Pacific Gas and Electric Company

Yvonne J. Meeks
Site Remediation - Portfolio Manager
Environmental Affairs

6588 Ontario Road
San Luis Obispo, CA 93405

Mailing Address
4325 South Higuera Street
San Luis Obispo, CA 93401

805.546.5243
Internal: 664-5243
Fax: 805.546.5232
E-mail: YJM1@pge.com

June 29, 2007

Mr. Aaron Yue
Project Manager
California Department of Toxic Substances Control
5796 Corporate Avenue
Cypress, CA 90630

Subject: Well Installation Report for Slant Wells MW-52 and MW-53
PG&E Topock Compressor Station, Needles, California

Dear Mr. Yue:

This letter transmits the Well Installation Report for Slant Wells MW-52 and MW-53. The document is submitted in conformance with the October 19, 2006 *Work Plan for Additional Groundwater Characterization beneath the Colorado River by Slant Boring in California at the PG&E Topock Compressor Station.* This report also provides the post-construction report required by Lease No. W 26189 between the California State Lands Commission and PG&E, as well as the as-built information required by the California Department of Transportation Encroachment Permit No. 08-06-6-SV-1140.

If you have questions, please do not hesitate to contact me. I can be reached at (805) 234-2247.

Sincerely,

Yvonne Meeks

cc: Chris Guerre/DTSC
John Earle/HNWR
Cathy Wolff-White/BLM
Behzad Sedighi/Caltrans
Susan Young/California State Lands Commission

Well Installation Report for Slant Wells MW-52 and MW-53

PG&E Topock Compressor Station Needles, California

Prepared for

California Department of Toxic Substances Control

On Behalf of

Pacific Gas and Electric Company

June 29, 2007

CH2MHILL
155 Grand Avenue, Suite 1000
Oakland, CA 94612

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This report was prepared under the supervision of a
California Certified Engineering Geologist

Paul Bertucci, C.E.G. No. 1977
Project Hydrogeologist

REGISTERED GEOLOGIST
PAUL F. BERTUCCI
8/31/08
No. CEG 1977
CERTIFIED
ENGINEERING
GEOLOGIST
STATE OF CALIFORNIA

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Acronyms and Abbreviations

µg/L	micrograms per liter
bgs	below ground surface
CDFG	California Department of Fish and Game
Cr(T)	total dissolved chromium
Cr(VI)	hexavalent chromium
CSLC	California State Lands Commission
DTSC	California Department of Toxic Substances Control
GMP	Topock groundwater and surface water monitoring program
HNWR	Havasu National Wildlife Refuge
mg/L	milligrams per liter
mV	millivolt
MLABS®	Multilevel Angled Borehole System®
ORP	oxidation-reduction potential
PG&E	Pacific Gas and Electric Company
psi	pounds per square inch
PVC	polyvinyl chloride
RCRA	Resource Conservation and Recovery Act of 1976
RFI/RI	RCRA facility investigation/remedial investigation

SECTION 1.0

Introduction

Pacific Gas and Electric Company (PG&E) is addressing chromium in groundwater at the Topock Compressor Station under the oversight of the California Environmental Protection Agency, Department of Toxic Substances Control (DTSC) and United States Department of the Interior. The Topock Compressor Station is located in eastern San Bernardino County, California about 15 miles southeast of Needles (Figure 1-1).

This report summarizes the work conducted to install groundwater monitoring wells using slant methods on the California shoreline of the Colorado River in the vicinity of the Topock Compressor Station and presents the results of the drilling, well installation, and initial groundwater sampling. Well installation activities occurred between February and April 2007, and well development and initial sampling activities continued through June 2007. The primary objectives of the slant drilling and groundwater investigation were to:

- Assess chromium concentrations in the fluvial sediments beneath the Colorado River downgradient of the chromium plume observed in the floodplain.
- Characterize the natural geochemical groundwater conditions, specifically the extent of reducing-water chemistry, in the fluvial sediments beneath the Colorado River and assess whether geochemical conditions in the sediments beneath the river favor chromium reduction.
- Install permanent multilevel monitoring points in the slant borings to serve as ongoing water quality and hydraulic monitoring points beneath the river, downgradient of the floodplain area of the Topock site.

The well installation was completed as outlined in the *Work Plan for Additional Groundwater Characterization Beneath the Colorado River by Slant Boring in California* (Work Plan) (CH2M HILL, 2006a) and *Addendum to Work Plan for Additional Groundwater Characterization Beneath the Colorado River by Slant Boring in California* (Work Plan Addendum) (CH2M HILL, 2006b). The drilling, well installation, and associated activities are collectively referred to in this report as the California Slant Drilling Program.

The restoration activities outlined in the work plan will be scheduled and executed at a future time in coordination with the United States Fish and Wildlife Service, Havasu National Wildlife Refuge (HNWR), and other stakeholders.

1.1 Approvals and Authorizations

The California Slant Drilling Program was executed in conformance with the following approvals and authorizations:

- DTSC approval of the Work Plan (DTSC, 2006) and DTSC approval of the Work Plan Addendum (DTSC, 2007)

- United States Fish and Wildlife Service, HNWR approval letter (USFWS 2007)
- Lease agreement (CSLC, 2006) and amendment (CSLC, 2007) between the California State Lands Commission (CSLC) and PG&E
- Agreement to Amend Lake or Streambed Alteration Agreement (Notification No. 1600-2005-0140-R6 between the California Department of Fish and Game (CDFG) and PG&E (CDFG, 2007)
- CalTrans Encroachment Permit No. 08-06-6-SV-1140
- San Bernardino County well permits (Nos. 2007020134 and 2007020135)

1.2 Report Organization

This report summarizes the work conducted as part of the California Slant Drilling Program and presents the results of the drilling, well installation, and initial groundwater sampling.

