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January 16, 2007

Mr. Jerry Smit
Manager, Voluntary Remediation Program Unit
Arizona Department of Environmental Quality
1110 West Washington Street
Phoenix, Arizona 85007

Subject: Work Plan for Groundwater Characterization on Arizona Shore of the Colorado River at Topock, Arizona
PG&E Topock Compressor Station, Needles, California

Dear Mr. Smit:

This letter transmits a *Work Plan for Groundwater Characterization on Arizona Shore of the Colorado River at Topock, Arizona.* This work plan is submitted in accordance with the Arizona Department of Environmental Quality (ADEQ) Voluntary Remediation Program (VRP) in A.R.S. §49-175.

The work plan identifies three locations and several contingent locations for well installation in Mojave County, Arizona. The objective of this investigation is to collect additional data to the supplement Pacific Gas and Electric Company's (PG&E's) ongoing remedial investigation and corrective action planning in response to history releases from the Topock Compressor Station. The additional data collected through implementation of this work plan will be further east and south than previous data collected at the Topock site.

A schedule for work plan review, permitting, and implementation of the investigation is provided in the work plan. We propose to commence the permitting activities for this investigation on approximately February 1, 2007. Comments on the work plan are appreciated prior to this time so that that input can be incorporated into the permitting documents. We would be happy to meet with you to discuss this work plan to facilitate your review.

PG&E is working directly with the property owners (U.S. Department of Interior for Location 1, and private property owners for the remaining locations) for access to the properties to install the wells.

If you have any questions, please do not hesitate to contact me. I can be reached at (805) 234-2257.

Sincerely,

Julie Eakins for Yvonne Meeks

cc. John Earle/HNWR
Casey Padgett/DOI
Carrie Marr/USFWS
Cathy Wolff-White/BLM
Jeff Smith/BOR
Aaron Yue/DTSC

Enclosure

Work Plan for Groundwater Characterization on Arizona Shore of the Colorado River at Topock, Arizona

PG&E Topock Compressor Station
Needles, California

Prepared for

Arizona Department of Environmental Quality

On Behalf of

Pacific Gas and Electric Company

January 16, 2007

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Work Plan for Groundwater Characterization on Arizona Shore of the Colorado River at Topock, Arizona

PG&E Topock Compressor Station
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Prepared for
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Pacific Gas and Electric Company

January 16, 2007

This work plan was prepared under supervision of an Arizona Professional Geologist:

Martin Barackman, P.G. No. 45424
Senior Hydrogeologist

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Acronyms and Abbreviations

ADEQ	Arizona Department of Environmental Quality
AZDOT	Arizona Department of Transportation
ADWR	Arizona Department of Water Resources
AZGFD	Arizona Game and Fish Department
BLM	U.S. Bureau of Land Management
BNSF	Burlington Northern Santa Fe Railway
BOR	Bureau of Reclamation
CACA	Corrective Action Consent Agreement
Caltrans	California Department of Transportation
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
Cr(T)	total chromium
Cr(VI)	hexavalent chromium
DOI	U.S. Department of the Interior
DTSC	California Department of Toxic Substances Control
ESA	Endangered Species Act
GPS	Global Positioning System
HNWR	Havasu National Wildlife Refuge
IDW	investigation-derived waste
IM	Interim Measure
MW	monitoring well
NHPA	National Historic Preservation Act
PBA	programmatic biological assessment
PG&E	Pacific Gas and Electric Company
PVC	polyvinyl chloride
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
RI	Remedial Investigation

ROW	right-of-way
SHPO	State Historic Preservation Office
SOP	Standard Operating Procedures
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
VRP	Voluntary Remediation Program

1.0 Introduction

This work plan outlines a proposed groundwater investigation on the Arizona shore of the Colorado River at Topock, Arizona to complete groundwater characterization associated with the Pacific Gas and Electric Company (PG&E) Topock Compressor Station. This work plan provides the objectives, rationale and technical approach, field investigative methods, administrative approvals, proposed schedule and reporting plans for this investigation.

1.1 Project Background

PG&E is addressing chromium in groundwater at the Topock Compressor Station located in San Bernardino County, approximately 15 miles to the southeast of Needles, California, as shown on Figure 1. (All figures are provided at the end of this report.) Investigative and remedial activities at the Topock Compressor Station are being performed under the Resource Conservation and Recovery Act (RCRA) Corrective Action process as well as the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), under agreements with the California Department of Toxic Substances Control (DTSC), and the Department of the Interior (DOI), respectively.

Under the terms of these agreements, PG&E is conducting the RCRA Facility Investigation/Remedial Investigation (RFI/RI) at the Topock Compressor Station. The purpose of the RFI/RI is to identify and evaluate the nature and extent of hazardous waste and constituent releases at the compressor station. Since 1996, there have been six phases of investigation at the Topock site to collect data to complete the RFI/RI. PG&E is currently planning additional groundwater data collection to complete the RFI/RI, including the activities proposed in this work plan. Information obtained through the implementation of this work plan is intended to be combined with the existing dataset and included in the Final Groundwater RFI/RI Report for the site.

Field efforts to date at the PG&E Topock site have concentrated on the California side of the Colorado River due to the location of areas with hexavalent chromium [Cr(VI)] concentrations and regional hydrogeologic information that suggests that the river acts as a hydrologic divide and is thus a barrier to eastward flow to the Arizona side of the river in the Topock area. Because there are no existing wells to define the downgradient limits of the plume to the east and south of the California floodplain, additional groundwater investigation and water quality characterization will be collected beneath the river and on the Arizona shore. This work will be conducted under the Voluntary Remediation Program (VRP) overseen by the Arizona Department of Environmental Quality (ADEQ). The VRP is a streamlined process for investigation or cleanup of contaminated sites to address applicable cross-program remediation efforts. PG&E submitted an application for the VRP on December 27, 2006.

1.2 Current Site Characterization and Monitoring

Under DTSC oversight, PG&E has conducted hydrogeologic investigations and groundwater characterization in the California floodplain area of the Topock site between 2000 and 2006 in support of the RFI/RI. Groundwater characterization activities in 2004, 2005, and 2006 were also implemented for performance monitoring for the Interim Measure (IM). The results of the more recent groundwater investigations in the floodplain area of the site are presented in the IM Phase 2 and IM 2006 well drilling investigation reports (CH2M HILL, 2005a, 2006a).

Since March 2004, PG&E has conducted routine monitoring of groundwater quality and hydraulic gradients in the floodplain area for evaluating the performance of the IM. PG&E's IM performance monitoring reports summarize the results of monitoring and operation of the IM groundwater extraction system activities and present the inferred distribution of Cr(VI) in the Alluvial Aquifer in the floodplain area (CH2M HILL, 2006b-c). These investigations have provided adequate characterization of the California floodplain. There are however some data gaps regarding the hydrogeologic conditions and the extent of chromium plume to the east and south of the current monitoring well network. The investigations proposed in this workplan are intended to fill those data gaps. Appendix A contains a figure from PG&E's most recent Monthly IM Performance Monitoring Report, dated January 15, 2007. Figure A-1 depicts the concentration contours in the deep aquifer zone. The limitations of this depiction are noted on that figure. As noted on the figure,"…there are no data confirming the existence of hexavalent chromium below the Colorado River."

1.3 Purpose and Objectives

Recent groundwater monitoring data indicate that the plume extends within the lower portion of the Alluvial Aquifer to monitoring well MW-34-100 (MW-34 cluster on Figure 2). The extent of the plume east of MW-34 is not certain. Because there are no existing wells to define the downgradient limits of the plume to the east and south of the California floodplain, additional groundwater investigation and water quality characterization will be collected beneath the river and on the Arizona shore. Multilevel monitoring wells are proposed at up to four locations in Arizona to provide additional groundwater characterization data for the final RFI/RI for the Topock site. At one of these locations, a slant well would be constructed that would extend under the Colorado River.

The primary objectives of the proposed groundwater investigation in Arizona are to:

- Assess chromium concentrations on the Arizona shore of the Colorado River to define the eastern limit of plume in the alluvial aquifer.
- Assess chromium concentrations in the fluvial sediments beneath the Colorado River downgradient of the chromium plume observed in the California floodplain.
- Characterize the natural geochemical groundwater conditions, specifically the extent of reducing water chemistry, in the fluvial sediments on the Arizona shore and beneath the Colorado River.

- Install permanent multilevel monitoring wells on the investigation sites to provide ongoing water quality and hydraulic monitoring in Arizona and beneath the river, downgradient of the California floodplain area.

The work plan is organized as follows:

- Section 2.0 describes the field investigation activities proposed for the drilling investigation in Arizona, including site preparation, sampling, well installation, and geophysical logging.
- Section 3.0 describes the procedures for managing investigation-derived waste (IDW) and equipment decontamination associated with the field investigation.
- Section 4.0 outlines the authorizations and approvals required from various agencies for the proposed drilling investigation and field work, and includes a biological evaluation of the proposed groundwater investigation activities.
- Section 5.0 presents the schedule for the planning, review, and implementation of the proposed drilling and groundwater investigation and describes the reporting activity for this investigation.
- Section 6.0 provides a list of works cited while compiling this work plan.

2.0 Field Investigation and Drilling Activities

This work plan addresses the field investigation activities for groundwater characterization along the Arizona shore of the Colorado River east of the PG&E Topock Compressor Station. The groundwater investigation will be conducted at three drilling sites, designated Sites 1, 2, and AB-2. A contingency investigation may be conducted at a fourth drilling site, designated Site 3, in the event that concentrations of Cr(VI) above background levels are detected at site AB-2. Figure 2 shows the proposed locations of the drilling sites and existing features. This section describes drill site selection; site preparation, access and staging; drilling method and requirements; depth-specific groundwater sampling; cased well geophysical logging; multilevel well installation; and groundwater sampling of the monitoring wells.

2.1 Drilling Site Selection

The rationale for each of the proposed drilling sites is described in this subsection. Multilevel monitoring wells would be installed at each site. If possible, drilling would proceed until the borings encountered bedrock at each site to provide characterization of the complete thickness of the alluvial aquifer. The location of screened intervals in each well would be determined based on data collected during drilling of the initial borehole.

Figure 3 shows a bedrock structure map of the investigation areas, showing inferred depth contours in feet below the river level. The depth to bedrock map is based on data collected during PG&E's completed drilling investigations in the California floodplain area, the 2004 seismic reflection survey conducted on the Colorado River (USGS, 2005), and exploration borings completed in 1962 by Caltrans for construction of the I-40 Bridge crossing at Topock, Arizona. The only well on the Arizona shore that reached bedrock is PGE-9 where bedrock was encountered at a depth of approximately 100 feet. There is uncertainty regarding depth to bedrock on the Arizona shore north of the inlet to Topock Marina. The 2004 seismic survey was not able to establish bedrock depth in this area due to the presence of a semi-consolidated older alluvium layer above the bedrock. Bedrock depths in this area have been extrapolated from the California side of the river. Depending on the characteristics of the geologic materials being penetrated, the rotosonic drilling method proposed for use in this investigation may have difficulty reaching depths greater than 400 feet. Based on our present understanding of bedrock depth and the characteristics of the geologic materials, sonic drilling methods will be near the limit of their capabilities for reaching bedrock at Site 1.

The United States Geological Survey (USGS) is planning to conduct a seismic survey during January 2007 that includes several transects across the Colorado River near the I-40 bridge to identify the deepest parts of the channel at that location. The current proposed well installation sites and slant boring angles may be revised based on the results of the survey.

Additional considerations for evaluating well locations included environmental, institutional, and property owner constraints. Figure B-1 in Appendix B presents the parcel

and property ownership map for the proposed drilling investigation. Appendix B also provides information on existing wells in Arizona in the area.

The peninsula directly across the river from the Topock site is part of the Havasu National Wildlife Refuge (HNWR). The vegetated portions of this peninsula are habitat for the Yuma clapper rail and the Southwestern Willow Flycatcher, both of which are endangered species. However, the westernmost portion of the peninsula area is more sparsely vegetated and is developed with an access road. Proposed investigative activities at Site 1 adjacent to the levee road, and within previously disturbed and sparsely vegetated areas, will have less impact on the critical habitat and are therefore more favorably accepted by USFWS than locations further east on the peninsula.

As shown in Appendix B, the property south of the inlet to the Topock Marsh is subdivided into numerous parcels. The area is relatively developed, and includes the Topock Marina, Interstate-40, the Burlington Northern and Santa Fe (BNSF) railway, houses, natural gas pipelines, and other utilities. Investigative activities within this area (Site 2, Site AB-2, and the contingent Site 3) would be limited by property use, structures, and agreements with private landowners.

2.1.1 Site 1 (Vertical Drilling Well Site)

Site 1 is located are located on a peninsula of the Arizona shore of the Colorado River, north of I-40 and Topock, Arizona. The peninsula separates the Topock Marsh from the Colorado River and is located on HNWR property that is managed by USFWS. This area is across the river from the chromium plume in California (Figure 2). Vertical borings with multilevel wells will provide data on the eastern limit of the chromium plume, on groundwater gradients, and geochemistry on the Arizona side of the river. Depth to bedrock at this location is likely to be near the limit of the drilling method. Access to this area will require travel down the levee road. Some grading of this road will be necessary to allow access of the drilling equipment and support trucks. In addition, the BOR has indicated that the well should be placed off the roadway and not penetrate the levee.

2.1.2 Site 2 (Vertical Drilling Well Site)

Site 2 is located is located on the Topock Marina property, immediately north of I-40 in Arizona. This site is located on private commercial property and lies between the chromium plume and water supply wells Topock 2 and 3. A vertical boring and multilevel well will provide data on the eastern limit of the chromium plume, groundwater gradients, and geochemistry on the Arizona side of the river. Because this location is located further from the river bank than Sites 1 and AB-2, it provides a water level monitoring point that will allow for triangulation with wells closer to the river to determine the direction of groundwater flow.

The depth to bedrock in this area is unknown, but because the bedrock dips to the northeast, it is anticipated that the alluvium will be thinner in this area than to the north on the peninsula or to the west within the main river channel.

The preferred Site 2 drilling location is shown on Figure 2 located in the parking lot of the Topock Marina Restaurant. This location is preferred because it is closer to the river and would therefore provide better definition of the eastern extent of the plume. An alternate

location for Site 2 has been identified further to the east that would result in less impact on the operations of the marina (Figure 2). PG&E has not yet obtained permission from the property owner to install wells at either the Site 2 or the Site 2 alternate location.

2.1.3 Site AB-2 (Slant Drilling Well Site)

Site AB-2 is located south of I-40 in Arizona, on private property. The location of this well may be on residential property or El Paso Natural Gas property depending on access arrangements with the property owners. Depending on access and location of a submerged former bridge piling offshore, the AB-2 drilling site may extend partially onto the Interstate 40 easement. Final determination of the location of the borehole will be made after the results of the seismic survey planned to be conducted by USGS in January 2007 are available and pending discussions with the property owner regarding access to this area. A slant boring and multilevel wells are proposed at this location to provide data on the downstream extent of plume and information on geochemistry and water levels beneath the Colorado River. Site AB-2 is part of an east-west investigation transect across the Colorado River, which includes a corresponding drill site, designated Site AB-1, on the California shore (Figure 2). The slant drilling and investigation activities proposed at corresponding Site AB-1 are under the jurisdiction of DTSC and were presented in a separate work plan that describes the same drilling technique as discussed herein (CH2M HILL, 2006d).

As noted on Figure 3, Miocene bedrock outcrops on the Arizona shore immediately north of the abutment of the BNSF railroad track. The inferred bedrock structure underneath the river at the I-40 Bridge is a bedrock structural "saddle" or rise. Based on the results of the previous 2004 seismic reflection survey, the fluvial deposits beneath the river increase in thickness to the north and south as the bedrock dips away from the rise under the I-40 Bridge. Hence, the area immediately south of the I-40 Bridge has been selected as a preferred location for the slant exploratory boring and groundwater characterization beneath the Colorado River. The 2004 seismic survey and driller's logs from the PGE-09 wells show that the depth to bedrock in this area varies from 100 feet to 300 feet. The alternate site AB-2 shown on Figure 2 is located on property owned by El Paso Natural Gas Company and would be used if access could not be obtained to the primary AB-2 site or if bedrock profiles indicated by the seismic survey planned to be conducted by USGS in January 2007 were unfavorable for borehole installation at the primary AB-2 location.

2.1.4 Site 3 (Contingency Vertical Drilling Well Site)

In the event Cr(VI) concentrations above background levels are found in the AB-2 boring, a contingency vertical boring and multilevel wells are proposed at Site 3. This site is located downstream of site AB-2, adjacent/underneath the I-3 Bridge abutment, and adjacent to existing PG&E wells PGE-9N and PGE-9S. This site is located on private commercial property owned by El Paso Natural Gas. Hexavalent chromium has not been detected in the PGE-9 wells during six sampling events between May 2005 and May 2006; however these wells are constructed as production wells with long screen intervals and large diameter casing. Properly constructed monitoring wells and contingency Site 3 could provide data on the southeastern extent of the chromium plume, if the plume extends beyond the AB-2 location.

2.2 Site Preparation, Access, and Equipment Staging

Proposed staging areas and access roads to sites without public roadways are shown in Figure 2. Two areas to the east of the levee road and south of the access gate would serve as staging areas for Site 1. The levee road will require some road grading prior to mobilization to improve the road for rubber tire vehicles to travel on. All grading work will be coordinated with the US Bureau of Reclamation and HNWR.

A clear area south of the road to the Topock Marina from I-40 will serve as the staging area for Site 2. The staging area for Sites AB-2 and 3 is located between the two sites in a clear field on El Paso Natural Gas land. These areas will be used for staging drilling materials and IDW storage containers required during the drilling and well development activities. Drilling equipment, supplies, and storage bins in the short-term staging areas will be removed within 30 days following completion of well development of the new monitoring wells.

Due to the long travel time required to access Site 1 via the levee road, a small boat may be used to transport crews to the site from the Topock Marina. This would reduce the travel time for personnel once the equipment has been set up. Figure 2 shows the boat landing location adjacent to Site 1. In the event of an emergency, the fastest way to transport personnel to urgent care facilities would be via boat.

The proposed access routes and drilling sites will be field-checked and clearly delineated prior to mobilization. If modifications to the access routes are needed, additional surveys will be conducted to ensure that no sensitive habitat will be impacted, that native vegetation is protected, and that integrity of pipelines and other structures is maintained. Field activities associated with the equipment access and well drilling on federal lands will be coordinated with HNWR, BOR, and as appropriate, BLM to ensure the protection of cultural and biological resources and the flood control levee.

Site preparation shall occur prior to equipment mobilization. Site preparation shall include surveying the area for biologically and/or culturally sensitive areas; identifying subsurface utilities and other structural constraints; identifying site hazards; and establishing access routes and work areas that will minimize impacts to these features to the extent possible. Drill rigs shall be cleaned before mobilization to the site and following completion of drilling at the site if visible grease, oil, or other contamination is evident on the equipment. After the drill rigs have been mobilized into place, the staging areas will be established in the drilling work area. Plastic sheeting will be laid on the ground surface in the staging areas to keep the drilling materials and equipment clean and to minimize impacts to the ground surface from the drilling materials and equipment. Materials to be stored at the well site include drilling equipment and well construction materials (e.g., casing and grout).

2.3 Drilling Method and Requirements

The drilling, core/borehole logging, and well construction will be performed under the supervision of an Arizona Registered Geologist. The drilling and well installation activities will be conducted in accordance with this work plan and modified methods and standard operating procedures (SOP) from the *Topock Program Sampling, Analysis, and Field Procedures*

Manual (CH2M HILL, 2005b). The applicable SOPs that pertain to the drilling, logging, and well installation activities are presented in Appendix C.

Table 1 summarizes proposed target drilling parameters for groundwater investigation borings and wells. (All tables are located at the end of this report.) Figure 2 presents the proposed locations of the borings and monitoring wells. The methods, equipment, and procedures for drilling, logging, and depth specific groundwater sampling are described below. The methods and procedures are based on the successful implementation and experience from the prior drilling programs conducted in the floodplain area on the California side of the river in 2005 and 2006 (CH2M HILL, 2005a, c, 2006a).

The primary slant boring at the AB-2 location will target the deepest part of the Colorado River bedrock channel that is within range of the drilling method. Depending on the depth to bedrock and the profile of the bedrock surface, a second angle boring may be installed, if needed, to provide monitoring of additional area beneath the river. The results of the seismic survey planned to be conducted by USGS in January 2007 will be reviewed to determine whether one or two borings will be needed at Site AB-2. An additional contingency vertical boring at Site 3 is proposed only if Cr(VI) concentrations above background are observed at AB-2 Borings will be advanced until consolidated Miocene bedrock is encountered or until refusal.

Drilling will be conducted in the unconsolidated Holocene and younger fluvial deposits of the Colorado River. The final angle from horizontal and the bearing (or azimuth direction) for each of the borings will be determined based on subsurface information available at the time of drilling and field conditions at the drill site. The slant borings will be advanced until consolidated Miocene bedrock is encountered or until refusal.

2.3.1 Rotosonic Drilling Method

Drilling will be accomplished using the rotosonic drilling technique, which involves advancing a rotating and vibrating drill head or core barrel through the subsurface. This method produces a continuous core from the land surface to the target drilling depths; generates minimal drilling wastes; and typically can drill through gravel, cobble, and softer bedrock formations.

Drilling activities at Sites 2 and 3 can be conducted using standard truck-mounted rotosonic drilling equipment. Drilling at Sites 1 and AB-2 may require the use of a track-mounted all-terrain drilling rig. To support the all-terrain drilling rig, a tracked or balloon-tired forklift and one or more all-terrain vehicles will be used to transport crew, equipment, and materials from the staging area to the drill site on the floodplain. The forklift will also be used to transport cuttings and excess core generated from drilling the soil borings to lined, steel rolloff soil bins that will be temporarily stored at the staging areas. Disposal procedures for IDW are discussed in Section 3.

2.3.2 Core Logging

Lithologic descriptions will be logged of each soil boring based on visual inspection of the retrieved core under the supervision of an Arizona Registered Geologist. The field log will document the following information for each soil boring:

- Unique soil boring or well identification
- Purpose of the soil boring (e.g., monitoring well)
- Location in relation to an easily identifiable landmark
- Names of the drilling subcontractor and logger
- Start and finish dates and times
- Drilling method
- If applicable, types of drilling fluids and depths at which they were used
- Diameters of surface casing, casing type, and methods of installation
- Depth at which saturated conditions were first encountered
- Lithologic descriptions (based on the Unified Soil Classification System)
- Sampling-interval depths
- Zones of caving or heaving
- Depth at which drilling fluid was lost and the volume lost
- Changes in drilling fluid properties
- Drilling rate
- Drilling rig reactions, such as chatter, rod drops, and bouncing

The results of the continuous core logging of the borings will be summarized in grain-size core plots for the hydrogeologic characterization to assist in selecting well screen intervals.

2.4 Depth-Specific Groundwater Sampling

Groundwater samples will be collected at discrete depths from each of the boreholes. The Isoflow® sampler or equivalent will be used for groundwater sample collection. Samples will be collected from a 10-foot open borehole at 20-foot intervals. Where feasible, a sample will also be collected from the zone just above the bedrock. Figure 4 presents a cross section of the anticipated sampling depths for collecting borehole depth-specific groundwater samples using the Isoflow® sampling method.

Depth-specific samples will be obtained from an open section of borehole below the drive casing by pumping using the Isoflow® vertical aquifer profiling system. The sampling pump incorporates a packer that is placed in the bottom of the temporary casing to isolate the open hole below the casing. Attached below the packer is a submersible pump enclosed in a short section of well screen. By using a packer to hydraulically isolate the sampling interval from the water standing in the temporary casing above, the purge volumes can be minimized and representative samples can be obtained from a discrete section of the borehole. An alternative to the hydraulic packer equipped Isoflow® tool, a mechanical "segregation-block" may be used on the Isoflow® pump assembly. The advantage of this method is that the water level response inside the sonic casing can be measured during borehole purging to assess the relative permeability of the open borehole interval.

Purging will involve pumping one to three borehole volumes from the open borehole interval being sampled and monitoring the field parameters (temperature, pH, specific conductance, and oxidation-reduction potential). After the field parameters have stabilized and at least one borehole volume has been removed, water quality parameters will be measured and groundwater samples will be collected for Cr(VI) and ferrous iron analyses, as presented in Table 2. The Cr(VI) and ferrous iron analyses will be conducted at the onsite

field laboratory currently set up at the IM No. 3 treatment plant using the HACH colorimetric method. A sufficient quantity of sample will be collected and filtered in the field so that confirmation samples can be sent to a certified laboratory for total chromium [Cr(T)] analysis if Cr(VI) is detected in any of the borehole groundwater grab samples. Because the time of field sample collection and screening precludes laboratory analysis of these samples within the Cr(VI) 24-hour holding time, the confirmation samples will be run for Cr(T) only. All groundwater grab samples will be filtered in the field prior to preservation and analysis.

2.4.1 Water Level Measurements During Borehole Groundwater Sampling

Additional characterization of the Alluvial Aquifer is proposed as part of the depth specific sampling activity. The Isoflow® sampling system can be configured with a casing segregation-block to allow the measurement of water levels during 10-foot open hole intervals for qualitative assessment of aquifer permeability. The recording of drawdown response for each zone purged may allow for distinguishing low-, medium-, and higher-permeability zones within the boreholes tested. Attempts will be made to measure drawdown during pumping for Isoflow® sample collection. For the slant borings, this will be attempted by fastening a pressure transducer secured to the Isoflow® sampling pipe. If the transducer is damaged by the process of pump insertion and retrieval, Isoflow® samples will then be collected without these water level measurements. An estimate of specific capacity would be obtained from the purging drawdown data, to provide a relative measure of the permeability of the borehole at the depth of the sample. This is considered screening-level data for use in selecting more permeable zones for well screens. It is not considered suitable for more quantitative purposes such as model calibration.

2.5 Cased Well Geophysical Logging

Immediately following completion of the deepest well at locations 1 and 2, cased well geophysical logs (natural gamma ray and induction) will be conducted. The geophysical logging will be used for hydrogeologic characterization. Geophysical logging will be scheduled immediately after the deepest well is completed at each drilling location so that the results of the geophysics can be used for selecting screened intervals in the second boring at that location. These types of geophysical surveys provide formation characteristics of the aquifer intervals and can be used for hydrogeologic interpretation and water quality characterization. Geophysical logs will not be run in the angled well at Site AB-2.

2.6 Monitoring Well Installation

2.6.1 Vertical Well Cluster Design and Specifications

The scope of work described here includes vertical well installation at two locations: Site 1, Site 2, plus contingency location Site 3. Figures 5A and 5B present generalized schematic diagrams for the construction of clustered groundwater monitoring wells to be installed in the vertical borings drilled for this investigation. Monitoring well screened intervals will be selected based on core and geophysical logs and the results of Isoflow® sampling. For the

purposes of this document, screened intervals will be generically described as shallow, middle, and deep.

A cluster of three wells is proposed for Site 1 (MW-54). The deep well will be installed in a single boring. A second boring within 15 feet of the first is proposed for installing the nested shallow and middle wells of MW-54. A nested well pair will be installed at Site 2 (MW-55). If concentrations of Cr(VI) above background levels are detected in the slant wells at AB-2, wells will be installed at Site 3. A cluster of up to three wells is proposed. The multilevel wells to be installed in the borings drilled for this project will be designated as listed in Table 1.

Consistent with existing California floodplain wells, the new monitoring wells will be identified by the well number (e.g., MW-54) followed by the bottom depth of the screen rounded to the nearest 5 feet (e.g., MW-54-380, screened to a depth of 380 feet below ground surface).

2.6.1.1 Well Casing and Screen

All new vertical monitoring wells will be constructed with 2-inch-diameter Schedule 40 polyvinyl chloride (PVC) casing and 10-feet length of factory-slotted well screen. Casing requirements are as follows:

- Casing will be new, unused, and decontaminated.
- Glue will not be used to join casing, and casings will be joined only with compatible threads that will not interfere with the planned use of the well.
- The PVC casing will conform to ASTM Standard F 480-88A or the National Sanitation Foundation Standard 14 (Plastic Pipe System).
- The casings will be straight and plumb.

Well screen requirements are as follows:

- Requirements that apply to casing also apply to well screen, except for strength requirements.
- Well screens will be factory slotted, with a size of 0.020 inch.

2.6.1.2 Borehole Completion Materials

The annular space will be filled with a filter pack, a bentonite seal, or casing grout between the well casing and the borehole wall. In the middle and/or shallow interval wells more than 50 feet deep, at least two stainless-steel centralizers will be used, one at the bottom of the screen and one at the top of the screen.

Filter Pack. The filter pack will consist of No. 3 silica sand (consistent with other monitoring wells completed in the Alluvial Aquifer) and will extend from the bottom of the hole to approximately 2 feet above the top of the well screen. The top of the sand pack will be sounded to verify its depth during placement. Additional filter pack will be placed as required to return the level of the pack to 2 feet above the screen. A minimum 1-foot-thick layer of fine sand will be placed above the No. 3 sand filter pack to minimize the potential

for the bentonite slurry (seal) material to invade the filter pack adjacent to the top of the well screen during well construction.

The contractor will record the volume of filter pack emplaced in the well. Potable water may be used, with the approval of the field geologist, to emplace the filter pack, as long as no contaminants are introduced to the subsurface.

Annular Seals. The bentonite seal requirements are as follows:

- The bentonite seal will consist of at least 2 feet of bentonite between the filter pack and the casing grout.
- Only 100 percent sodium bentonite will be used.
- Bentonite chips or pellets will be hydrated with potable water if the transition seal is not below the water table, otherwise a bentonite slurry (1 gallon water for 2 pounds bentonite) will be used.

A surface seal will be installed in the uppermost 20 feet of all wells. The grout requirements for the surface seal are as follows:

- The casing grout will extend a minimum of 20 feet below ground surface.
- The grout will be either a cement mixture in the following proportions:
  - Ninety-four pounds of neat Type I or Type II Portland or American Petroleum Institute Class A cement.
  - Not more than 4 pounds of 100 percent sodium bentonite powder.
  - Not more than 8 gallons of water.
- The grout for the surface seal will be pumped into place using tremie pipe in one continuous operation.
- The expected volume of each ingredient in the grout mixture will be pre-calculated and documented.

2.6.2 Slant Drilling Multilevel Well Design and Specifications

Figure 6 presents a generalized schematic diagram for the construction of multilevel wells in the slant boring drilled at Site AB-2. Three Barcad™ porous screens are planned for installation in the boring. Because groundwater at these sites is shallow, the Barcad™ screens will be sampled using peristaltic pumps rather than the gas lift pumping system used in conventional Barcad™ installations. The individual monitoring intervals will be selected based on the slant boring core log; and the results of Isoflow® sampling. The multilevel wells to be installed in the slant boring drilled for this project will be designated as listed in Table 1.

Following well screen selection, the individual Barcad™ sampling screens would be connected to 3/8-inch nylon tubing that would sit in the grooves of by a 1-1/2" solid PVC support rod to form a single multilevel well assembly. In the upper 30 feet, the three nylon tubes would transition to 1-inch PVC pipes that are big enough for transducer placement.

Custom centralizers would be placed approximately every 10 feet around the central support rod. The centralizers will be solid blocks of Delran plastic, machined to fit the support rod and with pass through holes for tremmie pipes. The natural formation will be allowed to collapse in place around the Barcad™ well screen after emplacement, with a completion interval of 8 to 10 feet maximum for each monitoring zone. The borehole above the monitoring zone will be sealed with a minimum 10 feet of a mixture of granular bentonite (Benseal) and filter-pack sand placed in the slant borehole using a tremie pipe. Alternatively, a grout slurry may be used or prepack grout assemblies may be installed on the central support rod. The method of establishing grout seals will be tested on an angled well to be installed on the California shore in February and March and the method found to be most successful will be applied to the Arizona slant well. The process of formation collapse surrounding the well screen and placement of an overlying sand/granular bentonite seal would be repeated for the intermediate and shallower completion intervals as illustrated in Figure 6.

The Barcad™ and casing requirements are:

- All Barcad™ samplers and casing will be new, unused, and decontaminated.
- Glue will not be used to join casing, and casings will be joined only with compatible threads that will not interfere with the planned use of the well.
- The Barcad™ samplers and casing will be straight.

A grout seal will be emplaced in the uppermost 20 feet of the well. The grout requirements for the surface seal are provided in Section 2.6.1.2.

2.6.3 Surface Completion

Surface completions for wells installed in this investigation will consist of either an above ground, steel, locking wellhead monument or a subsurface well vault with a locking cover. Figures 5a and 5b provide schematic diagrams of well construction, including surface completions. For above ground completions, the wellhead monument completion will be placed over the casing and cap and seated in a minimum 4-foot by 4-foot by 4-inch-thick concrete pad. The ground surface will be free of vegetation and scoured to a depth of 4 inches before setting the concrete pad. The concrete pad will be sloped away from the well sleeve. The identity of the well will be permanently marked on the casing cap and the protective sleeve. In addition, metal tags will be attached to each of the well casings to identify the specific wells within each well monument. For below ground completions, the well vault will be set in concrete and equipped with a traffic rated steel cover or lid. Wells inside the vault will be equipped with water-tight well seals to prevent surface water from entering the wells if the vaults fill with water. All wells will be secured as soon as possible after drilling by using corrosion-resistant locks. The locks will be keyed for opening with one master key.

2.6.4 Well Development

2.6.4.1 Vertical Well Cluster

Within 24 to 72 hours following well installation and annular seal placement, the individual vertical wells will be developed by purging, surging, and bailing. During development

pumping, temperature, pH, specific conductance, and turbidity will be measured using field instruments. Well purging will continue until field parameters stabilize and turbidity is reduced to less than 50 nephelometric turbidity units. The purge water produced during well development will be collected in portable tanks or drums at the drill site and transferred to cuttings bins or storage tanks in the staging area. Disposal procedures for IDW are discussed in Section 3.0.

2.6.4.2 Slant Multilevel Wells (Barcad™ System)

Within 24 to 72 hours following well installation and annular seal placement, the individual slant monitoring wells will be developed by purging with a peristaltic pump. Due to the small diameter of the wells and the design of the Barcad™ well screens, conventional development of these wells by surging and bailing is neither possible nor necessary. During development pumping, temperature, pH, specific conductance, and turbidity will be measured using field instruments. Well purging of the Barcad™ wells will continue until field parameters stabilize and turbidity is reduced to less than 50 nephelometric turbidity units. The purge water produced during well development will be collected in portable tanks or drums at the drill site and transferred to cuttings bins or storage tanks in the staging area. Disposal procedures for IDW are discussed in Section 3.0.

2.6.5 Well Surveying and Completion Diagram

Following surface completion, the new monitoring wells will be surveyed for well datum elevation and location. In addition to the lithologic core logs to be prepared for the borings, a well completion diagram will be prepared for each monitoring well installed. The diagrams include:

- Well identification.
- Drilling method.
- Installation date(s).
- Elevations of ground surface and the measuring point.
- Total boring depth.
- Lengths and descriptions of the screen and casing.
- Lengths and descriptions of the filter pack, bentonite seal, casing grout, and any back filled material.
- Depth to groundwater in the constructed wells.

2.7 Groundwater Sampling of Multilevel wells

The multilevel monitoring wells will be sampled following well development and completion. The applicable SOPs that pertain to groundwater monitoring and sampling procedures are presented in Appendix D. Vertical wells will be sampled using a submersible electric pump (Appendix D, SOP-A1). The slant wells will be sampled using a peristaltic pump (Appendix D, SOP-A2). The wells will be purged and sampled using the

casing-volume method purge rates selected to obtain representative groundwater samples from the aquifer zone and be consistent with the existing sampling procedures used for monitoring wells in PG&E's groundwater monitoring program. The groundwater samples collected from the new monitoring wells will be analyzed for Cr(VI), dissolved Cr(T), pH, specific conductance, ferrous iron, total dissolved solids, chloride, sulfate, alkalinity, carbonate/bicarbonate, nitrate, bromide, calcium, magnesium, potassium, sodium, boron, and stable isotopes oxygen 18 and deuterium. Table 2 summarizes the groundwater sampling and analysis plan for initial sampling after development. Field water quality parameters (temperature, pH, specific conductance, oxidation-reduction potential, dissolved oxygen, and turbidity) will also be measured and recorded.

Consistent with prior PG&E field investigations and the groundwater monitoring program, the samples for Cr(T), metals, and cations will be filtered in the field. The Cr(VI) samples will be filtered in the laboratory before analysis. Per the 2005 Field Procedures Manual (CH2M HILL, 2005b), one field duplicate is required every 10 samples, at a minimum of one per event. For the initial groundwater sampling, field duplicates will be collected at one well for all analytes. One equipment blank should be collected one per day, per crew, per piece of non-dedicated equipment.

Following initial sampling, the new wells will be incorporated, as appropriate, in the PG&E groundwater monitoring program and hydraulic monitoring (pressure transducer) network used for the IM performance monitoring program. The second sampling at these wells is anticipated to be performed approximately 1 month after the initial characterization and data from the first and second sampling events at these wells will be incorporated into the investigation summary report for this investigation (see Section 5.2).

2.8 Site Restoration Plan

The proposed drilling Site 1 is located on HNWR property managed by the USFWS. Very little vegetation is anticipated to be removed during proposed activities at Site 1. The proposed drilling Sites 2, AB-2, and 3 are located on private property that have been previously disturbed and are sparsely vegetated. Very little or no vegetation is anticipated to be removed during proposed activities at these drilling sites. After well installation at sites located in private property is complete, PG&E will work with landowners to minimize any ongoing disturbance to the property.

3.0 Waste Management and Decontamination

3.1 Investigation-derived Waste Management

Several types of waste materials will be generated during the drilling, development, and sampling of the performance monitoring wells. IDW materials that will be generated include groundwater, drill cuttings, and incidental trash.

Water generated during drilling, development, and sampling activities will be collected in bins or portable storage tanks temporarily located in staging areas near the drilling sites (Figure 2). Secondary containment will be set-up at the drilling area for the portable storage tanks or bins. Water generated from the monitoring well installations will be processed at the IM No. 3 treatment plant, transported to a permitted offsite disposal facility, or disposed at the drilling location or other location at the Topock site if acceptable to the property owner and in compliance with all applicable laws and regulations

Drill cuttings include the fragments of rock and soil that are removed to create the borehole. The cuttings will be contained in lined rolloff bins at the staging areas during the drilling and sampling activities. After sampling and characterization, cuttings bins will be removed from the staging areas for disposal in a permitted offsite disposal facility. Alternatively drill cuttings may be transferred to the drilling site or other location at the Topock site if acceptable to the property owner and in compliance with all applicable laws and regulations. It is estimated that the soil IDW bins temporarily stored in the staging areas will not remain longer than 45 days.

Incidental trash will be collected at the end of each drilling shift and hauled from the drill site to an appropriate offsite disposal facility.

3.2 Equipment Decontamination

The back of the track-mounted drilling rig and all down-hole drilling tools will be decontaminated prior to arrival at the site and subsequent to finishing the well installations at each site. Decontamination will be accomplished by steam cleaning the core barrel, drill stem, drive casing, and back of the drilling rig. The pre- and post-mobilization steam cleaning will be conducted on a temporary decontamination pad (lined plastic-sheeting) located on Topock Compressor Station property (Figure 2). Rinsate from the decontamination operation will be collected on the containment pad and transferred to the cuttings bin or purge water tanks. The decontamination rinsate will be managed along with the cuttings or purge water.

4.0 Approvals and Authorizations

4.1 Overview

Table 3 provides a listing of approvals and authorizations that have been identified as applicable to the implementation of the groundwater investigation.

The implementation of this work plan would be in accordance with terms and conditions of the ADEQ Voluntary Remediation Program. It is anticipated that approval from ADEQ will occur via written approval of the subject work plan.

The anticipated approval mechanism from the HNWR is expected to be an approval letter with conditions (if applicable). Prior to issuance of the approval letter, the HNWR is first required to comply with the Section 7 of the Endangered Species Act (ESA) and Section 106 of the National Historic Preservation Act (NHPA). Compliance with Section 7 ESA is expected to occur via completion of a Programmatic Biological Assessment (PBA) and related ESA consultation, currently in progress (see Section 4.2). Compliance with Section 106 of the NHPA is expected involve a consultation with local Native American tribes followed by a consultation with the State Historic Preservation Office (SHPO). Each consultation may require up to 30 days. BLM is taking the lead in implementing these reviews, pursuant to an agreement that it has entered into with FWS and BOR.

Portions of the project site and/or facilities may occur within the existing right of way (ROW) of I-40. This ROW is subject to the jurisdiction of the Arizona Department of Transportation (AZDOT). Project facilities/activities within the I-40 ROW will require issuance of an encroachment approval from the AZDOT. Similarly, although none are planned at present, any activities that occur within the railway ROW would require prior approval of BNSF.

The subject activities are not subject to approval from Arizona Game and Fish Department (AZGFD). However, the AZGFD will be notified of project activities and be provided with copies of all Arizona agency correspondence. Installation of the well facilities will also require the prior issuance of a well drilling permit from Arizona Department of Water Resources. Slant drilling activities extending beyond the shore beneath the Colorado River are subject to the approval of the Arizona State Land Department. Appropriate notices and/or applications will be provided to these authorities.

Project activities will also occur on private property. Prior to implementation of any investigative activities requiring the use of private lands, landowner approval will be obtained.

4.2 Biological Evaluation

The PBA addresses a variety of project related actions within the Area of Potential Effect (APE) (CH2M HILL, 2006e). The intent of the PBA is to obtain programmatic coverage of

these actions up to the final remedy and avoid the need for individual project specific consultations under the federal Endangered Species Act (ESA). The final PBA was submitted to the U.S. Bureau of Land Management (BLM) on December 19, 2006 to initiate Section 7 consultation with the U.S. Fish and Wildlife Service (USFWS) on behalf of PG&E. Completion of the USFWS consultation process is expected in March 2007. The purpose of this section is to outline project specifics as they relate to biological resources in the area and determine if the actions are within the context of the PBA as requested by the BLM. The following subjects are outlined in this section: project timing, project location and habitat sensitivity, habitat loss, listed species determinations, conservation measures, and PBA context.

4.2.1 Project Timing

As shown in the project schedule (Table 4), work activities are anticipated to begin by mid-April, 2007. The start date is dependent upon completion of the biological and cultural resources consultations, and receipt of necessary approvals and authorizations (Table 3). A letter of concurrence for the PBA is expected by this timeframe. The general start of the migratory bird nesting season is March 15. Additionally, May 1 has been identified as the start of the south western willow flycatcher nesting season. On December 29, 2006, a conference call was held with USFWS representative John Earle and BLM representative Jim Priest. It is expected that the work activities will go beyond March 15. Therefore, due to their locations it was agreed during the conference call that Sites 1 and 2 would be prioritized, and will be drilled simultaneously so that the wells can be completed as soon as practicable.

4.2.2 Project Location and Habitat Sensitivity

Site 1 is located directly west of suitable habitat for the south western willow flycatcher and occupied habitat for the Yuma clapper rail. Site 2 is located within the paved parking lot for the Topock Marina and Restaurant and the habitat directly north of the site is considered suitable habitat for the south western willow flycatcher and occupied habitat for the Yuma clapper rail. Sites AB-2 and 3 are located outside suitable habitat for listed species. All sites are located beyond the 300 foot buffer from sensitive habitat identified in the PBA.

4.2.3 Habitat Loss

Very little vegetation is anticipated to be removed during proposed activities in this work plan. At Site 1, no vegetation is expected to be removed; arrowweed may be crushed at Site 1, but is expected to recover. Site 2 is located within a parking lot that is denuded of vegetation. At Site AB-2, some horticultural plants may need to be removed, but no native vegetation is expected to be removed. At Site 3, very little (less than 0.10 acre) native vegetation (e.g.; common reed and possibly tamarisk) may need to be removed to access and establish the drill site. A backhoe or similar equipment may be used to remove the vegetation, however the vegetation is expected to recover.

4.2.4 Listed Species Determinations

Southwestern willow flycatcher –This action is anticipated to have no affect upon this species. For actions that may be taken after May 1 near suitable habitat for this species, the

action "may affect", but is "not likely to adversely affect" the species. This determination is within the context of the PBA.

Yuma clapper rail - This action is anticipated to have no affect upon this species. For actions that may be taken after March 15 near occupied habitat for this species, the action "may affect", but is "not likely to adversely affect" the species. This determination is within the context of the PBA.

The project is located outside suitable habitat for the desert tortoise, razorback sucker and the bonytail chub. Therefore, this action is anticipated to have no affect upon these species. However, with the exception of Site 2 alternate location, the activities will take place within the 100-year floodplain that is considered critical habitat for the bonytail chub. The magnitude of riparian function that may be affected by the proposed action is not expected to adversely impact the bonytail chub due to limited project-related activities and associated minor footprints directly adjacent to the Colorado River. Therefore, a critical habitat effects determination of "may affect" but "not likely to adversely affect" is concluded for this species. This determination is within the context of the PBA.

4.2.5 Conservation Measures

The measures identified within the PBA will be implemented. The following measures have been specifically requested by the regulatory agencies. Per USFWS, activities beyond March 15 at Site 1 will require a full-time biological monitor. Per BLM, a biologist will perform a pre-activity survey in search of nesting birds at Site 3.

The amount of vegetation that may need to be removed at Site 3 is well below the 2.5 acre floodplain threshold established in the PBA. A post-activity survey will be performed at Site 3 to document the amount of vegetation that may be removed. Re-vegetation of the drill sites is considered unnecessary in the context of the PBA.

4.2.6 PBA Context

The well installation activities proposed in this work plan are within the context and boundaries outlined in the PBA. These actions are fully covered by the PBA.

4.3 Cultural Resource Surveys, Reviews, and Consultations

This area of proposed well drilling as described in this work plan was included in a cultural resources survey of the area of potential effects (Applied Earthworks, 2005). Significant cultural resources were not found in this area in Arizona. The PG&E field contact representative will be responsible for providing archaeological sensitivity training to the workers implementing this work plan and for ensuring compliance with all applicable archaeological measures during drilling activities.

The Topock site and adjacent lands are contained within a larger geographic area that is considered sacred by the Fort Mojave Indian Tribe and by other Native American tribes. In recognition of this, all activities are planned in such a way as to minimize impact to this area. The work will be conducted in a manner which recognizes and respects these resources and the spiritual values of the landscape and the Colorado River. Practices which will be implemented with this objective in mind include: minimizing additional disturbance

to the landscape by installing wells in previously disturbed areas where possible; minimizing the size of drilling pads and staging areas; use of all terrain drilling and sampling equipment in areas not served by existing roadways; constructing nested wells with multiple well screens at different depths in a single boring where possible rather than drilling individual borings for each well depth' minimizing the amount of equipment and duration that equipment is present on site; painting wellheads in earth-tone colors; and providing training to all site employees to ensure that they are aware of and respectful of the spiritual value of this landscape and the sacred nature of the land.

5.0 Schedule, Reporting, and Community Involvement

5.1 Project Schedule

The proposed schedule for the planning, review, and implementation of the proposed drilling and groundwater investigation at the Arizona drilling sites is provided in Table 4. The implementation schedule is subject to obtaining approvals and authorizations from ADEQ, HNWR, landowners, and other agencies, as described in Section 4.0. Federal agency representatives have noted that access to the proposed Sites 1 and 2 may be limited due to biological impact restrictions associated with the migratory bird nesting season (conference call between PG&E, USFWS, and BLM representatives on December 29, 2006). Accordingly, the project schedule was developed with the goal to complete the Site 1 and Site 2 boring and well installation first and then moving to the other sites.

5.2 Reporting

Following completion of the field work, an investigation summary report will be prepared to present the results and document the drilling, well installation, and initial groundwater sampling. The summary report will include a compilation of lithologic, geophysical, and water quality data collected during drilling of the wells, survey coordinates for the wells, water level data, and results of groundwater sampling. The data summary report will be submitted approximately 9 weeks after the second round of groundwater sampling at all wells.

Progress reports will be provided to ADEQ monthly throughout the period during which the wells are being constructed.. The progress reports will not contain data, but will provide a summary of activities during the reporting period. Draft lithologic logs, results of depth specific samples collected during drilling, and results of geophysical surveys will be submitted to ADEQ and other interested parties via e-mail as these results become available during the investigation. These interim results will be used as a basis for determining screened intervals in the wells.

PG&E will notify ADEQ via e-mail and phone within 24 hours if any of the groundwater samples collected during this investigation are found to contain chromium at a concentration exceeding the California MCL of 50 µg/L.

Following the initial sampling, the new wells will be incorporated, as appropriate, in the PG&E groundwater monitoring program and hydraulic monitoring (pressure transducer) network used for the IM performance monitoring program. Monitoring reports under these programs are prepared under monthly, quarterly, and annual reporting schedules.

5.3 Community Involvement

PG&E will coordinate with ADEQ to develop a community involvement program for this investigation. It is anticipated that the program will include posting of signs during the well installation.

6.0 References

Applied Earthworks. 2005. *Cultural Resources Investigations, Third Addendum: Survey of the Original and Expanded APRE: Volume I, for Topock Compressor Station Site Vicinity, San Bernardino County, California*.

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United States Geological Survey (USGS). 2005. "Seismic Profiling Methods and Results from the September 2004 Seismic-reflection Survey on the Colorado River: Summary Memorandum and Attachments Presented to DTSC and Topock Project Technical Work Group Meeting, 2005."

