.5	<5	---	<1	<2
	15-May-08	N	338,000	8,130	---	---	37,100	3,350,000	55.0	<5	---	---	<2
	28-May-08	N	360,000	38,900	<5	---	20,800	1,050,000	118.0	---	1,420	<1	<2
	12-Jun-08	N	336,000	7,570	---	---	34,800	3,340,000	45.0	<5	---	---	<2
	26-Jun-08	N	326,000	6,960	8.3	---	35,400	3,300,000	46.3	---	4,950	<1	<2
	24-Jul-08	N	323,400	7,730	7.4	---	33,000	3,420,000	46.3	---	4,860	<2.5	3.2
	19-Aug-08	N	296,000	7,150	7.6	---	31,900	3,210,000	46.3	---	4,910	<1	2.0
	17-Sep-08	N	308,000	7,770	<25	---	34,900	3,260,000	45.0	---	4,950	<0.5	<2
	16-Oct-08	N	307,000	7,990	<25	---	34,700	3,130,000	47.6	---	4,870	<0.5	<2
	16-Oct-08	FD	310,000	7,880	<25	---	34,700	3,190,000	47.8	---	4,880	<0.5	<2
	13-Nov-08	N	302,000	7,600	<25	---	35,000	3,380,000	46.0	---	5,260	<0.5	<2

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Location Name	Sample Date	Sample Type	Dissolved Calcium (µg/L)	Dissolved Magnesium (µg/L)	Dissolved Arsenic (µg/L)	Total Arsenic (µg/L)	Dissolved Potassium (µg/L)	Dissolved Sodium (µg/L)	Alkalinity bicarbonate (mg/L)	Alkalinity carbonate (mg/L)	Chloride (mg/L)	Orthophosphate-p (mg/L)	Sulfide (mg/L)
MW-38S	17-Jul-07	N	84,200	---	<5	6.10	8,710	627,000	175	<5	680	<0.5	<2
	23-Jan-08	N	63,900	12,200	<5	---	7,400	546,000	175	---	546	<0.5	<2
	04-Mar-08	N	67,600	13,300	<5	---	7,910	607,000	185	---	534	<0.5	<2
	11-Mar-08	N	66,100	13,300	<5	---	7,920	586,000	175	---	571	<0.5	<2
	20-Mar-08	N	70,900	13,400	---	---	8,190	593,000	200	200	---	<0.5	<2
	26-Mar-08	N	71,000	13,500	<25	---	8,160	583,000	183	---	583	<0.5	<2
	01-Apr-08	N	60,500	11,600	---	---	7,010	57,500	290	<5	---	---	<2
	15-Apr-08	N	67,100	13,000	---	---	7,710	590,000	190	<5	---	---	<2
	28-Apr-08	N	67,000	13,000	<5	---	8,030	575,000	200	<5	---	<0.5	<2
	13-May-08	N	63,400	12,700	---	---	7,780	571,000	185	<5	---	---	<2
	27-May-08	N	62,600	12,200	<5	---	7,420	540,000	193	---	551	<0.5	<2
	10-Jun-08	N	63,000	12,400	---	---	7,670	620,000	180	<5	---	---	<2
	24-Jun-08	N	65,700	12,200	<5	---	7,690	570,000	185	---	533	<0.5	<2
	22-Jul-08	N	59,700	12,600	<5	---	7,270	534,000	183	---	523	<0.5	<2
	20-Aug-08	N	56,400	11,200	<5	---	7,160	540,000	175	---	487	<0.5	160.0
	16-Sep-08	N	54,200	10,900	<5	---	7,150	560,000	160	---	496	<0.5	<2
	14-Oct-08	N	53,700	10,400	<5	---	6,840	535,000	189	---	467	<0.5	<2
	11-Nov-08	N	53,000	9,220	<5	---	6,930	516,000	182	---	471	<0.5	<2
MW-38D	17-Jul-07	N	352,000	---	7.9	7.49	45,600	4,710,000	35.0	<5	7,240	<0.5	<2
	23-Jan-08	N	353,000	<20,000	<100	---	43,100	4,560,000	40.0	---	7,690	<2.5	<2
	04-Mar-08	N	343,000	7,150	8.6	---	44,500	5,070,000	31.0	---	7,390	<0.5	<2
	11-Mar-08	N	363,000	7,580	<25	---	47,000	4,970,000	32.0	---	7,710	<0.5	<2
	20-Mar-08	N	361,000	7,720	---	---	44,900	5,020,000	32.0	32	---	<2.5	<2
	20-Mar-08	FD	359,000	7,720	---	---	45,100	4,920,000	33.0	33	---	<2.5	<2
	26-Mar-08	N	362,000	7,580	<25	---	44,700	4,940,000	31.0	---	7,830	<1	<2
	01-Apr-08	N	353,000	7,040	---	---	46,100	4,870,000	31.0	<5	---	---	<2
	01-Apr-08	FD	335,000	6,680	---	---	44,000	4,900,000	32.0	<5	---	---	<2
	15-Apr-08	N	38,500	7,440	---	---	45,200	5,010,000	31.0	<5	---	---	<2
	15-Apr-08	FD	405,000	7,500	---	---	46,300	5,330,000	32.0	<5	---	---	<2
	28-Apr-08	N	346,000	7,700	<25	---	43,700	4,740,000	32.0	<5	---	<0.5	<2
	13-May-08	N	360,000	7,020	---	---	46,400	4,690,000	36.0	<5	---	---	2.0
	27-May-08	N	337,000	6,670	7.7	---	44,500	4,600,000	32.0	---	7,580	<0.5	<2
	10-Jun-08	N	352,000	6,960	---	---	44,900	4,860,000	---	---	---	---	<2
	24-Jun-08	N	377,000	6,610	9.0	---	45,200	5,000,000	32.5	---	7,420	<0.5	<2
	22-Jul-08	N	369,000	7,300	8.5	---	45,100	4,900,000	32.5	---	7,490	<0.5	<2
	20-Aug-08	N	364,000	6,950	8.9	---	43,200	3,200,000	31.3	---	7,230	<2.5	80.0
	16-Sep-08	N	367,000	7,240	8.6	---	44,700	4,870,000	32.0	---	7,390	<0.5	<2
	16-Sep-08	FD	339,000	7,750	<25	---	44,400	4,910,000	33.0	---	7,430	<0.5	<2
	14-Oct-08	N	361,000	8,180	<25	---	45,100	5,080,000	33.3	---	7,360	<0.5	<2
	11-Nov-08	N	365,000	6,670	8.1	---	42,400	487,000	32.4	---	7,210	<0.5	<2

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Needles, California
Upland Reductive Zone In-Situ Pilot Test Final Completion Report

Location Name	Sample Date	Sample Type	Dissolved Calcium (µg/L)	Dissolved Magnesium (µg/L)	Dissolved Arsenic (µg/L)	Total Arsenic (µg/L)	Dissolved Potassium (µg/L)	Dissolved Sodium (µg/L)	Alkalinity bicarbonate (mg/L)	Alkalinity carbonate (mg/L)	Chloride (mg/L)	Orthophosphate-p (mg/L)	Sulfide (mg/L)
PTR-1	19-Jul-07	N	254,000	---	<5	1.94	21,500	1,500,000	97.5	<5	1,940	<0.5	<2
	25-Jan-08	N	206,000	37,500	<5	---	16,400	1,190,000	123	---	1,610	<0.5	<2
	06-Mar-08	N	171,000	36,500	<25	---	12,800	882,000	208	---	1,360	<500	<2
	11-Mar-08	N	166,000	36,100	<25	---	13,000	872,000	158	---	1,190	<5	<2
	20-Mar-08	N	155,000	32,800	---	---	11,500	758,000	203	203	---	<50	<2
	27-Mar-08	N	112,000	21,600	<25	---	6,680	461,000	185	---	608	<20	3.2
	01-Apr-08	N	254,000	47,500	---	---	15,600	1,050,000	600	<5	---	---	<2
	16-Apr-08	N	175,000	40,900	---	---	12,500	833,000	138	<5	---	---	<2
	29-Apr-08	N	170,000	35,100	13.4	---	11,300	767,000	298	<5	---	<5	4.8
	15-May-08	N	188,000	37,800	---	---	11,800	818,000	300	<5	---	---	3.6
	29-May-08	N	157,000	35,700	<5	---	13,800	856,000	183	---	1,190	<0.5	4.0
	12-Jun-08	N	171,000	38,900	---	---	14,200	965,000	148	<5	---	---	<2
	19-Jun-08	N	---	---	---	---	---	---	---	---	---	---	---
	26-Jun-08	N	173,000	36,100	7.5	---	13,600	942,000	150	---	1,290	<0.5	<2
	01-Jul-08	N	---	---	---	---	---	---	---	---	---	---	---
	24-Jul-08	N	163,000	37,700	<5	---	12,300	916,000	160	---	1,180	<0.5	16.0
	19-Aug-08	N	170,000	37,500	6.0	---	14,200	979,000	140	---	1,330	<0.5	320.0
	18-Sep-08	N	182,000	40,200	8.5	---	15,000	1,040,000	115	---	1,450	<0.5	<2
	16-Oct-08	N	176,000	40,600	<5	---	16,300	992,000	106	---	1,440	<0.5	2.0
	13-Nov-08	N	209,000	32,300	<5	---	11,900	686,000	330	---	967	<0.5	<2
PTR-2	18-Jul-07	N	335,000	---	<5	1.99	23,200	1,610,000	92.5	<5	2,200	<0.5	<2
	25-Jan-08	N	427,000	34,400	<10	---	25,000	1,450,000	103	---	2,060	<0.5	2.0
	06-Mar-08	N	407,000	29,200	<25	---	26,800	1,780,000	92.5	---	2,460	<1	<2
	11-Mar-08	N	393,000	27,200	<5	---	26,300	1,770,000	92.5	---	2,470	<0.5	<2
	20-Mar-08	N	151,000	18,000	---	---	17,300	1,220,000	148	148	---	<250	<2
	27-Mar-08	N	88,500	13,000	<25	---	11,100	830,000	120	---	1,090	<500	<2
	01-Apr-08	N	404,000	28,900	---	---	28,500	2,120,000	145	<5	---	---	<2
	15-Apr-08	N	241,000	23,900	---	---	13,900	919,000	143	<5	---	---	<2
	29-Apr-08	N	410,000	25,300	5.6	---	26,200	1,920,000	120	<5	---	<1	<2
	15-May-08	N	396,000	26,900	---	---	28,800	1,970,000	105	<5	---	---	<2
	28-May-08	N	302,000	19,700	7.7	---	22,800	1,730,000	82.5	---	2,620	<1	<2
	10-Jun-08	N	397,000	25,200	---	---	26,200	203,000	95.0	<5	---	---	<2
	19-Jun-08	N	---	---	---	---	---	---	---	---	---	---	---
	26-Jun-08	N	397,000	24,000	<5	---	26,700	1,910,000	82.5	---	2,650	<1	<2
	01-Jul-08	N	---	---	---	---	---	---	---	---	---	---	---
	24-Jul-08	N	396,000	26,400	<5	---	25,900	1,960,000	95	---	2,660	<2.5	4
	19-Aug-08	N	254,000	26,100	<25	---	17,800	1,050,000	125	---	1,580	<0.5	80.0
	18-Sep-08	N	281,000	23,400	7.8	---	21,000	1,520,000	75.0	---	1,380	<0.5	<2
	16-Oct-08	N	354,000	26,600	<25	---	26,100	1,740,000	86.9	---	2,630	<0.5	<2
	13-Nov-08	N	364,000	22,700	<25	---	28,300	2,060,000	92.5	---	2,770	<1	<2

Table 6
Summary of Secondary Analytical Parameters
PG&E Topock
Needles, California
Upland Reductive Zone In-Situ Pilot Test Final Completion Report

Location Name	Sample Date	Sample Type	Dissolved Calcium (µg/L)	Dissolved Magnesium (µg/L)	Dissolved Arsenic (µg/L)	Total Arsenic (µg/L)	Dissolved Potassium (µg/L)	Dissolved Sodium (µg/L)	Alkalinity bicarbonate (mg/L)	Alkalinity carbonate (mg/L)	Chloride (mg/L)	Orthophosphate-p (mg/L)	Sulfide (mg/L)
Equipment Blank	17-Jul-07	EB	<1,000	---	<5	<1	<1,000	<1,000	<5	<5	<0.5	<0.5	<2
	22-Jan-08	EB	<1,000	<1,000	<5	---	<1,000	<1,000	<5	---	<0.5	<0.5	<2
	05-Mar-08	EB	<1,000	<1,000	<5	---	<1,000	<1,000	<5	---	<0.5	<0.5	<2
	11-Mar-08	EB	<1,000	<1,000	<5	---	<1,000	<1,000	<5	---	<0.5	<0.5	<2
	18-Mar-08	EB	<1,000	<1,000	---	---	<1,000	<1,000	<5	<5	<0.5	<0.5	<2
	25-Mar-08	EB	<1,000	<1,000	<5	---	<1,000	<1,000	<5	---	<0.5	<0.5	<2
	03-Apr-08	FB	<1,000	<1,000	---	---	<1,000	<1,000	<5	<5	---	---	<2
	15-Apr-08	EB	<1,000	<1,000	---	---	<1,000	<1,000	<5	<5	---	---	<2
	28-Apr-08	EB	<1,000	<1,000	<5	---	<1,000	<1,000	<5	<5	---	<0.5	<2
	13-May-08	EB	<1,000	<1,000	---	---	<1,000	<1,000	<5	<5	---	---	<2
	28-May-08	EB	<1,000	<1,000	---	---	<1,000	<1,000	<5	---	<0.5	<0.5	<2
	10-Jun-08	EB	<1,000	<1,000	---	---	<1,000	<1,000	<5	<5	---	---	<2
	24-Jun-08	EB	<1,000	<1,000	<5	---	<1,000	<1,000	<5	---	<0.5	<0.5	2.0
	22-Jul-08	EB	<1,000	<1,000	<5	---	<1,000	<1,000	<5	---	1.38	<0.5	<2
	20-Aug-08	EB	<1,000	<1,000	<5	---	<1,000	<1,000	<5	---	1.77	<0.5	<2
	16-Sep-08	EB	<1,000	<1,000	<5	---	<1,000	<1,000	<5	---	<0.5	<0.5	<2
	14-Oct-08	EB	<1,000	<1,000	<5	---	<1,000	<1,000	<5	---	<0.5	<0.5	<2
	11-Nov-08	EB	<1,000	<1,000	<5	---	<1,000	<1,000	<5	---	1.54	<0.5	<2
Field Blank	17-Jul-07	FB	<1,000	---	<5	<1	<1,000	<1,000	<5	<5	<0.5	<0.5	<2
	22-Jan-08	FB	<1,000	<1,000	<5	---	<1,000	<1,000	<5	---	116	<0.5	<2
	05-Mar-08	FB	<1,000	<1,000	<5	---	<1,000	<1,000	<5	---	<0.5	<0.5	<2
	11-Mar-08	FB	<1,000	<1,000	<5	---	<1,000	1,590	<5	---	<0.5	<0.5	<2
	18-Mar-08	FB	<1,000	<1,000	---	---	<1,000	<1,000	<5	<5	0.78	<0.5	<2
	25-Mar-08	FB	<1,000	<1,000	<5	---	<1,000	<1,000	<5	---	<0.5	<0.5	<2
	03-Apr-08	FB	<1,000	<1,000	---	---	<1,000	<1,000	<5	<5	---	---	<2
	15-Apr-08	FB	<1,000	<1,000	---	---	<1,000	<1,000	<5	<5	---	---	<2
	28-Apr-08	FB	<1,000	<1,000	<5	---	<1,000	<1,000	<5	<5	---	<0.5	<2
	13-May-08	FB	<1,000	<1,000	---	---	<1,000	<1,000	1.0	<5	---	---	<2
	28-May-08	FB	<1,000	<1,000	---	---	<1,000	<1,000	<5	---	<0.5	<0.5	<2
	10-Jun-08	FB	<1,000	<1,000	---	---	<1,000	<1,000	<5	<5	---	---	<2
	24-Jun-08	FB	<1,000	<1,000	<5	---	<1,000	<1,000	<5	---	1.15	<0.5	<2
	22-Jul-08	FB	<1,000	<1,000	<5	---	<1,000	<1,000	<5	---	1.45	<0.5	<2
	19-Aug-08	FB	<1,000	<1,000	<5	---	<1,000	<1,000	<5	---	<0.5	<0.5	<2
	16-Sep-08	FB	<1,000	<1,000	<5	---	<1,000	<1,000	<5	---	<0.5	<0.5	<2
	14-Oct-08	FB	<1,000	<1,000	<5	---	<1,000	<1,000	<5	---	<0.5	<0.5	<2
	11-Nov-08	FB	<1,000	<1,000	<5	---	<1,000	<1,000	<5	---	2.13	<0.5	<2

Table 6
Summary of Secondary Analytical Parameters
PG&E Topock
Needles, California
Upland Reductive Zone In-Situ Pilot Test Final Completion Report

Location Name	Sample Date	Sample Type	Dissolved Calcium (µg/L)	Dissolved Magnesium (µg/L)	Dissolved Arsenic (µg/L)	Total Arsenic (µg/L)	Dissolved Potassium (µg/L)	Dissolved Sodium (µg/L)	Alkalinity bicarbonate (mg/L)	Alkalinity carbonate (mg/L)	Chloride (mg/L)	Orthophosphate-p (mg/L)	Sulfide (mg/L)

NOTES

Most recent data indicated in **BOLD**

a	Samples were diluted in the laboratory
ft bgs	Feet below ground surface
mg/L	Milligrams per liter
µg/L	Micrograms per liter
<	Symbol indicates not detected at or above laboratory detection limit as noted.
EB	Equipment blank
FB	Field blank
FD	Field duplicate
J	Reported value is estimated.
N	Normal
NA	Not applicable
Dissolved	Samples were field filtered with a 0.45 micron filter.
---	Not analyzed/not sampled
*	PTR-1 Screen: 125-160 and 175-220 ft bgs. PTR-2 Screen: 118-158 and 173-218 ft bgs.

Table 7
Summary of Baseline Title 22 Metals Results
PG&E Topock
Needles, California
Upland Reductive Zone In-Situ Pilot Test Final Completion Report

Location Name	Sample Date	Antimony	Arsenic (T)	Barium	Beryllium	Cadmium	Chromium	Cobalt	Copper	Lead	Mercury	Molybdenum	Nickel	Selenium	Silver	Thallium	Vanadium	Zinc
		µg/L																
PT-7S	18-Jul-07	<1	9.65	156	1.92	<1	1,080	21.5	19.2	28.6	<0.2	23.0	19.6	42.2	<1	<1	51.5	47.7
PT-7M	19-Jul-07	<1	7.01	94.8	1.1	<1	2,110	12.4	8.32	18.6	1.98	14.7	16.4	101	<1	<1	30.1	34.5
PT-7D	18-Jul-07	<1	8.12	96.5	<1	<1	7,750	<1	4.54	<1	<0.2	129.0	3.12	8.11	<1	<1	5.47	<10
PT-8S	16-Jul-07	<1	5.13	86.9	<1	<1	1,620	5.18	9.22	7.75	<0.2	45.4	5.6	83.9	<1	<1	22.3	19.9
PT-8M	18-Jul-07	<1	1.53	33.7	<1	<1	4,140	<1	1.25	<1	<0.2	12.0	<1	151	<1	<1	5.73	<10
PT-8D	16-Jul-07	<1	9	105	<1	<1	7,290	6.03	4.35	9.13	<0.2	91.6	5.82	9.1	<1	<1	13.1	20.9
PT-9S	17-Jul-07	<1	5.36	67.2	<1	<1	1,170	2.86	6.31	2.57	<0.2	48.4	2.61	56.9	<1	<1	20	10.9
PT-9M	17-Jul-07	<1	1.4	46.8	<1	<1	2,250	1.09	<1	<1	<0.2	7.07	1.43	165	<1	<1	5.92	<10
PT-9D	17-Jul-07	<1	6.11	79.5	<1	<1	---	<1	<1	<1	<0.2	92.2	<1	9.06	<1	<1	3.95	<10
MW-11	17-Jul-07	<1	1.54	43.1	<1	<1	339	<1	2.46	2.48	<0.2	11.3	<1	6.12	<1	<1	9.16	10.9
MW-24A	18-Jul-07	<1	5.58	26.1	<1	<1	2,600	<1	4.89	1.1	<0.2	47.9	<1	3.36	<1	<1	30.6	14.4
MW-24B	18-Jul-07	<1	7.08	38.9	<1	<1	5,680	<1	207	<1	<0.2	59.8	<1	10.9	<1	<1	7.2	76.6
MW-38S	17-Jul-07	1.74	6.1	40.7	1.48	1.2	948	3.19	2.67	2.39	<0.2	65.3	2.85	7.15	1.38	1.47	26.2	<10
MW-38D	17-Jul-07	<1	7.49	45.7	<1	<1	66.2	<1	<1	<1	<0.2	77.9	<1	<1	<1	1.46	6.92	<10
PTR-1	19-Jul-07	<1	1.94	72.7	<1	<1	1240	1.1	1.42	<1	0.22	51.6	25.9	54	<1	<1	4.67	202
PTR-2	18-Jul-07	<1	1.99	39.7	<1	<1	4,020	<1	<1	<1	<0.2	26.0	1.12	82.8	<1	<1	4.24	14.9

NOTES	
µg/L	micrograms per liter
< 1	Sample is below detection limit of 1 µg/L
---	Not analyzed/not sampled

Table 8
Summary of Bulk Baseline Soil Results
PG&E Topock
Needles, California
Upland Reductive Zone In-Situ Pilot Test Final Completion Report

Location Name	Sample Date	Sample Depth (ft bgs)	Acidity (mg/Kg)	Alkalinity bicarbonate (mg/Kg)	Alkalinity carbonate (mg/Kg)	Alkalinity (mg/Kg)	Aluminum (mg/Kg)	Arsenic (mg/Kg)	Calcium (mg/Kg)	Hexavalent Chromium (mg/Kg)	Chromium (mg/Kg)	Iron (mg/Kg)	Magnesium (mg/Kg)	Manganese (mg/Kg)	Nitrate-n (mg/Kg)	Orthophosphate-p (mg/Kg)	pH	Sodium (mg/Kg)	Sulfate (mg/Kg)	Sulfide (mg/Kg)
PT-07	10-May-07	135	---	190	<.000	370	14,000	2.2	23,200	0.307	25.9	21,700	9,550	329	2.62 /J	<5	9.17	1,110	63.9	<5
	11-May-07	135	---	---	---	---	---	---	---	---	21.1	15,300	---	206	---	---	---	---	---	---
	11-May-07	201	---	450	<.000	790	7,850	2.15	10,100	0.394	25	13,800	6,010	204	3.95 /J	<5	9.58	1,220	172	<5
	11-May-07	208	---	30	<.000	40	9,690	6.09	22,000	3.72	35.3	19,900	7,280	523	4.20 /J	<5	9.06	2,320	384	<5
PT-08	11-May-07	140	---	---	---	---	---	---	---	---	14.2	10,800	---	154	---	---	---	---	---	---
	15-May-07	140	---	410	<.000	650	7,440	1.76	12,100	0.708	17.2	11,800	5,680	173	2.88 /J	<5	9.26	796	112	<5
	21-May-07	206	---	---	---	---	---	---	---	---	25.3	17,700	---	353	---	---	---	---	---	---
	07-Jun-07	217	---	---	---	---	---	---	---	---	24.1	16,600	---	311	---	---	---	---	---	---
PT-09	05-Jun-07	141	<10	52.5	15.0 /J	67.5	8,470	2.74	15,500	0.372	19.7	14,500	6,760	289	2.68 /J	<5	8.95	567 /J	104	8
	06-Jun-07	172	<10	47.5	5	52.5	13,000	3.34	13,100	0.37	42.3	22,300	9,130	283	1.15 /J	<5	8.54	889	159	10
	06-Jun-07	199.5	<10	95	60	155	11,400	5.25	25,500	0.803	33	20,000	8,280	388	3.69 /J	<5	9.39	1,490	184	20
PTR-01	27-Apr-07	126	<10	95	40.0 /J	135	7,870	2.68	33,800	<.1	16.7	13,200	5,790	258	1.64 /J	<5	8.81	668 /J	45.2	<5
	01-May-07	184	<10	30.04	6.66	36.7	13,600	4.65	25,400	<.1	26	27,600	9,660	536	1.48 /J	<5	8.6	1,980	310	<5
PTR-02	02-Jun-07	177	<10 /J	40.0 /J	20.0 /J	60.0 /J	11,200	4.54	12,900	0.146 /J	25	24,400	8,350	346	3.03 /J	<5 /J	8.79 /J	627	132 /J	<5 /J
	02-Jun-07	197	<10 /J	610 /J	160 /J	770 /J	11,300	3.24	15,700	0.238 /J	36.1	20,600	8,500	357	6.35 /J	<5 /J	9.27 /J	1,250	190 /J	<5 /J

NOTES	
ft bgs	feet below ground surface
J	Reported Value is estimated.
mg/Kg	milligrams per kilogram
Nitrate-N	Nitrate as Nitrogen
---	Not analyzed/not sampled
<	Symbol indicates not detected at or above laboratory detection limit as noted.

Table 9
Hexavalent Chromium Reduction in IRZ Monitoring Wells
PG&E Topock
Needles, California
Upland Reductive Zone In-Situ Pilot Test Final Completion Report

Location Name	**Pre-Pilot**			**Post-Pilot**			**% Reduction**
	Date	Cr (T) (µg/L)	Cr (VI) (µg/L)	Date	Cr (T) (µg/L)	Cr (VI) (µg/L)	
PT-7S	18-Jul-07	1,260	1,200	12-Nov-08	316	152	87
PT-7M	19-Jul-07	2,240	2,320	12-Nov-08	<1	<0.2	100
PT-7D	18-Jul-07	7,890	7,260	12-Nov-08	3	<0.2	100
PT-8S	16-Jul-07	1,660	1,750	12-Nov-08	<1	<0.2	100
PT-8M	18-Jul-07	4,120	3,960	12-Nov-08	1,650	1,660	58
PT-8D	16-Jul-07	7,260	6,540	12-Nov-08	802	714	89
MW-24A	18-Jul-07	2,550	2,480	13-Nov-08	7.2	<0.2	100

NOTES

Cr(T)	Total Chromium
Cr(VI)	Hexavalent Chromium
µg/L	micrograms per liter
<	symbol indicates not detected at or above reporting limit as noted

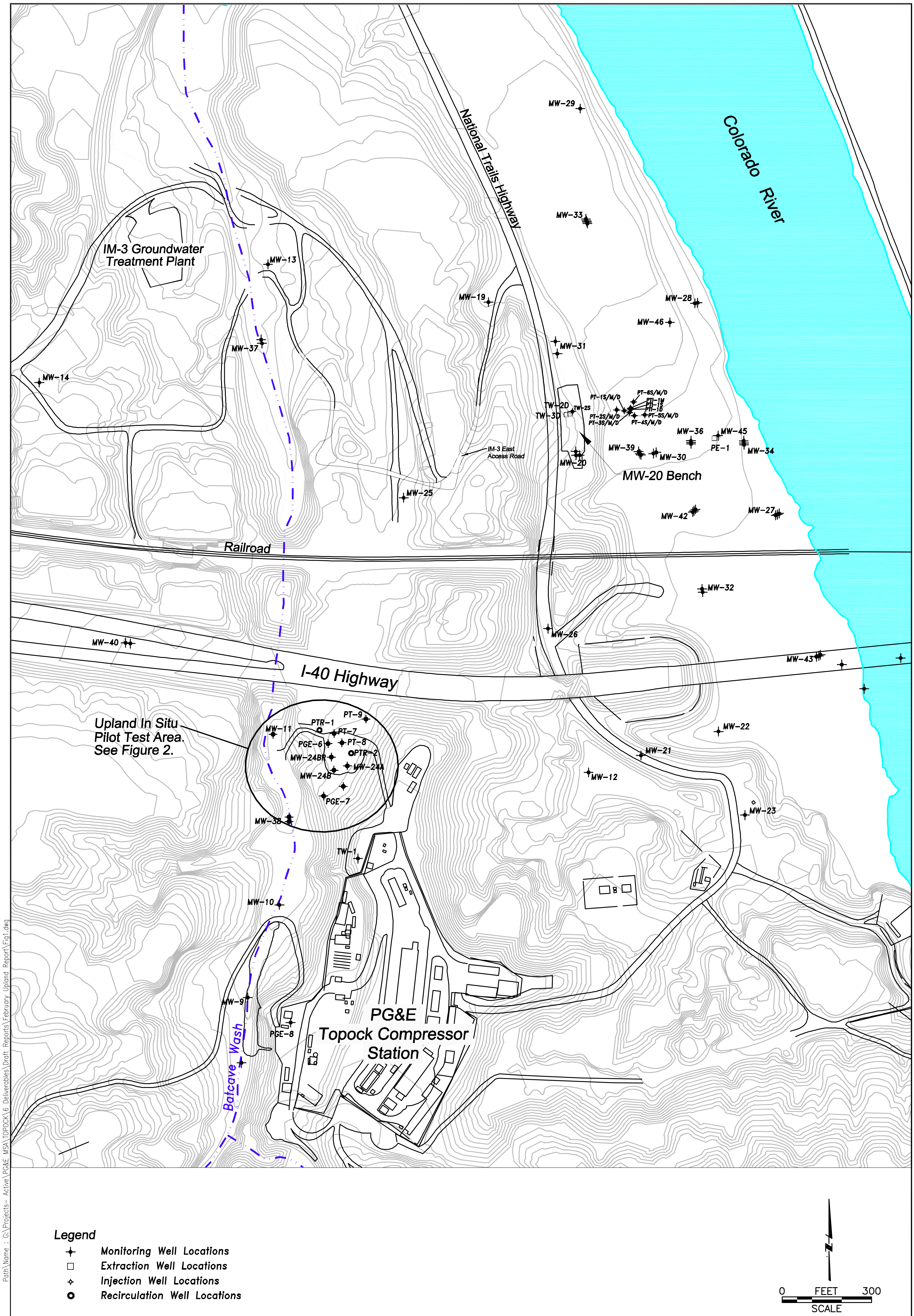
For the wells where the post-pilot Cr(VI) concentration was below detection, the detection value was used to calculate percent change.

Table 10
2009 Proposed Quarterly Monitoring Plan for Upland In-Situ Pilot Test Area

PG&E Topock
Needles, California
Upland Reductive Zone In-Situ Pilot Test Final Completion Report

Monitoring Location	Hexavalent Chromium (µg/L)	Total Dissolved Chromium (µg/L)	Fluorescein (ppb dye)	Rhodamine (ppb dye)	Dissolved Iron (µg/L)	Dissolved Manganese (µg/L)	Nitrate (mg/L)	Sulfate (mg/L)	Total Organic Carbon (mg/L)	Dissolved Arsenic (µg/L)	Alkalinity bicarbonate (mg/L)
PT-7 (S/M/D)	X	X	X	X	X	X	X	X	X	X	X
PT-8 (S/M/D)	X	X	X	X	X	X	X	X	X	X	X
PT-9 (S/M/D)	X	X	X	X	X	X	X	X	X	X	X
MW-24 (A/B)	X	X	X	X	X	X	X	X	X	X	X
MW-11	X	X	X	X	X	X	X	X	X	X	X

NOTES	
µg/L	micrograms per liter
mg/L	milligrams per liter
ppb dye	parts per billion of dye solution
S/M/D	Shallow/Middle/Deep Screen Intervals



Legend

✦ Monitoring Well Locations

☐ Extraction Well Locations

✧ Injection Well Locations

○ Recirculation Well Locations

Date\Time : Wed, 05 Mar 2008 - 2:44pm
Path\Name : G:\Projects- Active\PG&E MSA TOPOCK\6 Deliverables\Draft Reports\February Upland Report\Fig1.dwg

Acad Version : R17.0s (LMS Tech)
User Name : mchiu

Project Director L. KELLOGG	Area Manager J. PETERS
Task Manager J. ELY	Technical Review J. GILLOW
Drawing Date 4 MAR 08	Drawn By M. CHIU

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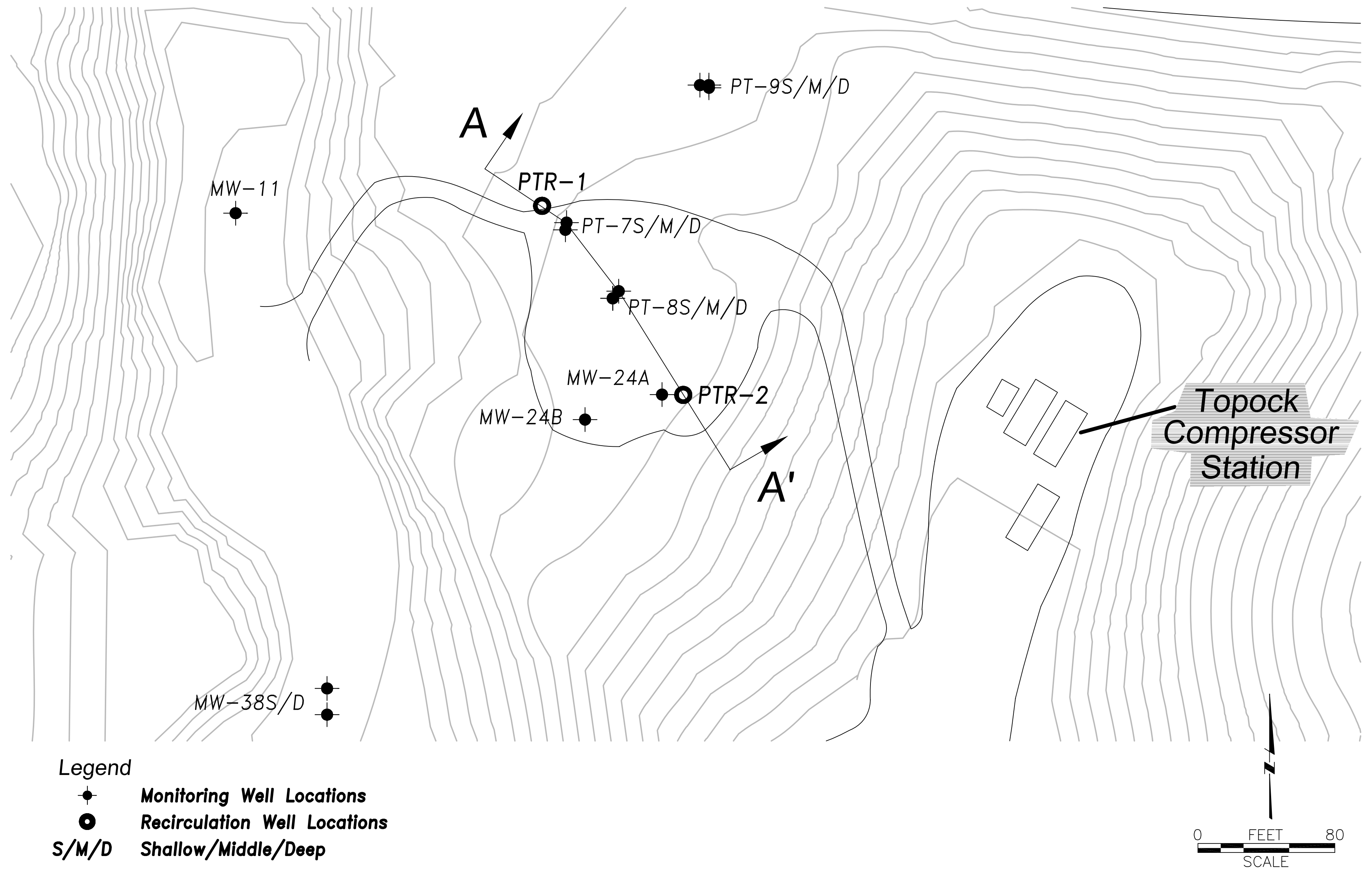
SITE PLAN
PG&E TOPOCK FACILITY
NEEDLES, CALIFORNIA

Project Number
RC000689.0001

Figure
1



Project Director	Area Manager
L. KELLOGG	J. PETERS
Task Manager	Technical Review
J. LUTRICK	M. GENTILE
Drawing Date	Drawn By
29 APR 08	M. CHIU

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UPLAND ISPT
SAMPLE LOCATION MAP
PG&E TOPOCK FACILITY
NEEDLES, CALIFORNIA

Project Number
RC000689.0004

Figure
2

Acad Version : R17.0s (LMS Tech)
User Name : Mhoefer

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Acad Version : R17.0s (LMS Tech)
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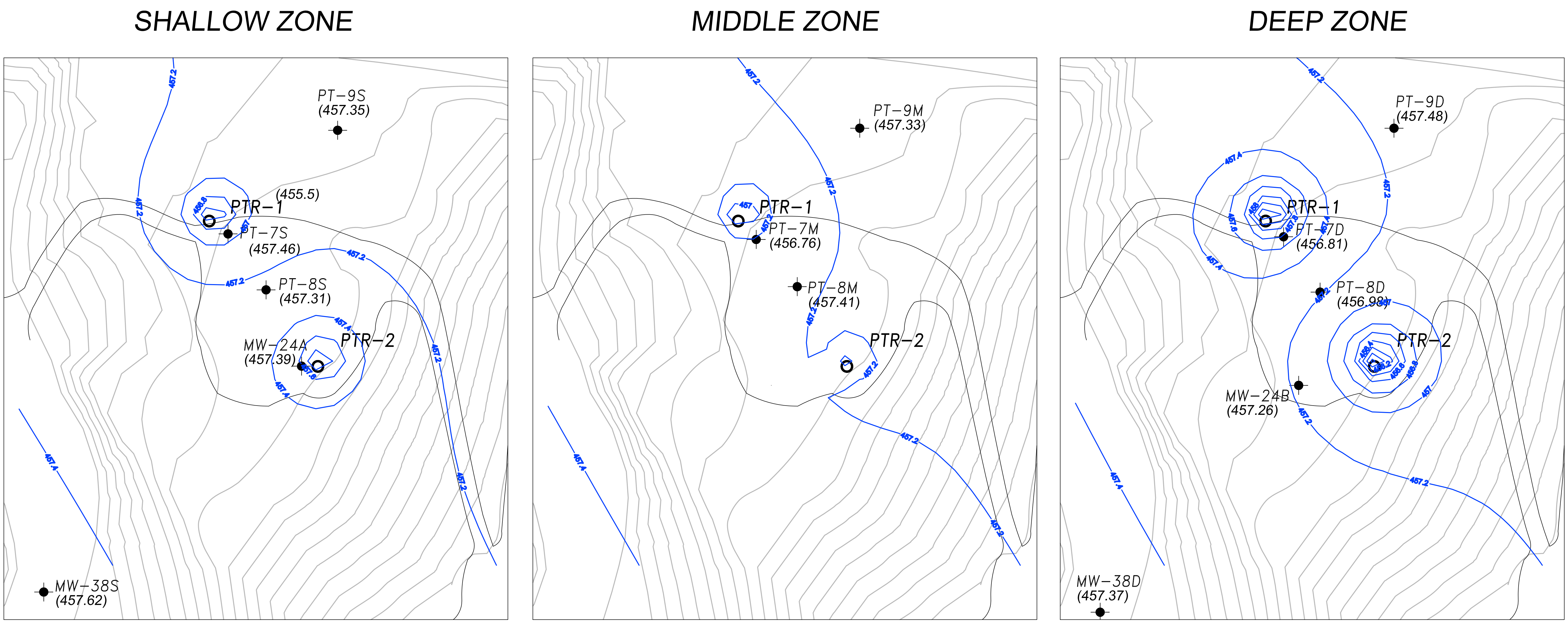

Legend

✦	Monitoring Well Locations
◉	Recirculation Well Locations
S/M/D	Shallow/Middle/Deep Wells
457.4	Simulated Groundwater Potentiometric Surface (ft−amsl)
PT−8S (457.31)	Measured Water Level (ft−amsl), June 2008

Notes:

The groundwater elevation contours in this figure could not be completely interpreted from the available set of monitoring well groundwater elevation data. To aid in interpretation, the groundwater elevation contours from numerical modeling (Appendix B) are presented with the groundwater elevation data.

0 FEET 75
SCALE

Project Director L. KELLOGG	Area Manager J. PETERS
Task Manager J. LUTRICK	Technical Review X. SONG
Drawing Date 08 FEB 09	Drawn By X. SONG

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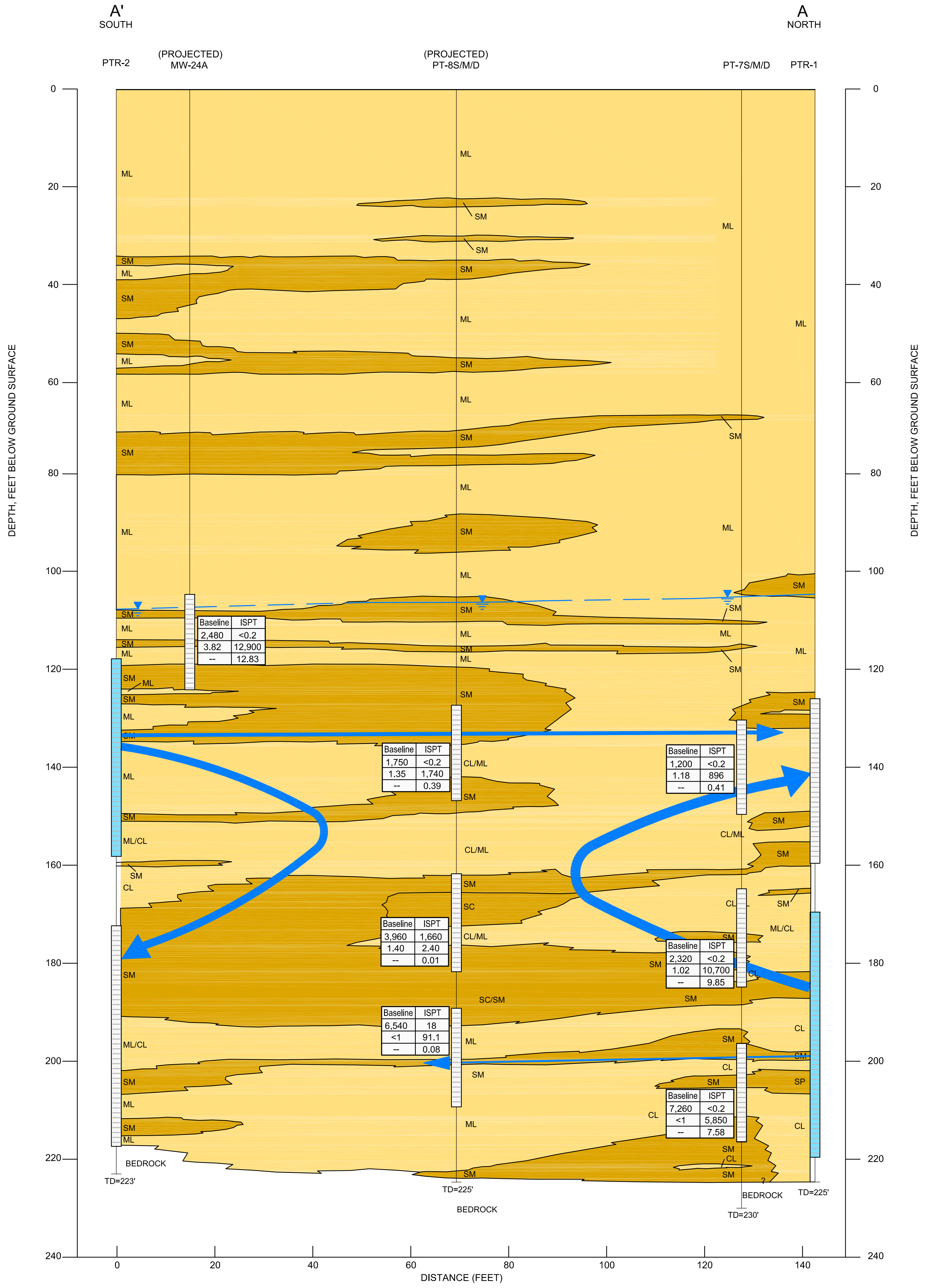
MODEL SIMULATED POTENTIOMETRIC SURFACE MAP
DURING ISPT OPERATION
(SHALLOW, MIDDLE AND DEEP ZONES)
PG&E TOPOCK FACILITY
NEEDLES, CALIFORNIA

Project Number
RC000689.0004

Figure
3



MW-24A

Baseline	ISPT
2,480	<0.2
3.82	12,900
--	12.83

PT-8S

Baseline	ISPT
1,750	<0.2
1.35	1,740
--	0.39

PT-8M

Baseline	ISPT
3,960	1,660
1.40	2.40
--	0.01

PT-8D

Baseline	ISPT
6,540	18
<1	91.1
--	0.08

PT-7S

Baseline	ISPT
1,200	<0.2
1.18	896
--	0.41

PT-7M

Baseline	ISPT
2,320	<0.2
1.02	10,700
--	9.85

PT-7D

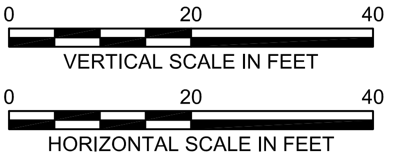
Baseline	ISPT
7,260	<0.2
<1	5,850
--	7.58

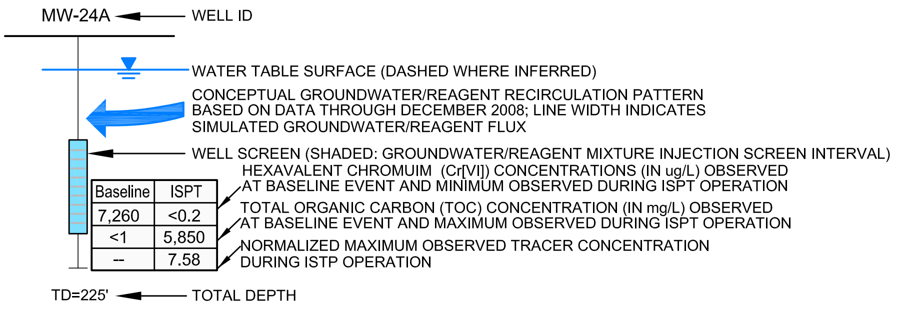
LEGEND:

▨	GENERALLY FINE GRAINED, LOWER PERMEABILITY
▨	GENERALLY COARSER GRAINED, HIGHER PERMEABILITY

SOIL CLASSIFICATION:

GW = WELL GRADED GRAVEL
SW = WELL GRADED SAND
SP = POORLY GRADED SAND
SM = SILTY SAND
SC = CLAYEY SAND
ML = SILT
CL = CLAY





Baseline	ISPT
7,260	<0.2
<1	5,850
--	7.58

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Project Director L. KELLOGG	Area Manager J. PETERS
Task Manager J. LUTRICK	Technical Review X. SONG
Drawing Date 04 FEB 09	Drawn By J. CHEN

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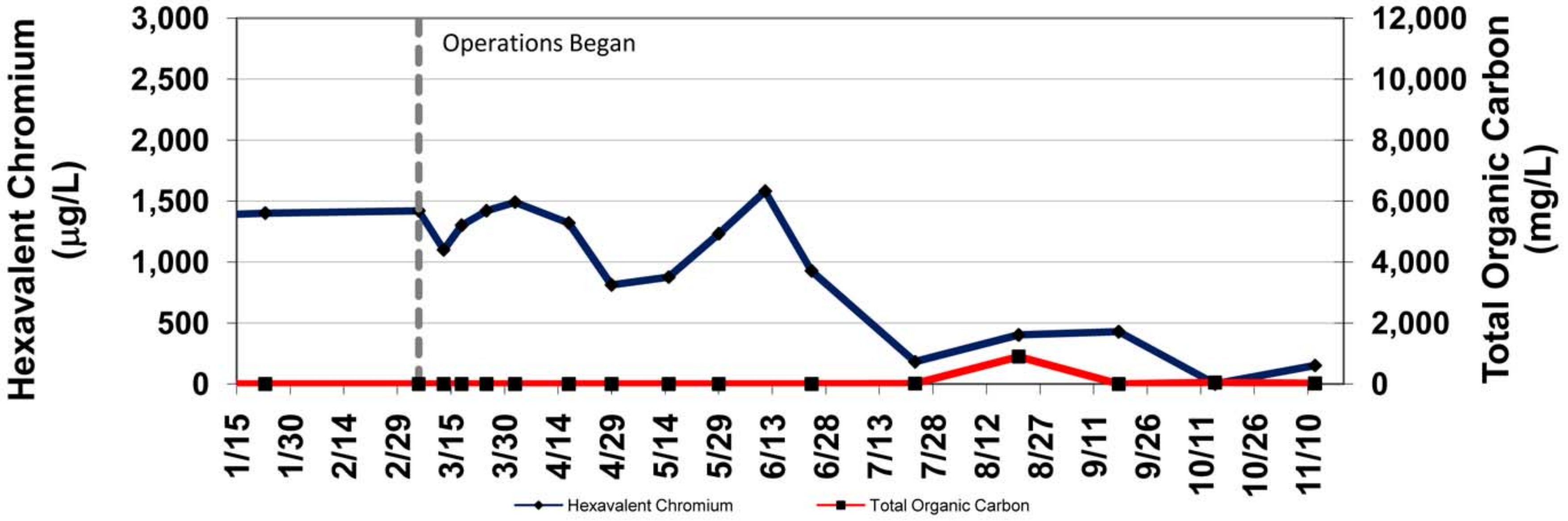
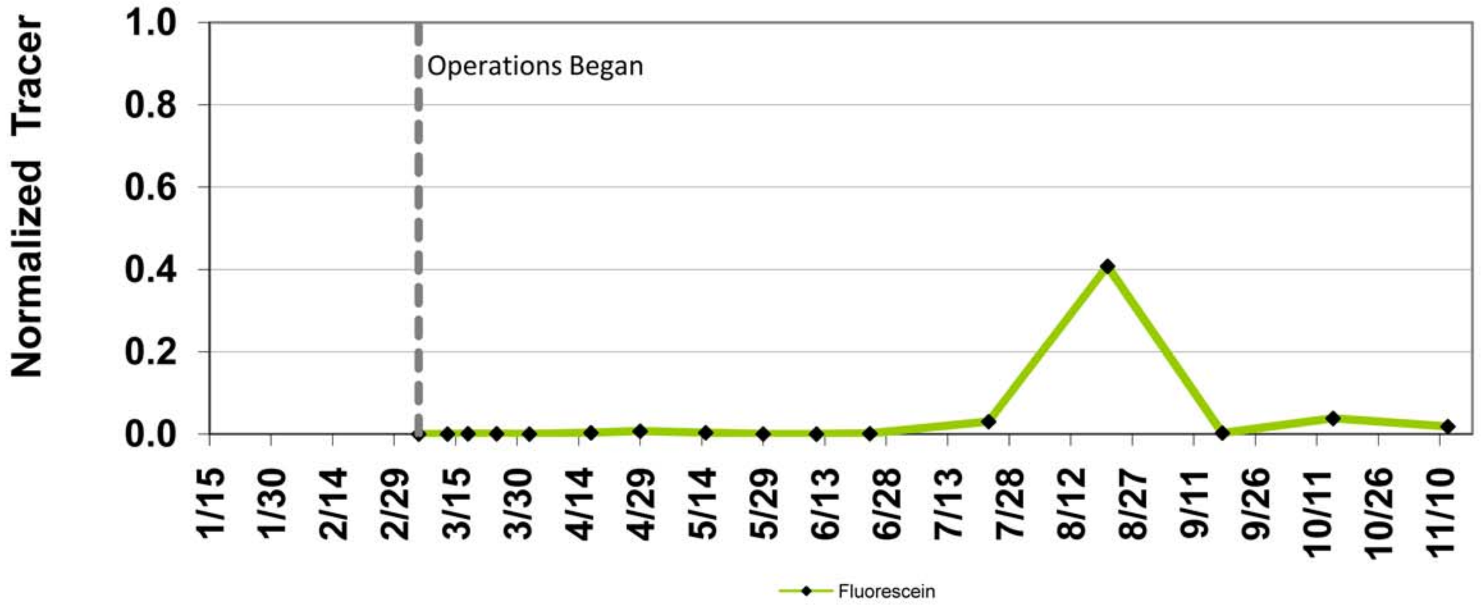
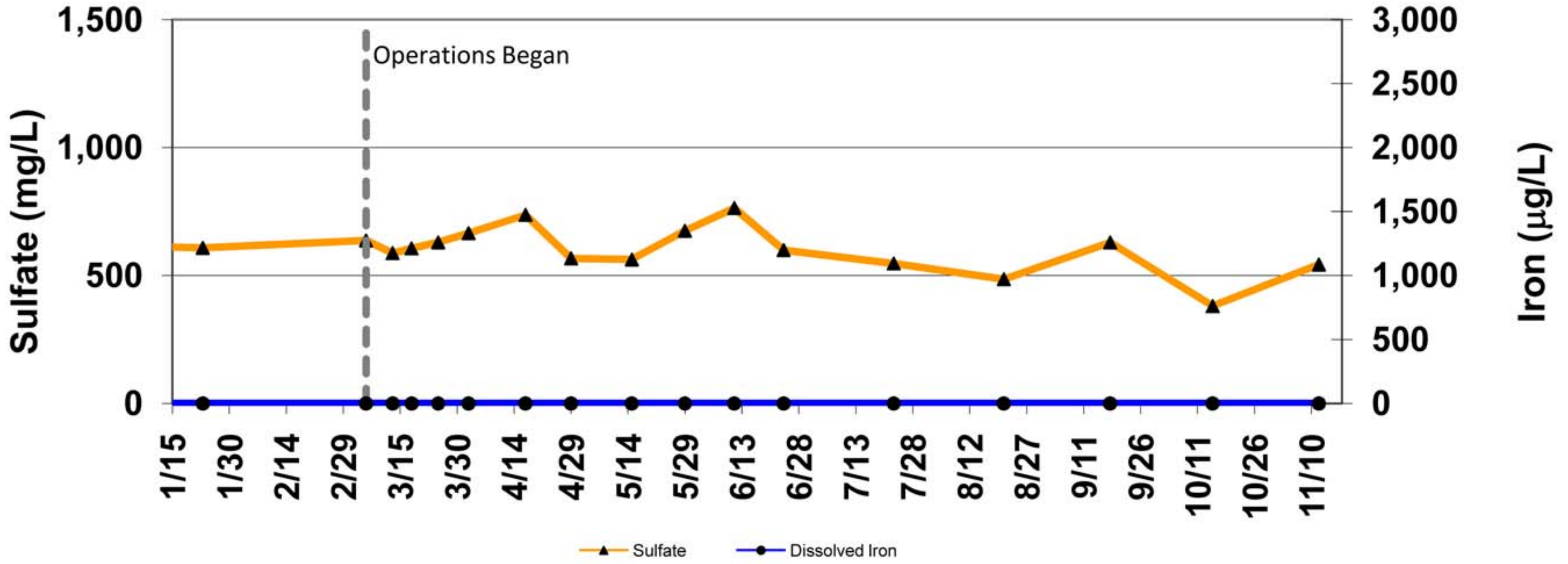
CONCEPTUAL GROUNDWATER/REAGENT RECIRCULATION HYDRAULICS
PG&E TOPOCK FACILITY
NEEDLES, CALIFORNIA

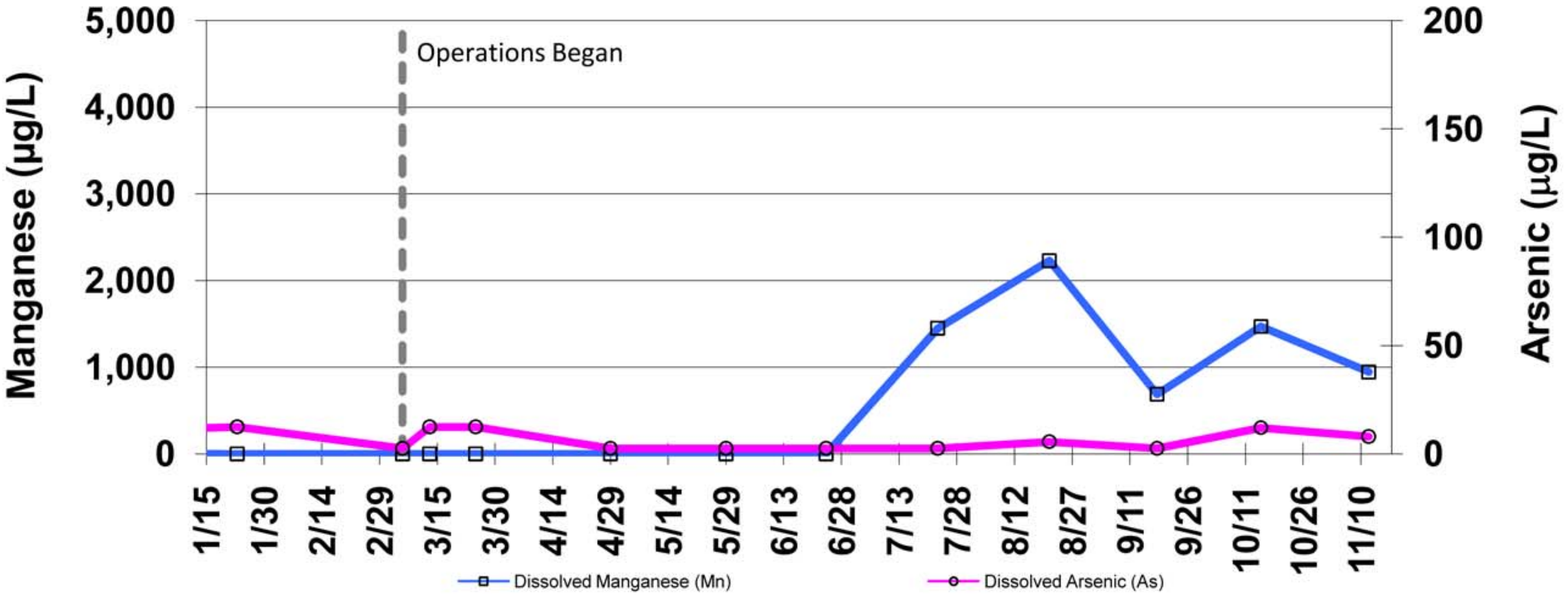
Project Number
RC000689.0004

Figure
4









Notes:	mg/L	Milligrams per liter
	µg/L	Micrograms per liter

Normalized Tracer Concentration= Concentration/(Concentration in Injection Solution)

Project Director L. KELLOGG	Area Manager J. PETERS
Task Manager J. LUTRICK	Technical Review K. J. PRESTON
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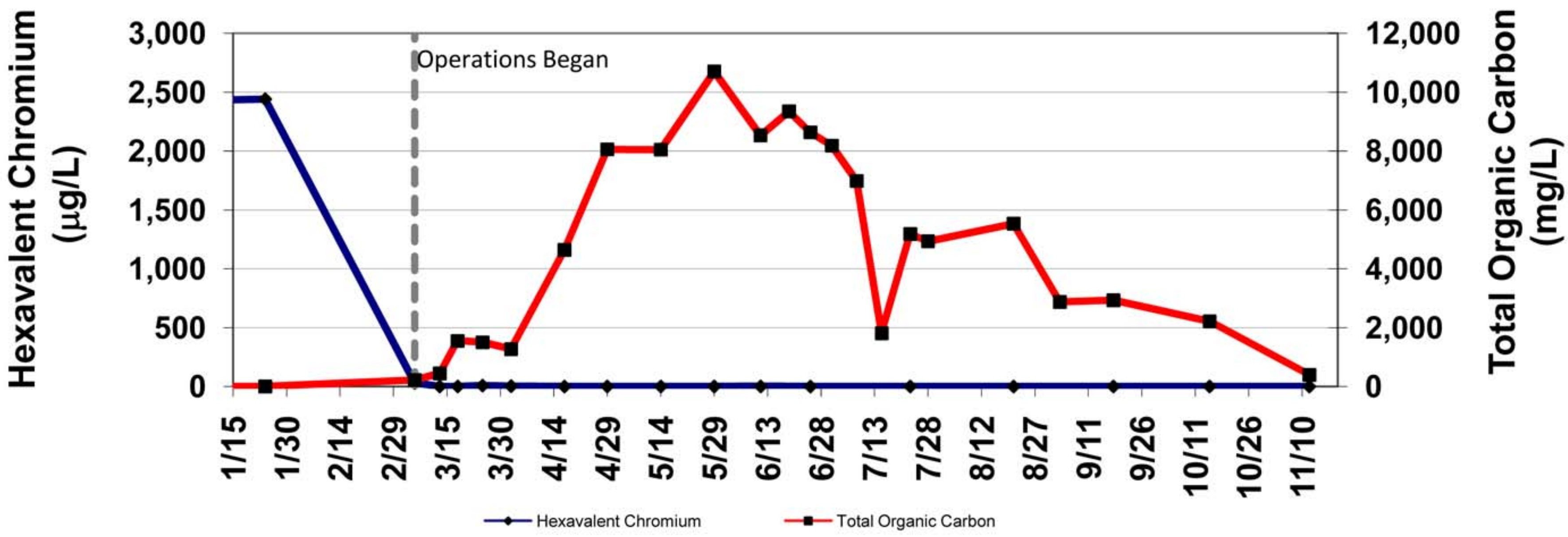
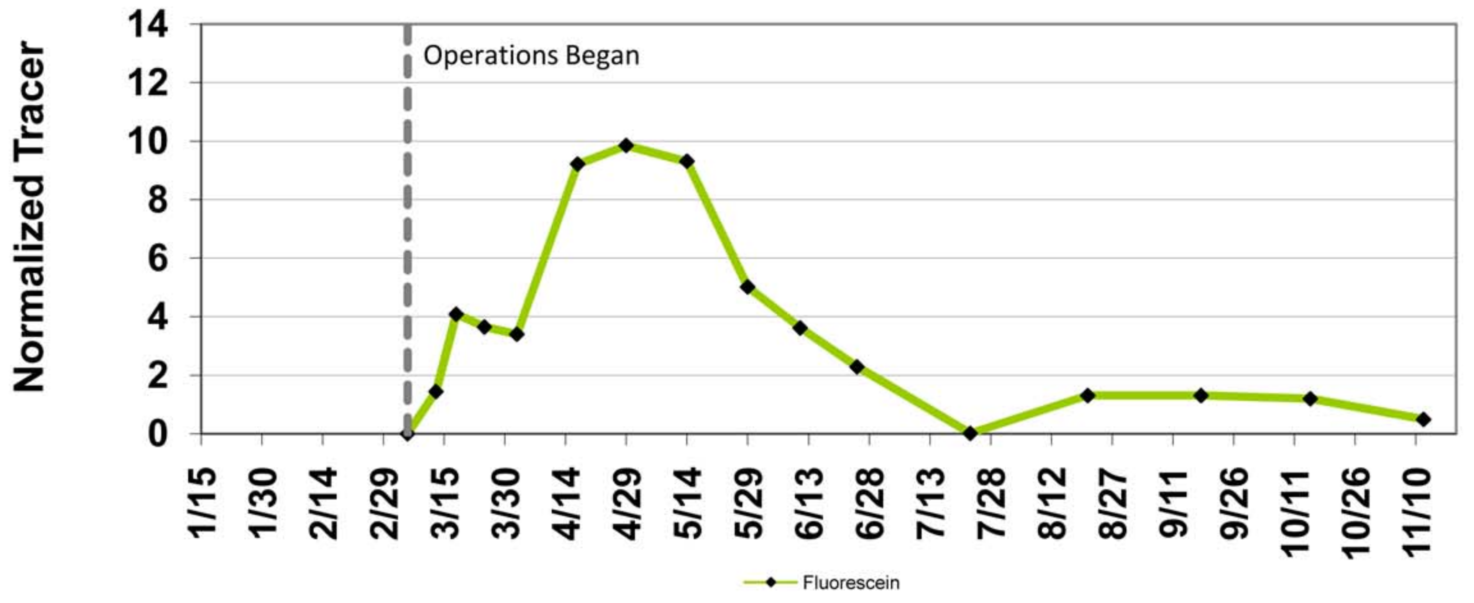
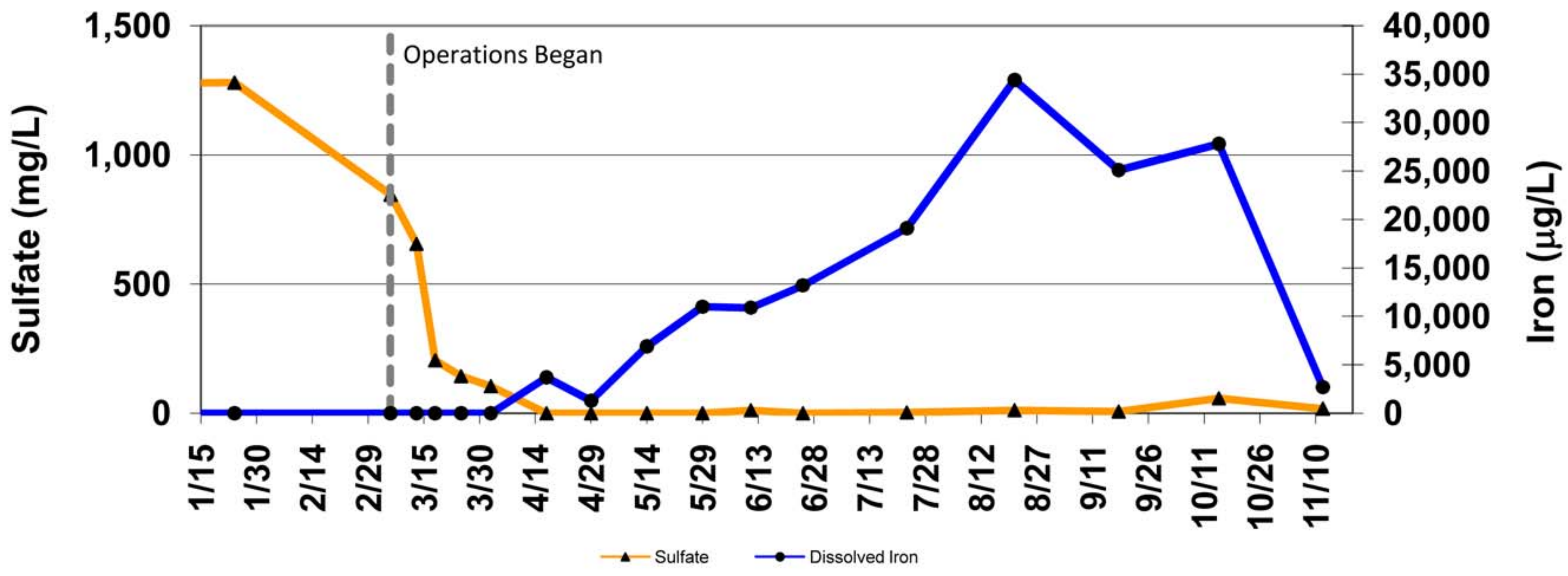
PERFORMANCE MONITORING DATA
FOR WELL PT-7S
PG&E TOPOCK FACILITY
NEEDLES, CALIFORNIA

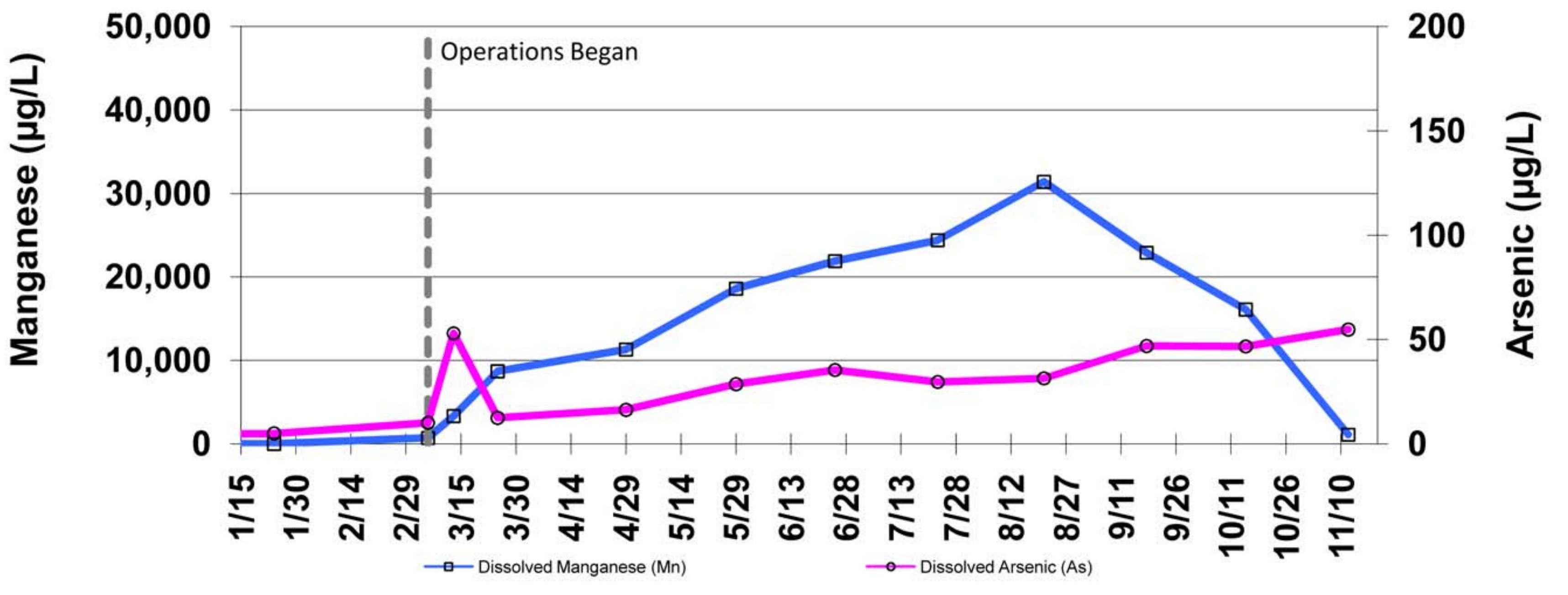
Project Number
RC000689.0004

Figure
5









Notes: mg/L Milligrams per liter
μg/L Micrograms per liter
Normalized Tracer Concentration= Concentration/(Concentration in Injection Solution)

User: JCHEN Path: K:\RC00689 PG&E TOPOCK\IMAGE\PHOTOSHOP\

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Task Manager J. LUTRICK	Technical Review K. J. PRESTON
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PERFORMANCE MONITORING DATA
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PG&E TOPOCK FACILITY
NEEDLES, CALIFORNIA

Project Number
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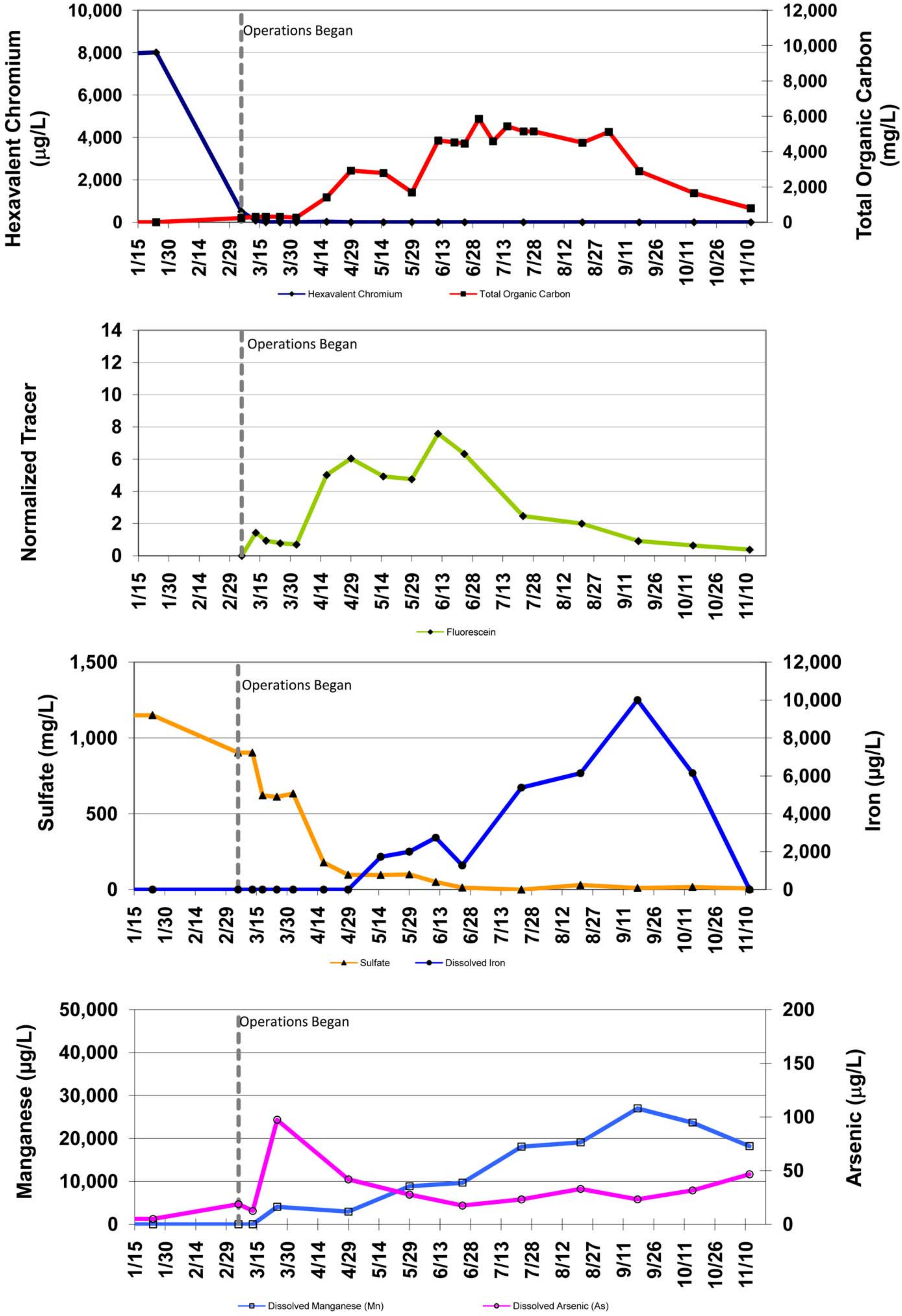
Figure
6