- Section 2.0 summarizes the drilling, well installation, and associated field activities performed.
- Section 3.0 presents the results of the slant drilling investigation, including lithologic observations, depth-discrete borehole groundwater sample data, and initial groundwater monitoring well sample data.
- Section 4.0 discusses attainment of the objectives of the California Slant Drilling Program, and incorporation of collected information into the Groundwater Resource Conservation and Recovery Act (RCRA) facility investigation/remedial investigation (RFI/RI).
- Documents referenced in the preparation of this report are provided in Section 5.0.

SECTION 2.0

Summary of Field Activities

This section summarizes the drilling, well installation, and associated field activities performed in accordance with the Work Plan (CH2M HILL, 2006a) and Work Plan Addendum (CH2M HILL, 2006b). Primary scope of work items conducted during this program include:

- Site preparation.
- Drilling of two angled boreholes to the bedrock surface.
- Collection of lithologic core and depth-specific groundwater samples during borehole drilling.
- Installation and development of a multilevel groundwater monitoring well in each angled boreholes (MW-52 and MW-53).
- Collection of initial groundwater samples for laboratory analysis from each sample interval of MW-52 and MW-53.

Figure 2-1 presents the locations of MW-52 and MW-53.

2.1 Site Access, Preparation, and Compliance Monitoring

An onsite biologist was present to conduct pre- and post-construction site surveys and direct vegetation clearance for drilling site access. A biologist was also at the work site to monitor bird activity several times after March 15, 2007. In addition, the NHWR manager requested additional frequent monitoring for bird activity during the entire duration of the drilling activity, which was conducted by a qualified onsite employee. Results of the pre- and post-construction surveys, and information collected during biological monitoring to assess compliance with HNWR-required conditions for well installation are provided in the *Biological Resources Completion Report for the California Slant Drilling Project: Topock Compressor Station Groundwater Monitoring* (CH2M HILL, 2007).

The slant drilling site was accessed by the approved, pre-existing routes identified in the Work Plan. Vegetation clearance within the work area was required prior to the commencement of drilling and well installation activities, and no additional vegetation clearance was required outside the work area in order to gain access to the work area. Approximately 0.08 acre of salt cedar and arrow weed were cleared from the slant drill work area on February 15, 2007. Subsequently, on March 5, 2007, an additional 100 square feet of salt cedar were removed to accommodate the drill rig worker platform at the MW-53 location within the cleared work area. Therefore, 0.082 acre of vegetation was removed from the work area to accommodate equipment access and installation of the wells. Vegetation was cut at the ground level to minimize the disturbance to root systems.

Prior to moving equipment onto HNWR properties, the drilling sites and the access routes were surveyed for cultural resources. In addition, a representative of the Fort Mojave Indian Tribe was present to observe well installation activities.

2.2 Drilling and Lithologic Logging

Two boreholes were drilled to the top of the Miocene conglomerate. Borehole drilling was accomplished using rotosonic drilling method, which involves advancing a steel drive casing and core barrel through the subsurface using a combination of rotation and vibration. This method was selected because it has the capability to drill at shallow angles, produces a continuous core from the land surface to the target drilling depth, generates minimal drilling wastes, and typically can drill through gravel, cobble, and competent bedrock formations. The continuous core obtained during borehole installation was used to prepare the lithologic logs provided in Appendix A. Lithologic descriptions were prepared under the supervision of a California professional geologist based on visual inspection of the retrieved core.

Drilling activities began at locations MW-52 and MW-53 on February 23, 2007 and March 12, 2007, respectively. The borehole drilled for the installation of MW-52 was drilled at an angle of 40 degrees from horizontal with an azimuth of 087 degrees true to a vertical depth of 102 feet below ground surface (bgs) as referenced from the top of the borehole. The total borehole length was 158 feet. The borehole drilled for the installation of MW-53 was drilled at an angle of 30 degrees from horizontal on an azimuth of 090 degrees to a total vertical depth of 133 feet bgs, as referenced from the top of the borehole. The total borehole length was 265 feet. Each borehole was drilled using a 4-inch-diameter core barrel followed by a 6-inch-diameter drive casing to total depth. Due to the depth of the MW-53 slant borehole, larger-diameter casing was used in the shallower portion of the borehole to minimize friction; however, this casing was retracted prior to well installation.

2.3 Depth-specific Groundwater Sampling

Depth-specific groundwater samples were collected at 20-foot intervals in each borehole. In addition, a sample was collected from the zone immediately above the bedrock in each borehole. Specific sample zones and analytical results are discussed in Section 3.2.

Depth-specific groundwater samples were collected during the installation of each borehole using the Isoflow® system. Samples were obtained by installing the Isoflow® tools to the bottom of the borehole and retracting the drive casing to expose the Isoflow® sampling screen to the formation. Once exposed, the submersible pump built into the Isoflow® system was used to purge the sample interval and obtain a sample.

To ensure the collection of a sample representative of formation groundwater, purging was conducted prior to sample collection to remove water that had been introduced during drilling. At a minimum, three borehole volumes plus twice the amount of water injected during the drilling of the last 20 feet were purged from each sample interval while monitoring field parameters (temperature, pH, specific conductance, and oxidation-reduction potential [ORP]). Once the minimum volume had been evacuated and field parameters had stabilized, final water quality parameters were recorded and sample aliquots were collected for hexavalent chromium [Cr(VI)] and ferrous iron for analysis at the onsite Interim Measures No. 3 laboratory. In addition, an aliquot for dissolved total chromium [Cr(T)] was collected for confirmation laboratory analysis if Cr(VI) was detected in the primary sample.