Tables

TABLE 1
Drilling and Well Installation Plan
Work Plan for Groundwater Characterization on Arizona Shore of the Colorado River at Topock, Arizona
PG&E Topock Compressor Station, Needles, California

Site ID Location	Drilling Plan		Depth-Specific Sampling		Well Installation Plan	Remarks
	Proposed Boring	Target Drilling Depth feet bgs	Groundwater Sampling during Drilling	Potential No. of Isoflow^{R} Samples	Proposed Monitoring Zone and Well Designation	
Site 1 HNWR sandbar	vertical boring #1	420	10' zones at 20' intervals	20 sample zones	base Alluvial Aquifer (MW-54D)	deep exploration boring on HNWR levee road
	vertical boring #2	350	none	none	middle Alluvial Aquifer (MW-54M) upper Alluvial Aquifer (MW-54S)	drill 2nd boring 8' from 1st boring
Site 2 Topock Marina	vertical boring	90	10' zones at 20' intervals	4 sample zones	base Alluvial Aquifer (MW-55D) middle Alluvial Aquifer (MW-55M)	expect thin saturated zone
Site AB-2 Smith property south of I-40	slant boring #1 30 degrees from horizontal	325 slant drilled	10' zones at 20' intervals	15 sample zones	base Alluvial Aquifer (MW-56D) middle Alluvial Aquifer (MW-56M) upper Alluvial Aquifer (MW-56S)	drill & install 30^{o} slant wells per results and procedures developed at CA slant drilling AB-1
CONTINGENCY DRILLING PLAN						
Site AB-2 Smith/EPNG property south of I-40	slant boring #2 40 degrees from horizontal	180 slant drilled	10' zones at 20' intervals	7 sample zones	middle Alluvial Aquifer (TBD) upper Alluvial Aquifer (TBD)	drill 2nd slant boring if field conditions allow & additional characterization required.
Site 3 EPNG property under I-3 bridge	vertical boring #1	135	10' zones at 20' intervals	6 sample zones	base Alluvial Aquifer (TBD)	drill Site 3 if elevated Cr(VI) plume encountered in AB-2 slant wells
	vertical boring #2	100	none	none	middle Alluvial Aquifer (TBD) upper Alluvial Aquifer (TBD)	drill 2nd boring 8' from 1st boring

Notes:

1. See Figure 2 for proposed drilling site locations and alternate sites. All drilling sites subject to property owner access agreements.
2. The AB-2 slant boring angles will be determined prior to drilling based on available data and site conditions.
3. Isoflow samples to be collected during drilling from purged open-hole.
4. Proposed monitoring well construction shown on Figures 5A/5B (vertical well clusters at Sites 1, 2 and 3) and Figure 6 (AB-2 slant multilevel wells).
5. EPNG = El Paso Natural Gas

TABLE 2
Groundwater Sampling and Analysis Plan
Work Plan for Groundwater Characterization on Arizona Shore of the Colorado River at Topock, Arizona
PG&E Topock Compressor Station, Needles, California

Analyte	Analytical Method	Standard Reporting Limit	Potential Number of Samples this Investigation
Depth-Specific Groundwater Samples from Borings (Sites 1, 2, and AB-2)			
Hexavalent chromium	Hach, IM3 field lab	10 μg/L	39
Dissolved total chromium (field filtered)	Method SW 6010B	1 μg/L	analyze if Cr(VI) detected
Specific conductance	field instrument	NA	39
Oxidation reduction potential	field instrument	NA	39
Dissolved oxygen	field instrument	NA	39
pH	field instrument	NA	39
Temperature	field instrument	NA	39
Ferrous iron	Hach, IM3 field lab	50 μg/L	39
Groundwater Samples from Multilevel Monitoring Wells (MW-54, MW-55, and MW-56)			
Hexavalent chromium	Method SW 7199	0.2 μg/L	8
Dissolved total chromium (field filtered)	Method SW 6010B	1 μg/L	8
Specific conductance	field instrument	NA	8
Oxidation reduction potential	field instrument	NA	8
Dissolved oxygen	field instrument	NA	8
pH	field instrument	NA	8
Temperature	field instrument	NA	8
Ferrous iron	Hach, IM3 field lab	50 μg/L	8
Iron (dissolved)	Method SW 6010B	0.5 mg/L	8
Total dissolved solids	EPA 160.1	10 mg/L	8
Chloride, Sulfate, Nitrate	EPA 300.0	0.5 mg/L	8
General minerals (Ca, Mg, K, Na) (dissolved)	Method SW 6010B	1 mg/L	8
Alkalinity	EPA 310.1	5 mg/L	8
Total Kjeldahl Nitrogen (TKN)	EPA 351.4/3	0.5 mg/L	8
Ammonia	EPA 350.2	0.5 mg/L	8
Manganese (dissolved)	Method SW 6010B	0.5 mg/L	8
Total Organic Carbon (TOC)	EPA 415.1/2	0.5 mg/L	8
Oxygen 18	CF-IRMS	NA	8
Deuterium	CF-IRMS	NA	8

NOTES:

See Figure 4 for anticipated borehole depth-specific sampling by the Isoflow™ method on the slant boring (Site AB-2).
Only first initial round of groundwater samples included. Second round to be determined based on results of first round.
Samples from contingent second slant boring at AB-2 and vertical boring at Site 3 are not included.
One equipment blank to be collected per day, per crew, per non-dedicated equipment.
Samples analyzed with Method SW 6010B may also be analyzed with Methods SW6020A, EPA 200.7 and EPA 200.8.
Not applicable (NA)
Continuous flow isotope ratio mass spectrometry (CF-IRMS)
Micrograms per liter (μg/L), milligrams per liter (mg/L)

TABLE 3
Approvals and Authorizations for Drilling
Work Plan for Groundwater Characterization on Arizona Shore of the Colorado River at Topock, Arizona
PG&E Topock Compressor Station, Needles, California

Agency [1]	Approvals and Authorizations
Arizona Department of Environmental Quality (ADEQ)	Approval of the investigative activities will occur via written approval of the subject work plan from ADEQ.
Havasu National Wildlife Refuge (HNWR)	Approval letter from USFWS HNWR required. Approval subject to NHPA Section 106 and ESA Section 7 consultations (see below).
U. S. Fish and Wildlife Service (USFWS)	HNWR approval subject to completion of a required Section 7 ESA consultation with the USFWS ecological services branch to address sensitive biological species, anticipated to occur via a Programmatic Biological Assessment (PBA).
State Historic Preservation Office (SHPO)	USFWS HNWR approval subject to NHPA Section 106 consultation process.
U.S. Bureau of Reclamation (BOR)	Subject to review of underlying land ownership of the project site, approval from the HNWR may require concurrence from the BOR.
Arizona Dept. of Water Resources	Well drilling permit
Arizona Department of Transportation (DOT)	Activities occurring within the right-of-way (ROW) of Interstate 40 subject to issuance of an encroachment permit from AZ DOT.
Burlington Northern Santa Fe Railway (BNSF)	Activities occurring within the ROW of the railway would require prior approval from BNSF.
Arizona Game and Fish	No approvals anticipated per prior communication with ADEQ. Arizona Game and Fish to notified of activities and copied on all AZ agency correspondence.
Arizona State Land Department	Anticipate approval of a right-of-entry application and agreement for slant well facilities extending below the Colorado River into lands owned by the State of Arizona

Notes:

[1] Activities on private land are also subject to property owner agreement.

TABLE 4

Planning and Implementation Schedule

Work Plan for Groundwater Characterization on Arizona Shore of Colorado River at Topock Arizona

PG&E Topock Compressor Station, Needles, California

Task / Activity	Estimated Duration	Estimated Completion Date	Remarks
1.0 Work Plan & Project Planning			
Preparation of Draft Work Plan		12-Jan-07	
ADEQ Review & Approval of Work Plan	8 days	24-Jan-07	per ADEQ Voluntary Remediation Program
Submit Final Work Plan	3 days	29-Jan-07	
2.0 Authorizations & Permitting			
Tribal Consultation (NHPA Section 106)	35 days	8-Mar-07	
SHPO Consultation (NHPA Section 106)	30 days	12-Apr-07	Start date subject to completion of tribal consultation process
ESA Section 7 Programmatic Consultation		1-Mar-07	Subject to BLM/HNWR concurrence that work plan activities are adequately assessed in the final Programmatic Biological Assessment
HNWR Approval	3 days	16-Apr-07	Subject to completion of the ESA Section 7 (biology) and NHPA Section 106 (cultural) consultation processes
Private Property Owner Access Agreements	60 days	26-Mar-07	for slant drilling AB-2, Site 2 & contingent Site 3
Arizona Agencies Permitting	45 days	15-Mar-07	ADOT (potential), AZ State Lands Department, ADWR drilling permits
3.0 Drilling Field Investigation			
Site Preparation & Staging	5 days	26-Apr-07	for Sites 1, 2 & AB-2 only
Drilling Equipment Mobilization	2 days	1-May-07	assume 2 rigs mobilized & drilling Sites 1 & 2 concurrently
Drilling/Sampling & Well Installation - Site 1	22 days	23-May-07	vertical boring, target 420' (bedrock est.), install 3-well cluster (Figure 5A/5B)
Drilling/Sampling & Well Installation - Site 2	6 days	14-May-07	vertical boring, target 90' (bedrock est.), install 2-well cluster (Figure 5A/5B)
Drilling/Sampling & Well Installation - Site AB-2	15 days	12-Jun-07	target 30^{o} slant boring to 325' (bedrock est.), install multilevel wells (Figure 6)
Monitoring Well Development and Sampling	2 weeks	26-Jun-07	
Second Sampling	2 days	26-Jul-07	
Contingent Drilling: 2nd Boring at Site AB-2	8 days	TBD	drill if field conditions allow & additional characterization required
Contingent Drilling: Site 3	10 days	TBD	drill if Cr(VI) plume encountered in AB-2 wells
4.0 Analysis & Reporting			
Preparation of Field Summary Report	9 weeks after the second round of groundwater sampling at all wells.		includes lab analyses & data validation

Notes:

All dates for authorizations and permits are estimated. Actual dates may change, subject to agency directives.

Completion dates estimated for primary drilling & sampling only. Schedules for contingent drilling to be determined (TBD).

Figures

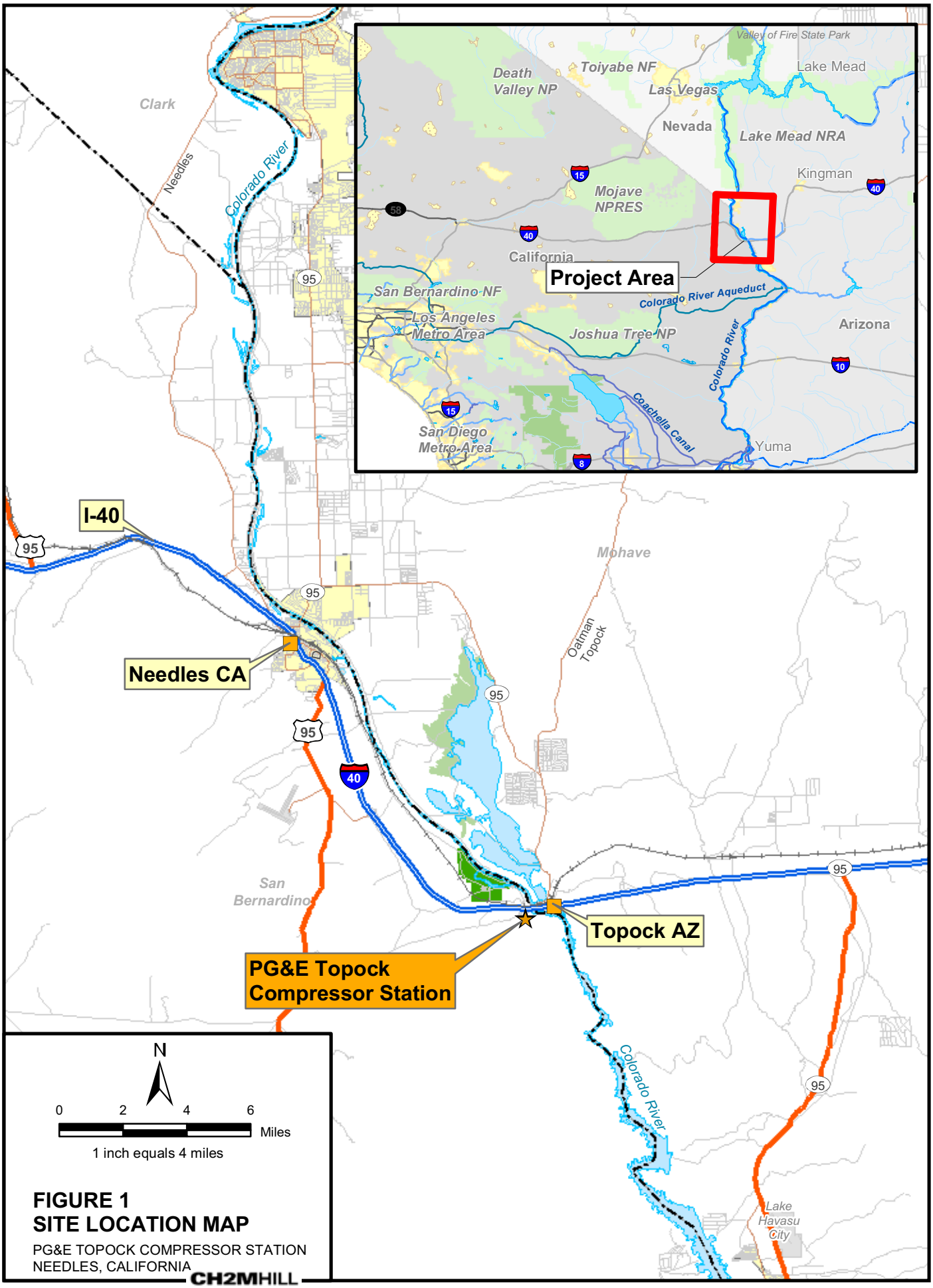


FIGURE 1
SITE LOCATION MAP

PG&E TOPOCK COMPRESSOR STATION
NEEDLES, CALIFORNIA

CH2MHILL

RDD \\ZINFANDEL\PROJ\PACIFICGASELECTRICCO\TOPOCKPROGRAM\GIS\MXD\2005\LOCATION_MAP_PORTRAIT.MXD 12/13/2005 16:33:49

Havasu National Wildlife Refuge (HNWR) (Managed by U.S. Fish and Wildlife Service)

Temporary levee road closure while drilling

Topock Marsh

ARIZONA

CALIFORNIA

Colorado River

Eastern limit of Area of Potential Effects (APE) for Topock site

Topock 2

Topock 3

MW-35

MW-49

MW-29

MW-47

MW-33

MW-13

MW-50

MW-19

MW-28

MW-46

MW-31

MW-37

MW-38

MW-44

MW-45

MW-36

MW-34

MW-20

MW-39

MW-30

MW-25

MW-42

MW-27

BNSF RAILROAD

MW-32

MW-26

MW-51

MW-43

INTERSTATE 40

MW-11

MW-24BR

MW-24B

MW-24

MW-39

MW-48

MW-21

MW-22

MW-12

MW-23

MW-10

Site 1

Boat landing (crew access)

Site 2

Site 2 (Alternate)

TOPOCK MARINA

Private

Angle Borings

AB-1

AB-2

Site AB-2 (Alternate)

Smith

Private

Sanders

PGE-9N

PGE-9S

Site 3

Contingent location for additional vertical boring/well cluster if Cr(VI) plume is encountered in AB-2

PG&E TOPOCK COMPRESSOR STATION

Proposed Decon/Staging Area

N

0 225 450 Feet

1 inch equals 450 feet

California State Plane NAD83 Zone 5 US Feet

LEGEND

- Existing groundwater monitoring well in California
- Existing Water Well
- Proposed general location for vertical boring/well cluster
- Proposed location for angle boring/well cluster (see separate DTSC Work Plan for Site AB-1)
- Proposed access route for drilling equipment
- Proposed staging areas for drilling equipment (Locations on private properties to be determined in access agreements)

FIGURE 2
PROPOSED LOCATIONS FOR ARIZONA DRILLING INVESTIGATIONS

WORK PLAN FOR GROUNDWATER CHARACTERIZATION
ON ARIZONA SHORELINE OF THE COLORADO RIVER
AT TOPOCK, ARIZONA
PG&E TOPOCK COMPRESSOR STATION
NEEDLES, CALIFORNIA

CH2MHILL

N

0 300 600 Feet

Colorado River

MW-49

MW-33

MW-46

MW-20 Bench

TW-2D
TW-3D

MW-44 109

MW-36-100

PE-1 77

MW-34-100 94

MW-39-100

MW-27-85 83

MW-32 31

MW-51

CB-14

MW-43 84

CB-07

CB-09

CB-10

CB-12

MW-22 9

MW-48

MW-23

Site 1

Site 2

Site 2 (alternate)

Miocene Bedrock Outcrop

BN & SF Railroad

Hydrogeologic Cross Section Figure 4

AB-1

AB-2

AB-2 (alternate)

PGE-9 100

Site 3 (contingent)

Miocene Bedrock Outcrop

PG&E

PG&E Topock Compressor Station

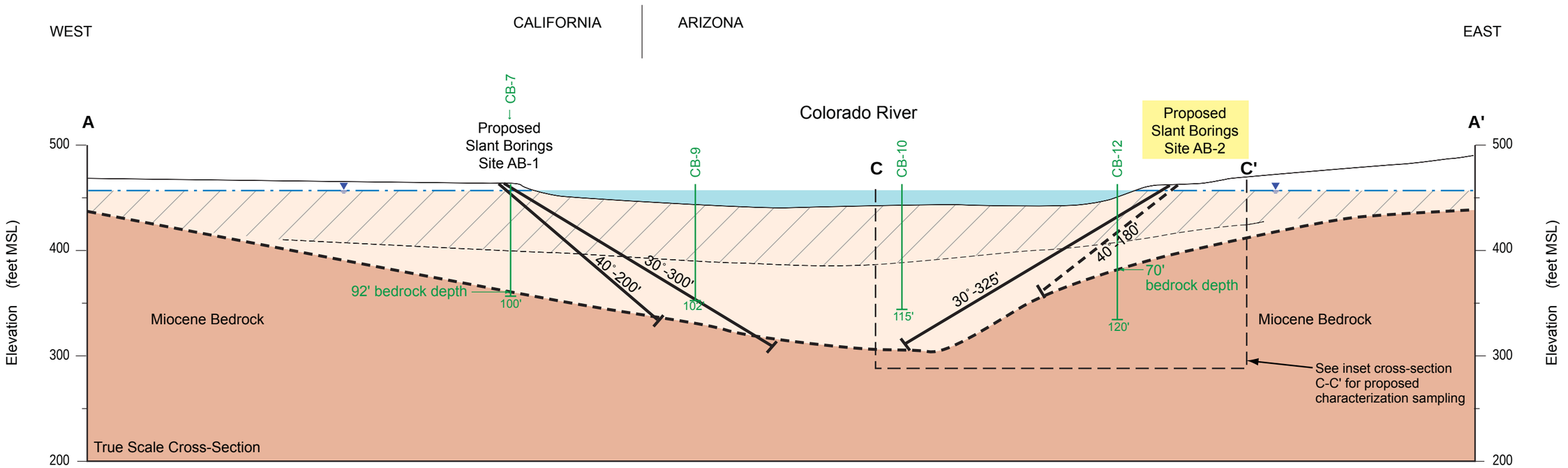
420 440 400 380 280 340 360 260 220 200 180 120 100 160 80 240 140 40 20 60 100 180 200

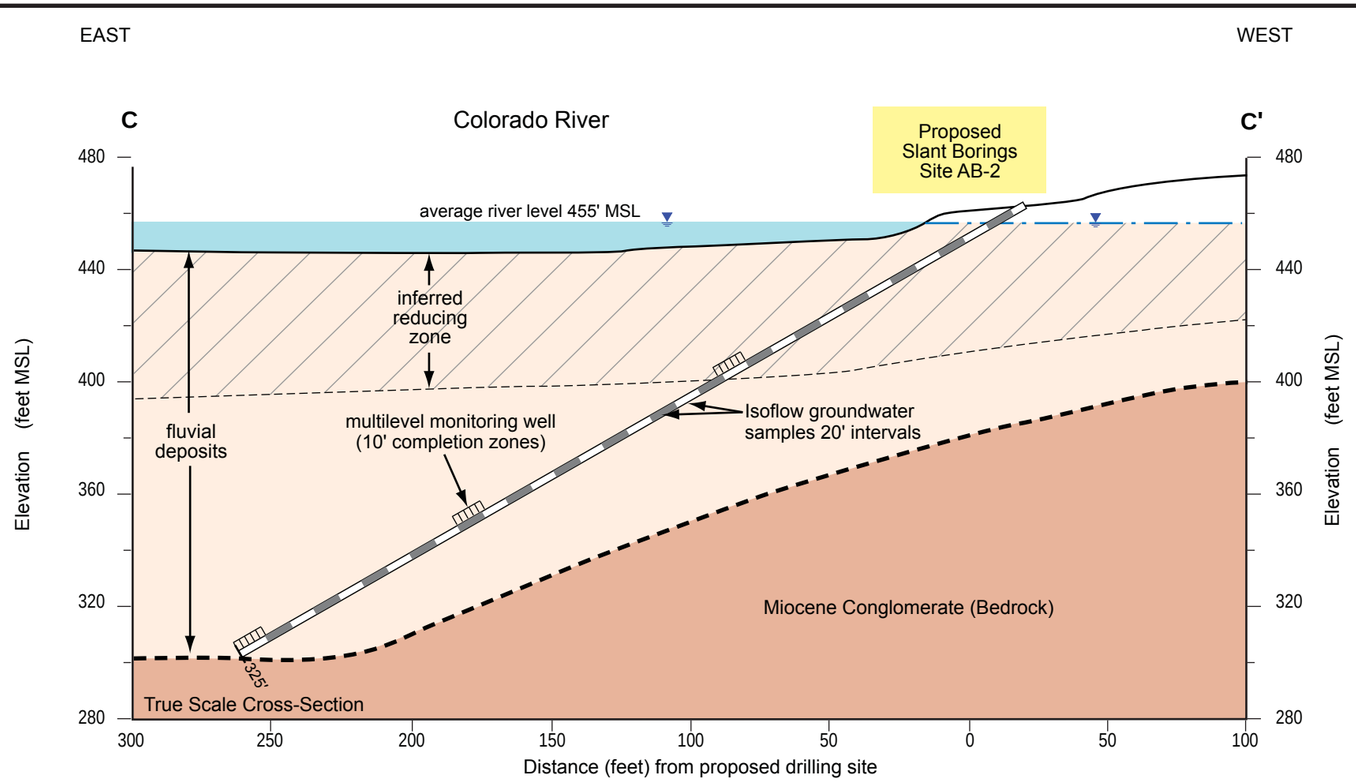
- Groundwater well/boring that encountered bedrock
- ▲ 1962 Caltrans I-40 bridge boring
- 100 Drilled depth to bedrock feet below average river level (MSL)
- (est) 92 Estimated depth to bedrock feet below average river level (MSL)
- 20 Inferred depth to bedrock contour, feet below average river level (455 ft. MSL)
- Approximate Location of September 2004 USGS Seismic Survey
- Proposed general location for vertical boring/well cluster
- Proposed location for angle boring/well cluster (see separate DTSC Work Plan for Site AB-1)

FIGURE 3
ESTIMATED DEPTH TO BEDROCK BELOW RIVER LEVEL

WORK PLAN FOR GROUNDWATER CHARACTERIZATION
ON ARIZONA SHORELINE OF THE COLORADO RIVER
AT TOPOCK, ARIZONA
PG&E TOPOCK COMPRESSOR STATION
NEEDLES, CALIFORNIA

CH2MHILL





LEGEND

- Saturated Fluvial deposits of Colorado River
- Natural reducing groundwater zone
- Bedrock (cemented Miocene Conglomerate)
- CB-7: Approximate location of 1962 Caltrans boring for I-40 bridge projected approximately 100' to 200' north of cross section
- 70': Approximate bedrock depth, feet below river
- 100': Approximate boring depth, feet below average river stage (455' MSL)

NOTES:

The drilling and installation of slant borings/wells at Site AB-1 on the California shoreline are addressed in a separate work plan.

The 40˚ slant boring shown at Site AB-2 may be drilled if field conditions allow and additional characterization is required.

Boring lengths and angles are approximate and subject to change based on results of upcoming seismic survey and final selection of drilling site.

FIGURE 4
CROSS-SECTIONS OF PROPOSED SLANT BORINGS AND WELLS BENEATH THE COLORADO RIVER
WORK PLAN FOR GROUNDWATER CHARACTERIZATION ON ARIZONA SHORELINE OF THE COLORADO RIVER AT TOPOCK, ARIZONA
PG&E TOPOCK COMPRESSOR STATION
NEEDLES, CALIFORNIA

CH2MHILL

ES102006003BAO topock_fig_4_AZ.ai_011507_llui

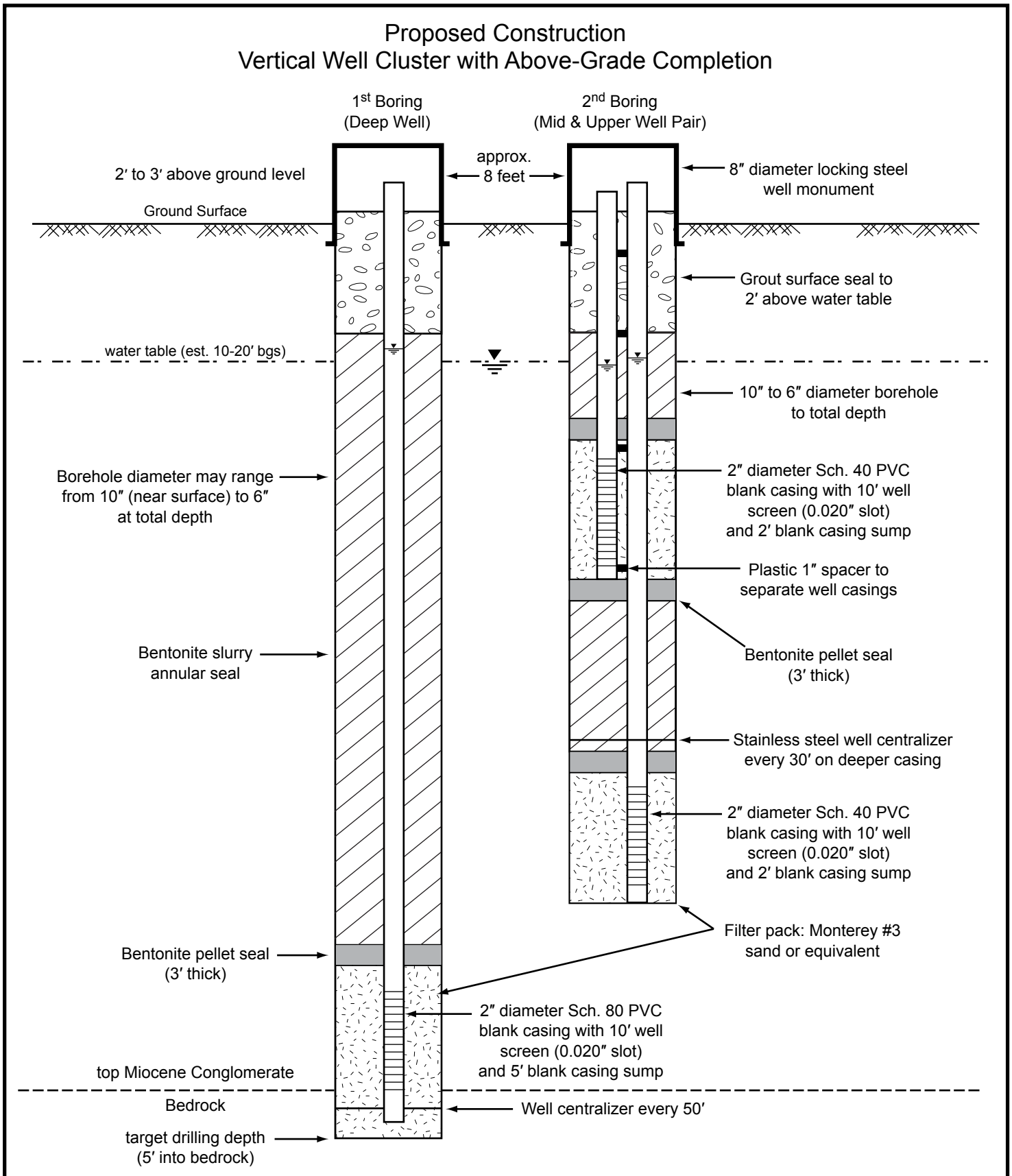


FIGURE 5A
MONITORING WELL CLUSTER SCHEMATIC
ABOVE-GRADE COMPLETION
WORK PLAN FOR GROUNDWATER
CHARACTERIZATION AT TOPOCK, ARIZONA
PG&E TOPOCK COMPRESSOR STATION
NEEDLES, CALIFORNIA

DIAGRAM NOT TO SCALE
All depths in feet below ground surface (bgs) are approximate and will be determined based on drilling log and Isoflow(™) sampling.

CH2MHILL

ES102006003BAO_Fig5a_Well_AboveGrade.ai_011507_ll

Proposed Construction
Vertical Well Cluster with Below-Grade Completion

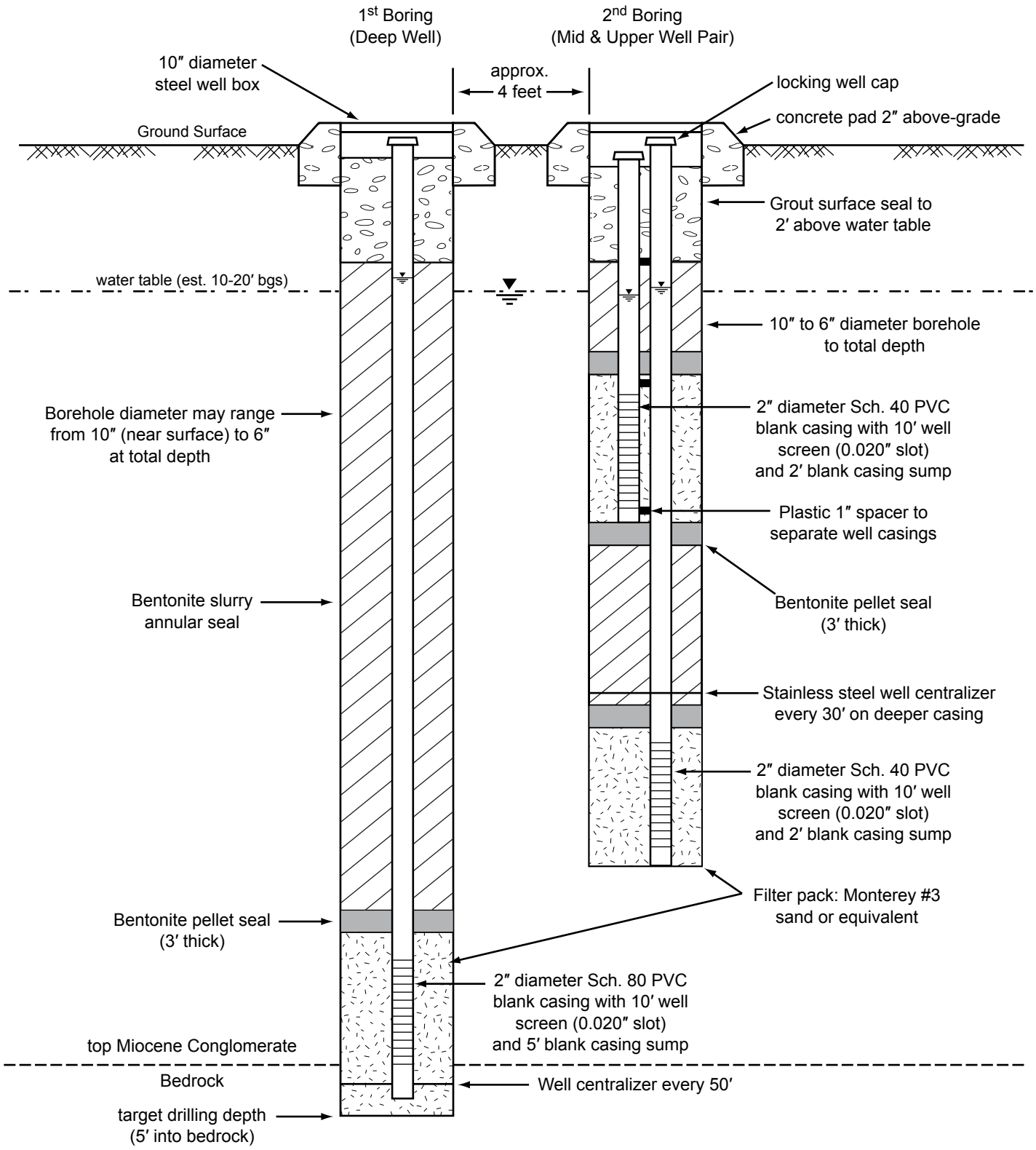
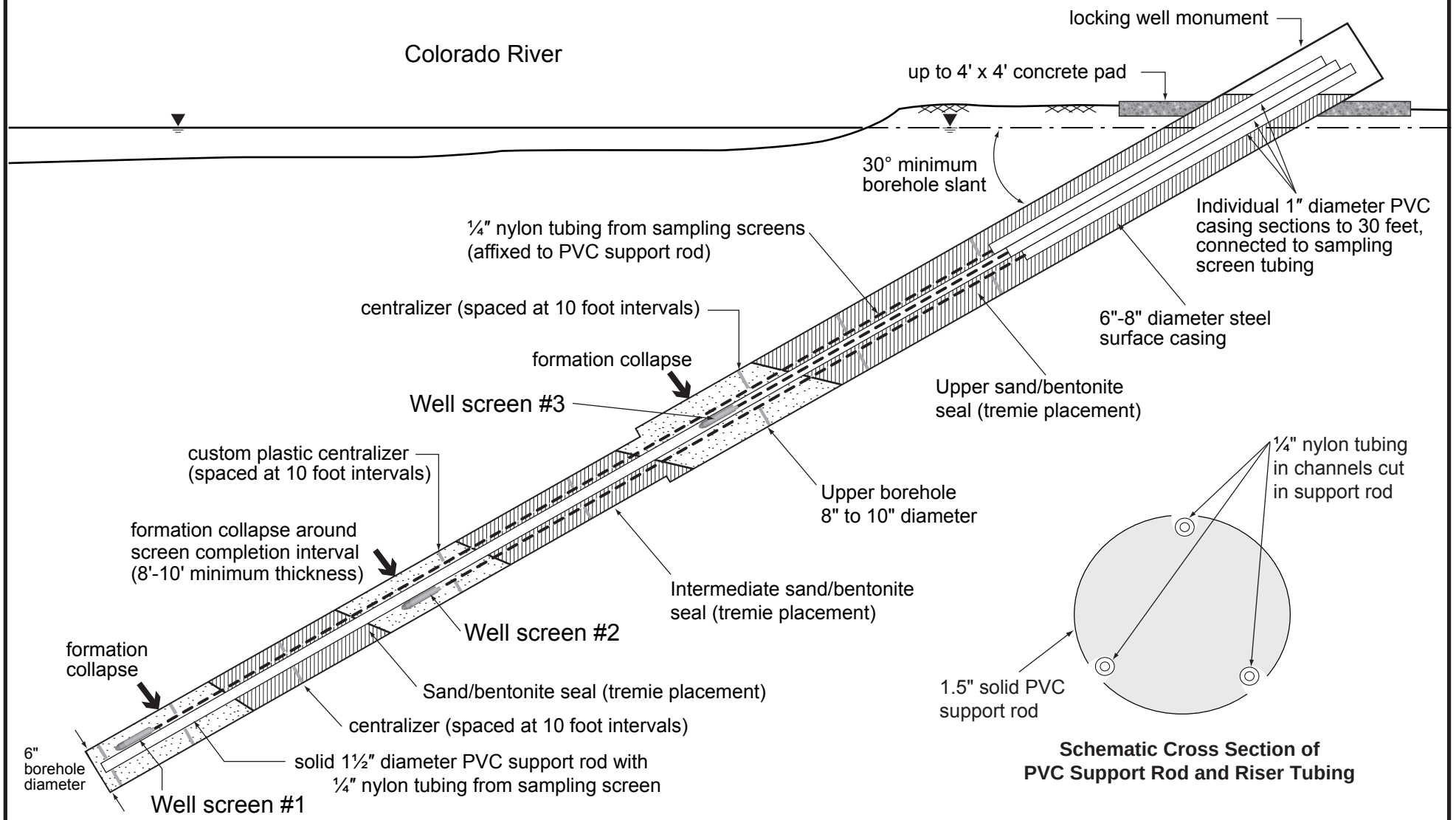


FIGURE 5B
MONITORING WELL CLUSTER SCHEMATIC
BELOW-GRADE COMPLETION
WORK PLAN FOR GROUNDWATER
CHARACTERIZATION AT TOPOCK, ARIZONA
PG&E TOPOCK COMPRESSOR STATION
NEEDLES, CALIFORNIA

DIAGRAM NOT TO SCALE
All depths in feet below ground surface (bgs) are approximate and will be determined based on drilling log and Isoflow(™) sampling.

CH2MHILL

ES102006003BAO_Fig5b_Well_BelowGrade.ai_011507_ll



Schematic Cross Section of PVC Support Rod and Riser Tubing

Proposed Monitoring Well Equipment

Well screens will consist of 1”x36” porous HDPE filters strapped to central PVC support rod.

Completion intervals to be determined based on core log and Isoflow™ sampling.

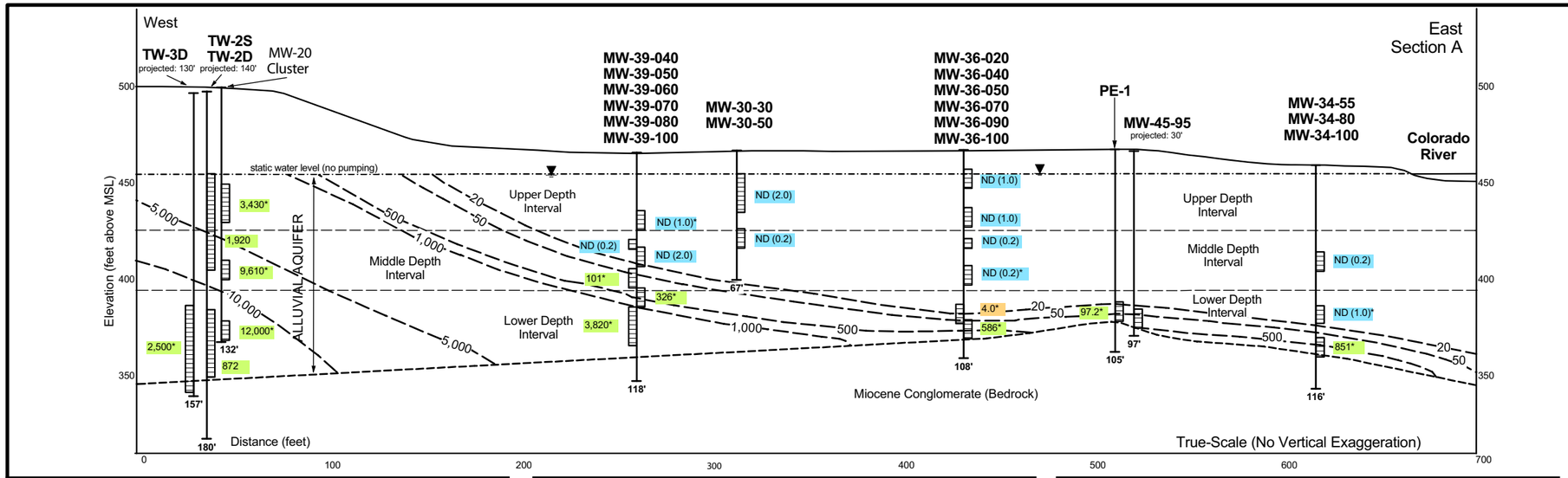
SCHEMATIC DIAGRAM – NOT TO SCALE

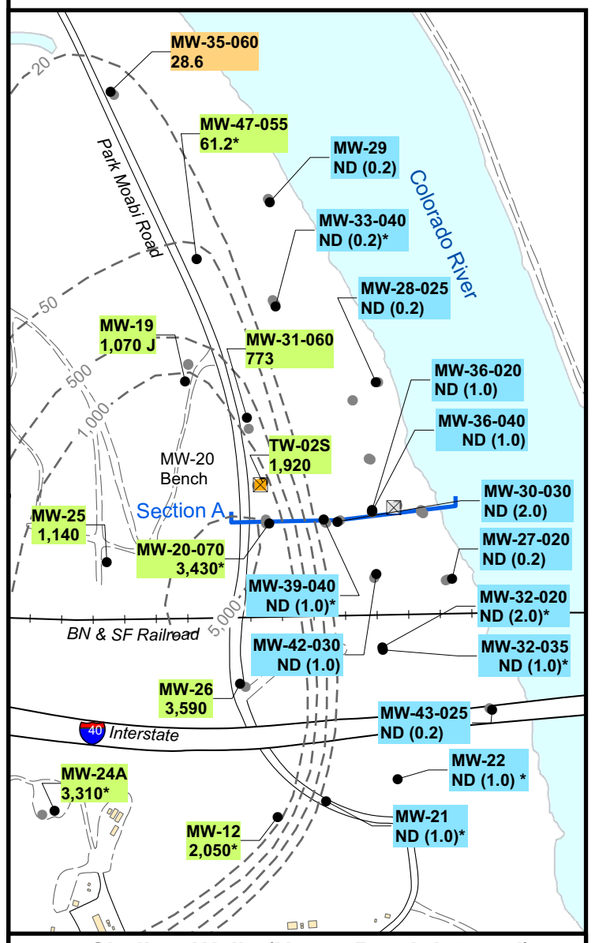
FIGURE 6
SLANT BORING MULTILEVEL MONITORING WELL SCHEMATIC
WORK PLAN FOR GROUNDWATER CHARACTERIZATION ON ARIZONA SHORELINE OF THE COLORADO RIVER AT TOPOCK, ARIZONA
PG&E TOPOCK COMPRESSOR STATION
NEEDLES, CALIFORNIA

CH2MHILL

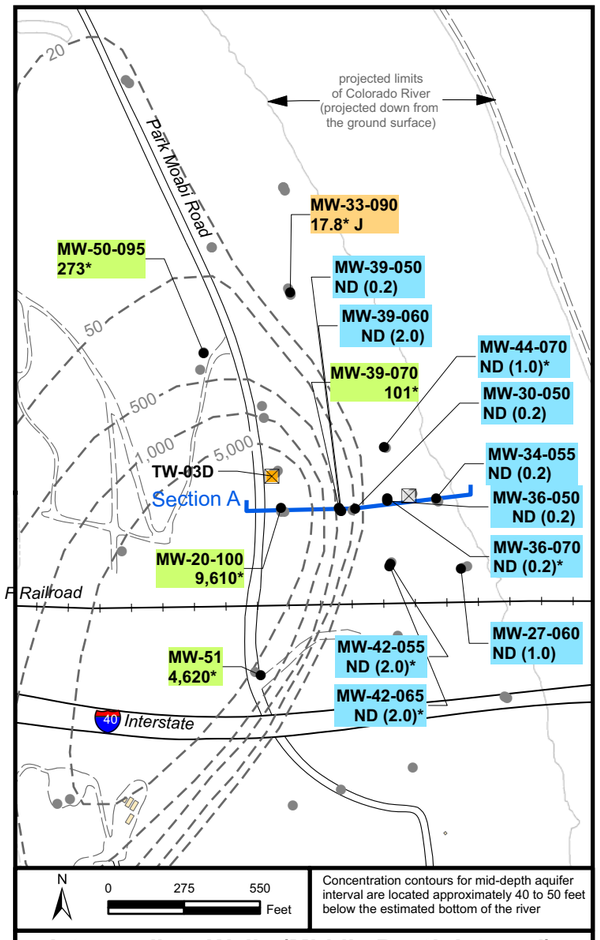
ES102006003BAO topock_fig_6_AZ.ai_011507_llui

Appendix A
Chromium Distribution Map for IM Performance Monitoring Area

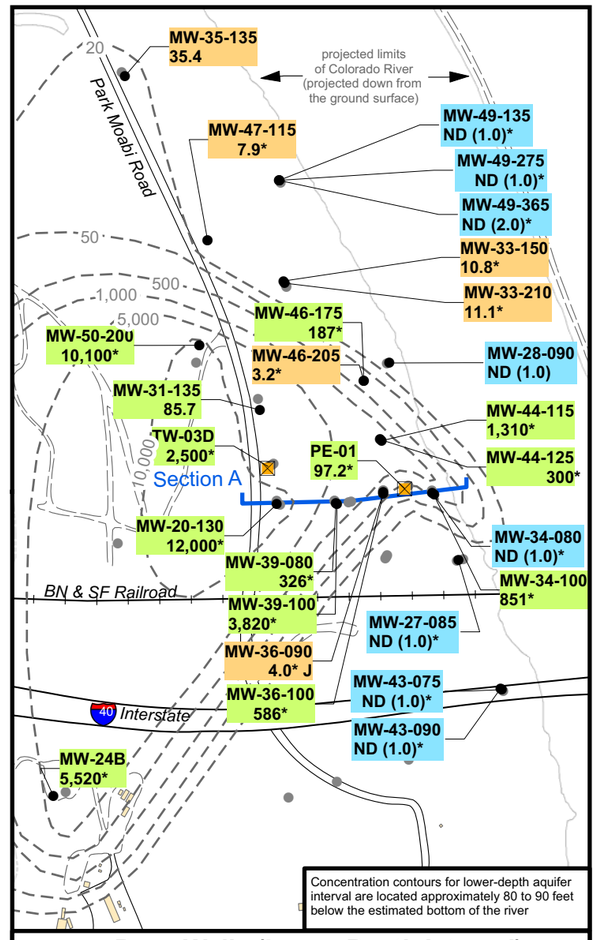




Shallow Wells (Upper Depth Interval)



Intermediate Wells (Middle Depth Interval)



Deep Wells (Lower Depth Interval)

LEGEND

Maximum Hexavalent Chromium [Cr(VI)] Concentrations in Groundwater, December 2006 Monitoring

Concentrations in micrograms per liter (µg/L)
equivalent to parts per billon (ppb)

ND = not detected at listed reporting limit
J = Concentration estimated by laboratory or data validation

Samples with * are from December 2006 sampling, all other samples are from October and November 2006.

Results posted are maximum concentrations from primary and duplicate samples.
See Tables B-1 and B-2 for sampling data and other results.

ND (1) — Not detected at listed reporting limit (ppb)

41 — Less than 50 ppb

3,810 — Greater than 50 ppb

— 50 — Inferred Cr(VI) concentration contour within aquifer depth interval

Contours incorporate the maximum concentration from wells within each depth interval

Hydrogeologic Section A (true-scale) showing aquifer depth intervals, well screens, and Cr(VI) sampling results.

NOTES ON CONTOUR MAPS

1. The Cr(VI) contour maps for 2006 performance monitoring have been revised to incorporate data from new wells and water quality data trends for floodplain area. The revised maps provide additional interpretation of plume limits and do not reflect plume migration during performance monitoring.

2. The locations of the Cr(VI) contours shown for depths 80-90 feet below the Colorardo River (east and southeast of well clusters MW-34) are estimated based on hydrogeologic and geochemical conditions documented in site investigations 2004-2006. The actual locations of contours beyond well control points in these areas are not certain, but are inferred using available site investigation and monitoring data (bedrock structure, hydraulic gradients, observed distribution of geochemically reducing conditions and Cr(VI) concentration gradients). There are no data confirming the existence of Cr(VI) under the Colorado River.

APPENDIX A
MAXIMUM CR(VI) CONCENTRATIONS IN ALLUVIAL AQUIFER, DECEMBER 2006

INTERIM MEASURES PERFORMANCE MONITORING
PG&E TOPOCK COMPRESSOR STATION
NEEDLES, CALIFORNIA

CH2MHILL

Appendix B
Property and Existing Well Information for Drilling Sites in Arizona

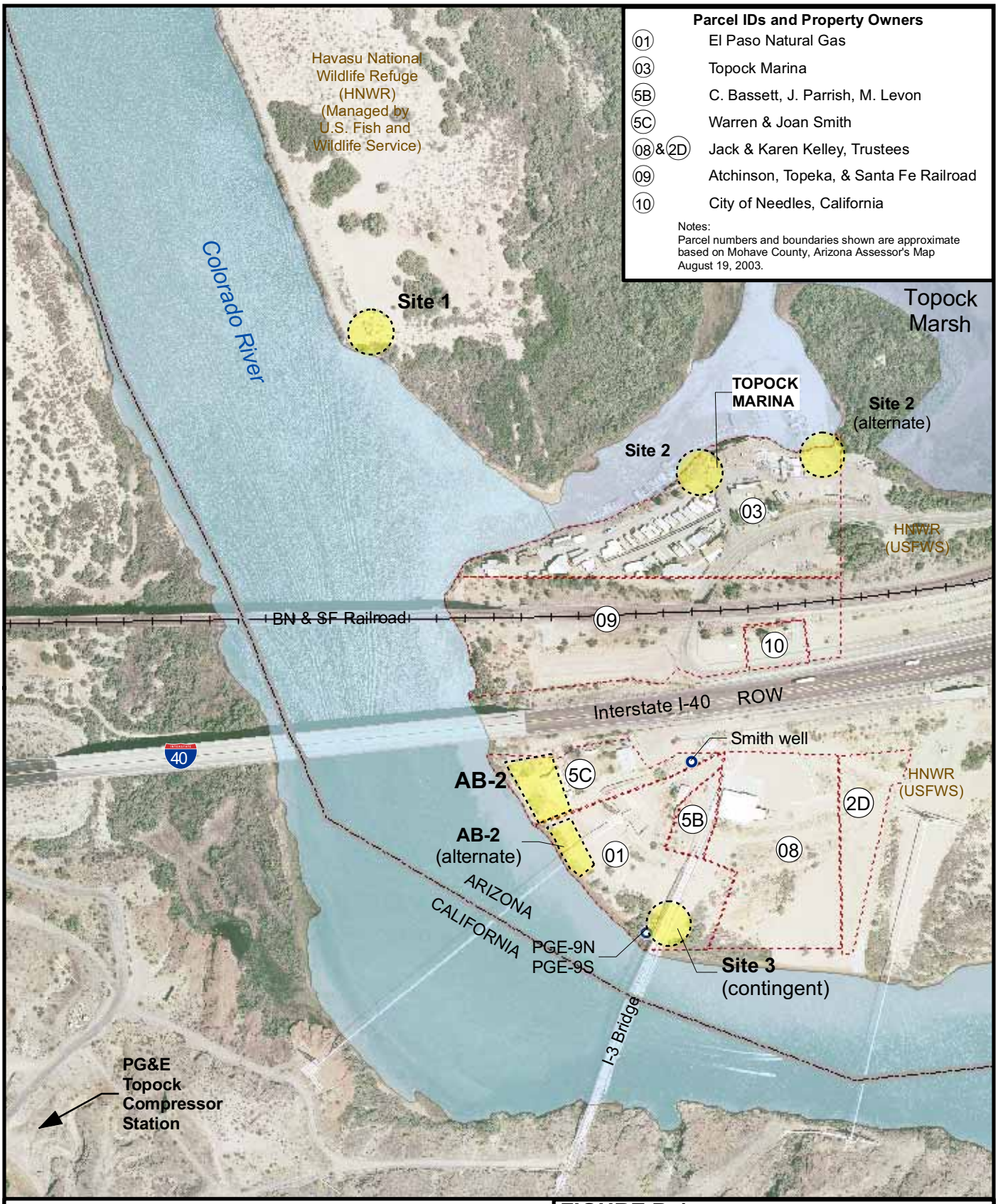


FIGURE B-1
PARCEL AND PROPERTY OWNERSHIP FOR PROPOSED DRILLING PROJECT

WORK PLAN FOR GROUNDWATER CHARACTERIZATION
ON ARIZONA SHORELINE OF THE COLORADO RIVER
AT TOPOCK, ARIZONA
PG&E TOPOCK COMPRESSOR STATION
NEEDLES, CALIFORNIA

CH2MHILL

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AZ_GW_PROPERTY_OWNERS.PDF 1/15/2007 10:58:20

Fed. Ex
Bkm

ARIZONA DEPARTMENT OF WATER RESOURCES
GROUNDWATER MANAGEMENT SUPPORT SECTION
MAIL TO: P.O. BOX 458 - PHOENIX, ARIZONA 85001-0458
500 North Third Street - Phoenix, Arizona 85004-3903
Phone (602) 417-2470

RECEIVED
Rec'd. #
MAR 17 1997
GROUNDWATER MGT
ADWR

NOTICE OF INTENTION TO DRILL, DEEPEN, REPLACE OR MODIFY A WELL

PLEASE READ SPECIFIC INSTRUCTIONS, LIMITATIONS AND CONDITIONS ON REVERSE SIDE OF THIS FORM BEFORE COMPLETING

PLEASE COMPLETE ALL ITEMS IN THE BOX BELOW DOWN TO COUNTY OR LOCAL AUTHORITY ENDORSEMENT. IF ANY WATER FROM THE PROPOSED WELL (LISTED BELOW) WILL BE USED FOR DOMESTIC PURPOSES ON A PARCEL OF LAND 20 OR FEWER ACRES, THE APPLICABLE COUNTY OR LOCAL HEALTH AUTHORITY MUST ENDORSE ALL ITEMS IN THE BOX BEFORE SUBMITTING TO THE DEPARTMENT OF WATER RESOURCES.

El Paso Natural Gas Co. | HC12 Box 7 | Topock | AZ | 86436-9799
Land Owner's Name | Current Mailing Address | City | State | Zip

Telephone No. 520-768-2531 Attn: Joe Burnett

COUNTY ASSESSOR'S PARCEL ID INFORMATION:

Well Located In Mojave County 210 (BOOK) ~~17~~ 48 (MAP) 001 (PARCEL) 3.61 (# of Acres)

Well/Land Location (must be completed as requested): Portion of Lot 1, Fractional

SW ¼ (10AC) NE ¼ (40AC) NE ¼ (160AC) of Section 3 Township 15 (N/S) Range 21 (E/W) GSRB&M

OFFICIAL SEAL OR STAMP

COUNTY OR LOCAL AUTHORITY ENDORSEMENT

Check one:
Recommend Approval X ; Insufficient Information to Make Determination ___ ; Variance Required ___ (Explanation attached)

DATE 3/13/97 AUTHORIZED SIGNATURE [signature] TITLE R.S.