Notes:

mg/L	Milligrams per liter
µg/L	Micrograms per liter

Normalized Tracer Concentration= Concentration/(Concentration in Injection Solution)

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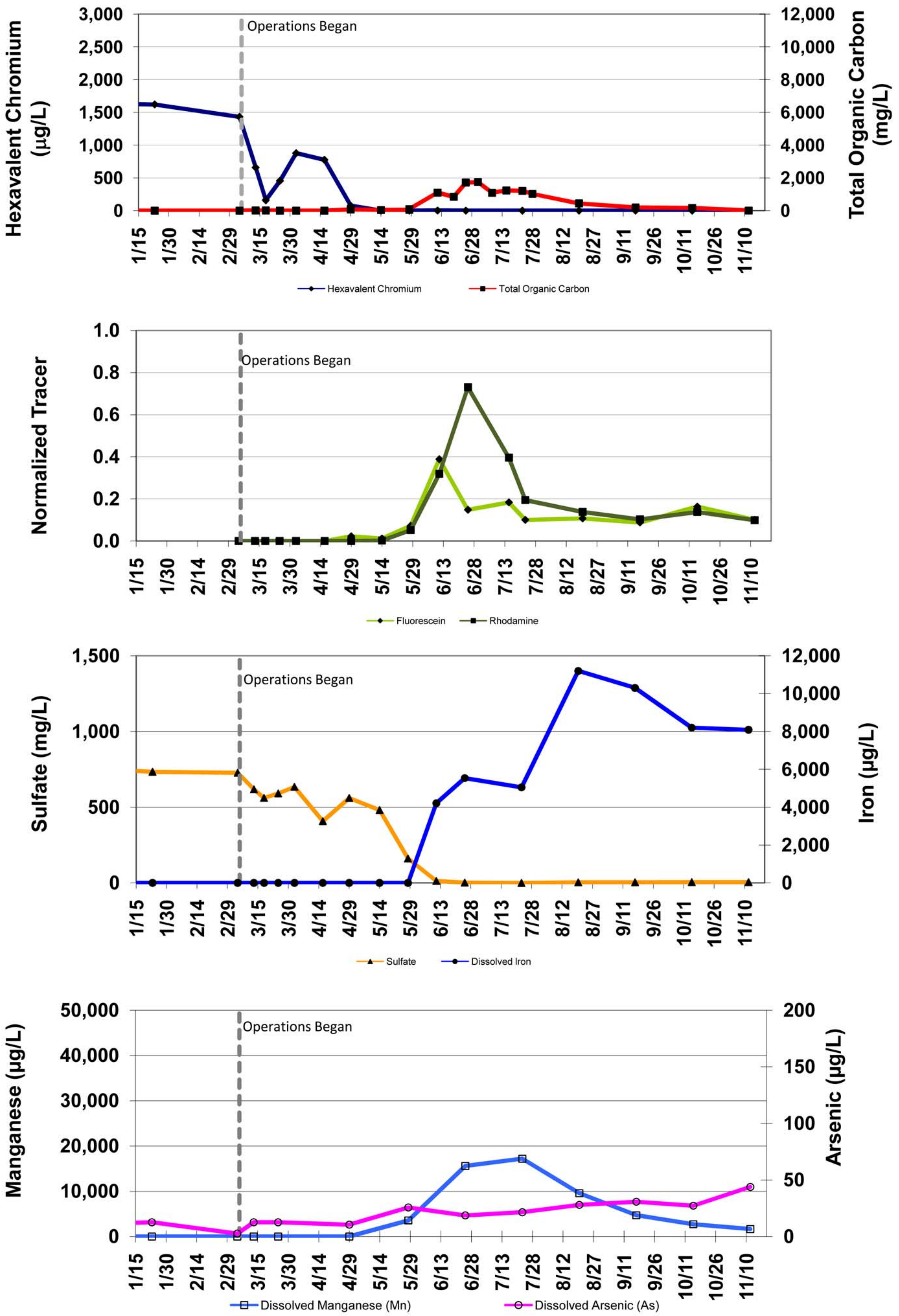
FOR WELL PT-7D**
PG&E TOPOCK FACILITY
NEEDLES, CALIFORNIA

Project Number
RC000689.0004

Figure
7



Notes:

mg/L Milligrams per liter
µg/L Micrograms per liter
Normalized Tracer Concentration= Concentration/(Concentration in Injection Solution)

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Task Manager J. LUTRICK	Technical Review K. J. PRESTON
Drawing Date 29 APR 08	Drawn By J. CHEN

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PERFORMANCE MONITORING DATA
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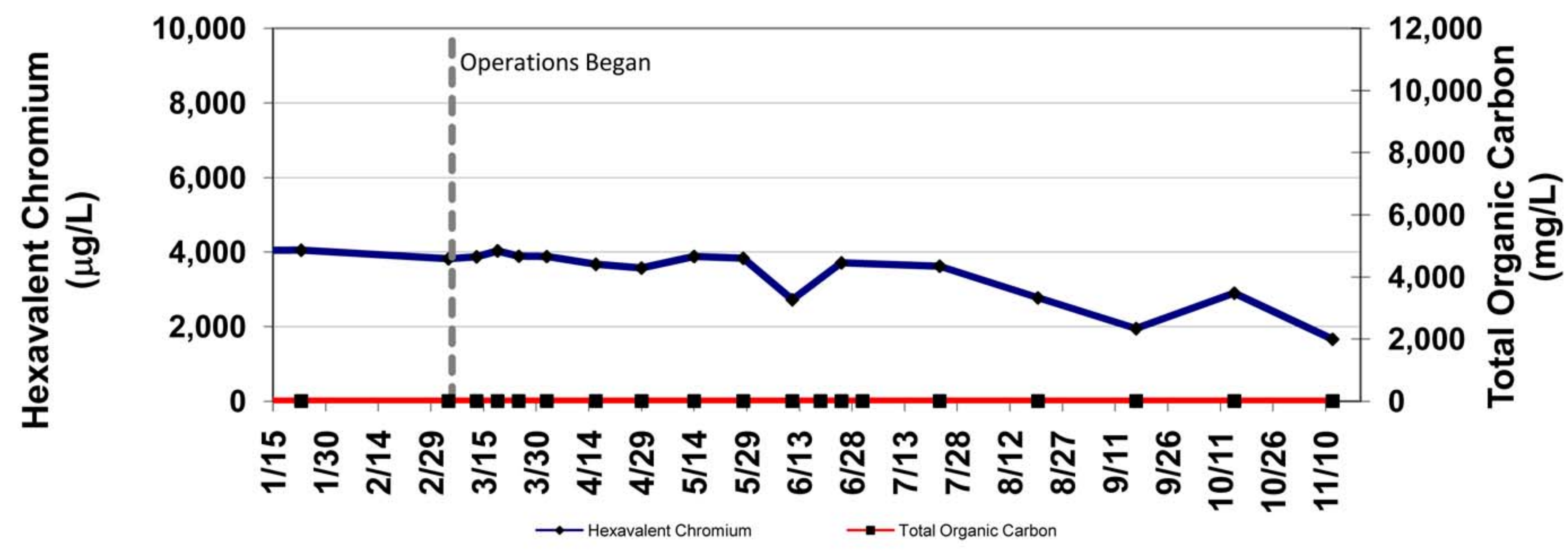
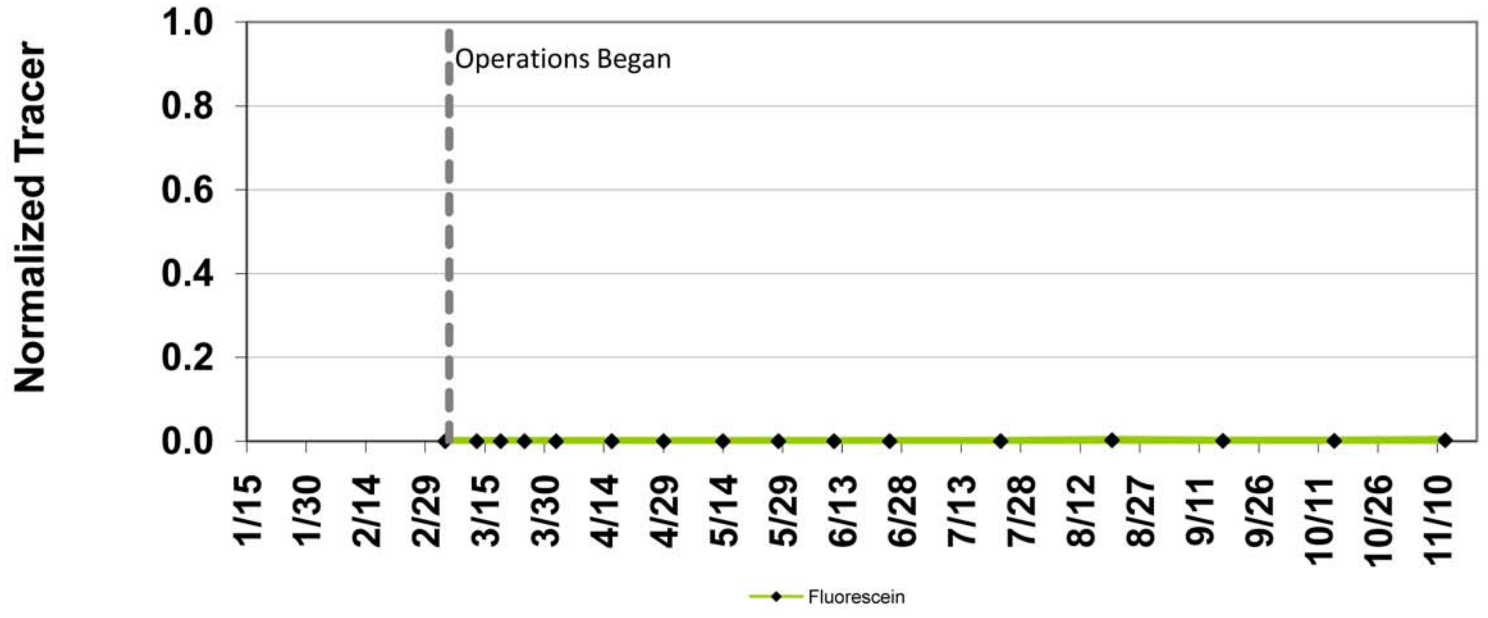
PG&E TOPOCK FACILITY
NEEDLES, CALIFORNIA

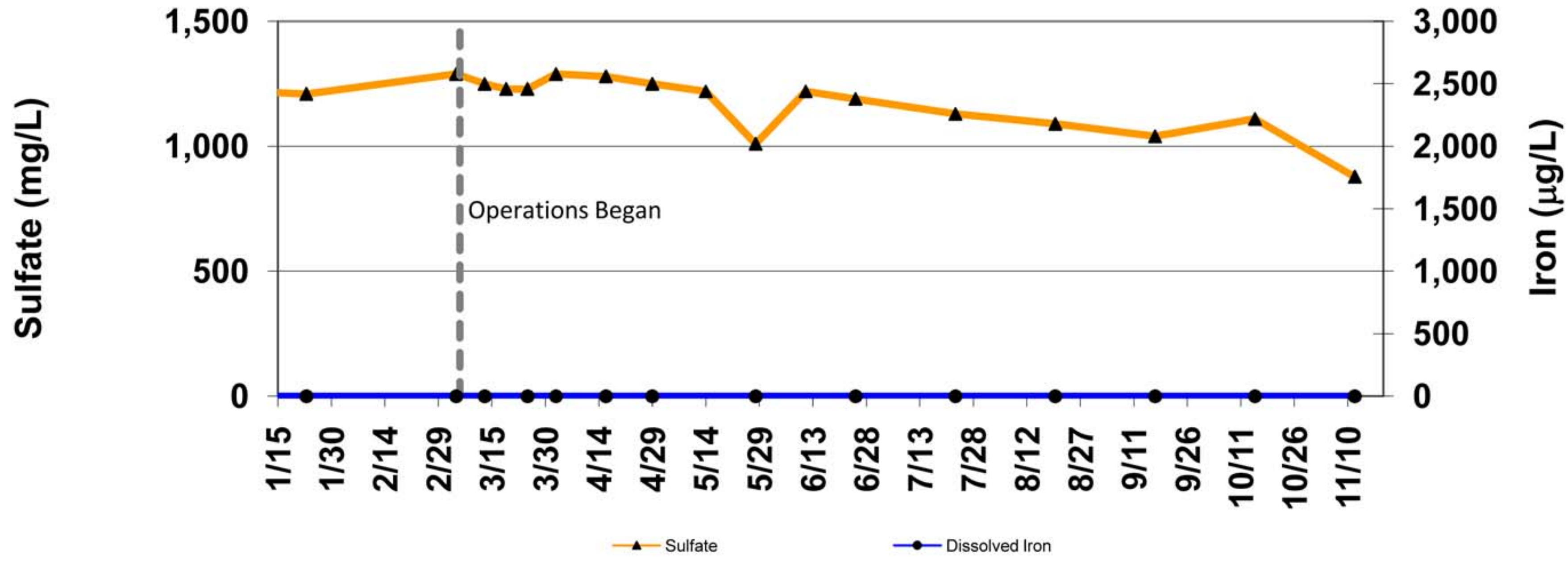
Project Number
RC000689.0004

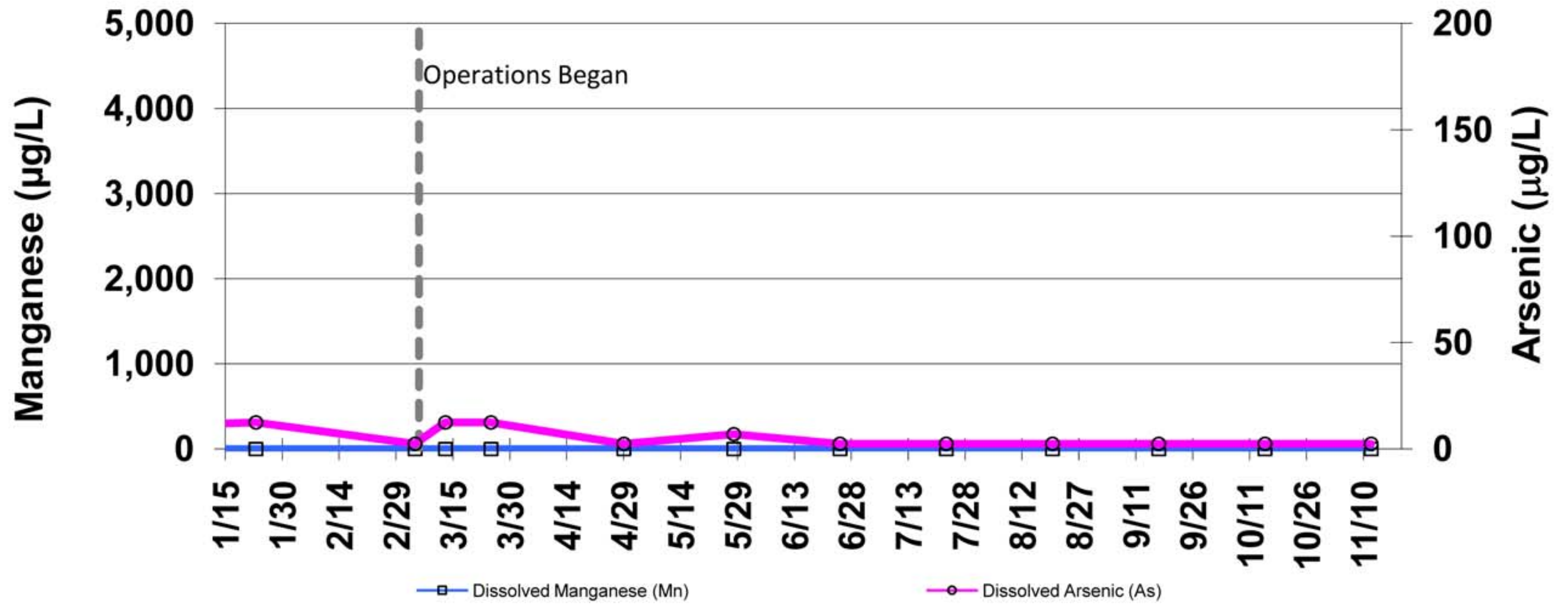
Figure
8

User: JCHEN Path: K:\RC00689 PG&E TOPOCK\IMAGE\PHOTOSHOP\









Notes:

mg/L	Milligrams per liter
µg/L	Micrograms per liter

Normalized Tracer Concentration= Concentration/(Concentration in Injection Solution)

User: JCHEN Path: K:\RC00689 PG&E TOPOCK\IMAGE\PHOTOSHOP\

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Task Manager J. LUTRICK	Technical Review K. J. PRESTON
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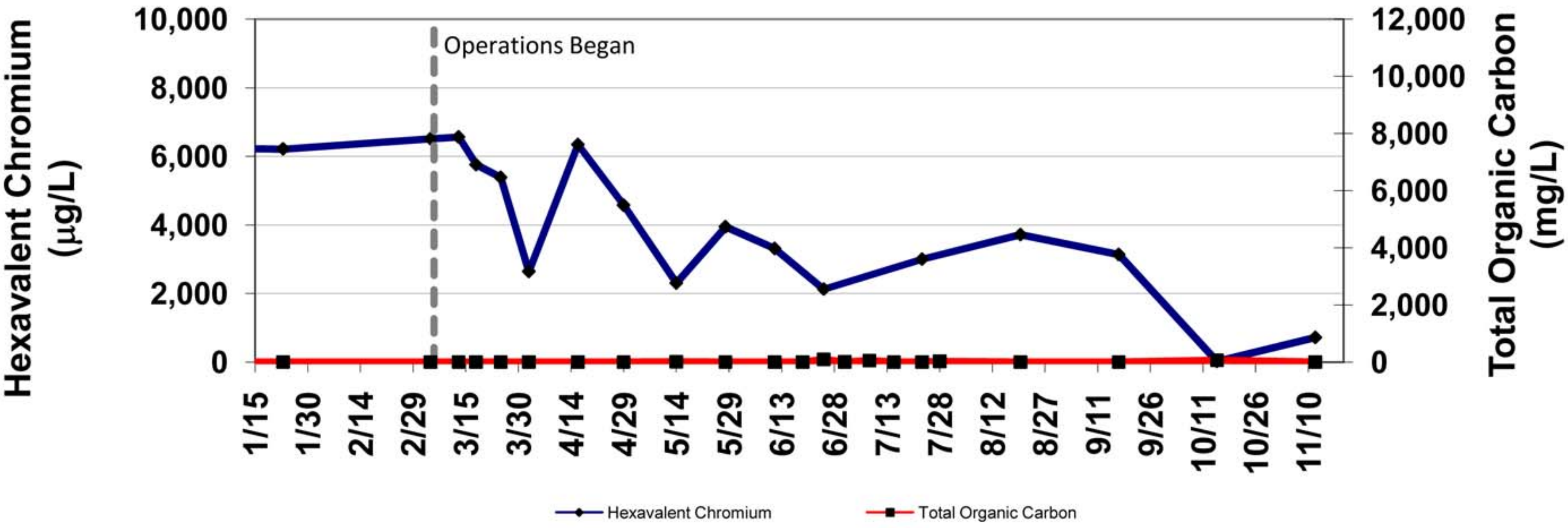
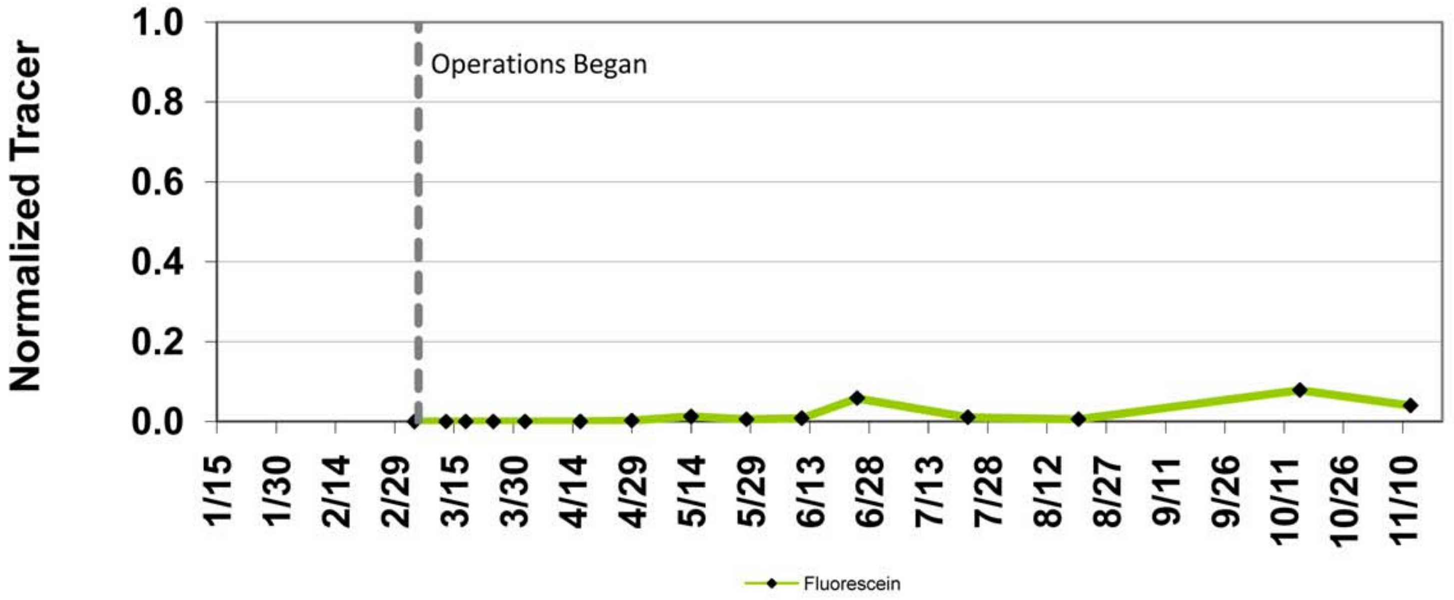
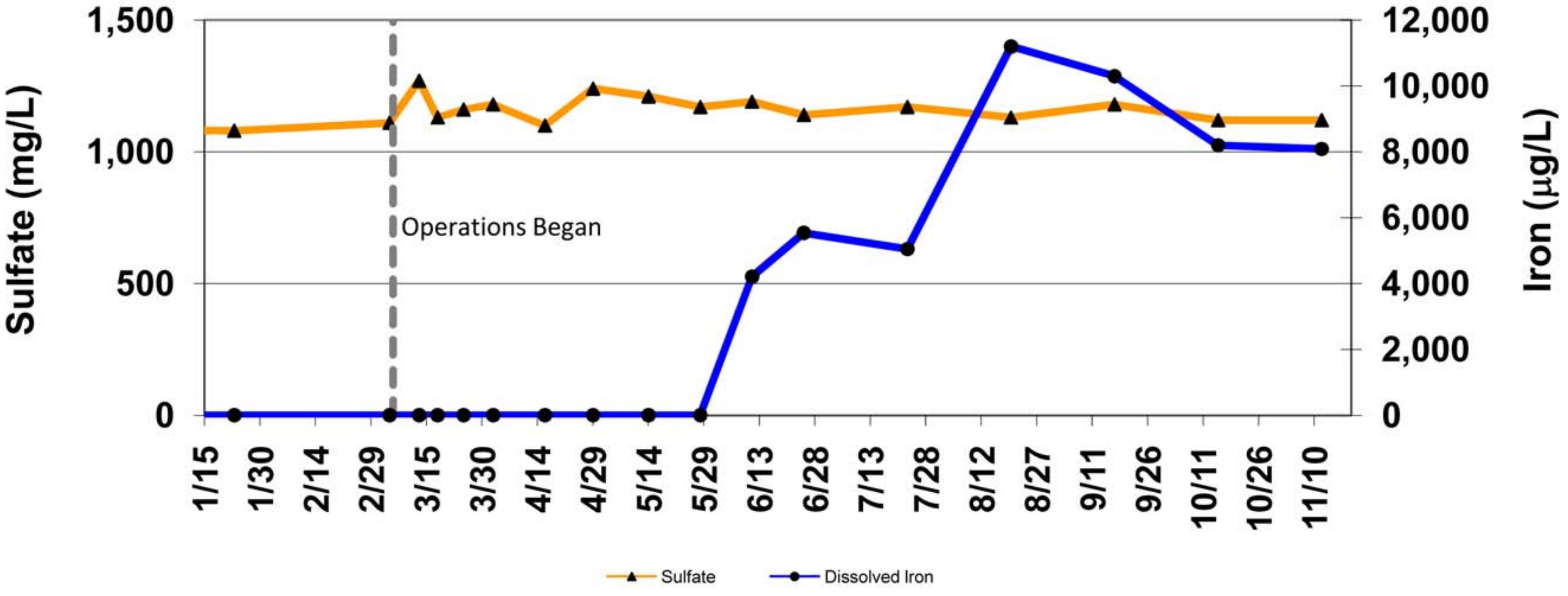
PERFORMANCE MONITORING DATA
FOR WELL PT-8M
PG&E TOPOCK FACILITY
NEEDLES, CALIFORNIA

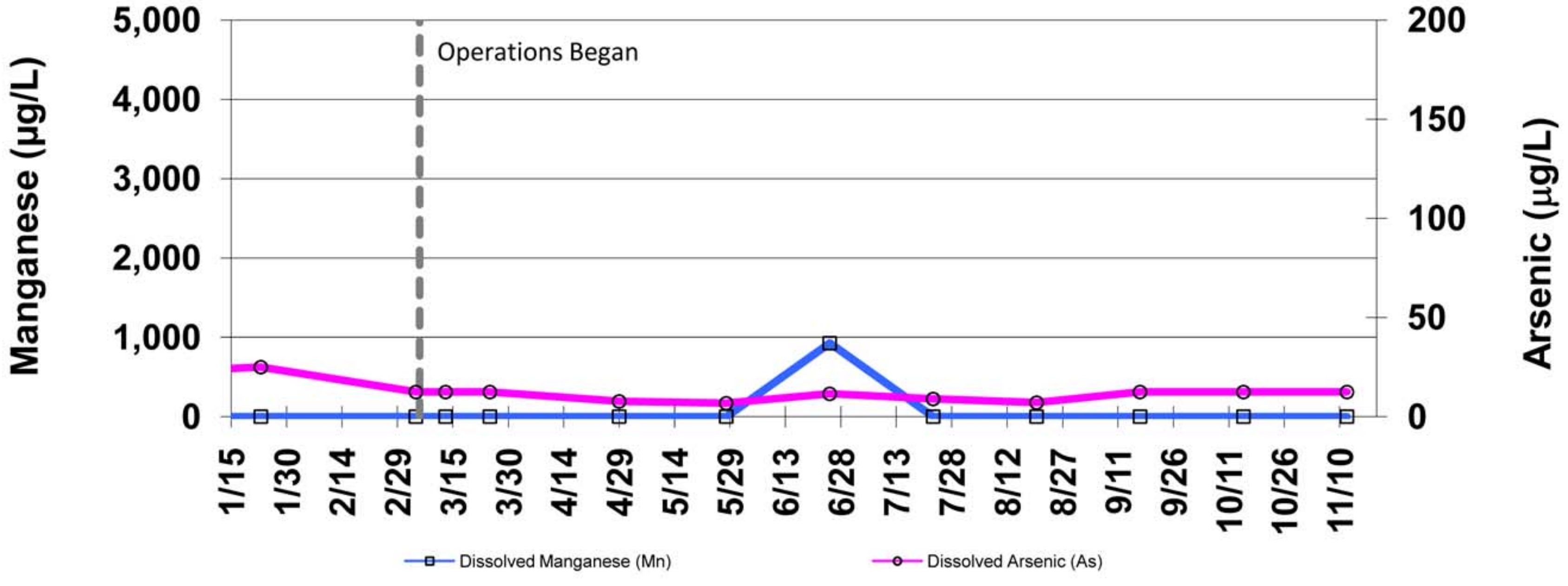
Project Number
RC000689.0004

Figure
9









Notes:	mg/L	Milligrams per liter
	µg/L	Micrograms per liter

Normalized Tracer Concentration= Concentration/(Concentration in Injection Solution)

User: JCHEN Path: K:\RC00689 PG&E TOPOCK\IMAGE\PHOTOSHOP\

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Task Manager J. LUTRICK	Technical Review K. J. PRESTON
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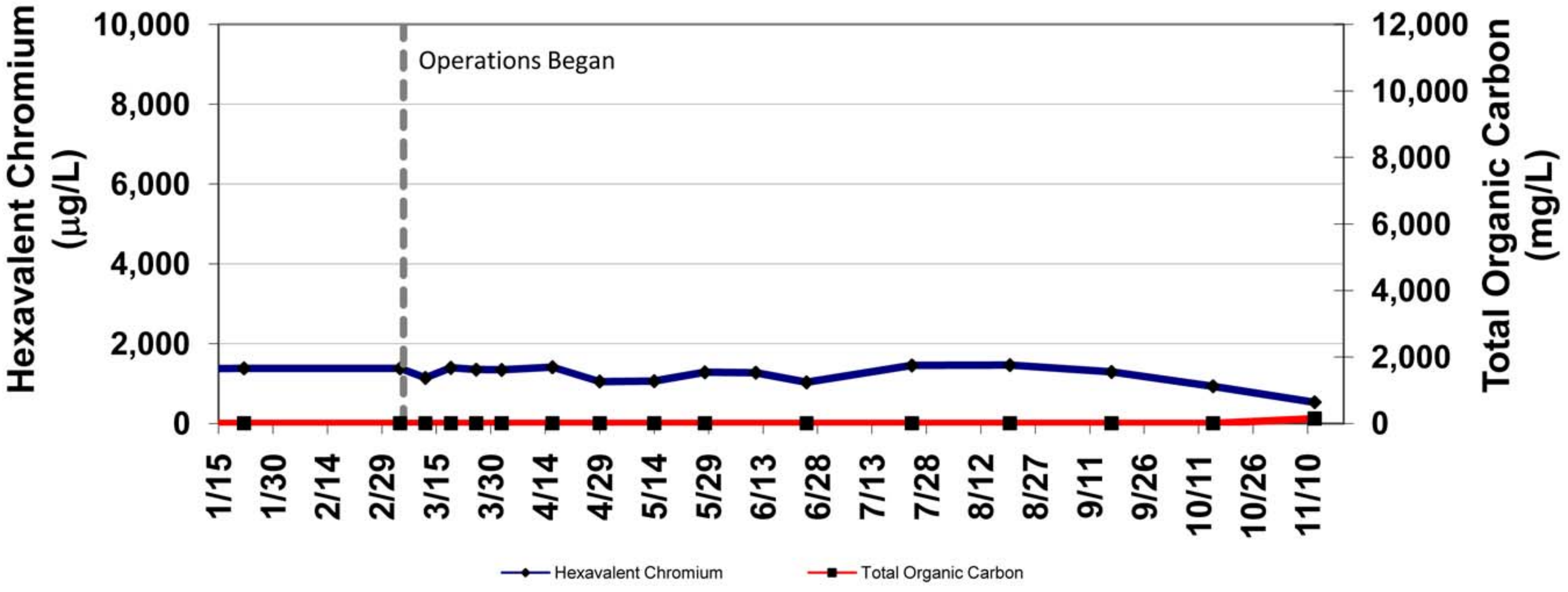
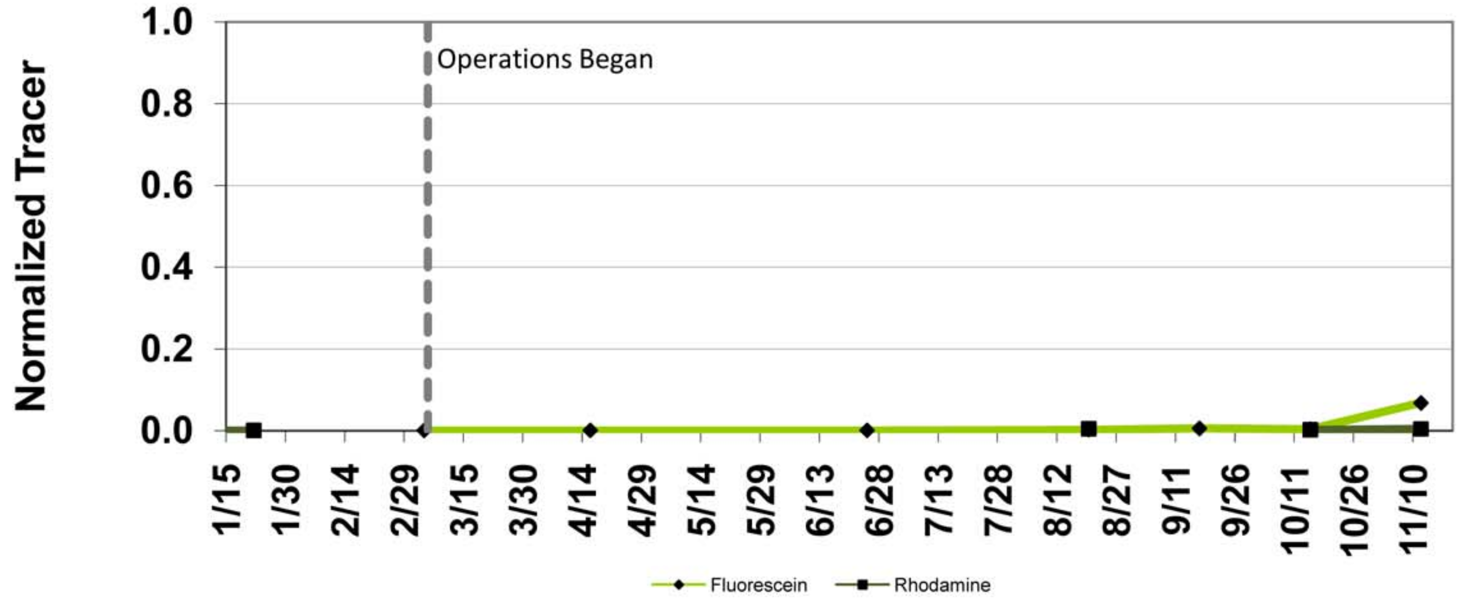
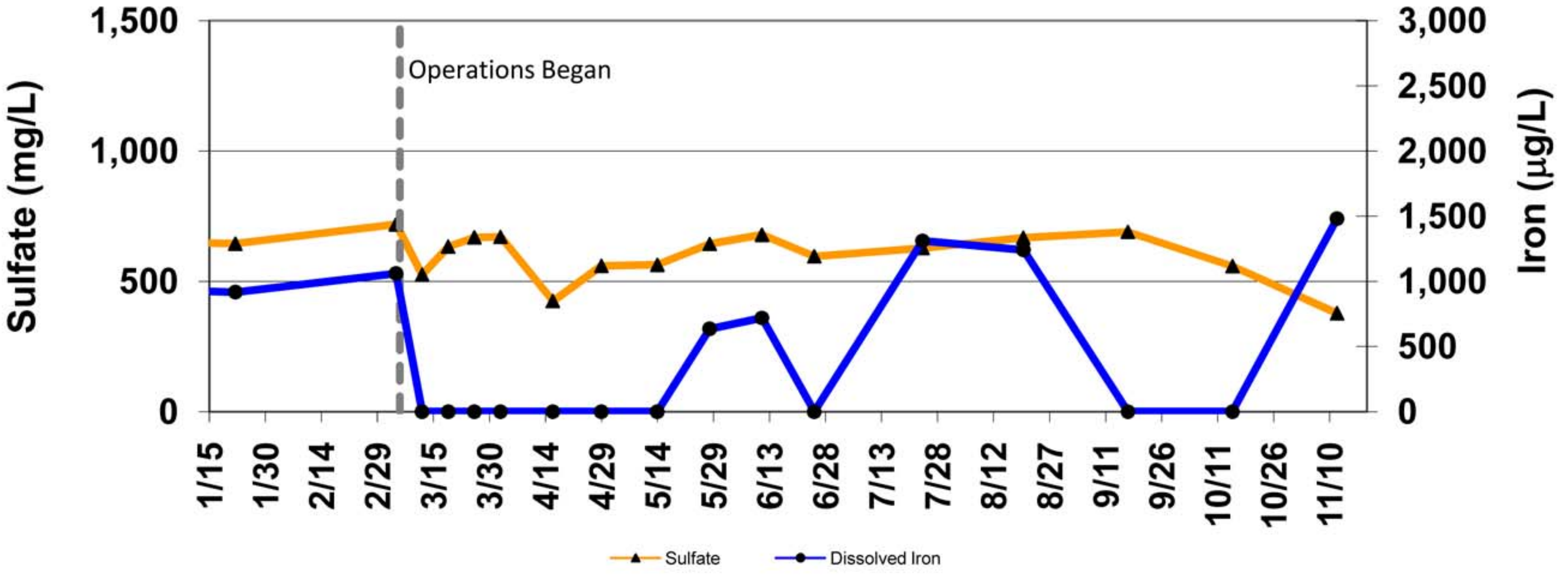
PERFORMANCE MONITORING DATA
FOR WELL PT-8D
PG&E TOPOCK FACILITY
NEEDLES, CALIFORNIA

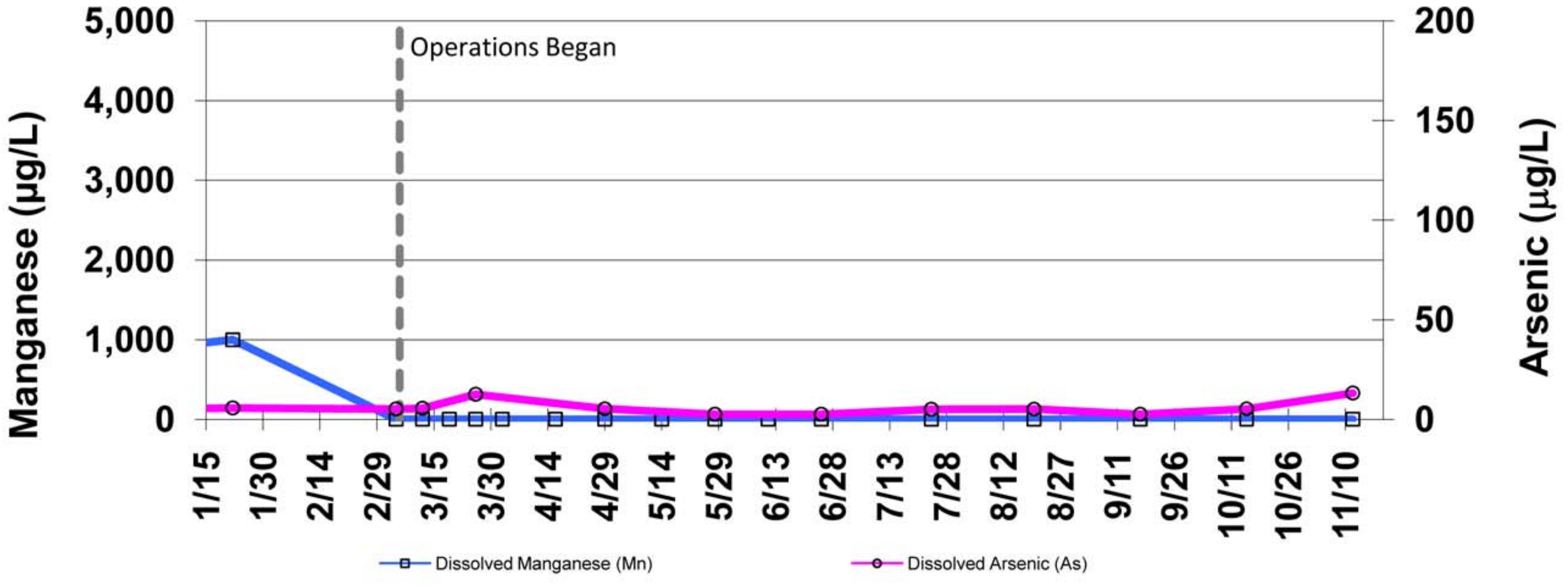
Project Number
RC000689.0004

Figure
10









Notes:

mg/L	Milligrams per liter
µg/L	Micrograms per liter

Normalized Tracer Concentration= Concentration/(Concentration in Injection Solution)

User: JCHEN Path: K:\RC00689 PG&E TOPOCK\IMAGE\PHOTOSHOP\

Project Director L. KELLOGG	Area Manager J. PETERS
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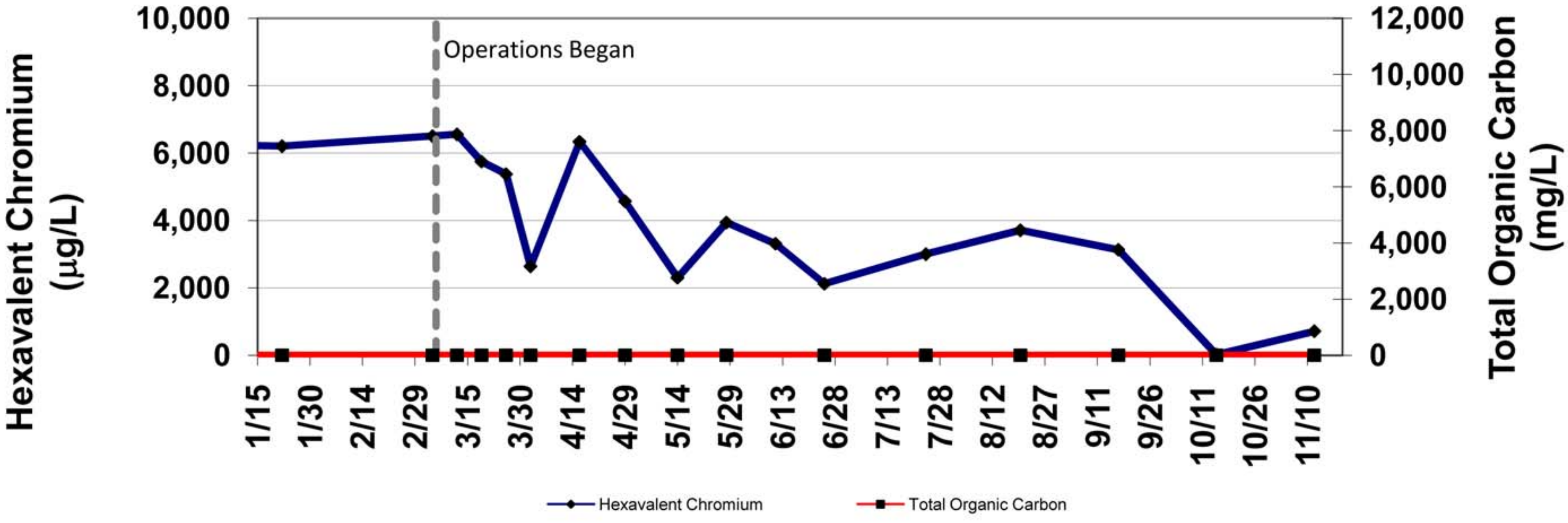
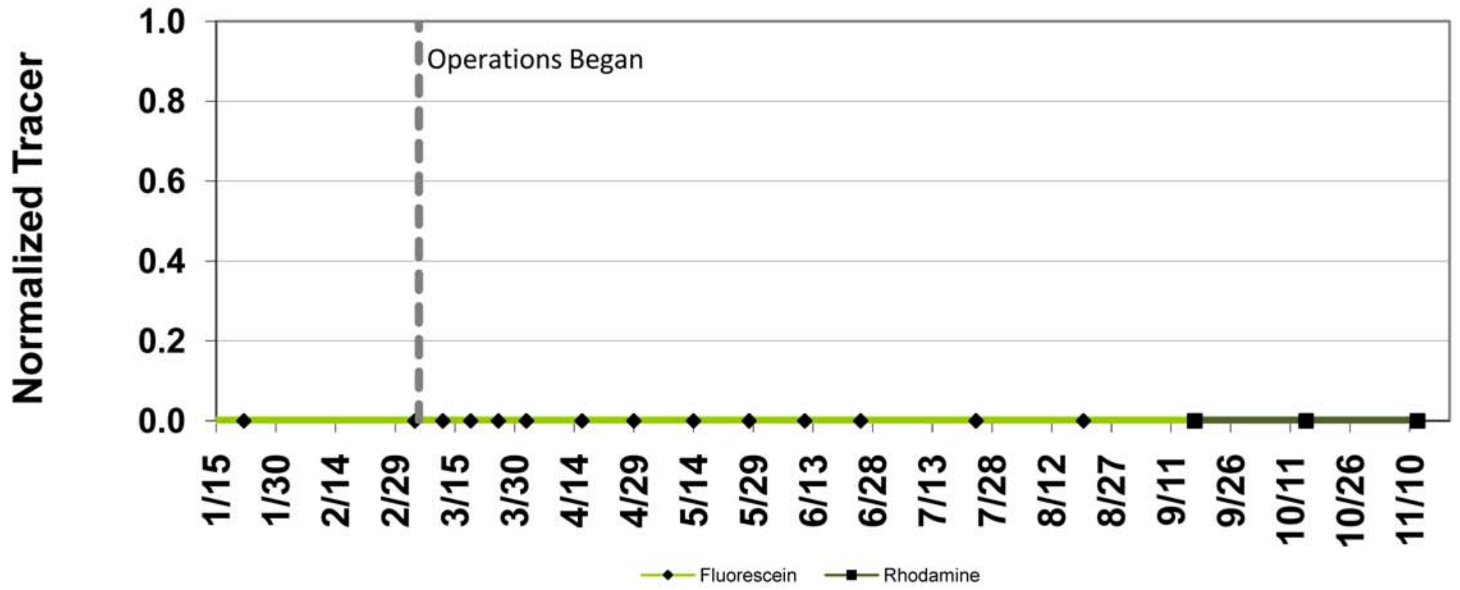
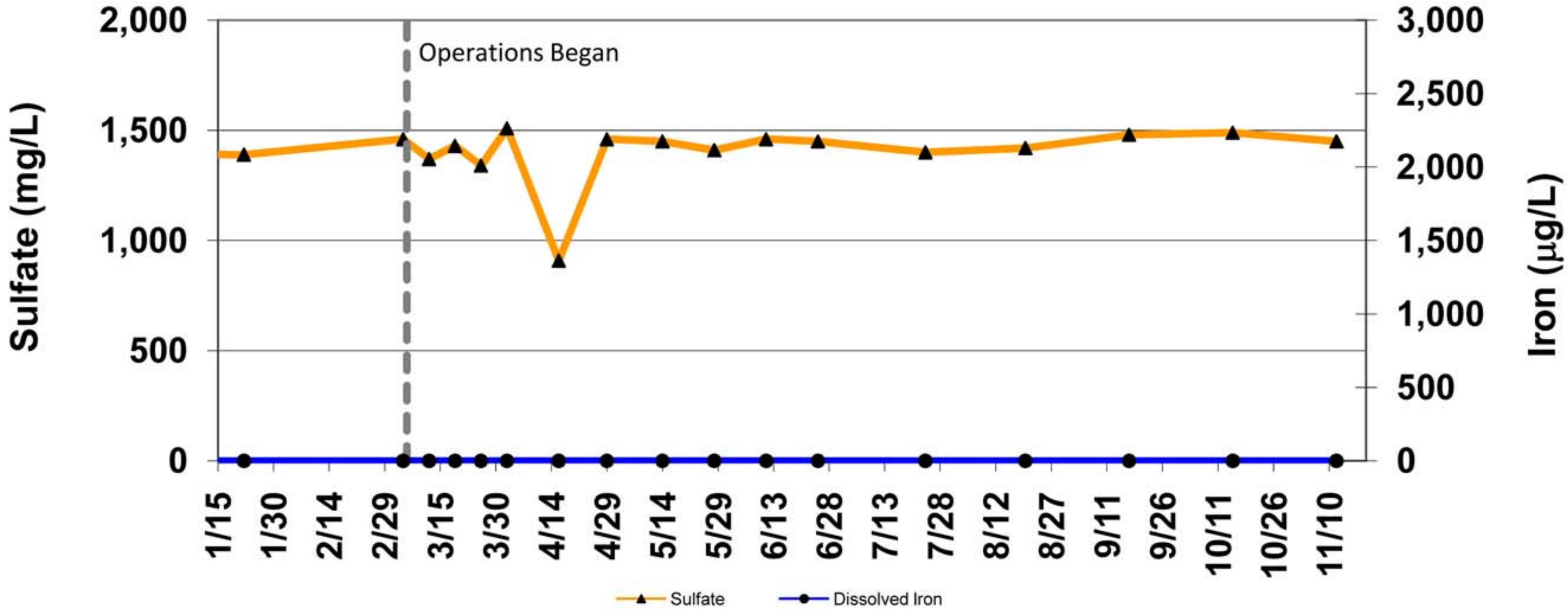
PERFORMANCE MONITORING DATA
FOR WELL PT-9S
PG&E TOPOCK FACILITY
NEEDLES, CALIFORNIA

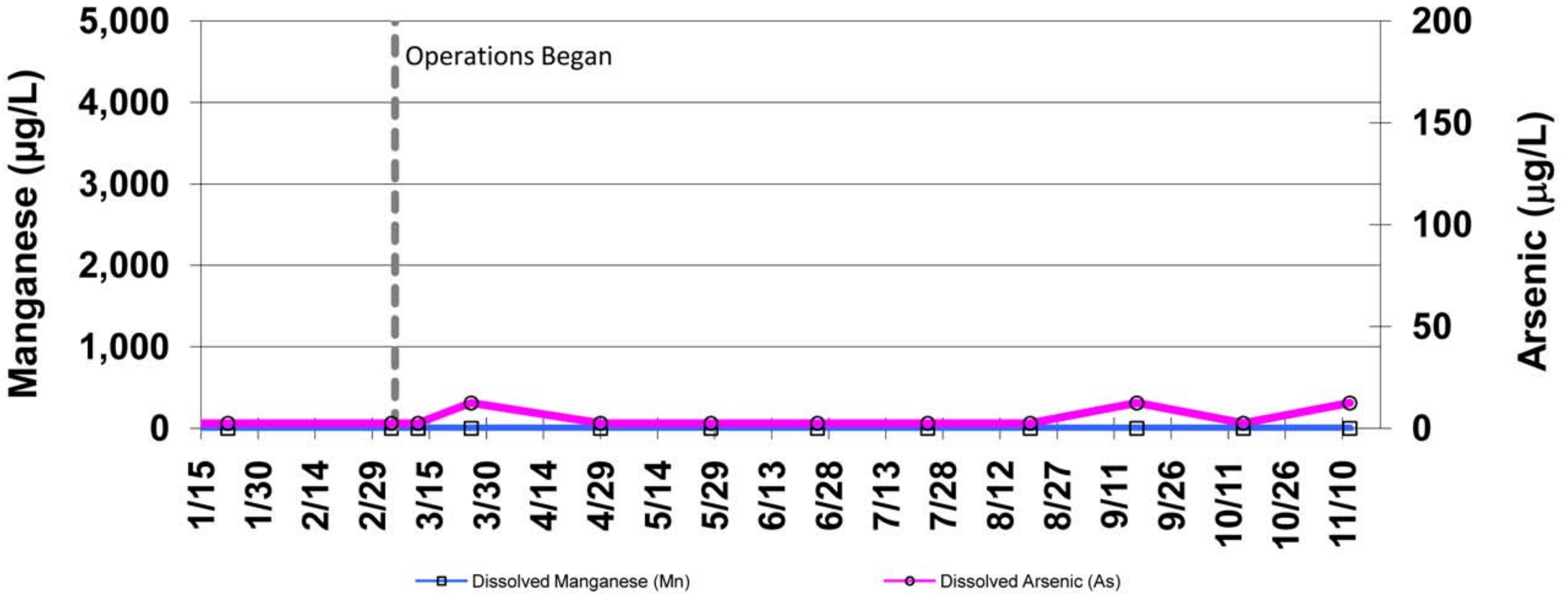
Project Number
RC000689.0004

Figure
11









Notes:	mg/L	Milligrams per liter
	µg/L	Micrograms per liter

Normalized Tracer Concentration= Concentration/(Concentration in Injection Solution)

Project Director L. KELLOGG	Area Manager J. PETERS
Task Manager J. LUTRICK	Technical Review K. J. PRESTON
Drawing Date 29 APR 08	Drawn By J. CHEN

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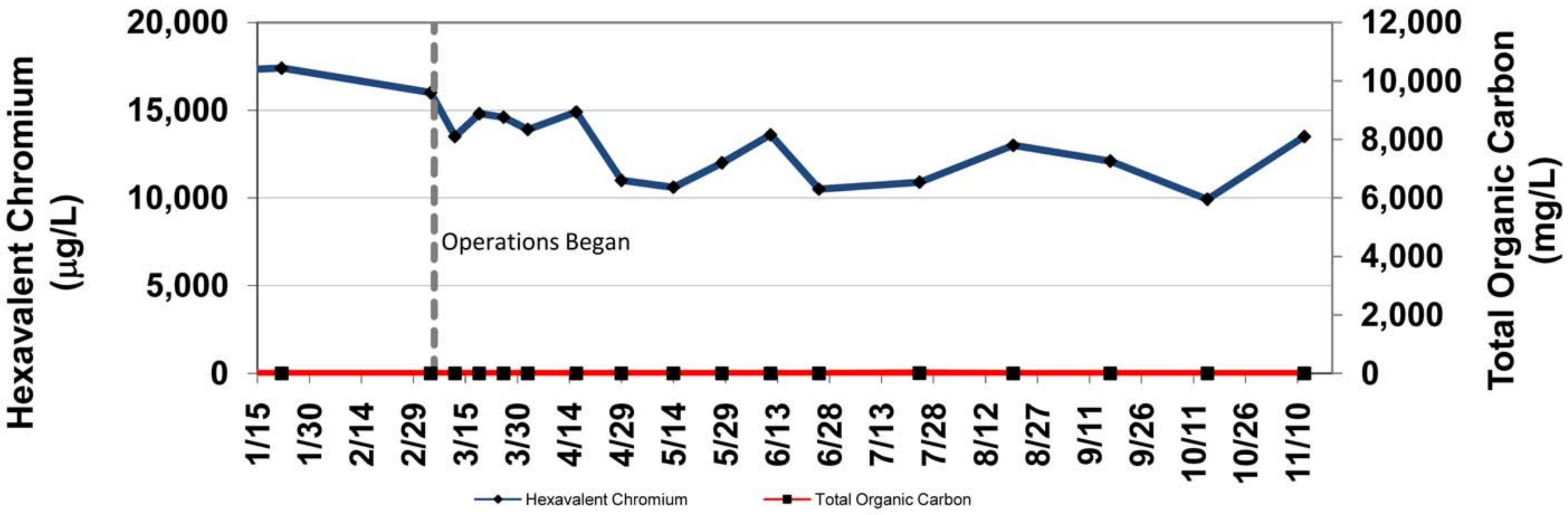
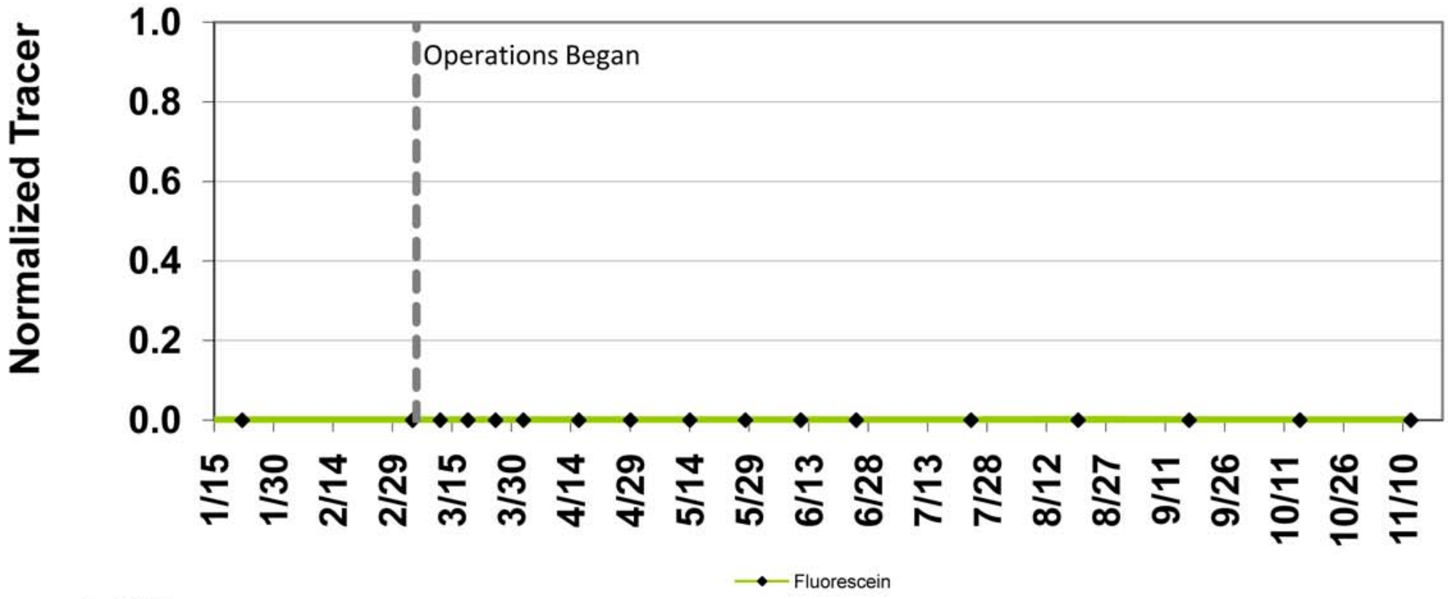
PERFORMANCE MONITORING DATA
FOR WELL PT-9M
PG&E TOPOCK FACILITY
NEEDLES, CALIFORNIA

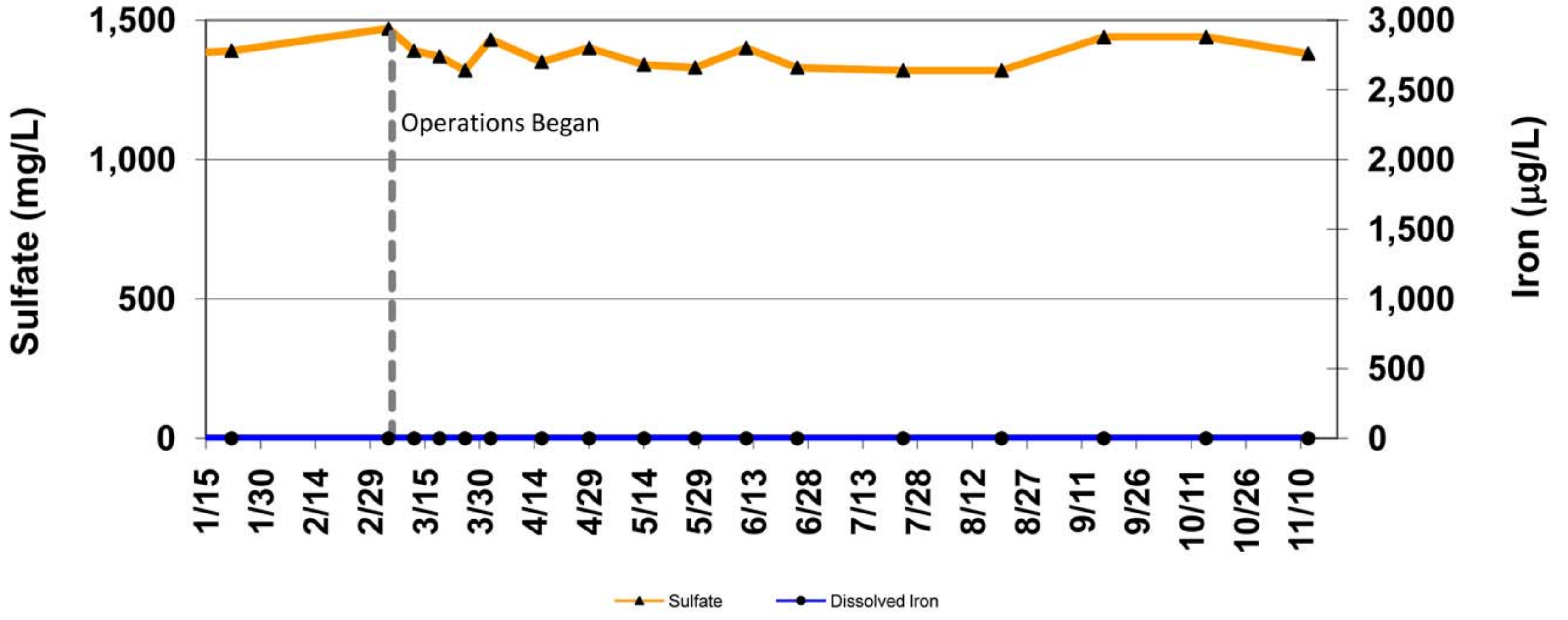
Project Number
RC000689.0004

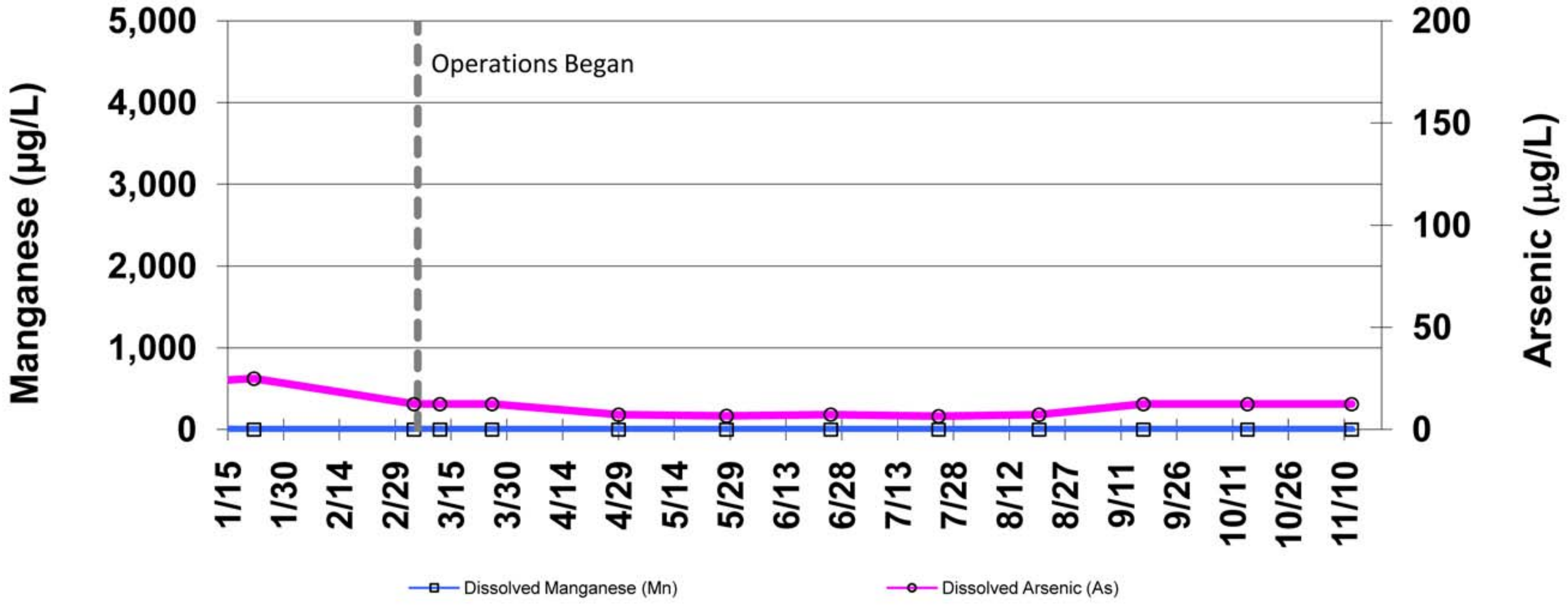
Figure
12

User: JCHEN Path: K:\RC00689 PG&E TOPOCK\IMAGE\PHOTOSHOP\









Notes:	mg/L	Milligrams per liter
	µg/L	Micrograms per liter

Normalized Tracer Concentration= Concentration/(Concentration in Injection Solution)

User: JCHEN Path: K:\RC00689 PG&E TOPOCK\IMAGE\PHOTOSHOP\

Project Director L. KELLOGG	Area Manager J. PETERS
Task Manager J. LUTRICK	Technical Review K. J. PRESTON
Drawing Date 29 APR 08	Drawn By J. CHEN

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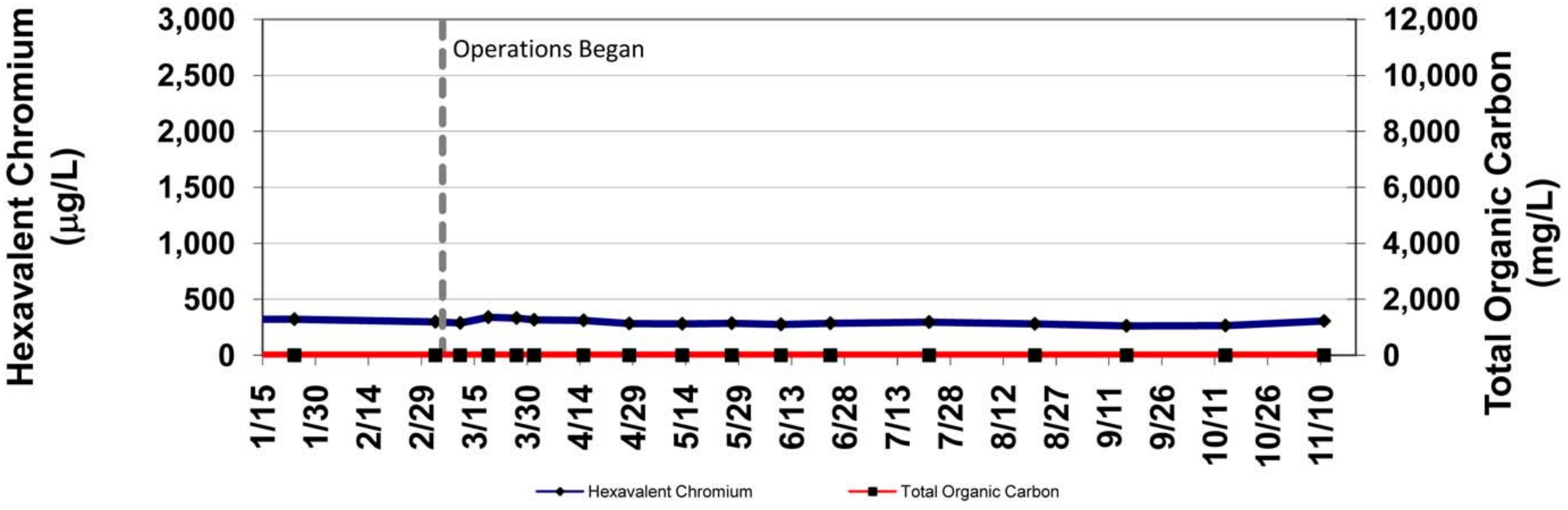
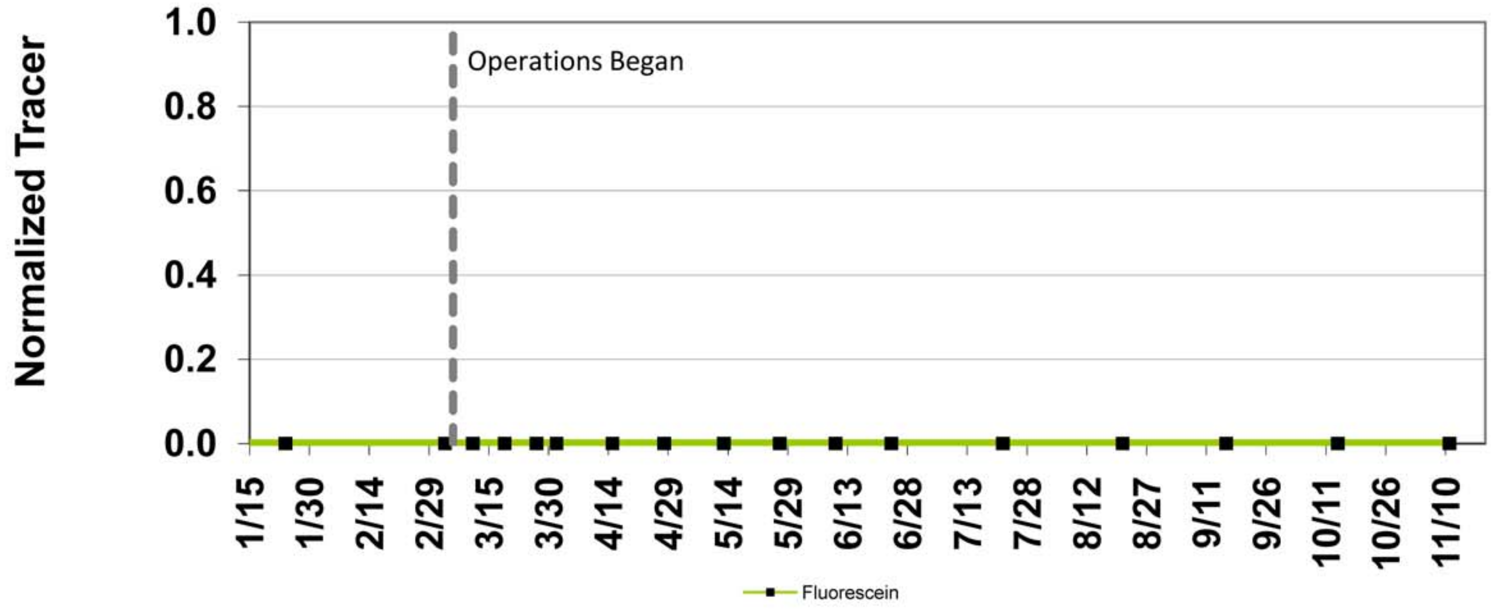
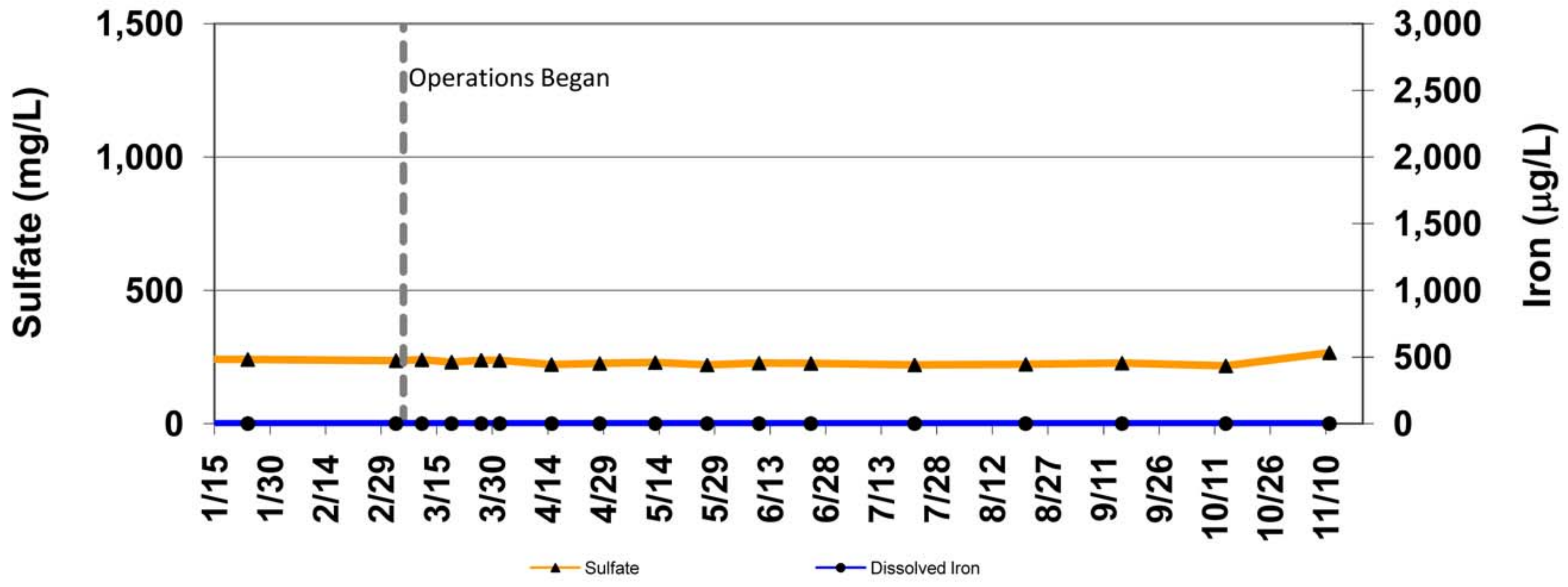
PERFORMANCE MONITORING DATA
FOR WELL PT-9D
PG&E TOPOCK FACILITY
NEEDLES, CALIFORNIA