2.4 Monitoring Well Installation and Development

Multilevel monitoring wells, designated MW-52 and MW-53, were installed in each of the angled borings. Primary well construction activities were completed at locations MW-52 and MW-53 on March 9 and March 29, 2007, respectively. With the exception of rehabilitation activities at MW-53S (see Section 2.5), construction activities at both wells were finalized on April 3, 2007. As approved by DTSC, the Multilevel Angled Borehole System® (MLABS®) well assembly, fabricated by BESST, Inc., was used to meet the technical requirements of the project. In consultation with DTSC, each well was constructed with three polyethylene MLABS® sample filters installed at selected depths based on lithologic and depth-specific groundwater sample data collected during drilling. Each well was constructed with three sampling intervals (shallow [S], middle [M], and deep [D]) and identified with a one letter suffix after the well number. For example, the deep sampling interval at location MW-52 is identified as “MW-52D.” Multilevel well construction details are summarized on Table 2-1. Well construction diagrams, executed San Bernardino County well permits, and Department of Water Resources well completion reports (as submitted to San Bernardino County and the State of California) for MW-52 and MW-53 are provided in Appendix A. Photographs of various elements of the MLABS® well assembly and installation procedures are provided in Appendix B.

Once each angled boring had been drilled to total depth, data collected during the drilling process was discussed with DTSC, and the sampling interval depths were selected. In preparation for well installation, the larger-diameter surface casing was removed from the borehole, leaving the 6-inch-diameter drive casing, extending from land surface to the top of bedrock. Prior to installing the well assembly, the open portion of the borehole in bedrock below the lowest was backfilled with sand.

Given the modular design of the MLABS® system, installation of the well assembly was conducted in 10-foot sections within the 6-inch drive casing. The individual sample filters were installed within a protective housing which is attached to a solid 1.5-inch-diameter polyvinyl chloride (PVC) support riser. Sections of the riser and filter housing were joined together using specialized centralizers and fiberglass pins. A 1.25-inch-outer-diameter, steel tremmie pipe and 1-inch PVC conduit for a sounding device (used to “feel” material depths in the borehole) was inserted with the well assembly (also in 10-foot sections), resting within grooves machined into each centralizer. At the bottom of the assembly, the support riser is permanently pinned to an anchor centralizer, while the tremmie pipe and sounding conduit temporarily attach to the anchor centralizer via left-handed threaded adaptors.

Each sample filter was constructed of one continuous piece of porous polyethylene 3 feet long and 1 inch in diameter (mean pore diameter is 60 microns). The filter is capped on the bottom and attached to nylon sample conveyance tubing at the top with a compression fitting. The tubing extends up the well assembly within a longitudinal recess in the support riser to a transition centralizer, at which point the tubing is fastened to a chamber with another compression fitting. Three continuous threaded, 1-inch PVC pipes are threaded into the transition centralizer (one for each chamber/sample filter) and extend to the ground surface with additional 10-foot sections. The 1-inch PVC pipes facilitate the collection of groundwater samples and the installation of pressure transducers to monitor the hydrostatic pressure in each monitoring zone.

Once the well assembly was installed to depth, the tremmie pipe and sounding conduit were unscrewed from the anchor centralizer (clockwise rotation unscrews the left-handed thread at bottom while individual joints remain tight). Prior to retracting the steel drive casing, the total depth of the borehole was verified using a 0.5-inch, solid PVC measurement rod through the sounding conduit. The steel drive casing, tremmie pipe, and sounding conduit were then retracted in 10-foot sections. During drive casing removal, borehole collapse around the well assembly was monitored with the measurement rod. DTSC required bentonite slurry grout seals to be placed between sampling intervals. Because the slant borehole collapsed immediately upon withdrawal of the drive casing, the grout had to be injected into the collapsed section of the borehole through a tremmie pipe that extended beyond the end of the drive casing. Once the drive casing had been removed to a depth adequately above the shallowest sample filter, a surface seal was constructed by placing a continuous column of bentonite slurry grout via tremmie into the drive casing, and the remaining casing was removed.

Each well was completed with an aboveground, protective monument at an angle surrounded a 3-foot by 3-foot by 4-inch-thick concrete pad (see Appendix B photographs). Consistent with other wells at the Topock site, each monument was secured with a padlock and painted a pale beige color. Following completion, each well was surveyed for location, ground surface elevation, and top-of-well-casing elevation. The north edge of the protective monument was used as a vertical datum for each well to date, since the tops of some casings were located too far down in the protective monument to be accessible by the surveyor's rod given the angle of the well casings. PG&E is planning to establish a universal datum for each angle well that can be surveyed that will be used as a reference for all depth measurements for the subject well group. Surveyed well location and protective monument elevation data are provided on Table 2-1.

Following well construction and annular seal placement, each sampling interval was developed by pumping using a peristaltic pump. During development, temperature, pH, specific conductance, and turbidity were measured using field instruments. Well development was continued until field parameters stabilized and turbidity was reduced to less than 50 nephelometric turbidity units.

2.5 MW-53S Rehabilitation

During initial development of the shallow monitoring zone MW-53S it was determined, based on visual inspection of the purged water and excessively low yield, that the filter had become clogged with bentonite during the installation process. In effort to clear the filter, an unclogging procedure was developed in conjunction with DTSC. The detailed procedure is provided in Appendix C. The procedure was initially implemented on April 25 and 26, 2007 and is summarized as follows:

1. The MW-53S sampling zone (well) was purged dry (approximately 1 gallon), and the water was contained for use later in the process.
2. The well was fitted with a gas flow manifold and pressurized (maximum pressure of 40 pounds per square inch [psi] per the manufacturer's specifications) with nitrogen gas to back-flush the filter and dislodge the bentonite that may have accumulated on the surface of the filter. Nitrogen was used rather than air because, being inert, nitrogen will not disrupt the geochemistry of the aquifer. During pressurization steps, observations of in-well equilibration pressure (11 psi) and the time required to achieve that pressure were recorded. A decrease in stabilization time would have indicated a more conductive well filter allowing 0gas to flow more freely out of the well; however, this trend was not observed, as approximately 5 seconds was consistently required to achieve the equilibration pressure of 11 psi.
3. Following several cycles of pressurization and depressurization, the flow manifold was removed from the well, and water level recovery was monitored for approximately 1 hour. During this time, the water level recovered 1.27 feet, which is indicative of less-than-optimal well performance.
4. The water that was initially purged from the well was used to make a solution of clay dispersant, which is commonly used in water well development to break up drilling muds. The dispersant, NuWell 220®, is a non-phosphatic polymer compound that is NSF-certified for use in potable wells.
5. The dispersant solution was poured into the well, and the gas flow manifold was once again fitted to the well. With the solution in the well, an in-well pressure of approximately 9 psi was established. This in-well pressure, which is slightly below the equilibration pressure of 11 psi, displaces the majority of the dispersant solution from the well into the sampling interval without moving gas through the filter. The well was left under 9 psi of pressure for approximately 14 hours.
6. Following the period of inactivity, the well was again pressurized to 40 psi and depressurized in cycles to agitate the material around the well filter. The pressurization cycles were halted, the gas flow manifold was removed, and water level recovery was monitored. The water level in the well was initially observed at a rate faster than that identified in Step 3; however, difficulty getting the water level meter to depth prevented further evaluation of recharge rate. After 3.25 hours, the water level had not recovered to 23 feet bgs (46 feet of measurement length), which is the deepest that the water level sounder could be deployed.