GENERAL INSTRUCTIONS FOR FILING NOTICE WITH ADWR

1. Section §45-596(D) provides that the Director shall determine that all information required on this form has been submitted. If not, the person filing will be notified, and the drilling, deepening or modification of the well may not proceed.
2. Section §45-596(d) provides that the Department has 15 days after the receipt of a complete and correct notice of intention to record the notice and mail duplicate to owner. Drill card will be mailed directly to drilling firm as stated in item #14.
3. Please mail two original notices with original signatures, a site plan in DUPLICATE, and a check or money order (no cash) in the amount of $10.00 to P.O. Box 458, Phoenix, Arizona 85001-0458 or hand deliver to 500 North Third Street, Phoenix, Arizona 85004-3903. USE BLACK OR BLUE INK.
4. If the well is a replacement, deepening or modification of an existing well, provide the registration number of the existing well in item 2.
5. Construction standards for wells, including abandonment, shall be in accordance with Department Rules.

1. Owner of well:
Pacific Gas & Electric Co.
Name
Post Office Box 337
Current Mailing Address
Needles, CA 92363
City State Zip
Telephone No. 619-326-5516

2. Action requested: Drill New Well X ; Deepen ___ Modify ___ Replace ___.
For a replacement well provide: Maximum capacity of the original well ___ gallons per minute; distance from the original well ___ feet.
Well Registration No.55-___

3. Construction will start about:
Month 4 Year 97

4. Description of proposed well:
Diameter 12 inches
Depth 90 feet
Type of Casing STEEL

5. Design pump capacity:
350 gallons per minute

6. Lessee of land of wellsite:
same as well owner
Name
Current Mailing Address
City State Zip
Telephone No.

7. Principal Use of Water; (be specific):
Industrial (cooling)

8. Other uses of Water; (be specific):
DOMESTIC

9. If use includes irrigation, state to nearest tenth, the number of acres to be irrigated; ___

FOR DEPARTMENT USE ONLY
File No. B(15-21)3 AAC
Filed 3-17-97 By SMR
Input ___ By ___
DUPLICATE MAILED
Date 3-19-97
Registration 55-561779
AMA/INA ___
W/S 02 S/B ___

RECEIVED MAR 2[illegible] 1997

10. Place of Use (Legal Description of Land):
5 1/2¼ 8W ¼ NE ¼ Section 8
10 AC 40AC 160AC
Township 7 N/S Range 24 E/W
ES B + M

11. Type of Well (Check One):
Exempt ___ Non-Exempt X

12. Check One:
Residential ___ Commercial X

13. Is the proposed wellsite within 100 feet of a septic tank system, sewage disposal area, landfill, hazardous materials or petroleum storage areas and tanks? Yes ___ No X

14. Drilling Firm:
Howard Pump Inc
Name
~~34550 Outer HWY 15~~ P.O. Box 1249
Mailing Address
~~Yermo, CA 92398~~ Barstow, CA 92312
City State Zip
615-254-3351
Telephone No.
~~076807~~ 436 -
DWR License Number
A-04 - C53
ROC License Category

I State that this Notice is filed in compliance with A.R.S. §§45-595 and 45-596 and is complete and correct to the best of my knowledge and belief and that I understand the limitations and conditions set forth on the reverse side of this form.

Jaime Troncoso, Project Manager — [signature] — 03-10-97
Typed or Printed Name and Title | Signature [ ] Land Owner [X] Lessee of Wellsite, Title | Date

ARIZONA DEPARTMENT OF WATER RESOURCES
GROUNDWATER MANAGEMENT SUPPORT SECTION
MAIL TO: P.O. BOX 458 - PHOENIX, ARIZONA 85001-0458
500 North Third Street - Phoenix, Arizona 85004-3903
Phone (602) 417-2470

RECEIVED
WELL #
MAR 17 1997
GROUNDWATER MGT

NOTICE OF INTENTION TO DRILL, DEEPEN, REPLACE OR MODIFY A WELL
PLEASE READ SPECIFIC INSTRUCTIONS, LIMITATIONS AND CONDITIONS ON REVERSE SIDE OF THIS FORM BEFORE COMPLETING

PLEASE COMPLETE ALL ITEMS IN THE BOX BELOW DOWN TO COUNTY OR LOCAL AUTHORITY ENDORSEMENT. IF ANY WATER FROM THE PROPOSED WELL (LISTED BELOW) WILL BE USED FOR DOMESTIC PURPOSES ON A PARCEL OF LAND 20 OR FEWER ACRES, THE APPLICABLE COUNTY OR LOCAL HEALTH AUTHORITY MUST ENDORSE ALL ITEMS IN THE BOX BEFORE SUBMITTING TO THE DEPARTMENT OF WATER RESOURCES.

El Paso Natural Gas Co. (Land Owner's Name) HC12 Box 7 (Current Mailing Address) Topock (City) AZ (State) 86436-9799 (Zip)

Telephone No. 520-768-2531 Attn: Joe Burnett

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SW ¼ (10AC) NE ¼ (40AC) NE ¼ (160AC) of Section 3 Township 15 (N/S) Range 21 (E/W) GSRB&M

OFFICIAL SEAL OR STAMP

COUNTY OR LOCAL AUTHORITY ENDORSEMENT

Check one: Recommend Approval X ; Insufficient Information to Make Determination ___ ; Variance Required ___ (Explanation attached)

DATE 3/17/97 AUTHORIZED SIGNATURE A. Stml TITLE R.S.

GENERAL INSTRUCTIONS FOR FILING NOTICE WITH ADWR

1. Section §45-596(D) provides that the Director shall determine that all information required on this form has been submitted. If not, the person filing will be notified, and the drilling, deepening or modification of the well may not proceed.
2. Section §45-596(d) provides that the Department has 15 days after the receipt of a complete and correct notice of intention to record the notice and mail duplicate to owner. Drill card will be mailed directly to drilling firm as stated in item #14.
3. Please mail two original notices with original signatures, a site plan in DUPLICATE, and a check or money order (no cash) in the amount of $10.00 to P.O. Box 458, Phoenix, Arizona 85001-0458 or hand deliver to 500 North Third Street, Phoenix, Arizona 85004-3903. USE BLACK OR BLUE INK.
4. If the well is a replacement, deepening or modification of an existing well, provide the registration number of the existing well in item 2.
5. Construction standards for wells, including abandonment, shall be in accordance with Department Rules.

1. Owner of well:
   Pacific Gas & Electric Co. (Name)
   Post Office Box 337 (Current Mailing Address)
   Needles, CA 92363 (City, State, Zip)
   Telephone No. 619-326-5516

2. Action requested: Drill New Well X ; Deepen ___ Modify ___ Replace ___. For a replacement well provide: Maximum capacity of the original well ___ gallons per minute; distance from the original well ___ feet.
   Well Registration No.55-___

3. Construction will start about: Month 4 Year 97

4. Description of proposed well:
   Diameter 12 inches
   Depth 90 feet
   Type of Casing STEEL

5. Design pump capacity: 350 gallons per minute

6. Lessee of land of wellsite:
   same as well owner (Name)
   ___ (Current Mailing Address)
   ___ (City, State, Zip)
   Telephone No. ___

7. Principal Use of Water; (be specific): Industrial (cooling)

8. Other uses of Water; (be specific): DOMESTIC

9. If use includes irrigation, state to nearest tenth, the number of acres to be irrigated; ___

FOR DEPARTMENT USE ONLY
File No. B(15-21)3AAC
Filed 3-17-97 By SMR
Input ___ By ___
DUPLICATE MAILED
Date 3-19-97
Registration 55-560780
AMA/INA ___
W/S 02 S/B ___

10. Place of Use (Legal Description of Land):
    5 1/2¼ 8W ¼ NE ¼ Section 8
    10 AC 40AC 160AC
    Township 7 N/S Range 24 E/W
    ES B + M

11. Type of Well (Check One):
    Exempt ___ Non-Exempt X

12. Check One:
    Residential ___ Commercial X

13. Is the proposed wellsite within 100 feet of a septic tank system, sewage disposal area, landfill, hazardous materials or petroleum storage areas and tanks? Yes ___ No X

14. Drilling Firm:
    Howard Pump, Inc.
    Name P.O. Box 1249
    34550 Outer HWY 15
    Mailing Address Barstow
    ~~Yermo~~, CA ~~92398~~ 92312
    City State Zip
    615-254-3351
    Telephone No.
    ~~076807~~ 436
    DWR License Number
    A-04 C53
    ROC License Category

ENTERED MAR 25 1997

I State that this Notice is filed in compliance with A.R.S. §§45-595 and 45-596 and is complete and correct to the best of my knowledge and belief and that I understand the limitations and conditions set forth on the reverse side of this form.

Jaime Troncoso, Project Manager — Jaime Troncoso — 03-10-97

Typed or Printed Name and Title | Signature [ ] Land Owner [X] Lessee of Wellsite, Title | Date

SPECIFIC INSTRUCTIONS, LIMITATIONS AND CONDITIONS

1. Pursuant to Section §45-596, Arizona Revised Statutes, provides: a person may not drill, deepen, or modify any well, without first filing a Notice of Intention to Drill with the Department.

2. If any water from a proposed well on a parcel of land of twenty or fewer acres will be used for domestic purposes, as defined in §45-454, the applicant shall submit a site plan to scale of the property with the county assessor's parcel identification number. The site plan:

   a. Will be on a 8½"x11" piece of plain paper with representation of the locations of all structures, septic tank or sewer systems and proximity of adjacent lot lines to scale.

   b. Must show the proposed well location and the location of any septic or sewer system that is either located on the property or within one hundred feet of the proposed well site.

   c. Shall demonstrate to the Director's satisfaction that the well will not be drilled within one hundred feet of any septic or sewer system.

   d. Must be approved by the county health authority, or by a local health authority in areas where the county health authority has delegated authority to approve septic or sewer systems. Before approval, the health authority shall review the plan and determine whether the proposed well location complies with applicable state and local laws regarding the placement of wells. If so, the health authority shall endorse the site plan and the proposed well placement.

3. Endorsement by the county/local authority is based on the best available judgement that this well, as shown on the site plan submitted, is 100 feet or more from all known and visually identifiable sewage treatment systems. It is not a representation that a well placed at this site will be guaranteed as to quantity or quality. Information brought to light at a future date may render this determination invalid.

4. If a well which was originally drilled as an exploration well, a monitor well, a piezometer well or for any use other than domestic use and is later proposed to be converted to use for domestic purposes, as defined in section §45-454, the well owner shall file a notice of intention to drill and comply with the requirements prescribed pursuant to this section before the well is converted and any water from that well used for domestic purposes.

5. Only a well driller licensed in the State of Arizona is authorized to drill, deepen or modify a well. A well driller may commence drilling a well only if the well drilling contractor or licensee has possession of a drilling card at the well site, issued by the Director in the name of the well drilling contractor or licensee, authorizing the drilling of the specific well in the specific location.

6. An exempt well means a well having a pump with a maximum capacity of not more than thirty-five (35) gallons per minute and may include the application of water to less than two (2) acres of land in an Irrigation Non-Expansion Area or Active Management Area to produce plants or parts of plants for sale, human consumption or for use as feed for livestock, range livestock or poultry.

7. The drilling, deepening, or modification of this well shall be completed within one (1) year of the date of the notice (§45-596.E.).

8. Within thirty (30) days after the installation of pumping equipment on this well, the registered well owner shall file the prescribed Completion Report. A form for this purpose will be furnished to the registered owner with the return of an annotated copy of this notice.

9. The person to whom a well is registered shall notify the Department of a change in ownership or a change in data relating to this well. The prescribed form for these purposes will be furnished to the registered owner with the return of an annotated copy of this Notice.

10. If an individual other than the land owner or lessee signs this Notice, an original letter of authorization from the land owner/lessee, stating that the individual has permission to sign this specific Notice on their behalf, shall accompany the Notice.

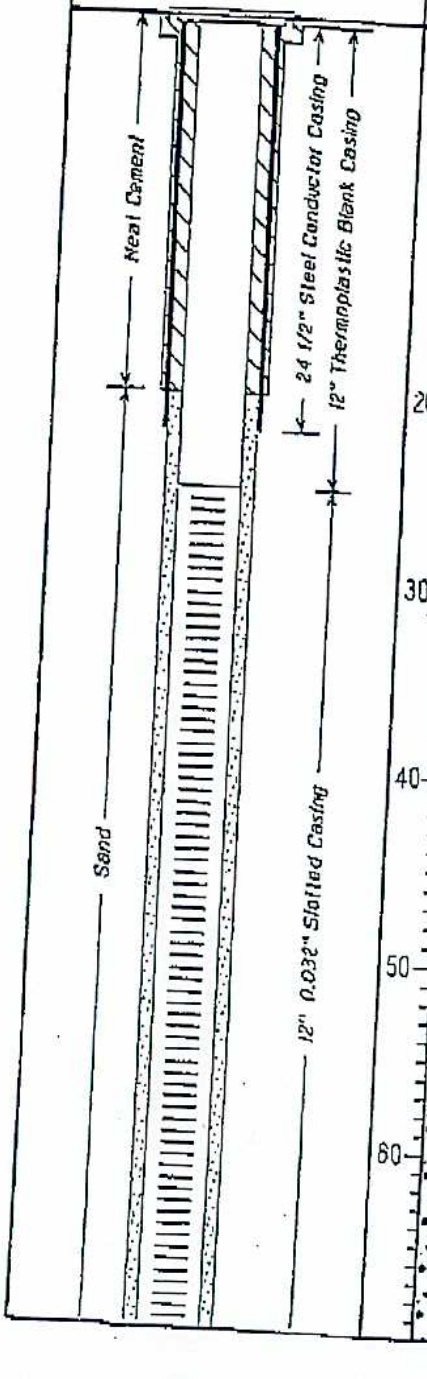
Now ID for db GIS PGE-9N

ALISTO ENGINEERING GROUP
WALNUT CREEK, CALIFORNIA

LOG OF WELL 15N/21W3A

SEE SITE PLAN

ALISTO PROJECT NO: 10-166-18 DATE DRILLED: 04/22/97
CLIENT: Pacific Gas and Electric
LOCATION: Topock Compressor Station, Topock Arizona
DRILLING METHOD: Mud Rotary, 10" Trilone
DRILLING COMPANY: Howard Pumping CASING ELEVATION: 460
LOGGED BY: Dan Birch APPROVED BY: David Lipnicke



DEPTH (feet)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION
		GW	sandy GRAVEL: brown, wet; fine to coarse gravel, fine sand.
10		SC	clayey SAND: light blue clay; fine sand.
20		SP	gravelly SAND: brown, wet; 75% fine to coarse sand, 20% fine to medium gravel, some clay 5%.
30		GW	sandy GRAVEL: brown, wet; 80% fine to medium gravel, 40% fine to coarse sand.
40			
50			
60			Same: with wood.

New ID for GIS = PGE-9N

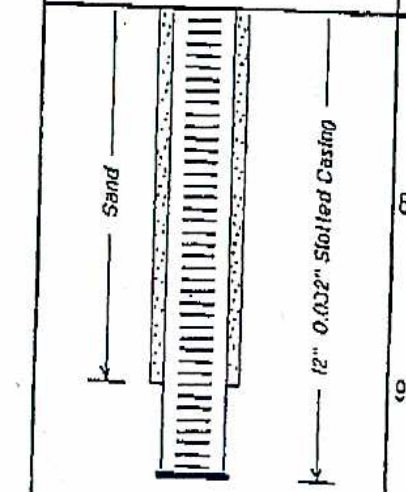
ALISTO ENGINEERING GROUP
WALNUT CREEK, CALIFORNIA

LOG OF WELL 15N/21W3A

Page 2 of 2

SEE SITE PLAN

ALISTO PROJECT NO: 10-188-18 DATE DRILLED: 04/22/97
CLIENT: Pacific Gas and Electric
LOCATION: Topock Compressor Station, Topock Arizona
DRILLING METHOD: Mud Rotary, 10" Trilone
DRILLING COMPANY: Howard Pumping CASING ELEVATION: 460
LOGGED BY: Dan Birch APPROVED BY: David Lipnicke



DEPTH (feet)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION
		SC	clayey gravelly SAND: brown, wet; 25% fine to coarse sand, 70% fine to coarse gravel, some brown clay 5%.
75		SW	gravelly SAND: brown, wet; 60% fine to coarse sand, 40% fine to coarse gravel.
80			
90			wood chips at 89' to 90'.
95			Fanglomerate bedrock at 94'.
			Well terminated at 95 feet.
100			
110			
120			
130			

PGE-9N

PGG 95

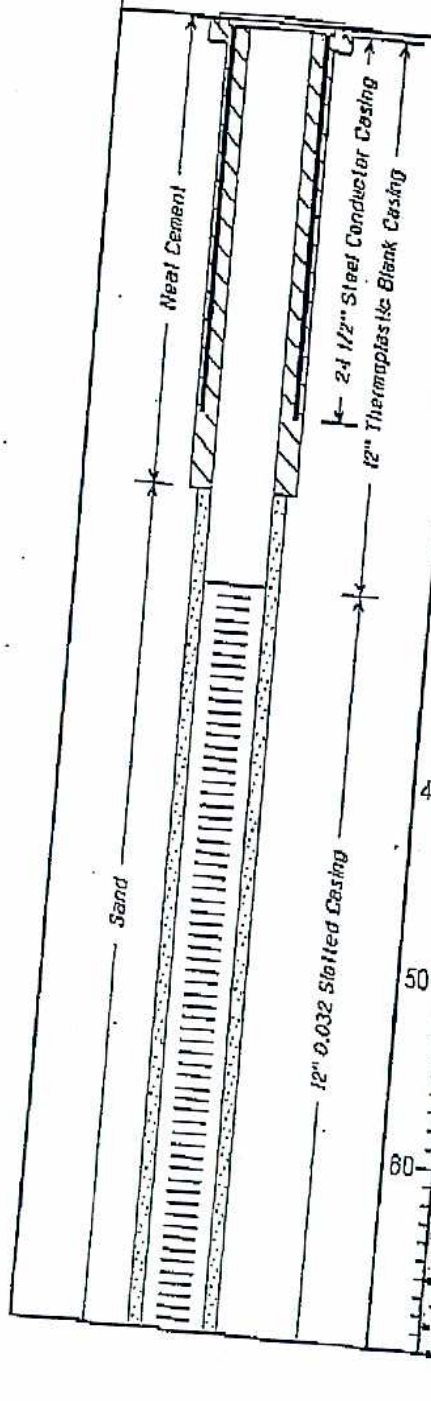
ALISTO ENGINEERING GROUP
WALNUT CREEK, CALIFORNIA

LOG OF WELL 15N/21W3B

Page 1 of 2

SEE SITE PLAN

ALISTO PROJECT NO: 10-188-18 DATE DRILLED: 04/04/97
CLIENT: Pacific Gas and Electric
LOCATION: Topock Compressor Station, Topock Arizona
DRILLING METHOD: Mud Rotary, 19" Trilone
DRILLING COMPANY: Howard Pumping CASING ELEVATION: 480
LOGGED BY: Dan Birch APPROVED BY: David Lipnicke



DEPTH (ft)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION
10		SW	gravelly SAND: brown, wet; 70% fine to coarse sand, 30% fine to coarse gravel
		SC	clayey SAND: blue clay; 70% fine to coarse sand, some burnt wood.
30		SW	gravelly SAND: brown, wet; 70% fine to coarse sand, 30% fine to medium gravel; wood at 29' to 31'.
50		GW	sandy GRAVEL: 80% fine to coarse gravel, 30% fine to coarse sand, 10% clay.
80		SW	Wood at 89'.

10
29
54
70

New ID for db GIS PGE-9S

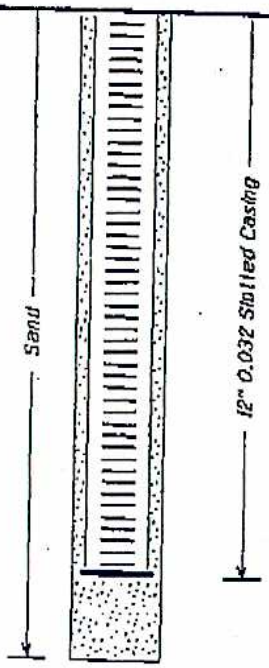
ALISTO ENGINEERING GROUP
WALNUT CREEK, CALIFORNIA

LOG OF WELL 15N/21W3B

Page 2 of 2

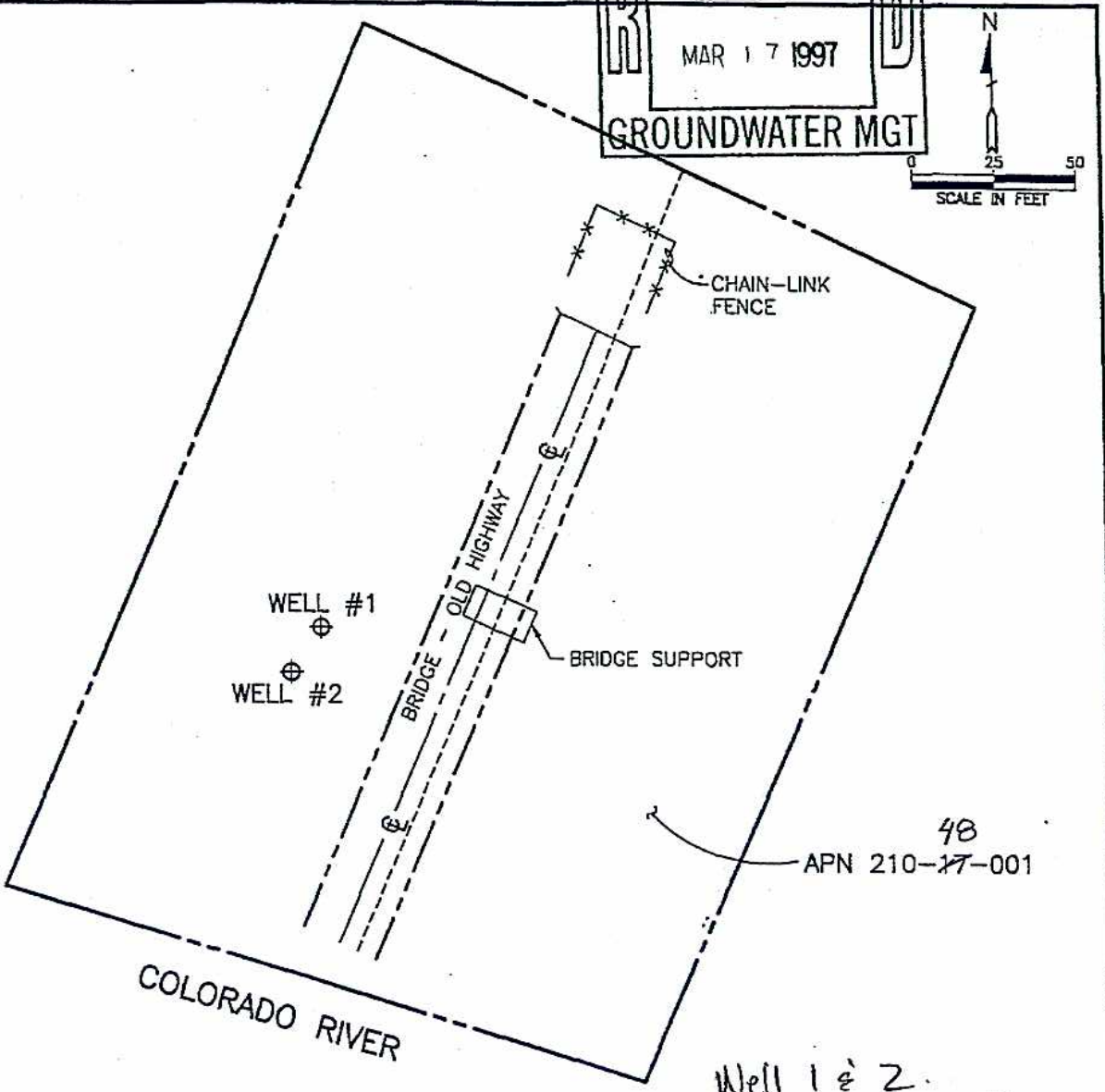
SEE SITE PLAN

ALISTO PROJECT NO: 10-188-16 DATE DRILLED: 04/04/97
CLIENT: Pacific Gas and Electric
LOCATION: Topock Compressor Station, Topock Arizona
DRILLING METHOD: Mud Rotary, 19" Trilone
DRILLING COMPANY: Howard Pumping CASING ELEVATION: 460
LOGGED BY: Dan Birch APPROVED BY: David Lipnicke



DEPTH feet	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION
80		SW	gravelly SAND: brown, wet; 70% fine to coarse sand, 30% fine to coarse gravel, color change to reddish-brown at 103'.
90			
100			Color change to reddish-brown at 103'.
			Conglomerate bedrock, red, hard, chips in cuttings refusal at tricon at 104' to 104.5'.
			Well terminated at 104.5 feet.
110			
120			
130			

PGE - 9S



Well 1 & 2.
Proposed plan approved for
Well location — 3/13/97.
Mohave County Onsite Wastewater
Setback [illegible] R.S.

LEGEND

- PROPERTY LINE
- ℄ CENTERLINE OF BRIDGE
- ⊕ PROPOSED WATER SUPPLY WELL

NOTE: NO SEPTIC OR SEWER SYSTEMS HAVE BEEN IDENTIFIED WITHIN 100 FEET OF PROPOSED WELL SITES.

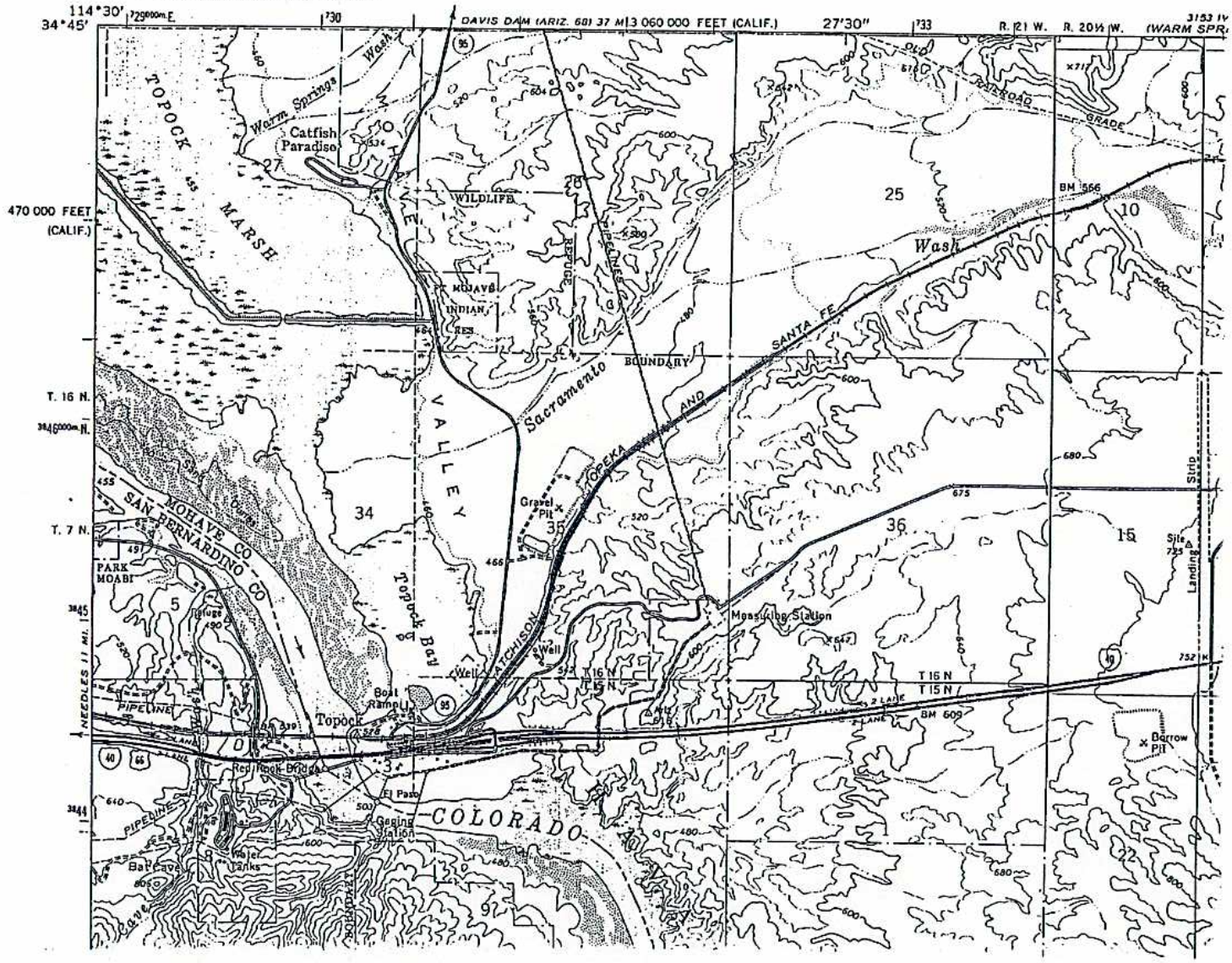
SITE PLAN

WELL INSTALLATION PROJECT
TOPOCK COMPRESSOR STATION
PACIFIC GAS AND ELECTRIC COMPANY
TOPOCK, ARIZONA

PROJECT NO. 10-186-12

ALISTO ENGINEERING GROUP
WALNUT CREEK, CALIFORNIA

1018SCO-DWG 3-10-97 RKW 1=50


1:62 500)
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
114°30'
34°45'
DAVIS DAM (ARIZ. 681 37 M) 3 060 000 FEET (CALIF.)
27'30"
R. 21 W.
R. 20½ W.
470 000 FEET (CALIF.)
T. 16 N.
T. 7 N.
TOPOCK MARSH
Warm Springs Wash
Catfish Paradise
MOHAVE VALLEY
WILDLIFE REFUGE
MOJAVE INDIAN RES
Sacramento Wash
SANTA FE
BOUNDARY
TOPEKA AND
Gravel Pit
Topock Bay
SAN BERNARDINO CO
MOHAVE CO
PARK MOABI
Gauge
Boat Ramp
Topock
Well
ATCHISON
Measuring Station
T 16 N
T 15 N
PIPELINE
Red Rock Bridge
El Paso
Gasing
Water Tanks
Bat Cave
COLORADO
OLD ROAD GRADE
BM 566
BM 609
Borrow Pit
Site
Landing
Stilo
NEEDLES 11 MI.

ALISTO ENGINEERING GROUP

March 13, 1997

Mr. Mike Ball
Arizona Department of Water Resources
Groundwater Management, Support
500 North Third Street
Phoenix, Arizona 85004

10-186-12

Subject: Notice of Intention to Drill Two New Industrial Supply Wells
Pacific Gas and Electric Company
Topock Compressor Station
Topock, Arizona

Dear Mr. Ball,

Enclosed for your review and processing are two completed "Notice of Intention" forms, a site plan of the proposed drilling location, and a two checks for $10.00 each. Please use the enclosed third party paid Federal Express package to forward drilling cards to Howard Pump the selected water well drilling contractor. We appreciate your processing of these documents at your earliest convenience. Contact me if there will be any delay or if you need additional information.

Sincerely,

ALISTO ENGINEERING GROUP

David Lipnicke, PE
Project Engineer

Enclosures

1575 TREAT BOULEVARD, SUITE 201 • WALNUT CREEK, CA 94598 • (510) 295-1650 • FAX (510) 295-1823
CONTRACTORS LICENSE NO. A-652544

ARIZONA DEPARTMENT OF WATER RESOURCES

500 North Third Street, Phoenix, Arizona 85004
Telephone (602) 417-2470
Fax (602) 417-2422

FIFE SYMINGTON
Governor

RITA P. PEARSON
Director

March 19, 1997

PACIFIC GAS & ELECTRIC CO.
PO BOX 337
NEEDLES, CA 92363

Registration No. 55-561779 AND 561780
File No. B (15-21) 3 AAC

Dear Well Owner:

Enclosed is a copy of the Notice of Intention (NOI) to drill/deepen/modify/replace a well. This NOI, which was recently filed with this Department, is being returned to you as evidence of your compliance with ARS §45-596. The enclosed Completion Report is to be submitted when pump equipment is installed. The Drilling Card and Well Drilling Report form have been sent to your driller. He may not begin drilling until he has received the Drilling Card and it must be displayed on the rig during drilling. If you change drillers, you must supply this Department with the new driller's identity. Please ensure that the driller you select is licensed to drill the type of well you require. All well drillers must pass an examination proving they understand the drilling methods for that particular license, and are familiar with the laws and regulations which govern well construction in Arizona.

If it is necessary to change the location of the proposed well, immediately contact the Department of Water Resources to obtain written permission before proceeding with the drilling. A properly signed, amended Drilling Card must be in the possession of the driller before drilling commences at a different location than originally authorized.

ARS §45-600 requires the registered well owner to submit a completion report within thirty (30) days after the installation of pumping equipment. It also requires the driller to furnish this Department a complete and accurate log of the well within thirty (30) days after completion of drilling. You should insist, and ensure, that both of these are done.

If in the course of drilling a new well, it is determined that the new well cannot be successfully completed as initially intended (dry hole, cave in, lost tools, etc.), the new well must be properly abandoned and a Well Abandonment Completion Report submitted per R12-15-816.F.

Per ARS §45-593 (C), the person to whom a well is registered shall notify this Department of a change in ownership of the well and/or information pertaining to the physical characteristics of the well in order to keep this well registration file current and accurate. We have enclosed a Change of Well Information Form should it be needed in the future.

Sincerely,

Stella Murillo-Ramirez

Stella Murillo-Ramirez
Water Resource Technician
Groundwater Management Support Section

FedEx USA Airbill 9915172525 FedEx Billing Copy

1 From

Date _____ Sender's FedEx Account Number _____

Sender's Name Groundwater Management Support Section Phone (602) 417-2470

Company Arizona Department of Water Resources

Address 500 North Third Street

City Phoenix State AZ Zip 85004

2 Your Internal Billing Reference Information 10-186-12-3

3 To

Recipient's Name NORMAN Todd Howard Phone (619) 234-3357

Company Howard Pump, Inc.

Address 34550 OUTER HWY 15 ~~34550 Outer Hwy 15~~

(To "HOLD" at FedEx location, print FedEx address here)

City Yermo State CA Zip 92398

For HOLD at FedEx Location check here

1 ☐ Hold Weekday 3 ☐ Hold Saturday (Not available at all locations) (Not available with FedEx First Overnight or FedEx Standard Overnight)

For Saturday Delivery check here

3 ☐ (Extra Charge. Not available to all locations) (Not available with FedEx First Overnight or FedEx Standard Overnight)

9 9 1 5 1 7 2 5 2 5

4 Service Delivery commitment may be later in some areas.

1 ☐ FedEx Priority Overnight (Next business morning) 5 ☒ FedEx Standard Overnight (Next business afternoon) 3 ☐ FedEx 2Day* (Second business day)

4 ☐ FedEx Govt. Overnight (Authorized user only) ☐ _____

7 ☐ FedEx Overnight Freight 8 ☐ FedEx 2Day Freight

(For packages over 150 pounds. Call for delivery schedule.)

6 ☐ NEW FedEx First Overnight (Earliest next business morning delivery to select locations) (Highest rates apply)

*FedEx Letter Rate not available. Minimum charge: One pound FedEx 2Day rate.

5 Packaging

6 ☒ FedEx Letter* 2 ☐ FedEx Pak* 3 ☐ FedEx Box 4 ☐ FedEx Tube 1 ☐ Other Packaging

*Declared value limit $500

6 Special Handling

Does this shipment contain dangerous goods? 4 ☐ Yes (No Dangerous Goods Shipper's Declaration) ☐ Yes (Shipper's Declaration not required)

6 ☐ Dry Ice Dry Ice, 9, UN 1845, x _____ kg 904 (Dangerous Goods Shipper's Declaration not required)

CA ☐ Cargo Aircraft Only

7 Payment

☐ Obtain Recipient FedEx Account No.

Bill to: 1 ☐ Sender (Account no. in section 1 will be billed) 2 ☐ Recipient 3 ☒ Third Party 4 ☐ Credit Card 5 ☐ Cash/Check

(Enter FedEx account no. or Credit Card no. below)

FedEx Account No 1568-2465-5

Credit Card No _____ Exp. Date _____

Total Packages	Total Weight	Total Declared Value*	Total Charges
		$ .00	$

*When declaring a value higher than $100 per package, you pay an additional charge. See SERVICE CONDITIONS, DECLARED VALUE AND LIMIT OF LIABILITY section for further information.

Credit Card Auth. _____

8 Release Signature

Your signature authorizes Federal Express to deliver this shipment without obtaining a signature and agrees to indemnify and hold harmless Federal Express from any resulting claims.

232

FORM ID NO. 0200

Rev. Date 10/95 • PART #147382 ©1994-95 FedEx • PRINTED IN U.S.A. GIN E 3/96

ARIZONA DEPARTMENT OF WATER RESOURCES
GROUNDWATER MANAGEMENT SUPPORT SECTION

500 North Third Street
Phoenix, Arizona 85004-3903

THIS AUTHORIZATION SHALL BE IN POSSESSION OF THE DRILLER DURING ALL DRILL OPERATIONS

WELL REGISTRATION NO: 55-561779 AND 561780

AUTHORIZED DRILLER: HOWARD PUMP, INC. LICENSE NO: 436

NOTICE OF INTENTION TO DRILL NON-EXEMPT WELLS HAS BEEN FILED WITH THE DEPARTMENT BY:

WELL OWNER: PACIFIC GAS & ELECTRIC CO.

The well(s) is/are to be located in the:

SW 1/4 of the NE 1/4 of the NE 1/4 Section 3 Township 15 NORTH Range 21 WEST

No. of wells in this project: 2

THIS AUTHORIZATION EXPIRES AT MIDNIGHT ON THE 16TH DAY OF MARCH, 1998.

CHIEF, GROUNDWATER MANAGEMENT SUPPORT

THE DRILLER MUST FILE A LOG OF THE WELL
WITHIN 30 DAYS OF COMPLETION OF DRILLING

smr

WESTERN TECHNOLOGIES INC.

4085 Nevso Drive, Suite G
Las Vegas, Nevada 89103
(702) 252-0380

December 14, 1990

Project No. 7470K149

Arizona Department of Water Resources
15 South 15th Avenue
Phoenix, Arizona 85007

ATTENTION: MR. JIM GOFF

REFERENCE: ENVIRONMENTAL CONTAMINATION ASSESSMENT OF THE GOLDEN SHORES MARINA LOCATED AT HC 12 BOX 502 IN TOPOCK, ARIZONA. REQUEST FOR FIVE MONITORING WELL PERMITS

Dear Mr. Goff:

Enclosed, please find ~~10~~ 5 Notice Of Intent To Drill Monitor/Piezometer Well(s) permits for the installation of five monitoring wells at the above mentioned site (one permit for each proposed well with duplicates). The required filing fee ($ 50.00) is also enclosed.

The five proposed wells will be installed in a traffic area and will require variances for PVC construction below grade and reduced surface seals. The wells will be enclosed in traffic rated vaults. Reduced surface seals are required due to the shallow groundwater at the site (approximately 15 feet below grade).

If you need any additional information, please call us at (702) 252-0580.

Sincerely,

WESTERN TECHNOLOGIES INC.

Jack Arendt, R. G.
Associate/Senior Hydrogeologist
Environmental Engineering Services

enclosures

MONITOR/PIEZOMETER WELL

FILING FEE $10.00

ARIZONA DEPARTMENT OF WATER RESOURCES
15 SOUTH 15TH AVENUE
PHOENIX, ARIZONA 85007

NOTICE OF INTENTION TO DRILL MONITOR/PIEZOMETER WELL(s)

MONITOR/PIEZOMETER WELL

FILING FEE $10.00

Section §45-596, Arizona Revised Statutes provide: Prior to drilling a monitor or piezometer well, the well owner or lessee shall file a Notice of Intention to Drill on a form provided by the Department

1. WELL/LAND LOCATION:

15 (N)/S	21 E/(W)	3
Township	Range	Section

10 Acre Subdivision

NE ¼	NE ¼	NE ¼
10 ACRE	40 ACRE	160 ACRE

2. County Mohave

3. Applicant:
Western Technologies
Name
4085 Nevso Dr. Suite G
Address
Las Vegas, Nevada 89103
City State Zip

4. Jack Arendt
Name of Contact Person

Phone (702) 252-0580

Agency

5. Owner of Well:
Norma Phillips
Name
HC 12 Box 502
Address
Topock, Arizona 86436
City State Zip

6. Purpose of well drilled pursuant to this notice:

Monitor X

Piezometer

7. If for Deepening, Well Registration No:
55-

8. Owner of Land:
Norma Phillips
Name
HC 12 Box 502
Address
Topock, Arizona 86436
City State Zip

DO NOT WRITE IN THIS SPACE
OFFICE RECORD
File No. 13(15-21) 3AAA
Filed 12-17-90 By ak
Input ENTERED JAN - 4 1991 By
DUPLICATE
Mailed 1-3-91 By ak
Registration 55-530349
AMA/INA -
W/S 02 S/B

9. Construction will start:
1 7 91
Month Day Year

10. Period well will remain in use 1 Years

11. For monitoring wells, is pump equipment to be installed? Yes x No

(a) If yes, design pump capacity 10 to 20 gpm

(b) Type of pump:
Submersible
submersible, turbine, etc

(c) What use will be made of the water Remediation

12. Drilling Firm:
Enviro Drill
Name
P.O. Box 24189
36th Tompkins Ave
Address
Las Vegas, Nev. 89105
City State Zip

DWR License No. 533

ROC Category

13. Proposed method of abandonment of well after project is completed: Borehole will be drilled, Well materials Removed and Replaced with Neat Cement

14. Is this well to monitor exisitng contamination? Potential contamination x Please explain:
Wells will be installed to monitor potential contamination

JAN 1991
HYDROLOGY
APPROVED
A. Malik

GENERAL INSTRUCTIONS

1. Fill out this form in DUPLICATE and send WITH $10.00 FEE to 15 South 15th Avenue, Phoenix, AZ 85007.
2. For specific instructions, limitations and conditions, see the reverse side of this form.

I state that Notice is filed in compliance with Section §45-596 and is complete and correct to the best of my knowledge and belief and that I understand the conditions set forth on the reverse side of this form.

VARIANCE GRANTED

12/14/90
Date

Signature of Applicant/Owner

DWR 55-44-7/90 (Rev.)

15. If construction plans have been coordinated with Az. Dept. of Environmental Quality, who is the agency contact? NONE

If construction plans have been coordinated with Az. Dept. Water Resources, Hydrology/Water Quality Division, who is the division contact? NONE

16. WELL CONSTRUCTION PLAN

a) Drilling method (mud rotary, hollow-stem auger, etc.) Mud Rotary

b) Borehole diameters: 12 inches from 0 feet to 35 feet

____ inches from ____ feet to ____ feet

c) Casing materials (PVC, steel, stainless steel, etc.):

material PVC diameter 4 inches from 0 feet to 35 feet

material ____ diameter ____ inches from ____ feet to ____ feet

d) Method of sealing at reductions ____

e) Annular seal materials (cement, grout, etc.); method of placement (tremied, circulated)

material Grout diameter 12 inches from 0 feet to 10 feet

material Bentonite diameter 12 inches from 10 feet to 12 feet

f) Gravel packs (state material and whether natural or artificial):

material #3 Silica Sand inches from 12 feet to 35 feet

material ____ inches from ____ feet to ____ feet

g) Perforations (if pre-manufactured, please give specs of perforations or screens:

type PVC 4" Dia 0.02 perf- (slots) from 13 feet to 33 feet

type ____ from ____ feet to ____ feet

h) Method of well development (bail, air lift, surge) Bail # Surge

i) Will surface or conductor casing extending above grade be used to protect the aquifer from additional surface contaminants during drilling and construction? Yes ____ No X

17. Include detailed construction diagram, if available.

18. Is the proposed wellsite within 100 feet of a septic tank system, sewage disposal area, landfill, hazardous waste facility, storage area of hazardous materials or petroleum storage areas and tanks? Yes X No ____

RECEIVED DEC 17 1990 WATER RESOURCES DEPT OF

CONDITIONS

I. Construction and abandonment standards for all wells shall be in accordance with A.A.C. Rules R12-15-811 and R12-15-816.

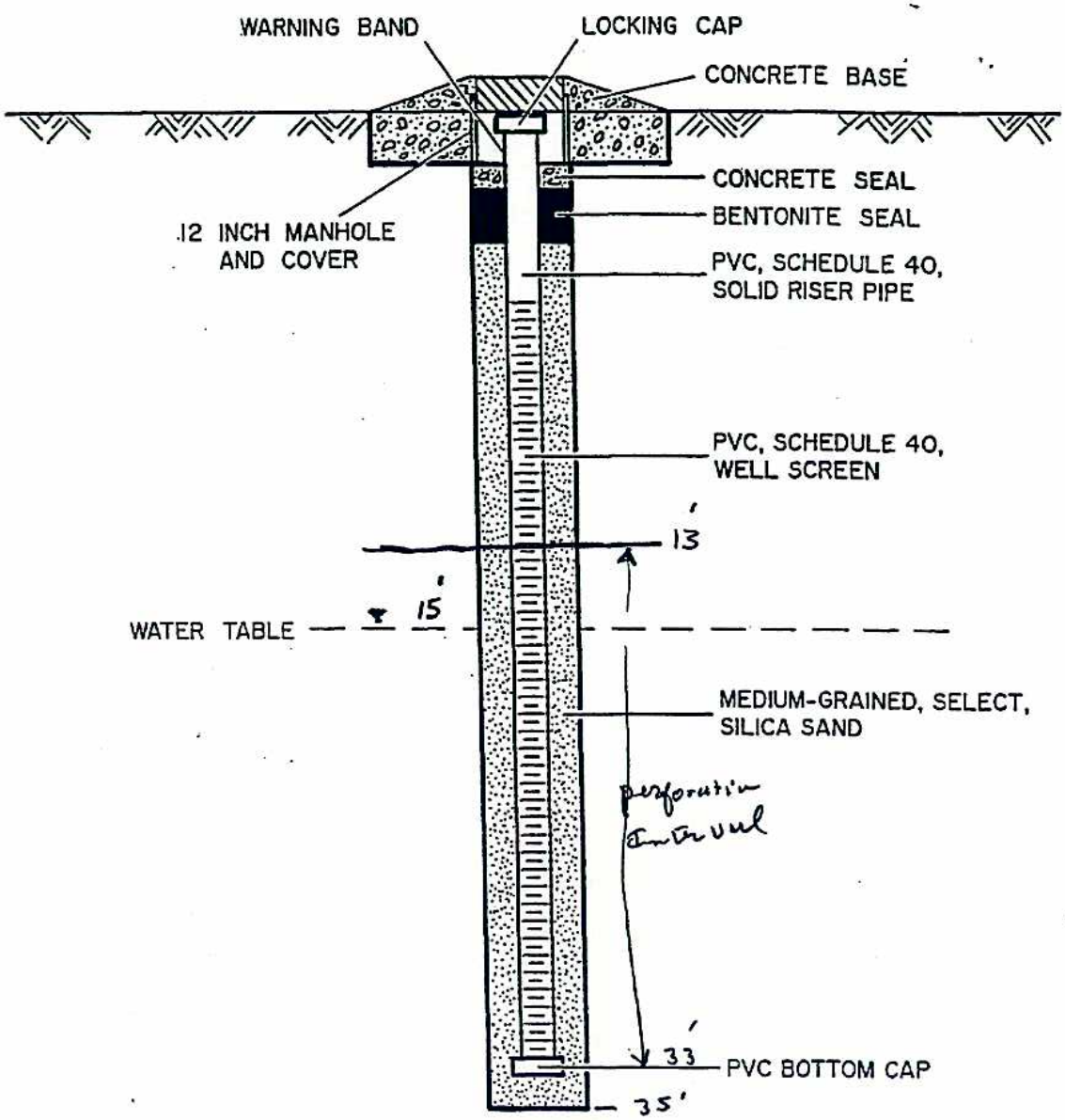
II. Drilling of the well shall be completed within one (1) year after the date of Notice.

III. A Well Driller Report, is required within 30 days of completion of drilling. A Completion Report, is required to be filed with the Department within 30 days after installation of pump equipment for monitor wells.

IV. Pump equipment may not be installed on a well drilled for piezometer purposes. If a monitor well is pumped, pumping is limited to the maximum amount required for monitor purposes, but in no case may exceed 35 gallons per minute and an annual amount of 10 acre feet total.

V. A.A.C. Rule R12-15-811.H.2, requires that: "A monitor well shall be identified as such on the vault cover or at the top of the steel casing. Identification information will include well registration number."

VI. Special construction standards required pursuant to A.A.C. Rule R12-15-821: ____



WELL LOG

Well Size	= 4" Diameter	Depth To Groundwater	= 15 Ft
Total Depth	= 35 Ft	Sand (Depth)	= 12 to 35 Ft
Screen Slot =	= 0.02 inches	Bentonite (Depth)	= 10 to 12 Ft
Screened Interval	= 13 to 33 Ft	Concrete (Depth)	= 0 to 10 ft

WESTERN TECHNOLOGIES INC.

Golden Shores Marina
HC12 Box 502
Topock, Arizona 86436

BY: Jack Trexler	DATE: 12-13-90	PROJECT NO.: 7470K149	PLATE:

2181 J016 185

STATE OF ARIZONA
DEPARTMENT OF WATER RESOURCES
15 South 15th Avenue
Phoenix, Arizona 85007

RECEIVED
OCT 15 1991
OPERATIONS

WELL DRILLER REPORT

This report should be prepared by the driller in all detail and filed with the Department within 30 days following completion of the well.

1. Owner NORMA PHILLIPS
   Name
   HC 12, BOX 502, TOPOCK, ARIZONA 86436
   Mailing Address
2. Driller ENVIRO DRILL, INC. LICENSE NO. 533
   Name
   3737 EAST BROADWAY ROAD PHOENIX, ARIZONA 85040
   Mailing Address
3. Location of well: T15N, R21W, SEC. 3, NE, NE, NE
4. Permit No. (MW-6)
   (If issued)

DESCRIPTION OF WELL

5. Total depth of hole 35 ft.
6. Type of casing PVC SCH 40
7. Diameter and length of casing 4 in. from 0 to 32, 0 in from 32 to 35.
8. Method of sealing at reduction points BENTONITE
9. Perforated from 12 to 32, from ____ to ____, from ____ to ____.
10. Size of cuts 0.020 Number of cuts per foot 48
11. If screen was installed: Length 20 ft. Diam 4 in. Type SCH 40 PVC
12. Method of construction ROTARY DRILL
    drilled, dug, driven, bored, jetted, etc
13. Date started JANUARY (Month) 15 (Day) 1991 (Year)
14. Date completed JANUARY (Month) 15 (Day) 1991 (Year)
15. Depth to water 19 ft. (If flowing well, so state)
16. Describe point from which depth measurements were made, and give sea-level elevation if available FROM TOP OF MANHOLE @ 468.465 FT ABOVE MEAN SEA LEVEL
17. If flowing well, state method of flow regulation:
18. Remarks:

DO NOT WRITE IN THIS SPACE
OFFICE RECORD

REG. No. 55-530349

File No. B(15-21)3aaa

Entered ENTERED OCT 16 1991

DWR-55-55-2/89

LOG OF WELL

Indicate depth at which water was first encountered, and the depth and thickness of water bearing beds. If water is artesian, indicate depth at which encountered, and depth to which it rose in well.