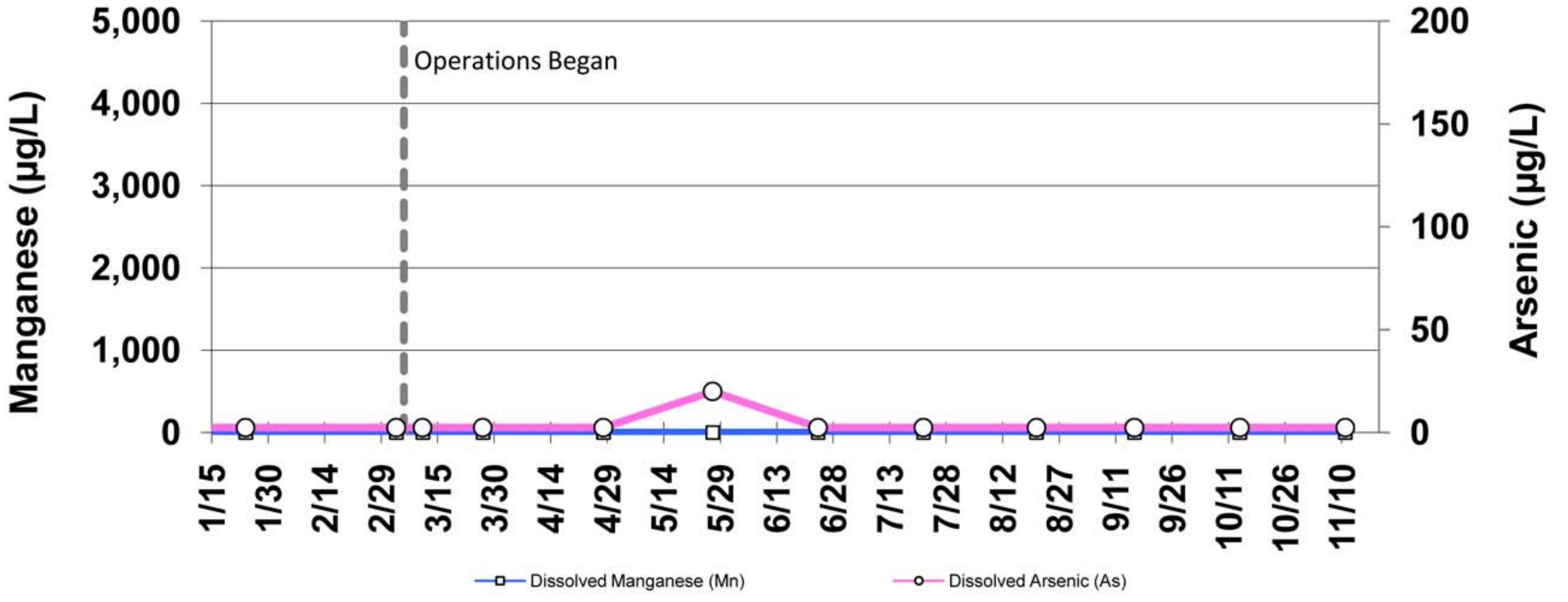
Project Number
RC000689.0004

Figure
13









Notes:	mg/L	Milligrams per liter
	µg/L	Micrograms per liter

Normalized Tracer Concentration= Concentration/(Concentration in Injection Solution)

User: JCHEN Path: K:\RC000689 PG&E TOPOCK\IMAGE\PHOTOSHOP\

Project Director L. KELLOGG	Area Manager J. PETERS
Task Manager J. LUTRICK	Technical Review K. J. PRESTON
Drawing Date 29 APR 08	Drawn By J. CHEN

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PERFORMANCE MONITORING DATA
FOR WELL MW-11
PG&E TOPOCK FACILITY
NEEDLES, CALIFORNIA

Project Number
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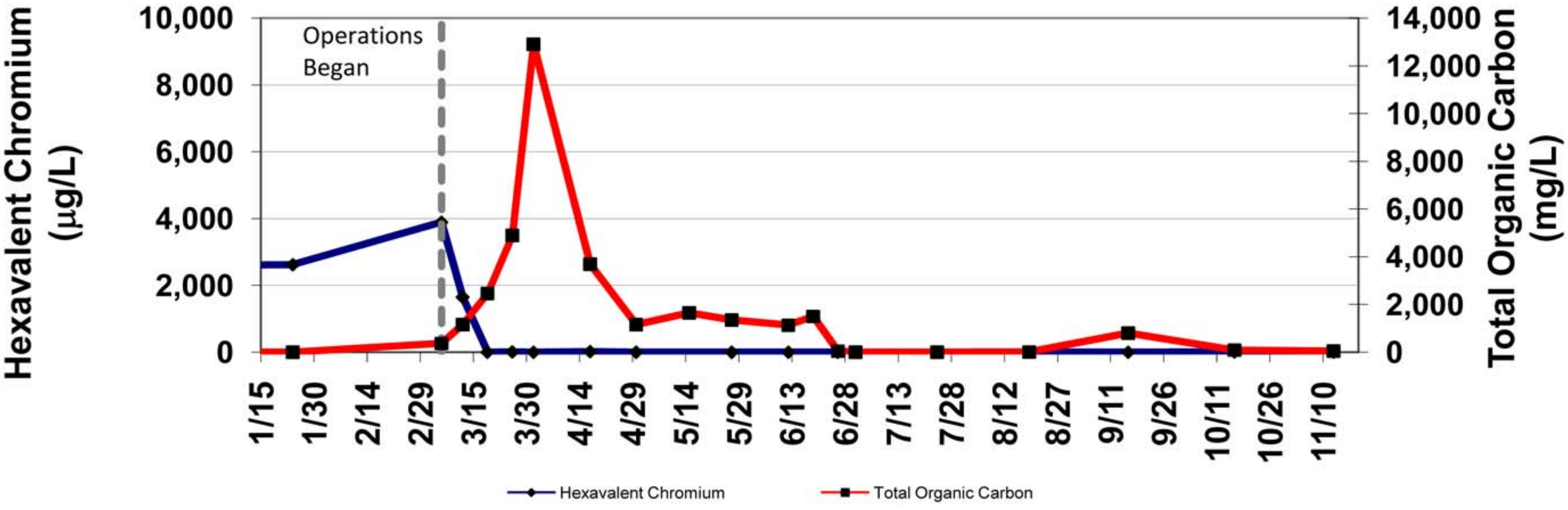
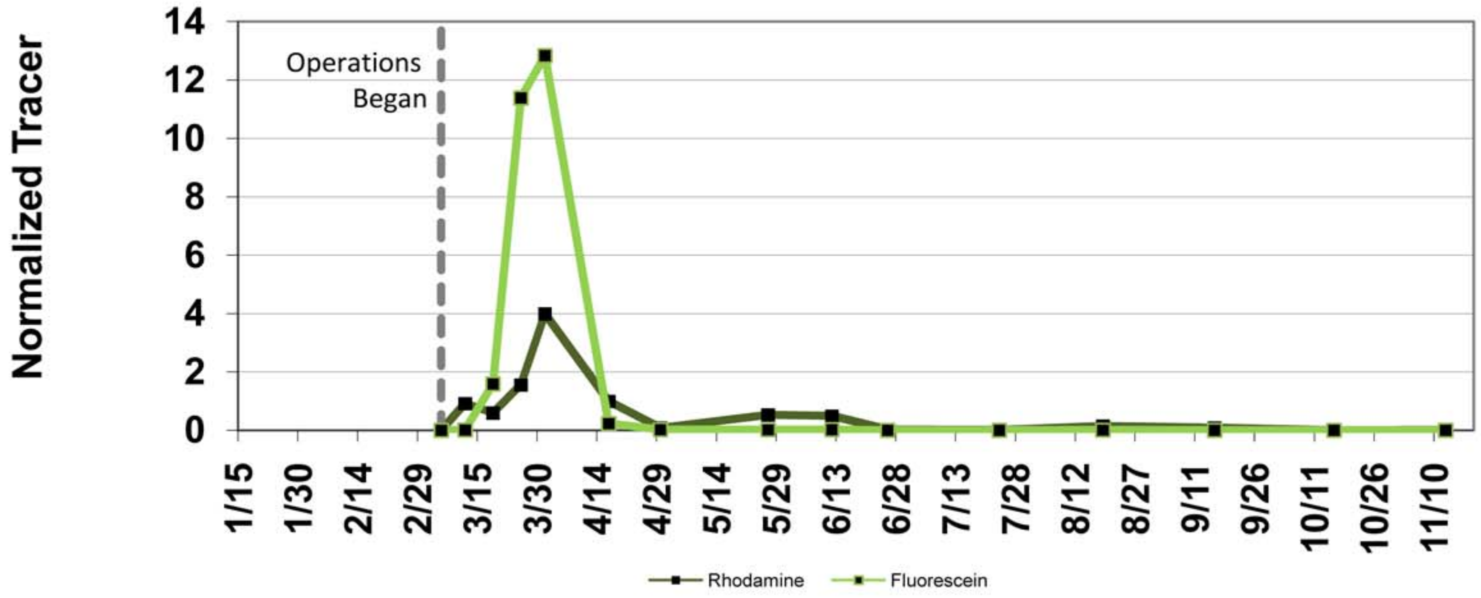
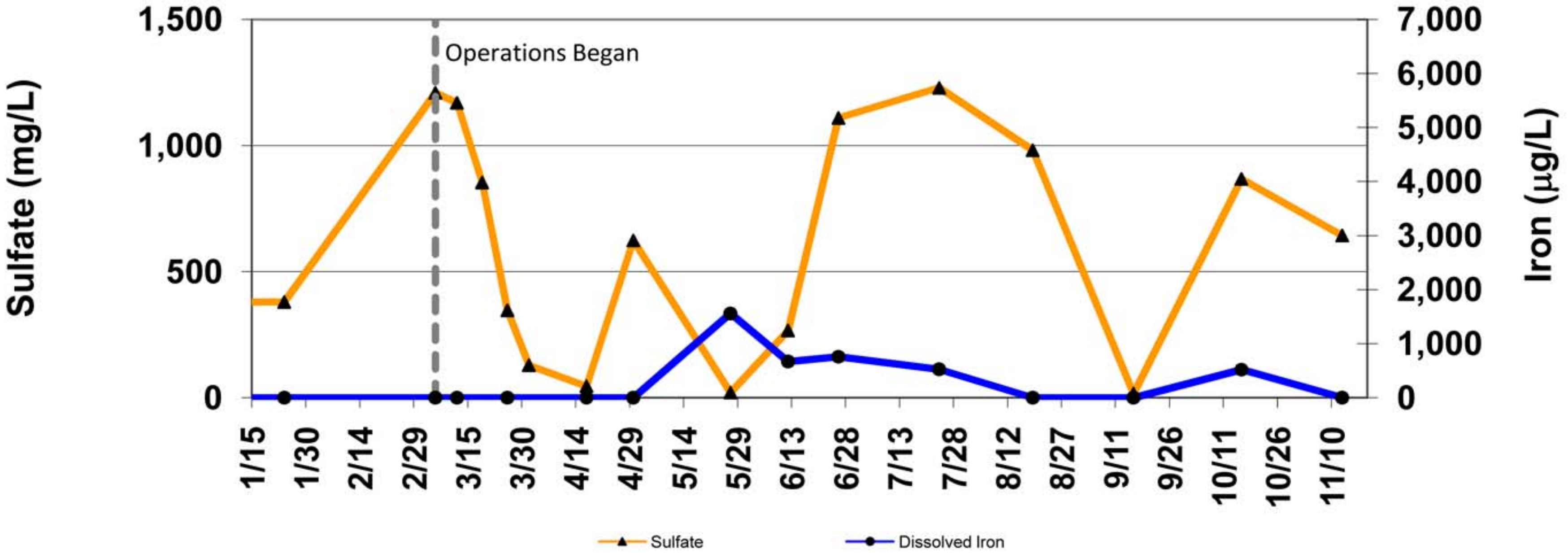
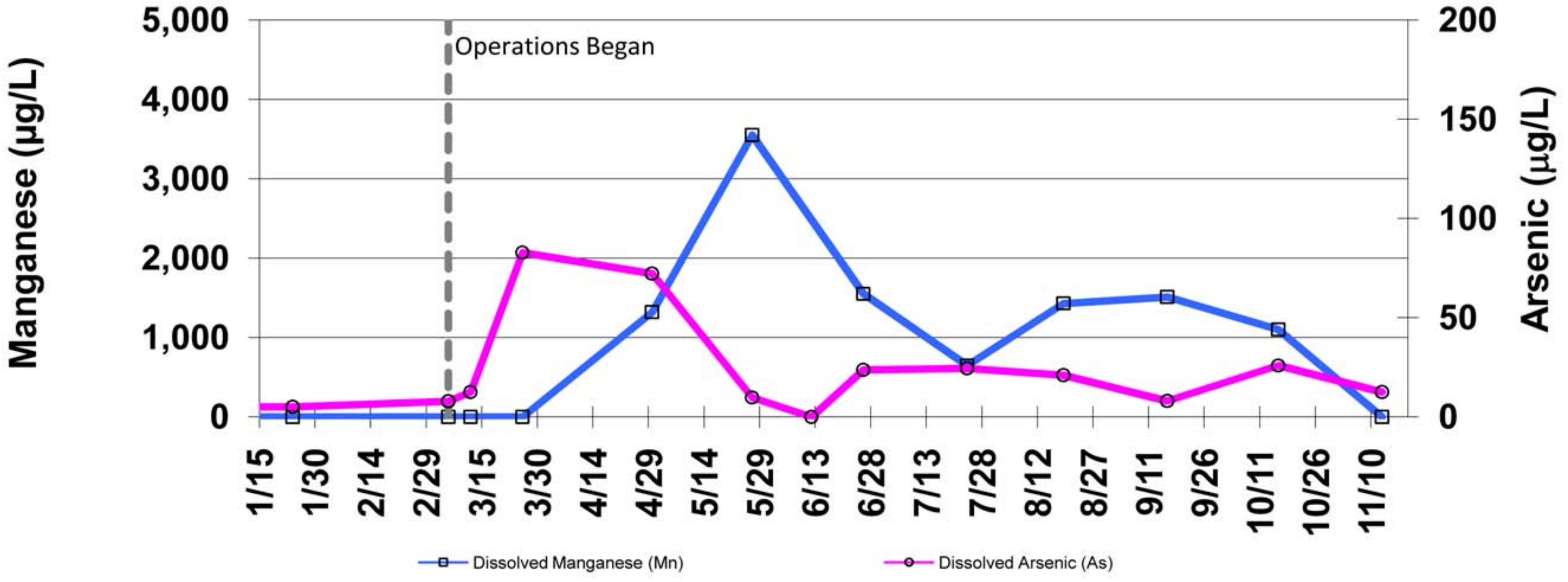
Figure
14









Notes:	mg/L	Milligrams per liter
	µg/L	Micrograms per liter

Normalized Tracer Concentration= Concentration/(Concentration in Injection Solution)

Project Director	Area Manager
L. KELLOGG	J. PETERS
Task Manager	Technical Review
J. LUTRICK	K. J. PRESTON
Drawing Date	Drawn By
29 APR 08	J. CHEN

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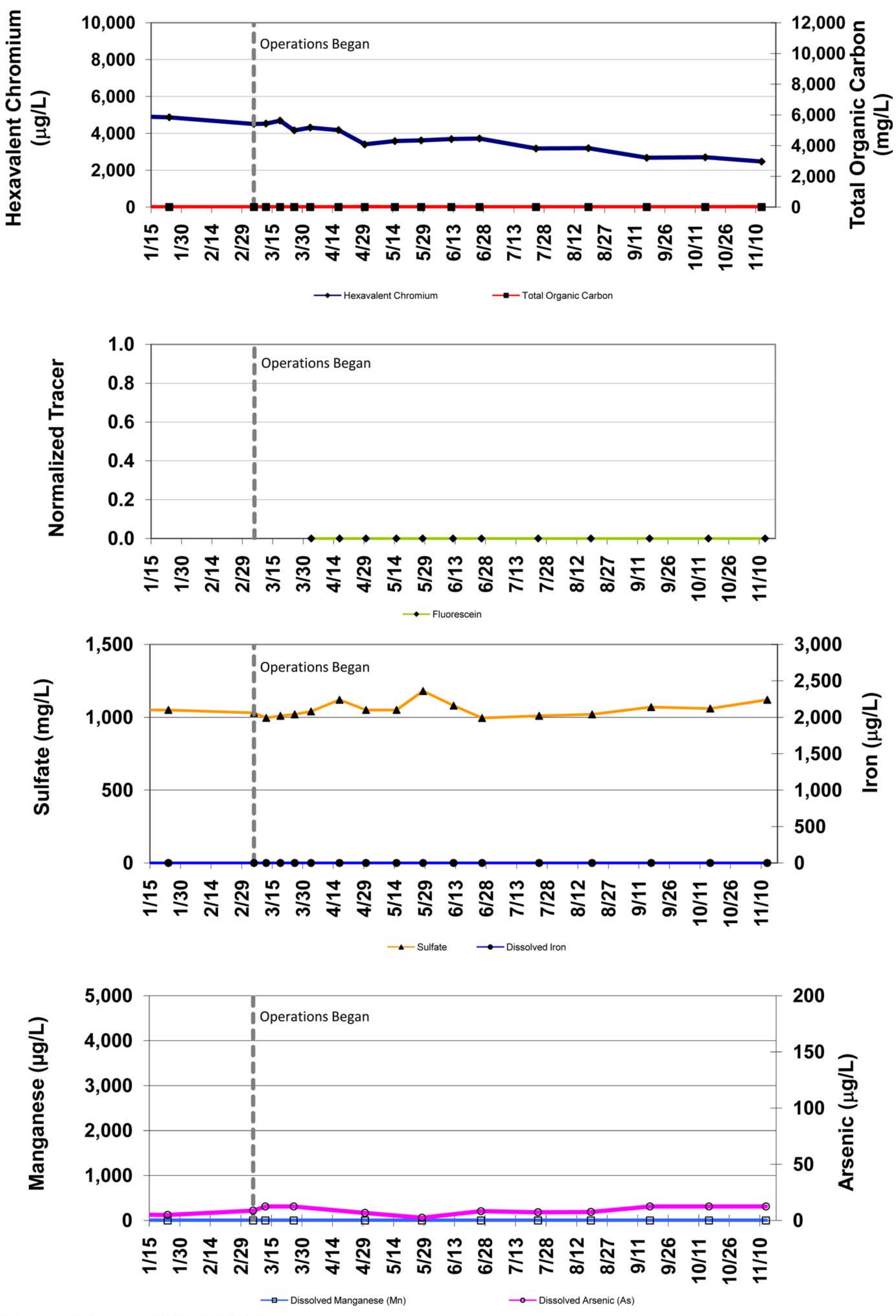
PERFORMANCE MONITORING DATA
FOR WELL MW-24A
PG&E TOPOCK FACILITY
NEEDLES, CALIFORNIA

Project Number
RC000689.0004

Figure
15

User: JCHEN Path: K:\RC00689 PG&E TOPOCK\IMAGE\PHOTOSHOP\



Notes:

mg/L	Milligrams per liter
µg/L	Micrograms per liter

Normalized Tracer Concentration= Concentration/(Concentration in Injection Solution)

Project Director L. KELLOGG	Area Manager J. PETERS	Project Number RC000689.0004
Task Manager J. LUTRICK	Technical Review K. J. PRESTON	Figure 16
Drawing Date 29 APR 08	Drawn By J. CHEN	

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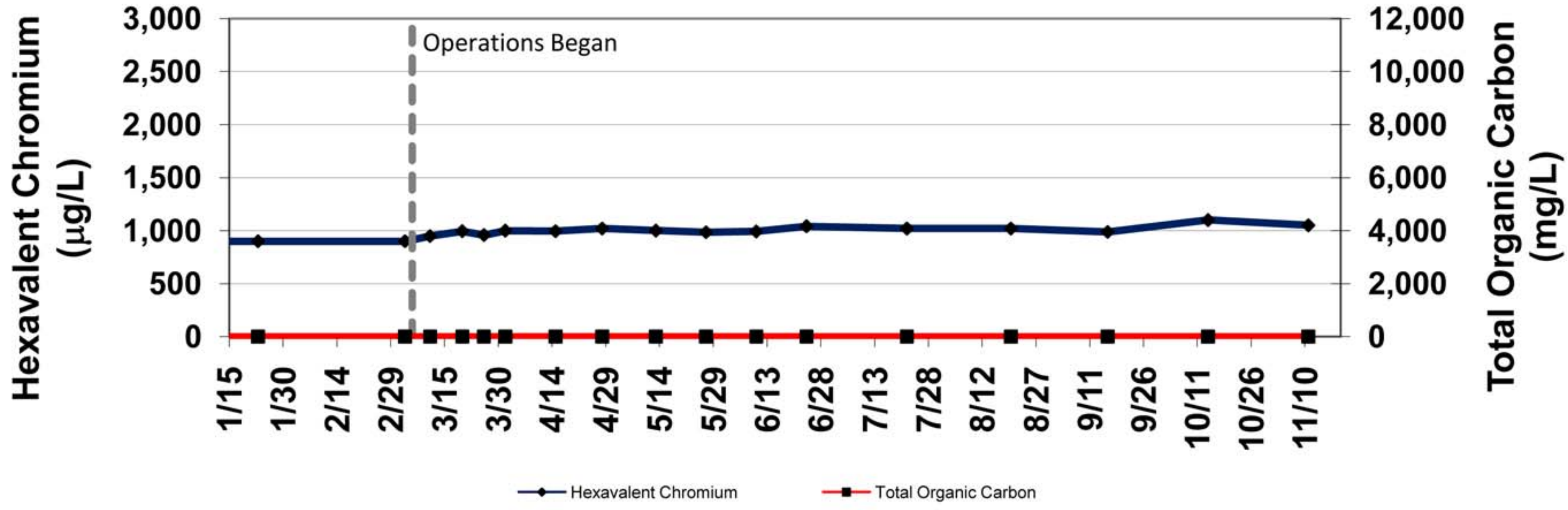
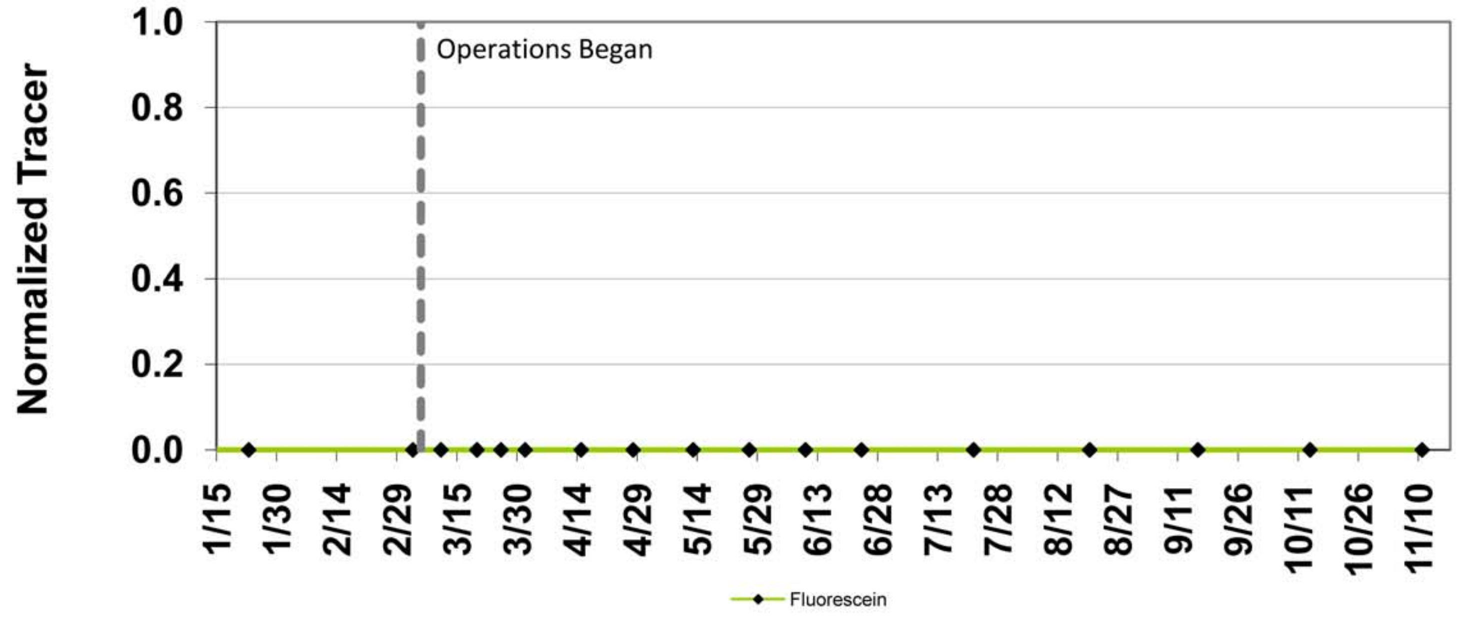
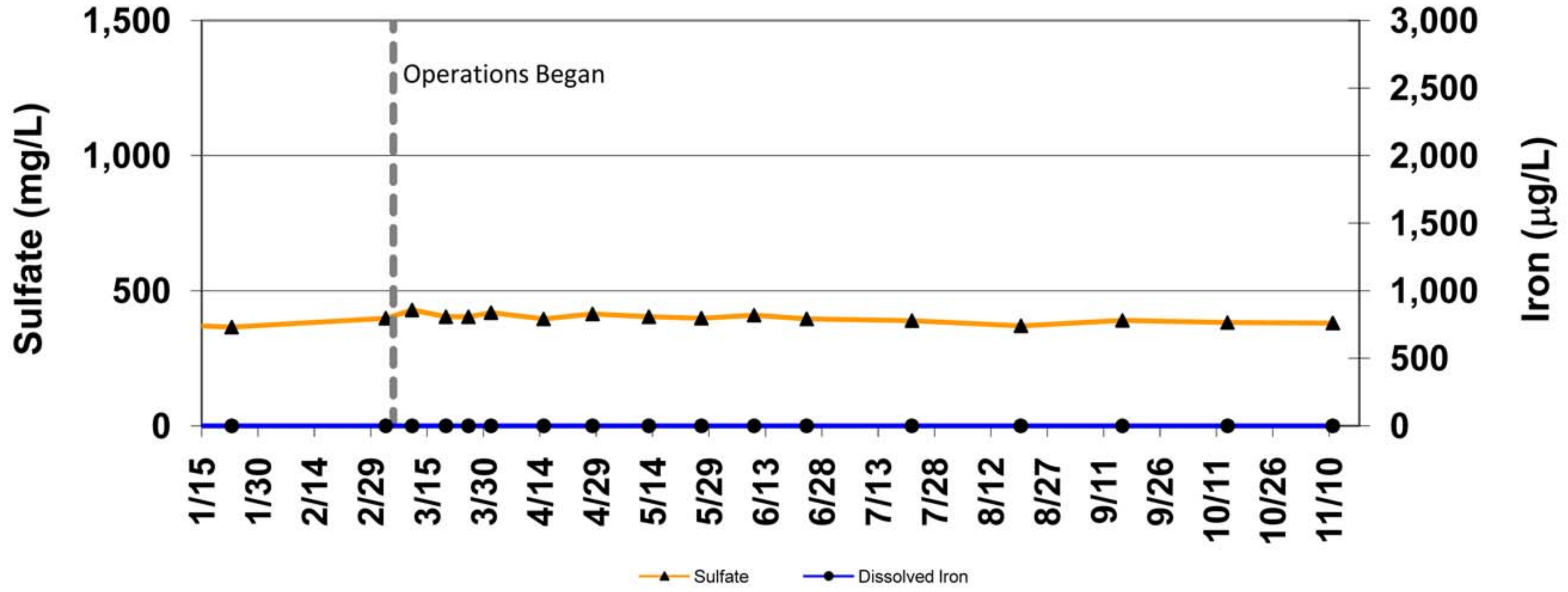
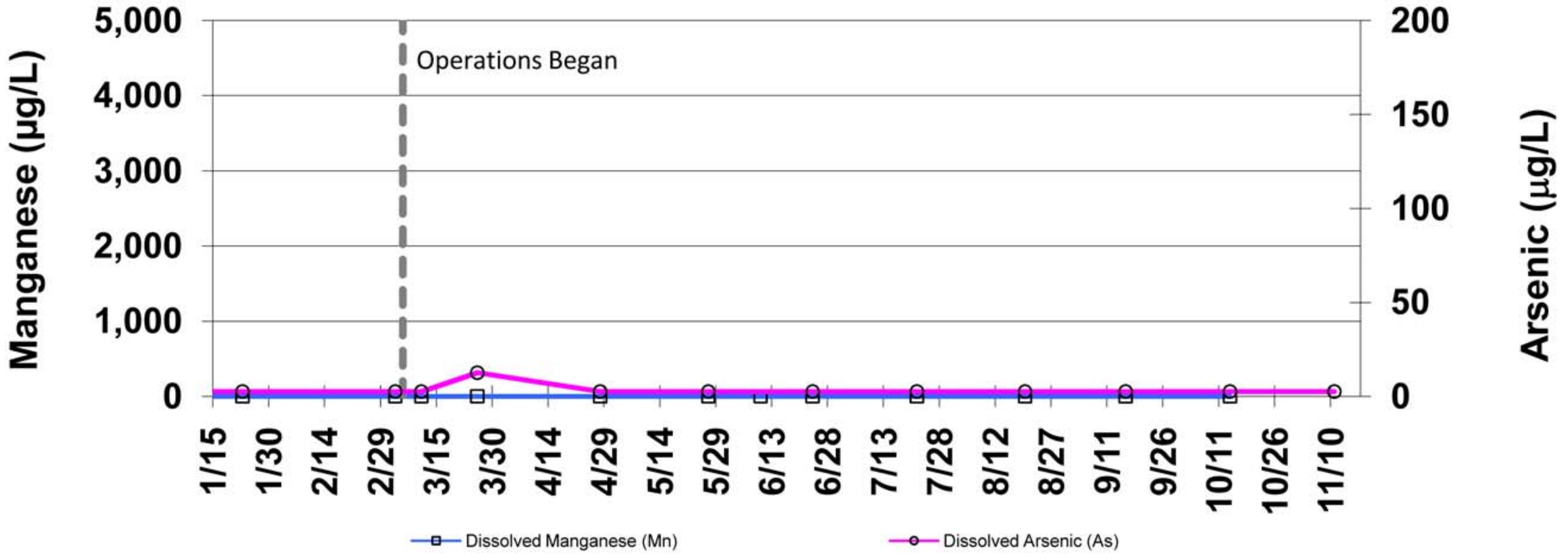
PERFORMANCE MONITORING DATA
FOR WELL MW-24B
PG&E TOPOCK FACILITY
NEEDLES, CALIFORNIA

User: JCHEN Path: K:\RC00689 PG&E TOPOCK\IMAGE\PHOTOSHOP\









Notes:

mg/L	Milligrams per liter
µg/L	Micrograms per liter

Normalized Tracer Concentration= Concentration/(Concentration in Injection Solution)

User: JCHEN Path: K:\RC00689 PG&E TOPOCK\IMAGE\PHOTOSHOP\

Project Director L. KELLOGG	Area Manager J. PETERS
Task Manager J. LUTRICK	Technical Review K. J. PRESTON
Drawing Date 29 APR 08	Drawn By J. CHEN

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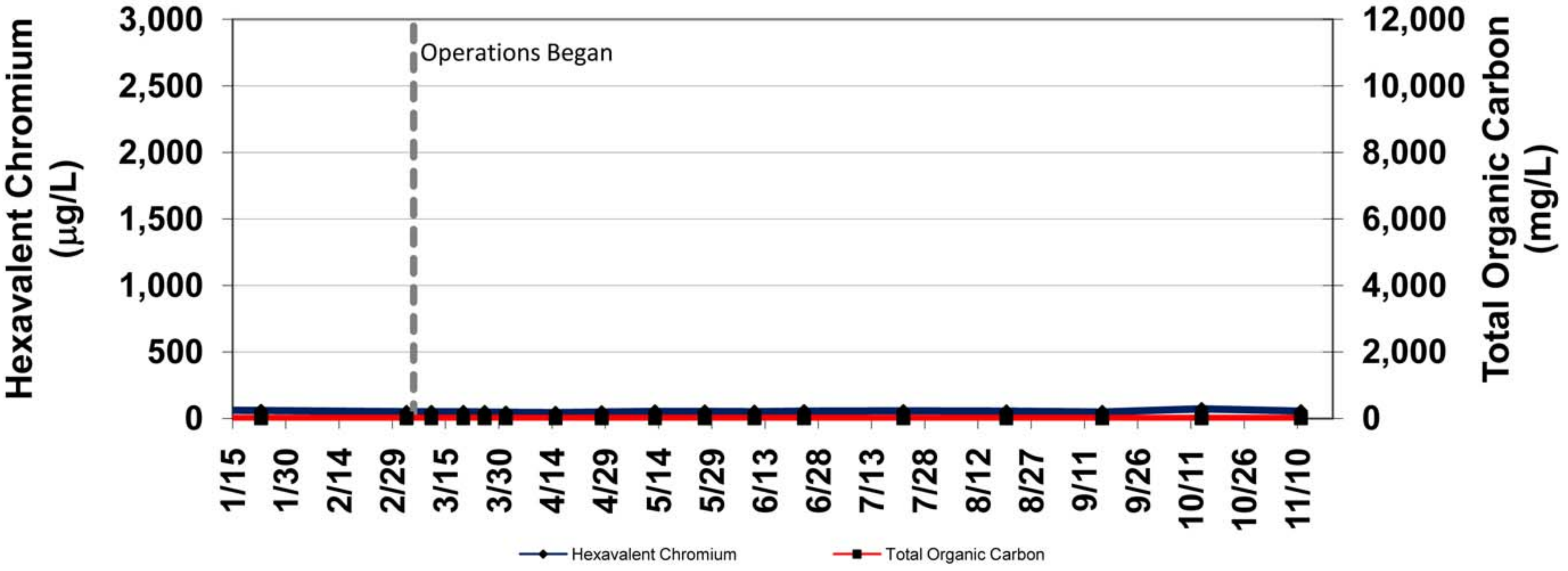
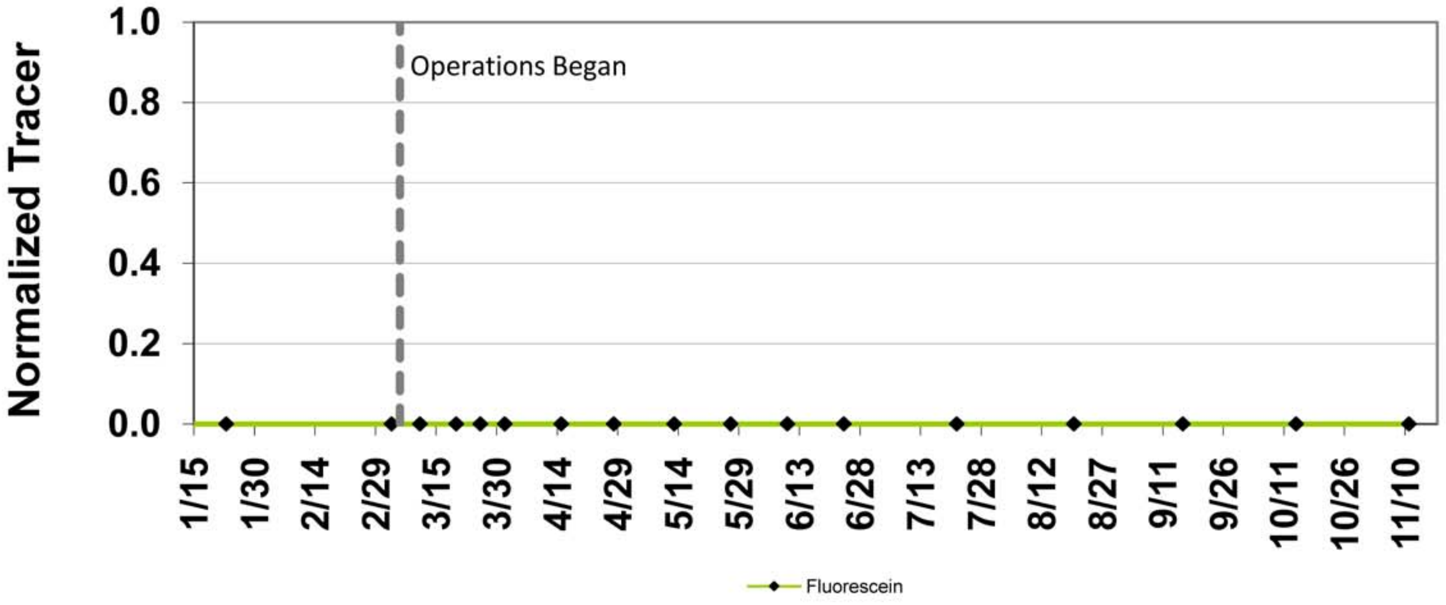
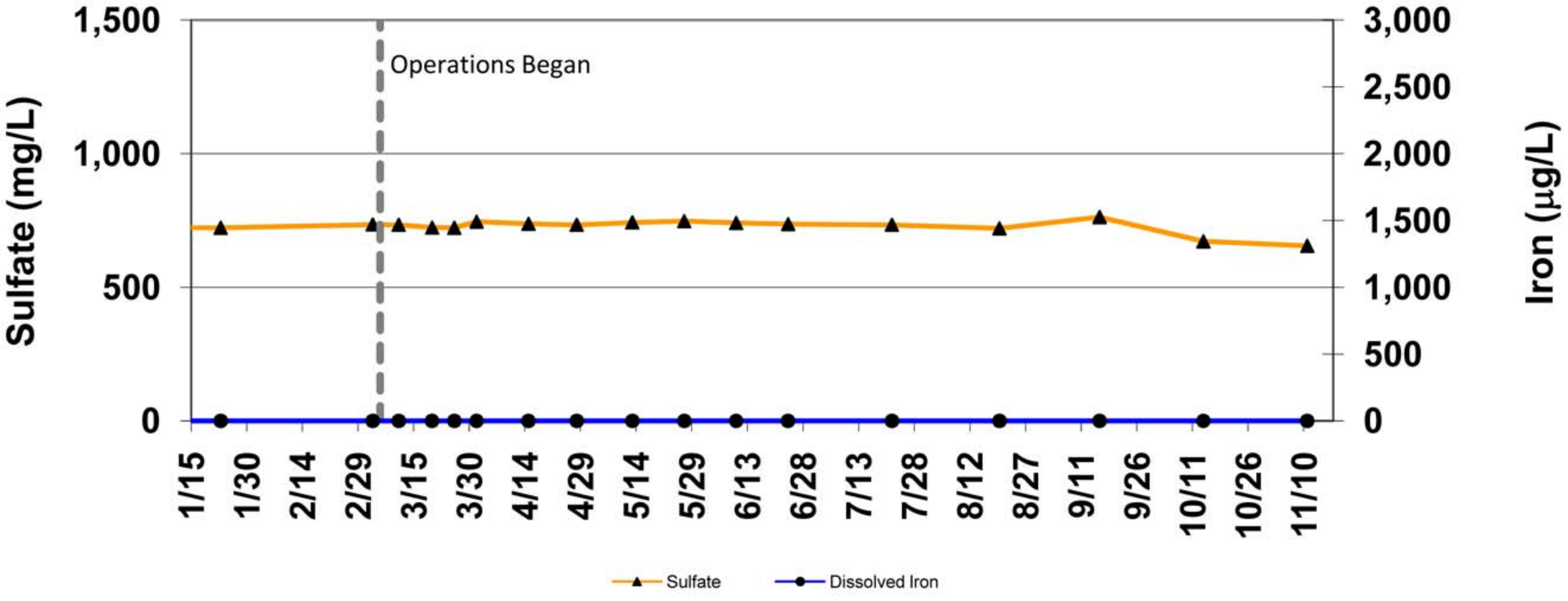
PERFORMANCE MONITORING DATA
FOR WELL MW-38S
PG&E TOPOCK FACILITY
NEEDLES, CALIFORNIA

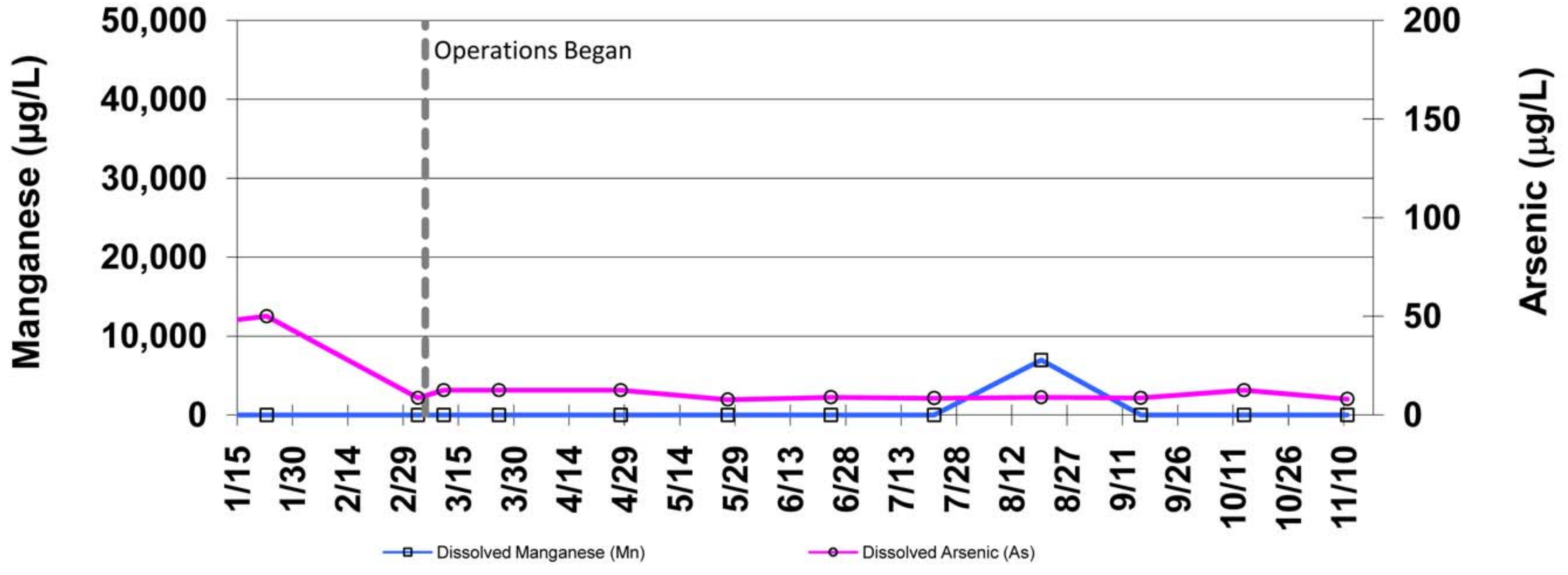
Project Number
RC000689.0004

Figure
17









Notes:

	mg/L	Milligrams per liter
	µg/L	Micrograms per liter

Normalized Tracer Concentration= Concentration/(Concentration in Injection Solution)

Project Director L. KELLOGG	Area Manager J. PETERS
Task Manager J. LUTRICK	Technical Review K. J. PRESTON
Drawing Date 29 APR 08	Drawn By J. CHEN

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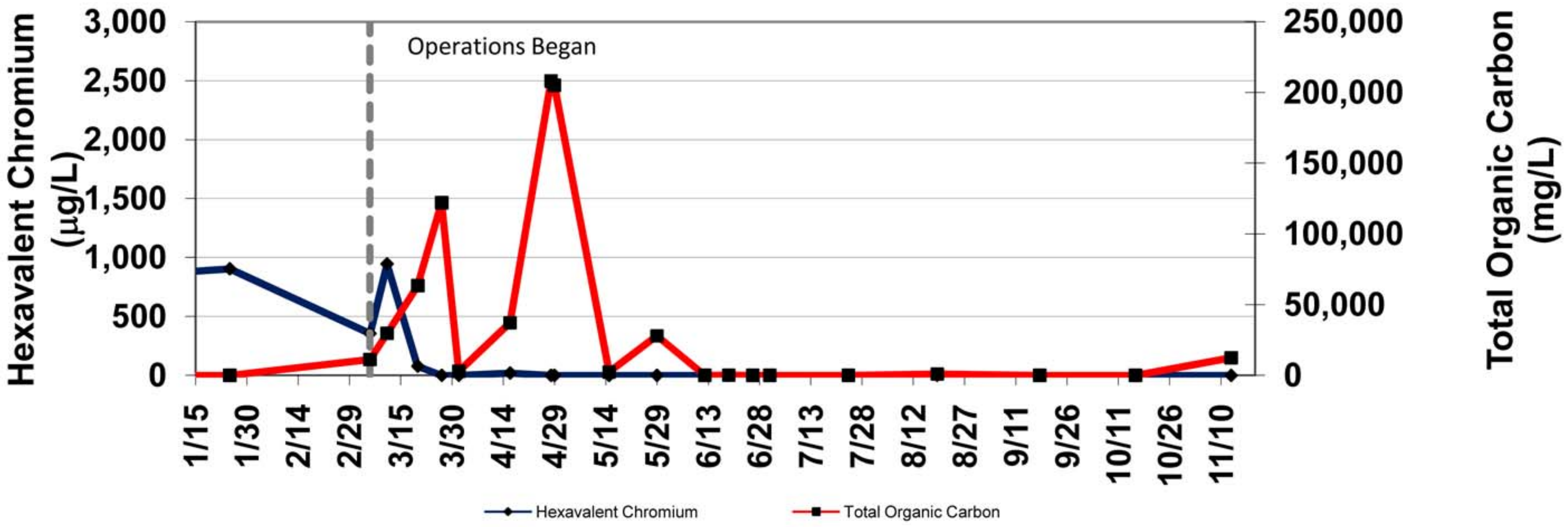
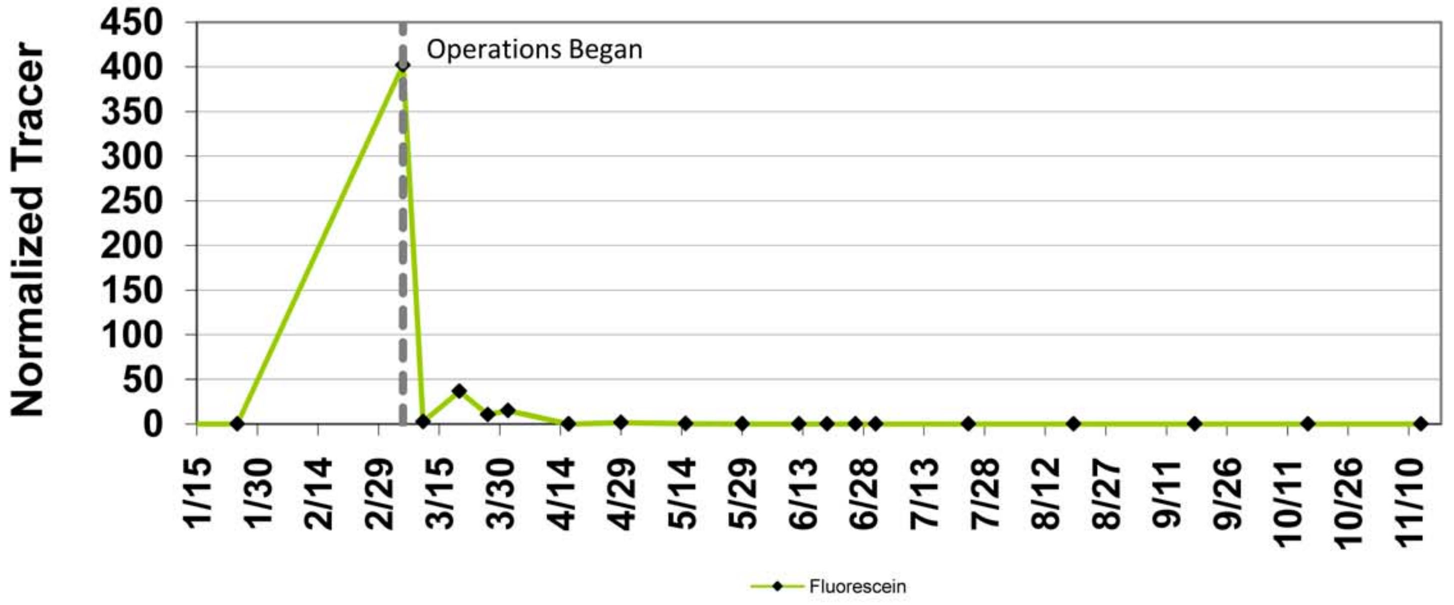
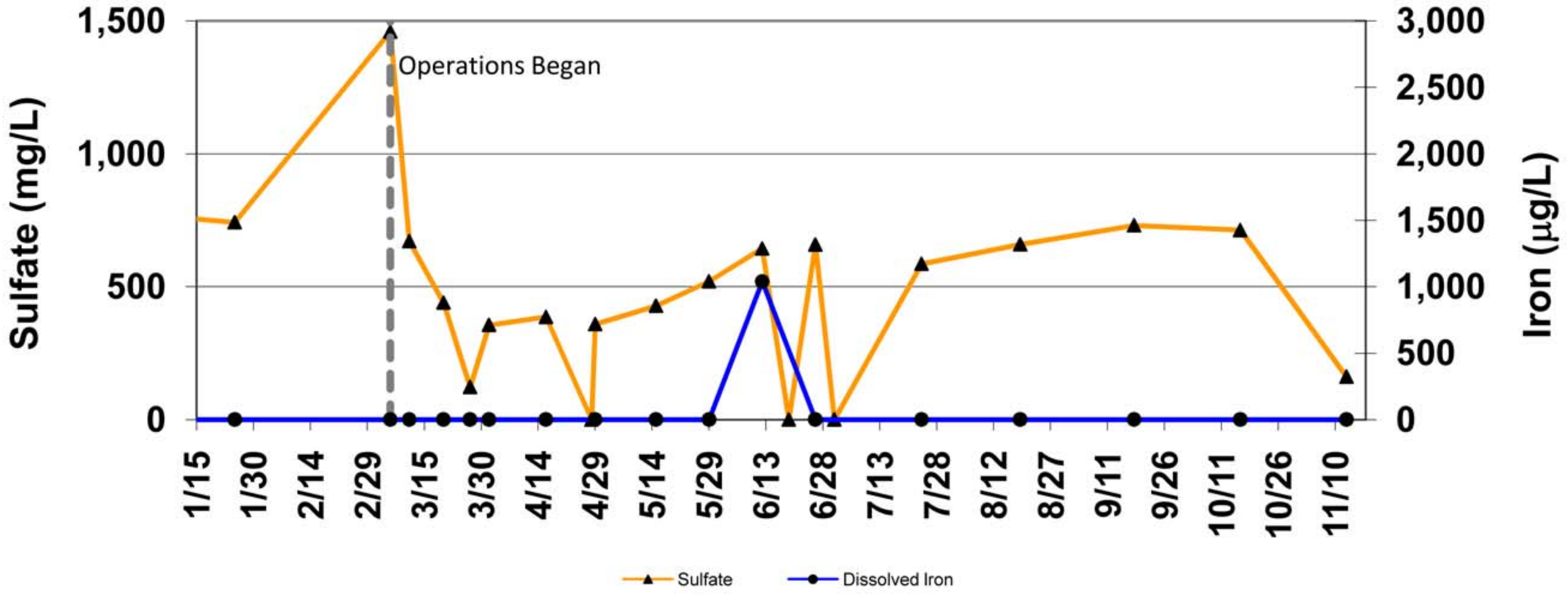
PERFORMANCE MONITORING DATA
FOR WELL MW-38D
PG&E TOPOCK FACILITY
NEEDLES, CALIFORNIA

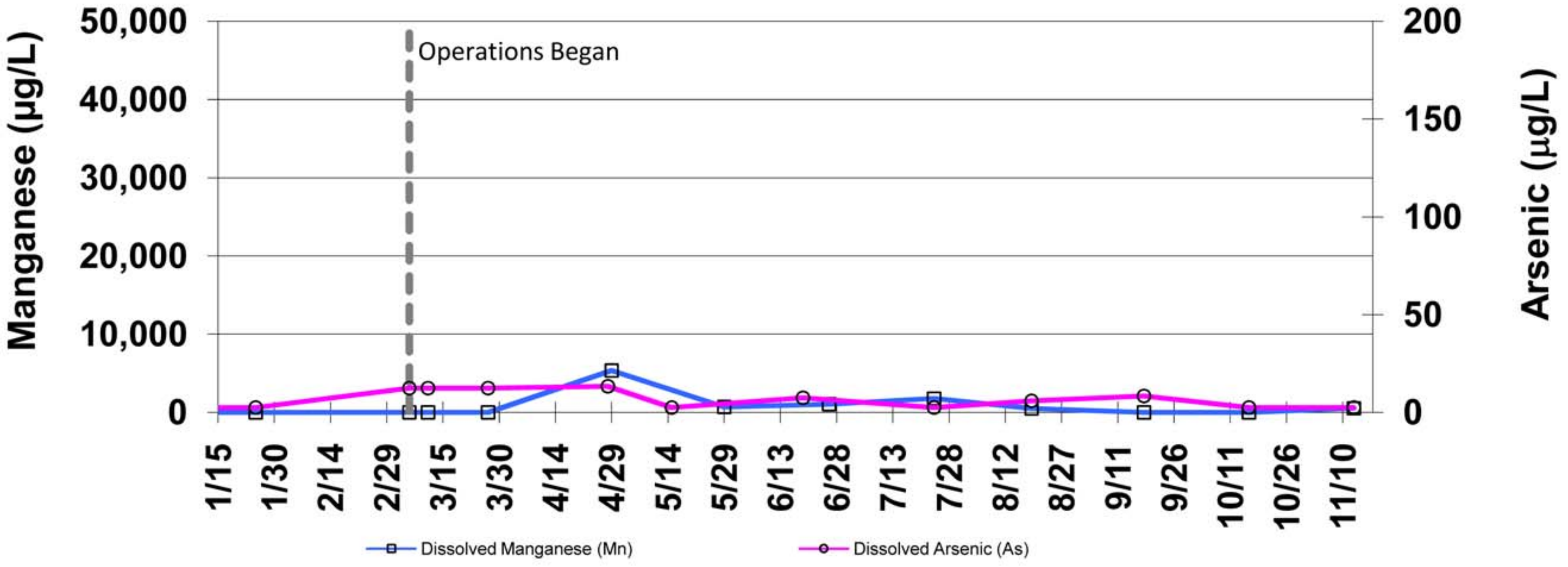
Project Number
RC000689.0004

Figure
18









Notes:		
	mg/L	Milligrams per liter
	µg/L	Micrograms per liter

Normalized Tracer Concentration= Concentration/(Concentration in Injection Solution)

User: JCHEN Path: K:\RC00689 PG&E TOPOCK\IMAGE\PHOTOSHOP\

Project Director L. KELLOGG	Area Manager J. PETERS
Task Manager J. LUTRICK	Technical Review K. J. PRESTON
Drawing Date 29 APR 08	Drawn By J. CHEN

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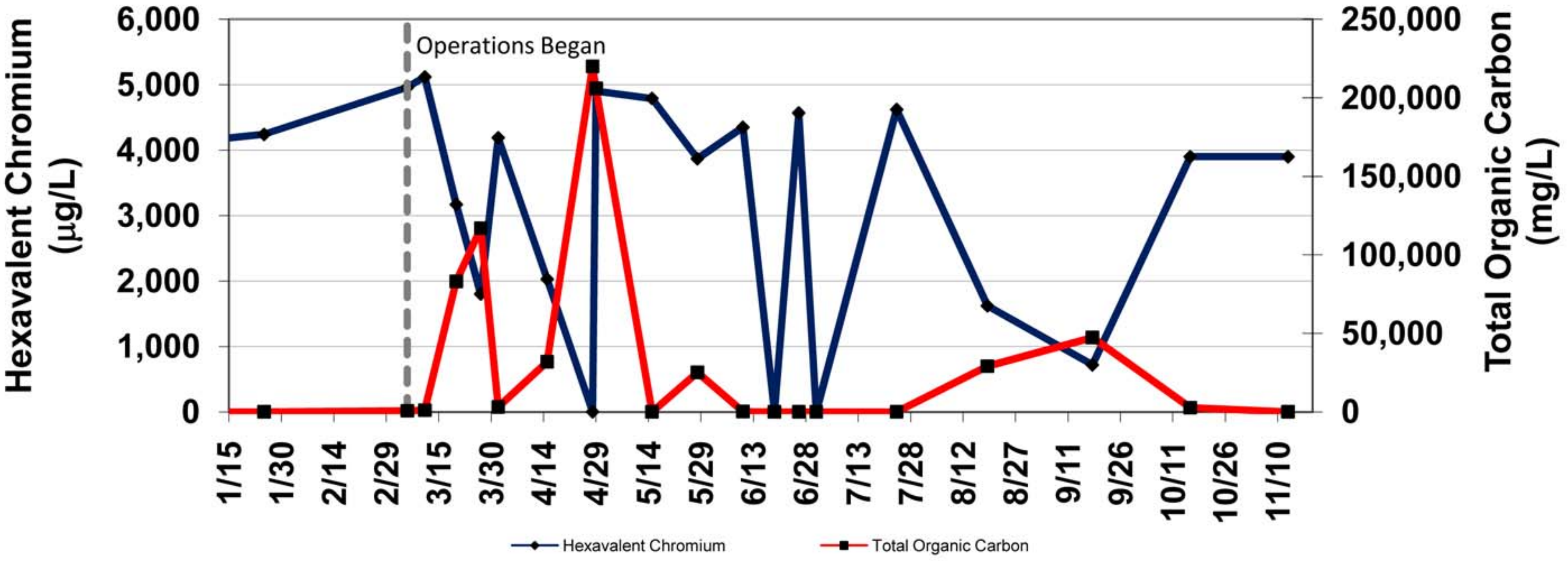
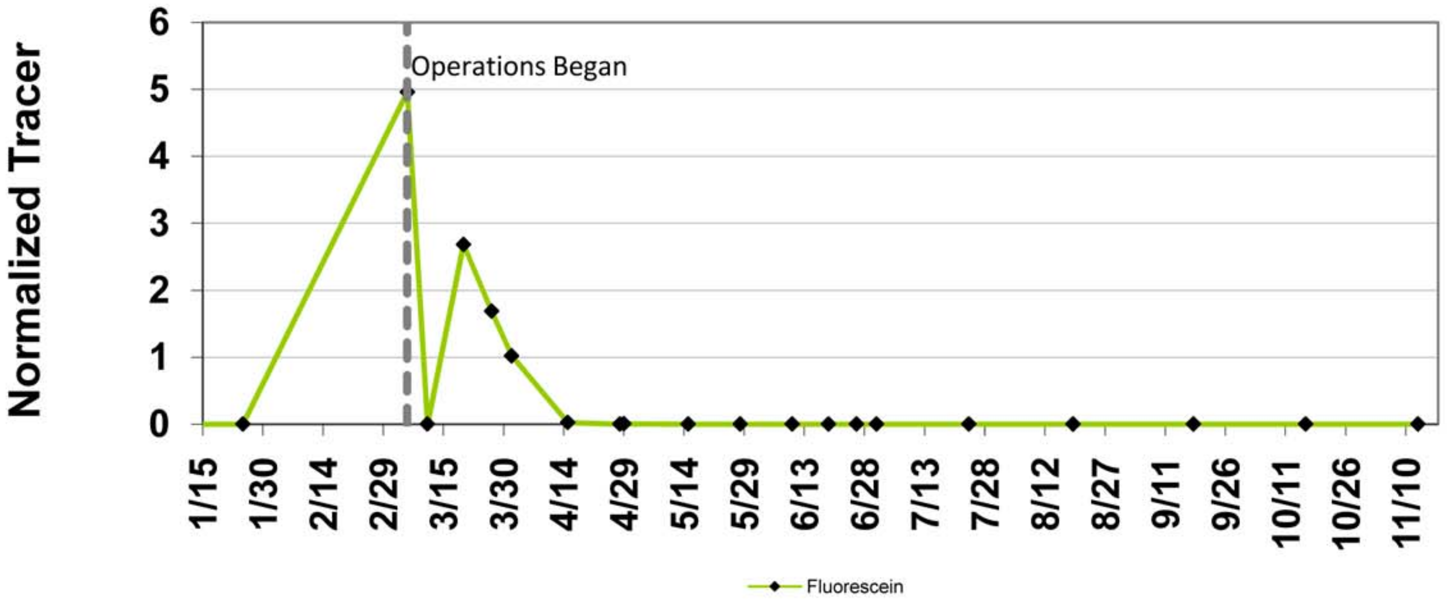
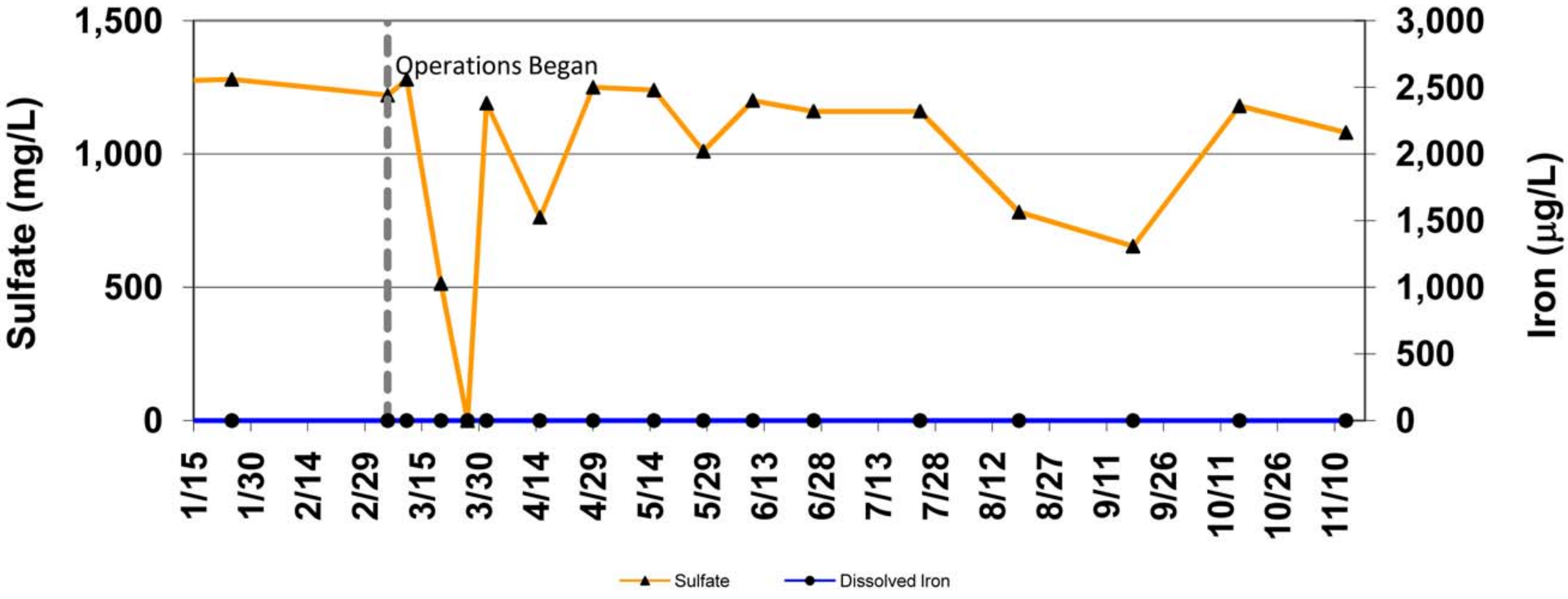
PERFORMANCE MONITORING DATA
FOR RECIRCULATION WELL PTR-1
PG&E TOPOCK FACILITY
NEEDLES, CALIFORNIA

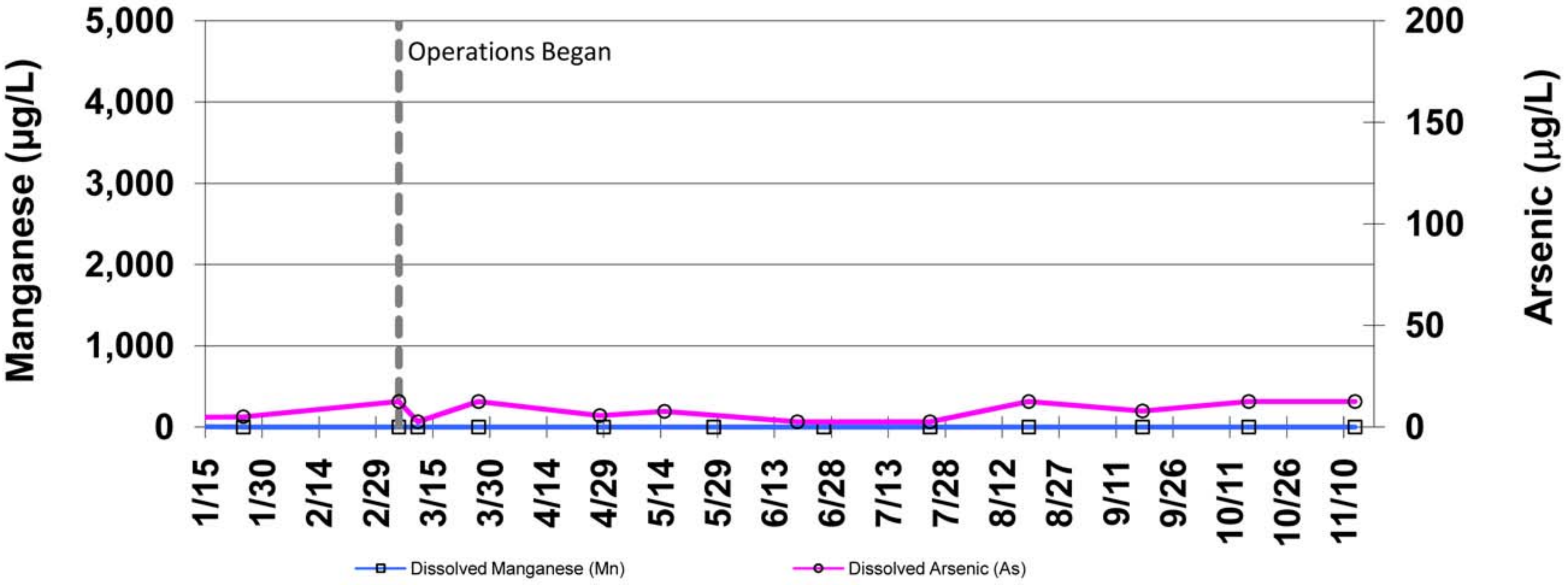
Project Number
RC000689.0004

Figure
19









Notes:

mg/L	Milligrams per liter
µg/L	Micrograms per liter

Normalized Tracer Concentration= Concentration/(Concentration in Injection Solution)

User: JCHEN Path: K:\RC00689 PG&E TOPOCK\IMAGE\PHOTOSHOP\

Project Director L. KELLOGG	Area Manager J. PETERS
Task Manager J. LUTRICK	Technical Review K. J. PRESTON
Drawing Date 29 APR 08	Drawn By J. CHEN

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PERFORMANCE MONITORING DATA
FOR RECIRCULATION WELL PTR-2
PG&E TOPOCK FACILITY
NEEDLES, CALIFORNIA

Project Number
RC000689.0004

Figure
20

Acad Version : R17.0s (LMS Tech)
User Name : Jchen

Date\Time : Mon, 16 Feb 2009 - 4:44pm
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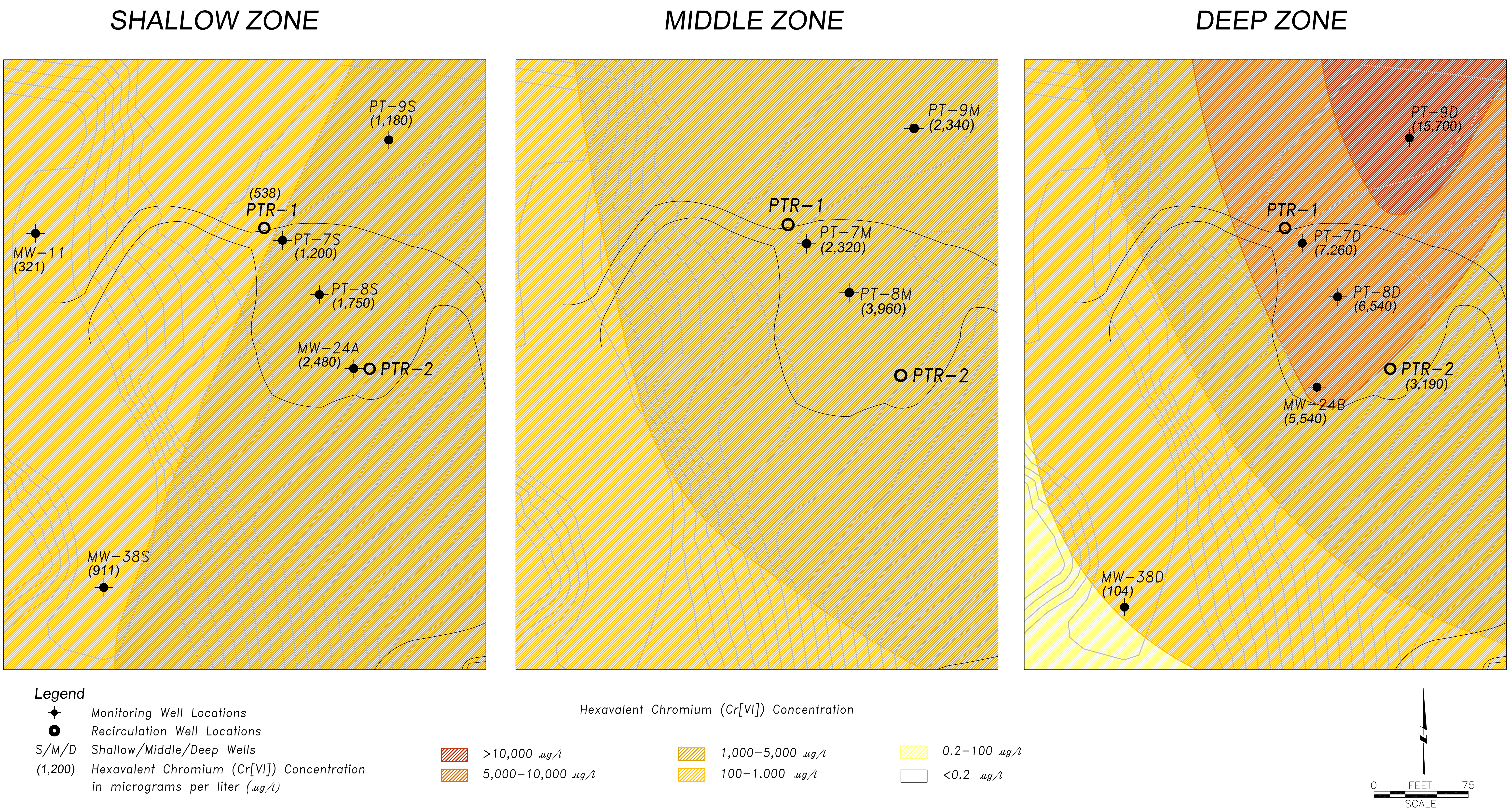

Legend

⌖	Monitoring Well Locations
⊙	Recirculation Well Locations
S/M/D	Shallow/Middle/Deep Wells
(1,200)	Hexavalent Chromium (Cr[VI]) Concentration in micrograms per liter (ug/l)

Hexavalent Chromium (Cr[VI]) Concentration

▨	>10,000 ug/l	▨	1,000–5,000 ug/l	▨	0.2–100 ug/l
▨	5,000–10,000 ug/l	▨	100–1,000 ug/l	☐	<0.2 ug/l

Project Director L. KELLOGG	Area Manager J. PETERS
Task Manager J. LUTRICK	Technical Review K.J. PRESTON
Drawing Date 02 FEB 09	Drawn By J. CHEN

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BASELINE HEXAVALENT CHROMIUM CONCENTRATION MAP
(SHALLOW, MIDDLE AND DEEP ZONES)
PG&E TOPOCK FACILITY
NEEDLES, CALIFORNIA