Following this work, MW-53S was left inactive for 20 days, with the dispersant solution remaining in the well under ambient pressure conditions. Given the data obtained from the initial unclogging effort (equalization pressure and rate), a modified version of the unclogging procedure was implemented on May 16 and 17, 2007 and is summarized as follows:

1. One gallon of dispersant solution was mixed using water from nearby monitoring well MW-52S. Water from MW-53S was not used because the objective of the next step was to force any partially disaggregated bentonite away from the well filter. Initial pumping of MW-53S would have drawn this material towards the well filter.

2. The gas flow manifold was fitted to MW-53S, and the in-well pressure was increased to 40 psi until nitrogen gas was being forced through the well filter (i.e., forcing the entire water column into the formation).
3. Once the water column had been evacuated, the well was depressurized, the gas flow manifold was removed, and the dispersant solution was immediately poured into the well.
4. The gas flow manifold was then re-fitted to the well, and the in-well pressure was increased to 9 psi as discussed in Step 5 above. The well was left under 9 psi of pressure for approximately 20 hours.
5. Following the period of inactivity, the in-well pressure was relieved to ambient conditions and water level recovery was monitored. Over the course of approximately 3 hours, well recharge rates were observed between 6 and 22 milliliters per minute.

The procedures performed on May 16 and 17, 2007 were repeated on May 30 without any significant improvement in well recharge. After pumping the well dry on May 30, water levels had not yet recovered to static levels by June 5. The filter in MW-53S appears to be plugged to an extent that would likely render this sampling interval unusable for groundwater sampling.

2.6 Monitoring Well Groundwater Sampling

The sampling intervals, except MW-53S, were sampled using the methods and procedures described in the Work Plan, which are consistent with sampling procedures used by the Topock Groundwater and Surface Water Monitoring Program (GMP). Given the small diameter of the wells and the shallow depth to groundwater, a peristaltic pump (with an in-line water quality meter and flow-cell) was used to purge and sample the MW-52 and MW-53 wells. The pump intake was placed at the bottom of the 1-inch transducer pipes to maximize available drawdown. The wells were purged and sampled using the casing volume method purge rates to obtain representative groundwater samples from the aquifer zone and to be consistent with the existing monitoring wells in the floodplain. The results of the monitoring well sampling event are discussed in Section 3.3.

The newly installed groundwater monitoring well at MW-52 and MW-53, with the exception of MW-53S, were sampled approximately 24 hours after well development on March 13 and April 3, 2007. Each sample collected was analyzed for Cr(VI), Cr(T), and stable isotopes (oxygen 18 and deuterium). The stable isotope data were of specific interest to determine if residual water from the Colorado River, which was used during drilling because it has an isotopic signature different than that of the groundwater, had been completely removed during well development.

Groundwater sampling for the suite of analytes described in the work plan at MW-52 and MW-53 monitoring wells (with the exception of MW-53S) was conducted on May 1 and 2, 2007. As described in the Work Plan, groundwater samples were analyzed for Cr(VI), Cr(T), total dissolved solids, alkalinity, cations (calcium, magnesium, potassium, sodium, manganese, and iron), anions (chloride, nitrate, and sulfate), ammonia, total Kjeldahl nitrogen, and total organic carbon. Stable isotope analysis (oxygen 18 and deuterium) was omitted from this sampling event, as it was collected during the earlier sampling events. Samples from the MW-52 and MW-53 wells for ferrous iron analysis at the Interim Measure No. 3 laboratory were collected on June 5, 2007. Field water quality parameters (temperature, pH, specific conductance, ORP, dissolved oxygen, and turbidity) were also measured and recorded during each sampling event.

Groundwater sampling activities followed the procedures, analytical methods, reporting limits, and quality control plan used for the Topock GMP, as described in the *Sampling, Analysis, and Field Procedures Manual* (CH2M HILL, 2005). The Cr(VI) samples were filtered in the laboratory before analysis, while the Cr(T) and metal samples were filtered and preserved in the field, consistent with the GMP procedures.

2.7 Investigation-derived Waste Management

Investigation-derived waste was managed in accordance with the procedures detailed in the Work Plan. Solid and liquid wastes generated during this investigation were temporarily stored at the work area in portable tanks (liquids) and hoppers (drill cuttings). As necessary, drill cuttings were transferred to lined roll-off bins located at the equipment staging area at the Topock Compressor Station pending characterization sampling. Similarly, purge water was transferred to the Interim Measure No. 3 Groundwater Treatment Facility for treatment and injection in compliance with Regional Board Order R7-2006-0060. Incidental trash was removed from the work area daily and transferred to a standard trash bin at the Topock Compressor Station for offsite disposal.