From (feet)	To (feet)	Description of formation material
0	17	FILL: DARK GRAY, WELL GRADED SANDY SILT, CHANGING TO TAN CLEAN, FINE TO MEDIUM GRAINED SUBROUNDED TO SUBANGULAR COARSE GRAINED SAND WITH ANGULAR COBBLES & GRAVELS.
17	35	ALLUVIUM: GRAY BROWN SILTY, CLAYEY, FINE TO MEDIUM GRAINED SAND WITH GRAVEL.

I hereby certify that this well was drilled by me (or under my supervision), and that each and all statements herein contained are true to the best of my knowledge and belief.

Driller Gabriel R. Escamilla
Name

ENVIRO-DRILL, INC.
P O BOX 24189
PHOENIX, AZ 85074
Address

City State Zip

Date 2/11/91

2181J016 2c

STATE OF ARIZONA
DEPARTMENT OF WATER RESOURCES
15 South 15th Avenue
Phoenix, Arizona 85007

RECEIVED
OCT 15 1991
OPERATIONS DIV.

WELL DRILLER REPORT

This report should be prepared by the driller in all detail and filed with the Department within 30 days following completion of the well.

1. Owner NORMA PHILLIPS
   Name
   HC 12, BOX 502, TOPOCK, ARIZONA 86436
   Mailing Address
2. Driller ENVIRO DRILL, INC. LICENSE NO. 533
   Name
   3737 EAST BROADWAY ROAD PHOENIX, ARIZONA 85040
   Mailing Address
3. Location of well: T15N, R21W, SEC.3, NE, NE, NE
4. Permit No. (MW-8)
   (If issued)

DESCRIPTION OF WELL

5. Total depth of hole 31 ft.
6. Type of casing SCH 40 PVC
7. Diameter and length of casing 4 in. from 0 to 25, 0 in from 25 to 31.
8. Method of sealing at reduction points BENTONITE
9. Perforated from 5 to 25, from – to –, from – to –.
10. Size of cuts 0.020 Number of cuts per foot 48
11. If screen was installed: Length 20 ft. Diam 4 in. Type SCH 40 PVC
12. Method of construction ROTARY DRILLED
    drilled, dug, driven, bored, jetted, etc
13. Date started JANUARY (Month) 16 (Day) 1991 (Year)
14. Date completed JANUARY (Month) 16 (Day) 1991 (Year)
15. Depth to water 11 ft. (If flowing well, so state)
16. Describe point from which depth measurements were made, and give sea-level elevation if available TOP OF MANHOLE COVER AT 461.232 FT ABOVE MEAN SEA LEVEL
17. If flowing well, state method of flow regulation:
18. Remarks:

DO NOT WRITE IN THIS SPACE
OFFICE RECORD

REG. No. 55-530350

File No. B(15-21)3aaa

Entered ENTERED OCT 16 1991 BY

DWR-55-55-2/89

LOG OF WELL

Indicate depth at which water was first encountered, and the depth and thickness of water bearing beds. If water is artesian, indicate depth at which encountered, and depth to which it rose in well.

From (feet)	To (feet)	Description of formation material
0	10	ALLUVUIM - BROWN AND RED BROWN, SILTY, FINE TO MEDIUM GRAINED SAND WITH GRAVEL
10	31	BROWN SAND, AS ABOVE, WITH COBBLES

I hereby certify that this well was drilled by me (or under my supervision), and that each and all statements herein contained are true to the best of my knowledge and belief.

Driller Gabriel D Esomillo Jr
Name

ENVIRO-DRILL, INC.
P O BOX 24189
PHOENIX, AZ 85074
Address

City State Zip

Date 9/11/91

2181J016 395

STATE OF ARIZONA
DEPARTMENT OF WATER RESOURCES
15 South 15th Avenue
Phoenix, Arizona 85007

RECEIVED
OCT 15 1991
OPERATIONS DIV.

WELL DRILLER REPORT

This report should be prepared by the driller in all detail and filed with the Department within 30 days following completion of the well.

1. Owner NORMA PHILLIPS
Name
HC 12, BOX 502, TOPOCK, ARIZONA 86436
Mailing Address

2. Driller ENVIRO DRILL, INC. LICENSE NO. 533
Name
3737 EAST BROADWAY ROAD PHOENIX, ARIZONA 85040
Mailing Address

3. Location of well: T15N, R21W, SEC.3, NE, NE, NE

4. Permit No. (MW-9)
(If issued)

DESCRIPTION OF WELL

5. Total depth of hole 31 ft.

6. Type of casing SCH 40 PVC

7. Diameter and length of casing 4 in. from 0 to 31, ____ in from ____ to ____.

8. Method of sealing at reduction points BENTONITE

9. Perforated from 6 to 31, from ____ to ____, from ____ to ____.

10. Size of cuts 0.020 Number of cuts per foot 48

11. If screen was installed: Length 25 ft. Diam 4 in. Type SCH 40 PVC

12. Method of construction ROTARY DRILLED
drilled, dug, driven, bored, jetted, etc

13. Date started JANUARY 16 1991
Month Day Year

14. Date completed JANUARY 16 1991
Month Day Year

15. Depth to water 11 ft. (If flowing well, so state)

16. Describe point from which depth measurements were made, and give sea-level elevation if available TOP OF MANHOLE COVER @ 460.270 FT ABOVE MEAN SEA LEVEL

17. If flowing well, state method of flow regulation: ____

18. Remarks: ____

DO NOT WRITE IN THIS SPACE
OFFICE RECORD
REG. No. 55-530351
File No. B(15-21)3aaa
Entered ENTERED OCT 16 1991 By ____

DWR-55-55-2/89

LOG OF WELL

Indicate depth at which water was first encountered, and the depth and thickness of water bearing beds. If water is artesian, indicate depth at which encountered, and depth to which it rose in well.

From (feet)	To (feet)	Description of formation material
0	10	FILL: BROWN, FINE TO COURSE GRAINED SAND WITH GRAVEL
10	14	BROWN TO DARK GRAY, SILTY FINE TO MEDIUM GRAINED SAND
14	18	ALLUVIUM: DARK GRAY, SILTY SAND AND SANDY SILT
18	31	RED BROWN, AND DARK GRAY SILTY SAND WITH GRAVEL

I hereby certify that this well was drilled by me (or under my supervision), and that each and all statements herein contained are true to the best of my knowledge and belief.

Driller Gabriel R. Escamilla
Name

ENVIRO-DRILL, INC.
P O BOX 24189
PHOENIX, AZ 85074
Address

City State Zip

Date 2/11/91

2181J016 485

STATE OF ARIZONA
DEPARTMENT OF WATER RESOURCES
15 South 15th Avenue
Phoenix, Arizona 85007

RECEIVED
OCT 15 1991
OPERATIONS DIV.

WELL DRILLER REPORT

This report should be prepared by the driller in all detail and filed with the Department within 30 days following completion of the well.

1. Owner NORMA PHILLIPS
   Name
   HC 12, BOX 502, TOPOCK, ARIZONA 86436
   Mailing Address
2. Driller ENVIRO DRILL, INC. LICENSE NO. 533
   Name
   3737 EAST BROADWAY ROAD PHOENIX, ARIZONA 85040
   Mailing Address
3. Location of well: T15N, R21W, SEC.3, NE, NE, NE
4. Permit No. (MW-10) (If issued)

DESCRIPTION OF WELL

5. Total depth of hole 35 ft.
6. Type of casing PVC SCH 40
7. Diameter and length of casing 4 in. from 0 to 30, 0 in from 30 to 35.
8. Method of sealing at reduction points BENTONITE
9. Perforated from 10 to 30, from ____ to ____, from ____ to ____.
10. Size of cuts 0.020 Number of cuts per foot 48
11. If screen was installed: Length 20 ft. Diam 4 in. Type PVC SCH 40
12. Method of construction ROTARY DRILLED
    drilled, dug, driven, bored, jetted, etc
13. Date started JANUARY (Month) 17 (Day) 1991 (Year)
14. Date completed JANUARY (Month) 17 (Day) 1991 (Year)
15. Depth to water 21 ft. (If flowing well, so state)
16. Describe point from which depth measurements were made, and give sea-level elevation if available TOP OF MANHOLE COVER AT 470.00 FT ABOVE MEAN SEA LEVEL
17. If flowing well, state method of flow regulation: ____
18. Remarks: ____

DO NOT WRITE IN THIS SPACE
OFFICE RECORD

REG. No. 55-530352

File No. B915-21)3aaa

Entered ENTERED OCT 16 1991 By

DWR-55-55-2/89

LOG OF WELL

Indicate depth at which water was first encountered, and the depth and thickness of water bearing beds. If water is artesian, indicate depth at which encountered, and depth to which it rose in well.

From (feet)	To (feet)	Description of formation material
0	5	FILL: BROWN, DAMP, LOOSE TO MEDIUM DENSE, SANDY GRAVEL AND COBBLES
5	18	BROWN TO TAN, MOIST, LOOSE TO MEDIUM DENSE, FINE TO MEDIUM GRAINED SAND WITH GRAVEL AND COBBLES
18	24	ALLUVIUM: GRAY-BROWN, SILTY CLAYEY, FINE TO MEDIUM GRAINED SAND
24	30	SAND ABOVE, BECOMING COURSE GRAINED
30	35	BROWN TO GRAY BROWN, MEDIUM AND COURSE GRAINED SILTY SAND

I hereby certify that this well was drilled by me (or under my supervision), and that each and all statements herein contained are true to the best of my knowledge and belief.

Driller Gabriel R. Escamilla Jr
Name

ENVIRO-DRILL, INC.
P O BOX 24189
PHOENIX, AZ 85074
Address

City State Zip

Date 2/11/91

2181J016 585

STATE OF ARIZONA
DEPARTMENT OF WATER RESOURCES
15 South 15th Avenue
Phoenix, Arizona 85007

RECEIVED
OCT 15 1991
OPERATIONS DIV.

WELL DRILLER REPORT

This report should be prepared by the driller in all detail and filed with the Department within 30 days following completion of the well.

1. Owner NORMA PHILLIPS
Name
HC 12, BOX 502, TOPOCK, ARIZONA 86436
Mailing Address

2. Driller ENVIRO DRILL, INC. LICENSE NO. 533
Name
3737 EAST BROADWAY ROAD PHOENIX, ARIZONA 85040
Mailing Address

3. Location of well: T15N, R21W, SEC.3, NE, NE, NE

4. Permit No. (MW-11)
(If issued)

DESCRIPTION OF WELL

5. Total depth of hole 35 ft.

6. Type of casing SCH 40 PVC

7. Diameter and length of casing 4 in. from 0 to 30, 0 in from 30 to 35.

8. Method of sealing at reduction points BENTONITE

9. Perforated from 10 to 30, from - to -, from - to -.

10. Size of cuts 0.020 Number of cuts per foot 48

11. If screen was installed: Length 20 ft. Diam 4 in. Type SCH 40 PVC

12. Method of construction ROTARY DRILLED
drilled, dug, driven, bored, jetted, etc

13. Date started JANUARY 18 1991
Month Day Year

14. Date completed JANUARY 18 1991
Month Day Year

15. Depth to water 19 ft. (If flowing well, so state)

16. Describe point from which depth measurements were made, and give sea-level elevation if available TOP OF MANHOLE COVER AT 468.137 FT ABOVE MEAN SEA LEVEL

17. If flowing well, state method of flow regulation:

18. Remarks:

DO NOT WRITE IN THIS SPACE
OFFICE RECORD

REG. No. 55-530353

File No. B(15-21)3aaa

Entered ENTERED OCT 16 1991 By

DWR-55-55-2/89

LOG OF WELL

Indicate depth at which water was first encountered, and the depth and thickness of water bearing beds. If water is artesian, indicate depth at which encountered, and depth to which it rose in well.

From (feet)	To (feet)	Description of formation material
0	5	FILL: BROWN, DAMP, LOOSE TO MEDIUM DENSE, SANDY GRAVEL AND COBBLES
5	18	BROWN MOIST, LOOSE TO MEDIUM DENSE, FINE TO MEDIUM GRAINED SAND WITH COBBLES AND GRAVEL
18	35	ALLUVIUM: GRAY TO BROWN, SILTY CLAYEY, FINE TO MEDIUM GRAINED SAND

I hereby certify that this well was drilled by me (or under my supervision), and that each and all statements herein contained are true to the best of my knowledge and belief.

Driller Gabriel D. Escamilla
Name

Address ENVIRO-DRILL, INC.
P O BOX ~~24189~~
~~PHOENIX~~, AZ 85074

City State Zip

Date 9/11/91

B(15-21) 3 ADB

ARIZONA DEPARTMENT OF WATER RESOURCES

500 North Third Street
Phoenix, Arizona 85004

WELL DRILLER REPORT

*

RECEIVED
MAR 20 1998
RECORDS MGT

This report should be prepared by the driller in all detail and filed with the Department within 30 days following completion of the well.

1. VALLEY WELL DRILLING
P.O. BOX 637
TOPOCK, AZ 86436-0637

2. Owner Name: STANLEY + WARREN Smith
Address: 2095 Fox Hill Flagstaff AZ 86004
City State Zip

3. Location: 15N N/S 21W E/W 3 ¼ NW ¼ SE ¼ NE
Township Range Section 10-acre 40-acre 160-acre

4. Well Registration No. 55- 565878 (Required)
5. Permit No. _____ (If issued)

DESCRIPTION OF WELL

6. Total depth of hole 80 ft.
7. Type of casing PVC
8. Diameter and length of casing 5 in. from 0 to 80, in from _____ to _____
9. Method of sealing at reduction points NA
10. Perforated from 48 to 68, from _____ to _____ from _____ to _____
11. Size of cuts .35 Number of cuts per foot 20
12. If screen was installed: Length NA ft. Diam _____ in. Type _____
13. Method of construction DRILLED
(drilled, dug, driven, bored, jetted, etc)
14. Date started 2/21/98
Month Day Year
15. Date completed 2/21/98
Month Day Year
16. Depth to water 50 ft. (If flowing well, so state)
17. Describe point from which depth measurements were made, and give sea-level elevation if available
GROUND LEVEL
18. If flowing well, state method of flow regulation: _____
19. Remarks: _____

DO NOT WRITE IN THIS SPACE
OFFICE RECORD

Registration No. 55-565878
File No. B(15-21) 3 ADB
Received _____ By _____
Entered _____ By _____

DWR-55-55-7/95 (Rev.)

ENTERED APR 1 1998

LOG OF WELL

Indicate depth at which water was first encountered, and the depth and thickness of water bearing beds. If water is artesian, indicate depth at which encountered, and depth to which it rose in well.

From (feet)	To (feet)	Description of formation material
0	8	BROWN CLAY - ROCKS
8	68	COARSE SAND + GRAVEL
68	80	Red Decomposed Rock ledge + shale
		NOTE:
		This well has a high salt content and may be unuseable for domestic use. Testing is being done to determine salt + Mineral content. This hole may be abandoned after testing.

I hereby certify that this well was drilled by me(or under my supervision), and that each and all statements herein contained are true to the best of my knowledge and belief.

Driller Name: VALLEY WELL DRILLING

P.O. BOX 637
Street

TOPOCK, AZ 86436-0637
City State Zip Phone No.

Mike Epstead 2/27/98
Signature of Driller Date

BLUE SNAKE #394170 (OK BY 11-7-97)

ARIZONA DEPARTMENT OF WATER RESOURCES
GROUNDWATER MANAGEMENT SUPPORT SECTION
MAIL TO: P.O. BOX 458 - PHOENIX, ARIZONA 85001-0458
500 North Third Street - Phoenix, Arizona 85004-3903
Phone (602) 417-2470

RECEIVED DEC 1 - 1997 GROUNDWATER MGT.

NOTICE OF INTENTION TO DRILL, DEEPEN, REPLACE OR MODIFY A WELL

PLEASE READ SPECIFIC INSTRUCTIONS, LIMITATIONS AND CONDITIONS ON REVERSE SIDE OF THIS FORM BEFORE COMPLETING.

PLEASE COMPLETE ALL ITEMS IN THE BOX BELOW DOWN TO COUNTY OR LOCAL AUTHORITY ENDORSEMENT. IF ANY WATER FROM THE PROPOSED WELL (LISTED BELOW) WILL BE USED FOR DOMESTIC PURPOSES ON A PARCEL OF LAND 20 OR FEWER ACRES, THE APPLICABLE COUNTY OR LOCAL HEALTH AUTHORITY MUST ENDORSE ALL ITEMS IN THE BOX BEFORE SUBMITTING TO THE DEPARTMENT OF WATER RESOURCES.

STANLEY Smith & WARREN S. Smith | 2095 Fox Hill | Flagstaff | AZ | 86604
Land Owner's Name | Current Mailing Address | City | State | Zip

Telephone No. 520 - 768 - 8716

COUNTY ASSESSOR'S PARCEL ID INFORMATION:

Well Located in MOHAVE County

210 - 48 - 005C | 1.2
BOOK MAP PARCEL # of Acres

OFFICIAL SEAL OR STAMP

Well/Land Location (must be completed as requested):

NW ¼ SE ¼ NE ¼ of Section 3 Township 15 N N/S Range 21 W E/W
10AC 40AC 160AC

COUNTY OR LOCAL AUTHORITY ENDORSEMENT

Check one:
Recommend Approval ✓; Insufficient Information to Make Determination ___; Variance Required ___ (Explanation attached)

DATE 11/25/97 AUTHORIZED SIGNATURE Melissa Crocker TITLE R.S.

GENERAL INSTRUCTIONS FOR FILING NOTICE WITH ADWR

- Section §45-596(D) provides that the Director shall determine that all information required on this form has been submitted. If not, the person filing will be notified, and the drilling, deepening or modification of the well may not proceed.
- Section §45-596(d) provides that the Department has 15 days after the receipt of a complete and correct notice of intention to record the notice and mail duplicate to owner. Drill card will be mailed directly to drilling firm as stated in item #14.
- Please mail two original notices with original signatures, a site plan in DUPLICATE, and a check or money order (no cash) in the amount of $10.00 to P.O. Box 458, Phoenix, Arizona 85001-0458 or hand deliver to 500 North Third Street, Phoenix, Arizona 85004-3903. USE BLACK OR BLUE INK.
- If the well is a replacement, deepening or modification of an existing well, provide the registration number of the existing well in item 2.
- Construction standards for wells, including abandonment, shall be in accordance with Department Rules.

1. Owner of well:
STANLEY & WARREN Smith
Name
2095 FOX Hill
Current Mailing Address
Flagstaff AZ 86604
City State Zip
Telephone No. 520 - 768 - 8716

2. Action requested: Drill New Well ✓; Deepen ___ Modify ___ Replace ___. For a replacement well provide: Maximum capacity of the original well ___ gallons per minute; distance from the original well ___ feet.
Well Registration No.55-___

3. Construction will start about:
Month NOV Year 97

4. Description of proposed well:
Diameter 5 inches
Depth 125 feet
Type of Casing PVC

5. Design pump capacity:
35 gallons per minute

6. Lessee of land of wellsite:
Name
Current Mailing Address
City State Zip
Telephone No.

7. Principal Use of Water; (be specific):
DOMESTIC

8. Other uses of Water; (be specific):
IRRIGATION

9. If use includes irrigation, state to nearest tenth, the number of acres to be irrigated; 1.2

FOR DEPARTMENT USE ONLY
File No. 55-213ADD
Filed 12-1-97 By VB
Input DEC 0 0 By 1997
DUPLICATE MAILED
Date 12-22-97
Registration 55-565878
AMA/INA —
W/S 02 S/B —

10. Place of Use (Legal Description of Land):
NW ¼ SE ¼ NE ¼ Section 3
10 AC 40AC 160AC
Township 15N N/S Range 21W E/W

11. Type of Well (Check One):
Exempt ✓ Non-Exempt ___

12. Check One:
Residential ✓ Commercial ___

13. Is the proposed wellsite within 100 feet of a septic tank system, sewage disposal area, landfill, hazardous materials or petroleum storage areas and tanks? Yes ___ No ✓

14. Drilling Firm:
VALLEY WELL DRILLING
Name
P.O. Box 637
Mailing Address
TOPOCK AZ 86436
City State Zip
520 - 768 - 7111
Telephone No.
341
DWR License Number
C-53 L-53
ROC License Category

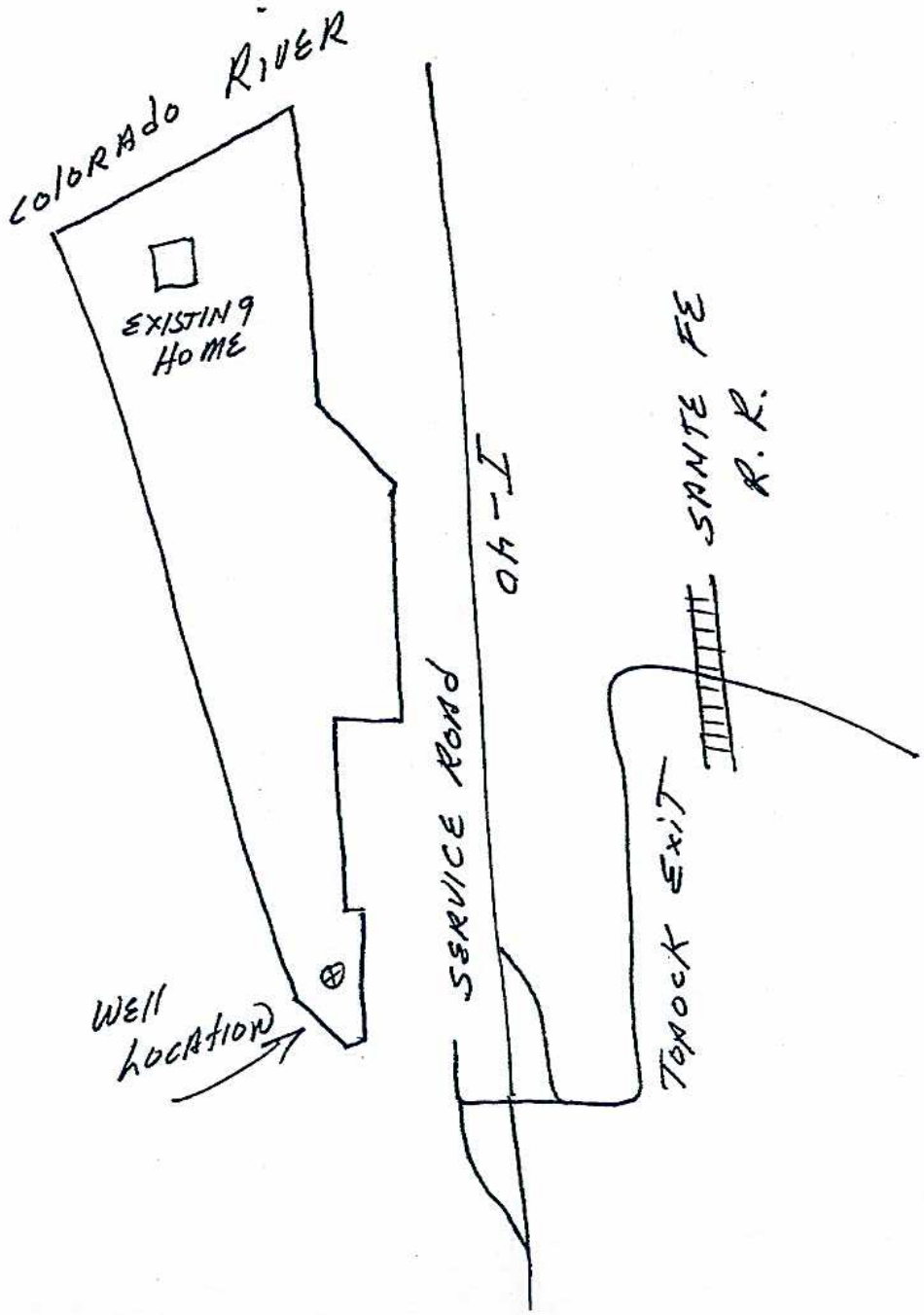
State that this Notice is filed in compliance with A.R.S. §§45-595 and 45-596 and is complete and correct to the best of my knowledge and belief and hat I understand the limitations and conditions set forth on the reverse side of this form.

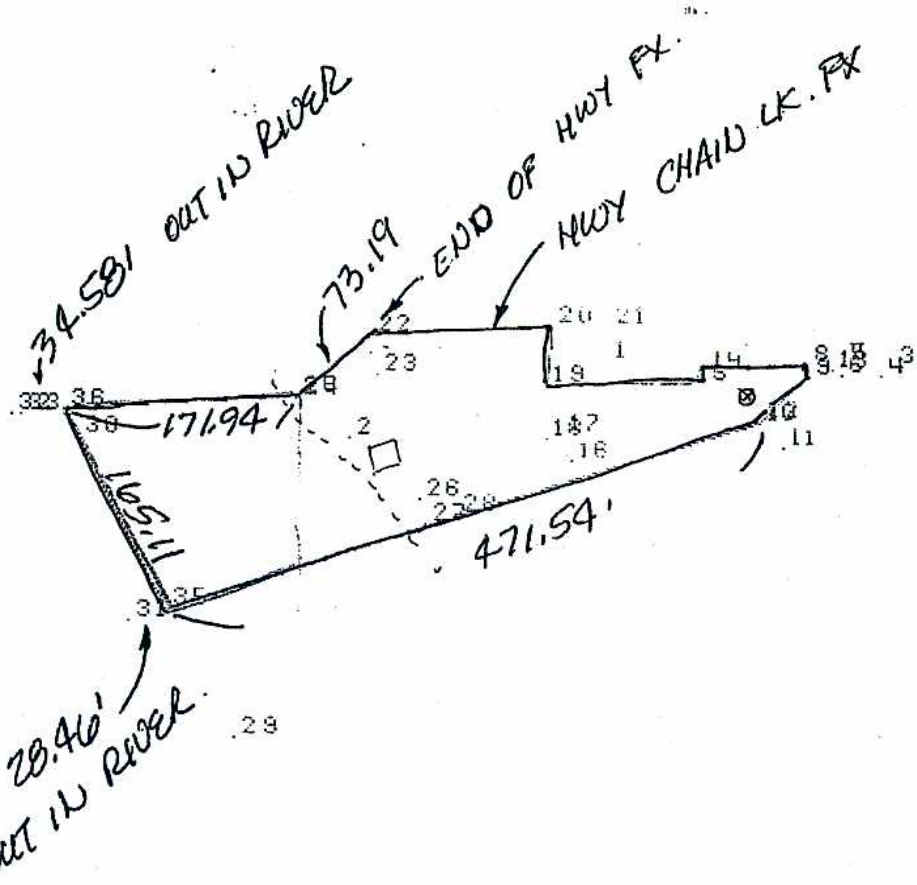
STANLEY & WARREN Smith | Stanley Smith Warren Smith | 11-3-97
yped or Printed Name and Title | Signature [ ] Land Owner [ ] Lessee of Wellsite, Title | Date

Stanley Smith
2095 Fox Hill
Flagstaff AZ 86604
520-768-8716

PARCEL # 210-48-005C

TN. 15N RN 21W SECT 3





A:TOPCC 08-22-1997 1:24 PM

WELL DRILLING LEGAL (10 ACRE)

SE1/4 NE1/4 NE1/4 SEC. 3 T 15 N. R. 21 W.

Appendix C
Standard Operating Procedures for Drilling, Logging, and Well Installation Activities

SOP-B1

General Guidance for Monitoring Well Installation and Development Standard Operating Procedures for PG&E Topock Program

---

This Standard Operating Procedure provides site personnel with a review of well installation procedures. These procedures are to be considered general guidelines only and are in no way intended to supplement or replace the contractual specifications in the driller's subcontract.

REQUIRED DOCUMENTS

1) Event-specific sampling and analysis plan (SAP).
2) Applicable project work plan or monitoring plan. Refer to Topock Program *Sampling, Analysis, and Field Procedures Manual* and *Quality Assurance Project Plan* (Procedures Manual), as required.
3) Topock Program Health and Safety Plan.
4) Well construction logs/specifications.
5) Previous sampling logs or tabular historic field data.
6) Blank sampling logs and field notebook.
7) Blank CH2M HILL Well Completion Diagrams.

EQUIPMENT LIST

- Drilling rig (hollow stem auger, sonic, air hammer, air rotary, or mud rotary).
- Polyvinyl chloride (PVC), Schedule 40, minimum 2-inch-diameter, flush-threaded, blank casing; alternatively, stainless-steel casing.
- PVC, Schedule 40, minimum 2-inch-inside-diameter, flush-threaded, factory-slotted screen; alternatively, stainless-steel casing.
- PVC or stainless-steel centering guides (if used).
- Above-grade well completion: PVC, threaded or push-on type, vented cap.
- Clean silica sand, in-factory-sealed bags, non-reactive, rounded, water-washed for constructing the primary (coarse) filter pack and secondary (fine optional) filter pack. Grain size determined based on sediments observed during drilling, geotechnical tests, or from previous well installations.
- Pure, additive-free bentonite pellets, chips, and/or powder.
- Coated bentonite pellets.
- Portland cement.

- Above-grade well completion: minimum 6-inch-inside-diameter steel pipe with locking cover, diameter at least 2 inches greater than the well casing, painted for rust protection; heavy duty lock; protective posts if appropriate.
- Flush-mount well completion: Morrison 9-inch or 12-inch 519 manhole cover or equivalent; rubber seal to prevent leakage; locking cover inside of traffic-rated box.
- Single- or double-surge block with solid bottom, open top, separated by 2 feet of slotted pipe (double surge block only).
- Well-development pump, pump controller, and steam cleaner.
- Calibrated meter(s) to measure pH, temperature, specific conductance, turbidity, dissolved oxygen, and total dissolved solids (TDS) of purged water during well development.
- Containers (Department of Transportation [DOT]-approved 5-gallon drums or trailer-mounted water tank) for water produced from well.

GUIDELINES

1) Wells will be installed in accordance with standard United States Environmental Protection Agency (USEPA) procedures.
2) The threaded connections will be water-tight.
3) Well screens generally will be constructed of 10-slot or 20-slot Schedule 40 PVC and will be 10 to 20 feet long, depending on the requirements of the well. The exact slot size and length will be determined by the field team supervisor. Stainless steel may be required under certain contaminant conditions.
4) Wells will be surrounded by four concrete-filled, 3-inch-diameter guard posts.
5) A record of the finished well construction will be compiled.
6) All soils and liquids generated during well installations will be placed in lined, roll-off containers pending proper disposal.

WELL TYPES

There are several basic types of monitoring wells: single-cased, double-cased, clustered, nested, and multiple-port wells. The first three are recommended for general use in most hydrogeologic investigations.

Single-cased Wells. A single-cased well consists of a section of slotted well screen connected to a riser pipe that extends to above or just below the ground surface. An artificial filter pack is placed in the annulus between the screen and the borehole to 2 to 3 feet above the top of the well screen. A transitional seal fills the annular space directly above the filter pack, followed by bentonite-cement or sand-cement grout to the ground surface.

Double-cased Wells. Double- or multiple-cased wells are often installed when the aquifer zone to be sampled must be isolated from overlying aquifer zones to prevent cross contamination between aquifer zones. Typically, a large-diameter boring (14 to 16 inches or more in diameter) is drilled into a low-permeability material (clay) immediately below the

zone to be sealed off. Steel conductor casing with welded joints and an outside diameter that is at least 4 inches smaller than the hole diameter is lowered into the borehole, centered, and pushed into the clay up to 10 feet. A bentonite-cement or sand-cement grout is then pumped through a tremie pipe into the annular space, between the conductor casing and the formation from the bottom up to the ground surface.

Clustered Wells. Well clusters consist of two or more wells installed in proximity to one another but screened at different intervals in different boreholes. Single- and double-cased wells may both be included in the well cluster. Well cluster systems allow sampling of groundwater from different aquifers or from different zones within the same aquifer with essentially no risk of cross contamination between the aquifers. Installation procedures for each well in a well cluster are the same as for single- or double-cased wells.

Nested Wells. Nested wells consist of more than one well casing installed in a single borehole. Nested wells allow groundwater sampling and measurement of water levels from two or more different zones or aquifers using one borehole. Each well is screened at a different depth, and seals are placed above and below each well screen.

Multiple-port Wells. Multiple-port wells have multiple screens on the same casing string with sampling ports at different depths separated by inflatable or mechanical packers. This arrangement allows for discrete sampling at different depths across a large vertical extent in one thick aquifer or in several thinner ones.

PROCEDURES

Monitoring Well Installation

This section presents procedures for the installation of the monitoring wells, including discussion of borehole completion; installation of the casing and screen, artificial filter pack, and borehole seals; and surface completion.

1) Monitoring wells in unconsolidated materials will be installed in at least 6-inch-diameter boreholes to accommodate well completion materials in designated locations.

2) Monitoring wells in unconsolidated materials will be constructed of 2-inch-diameter, factory manufactured, flush-jointed, Schedule 40 PVC screen with threaded bottom plug and riser.

3) Screens will be filter packed with a properly-sized, properly-graded, thoroughly-washed, sound, durable, well-rounded basalt or siliceous sand. When using sonic drill casing, the filter pack will be installed by slowly pouring the sand into the annular space while raising the casing in 1 to 3 foot intervals and using a weighted tape to sound for the sand surface.

4) Following each lift of the drill casing, the well casing height will be checked for settling or to see if the casing was pulled up.

5) The primary filter sand pack (typically Monterey #3 or equivalent) will extend from 1 to 2 feet below the base to 2 feet above the top of the screen; for non-sonic drilling methods the filter pack will be allowed to settle and hydrate before final measurement is taken. Alternately, a surge block can be used to agitate the sand and facilitate settling. For sonic drilling, the vibration induced during casing removal serves to properly settle the sand.

For wells that are installed with approved screen lengths longer than 20 feet, the filter pack will be proportionally extended above the top of the screen to allow for settling of the longer pack.

6) A secondary filter sand pack (typically Monterey #30 or equivalent) 1 foot thick will be placed above the primary sand pack.

7) Annular well seals will consist of 2 to 5 feet of pelletized or granular bentonite clay placed above the filter pack. If necessary, the pellets will be hydrated using potable water. For wells drilled using sonic, the bentonite will be poured into the annular space while raising the drill casing in 1- to 3-foot increments and sounding for the top of the bentonite with a weighted tape. The height of the well seal also will be sounded with a weighted tape.

8) The top of the annular seal will be measured after the pellets have been allowed to hydrate and before the grout is applied. The pellets will be allowed to hydrate for at least 30 minutes before work in the well continues.

9) The annular space above the bentonite seal will be filled to grade with a bentonite-cement slurry grout mixture.

10) The grout mixture consists of 94 pounds of cement (1 bag) per 6 gallons of water and 2 to 3 pounds of powdered bentonite per bag of cement to reduce shrinkage.

11) The grout mix will be carefully applied to avoid disturbing the bentonite seal; the method of grout placement must force grout from the bottom of the space to be grouted to the surface.

12) After allowing the grout to settle and set up overnight, additional grout will be added to maintain grade.

13) A protective steel casing equipped with keyed-alike locking caps will be grouted in place for each new well; the casing will extend at least 2 feet above grade and 3 feet below grade and will be painted a bright color.

Well Development

1) New monitoring wells will be developed after the well has been completely installed and the grout has hardened (a minimum of 24 hours following grouting).

2) The well will be developed by bailing, surging, and pumping.

3) Equipment placed in the well will be decontaminated before use.

4) If information is available, the least-contaminated well will be developed first.

5) Initial development will be with a bailer (i.e., stainless-steel, 10-foot-long bailer) to facilitate removal of coarse-grained sediment.

6) The well will subsequently be surged using a surge block across the screened interval. Additional bailing will be performed if significant coarse sediment is still present.

7) Following bailing and surging, a submersible pump will be lowered into the well. Development may include surging the well by abruptly stopping flow and allowing water in the well column to fall back into the well.

8) Pumping will continue until the water produced is free of turbidity (less than 10 NTU) and water quality parameters (i.e., pH, temperature, conductivity, TDS, and dissolved oxygen) have stabilized.

9) Development water will be considered hazardous and placed in sealed 55-gallon DOT-approved steel drums or other approved containers (i.e., lined roll-off bins).

KEY CHECK AND ITEMS

- Ensure that all equipment is properly decontaminated as needed.
- Only new, sealed materials (e.g., screens, risers, and sand) will be used in constructing the well.
- Care will be taken when making downhole measurements to ensure that proper heights of sand, seal, and grout are achieved.
- Fill out CH2M HILL Well Completion Diagram (see Attachment A).
- All materials generated during sampling (debris, PPE, decontamination liquids, etc.) will be placed in approved investigation-derived waste storage containers (i.e., drums or roll-offs) for storage pending analysis and disposal off site.

SOP-B2

Soil Classification and Logging Procedures
Standard Operating Procedures for PG&E Topock Program

This standard operating procedure (SOP) provides guidance to obtain accurate and consistent descriptions of soil characteristics during soil-sampling operations. The characterization is based on visual examination and manual tests not on laboratory determinations.

REQUIRED DOCUMENTS

1) Event-specific sampling and analysis plan, work plan or event-specific field instructions. Planned borehole depth, proposed well construction/specifications, and field sampling summary table, if available.

2) Applicable project work plan or monitoring plan. Refer to Topock Program *Sampling, Analysis, and Field Procedures Manual* and *Quality Assurance Project* Plan (Procedures Manual), as required.

3) Topock Program Health and Safety Plan (HSP).

4) Previous sampling, drilling, or well construction logs from other boreholes or wells in the vicinity, if available.

5) Blank field notebook.

6) Blank CH2M HILL soil boring log Form D1586.

PREPARATION AND SETUP

1) Review event-specific work plan or event-specific field instructions, previous sampling logs, Procedures Manual, and HSP.

2) Initiate field logbook for sampling activity.

3) Review sampling procedures and equipment, and planned sample depths with drilling contractor and field crew.

EQUIPMENT LIST

- Indelible pens
- Tape measure or ruler
- Field logbook
- Spatula
- HCl, 10-percent solution
- Squirt bottle/Spray bottle with water

- Rock- or soil-color chart (e.g., Munsell)
- Grain-size chart
- Hand lens
- Unified Soil Classification System index charts and tables to help with soil classification

PROCEDURES

This section covers several aspects of the soil characterization: instructions for completing the CH2M HILL soil boring log (see Form D1586, Attachment A) and the field logging of soil using the "Unified Soil Classification System and Logging Criteria" (Attachment B).

Instructions for Completing Soil Boring Logs

- Soil boring logs will be completed on field boring log forms. Information collected will be consistent with that required for Form D1586 (attached), a standard CH2M HILL form, or an equivalent form that supplies the same information.
- The information collected in the field to perform the soil characterization is described below.
- Field personnel should review completed logs for accuracy, clarity, and thoroughness of detail. Samples also should be checked to see that information is correctly recorded on both jar lids and labels and on the log sheets.

Heading Information

1) **Boring/Well Number.** Enter the boring/well number. A numbering system should be chosen that does not conflict with information recorded for previous exploratory work done at the site. Number the sheets consecutively for each boring.
2) **Location.** If stationing, coordinates, mileposts, or similar project layout information is available, indicate the position of the boring to that system using modifiers such as "approximate" or "estimated," as appropriate.
3) **Elevation.** Elevation will be determined at the conclusion of field activities.
4) **Drilling Contractor.** Enter the name of the drilling company and the city and state where the company is based.
5) **Drilling Method and Equipment.** Identify the bit size and type, drilling fluid (if used), and method of drilling (e.g., rotary, hollow-stem auger, sonic). Information on the drilling equipment (e.g., CME 55, Mobile B61) should be noted.
6) **Water Level and Date.** Enter the depth below ground surface to the apparent water level in the borehole. The information should be recorded as a comment. If free water is not encountered during drilling or cannot be detected because of the drilling method, this information should be noted. Record date and time of day (for tides, river stage) of each water level measurement.

7) **Date of Start and Finish.** Enter the dates the boring was started and completed. Time of day should be added if several borings are performed on the same day.

8) **Logger.** Enter the first initial and full last name of the logger.

Technical Data

1) **Depth Below Surface.** Use a depth scale that is appropriate for the sample spacing and for the complexity of subsurface conditions.

2) **Sample Interval.** Note the depth at the top and bottom of the sample interval.

3) **Sample Type and Number.** Enter the sample type and number. SS-1 = split spoon, first sample. Number samples consecutively regardless of type. Enter a sample number even if no material was recovered in the sampler.

4) **Sample Recovery.** Enter the length to the nearest 0.1 foot of soil sample recovered from the sampler. Often, there will be some wash or caved material above the sample; do not include the wash material in the measurement. Record recovery in feet.

5) **Soil Description.** The soil classification should follow the format described in the "Field Classification of Soil" subsection below.

6) **Comments.** Include all pertinent observations (changes in drilling fluid color, rod drops, drilling chatter, rod bounce as in driving on a cobble, damaged Shelby tubes, and equipment malfunctions). In addition, note if casing was used, the sizes and depths installed, and if drilling fluid was added or changed. You should instruct the driller to alert you to any significant changes in drilling (changes in material, occurrence of boulders, and loss of drilling fluid). Such information should be attributed to the driller and recorded in this column. Specific information might include:

   - The date and the time drilling began and ended each day.
   - The depth and size of casing and the method of installation.
   - The date, time, and depth of water level measurements.
   - Depth of rod chatter.
   - Depth and percentage of drilling fluid loss.
   - Depth of hole caving or heaving.
   - Depth of change in material.
   - Health and safety monitoring data.
   - Drilling interval through a boulder.

Field Classification of Soil

This section presents the format for the field classification of soil. In general, the approach and format for classifying soils should conform to the "United Soils Classification System and Logging Criteria" (see charts and criteria, Attachment B).

- The Unified Soil Classification System (USCS) is based on numerical values of certain soil properties that are measured by laboratory tests (ASTM D 2487). It is possible, however, to estimate these values in the field with reasonable accuracy using visual-manual procedures (ASTM D 2488). In addition, some elements of a complete soil description, such as the presence of cobbles or boulders, changes in strata, and the relative proportions of soil types in a bedded deposit can be obtained only in the field.
- Soil descriptions should be precise and comprehensive without being verbose. The correct overall impression of the soil should not be distorted by excessive emphasis on insignificant details. In general, similarities rather than differences between consecutive samples should be stressed.

Soil Descriptions

Soil descriptions must be recorded for every soil sample collected. The format and order for soil descriptions should be:

1) Soil name (synonymous with ASTM D 2488 Group Name) with appropriate modifiers. Soil name should be in all capitals in the log, for example "POORLY-GRADED SAND."
2) Group symbol, in parentheses, for example, "(SP)."
3) Color, using Munsell color designation.
4) Particle size distribution (i.e., sand, silt, clay).
5) Moisture content.
6) Relative density or consistency.
7) Soil structure, mineralogy, or other descriptors.

This order follows, in general, the format described in ASTM D 2488.

(1) Soil Name

The basic name of a soil should be the ASTM D 2488 Group Name on the basis of visual estimates of gradation and plasticity. The soil name should be capitalized.

Examples of acceptable soil names are illustrated by the following descriptions:

- A soil sample is visually estimated to contain 15-percent gravel, 55-percent sand, and 30-percent fines (passing No. 200 sieve). The fines are estimated as either low- or highly-plastic silt. This visual classification is SILTY SAND WITH GRAVEL with a Group Symbol of (SM).
- Another soil sample has the following visual estimate: 10-percent gravel, 30-percent sand, and 60-percent fines (passing the No. 200 sieve). The fines are estimated as low-plastic silt. This visual classification is SANDY SILT. The gravel portion is not included in the soil name because the gravel portion was estimated as less than 15 percent. The Group Symbol is (ML).

The gradation of coarse-grained soil (more than 50 percent retained on No. 200 sieve) is included in the specific soil name in accordance with ASTM D 2488.

- There is no need to further document the gradation.
- However, the maximum size and angularity or roundness of gravel and sand-sized particles should be recorded.
- For fine-grained soil (50 percent or more passing the No. 200 sieve), the name is modified by the appropriate plasticity/elasticity term in accordance with ASTM D 2488.

Interlayered soil should each be described starting with the predominant type.

- An introductory name, such as "Interlayered Sand and Silt," should be used.
- In addition, the relative proportion of each soil type should be indicated (see Table 1 for example).

Where helpful, the evaluation of plasticity/elasticity can be justified by describing results from any of the visual-manual procedures for identifying fine-grained soils, such as reaction to shaking, toughness of a soil thread, or dry strength as described in ASTM D 2488.

(2) Group Symbol

The appropriate group symbol from ASTM D 2488 must be given after each soil name.

1) The group symbol should be placed in parentheses to indicate that the classification has been estimated.
2) In accordance with ASTM D 2488, dual symbols (e.g., GP-GM or SW-SC) can be used to indicate that a soil is estimated to have about 10-percent fines.
3) Borderline symbols (e.g., GM/SM or SW/SP) can be used to indicate that a soil sample has been identified as having properties that do not distinctly place the soil into a specific group. Generally, the group name assigned to a soil with a borderline symbol should be the group name for the first symbol. The use of a borderline symbol should not be used indiscriminately. Every effort should be made to first place the soil into a single group.

(3) Color

Soil color is described by comparing the sample with the Munsell Soil Color Charts. The Munsell colors should be used unless directed otherwise by project sampling plans. Instructions for their proper use are in the color charts. The color name shall precede the Munsell color notation (e.g., "yellowish brown, 10 YR 5/4"), with color hue and chroma number parenthetically entered in the borelog description. If no color chip is available, the color should be simply described as primary color (i.e., green, brown, gray, yellow, tan, etc.).

(4) Particle Size Distribution

Within the gravel sizes and the sand sizes, there are further divisions based on particle sizes. Gravel is divided into fine and coarse gravel. Fine-gravel particles (pebbles) are those that would pass through 3/4-inch opening but not a 1/4-inch opening. The fine gravel ranges from pea- to marble-sized. Coarse-gravel particles are those that would pass through a 3-inch opening but not a 3/4-in opening. Common objects of this size are grapes and tennis balls. Cobbles range from 3 inches to 12 inches in size; boulders are larger than 12 inches.

Sand is divided into three sizes: fine, medium, and coarse. Sand passes a No. 4 sieve (approximately 1/4 inch) and is retained in a No. 200 sieve (0.003 inch). Fine-sand particles pass a No. 40 sieve (approximately 1/64 inch) and are retained in the No. 200 (0.003 inch) sieve. These particles are sugar- or table salt-sized. Medium sand passes the No. 10 sieve (approximately 1/2 inch) and retained on the No. 40 sieve. These particles are about the same size as the openings in window screening. Coarse-sand particles would pass a No. 4 sieve (approximately 1/4 inch) and be retained on a No. 10 sieve. Rock salt granules fall in this size range. Sand and gravel particle sizes are illustrated in ASTM D2488 along with percentage estimating charts. The percentages of different grain size fractions are important in the soil type determination.

(5) Moisture Content

Soil moisture content shall be estimated using only the terminology described below:

- Dry - Absence of moisture, dusty, dry to the touch
- Moist - Damp but no visible water
- Wet - Visibly free water, usually sampled from below the water table

(6) Relative Density or Consistency

An estimate of the consistency shall accompany descriptions of all fine-grained soil (silt and clay where more than 50 percent of the material would pass the No. 200 sieve). A pocket penetrometer is the most accurate method for estimating the consistency of fine-grained soils. The table below lists characteristics for soil consistency identification.

Consistency	Unconfined Compressive Strength (tons/ft)[a]	Blows/foot (SPT) [b]	Manual Procedure
Very soft	<0.25	0 – 4	Thumb will penetrate soil more than 1 inch (25 mm).
Soft	0.25 - 0.50	4 – 8	Thumb will penetrate soil about 1 inch (25 mm).
Firm (formerly stiff)	-1.50	8 – 15	Thumb will indent soil about 1/4 inch (6 mm).
Hard	-2.00	15 – 30	Thumb will not indent soil but readily indented with thumbnail.
Very hard	>4.0	> 30	Thumbnail will not indent soil.

Notes:

[a] Pocket penetrometer

[b] Blows/foot is defined as the total number of blows required to drive the second and third 6 inches of penetration (blow counts for the first 6 inches are also noted) while driving an 18-inch SPT sampler with a 140-pound hammer falling a free height of 30 inches. Conversion factors may be applied when the field log information is transferred to the final log when using a sampler other than an SPT (Standard penetrometer) (e.g., S&H or Modified California), or when using different hammer weights and drop. The conversion factor is approximately 0.5 for an S&H sampler with a hammer weight of 140 pounds falling 30 inches.

Descriptions of all coarse-grained soil (sand and gravel where less than 50 percent of the material would pass the No. 200 sieve and 100 percent would pass the 3-inch sieve) shall be

accompanied by an estimate of the density based upon standard penetrometer (SPT) blow counts. The following terminology should be used:

Density	Blows/foot (SPT)
Very loose	< 4
Loose	4-10
Medium dense	10-30
Dense	30-50
Very dense	> 50

(7) Soil Structure, Mineralogy, and Other Descriptors

Discontinuities and inclusions are important and should be described. Such features include joints or fissures, slickensides, bedding or laminations, veins, root holes, and wood debris.

Significant mineralogical information such as cementation, abundant mica, or unusual mineralogy should be described.

Other descriptors may include particle angularity or shape, maximum particle size, hardness of large particles, plasticity of fines, dry strength, dilatancy, toughness, reaction to HCl, and staining, as well as other information such as organic debris, odor, or presence of free product. Criteria for the use of these other descriptions include:

- Structure:
  - Stratified - Alternating layers of varying material or color with layers at least 1/4-inch thick; note thickness.
  - Laminated - Alternating layers of varying material or color with the layers less than 1/4-inch thick; note thickness.
  - Fissured - Breaks along definite planes of fracture with little resistance.
  - Slickensides - Fracture planes appear polished or glossy, often striated.
  - Blocky - Cohesive soil that can be broken down into small angular lumps that resist further breakdown.
  - Lensed - Inclusion of small pockets of different soils, such as lenses of sand within clay; note thickness.
  - Homogeneous - Same color and appearance throughout.
  - Grading - Whether the particles increase or decrease in size toward the top of logged interval.
- Particle Shape:
  - Flat - Particles with width/thickness ratio > 3.
  - Elongated - Particles with length/width ratio > 3.

  - Elongated and flat - Particles meet criteria for both flat and elongated.

- Particle Angularity:
  - Angular - Particles have sharp edges and relatively planar sides with unpolished surfaces.
  - Subangular - Particles are similar to angular description but have rounded edges.
  - Subrounded - Particles have nearly planar sides but have well-rounded corners and edges.
  - Rounded - Particles have smoothly-curved sides and no edges.
- Cementation:
  - Weak - rumbles or breaks with handling or little finger pressure.
  - Moderate - Crumbles or breaks with considerable finger pressure.
  - Strong - Will not crumble or break with finger pressure.
- Reaction with HCl:
  - None - No visible reaction.
  - Weak - Some reaction, bubbles forming slowly.
  - Strong - Vigorous reaction, bubbles forming immediately.

Comments

This section should be reserved for information not pertaining to lithologic description. Sample information including sample identifier, analysis, matrix, and depth interval should be included in the boring log comments. Information related to drilling, such as drilling rate, chatter, and equipment malfunctions should also be well documented in the comments section of the boring log. Additionally interpretations of the lithologic data may also be presented in the comments section. Examples of this include "transition between Older Alluvium and Fanglomerate," "paleosol horizon B," or "conductive zone."

Recovery

Recovery data are entered along the left side of the boring log. Enter the length of retrieved core to the nearest 0.1 foot of sample recovered and record the value in feet. Do not count slough or caved material as part of the total recovered length of core. Record total length and percent of sample recovered. If using a 5-foot sample barrel, multiply the total length by 2 and 100 to get a percentage number. Similarly, if using a 2.5-foot sampler, multiply by 4 and 100 to get the percent recovery.