Project Number
RC000689.0004

Figure
21

Acad Version : R17.0s (LMS Tech)
User Name : Jchen
Date\Time : Mon, 16 Feb 2009 - 4:43pm
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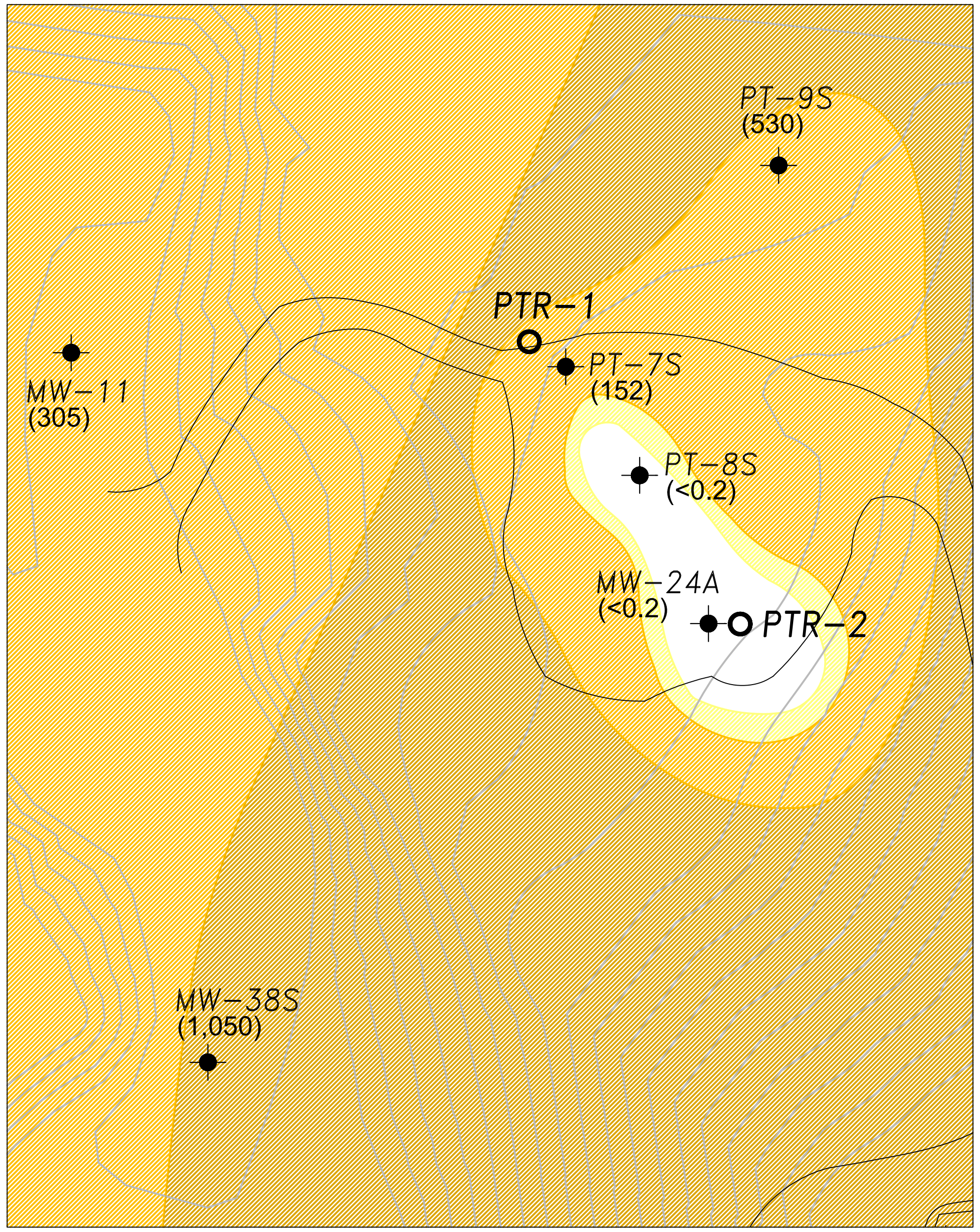
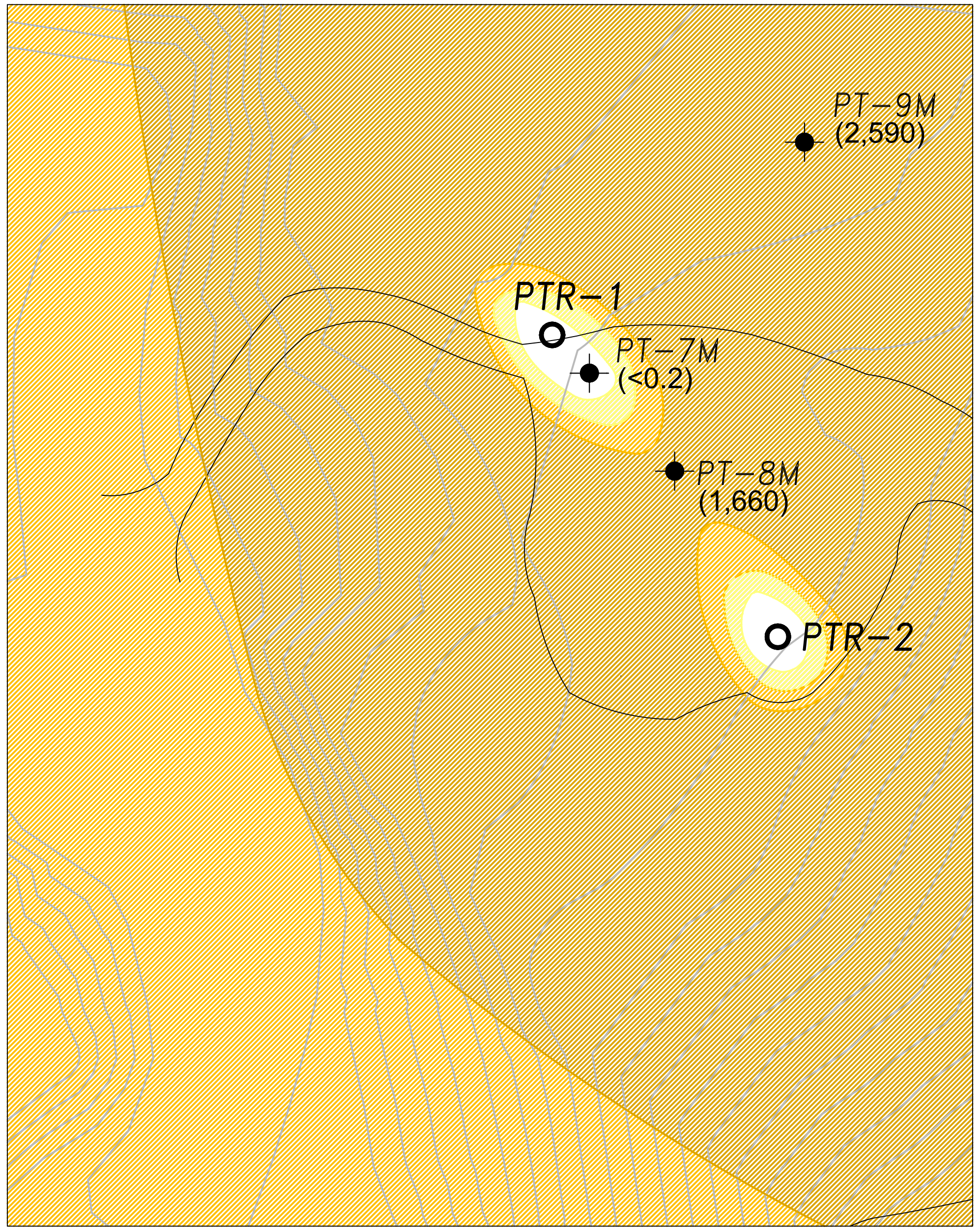
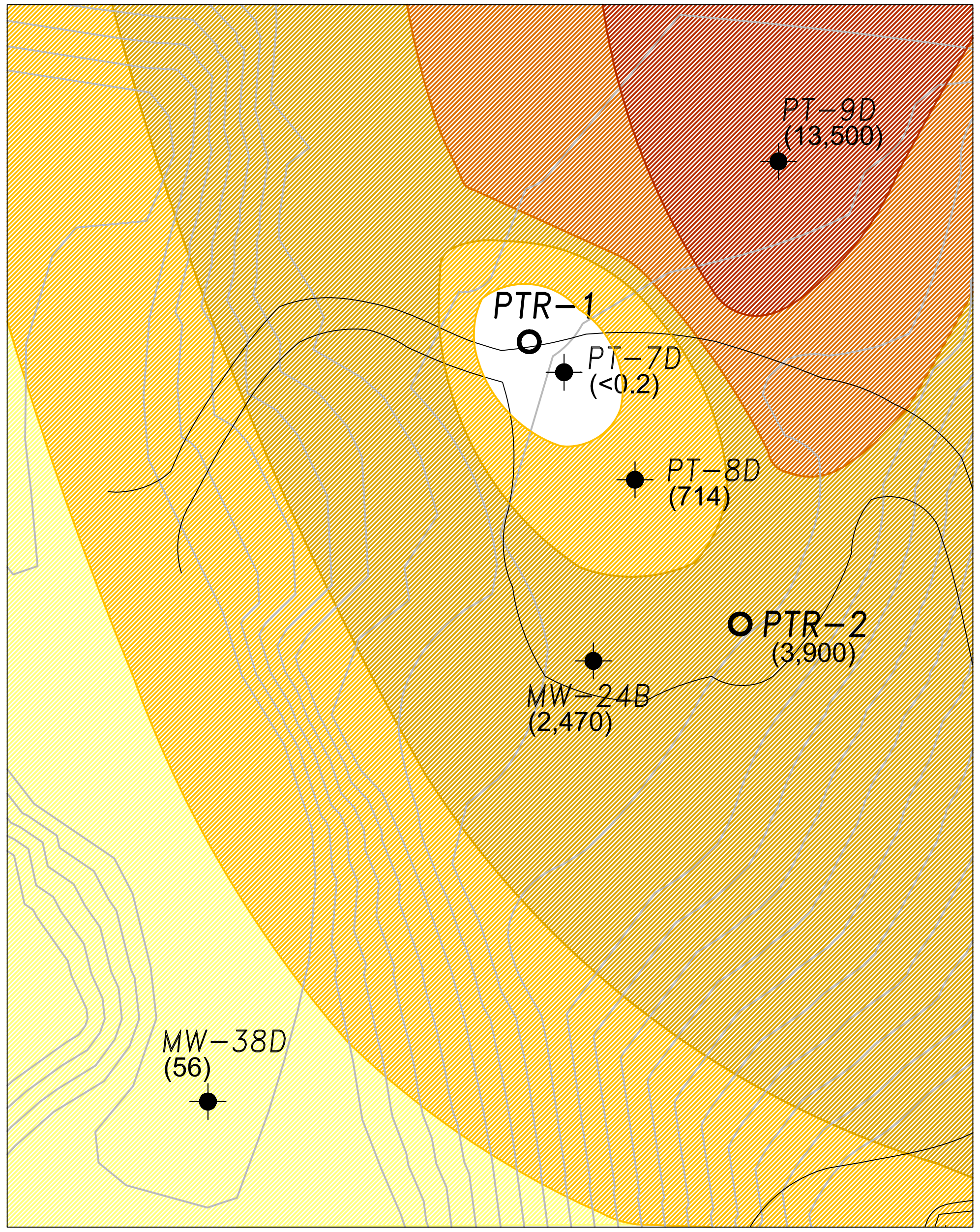
SHALLOW ZONE



MIDDLE ZONE



DEEP ZONE

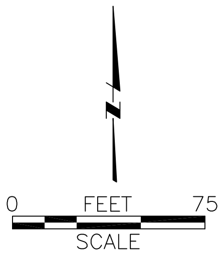


Legend

✦	Monitoring Well Locations
●	Recirculation Well Locations
S/M/D	Shallow/Middle/Deep Wells
(1,200)	Hexavalent Chromium (Cr[VI]) Concentration in micrograms per liter (ug/l)

Hexavalent Chromium (Cr[VI]) Concentration

▨	>10,000 ug/l
▨	5,000-10,000 ug/l
▨	1,000-5,000 ug/l
▨	100-1,000 ug/l
▨	0.2-100 ug/l
☐	<0.2 ug/l



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Project Director L. KELLOGG	Area Manager J. PETERS
Task Manager J. LUTRICK	Technical Review K.J. PRESTON
Drawing Date 02 FEB 09	Drawn By J. CHEN

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POST-OPERATION HEXAVALENT CHROMIUM CONCENTRATION MAP
(SHALLOW, MIDDLE AND DEEP ZONES)
PG&E TOPOCK FACILITY
NEEDLES, CALIFORNIA

Project Number
RC000689.0004

Figure
22

Appendix **A**

Communications

Pacific Gas and Electric Company

Yvonne Meeks
Manager

Environmental Remediation
Gas T&D Department

Mailing Address
4325 South Higuera Sreet
San Luis Obispo, CA 93401
Location
6588 Ontario Road
San Luis Obispo, CA 93405
Tel: (805) 234-2257
Email: yjm1@pge.com

May 29, 2008

Mr. Robert Purdue
Executive Officer
California Regional Water Quality Control Board
Colorado River Basin Region
73-720 Fred Waring Drive, Suite 100
Palm Desert, California 92260

Subject: **Board Order R7-2007-0015**
PG&E Topock Compressor Station, Needles, California
Upland In-Situ Pilot Test
Changes in Pilot Test Operations

Dear Mr. Purdue:

As we discussed yesterday, PG&E is submitting this letter is to notify the Regional Water Quality Control Board (RWQCB) that PG&E would like to temporarily discontinue injection of reagent for the Upland In-Situ Pilot Test (ISPT) operating under Board Order No. R7-2007-0015. Currently, the concentration of total dissolved carbon (TOC) within the aquifer is sufficient to sustain a viable in-situ reactive zone (IRZ). The plan is to withhold treatment discharge (reagent dosing via the recirculation wells) for approximately one month to monitor the recirculation systems ability to distribute the TOC sufficiently through the recirculation cell. There will be no change in the recirculation rate - the system will continue to circulate water during this time period.

To evaluate the TOC distribution, PG&E is recommending that weekly sampling of TOC be collected from eight wells: PT-7M, PT-7D, PT-8S, PT-8M, PT-8D, MW-24A, PTR-1, and PTR-2 during the one month evaluation period. After the evaluation period, PG&E will identify a path forward to continue the dosing of the Upland ISPT, potentially at a reduced rate, or will discuss other options with the RWQCB. All supplemental data collected and the plan for continued dosing the Upland ISPT will be communicated to the RWQCB.

From an engineering perspective, because of the continual evaluation inherent in any pilot test, the optimal approach to the Upland ISPT was anticipated to be conducted in a semi-continuous manner, with breaks as needed to assess progress or fine-tune approaches. PG&E discussed this type of phasing with the RWQCB during the preparation of the Waste Discharge Requirement (WDR), e.g. as described in Finding II.A.1, the pilot test "...is expected to take up to six months and will be conducted within a nine-month calendar period".

Based on our review of the Waste Discharge Requirements, it does not appear as though the proposed actions fall under the Effluent Limitations and Discharge Specifications IV.A.5 that states, "Any changes in the type of amount of treatment chemicals added to the process water, duration of the pilot test, or other specific design elements as described in this Board Order shall be made with prior written approval of the Regional Water Board's Executive Officer." or Provision V.A.1.e that states, "Prior to modifications in this facility, which would results in material change in the quality or quantity of wastewater treated or discharged, or any material change in the location of discharge, the Discharger shall report all pertinent information in writing to the RWQCB and obtain revised requirements before modifications are implemented."

We understand however that you will determine if the proposal to temporarily discontinue discharge, and subsequent restart requires a simple notification to the RWQCB or if the permit requires that Board or Executive Officer approval is necessary. If such approval is necessary, please consider this letter our request for approval.

We have a scheduled ethanol delivery on June 2nd that we may be able to reschedule if we are allowed to cease the dosing operation per the information provided above. We appreciate your timely consideration of this letter.

If you have any questions regarding this information, please call me at (805) 234-2257.

Sincerely,

Yvonne Meeks

Yvonne Meeks
Topock Project Manager

cc: Cliff Raley, Water Board
Tom Vandenberg, Water Board
Aaron Yue, DTSC

California Regional Water Quality Control Board
Colorado River Basin Region

Linda S. Adams
Secretary for
Environmental Protection

73-720 Fred Waring Drive, Suite 100, Palm Desert, California 92260
(760) 346-7491 • Fax (760) 341-6820
http://www.waterboards.ca.gov/coloradoriver

Arnold Schwarzenegger
Governor

May 29, 2008

Yvonne J. Meeks, Project Manager
Pacific Gas & Electric Company
4325 S. Higuera Street
San Luis Obispo, CA 93401

SUBJECT: APPROVAL OF A CESSATION IN THE REAGENT INJECTION PROCESS, WASTE DISCHARGE REQUIREMENTS BOARD ORDER NO. R7-2007-0015 (WDRs), PG&E TOPOCK COMPRESSOR STATION

We received your letter, dated May 29, 2008 (Letter), requesting approval to temporarily discontinue reagent injections while continuing to pump and monitor recirculation wells associated with the Upland In-situ Pilot Test (Upland ISPT) at the subject facility. You explain the reason for your request by stating: "Currently, the concentration of total dissolved carbon (TOC) within the aquifer is sufficient to sustain a viable in-situ reactive zone (IRZ)." You explain further that PG&E would like "to withhold treatment discharge for approximately one month to monitor the recirculation systems ability to distribute the TOC sufficiently through the recirculation cell." You add that no change in the recirculation rate will occur during this time period. Also, you indicate that to evaluate the TOC distribution, weekly sampling of TOC will be conducted from eight specified monitoring wells. Following this one-month evaluation period, you state that PG&E would continue the dosing of the Upland ISPT, potentially at a reduced rate, or would discuss other options with the Colorado River Basin Regional Water Quality Control Board (Board), and that the monitoring data and continued dosing plans would be communicated to the Board.

The latter part of your letter discusses your view that the proposed temporary cessation of reagent injection appears to be the type of testing approach to the Upland ISPT that was anticipated to be conducted in a semi-continuous manner, with breaks as needed to assess progress or fine-tune approaches. You point out that this type of phasing was discussed with Board staff during the drafting of the subject Board Order, as reflected in Finding II.A.1, which provides that the Upland ISPT "is expected to take up to six months and will be conducted within a nine-month calendar period." Based on this Finding, you conclude that the proposed temporary cessation and subsequent "fine-tuning" for determining the optimal dosing rate for the reagent injections do not appear to fall under Effluent Limitations and Discharge Specifications IV.A.5 to require formal written approval by the Regional Board's Executive Officer.[1] In the event that the Executive Officer does not share this conclusion, you requested that your letter be considered a request for the Executive Officer's approval.

I have concluded that the temporary cessation of reagent injection for one month in a testing protocol that envisions that the injection portion of the pilot test would take up to six months and be conducted within a nine-month calendar period (Finding II.A.1) is a significant enough delay to be considered a "change[ ] in the amount of treatment chemicals added to the process water" or, at a minimum, a "change[ ] in ... other specific design elements as described in [the Board Order]." (Specification IV.A.5.) Thus, the proposed temporary cessation of reagent injection is subject to Specification IV.A.5. As such, my written approval is required. Accordingly, I have treated your letter as requesting that approval, which is hereby granted.

As for the "fine-tuning" of the dosing rate, which is proposed to occur upon restart of the reagent injection process, I agree that the starts/stops and breaks involved for this fine-tuning work are of a short-term nature and thus, would not rise to the level of specific design element changes that would require my written approval. Therefore, with respect to the fine-tuning phase of the Upland ISPT, your notice regarding this phase of the work is sufficient.

Please keep in mind, however, that it is necessary that you keep the Regional Board and the Department of Toxic Substances Control staff apprised, at the earliest practicable time, of all design and operational parameters involved in the Upland ISPT.

The subject Board Order remains in full effect and is not modified by this letter. If you have any questions, or require additional information regarding this matter, please call Cliff Raley at (760) 776-8962.

Cliff Raley for
ROBERT PERDUE
Executive Officer

CR/tab

---

[1] Specification IV.A.5 states: "Any changes in the type or amount of treatment chemicals added to the process water, duration of the pilot test, or other specific design elements as described in this Board Order shall be made with prior written approval of the Regional Water Board's Executive Officer."

cc: Curt Russell, Onsite Project Manager, PG&E Topock
Julie Eakins, PE, CH2M HILL,
Lisa Kellogg, PE, ARCADIS, Inc.,
Aaron Yue, Project Manager, DTSC

File: WDID No. 7B 36 2186 001, PG&E Topock Compressor Station,
Board Order No. R7-2007-0015

-----Original Message-----
From: Meeks, Yvonne J [mailto:YJM1@pge.com]
Sent: Monday, August 04, 2008 4:12 PM
To: Robert Perdue; Cliff Raley; Tom Vandenberg
Cc: Gilbert, David; Doss, Robert; Jayo, Juan (Law); Kellogg, Lisa; Robert Lucas
Subject: PGE Uplands ISPT Reagent Dosing

Robert and all -- Per the attached letter from the RWQCB, we are providing this notice that PG&E intends to re-start ethanol dosing in uplands pilot study well PTR-2 at a rate of between 15 and 45 gallons per day (a reduction from the 100 gallons per day specified in the WDR).

As you recall, with your approval, we temporarily discontinued reagent injection in both injection wells in late May. At that time, we proposed to evaluate the data results and make a recommendation for the restarting reagent dosing. PG&E has evaluated the recent monitoring data and intends to begin recirculation with ethanol dosing in PTR-2 within the next week. PG&E will continue to review the data and plans to make a recommendation regarding dosing in PTR-1 at the end of August.

We will continue to keep the RWQCB informed. Let me know if you have any questions.

Yvonne Meeks

From: Meeks, Yvonne J [mailto:YJM1@pge.com]
Sent: Thursday, October 23, 2008 4:07 PM
To: Robert Perdue; Tom Vandenberg; Cliff Raley
Cc: Gilbert, David; Doss, Robert; Robert Lucas; Ayue@dtsc.ca.gov; Christopher Guerre
Subject: Topock - Notification request to the RWQCB regarding Uplands dosing

Robert --

In accordance with the attached letter from the RWQCB, we are providing this notice that tomorrow, October 24, PG&E intends to increase the ethanol dosing in uplands pilot study wells , PTR-1 and PTR-2 , to a rate of 100 gallons per day for each well. We are essentially going back to the injection rate as was originally specified in Board Order No. R7-2007-0015. You will recall that we had decreased the rate back in August to 15-45 gallons per day.

Looking ahead, weplan to complete the ethanol dosing on November 6, the final day per the WDR permit. After that we will just be recirculating groundwater until December 3rd , also consistent with the WDR. Since these timeframes are consistent with the timeframes in the WDR permit, these completion activities didn't require notification, but I thought you might like to know that we are finishing up another (successful) pilot test.

Let me know if you have any questions, Yvonne

Preston, Kelli Jo

From: Meeks, Yvonne J [YJM1@pge.com]
Sent: Monday, November 24, 2008 8:57 PM
To: Robert Perdue; Tom Vandenberg; Cliff Raley
Cc: Aaron Yue; Kellogg, Lisa; Sullivan, Kevin M; Doss, Robert; Gilbert, David
Subject: Notification regarding PG&E Topock Uplands pilot test
Attachments: Appendix A-Communications.pdf

Robert --

In accordance with the attached letter from the RWQCB, we are providing this notice that PG&E intends to modify the flow pattern in uplands pilot study well PTR-2 to perform a hydraulic extraction test. PTR-1 will be brought off-line and the recirculation pattern in PTR-2 will be reversed. This reversal will be allowed to run for 4-6 hours to evaluate the extraction capacity of the well. Once the 4-6 hour test is complete, the downhole equipment will be removed. As specified within Board Order No. R7-2007-0015, the pilot will be concluded on December 3rd, after 9 months of operation.

Let me me know if you have any questions regarding this email or any other aspect of the uplands test.

Yvonne Meeks

Appendix **B**

Hydrology Addendum

PG&E Topock Compressor Station
Needles, California

Appendix B

Hydrologic Analysis

Upland Reductive Zone In-Situ Pilot Test
Final Completion Report

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1. Introduction

Pacific Gas and Electric (PG&E) has implemented the Upland reductive zone in-situ pilot test (ISPT) at the Topock Compressor Station (the Site) near Needles, California. The purpose of the ISPT is to evaluate the efficacy of a recirculation system for distribution of ethanol to reduce hexavalent chromium (Cr[VI]) in groundwater. The Upland ISPT consists of the recirculation of the reagent mixture (referring to ethanol (measured as total organic carbon) and tracers (fluorescein and Rhodamine WT)) between two recirculation wells (PTR-1 and PTR-2) completed with dual screens and monitoring the results in the surrounding groundwater monitoring well network. Figure 2 in the main body of this report shows the layout of the recirculation wells and their groundwater monitoring well network, which includes PT-7 Shallow/Middle/Deep (S/M/D), PT-8 S/M/D, PT-9 S/M/D, MW-11, MW-24 A/B and MW-38 S/D.

Hydraulic testing of the dual-screen recirculation wells was conducted prior to the operation of the recirculation and reagent injection system from March 5, 2008 to December 3, 2008. This appendix presents the results and detailed analysis of the hydraulic testing and operation of the recirculation and reagent injection system. In addition, a groundwater flow and solute transport model was developed for analysis of recirculation hydraulics and optimization of recirculation performance. The construction of the model and results of modeling analysis are also presented in this appendix.

As the first step in the ISPT, hydraulic testing was conducted in February and March 2008 to evaluate well performance and measure hydraulic parameters of the aquifer. Specific goals of hydraulic aquifer testing at the upland pilot test site were:

- To further develop the pumping intervals of PTR-1 and PTR-2 in order to optimize well performance,
- To test well capacities for pumping and injection of groundwater by completing step-extraction tests for both wells,
- To characterize the hydraulic performance of wells PTR-1 and PTR-2 during extraction and reinjection by operating each well individually and collecting flow-rate and water-level data that describe the resulting flow system,

- To characterize the hydraulic performance and resulting flow system when wells PTR-1 and PTR-2 are operated in tandem, and,

- To identify appropriate sustainable recirculation rates for subsequent reagent mixture recirculation tests.

A preliminary groundwater flow and solute transport model was developed in the ISPT design phase. With additional information obtained from the hydraulic aquifer testing and the continuous operation of the recirculation system and tracer testing conducted during ISPT, a more detailed groundwater and solute transport model was re-developed. Specific objectives of the groundwater flow and transport model were:

- To provide a conceptual model of recirculation hydraulics,

- To characterize the reagent distribution between the two recirculation wells and the resulting performance data in the groundwater monitoring well network,

- To assist in optimizing the ISPT operation, in order to improve the reagent distribution in the subsurface, and,

- To further evaluate different recirculation well configuration alternatives for full-scale in situ reactive zone (IRZ) remediation system design.

2. Hydraulic Aquifer Testing

2.1 Hydrogeologic Setting

The Site is characterized by arid conditions with precipitation averaging less than 5 inches per year and high temperatures. The ISPT area is located in an upland area, near the Topock Compressor Station, where the topography is generally steep. There is an abrupt decline in elevation towards the Colorado River floodplain.

Groundwater at the Site occurs under unconfined to semi-confined conditions within alluvial fan and fluvial sediments. The saturated portion of the alluvial fan and fluvial sediments are collectively referred as the alluvial aquifer. In the floodplain area adjacent to the Colorado River the fluvial deposits interfinger with, and are hydraulically connected to, the alluvial fan deposits. The unconsolidated alluvial and fluvial deposits are underlain by Miocene conglomerate and pre-Tertiary metamorphic and igneous bedrock.

The water table has a very flat slope at the ISPT area and is about 455 ft above mean sea level (AMSL). Hydraulic gradients across the pilot test area are low, generally between 0.0001 to 0.001 feet per foot (ft/ft). The measured saturated thickness of the alluvial aquifer at the upland pilot study site area is approximately 113 feet at MW-24 BR. Lithologic logs and hydraulic testing suggest that the alluvial materials undergo facies changes across the Site and that the lower portion of the aquifer (lower 35 feet) is expected to have a lower hydraulic conductivity. Additionally, some inter-fingering of coarser material is observed throughout the sediments (CH2M Hill, 2005).

2.2 Test Well Characteristics

Recirculation wells PTR-1 and PTR-2 are located 140 feet laterally from each other. Each well is completed with dual screens and associated piping, packers and pumps to extract groundwater through one of the screens and re-inject this water to the aquifer through the other screen. As constructed, PTR-1 extracts groundwater from the shallow well screen and injects groundwater into the deep well screen. Extraction and injection intervals are reversed in PTR-2. Packers and bentonite seals are used between well screens to restrict vertical flow in the well bore from one screen interval to the other. Treatment reagents can be added to the groundwater in the well casing between the packers or in a vault at the well head so that the water being forced back into the aquifer through the well screen contains treatment reagents.

Screen intervals in PTR-1 and PTR-2 were selected on the basis of geologist logs were placed across sandy strata in shallow and deep portions of the aquifer. Figure 4 in the main body of this report shows a cross-section of the recirculation well-layout. Both wells have a twenty five foot screen interval near the top of the saturated portion of the aquifer and 30 feet of screen in the lower portion of the aquifer. The screen sections are separated by 15 feet of solid well casing and the bottom screen interval ends near bedrock.

Airline tubing was installed into each of the upper and lower well intervals except the lower (extraction), interval of well PTR-2. The airlines were installed for measuring water levels or hydraulic head pressures in each of the intervals. Hydraulic head measurements in the pumping and injection wells were made by manometer/air pressure measurement of the displacement of water from the airline tubing installed in the upper and lower screened intervals of well PTR-1 and in the upper interval of well PTR-2. Non-vented transducer/data loggers were placed in pressure vessels in the airline circuits to measure and record pressures. The lower pumping interval of well PTR-2 does not have an airline installed so no hydraulic head pressure readings were possible.

2.3 Testing Protocol, Data Collection, and Observations

Hydraulic aquifer tests were completed during February and March, 2008. Tests included two step-extraction tests, two single-well recirculation tests and one dual-well recirculation test. Step extraction tests were conducted separately for the shallow screen interval of PTR-1 and the deep screen interval in PTR-2. Water pumped during these tests was retained at land surface and transported by truck to the water storage tanks at IM-2 under the direction of PG&E. The single-well recirculation tests extracted groundwater from the selected screen intervals and re-injected it into the corresponding injection interval of the same well. During the dual-well recirculation test, both PTR-1 and PTR-2 were operated simultaneously at the same extraction/injection rate. In addition to collecting data to characterize well hydraulics, these tests also served to initiate system start up and shake downs procedures.

Water level data were collected at monitoring wells during each test and during subsequent periods of water-level recovery. Water-level changes were measured in monitoring wells using twelve pressure transducers with vented cables and data loggers. Pressure transducers were deployed in monitoring wells MW-11, MW-24A, MW-24B, PT-7S, PT-7M, PT-8S, PT-8M, PT-8D, PT-9S, PT-9M, and PT-9D. Water level changes in recirculation wells were monitored using two non-vented transducers equipped with data loggers. An additional pressure transducer was used to collect barometric pressure readings. Baseline data collection started on February 5, 2008. These data were collected to establish long-term regional trends that may affect test interpretation, and to estimate barometric efficiency of wells and storage coefficient of the aquifer.

2.3.1 Step Extraction Tests

The step extraction tests were conducted such that the extraction rate was increased stepwise periodically through the test. Each pumping rate was maintained until the drawdown in the well stabilized and the water being produced was very clear (low turbidity), or until a maximum time of 2-hours has been reached. The pumping rate during any portion of the test was not allowed to deviate by more than ±10 percent of the initial pumping rate; if a deviation occurred, efforts were quickly made to restore the appropriate pumping rate. Extracted groundwater was containerized at the land surface in temporary holding tanks for later transportation and storage at the IM-2 treatment facility.

The step extraction tests were performed February 6 to 7, 2008. Extraction from the shallow screen interval of PTR-2 occurred on February 6, 2008. Extraction from the deep screen interval of PTR-1 occurred following day. Water-level data for the PTR-1 step-extraction test are plotted in Figure B-1.

The rate steps for the PTR-2 test were approximately 6 gallons per minute (gpm, 85 minutes), 13.25 gpm (75 minutes), 25 gpm (65 minutes), and 36 gpm (70 minutes). A total of 6810 gallons of groundwater were extracted from PTR-2. Rate steps for the PTR-1 test were approximately 5 gpm (125 minutes), 10 gpm (94 minutes), 21 gpm (73 minutes), and 40 gpm (54 minutes). A total of 5,490 gallons of groundwater were extracted.

2.3.2 Single Well Recirculation Tests

The single-well recirculation tests occurred on February 14th for PTR-2 and February 26th for PTR-1. Water extracted from one well screen was re-injected simultaneously in the other well screen within the same well. The single-well recirculation tests were conducted in a stepwise fashion and extraction rates were measured. Injection rates are assumed to equal extraction rates. Rate steps for the PTR-2 test were approximately 7 gpm (130 minutes), 15 gpm (88 minutes), 30 gpm (142 minutes), and 40 gpm (110 minutes). Rate steps for the PTR-1 recirculation test were approximately 10 gpm (109 minutes), 25 gpm (98 minutes), and 38 gpm (71 minutes).

During the PTR-2 test, water levels in deep and middle screen intervals of monitoring wells decreased while water levels in shallow wells increased (Figure B-2).

Groundwater levels after recovery are slightly higher that initial conditions. During the PTR-1 test, water levels decreased in the shallow wells and increased in the middle and deep screened wells (Figure B-3). Water levels in MW-11 show a slight drawdown over the testing period. Depth-to-water measurements were collected from the shallow screen interval of PTR-1 during this single well recirculation test. The pump was inoperable for a few minutes at approximately 167 minutes after the test began and the final step was initiated. The data from the PTR-1 single well recirculation test is relatively free of anomalous noise.

2.3.3 Dual- Well Recirculation Tests

The dual-well recirculation test was conducted shortly after the end of the PTR-1 single well recirculation test. As a result, water level recovery had not fully stabilized prior to the initiation of the dual-well recirculation test. The dual-well recirculation test was initiated on February 27 and was terminated on March 1, 2008. Both PTR-1 and PTR-2 were operated simultaneously for approximately 72 hours. Recirculation rates for the two wells were monitored and were not identical. The rates used at PTR-1 were 23 gpm, 15.5 gpm, and 30 gpm. The rates used at PTR-2 were 29 gpm, 23 gpm, and 30 gpm. Adjustments to the flow rates were done as needed and these times do not coincide between wells. No pressure transducer data was collected for PTR-1 or PTR-2 but depth to water in the shallow screen of PTR-1 was collected. Water level data for monitoring wells are plotted in Figure B-3, along with the PTR-1 single well recirculation test data.

2.4 Test Results and Analysis

2.4.1 Step Extraction Test Data

Step extraction test data have been interpreted by analytical-solution techniques using the AQTESOLV aquifer-testing software (HydroSOLVE, 2006). Analytical solution techniques typically require simplifying assumptions regarding aquifer property homogeneity and boundary conditions while numerical models can be used to address more complex aquifer heterogeneity. Nevertheless, as a preliminary method for data interpretation, AQTESOLV provides a valuable tool for assessing the test results. This type of analysis provides initial estimates of aquifer properties that can be refined using more sophisticated methods such as numerical modeling.

During both step-extraction tests, aquifer property estimates obtained from water-level changes in the pumping wells are not considered to be as useful as estimates obtained from water-level changes in monitoring wells due to well losses, turbidity and groundwater entry velocity across the screens. Therefore, only observation well data have been used for the analysis.

Data collected during the PTR-2 step-extraction test was imported to the AQTESOLV program and estimates of transmissivity (T) and storage coefficient (S) were made. The current geologic framework suggests that the alluvial aquifer functions as a deep unconfined system. Therefore the Moench unconfined solution technique was used for data analysis (Duffield, 2007). This solution is applicable to partial penetrating wells with well bore storage and skin effects in an unconfined, homogeneous anisotropic aquifer with delayed gravity yield. The aquifer was assumed to be 120 feet in saturated thickness; the height of the water column above bedrock.

Table B-1 displays the estimates for T, S, and hydraulic conductivity (K) during the PTR-2 extraction pump test. Well MW-11 did not respond significantly during the PTR-2 step extraction pump test; therefore no estimates of T or S could be made. However, it does provide a useful background well for monitoring regional trends in water level during the test.

Plots of the drawdown (data not shown) at each step extraction rate indicate the maximum drawdown occurred in wells close to the pumping well and, on average, decreased with distance. The maximum drawdown near the end of the final step extraction rate is plotted as a function of well distance from PTR-2 (Figure B-4). This plot shows that there is generally good correlation between distance and drawdown in the shallow monitoring well network. The plot also shows that well nests PT-8 and PT-9 have a larger range in drawdown relative to the PT-7 nest. Differences in water-level response at well nests are attributed principally to spatial variations in aquifer geometry and/or faces changes.

Table B-1 Aquifer Property Estimates Obtained From the PTR-2 Step Extraction Test

Well	Average Barometric Efficiency	Storage Coefficient		Transmissivity (ft^2/day)	Hydraulic Conductivity (ft/day)
		Barometric Efficiency	Step-Extraction Test		
MW-11	0.56	9.23E-05	NA	NA	NA
MW-24A	0.60	8.61E-05	4.1E-07	927	8
MW-24B	0.76	6.80E-05	3.2E-05	78,000	650
PT-7S	0.55	9.39E-05	1.6E-06	8,473	71
PT-7M	0.72	7.18E-05	2.7E-05	110,000	917
PT-7D	0.69	7.54E-05	3.8E-05	151,000	1,258
PT-8S	0.57	9.06E-05	1.8E-06	7,184	60
PT-8M	0.68	7.60E-05	2.1E-05	51,000	425
PT-8D	0.74	6.98E-05	3.3E-05	78,000	650
PT-9S	0.59	8.76E-05	1.2E-06	10,450	87
PT-9M	0.63	8.20E-05	1.3E-05	75,700	631
PT-9D	0.65	8.01E-05	1.5E-05	92,000	767

2.4.2 Single-Well Recirculation Test Data

Water level data collected during the single-well recirculation tests reflect the more complex distribution of extraction and injection used. During the PTR-1 test, groundwater was extracted from the shallow screen and injected in the lower screen interval. Water levels in wells screened in shallow strata of the aquifer show declines while water levels in wells screened in deeper strata generally show increases. During the PTR-2 test these trends were reversed, reflecting extraction from the deep screen interval of PTR-2 and injection in the shallow screen interval.

Water level data from prior to the initiation of the test, near the end each step and after recovery was used to generate plots of drawdown versus flow rate and drawdown versus distance from the recirculation well. The drawdown-rate plots showed no large changes in rates of drawdown with increased pumping in either test (plots not shown). This indicates that the larger recirculation rates used during the tests are suitable for use in longer term testing. Plots of drawdown with distance display larger changes in head near the well and smaller changes farther from the well (Figures B-6 and B-7). The x-axis has been reversed in the plot of PTR-2 test results (Figure B-7) to facility comparisons between the two figures. The viewed by facing north, PTR-2 is to the right of PTR-1.

Figures B-6 and B-7 show that groundwater extraction occurred in the shallow screen interval at PTR-1 and in the deeper screen interval in PTR-2. Hydraulic gradients across the pilot test area are between 0.0001 to 0.001 ft/ft. At a distance of approximately 75 feet, pumping at PTR-1 (approximately 20.6 gpm) caused approximately 0.1 feet of drawdown in the shallow zone, an increase of 0.1 feet in the middle wells and an increase of 0.4 feet in the deep screened wells. At a distance of approximately 75 feet, pumping at PTR-2 (approximately 40 gpm) caused an increase of approximately 0.2 feet in water levels in the shallow zone, a decrease of 0.3 feet in the middle wells and a decrease of 0.6 feet in the deep screened wells.

Data from the single well recirculation tests have not been interpreted using the analytical-solution techniques because they are limited in ability to address simultaneous extraction and injection in different strata of a three-dimensional flow system. More sophisticated semi-analytical and/or numerical modeling techniques are more appropriate for further analyses, as presented in Section 3.4.

2.4.3 Dual-Well Recirculation Test Data

Water level data collected during the dual-well recirculation test reflect the complex distribution of extraction and injection used. During the test, groundwater was extracted from the shallow screen and injected in the lower screen interval of PTR-1. At the same time, groundwater was extracted extraction from the deep screen interval of PTR-2 and injection in the shallow screen interval. Test duration was approximately 48 hours, much longer than the duration of the previous tests. Plots of drawdown versus distance from recirculation well show trends that were generally similar to those obtained during single-well tests (data not shown).

Vertical gradients throughout the test were calculated at the well clusters PT-7, PT-8 and PT-9 (Figure B-7). Gradients were calculated between the deep and middle screened wells and between the middle and shallow wells. The top-of-casing elevations used in calculated vertical gradients are approximate. Figure B-7 is useful in understanding the relative responses of observation wells and how responses changed during the test. Specifically, the results are useful in understanding the three-dimensional flow patterns that are expected to develop during a long term test. The plot shows that pre-test vertical gradients are altered in magnitude or even reversed at some locations once recirculation began. Strong vertical gradients near the PT-7 series wells were observed; however, these gradients reduce in magnitude relatively quickly. This observation was further confirmed in the modeling analysis of the recirculation hydraulics.

3. Groundwater Flow and Transport Model Construction

Upon the completion of the aquifer testing analyses and the on-going ISPT operation, an updated groundwater flow and solute transport was developed to evaluate the observed reagent distribution in the subsurface and to optimize the operation to improve the reagent delivery to the stagnation zone in the current ISPT recirculation system.

Model construction is the process of transforming the descriptive features of the conceptual model into their numerical or mathematical equivalents. This section describes the construction of the groundwater flow and transport model for the ISPT. The primary phases in the development of a numerical groundwater flow model included the construction of a finite-difference grid for the model area, specification of model layer top and bottom elevations, assignment of boundary conditions, specification of hydraulic parameter values and zones, and finally selection of appropriate water levels and/or aquifer testing for calibration of the model. These main features form the basis for subsequent calibration of the numerical model and are discussed below.

3.1 Model Code Selection

The groundwater model was developed using the numerical code MODFLOW-SURFACT (HydroGeologic, 1996), which is a comprehensive three-dimensional flow modeling code based on the United States Geological Survey (USGS) modular groundwater flow code MODFLOW (MacDonald and Harbaugh, 1988). MODFLOW-SURFACT is functionally identical to the standard MODFLOW code with several enhancements for improved handling of unsaturated cells and pumping wells.

MODPATH (Pollock, 1989) was also utilized in the modeling effort to conceptually depict the recirculation hydraulics in the ISPT recirculation system. MODPATH is a particle tracking post-processing package that was developed to three-dimensional flow paths using output from groundwater flow simulations. It uses a semi-analytical tracking scheme that allows an analytical expression of the particle’s flow path to be obtained within each finite-difference grid cell. Particle paths can be used to demonstrate the reagent migration over the operational period.

3.2 Model Code Description

MODFLOW-SURFACT is a three-dimensional finite-difference code that can simulate variably saturated groundwater flow and solute transport. This code is based on the widely popular USGS modular groundwater flow code MODLFOW. MODFLOW-SURFACT is fully compatible with standard MODLFOW but has several computational modules that overcome limitations associated with MODFLOW such as re-saturation of drained cells. Detailed description of MODFLOW-SURFACT capabilities, mathematical formulation, and model verification can be found in its user’s manual.

MODFLOW simulates transient, three-dimensional groundwater flow through porous media described by the following partial differential equation for a constant density fluid:

$$\frac{\partial}{\partial x}\left(K_{xx}\frac{\partial h}{\partial x}\right)+\frac{\partial}{\partial y}\left(K_{yy}\frac{\partial h}{\partial y}\right)+\frac{\partial}{\partial z}\left(K_{zz}\frac{\partial h}{\partial z}\right)-W=S_s\frac{\partial h}{\partial t} \qquad (3\text{-}1)$$

where:

K_{xx}, **K_{yy}** and **K_{zz}** are values of hydraulic conductivity along the x, y, and z coordinate axes, which are assumed to be parallel to the major axes of hydraulic conductivity [L/T];

h is the potentiometric head [L];

W is a volumetric flux and represents sources and/or sinks of water [1/T];

S_s is the specific storage of the porous material [1/L]; and,

t is time [T];

In Equation 3-1, the hydraulic parameters (i.e., K_{xx}, K_{yy}, K_{zz} and S_s) may vary in space but not in time while the source/sink (W) terms may vary in both space and time.

The solute transport modeling approach utilizing the classical, Fickian advection-dispersion transport equation for a contaminant solute in single domain was used (Freeze and Cherry, 1979); namely

$$\theta\frac{\partial C}{\partial t}=\frac{\partial}{\partial x_i}(\theta D_{ij}\frac{\partial C}{\partial x_j})-\frac{\partial}{\partial x_i}(q_i C)+q_s C_s \qquad (3\text{-}2)$$

where C is the solute concentration, θ is the porosity, t is time, x_i is the horizontal coordinate (east-west direction), x_j is the transverse coordinate (north-south direction), D_{ij} is the dispersion coefficient tensor, q_i is the Darcy flux, q_s is the fluid source/sink, and C_s is the concentration of fluid source/sink. The classical advection-dispersion model is also called a single-domain model because aquifer properties within each model cell are represented by single values.

3.3 Model Domain and Grid

The model domain and grid is shown in Figure B-8. The boundaries of the model grid were set at a significant distance from the pilot test location to minimize the influence of model boundaries on simulation results. The horizontal grid cell spacing was based on the size of the area of interest, the total area of the model domain, and the degree of accuracy and precision needed. The model grid was rotated 30 degrees clockwise to align the grid cells in the direction of groundwater flow at the Site. The finite-difference grid is composed of 302 columns, 281 rows, and 14 layers for a total of almost 1.2 million active nodes. The model grid was refined in the vicinity of the pilot test area to get a more accurate analysis of groundwater flow and solute transport. In the vicinity of the recirculation system, the grid spacing is as small as 2-ft by 2-ft. As distance from the ISPT area increases, the grid grades up to 25 ft spacing near the model boundaries. Particularly, the model is vertically discretized into 14 layers, as shown in the model hydrostratigraphic structure Figure B-9. It should be noted that the alluvial aquifer thins and pinches out to the south of the pilot tests area. The model domain represents the approximate location of the alluvial aquifer pinch-out to the south with a no-flow boundary. The model assumes a uniformly aquifer thickness, however sensitivity testing confirmed that hydraulic behavior in the pilot test area is minimally sensitive to the aquifer boundary because it is so distal, therefore, the simplified representation of aquifer geometry is appropriate.

This fine vertical discretization is necessary not only to better represent the significant hydrostratigraphic layers identified in the geological logs, but also to minimize numerical dispersion in the vertical direction, and provide an accurate representation in the evaluation of connections between dual screens within each recirculation well.

3.4 Hydraulic Parameters

CH2M Hill has developed a numerical groundwater flow model of the entire Site. Although model development is ongoing, preliminary estimates of hydraulic conductivity in alluvial aquifers were provided by personal communication (Fritz Carlson, CH2M Hill). The horizontal hydraulic conductivity (K_h) and vertical hydraulic conductivity (K_v) for the upper alluvial aquifer are estimated at 35.2 and 3.52 feet per day (ft/day), respectively, which results in an anisotropy of 0.1 (ratio of K_v to K_h). For the lower alluvial aquifer, the horizontal and vertical hydraulic conductivities are 24.77 and 0.22 ft/day. The anisotropy in the lower alluvial aquifer is more significant compared to the upper alluvial aquifer, with a value of 0.009.

Furthermore, CH2M HILL analyzed the aquifer data obtained from the hydraulic aquifer testing from February 6 to March 1, 2008 using MLU (Multi-Layer Unsteady State), a Windows application for the analysis of aquifer tests in layered system. MLU was used to estimate hydraulic parameters based on a best fit semi-analytical solution. This software was designed for analysis of transient well flow in layered aquifer systems and stratified aquifers. The semi-analytical algorithm computes the transmissivity of each layer and the vertical resistance between layers. MLU allows for multiple injection/extraction wells with multiple injection/extraction screen interval, which are the characteristics of the ISPT.

Based on the MLU analysis, the difference in transmissivities between the upper alluvial aquifer and the lower alluvial aquifer was not distinguishable. The estimated transmissivities are 4477, 3704 and 926 ft^2/day, for the upper alluvial aquifer, lower alluvial aquifer and bedrock aquifer, respectively. The corresponding hydraulic conductivity values for these three aquifers were estimated to be 89.5, 92.6 and 35.6 ft/day, respectively.

These estimated alluvial aquifer permeability values, combined with the hydraulic conductivity estimates obtained from AQTESOLV analyses from the aquifer testing, were used as the initial hydraulic parameters in the model. Due to the small areal model domain, a uniform hydraulic conductivity value was applied within each layer. These values were adjusted within reasonable ranges to minimize the difference between observed and simulated groundwater drawdown during the aquifer testing calibration. The calibrated K distribution is shown in Figure B-9.

3.5 Boundary Conditions

Boundary conditions must be imposed to define the spatial boundaries of the top, bottom and all sides of the model grid. Additionally, boundary conditions can be assigned to represent different types of physical features, depending on the rules that govern groundwater flow related to the feature. A constant head boundary is a specified head boundary that is assigned a head value that does not vary throughout the simulation. Constant head boundaries were applied to the west and east of model domain in layers 1 through 14, with their values interpreted from average groundwater elevations in shallow wells and river elevation February through April (CH2M HILL 2008b). The constant head boundaries resulted in an applied average horizontal hydraulic gradient of 0.0008 (no ambient vertical hydraulic gradient was assumed).

4. Flow and Transport Model Calibration

Calibration of a groundwater flow model encompasses the process of adjusting model parameters to obtain a reasonable match between observed and model-simulated water levels/drawdown and flows. In general, model calibration is an iterative process that involves variation of hydraulic properties or boundary conditions to achieve the best match between observed and simulated water levels or flows. During model calibration, model parameters are varied over a narrow range set by site-specific data using the conceptual model as a guide.

The model was quickly calibrated to steady-state conditions, qualitatively to match the limited water levels observed in the monitoring well network prior to the start of ISPT. This process was fairly straightforward because the model upgradient and downgradient were bounded by observed constant head values. The major efforts in modeling calibration were focused on the aquifer testing.

4.1 Aquifer Testing Calibration

The groundwater flow model was further calibrated to the single-well PTR-1 recirculation test (February 26, 2008), as part of the calibration procedure. Single well recirculation test at PTR-1 test was selected for calibration, because the data from this test is relatively free of anomalous noise.

The simulated drawdown was compared to the observed drawdown in the monitoring well network, and the storage coefficient and hydraulic conductivity were adjusted to obtain a reasonable fit. Figure B-10, B-11 and B-12 present the simulated drawdown, along with the observed drawdown, for PT-7S, PT-8S, PT-7M, PT-8M, PT-7D and PT-8D, respectively. As demonstrated in these figures, the simulated and observed values match well, indicating that the hydraulic parameters represent the hydrogeological settings at the ISPT area very well. The finalized hydraulic parameters are shown on Figure B-9.

There are two important observations in the hydraulic parameter calibration. First, the calibrated K distribution shows that the permeability in the deep aquifer zone is significantly lower compared to that in the shallow aquifer zone. Second, the calibrated ratio of K_v to K_h is 0.75 for each layer, which is higher than anticipated at the ISPT area. These two observations in the aquifer testing calibration suggest that there is more significant vertical flow at PTR-1 than expected, due to the fact that the system was designed on an assumption that the anisotropy ratio of K_v to K_h is in the range of 0.1. This concept was further verified in the following tracer test calibration.

4.2 Tracer Calibration in the Continuous Recirculation Test

To further calibrate the hydraulic parameters in the model domain and verify the insignificant anisotropy at the ISPT area, transport model simulations were carried out. Monitoring data from tracer fluorescein injection into PTR-1 deep well screen for the first 30 days of the ISPT was utilized for this purpose.

4.2.1 Tracer (Fluorescein) Distribution

Fluorescein was injected into PTR-1 deep well screen for the first 30 days of the ISPT and the target concentration in the aquifer was 0.8 milligrams per liter (mg/L). The resulting fluorescein concentrations in the monitoring well network were measured during the operational period and the normalized fluorescein concentrations (observed concentrations divided by the target concentration) concentration trend graphs are presented in Figures 7 through 22 in the main body of the report.

The key observations in the tracer distribution in the subsurface are as follows:

- Higher than expected concentrations were detected at PT-7M and PT-7D on the very first day of ISPT injection, with their calculated normalized concentrations at 1.44 and 1.43, respectively.

- Significant breakthrough of tracer was observed at PT-7S, PT-7M, PT-7D, and PT-8S. Peak breakthrough concentrations were much higher than the target concentrations at PT-7M and PT-7D. The calculated normalized peak breakthrough concentrations for PT-7M and PT-7D were 9.8 and 7.6, respectively.

- Low concentrations of fluorescein were detected at PT-8M, PT-8D, PT-9S, PT-9M and PT-9D, especially at the end of the nine months of operation, when the recirculation rate at PTR-2 was increased to 30 gpm to 40 gpm.

4.2.2 Recirculation Hydraulics

In the original conceptual model, which assumed relatively a homogeneous permeability distribution and an anisotropy ratio of approximately 0.1, the horizontal distribution of reagent was expected to be much more significant than vertical distribution. Groundwater amended with reagents and injected into the deep zone at PTR-1 was expected to primarily migrate to the deep extraction interval at PTR-2. Similarly, groundwater amended with reagents and injected into PTR-2 shallow was expected to primarily migrate to PTR-1 shallow extraction screen interval. However, the actual distribution of reagent mixture observed during the pilot test showed much more significant vertical flow and reagent distribution, which indicates that the actual vertical anisotropy was much less than what was originally assumed, and the permeability distribution is more heterogeneous than what was assumed in the design simulations.

The conceptual model was modified to reflect the observed insignificant anisotropy and more heterogeneities at the ISPT area (Figure 4 of the main body of this report). At PTR-1, the majority of the injected reagent mixture at the deep screen interval was re-circulated back to the extraction screen interval at shallow zone, as illustrated the thick flow line extending from PTR-1 deep to PTR-1 shallow. A small portion of the injected reagent mixture into PTR-1 deep migrated to the PTR-2 deep, as represented by the thin line extending from PTR-1 deep towards PT-8D.

At PTR-2, injection occurred at the shallow screen interval, where the permeability is high. Because of the much higher permeability of at the shallow aquifer zone, a portion of the reagents injected migrated towards PTR-1 shallow, as shown by the flow line extending from PTR-2 shallow towards PT-7S. As at PTR-1, due to the low anisotropy and more vertical heterogeneities at the area, there was a strong vertical connection. The majority of the injected reagent at PTR-2 shallow was re-circulated back to the top of the deep screen interval. This is illustrated by the thick flow line extending from PTR-2 shallow towards the middle aquifer zone and the top of deep aquifer zone. Compared to PTR-1, less self-recirculation was observed at PTR-2 because injection occurred at the higher permeable shallow zone.

4.2.3 Model Calibration of Recirculation Hydraulics and Tracer Distribution

The re-developed model simulation was calibrated to the field measured tracer data from the nine months of continuous recirculation system operation, to verify the modified recirculation hydraulics and estimate the effective porosity.

Based on the tracer distribution observations at PT-7M, it was inferred that this well was located in the migration pathway between PTR-1 shallow and PTR-1 deep. The injected reagents accumulated within PTR-1 over the operational time because of the strong vertical connections between the shallow and deep well screens. The high reagent concentrations observed at PT-7M represented the actual reagent concentrations re-circulating between PTR-1 shallow and PTR-2 deep. Therefore, the tracer concentration trend graph observed at PT-7M was applied in the model as the injection concentrations. An effective porosity of 0.35 was used in the model simulation. Note that the dual-domain mass transfer model of Zheng and Wang (Zheng and Wang, 1999) was not used in the solute transport model because minimal tailing was observed in the actual tracer breakthrough curves and that a dual-domain approach to solute transport was not necessary to closely simulate tracer behavior.

The model simulation results are shown in Figure B-13, for representative monitoring locations PT-7M, PT-7D. As shown in the figure, the model simulated concentrations provide a reasonable fit to the observed field data.

The modified conceptual model was then further verified and the solute transport model was calibrated as described below. Meaningful breakthrough times were interpreted based on the tracer data and geochemistry data measured in the monitoring wells. They were then compared with the model simulated breakthrough times and the comparison are shown in the following table (Table B-2). As shown in the table, the simulated breakthrough times match closely with the interpreted breakthrough times, suggesting the applied flow and transport parameters represent the field conditions well.

Table B-2. Observed Versus Simulated Groundwater Travel Times

Well	Field Observation of Travel Time (days)	Model Simulated Travel Time (days)
PT-7S	54	54
PT-7M	<7	2
PT-7D	<7	5
PT-8S	8 (PTR-2)	NA
PT-8M	168	54
PT-8D	70	79
PT-9S	252	228
PT-9M	141	199
PT-9D	NA	NA
MW-24A	<7 (PTR-2)	NA

NA- Not Applicable

4.2.4 ISPT Tracer Distribution Analysis

After the model calibration, pathline analysis was used to demonstrate the ISPT recirculation hydraulics from March through December 2008 and reagent mixture distribution in the subsurface. The simulated flow path results are shown in Figure B-14 and Figure B-15, for PTR-1 and PTR-2, respectively.

On Figure B-14, panel A presents the plan view of reagent migration paths in the shallow, middle and deep aquifers, and panel B shows the cross-section view of reagent migration paths. At PTR-1, as shown in panel B, the majority of the injected reagent mixture at PTR-1 deep screen interval migrated upward and re-circulated back to PTR-1 shallow. Groundwater was then extracted, dosed with amendment and re-injected into PTR-1 deep, which led to a reagent/mixture accumulation in PTR-1. PT-7M and PT-3D are located on the re-circulation path of the reagent mixtures in the vicinity of PTR-1. This partially explained the elevated reagent concentrations observed at PT-7M and PT-7D. A second factor that contributed to the high observed reagent concentrations at PT-7M and PT-7D was the impulse dosing strategy. The reagent was dosed at a concentration of 24 times of the target concentration. Due to the short distance between PT-7 and PTR-1, the reagent was not completely mixed because of the short arrival time at PT-7M and PT-7D (shown in panel A). Reagents arrived at PT-8D, yet no arrival at PTR-2 deep, because of the lower permeability in the deep aquifer.

At PTR-2, the reagent injection occurred at the shallow screen interval, where the permeability is high. As shown in the panel B on Figure B-15, the majority of reagents migrated out and re-circulated back to the middle aquifer zone and the top deep aquifer zone. Some particles (shown in panel A on Figure B-15) migrated across PT-8S and arrived at PT-7S. This was consistent with tracer (Rhodamine WT) detection at PT-8S and PT-7S. The farther migration distance observed at PTR-2 compared to that at PTR-1 was due to the higher permeability at the shallow aquifer zone. The third destination for the reagents injected at PTR-2 shallow was downgradient migration (shown in panel A on Figure B-15). The reagents injected at PTR-2 were not completely captured by the ISPT recirculation system. This explains the Rhodamine WT detection at PT-9S, along with other geochemical indicators of breakthrough observed at PT-9S.

5. Model Application

5.1 Optimizing ISPT operations

One objective of the re-developed model was to optimize the ISPT operation. There was no detection at PT-8M and PT-8D after 6 months of operation, although they are located only 75 ft away from PTR-1 and PTR-2. As previously discussed, this is because a higher-than-expected fraction of the injected reagent mixture was re-circulated vertically back to the extraction well screen. In order to improve the reagent distribution to PT-8M and PT-8D, the model was utilized to evaluate potential operation changes and make recommendations for the remaining months of operation.

Possible options considered for improving distribution in the deep zone include: changing the spacing between the shallow and deep screen intervals, changing the spacing between PTR-1 and PTR-2, changing the recirculation configuration (e.g. injecting in both screen intervals at one well and extracting from both screen intervals at the other well), and changing the recirculation rates (by either changing the relative injection and extraction rates within a recirculation well or by changing the relative recirculation rates between wells). During the ISPT, the only feasible change that could be made to improve distribution was a change in the relative recirculation rates between wells while keeping the injection and extract rates within a given well equal. Based on the modified conceptual model, less vertical recirculation in the aquifer near each well was expected to increase the connection between PTR-1 and PTR-2 and overcome the stagnation zone at PT-8M and PT-8D. Therefore, different recirculation rates were evaluated by the numerical model. The final recommendation was to maintain operation of PTR-1 at its current rate, while, increasing the recirculation rate at PTR-2. The model simulation predicted that increasing the recirculation rate at PTR-2 relative to PTR-1 increased the hydraulic gradient in the deep zone between PTR-1 and PTR-2. Consequently, the degree of stagnation in the PT-8M area was predicted to be reduced and improved reagent distribution to PT-8M and PT-8D was expected. In addition, due to the increased injection rate at PTR-2 shallow, the hydraulic gradient in the shallow zone between PTR-2 and PT-9S would be increased and thus the reagent distribution towards PT-9S was expected.

As verified by the last two samples collected at PT-8S and PT-8D, significant tracer concentrations were measured at these two sampling locations following the increase in flow rate at PTR-2 on October 14. The sample taken at PT-9S on November 8, 2008 shows arrival of the reagent mixture, concurrent with decreasing Cr[VI]concentrations, verifying improved reagent delivery to PT-9S. These results are consistent with the optimization simulations and confirm the utility of numerical modeling for evaluating and optimizing performance of these types of systems.

5.2 Evaluating Recirculation Well Configuration Alternatives

The second objective of the re-developed model was to evaluate different recirculation well configuration alternatives and make recommendations on how to improve reagent distribution in the subsurface for the full-scale IRZ system design. Three additional recirculation well configuration alternatives were evaluated with the numerical model.

The three additional alternatives were considered to reduce the fraction of vertical recirculation flow near each well, and therefore increase the hydraulic connection and horizontal reagent distribution between PTR-1 and PTR-2.

- The first alternative considered an increase in the spacing between the shallow well screen and the deep well screen at PTR-1, which was expected to reduce the relative flux between the shallow and deep well screens, resulting in an improved reagent distribution areally.

- The second alternative considered reduced the lateral spacing between PTR-1 and PTR-2, which was expected increase the horizontal hydraulic gradient between the two recirculation wells and reduce the stagnation zone at PT-8 area, which would also improve the reagent delivery in the subsurface. This alternative was intended to better understand the relationship between well spacing and reagent distribution, and provide guidance for a recommended minimum well spacing used in full-scale IRZ system design.

- The last alternative evaluated considered geologic conditions with more significant anisotropy, with the purpose of evaluating possible system designs that could effectively accommodate the range of anisotropy likely present across the Site.

The performances of these three alternatives were compared with the current PTR-1 and PTR-2 recirculation system and were discussed in detail in the following sections. In this recirculation well configuration analysis, solute transport simulations were carried out to quantify the reagent distribution changes. Reagents were injected at the injection well screen interval continuously (PTR-1 deep) at a concentration of 1 mg/L. Reagent masses captured by the extraction well screen intervals (PTR-1 shallow and PTR-2 deep) were calculated and normalized to the injected reagent mass. The relative reagent distribution (dimensionless) was used to quantify the reagent distribution across PTR-1 and PTR-2 (represented by the reagent mass arrival at PTR-2 deep) and within the recirculation well (represented by the reagent mass captured by PTR-1 shallow). This quantitative analysis results are summarized in Table B-3. Pathline analyses were utilized to visually demonstrate the reagent migration in different alternatives (Figure B-16).

Table B-3. Relative Reagent Mass Distribution in the Recirculation Systems

Well	Relative Mass at PTR-1 Shallow	Relative Mass at PTR-2 Deep
Current ISPT	0.56	0.04
Alternative 1	0.50	0.05
Alternative 2	0.51	0.31
Alternative 3	0.22	0.2

5.2.1 Alternative 1: Increased Spacing between the Shallow and Deep Well Screens

In Alternative 1, the spacing between the shallow well screen and the deep well screen was increased from 10 feet to 20 feet. The change in the reagent distribution is demonstrated by the pathline analysis in panel B on Figure B-16. Compared to the pathline analysis in panel A for the current ISPT recirculation system, fewer particles were re-circulated back to PTR-1 shallow and the lateral distribution of reagent cross PTR-1 and PTR-2 was improved, particularly at the vertical interval between the well screens. As summarized in the Table B-3, the relative reagent mass to PTR-1 shallow and PTR-2 deep are 0.50 and 0.05, respectively, compared to the current recirculation system relative mass distribution of 0.56 and 0.04. This also shows an increased areal reagent distribution of 20% and a decreased vertical recirculation of 11%, which indicates an improvement in terms of reagent delivery across PTR-1 and PTR-2. However, due to the high hydraulic horizontal gradient in the deep zone between PTR-1 shallow and PTR-2, the relative reagent mass to PTR-1 shallow is still greater than that to PTR-2 deep. The change in Alternative 1 is expected to improve the reagent delivery towards PT-8M, as illustrated by more particles in the middle aquifer zone migrating towards PT-8 in panel B. The effects and potential benefits of increased well spacing are strongly related to the degree of anisotropy present at specific locations (see Alternative 3 results below). Practically, wells constructed with triple screens (with the option of puckering off the middle screen) would allow the flexibility to optimize operations to accommodate local geologic conditions.

5.2.2 Alternative 2: Decreased Spacing between PTR-1 and PTR-2

In Alternative 2, the spacing between PTR-1 and PTR-2 was decreased 33% from 140 ft to 100 ft. The performance changes are shown in panel C on Figure B-16. Compared to the current system, more particles arrive at PTR-2 deep. Ultimately, this is caused by the shorter travel distance between the wells and the higher induced hydraulic gradient between PTR-1 and PTR-2. The relative reagent mass distribution results show that the relative reagent mass to PTR-1 shallow decreases from 0.56 to 0.51, while the relative mass to PTR-2 deep increases from 0.04 to 0.31. Although the recirculation between PTR-1 shallow well screen and PTR-1 deep well screen is still strong, the connection between PTR-1 and PTR-2 has increased compared to that of the current ISPT recirculation system. This will lead to a significant improvement in the reagent delivery across PTR-1 and PTR-2 in the subsurface. The decreased spacing between PTR-1 and PTR-2 is expected to improve the reagent delivery towards PT-8M, as shown by the arrival of more particles at PT-8M in panel C. Based on the observations from the ISPT, adequate horizontal hydraulic gradient and flow was achieved to distribute reagent across the 140-ft spacing. However, because reduced well spacing improves lateral distribution and shortens travel times by increasing the induced horizontal hydraulic gradient and flow, it could improve cross-well coverage in areas where the ambient groundwater flow greater or where the sustainable re-circulations rates are lower.

5.2.3 Alternative 3: Increased Anisotropy

The ratio of K_v to K_h was decreased from 0.75 for the current recirculation system, to 0.1 in Alternative 3, which indicates an increased anisotropy. The performance of a recirculation system with increased anisotropy is presented in panel D on Figure B-16. The pathline analysis shows that fewer particles are re-circulated back to PTR-1 shallow and more particles migrate towards PTR-2 deep. The relative reagent mass calculation from the solute transport simulation for Alternative 3 shows that only 0.22 of the injected reagent is re-circulated back to PTR-1 shallow, while the relative mass to PTR-2 deep increased from 0.04 to 0.20, indicating a stronger areal connection across PTR-1 and PTR-2 in the subsurface. This suggests that the increased anisotropy will result in an improvement of the reagent delivery towards PT-8M. As noted above, increased anisotropy reduces the potential benefit of increased spacing between screens, therefore, wells constructed with multiple screens would allow the most flexibility to best accommodate local geologic conditions.