One lined roll-off bin was filled (approximately 70 percent full) with drill cuttings during this investigation. A composite soil characterization sample was collected from the bin following well construction activities. The sample was collected on May 9, 2007 and submitted to the laboratory for the same analyses used for disposal characterization of drill cuttings during previous drilling projects in the floodplain, including CAM metals (6010B), mercury, and percent moisture. After the results of the soil characterization have been received from the lab, the final disposition of the drill cuttings will be determined in consultation with the Fort Mojave Indian Tribe, the appropriate agencies, and the affected landowner.

SECTION 3.0

Investigation Results

This section presents the results of the lithologic and water quality sampling conducted for the California Slant Drilling Program. More detailed analysis and interpretation of the investigation results, as well as integration of the data in the Topock site hydrogeologic conceptual model, will be provided in the final RFI/RI Report prepared for the Topock site.

3.1 Hydrogeology at the Slant Drilling Site

One of the primary objectives of the California Slant Drilling Program was to further characterize the hydrogeologic conditions beneath the Colorado River. Continuous core was collected from both angled boreholes, which extended from ground surface to several feet into the Miocene conglomerate bedrock. The lithologic logs and well construction diagrams for MW-52 and MW-53 are provided in Appendix A.

A hydrogeologic cross-section, which includes information from MW-52, MW-53, and other borings, is presented on Figure 3-1 (cross-section transect location is illustrated on Figure 2-1). Lithologic and bedrock elevation data are taken from the MW-43 monitoring well cluster and the newly installed slant wells (MW-52 and MW-53). Additional bedrock elevation data are taken from CalTrans borings CB-07 and CB-09. The elevation of the riverbed has been estimated using data from "Transect B" of a river bed survey conducted by PG&E in July 2005.

Beneath the Colorado River, in the area of MW-52 and MW-53, predominantly fluvial sediments overlie the surface of the Miocene conglomerate bedrock. As observed in the core, sediments primarily are composed of poorly-graded, fine-to-medium sands with little to no silt or clay. Intervals containing organic material (i.e., wood and various plant debris) were observed sporadically throughout the fluvial sediments. Layers and interbeds of fluvial gravel were observed in both borings at depths approximately 50 feet bgs and in proximity to the bedrock surface. Poorly-sorted angular sand and fine gravel (inferred alluvial fan deposits) were observed in MW-53 at an interval of approximately 107 to 113 feet bgs. No extensive clay or fine-grained sediments (aquitards) were encountered in either borehole. Miocene conglomerate bedrock was encountered at vertical depths of 87 and 129 feet bgs in the MW-52 and MW-53 boreholes, respectively (Figure 3-1).

The hydrogeologic information from the California Slant Drilling Program, including the elevation of Miocene bedrock, will be incorporated into the site hydrogeologic conceptual model in the final RFI/RI Report.

3.2 Depth-specific Groundwater Sample Results

As described in Section 2.3, depth-specific groundwater samples were collected during borehole drilling using the Isoflow® system for Cr(VI) and ferrous iron field laboratory analysis and for field water quality measurement. Since the groundwater samples were obtained from open boreholes during drilling (i.e., grab samples), the sampling results are considered screening-level data for qualitative assessment of water quality conditions in the aquifer.

During drilling, seven grab samples were collected from the MW-52 borehole, and 12 grab samples were collected from the MW-53 borehole. Table 3-1 summarizes the depth-discrete groundwater sample results and field measurement data.

Cr(VI) was not detected in the grab groundwater samples analyzed by the Interim Measures No. 3 field laboratory. Ferrous iron was detected in six of the seven grab samples from the MW-52 borehole at a range of concentrations from 0.152 milligrams per liter (mg/L) to 16.4 mg/L. Similarly, ferrous iron was detected in five of 12 samples from the MW-53 borehole at a range of concentrations from 0.216 mg/L to 13.1 mg/L. The most elevated concentrations of ferrous iron in both boreholes are observed at approximately 40 feet bgs.

Field measurements of ORP in groundwater grab samples from the MW-52 borehole ranged from -105 millivolts (mV) to -346 mV. ORP measurements in grab samples from the MW-53 borehole ranged from 120 mV to -530 mV. In general, ORP measurements became more negative (i.e., indicative of increasingly stronger reducing conditions) with depth. The least negative ORP measurements (positive measurements in the MW-53 borehole) were observed in the shallowest samples and likely indicative of a mixing zone between groundwater and the surface flow of the Colorado River. Depth trends observed in the dissolved oxygen and specific conductance measurements also support this interpretation.

Estimations of specific capacity based on average pumping rates and drawdown measurements during grab sample collection are presented in Table 3-1. Several variables, including the degree of borehole collapse and the degree of formation disturbance induced by drilling, limit the precision of these data; however, in general, elevated specific capacity values correspond with zones of coarser-grained sediments.

3.3 Multilevel Groundwater Monitoring Well Sampling

As discussed in Section 2.6, preliminary samples were collected from each well at locations MW-52 and MW-53 (except MW-53S) approximately 24 hours after the completion of well development. Analytical results were less than laboratory reporting limits for Cr(VI) and Cr(T) (Table 3-2). Stable isotope analytical data indicated that no additional well development was required, as the oxygen isotope signatures compared similarly with groundwater samples from other floodplain monitoring wells (i.e., river water used during drilling does not appear to be present in the samples).

The full suite groundwater sampling event for multilevel wells MW-52 and MW-53 (except MW-53S) was conducted on May 1 and 2, 2007. Laboratory analytical results and field measurement data are summarized on Tables 3-2 and 3-3. Cr(VI) was not detected in these samples. Cr(T) was detected in well MW-53D with a concentration of 1.41 micrograms per liter (µg/L)

The groundwater sampling general chemistry results are presented in Table 3-3. Groundwater total dissolved solids concentrations ranged from 7,020 mg/L in shallow well MW-52S to 14,800 mg/L in the deep well MW-53D. The cation and anion data summarized in Table 3-3 indicate that the dissolved solids are predominantly chloride and sodium, with lesser sulfate concentrations. Ferrous iron results from the Interim Measures No. 3 laboratory were less than the reporting limit of 0.05 mg/L, with the exception of the ferrous iron concentration from MW-52S sample, which was 1.67 mg/L.