Backfilling

When a boring is completed and the water level measured, the boring shall be backfilled to ground surface according to applicable regulations. The destruction of the hole shall be noted on the log. Borehole destruction should follow SOP 28 *Soil Boring Abandonment*

Attachments

- Soil Boring Log, CH2M HILL Form D1586, and a completed example
- Unified Soil Classification System and Logging Criteria

Key Checks and Preventive Maintenance

Check entries to the soil boring log and field logbook in the field; because the samples will be disposed of, confirmation and corrections cannot be made later. Check that sample numbers and intervals are properly specified. Check that drilling and sampling equipment is decontaminated using the procedures defined in SOP *Decontamination of Drilling Rigs and Equipment*.

ATTACHMENT A

Examples of Soil Bore Logs

CH2MHILL

PROJECT NUMBER	BORING NUMBER SHEET OF

SOIL BORING LOG

PROJECT _____ LOCATION _____

ELEVATION _____ DRILLING CONTRACTOR _____

DRILLING METHOD AND EQUIPMENT _____

WATER LEVELS _____ START _____ FINISH _____ LOGGER _____

DEPTH BELOW SURFACE (FT)	SAMPLE			STANDARD PENETRATION TEST RESULTS	SOIL DESCRIPTION	COMMENTS
	INTERVAL	NUMBER AND TYPE	RECOVERY (FT)	6"-6"-6" (N)	SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION

SHEET 1 of 9	**PROJECT NUMBER:** 326128.01.16.EN	**BORING NUMBER:** *MW-47*

SOIL BORING LOG - DRAFT FOR DISCUSSION

PROJECT NAME: IMPM Drill Program		**HOLE DEPTH (ft):** 288.0	**DRILLING CONTRACTOR:** Prosonic Corp. Phoenix, AZ	
SURFACE ELEVATION: 482.6 ft. MSL	**NORTHING (CCS NAD 27 Z 5):** 2,103,450.05	**EASTING (CCS NAD 27 Z 5):** 7,615,629.49	**DATE STARTED:** 02/27/2006	**DATE COMPLETED:** 03/13/2006
DRILLING METHOD: Rotosonic			**DRILLING EQUIPMENT:** Sonic AT (track mounted)	
LOCATION: PG&E Compressor Station - Flood Plain, Topock, California			**LOGGED BY:** B. Moayyad, K. Ebel	

DEPTH BGS (feet)	SAMPLE INTERVAL	SAMPLE TYPE/ NUMBER	SAMPLE RECOVERY (ft)	USCS CODE	SOIL DESCRIPTION SOIL NAME, USCS SYMBOL, COLOR, PERCENT COMPOSITION, GRADING, GRAIN SHAPE, MINERALOGY, DENSITY/CONSISTENCY, STRUCTURE, MOISTURE.	COMMENTS DRILLING OBSERVATIONS AND OPERATIONS, DAILY START AND END TIMES , DRILL RATE, REFUSALS, SAMPLING AND TESTING NOTES.
5			6	SP	**POORLY GRADED SAND (SP)** - very lt brn (10YR7/3), =2% fines, 98% f to m lithic quartz sand, subang to subrnd, dry - fine roots, iron staining, some iron oxide coating on grains	Hand augured to 5' bgs
10			10	SP	- slightly moist - dry	Rapid drill rate, no chatter
15						
20			16	SW	**WELL GRADED SAND w/ GRAVEL (SW)** - lt yellowish brn (10YR6/4), 45% gravel up to 7cm, 50% f to m sand, 5% fines, loose, met subang gravel, dry(moist@ 17') - cobble present in slough - one subrnd chert gravel - Possible Fluvially Reworked Alluvium - lt grey (10YR7/2), subang to rnd met gravel up to 9cm, 2% to 5% fines - dk yellowish brn (10YR4/4), mostly c sand subang to ang, met, some Miocene conglomerate gravel	
25				SW	- 65% sand, 30% gravel up to 4cm, 5% fines	
30				SW	**WELL GRADED SAND w/ GRAVEL (SW)** - dk yellowish brn (10YR3/6), 35% gravel up to 4cm, 55% m to c sand, 10% silty fines, met clasts are grain supported some mm siltstone - some oxide staining	
35				SW	**WELL GRADED SAND w/ GRAVEL AND CLAY (SW)** - dk yellowish brn (10YR3/6), 30% subang met gravel up to 7 cm, 55% subrnd to subang m to c sand, 15% clayey fines, m density, moist	Drill rate slowed to clean out 8" pipe

CH2MHILL

PROJECT NUMBER: 326128.01.16.EN

BORING NUMBER: *MW-47*

SOIL BORING LOG - DRAFT FOR DISCUSSION

PROJECT NAME: IMPM Drill Program		**HOLE DEPTH (ft):** 288.0	**DRILLING CONTRACTOR:** Prosonic Corp. Phoenix, AZ	
SURFACE ELEVATION: 482.6 ft. MSL	**NORTHING (CCS NAD 27 Z 5):** 2,103,450.05	**EASTING (CCS NAD 27 Z 5):** 7,615,629.49	**DATE STARTED:** 02/27/2006	**DATE COMPLETED:** 03/13/2006
DRILLING METHOD: Rotosonic			**DRILLING EQUIPMENT:** Sonic AT (track mounted)	
LOCATION: PG&E Compressor Station - Flood Plain, Topock, California			**LOGGED BY:** B. Moayyad, K. Ebel	

DEPTH BGS (feet)	SAMPLE INTERVAL	SAMPLE TYPE/ NUMBER	SAMPLE RECOVERY (ft)	USCS CODE	SOIL DESCRIPTION SOIL NAME, USCS SYMBOL, COLOR, PERCENT COMPOSITION, GRADING, GRAIN SHAPE, MINERALOGY, DENSITY/CONSISTENCY, STRUCTURE, MOISTURE.	COMMENTS DRILLING OBSERVATIONS AND OPERATIONS, DAILY START AND END TIMES , DRILL RATE, REFUSALS, SAMPLING AND TESTING NOTES.
			2.5	SW	**WELL GRADED SAND w/ GRAVEL (SW)** - dr yellowish brn (10YR3/6), 30% gravel, 60% sand, 10% silty fines	Drilling smooth but preceeds less rapidly
40			10	SW	**WELL GRADED SAND w/ GRAVEL (SW)** - 40% subang met gravel up to 6cm, 55% subrnd to ang sand, 5% fines - more gravel below 38' - gravel is mostly fine	
45						
50			10	SW	**WELL GRADED SAND w/ GRAVEL (SW)** - Pale brn (10YR6/3), 30% subang met gravel up to 5cm, 60% subrnd to subang m to c met sand, 10% silty fines, wet	Soil sample collected
				SP	**POORLY GRADED SAND w/ GRAVEL (SP)** - pale brn (10TR6/3), 30% f subang gravel up to 2 cm, 65% mostly c sand, =2% fines	
55				SW	**WELL GRADED SAND w/ GRAVEL (SW)** - yellowish brn (10YR5/4), 40% subang met gravel up to 9cm, 55% f to c met sand, 5% silty fines, clast supported, m density, wet	
60			9.5	GW	**WELL GRADED GRAVEL w/ SILT AND SAND (GW)** - brn (7.5YR5/4), 55% subang to ang met gravel up to 4cm, 25% f to c sand, 20% silty fines, dense, moist to dry - soil dries out	Collected Isoflow sample
65					- lt grey (10YR7/2) and powder dry - moist sandy zone, 55% gravel, 35% sand, 10% fines - dry silty lt grey GW below 65'	Drill rate slows to 2' / min
70				SW	**WELL GRADED SAND w/ GRAVEL (SW)** - yellowish brn (10YR5/4), 35% subang met gravel up to 4cm, 60% subrnd sand, 5% silty fines, loose, moist to wet	Moderate Drill Rate

CH2MHILL

PROJECT NUMBER: 326128.01.16.EN

BORING NUMBER: *MW-47*

SOIL BORING LOG - DRAFT FOR DISCUSSION

PROJECT NAME: IMPM Drill Program		**HOLE DEPTH (ft):** 288.0	**DRILLING CONTRACTOR:** Prosonic Corp. Phoenix, AZ	
SURFACE ELEVATION: 482.6 ft. MSL	**NORTHING (CCS NAD 27 Z 5):** 2,103,450.05	**EASTING (CCS NAD 27 Z 5):** 7,615,629.49	**DATE STARTED:** 02/27/2006	**DATE COMPLETED:** 03/13/2006
DRILLING METHOD: Rotosonic			**DRILLING EQUIPMENT:** Sonic AT (track mounted)	
LOCATION: PG&E Compressor Station - Flood Plain, Topock, California			**LOGGED BY:** B. Moayyad, K. Ebel	

DEPTH BGS (feet)	SAMPLE INTERVAL	SAMPLE TYPE/ NUMBER	SAMPLE RECOVERY (ft)	USCS CODE	SOIL DESCRIPTION SOIL NAME, USCS SYMBOL, COLOR, PERCENT COMPOSITION, GRADING, GRAIN SHAPE, MINERALOGY, DENSITY/CONSISTENCY, STRUCTURE, MOISTURE.	COMMENTS DRILLING OBSERVATIONS AND OPERATIONS, DAILY START AND END TIMES , DRILL RATE, REFUSALS, SAMPLING AND TESTING NOTES.
			6	SP	**POORLY GRADED SAND w/ SILT (SP)** - brn (7.5YR4/4), 5% subrnd to subang met gravel up to 4cm, 85% f to c sand, 10% fines, poorly graded, wet, no odor	
145			3	SM	**SILTY SAND W/ GRAVEL (SM)** - brn (7.5YR4/4), 20% subang to subrnd gravel up to 6cm, 60% f to c sand, 20% silty fines, well graded, m consolidated, met, wet, no odor	
150			5	SM	**SILTY SAND w/ GRAVEL (SM)** - dk yellowish brn (10YR4/4), 25% subang to subrnd up to 4cm met gravel, 60% well graded f to c sand, 15% fines, wet, no odor	
155			4	SW	**WELL GRADED SAND w/ SILT AND SAND (SW)** - dr yellowish brn (10YR4/4), 10% subang to subrnd up to 3cm met gravel, 75%well graded f to c sand, 15% fines, moist to wet	
			2	SW	**SILTY SAND (SM)** - brn (7.5YR4/4), 5% ang to subrnd met gravel up to 1.5cm increasing with depth, 85% poorly graded m to c sand, 10% fines, loose, wet	
			2	SM	**SILTY SAND w/ GRAVEL (SM)** - dk yellowish brn (10YR4/4), 15% subang to subrnd up to 2.5cm met gravel, 75% well graded f to c sand, 10% fines, mostly met, trace chert, loose, wet, no odor	Collected Isoflow sample
160			4	SM	**SILTY SAND W/ GRAVEL (SM)** - brn (7.5YR4/4), 25% subang to subrnd gravel up to 6.5cm, 60% m to c sand, 15% silty fines, well graded, m consolidated, met, wet, no odor	Drill rate = 0.75' to 1.5' / min
165			4	SW	**SILTY SAND (SW)** - mottled dk reddish brn (5YR3/4), 10% subang to subrnd gravel up to 2.5cm, 50% well graded f to m sand, 40% silt, metamorphic, dry to damp, no odor, interbedded sandy silt laminations	
170			5.5	SW	**SAND w/ GRAVEL (SW)** - dk reddish brn (5YR3/4), 20% subang to subrnd gravel up to 5cm, 75% f to c sand, 5% fines, well graded, loose, met, wet	
175			2.5	SM	**SILTY SAND w/ GRAVEL (SM)** - brn (7.5YR4/4), 15% subang to subrnd gravel, 70% f to m sand, 15% fines, poorly graded, met,increasingly consolidated, slightly to moderately calcareous, moist to wet	

PROJECT NUMBER:	BORING NUMBER:
326128.01.16.EN	*MW-47*

SOIL BORING LOG - DRAFT FOR DISCUSSION

PROJECT NAME: IMPM Drill Program		**HOLE DEPTH (ft):** 288.0	**DRILLING CONTRACTOR:** Prosonic Corp. Phoenix, AZ	
SURFACE ELEVATION: 482.6 ft. MSL	**NORTHING (CCS NAD 27 Z 5):** 2,103,450.05	**EASTING (CCS NAD 27 Z 5):** 7,615,629.49	**DATE STARTED:** 02/27/2006	**DATE COMPLETED:** 03/13/2006
DRILLING METHOD: Rotosonic			**DRILLING EQUIPMENT:** Sonic AT (track mounted)	
LOCATION: PG&E Compressor Station - Flood Plain, Topock, California			**LOGGED BY:** B. Moayyad, K. Ebel	

DEPTH BGS (feet)	SAMPLE INTERVAL	SAMPLE TYPE/ NUMBER	SAMPLE RECOVERY (ft)	USCS CODE	SOIL DESCRIPTION SOIL NAME, USCS SYMBOL, COLOR, PERCENT COMPOSITION, GRADING, GRAIN SHAPE, MINERALOGY, DENSITY/CONSISTENCY, STRUCTURE, MOISTURE.	COMMENTS DRILLING OBSERVATIONS AND OPERATIONS, DAILY START AND END TIMES , DRILL RATE, REFUSALS, SAMPLING AND TESTING NOTES.
285			0	BR	**MIOCENE CONGLOMERATE BEDROCK (BR)** - 60% well graded subang to rnd gravel up to 10cm, 30% well graded sand, 10% fines, very calcareous, well consolidated to mostly hard, mod to very altered locally, mostly met, dry to moist	
					Boring Terminated at 288 ft	

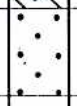
ABBREVIATIONS

cc = continuous core run
brn = brown
lt = light
dk = dark
vf = very fine-grained
f = fine-grained
m = medium-grained
c = coarse-grained
vc = very coarse-grained
ang = angular
subang = subangular
subrnd = subrounded
rnd = rounded
br = bedrock formation
ss = sandstone
conglom = conglomerate
comptd = compacted
qtz = quartz

CH2MHILL

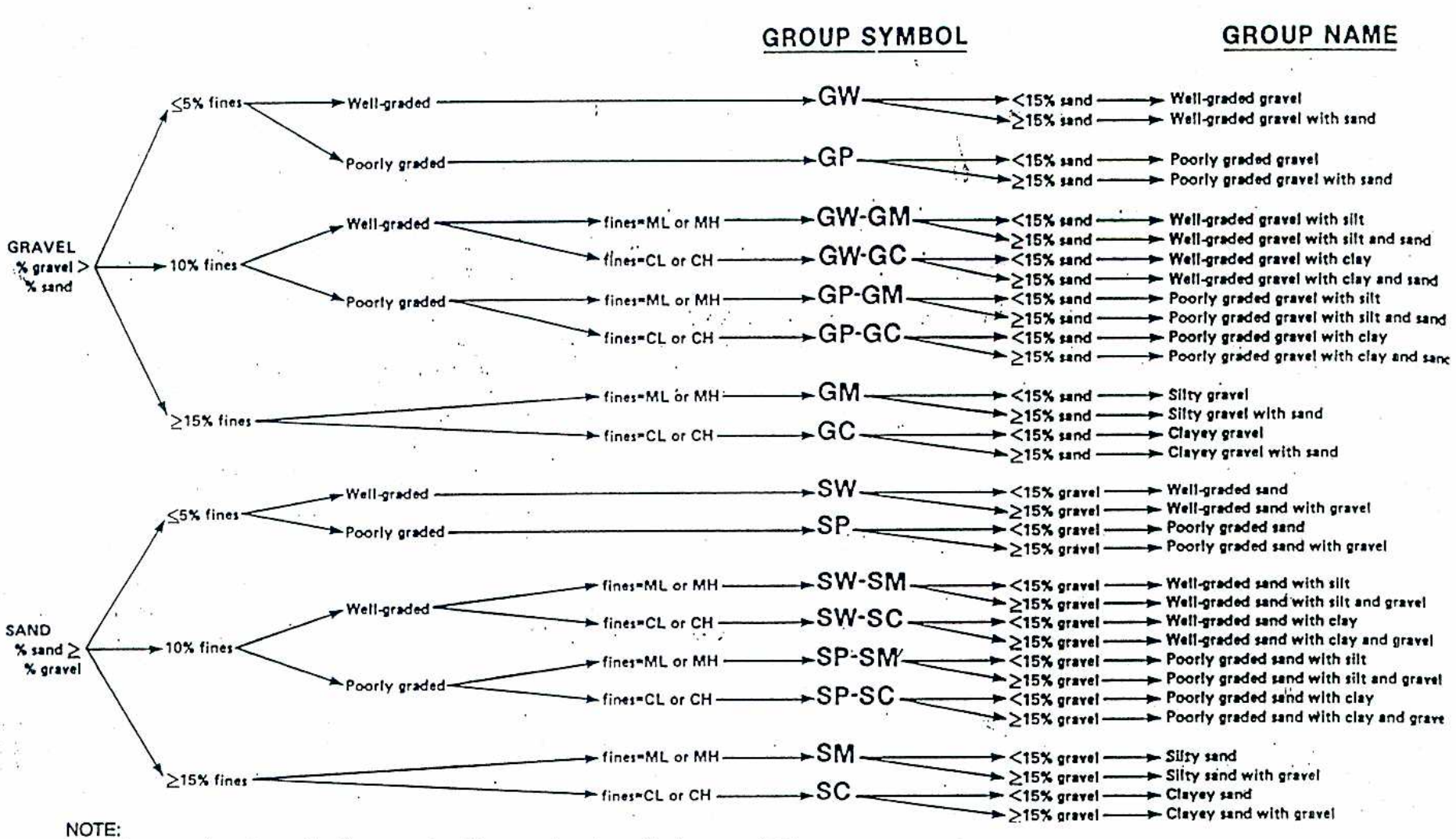
ATTACHMENT B

Unified Soil Classification System and Logging Criteria

GENERAL SOIL CATEGORIES			SYMBOLS		TYPICAL SOIL TYPES
COARSE GRAINED SOILS More than half is larger than No. 200 sieve	GRAVEL More than half coarse fraction is larger than No. 4 sieve size	Clean Gravel with little or no fines	GW		Well Graded Gravel, Gravel-Sand Mixtures
			GP		Poorly Graded Gravel, Gravel-Sand Mixtures
		Gravel with more than 12% fines	GM		Silty Gravel, Poorly Graded Gravel-Sand-Silt Mixtures
			GC		Clayey Gravel, Poorly Graded Gravel-Sand-Clay Mixtures
	SAND More than half coarse fraction is smaller than No. 4 sieve size	Clean sand with little or no fines	SW		Well Graded Sand, Gravelly Sand
			SP		Poorly Graded Sand, Gravelly Sand
		Sand with more than 12% fines	SM		Silty Sand, Poorly Graded Sand-Silt Mixtures
			SC		Clayey Sand, Poorly Graded Sand-Clay Mixtures
FINE GRAINED SOILS More than half is smaller than No. 200 sieve	SILT AND CLAY Liquid Limit Less than 50%		ML		Inorganic Silt and Very Fine Sand, Rock Flour, Silty or Clayey Fine Sand, or Clayey Silt with Slight Plasticity
			CL		Inorganic Clay of Low to Medium Plasticity, Gravelly Clay, Sandy Clay, Silty Clay, Lean Clay
			OL		Organic Clay and Organic Silty Clay of Low Plasticity
	SILT AND CLAY Liquid Limit Greater than 50%		MH		Inorganic Silt, Micaceous or Diatomaceous Fine Sandy or Silty Soils, Elastic Silt
			CH		Inorganic Clay of High Plasticity, Fat Clay
			OH		Organic Clay of Medium to High Plasticity, Organic Silt
HIGHLY ORGANIC SOILS			PT		Peat and Other Highly Organic Soils

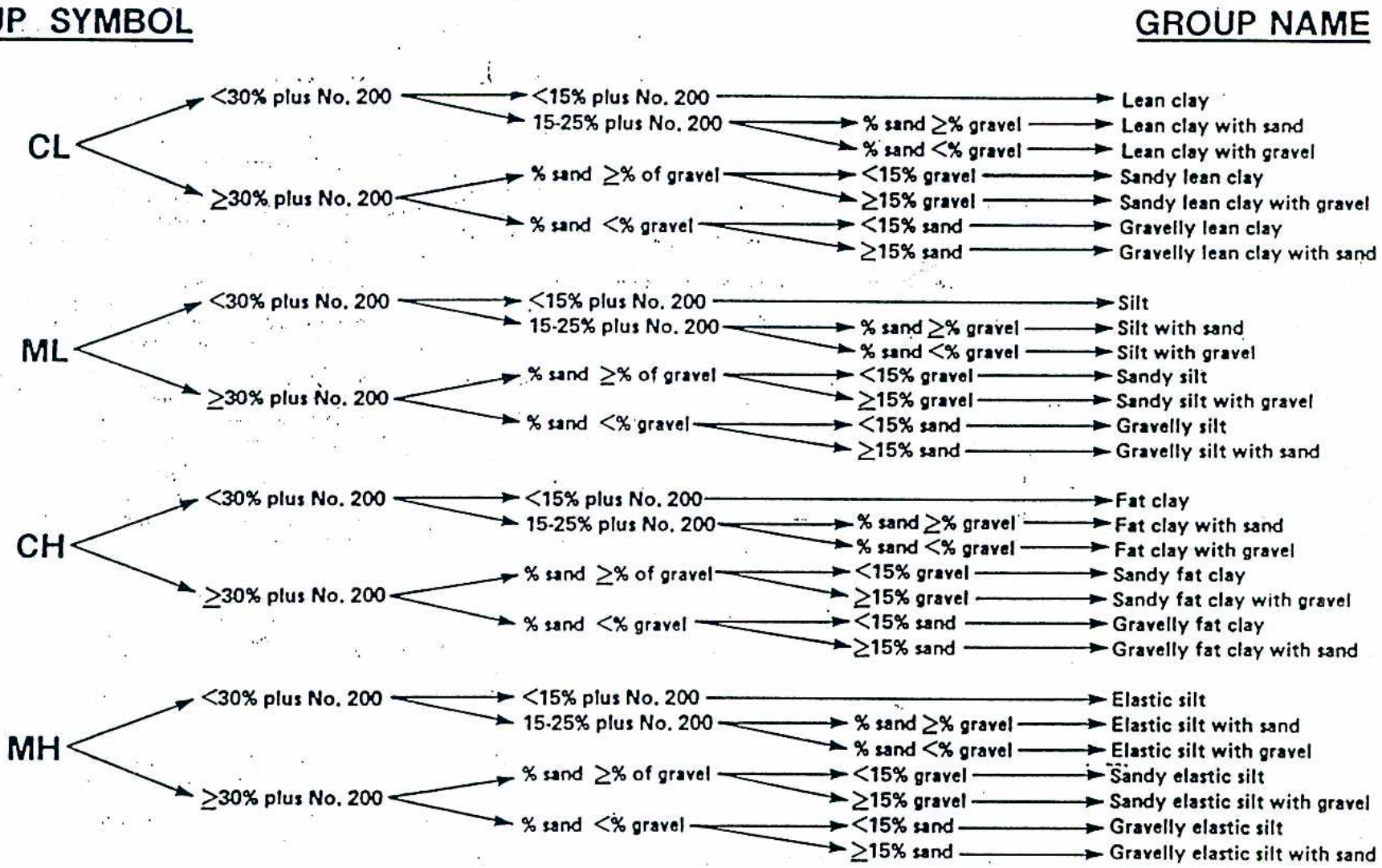
UNIFIED SOIL CLASSIFICATION SYSTEM

		PLATE
JOB NUMBER	DATE APPROVED	



NOTE:
Percentages are based on estimating amounts of fines, sand, and gravel to the nearest 5%
(After ASTM Designation D2488 Standard Test Method for Classification of Soils for Engineering Purposes)

Flow Chart for Classifying Coarse-grained Soil
(50% or more retained on No. 200 sieve)
Field Guide for Soil Classification and Logging Procedures



NOTE:
Percentages are based on estimating amounts of fines, sand, and gravel to the nearest 5%
(After ASTM Designation D2488 Standard Test Method for Classification of Soils for Engineering Purposes)

Flow Chart for Classifying Fine-grained Soil
(50% or more passing No. 200 sieve)
Field Guide for Soil Classification and Logging Procedures

similar, the material is classified as poorly graded or well sorted. If fines represent less than 5 percent of the total mass, the symbol SP is used for a poorly-graded sand and SW for a well graded sand. If silts and/or clays exceed 12 percent, the symbols GC, SC, GM, and SM are used, respectively.

If the silts and clays are between 5 to 12 percent of the total sample weight, a dual classification with two group symbols is used. The first symbol is GW, GP, SW, or, SP, and the second is GC, GM, SC, or SM. The group name corresponds to the first group symbol plus the modifying words "with clay" or "with silt" to indicate the plasticity characteristics. If the fines plot on the CL-ML range on the plasticity chart (Figure 2-2), possible dual classification group names are:

GW-GM	well graded gravel with silt
GW-GC	well graded gravel with clay
GP-GM	poorly graded gravel with silt
GP-GC	poorly graded gravel with clay
SW-SM	well graded sand with silt
SW-SC	well graded sand with clay
SP-SM	poorly graded sand with silt
SP-SC	poorly graded sand with clay

If silts and clays exceed 12 percent of the total weight of sample, the modifiers "M" and "C" are used, respectively. If a sand or gravel has more than 15 percent of the other coarse-grained constituent, the words "with gravel" or "with sand" are added to the group name. A flow chart for classifying coarse-grained soils is presented in Figure 2-3.

2.2 Fine-grained Soils

Particles passing the No. 200 sieve are silts (M) and clays (C). These soils must undergo testing in order to differentiate between them. Typical tests used are: dry strength, dilatancy, toughness, and plasticity. These terms are further discussed in Tables 2-2 through Table 2-6. Silts have little or no dry strength when dry, while clays have considerable dry strength. Dry strength, dilatancy, and toughness are also used to identify the fine-grained fraction of coarse-grained soils.

TABLE 2-2
Criteria for Describing Dry Strength

Description	Criteria
None	The dry specimen crumbles into powder with the mere pressure of handling.
Low	The dry specimen crumbles into powder with some finger pressure.
Medium	The dry specimen breaks into pieces or crumbles with considerable finger pressure.
High	The dry specimen cannot be broken with finger pressure. The specimen will break into pieces between the thumb and a hard surface.
Very high	The dry specimen cannot be broken between the thumb and a hard surface.

TABLE 2-3
Criteria for Describing Dilatancy

Description	Criteria
None	There is no visible change in the specimen.
Slow	Water appears slowly on the surface of the specimen during shaking, and does not disappear, or disappears slowly upon squeezing.
Rapid	Water appears quickly on the surface of the specimen during shaking, and disappears quickly upon squeezing.

TABLE 2-4
Criteria for Describing Toughness

Description	Criteria
Low	Only slight pressure is required to roll the thread near the plastic limit. The thread and the lump are weak and soft.
Medium	Medium pressure is required to roll the thread to near the plastic limit. The thread and the lump have medium stiffness.
High	Considerable pressure is required to roll the thread to near the plastic limit. The thread and the lump have very high stiffness.

TABLE 2-5
Identification of Inorganic Fine-grained Soils from Manual Tests

Soil Symbol	Dry Strength	Dilatancy	Toughness
ML	None to low	Slow to rapid	Low or thread cannot form
CL	Medium to high	None to slow	Medium
MH	Low to medium	None to slow	Low to medium
CH	High to very high	None	High

TABLE 2-6
Criteria for Describing Plasticity

Description	Criteria
Nonplastic	A 1/8-inch (3-mm) thread cannot be rolled at any water content.
Low	The thread can barely be rolled, and the lump cannot be formed when drier than the plastic limit.
Medium	The thread is easy to roll, and not much time is required to read the plastic limit. The thread cannot be re-rolled after reaching the plastic limit. The lump crumbles when drier than the plastic limit.
High	It takes considerable time rolling and kneading to reach the plastic limit. The thread can be re-rolled several times after reaching the plastic limit. The lump can be formed without crumbling when drier that the plastic limit.

Fine-grained soils are accurately determined in the laboratory using the Atterberg Limits test. This test include liquid limit, plastic limit, and plasticity index measurements. The liquid limit is the water content of a soil at the point of transition from a plastic to a liquid state. The plastic limit is the water content of a soil at the point of transition from a semisolid to a plastic state. The plasticity index is the difference between the liquid limit and the plastic limit.

As shown in the Figure 2-2, five fields have been identified. These include:

- Silty Clays (CL), Organic Silts (OL) or Organic Silty Clays (OL) of low plasticity
- Fat Clays (CH) and Organic Clays (OH)
- Inorganic Silts (ML) and Organic Silty Clays (OL) of low plasticity
- Silts (MH) and Organic Clays (OH) of a high plasticity
- Silty Clays to Clayey Silt (CL-ML) of low plasticity

Fine-grained soils with a liquid limit > 50 are modified by the symbol H (MH or CH), and those with a liquid limit < 50 are modified by the symbol L (ML or CL). Fine-grained soils containing 30 percent or more coarse-grained fraction should be modified by descriptive terms, such as "gravelly" or "sandy." If the coarse fraction is between 15 and 30 percent, the words" with sand and/or gravel" should be added to the group name. A flow chart for classifying fine-grained soils is presented in Figure 2-4.

2.3 Organic Soils

To classify organic soils, the percentage organic material present in the soil as well as the non-organic fines must be estimated. When the organic content ranges from 18 to 36 percent, the material is an organic clay or an organic silt, depending on the nature of the fine-grained constituents. When the organic content is between 36 and 90 percent, the material is designated a muck or peaty muck (OL or OH). A flow chart for classifying organic soil is presented in Figure 2-4. The term "peaty" is added if the organic remains are

SOP-B3

Borehole Sampling and Logging of Soil Borings
Standard Operating Procedures for PG&E Topock Program

This standard operating procedure (SOP) provides guidance for sample collection from soil borings during the drilling process, and proper documentation necessary. Detailed guidance for sample collection, preservation and handling is provided in Section 4.0 of the site Quality Assurance Project Plan (QAPP) and in the Topock Program *Sampling, Analysis, and Field Procedures Manual* (Procedures Manual). SOP-B2 provides detailed guidance for soil characterization and logging.

REQUIRED DOCUMENTS

1) Event-specific sampling and analysis plan (SAP), work plan or event-specific field instructions. Planned borehole depth, proposed well construction/specifications, and field sampling summary table, if available.

2) Applicable project work plan or monitoring plan. Refer to the Procedures Manual and QAPP, as required.

3) Topock Program Health and Safety Plan (HSP).

4) Previous sampling, drilling, or well construction logs from other boreholes or wells in the vicinity, if available.

5) Blank sampling log and field notebook.

PREPARATION AND SETUP

1) Review event-specific work plan or event-specific field instructions, previous sampling logs, Procedures Manual, and HSP.

2) Initiate field logbook for sampling activity.

3) Review sampling procedures and equipment, and planned sample depths with drilling contractor and field crew.

Equipment List

- Field logbook
- Borehole log
- Blue or black waterproof or permanent ink pens
- Trash bags
- Plastic sandwich bags
- Paper towels

- Stainless steel sampling equipment (provided by driller)
- Decontamination equipment (Alconox® solution in spray bottle, brushes, buckets, rinse water spray bottle)
- Soil sample containers appropriate for sample analysis and preservation as called for in SAP and QAPP (glass jars, brass sleeves, Encore® containers, sandwich bags, etc.)
- Soil sampling equipment not provided by driller (spatula or putty knife, stainless steel compositing bowl, hand auger, etc.)
- Groundwater sample containers appropriate for sample analysis and preservation as called for in SAP and QAPP (glass jars, VOA vials, plastic jars, etc.)
- Groundwater sample equipment not provided by driller (pump, filters, tubing, power supply, etc.)
- Water quality meters
- Water level indicator
- Distilled water
- Coolers with ice
- Protective waterproof gloves (nitrile or latex)

GUIDELINES

Soil Boring Logs Documentation

Soil boring logs will be completed on the soil boring log forms during the drilling activities at the time of the logging and soil descriptions. Information collected will be consistent with the standard CH2M HILL form (See SOP-B2 attachment A). Sample data may also be documented in the comments section of the boring log.

Items documented on the borehole log include:

1) **Sample Interval:** The top and bottom depth of each sample run should be recorded on the borelog. Sampling includes samples collected for analysis as well as core retrieved for logging purposes.

2) **Sample Type and Number:** Enter the sample type and number consistent with the sampling and analysis plan at the correct depth intervals. An "x" should be placed across the vertical interval where the environmental soil, grab groundwater, or geotechnical sample was collected.

3) **Sample Recovery:** Enter the length of retrieved core to the nearest 0.1 foot of sample recovered, and record the value in feet. Do not count slough or caved material as part of the total recovered length of core. Record total length and percent of sample recovered. If using a 5-foot sample barrel, multiply the total length by 2 and 100 to get a percentage number. Similarly, if using a 2.5-foot sampler, multiply by 4 and 100 to get the percent recovery.

4) **Sampling:** Sampling difficulties shall be noted. Disturbed samples shall be noted on the log as well as the sample recovery. The top of the sample shall be marked on the container.

5) **Water Levels:** Water-level measurements, where groundwater is encountered, are required for each boring. Changes in soil moisture shall be noted and, if there is no water encountered, a note to that effect shall be included on the borehole log. The date and time of water-level measurements shall be documented.

At a minimum, sample identifiers (IDs) should be noted on boring logs at the depth collected. When time and space allows, a summary of analytical sample information can be included. When inclusion of these data prevents documentation of drilling information, sample data should be omitted in order to document drilling.

Borehole Sampling by Drilling—General Procedure

Split-spoon sampling procedures shall be executed in accordance with American Society for Testing and Materials (ASTM) D1586, "Standard Method for Penetration Test and Split-barrel Sampling of Soils" (ASTM 1984). California (2-inch) or Modified California (2.5-inch) split-barrel samplers may also be used.

1) The split-spoon or split-barrel sampler shall be advanced to the top of the sampling interval using a wire-line or sample rods such as A or AW. The larger-diameter samplers may be fitted with three 6-inch-long stainless-steel sleeves. The sampler shall be driven 18 inches or to refusal, with a 140-pound hammer dropping repeatedly 30 inches. Refusal shall be defined as requiring 50 blows with the hammer to advance the sampler less than 6 inches.

2) The number of blows required to drive the sampler each 6 inches shall be recorded on the borelog.

3) As the sample tubes are disassembled, an organic vapor monitor probe shall be inserted into the gap between two sample liners, and the liner exhibiting the highest reading shall be selected for analysis.

4) In general, the middle liner is collected for laboratory analysis, and 10 percent of the bottom liners are collected for quality assurance testing. A sample of the soil in the top liner typically is placed in a re-sealable plastic bag or 8-ounce clear glass jar and left in the sun for approximately 15 minutes to allow any volatile organic compounds (VOC) to volatilize.

5) After the 15 minute volatilization period, the soil vapor in the plastic bag is then measured for VOCs by taking a reading of the headspace. Background VOCs for the bag are determined by monitoring the air in an empty bag.

6) Results of the organic vapor monitoring are recorded on the boring log.

7) Small portions of soil at the ends of the sleeve are scraped off for classification.

Borehole Sampling by Drilling—Split Spoon Sampling

1) Samples collected for laboratory analysis using split spoon sampling device will be separated and transferred from the split-spoon halves into sample jars by clean stainless-steel utensils.

2) Samples for VOCs will be separated and collected first, followed by semivolatile organic compounds samples.

3) For VOC samples, avoid mixing the soil before sampling and sample directly from the split spoon. See SOPs for guidance on homogenizing soil samples and for VOC sampling using EnCore samplers, respectively.

Borehole Sampling by Drilling—Direct-push Sampling

1) Samples collected for laboratory analysis using a direct-push sampling drill rig will be handled by either opening the tube and placing the soil in sample jars or cutting the acetate tube and submitting it the laboratory directly.

2) For samples that will be removed from the acetate tube, the tube will be cut open longitudinally using a double-bladed razor knife.

   - Soil will be inspected and logged prior to removal of soil samples.
   - A short section of soil will be removed from the acetate sleeve using a stainless-steel utensil, homogenized in a clean stainless-steel bowl, and placed in sample jars.
   - Soil collected for VOC analysis will be sampled directly from the split acetate sleeve using EnCore samplers.

3) Alternatively, a short (6-inch) length of liner will be cut from the acetate sleeve and collected directly for laboratory analysis.

   - The section of acetate liner will be removed, capped with Teflon sheeting and plastic end caps at both ends, and taped with clear label or packing tape.
   - Labels shall be affixed to the liners with job designation, time, boring number, sample depth interval, sample number, date sampled, and the initials of the sampler clearly marked.
   - The samples shall then be enclosed in a plastic bag and stored in a cooler maintained at 4˚C.
   - Sample information shall be placed on the chain-of-custody, the borelog, and the field logbook. All samples shall be handled in accordance with *Chain of Custody Procedures*.

Borehole Sampling by Drilling—Split-barrel Sampling

Soil samples can also be collected using a 3-foot-long or 5-foot-long split-barrel sampler. The split-barrel sampler is similar to the split-spoon sampler that is used to hold steel or brass sampling sleeves, but the split-barrel sampler typically is not used to hold sample sleeves.

1) The sampler is lowered to the base of the drill bit and is advanced slightly ahead of the drill bit and augers (or conductor casing). The weight of the drill string and sample barrel along with the drilling and cutting action of the drill bit advances the face of the split-barrel sampler into the formation.

2) Once the desired depth interval is reached, the split-barrel sampler is retrieved using a cable or tool steel sections.

3) The retrieved sampler is unscrewed, and one or both halves are laid on the sample table. The soil typically will form a continuous column of soil in one of the split-barrel halves.

4) The soil column is split longitudinally for soil descriptions using a putty knife or spatula.

5) Samples for VOC analysis are collected immediately directly from the soil column.

6) Other soil samples are collected after the core section has been described and logged. The soil is described following the procedures in the following sections.

Groundwater Sampling

1) Groundwater samples can be collected by hydropunch by bailer or by pumping from an isolated zone. Collection of groundwater by bailing is not an accurate method of collection depth discrete groundwater samples, as the zone sampled is poorly isolated.

2) Hydropunch samples are collected below the bit of the drill stem, in relatively undisturbed soil zone. This method of sample collection may be difficult in fine-textured soils and in very rocky soils. To collect these samples, a point is driven below the depth of the drill bit, then a screen zone is opened within this point and water allowed to flow in. The hydropunch tool must be decontaminated between samples.

Groundwater can also be collected from the open or cased borehole with a bailer. A disposable or decontaminated stainless-steel bailer is lowered into the boring, and water is collected. This method is preferable for collection of groundwater from the water table. Attempts can be made to collect discrete groundwater samples beneath the water table; however, the boring must be cased with watertight, stainless-steel pipe, and the boring must be evacuated prior to collection of samples.

Alternatively, discrete groundwater samples can be collected by isolating a zone with casing and packers. To collect these samples, the borehole is first advanced to the depth at which a sample is required. Then casing is advanced to within 20 feet of the sample zone. Next, a pump and packers are lowered into the hole. The zone from which samples are to be collected is isolated with a packer, and water is pumped directly from the target zone.

Sample Handling

Sample preservation and sampling procedures are detailed in Section 4.0 of the QAPP. Additional information is provided in the Procedures Manual and in the appropriate SAP.

KEY CHECKS AND ITEMS

- Check entries to the soil boring log and field logbook in the field during sampling activities because the samples will be disposed at the end of the fieldwork, confirmation and corrections cannot be made later.

- Check that the sample numbers and intervals are properly specified.
- Ensure that drilling equipment is decontaminated prior to the beginning of work and between each borehole.
- All materials generated during sampling (debris, PPE, decontamination liquids, etc.) will be placed in 55-gallon drums or roll-off bins for storage pending analysis and disposal off site, as outlined in SOP 39, Standard of Practice H-83, and Appendix D of the project *Soil and Groundwater Management Plan*.

ATTACHMENT A

Examples of Soil Bore Logs

CH2MHILL

PROJECT NUMBER	BORING NUMBER SHEET OF

SOIL BORING LOG

PROJECT _____ LOCATION _____

ELEVATION _____ DRILLING CONTRACTOR _____

DRILLING METHOD AND EQUIPMENT _____

WATER LEVELS _____ START _____ FINISH _____ LOGGER _____

DEPTH BELOW SURFACE (FT)	SAMPLE			STANDARD PENETRATION TEST RESULTS	SOIL DESCRIPTION	COMMENTS
	INTERVAL	NUMBER AND TYPE	RECOVERY (FT)	6"-6"-6" (N)	SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION

SHEET 1 of 9	**PROJECT NUMBER:** 326128.01.16.EN	**BORING NUMBER:** *MW-47*

SOIL BORING LOG - DRAFT FOR DISCUSSION

PROJECT NAME: IMPM Drill Program		**HOLE DEPTH (ft):** 288.0	**DRILLING CONTRACTOR:** Prosonic Corp. Phoenix, AZ	
SURFACE ELEVATION: 482.6 ft. MSL	**NORTHING (CCS NAD 27 Z 5):** 2,103,450.05	**EASTING (CCS NAD 27 Z 5):** 7,615,629.49	**DATE STARTED:** 02/27/2006	**DATE COMPLETED:** 03/13/2006
DRILLING METHOD: Rotosonic			**DRILLING EQUIPMENT:** Sonic AT (track mounted)	
LOCATION: PG&E Compressor Station - Flood Plain, Topock, California			**LOGGED BY:** B. Moayyad, K. Ebel	

DEPTH BGS (feet)	SAMPLE INTERVAL	SAMPLE TYPE/ NUMBER	SAMPLE RECOVERY (ft)	USCS CODE	SOIL DESCRIPTION SOIL NAME, USCS SYMBOL, COLOR, PERCENT COMPOSITION, GRADING, GRAIN SHAPE, MINERALOGY, DENSITY/CONSISTENCY, STRUCTURE, MOISTURE.	COMMENTS DRILLING OBSERVATIONS AND OPERATIONS, DAILY START AND END TIMES , DRILL RATE, REFUSALS, SAMPLING AND TESTING NOTES.
5			6	SP	**POORLY GRADED SAND (SP)** - very lt brn (10YR7/3), =2% fines, 98% f to m lithic quartz sand, subang to subrnd, dry - fine roots, iron staining, some iron oxide coating on grains	Hand augured to 5' bgs
10			10	SP	- slightly moist - dry	Rapid drill rate, no chatter
15						
20			16	SW	**WELL GRADED SAND w/ GRAVEL (SW)** - lt yellowish brn (10YR6/4), 45% gravel up to 7cm, 50% f to m sand, 5% fines, loose, met subang gravel, dry(moist@ 17') - cobble present in slough - one subrnd chert gravel - Possible Fluvially Reworked Alluvium - lt grey (10YR7/2), subang to rnd met gravel up to 9cm, 2% to 5% fines - dk yellowish brn (10YR4/4), mostly c sand subang to ang, met, some Miocene conglomerate gravel	
25				SW	- 65% sand, 30% gravel up to 4cm, 5% fines	
30				SW	**WELL GRADED SAND w/ GRAVEL (SW)** - dk yellowish brn (10YR3/6), 35% gravel up to 4cm, 55% m to c sand, 10% silty fines, met clasts are grain supported some mm siltstone - some oxide staining	
35				SW	**WELL GRADED SAND w/ GRAVEL AND CLAY (SW)** - dk yellowish brn (10YR3/6), 30% subang met gravel up to 7 cm, 55% subrnd to subang m to c sand, 15% clayey fines, m density, moist	Drill rate slowed to clean out 8" pipe

CH2MHILL

PROJECT NUMBER: 326128.01.16.EN

BORING NUMBER: *MW-47*

SOIL BORING LOG - DRAFT FOR DISCUSSION

PROJECT NAME: IMPM Drill Program		**HOLE DEPTH (ft):** 288.0	**DRILLING CONTRACTOR:** Prosonic Corp. Phoenix, AZ	
SURFACE ELEVATION: 482.6 ft. MSL	**NORTHING (CCS NAD 27 Z 5):** 2,103,450.05	**EASTING (CCS NAD 27 Z 5):** 7,615,629.49	**DATE STARTED:** 02/27/2006	**DATE COMPLETED:** 03/13/2006
DRILLING METHOD: Rotosonic			**DRILLING EQUIPMENT:** Sonic AT (track mounted)	
LOCATION: PG&E Compressor Station - Flood Plain, Topock, California			**LOGGED BY:** B. Moayyad, K. Ebel	

DEPTH BGS (feet)	SAMPLE INTERVAL	SAMPLE TYPE/ NUMBER	SAMPLE RECOVERY (ft)	USCS CODE	SOIL DESCRIPTION SOIL NAME, USCS SYMBOL, COLOR, PERCENT COMPOSITION, GRADING, GRAIN SHAPE, MINERALOGY, DENSITY/CONSISTENCY, STRUCTURE, MOISTURE.	COMMENTS DRILLING OBSERVATIONS AND OPERATIONS, DAILY START AND END TIMES , DRILL RATE, REFUSALS, SAMPLING AND TESTING NOTES.
			2.5	SW	**WELL GRADED SAND w/ GRAVEL (SW)** - dr yellowish brn (10YR3/6), 30% gravel, 60% sand, 10% silty fines	Drilling smooth but preceeds less rapidly
40			10	SW	**WELL GRADED SAND w/ GRAVEL (SW)** - 40% subang met gravel up to 6cm, 55% subrnd to ang sand, 5% fines - more gravel below 38' - gravel is mostly fine	
45						
50			10	SW	**WELL GRADED SAND w/ GRAVEL (SW)** - Pale brn (10YR6/3), 30% subang met gravel up to 5cm, 60% subrnd to subang m to c met sand, 10% silty fines, wet	Soil sample collected
				SP	**POORLY GRADED SAND w/ GRAVEL (SP)** - pale brn (10TR6/3), 30% f subang gravel up to 2 cm, 65% mostly c sand, =2% fines	
55				SW	**WELL GRADED SAND w/ GRAVEL (SW)** - yellowish brn (10YR5/4), 40% subang met gravel up to 9cm, 55% f to c met sand, 5% silty fines, clast supported, m density, wet	
60			9.5	GW	**WELL GRADED GRAVEL w/ SILT AND SAND (GW)** - brn (7.5YR5/4), 55% subang to ang met gravel up to 4cm, 25% f to c sand, 20% silty fines, dense, moist to dry - soil dries out	Collected Isoflow sample
65					- lt grey (10YR7/2) and powder dry - moist sandy zone, 55% gravel, 35% sand, 10% fines - dry silty lt grey GW below 65'	Drill rate slows to 2' / min
70				SW	**WELL GRADED SAND w/ GRAVEL (SW)** - yellowish brn (10YR5/4), 35% subang met gravel up to 4cm, 60% subrnd sand, 5% silty fines, loose, moist to wet	Moderate Drill Rate

CH2MHILL

PROJECT NUMBER: 326128.01.16.EN

BORING NUMBER: *MW-47*

SOIL BORING LOG - DRAFT FOR DISCUSSION

PROJECT NAME: IMPM Drill Program		**HOLE DEPTH (ft):** 288.0	**DRILLING CONTRACTOR:** Prosonic Corp. Phoenix, AZ	
SURFACE ELEVATION: 482.6 ft. MSL	**NORTHING (CCS NAD 27 Z 5):** 2,103,450.05	**EASTING (CCS NAD 27 Z 5):** 7,615,629.49	**DATE STARTED:** 02/27/2006	**DATE COMPLETED:** 03/13/2006
DRILLING METHOD: Rotosonic			**DRILLING EQUIPMENT:** Sonic AT (track mounted)	
LOCATION: PG&E Compressor Station - Flood Plain, Topock, California			**LOGGED BY:** B. Moayyad, K. Ebel	

DEPTH BGS (feet)	SAMPLE INTERVAL	SAMPLE TYPE/ NUMBER	SAMPLE RECOVERY (ft)	USCS CODE	SOIL DESCRIPTION SOIL NAME, USCS SYMBOL, COLOR, PERCENT COMPOSITION, GRADING, GRAIN SHAPE, MINERALOGY, DENSITY/CONSISTENCY, STRUCTURE, MOISTURE.	COMMENTS DRILLING OBSERVATIONS AND OPERATIONS, DAILY START AND END TIMES , DRILL RATE, REFUSALS, SAMPLING AND TESTING NOTES.
			6	SP	**POORLY GRADED SAND w/ SILT (SP)** - brn (7.5YR4/4), 5% subrnd to subang met gravel up to 4cm, 85% f to c sand, 10% fines, poorly graded, wet, no odor	
145			3	SM	**SILTY SAND W/ GRAVEL (SM)** - brn (7.5YR4/4), 20% subang to subrnd gravel up to 6cm, 60% f to c sand, 20% silty fines, well graded, m consolidated, met, wet, no odor	
150			5	SM	**SILTY SAND w/ GRAVEL (SM)** - dk yellowish brn (10YR4/4), 25% subang to subrnd up to 4cm met gravel, 60% well graded f to c sand, 15% fines, wet, no odor	
155			4	SW	**WELL GRADED SAND w/ SILT AND SAND (SW)** - dr yellowish brn (10YR4/4), 10% subang to subrnd up to 3cm met gravel, 75%well graded f to c sand, 15% fines, moist to wet	
			2	SW	**SILTY SAND (SM)** - brn (7.5YR4/4), 5% ang to subrnd met gravel up to 1.5cm increasing with depth, 85% poorly graded m to c sand, 10% fines, loose, wet	
			2	SM	**SILTY SAND w/ GRAVEL (SM)** - dk yellowish brn (10YR4/4), 15% subang to subrnd up to 2.5cm met gravel, 75% well graded f to c sand, 10% fines, mostly met, trace chert, loose, wet, no odor	Collected Isoflow sample
160			4	SM	**SILTY SAND W/ GRAVEL (SM)** - brn (7.5YR4/4), 25% subang to subrnd gravel up to 6.5cm, 60% m to c sand, 15% silty fines, well graded, m consolidated, met, wet, no odor	Drill rate = 0.75' to 1.5' / min
165			4	SW	**SILTY SAND (SW)** - mottled dk reddish brn (5YR3/4), 10% subang to subrnd gravel up to 2.5cm, 50% well graded f to m sand, 40% silt, metamorphic, dry to damp, no odor, interbedded sandy silt laminations	
170			5.5	SW	**SAND w/ GRAVEL (SW)** - dk reddish brn (5YR3/4), 20% subang to subrnd gravel up to 5cm, 75% f to c sand, 5% fines, well graded, loose, met, wet	
175			2.5	SM	**SILTY SAND w/ GRAVEL (SM)** - brn (7.5YR4/4), 15% subang to subrnd gravel, 70% f to m sand, 15% fines, poorly graded, met,increasingly consolidated, slightly to moderately calcareous, moist to wet	

PROJECT NUMBER:	BORING NUMBER:
326128.01.16.EN	*MW-47*

SOIL BORING LOG - DRAFT FOR DISCUSSION

PROJECT NAME: IMPM Drill Program		**HOLE DEPTH (ft):** 288.0	**DRILLING CONTRACTOR:** Prosonic Corp. Phoenix, AZ	
SURFACE ELEVATION: 482.6 ft. MSL	**NORTHING (CCS NAD 27 Z 5):** 2,103,450.05	**EASTING (CCS NAD 27 Z 5):** 7,615,629.49	**DATE STARTED:** 02/27/2006	**DATE COMPLETED:** 03/13/2006
DRILLING METHOD: Rotosonic			**DRILLING EQUIPMENT:** Sonic AT (track mounted)	
LOCATION: PG&E Compressor Station - Flood Plain, Topock, California			**LOGGED BY:** B. Moayyad, K. Ebel	

DEPTH BGS (feet)	SAMPLE INTERVAL	SAMPLE TYPE/ NUMBER	SAMPLE RECOVERY (ft)	USCS CODE	SOIL DESCRIPTION SOIL NAME, USCS SYMBOL, COLOR, PERCENT COMPOSITION, GRADING, GRAIN SHAPE, MINERALOGY, DENSITY/CONSISTENCY, STRUCTURE, MOISTURE.	COMMENTS DRILLING OBSERVATIONS AND OPERATIONS, DAILY START AND END TIMES , DRILL RATE, REFUSALS, SAMPLING AND TESTING NOTES.
285			0	BR	**MIOCENE CONGLOMERATE BEDROCK (BR)** - 60% well graded subang to rnd gravel up to 10cm, 30% well graded sand, 10% fines, very calcareous, well consolidated to mostly hard, mod to very altered locally, mostly met, dry to moist	
					Boring Terminated at 288 ft	