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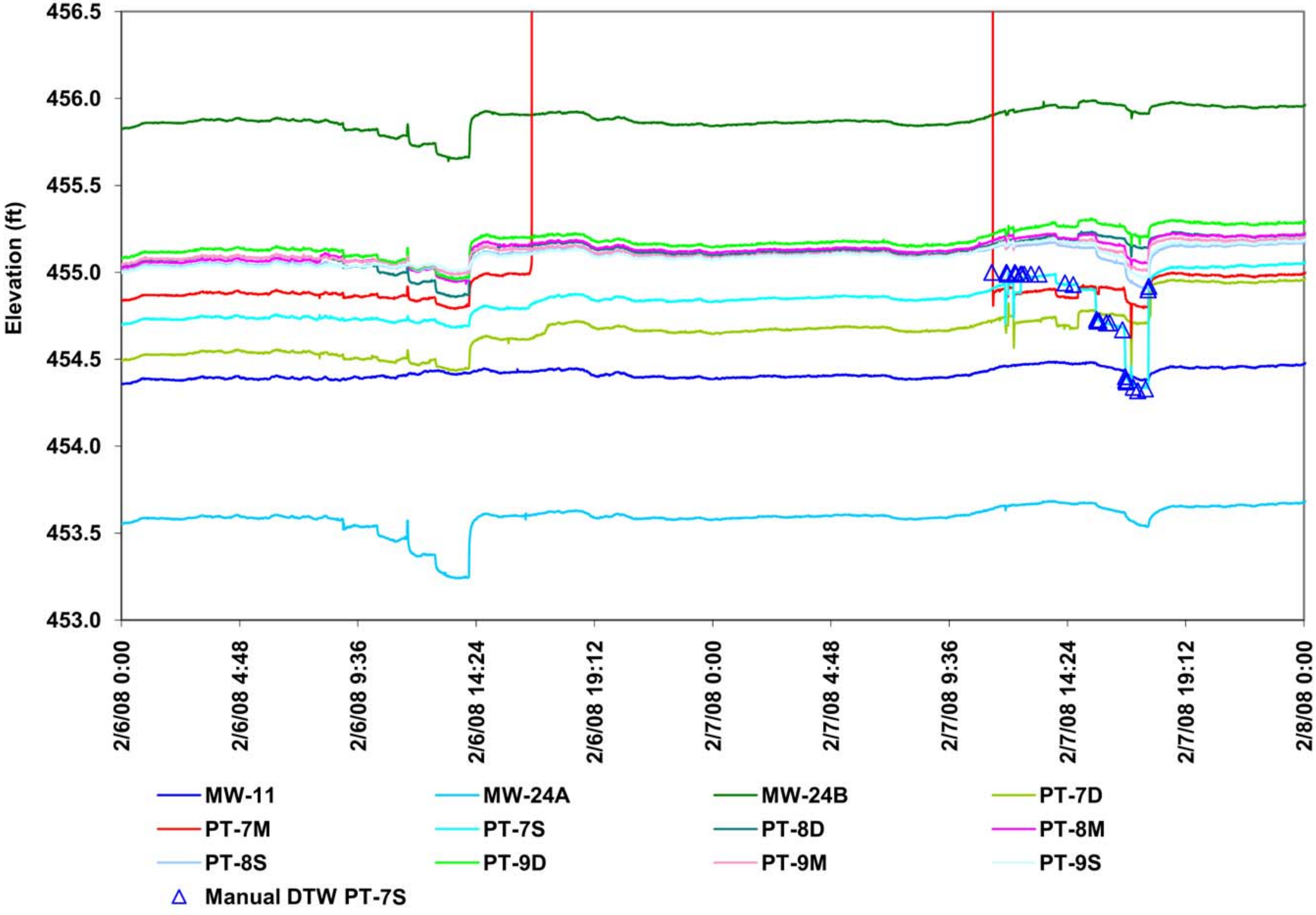

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WATER-LEVEL CHANGES
DURING STEP-EXTRACTION TESTS
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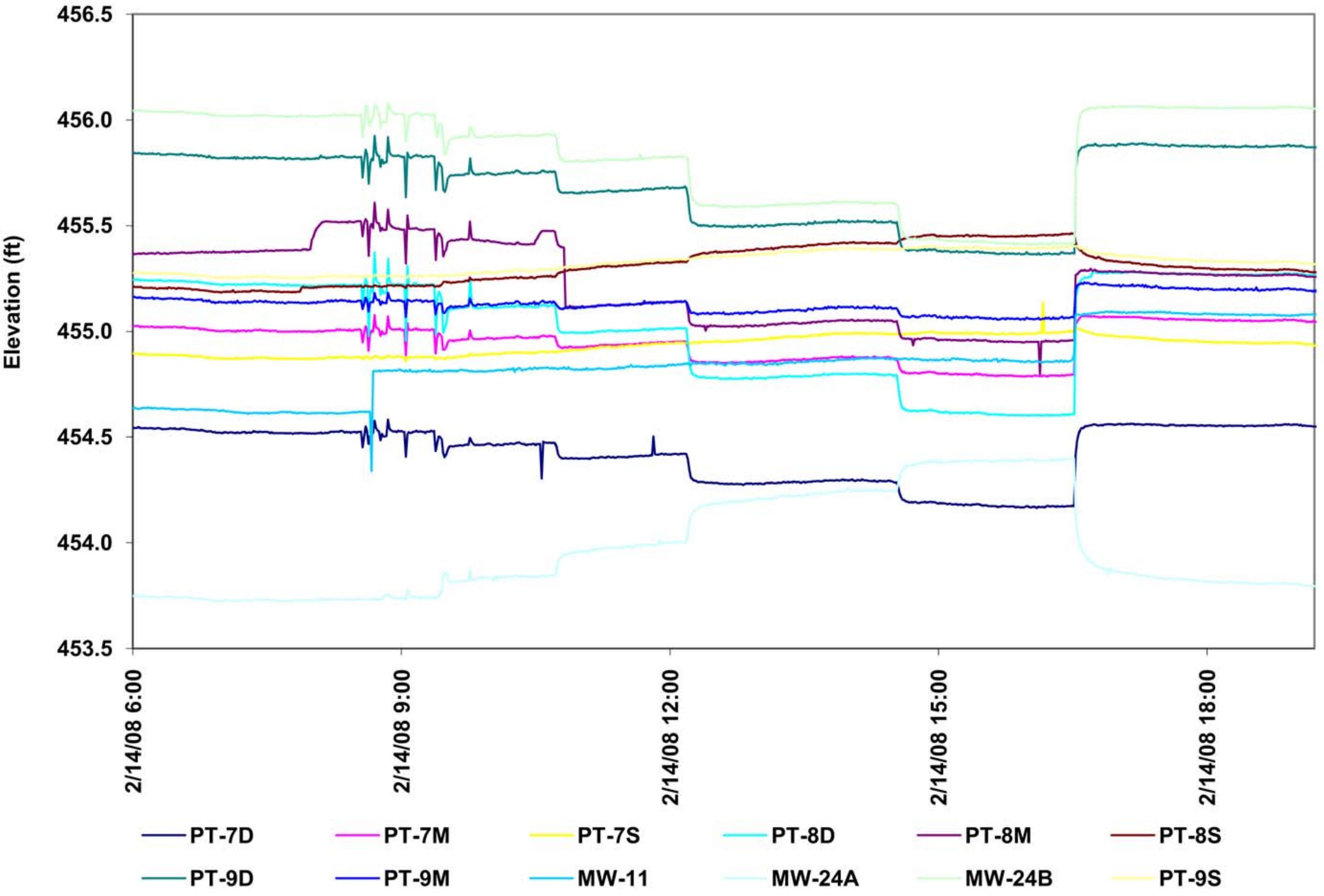
NEEDLES, CALIFORNIA

Project Number
RC000689.0004

Figure
B-1



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WATER-LEVEL CHANGES DURING THE PTR-2 SINGLE-WELL RECIRCULATION TEST

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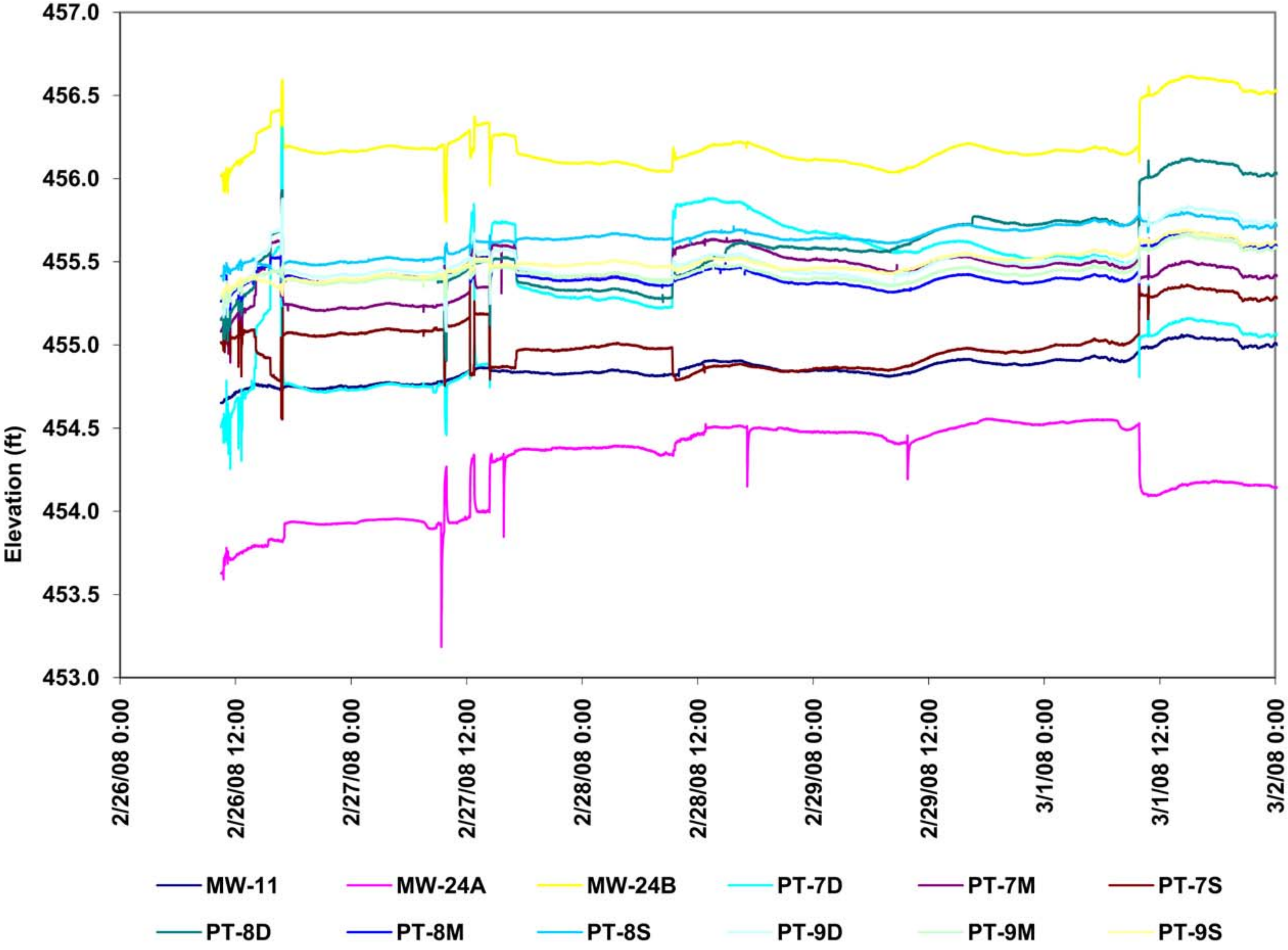
Figure
B-2



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WATER-LEVEL CHANGES DURING THE PTR-1 SINGLE-WELL RECIRCULATION TEST AND THE DUAL-WELL RECIRCULATION TEST

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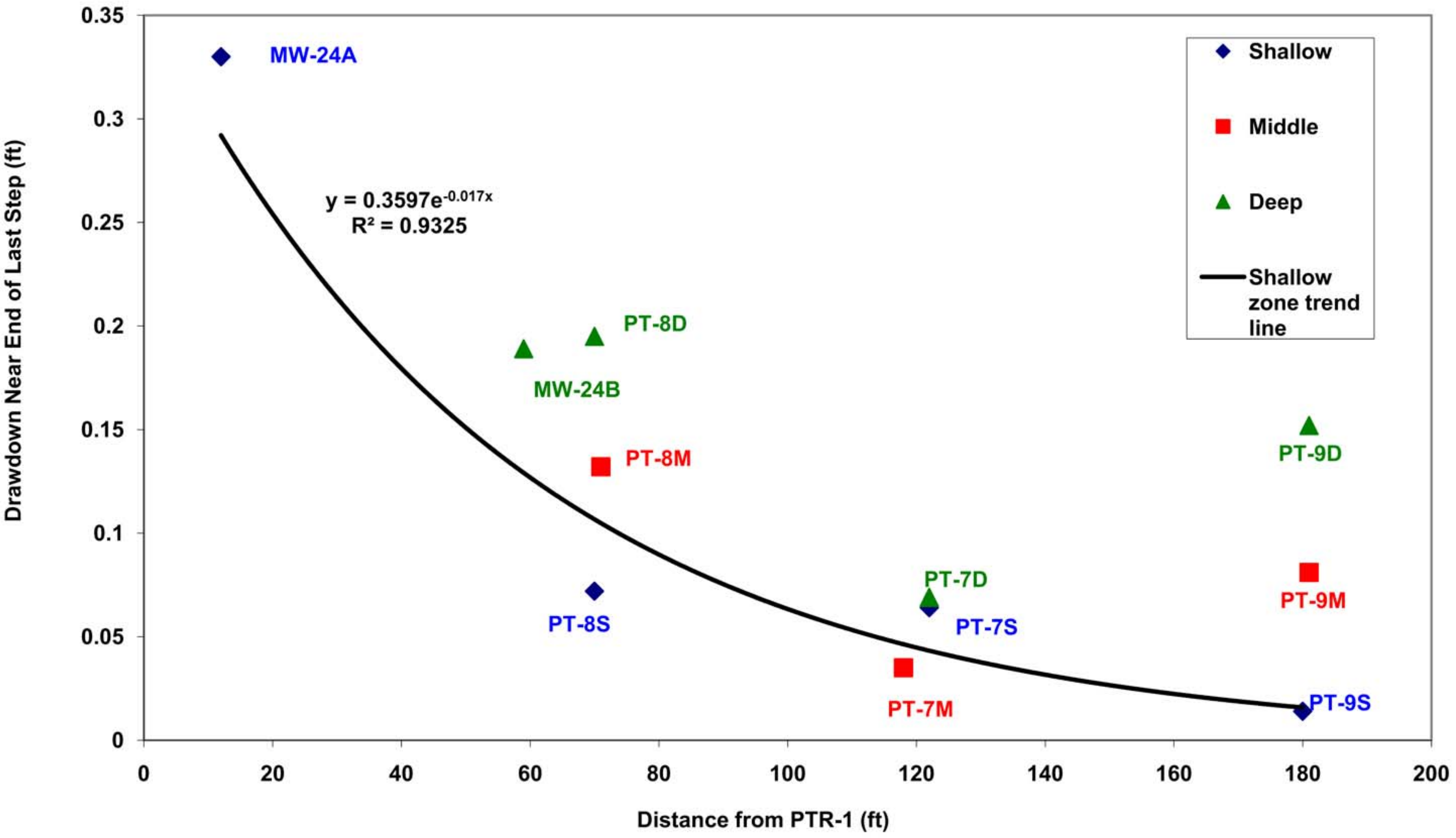
Figure
B-3



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DISTANCE-DRAWDOWN PLOT
NEAR THE END OF THE PTR-2 EXTRACTION TEST

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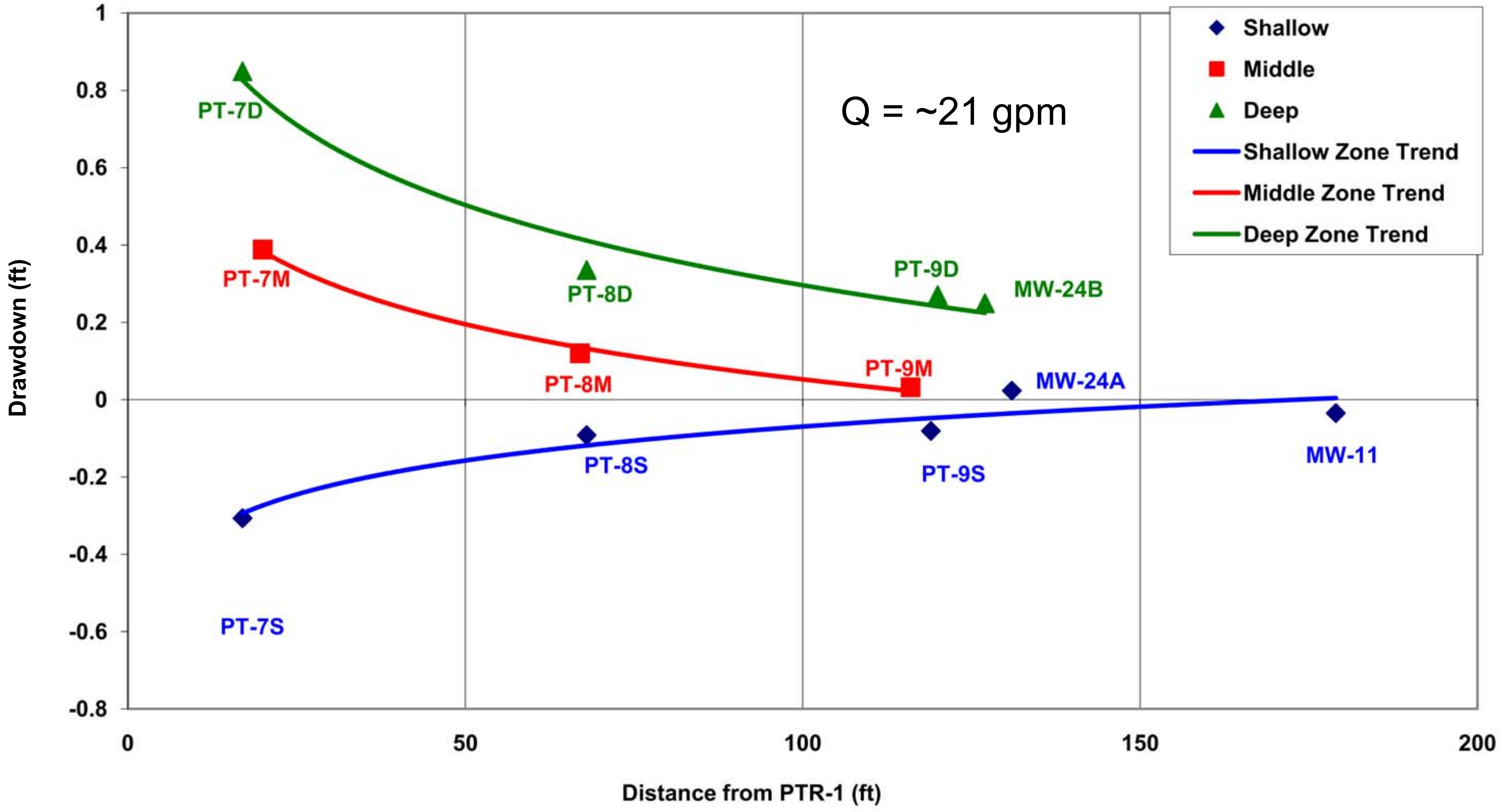
Figure
B-4



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DISTANCE - DRAWDOWN PLOT DURING THE PTR-1 RECIRCULATION TEST

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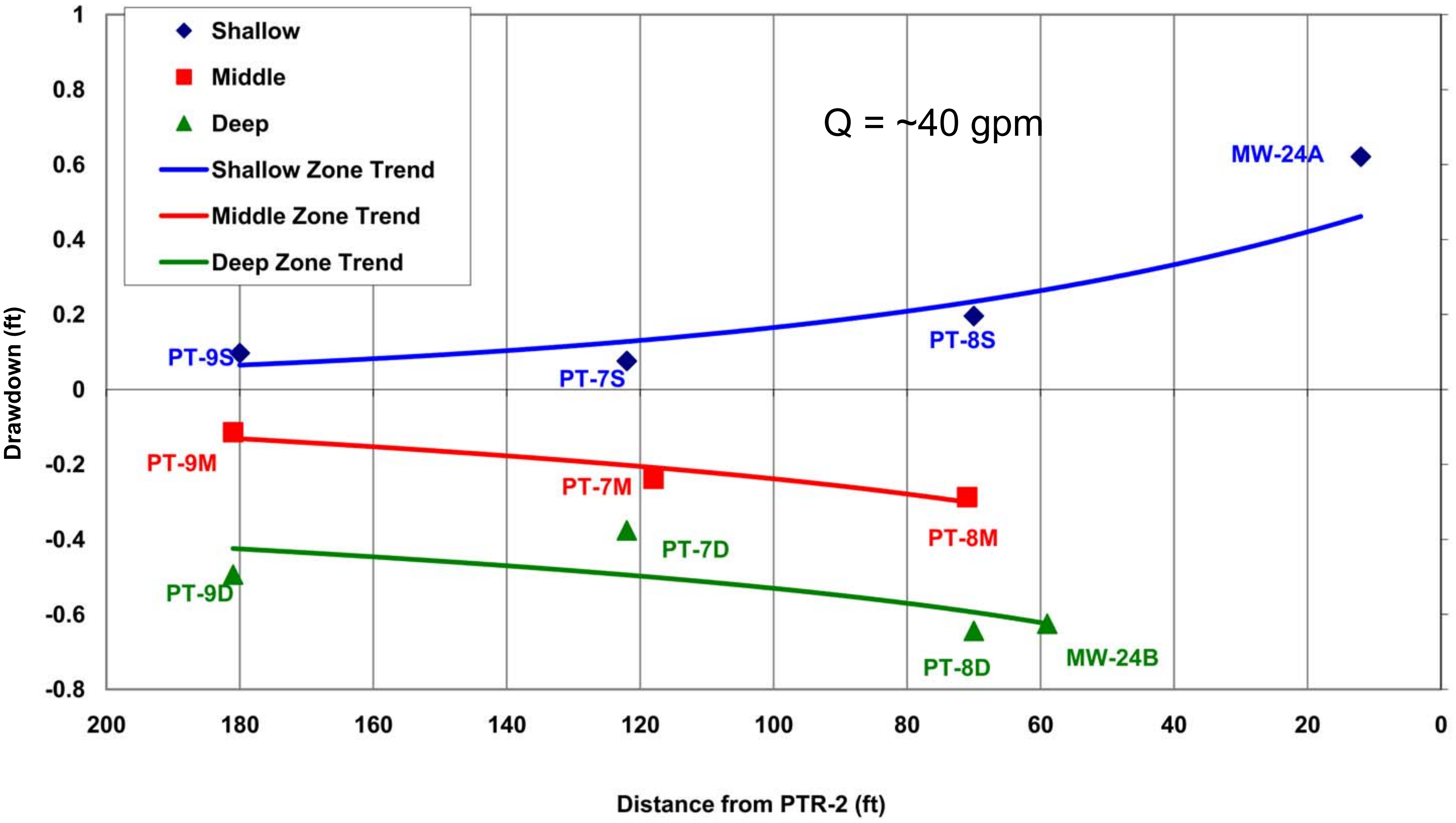
Figure: B-5



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DISTANCE - DRAWDOWN PLOT DURING THE PTR-2 RECIRCULATION TEST

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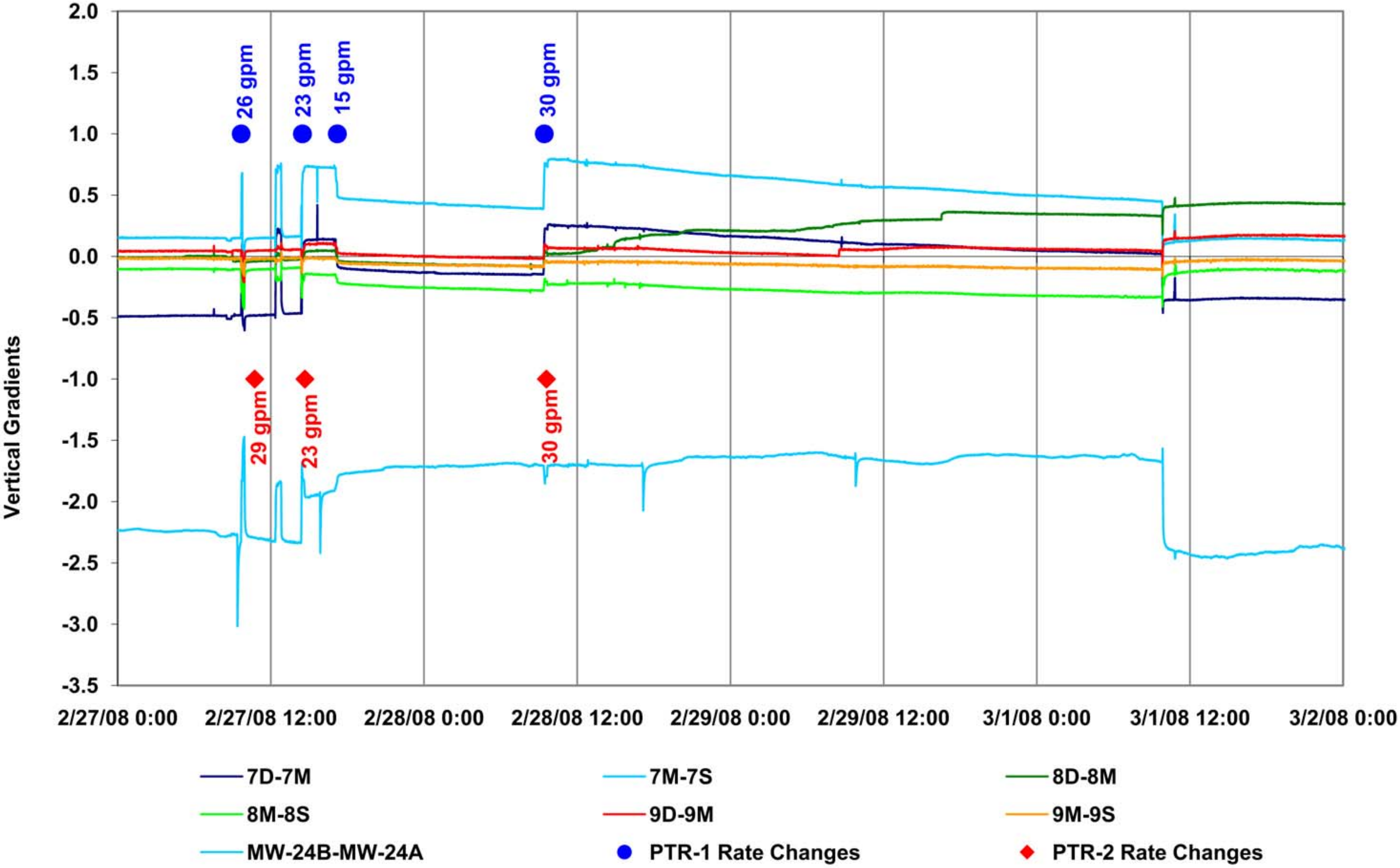

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VERTICAL GRADIENTS AT WELL CLUSTERS DURING THE DUAL-WELL RECIRCULATION TEST

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Figure
B-7

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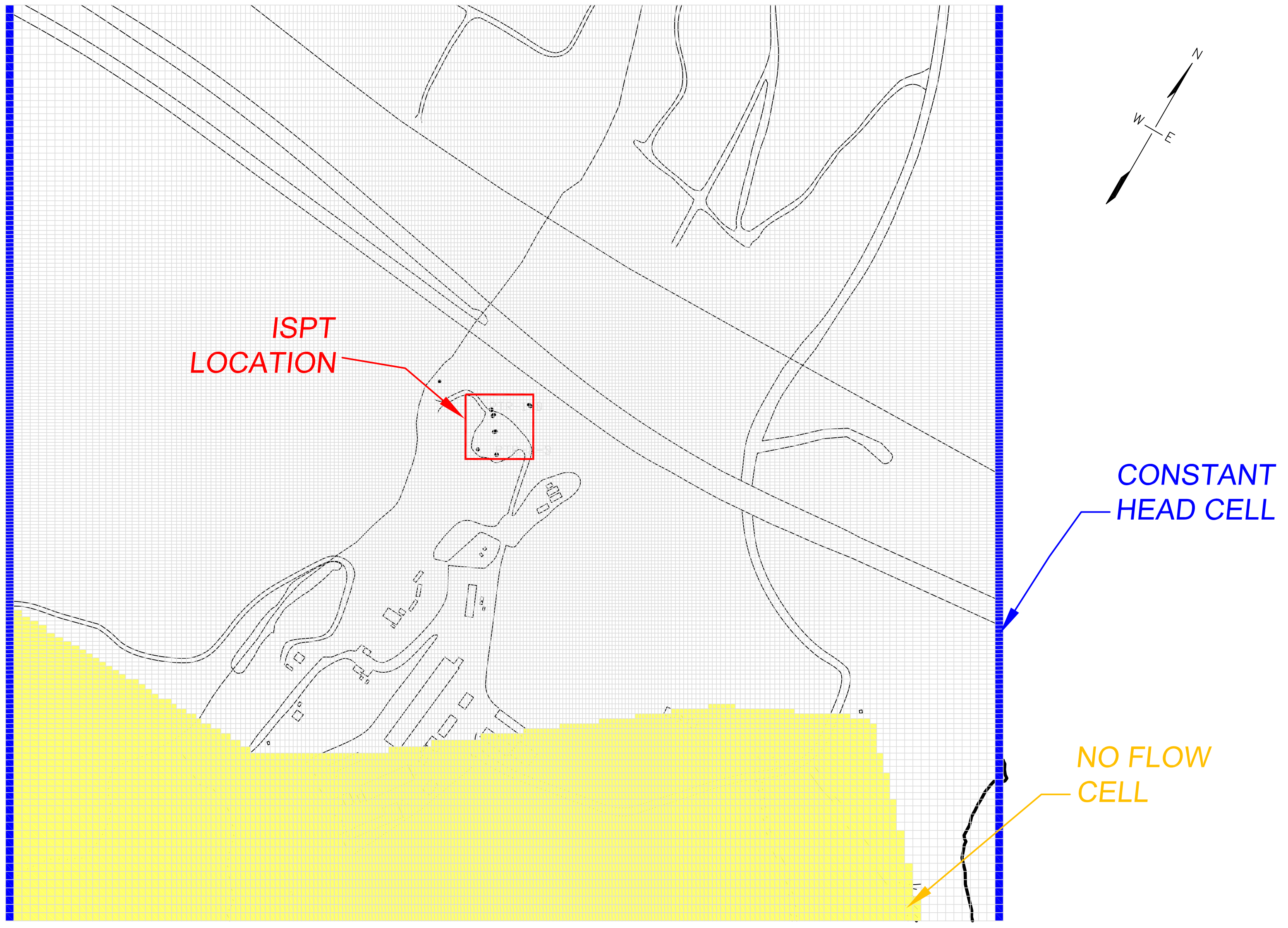

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MODEL DOMAIN AND BOUNDARY CONDITIONS

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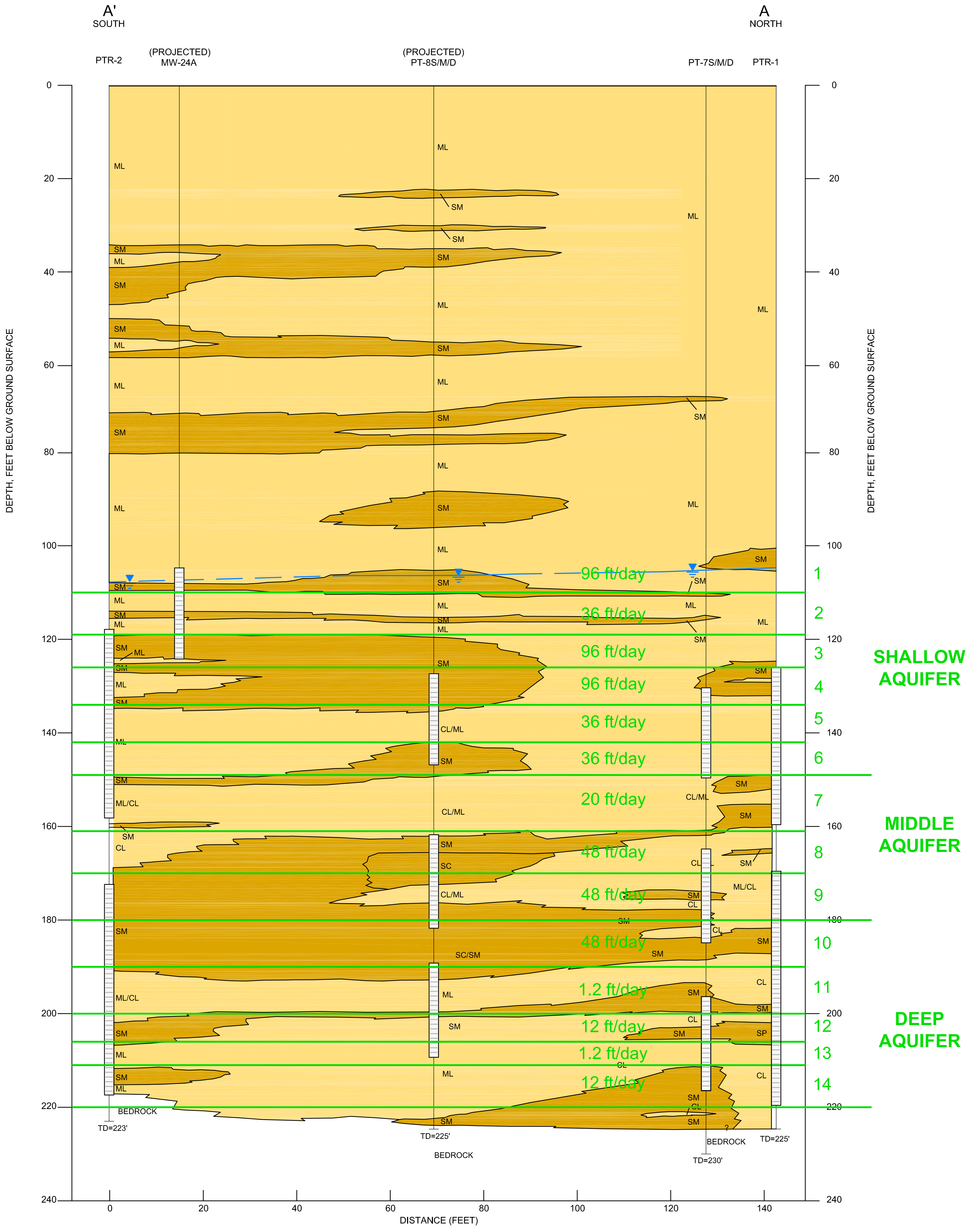
Figure
B-8



LEGEND:

▨ GENERALLY FINE GRAINED, LOWER PERMEABILITY

■ GENERALLY COARSER GRAINED, HIGHER PERMEABILITY

SOIL CLASSIFICATION:

GW = WELL GRADED GRAVEL
SW = WELL GRADED SAND
SP = POORLY GRADED SAND
SM = SILTY SAND
SC = CLAYEY SAND
ML = SILT
CL = CLAY

0 20 40
VERTICAL SCALE IN FEET

0 20 40
HORIZONTAL SCALE IN FEET

MW-24A ← WELL ID

▼ ← WATER TABLE SURFACE (DASHED WHERE INFERRED)

← WELL SCREEN

TD=225' ← TOTAL DEPTH

96 ft/day ← HYDRAULIC CONDUCTIVITY (K_h)

← MODEL LAYER DIVIDER

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MODEL HYDROSTRATEGRAPH STRUCTURE
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Figure
B-9

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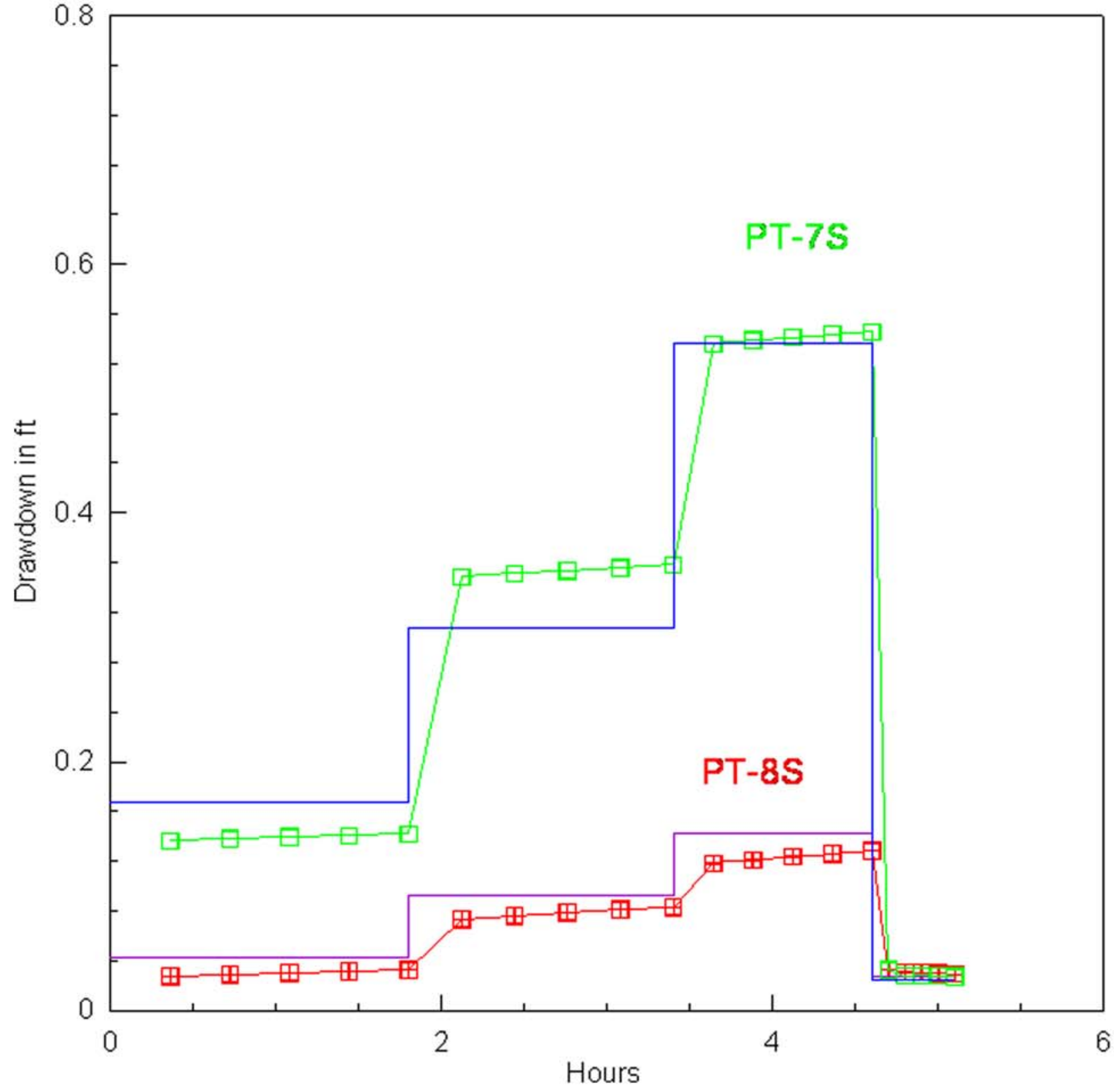

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AQUIFER TESTING CALIBRATION RESULTS
(PT-7S AND PT-8S)

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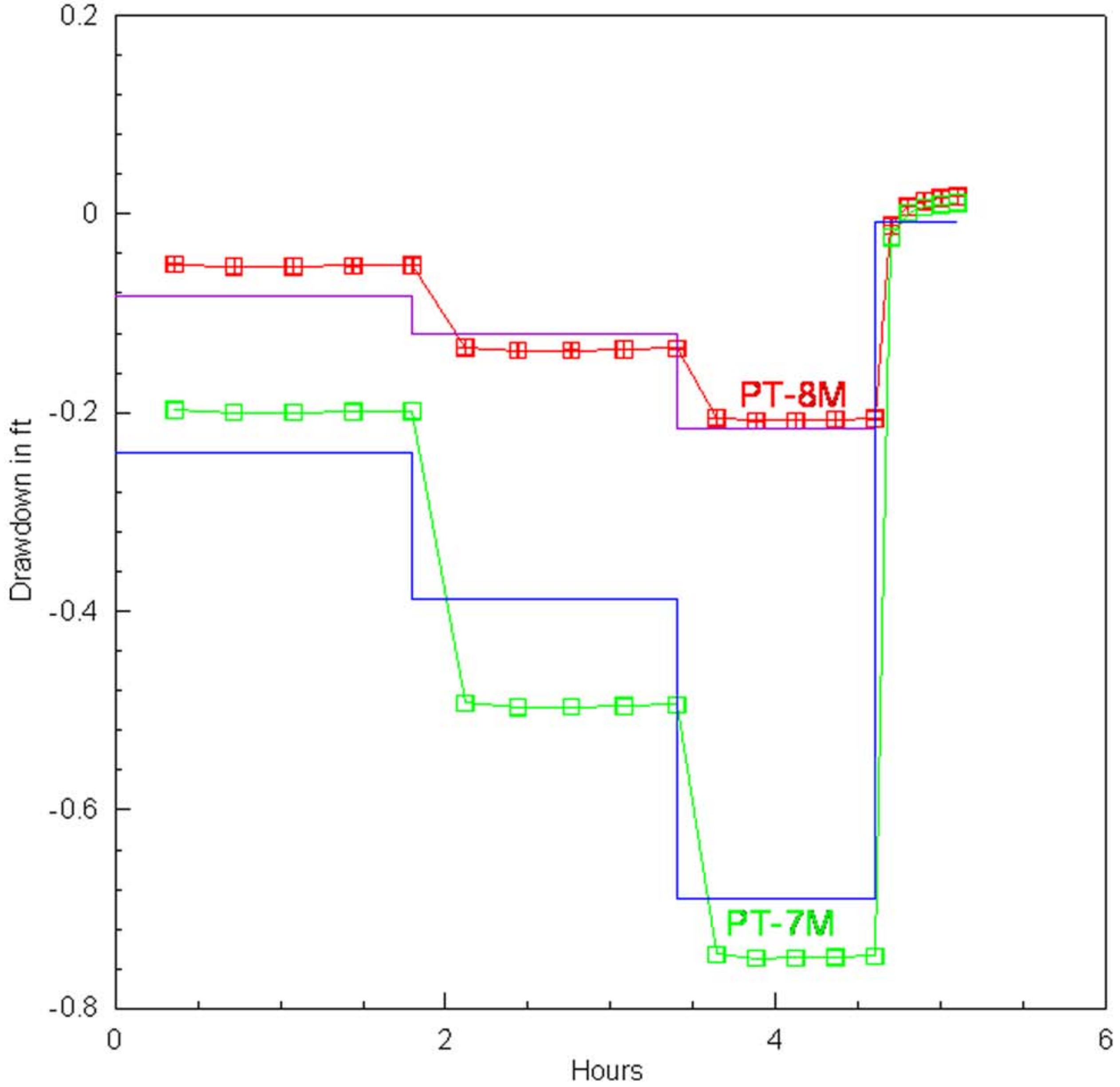
NEEDLES, CALIFORNIA

Project Number
RC000689.0004

Figure
B-10



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AQUIFER TESTING CALIBRATION RESULTS
(PT-7M AND PT-8M)

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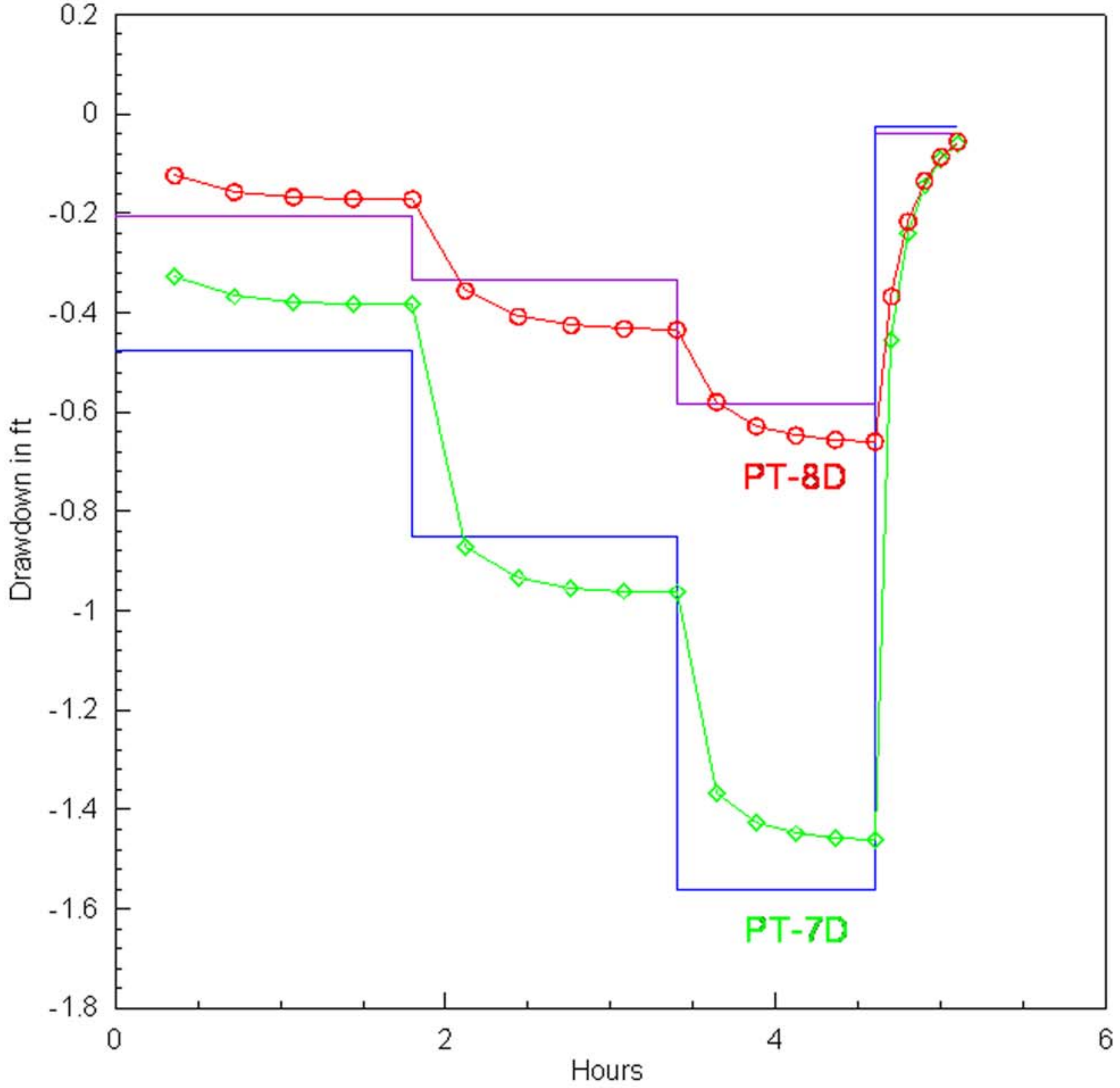
Figure
B-11



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AQUIFER TESTING CALIBRATION RESULTS (PT-7D AND PT-8D)

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Project Number
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Figure
B-12

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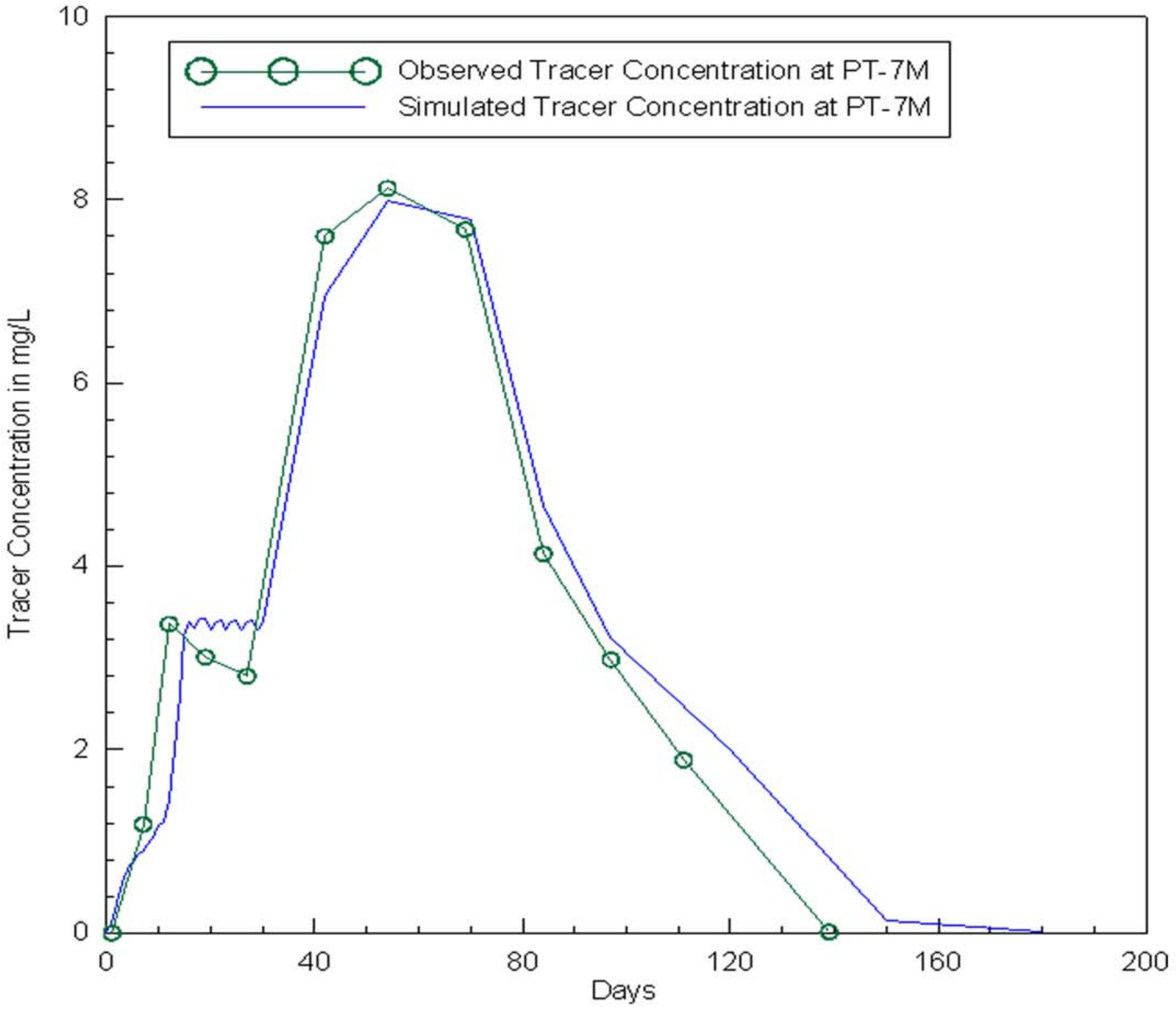
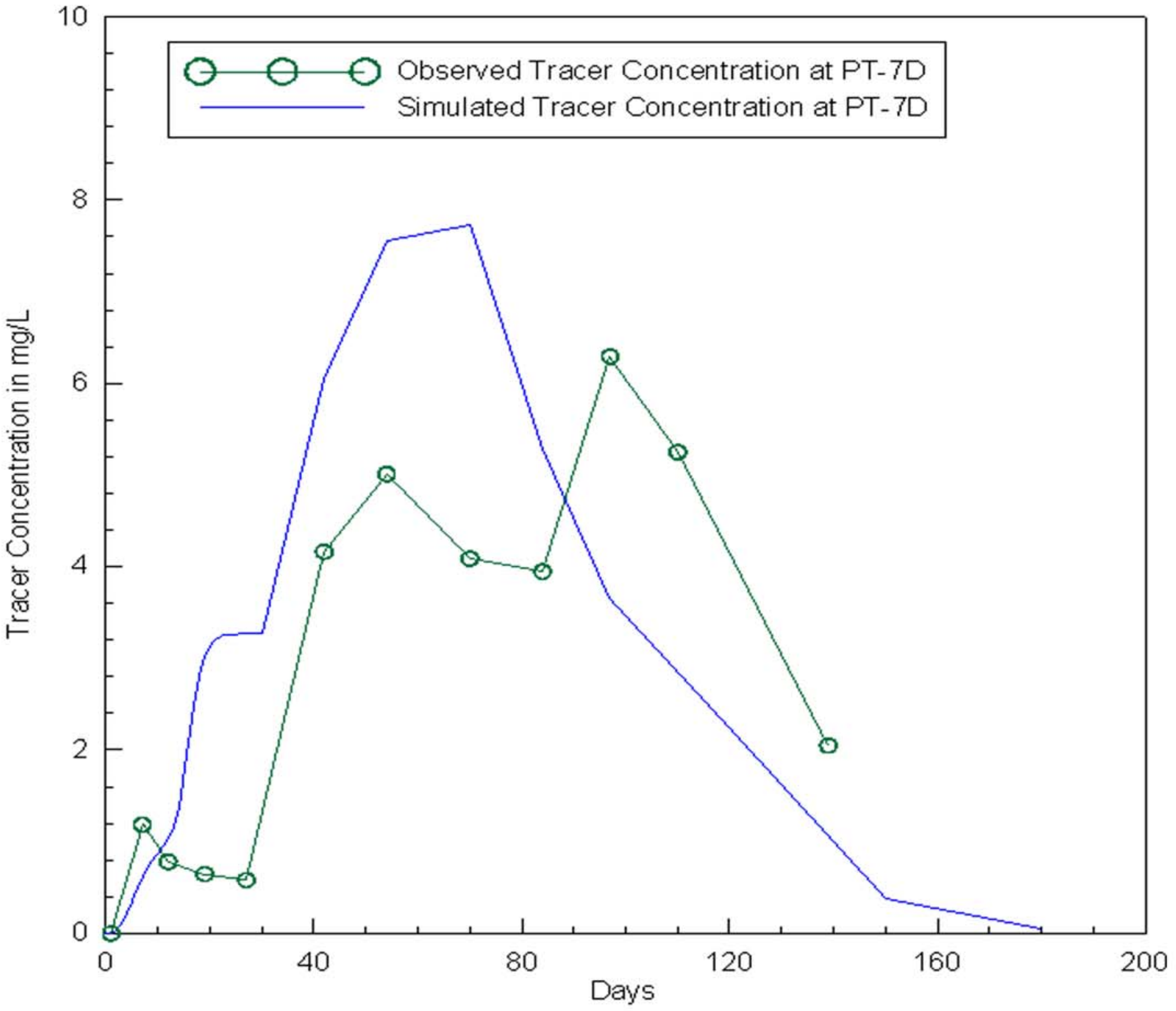
ISPT TRACER TESTING CALIBRATION AT PT-7M



ISPT TRACER TESTING CALIBRATION AT PT-7D



User: JCHEN Path: K:\RC00689 PG&E TOPOCK\IMAGE\PHOTOSHOP\

Project Director L. KELLOGG	Area Manager J. PETERS
Task Manager J. LUTRICK	Technical Review X. SONG
Drawing Date 29 APR 08	Drawn By J. CHEN

ARCADIS

ARCADIS, Inc.
155 Montgomery Street, Suite 1510
San Francisco, CA 94104
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ISPT TRACER TESTING CALIBRATION
AT PT-7M & PT-7D
PG&E TOPOCK FACILITY
NEEDLES, CALIFORNIA

Project Number
RC000689.0004

Figure
B-13

Acad Version : R17.0s (LMS Tech) Date\Time : Mon, 16 Feb 2009 – 5:25pm
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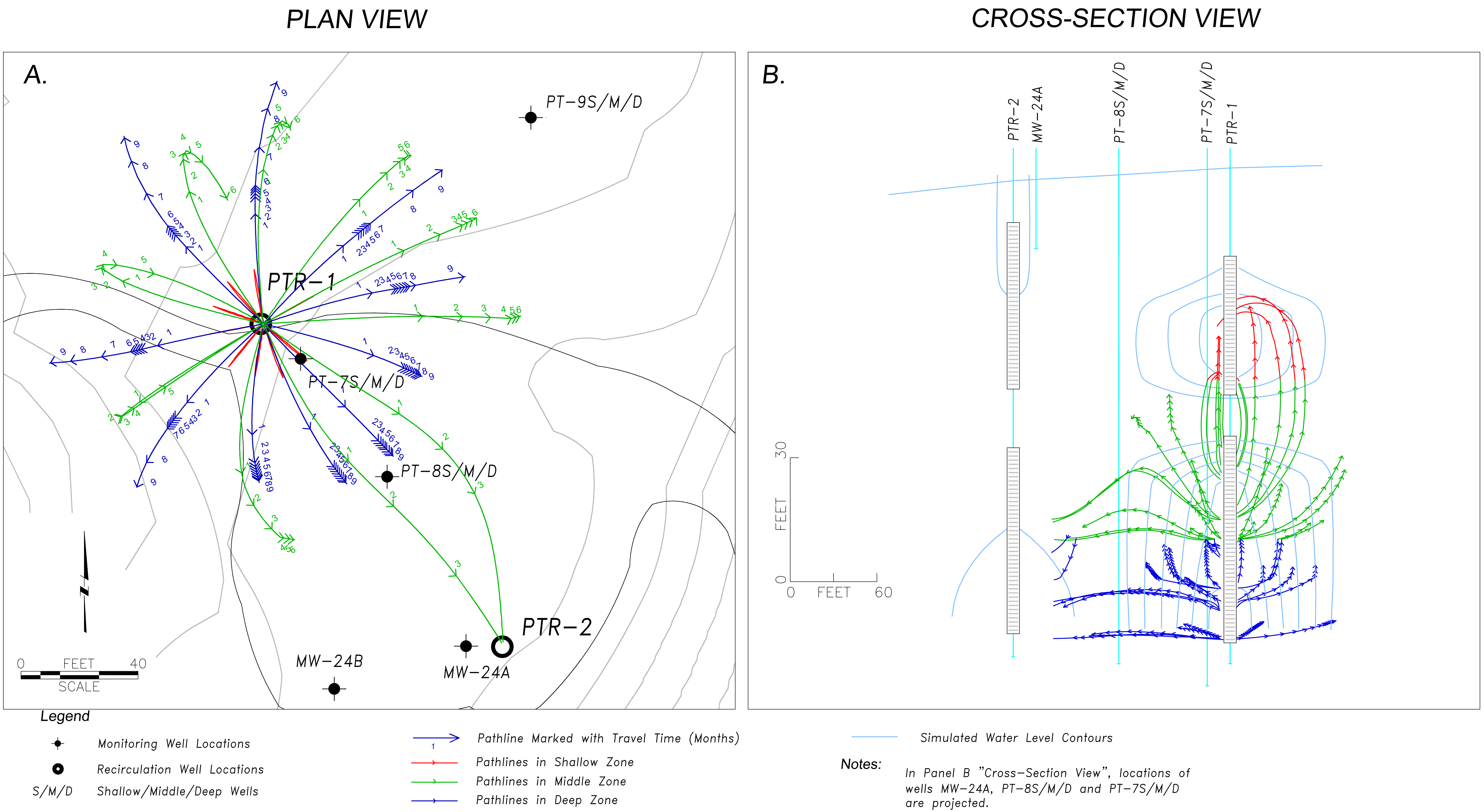

Notes:

In Panel B "Cross-Section View", locations of wells MW-24A, PT-8S/M/D and PT-7S/M/D are projected.

Project Director L. KELLOGG	Area Manager J. PETERS
Task Manager J. LUTRICK	Technical Review X. SONG
Drawing Date 08 FEB 09	Drawn By J. CHEN

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FLOW PATH DEMONSTRATION ON REAGENT MIGRATION PATHWAY
(PTR-1)
PG&E TOPOCK FACILITY
NEEDLES, CALIFORNIA

Project Number
RC000689.0004

Figure
B-14

Acad Version : R17.0s (LMS Tech)
User Name : Jchen
Date\Time : Mon, 16 Feb 2009 - 5:25pm
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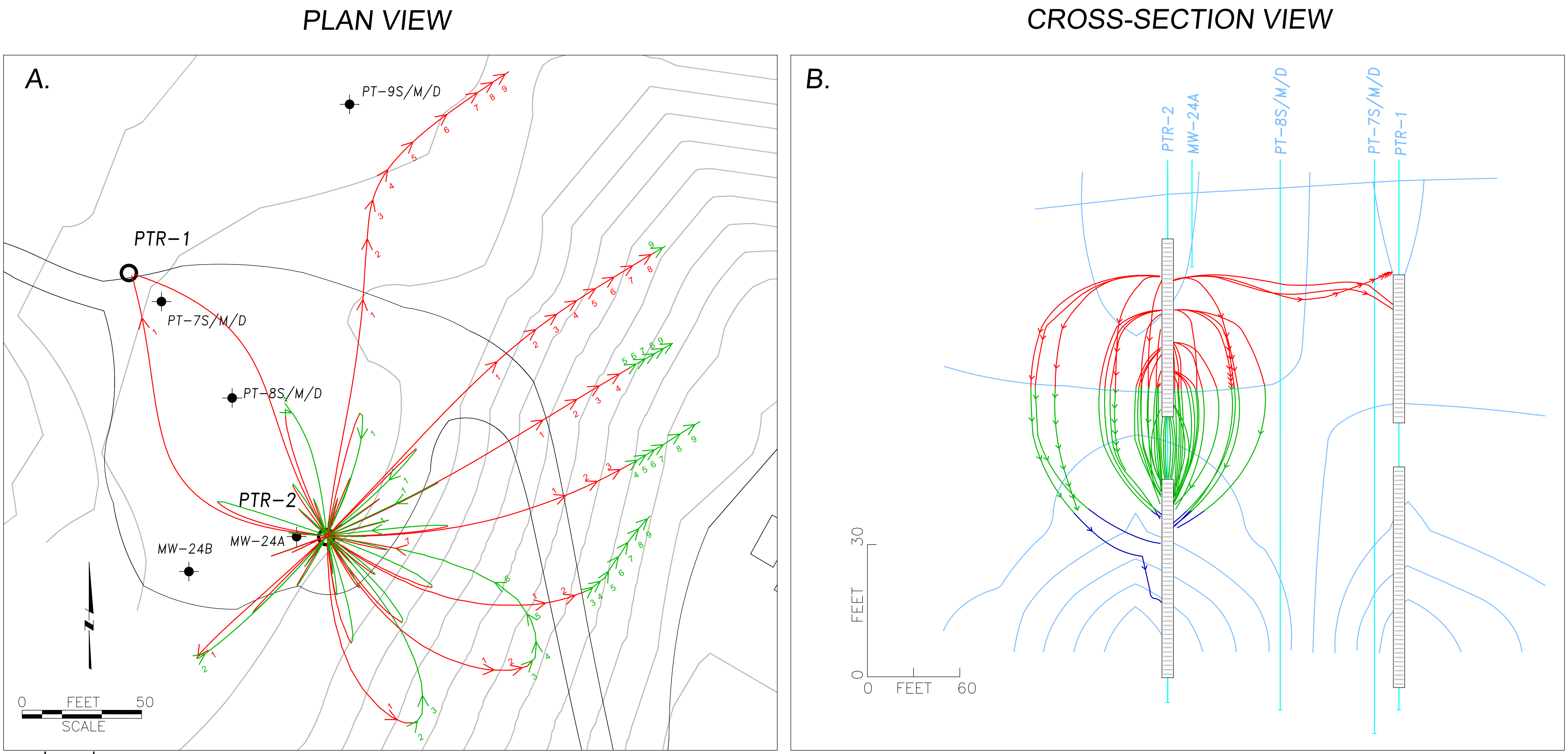

Legend

●	*Monitoring Well Locations*
⊙	*Recirculation Well Locations*
S/M/D	*Shallow/Middle/Deep Wells*
→ 1	*Pathline Marked with Travel Time (Months)*
→	*Pathlines in Shallow Zone*
→	*Pathlines in Middle Zone*
→	*Pathlines in Deep Zone*
—	*Simulated Water Level Contours*

Notes:

In Panel B "Cross-Section View", locations of wells MW-24A, PT-8S/M/D and PT-7S/M/D are projected.

Project Director L. KELLOGG	Area Manager J. PETERS
Task Manager J. LUTRICK	Technical Review X. SONG
Drawing Date 08 FEB 09	Drawn By J. CHEN

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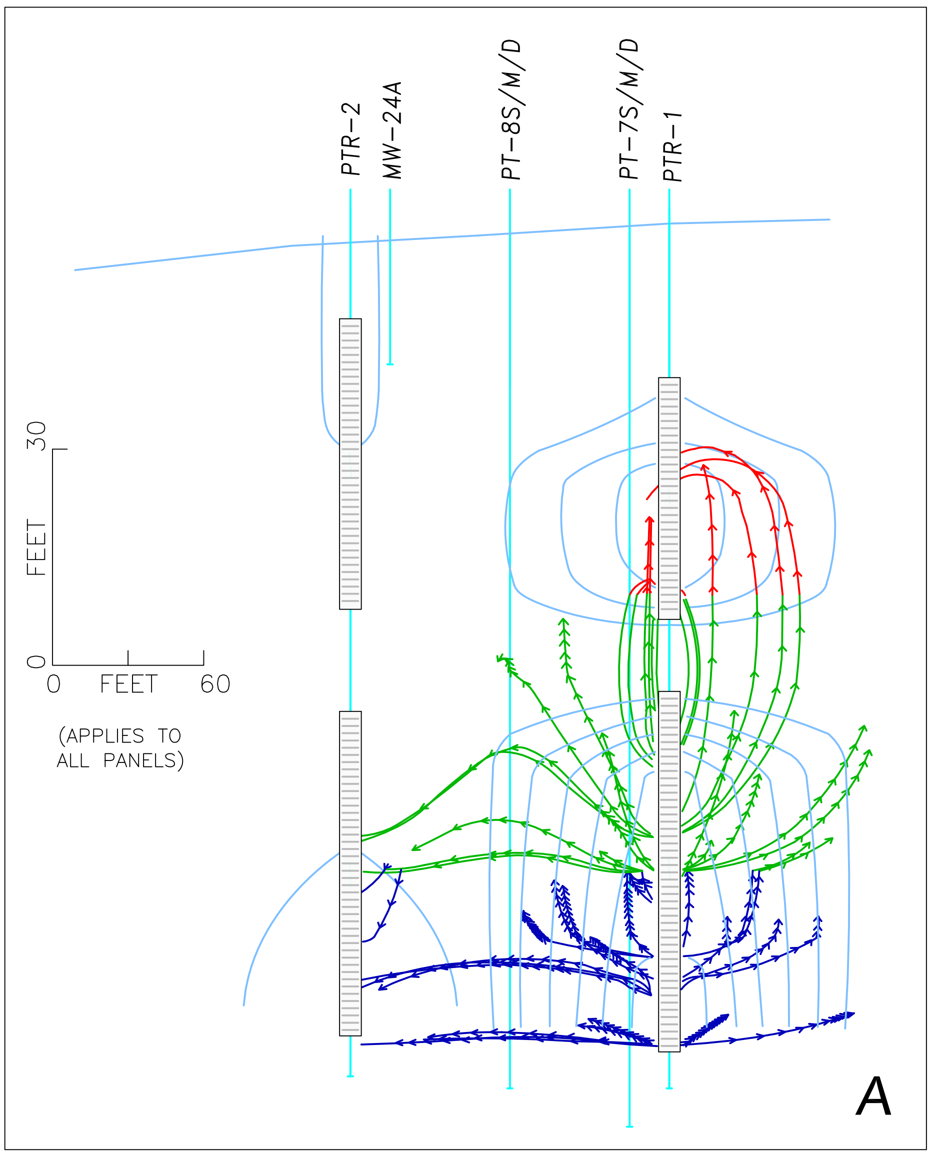
FLOW PATH DEMONSTRATION ON REAGENT MIGRATION PATHWAY
(PTR-2)
PG&E TOPOCK FACILITY
NEEDLES, CALIFORNIA

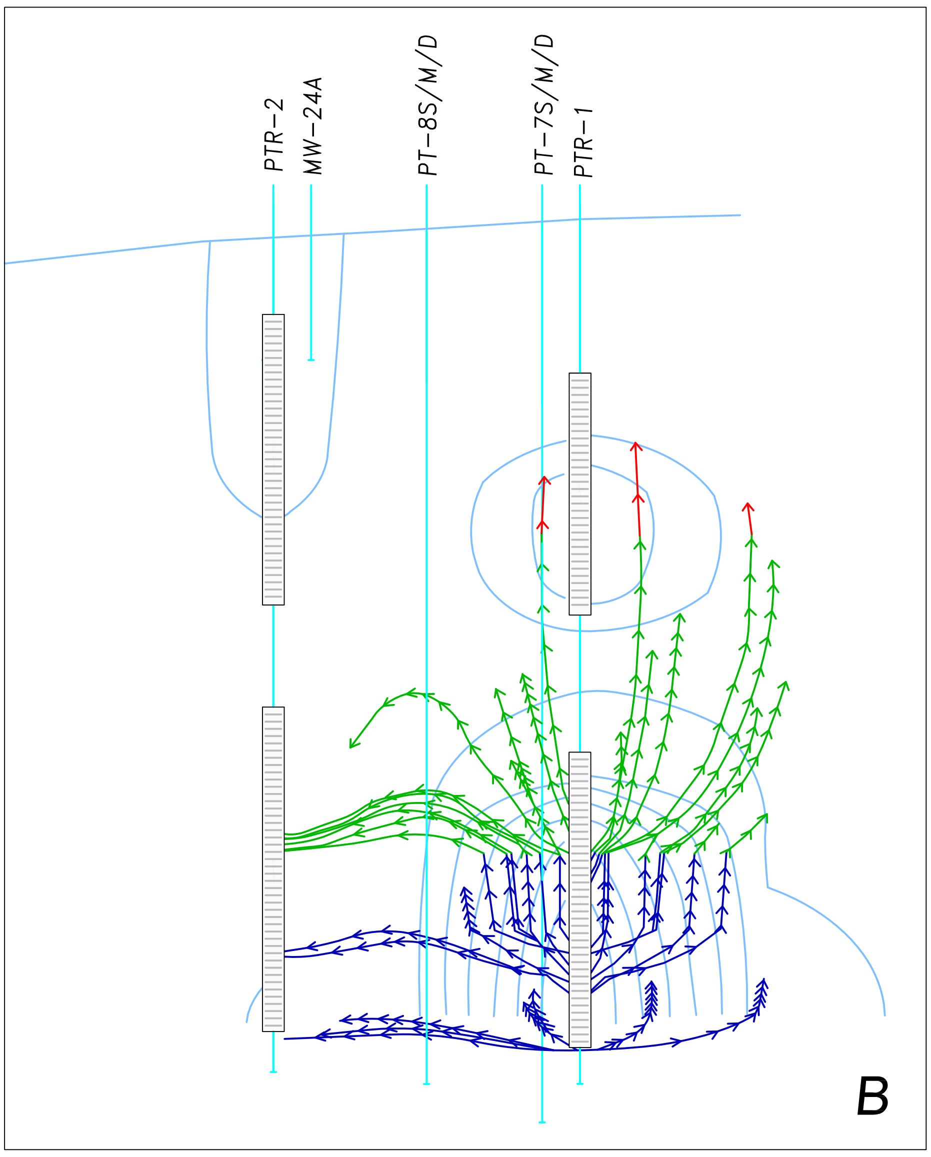
Project Number
RC000689.0004

Figure
B-15

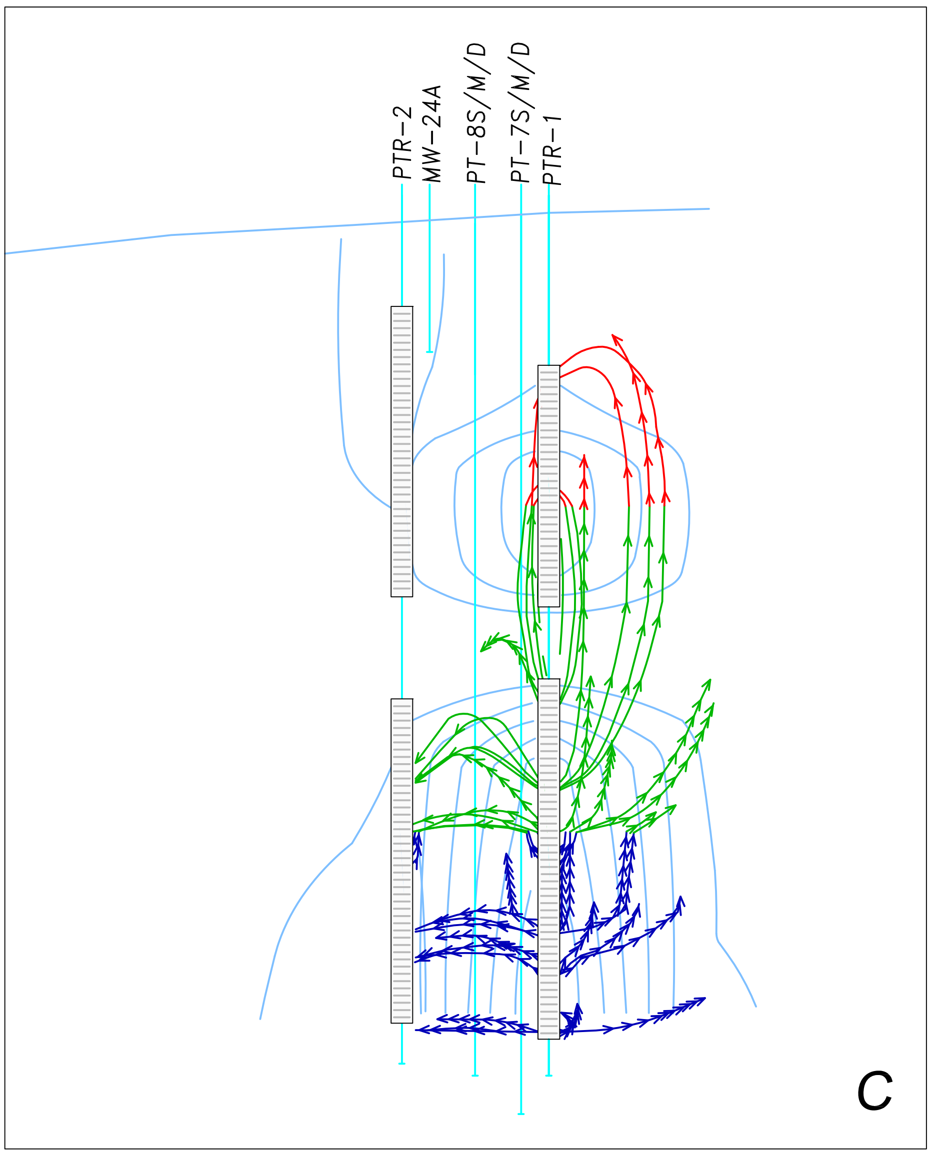
CURRENT ISPT OPERATION CONDITIONS



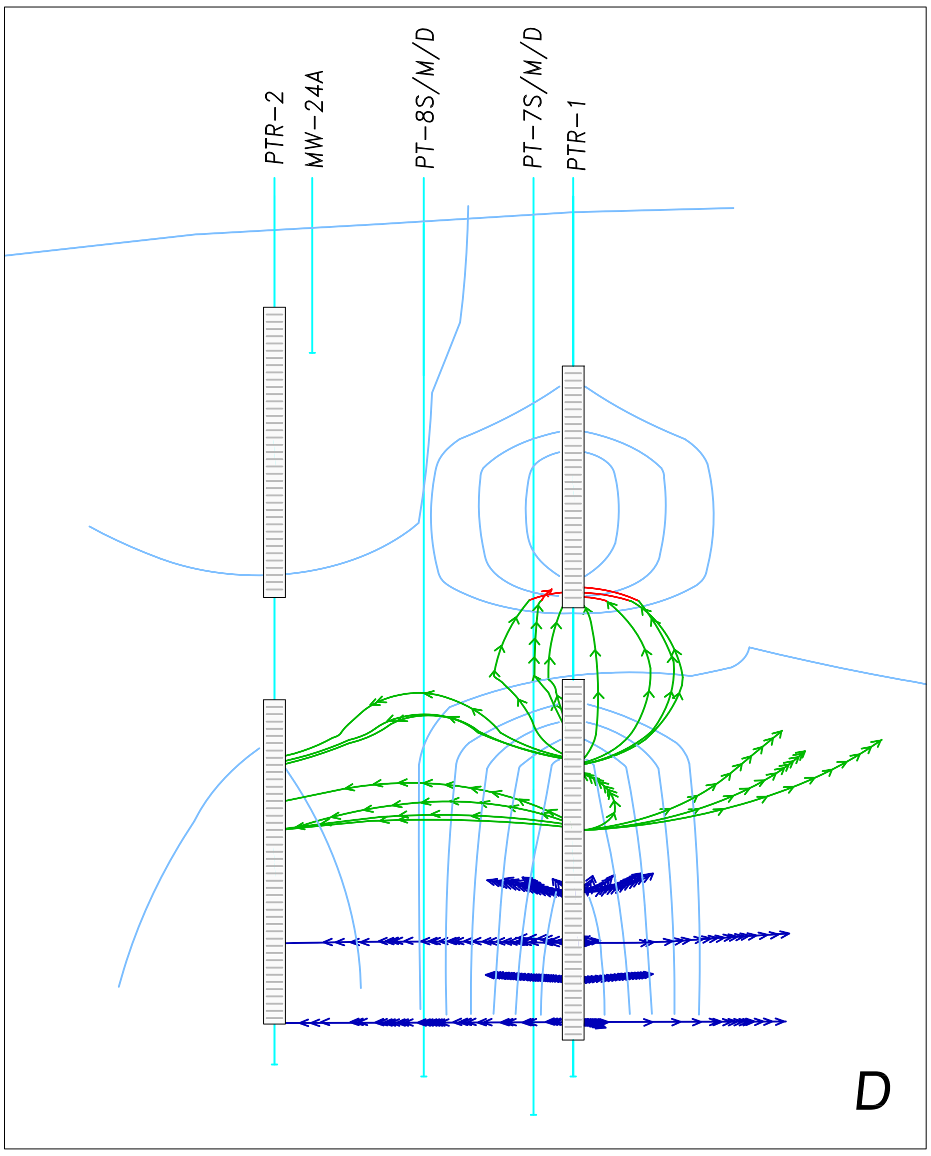
ALTERNATIVE 1:
INCREASE THE DISTANCE BETWEEN THE DUAL SCREEN (from 10 ft to 20 ft)



ALTERNATIVE 2:
DECREASE THE DISTANCE BETWEEN PTR-1 AND PTR-2 (from 150 ft to 100 ft)



ALTERNATIVE 3:
INCREASED ANISOTROPY



Legend

- → Pathlines in Shallow Zone
- → Pathlines in Middle Zone
- → Pathlines in Deep Zone
- — Simulated Water Level Contours

Notes:

1. Reagent injection occurred at PTR-1 Deep.
2. Each arrow on a pathline indicates a travel time of 1 month.
3. Locations of well MW-24A, PT-8S/M/D and PT-7S/M/D are projected.

Project Director L. KELLOGG	Area Manager J. PETERS	**FLOW PATH DEMONSTRATION ON REAGENT MIGRATION PATHWAY FOR ALTERNATIVES** PG&E TOPOCK FACILITY NEEDLES, CALIFORNIA	Project Number RC000689.0004
Task Manager J. LUTRICK	Technical Review X. SONG		Figure B-16
Drawing Date 04 FEB 09	Drawn By J. CHEN		

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155 Montgomery Street, Suite 1510
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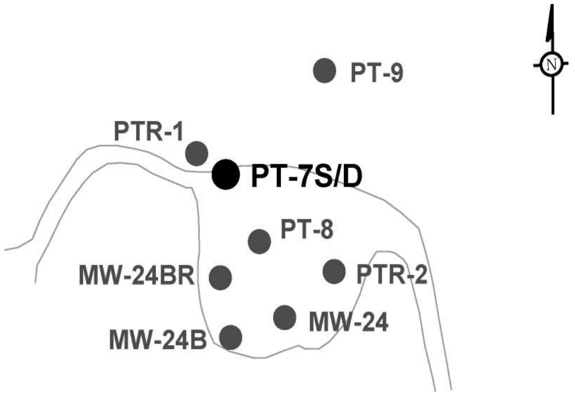
Date\Time : Mon, 02 Mar 2009 – 5:07pm
Path\Name : K:\RC00689_PG&E_TOPOCK\ACAD\B16_new.dwg

Acad Version : R17.0s (LMS Tech)
User Name : Jchen

Appendix C

Boring Logs



LOG OF BORING PT-7 S/D

PG&E Topock Site
Needles, California

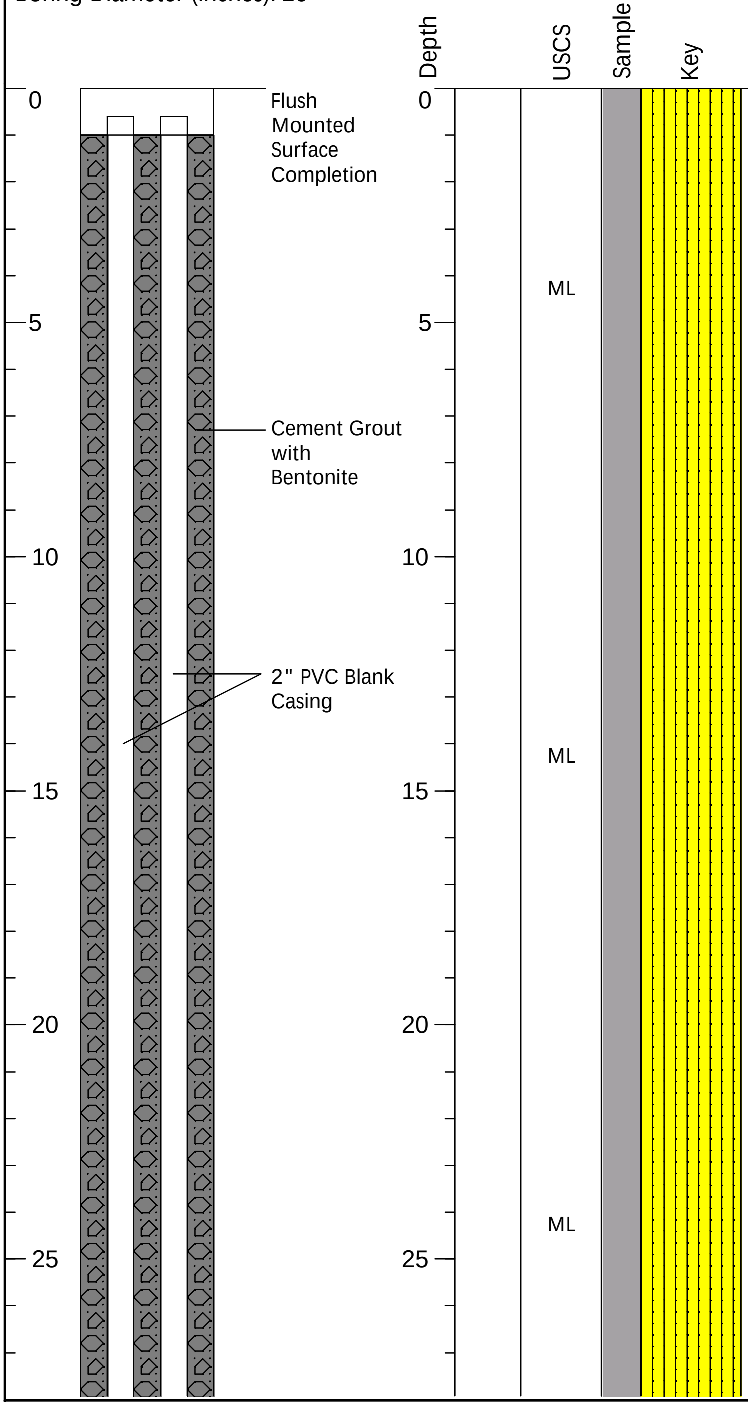
Project No.: RC000689.0004
Logged by: Brett Bardsley
Drilling Co.: WDC
Drillers: Rivera, West, Sakioka, Villegas
Well Permit #2007040402, 2007040400

Date Started: 9 May 2007
Date Completed: 11 May 2007
Drilling Method: Rotosonic/Mud Rotary
Sample Method: 4" x 6" Core Rod
Driller's License: C57-283326

WELL CONSTRUCTION

LITHOLOGIC DESCRIPTION

Boring Diameter (inches): 10



Sandy Silt with Gravel; very pale brown (10YR 8/2); 60% silt, 20% medium to coarse grained sand; 20% fine to coarse subangular gravel; trace subangular cobbles; non-plastic; dry. Cobbles average 3 to 3.5 inches from 0 to 15 feet bgs.