Field measurements of ORP in groundwater samples from the MW-52 and MW-53 boreholes ranged from -131 mV to -339 mV. Specific conductance ranged from 10,100 to 24,800 µS/cm. Generally, specific conductance increased with depth, the highest field reading measured in MW-53D in both April and May sampling (Table 3-2).

3.4 Data Quality Assessment

The laboratory analytical data from slant well sampling were independently reviewed by project chemists to assess data quality and to identify deviations from analytical requirements. The quality assurance and quality control requirements are outlined in the Quality Assurance Project Plan for the PG&E Topock Program, which is Appendix D of the *Sampling, Analysis, and Field Procedures Manual, Revision 1* (CH2M HILL, 2005). A discussion of the data quality review and results is presented in the data validation reports, which are kept in the project file and are available upon request.

- **Matrix Interference:** Due to matrix interference encountered in the groundwater samples from both MW-52 and MW-53, the detection limits for Cr(VI) groundwater analytical results were reported as 1 µg/L, rather than 0.2 µg/L.
- **Quantitation and Sensitivity:** All method and analyte combinations met the project reporting limit objectives.
- **Holding Time Data Qualification:** All method holding time requirements were met.
- **Field Blanks:** No equipment blanks were required due to the use of dedicated equipment.
- **Calibration:** All initial and continuing instrument calibration criteria were met.
- **Matrix Spike Sample:** All matrix spike acceptance criteria were met.
- **Chain of Custody:** Each sample was documented in a completed chain-of-custody form and received at the laboratory in good condition. All discrepancies identified in laboratory custody were promptly resolved.
- **Field Duplicates:** All field duplicate acceptance criteria were met.
- **Laboratory Duplicate Samples:** Duplicate acceptance criteria for all methods were met.

SECTION 4.0

Summary

This report presents the results of installation and initial sampling of slant wells beneath the Colorado River at the Topock Compressor Station. The primary objective of the well installation program was assess chromium concentrations and groundwater geochemical conditions beneath the Colorado River downgradient of the floodplain area at the Topock site for completion of the Groundwater RFI/RI and corrective measures planning.

The field investigation and sampling tasks completed included:

- Completing the necessary site preparation including cultural and biological pre- and post-construction surveys and vegetation removal.
- Performing drilling and lithologic logging of two angled borings beneath the Colorado River.
- Collecting 19 depth-discrete groundwater samples during drilling to provide a screening assessment of water quality in the sediments that underlie the Colorado River.
- Installing multilevel groundwater monitoring wells in two separate angled borings (three monitoring zones each) beneath the Colorado River.
- Performing well rehabilitation activities at one of the six groundwater monitoring zones (affected by bentonite grout intrusion during construction).
- Performing initial groundwater sampling and analyses for Cr(VI), Cr(T), and general chemistry parameters for water quality characterization at the new monitoring well locations.
- Performing biological compliance monitoring for bird species in the vicinity of the work area.

Activities conducted during the California Slant Drilling Program accomplished the Work Plan objectives for characterizing chromium concentrations in groundwater and natural geochemical groundwater conditions in the Alluvial Aquifer beneath the Colorado River. Further, permanent monitoring points were installed for ongoing water quality monitoring.

The drilling and lithologic data collected during this project has further characterized the sediment characteristics and hydrostratigraphy beneath the Colorado River and confirmed the overall hydrogeologic framework. The new data confirm that sand and fine-gravel fluvial deposits overlie relatively shallow Miocene bedrock at the California slant drilling site. The depth of the Miocene conglomerate bedrock encountered in the slant borings is generally consistent with that interpreted from the 1962 Caltrans boring logs and the United States Geologic Survey seismic survey.

Groundwater quality data collected during drilling and the initial well sampling indicate that a strongly reducing natural geochemical environment exists in the fluvial sediments encountered by the slant borings. Cr(VI) would be reduced to trivalent chromium in this geochemical environment. Cr(VI) was not detected in any of the depth-specific groundwater samples from the two borings (onsite laboratory analyses), and Cr(VI) was not detected in the samples collected from the developed multilevel well samples from the initial sampling events (certified laboratory analyses).

The characterization data collected during installation of slant wells MW-52 and MW-53 will be integrated into the hydrogeological conceptual model that will be provided in the final Groundwater RFI/RI Report for the PG&E Topock site. In addition, as required by DTSC (DTSC, 2006), the wells will be sampled on a monthly basis for the first 6 months after installation. The results from these monthly monitoring events, following the events reported herein, will be reported in routine GMP monitoring reports. On the basis of the characterization data collected from the installation of these wells, it is not considered necessary to also include monitoring data collected from these wells into the Interim Measure performance monitoring program.

SECTION 5.0

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Tables

TABLE 2-1
Summary of Well Installation Details
Well Installation Report for Slant Wells MW-52 and MW-53
PG&E Topock Compressor Station

	Borehole Details									Well Details			
Boring ID & Drill Site Location	**Borehole Angle from Horizontal**	**Azimuth**	**Borehole Depth**	**Borehole Depth**	**Lateral Projection**	**Ground Surface Northing**	**Ground Surface Easting**	**Ground Surface Elevation**	**Borehole Logging**	**Wells Installed**	**Sample Filter Interval**	**Sample Filter Interval**	**Protective Monument Elevation[a]**
	(degrees)	(degrees)	(feet drilled)	(feet bgs)	(feet)	--	--	(feet msl)			(feet drilled)	(feet bgs)	(ft msl)
MW-52	40	087	158	102	121	2101738.98	7616776.33	459.52	Continuous core log	**MW-52S**	72.5 - 75.5	46.6 - 48.6	462.55
										MW-52M	102.5 - 105.5	65.9 - 67.8	462.55
										MW-52D	132.5 - 135.5	85.2 - 87.1	462.55
MW-53	30	090	265	133	229	2101761.472	7616788.39	459.82	Continuous core log	**MW-53S**	57.0 - 60.0	28.50 - 30.0	461.76
										MW-53M	197.0 - 200.0	98.5 - 100.0	461.76
										MW-53D	247.0 - 250.0	123.5 - 125.0	461.76