ABBREVIATIONS

cc = continuous core run
brn = brown
lt = light
dk = dark
vf = very fine-grained
f = fine-grained
m = medium-grained
c = coarse-grained
vc = very coarse-grained
ang = angular
subang = subangular
subrnd = subrounded
rnd = rounded
br = bedrock formation
ss = sandstone
conglom = conglomerate
comptd = compacted
qtz = quartz

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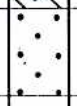
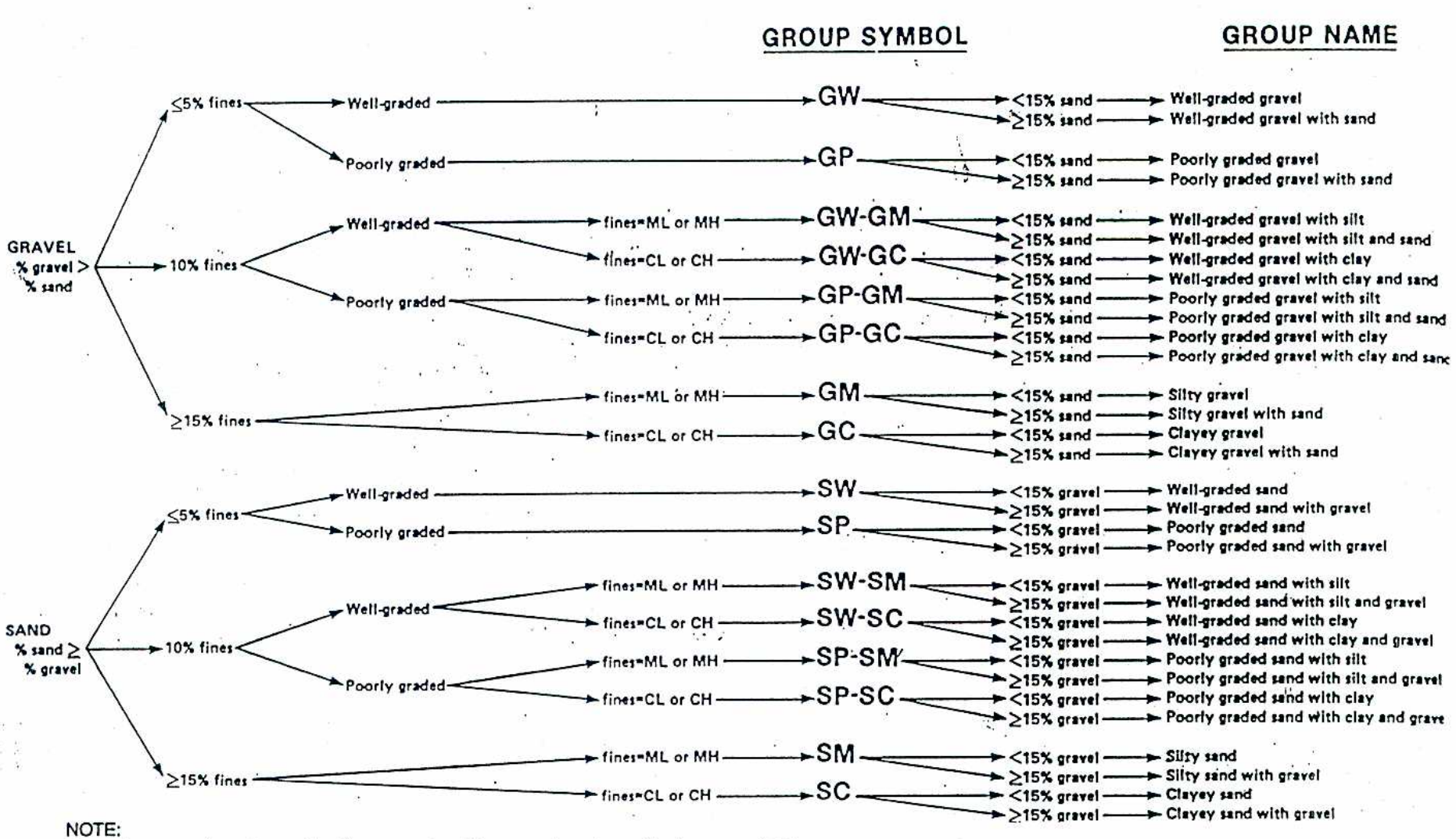
ATTACHMENT B

Unified Soil Classification System and Logging Criteria

GENERAL SOIL CATEGORIES			SYMBOLS		TYPICAL SOIL TYPES
COARSE GRAINED SOILS More than half is larger than No. 200 sieve	GRAVEL More than half coarse fraction is larger than No. 4 sieve size	Clean Gravel with little or no fines	GW		Well Graded Gravel, Gravel-Sand Mixtures
			GP		Poorly Graded Gravel, Gravel-Sand Mixtures
		Gravel with more than 12% fines	GM		Silty Gravel, Poorly Graded Gravel-Sand-Silt Mixtures
			GC		Clayey Gravel, Poorly Graded Gravel-Sand-Clay Mixtures
	SAND More than half coarse fraction is smaller than No. 4 sieve size	Clean sand with little or no fines	SW		Well Graded Sand, Gravelly Sand
			SP		Poorly Graded Sand, Gravelly Sand
		Sand with more than 12% fines	SM		Silty Sand, Poorly Graded Sand-Silt Mixtures
			SC		Clayey Sand, Poorly Graded Sand-Clay Mixtures
FINE GRAINED SOILS More than half is smaller than No. 200 sieve	SILT AND CLAY Liquid Limit Less than 50%		ML		Inorganic Silt and Very Fine Sand, Rock Flour, Silty or Clayey Fine Sand, or Clayey Silt with Slight Plasticity
			CL		Inorganic Clay of Low to Medium Plasticity, Gravelly Clay, Sandy Clay, Silty Clay, Lean Clay
			OL		Organic Clay and Organic Silty Clay of Low Plasticity
	SILT AND CLAY Liquid Limit Greater than 50%		MH		Inorganic Silt, Micaceous or Diatomaceous Fine Sandy or Silty Soils, Elastic Silt
			CH		Inorganic Clay of High Plasticity, Fat Clay
			OH		Organic Clay of Medium to High Plasticity, Organic Silt
HIGHLY ORGANIC SOILS			PT		Peat and Other Highly Organic Soils

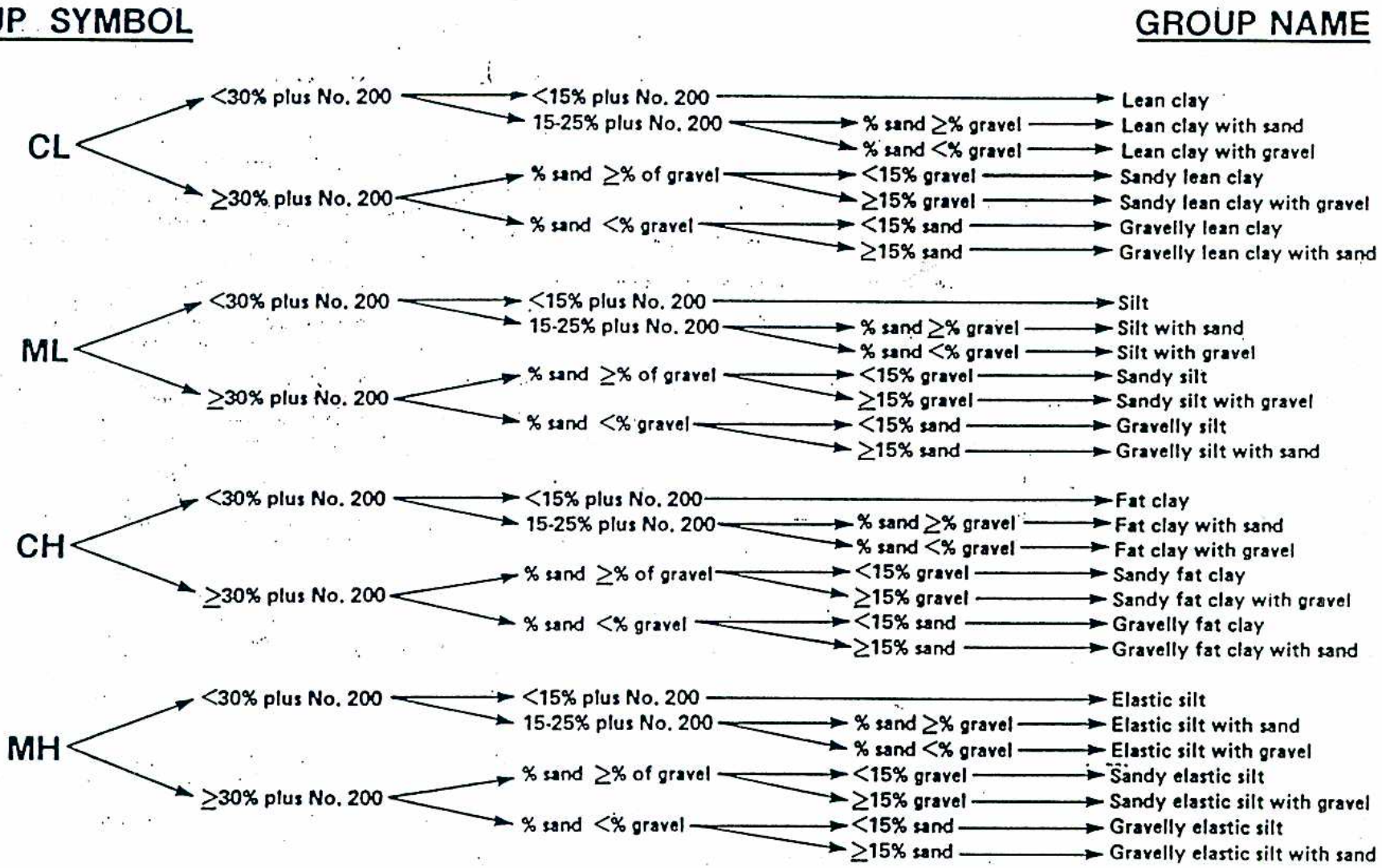
UNIFIED SOIL CLASSIFICATION SYSTEM

		PLATE
JOB NUMBER	DATE APPROVED	



NOTE:
Percentages are based on estimating amounts of fines, sand, and gravel to the nearest 5%
(After ASTM Designation D2488 Standard Test Method for Classification of Soils for Engineering Purposes)

Flow Chart for Classifying Coarse-grained Soil
(50% or more retained on No. 200 sieve)
Field Guide for Soil Classification and Logging Procedures



NOTE:
Percentages are based on estimating amounts of fines, sand, and gravel to the nearest 5%
(After ASTM Designation D2488 Standard Test Method for Classification of Soils for Engineering Purposes)

Flow Chart for Classifying Fine-grained Soil
(50% or more passing No. 200 sieve)
Field Guide for Soil Classification and Logging Procedures

similar, the material is classified as poorly graded or well sorted. If fines represent less than 5 percent of the total mass, the symbol SP is used for a poorly-graded sand and SW for a well graded sand. If silts and/or clays exceed 12 percent, the symbols GC, SC, GM, and SM are used, respectively.

If the silts and clays are between 5 to 12 percent of the total sample weight, a dual classification with two group symbols is used. The first symbol is GW, GP, SW, or, SP, and the second is GC, GM, SC, or SM. The group name corresponds to the first group symbol plus the modifying words "with clay" or "with silt" to indicate the plasticity characteristics. If the fines plot on the CL-ML range on the plasticity chart (Figure 2-2), possible dual classification group names are:

GW-GM	well graded gravel with silt
GW-GC	well graded gravel with clay
GP-GM	poorly graded gravel with silt
GP-GC	poorly graded gravel with clay
SW-SM	well graded sand with silt
SW-SC	well graded sand with clay
SP-SM	poorly graded sand with silt
SP-SC	poorly graded sand with clay

If silts and clays exceed 12 percent of the total weight of sample, the modifiers "M" and "C" are used, respectively. If a sand or gravel has more than 15 percent of the other coarse-grained constituent, the words "with gravel" or "with sand" are added to the group name. A flow chart for classifying coarse-grained soils is presented in Figure 2-3.

2.2 Fine-grained Soils

Particles passing the No. 200 sieve are silts (M) and clays (C). These soils must undergo testing in order to differentiate between them. Typical tests used are: dry strength, dilatancy, toughness, and plasticity. These terms are further discussed in Tables 2-2 through Table 2-6. Silts have little or no dry strength when dry, while clays have considerable dry strength. Dry strength, dilatancy, and toughness are also used to identify the fine-grained fraction of coarse-grained soils.

TABLE 2-2
Criteria for Describing Dry Strength

Description	Criteria
None	The dry specimen crumbles into powder with the mere pressure of handling.
Low	The dry specimen crumbles into powder with some finger pressure.
Medium	The dry specimen breaks into pieces or crumbles with considerable finger pressure.
High	The dry specimen cannot be broken with finger pressure. The specimen will break into pieces between the thumb and a hard surface.
Very high	The dry specimen cannot be broken between the thumb and a hard surface.

TABLE 2-3
Criteria for Describing Dilatancy

Description	Criteria
None	There is no visible change in the specimen.
Slow	Water appears slowly on the surface of the specimen during shaking, and does not disappear, or disappears slowly upon squeezing.
Rapid	Water appears quickly on the surface of the specimen during shaking, and disappears quickly upon squeezing.

TABLE 2-4
Criteria for Describing Toughness

Description	Criteria
Low	Only slight pressure is required to roll the thread near the plastic limit. The thread and the lump are weak and soft.
Medium	Medium pressure is required to roll the thread to near the plastic limit. The thread and the lump have medium stiffness.
High	Considerable pressure is required to roll the thread to near the plastic limit. The thread and the lump have very high stiffness.

TABLE 2-5
Identification of Inorganic Fine-grained Soils from Manual Tests

Soil Symbol	Dry Strength	Dilatancy	Toughness
ML	None to low	Slow to rapid	Low or thread cannot form
CL	Medium to high	None to slow	Medium
MH	Low to medium	None to slow	Low to medium
CH	High to very high	None	High

TABLE 2-6
Criteria for Describing Plasticity

Description	Criteria
Nonplastic	A 1/8-inch (3-mm) thread cannot be rolled at any water content.
Low	The thread can barely be rolled, and the lump cannot be formed when drier than the plastic limit.
Medium	The thread is easy to roll, and not much time is required to read the plastic limit. The thread cannot be re-rolled after reaching the plastic limit. The lump crumbles when drier than the plastic limit.
High	It takes considerable time rolling and kneading to reach the plastic limit. The thread can be re-rolled several times after reaching the plastic limit. The lump can be formed without crumbling when drier that the plastic limit.

Fine-grained soils are accurately determined in the laboratory using the Atterberg Limits test. This test include liquid limit, plastic limit, and plasticity index measurements. The liquid limit is the water content of a soil at the point of transition from a plastic to a liquid state. The plastic limit is the water content of a soil at the point of transition from a semisolid to a plastic state. The plasticity index is the difference between the liquid limit and the plastic limit.

As shown in the Figure 2-2, five fields have been identified. These include:

- Silty Clays (CL), Organic Silts (OL) or Organic Silty Clays (OL) of low plasticity
- Fat Clays (CH) and Organic Clays (OH)
- Inorganic Silts (ML) and Organic Silty Clays (OL) of low plasticity
- Silts (MH) and Organic Clays (OH) of a high plasticity
- Silty Clays to Clayey Silt (CL-ML) of low plasticity

Fine-grained soils with a liquid limit > 50 are modified by the symbol H (MH or CH), and those with a liquid limit < 50 are modified by the symbol L (ML or CL). Fine-grained soils containing 30 percent or more coarse-grained fraction should be modified by descriptive terms, such as "gravelly" or "sandy." If the coarse fraction is between 15 and 30 percent, the words" with sand and/or gravel" should be added to the group name. A flow chart for classifying fine-grained soils is presented in Figure 2-4.

2.3 Organic Soils

To classify organic soils, the percentage organic material present in the soil as well as the non-organic fines must be estimated. When the organic content ranges from 18 to 36 percent, the material is an organic clay or an organic silt, depending on the nature of the fine-grained constituents. When the organic content is between 36 and 90 percent, the material is designated a muck or peaty muck (OL or OH). A flow chart for classifying organic soil is presented in Figure 2-4. The term "peaty" is added if the organic remains are

SOP-B5

Decontamination of Personnel and Equipment, Well Drilling, and Subsurface Sampling and Investigations
Standard Operating Procedures for PG&E Topock Program

This standard operating procedure provides general guidelines for the decontamination of personnel, sampling equipment, and monitoring equipment used in potentially-contaminated areas.

REQUIRED DOCUMENTS

1) Event-specific sampling and analysis plan (SAP).

2) Applicable project work plan or monitoring plan, which includes a health and safety plan. Refer to Topock Program *Sampling, Analysis, and Field Procedures Manual* and *Quality Assurance Project Plan*, as required.

PREPARATION AND SETUP

1) Initiate field log sampling book for activity.

2) Inspect all equipment necessary to carry out activities detailed in event-specific SAP.

3) Review decontamination guidelines for equipment necessary to carry out activities.

Equipment List

- Demonstrated analyte-free, deionized water (specifically, ASTM Type II water)
- Distilled water
- Potable water; must be from a municipal water supplier, otherwise an analysis must be run for appropriate volatile and semivolatile organic compounds and inorganic chemicals (e.g., Target Compound List and Target Analyte List chemicals)
- 2.5% (W/W) Liquinox® and water solution
- Large plastic pails or tubs for Liquinox® and water, scrub brushes, spray or squirt bottles for Liquinox® solution, and distilled or deionized water, plastic bags, and sheets
- Department of Transportation (DOT)-approved 55-gallon drum for disposal of waste
- Nitrile or latex gloves
- Decontamination pad and steam cleaner/high pressure cleaner for large equipment

GUIDELINES

Personnel Decontamination

Decontamination should be performed after completion of tasks whenever personnel come in contact with contaminated (or potentially-contaminated) soils or fluids. Full or emergency decontamination should be performed when contaminant concentrations are not known and when potentially-contaminated fluids come into contact with skin beneath clothing, eyes, nose, or ears.

Procedures for full/emergency decontamination are to:

1) Remove contaminated clothing.

2) Step into containment area (decontamination pad or large pail).

3) Rinse away fluids and soil.

4) Wash skin with Liquinox® solution in such a way as to not abrade skin. (Liquinox® solution should be made with potable water and sufficient detergent to create foamy suds.) Eyes and mucus membranes in contact with contaminants must be washed with eye wash or drinking water continuously for at least 15 minutes.

5) Rinse with potable water.

6) If no other clothes are available, wash affected clothes in Liquinox® solution prior to donning. If other clothes are available, contaminated clothes may be isolated for later wash or disposed of along with personal protective equipment (PPE).

7) Any PPE worn (including disposable latex booties, gloves, and disposable coveralls) should be discarded into DOT-approved 55-gallon drum located at the MW-20 bench.

8) Dispose of wash and rinseate water in an appropriate container with other chromium contaminated fluids. These fluids may be taken to the MW-20 bench for treatment or to a Baker® tank within the PG&E facility for containerization.

9) Replace all appropriate clothing and PPE before resuming work or departing site.

Moist soil or water containing known concentrations of hexavalent chromium less than 50 parts per billion that comes into contact with hands need not require full decontamination. Dry soil containing chromium that comes into contact with clothing can also be decontaminated in an abbreviated manner.

Daily decontamination and minor exposure contact decontamination procedures are to:

1) Wash hands and skin that comes in contact with soils or water that may contain small concentrations of chromium as soon as possible after contact. Wash with Liquinox® solution and rinse with potable water.

2) If contaminated soil or water contacts hands through hole or over lip of gloves, remove gloves and wash hands thoroughly before donning new gloves.

3) Discard gloves into DOT-approved 55-gallon drum located on the MW-20 bench at the end of the day or event.

4) Remove coveralls or dry soils from clothing before leaving site. Clothing contaminated by moist soil or water containing hexavalent chromium should be removed and promptly washed.

5) At the end of the work day, shower entire body, including hair, either at the work site or at hotel.

Sampling Equipment Decontamination—Groundwater Sampling Pumps

Sampling pumps are decontaminated after each use as follows:

1) Don waterproof (nitrile or latex) gloves.

2) Run pump and reusable tubing through with Liquinox® solution (made with potable water) so that the pump and all portions or the tubing have been flushed with the solution for at least 30 to 60 seconds. More time is required if water is present in the tubing. If unsure, run for 2.5 minutes. Outside of the tubing should also be submerged and washed in the solution.

3) Run pump and reusable tubing through first rinse (with potable or distilled water) so that the pump and all portions or the tubing have been flushed with the solution for at least 60 seconds. More time is required if any suds are present in the pump or tubing.

4) Run pump and reusable tubing through second rinse (with distilled water) so that the pump and all portions or the tubing have been flushed with the solution for at least 30 seconds. More time is required if water from first rinse is present in tubing.

5) Equipment blank samples may be taken at this point using ASTM Type II water or distilled water as required by laboratory.

Sampling Equipment Decontamination—Other Equipment

Reusable sampling equipment is decontaminated after each use as follows:

1) Don nitrile or latex gloves.

2) Wash all equipment surfaces that contacted the potentially contaminated soil/water with Liquinox® solution (made from potable water). Water quality meters that are not placed within wells should not be washed with detergent, as this will degrade sensors; these meters should be double-rinsed. Any portion of equipment that is placed inside wells (including cables and pipe) and that comes in contact with moisture should be washed with detergent.

3) Rinse equipment and supplies with potable water, if the equipment is not used to collect groundwater or soil samples. Equipment used to collect samples or take water quality parameters should be rinsed with distilled water.

4) Air dry or towel dry with paper towels.

5) Collect all rinseate and dispose of in Baker® tank within the PG&E facility or Denbeste® tank at the MW-20 bench.

6) Decontamination materials (e.g., plastic sheeting, tubing, etc.) that have come in contact with used decontamination fluids or sampling equipment will be disposed of in DOT-approved 55-gallon drums if highly contaminated. If not contaminated, equipment can be washed and disposed of in trash.

7) Preserved bottles may need to be washed before being packed or handed without gloves. The outsides of filled bottles should be rinsed and toweled dry to prevent contact with strong acids or based.

Heavy Equipment and Tools

Heavy equipment such as drilling rigs, drilling rods/tools, and the backhoe will be decontaminated upon arrival at the site and between locations as follows:

1) Set up a decontamination pad in designated area.

2) Steam clean heavy equipment until no visible signs of dirt are observed. This may require wire or stiff brushes to dislodge dirt from some areas.

KEY CHECKS AND ITEMS

- Clean with solutions of Liquinox® and potable water. Rinse with distilled or deionized water if equipment is used to collect samples or water readings; otherwise, rinse with potable water.
- Equipment placed within wells should be thoroughly decontaminated and before being placed in a well. All potions of this equipment that come into contact with moisture should be decontaminated.
- Decontaminate filled sample bottles before relinquishing them to anyone.

SOP-B6

Disposal of Waste Fluids and Solids (IDW)
Standard Operating Procedures for PG&E Topock Program

This standard operation procedure (SOP) describes the procedures used to dispose of hazardous fluid and solid materials generated as a result of the site operations. This SOP does not provide guidance on the details of Department of Transportation (DOT) regulations pertaining to the transport of hazardous wastes; the appropriate Code of Federal Regulations (49 CFR 171 through 177) should be referenced. Also, the site investigation-derived waste management plan should be consulted for additional information and should take precedence over this SOP.

REQUIRED DOCUMENTS

1) Event-specific sampling and analysis plan.

2) Applicable project work plan or monitoring plan. Refer to Topock Program *Sampling, Analysis, and Field Procedures Manual* and *Quality Assurance Project Plan*, as required.

3) Topock Program Health and Safety Plan.

PREPARATION AND SETUP

1) For soil and groundwater collection and storage, a subcontractor (either Denbeste Transportation, Inc. or a drilling or sampling contractor) will bring clean, empty drums, roll-off bins, Denbeste® tanks, or Baker® Tanks to the site.

2) Locate the empty drums at the field staging area and move drums to drilling locations as required.

EQUIPMENT LIST

- DOT-approved 55-gallon steel drums, Denbeste® Tanks, Baker® Tanks or roll-off bins
- Portable polytanks for transferring water from well samples locations to tanks or bins
- Tools for securing drum lids
- Funnel for transferring liquid into drum
- Water pump to transfer liquids
- Labels
- Marking pen for appropriate labels
- Seals for 55-gallon steel drums
- Plastic sheets and buckets to catch leaks and drips

PROCEDURES

General Methodology

1) Prior to filling soil bins, determine if plastic sheeting is required for soil disposal bins. Line bins with plastic sheeting as required by disposal contractor and facility. Seal bins and

check for water tightness on soil bins and water tanks. Inventory all bins and tanks by unique identifier.

2) Fill soil bins with drilling and well installation wastes. When three-fourths full, cap or close, and update inventory. The drilling, sampling, or waste disposal subcontractor will move the drums to the on-site drum storage area. Fill tanks with clear water. Muddy water should be allowed to settle out in soil bins or separator tanks prior to transfer to Denbeste® or Baker® Tanks.

3) Separate full drums by waste and media types.

4) As the drums are filled in the field, affix labels indicating that the contents are potentially hazardous. Update bin log with type of waste and locations from which soil is obtained.

5) Drums may be used for temporary storage of soil or water. The drums should be closed and sealed at the end of each work day or when full. Drums used for soil should not be used for clear water storage without decontamination. Drums should be labeled if the contents are not transferred to a tank or bin by the end of the day.

6) Portable polytanks are used to transfer water from wells being sampled or developed to Denbeste® or Baker® tanks. These tanks should be emptied at the end of each day or when full. Sediment that accumulates that the bottom of these tanks should be removed and disposed of with contaminated soil on a regular basis.

7) Soils and groundwater from the site have been characterized for waste disposal. Wastes, which have not been included in the characterization, should be labeled sampled and separated from other wastes.

8) Typically Denbeste Transportation, Inc. should be contacted for disposal of wastes and movement of soil bins and large water tanks. Other contractors may also be involved in waste disposal.

Labeling

1) Label drums and other containers used for storing wastes from drilling, development, and sampling operations when accumulation in the container begins. Labels will include the following minimum information:

   - Container number
   - Container contents
   - Origin (source area including individuals wells, piezometers, and soil borings)
   - Date that accumulation began
   - Date that accumulation ended

2) When laboratory results are received, complete or revise drum labels to indicate the hazardous waste constituents in compliance with 40 CFR, Part 262, Subpart C.

Groundwater and Drilling Fluids

1) Collect water and drilling fluids generated during well sampling and development and during soil boring in polytank or hopper (water-tight bin used to transport cuttings with forklift).

SOP-B8

General Guidance for Well Surveying
Standard Operating Procedures for PG&E Topock Program

To provide site personnel with a review of the procedures necessary to perform a proper survey of monitoring wells and other site features at the Topock site. These procedures are to be considered general guidelines only and are in no way intended to supplement or replace the PG&E guidelines.

REQUIRED DOCUMENTS

1) Topock Program Health and Safety Plan (HSP)
2) Topographic map(s) of the Topock station and surrounding sites.
3) Maps that show features to be surveyed and reference landmarks.
4) Soil Boring Log and or other lithologic descriptions of the local area
5) Well construction logs/specifications for wells to be surveyed.
6) Blank survey logs and field notebook

EQUIPMENT LISTS

The equipment needed for surveying are simply the survey or global positioning equipment, and the vehicle and keys needed to access each site.

DEFINITIONS

The following terms are defined to clarify discussion in this SOP:

- North American Datum (NAD) -The standard geodetic datum on the North American continent.
- North American Vertical Datum (NAVD) 1983 - The vertical-control datum used by the National Geodetic Survey for all new vertical control.
- Horizontal Control - Horizontal location of an object from surveyed corners or other features on permanent land monuments in the immediate site area. Will be based on North American Datum (NAD) 1983 and state plane grid systems (California State Plane Coordinate System, Zone 5).
- Vertical Control - Vertical location of an object compared to the adjacent ground surface.
- Bench Mark - Precisely determined elevation above or below sea level. May also have horizontal control (northing, easting) determined for location.

PROCEEDURES

Record Keeping

All field notes should be kept in bound books. Each book should have an index. Each page of field notes should be numbered and dated and should show the initials of all crew

members. The person taking field notes will be identified in the log. Information on weather (wind speed/wind direction, cloud cover, etc.) and on other site conditions should also be entered in the notes. Notes should also include instrument field identification number and environmental settings. Graphite pencils should be used. Erasing is not acceptable; use a single-strike-through and initial it. The note keeping format should conform to the *Handbook of Survey Note keeping* by William Pafford. A survey work drawing with grid lines and at the scale of the topographic map should be prepared for all survey field work in AutoCAD or Microstation (depending on client specifications).

Horizontal Survey

Horizontal angular measurements shall be made with a 5-second or better total station. All angles shall be doubled (once each direct and inverted), with the mean of the second angle within 5 seconds of the first angle. The minimum length of any traverse courses shall be 300 feet.

Distance measurements shall be made with a total station. When using a total station the parts per million (PPM), curvature and refraction corrections shall be made. Vertical angle measurements used for distance slope corrections shall be recorded to the nearest 5 seconds of arc deviation from the horizontal plane. Horizontal locations will be surveyed to within 0.05-foot of the true location.

Horizontal traverse stations shall be established and referenced for future use. All stations shall be described in the field notes with sufficient detail to facilitate their recovery at a later date. The station shall consist of a permanent mark scribed on facilities such as sidewalks, curbs, concrete slabs, or iron rod and cap.

The horizontal location will be referenced to NAD83 and California Zone 5 in the state plane grid system.

Some horizontal coordinates will be measured using Geographic Positioning System (GPS) equipment. This approach will be used in particular for determining the coordinates of surface-water and sediment sampling locations, and may be used also for determining the locations of piezometers and monitoring wells. The GPS survey will be performed by staff trained in the use of the equipment and will conform to guidance provided by the manufacturer.

Vertical Survey

When practical, vertical control will be referenced to the North American Vertical Datum (NAVD) of 1988, obtained from a permanent benchmark. If practical, level circuits should close on a known benchmark other than the starting benchmark. The following criteria shall be met in conducting the survey:

Using a Conventional Level

- Instruments shall be pegged weekly or after any time it is dropped or severely jolted.
- Foresight and backsight distances shall be reasonably balanced and shall not be greater than 250 feet in length.
- No side shot shall be used as a beginning or ending point in another level loop.

- Rod readings shall be made to 0.01-foot and estimated to 0.005-foot.
- Elevations shall be adjusted and recorded to 0.01-foot.

Using an electronic Digital Level

- Use the electronic level per the instructions for the specific instrument.
- Balance forsight and backsight distances per instrument specifications.
- Elevations shall be adjusted and recorded to 0.01-foot.

Using a Total Station (Trig levels)

- From each instrument station readings will be taken both with a direct scope and an inverted scope.
- Direct and inverted measurements will be meaned and than meaned again with the adjacent stations.
- The level loop will be closed to another known monument or back on the beginning monument.
- Elevations shall be adjusted and recorded to 0.01-foot.

Using Global Positioning Systems (GPS)

- The GPS survey will be performed staff trained in the use of the equipment.
- All monuments to be used for Vertical Control will be tied from two existing vertical control monuments.
- Geoid03 model will be used.
- Elevations shall be adjusted and recorded to 0.01-foot.

Temporary benchmarks (TBM's) shall be established and referenced for future use. All TBM's shall be described in the field notes with sufficient detail to facilitate their recovery at a later date. The TBM's shall consist of a permanent mark scribed on facilities such as sidewalks, curbs, concrete slabs, etc. or spikes set in the base of trees (not power poles), or tops of anchor bolts for transmission line towers, etc. (If suitable Horizontal traverse stations can be used as a TBM's .)

Traverse Computations and Adjustments

Traverses will be closed and adjusted in the following manner:

1) Coordinate closures will be computed using unadjusted bearings and unadjusted field distances.
2) Coordinate positions will be adjusted (if the traverse closes within the specified limits) using the compass rule or a Least Square Adjustment Program.
3) Final adjusted coordinates will be labeled as "adjusted coordinates." Field coordinates should be specifically identified as such.

4) The direction and length of the unadjusted error of closure, the ratio of error, and the method of adjustment shall be printed with the final adjusted coordinates.

5) The adjustment shall meet 3rd order specifications.

Level Circuit Computations and Adjustments

Level circuits will be closed and adjusted in the following manner:

- For a single circuit, elevations will be adjusted proportionally, provided the raw closure is within the prescribed limits for the circuit.
- In a level net where the elevation of a point is established by more than one circuit, the method of adjustment should consider the length of each circuit, the closure of each circuit, and the combined effect of all the separate circuit closures on the total net adjustments.

Piezometer and Monitoring-Well Surveys

Piezometer and monitoring-well locations will be surveyed only after the installation of the protective casing, which is set in concrete. The horizontal plane survey accuracy is +0.05-foot and is measured to any point on the protective-casing cover. The vertical plane survey must be accurate to ±0.01-foot. The following two elevations will be measured at piezometers and monitoring wells:

- Top of the piezometer or well riser (not on the protective casing), preferably on the north side
- Ground surface, preferably on the north side of the well

If no notch or mark exists, the point at which the elevation was measured on the inner casing shall be described and marked so that water-level measurements may be taken from the same location.

Grid Surveys

Selected soil boring locations may be located by the survey crew after the soil borings are complete. The selected borings will be staked in the field by the field team leader. The stake will be marked with the boring number for reference. The horizontal plane survey accuracy is ± 1 foot and is measured to any point on the ground surface immediately adjacent to the stake.

KEY CHECK

STANDARDS FOR MODIFIED THIRD-ORDER PLANE SURVEYS

Traverse

Max Number of bearing courses between azimuth checks	30
Astronomical bearings standard error of results:	6"
Azimuth closure at azimuth checkpoint not to exceed	20" $\sqrt{N}$
Standard error of the mean for length measurements	1 in 50,000
Position closure per loop in feet before azimuth adjustment	1:10,000

Leveling

Levels error of closure per loop in feet $0.05\sqrt{M}$

N = the number of stations for carrying bearing
M = the distance in miles

SOP-B9

Drilling--Sonic Method
Standard Operating Procedures for PG&E Topock Program

REQUIRED DOCUMENTS

1) Event-specific sampling and analysis plan (SAP), Work Plan or event-specific field instructions. Planned borehole depth, proposed well construction/specifications, and field sampling summary table, if available.

2) Applicable project work plan or monitoring plan. Refer to Topock Program Sampling, Analysis, and Field Procedures Manual and QAPP (Procedures Manual), as required.

3) Topock Program Health and Safety Plan (HSP)

4) Previous sampling, drilling, or well construction logs from other boreholes or wells in the vicinity, if available

5) Blank sampling log and field notebook

Equipment List:

- Drilling rig (Sonic)
- Drill rods and core barrel

GUIDELINES

PRIOR TO INTRUSIVE ACTIVITIES AT ANY DRILLING LOCATION THE AREA WILL HAVE BEEN CLEARED OF ALL UTILITIES AND THE CLEARANCE RECORDED IN THE FIELD LOGBOOK. It is also the field team leader's responsibility to confirm that all required access permits are in place.

Prior to the start of drilling, the area of site activity will be identified and delineated using stakes and/or flagging. The extent of impact will be mineralized at all times and the delineated area of activity decreased when possible. All sensitive vegetation or habitats will be delineated with stakes and/or flagging and no impact will occur in these areas.

Sampling depths and total depths of holes shall be determined by temporary marking of drill equipment, by reference to standard equipment dimensions (for example, 5-foot hollow-stem auger flights), or by measurement using a fiberglass tape. Final total depth measurements will be confirmed using a weighted fiberglass tape. Observations by the field geologist or engineer shall be recorded directly in the borehole log.

The field borehole log is the standard form used to document subsurface geologic conditions. The borehole log is divided into two areas. One portion contains spaces for noting information on the drilling and sampling methods. The second portion contains space for noting lithologic descriptions. All sheets shall be filled out completely, legibly, and in ink. The borehole log will be filled out in the field at the time of the drilling and sampling. The original logs shall be permanent records, and information on the logs may not be

erased. If corrections are needed, information shall be crossed out with a single line and the correction shall be initialed and dated.

The use of water and drilling fluid to assist in sonic drilling for monitoring well installation will be avoided, unless required for such conditions as running sands or drilling bedrock formations.

Temporary outer casing, drill rods, core barrels, and other downhole drilling tools will be properly decontaminated prior to the initiation of drilling activities and between each borehole location. Core barrels and other downhole soil sampling equipment will also be properly decontaminated before and after each use.

Sonic inner casing (sample tube) will have an inside diameter of at least 3.25 inches. Samples may be collected for chemical analysis. For sonic drilling, these samples are collected in a metal trough. A continuous core is collected and the sample interval is selected from the length of core run.

Surface casing may be installed where soil borings will penetrate a confining layer or when there is risk of eroding soil during the drilling process if water is used.

PROCEDURES

Instructions for Completing Soil Boring Logs

Soil boring logs will be completed in the field log books. Information collected will be consistent with that required for Form D1586 (attached), a standard CH2M HILL form or an equivalent form that supplies the same information. Procedures will follow the SOP "*Soil*

Non-Core Collection Drilling

At locations or depths from which core collection is not required, drilling may proceed without the recovery of soil cores. The drilling will include advancing the larger outer casing and the use of water to facilitate cuttings removal from the boring. The inner casing drill rods may or may not be used, depending on the cuttings recovery when drilling with the larger outer casing.

Continuous Core Drilling

At locations or depths when core collection is required, drilling will proceed using an outer casing and an inner core sample tube. The inner core sampling tube will be advanced first without the use of water. Before removal of the sampling tube, the outer casing will be advanced, using water only as needed for cuttings removal, to the same total depth as the inner casing. The outer casing will stabilize the boring when the sampling tube is removed. The process is repeated in 10 to 20 foot intervals, as the lithology of the boring permits.

The length of each drilling interval should be adjusted depending on the lithology and the quality and recovery percentage of the sample cores retrieved. At locations with very hard drilling (i.e. with large cobbles or hard materials) or when percent recovery decreases, the drilling interval should be decreased until such time that the conditions change.

After retrieval of the inner sampling core tube, the minimally disturbed sample cores will be collected into plastic liner sleeves in intervals of 2 to 3 feet. The plastic sleeves will be

immediately sealed on both ends. The cores will be used for visual descriptions and may be used for analysis for geochemical and geotechnical parameters.

KEY CHECKS AND ITEMS

- Check entries to the soil boring log and field logbook in the field during sampling activities because the cores will be disposed at the end of the fieldwork, confirmation and corrections cannot be made later.
- Check that the sample numbers and intervals are properly specified.
- Ensure that drilling equipment is decontaminated prior to the beginning of work and between each borehole.
- All materials generated during sampling (debris, PPE, decontamination liquids, etc.) will be placed in approved IDW storage containers pending analysis and disposal off site as outlined in SOP-B6, *Disposal of Waste Fluids and Solids (IDW)*.

SOP-B11

Site Clearance and Permitting
Standard Operating Procedures for PG&E Topock Program

This standard operating procedure (SOP) addresses the procedures for site clearance and permitting at the Topock site. This SOP should be used to obtain proper site clearance and permits before any work is performed at a site.

REQUIRED DOCUMENTS

1) Applicable project work plan, event-specific sampling and analysis plan (SAP), and/or Procedures Manual, if applicable.

2) Topock Program Health and Safety Plan (HSP).

3) Site map with work locations identified.

PREPARATION AND SETUP

1) Review applicable project work plan, event-specific SAP, Procedures Manual, and HSP.

2) Identify locations where work will be performed, determine if any subsurface work will be needed.

3) Before the start of any work obtain approval by the appropriate land agencies (such as BLM, USFWS, or the County of San Bernardino). Activities located on PG&E property fall under the jurisdiction of the County; however, approval may also be required from BLM and/or USFWS for activities such as access, waste management, etc.

4) Before the start of any work obtain appropriate approval by the regulatory agencies. These include at a minimum the DTSC. Other regulatory approvals that may be required include, but are not limited to CDFG, USFWS, USACE and RWQCB.

If subsurface work will be involved, follow the following steps:

1) Follow the guidelines of the Southern California Underground Service Alert (USA) agency to mark the edges of the work location as outlined on their web page (http://www.digalert.org). Make sure to:

   - Identify delineated areas with white markings with the requesters company name or logo within the pre-marked zones

   - Delineate the exact area of excavation with white paint through the use of dots or dashes, or a continuous solid line. Limit the size of each dash to approximately 6" in length and 1" width with interval spacing not less that approximately 4 feet. Dots of approximately 1" diameter are typically used to define arcs or radii and may be placed at closer intervals in lieu of dashes. Limit width of lines to 1".

- For point locations (such as a soil boring or well) mark the exact location in the USA box with a stake. Make sure the delineated area around the stake is of adequate radius (50 to 100 feet is appropriate for drilling).

2) Call USA at 1-800-227-2600 at least three working days before the start of work at the identified location and provide them with the information requested on the location request form, shown in Attachment 1. Be ready to give the location in terms of feet relative to I-40 and to Park Moabi Road when calling. You will be assigned a Dig Alert Number, file this number until work at the delineated area is complete. (The number does expire after two weeks and a new number may need to be obtained if work has been delayed.)

3) Mark the Dig Alert Number in the delineated area using white paint as soon as possible after calling USA.

4) If the location is in a developed area, contact a private utility locator and have them perform a sweep of the delineated work area. Util-Locate at (866) 421-5325 is typically used for this service.

5) In some cases the utility companies may need to be contacted directly by CH2M HILL. If the following companies do not respond to the USA ticket or if we are working in their easements, use the following contact information and procedures:

   Southwest Gas: Main contact is Jim Default/702-365-2097 (The required minimum clearance distance from gas pipelines is 18-inches**.** Potholing may need to be performed in advance of design completion Southwest Gas should be called prior to construction activities). If Southwest Gas does not come to the site after the USA call, contact them at their Bullhead City office at (928) 763-7766

   Southern California Gas Co.: Main contact is Frank Castro/818-701-4566; secondary contact is Martin Woodsworth/818-701-4543. If we need to work in their easement, we must provide a letter from BLM giving us permission to be on the property. Southern California Gas Co. also requires advance notification of construction activities. They may also require a copy of the design drawing, potholing activities, and the issuance of a "Non-Interference" letter, if applicable, before work can proceed. One of their representatives may need to be in the field when digging is occurring near their pipeline.

   TransWestern Pipeline Co.: Main contacts are Ron Westbrook (ROW Department)/713-345-3067 and Mike Baxter (Operations)/928-757-3620. They may require potholing if proposed construction activities are near their pipelines. Crossing pipeline requires filling out a simple form.

   Burlington Northern Santa Fe Railroad: Main contact is Greg Rousseau (BNSF)/909-386-4079. Prior to work in their easements submit the proper application with the $250 fee to the Staubach Company.

   City of Needles Utility Dept: Main contact is Ron Myers/760-326-5700 (ext. 7 for the utilities department). Work activities may need to be a minimum of 10 to 15 feet from their utility poles.

6) Do not start subsurface work at the site until the delineated area has been marked or cleared by the appropriate utility agencies.

If the work includes a performing a well installation or abandonment, or drilling a boring:

1) Apply for a San Bernardino County well permit two to three weeks before the start of drilling (one permit per well; cost is /$212.00 per well). Obtain a permit application by calling the Environmental Health Services Department at 1-909-387-4666 (open Monday through Friday, 8:00 a.m. to 5:00 p.m). An example well permit form is shown in Attachment2. The fee schedule for permits is located at http://www.sbcounty.gov/dehs/FEESCHEDULE/feeschedule.htm#wateranchor. Fill out the appropriate permit form and provide it to the California-licensed driller contracted to perform the well installation. The driller is expected to review and file the permit with the San Bernardino County Department of Environmental Health Services (Steve Sesler), address below.

   Environmental Health Services
   385 N. Arrowhead, 2nd Floor
   San Bernardino, CA 92415-0160

2) A well permit needs to be obtained from San Bernardino County for well abandonment by the same procedure described in #11. Check the 'destruction' box on the same permit form used for well installation.

3) A permit also needs to be obtained from San Bernardino County for any boring that reaches to or below the water table, even if a well is not actually installed. The permit process is the same as described in #11.

SOP-B12

General Guidance for Wireline Geophysical Logging
Standard Operating Procedures for PG&E Topock Program

This standard operating procedure (SOP) addresses the procedures and equipment to be used for oversight of down-hole geophysical surveys performed during drilling and well inspection operations at the Topock site. These procedures are to be considered general guidelines only and are in no way intended to supplement or replace the contractual specifications in the subcontractor's agreements.

REQUIRED DOCUMENTS

1) Applicable project work plan or monitoring plan. Refer to Topock Program Sampling, Analysis, and Field Procedures Manual and QAPP (Procedures Manual), as required.
2) Topock Program Health and Safety Plan (HSP)
3) Soil Boring Log and or other lithologic descriptions of the local area
4) Well construction logs/specifications (if performed in cased borehole)
5) Available soil and groundwater sample results or field parameter measurements
6) Blank geophysical survey logs and field notebook

EQUIPMENT LISTS

Equipment may vary considerably depending on the scope of work and site conditions. The following pieces of equipment are common, however, the logging contractor typically brings only what is necessary to complete their scope of work.

- Contractor rig or winch system (equipment with proper mast arm and stabilization equipment necessary to lower and raise geophysical equipment within borehole or well)
- Caliper logging tool (for caliper logging)
- Temperature logging tool (for temperature logging)
- Electric logging tools (for spontaneous potential and resistivity logging)
- Brine injection apparatus (for brine tracer test)
- Fluid conductivity logging tool (for brine tracer test)
- Gamma ray logging tool (for gamma ray logging)
- Acoustic spectrum tool (for acoustic imaging)
- Electromagnetic borehole flowmeter (for flow characterization)
- Video-camera logging tool (for video imaging)

- Decontamination materials
- Electrical power supply
- Appropriate data logging, data analysis and computer equipment

GUIDELINES

Various down-hole geophysical methods are available for subsurface investigation. Some common methods are listed in this section. They can be used to: (i) characterize subsurface lithology, aquifers, or groundwater, (ii) characterize the borehole or well, and (iii) assist in design of wells. This section provides summary information on method applicability and basic guidelines.

Caliper Logging

The caliper log is a record of the average diameter of the borehole. Caliper logs primarily are run to determine annular volumes prior to well construction, locate fractures or other openings might intersect the borehole and assess whether or not squeezing or other effects may have reduced the diameter of the borehole. Caliper logs may be either three-arm or four-arm (X-Y) types. Four-arm caliper logging tools are capable of measuring borehole deviation and direction.

Guidelines:

1) A caliper log must be performed in uncased boreholes.
2) A caliper log featuring arm-type devices is preferable to one featuring bow springs because of greater sensitivity of the arms.
3) Logs should have at least 1 inch of chart width per inch of hole diameter to provide adequate sensitivity of recording.
4) Several feet of casing should be logged so that the accuracy of the tool can be checked.

Electric Logs (E-Logs)

The most common suite of e-logs run in boreholes during well drilling and/or exploration operations include spontaneous potential, sing point resistivity, 16-inch normal, 64-inch normal and guard resistivity. They are all based on the same principals of electrical conductivity, but can be used to extract different sorts of subsurface information. Resistance is measured between two electrodes. When electrodes are closely spaced and boreholes are large, the resistance is affected primarily by borehole fluids. When electrodes are spaced farther apart, the resistance is largely affected by lithology and stratigraphy. The logging records are taken continuously in units of ohm-meters.

Single-point resistance logs record the electrical resistance from points within the borehole to an electrical ground at land surface. In general, resistance increases with increasing grain size and decreases with increasing borehole diameter, fracture density, and dissolved-solids concentration of the water. Single-point resistance logs are useful in the determination of lithology, water quality, and location of fracture zones.

Normal resistance logs record the electrical resistivity of the borehole environment and surrounding rocks and water as measured by variably spaced potential electrodes on the logging probe. Typical spacing for potential electrodes is 16 inches for short-normal resistivity and 64 inches for long-normal resistivity. Normal-resistivity logs are affected by bed thickness, borehole diameter, and borehole fluid and can only be collected in water- or mud-filled open holes

Fluid-resistivity logging provides a measurement of the resistivity of the borehole fluid between closely spaced electrodes in the probe. Abrupt and significant changes in fluid resistivity in the borehole may indicate the entry of groundwater of differing resistivity into the borehole via fractures and other openings in the geologic materials surrounding the borehole.

The fluid-resistivity log should be one of the first logs run because other logging methods will disturb the water in the borehole.

Temperature Logging

The temperature log measures the temperature and temperature gradient of the fluid in the boreholes. It can provide information on the source and movement of groundwater into and out of the borehole. Generally the temperature of the groundwater in the borehole will increase with depth. Deviations from this general trend may indicate where groundwater is flowing up, down, into, or out of the borehole. The presence of water producing zones in the borehole can be inferred from the temperature log data and correlated with other borehole flow data to determine the best well construction parameters for monitoring wells and potential extraction wells.

The temperature log may be made using the same tool as the fluid-resistivity log.

Guidelines:

1) A temperature log can be performed in uncased boreholes or wells.

2) Drilling, pumping and disruption to the fluid column will disturb the temperature gradient. For best results, the borehole needs to stabilize for at least 5 days before temperature logging.

3) The temperature log should be one of the first logs run because other logging methods will disturb the water in the borehole.

4) All temperature sensors have an inherent response lag, or time constant, so that the logging speed must be constant and slow enough that the temperatures are accurately reflected at the true depths on the log.

Flow Logging

Borehole flow logging is performed using an electromagnetic borehole flowmeter. Flow logging can identify the zones with the highest flow rate. These data are correlated with other flow data and fracture data using Geostatistics and used to evaluate the most permeable portions of the rock formation.

Guidelines:

1) Flow logging can be performed in uncased borings or wells.

2) This method may not be accurate in a boring drilled using the mud rotary method since drilling fluids may disrupt the natural flow patterns, and inhibit flow from permeable zones.

3) Results of flow logging may be biased by differing gradients at various zones. To determine the response of various zones to specific aquifer units, flow logging can be performed in an observation borehole or well during a pump test. To determine hydraulic properties, flow logging should be performed in boreholes where horizontal gradients are relatively equivalent with depth.

Brine Tracing

Brine tracing is used to measure natural or artificially induced flow within a borehole. Data on borehole flow is related to well construction, vertical differences in hydraulic head within the open or screened interval in the well, and the relative magnitude or permeability of the water-bearing units open to the well.

Guidelines:

1) Brine tracing can be performed in uncased borings or though the screened zones of cased borings or wells.

2) The fluid conductivity of the borehole should be profiled previous to the injection of brine. Low conductivity fluids, with a flat conductivity profile are ideal.

3) Lithologic stratigraphy data should be detailed enough to determine if conductivity anomalies are caused by stratigraphic changes.

4) The conductivity difference between the brine and borehole fluids needs to be large enough to easily distinguish between dilution caused by brine moving downwards though the borehole, and dilution caused by fluid movement from the aquifer.

5) The brine should be more dense than the borehole fluid, in order to move downward through the borehole from the injection point near the surface of the borehole fluid.

6) The dilution and movement are monitored by moving the detector slowly up and down through the tracer. Care is required so that the movement of the detector does not cause excessive spreading of the tracer; this effect can be minimized by using the smallest-diameter probe available.

Gamma Ray Log

The gamma ray log is used to measure the naturally occurring gamma emissions in counts per second (cps) from the formation surrounding the boreholes, due to potassium and elements of the uranium and thorium series present in the rocks. The log is a single trace of measured average radiation versus depth. Changes in the amount of gamma emissions result in significant changes in the single trace which will display measured average radiation versus depth. The presence of lithological changes in the borehole can be inferred

from the gamma ray log data and correlated with other lithological data derived from formation samples.