@ 2 feet: changes to light gray (10YR 7/2).

@ 6 feet: 4-inch cobble observed.

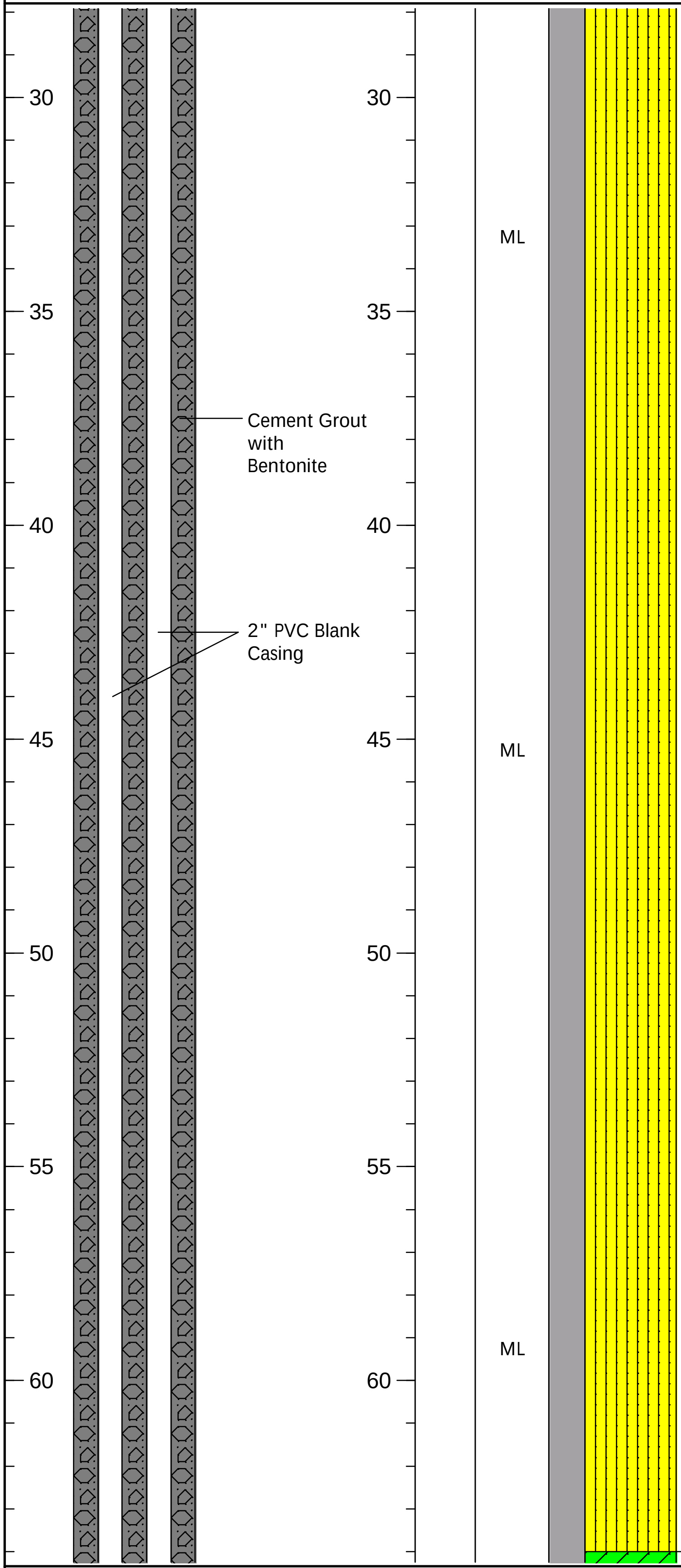
@ 15 feet: changes to Silt; light gray (2.5Y 7/2); 95% silt; 5% coarse grained sand; non-plastic; dry.

@ 18 feet: changes to Silt with Sand; 80% silt; 15%coarse grained sand; 5% fine subangular gravel. Gravel is approximately 1 inch.

@ 20 feet: changes to Sandy Silt with Gravel; 60% silt; 25% medium to coarse grained sand; 15% fine to coarse subangular gravel.

LOG OF BORING PT-7 S/D
(Continued)

WELL CONSTRUCTION | Depth | USCS | Sample | Key | LITHOLOGIC DESCRIPTION



@ 30 feet: Silt with Sand; 90% silt; 10% medium to coarse grained sand.

@ 31 feet: Silt with Gravel; 85% silt; 15% fine to coarse subangular gravel ranging from 1 to 3 inches.

@ 32 feet: Sandy Silt; grayish brown (10YR 5/2); 60% silt; 40% medium to coarse grained sand; non-plastic; moist.

@ 34 feet: trace subangular cobbles ranging from 3 to 4 inches.

@ 35 feet: no cobbles.

@ 37 feet: changes to light gray (2.5Y 7/2); 75% silt; 25% medium to coarse grained sand; non-plastic; dry.

@ 40 feet: Sandy Silt with Gravel; light gray (2.5Y 7/2); 60% silt; 20% fine to coarse grained sand; 20% fine subangular gravel.

@ 42 feet: changes to light gray (5Y 7/1).

@ 43 feet: changes to pinkish gray (5YR 6/2) to dark reddish brown (5YR 3/4).

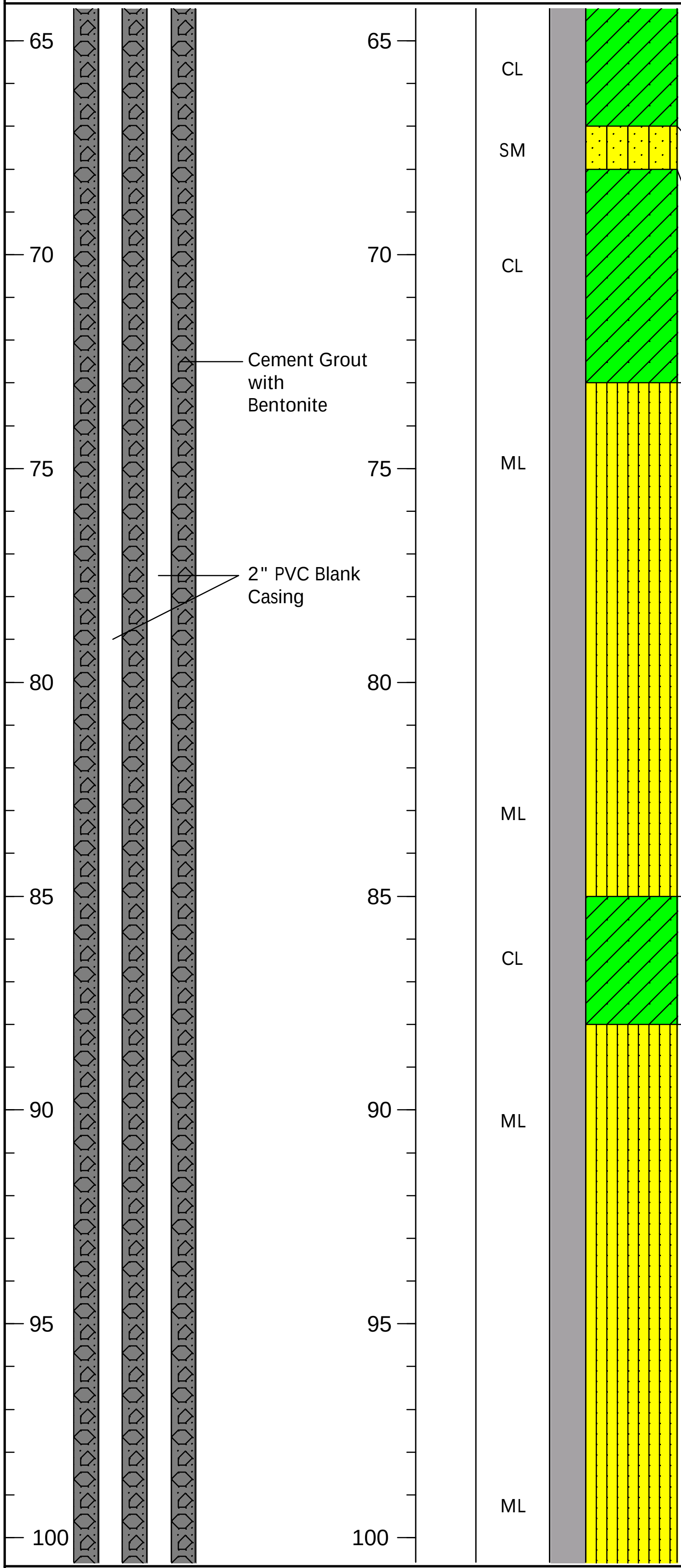
@ 45 feet: Sandy Silt with Gravel; light gray (2.5Y 7/2); 60% silt; 30% fine to medium grained sand; 10% fine subangular gravel.

@ 47 feet: fine to coarse grained sand.

@ 63 feet: trace subangular cobbles up to 3.5 inches.

LOG OF BORING PT-7 S/D
(Continued)

WELL CONSTRUCTION | Depth | USCS | Sample | Key | LITHOLOGIC DESCRIPTION



Sandy Clay; dark reddish brown (5YR 3/3); 60% lean clay; 40% fine to coarse grained sand; low plasticity; wet.

@ 65 feet: Sandy Clay with Gravel; dark grayish brown (10YR 5/2); 60% lean clay; 30% medium to coarse grained sand; 10% fine subangular gravel; low plasticity; wet.

Silty Sand; dark grayish brown (10YR 5/2); 90% medium to coarse grained sand; 10% silt; non-plastic; wet.

Lean Clay with Gravel; very dark gray (6YR 3/1); 90% clay; 10% fine subanguar gravel; low plasticity; moist.

@ 72 feet: Lean Clay; dark grayish brown (10YR 4/2); 95% lean clay; 5% fine subangular gravel; low plasticity; moderately cemented; moist.

Silt with Sand; light brownish gray (10YR 6/2); 80% silt; 15% coarse grained sand; 5% fine subangular gravel; non-plastic; dry.

@ 77 feet: trace subangular cobbles.

@ 78 feet: Sandy Silt with Gravel; light brownish gray; 70% silt; 20% medium to coarse grained sand; 10% fine subangular gravel; trace cobbles to 3.5 inches; non-plastic; dry.

Sandy Clay; dark grayish brown (10YR 4/2) and zones of dark red (10R 3/6); 80% lean clay; 20% medium to coarse grained sand; trace cobbles up to 4 inches; low plasticity; moist.

Sandy Silt with Gravel; dark grayish brown (10YR 4/2); 55% silt; 35% medium to coarse grained sand; 10% fine to coarse subangular gravel; non-plastic; moist. Thin moderately cemented zones (hardpan).

@ 90 feet: pale brown (10YR 6/3); trace subangular cobbles up to 3.5 inches; dry.

@ 93 feet: 70% silt; 20% medium to coarse grained sand; 10% fine to coarse grained gravel; trace subangular cobbles.

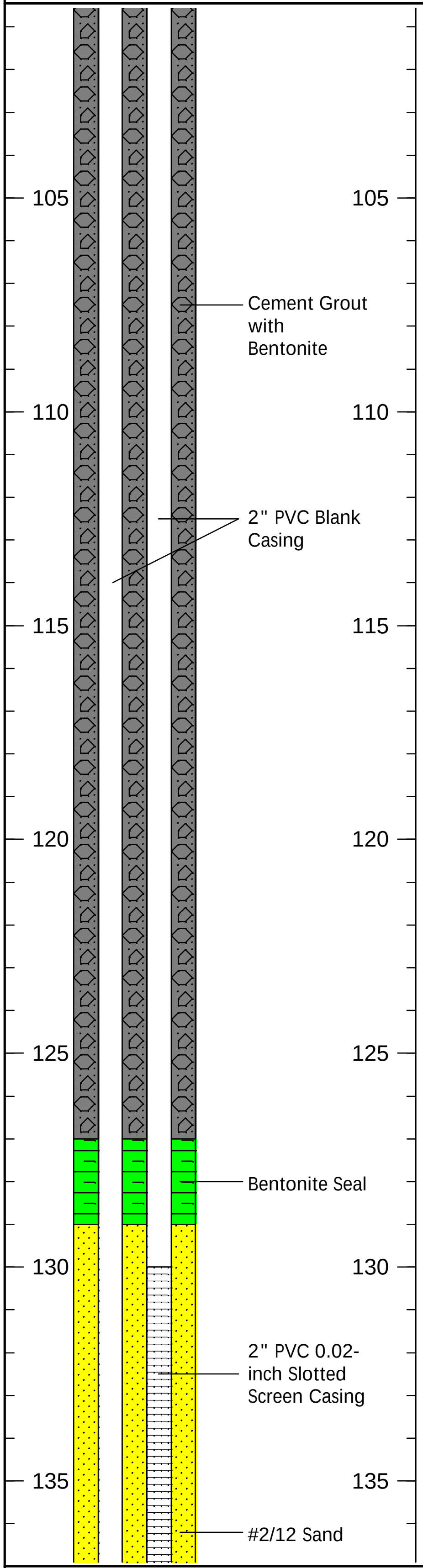
@ 97 feet: larger quantity of cobbles ranging from 3.5 to 4 inches.

@ 98 feet: Silt with Gravel; pale brown (10YR 6/3); 85% silt; 10% fine subangular gravel; 5% coarse grained sand; one 3.5-inch subangular cobble; non-plastic; dry.

@ 100 feet: Sandy Silt with Gravel; pale brown (10YR 6/3); 70% silt; 20% medium to coarse grained sand; 10% fine subangular gravel.

LOG OF BORING PT-7 S/D
(Continued)

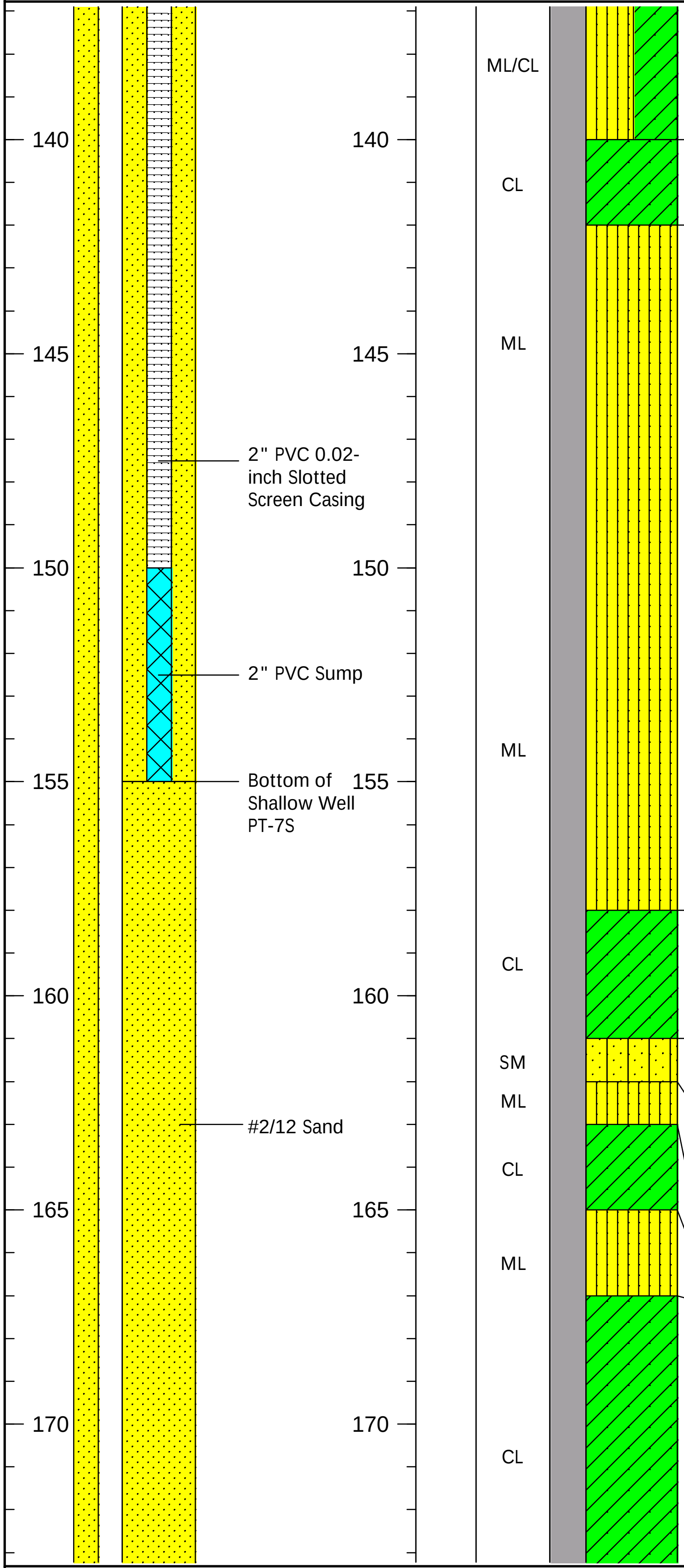
WELL CONSTRUCTION



USCS	LITHOLOGIC DESCRIPTION
ML	
SM	Silty Sand with Gravel; dark grayish brown (10YR 4/2); 70% medium to coarse grained sand; 20% silt; 10% fine subangular gravel; wet.
CL	Sandy Lean Clay; dark reddiish gray (5YR 4/2); 75% lean clay; 20% medium to coarse grained sand; 5% fine subangular gravel; low plasticity; moist. @ 106 feet: dark reddish gray (5YR 4/2); 90% lean clay; 5% coarse grained sand; 5% fine subangular gravel; low plasticity; moist.
SM	Silty Sand; dark reddish gray (5YR 4/2); moist.
ML	Silt; dark reddish gray (5YR 4/2); moist.
CL	Lean Clay; dark reddish gray (5YR 4/2) with dark olive gray seams (5Y 3/2); moist.
SM	Silty Sand; dark reddish gray (5YR 4/2); moist.
CL	Lean Clay; dark reddish gray (5YR 4/2) with dark olive gray seams (5Y 3/2); moist.
SM	Silty Sand; dark reddish gray (5YR 4/2); moist.
ML	Sandy Silt with Gravel; dark reddish gray (5YR 4/2); 70% silt; 20% medium to coarse grained sand; 10% fine subangular gravel; non-plastic; moist.
CL	Lean Clay; dark grayish brown (10YR 4/2); 95% clay; 5% fine to medium grained sand; low plasticity; wet. @ 125 feet: moist.
ML	Silt; dark reddish gray (5YR 4/2); 95% silt; 5% fine to medium grained sand; non-plastic; moist. @ 128 feet: 3 to 4-inch layers of low plasticity lean clay.
CL	Lean Clay with Sand; light gray (5YR 7/1), pink (5YR 8/4), and dark gray (2.5Y 4/1); 85% clay; 10% medium to coarse grained sand; 5% fine subangular gravel; trace subangular cobbles; low to medium plasticity; wet. @ 135.5 feet: a seam of greenish black (GLEY2 5BG).
	Clayey Silt; dark grayish brown (10YR 4/2); 55% silt; 45% clay; trace medium to

LOG OF BORING PT-7 S/D
(Continued)

WELL CONSTRUCTION | Depth | USCS | Sample | Key | LITHOLOGIC DESCRIPTION



coarse grained sand and fine subangular gravel; low plasticity; hard; moist.

Lean Clay; dark grayish brown (10YR 4/2); 95% lean clay; 5% medium to coarse grained sand; low plasticity; very stiff; wet.

Silt; dark grayish brown (10YR 4/2); 95% silt; 5% medium to coarse grained sand; non-plastic; hard; moist.

@ 144 feet: moderately cemented.

@ 152 feet: Sandy Silt with Gravel; light gray (5Y 7/1); 70% silt; 20% medium to coarse grained sand; 10% fine subangular gravel; non-plastic; very soft; moist.

@ 156 feet: very dark grayish brown (10YR 3/2); with areas of light reddish brown (2.5YR 7/4) and dark red (2.5YR 3/6); 60% silt; 30% fine to coarse grained sand; 10% fine subangular gravel.

Lean Clay with Sand; dark reddish gray (2.5YR 3/1) with areas of light reddish brown (2.5YR 7/4) and dark red (2.5YR 3/6); 90% lean clay; 10% fine to medium grained sand; low plasticity; soft; wet.

Silty Sand; dark reddish gray (2.5YR 4/1); 90% medium to coarse grained sand; 10% silt; wet.

Silt with Gravel; dark reddish gray (2.5YR 4/1) with areas of light red (2.5YR 7/8); 80% silt; 15% fine subangular gravel; 5% medium to coarse grained sand; non-plastic; wet.

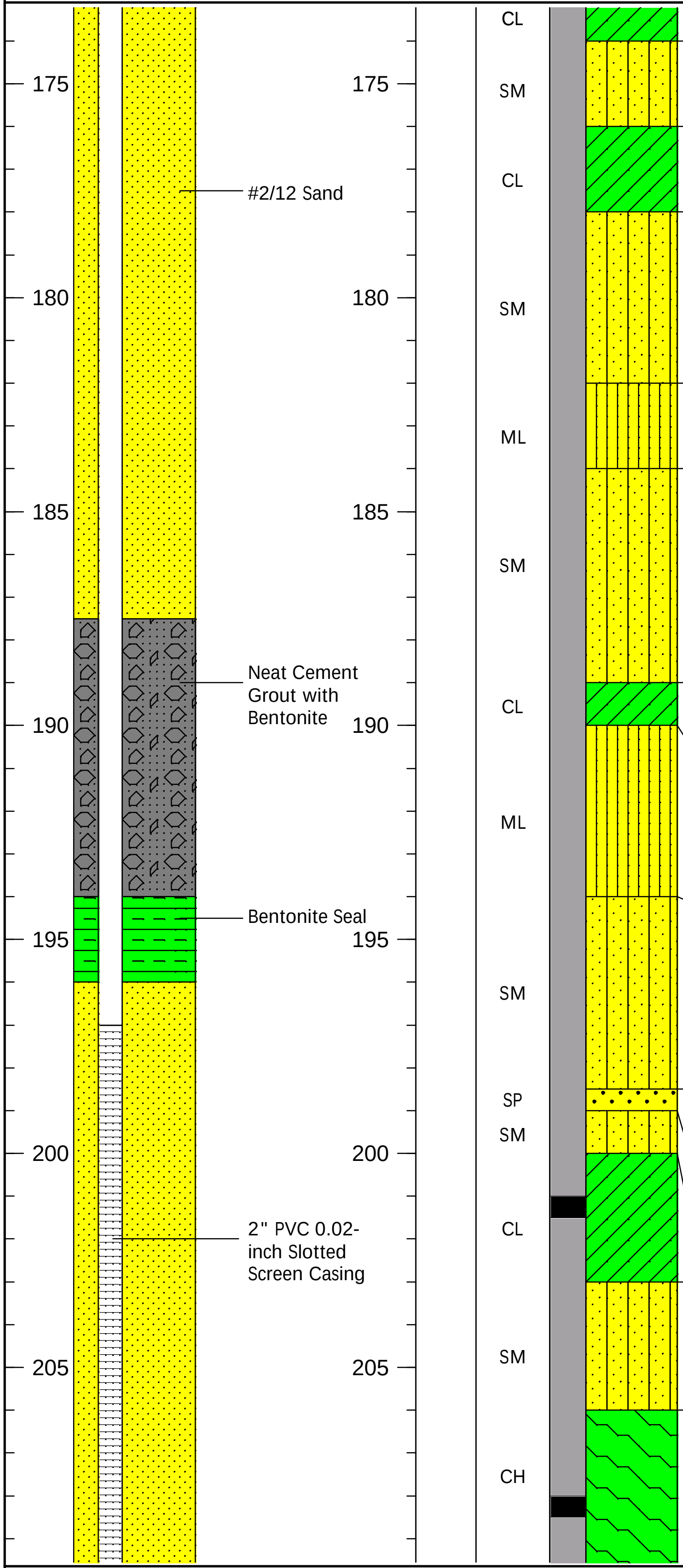
Silty Clay with Sand; dark reddish brown (2.5YR 3/4); 50% clay; 40% silt; 10% coarse grained sand; low plasticity; wet.

Sandy Silt with Gravel; dark reddish gray (2.5YR 4/1); 70% silt; 20% medium to grained sand; 10% fine subangular gravel; non-plastic; moist.

Lean Clay; dark reddish gray (10R 3/1); 95% clay; 5% medium to coarse grained sand; low plasticity; very soft; wet.

LOG OF BORING PT-7 S/D
(Continued)

WELL CONSTRUCTION | Depth | USCS | Sample | Key | LITHOLOGIC DESCRIPTION



Silty Sand; dark reddish gray (10R 3/1); 70% medium to coarse grained sand; 30% silt; non-plastic; wet.

Lean Clay; dark reddish gray (2.5YR 3/1); 95% clay; 5% medium to coarse grained sand; trace fine subangular gravel; low plasticity; medium stiff; moist.

Silty Sand with Gravel; dark reddish brown (2.5YR 3/4); 60% fine to coarse grained sand; 30% silt; 10% fine subangular gravel; moist.

@ 181 feet: coarse subangular gravel ranging from 2.5 to 2.9 inches.

Sandy Silt with Gravel; dark red (2.5YR 3/6); 60% silt; 30% fine to coarse grained sand; 10% fine to coarse subangular gravel; non-plastic; moist.

Silty Sand with Gravel; dark reddish gray (10R 3/1); 60% medium to coarse grained sand; 30% silt; 10% fine to coarse grained gravel; non-plastic; wet.

@ 186 feet: dark reddish gray (2.5YR 4/1).

Lean Clay with Gravel; dark reddish gray (2.5YR 4/1); 85% clay; 10% fine subangular gravel; 5% fine to coarse grained sand; low plasticity; very stiff; moist.

Silt with Gravel; reddish gray (2.5YR 6/1); 90% silt; 10% fine to coarse subangular gravel; trace coarse grained sand; moist.

Gravel coarsens with depth.

@ 192 feet: Gravelly Silt; dark reddish gray (2.5YR 4/1); 60% silt; 35% fine to coarse subangular gravel; 5% fine to coarse grained sand; non-plastic; moist.

Silty Sand with Gravel; dark reddish gray (2.5YR 4/1); 60% fine to coarse grained sand; 25% silt; 15% fine to coarse subangular gravel; moist.

@ 198 feet: very dark grayish green (GLEY1 2.5/2).

Poorly Graded Sand; dark grayish brown (2.5Y 3/2); 100% fine to medium grained sand; wet.

Silty Sand with Gravel; dark reddish gray (2.5YR 4/1); 60% fine to coarse grained sand; 25% silt; 15% fine to coarse subangular gravel; wet.

Sandy Lean Clay with Gravel; dark reddish gray (2.5YR 4/1); 70% clay; 20% medium to coarse grained sand; fine subangular gravel; low plasticity; wet.

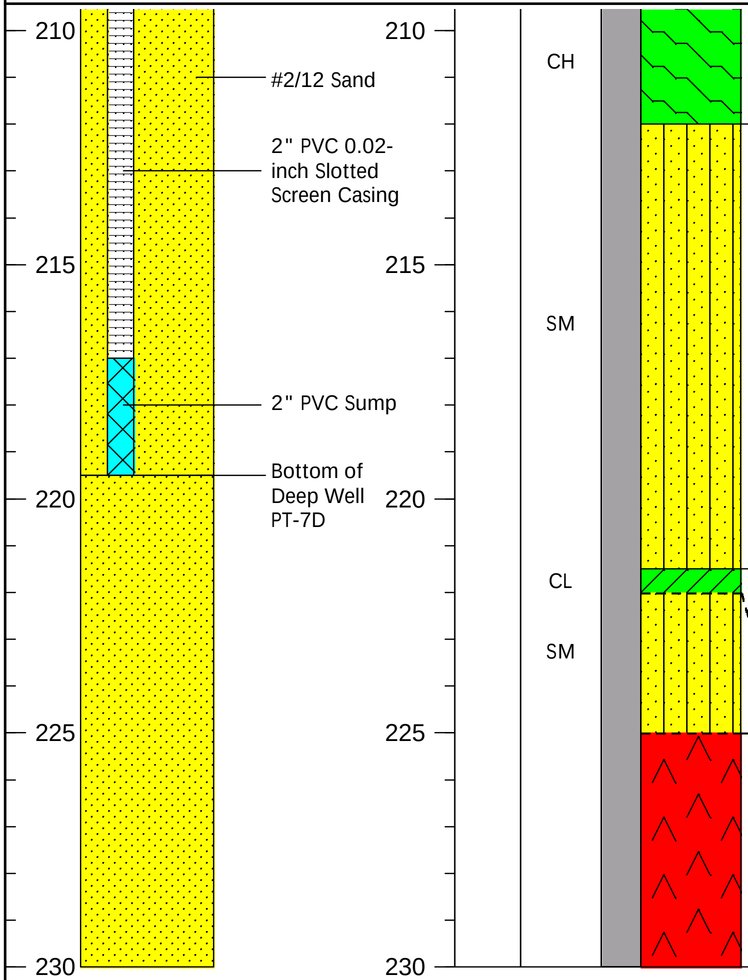
Silty Sand with Gravel; dark reddish gray (2.5YR 4/1); 60% fine to coarse grained sand; 25% silt; 15% fine to coarse subangular gravel; wet.
@ 203.5 feet: very dark grayish green (GLEY1 2.5/2).

Fat Clay; dark red (2.5YR 3/6); 100% clay; plasticity; very soft; wet.

@ 209 feet: trace fine subangular gravel.

LOG OF BORING PT-7 S/D
(Continued)

WELL CONSTRUCTION



LITHOLOGIC DESCRIPTION

@ 210 feet: Sandy Fat Clay; dark red (2.5YR 3/6); 80% clay; 20% coarse grained sand; medium stiff; wet.

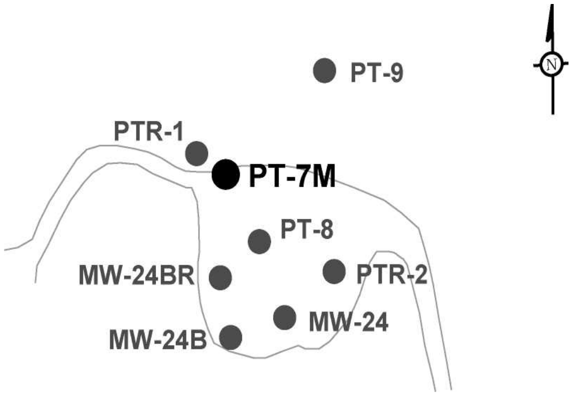
Silty Sand with Gravel; dark red (2.5YR 3/6); 60% medium to coarse grained sand; 30% silt; 10% fine to coarse subangular gravel; non-plastic; wet.

Lean Clay with Sand; dark red (2.5YR 3/6); 90% clay; 10% coarse grained sand; medium stiff; wet.

Silty Sand with Gravel; dark red (2.5YR 3/6); 60% medium to coarse grained sand; 30% silt; 10% fine to coarse subangular gravel; non-plastic; wet. (Based on soil cuttings; driller lost sample).

Bedrock; conglomerate; reddish brown (5YR 4/4); 100% silt; homogeneous; dry.

Total Depth Explored: 230 feet bgs



LOG OF BORING PT-7 M

PG&E Topock Site
Needles, California

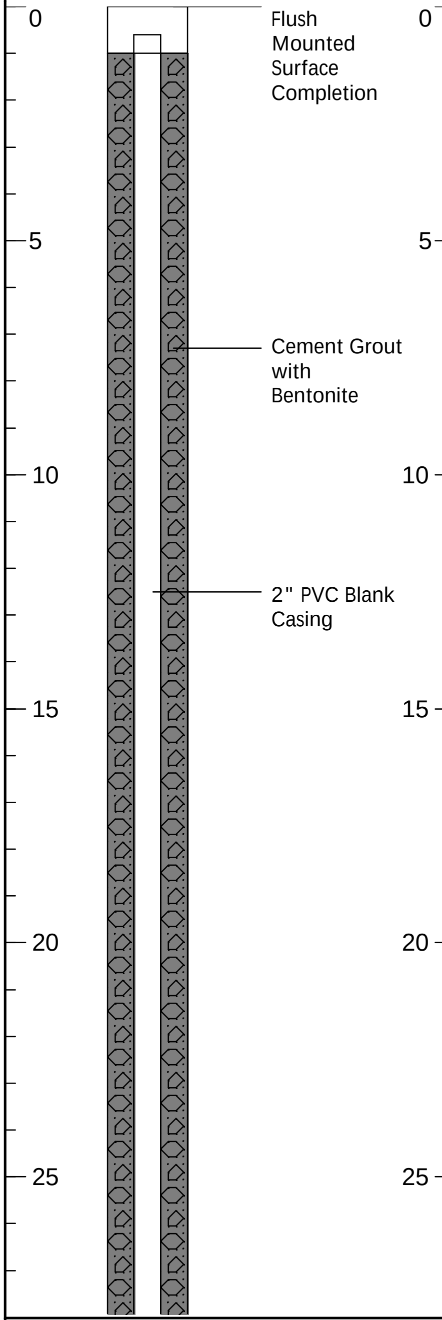
Project No.: RC000689.0004
Logged by: Brett Bardsley
Drilling Co.: WDC
Drillers: Rivera, West, Sakioka, Villegas
Well Permit #2007040401

Date Started: 9 May 2007
Date Completed: 11 May 2007
Drilling Method: Rotosonic/Mud Rotary
Sample Method: 4" x 6" Core Rod
Driller's License: C57-283326

WELL CONSTRUCTION

LITHOLOGIC DESCRIPTION

Boring Diameter (inches): 6

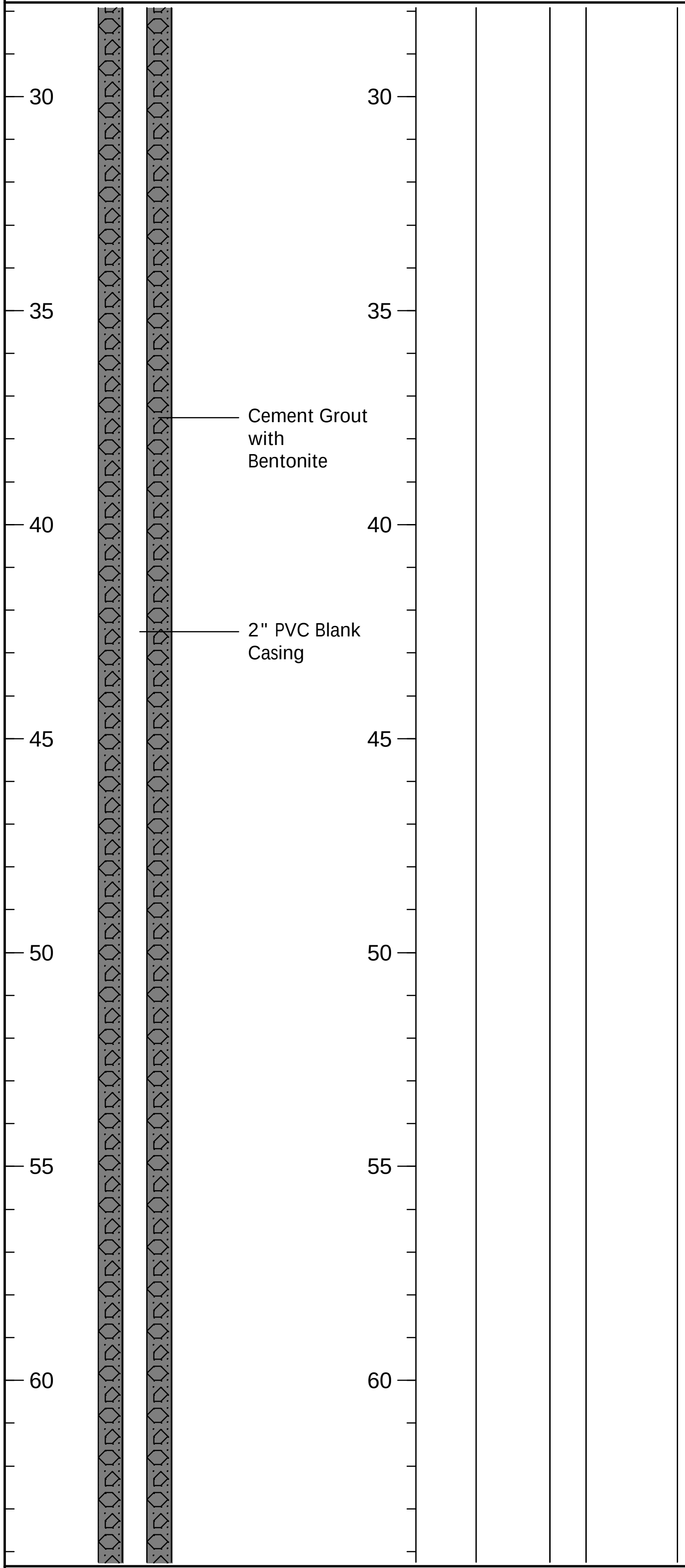


Depth	USCS	Sample	Key	
0				For lithologic description, see PT-7 S/D.
5				
10				
15				
20				
25				

ARCADIS

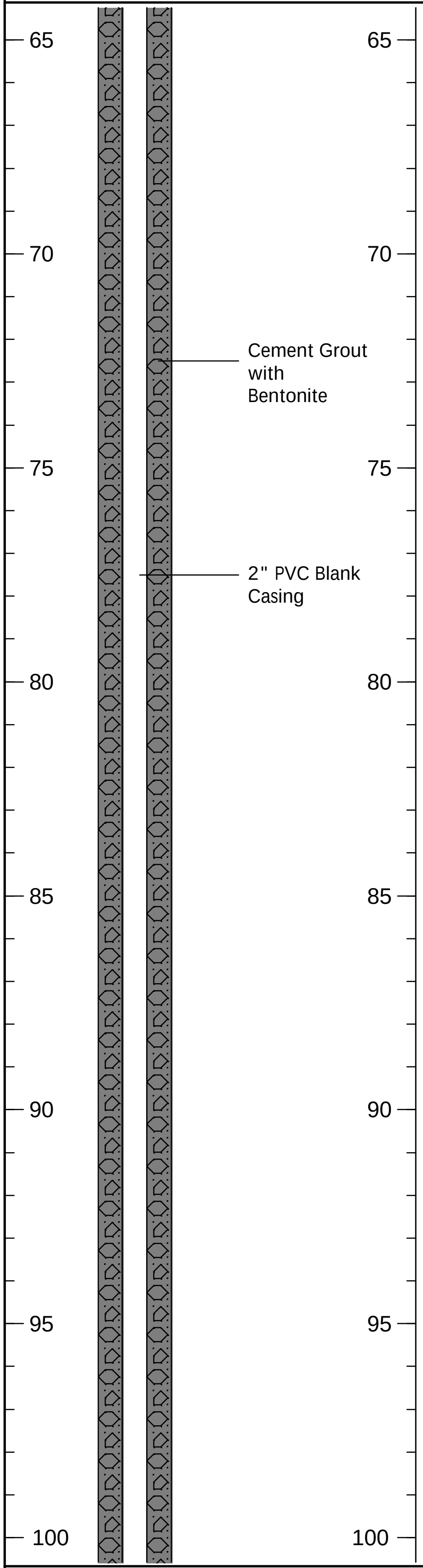
LOG OF BORING PT-7 M
(Continued)

WELL CONSTRUCTION | Depth | USCS | Sample | Key | LITHOLOGIC DESCRIPTION



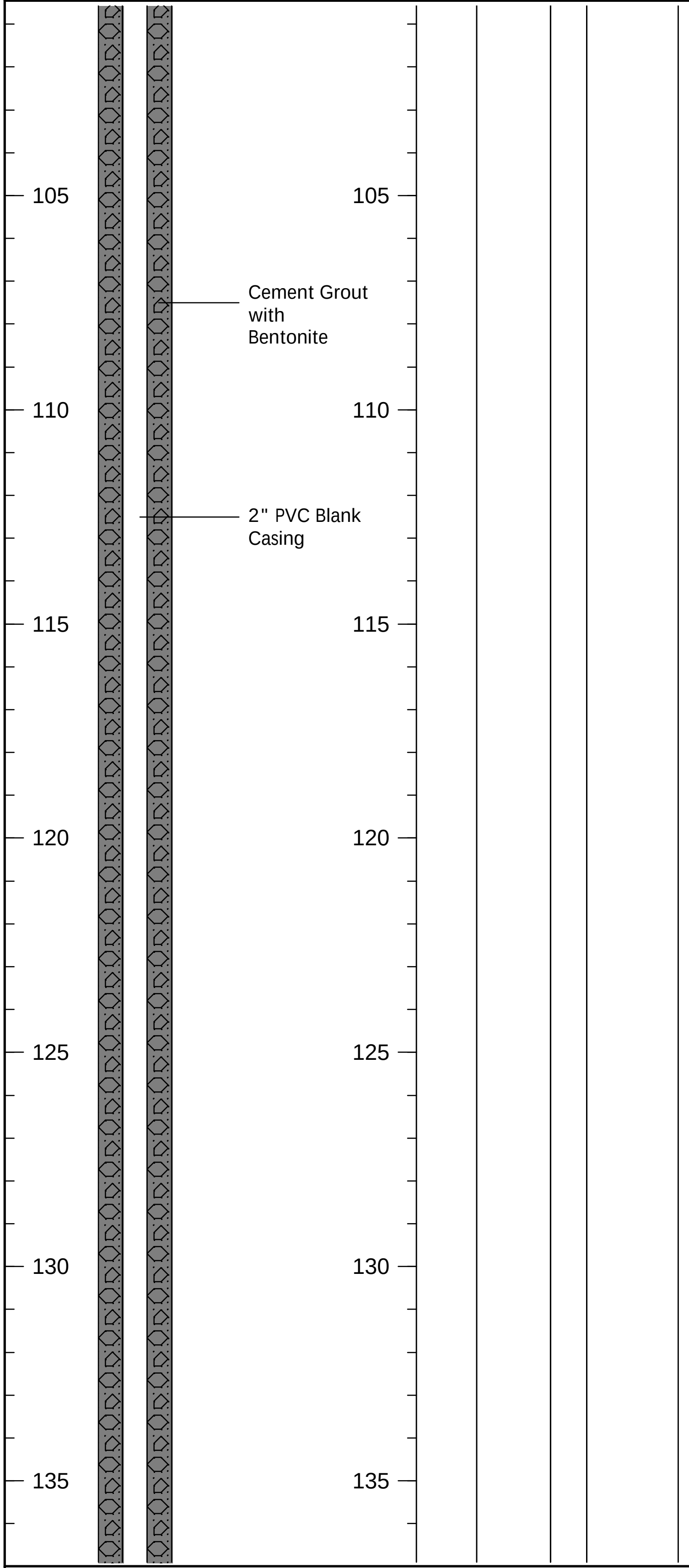
LOG OF BORING PT-7 M
(Continued)

WELL CONSTRUCTION | Depth | USCS | Sample | Key | LITHOLOGIC DESCRIPTION



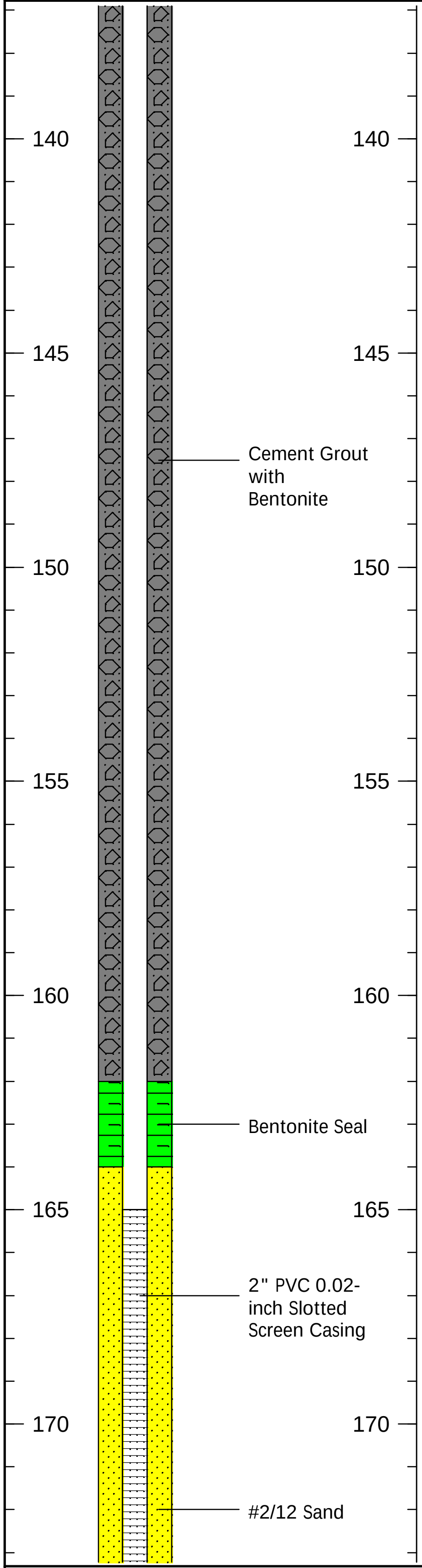
LOG OF BORING PT-7 M
(Continued)

WELL CONSTRUCTION | Depth | USCS | Sample | Key | LITHOLOGIC DESCRIPTION



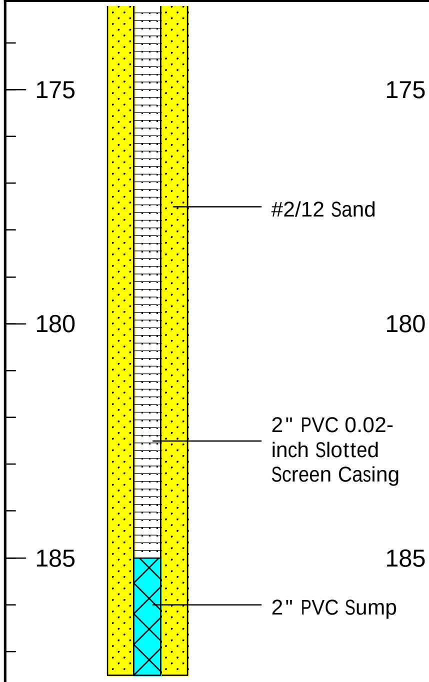
LOG OF BORING PT-7 M
(Continued)

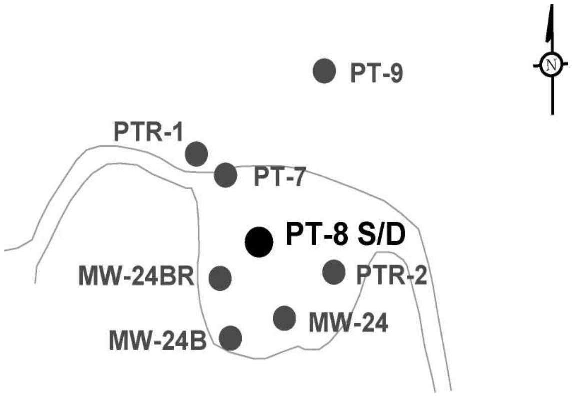
WELL CONSTRUCTION	Depth	USCS	Sample	Key	LITHOLOGIC DESCRIPTION



LOG OF BORING PT-7 M
(Continued)

WELL CONSTRUCTION	Depth	USCS	Sample	Key	LITHOLOGIC DESCRIPTION
	175				
	180				
	185				
					End of boring at 187.5 feet bgs





LOG OF BORING PT-8 S/D

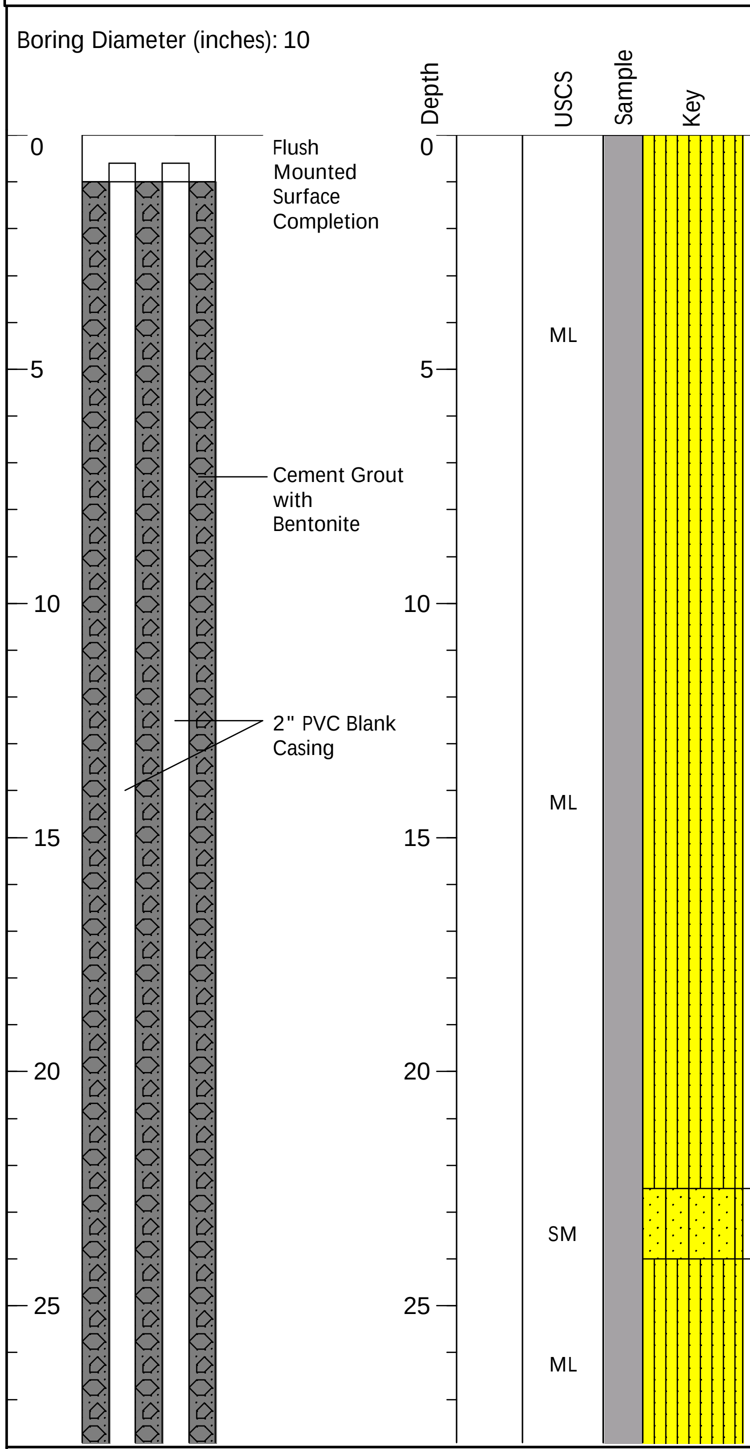
PG&E Topock Site
Needles, California

Project No.: RC000689.0004
Logged by: Brett Bardsley
Drilling Co.: WDC
Drillers: Rivera, West, Sakioka, Villegas
Well Permit #2007040403, 2007040405
Date Started: 12 May 2007
Date Completed: 21 May 2007
Drilling Method: Rotosonic/Mud Rotary
Sample Method: 4" x 6" Core Rod
Driller's License: C57-283326

WELL CONSTRUCTION

LITHOLOGIC DESCRIPTION

Boring Diameter (inches): 10



Sandy Silt with Gravel; light gray (10YR 7/2); 60% silt, 20% fine to coarse grained sand; 20% fine to coarse subangular gravel; non-plastic; dry.

@ 3 feet: trace subangular cobbles ranging from 2.9 to 3.5 inches.

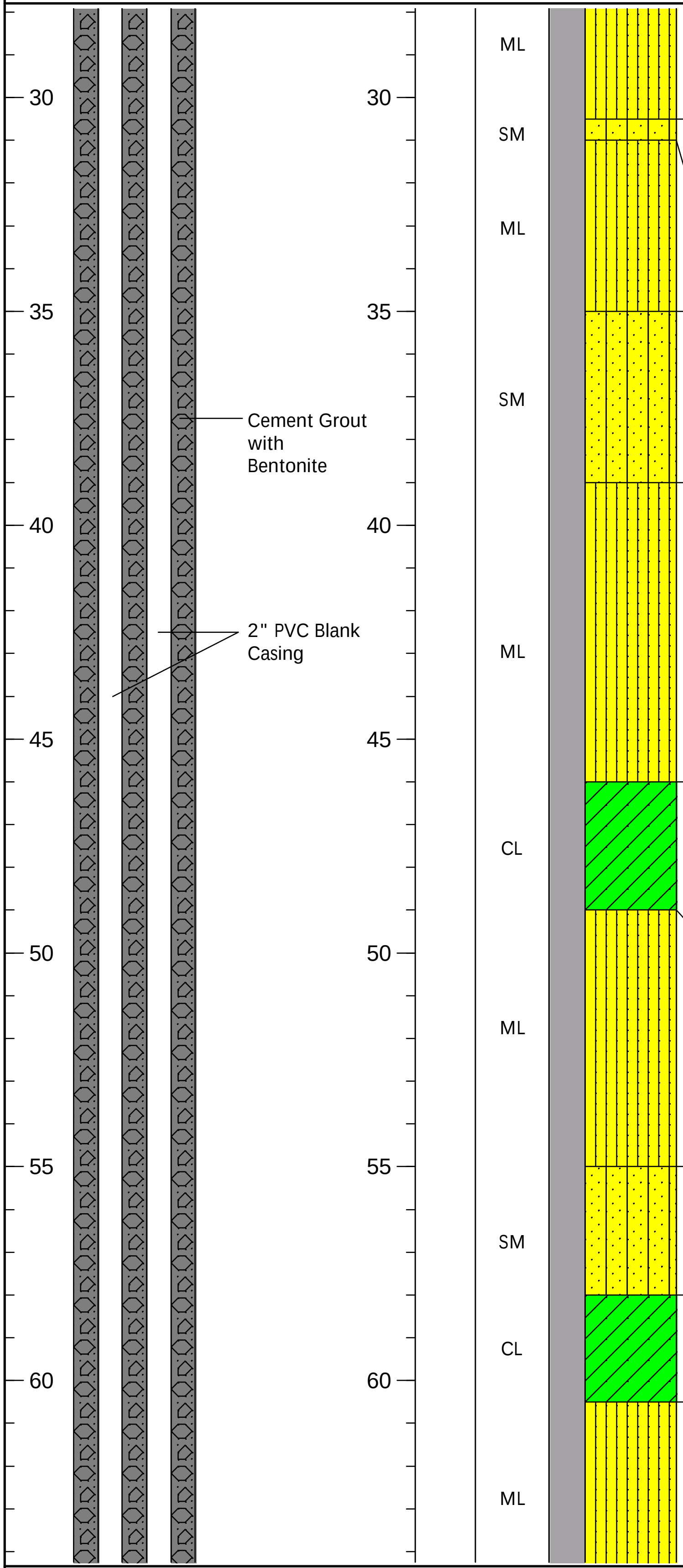
@ 15 feet: light brownish gray (10YR 6/2).

Silty Sand with Gravel; dark grayish brown (10YR 4/1); 60% fine to coarse grained sand; 30% silt; 10% fine to coarse subangular gravel; moist.

Sandy Silt with Gravel; light gray (10YR 7/2); 60% silt, 20% fine to coarse grained sand; 20% fine to coarse subangular gravel; trace cobbles up to 3.5 inches; non-plastic; dry.

LOG OF BORING PT-8 S/D
(Continued)

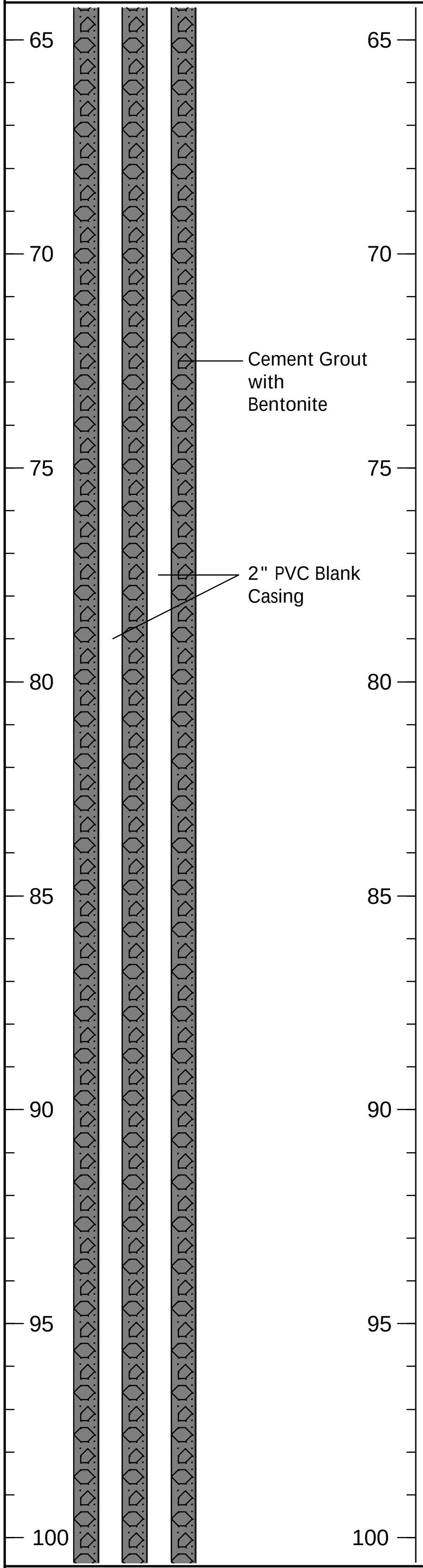
WELL CONSTRUCTION | Depth | USCS | Sample | Key | LITHOLOGIC DESCRIPTION



USCS	LITHOLOGIC DESCRIPTION
ML	
SM	Silty Sand with Gravel; pale brown (10YR 6/3); 70% fine to coarse grained sand; 20% silt; 10% fine to coarse subangular gravel; dry.
ML	Sandy Silt with Gravel; light gray (10YR 7/2); 60% silt, 20% fine to coarse grained sand; 20% fine to coarse subangular gravel; non-plastic; dry.
SM	Silty Sand; dark reddish gray (10YR ?/?); 70% medium to coarse grained sand; 25% silt; 5% fine subangular gravel; wet. @ 37 feet: fine to coarse grained sand and trace cobbles up to 3.3 inches.
ML	Sandy Silt with Gravel; light gray (10YR 7/2); 60% silt, 30% fine to coarse grained sand; 10% fine to coarse subangular gravel; non-plastic; dry.
CL	Sandy Lean Clay; dark reddish gray (2.5YR 3/1) with some dark red (2.5YR 3/6); 60% lean clay; 40% medium to coarse grained sand; low plasticity; medium stiff, wet. @ 47 feet: changes to very dark grayish brown (10YR 3/2) with some dark red (2.5YR 3/6); 80% lean clay; 20% medium to coarse grained sand; soft; moist.
ML	Sandy Silt with Gravel; reddish gray (2.5YR 6/1); 70% silt, 20% fine to coarse grained sand; 10% fine to coarse subangular gravel up to 2 inches; non-plastic; dry.
SM	Silty Sand; dark reddish gray (10R 3/1); with a seam of dark greenish gray (GLEY1 4/1); 60% medium to coarse grained sand; 40% silt; trace fine subangular gravel; wet.
CL	Lean Clay with Gravel; very dark grayish brown (10YR 3/2); 90% lean clay; 10% fine subangular gravel; low plasticity; stiff; moist. @ 60 feet: 4-inch moderately cemented layer; hard.
ML	Sandy Silt with Gravel; light reddish gray (2.5YR 7/1); 70% silt, 20% medium to coarse grained sand; 10% fine subangular gravel; non-plastic; dry.

LOG OF BORING PT-8 S/D
(Continued)

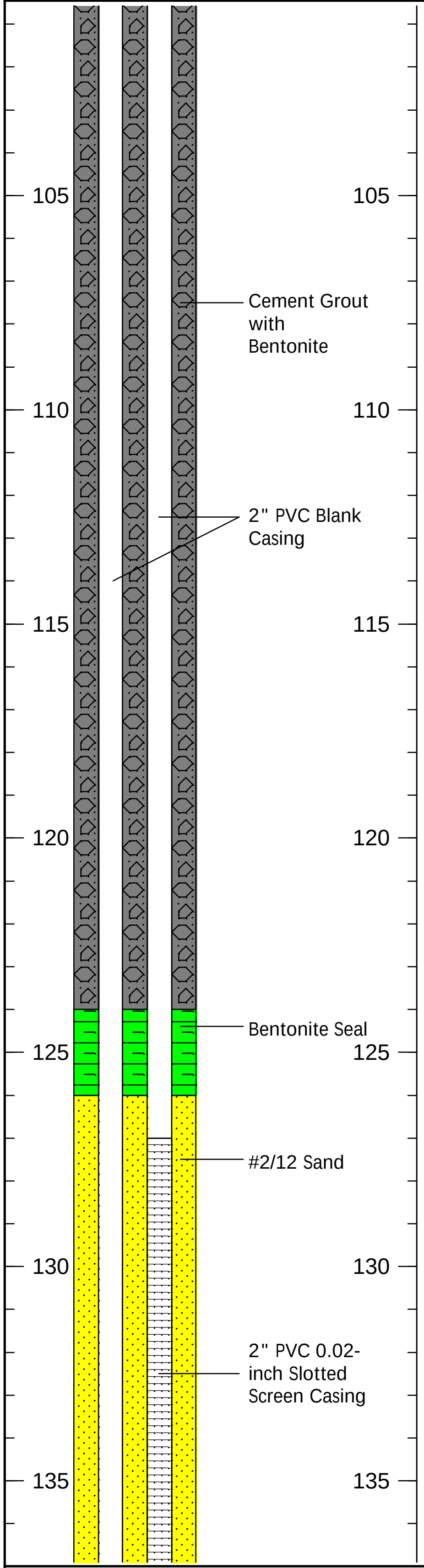
WELL CONSTRUCTION | Depth | USCS | Sample | Key | LITHOLOGIC DESCRIPTION

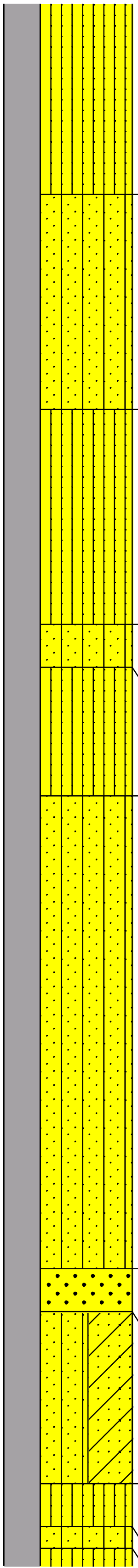


USCS	LITHOLOGIC DESCRIPTION
CL	Sandy Clay; dark reddish gray (2.5YR 3/1); 70% clay, 20% medium to coarse grained sand; trace subangular fine gravel; low plasticity; very soft; wet. @ 68 feet: dark greenish (GLEY 4/1) to light greenish gray (GLEY 7/1) seam (0.5-inch thick)
SM	Silty Sand with Gravel; dark reddish gray (2.5YR 3/1); 60% fine to medium grained sand; 25% silt; 15% fine to coarse subangular gravel; moist.
ML	Sandy Silt with Gravel; light reddish gray (2.5YR 7/1); 70% silt, 20% medium to coarse grained sand; 10% fine subangular gravel; non-plastic; very soft; dry. Alternating with weakly cemented stiff layers.
SM	Silty Sand with Gravel; light gray (10R 7/2); 55% fine to coarse grained sand; 25% silt; 15% fine to coarse subangular gravel; dry.
ML	Sandy Silt with Gravel; light gray (10R 7/2); 70% silt, 25% fine to coarse grained sand; 15% fine to coarse subangular gravel; non-plastic; dry.
CL	Lean Clay with Gravel; dark grayish brown (10YR 4/2); 90% lean clay; 10% fine subangular gravel; medium plasticity; medium stiff; moist.
ML	Silt with Gravel; light reddish gray (2.5YR 7/1); 90% silt; 10% fine subangular gravel; non-plastic; dry. @ 87 feet: 70% silt; 30% fine subangular gravel.
GW	Sandy Gravel; light reddish gray (2.5YR 7/1); 60% fine to coarse subangular gravel; 35% fine to coarse grained sand; 5% silt; moist.
SM	Silty Sand with Gravel; light reddish gray (2.5YR 7/1); 60% fine to coarse grained sand; 20% silt; 20% fine to coarse subangular gravel; dry. @ 93 feet: moderately cemented 2-inch layers. @ 95 feet: dark grayish brown (10YR 4/2); wet.
CL	Lean Clay with Gravel; dark brown (10YR 3/3); 90% clay; 10% fine to coarse subangular gravel; low to medium plasticity; moist.
ML	Sandy Silt; light reddish gray (2.5YR 7/1); 70% silt, 25% fine to coarse grained sand; 5% fine subangular gravel; non-plastic; 1-inch layers that are weakly cemented; stiff; dry, alternating with layers that are non-cemented and soft.

LOG OF BORING PT-8 S/D
(Continued)

WELL CONSTRUCTION | Depth | USCS | Sample | Key | LITHOLOGIC DESCRIPTION

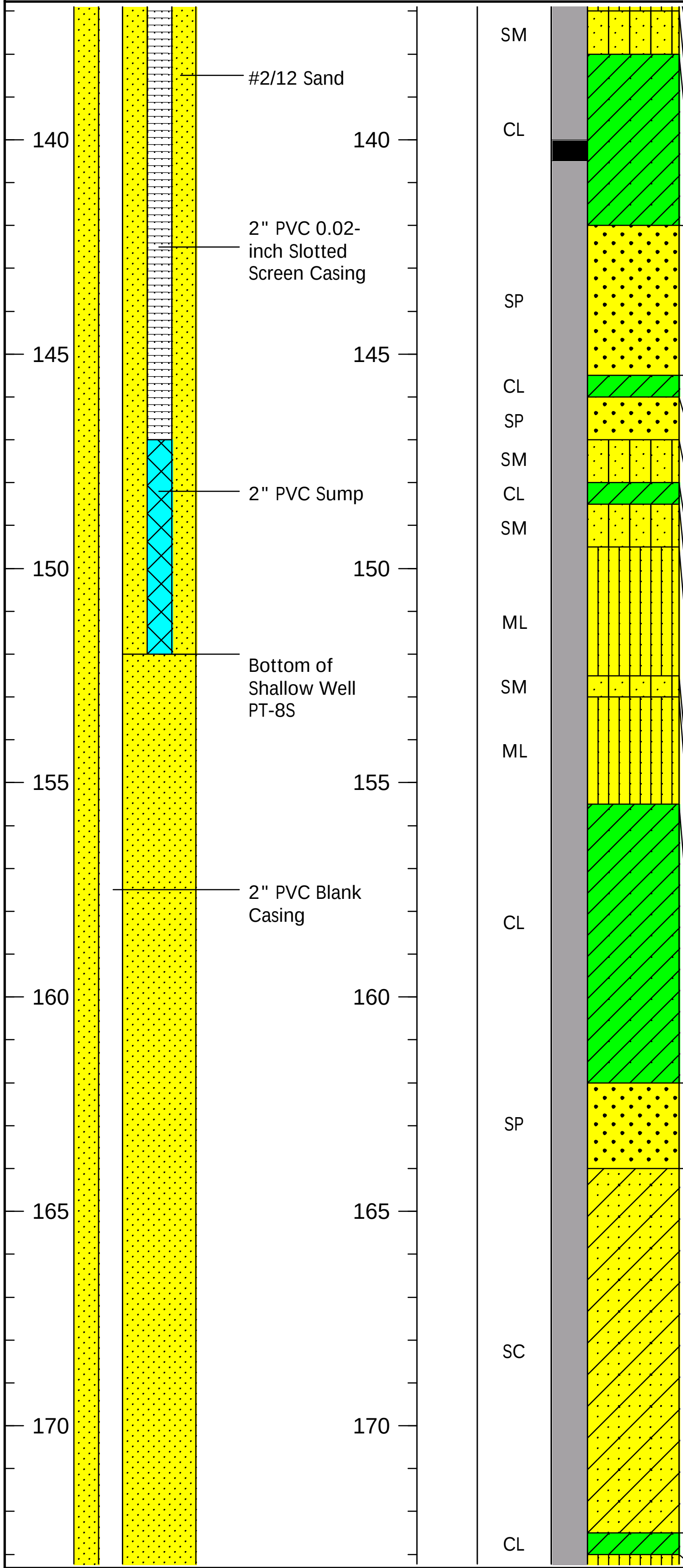




USCS	Lithologic Description
ML	@ 101 feet: light gray (5YR 7/1). @ 103 feet: light reddish gray (2.5YR 7/1); 80% silt; 20% fine to coarse grained sand; weak cementation; very stiff; dry.
SM	Silty Sand with Gravel; light gray (5YR 7/1); 60% fine to coarse grained sand; 25% silt; 15% fine subangular gravel; dry. There are layers that are weak to moderately cemented.
ML	Sandy Silt; light gray (5YR 7/1); 80% silt; 20% fine to coarse grained sand; non-plastic; weakly cemented; stiff; moist. @ 113 feet: very stiff.
SM	Silty Sand with Gravel; dark reddish gray (5YR 4/2); 60% fine to coarse grained sand; 30% silt; 10% fine to coarse subangular gravel; moist.
ML	Sandy Silt; light gray (5YR 7/1); 80% silt; 20% fine to coarse grained sand; non-plastic; weakly cemented; stiff; moist.
SM SM	Silty Sand with Gravel; dark reddish gray (5YR 4/2); 60% fine to coarse grained sand; 30% silt; 10% fine subangular gravel; moist. @ 125 feet: Silty Sand; dark reddish brown (5YR 3/2); 80% medium to coarse grained sand; 20% silt; trace fine to coarse subangular gravel; wet.
SP	Poorly Graded Sand; dark reddish brown (5YR 3/2); 95% medium to coarse grained sand; 5% silt; wet.
SM/SC	Silty Sand; dark reddish brown (5YR 3/2); 80% medium to coarse grained sand; 20% silt; trace fine to coarse subangular gravel; wet. 0.5-inch seams of Clayey Sand; dark reddish brown (5YR 3/2); 70% medium to coarse grained sand; 30% lean clay; low to medium plasticity; wet.
ML	Sandy Silt; reddish gray (10R 6/1); 70% silt, 30% fine to coarse grained sand; moderately cemented; non-plastic; stiff; dry.
SM	Silty Sand; dark reddish brown (5YR 3/2); 80% medium to coarse grained sand;
ML	

LOG OF BORING PT-8 S/D
(Continued)

WELL CONSTRUCTION | Depth | USCS | Sample | Key | LITHOLOGIC DESCRIPTION



20% silt; trace fine to coarse subangular gravel; moist.

Sandy Silt; reddish gray (10R 6/1); 70% silt, 30% fine to coarse grained sand; moderately cemented; non-plastic; stiff; dry. Underlied and overlied by 1 to 2-inch layers of moderately cemented silt with fine to coarse grained sand (hardpan).

Silty Sand; dark reddish gray (10R 4/1); 70% medium to coarse grained sand; wet.

Gravelly Clay; dark reddish gray (10YR 4/1); 70% lean clay; 20% fine to coarse subangular gravel; 10% coarse grained sand; medium plasticity; wet.

Poorly Graded Sand; dark reddish gray (10R 4/1); 95% coarse grained sand; 5% silt; wet.

Sandy Clay; dark reddish gray (10R 4/1); 60% clay, 40% medium to coarse grained sand; low plasticity; wet.

Poorly Graded Sand; dark reddish gray (10R 4/1); 95% fine to coarse grained sand; 5% silt; wet.

Silty Sand; dark reddish gray (10R 4/1); 70% fine to coarse grained sand; 30% silt; wet.