Notes:
Feet bgs = feet below ground surface (datum is ground surface at top of borehole)
[a] North edge of protective monument is being used as a general vertical datum for each well until universal measurement datums can be installed and surveyed.
Survey Datum: North American Datum 1983, California State Plane, Zone V, Feet

TABLE 3-1

Depth-Discrete Groundwater Sample Results and Field Measurements

Well Installation Report for Slant Wells MW-52 and MW-53

PG&E Topock Compressor Station

Isoflow Sample Collection Data						Analysis Results			Isoflow Purge WQ Parameters (final reading)							Isoflow Purging Data				
Sample Interval Angle Boring Depth (feet drilled)	Vertical Depth (ft)	Lateral Distance (ft)	Date	Time	Sample ID	Cr(VI) HACH Analysis IM3 Lab (µg/L)	Ferrous Iron IM3 Lab (mg/L)	Cr(T) Analysis Certified Lab (µg/L)	ORP (mV)	DO (mg/L)	Spec. Conduct. (µS/cm)	Temp. (°C)	pH	TDS (mg/L)	Turbidity (NTU)	Volume Purged (gallons)	Average Pumping Rate (gpm)	Drawdown (ft from TOC)	Specific Capacity (gpm/ft)	Remarks
MW-52 Angle = 40° from horizontal																				
13-23	15	18	24-Feb-07	8:10	MW52-GGW-23	ND <10	ND <0.050	NA	-265	4.38	817	22.5	8.11	500	43	110	2.5	2.4	1.62	
33-43	28	33	24-Feb-07	13:50	MW52-GGW-43	ND* <10	13.3	NA	-181	2.90	2,650	23.0	6.95	1,700	7.55	320	2.5	2.9	1.34	100 gal of water injected during drilling
56-63	40	48	24-Feb-07	17:20	MW52-GGW-63	ND* <10	16.4	NA	-105	2.33	8,370	21.3	6.50	5,200	324	300	2.5	6.65	0.58	60 gal water injected during drilling
76-83	53	64	25-Feb-07	10:30	MW52-GGW-83	ND* <10	5.8	NA	-255	0.14	14,200	22.3	7.32	9,000	4	305	5	4.27	1.82	130 gal of water injected during drilling
96-103	66	79	25-Feb-07	15:55	MW52-GGW-103	ND <10	0.152	NA	-248	0.24	23,900	22.8	7.76	15,000	1	460	4	3.63	1.7	200 gal of water injected during drilling
116-123	79	94	26-Feb-07	10:50	MW52-GGW-123	ND* <10	0.566	NA	-346	2.66	23,500	25.2	8.21	15,000	11	330	4	6.85	0.91	160 gal of water injected during drilling
133-143	92	110	26-Feb-07	16:00	MW52-GGW-143	ND <10	0.184	NA	-309	2.18	24,400	23.1	8.18	15,000	22	540	5	4.32	1.80	240 gal of water injected during drilling
MW-53 Angle = 30° from horizontal																				
25-35	18	30	12-Mar-07	16:57	MW53-GGW-35	ND <10	ND <0.050	NA	120	5.18	1,140	26.9	6.45	700	3.6	342	2.3	NA		100 gal of water injected during drilling
45-55	28	48	13-Mar-07	8:28	MW53-GGW-55[a]	ND** <10	ND <0.050	NA	50	0.15	588	23.7	8.01[b]	380	1.3	290	3	NA		80 gal water injected during drilling
65-75	38	65	13-Mar-07	10:54	MW53-GGW-75	ND* <10	13.1	NA	-86	0.21	3,290	26.5	6.88[b]	2,100	2.2	338	2.5	NA		130 gal of water injected during drilling
85-95	48	82	13-Mar-07	15:11	MW53-GGW-95	ND* <10	1.1	NA	-151	0.40	8,340	20.5	7.18b	-	8.5	428	4	NA		130 gal of water injected during drilling
105-115	58	100	14-Mar-07	9:30	MW53-GGW-115	ND* <10	1.3	NA	-218	0.20	10,140[b]	26.4	7.22[b]	-	2.9	492	2	6.4	0.49	200 gal of water injected during drilling
125-135	68	117	15-Mar-07	9:06	MW53-GGW-135	ND* <10	0.487	NA	-426	0.43	15,300	21.9	7.70	10,000	1.3	337	2	5.9	0.52	140 gal of water injected during drilling
145-155	78	134	20-Mar-07	9:53	MW53-GGW-155	ND <10	0.216	NA	-452	0.99	14,580[b]	21.6	7.55[b]	-	7.2	444	8	0.5	23.05	170 gal of water injected during drilling
165-175	88	152	20-Mar-07	13:41	MW53-GGW-175	ND <10	ND <0.050	NA	-358	0.86	16,560[b]	24.7	7.48[b]	-	9.9	420	3.5	2.3	2.42	180 gal of water injected during drilling
185-195	98	169	21-Mar-07	14:10	MW53-GGW-195	ND <10	ND <0.050	NA	-223	0.94	19,880[b]	24.6	7.64[b]	-	0.6	1,559	7	4.9	2.21	750 gal of water injected during drilling
205-215	108	186	22-Mar-07	12:40	MW53-GGW-215	ND <10	ND <0.050	NA	-256	0.94	20,260[b]	22.5	7.40[b]	-	1.9	1,644	6.4	11.9	0.84	750 gal of water injected during drilling
225-235	118	204	25-Mar-07	10:03	MW53-GGW-235	ND <10	ND <0.050	NA	-530	1.05	22,560[b]	22.2	7.54[b]	-	2	960	8	12.3	1.01	400 gal of water injected during drilling
245-255	128	221	25-Mar-07	14:00	MW53-GGW-255	ND <10	ND <0.050	NA	-371	1.06	26,460[b]	23.3	7.83[b]	-	4.5	670	6.5	3.2	3.16	300 gal of water injected during drilling

Notes:

ND = Not detected at listed reporting limit.