Guidelines:

1) Gamma ray logs can be performed in cased and uncased borings or wells.

2) The logging tool will need to be moved at a constant rate in order for counts to be weighed accurately to various depths.

3) For a given site, the rate of movement may have to be adjusted to the geologic materials present in the borehole walls. In general, the smaller the gamma counts, the slower the tool should be moved.

4) These logs may be biased by water with radiological contaminants

5) Gamma ray logging equipment does not contain radiological emission sources, as does some radiological methods (neutron probe). Therefore this equipment does not have to be treated as a hazard.

Video Logging

Video logging provides a real-time and recorded image of the actual conditions in the borehole. The video log typically is used to identify the depths of fractures and other openings in the borehole. Well videos can also be performed in order to assess damage and structure of wells. It is important to ensure the video log tool has side-scan capabilities.

Guidelines:

1) The log should be run at a sufficiently slow speed that features can be accurately recorded.

2) The field geologist (or technician), if possible, should observe the logging image so that the operator can be directed to stop or reduce logging speed at any critical locations, such as intervals where flow may be occurring as indicated by the movement of particles in the borehole.

3) If a non-aqueous phase liquid (NAPL), particularly one that floats on the surface, is present in the borehole, the image may be so adversely affected that the NAPL may have to be removed from the borehole before logging can be completed.

4) The field geologist (or technician) should obtain a copy of the video in VHS format while the operator is still in the field.\

5) A video log report containing photos of key features and their depths should be generated and provided to the CH2M HILL representative on site immediately following the logging.

Acoustic Televiewer/Spectrum System

The acoustic logs are used to measure the amplitude and pulse travel time of transmitted acoustic pulses returning from the borehole wall. The generated log is a pseudo log in waveform graphics. The pseudo log consists of an image oriented to the magnetic north as a two dimensional presentation of direction and depth. From left to right, the quadrants

run north, east, south, west, and back again to north (360 degrees). The final image is a continuous picture of the borehole, with depths to the far right and the image, laid flat, to the left. From these pseudo logs, the depth, orientation, and dip of bedding intersecting the borehole can be determined. These data are correlated with other data using geostatistical analysis to determine the best location to monitor for groundwater contamination.

Guidelines:

1) This visualization method should be performed in an open borehole, with no opaque fluids.

2) The log should be run at a sufficiently slow speed that features can be accurately recorded.

EXECUTION/PROCEEDURES

Specific procedures vary according to the geophysical method used, and the specific equipment and software used. The general procedures are as follows:

1) Prior to commencement of down-hole measurements, the site should be evaluated to determine if the site conditions are safe and appropriate for the specific work to be performed.

2) Determine the proper order or combination of geophysical logs/tests that will provide the best data, and minimal interference.

3) Calibrate all down-hole instruments and check that all equipment is working in proper order. Calibration should be properly documented.

4) Collect preliminary measurements pertinent to all geophysical logs/tests.

5) Set up equipment, making sure that all electrical equipment is properly grounded, and all mechanical equipment is properly supported. Cables should not be positioned such that they may be entangled or cause tripping hazards.

6) The logging equipment should be adequately decontaminated before the first use on the site and between boreholes.

7) Perform down-hole geophysics with oversight of appropriately trained and experienced scientist or engineer, with appropriate documentation of field techniques.

8) Review each log, test or visualization prior to removal of instruments from boring to determine if, and where new data needs to be collected.

9) Allow borehole fluids to equilibrate as is necessary and practicable between logging runs.

10) Secure each boring or well prior to proceeding to another location. No instruments, cables or fluids should be suspended within unattended borehole.

11) Collect all available electronic and hardcopy data from subcontractor prior to departure.

KEY CHECK AND ITEMS

- Ensure that subcontractor follows their procedures, particularly those for calibration of the instruments and the rate of logging.
- Obtain copies of logs at the site.
- Temperature and fluid-resistivity logs should be run first so that the disturbance caused by the other logging methods does not disrupt the results of these two methods.
- Decontaminate as necessary.

DELIVERABLES

Geophysical logs should be run in the presence of a CH2M HILL representative and the results, including three field copies of each log, provided to a CH2M HILL representative immediately after completion. The logs become the property of CH2M HILL at the time the logging is completed. In addition to the three field copies, the logging specialist shall submit the following:

1) Five final copies of each geophysical log.
2) Digital ASCII files of all geophysical data on a compact disk.
3) Digital PDF files of all geophysical data on compact disk.

Upon receiving copies of the geophysical logs, the CH2M HILL representative in the field should distribute copies of the logs to the appropriate senior level staff in the office and field. Geophysical logs should also be reviewed by the driller (in the case of drilling operations) and in the presence of the logging specialist contracted to perform the wireline logging.

REFERENCES

The following are useful technical references:

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Appendix D
Standard Operating Procedures for Groundwater Monitoring and Sampling Activities

SOP-A1

Purging and Sampling of Groundwater Monitoring Wells
Well-Volume Method
Standard Operating Procedures for PG&E Topock Program

This standard operating procedure (SOP) addresses the procedures and equipment to be used for purging and sampling all groundwater monitoring wells at the Topock site with casing diameters larger than 1-inch. A well-volume based purging and sampling method will be used for these wells.

REQUIRED DOCUMENTS

1) Event-specific planned sample table (PST).
2) Applicable project work plan or monitoring plan. Refer to Topock Program Sampling, Analysis, and Field Procedures Manual and Quality Assurance Project Plan (QAPP) as required.
3) Topock Program Health and Safety Plan (HSP).
4) Field notebook.
5) Database generated sampling logs.
6) Tabular historic field data if previous results not available on database generated sampling logs.

PREPARATION & SETUP

1) Review event-specific PST or event-specific field instructions, previous sampling logs, Procedures Manual, and HSP.
2) Initiate field logbook for sampling activity.
3) Inspect all equipment and verify that the field water quality (WQ) meters have been calibrated prior to use according to SOP-A9, *Calibration of Field Instruments*.
4) Inventory sample bottles and filters for required analyses, and confirm the lab courier schedule.
5) Prepare bottles for metals analyses that require preservation according to the event specific PST with procedures outlined in SOP-A6, *Sampling Field Filtration and Preservation for Metals Analyses*.
6) Field-check and setup sampling equipment: water level (WL) meter, WQ meters, flow-through cell, pump control and power supply, pump discharge/sampling tubing, spill containment equipment, health and safety equipment, etc.
7) Open well protection lid and measure initial static WL according to SOP-A7, *Water level Measurements*. Record WL value on sampling log.

8) If well is equipped with a transducer, remove transducer from the well according to SOP-C1, *Temporary Removal and Replacement of Transducers.*

9) Measure total depth of well with a decontaminated weighted tape according to SOP-A11, *Total Depth Measurements*. Record measured total depth of well on sampling log under 'Field measured confirmation of Well Depth'.

10) If the well is not equipped with a dedicated sampling system, install a decontaminated pump or intake tube with the intake located 10 feet below the static water column, or at the depth prescribed by the Project Manager (PM) or Field Task Manager (FTM).

PURGING AND SAMPLING PROCEDURES

1) Prepare database generated groundwater sampling log for the well.

2) Use the water level and the measured total depth recorded in the steps 7 and 9 above to calculate the column of standing water in the well (total depth minus water level). Enter the standing water height in the groundwater sampling log.

3) Calculate 3-casing volumes using the following equation:

   3*(SWH*D) = 3 casing volumes

   SWH = standing water height
   D = the volume of water per foot of height for the well's diameter

   The following values are used for D:

   1″ well = 0.04
   2″ = 0.17
   4″ = 0.66
   6″ = 1.5
   8″ = 2.6

   Record purge volume on sampling log.

4) Use the purge rate listed on the PST to determine the target purge rate. Compare the calculated purge volume and purge duration from prior events listed on the PST to the current calculations. If the well has not been previously sampled, estimate the expected purge parameters using previous sampling information from nearby wells. Start purging, measure WL, and confirm purge rate.

5) Continue purging, and measure WL and field parameters every 2-3 minutes at a minimum. Decrease the purge rate and measure/record new purge rate if significant drawdown is observed (WL is below the top of the screen) or turbidity increases more than 5-10 NTU's. Record time for all measurements collected. Note and provide qualifying remarks if parameter readings are anomalous or unstable due to instrument problem.

6) Observations on sample appearance and clarity during purging and at sampling are required. For standardization, use a glass jar or clear plastic bottle to collect and record observations of discharge water appearance during purging. Also note characteristics of any odors associated with discharge.

7) Continue purging until **3-casing volumes** have been purged **and** field parameters stabilize. Indicator parameters are considered stabilized when 3 consecutive readings made several minutes apart fall within the following EPA stabilization criteria:

   - pH ± 0.1 pH units
   - Specific conductance ± 3%
   - ORP ± 10 millivolts
   - Turbidity ± 10% NTU units (when turbidity is >10 NTUs)
   - Dissolved oxygen ± 0.3 mg/L
   - Temperature ± 2° Celsius

8) Collect samples for analyses according to event-specific PST. For all samples, decrease the discharge rate to reduce water turbulence at the pump discharge point. Prepare sample containers and collect gas-sensitive analytes first. The preferred collection order will be volatile organic compounds (VOCs), semi-volatile organic compound (SVOCs), metals (including hexavalent chromium [Cr(VI)] and total chromium [Cr(T)]; see SOP-A6), then general chemistry with stable isotopes last. Sample containers are to be filled by transferring water directly from the pump discharge to the appropriate sample container. Filter and preserve as required for individual samples as outlined in the event-specific PST.

9) Record sample information, final WL, and purge volume data on sampling log.

10) If well was equipped with a transducer, replace transducer according to SOP-C1, *Temporary Removal and Replacement of Transducers.*

11) Close and secure well protection lid.

12) Follow the Field Procedures Manual for sample handing and management, equipment decontamination, and investigation-derived waste (IDW) management.

LOW VOLUME AND POOR RECOVERY WELLS

Some groundwater monitoring wells under the GMP may exhibit slow or poor recovery upon purging. These groundwater monitoring wells may not recover sufficiently during purging and run completely dry without an opportunity to collect the required series of groundwater stabilization parameters, or run dry prior to sampling. The following procedures should be followed for wells that go dry during purging activities in preparation for groundwater sampling.

PREPARATION & SETUP

Follow steps in Preparation and Setup above and evaluate the volume of water to be discharged prior to the groundwater monitoring well going dry, if known.

PURGING AND SAMPLING PROCEDURES FOR LOW RECOVERY WELLS

1) Prepare database generated groundwater sampling log for the well.
2) Use the water level and the measured total depth recorded in the steps 7 and 9 in Preparation and Setup above, to calculate the column of standing water in the well (total depth minus water level). Enter the standing water height in the groundwater sampling log.
3) Calculate 3-casing volumes and record on sample log.
4) Use the purge rate listed on the PST to determine the target purge rate. Compare the calculated purge volume and purge duration from prior events listed on the PST to the current calculations. If the well has not been previously sampled, estimate the expected purge parameters using previous sampling information from nearby wells. Start purging at a rate of less than one gallon per minute if the pump capacity allows. Measure WL and confirm purge rate.
5) Continue purging, and measure WL and field parameters every 2-3 minutes at a minimum. Record time for all measurements collected. Note and provide qualifying remarks if parameter readings are anomalous or unstable due to instrument problem.
6) Observations on sample appearance and clarity during purging and at sampling are required. For standardization, use a glass jar or clear plastic bottle to collect and record observations of discharge water appearance during purging. Also note characteristics of any odors associated with discharge.
7) Continue purging until **3-casing volumes** have been purged **and** field parameters stabilize, or until the well is purged dry. If the well purges dry during the observation period, immediately shut off the pump and collect a final set of water quality parameters (ph, specific conductance, ORP, turbidity, dissolved oxygen, and temperature).
8) Record the final water level, note the time, the volume of water discharged and the elapsed time for the complete discharge of the well.
9) Allow the well to recharge to 80 percent of the original height of the water column. Ideally, this should be the following day - within 24 hours of the well being purged dry. The recovery period to achieve 80 percent of the height of the water column could take longer than 24 hours in some instances.
10) Calculate the volume of water in the well and volume of water needed to fill all of the sample containers. Initiate procedures for the well sampling. Begin to slowly purge the well and collect at least one set of water quality parameters prior to filling the sample containers. Collect samples for analyses according to event-specific PST. Prepare sample containers and collect gas-sensitive analytes first. The preferred collection order will be VOCs, SVOCs, metals, and then general chemistry. If an insufficient volume of water is generated to fill all of the sample containers, prioritize the sample collection to obtain the critical analytes for the main COCs first, then continue collecting samples until the groundwater supply is exhausted. Verify the critical analyte list with the PM or the FTM. Sample containers are to be filled by transferring water directly from the pump discharge to the appropriate sample container. Filter and preserve as required for individual samples as outlined in the event-specific PST.

11) Record sample information, final WL, and purge volume data on sampling log.

12) If well was equipped with a transducer, replace transducer according to SOP-C1, *Temporary Removal and Replacement of Transducers*.

13) Close and secure well protection lid.

14) Follow the Field Procedures Manual for sample handing and management, equipment decontamination, and IDW management.

Project Name PGE Topock GMP
Job Number
Field Team Field Conditions

Sampling Event
Date
Page of

Well/Sample Number **QC Sample ID** QC Sample Time

Purge Start Time Purge Method Ded. Pump

Flow Cell: Y / N Min. Purge Volume (gal)/(L) Purge Rate (gpm)/(mLpm)

Water Level	Time	Vol. Purged gallons / liters	pH	Conductivity mS/cm	Turbidity NTU	Diss. Oxygen mg/L	Temp. oC	Salinity %	TDS g/L	Eh/ORP mv	Comments (See description below
Parameter Stabilization Criteria			+/- 0.1 pH units	+/- 3%	+/- 10% NTU units when >10 NTUs	+/- 0.3 mg/L	NA	NA	NA	+/- 10 mV	
Did Parameters Stablize prior to sampling?							NA				
Are measurements consistent with previous?							NA				

Sample Time Sample Location: pump tubing well port spigot bailer other

Comments:

Initial Depth to Water (ft BTOC): Measure Point: Well TOC Steel Casing WATER LEVEL METER SERIAL NUMBER:

Field measured confirmation of Well Depth (ft btoc):

WD (Well Depth - from database) ft btoc

SWH (Standing Water Height) = WD-Initial Depth

D (Volume as per diameter) 2"= 0.17, 4"= 0.66, 1"=0.041

One Casing Volume = D*SWH

Three Casing Volumes =

Initial DTW / Before Removal		**If Transducer**		
		Approx. 5 min After Reinstallation		Time of Removal
Time	Initial DTW	Time	Final DTW	Time of Reinstallation
Comments:				

Color: clear, grey, yellow, brown, black, cloudy, green **Odor:** none, sulphur, organic, other **Solids:** Trace, Small Qu, Med Qu, Large Qu, Particulate, Silt, Sand

EXAMPLE PLANNED SAMPLE TABLE

Date: December 31, 2006 Event: 2006-GMP-000

								Aqueous Sample Container		250 ml Poly	500 ml Poly		
								Aqueous Preservatives		4'C	HNO3, 4'C		
								Filtered		Lab	Field		
								Lab		TLI	TLI		
								Analysis Holding Time		1	28		
Sample ID	Sample Location	Team	Approx DTW (feet TOC)	Target Purge Rate (gpm)	Est. Total Purge (gal)	Est. Total Purge Duration (min)	Previous CR (VI) µg/L	Sampling System	Sampling Type	CR6 (7199) Lab Filtered	Diss Metals (6010B) Field Filtered Chromium		
EB-GMP	EB-000-1	1							N	10			
MW-10-000	MW-10	1	74.36	5	40	8.00	1610	CD pump	N	10	10		
MW-11-000	MW-11	1	66.31	5	30	6.00	323	CD pump	N	10	10		
MW-12-000	MW-12	1	28.46	3	40	13.33	1250	Temp. pump	N	10	10		

NOTES:

1. Purge and sample in accordance with July 2004 Sample and Analysis Plan and March 2005 Field Procedures Manual.
2. Record the water level and field parameters during purging. Compare parameters with previous (Table 2). Note where anamalous data is suspected and investigate equipment problems
3. Complete the entire field data form and note "NA" where data is not applicable
4. Sample when purge volume is greater than or equal to three casing volumes and stablization criteria have been met
5. Fax Purge forms, COCs, Field notes, and Calibration forms daily to Oakland office (510)-622-9210.
6. Turnaround times stated in analyses columns.

Date Printed:8/28/2006

Example Analyte List

Field Team _____

Project Name PGE Topock GMP

Job Number 338234.GM.02.00

Sampling Event 2006-GMP-000

Date

Well/Sample Number MW-10-000

QC Sample ID NA

Samples Samples are to be collected in the order listed

Lab	Turnaround Time	Analyte	Field Filtered (Y/N)	Share Group	Bottle			Preservative	pH check	Notes
					Material	Size	Number			
TLI	10 days	CR6 (7199) - Lab Filtered	N	Hex Cr	Poly	250 mg/L	1	4'C	NA	
TLI	10 days	Diss Metals (6010B) - Chromium	Y	Metals-DissolvedField	Poly	1000 mg/L	1	HNO3, 4'C	NA	

SOP-A2

Purging and Sampling of 1-inch-diameter Groundwater Monitoring Wells Modified Well-Volume Method Standard Operating Procedures for PG&E Topock Program

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This standard operating procedure (SOP) addresses the procedures and equipment to be used for purging and sampling all groundwater monitoring wells at the Topock site with 1-inch casing diameters. This SOP should be used for sampling groundwater monitoring wells using dedicated tubing and a peristaltic pump (one or two). A well-volume based purging and sampling method will be used for these wells.

REQUIRED DOCUMENTS

1) Event-specific planned sample table (PST).
2) Applicable project work plan or monitoring plan. Refer to Topock Program Sampling, Analysis, and Field Procedures Manual and Quality Assurance Project Plan (QAPP) as required.
3) Topock Program Health and Safety Plan (HSP).
4) Field notebook.
5) Database generated sampling logs.
6) Tabular historic field data if previous results not available on database generated sampling logs.

PREPARATION & SETUP

1) Review event-specific PST or event-specific field instructions, previous sampling logs, Procedures Manual, and HSP.
2) Initiate field logbook for sampling activity.
3) Inspect all equipment and verify that the field water quality (WQ) meters have been calibrated prior to use according to SOP-A9, *Calibration of Field Instruments*.
4) Inventory sample bottles and filters for required analyses, and confirm the lab courier schedule.
5) Prepare bottles for metals analyses that require preservation according to the event specific PST with procedures outlined in SOP-A6, *Sampling Field Filtration and Preservation for Metals Analyses*.
6) Field-check and setup sampling equipment: WL meter, WQ meters, flow-through cell, pump control and power supply, pump discharge/sampling tubing, spill containment equipment, health and safety equipment, etc. Install dedicated tubing and connect to peristaltic pump. Connect peristaltic pump to power supply.
7) Open well protection lid and measure initial static WL according to SOP-A7, *Water level Measurements*. Record WL value on sampling log.

8) If the well is equipped with a transducer and it is necessary to remove transducer from the well for sampling, follow SOP-C1, *Temporary Removal and Replacement of Transducers*

9) Measure total depth of well with a decontaminated weighted tape according to SOP-A11, *Total Depth Measurements*. Record measured total depth of well on sampling log under 'Field measured confirmation of Well Depth'.

PURGING AND SAMPLING PROCEDURES

1) Prepare database generated groundwater sampling log for the well.

2) Use the water level and the measured total depth recorded in the steps 7 and 9 above to calculate the column of standing water in the well (total depth minus water level). Enter the standing water height in the groundwater sampling log.

3) Calculate 3-casing volumes using the following equation:

   3*(SWH*D) = 3 casing volumes

   SWH = standing water height
   D = the volume of water per foot of height for the well's diameter

   The following values are used for D:

   1″ well = 0.04
   2″ = 0.17
   4″ = 0.66
   6″ = 1.5
   8″ = 2.6

   Record purge volume on sampling log.

4) Use the purge rate listed on the PST to determine the target purge rate. Compare the calculated purge volume and purge duration from prior events listed on the PST to the current calculations. If the well has not been previously sampled, estimate the expected purge parameters using previous sampling information from nearby wells. Start purging and measure WL and calculate the purge rate every 2 minutes during the start of purging. Allow 500 milliliters of purge water to pass through the system (approximately 1-system volume), start recording field indicator parameters per sampling sheet.

5) Continue purging, and measure WL and field parameters every 2-3 minutes at a minimum. Decrease the purge rate and measure/record new purge rate if significant drawdown is observed (WL is below the top of the screen) or turbidity increases more than 5-10 NTU's. Record time for all measurements collected. Note and provide qualifying remarks if parameter readings are anomalous or unstable due to instrument problem.

6) Observations on sample appearance and clarity during purging and at sampling are required. For standardization, use a glass jar or clear plastic bottle to collect and record observations of discharge water appearance during purging. Also note characteristics of any odors associated with discharge.

7) Continue purging until **3-casing volumes** have been purged **and** field parameters stabilize. For 1-inch wells the total volume purged is typically 4-6 casing volumes. Indicator parameters are considered stabilized when 3 consecutive readings made several minutes apart fall within the following EPA stabilization criteria:

   - pH ± 0.1 pH units
   - Specific conductance ± 3%
   - ORP ± 10 millivolts
   - Turbidity ± 10% NTU units (when turbidity is >10 NTUs)
   - Dissolved oxygen ± 0.3 mg/L
   - Temperature ± 2° Celsius

8) Collect samples for analyses according to event-specific PST. For all samples, decrease the discharge rate to reduce water turbulence at the pump discharge point. Prepare sample containers and collect gas-sensitive analytes first. The preferred collection order will be volatile organic compounds (VOCs), semi-volatile organic compound (SVOCs), metals (including hexavalent chromium [Cr(VI)] and total chromium [Cr(T)], then general chemistry with stable isotopes last. Sample containers are to be filled by transferring water directly from the pump discharge to the appropriate sample container. Filter and preserve as required for individual samples as outlined in the event-specific PST.

9) Record sample information, final WL, and purge volume data on sampling log.

10) If well was equipped with a transducer, replace transducer according to SOP-C1, *Temporary Removal and Replacement of Transducers*.

11) Close and secure well protection lid.

12) Follow the Field Procedures Manual for sample handing and management, equipment decontamination, and investigation-derived waste (IDW) management.

LOW VOLUME AND POOR RECOVERY WELLS

Some groundwater monitoring wells under the GMP may exhibit slow or poor recovery upon purging. These groundwater monitoring wells may not recover sufficiently during purging and run completely dry without an opportunity to collect the required series of groundwater stabilization parameters, or run dry prior to sampling. The following procedures should be followed for collection representative groundwater samples from wells that go dry during purging activities in preparation for groundwater sampling.

PREPARATION & SETUP

Follow steps in Preparation and Setup above and evaluate the volume of water to be discharged prior to the groundwater monitoring well going dry, if known.

PURGING AND SAMPLING PROCEDURES FOR LOW RECOVERY WELLS

1) Prepare database generated groundwater sampling log for the well.
2) Use the water level and the measured total depth recorded in the steps 7 and 9 above to calculate the column of standing water in the well (total depth minus water level). Enter the standing water height in the groundwater sampling log.
3) Calculate 3-casing volumes and record on sampling log.
4) Use the purge rate listed on the PST to determine the target purge rate. Compare the calculated purge volume and purge duration from prior events listed on the PST to the current calculations. If the well has not been previously sampled, estimate the expected purge parameters using previous sampling information from nearby wells. Start purging at a rate of less than one gallon per minute. Measure WL and confirm purge rate.
5) Continue purging and measuring WL. Begin recording field indicator parameters after 500 milliliters of water has been purged, and every 2-3 minutes at a minimum thereafter. Record time for all measurements collected. Note and provide qualifying remarks if parameter readings are anomalous or unstable due to instrument problem.
6) Observations on sample appearance and clarity during purging and at sampling are required. For standardization, use a glass jar or clear plastic bottle to collect and record observations of discharge water appearance during purging. Also note characteristics of any odors associated with discharge.
7) Continue purging until **3-casing volumes** have been purged **and** field parameters stabilize, or until the well is purged dry. If the well purges dry during the observation period, immediately shut off the pump and collect a final set of water quality parameters (ph, specific conductance, ORP, turbidity, dissolved oxygen, and temperature).
8) Record the final water level, note the time, the volume of water discharged and the elapsed time for the complete discharge of the well.
9) Allow the well to recharge to 80 percent of the original height of the water column. Ideally, this should be the following day - within 24 hours of the well being purged dry. The recovery period to achieve 80 percent of the height of the water column could take longer than 24 hours in some instances.
10) Calculate the volume of water in the well and volume of water needed to fill all of the sample containers. Initiate procedures for the well sampling. Begin to slowly purge the well and collect at least one set of water quality parameters prior to filling the sample containers. Collect samples for analyses according to event-specific PST. Prepare sample containers and collect gas-sensitive analytes first. The preferred collection order will be VOCs, SVOCs, metals, and then general chemistry. If an insufficient volume of water will be generated to fill all of the sample containers, prioritize the sample collection to obtain the critical analytes for the main COCs first, then continue collecting samples until the groundwater supply is exhausted. Verify the critical analyte list with the Project Manager or the Field Task Manager. Sample containers are to be filled by transferring water directly from the pump discharge to the appropriate sample

container. Filter and preserve as required for individual samples as outlined in the event-specific PST.

11) Record sample information, final WL, and purge volume data on sampling log.

12) If well was equipped with a transducer, replace transducer according to SOP-C1, *Temporary Removal and Replacement of Transducers*.

13) Close and secure well protection lid.

14) Follow the Field Procedures Manual for sample handing and management, equipment decontamination, and IDW management.

Project Name PGE Topock GMP
Job Number
Field Team Field Conditions

Sampling Event
Date
Page of

Well/Sample Number **QC Sample ID** QC Sample Time

Purge Start Time Purge Method Ded. Pump

Flow Cell: Y / N Min. Purge Volume (gal)/(L) Purge Rate (gpm)/(mLpm)

Water Level	Time	Vol. Purged gallons / liters	pH	Conductivity mS/cm	Turbidity NTU	Diss. Oxygen mg/L	Temp. oC	Salinity %	TDS g/L	Eh/ORP mv	Comments (See description below
Parameter Stabilization Criteria			+/- 0.1 pH units	+/- 3%	+/- 10% NTU units when >10 NTUs	+/- 0.3 mg/L	NA	NA	NA	+/- 10 mV	
Did Parameters Stablize prior to sampling?							NA				
Are measurements consistent with previous?							NA				

Sample Time Sample Location: pump tubing well port spigot bailer other

Comments:

Initial Depth to Water (ft BTOC): Measure Point: Well TOC Steel Casing WATER LEVEL METER SERIAL NUMBER:

Field measured confirmation of Well Depth (ft btoc):

WD (Well Depth - from database) ft btoc

SWH (Standing Water Height) = WD-Initial Depth

D (Volume as per diameter) 2"= 0.17, 4"= 0.66, 1"=0.041

One Casing Volume = D*SWH

Three Casing Volumes =

Initial DTW / Before Removal		**If Transducer**		
		Approx. 5 min After Reinstallation		Time of Removal
Time	Initial DTW	Time	Final DTW	Time of Reinstallation
Comments:				

Color: clear, grey, yellow, brown, black, cloudy, green **Odor:** none, sulphur, organic, other **Solids:** Trace, Small Qu, Med Qu, Large Qu, Particulate, Silt, Sand

EXAMPLE PLANNED SAMPLE TABLE

Date: December 31, 2006 Event: 2006-GMP-000

								Aqueous Sample Container		250 ml Poly	500 ml Poly		
								Aqueous Preservatives		4'C	HNO3, 4'C		
								Filtered		Lab	Field		
								Lab		TLI	TLI		
								Analysis Holding Time		1	28		
Sample ID	Sample Location	Team	Approx DTW (feet TOC)	Target Purge Rate (gpm)	Est. Total Purge (gal)	Est. Total Purge Duration (min)	Previous CR (VI) µg/L	Sampling System	Sampling Type	CR6 (7199) Lab Filtered	Diss Metals (6010B) Field Filtered Chromium		
EB-GMP	EB-000-1	1							N	10			
MW-10-000	MW-10	1	74.36	5	40	8.00	1610	CD pump	N	10	10		
MW-11-000	MW-11	1	66.31	5	30	6.00	323	CD pump	N	10	10		
MW-12-000	MW-12	1	28.46	3	40	13.33	1250	Temp. pump	N	10	10		

NOTES:

1. Purge and sample in accordance with July 2004 Sample and Analysis Plan and March 2005 Field Procedures Manual.
2. Record the water level and field parameters during purging. Compare parameters with previous (Table 2). Note where anamalous data is suspected and investigate equipment problems
3. Complete the entire field data form and note "NA" where data is not applicable
4. Sample when purge volume is greater than or equal to three casing volumes and stablization criteria have been met
5. Fax Purge forms, COCs, Field notes, and Calibration forms daily to Oakland office (510)-622-9210.
6. Turnaround times stated in analyses columns.

Date Printed:8/28/2006

Example Analyte List

Field Team _____

Project Name PGE Topock GMP

Job Number 338234.GM.02.00

Sampling Event 2006-GMP-000

Date

Well/Sample Number MW-10-000

QC Sample ID NA

Samples Samples are to be collected in the order listed

Lab	Turnaround Time	Analyte	Field Filtered (Y/N)	Share Group	Bottle			Preservative	pH check	Notes
					Material	Size	Number			
TLI	10 days	CR6 (7199) - Lab Filtered	N	Hex Cr	Poly	250 mg/L	1	4'C	NA	
TLI	10 days	Diss Metals (6010B) - Chromium	Y	Metals-DissolvedField	Poly	1000 mg/L	1	HNO3, 4'C	NA	

SOP-A5

Groundwater Sampling from Sonic Drilling Boreholes
Standard Operating Procedures for PG&E Topock Program

This standard operating procedure (SOP) addresses the procedures and equipment to be used for purging and collection of grab groundwater samples from boreholes during sonic drilling. When a pump sampling system (Prosonic "Isoflow") is available and feasible, Isoflow sampling is the preferred method. When Isoflow sampling is not available or not feasible then a bailer method will be used for grab groundwater sampling while drilling.

REQUIRED DOCUMENTS

1) Event-specific sampling and analysis plan (SAP), Work Plan or event-specific field instructions. Planned borehole depth, proposed well construction/specifications, and field sampling summary table, if available.
2) Applicable project work plan or monitoring plan. Refer to Topock Program Sampling, Analysis, and Field Procedures Manual and QAPP (Procedures Manual), as required.
3) Topock Program Health and Safety Plan (HSP)
4) Previous sampling, drilling, or well construction logs from other boreholes or wells in the vicinity, if available
5) Blank sampling log and field notebook

PREPARATION & SETUP

1) Review event-specific Work Plan or event-specific field instructions, previous sampling logs, Procedures Manual, and HSP.
2) Initiate field logbook for sampling activity.
3) Review sampling procedures and equipment, and planned sample depths with drilling contractor and field crew.
4) Inspect all required field equipment and calibrate field water quality (WQ) meters according to SOP-A9, *Calibration of Field Instruments*.
5) Inventory sample bottles, review required analyses, and understand lab courier schedule.
6) Field-check and setup sampling equipment: Decontaminated Isoflow pump or stainless steel bailer, rig hoist, generator, containers for purge water management, water level (WL) meter, WQ meters, flow-through cell, pump control and power supply, pump discharge/sampling tubing, health and safety equipment, etc.

PURGING AND SAMPLING PROCEDURES FOR ISOFLOW SAMPLING FROM BOREHOLE

7) Prepare groundwater sampling log (use field notebook and summarize relevant information on sampling form).

8) Insert the Isoflow into the sonic casing. After the Isoflow is set, retract the sonic casing approximately 10 feet. Record the top and bottom of this open borehole interval and identify the grab groundwater sample as the mid-point of this interval. If possible, a water level measurement can be taken before Isoflow pumping begins. Measure initial static WL according to SOP-A7, *Water level Measurements*. Record WL value on sampling log. Monitor and record Isoflow pumping rate and WL measurements made while pumping. The length of the open borehole interval will be a field decision based on the frequency of Isoflow sampling and the formation conditions. Shorter open borehole intervals (as short as 5 feet) are appropriate for Isoflow sampling frequency of every 20 feet of drilled depth, or in heterogeneous conditions where it is desired to sample from a specific conductive zone. Longer open borehole intervals of up to 20 feet are appropriate if the Isoflow sampling frequency is every 50 to 60 feet of drill depth.

9) Measure water quality parameters using a flow-through cell connected directly to the sampling port. If it is not possible to connect the flow-through cell, a clean 5-gallon bucket may be used by filling the bucket with purge water and inserting the instrument probes directly into the bucket. If the bucket is used, turbulence in the bucket should be minimized to the extent possible. Record time for all measurements collected. Note and provide qualifying remarks if parameter readings are anomalous or unstable due to instrument problems. Record the purge rate. Purge water should be contained in a portable water storage tank, as directed by the Field Team Manager.

10) Observations on sample appearance and clarity during purging and at sampling are required. For standardization, use a clear glass jar to collect and record observations of discharge water appearance during purging. Also note characteristics such as any odors associated with the discharge water. Record the following water quality data on the field data sheet: pH, specific conductance, ORP, turbidity, TDS, and dissolved oxygen, and temperature. Indicator parameters are considered stabilized, and thus sampling may commence, when 3 consecutive readings made several minutes apart fall within the following EPA-recommended stabilization criteria:

- pH +/- 0.1 pH units
- Specific conductance +/- 3%
- ORP +/- 10 millivolts
- Turbidity +/- 10% NTU units (when turbidity is >10 NTUs)
- Dissolved oxygen +/- 0.3 mg/L

However, parameter stabilization is not a requirement for sampling from open boreholes. Typically, TDS is used as a reliable indicator for borehole sampling at the site, given the known increasing concentration with depth across the site.

11) Collect samples for analyses according to event-specific SAP. For all samples, decrease the discharge rate to reduce water turbulence at the pump discharge point. Prepare sample containers and collect gas-sensitive analytes first. The preferred collection order

will be volatile organic compounds (VOCs), semi-volatile organic compound (SVOCs), metals (including hexavalent chromium [Cr(VI)] and total chromium [Cr(T)]), then general chemistry (cations, anions, stable isotopes). Sample containers are to be filled by transferring water directly from the pump discharge to the appropriate sample container.

12) Record sample information, final WL, and purge volume data on field log.

13) Oversee the driller's removal and decontamination of the Isoflow sampling pump.

14) Oversee the driller in resuming drilling and soil sampling.

15) Follow SOPs in Program Procedures Manual for sample handing and management, equipment decontamination, and investigation-derived waste (IDW) management.

PURGING AND SAMPLING PROCEDURES FOR BAILER SAMPLING FROM BOREHOLE

7) Prepare groundwater sampling log (use field notebook and summarize relevant information on sampling form).

8) Collect the grab groundwater sample by bailing the open hole interval below the sonic casing after removing a 10 to 20-foot sonic core run.

9) Sound the bottom of the borehole after removing the core barrel. Measure initial static WL according to SOP-A7, *Water level Measurements*. Record WL value on sampling log.

10) Calculate 1-casing volume using measured WL depth, casing diameter, and total well depth information. Insert the decontaminated stainless steel bailer into the borehole and begin bailing a minimum of one casing volume. Purge water should be contained in a portable water storage tank, as directed by the Field Team Manager.

11) Measure water quality parameters using a clean 5-gallon bucket and inserting the instrument probes directly into the bucket. If the bucket is used, turbulence in the bucket should be minimized to the extent possible. Record time for all measurements collected. Record the following water quality data on the field data sheet: pH, specific conductance, ORP, turbidity, TDS, dissolved oxygen, sample appearance, and odor. Parameter stabilization is not a requirement for sampling from open boreholes. Typically, TDS is used as a reliable indicator for borehole sampling at the site, given the known increasing concentration with depth across the site.

12) Collect samples for analyses according to event-specific SAP. Prepare sample containers and collect gas-sensitive analytes first. The preferred collection order will be volatile organic compounds (VOCs), semi-volatile organic compound (SVOCs), metals (including hexavalent chromium [Cr(VI)] and total chromium [Cr(T)]), then general chemistry (cations, anions, stable isotopes). Sample containers are to be filled by transferring water directly from the bailer to the appropriate sample container. For all samples, handle the bailer with care and decant from the bailer slowly to minimize the potential for aeration and turbulence as containers are filled.

13) Record sample information, final WL, and purge volume data on field log.

14) Follow SOPs in Program Procedures Manual for sample handing and management, equipment decontamination, and IDW management.

SOP-A6

Sample Field Filtration and Preservation for Metals Analyses
Standard Operating Procedures for PG&E Topock Program

This standard operating procedure (SOP) addresses the procedures and equipment to be used for collecting groundwater / surface water samples for field filtered metals analyses at the Topock site. Refer to SOP- A1, A2, A3, or A4 for specific groundwater and surface water sampling methods.

REQUIRED DOCUMENTS

1) Event-specific sampling and analysis plan (SAP).
2) Applicable project work plan or monitoring plan. Refer to Topock Program Sampling, Analysis, and Field Procedures Manual and QAPP (Procedures Manual), as required.
3) Topock Program Health and Safety Plan (HSP)
4) Previous sampling logs
5) Blank sampling logs and field notebook

PREPARATION & SETUP

1) Review event-specific SAP or event-specific field instructions, previous sampling logs, Procedures Manual, and HSP.
2) Initiate field logbook for sampling activity.
3) Inventory sample bottles, required analyses, and lab courier schedule.
4) Field-check and setup sampling equipment: field filters, buffering solution, acid, and sample bottles.

FIELD-FILTRATION AND SAMPLE COLLECTION PROCEDURES FOR GROUNDWATER FROM MONITORING AND EXTRACTION WELLS

1) Follow SOPs A1 and A2.

Sample Collection

1) Once parameters are stabilized and a minimum 3-casing volumes have been removed from the well, disconnect the tubing from the flow-through cell and connect the inline 0.45 micron filter.
2) Allow 500 milliliters to flow through the inline filter. Fill the sample container by transferring water directly from the filter discharge to the appropriate sample container.

Total Chromium and Metals Method SW 6010B

(i) Fill a laboratory provided pre-preserved sample bottle (250 ml poly containing HNO_3) or unpreserved sample bottle (250 mL poly) with the sample to the top of the bottle neck. CARE MUST BE TAKEN NOT TO OVERFILL THE BOTTLE.

(ii) Test the pH of the sample with laboratory provided pH paper.

(iii) If the pH of the sample is greater than 2, add 5 drops of HNO_3. Close the bottle, shake, test pH. Continue adding HNO_3 in 5-drop increments until the pH is less than 2.

(iv) Record the total amount of HNO_3 added to the sample and the pH on the chain of custody and field form. Seal, label, and place the sample on ice.

Hexavalent Chromium Method SW 7196A

(i) Fill a laboratory provided sample bottle (250 mL poly) to the top of the bottle neck.

(ii) Seal, label, and place the sample on ice.

Hexavalent Chromium Method SW 7199

(i) Fill a laboratory provided sample bottle (250 mL poly) to approximately 235 mL, leaving headspace for the addition of buffer solution.

(ii) Add 3 mL of laboratory provided buffer solution using a pipette. Place the lid on the sample bottle and shake gently. Test the pH using laboratory provided pH strips.

(iii) If the pH is less than 9, add ten drops (0.5 mL) of buffer solution, close bottle and shake gently. Test pH using laboratory provided pH strips. If the pH is less than 9, continue adding the buffer solution in 10-drop increments until the pH is between 9 and 9.5 or until 12.5 mL of buffer solution is added.

(iv) If the pH is less than 9 and 12.5 mL of buffer solution has been added, add one drop of 20% NH_4OH, close bottle, gently shake, test pH. Continue until the pH is between 9 and 9.5.

(v) When the pH of the sample is between 9 and 9.5, record the total amount of pH buffer and 20% NH_4OH added to the sample and the pH of the sample on the chain of custody and field form. Seal, label, and place the sample on ice.

3) Discard used pH paper(s) and filter in IDW bin.

4) Record sample information, final WL, and purge volume data on field log.

FILTRATION AND SAMPLE COLLECTION PROCEDURES FOR SURFACE WATER AND GROUNDWATER FROM PRODUCTION WELLS

5) Follow SOP-A4 for surface water and SOP-A3 for production well sampling.

Sample Collection

6) At the support vehicle, use a peristaltic pump to pump collected surface water from the 1-liter laboratory-provided sample container through an inline 0.45 micron filter. 500 milliliters of sample should be passed through the filter prior to sample collection.

7) Sample containers are to be filled by transferring water directly from the filter discharge to the appropriate sample container.

Total Chromium and Title 22 Metals Method SW 6010B

(i) Fill a laboratory provided pre-preserved sample bottle (250 ml poly containing HNO_3) or unpreserved sample bottle (250 mL poly) with the sample to the top of the bottle neck. CARE MUST BE TAKEN NOT TO OVERFILL THE BOTTLE.

(ii) Test the pH of the sample with laboratory provided pH paper.

(iii) If the pH of the sample is greater than 2, add 5 drops of HNO_3. Close the bottle, shake, test pH. Continue adding HNO_3 in 5-drop increments until the pH is less than 2.

(iv) Record the total amount of HNO_3 added to the sample and the pH on the chain of custody and field form. Seal, label, and place the sample on ice.

Hexavalent Chromium Method SW 7196A

(i) Fill a laboratory provided sample bottle (250 mL poly) to the top of the bottle neck.

(ii) Seal, label, and place the sample on ice (no field preservation required).

Hexavalent Chromium Method SW 7199

(i) Fill a laboratory provided sample bottle (250 mL poly) to approximately 235 mL, leaving headspace for the addition of buffer solution.

(ii) Add 3 mL of laboratory provided buffer solution using a pipette. Place the lid on the sample bottle and shake gently. Test the pH using laboratory provided pH strips.

(iii) If the pH is less than 9, add ten drops (0.5 mL) of buffer solution, close bottle and shake gently. Test pH using laboratory provided pH strips. If the pH is less than 9, continue adding the buffer solution in 10-drop increments until the pH is between 9 and 9.5 or until 12.5 mL of buffer solution is added.

(iv) If the pH is less than 9 and 12.5 mL of buffer solution has been added, add one drop of 20% NH_4OH, close bottle, gently shake, test pH. Continue until the pH is between 9 and 9.5.

(v) When the pH of the sample is between 9 and 9.5, record the total amount of pH buffer and 20% NH_4OH added to the sample and the pH of the sample on the chain of custody and field form. Seal, label, and place the sample on ice.

8) Discard used pH paper(s), filter, and initial sample collection bottle in IDW bin.

9) Record sample information on field log.

SOP-A7

Water Level Measurements
Standard Operating Procedures for PG&E Topock Program

This standard operating procedure (SOP) addresses the procedures and equipment to be used for manually measuring the depth to water at surface water locations, groundwater monitoring wells and production wells.

REQUIRED DOCUMENTS

1) Event-specific sampling and analysis plan (SAP).
2) Applicable project work plan or monitoring plan. Refer to Topock Program Sampling, Analysis, and Field Procedures Manual and QAPP (Procedures Manual), as required.
3) Topock Program Health and Safety Plan (HSP)
4) Well construction logs/specifications
5) Previous water level data
6) Blank sampling logs and field notebook

PREPARATION & SETUP

1) Review event-specific SAP or event-specific field instructions, previous sampling logs, Procedures Manual, and HSP.
2) Ensure that the WL meter has been decontaminated (check for label/tag) or decontaminate as needed following SOP-A10 *Decontamination of Water Sampling Equipment.*
3) Initiate field logbook for sampling activity.
4) Inspect all equipment and calibrate water level meters if multiple meters are being used according to SOP-A9, *Calibration of Field Instruments*.
5) If a transducer is present in the well and it is necessary to remove transducer to allow well access, refer to SOP-C1, *Temporary Removal and Replacement of Transducers.*
6) Calibrate wrist-watch to the atomic clock at the Topock Compressor Station.

MEASUREMENT PROCEDURES

7) Prepare groundwater sampling log (use attached form dated March 2005).
8) At the beginning of a sampling event, if a decontamination label is not visible/complete on the water level meter to be used, proceed with decontamination of equipment. If present, remove the tag prior to use.
   During a sampling event, if the water level meter is not noted as decontaminated in the field notes, decontaminate the lower 5 feet of the water level probe before using according to SOP-A10*, Decontamination of Water Sampling Equipment*.

9) Place water level probe into well or from surface water monitoring point and lower until sensor sounds. Shake the line to remove any retained water. Note depth to water (DTW) measurement to mark on well casing, if there is no mark on casing measure to the north. Repeat 3 times and record final DTW to the nearest hundredth of a foot on the sampling log. Record well identification, time, date, DTW, and water level meter number.

10) Compare DTW measurement with previous data and note discrepancies on the sampling form. Repeat step #8 if an unexpected discrepancy is noted.

11) Decontaminate the lower five feet of measuring tape, or any portion of the instrument that came in contact with water, by unwinding the tape and following SOP-A10, *Decontamination of Water Sampling Equipment*. Record decontamination procedures and the serial number of the water level meter in the field book. If the field event is complete, attach a label to the water level meter and note decontamination procedure, initials, and date, and place the water level meter in a clean plastic bag.

SOP-A8

Field Water Quality Measurements Using a Flow-through Cell Standard Operating Procedures for PG&E Topock Program

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This Standard Operating Procedure (SOP) provides general guidelines for using the Horiba® U-22 meter and flow-through cell or similar device for field measurements of pH, specific conductance, turbidity, dissolved oxygen, oxidation-reduction potential (ORP), and temperature of groundwater samples. Additionally addressed are procedures for measuring water sample turbidity using the Hach turbidity meter. The manufacturer's manual should be consulted for detailed calibration and operating procedures.

REQUIRED DOCUMENTS

1) Event-specific sampling and analysis plan (SAP).
2) Applicable project work plan or monitoring plan. Refer to Topock Program Sampling, Analysis, and Field Procedures Manual and QAPP (Procedures Manual), as required.
3) Topock Program Health and Safety Plan (HSP)
4) Manufacturer Manuals
5) Previous sampling logs
6) Blank sampling logs and field notebook

PREPARATION & SETUP

1) Review event-specific SAP or event-specific field instructions, previous sampling logs, Procedures Manual, and HSP.
2) Initiate field logbook for sampling activity.
3) Inspect all equipment : Horiba® U-22 Water Quality Meter with flow-through cell, or similar device; Hach turbidity meter; distilled water in squirt bottle.
4) Prior to each day's use, clean the probes and flow-through cell according to manufacturer's directions and calibrate the field water quality (WQ) meters according to SOP-A9, *Calibration of Field Instruments*.

The Horiba® U-22 meter is capable of measuring the following parameters:

Parameter	Range of Measurement	Accuracy
pH	0 – 14 pH	+/- 0.1 pH units
Specific Conductivity	0 – 100 mS/cm	+/- 3 % full scale
Dissolved Oxygen	0 – 19.9 mg/l	+/- 0.2 mg/l
Temperature	0 – 55 ^{o}C	+/- 1.0 ^{o}C
ORP	-1999 mv - +1999 mv	+/- 15 mV
Salinity	0 - 4 %	+/- 0.3 %
Turbidity	0 – 800 NTU	+/- 5 % full scale

Note: Experience with field instruments indicates the Hach® turbidity meter provides a more consistent and responsive measurement of turbidity compared to the turbidity probe on the Horiba® U-22. Therefore, the Hach® turbidity meter should be used for turbidity measurements when available.

SAMPLE MEASUREMENT PROCEDURES

1) Connect the discharge tubing from the pump to the inlet side (bottom port) of the flow-through cell.

2) Connect the discharge tubing to the outlet side (top port) of the flow-through cell.

3) Place the discharge tube in a purge water collection vessel.

4) Record the time and start the pump.

5) Establish a suitable discharge rate of the pump that is consistent with the SAP and guidance.

6) Allow the well drawdown to stabilize and the temperature of the flow-through cell to equilibrate with the water temperature.

7) Turn the meter on to the measure mode.

8) Record water quality readings at regular intervals every three minutes; however the time interval between successive readings should not be shorter than the recharge time of the flow-through cell. For example, if the volume of the flow-through cell is 375 mL and the stabilized discharge rate is 137 mL/minute, the water quality readings should be at least 3 minutes apart.

9) Fill the sample vial associated with the Hach turbidity meter from the flow-through cell's discharge point. Wipe the vial dry and place in the Hach meter . Close the lid of the Hach meter completely and record the turbidity of the sample by pressing 'Read'. Adjust the range as needed.

10) Record the water quality information, volume of water discharged, the ending water quality characteristics, the ending water level, and the sample time and number in the field logbook and/or field sampling data sheet, if used.

Key Checks and Preventive Maintenance

- Calibrate meter.
- Clean probe with distilled water when done.
- If probes are dirty, rinse with a weak Alconox solution in the flow-through cell. If the device still does not calibrate, rinse with weak Alconox solution, isopropyl alcohol, Alconox, and rinse well with distilled or tap water.
- Store device using tap water. Use of deionized water will ruin the probes.
- Refer to operations manual for recommended maintenance.
- Check batteries, and have a replacement set on hand.

SOP-A9

Calibration of Field Instruments
Standard Operating Procedures for PG&E Topock Program

This standard operating procedure (SOP) addresses the procedures and equipment to be used for calibration of field instruments at the Topock site. This SOP should be used for calibration of water level meters, Horiba-U22, Orion meter, and a Hach turbidity meter.

Required Documents

1) Event-specific sampling and analysis plan (SAP).
2) Applicable project work plan or monitoring plan. Refer to Topock Program Sampling, Analysis, and Field Procedures Manual and QAPP (Procedures Manual), as required.
3) Equipment Manufacturers' Manual
4) Previous Calibration Records
5) Field Equipment Binder (documents equipment servicing, calibration, etc..)
6) Blank Calibration Sheets (see attached)

Preparation and Setup

1) Initiate field log sampling book for activity.
2) Inspect all equipment necessary to carry out activities detailed in event-specific SAP.
3) Always use fresh solutions for calibration.
4) Calibration should be performed prior to initiating sampling each day.
5) Review Field Equipment Binder equipment servicing records to anticipate next service.
6) All equipment and solutions are stored in an air-conditioned office onsite to maintain the integrity. Due to extreme temperature at the site, all calibrations are performed within this office.
7) The Horiba U-22 or Horiba U-23 and Hach turbidity meter shall be used as the principal field instruments for measuring water quality parameters during groundwater and surface water sampling. Use of the Orion pH/ORP meter should be restricted to field laboratory due to the less robust mechanics of the Orion and the specific design of the Horiba as a field instrument. If a Horiba instrument initial calibration fails and cannot be properly calibrated after repeated attempts and a replacement Horiba instrument is not available at the time, the Orion can be used as a field instrument on a temporary basis until a replacement Horiba is obtained.

Horiba U-22 – Equipment List:

-Autocal solution
-Level II solution
-Zobell's ORP check solution

-Spare batteries
-DI water

Orion pH/ORP Meter – Equipment List

-pH 7 and 10 calibration standards
-Zobell's ORP check solution
-DI water
-Spare batteries

Hach Turbidity Meter – Equipment List

-Hach DI water, NTU =0
-Gell standard solutions, NTU= 10 and NTU=100
-Spare Batteries

Calibration Procedures

Horiba U-22

1) Check expiration date of calibration solution and discard if expired.
2) Fill Horiba calibration cup to fill line with fresh autocal solution.
3) Remove storage cap (containing DI water) from probes and place probes into the calibration cup.
4) Allow approximately 10 minutes for probe stabilization (view 'read parameter' screen to determine).
5) Follow procedures in Horiba U-22 manual for auto-calibration using autocal solution.
6) Once auto-calibration is complete, check the accuracy by recording all parameters in the measurement mode. Record Horiba serial number, measured parameters, date, and time on the calibration sheet.
7) If measured parameters are not within acceptable limits (+/-0.1 pH units and +/-10% for specific conductance), repeat procedure as needed and investigate equipment malfunction. Note temperature as standard values are expected at 25^0C.
8) Discard used auto-cal solution.
9) Rinse calibration cup and probes with DI water.
10) Fill calibration cup to fill line with Level II solution.
11) Place probes in calibration cup.
12) Allow approximately 10 minutes to equilibrate.
13) Operate Horiba in read mode and record field parameter measurements on the calibration sheet.