Sandy Clay; dark reddish gray (10R 4/1); 60% clay, 40% medium to coarse grained sand; low plasticity; wet.

Silty Sand; dark reddish gray (10YR 4/1); 70% fine to coarse grained sand; 30% silt; wet.

Sandy Silt with Gravel; dark reddish gray (10R 4/1); 60% silt, 30% fine to coarse grained sand; moderately cemented; non-plastic; moist.
@ 150 feet: light gray (10Y 7/1); 70% silt; 20% fine to coarse grained sand; 10% fine to coarse subangular gravel; non-plastic; moist. 1-inch moderately cemented layers present.

Silty Sand; dark reddish gray (10R 3/1); medium to coarse grained sand; wet.

Sandy Silt with Gravel; light gray (10Y 7/1); 70% silt; 20% fine to coarse grained sand; 10% fine to coarse subangular gravel; non-plastic; moist.
@ 154.5 feet: Sandy Silt; 80% silt; 20% fine to coarse grained sand; trace fine subangular gravel; moderately cemented.

Sandy Lean Clay; dark reddish gray (10R 3/1) with dark red (10R 3/6); 80% clay; 20% medium to coarse grained sand; low plasticity; moderately cemented; moist (hardpan).
@ 158 feet: 70% clay; 30% coarse grained sand; medium plasticity; very soft; wet.
@ 159 feet: weak cementation.
@ 161 feet: fine to coarse grained sand; low plasticity; very soft.

Poorly Graded Sand; dark reddish brown (2.5YR 3/4); 95% fine to coarse grained sand; 5% silt; wet.

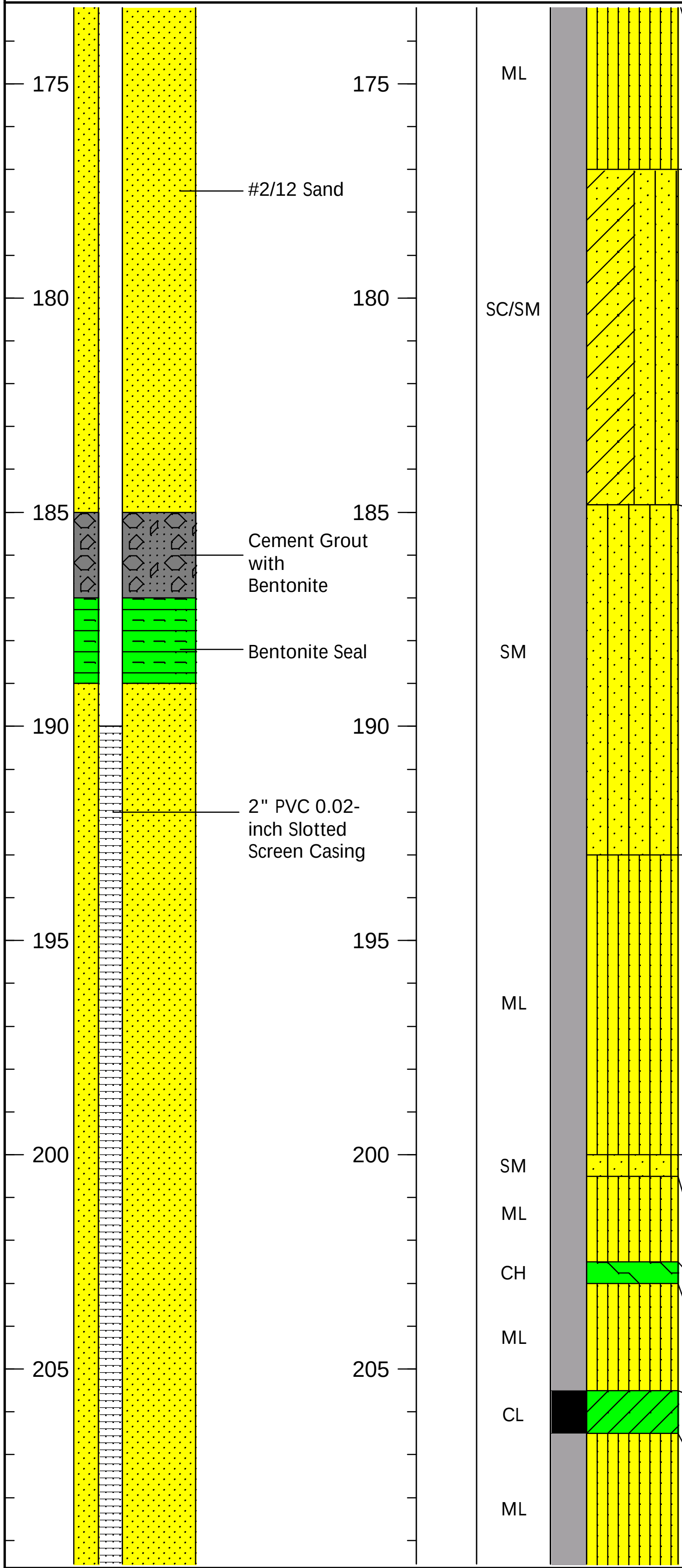
Clayey Sand; dark reddish brown (2.5YR 3/4); 80% fine to coarse grained sand; 20% lean clay; trace fine to coarse subangular gravel up to 3.5-inches; low plasticity; very soft; wet.

@ 165 feet: trace fine subangular gravel.

Sandy Lean Clay; dark reddish brown (2.5YR 3/4); 70% medium to coarse grained

LOG OF BORING PT-8 S/D
(Continued)

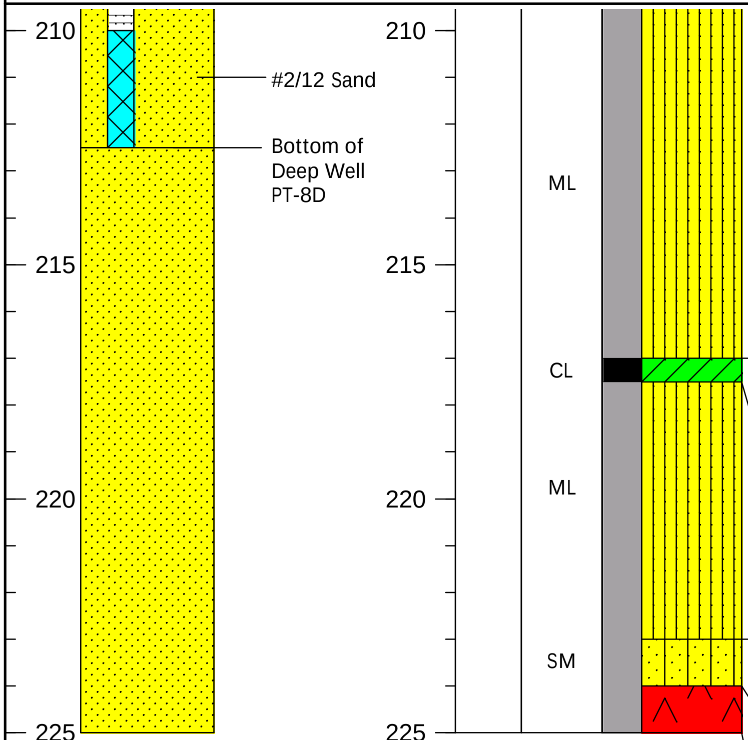
WELL CONSTRUCTION | Depth | USCS | Sample | Key | LITHOLOGIC DESCRIPTION



USCS	LITHOLOGIC DESCRIPTION
	sand; 30% ??; low plasticity; weak to moderate cementation; very stiff.
ML	Sandy Silt with Gravel; light reddish gray (2.5YR 7/1) to light reddish brown (2.5YR 7/4); 60% silt; 20% fine to coarse grained sand; non-plastic; moist to wet. Layers of weak to moderate cementation.
SC/SM	Clayey Sand with Gravel; dark reddish brown (2.5YR 3/4); 65% medium to coarse grained sand; 30% clay; 5% fine subangular gravel; low plasticity; very soft; wet. There are 1 to 2-inch thick layers of silty sand in between. @ 184.5 feet: Moderately cemented layer; hard (round disc).
SM	Clayey Sand with Gravel; dark reddish brown (2.5YR 3/4); 65% medium to coarse grained sand; 30% clay; 5% fine subangular gravel; low plasticity; very soft; wet. Has moderately cemented hard layers (1 to 2 inches); some layers are light reddish gray (2.5YR 7/1).
ML	Sandy Silt; light reddish gray (2.5YR 7/1); 80% silt; 20% fine to coarse grained sand; trace fine subangular gravel; non-plastic; very soft; moist. Moderately cemented, hard layers (1 to 2 inches). @ 197 feet: moderately cemented; hard. @ 199 feet: alternating non to moderately cemented with gravel layers that are very soft to stiff.
SM	Silty Sand with Gravel; light reddish gray (2.5YR 7/1); 70% fine to coarse grained sand; 20% silt; 10% fine subangular gravel; moist.
ML	Sandy Silt; light reddish gray (2.5YR 7/1); 80% silt; 20% fine to coarse grained sand; trace fine subangular gravel; non-plastic; very soft; moist.
CH	Fat Clay; dark reddish gray; high plasticity; very soft; wet.
ML	Sandy Silt with Gravel; dark reddish brown (2.5YR 3/4); 60% silt; 30% fine to coarse grained sand; 10% fine subangular gravel; non-plastic; moderately cemented; very stiff; moist.
CL	Sandy Lean Clay; dark reddish brown (2.5YR 3/4); 80% clay; 15% medium to coarse grained sand; 5% fine subangular gravel; medium plasticity; soft; wet.
ML	Sandy Silt with Gravel; dark reddish brown (2.5YR 3/4); 60% silt; 30% fine to coarse grained sand; 10% fine subangular gravel; non-plastic; moderately cemented; very stiff; moist.

LOG OF BORING PT-8 S/D
(Continued)

WELL CONSTRUCTION | Depth | USCS | Sample | Key | LITHOLOGIC DESCRIPTION



@ 211-212 feet: very soft.

Sandy Lean Clay; dark reddish brown (2.5YR 3/4); 80% clay; 15% medium to coarse grained sand; 5% fine subangular gravel; medium plasticity; soft; wet.

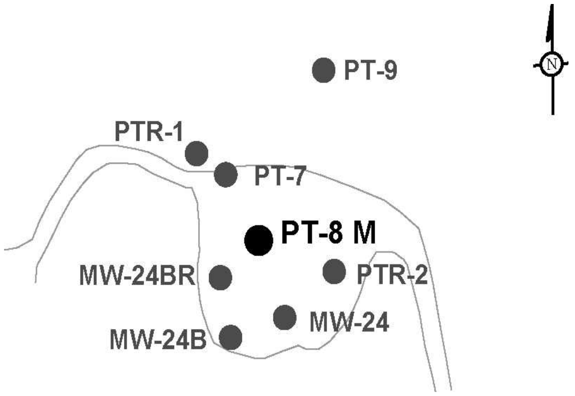
Sandy Silt with Gravel; dark reddish brown (2.5YR 3/4); 60% silt; 30% fine to coarse grained sand; 10% fine subangular gravel; non-plastic; weakly cemented; stiff; wet.

@ 221 feet: moderately cemented; very stiff.

Silty Sand; dark reddish brown (2.5YR 3/4); 80% medium to coarse grained sand; 20% silt; non-plastic; not cemented; wet.

Bedrock

Total Depth Explored: 225 feet bgs



LOG OF BORING PT-8 M

PG&E Topock Site
Needles, California

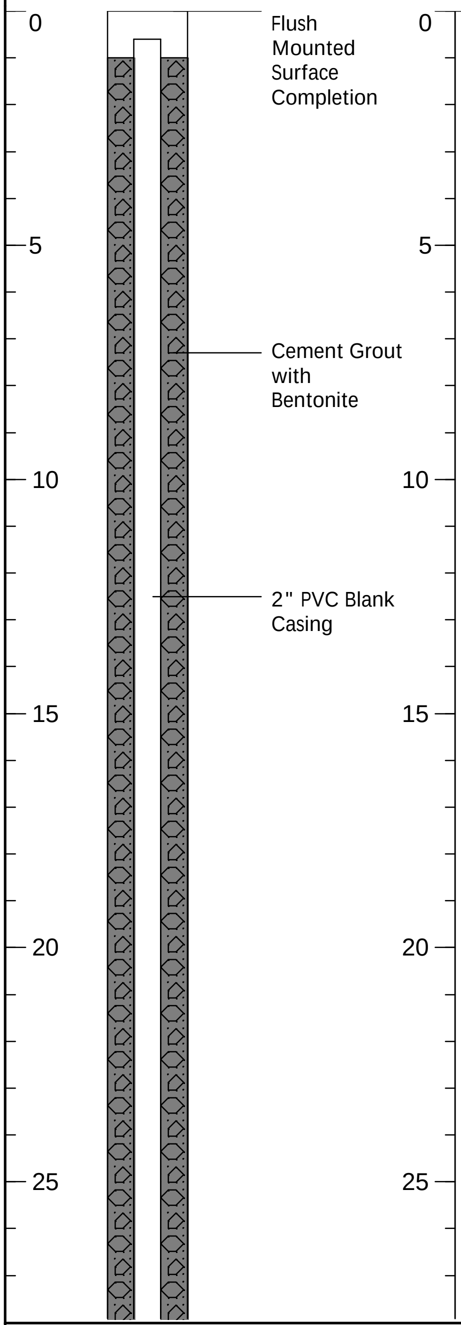
Project No.:	RC000689.0004	Date Started:	12 May 2007
Logged by:	Brett Bardsley	Date Completed:	21 May 2007
Drilling Co.:	WDC	Drilling Method:	Rotosonic/Mud Rotary
Drillers:	Rivera, West, Sakioka, Villegas	Sample Method:	4" x 6" Core Rod
Well Permit #2007040404		Driller's License:	C57-283326

WELL CONSTRUCTION

LITHOLOGIC DESCRIPTION

Boring Diameter (inches): 6

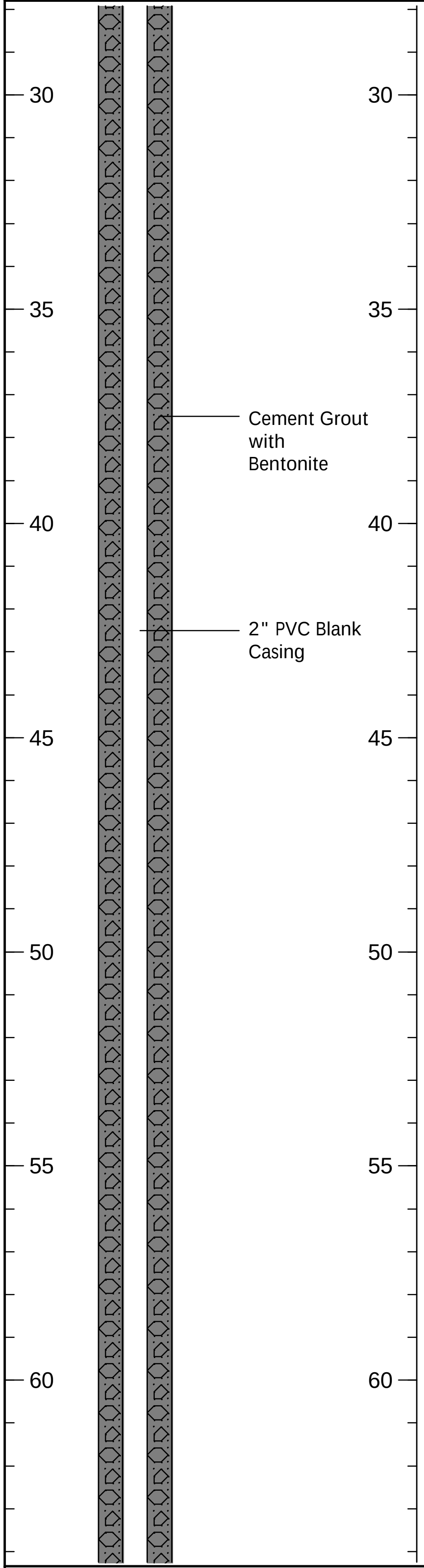
Depth USCS Sample Key



For lithology description see PT-7 S/D.

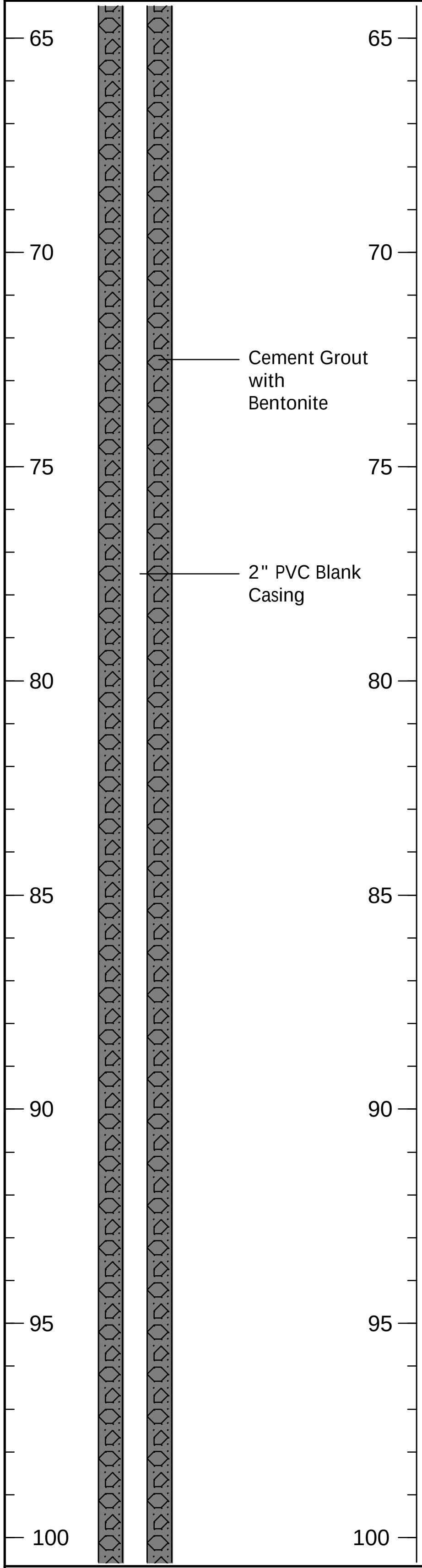
LOG OF BORING PT-8 M
(Continued)

WELL CONSTRUCTION	Depth	USCS	Sample	Key	LITHOLOGIC DESCRIPTION



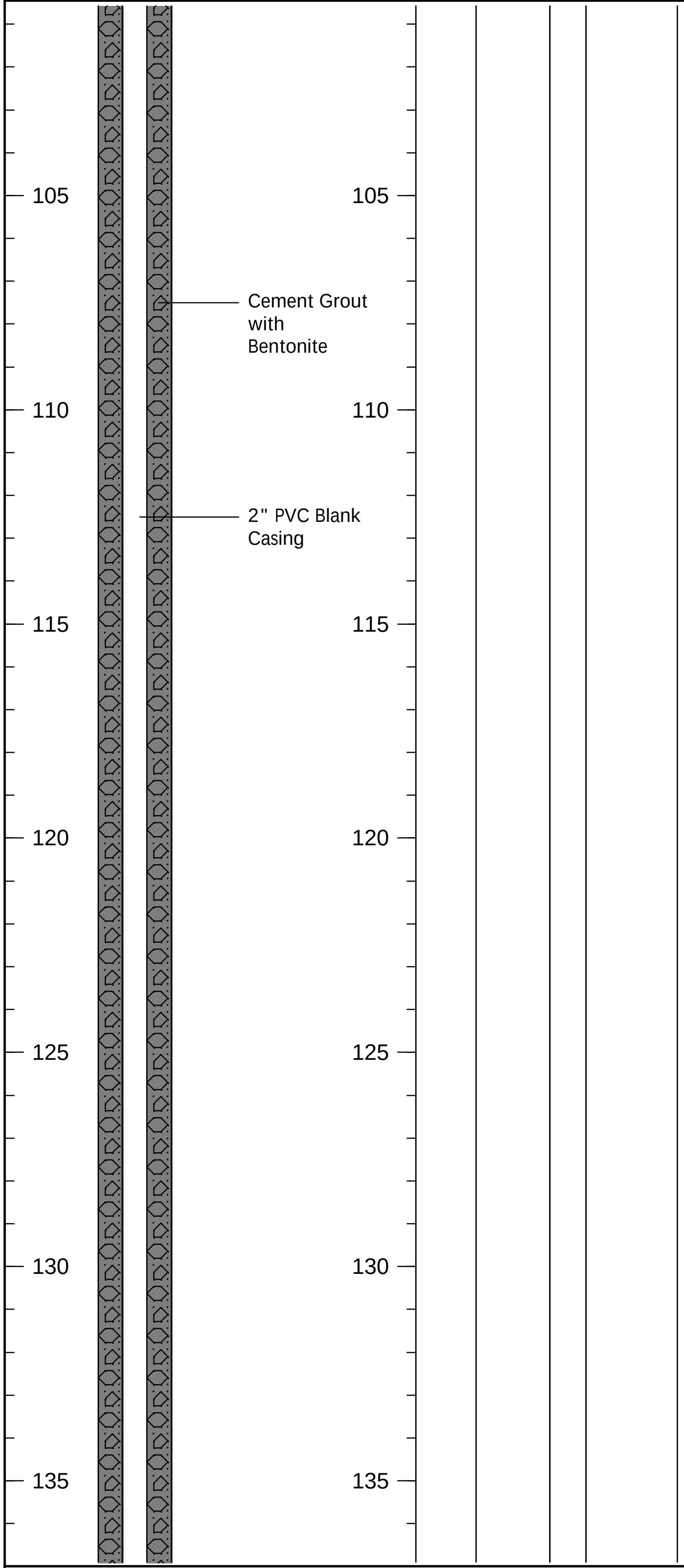
LOG OF BORING PT-8 M
(Continued)

WELL CONSTRUCTION	Depth	USCS	Sample	Key	LITHOLOGIC DESCRIPTION



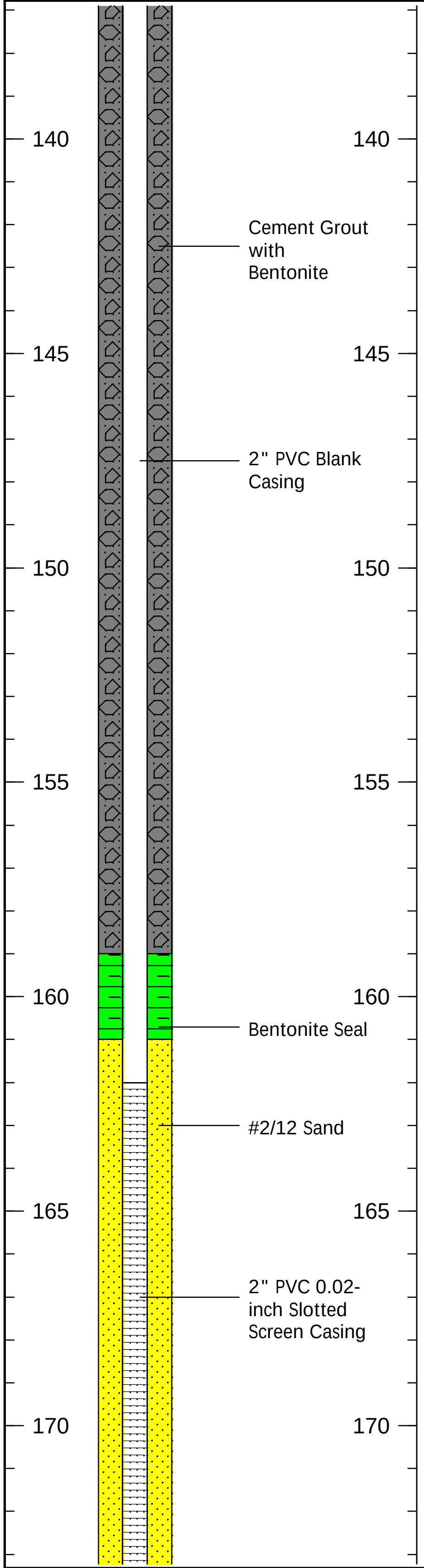
LOG OF BORING PT-8 M
(Continued)

WELL CONSTRUCTION | Depth | USCS | Sample | Key | LITHOLOGIC DESCRIPTION



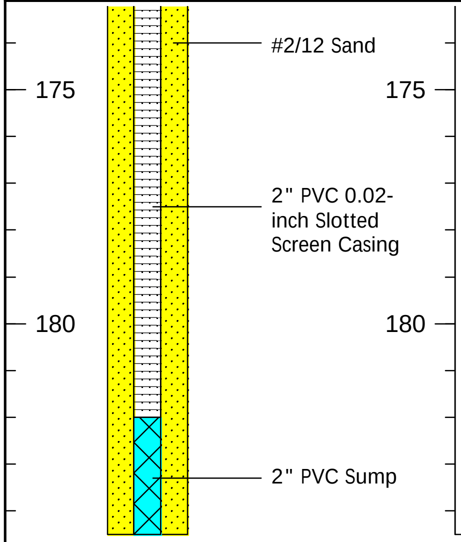
LOG OF BORING PT-8 M
(Continued)

WELL CONSTRUCTION | Depth | USCS | Sample | Key | LITHOLOGIC DESCRIPTION

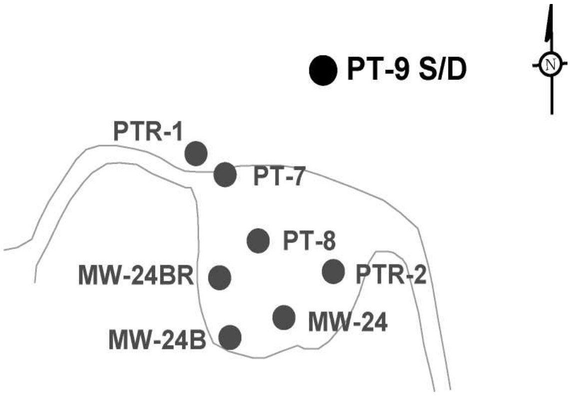


LOG OF BORING PT-8 M
(Continued)

WELL CONSTRUCTION | Depth | USCS | Sample | Key | LITHOLOGIC DESCRIPTION



End of boring at 184.5 feet bgs



LOG OF BORING PT-9 S/D

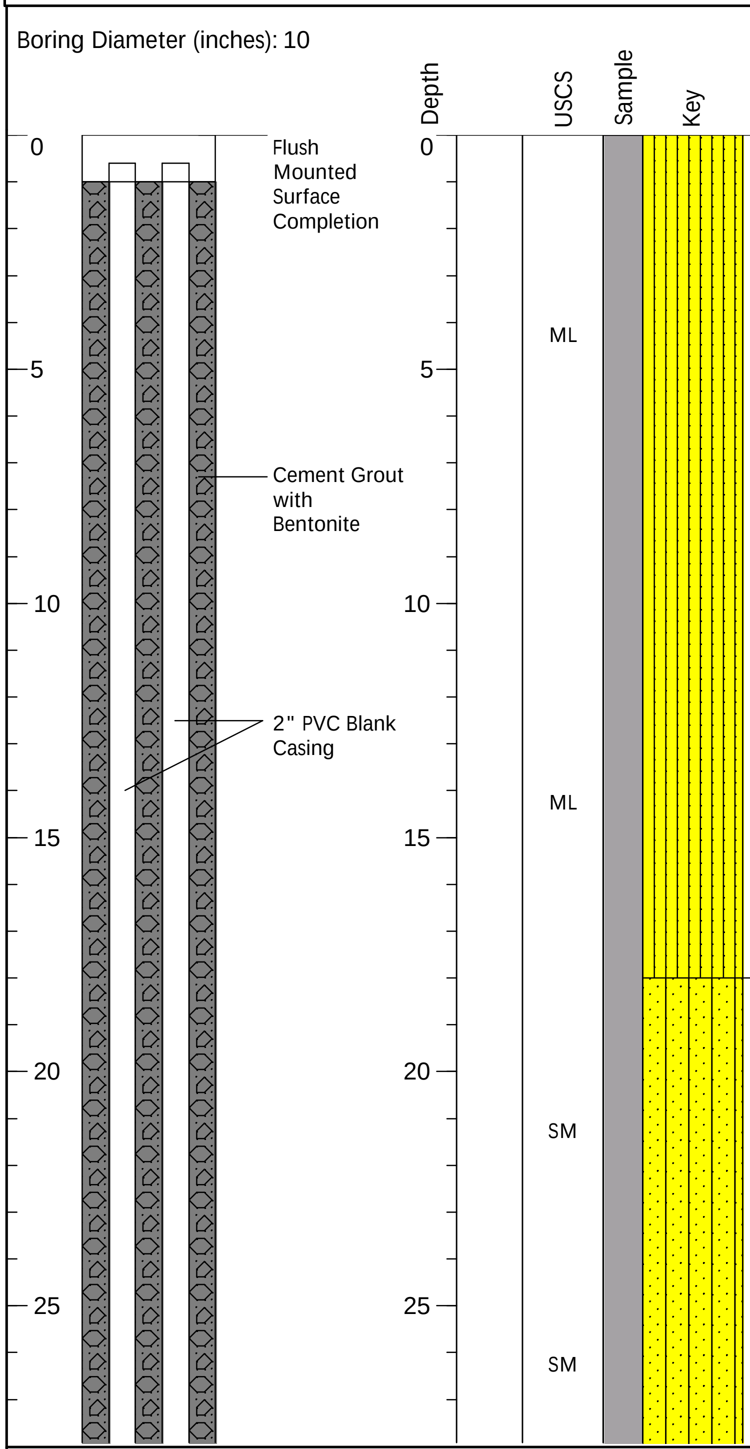
PG&E Topock Site
Needles, California

Project No.:	RC000689.0004	Date Started:	4 June 2007
Logged by:	Brett Bardsley	Date Completed:	6 June 2007
Drilling Co.:	WDC	Drilling Method:	Rotosonic/Mud Rotary
Drillers:	Rivera, West, Sakioka, Villegas	Sample Method:	4" x 6" Core Rod
Well Permit #	2007040408, 2007040406	Driller's License:	C57-283326

WELL CONSTRUCTION

LITHOLOGIC DESCRIPTION

Boring Diameter (inches): 10



Sandy Silt with Gravel; very pale brown (10YR 7/3); 70% silt, 20% fine to coarse grained sand; 20% fine to coarse subangular gravel; non-plastic; very soft; dry.

@ 2 feet: 95% silt; 5% fine subangular gravel.

@ 5 feet: light gray (10YR 7/1); 60% silt; 20% fine to coarse grained sand; 20% fine to coarse subangular gravel.

@ 7 feet: trace cobbles to 3.5 inches.

@ 8 feet: 80% silt; 15% fine subangular gravel; 5% fine to coarse grained sand.

@ 12 feet: trace cobbles up to 3.5 inches.

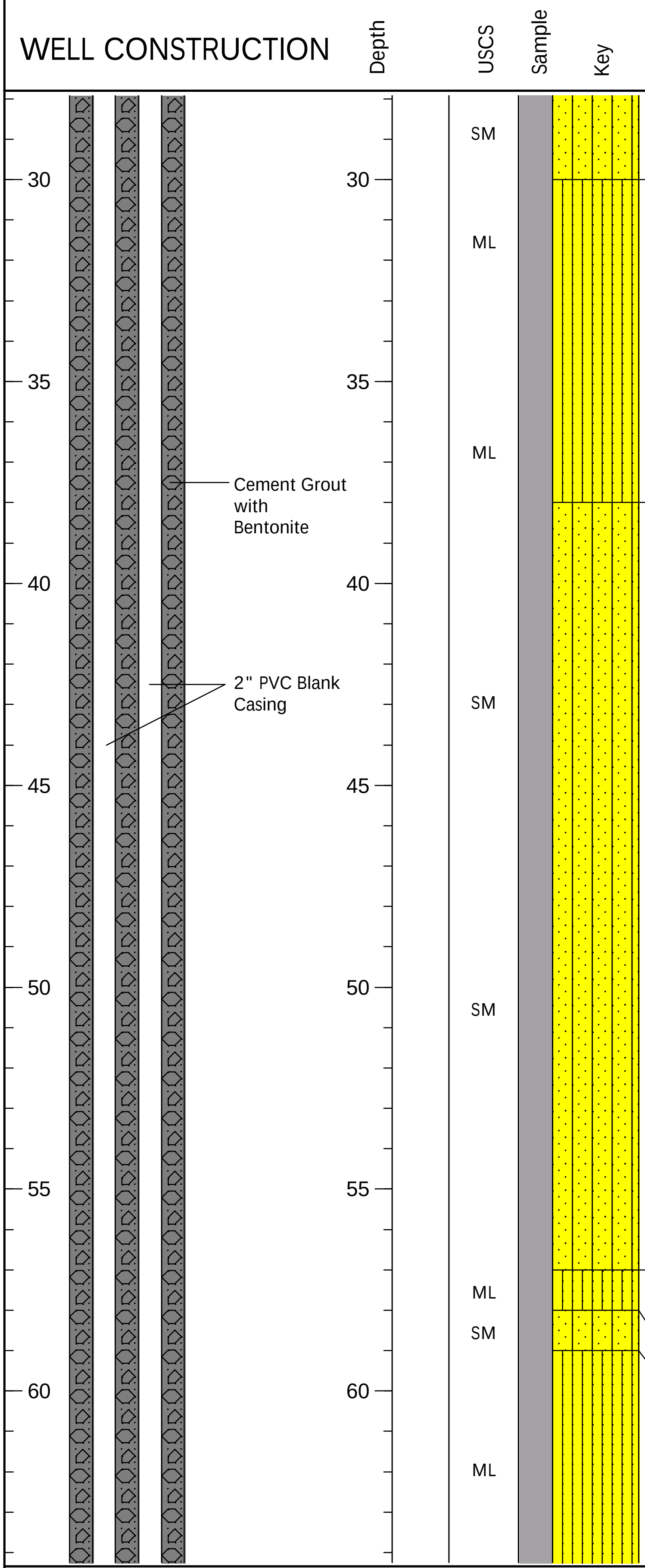
@ 14 feet: Gravelly Silt; light gray (10YR 7/1); 70% silt; 20% fine to coarse subangular gravel; 10% fine to coarse grained sand; non-plastic; very soft; dry.

Silty Sand with Gravel; light gray (10YR 7/1); 60% fine to coarse grained sand; 15% silt; 15% fine subangular gravel; dry.

@ 20 feet: 60% fine to coarse grained sand; 30% silt; 10% fine to coarse subangular gravel; dry; occasional 1 to 2-inch weakly cemented hard layers.

@ 22 feet: light gray (5YR 7/1) to light reddish brown (5YR 6/4); trace subangular cobbles up to 3.5 inches.

LOG OF BORING PT-9 S/D
(Continued)



LITHOLOGIC DESCRIPTION

Sandy Silt with Gravel; light gray (5YR 7/1) to light reddish brown (5YR 6/4); 60% silt, 20% fine to coarse grained sand; 20% fine subangular gravel; non-plastic with alternating layers ranging from non-cemented very soft to moderately cemented hard material.

@ 36 feet: moderately cemented layers; hard; dense; up to 2.5-inches thick.

Silty Sand with Gravel; light gray (10YR 7/1); 60% fine to coarse grained sand; 30% silt; 10% fine to coarse subangular gravel; hard; dry; occasional 1 to 2-inch weakly cemented hard layers.

@ 40 feet: Alternating layers ranging from soft, non-cemented to moderately cemented.

@ 46 feet: reddish gray (10R 6/1) to light red (10R 6/6); 60% fine to coarse grained sand; 30% silt; 10% fine subangular gravel; non-cemented to moderately cemented; soft to hard; dry.

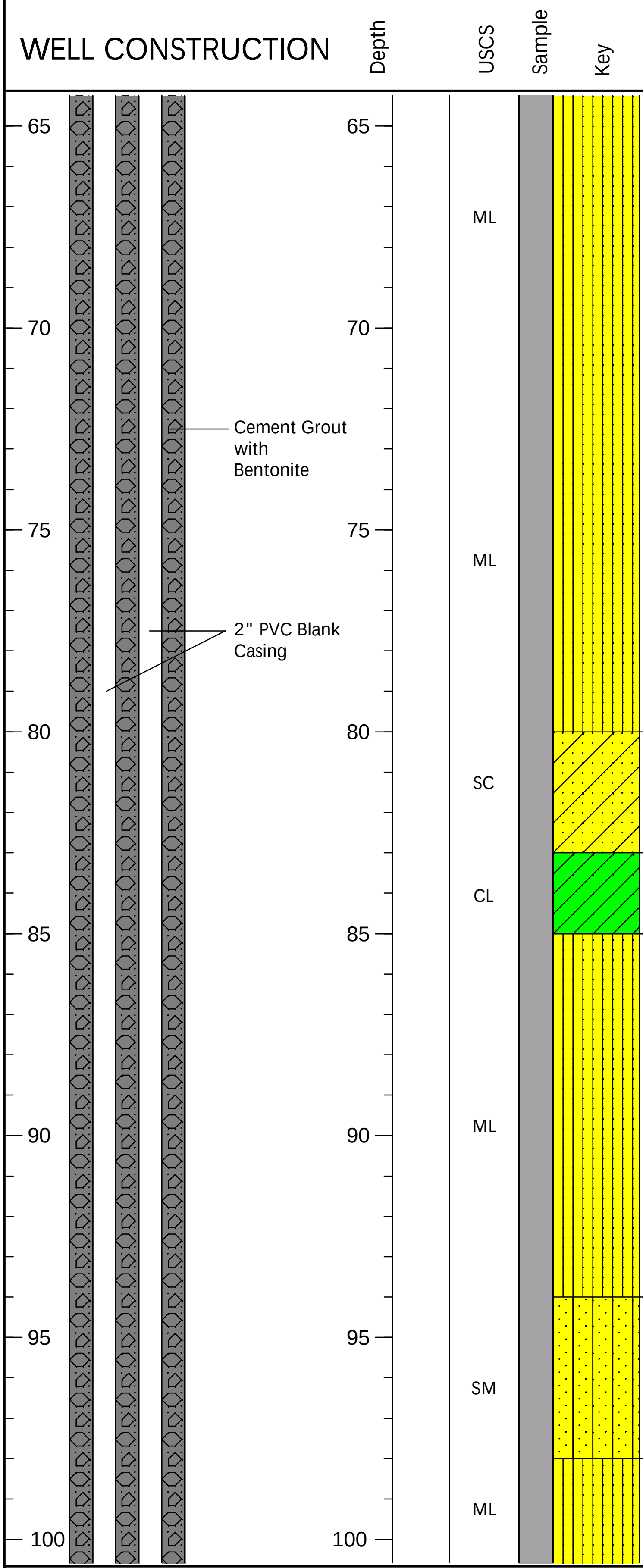
Silt with Gravel; light gray (5YR 7/1); 85% silt, 10% fine subangular gravel; trace fine to coarse grained sand; non-plastic; soft; dry.

Silty Sand with Gravel.

Sandy Silt with Gravel; light reddish brown (5YR 6/3); 60% silt, 20% fine to coarse grained sand; 20% fine subangular gravel; non-cemented; soft; dry. Occasional 2 to 3-inch hard, moderately cemented layers.

@ 62 feet: 70% silt; 30% fine to coarse grained sand; 10% fine subangular gravel.

LOG OF BORING PT-9 S/D
(Continued)



LITHOLOGIC DESCRIPTION

@ 72 feet: reddish brown (2.5YR 4/4) to reddish gray (2.5YR 6/1); 60% silt, 30% fine to coarse grained sand; 10% fine subangular gravel; weak to moderate cementation; non-plastic; dense; very stiff to hard; dry to moist.

@ 74 feet: One cemented layer was 6-inches thick.

Clayey Sand; dark reddish gray (10R 4/1); 70% medium to coarse grained sand; 25% lean clay; 5% fine subangular gravel; low plasticity; soft; wet.

Sandy Lean Clay; dark reddish gray (10R 4/1); 80% lean clay; 20% medium to coarse grained sand; low to medium plasticity; very stiff; dense; moist.

Sandy Silt with Gravel; greenish gray (GLEY2 6/1) with pale red (10R 6/4); 70% silt; 20% medium to coarse grained sand; 10% fine subangular gravel; non-plastic; weak to moderately cemented; hard; dry.

@ 90 feet: trace cobbles up to 3.5 inches.

@ 92 feet: no cobbles; occasional layers of moderately cemented, very stiff material (1 to 2-inches). The majority is very soft, dry.

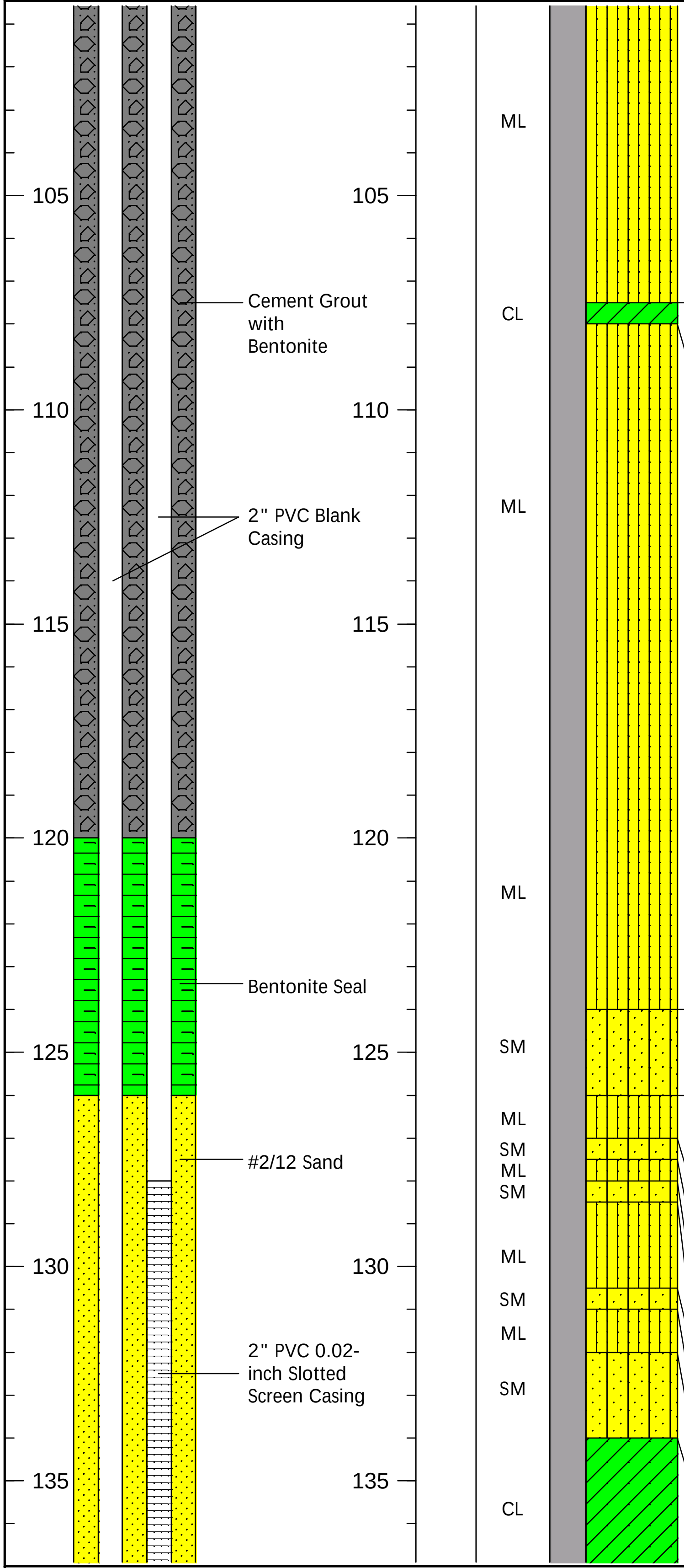
Silty Sand; reddish gray to light red (10R 6/6); 55% fine to coarse grained sand; 45% silt; trace fine subangular gravel; dry with occasional moderately cemented, very stiff layers.

Sandy Silt with Gravel; reddish gray (10R 6/1) with light red (10R 6/6); 70% silt, 20% fine to coarse grained sand; 10% fine subangular gravel; non-plastic; soft; dry. Alternating with moderately cemented, very stiff layers.

@ 100 feet: Gravelly Silt; reddish brown (2.5YR 4/3); 75% silt; 20% fine subangular

LOG OF BORING PT-9 S/D
(Continued)

WELL CONSTRUCTION | Depth | USCS | Sample | Key | LITHOLOGIC DESCRIPTION



gravel; 5% medium to coarse grained sand; non-plastic; moderately cemented; hard; moist.

@ 102 feet: Sandy Silt with Gravel; light reddish gray (2.5YR 7/1) to reddish brown (2.5YR 4/3); 70% silt; 20% fine coarse grained sand; 10% fine subangular gravel; non-plastic; weakly to moderately cemented; hard; dry to moist.

Sandy Lean Clay; reddish brown (2.5YR 4/3); 80% lean clay; 20% medium to coarse grained sand; low plasticity; soft; wet.

Sandy Silt; light reddish gray (2.5YR 7/1) with light reddish brown (2.5YR 7/4); 80% silt, 20% fine to coarse grained sand; trace subangular to angular gravel; non-plastic; moderately cemented; hard; dry.

@ 112 feet: Silt; 90% silt; 5% coarse grained sand; 5% coarse subangular gravel; non-plastic; moderately cemented; hard; dry to moist.

@ 114 feet: Sandy Silt with Gravel; 60% silt; 20% fine to coarse grained sand; 20% fine subangular gravel; non-plastic; moderately cemented; hard; dry.

@ 122 feet: 60% silt; 30% medium to coarse grained sand; 10% fine subangular gravel.

Silty Sand; dark reddish gray (5YR 4/2); 75% medium to coarse grained sand; 20% silt; 5% fine subangular gravel; non-plastic; loose; wet.

Sandy Silt with Gravel; dark reddish gray (5YR 4/2); 65% silt; 25% fine to coarse grained sand; 10% fine subangular gravel; non-plastic; moderately cemented; very stiff; wet.

Silty Sand.

Sandy Silt with Gravel.

Silty Sand.

Sandy Silt with Gravel.

Silty Sand.

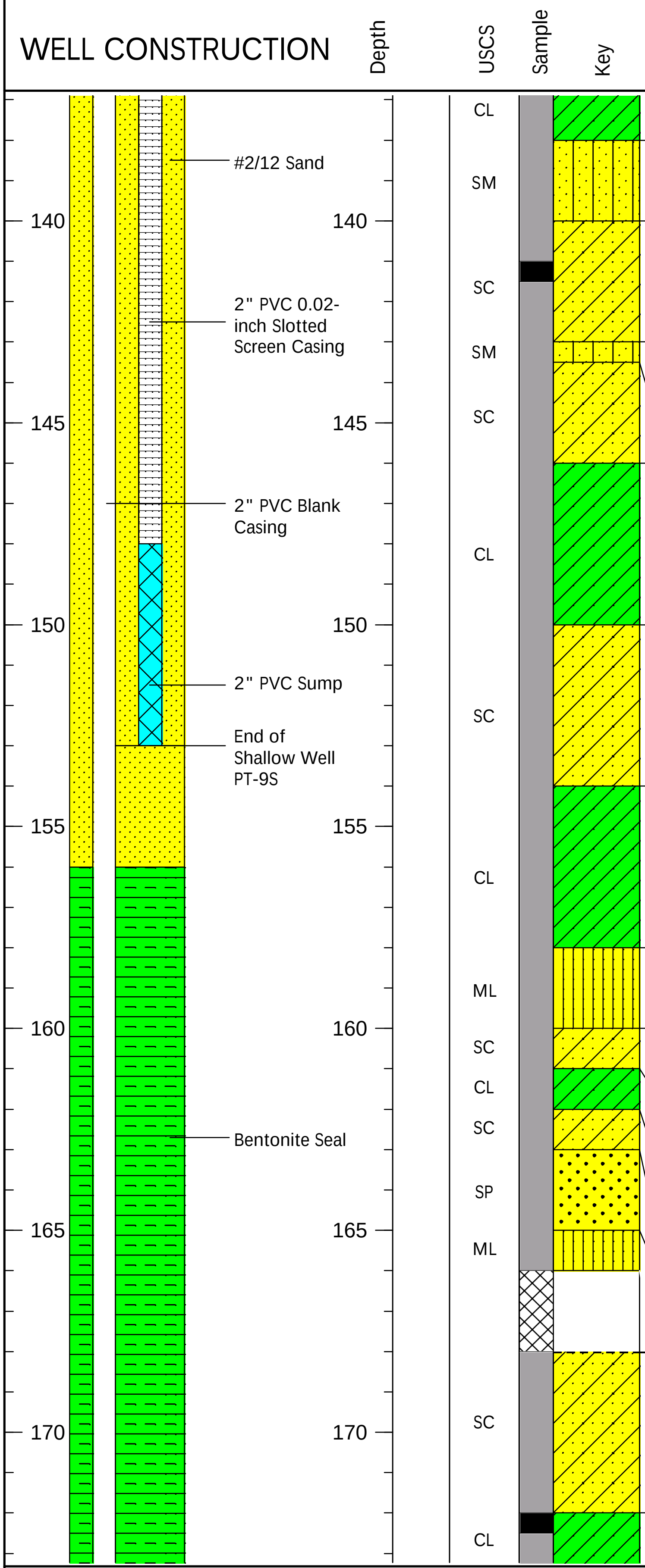
Sandy Silt with Gravel.

Silty Sand with Gravel; dark reddish gray (5YR 4/2); 70% medium to coarse grained sand; 20% silt; 10% fine subangular gravel; dense; wet.

Sandy Clay with Gravel; dark reddish gray (5YR 4/2); 70% silt; 20% medium to coarse grained sand; 10% fine subangular gravel; low plasticity; soft; wet.

@ 136 feet: moderately cemented; very stiff.

LOG OF BORING PT-9 S/D
(Continued)



LITHOLOGIC DESCRIPTION

Silty Sand with Gravel; reddish brown (5YR 4/4); 70% medium to coarse grained sand; 20% silt; 10% fine to coarse subangular gravel; loose; wet.

Clayey Sand with Gravel; dark reddish brown (2.5YR 3/3); 60% medium to coarse grained sand; 30% lean clay; 10% fine to coarse subangular gravel; low to medium plasticity; wet.

@ 141.5-142 feet: moderately cemented; very stiff.

Silty Sand with Gravel; reddish brown (5YR 4/4); 70% medium to coarse grained sand; 20% silt; 10% fine to coarse subangular gravel; loose; wet.

Clayey Sand with Gravel; dark reddish brown (2.5YR 3/3); 60% medium to coarse grained sand; 30% silt; 10% fine subangular gravel; low plasticity; dense; wet.

Sandy Lean Clay; dark reddish brown (2.5YR 3/3); 70% lean clay; 30% fine to coarse grained sand; low plasticity; soft; wet.

@ 147-148 feet: very stiff.

@ 148 feet: 75% lean clay; 20% medium to coarse grained sand; 5% fine subangular gravel; low to medium plasticity; soft; wet.

Clayey Sand with Gravel; dark reddish brown (2.5YR 3/3); 70% medium to coarse grained sand; 20% lean clay; 10% fine to coarse subangular gravel; low plasticity; loose; wet.

Sandy Lean Clay with Gravel; dark reddish gray (2.5YR 3/1); 70% lean clay; 20% medium to coarse grained sand; 10% fine subangular gravel; low plasticity; medium stiff; wet.

@ 156 feet: moderately cemented; hard.

Sandy Silt with Gravel; dark reddish gray (2.5YR 3/1); 70% silt, 20% fine to coarse grained sand; 10% fine to coarse subangular gravel; non-plastic; moderately cemented; hard; dry.

Clayey Sand with Gravel; dark reddish gray (2.5YR 3/1); 60% medium to coarse grained sand; 30% lean clay; 20% fine subangular gravel; low plasticity; loose; wet.

Sandy Clay; dark reddish gray (10R 4/1); 60% clay, 40% medium to coarse grained sand; low plasticity; wet.

Clayey Sand with Gravel; dark reddish gray (2.5YR 3/1); 60% medium to coarse grained sand; 30% lean clay; 20% fine subangular gravel; low plasticity; loose; wet.

Poorly Graded Sand; reddish black (2.5YR 2.5/1); 95% medium to coarse grained sand; 5% silt; very loose; wet.

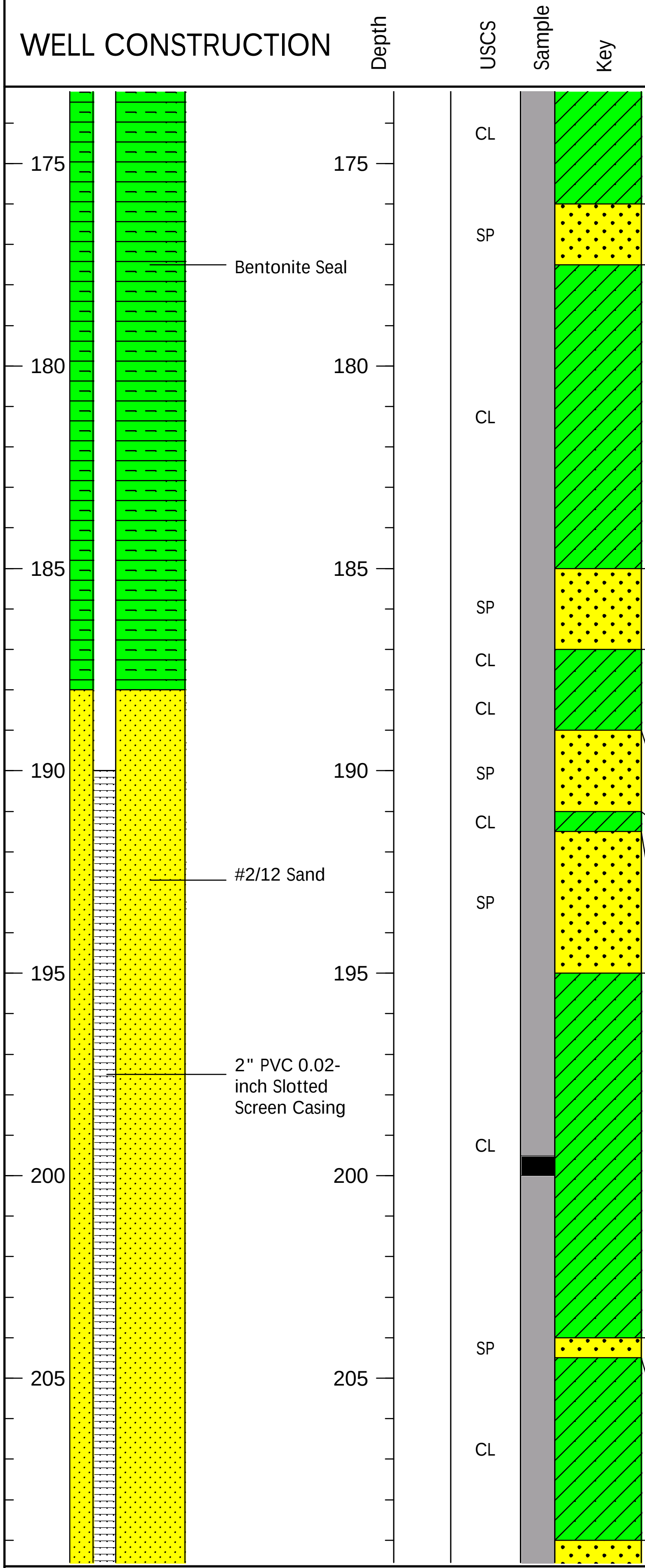
Sandy Silt with Gravel; dark reddish gray (2.5YR 3/1); 70% silt, 20% fine to coarse grained sand; 10% fine to coarse subangular gravel; moderately cemented; non-plastic; very stiff; wet.

Clayey Sand with Gravel; dark reddish gray (2.5YR 3/1); 70% coarse grained sand; 20% lean clay; 10% fine to coarse subangular gravel; low to medium plasticity; very soft; wet.

@ 170 feet: trace cobbles up to 3.5 inches.

Sandy Lean Clay with Gravel; dark reddish gray (2.5YR 3/1); 70% lean clay; 20% fine to coarse grained sand; 10% fine to coarse subangular gravel; medium

LOG OF BORING PT-9 S/D
(Continued)



LITHOLOGIC DESCRIPTION

plasticity; non-cemented; soft; wet.

@ 173 feet: moderately cemented; hard; moist.

@ 174 feet: light red areas (2.5YR 7/8); weakly cemented; stiff.

Poorly Graded Sand; dark red (2.5YR 3/6); 95% medium to coarse grained sand; 5% silt; trace fine subangular gravel; loose; wet.

Sandy Lean Clay with Gravel; dark red (2.5YR 3/6); 70% lean clay; 20% medium to coarse grained sand; 10% fine subangular gravel; low plasticity; weakly cemented; very stiff; wet.

@ 180 feet: moderately cemented; hard.

@ 182 feet: weakly cemented layers present (approximately 4-inches thick); medium stiff.

Poorly Graded Sand; dark red (2.5YR 3/6); 95% medium to coarse grained sand; 5% silt; trace cobbles to 3.5 inches; loose; wet.

Sandy Lean Clay with Gravel; dark red (2.5YR 3/6); 70% lean clay; 20% medium to coarse grained sand; 10% fine subangular gravel; low plasticity; moderately cemented; hard; wet.
@ 187.5 feet: White colored moderately cemented zone.
@ 188 feet: medium plasticity; not cemented; soft.

Poorly Graded Sand; dark red (2.5YR 3/6); 95% medium to coarse grained sand; 5% silt; loose; wet.

Sandy Lean Clay with Gravel; dark red (2.5YR 3/6); 70% lean clay; 20% medium to coarse grained sand; 10% fine subangular gravel; medium plasticity; non-cemented; soft; wet.

Poorly Graded Sand; dark red (2.5YR 3/6); 95% medium to coarse grained sand; 5% silt; loose; wet. Density of sand increases with depth.

Sandy Lean Clay with Gravel; dark red (2.5YR 3/6); 70% lean clay; 20% medium to coarse grained sand; 10% fine subangular gravel; low plasticity; moderately cemented; very stiff; wet.

@ 196 feet: thin layers of medium plasticity.

@ 198 feet: low to medium plasticity; medium stiff; weak cementation.

@ 200 feet: moderate cementation; stiff.

@ 202 feet: weak cementation; medium stiff; wet.

Poorly Graded Sand; dark red (2.5YR 3/6); 95% medium to coarse grained sand; 5% silt; loose; wet.

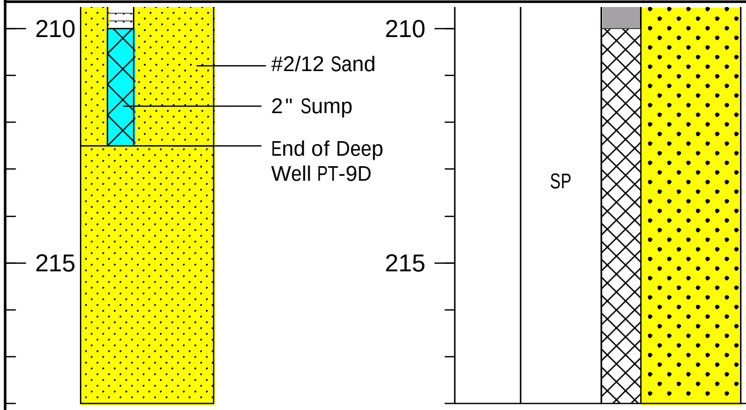
Sandy Lean Clay with Gravel; dark red (2.5YR 3/6); 70% lean clay; 20% medium to coarse grained sand; 10% fine subangular gravel; low plasticity; weakly cemented; stiff; wet.

@ 207 feet: moderately cemented; very stiff.

Poorly Graded Sand; dark red (2.5YR 3/6); 95% medium to coarse grained sand;

LOG OF BORING PT-9 S/D
(Continued)

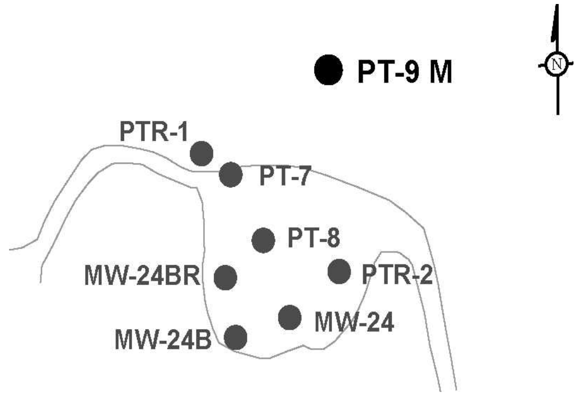
WELL CONSTRUCTION | Depth | USCS | Sample | Key | LITHOLOGIC DESCRIPTION



5% silt; loose; wet.

Bedrock encountered at 218 feet bgs.

Total Depth Explored: 218 feet bgs



LOG OF BORING PT-9 M

PG&E Topock Site
Needles, California

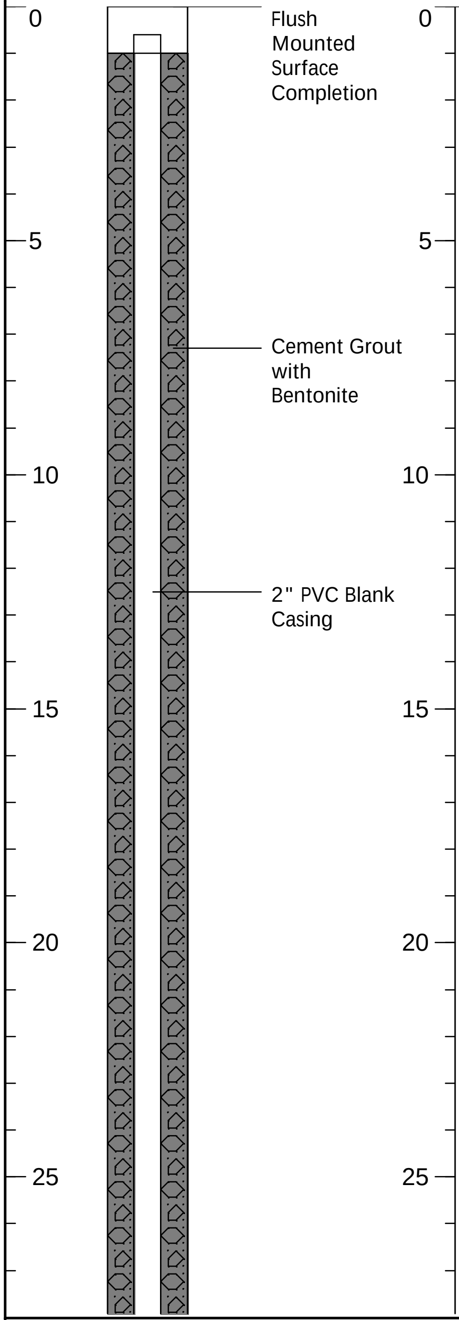
Project No.:	RC000689.0004	Date Started:	4 June 2007
Logged by:	Brett Bardsley	Date Completed:	6 June 2007
Drilling Co.:	WDC	Drilling Method:	Rotosonic/Mud Rotary
Drillers:	Rivera, West, Sakioka, Villegas	Sample Method:	4" x 6" Core Rod
Well Permit #2007040407		Driller's License:	C57-283326

WELL CONSTRUCTION

LITHOLOGIC DESCRIPTION

Boring Diameter (inches): 6

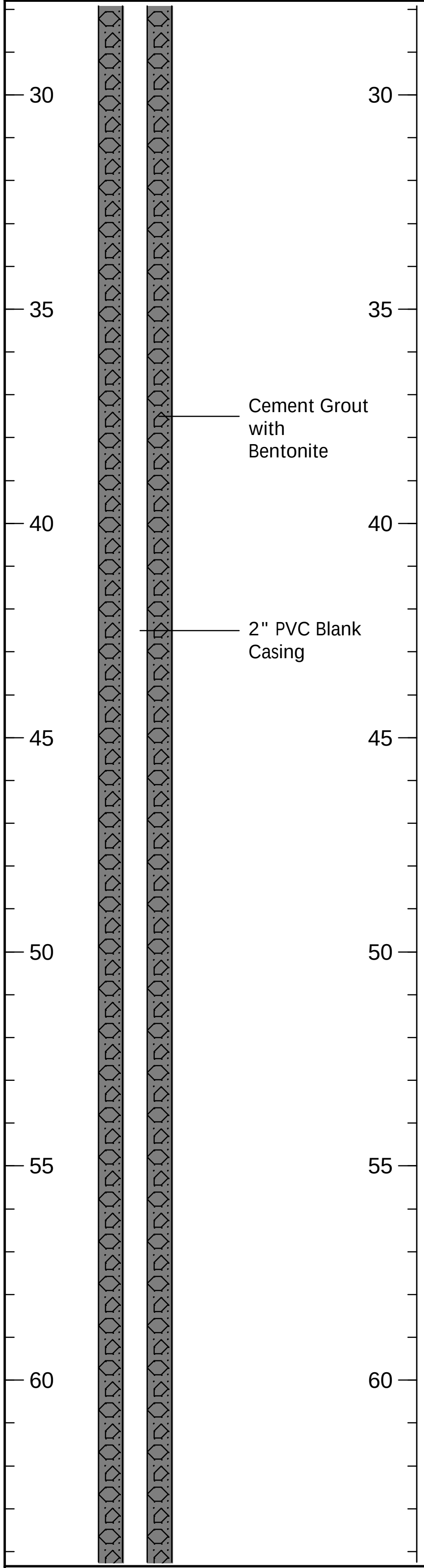
Depth USCS Sample Key



For lithologic description see PT-9 S/D.

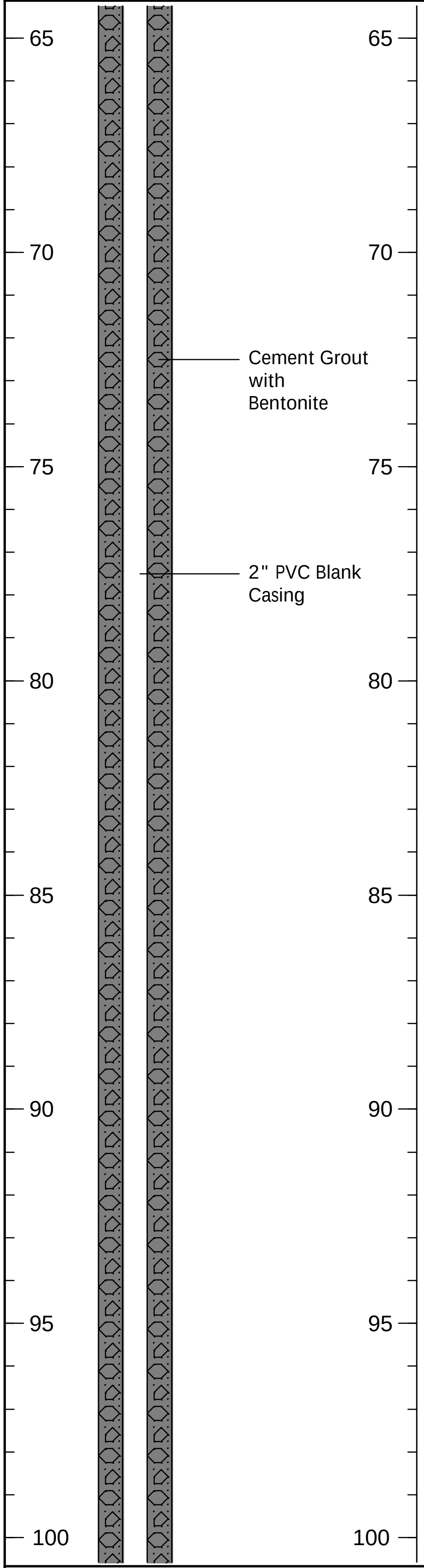
LOG OF BORING PT-9 M
(Continued)

WELL CONSTRUCTION | Depth | USCS | Sample | Key | LITHOLOGIC DESCRIPTION



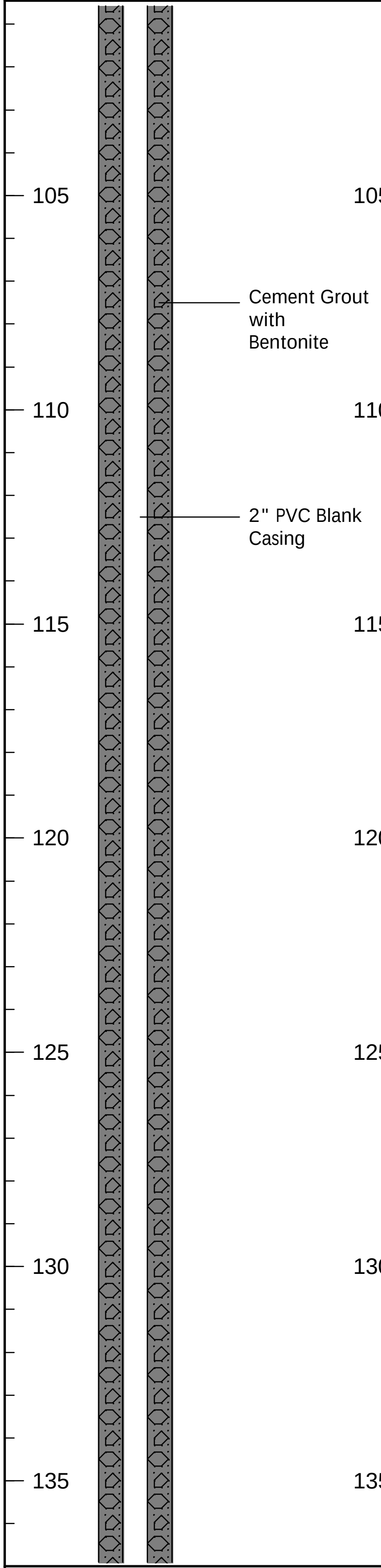
LOG OF BORING PT-9 M
(Continued)

WELL CONSTRUCTION | Depth | USCS | Sample | Key | LITHOLOGIC DESCRIPTION



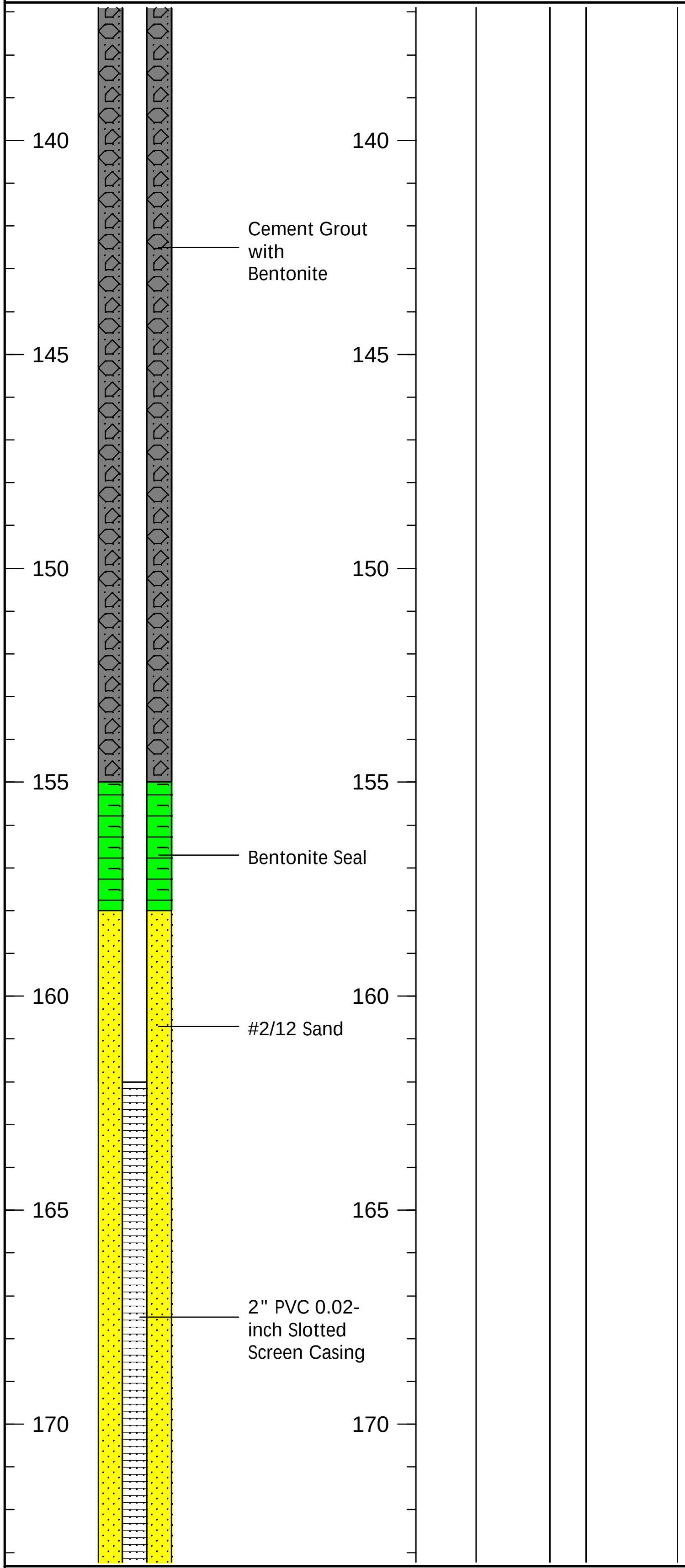
LOG OF BORING PT-9 M
(Continued)

WELL CONSTRUCTION	Depth	USCS	Sample	Key	LITHOLOGIC DESCRIPTION
	105				
	110				
	115				
	120				
	125				
	130				
	135				



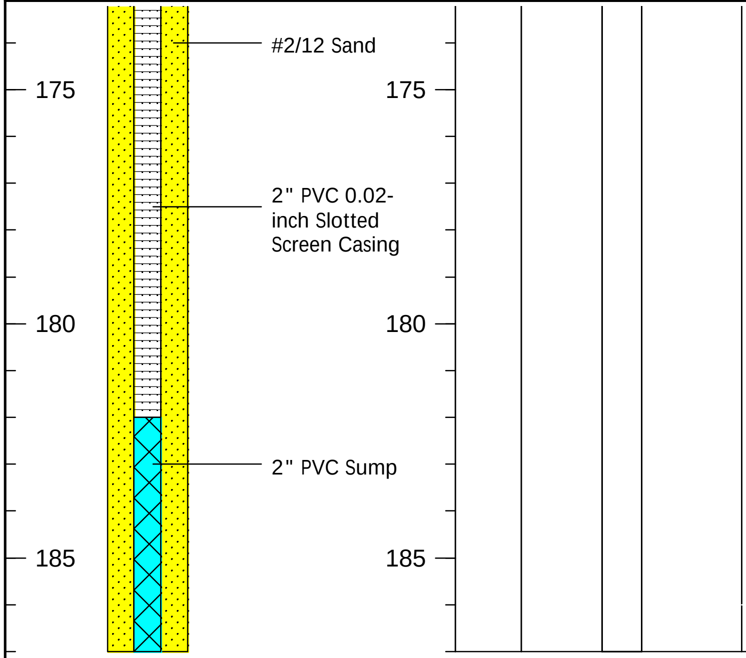
LOG OF BORING PT-9 M
(Continued)

WELL CONSTRUCTION | Depth | USCS | Sample | Key | LITHOLOGIC DESCRIPTION

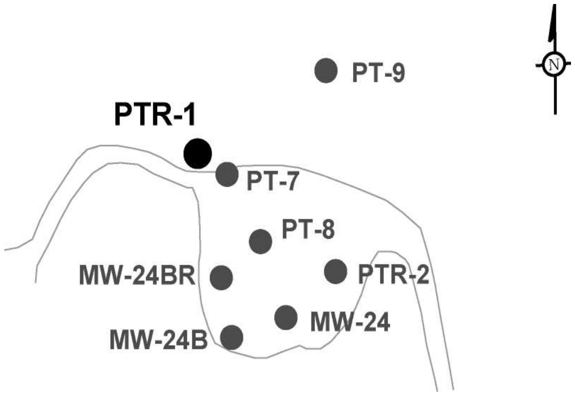


LOG OF BORING PT-9 M
(Continued)

WELL CONSTRUCTION | Depth | USCS | Sample | Key | LITHOLOGIC DESCRIPTION



End of boring at 187 feet bgs



LOG OF BORING PTR-1

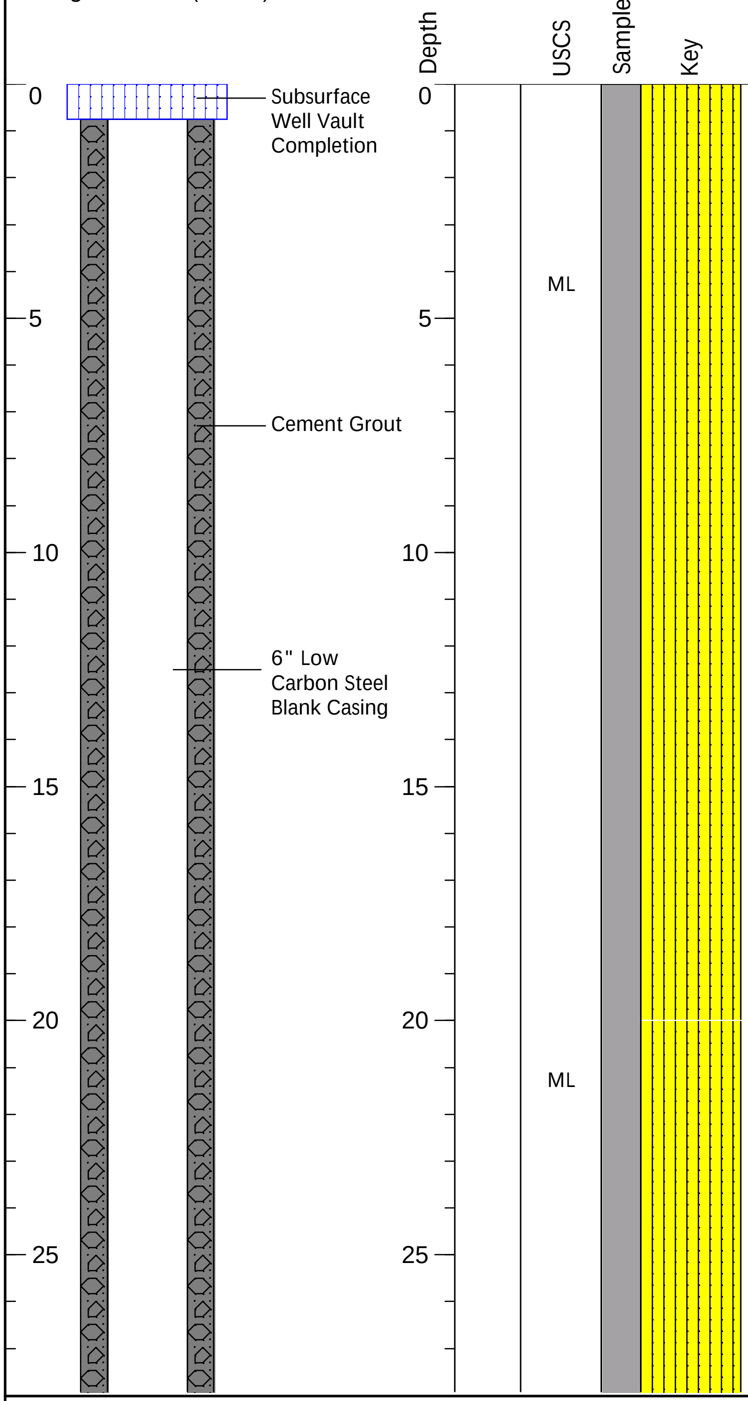
PG&E Topock Site
Needles, California

Project No.:	RC000689.0004	Date Started:	24 April 2007
Logged by:	Brett Bardsley	Date Completed:	2 May 2007
Drilling Co.:	WDC	Drilling Method:	Rotosonic/Mud Rotary
Drillers:	Rivera, West, Sakioka, Villegas	Sample Method:	4" x 6" Core Rod
Well Permit #2007040409		Driller's License:	C57-283326

WELL CONSTRUCTION

LITHOLOGIC DESCRIPTION

Boring Diameter (inches): 10



Sandy Silty with Gravel; light gray (10YR 7/2); 60% silt, 20% fine to coarse subangular gravel; 20% medium to coarse grained sand; trace subangular cobbles up to 3.2 inches in length.