NA = Not Analyzed—only samples with detectable Cr(VI) will be analyzed at certified lab.

Field water quality (WQ) parameters measured using flow-thru cell and Horiba field meter. Turbidity readings are from the Hach 2100P.

* Presence of high ferrous iron reduced recovery of matrix spike.

** Unknown interference reduced recovery of matrix spike.

[1] Sample displayed gas effervescence during collection. The reason for this is still being investigated. The Cr(VI) concentration is considered to be representative; however, the field measurements (particularly ORP) are not representative.

[2] Reading is from IM3 lab.

TABLE 3-2

Groundwater Analytical Results for New Monitoring Wells, Chromium and Field Water Quality Parameters

Well Installation Report for Slant Wells MW-52 and MW-53

PG&E Topock Compressor Station

Location	Sampling Date	Chromium (µg/L)	Hexavalent Chromium (µg/L)	Specific Conductance (µS/cm)	Temperature (°C)	pH (pHunits)	ORP (mV)	Dissolved Oxygen (mg/L)	Salinity (%)	Turbidity (NTU)
MW-52D	13-Mar-07	ND (1.0)	ND (1.0)	16800	24.3	8.44	-306	0.24	1.00	1.00
MW-52D	01-May-07	ND (1.0)	ND (1.0)	18600	20.9	8.60	-221	0.23	1.10	4.34
MW-52M	13-Mar-07	ND (1.0)	ND (1.0)	18500	21.3	9.08	-263	0.19	1.00	1.20
MW-52M	01-May-07	ND (1.0)	ND (1.0)	13100	21.5	8.36	-240	0.00	0.70	7.56
MW-52S	13-Mar-07	ND (1.0)	ND (1.0)	17600	20.5	8.47	-230	0.19	1.00	1.70
MW-52S	01-May-07	ND (1.0)	ND (1.0)	10100	21.0	7.94	-234	0.00	0.60	0.84
MW-53D	03-Apr-07	ND (1.0)	ND (1.0)	24800	27.4	8.93	-131	4.90	1.50	0.90
MW-53D	02-May-07	1.41	ND (1.0)	22700	19.5	9.36	-280	0.00	1.40	1.27
MW-53M	03-Apr-07	ND (1.0)	ND (1.0)	13400	25.8	9.35	-339	0.55	0.80	1.40
MW-53M	01-May-07	ND (1.0)	ND (1.0)	11300	20.0	9.53	-222	0.04	0.60	0.84

NOTES:

µS/cm microSiemens per centimeter
°C degree centigrade
ORP oxidation reduction potential, results rounded off to whole point
mV millivolts
µg/L micrograms per liter
mg/L milligrams per liter
% percentage
NTU Nephelometric Turbidity Unit
ND not detected at listed reporting limit

TABLE 3-3
Groundwater Analytical Results for New Monitoring Wells, General Chemistry Parameters
Well Installation Report for Slant Wells MW-52 and MW-53
PG&E Topock Compressor Station

Loc ID	Sample Date	Alkalinity, as carbonate (mg/L)	Alkalinity, bicarbonate as CaCo3 (mg/L)	Alkalinity, total as CaCO3 (mg/L)	Ammonia as nitrogen (mg/L)	Calcium (mg/L)	Chloride (mg/L)	Magnesium (mg/L)	Manganese (mg/L)	Nitrate/Nitrite as nitrogen (mg/L)	Iron (mg/L)	Deuterium (0/00)	Oxygen 18 (0/00)	Potassium (mg/L)	Sodium (mg/L)	Sulfate (mg/L)	Total Dissolved Solids (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Total Organic Carbon (mg/L)
MW-52D	13-Mar-07	---	---	---	---	---	---	---	---	---	---	-85.2	-11.6	---	---	---	---	---	---
MW-52D	01-May-07	ND (5)	52.5	52.5	ND (0.5)	303	6950	21.6	ND (0.5)	0.153	ND (0.5)	---	---	59.9	4570	1000	13200	ND (0.5)	5.17
MW-52M	13-Mar-07	---	---	---	---	---	---	---	---	---	---	-89.8	-12	---	---	---	---	---	---
MW-52M	01-May-07	ND (5)	95	95	ND (0.5)	305	4600	42.1	ND (0.5)	0.159	ND (0.5)	---	---	37.3	2940	678	9180	ND (0.5)	12.2
MW-52S	13-Mar-07	---	---	---	---	---	---	---	---	---	---	-86.8	-11.5	---	---	---	---	---	---
MW-52S	01-May-07	ND (5)	248	248	ND (0.5)	332	3720	66.9	0.89	0.128	5.24	---	---	42.2	2300	418	7020	0.811	3.05
MW-53D	03-Apr-07	---	---	---	---	---	---	---	---	---	---	-87.6	-11.4	---	---	---	---	---	---
MW-53D	02-May-07	ND (5)	33	33	ND (0.5)	298	8490	18.9	2.49	ND (0.1)	ND (0.5)	---	---	51.8	6150	1070	14800	ND (0.5)	3.36
MW-53M	03-Apr-07	---	---	---	---	---	---	---	---	---	---	-96.4	-12.2	---	---	---	---	---	---
MW-53M	01-May-07	ND (5)	62.5	62.5	ND (0.5)	161	4030	12.9	ND (0.5)	0.112	ND (0.5)	---	---	43.4	2630	630	7510	ND (0.5)	34.7

NOTES:

ND not detected at listed reporting limit
mg/L milligrams per liter
0/00 differences from global standard in parts per thousand

Figures

Appendix A
Drilling and Well Construction Records

Appendix B
Photographs of Slant Wells MW-52 and MW-53 Assembly and Installation

Appendix C
Procedure for Unclogging MW-53S Sample Filter