14) If measured parameters are not within acceptable limits (+/-0.1 pH units and +/-10% for specific conductance), perform manual calibration of each parameter standard to match Level II solution. Note temperature as standard values are expected at 25^0C.

15) Operate Horiba in read mode and record field parameter measurements on the calibration sheet.

16) Discard used Level II solution.

17) Rinse probes with DI water.

18) Mix a fresh bottle of Zobell's solution using DI water as per manufacturer's instructions.

19) Fill calibration cup with the Zobells's solution

20) Place probes into calibration cup.

21) Allow 10 minutes to equilibrate (view 'read parameter' screen to determine).

22) Operate Horiba in read mode and record field parameter measurements, temperature, time, and date on field calibration sheet.

23) If ORP exceeds +/- 25mV troubleshoot and repeat calibration. If the discrepancy persists, mark meter as "Not in Service" and use a different Horiba if available. Otherwise, use the Orion ORP meter.

24) Cap probes with transfer cup containing DI water.

25) Proceed with field measurements as needed while noting:

-probes must be rinsed thoroughly with DI water after each well.
-probes must always be submersed in liquid (DI water when not in use).
–absolutely no air bubbles nor leaks should be present in the flow-through cell, repair and/or replace as needed.
–ensure all readings have stabilized prior to recording a measurement.
–all field parameters must be compared with previous data and documented on the field data sheet.

Orion pH/ORP Meter

1) Inspect electrode for scratches, cracks, salt crystal build-up, or membrane/junction deposits.

2) Rinse off any salt build-up with DI water. Follow manufacturer cleaning procedures if needed.

3) Check expiration date of calibration solution and discard if expired.

<u>pH probe</u>

1) Attach the pH probe to the Orion meter.

2) Rinse electrode with DI water.

3) Place electrode into fresh container of pH 7 and wait until reading stabilizes.

4) Record reading, time, and date on field calibration sheet.

5) Rinse electrode with DI water and then pH 10 buffer.
6) Place electrode in container of pH 10 buffer and wait until reading stabilizes.
7) Set meter to the actual pH value of the buffer.
8) Record reading, time, and date on field calibration sheet.
9) If the slope is between 92 and 102% or < +/- 0.1 pH units, proceed with pH measurements. If values are not within this range, troubleshoot and repeat as needed.

ORP probe

1) Mix a fresh bottle of Zobell's solution using DI water as per manufacturer's instructions.
2) Attach the ORP probe to the Orion meter.
3) Rinse electrode with DI water.
4) Place electrode into fresh container of Zobell's, wait at least 10-15 minutes until reading stabilizes.
5) Record ORP, temperature, time, and date on field calibration sheet.
6) Use the temperature/ORP table to determine the standard and compare.
7) If ORP is within 25 mV proceed with ORP measurements. If ORP is not +/- 25 mV, troubleshoot and repeat as needed.

Hach Turbidity Meter

1) Perform a check as per manufacturer's instructions with Hach DI water and standard solutions.
2) Record reading, time, and date on calibration sheet for both DI water and standard solution.
3) If the readings are within 10%, proceed with turbidity measurements; If not within this range, troubleshoot and repeat as needed.

Water-level Meters

When using multiple water-level meters at the site it is necessary to calibrate each against each-other at least once during the sampling event using the following procedure:

1. At a well with shallow depth to water (less than 20 feet), without dedicated tubing, piping, pump, or transducer, lower each water level meter into the well and record the reading to the nearest hundredth of a foot on the calibration sheet along with water-level meter number, time, and date.
2. Repeat step #1 at a well with deep depth to water (greater than 70 feet).

Horiba U-22/U-23, ORION, and Hach Turbidity Meter Calibration Sheet Updated: February 2005
Project Site: PG&E Topock

Calibrate each day prior to inititating sampling following SOP-A9.

U-22 instrument serial #								
Auto Calibration Performed: Y / N	**Units**	**Date/Time**	**Standard**	**Measured**	**Standard**	**Measured**	**Standard**	**Measured**
Auto Calibration solution reading:								
pH	pH		4.00		4.00		4.00	
Conductivity	mS/cm		4.49		4.49		4.49	
Turbidity	ntu							
DO	mg/L							
Temperature	celsius		25.00		25.00		25.00	
Salinity	%							
TDS	g/L							
ORP	mV (Ag/AgCl)							
Manufacturer, expiration date, lot number of auto calibration solution								
Manual Calibration Performed: Y / N								
Readings (Auto Calibration solution)								
pH	pH							
Conductivity	mS/cm							
Turbidity	ntu							
DO	mg/L							
Temperature	celsius							
Salinity	%							
TDS	g/L							
ORP	mV (Ag/AgCl)							
Manufacturer, expiration date, lot number of auto calibration solution								
Level II Solution Readings								
pH	pH		6.68		6.68		6.68	
Conductivity	mS/cm		53.00		53.00		53.00	
Turbidity	ntu		10 or 100		10 or 100		10 or 100	
DO	mg/L							
Temperature	celsius							
Salinity	%							
TDS	g/L							
ORP	mV (Ag/AgCl)							
Manufacturer, expiration date, lot number of solution								
Manual Calibration Performed: Y / N								
Readings (Level II solution)								
pH	pH							
Conductivity	mS/cm							
Turbidity	ntu							
DO	mg/L							
Temperature	celsius							
Salinity	%							
TDS	g/L							
ORP	mV (Ag/AgCl)							

Auto Calibration Performed: Y / N	Units	Date/Time	Standard	Measured	Standard	Measured	Standard	Measured
Auto Calibration solution reading:								
ORP - Zobell Check Only								
Temperature	celsius							
ORP	mV (Ag/AgCl)							
Manufacturer, expiration date, lot number of solution								
Within 25 mV of ORP standard? Y / N								
End of Day Zobell Check								
Temperature	celsius							
ORP	mV (Ag/AgCl)							
ORION Serial #								
pH 7 calibrated: Y / N								
pH 7 solution reading								
pH 10 Calibrated: Y / N								
pH 10 Solution Reading								
Manufacturer, expiration date, lot number of solution								
ORP - Zobell Check Only								
pH	pH							
Conductivity	mS/cm							
Turbidity	ntu							
DO	mg/L							
Temperature	celsius							
Salinity	%							
TDS	g/L							
ORP	mV (Ag/AgCl)							
Manufacturer, expiration date, lot number of solution								
Within 25 mV of ORP standard? Y / N								
Turbidity meter serial #								
	Units		**Standard**	**Measured**	**Standard**	**Measured**	**Standard**	**Measured**
Hach DI water reading	NTU		0					
Standard Solution Reading	NTU		10 or 100					
Manufacturer, expiration date, lot number of solution								
			DTW at one site well					
Water Level Meter ID								
Water Level Meter ID								
Water Level Meter ID								

Notes: * From the measured temperature value, find the closest standard temperature from the Zobell table and use the corresponding ORP standard.

Zobell solution-Temp/ORP Table

Temp in deg C	ORP (Ag/AgCl) (4M KCl) mV	Temp in deg C	ORP (Ag/AgCl) (4M KCl) mV
-5	270.0	23	233.6
-4	268.7	24	232.3
-3	267.4	25	231.0
-2	266.1	26	229.7
-1	264.8	27	228.4
0	263.5	28	227.1
1	262.2	29	225.8
2	260.9	30	224.5
3	259.6	31	223.2
4	258.3	32	221.9
5	257.0	33	220.6
6	255.7	34	219.3
7	254.4	35	218.0
8	253.1	36	216.7
9	251.8	37	215.4
10	250.5	38	214.1
11	249.2	39	212.8
12	247.9	40	211.5
13	246.6	41	210.2
14	245.3	42	208.9
15	244.0	43	207.6
16	242.7	44	206.3
17	241.4	45	205.0
18	240.1	46	203.7
19	238.8	47	202.4
20	237.5	48	201.1
21	236.2	49	199.8
22	234.9	50	198.5

SOP-A10

Decontamination of Water Sampling Equipment
Standard Operating Procedures for PG&E Topock Program

This standard operating procedure (SOP) addresses the procedures and equipment to be used for decontamination of sampling equipment at the Topock site.

Required Documents

1) Event-specific sampling and analysis plan (SAP).
2) Applicable project work plan or monitoring plan. Refer to Topock Program Sampling, Analysis, and Field Procedures Manual and QAPP (Procedures Manual), as required.

Preparation and Setup

1) Initiate field log sampling book for activity.
2) Inspect all equipment necessary to carry out activities detailed in event-specific SAP.
3) Review decontamination guidelines for equipment necessary to carry out activities.

Equipment List:

-Distilled water
-2.5 percent (W/W) Alconox and distilled water solution
-Large plastic pails or tubs for Alconox and distilled water, scrub brushes, squirt bottles for Alconox solution, distilled water, and clean plastic bags.
-Trash pump to transfer used decontamination water from tubs to holding tank for disposal of waste.
-Phthalate-free gloves

Guidelines

Field Equipment

Water-level Indicators

Any portion of a water-level indicator (e.g. probe and/or cable) that contacts the groundwater must be decontaminated by washing with Alconox or Liquinox solution and rinse with distilled water after use.

Probes/Cables
Probes (e.g., pH or specific ion electrodes, geophysical probes, etc..) and/or cables that come into contact with groundwater will be decontaminated using the procedures specified below unless manufacturer's instructions indicate otherwise.
For probes that make no direct contact (e.g.,OVM equipment), the probe will be wiped with paper towels.

Other Sampling Equipment
Other sampling equipment such as surface water sampling containers, spatulas, spoons, or bowls should be decontaminated and cleaned in the manner prescribed in this SOP.

Procedures

Sampling Equipment Decontamination – Groundwater Sampling Pumps

Sampling pumps are decontaminated after each use as follows:

1. Don phthalate-free gloves.
2. Turn off pump after sampling. Remove pump from well and place pump in decontamination tub, making sure that tubing does not touch the ground.
3. Turn pump back on and pump 1 gallon of Alconox solution through the sampling pump.
4. Rinse with a minimum of 1 gallon of distilled water.
5. Keep decontaminated pump in decontamination tub or remove and wrap in clean plastic sheeting or clean plastic garbage bag.
6. Collect all rinsate and dispose of in a DOT-approved 55-gallon drum or holding tank.
7. Decontamination materials (e.g., plastic sheeting, tubing, etc.) that have come in contact with used decontamination fluids or sampling equipment will be disposed of in DOT-approved 55-gallon drums.

Sampling Equipment Decontamination – Other Equipment

Reusable sampling equipment is decontaminated after each use as follows.

1. Don phthalate-free gloves.
2. Wash all equipment surfaces that contacted the potentially contaminated soil/water with Alconox solution.
3. Rinse with distilled water or triple rinse with potable water.
4. Air dry and wrap exposed areas with plastic sheeting or a clean plastic garbage bag for transport and handling if equipment will not be used immediately.
5. Collect all rinsate and dispose of in a DOT-approved 55-gallon drum or holding tank.
6. Decontamination materials (e.g., plastic sheeting, tubing, etc.) that have come in contact with used decontamination fluids or sampling equipment will be disposed of in DOT-approved 55-gallon drums.

Key Checks and Items

- Clean with solutions of Alconox and distilled water.
- If necessary, decontaminate the outside of filled sample bottles before relinquishing them to anyone.

- All materials generated during sampling (debris, PPE, decontamination liquids, etc.) will be placed in 55-gallon drums or rolloff bins for storage pending analysis and disposal off site.
- Document all decontamination procedures in the field log book. Prior to use of equipment during a sampling event, check log book to see that equipment was decontaminated, if not proceed with decontamination procedures prior to use. At the end of an event, tag equipment as decontaminated with initials and date. Remove the tag prior to use at the beginning of the next event. If at the beginning of a sampling event this tag is not visible/complete, proceed with decontamination of equipment.
- The effectiveness of field cleaning procedures will be monitored by rinsing decontaminated equipment (i.e. portable pump) with organic-free water and submitting the rinse water in standard sample containers for analysis. The minimum number of equipment blank samples will be at least one per team (per event), per piece of equipment decontaminated, during large-scale field sampling efforts.

SOP-A11

Total Depth Measurements
Standard Operating Procedures for PG&E Topock Program

This standard operating procedure (SOP) addresses the procedures and equipment to be used for manually measuring the total depth at groundwater monitoring wells and production wells.

REQUIRED DOCUMENTS

1) Event-specific sampling and analysis plan (SAP).
2) Applicable project work plan or monitoring plan. Refer to Topock Program Sampling, Analysis, and Field Procedures Manual and QAPP (Procedures Manual), as required.
3) Topock Program Health and Safety Plan (HSP)
4) Well construction logs/specifications
5) Previous total depth data
6) Blank sampling logs and field notebook

PREPARATION & SETUP

1) Review event-specific SAP or event-specific field instructions, previous sampling logs, Procedures Manual, and HSP.
2) Ensure that the measurement probe (weighted tape measure) has been decontaminated (check for label/tag) or decontaminate as needed following SOP-A10 *Decontamination of Water Sampling Equipment.*
3) Initiate field logbook for sampling activity.
4) If a transducer is present in the well and it is necessary to remove transducer to allow well access, refer to SOP-C1, *Temporary Removal and Replacement of Transducers.*
5) Calibrate wrist-watch to the atomic clock at the Topock Compressor Station.

MEASUREMENT PROCEDURES

6) Prepare Total Depth measurement log (use attached form dated March 2005).
7) Decontaminate the entire length of the measuring tape before using, according to SOP-A10*, Decontamination of Water Sampling Equipment*.
8) Place measurement tape into well and lower until the bottom of the probe touches the bottom of the well. Note total depth (TD) measurement to mark on well casing, if there is no mark on casing measure to the north. Repeat 3 times and record final TD to the nearest hundredth of a foot on the log. Also note the condition of the well bottom (i.e. hard bottom, soft bottom). Record well identification, time, date, TD, and measurement tape identification.

9) Compare TD measurement with previous data and note discrepancies on the sampling form. Repeat step #8 if an unexpected discrepancy is noted.

10) Decontaminate the entirety of the measuring tape, or any portion of the instrument that came in contact with water, following SOP-A10, *Decontamination of Water Sampling Equipment*.

Field Staff: _____ Topock Total Depth Survey Log Updated: March 2005

Well ID	Date	Measured Total Depth ft BTOC	Constructed Total Depth ft BTOC	Comments

SOP-A13

Spill Prevention, Containment, and Control Measures for Monitoring Well Sampling Standard Operating Procedures for PG&E Topock Program

This standard operating procedure (SOP) addresses the procedures and equipment to be used for spill prevention, containment, and control associated with groundwater sampling activities at the Topock site. This SOP applies to containment and control of potential spills of purge and equipment decontamination water generated during the sampling of monitoring wells.

REQUIRED DOCUMENTS

1) Topock Program Health and Safety Plan (HSP).
2) Emergency Notification Binder. Note: This binder will be carried by field crews.

PREPARATION & SETUP

1) Prepare and load required spill containment equipment for use during monitoring well purging
2) Inspect reusable spill containment equipment for damage and report any damage found to the Field Task Manager.
3) Review this SOP and the Emergency Notification Binder.

EQUIPMENT LIST

- Small (4′ by 6′ by 1′ deep) "Throw N′ Go" spill containment basin for ATV trailer-mounted purge water tank, when sampling on floodplain. Containment capacity is 154 gallons on level ground.
- Large (8′ by 23′ by 1′ deep) "Throw N′ Go" spill containment basin for truck bed-mounted purge water tank. Containment capacity is 1,274 gallons on level ground
- Vinyl liner for ATV trailer-mounted purge water tank that fits inside the trailer bed, for sampling in the upload areas.
- Portable work surface (4′ x 4′ Collapse-a-tainer Lite) for 5-gallon purge buckets and smaller equipment such as water quality meters.
- Small spill containment pad (2′ x 2′).
- 5-gallon buckets
- Hydrophilic sorbent material (absorbent pads or mats).
- Hand-operated or other water pump for transferring fluids.
- Plastic sheeting/visqueen
- Shovel and/or other hand tools.
- Plastic bags for storage and disposal of used sorbent material.

GENERAL SPILL PREVENTION PRACTICES

- Do not place wet items or items that have been in the well onto the ground. All items with fluids should be placed on the small spill containment pad as a working surface
- No drops of water should hit the ground. Use either 5-gallon buckets or the small spill containment pad to avoid drops from equipment
- Only use restroom facilities at the GMP trailer or the IM3 facility.

CONTAINMENT SCENARIO 1: SAMPLING ON FLOODPLAIN

For monitoring well sampling on the floodplain, purge water is placed in a 200-gallon ATV trailer-mounted tank. The trailer-mounted tank is situated adjacent to the monitoring well to be sampled. Purge water is pumped directly into the tank via transfer hose at approximately 3 gallons per minute (gpm). Purge water from the Horiba flow cell is contained in a 5-gallon bucket and is manually transferred into the purge water tank.

Potential Spill Scenarios

- Overfill of ATV trailer-mounted purge water tank
- Spills at time of hose disconnection from tank or during manual transfer into tank from bucket
- Disrupted bucket of purge water

Required Equipment

- Small (4′ by 6′) "Throw N′ Go" spill containment basin for ATV trailer-mounted purge water tan
- Vinyl liner for ATV trailer
- Portable work surface
- Small spill containment pad
- Sorbent material
- Hand-operated or other water pump for transferring fluids

Procedures

1) Deploy the ATV trailer-sized "Throw N′ Go" containment basin. Situate ATV trailer with purge water tank inside the containment basin, as close to well head as possible. Secure the transfer hose in the tank opening.

2) Evaluate the remaining capacity of the tank prior to initiating well purging to ensure that there is sufficient capacity to hold the amount of purge water anticipated to be generated during purging of the well.

3) Any buckets for purge water and smaller equipment such as the Horiba must be placed inside the portable work surface prior start of purging.

4) During purging, field staff will remain at the discharge end of the hose and will monitor transfer of water into the purge water tank. If tank approaches being full, discontinue purging.

5) If there are any small drips that arise (i.e. from hose fittings), immediately place the small spill containment pad underneath the drip.

6) At completion of purging, when disconnecting the transfer hose from the tank opening, perform hose disconnection within the containment basin to ensure that any drips or spills of purge water are contained within the basin. If any purge water is present in the containment basin, transfer the water into the purge water tank.

7) Secure purge water tank openings and ensure that the tank is well secured to the ATV trailer. Remobilize to the next well to be sampled.

8) Repeat the preceding steps at the next well to be sampled.

9) When the ATV trailer-mounted purge water tank is full, continue with procedures under Containment Scenario 3.

CONTAINMENT SCENARIO 2: SAMPLING IN NON-FLOODPLAIN AREA

For monitoring well sampling in non-floodplain areas of the site, wells can be accessed by truck, and purge water is placed in a 400-gallon truck bed-mounted tank. Purge water is pumped directly into this tank via transfer hose at rates up to 10 gpm. Purge water from the Horiba flow cell is contained in a 5-gallon bucket and is manually transferred into the purge water tank.

Potential Spill Scenarios

- Overfill of truck bed-mounted purge water tank
- Spills at time of hose disconnection from tank or during manual transfer into tank from bucket
- Disrupted bucket of purge water

Required Equipment

- Large (8′ by 23′) "Throw N' Go" spill containment basin for truck bed-mounted purge water tank
- Portable work surface
- Small spill containment pad
- Sorbent material
- Hand-operated or other water pump for transferring fluids

Procedures

1) Deploy the truck-sized "Throw N' Go" containment basin. Situate truck with purge water tank inside the containment basin, as close to well head as possible. Secure transfer hose in tank opening.

2) Evaluate the remaining capacity of the tank prior to initiating well purging to ensure that there is sufficient capacity to hold the amount of purge water anticipated to be generated during purging of the well.

3) Any buckets for purge water and smaller equipment such as the Horiba must be placed inside the portable work surface prior start of purging.

4) During purging, field staff will remain at the discharge end of the hose and will monitor transfer of water into the purge water tank. If tank approaches being full, discontinue purging.

5) If there are any small drips that arise (i.e. from hose fittings), immediately place the small spill containment pad underneath the drip.

6) At completion of purging, when disconnecting the transfer hose from the tank opening, perform hose disconnection within the containment basin to ensure that any drips or spills of purge water are contained within the basin. If any purge water is present in the containment basin, transfer the water into the purge water tank.

7) Secure purge water tank openings and ensure that the tank is well secured to the truck bed. Remobilize to the next well to be sampled.

8) Repeat the preceding steps at the next well to be sampled.

9) When the truck-mounted purge water tank is full, continue with procedures under Containment Scenario 4.

CONTAINMENT SCENARIO 3: TRANSFER OF PURGE WATER FROM ATV TRAILER-MOUNTED TANK TO TRUCK BED-MOUNTED TANK

When the ATV trailer-mounted purge water tank requires emptying to a truck bed-mounted tank, the following procedures will be used. Purge water is transferred using a sump pump and transfer hose at rates up to 10 gpm.

Potential Spill Scenarios

- Overfill of truck bed-mounted poly tank
- Pump or transfer hose leakage during pumping into tank or at time of hose disconnection

Required Equipment

- Large (8′ by 23′) "Throw N′ Go" spill containment basin for truck bed-mounted purge water tank
- Small (4′ by 6′) "Throw N′ Go" spill containment basin for ATV trailer-mounted purge water tank
- Sorbent material
- Hand-operated or other water pump for transferring fluids

Procedures

1) Ensure that the truck with truck bed-mounted purge water tank is situated within its containment basin.

2) Deploy the ATV trailer-sized containment device. Situate ATV trailer with purge water tank inside the containment basin, as close to the truck as possible.

3) Evaluate the remaining capacity of the truck bed-mounted tank prior to initiating transfer from the ATV trailer-mounted tank, to ensure that there is sufficient capacity to hold the amount of purge water to be transferred.

4) Using sump pump and transfer hose, pump water from the ATV trailer-mounted tank to the truck bed-mounted tank. Field staff will be present during the entire transfer to

monitor the water level in the receiving tank and to ensure no leakage or spills occur. If the tank approaches being full, discontinue transfer operations.

5) At the completion of transfer operations, when disconnecting the transfer hose from the receiving tank opening, perform hose disconnection within the containment basin to ensure that any drips or spills of purge water are contained within the basin. If any purge water is present in the containment basin, transfer the water into the purge water tank.

6) Secure purge water tank openings and ensure that the tank is well secured to the truck bed.

7) When the truck-mounted purge water tank is full, continue with procedures under Containment Scenario 5.

CONTAINMENT SCENARIO 4: TRANSFER OF PURGE WATER FROM TRUCK BED-MOUNTED TANK TO FINAL STORAGE LOCATION

When the truck bed-mounted purge water tank requires emptying, the following procedures will be used. Purge water is transferred into a 5,500-gallon storage tank at the PG&E Topock Compressor Station, at rates up to 20 gpm. The 5,500-gallon tank is located within a permanent containment structure.

Potential Spill Scenarios

- Overfill of tank at final storage location
- Pump or transfer hose leakage during pumping into tank or at time of hose disconnection.

Required Equipment

- Large (8′ by 23′) "Throw N' Go" spill containment basin for truck bed-mounted purge water tank
- Sorbent material
- Hand-operated or other water pump for transferring fluids

Procedures

1) Ensure that the truck with bed-mounted tank is situated within its containment basin.

2) Evaluate the remaining capacity of the receiving tank prior to initiating transfer from the truck-mounted tank, to ensure that there is sufficient capacity to hold the amount of purge water to be transferred.

3) Using pump and transfer hose, pump water from the truck-mounted tank to the receiving tank. Field staff will be present during the entire transfer to monitor the water level in the receiving tank and to ensure no leakage or spills occur. If the receiving tank approaches being full, discontinue transfer operations.

4) At the completion of transfer operations, when disconnecting the transfer hose from the receiving tank opening, perform hose disconnection within the containment basin to

ensure that any drips or spills of purge water are contained within the basin. If any purge water is present in the containment basin, transfer the water into the purge water tank.

5) Secure tank openings on the receiving tank.

SPILL RESPONSE ACTIONS

In the event purge water is spilled outside of containment basins, the field team will take the following actions.

Required Equipment

- Sorbent material
- Plastic sheeting/visqueen
- Hand-operated or other water pump for transferring fluids
- Shovel and/or other hand tools
- 5-gallon buckets
- Plastic bags for storage and disposal of used sorbent material

Procedures

1) To the extent possible, use sorbent material and plastic sheeting/visqueen to contain the spilled purge water.

2) With the exception of the low-impact area of the floodplain, dig a small pit and line with visqueen to serve as a containment area for collection of spilled purge water. Use of this technique will be limited to only those areas where water does not immediately percolate into the ground surface. DO NOT dig into the ground or otherwise disturb the ground surface in the low-impact area of the floodplain.

3) Transfer any contained purge water into the purge water tank.

4) Manually dig up any saturated soil and place in 5-gallon bucket(s) or other appropriate containers. DO NOT dig into the ground or otherwise disturb the ground surface in the low-impact area of the floodplain.

5) Dispose of containerized soil, used sorbent material, and gloves in accordance with SOP-B6, *Disposal of Waste Fluids and Solids (IDW)*.

6) Perform notifications as required in the Emergency Notification Binder. Complete the Notification Documentation Form provided in the Binder.

SOP-A16

Access Routes
Standard Operating Procedures for PG&E Topock Program

This standard operating procedure (SOP) addresses the procedures to be used when accessing wells or other sampling stations at the Topock site. This SOP should be used for all travel to collect data on site. All field personnel and subcontractors are required to read this SOP and sign on the Employee Signoff Form.

OVERVIEW

Figure 1 shows the Topock project groundwater and surface water data collection locations.[1] The map also shows the access routes used for sampling and transducer downloads. These lines indicate vehicle access on existing roads, and indicate where all-terrain vehicle (ATV) or foot access is used at locations where pickup truck access is not possible. Purple lines on the map indicate where either pickup trucks or ATVs are used. Blue lines indicate routes with allowed access by ATV but not by pickup truck. Black dotted lines indicate foot access routes. Where the black dots overlay the blue routes on the floodplain area, the access is on foot during the Southwestern Willow Flycatcher nesting season (May 1st through September 30th), and by ATV outside of nesting season. The access routes with specific mitigation measures or access procedures discussed herein are highlighted in green.

Table 1 summarizes the frequency of the current sampling schedule at each data collection point and the means of access by code. As Table 1 indicates, there are 3 access procedures that are to be followed depending on when fieldwork is to occur:

A = Universal for the site

B = Floodplain during Flycatcher summer nesting season (May 1st through September 30th)

C = Upland close to cultural resources (Year-round)

A work orientation is to be provided to all field personnel regarding cultural and biological resources and the spiritual importance of the geographic area and the river to local tribes. The orientation should emphasize the need to stay within the established, marked access routes and work areas, and to prevent enlargement of previously used areas. It should also include instilling awareness of specific access details.

A SITES ACCESS PROCEDURES – APPLIES TO ALL SITES

Personnel must obey the following procedures when accessing all data collection sites (refer to Figure 1):

[1] Data collection locations do not include boat-based sampling in Colorado River, future well locations, or past or future soil/sediment sampling locations.

- Access by vehicles is restricted to established roads or tracks. For off-road access the number of vehicles used should be minimized (usually one pickup and trailer for SEFS and one pickup or SUV for CH2M HILL).
- All vehicles are to observe a 10-mph speed limit on Historic Route 66 (H-66), drive in the center of H-66 to avoid wear on the H-66 shoulders, and not cut corners when exiting H-66 to access well locations.
- All vehicles are to travel slowly off-road (5 mph speed where possible) to give time to observe and avoid wildlife and minimize noise, dust, and vehicle rutting.
- Most off-road access is to be by low-impact All Terrain Vehicles (ATV's) which carry sampling or data collection equipment and can tow a small trailer for management of groundwater sampling purge water.
- Access beyond the purple lines on the map is by ATV (blue lines) or on foot (dotted black lines). Access follows consistent routes or paths.
- Minimize time near possible wildlife habitat.
- Coordinate with on-site field client representative (FCR) and security patrol to prevent unauthorized access to site areas.

These minimum procedures are followed for all data collection locations. More rigorous procedures are to be used at locations where potential concerns have been identified.

B SITES ACCESS PROCEDURES

Field crews are to follow the following mitigation measures for the floodplain wells as listed below during the Southwestern Willow Flycatcher nesting season, May 1st through September 30th. The universal A sites measures that were outlined above will also apply at these locations. Site B locations include:

- Well locations MW-27, MW-30, MW-34, MW-36, MW-42, MW-45, PE-1, and shoreline location R-27 on the Bureau of Land Management (BLM) managed area
- Well locations MW-22, MW-32, MW-43, and shoreline location R-22 on the Havasu National Wildlife Refuge (HNWR) area

Well sampling, transducer data collection, and any other work activities will not occur during the protocol survey timing for the Flycatcher. Upon completion of the surveys, the onsite biologist will approve/disapprove of work activities depending on the survey results. If a Flycatcher is not detected, then the biologist will permit the activities. If a Flycatcher is detected, then the biologist will not permit the work activities, and the regulatory agencies will be consulted.

Specialized Field Equipment

A 6x6 Polaris ATV with a stealth muffler will be utilized while accessing B sites on BLM property during the nesting season. The larger ATV will minimize noise and enable towing water storage tanks through the sand without getting stuck at low revolutions per minute (RPM). The larger ATV will also be able to trailer a 200-gallon purge tank, which would minimize the number of trips needed to dispose of the purge water from a typical well cluster.

New power supply outlets have been installed at PE-1 and a leak detection vault north of MW-39. By using this power supply to power the groundwater pumps instead of a generator, the sampling operation is virtually noiseless when sampling the following wells near PE-1: MW-27, MW-30, MW-34, MW-36, MW-42, and MW-45 clusters. Using a heavy-gauge extension cord, it is possible to use this power source for sampling at these locations on BLM property.

Approximately 700 feet of 4-inch "lay-flat" hose is to be used to replace the current garden hose used to connect the pumps at the well head to the purge tanks at the staging areas. The lay-flat hose will be rolled out using an ATV, generally before the nesting season when possible. The need to transport the hose prior to each monitoring well would be eliminated by leaving the hose in place after sampling is completed, minimizing the impact in areas of potential Flycatcher habitat. Spill containment will be provided under any hose connections where multiple hose segments are required to reach more distant wells. The hose will be cleared of all water after sampling is completed and left in place until the next sampling event. Clearing water from the hose will be accomplished by lifting the hose to shoulder height to drain the water into the purge water storage tank. Since the area is open to public recreation and the potential for damage to the hose exists, the field crews will carefully inspect the hose before each use.

New dedicated pumps were installed in late 2005 in MW-27, MW-34, and MW-43 well clusters. These new dedicated pumps are in addition to existing dedicated pumps in wells at MW-30, MW-32, and MW-36. Therefore, pumps and decontamination equipment will no longer need to be transported to these wells, decreasing the overall impact associated with sampling at these locations.

Access Procedures for Wells on BLM Property

For wells located on the BLM property, pickup-truck-carried equipment is staged on the graded road approximately 120 feet south of well cluster MW-35 (Figure 1). The pickup-truck is therefore located a minimal distance from the paved road and on an established access route. From that point, 2 ATVs travel south to access monitoring well clusters. One will be a heavy duty 6x6 ATV that transports equipment and tows the water tank trailer, while the other will be a light duty 4x4 ATV that transports personnel. Well clusters MW-30, MW-36, and MW-42 will be accessed directly by ATVs. For sampling MW-34 and MW-45 clusters, the ATV's will park in the staging area at the PE-1 location and field crews will travel and carry equipment by foot to the wells. For sampling the MW-27 cluster and R-27, the ATVs will park in the staging area mid-way between MW-42 and MW-27. Field crews will then carry equipment by foot to the sampling locations. The power source at PE-1 will be used to sample the B site wells on BLM property.

Access Procedures for Wells on HNWR Property

On HNWR property, located to the south of the railroad bridge, pickup-truck-carried equipment is to be staged at the cleared and graded area to the west of well cluster MW-32 (Figure 1). All power equipment and purge water storage tanks are staged at this location. No ATV's will be allowed for work in this area. Only foot traffic along established trails is permitted from the MW-32 staging area to the three well clusters MW-22, MW-32, and MW-43, and shoreline station R-22 located near potential nesting habitat on the HNWR property.

Sampling Procedures for B Site Wells with Dedicated Pumps

The following list summarizes the modified "nesting season" sampling procedures for the B site monitoring wells with dedicated pumps. These modified procedures will be followed each year during May 1st through September 30th:

- A biologist will pre-survey the planned work area for the presence of nesting listed-bird species, and sampling will proceed if the survey results are negative. BLM and DTSC will be contacted and sampling will not proceed if the pre-survey finds nesting listed-bird species.
- New sampling procedures and biological resource sensitivity will be reviewed at each field event kickoff briefing.
- Pickup trucks will stage at the MW-35 area off Park Moabi Road (BLM property) or west of the MW-32 cluster (HNWR property).
- On BLM property, only two ATVs will transport equipment from MW-35 area to the staging areas.

- The ATVs will maintain low speeds and low revolutions per minute to minimize noise. The target speed will be 5 mph on the floodplain, per BLM direction. The ATVs will maintain a reduced speed to the extent possible while avoiding getting lodged or stuck.
- A biologist will accompany the sampling team upon startup of activities and will provide a reconnaissance "sweep" during the sampling event.
- All equipment transported by ATV will be staged at one of the two ATV staging areas.
- Generators will be operated at the staging area where there is no nearby power supply (HNWR). Two 2-kilowatt generators will be operated in parallel to mitigate noise.
- Spill prevention, containment, and control measures outlined in SOP-A13 will be implemented. This includes the use of large plastic spill containment trays under each lay-flat hose connection between the well and the staging area.
- The well purge will be conducted with the dedicated pump and documented.
- When the well purge is complete, samples will be collected.
- After sample bottles are filled, the dedicated pump will be shut down.
- The sample cooler will be carried back to the staging area.
- At all times, conversation noise and abrupt or unnecessary movements will be avoided, and equipment noise will be minimized. Equipment will be muffled or padded during transport and setup to avoid clanging or other impact noises from bottles and metal components.
- A biologist's report of the sampling activities will be completed within a week of the sampling and submitted to DTSC and BLM.

Sampling Procedures for B Site Wells without Dedicated Pumps

For monitoring wells without a dedicated pump installed (MW-27-20 and MW-43-25), an electric submersible pump is carried on foot from the ATV staging area to each well location. From the wellhead, discharge tubing is run along the trails to the purge water holding tanks at the staging area. The distance from the sample location to the staging area is as much as 750 feet. Electrical power cords are also run along the trails from a portable electric generator at the staging area to the pump control box. The pump control box is situated approximately 350 feet from the wellhead. That distance is determined by the maximum length of the motor lead cable that connects the control box to the pump.

The following list summarizes the modified "nesting season" sampling procedures for the B site monitoring wells without dedicated pumps. These modified procedures will be followed each year during May 1st through September 30th:

- A biologist will pre-survey the planned work area for the presence of nesting listed-bird species, and sampling will proceed if the survey results are negative. BLM and DTSC will be contacted and sampling will not proceed if the pre-survey finds nesting listed-bird species.

- New sampling procedures and biological resource sensitivity will be reviewed at each field event kickoff briefing.
- Pickup trucks will stage at the MW-35 area off Park Moabi Road (BLM property) or west of the MW-32 cluster (HNWR property).
- On BLM property, only two ATVs will transport equipment from MW-35 area to the staging areas.
- The ATVs will maintain low speeds and low revolutions per minute to minimize noise. The target speed will be 5 mph on the floodplain, per BLM direction. The ATVs will maintain a reduced speed to the extent possible while avoiding getting lodged or stuck.
- A biologist will accompany the sampling team upon startup of activities and will provide a reconnaissance "sweep" during the sampling event.
- On BLM property, all equipment transported by ATV will be staged at one of the two ATV staging areas.
- Generators will be operated at staging areas where no is no nearby power supply (HNWR). Two 2-kilowatt generators will be operated in parallel to mitigate noise.
- The pump control box will be staged on the established footpath about 350 feet from the well to be sampled (MW-22, MW-45).
- Spill prevention, containment, and control measures outlined in SOP-A13 will be implemented. This includes the use of large plastic spill containment trays under each lay-flat hose connection between the well and the staging area.
- The pump flow rate will be set at the pump control box as the purge is started, and then the control box will be left unattended.
- The well purge will be conducted and documented from the staging areas.
- When the well purge is complete, two people will carry a cooler with sample bottles to the well head and one person will go to the pump control box.
- After sample bottles are filled, the pump will be shut down at the control box, and the pump will be removed from the well.
- The pump and sample cooler will be carried back to the MW-39 or MW-32 staging area.
- The pump and first hose length will be decontaminated and taken to the next well for sampling.
- At all times, conversation noise and abrupt or unnecessary movements will be avoided, and equipment noise will be minimized. Equipment will be muffled or padded during transport and setup to avoid clanging or other impact noises from bottles and metal components.
- A biologist's report of the sampling activities will be completed within a week of the sampling and submitted to DTSC and BLM.

Modified Purging and Sampling Procedures for Wells Without Dedicated Pumps

To minimize the presence of the sampling crew members near the well locations, water quality readings are to be measured from the discharge at the staging area. Typically, the water quality readings are measured at the well head. Field readings are measured using a Horiba U-22 water quality meter with a flow cell. Normally, three consecutive readings taken at least 3 minutes apart must meet the following criteria:

- pH +/- 0.1 pH units
- Specific conductance +/- 3%
- ORP +/- 10 millivolts
- Turbidity +/- 10% NTU units (when turbidity is >10 NTUs)
- Dissolved oxygen +/- 0.3 mg/L
- Temperature +/- 2^{o} Celsius

It is expected that discharged purge water will be heated after traveling across hot sand on the floodplain. For this reason, temperature and dissolved oxygen are eliminated as stabilization criteria at these wells. The revised stabilization criteria include:

- pH +/- 0.1 pH units
- Specific conductance +/- 3%
- ORP +/- 10 millivolts
- Turbidity +/- 10% NTU units (when turbidity is >10 NTUs)

In addition, water level measurements are to be taken at the beginning and end of the purge only. No measurements will be taken during the purge.

Since the water from the discharge hose is expected to be heated, analytical samples will be collected at the wellhead. Once the field parameters are stable and three well volumes have been purged from the well, one crew member will carry an ice chest with sample bottles to the well head and collect the samples in accordance with the SOP. A tee fitting on the sampling hose is to be used for sample collection at the wellhead. After the samples are collected, the pump will be shut down and pulled from the well. Equipment that requires decontamination is to be carried back to the staging area before sampling the next well. Otherwise, equipment will be moved directly to the next well location to be sampled.

A PG&E-designated biologist is to be onsite during sampling to ensure that these measures are adequate to avoid any potential direct or indirect impacts to the Southwestern Willow Flycatcher near the monitoring wells.

Health and Safety

The nesting season of the Southwestern Willow Flycatcher occurs during the hottest part of the year when temperatures can exceed 120 degrees Fahrenheit in the afternoon. Additional health and safety procedures are put in place to address the additional exertion required for the modified sampling procedures while working in the summer heat.

The following procedures are implemented for sampling in hot weather conditions:

- The workday begins at 5:00 a.m. and work ceases no later than 12:00 p.m.

- Crew numbers are at least doubled to allow for crew rotations for rest and rehydration breaks.
- Oral body temperature is monitored to determine if employees are adequately dissipating heat buildup. If an employee's body temperature exceeds 99.6 degrees Fahrenheit, the following work period will be shortened by one-third. If an employee's oral temperature exceeds 100.4 degrees Fahrenheit, he or she will not return to work for the rest of the day.
- Heart rate is measured during each break period. If an employee's heart rate exceeds 100 beats per minute (bpm), or 20 bpm above resting rate, the subsequent work period will be shortened by one-third. If the heart rate exceeds 180 bpm minus the employee's age, then work activities are suspended until the rate returns to resting rate.
- Each individual's weight is measured throughout the day. If weight loss exceeds 1.5 percent of total body weight, the worker will be removed from work until fluids have had time to be absorbed and body weight returns to less than 1.5 percent of loss. If body weight loss exceeds 3 percent, the employee will be removed from work for the day.

C SITES ACCESS PROCEDURES

Field crews are to implement the following mitigation measures for the upland wells listed below to prevent impacts from data collection on cultural or biological resources.

- East Mesa wells (IW-2, IW-3, OW-1, OW-2, and OW-5 well clusters)
- West Mesa wells (OW-3 well cluster)
- Compliance wells (CW-1, CW-2, CW-3, and CW-4 well clusters).
- Monitoring wells MW-14, MW-15, MW-16, MW-18, and MW-25.

The goal of these additional precautions is to prevent any excursion onto areas that were not previously disturbed or are not allowable for access or work area use. Unlike the B sites access procedures that were developed for use on the floodplain only during the summer nesting season, the additional precautions for these upland area C sites will be applied on a year-round basis. The universal A sites measures that were outlined above will also apply at these locations year round.

- Personnel and vehicles are required to stay within the areas that were previously used.
- Use 'inclusive' fencing to mark the boundaries of allowable access routes or work areas to these locations, rather than fencing to exclude specific cultural and biological resources.
- For the less frequent quarterly or semiannual access to wells MW-15, MW-16, MW-18, and MW-25, crews must stay on the clearly defined gravel access roads to each well.
- Use lathe stakes to mark boundaries during construction and well installation, rather than orange plastic fencing. These boundary stakes will be maintained, and if needed a similar marker for both access routes and work area boundaries may be substituted in the future. Any replacement should have limited visual impacts, such as small fiberglass or ABS plastic pole markers often used to mark driveway entrances, topped with a taut rope to prevent travel off existing designated work areas. Specific areas where these boundary markings are maintained include:
  - Access route on and off H-66 and edges of the East Mesa.
  - Access route from H-66 and a turnaround/work area near OW-3 on the West Mesa.
  - Access route from H-66 and a turnaround/work area near CW-4 in the unnamed wash.
  - Access routes past CW-2 and turnaround area at CW-3.
  - Defined access turn-off from H-66 to CW-1 and MW-14.
- Drive one-way on the CW-2 and CW-3 access track and turn vehicles only at the established turnaround at CW-3.
- Drive in only the active channel area of the wash when accessing CW-1.
- Stay on established roads to access MW-15 and MW-16.

TABLE 1
Data Collection Locations, Sampling Frequency and Site Access Codes
SOP-A16 Access Routes
PG&E Topock Site, Needles, California

Well ID	Sampling Frequency [1]	Site Access Code
GMP Monitoring Wells		
MW-9	S	A
MW-10	S	A
MW-11	S	A
MW-12	Q	A
MW-13	Q	A
MW-14	Q	C
MW-15	S	C
MW-16	S	C
MW-17	S	A
MW-18	S	C
MW-19	Q	A
MW-20-70	Q	A
MW-20-100	Q	A
MW-20-130	Q	A
MW-21	Q	A
MW-22	Q	B
MW-23	Q	A
MW-24A	S	A
MW-24B	S	A
MW-24BR	Q	A
MW-25	Q	C
MW-26	Q	A
MW-27-20	Q	B
MW-27-60	Q	B
MW-27-85	M	B
MW-28-25	Q	A
MW-28-90	M	A
MW-29	Q	A
MW-30-30	Q	B
MW-30-50	Q	B
MW-31-60	Q	A
MW-31-135	Q	A
MW-32-20	Q	B
MW-32-35	Q	B
MW-33-40	Q	A
MW-33-90	Q	A
MW-33-150	M	A
MW-33-210	M	A
MW-34-55	Q	B
MW-34-80	M	B
MW-34-100	BW	B
MW-35-60	Q	A
MW-35-135	Q	A
MW-36-20	Q	B
MW-36-40	Q	B
MW-36-50	Q	B
MW-36-70	M	B
MW-36-90	M	B
MW-36-100	M	B
MW-37D	Q	A
MW-37S	Q	A
MW-38D	S	A
MW-38S	S	A
MW-39-40	Q	A
MW-39-50	Q	A
MW-39-60	Q	A
MW-39-70	M	A
MW-39-80	M	A
MW-39-100	M	A
MW-40D	Q	A
MW-40S	Q	A
MW-41D	Q	A
MW-41M	Q	A
MW-41S	Q	A
MW-42-30	Q	B
MW-42-55	Q	B
MW-42-65	Q	B
MW-43-25	Q	B
MW-43-75	M	B
MW-43-90	M	B
MW-44-70	ND	A
MW-44-115	BW	A
MW-44-125	BW	A
MW-45-95a	ND	B
MW-45-95b	ND	B
MW-46-175	BW [2]	A
MW-46-205	ND	A
MW-47-55	ND	A
MW-47-115	ND	A
MW-48	ND	A
MW-49-135	ND	A
MW-49-275	ND	A
MW-49-365	ND	A
MW-50-95	ND	A
MW-50-200	ND	A
MW-51	ND	A
GMP Shoreline Surface Water Sampling Locations		
I-3	M	A
R-22	M	B
R-27	M	B
R-28	M	A
RRB	M	A
CON	M	A
A-Dock	M	A
NR-1	M	A
NR-2	M	A
NR-3	M	A
Test Wells and Extraction Wells		
PE-1	M	B
TW-2S	Q*	A
TW-2D	Q*	A
TW-3D	M	A
TW-4	ND	A
TW-5	ND	A
Water Supply Wells		
PGE-6	2A	A
PGE-7	2A	A
Park Moabi	Q	A

Well ID	Sampling Frequency [1]	Site Access Code
Injection Wells		
IW-2	NS	C
IW-3	NS	C
PGE-8	2A	A
IM3 Observation Wells		
OW-1 (S,M,D)	Q	C
OW-2 (S,M,D)	Q	C
OW-3 (S,M,D)	S	C
OW-5 (S,M,D)	Q	C
IM3 Compliance Wells		
CW-1 (M,D)	S	C
CW-2 (M,D)	S	C
CW-3 (M,D)	S	C
CW-4 (M,D)	S	C
Additional Water Level Measurement Locations		
MWP-08	NS	A
MWP-10	NS	A
MW-01	NS	A
MW-02	NS	A
MW-03	NS	A
MW-04	NS	A
MW-05	NS	A
MW-06	NS	A
MW-07	NS	A

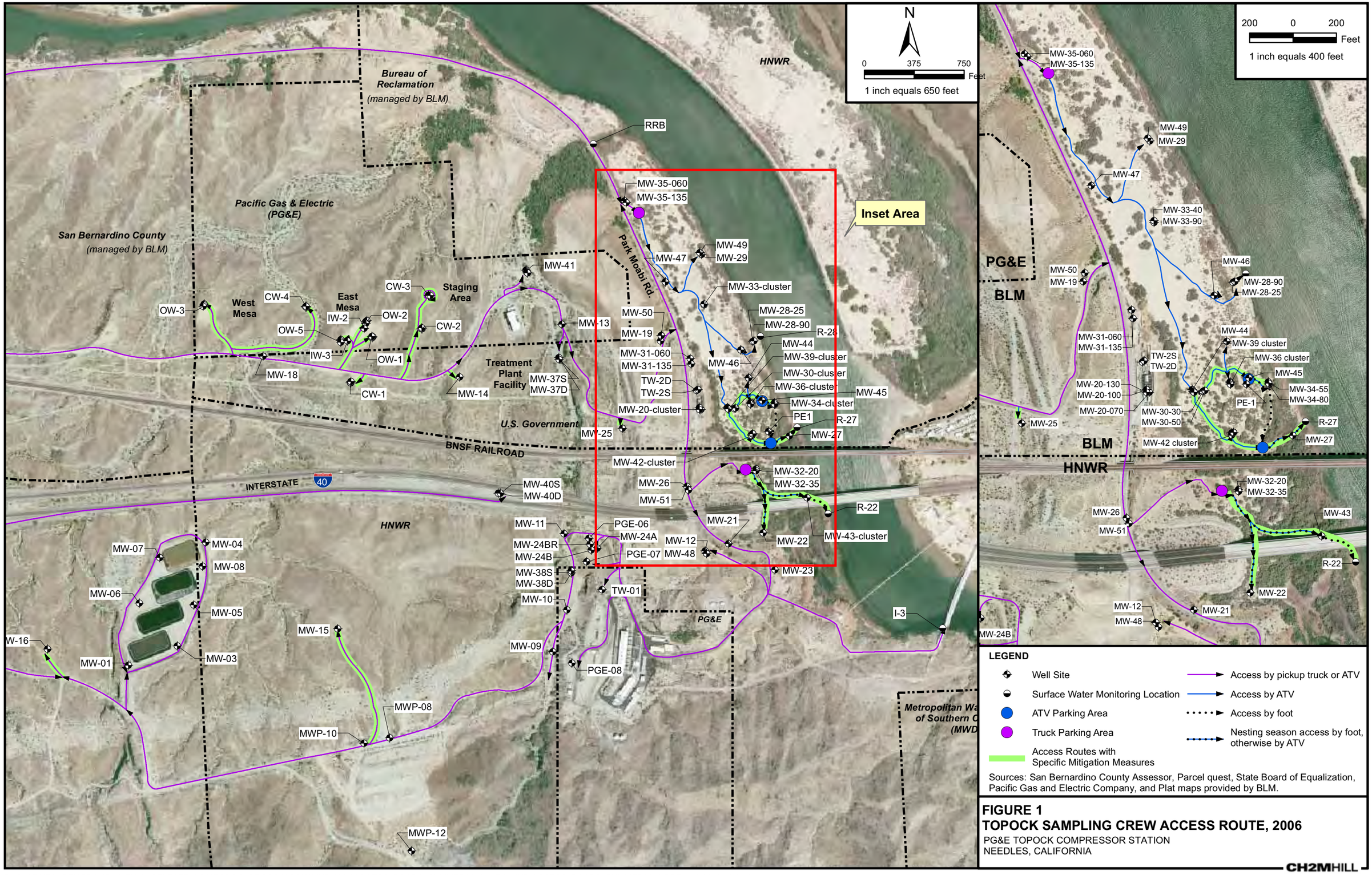
Notes:

W	Weekly
BW	Biweekly
M	Monthly
Q	Quarterly
A	Annual
S	Semi-Annually
2A	Every 2 years
NS	Not sampled routinely
Q*	Revert to Monthly if active
ND	Routine sampling frequency not determined yet

[1] As of May 17, 2006

[2] Through June 2006

Shoreline sampling locations are accessed by foot or by boat from the river.



LEGEND

- Well Site
- Surface Water Monitoring Location
- ATV Parking Area
- Truck Parking Area
- Access Routes with Specific Mitigation Measures
- Access by pickup truck or ATV
- Access by ATV
- Access by foot
- Nesting season access by foot, otherwise by ATV

Sources: San Bernardino County Assessor, Parcel quest, State Board of Equalization, Pacific Gas and Electric Company, and Plat maps provided by BLM.

FIGURE 1
TOPOCK SAMPLING CREW ACCESS ROUTE, 2006
PG&E TOPOCK COMPRESSOR STATION
NEEDLES, CALIFORNIA

CH2MHILL

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EMPLOYEE SIGNOFF FORM

Site Access SOP

The CH2M HILL project employees and subcontractors listed below have been provided with a copy of this SOP, have read and understood it, and agree to abide by its provisions.

Project Name: Topock Projects (GMP, CMP, BKG, IM3, PWSS) **Project Number:** varies by project

EMPLOYEE NAME (Please print)	**EMPLOYEE SIGNATURE**	**COMPANY**	**DATE**