@ 2 feet: largest cobble was approxiamtely 4 inches.

@ 4 feet: amounts of medium grained sand increases.

@ 8 feet: amount of fine gravel increases.

@ 10 feet: all gravel is fine.

@ 18 feet: fine and coarse subangular gravel present.

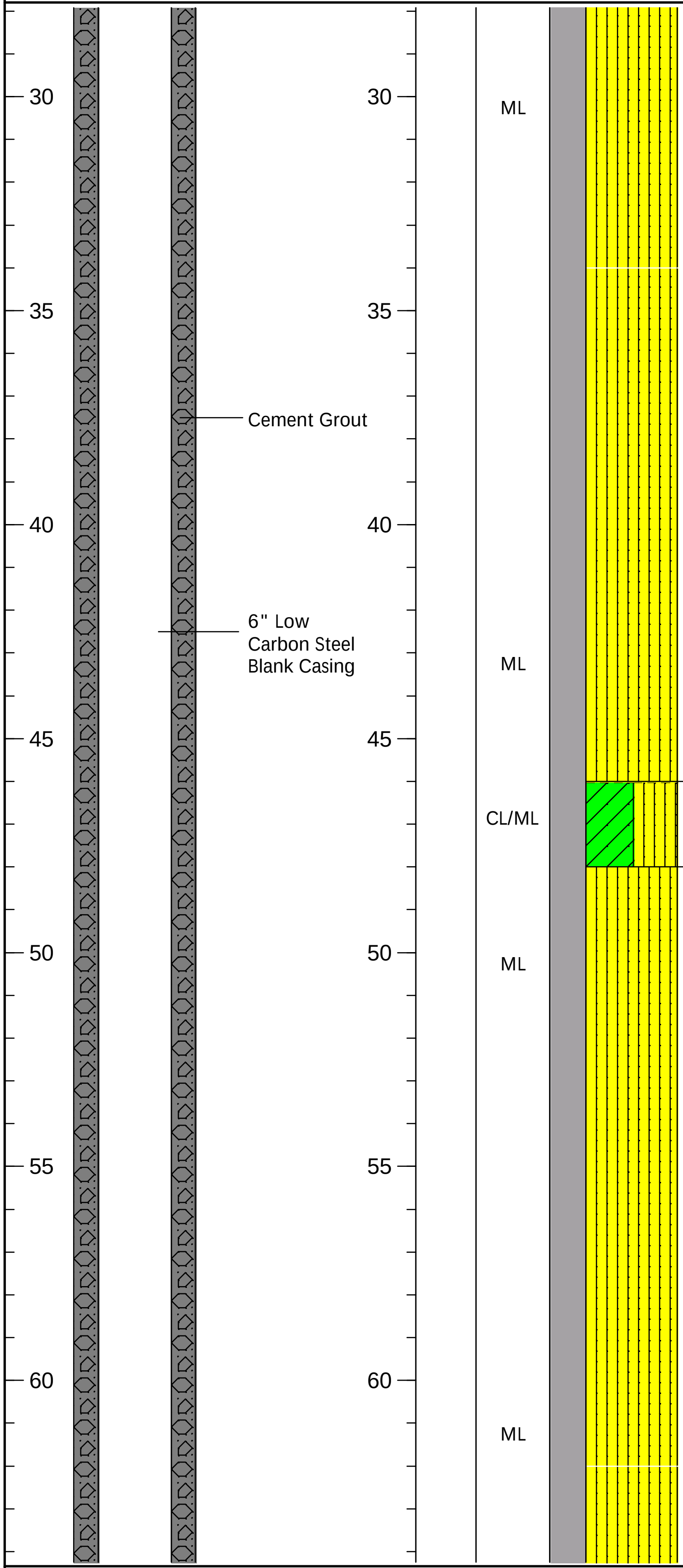
@ 20 feet: changes to 65% silt; 20% medium to coarse grained sand; 15% fine subangular gravel; dry.

@ 22 feet: changes to 70% silt; 20% medium to coarse grained sand; 10% fine subangular gravel.

@ 24 feet: changes to 60% silt; 20% medium to coarse grained sand; 20% fine to coarse subangular gravel; trace cobbles up to to 3.5 inches.

LOG OF BORING PTR-1
(Continued)

WELL CONSTRUCTION | Depth | USCS | Sample | Key | LITHOLOGIC DESCRIPTION



@ 35 feet: wet.

@ 36 feet: changes to greenish gray (GLEY2 6/1); dry.

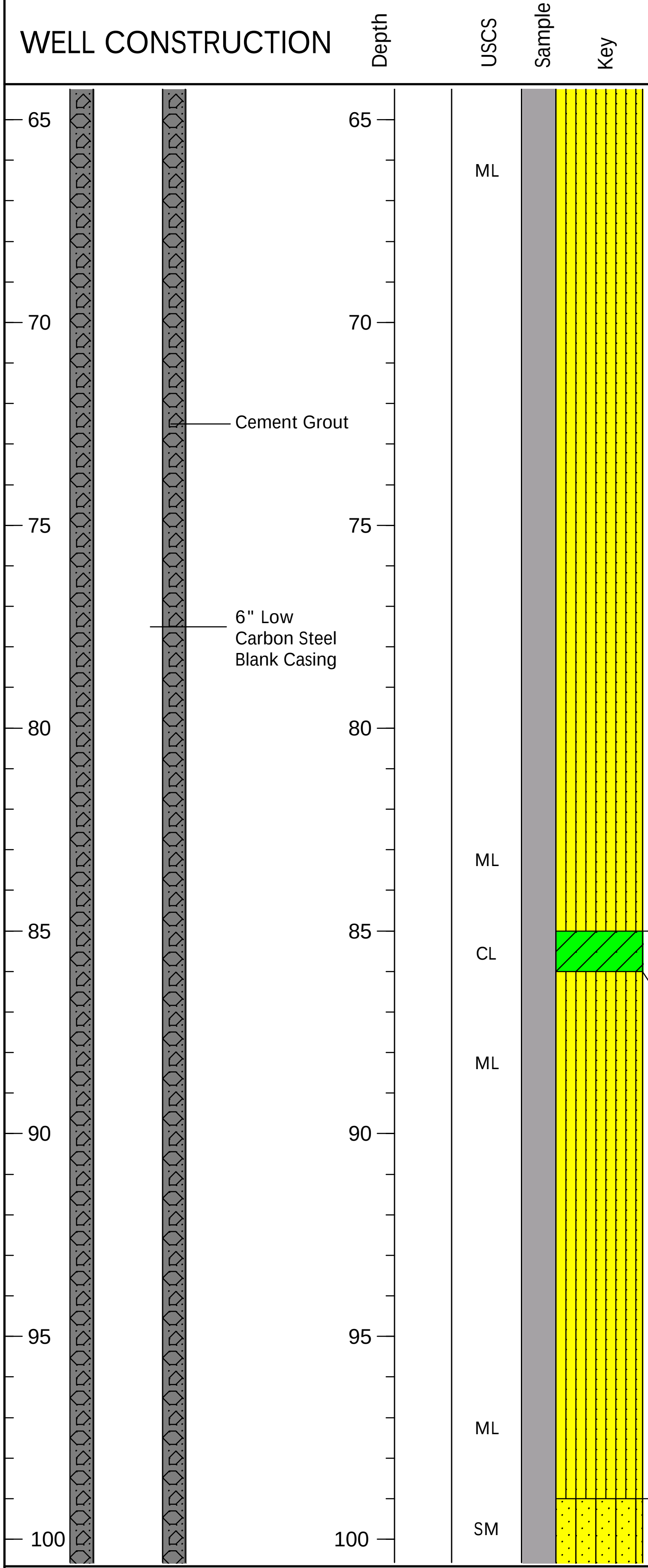
@ 37 feet: changes to light gray (10YR 7/2); dry.

Silty Clay with Gravel; brown (7.5YR 4/2); 75% silt and clay; 15% fine subangular gravel; 10% medium to coarse grained sand; low plasticity; moist.

Sandy Silt with Gravel; 60% silt; 20% medium to coarse grained sand; 20% fine to coarse subangular gravel; trace cobbles up to 3.5 inches.

@ 62-64 feet: more cobbles present, between 3 and 3.5 inches in length.

LOG OF BORING PTR-1
(Continued)



LITHOLOGIC DESCRIPTION

@ 66 feet: changes to Gravelly Silt; 60% silt, 30% fine to coarse subangular gravel; 10% fine to coarse grained sand; non-plastic; dry.

@ 68 feet: changes to Sandy Silt with Gravel; 60% silt; 20% medium to coarse grained sand; 20% fine to coarse subangular gravel.

Gravelly Clay; very dark grayish brown (10YR 3/2); 60% clay; 35% fine subangular gravel; 5% medium to coarse grained sand; low plasticity; stiff; moist.

Sandy Silt with Gravel; light gray (10YR 7/2); 60% silt; 20% medium to coarse grained sand; 20% fine to coarse subangular gravel; non-plastic; dry.

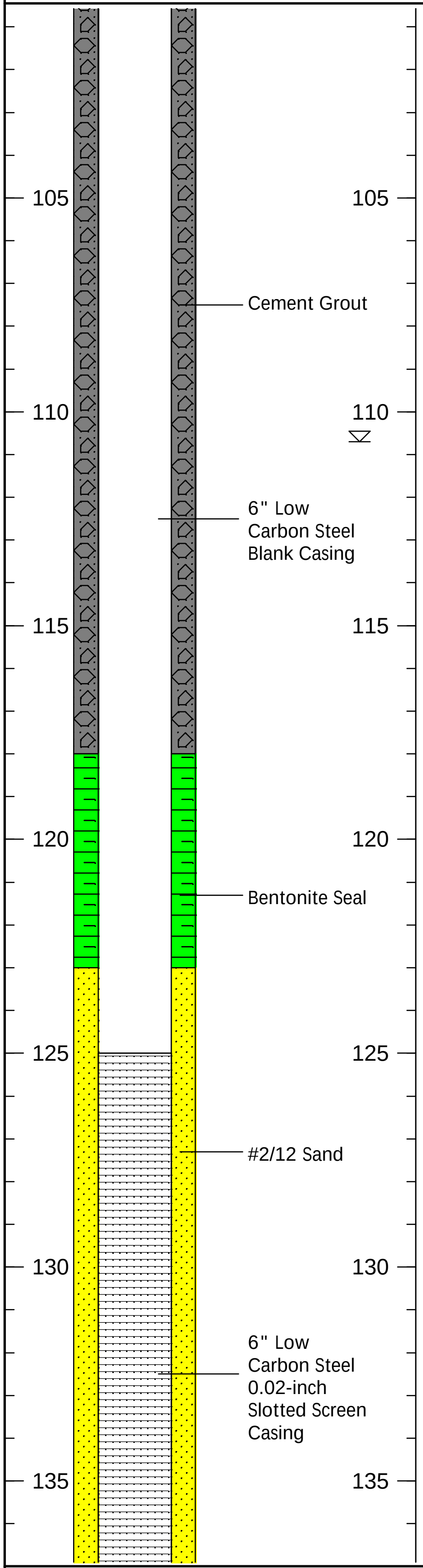
@ 88 feet: moderately cemented layers; stiff.

@ 90 feet: trace cobble up to 3.5 inches.

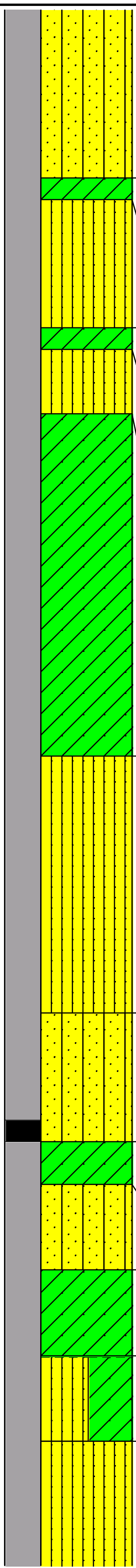
Silty Sand with Gravel; very dark grayish brown (10YR 3.2); 20% silt; 60% fine to coarse grained sand; 20% fine subangular gravel; non-plastic; moist.

LOG OF BORING PTR-1
(Continued)

WELL CONSTRUCTION



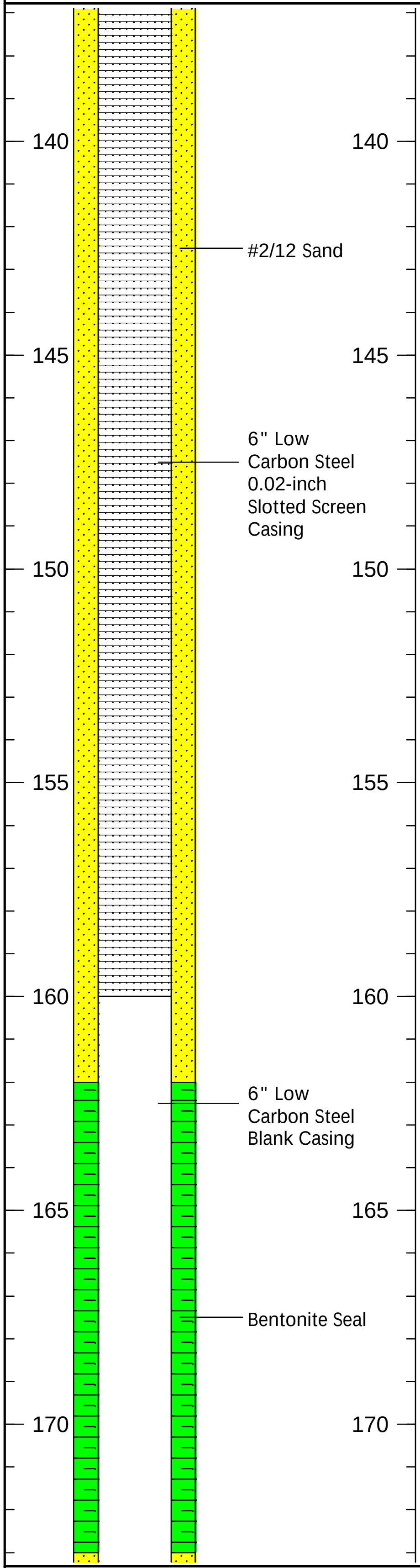
Sample Key

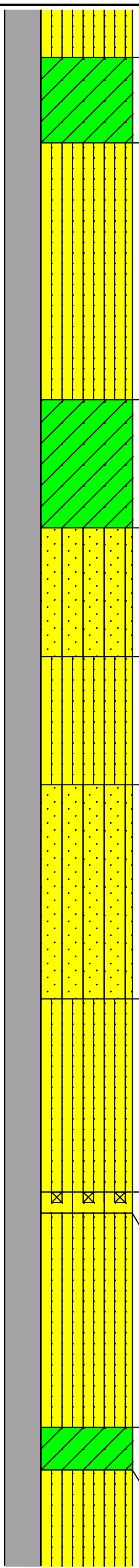


USCS	LITHOLOGIC DESCRIPTION
SM	
CL	Gravelly Clay; very dark grayish brown (10YR 3/2); 75% lean clay; 20% fine subangular gravel; 5% medium to coarse grained sand; low plasticity; moist.
ML	Sandy Silt with Gravel; light gray (10YR 7/2); 60% silt; 20% medium to coarse grained sand; 20% fine grained gravel; non-plastic; dry.
CL	Gravelly Clay; very dark grayish brown (10YR 3/2); 75% clay; 20% fine subangular gravel; 5% medium to coarse grained sand; low plasticity; moist.
ML	Sandy Silt with Gravel; light gray (10YR 7/2); 60% silt; 20% medium to coarse grained sand; 20% fine grained gravel; non-plastic; moderately cemented; very stiff; dry.
CL	Lean Clay with Sand; dark grayish brown (10Y 4/2); 90% clay; 10% medium to coarse grained sand; trace fine subangular gravel; low plasticity; weak to moderately cemented; stiff; wet.
ML	Sandy Silt; dark grayish brown (10Y 4/2); 90% silt; 10% medium to coarse grained sand; trace fine subangular gravel; non-plastic; weak cementation; stiff; wet
SM	Silty Sand with Gravel; dark grayish brown (10YR 4/2); 30% silt; 60% fine to coarse grained sand; 10% fine subangular gravel; non-plastic; weak cementation; stiff; wet.
CL	Lean Clay with Sand; dark grayish brown (10Y 4/2); 85% lean clay; 10% fine to coarse grained sand; low plasticity; wet.
SM	Silt Sand with Gravel; dark grayish brown (10Y 4/2); 60% fine to coarse grained sand; 30% silt; 10% fine subangular gravel; non-plastic; wet.
CL	Lean Clay with Gravel; dark gray (2.5Y 4/1); 90% lean clay; 10% fine subangular gravel; low to medium plasticity; soft; wet.
ML/CL	Clayey Silt; very dark gray (2.5Y 3/1); 55% silt; 45% clay; trace subangular gravel; low to no plasticity; moderately cemented layers; stiff; moist.
ML	Silt with Gravel; dark grayish brown (2.5Y 4/2); 85% silt; 10% fine subangular gravel; non-plastic; moist. @ 136 feet: changes to 80% silt; 10% fine to coarse subangular gravel up to 3.5 inches; 5% coarse grained sand; weak to moderate cementation; stiff.

LOG OF BORING PTR-1
(Continued)

WELL CONSTRUCTION

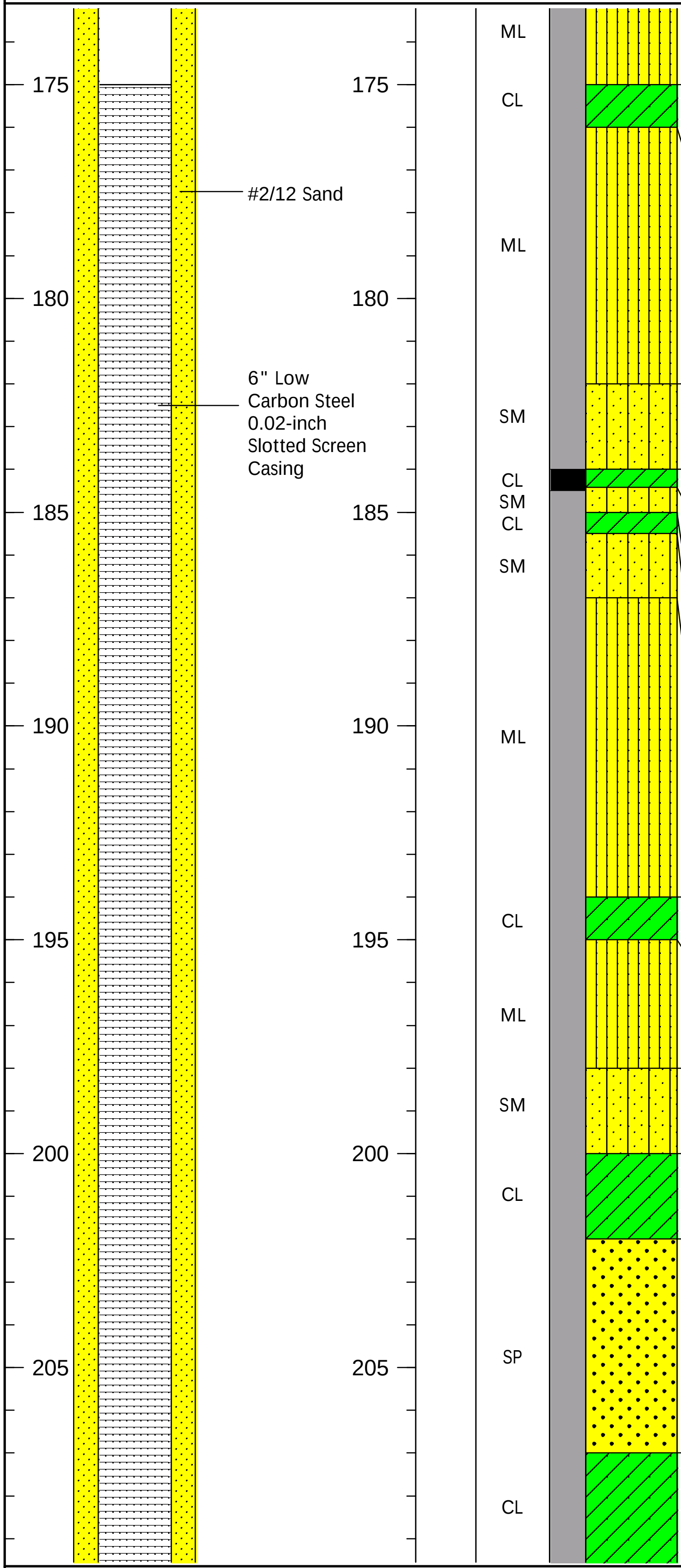




USCS	LITHOLOGIC DESCRIPTION
ML	
CL	Lean Clay with Gravel; dark grayish brown (2.5Y 4/2); 85% clay; 10% fine to coarse subangular gravel; 5% medium to coarse grained sand; low plasticity; moist.
ML	Gravelly Silt; dark grayish brown (2.5Y 4/2); 80% silt; 20% fine to coarse subangular gravel; non-plastic; moderate cementation; very stiff; moist. @ 144 feet: changes to weak cementation; wet.
CL	Sandy Clay; dark clay (5Y 4/1); 70% clay; 25% medium to coarse grained sand; 5% fine subangular gravel; low plasticity; weak cementation; medium stiff; wet.
SM	Silty Sand with Gravel; dark gray (5YR 4/1); 60% fine to coarse grained sand; 30% silt; 10% fine to coarse subangular gravel; trace of cobbles; non-plastic; wet.
ML	Sandy Silt with Gravel; dark gray (5Y 4/1); 60% silt; 30% fine to medium grained sand; 10% fine to coarse subangular gravel; non-plastic; stiff; wet.
SM	Silty Sand with Gravel; brown (10YR 4/3); 60% medium to coarse grained sand; 30% silt; 10% fine subangular gravel; non-plastic; moist. @ 158 feet: chages to wet. @ 159 feet: thin zone of lean clay (~3 inches).
ML	Silt with Sand; very dark grayish brown (10YR 3/2); 90% silt; 10% coarse grained sand; non-plastic; moderate cementation; moist. @ 162 feet: changes to dark reddish brown (2.5YR 3/4); moderate cementation; hard; medium dry strength.
GM	Fine Silty Gravel; subangular gravel with some silt; moist.
ML	Silt with Sand; very dark grayish brown (10YR 3/2); 90% silt; 10% coarse grained sand; no plasticity; moderate cementation; moist. @ 167 feet: changes Sandy Silt with Gravel; light gray (10YR 7/1); 60% silt; 20% coarse grained sand; 10% fine subangular gravel; non-plastic; weak cementation; stiff; dry. @ 169 feet: changes to moderate cementation.
CL	Lean Clay with Gravel; dark grayish brown (10YR 3/2); 95% clay; 5% medium to coarse grained sand; medium plasticity; wet.
ML	Silt; dark grayish brown (10YR 3/2); 95% clay; 5% coarse grained sand; no plasticity; moderate cementation; very stiff; moist.

LOG OF BORING PTR-1
(Continued)

WELL CONSTRUCTION | Depth | USCS | Sample | Key | LITHOLOGIC DESCRIPTION



Lean Clay with Gravel; dark grayish brown (10YR 4/2); 95% clay; 5% fine subangular gravel; medium plasticity; weak to moderately cemented; stiff to very stiff; wet.

Silt with Gravel; dark reddish brown (5YR 3/2); 90% silt; 10% fine subangular gravel; non-plastic; weak cementation; stiff; wet.

@ 179 feet: changes to Gravelly Silt; dark reddish brown (5YR 3/4); 70% silt; 25% fine subangular gravel; 5% medium to coarse grained sand; non-plastic; moist.

Silty Sand with Gravel and Cobbles; dark reddish brown (5YR 3/4); 55% fine to coarse grained sand; 30% silt; 10% fine subangular gravel; 5% cobbles up to 3.5 inches; wet.

Lean Clay; medium plasticity.

Silty Sand with Gravel and Cobbles; very dark grayish brown (2.5Y 3/2); 55% fine to coarse grained sand; 30% silt; 10% fine subangular gravel; 5% cobbles up to 3.5 inches; wet.

Lean Clay; medium plasticity.

Silty Sand with Gravel and Cobbles; dark grayish brown (2.5Y 3/2); 55% fine to coarse grained sand; 30% silt; 10% fine subangular gravel; 5% cobbles; wet.

Sandy Silt with Gravel; light brownish gray (10YR 6/2); 60% silt; 30% fine to coarse grained sand; 10% fine subangular gravel; non-plastic; moist.

@ 190 feet: changes to wet.

@ 191 feet: chages to moist.

Gravelly Clay; light brownish gray (10YR 6/2); 80% clay; 20% fine subangular gravel; low to medium plasticity; wet.

Gravelly Silt; light brownish gray (10YR 6/2); 70% silt; 25% fine subangular gravel; 5% coarse grained sand; non-plastic; moist.

Silty Sand with Gravel; dark reddish brown (5YR 3/4); 55% medium to coarse grained sand; 30% silt; 15% fine subangular gravel; non-plastic; wet.

Gravelly Clay; brown (10YR 4/3); 80% clay; 20% fine subangular gravel; medium plasticity; wet.

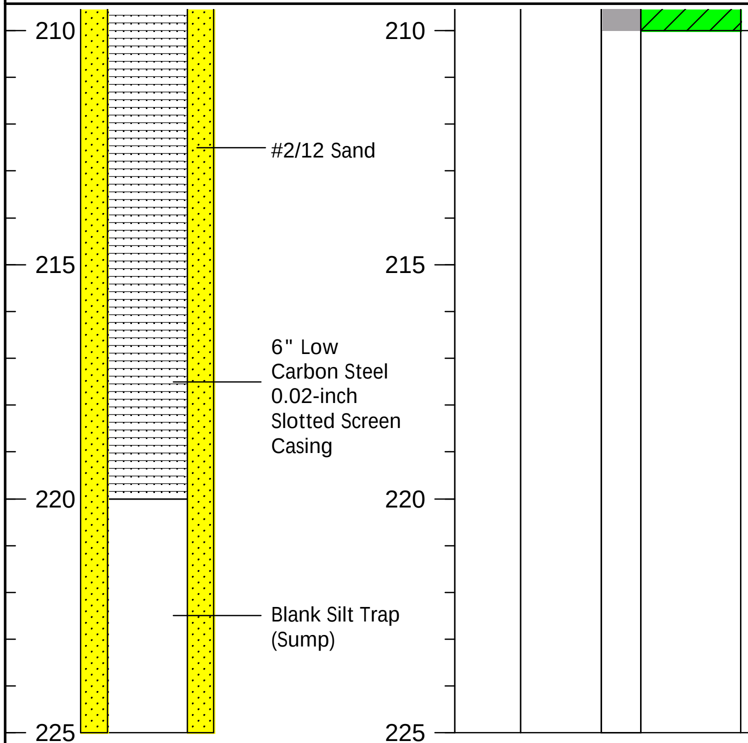
Poorly Graded Sand; dark reddish gray (10R 4/1); 95% medium to coarse grained sand; 5% silt; wet.

Occasional 1-2 inch layers of Sandy Silt; dark reddish gray (10R 4/1); 80% silt; 20% fine to coarse grained sand.

Lean Clay with Sand; dark red (10YR 3/6); 90% clay; 10% coarse grained sand; medium plasticity; wet.

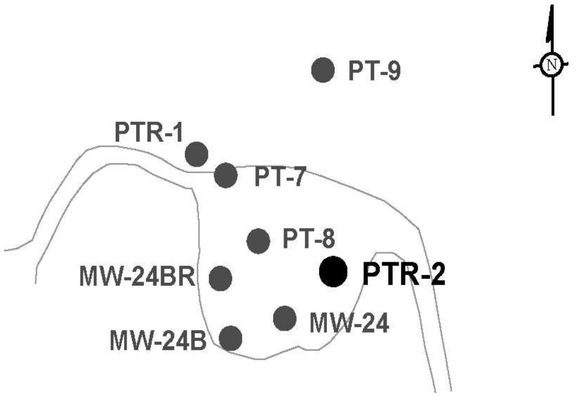
LOG OF BORING PTR-1
(Continued)

WELL CONSTRUCTION | Depth | USCS | Sample | Key | LITHOLOGIC DESCRIPTION



Boring logged to 210 feet bgs

End of boring at 225 feet bgs



LOG OF BORING PTR-2

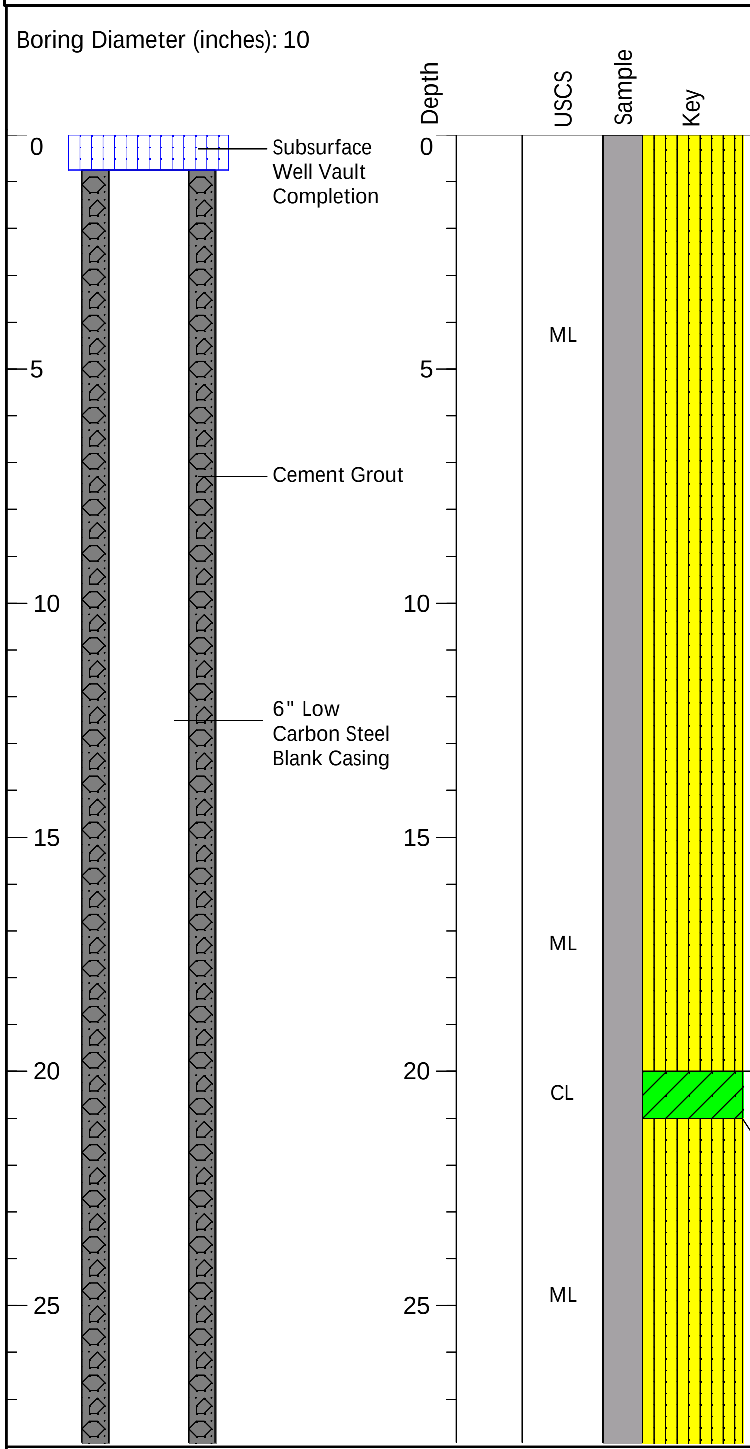
PG&E Topock Site
Needles, California

Project No.:	RC000689.0004	Date Started:	22 May 2007
Logged by:	B. Bardsley/ B. Evans	Date Completed:	2 June 2007
Drilling Co.:	WDC	Drilling Method:	Rotosonic/Mud Rotary
Drillers:	Rivera, West, Sakioka, Villegas	Sample Method:	4" x 6" Core Rod
Well Permit #2007040410		Driller's License:	C57-283326

WELL CONSTRUCTION

LITHOLOGIC DESCRIPTION

Boring Diameter (inches): 10



Silt with Gravel; pale brown (10YR 6/3); 90% silt, 10% fine subangular gravel; non-plastic; very soft; dry.

@ 4 feet: changes to Gravelly Silt; pale brown (10YR 6/3) and light gray (10YR 7/1); 60% silt; 30% fine to coarse subangular gravel; 10% medium to coarse grained.

@ 6 feet: changes to Sandy Silt with Gravel; light gray (10YR 7/1); 70% silt; 20% fine to coarse grained sand; 10% fine to coarse subangular gravel; non-plastic; very soft; dry.

@ 8 feet: changes to pale brown (10YR 6/3).

@ 12 feet: changes to Silt with Gravel; light gray (10YR 7/2); 90% silt; 10% fine subangular gravel; trace medium to coarse grained sand; non-plastic; very soft; dry.

@ 14 feet: changes to Sandy Silt with Gravel; light gray (10YR 7/1); 70% silt; 20% fine to coarse grained sand; 10% fine subangular gravel; non-plastic; very soft; dry.

@ 16 feet: changes to coarse subangular gravel.

@ 18 feet: changes to fine subangular gravel and has weakly cemented and hard 1-inch layers.

Lean Clay with Sand; dark reddish gray (2.5YR 4/1); 90% lean clay; 10% fine to coarse grained sand; low plasticity; very soft; moist.

Silt with Sand; dark reddish gray (2.5YR 4/1); 90% silt; 10% fine to coarse grained sand; non-plastic; weak cementation; hard; dry.

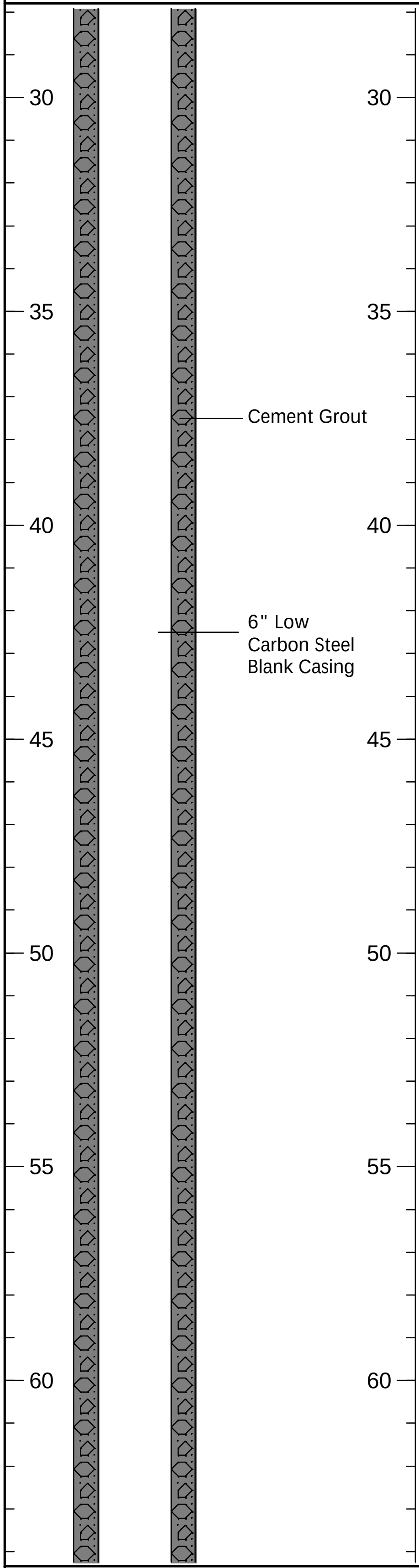
@ 23 feet: Sandy Silt with Gravel; light reddish gray (2.5YR 7/1); 70% silt; 20% fine to coarse grained sand; 10% fine subangular gravel; non-plastic; soft; dry.

@ 25 feet: 2-inch layer that is weakly cemented; very stiff; friable.

@ 26.5 feet: changes to 60% silt; 20% fine to coarse grained sand; 20% fine to coarse subangular gravel.

LOG OF BORING PTR-2
(Continued)

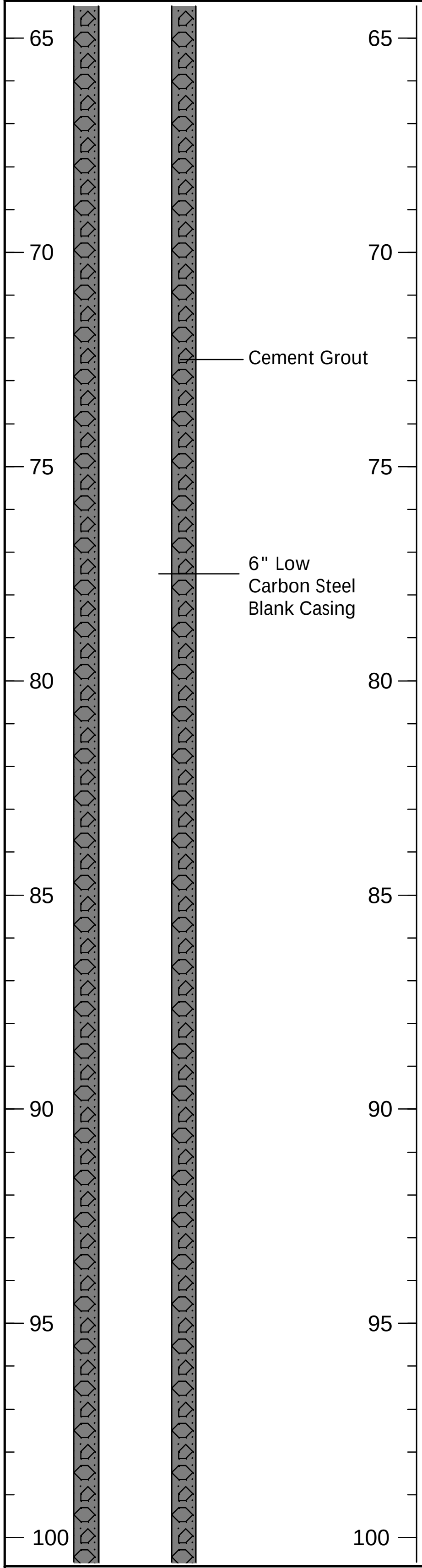
WELL CONSTRUCTION



USCS	LITHOLOGIC DESCRIPTION
ML	@ 29 feet: changes to 70% silt; 20% fine to coarse grained sand; 10% fine to coarse subangular gravel. @ 32 feet: 2-inch layer that is weakly cemented; very stiff.
SM	Silty Sand with Gravel; dark reddish gray (2.5YR 4/1); 70% fine to coarse grained sand; 20% silt; 10% fine subangular gravel; moist.
ML	Sandy Silt with Gravel; light reddish gray (2.5YR 7/1); 50% silt; 30% fine to coarse grained sand; 20% fine to coarse subangular gravel; non-plastic; very soft; dry. @ 37 feet: changes to Silt with Sand; 90% silt; 10% fine to coarse grained sand. Contains weakly cemented 1-inch layers; friable; very stiff.
SM	Silty Sand; red (2.5YR 4/8); 80% fine to coarse grained sand; 20% silt; trace fine subangular gravel; dry. Contains weakly cemented layers up to 3-inches; friable; very stiff. @ 41 feet: increasing to 10% fine to coarse subangular gravel. @ 43 feet: larger percentage of material is light reddish gray (2.5YR 7/1). @ 45 feet: changes to Silty Sand with Gravel; dark reddish gray (2.5YR 4/1); 70% fine to coarse grained sand; 20% silt; 10% fine to coarse subangular gravel; dry.
ML	Sandy Silt with Gravel; light reddish gray (2.5YR 7/1); 60% silt; 30% fine to coarse grained sand; 10% fine subangular gravel; non-plastic; very soft; dry. Contains weakly cemented layers; very stiff; friable.
SM	Silty Sand with Gravel; very dark grayish brown (10YR 3.2); 20% silt; 60% fine to coarse grained sand; 20% fine subangular gravel; no plasticity; moist.
SP	Poorly Graded Sand with Gravel; dark reddish gray (2.5YR 3/1); 85% medium to coarse grained sand; 15% fine subangular gravel; moist.
ML	Silt with Sand; light reddish gray (2.5YR 7/1); 90% silt; 10% medium to coarse grained sand; moderately cemented; friable; non-plastic; very stiff; dry. @ 55 feet: Sandy Silt with Gravel; dark reddish gray (2.5YR 4/1); 60% silt; 30% fine to coarse grained sand; 10% fine to coarse gravel; non-plastic; moist.
SM	Silty Sand with Gravel; reddish gray (2.5YR 5/1); 50% fine to very coarse grained sand; 30% coarse subangular gravel; 20% silt; non-plastic; dense; moist.
ML	Sandy Silt with Gravel; weak red (2.5YR 5/2); 60% silt; 30% fine to medium coarse grained sand; 10% fine to medium grained subangular gravel; non-plastic; dense; dry.
CL	Lean Clay with Gravel; dark grayish brown (10YR 4/2); 80% lean clay; 10% fine subangular gravel; 10% fine grained sand; low plasticity; moist.
ML	Sandy Silt with Gravel; reddish gray (2.5YR 6/1); 70% silt; 20% fine to coarse grained sand; 10% subangular gravel; dense; crumbly; dry.

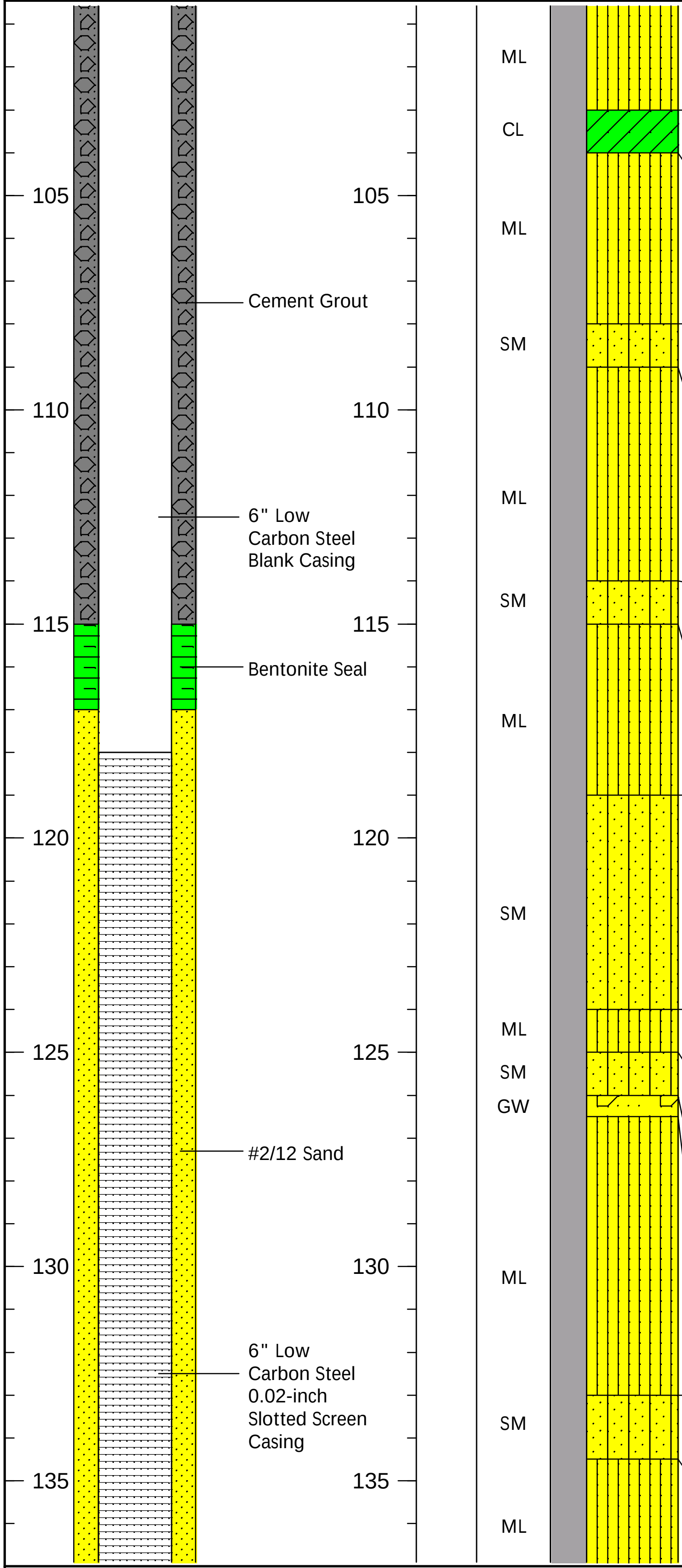
LOG OF BORING PTR-2
(Continued)

WELL CONSTRUCTION



USCS	LITHOLOGIC DESCRIPTION
ML	@ 65 feet: light reddish gray (2.5YR 7/1); solid pieces very dense; brittle; hard. Increased amount of gravel; dark greenish gray (GLEY1 4/1); crystalline.
CL	Sandy Clay; dark reddiah gray (2.5YR 4/1); 70% clay; 30% medium to coarse grained sand; trace subangular gravel; low plasticity; moist.
SM	Silty Sand with Gravel; dark reddish gray (2.5YR 3/1); 50% fine to coarse grained sand; 30% silt; 20% fine to medium subangular gravel; loose with dense pieces; dry.
ML/SM	Sandy Silt with Gravel; weak red (2.5YR 4/2); 50% silt; 30% fine to coarse grained sand; 20% fine to coarse subangular gravel; non-plastic; dense to soft; dry-moist. Contains some white cemented layers (0.25 to 1-inch thick). @ 75 feet: light brownish gray (10YR 6/2); 50% fine to coarse grained sand; 30 to 40% silt; 10 to 20% angular to subangular gravel; dense; dry. Sand and gravel are dark greenish gray, crystalline. Contains cemented white material.
CL	Clay with Gravel; greenish gray (GLEY1 6/1); 80 to 90% powdery clay; 10 to 20% fine to very coarse subangular gravel; cobbles up to 3-inch diameter; loose; dry.
ML	Sandy Silt with Gravel; light reddish grey (2.5YR 7/1); 50% silt; 30 to 40% fine to very coarse grained subangular sand; 10 to 20% fine to coarse sand; loose with hard brittle pieces; dry; heavily cemented with white material. @ 83 feet: decreasing gravel; increasing sand; moist.
CL	Silty Sand with Gravel; dark grayish brown (10YR 4/2); 70% clay; 20% fine to coarse subaungular to angular gravel; 10% fine to coarse grained sand; loose; moist.
ML	Sandy Silt with Gravel; reddish grey (2.5YR 6/1); 60 to 70% silt; 20% fine to coarse grained sand; 10 to 20% fine to coarse subangular-angular gravel; non-plastic; loose; dry to moist. @ 87 feet: becoming dark grayish brown (10YR 4/2); wet.
CL	Lean Clay with Gravel; dark grayish brown (10YR 4/2); 80% clay; 20% fine to coarse angular-subangular gravel; medium plasticity; medium stiff; moist to wet.
ML	Sandy Silt with Gravel; reddish gray (2.5YR 6/1); 70% silt; 20% fine to coarse angular to subangular gravel; 10% fine to coarse sand; loose with harder cemented pieces; moist.
CL	Lean Clay with Gravel; light brownish gray (10YR 6/2); 90% powdery clay; 10% fine to coarse angular to subangular gravel; medium plasticity; dry.
	Sandy Silt with Gravel; reddish grey (2.5YR 6/1); 60 to 70% silt; 20% fine to coarse

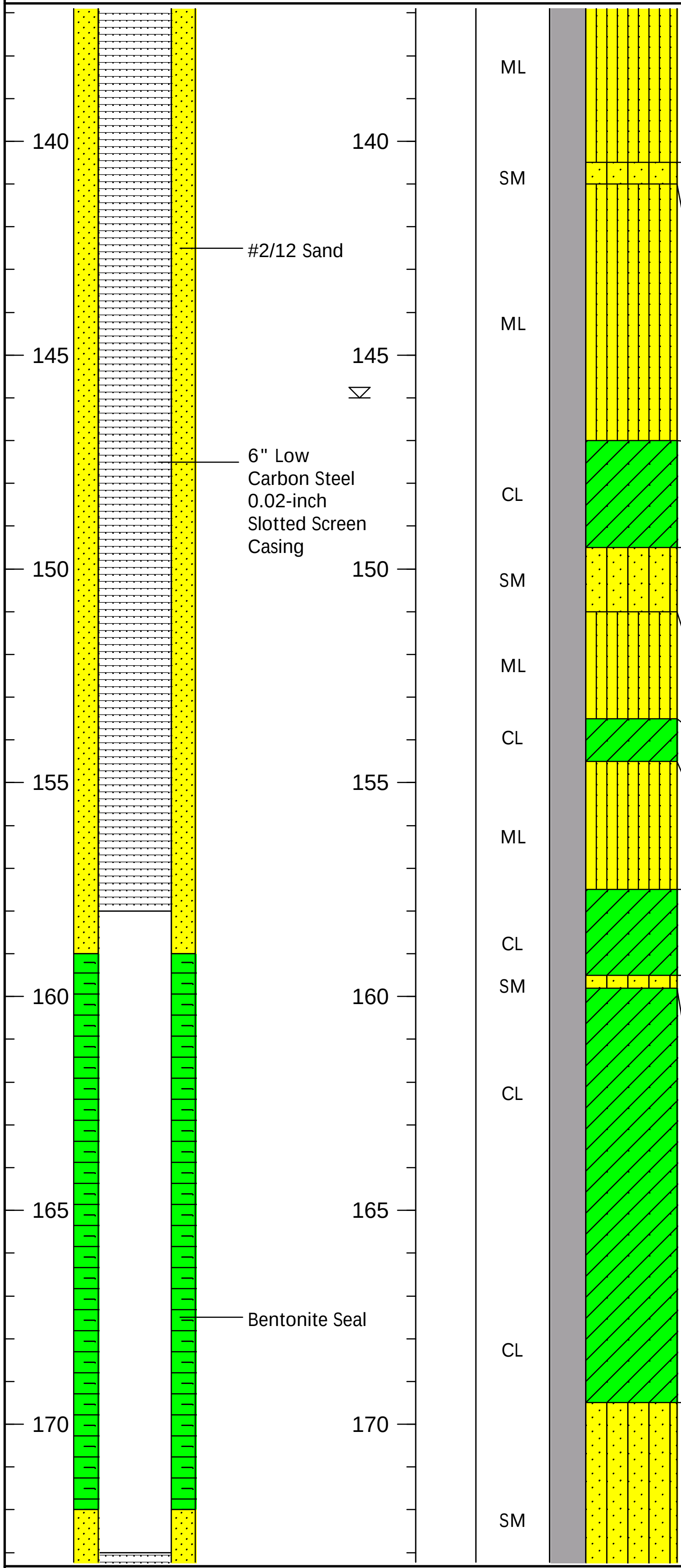
LOG OF BORING PTR-2
(Continued)



USCS	LITHOLOGIC DESCRIPTION
ML	grained sand; 10 to 20% fine to coarse subangular to angular gravel; non-plastic; loose; dry to moist.
CL	Lean Clay; dark grayish brown (10YR 9/2); 80% clay; 10% fine to coarse sand; 10% fine to coarse angular to subangular gravel; medium plasticity; wet.
ML	Sandy Silt with Gravel; light brownish gray (10YR 6/2); 60% silt; 20% fine to coarse grained sand; 20% fine to coarse angular to subangular gravel; non-plastic; loose with cemented pieces; dry. @ 105 feet: clay increases; slightly plastic; moist to wet.
SM	Silty Sand with Gravel; dark reddish grey (5YR 4/2); 50% fine to very coarse grained sand; 40% silt; 10% fine to coarse angular to subangular gravel; very well graded; stiff; moist to wet.
ML	Sandy Silt with Gravel; dark reddish gray (5YR 4/2); 60-70% silt; 20-30% fine to coarse grained sand; 10% fine to coarse angular to subangular gravel; well graded gravel; stiff; moist to wet. @ 111 feet: changes to Sandy Silt; dark grayish brown (10YR 4/2); 70% silt; 30% fine to coarse grained sand; trace fine gravel; well graded; non-plastic; sporadic cementing; stiff; moist. @ 113 feet: increasing gravel.
SM	Silty Sand with Gravel; dark grayish brown (10YR 4/2) mottled with reddish brown (2.5YR 4/3); 50% fine to very coarse grained sand; 40% silt; 10% fine to very coarse angular to subangular gravel; well graded; minor cementing; stiff; moist.
ML	Sandy Silt with Gravel; reddish brown (5YR 4/3); 60 to 70% silt; 20 to 30% fine to coarse grained sand; 10% fine to coarse angular to subangular gravel; well graded; firm; stiff; very moist.
SM	Silty Sand with Gravel; reddish brown (5YR 4/3); 50 to 60% fine to coarse grained sand; 40 to 50% silt; 10% fine to very coarse angular to subangular gravel; well graded; minor cementing; very stiff; dense; very moist. @ 119.5 feet: interbedded silt layers 0.8 to 1-inch thick; grayish brown (10YR 5/2). @ 122 feet: varying percentages of silt and sand.
ML	Sandy Silt to Silty Sand with Gravel; varying percentages; very moist; interbedded silt layers.
SM	Silty Sand with Gravel; reddish brown (5YR 4/3); 50 to 60% fine to very coarse grained sand; 30 to 40% silt; 10% fine to coarse subangular gravel; very well graded; medium stiff; loose; wet.
GW	Sand and Gravel; multicolored grains; 60 to 70% medium to very coarse sand; 30 to 40% fine to very coarse subangular gravel; well graded coarse mix; loose; wet.
ML	Sandy Silt with Gravel; reddish brown (5YR 4/3); 60% silt; 30% medium to very coarse grained sand; 10% fine to coarse angular to subangular gravel; moderately stiff; wet. @ 132.8 feet: variable percentages of sand and silt; 30 to 90% gravel and cobbles.
SM	Silty Sand; grayish brown (10YR 5/2); 60-70% medium to very coarse grained sand; 20% silt; 10 to 20% fine to very coarse angular to subangular gravel; well graded with gravel; loose to medium stiff; loose; wet.
ML	Silty Sand with Gravel; grayish brown (10YR 5/2); 60 to 70% medium to very coarse grained sand; 20% silt; 10 to 20% fine to very coarse angular to subangular gravel; slightly plastic; medium stiff; sticky; wet.

LOG OF BORING PTR-2
(Continued)

WELL CONSTRUCTION | Depth | USCS | Sample | Key | LITHOLOGIC DESCRIPTION



@ 135 feet: Sandy Silt with Gravel; dark grayish brown (10YR 4/2); 60% silt; 20% fine to very coarse subangular to subrounded gravel; 20% fine to coarse sand; very stiff; dense; moist.

Silty Sand with Gravel; dark grayish brown (10YR 4/2); 60% fine to medium coarse grained sand; 30% silt; 10% fine to very coarse angular to subangular gravel; moderately graded; moderately stiff and dense; moist.

Sandy Silt with Gravel; dark grayish brown (10YR 4/2); 60% silt; 20% fine to very coarse subangular to subrounded gravel; 20% fine to coarse sand; very stiff; dense; moist.
@ 141.5 feet: changes to light brownish gray (10YR 6/2); 50% silt; 50% fine to very coarse angular gravel and rock fragments; loose; dry.

@ 142.5 feet: changes to brown (7.5YR 4/3); 60% silt; 30% fine to very coarse angular/subangular gravel; 10% fine to coarse sand; very stiff and dense; moist.
@ 145 feet: 40% coarse angular gravel; moist.

Sandy Clay with Silt and Gravel; dark grayish brown (10YR 4/2); 40% clay; 30% silt; 20% fine to coarse grained sand; 10% fine to very coarse gravel; slighty plastic; soft; sticky; moist to wet.
@ 149 feet: increasingly more silty and dense.

Silty Sand with Gravel; dark grayish brown (10YR 4/2); 50% medium to very coarse grained sand; 30% silt; 20% fine to very coarse angular to subangular gravel; very stiff; very dense; moist.
@ 150 feet: some white cementation.

Sandy Silt with Gravel; grayish brown (10YR 5/2); 70% silt; 20% fine to coarse angular to subangular gravel; non-plastic; firm; very dense; moist; cemented with white material.

Clay with Gravel; greenish gray (GLEY1 6/1); 80% powdery clay; 20% fine to very coarse angular gravel; loose; dry.

Sandy Silt with Gravel; gray (10YR 5/1) mottled with brown (10YR 5/3); 70% silt; 10 to 20% fine to very coarse sand; 10 to 20% fine to very coarse angular to subangular gravel; non-plastic; very firm; dense; moist to dry.
Some silt layering: 3 1-inch thick silt light brownish gray (10YR 6/2).

Sandy Silty Lean Clay; grayish brown (10YR 5/2) mottled with dark red (10YR 3/6); 70% clay; 20% fine to coarse sand; trace fine to very coarse angular gravel; medium plasticity; slightly soft; moist to wet.

Silty Sand with Gravel; grayish brown (10YR 5/2); 60% fine to very coarse grained sand; 20% silt; 20% fine to coarse angular to subangular gravel; well graded; loose with cemented pieces; moist to dry.

Clay with Gravel; greenish gray (GLEY1 6/1); 80% powdery clay; 20% fine to very coarse angular gravel; loose; moist.
@ 160.5 feet: changes to Sandy Clay with Gravel; dark reddish gray (5YR 4/2); 60% clay; 15% fine to coarse grained sand; 15% fine to coarse angular to subangular gravel; 10% silt; medium plasticity; soft; very moist to wet. Sand and gravel percentages vary in clay matrix.

@ 163 feet: changes to Sandy Clay; 20 to 30% silt; non-plastic; firm with brittle pieces; moist to dry.

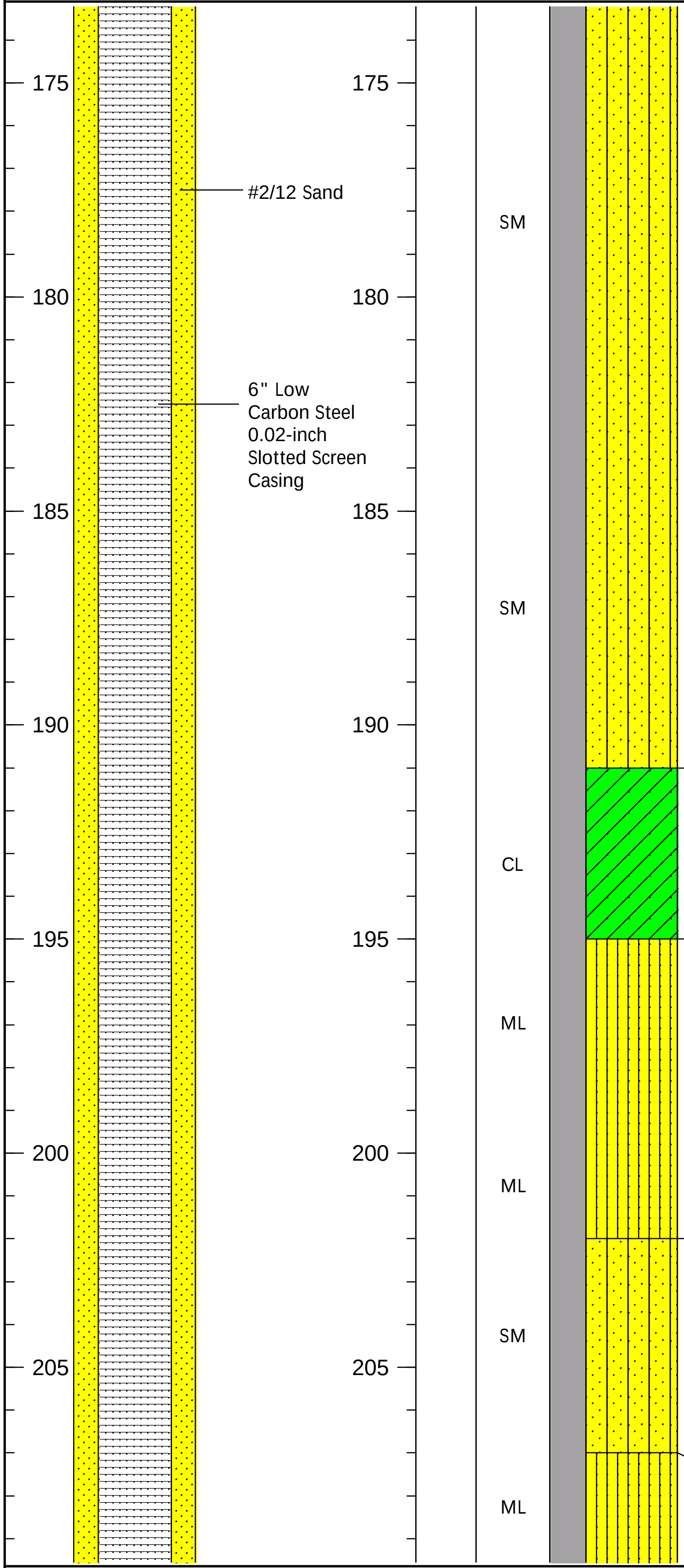
@ 164 feet: Sandy Clay with Gravel; brown (7.5YR 4/2); 60 to 70% clay; 15% fine to coarse grained sand; 15% fine to very coarse angular to subangular gravel; medium plasticity; firm; densely packed sand and gravel in silt matrix; very moist to wet.
@ 166-167 feet: sand and gravel percentages increasing to 25%; color changes to reddish brown (5YR 4/3).

Clayey Sand with Gravel; reddish brown (5YR 4/3); 60% fine to coarse grained sand; 20% fine to coarse angular to subangular gravel densely packed in a 20% clay matrix; very firm; hard; very dense; moist. Secondary cementation with white material.

@ 171 to 175 feet: interbedded silt layers; 100% silt; brown (7.5YR 4/3); 0.5-inch thick and less; 2-4-inch spacing; sand and gravel percentages varying; some mottling caused by reddish brown (5YR 4/4) clay.

LOG OF BORING PTR-2
(Continued)

WELL CONSTRUCTION | Depth | USCS | Sample | Key | LITHOLOGIC DESCRIPTION



@ 176 feet: changes to dark reddish brown (2.5YR 3/4); 60% fine to very coarse sand; 30% clay; 10% fine to coarse subangular gravel; low plasticity; soft; wet.

@ 179 feet: changes to 50% sand; 40% clay; moderately plastic.

@ 180 feet: varying percentages of sand, clay and gravel; soft; sticky.

@ 183 feet: Sandy Clay with Gravel; 60% clay; 20% fine coarsed grained sand; 20% fine to very coarse angular to subangular gravel; medium plasticity.

@ 184 feet: 60% fine to very coarse sand; 30% clay; 10% fine to coarse subangular gravel; low to medium plasticity.

@ 187 feet: 80% sand; 20% clay; 10% gravel; slightly loose.

@ 190 feet: changes to grayish brown (10YR 5/2); 70 to 80% medium to coarse sand; 15 to 20% clay; 5 to 10% fine to very coarse subangular gravel; moderately graded; loose.

Sand and Clay with Gravel; grayish brown (10YR 5/2); 60 to 70% clay; 20 to 30% fine to very coarse sand; 10 to 20% fine to very coarse angular-subangular gravel; moderately plastic; medium soft; wet.
@ 192-192.5 feet: zones of cemented sand.

Sandy Silt with Gravel; grayish brown (10YR 5/2); 70% silt; 20% fine to coarse sand; 10% fine to very coarse aungular to subangular gravel; slightly plastic; soft; moist; cemented sand zones throughout.

@ 199 feet: changes to reddish brown (5YR 4/3); 70% silt; 15% fine to coarse grained sand; 15% fine to very coarse angular to subangular gravel; non-plastic; very hard; moist-dry. Dense silt matrix with sand and gravel.

@ 202 feet: changes to moist and decreasing hardness.

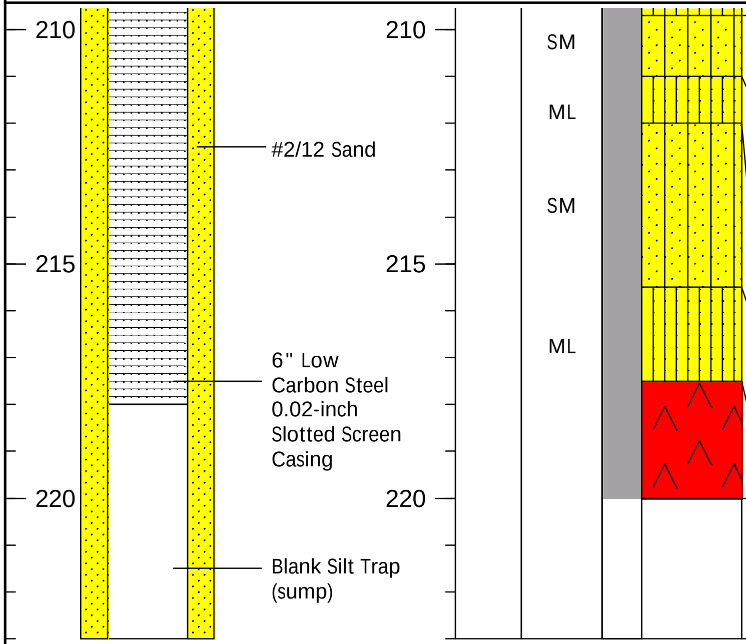
Silty Sand with Gravel; reddish brown (5YR 4/3); 50% fine to coarse grained sand; 30% silt; 20% fine to very coarse angular to subangular gravel; non-plastic; very hard; dense; moist; secondary cementation.
@ 203 feet: 60% sand; 20% silt; very cemented; hard; brittle; dry to moist.

@ 204.5 feet: reddish brown (2.5YR 4/1); 50% fine to coarse grained sand; 35% silt; 15% fine to very coarse angular to subangular gravel; slightly plastic; moderately soft; moist to wet.
@ 206 feet: extremely dense; hard; dry to moist; very compacted silt, sand and gravel mix.

Sandy Silt with Gravel; reddish brown (2.5YR 3/4); 50% silt; 30% fine to coarse grained sand; 20% fine to coarse aungular to subangular gravel; non-plastic; firm; hard; moist to very moist.

LOG OF BORING PTR-2
(Continued)

WELL CONSTRUCTION | Depth | USCS | Sample | Key | LITHOLOGIC DESCRIPTION



Silty Sand with Gravel; reddish brown (2.5YR 3/4); 50% medium to very coarse grained sand; 40% silt; 10% fine to very coarse subangular gravel; well graded; soft; loose; wet; sticky.

Sandy Silt with Gravel; reddish brown (2.5YR 3/4); 50% silt; 30% fine to coarse grained sand; 20% fine to coarse aungular-subangular gravel; non-plastic; hard; moist to very moist.
@ 211.3 feet: reddish brown (5YR 4/3); 60% silt and clay; 20% fine to coarse grained sand; 20% fine to coarse subangular to subrounded gravel; slightly plastic; moderately soft; wet; sticky.

Silty Sand with Gravel; reddish brown (5YR 4/3); 70% fine to coarse grained sand; 20% silt; 10% fine to coarse gravel; well graded; soft; loose; wet; sticky.

Silty Sand with Gravel; reddish brown (5YR 4/3) and yellowish red staining (5YR 4/6); 50% silt; 20% fine to coarse grained sand; 25% fine to coarse angular to subangular gravel; non-plastic; hard; dense; moist.
@ 216.5 feet: pieces of weathered bedrock; dry to moist.

Bedrock; broken pieces conglomerate; dry.

Boring logged to 220 feet bgs

End of boring at 223 feet bgs