# Conceptual Approach for a Pore Water Sampling and Seepage Study

## Pacific Gas & Electric Topock Compressor Station
## Needles, California

**DATE:** June 27, 2005

# Introduction

Pacific Gas and Electric Company (PG&E) is addressing chromium in groundwater at the Topock Compressor Station in Needles, California under the oversight of the California Environmental Protection Agency, Department of Toxic Substances Control (DTSC). This memorandum, the *Conceptual Approach and Framework for a Pore Water Sampling and Seepage Study,* has been prepared in response to DTSC's June 9, 2005 letter. This submittal addresses DTSC's requirement to provide a technical memorandum that outlines the basic concepts for a pore water and seepage study by June 27, 2005.

# Investigation Background

## Current Project Work

In July 2004, PG&E submitted a *Sampling and Analysis Plan, Groundwater and Surface Water Monitoring* (SAP) (CH2M HILL 2004) that describes the scope, schedule, and sampling and analysis procedures for the ongoing Groundwater and Surface Water Monitoring Program (GMP). The SAP, approved by DTSC, establishes specific objectives for surface water monitoring at the Topock site, including routine monitoring of near-shore surface water locations both upgradient and downgradient of the Topock site. This program is being further augmented by routine collection of depth-specific surface water samples in the river channel, commencing in July 2005. The additional river channel sampling stations are located approximately one-third of the river width from the corresponding shoreline stations, on the California side (see Figure 1). Samples will be collected from one-foot off the bottom of the river channel, halfway through the water column, and within one-foot of the water surface (revised SAP) (CH2M HILL 2005b). A pore water sampling and seepage study is being developed in the context of this current surface water sampling program. The upcoming depth-specific surface water sampling results will provide data that can be compared with pore water sampling results.

## Previous Pore Water Sampling

Two separate sets of shallow sediment pore water samples have been collected and analyzed for pore water quality, using two distinct methods. Both sets were obtained from the edge of the Colorado River in the immediate vicinity of the Topock site and at various

upstream reference locations. Samples were collected in 2003 by Ecology and Environment, Inc. (E&E) and the results were reported as part of the Draft and Final RCRA Facility Investigation Reports (RFI) (E&E 2004, CH2M HILL 2005a). In addition, the U.S. Geological Survey (USGS) collected and analyzed river sediment samples in 2001 for the U.S. Fish and Wildlife Service (USFWS) and reported the results in a report dated March 2004 (USFWS 2004).

For the 2003 RFI pore water characterization (E&E 2004), eight samples from both upstream and within-site locations were collected by wading into the river from shore or a boat, and pushing a drive point piezometer 2 to 3 feet into the river sediments. All samples collected were labeled as "close to shore". A peristaltic pump was then used to sample the water directly from saturated sediments around the drive point. Porewater samples were analyzed using State-certified EPA Method 7196A. Hexavalent chromium [Cr(VI)], at detection limit of 10 μg/L, was not found in any sample, including those in the river sediments near floodplain wells MW-27, MW-28, and MW-29. Background (upstream) sites included Park Moabi and the river north of Bat Cave Wash. Presumably, those samples collected from several feet deep in river bottom sediments would be representative of shallow groundwater conditions.

In contrast to the interstitial, RFI samples, the top 5 centimeters (cm) of surface sediments were sampled from the river's edge for the USFWS study in 2001 (USFWS 2004). The USFWS report does not include identifiable sample locations, making it difficult to assess what area relative to the Topock site is represented by the samples. More importantly, available data suggests that the sampling and analysis methods used in the USFWS study may have resulted in trivalent chromium [Cr(III)] being falsely reported as Cr(VI). At a minimum, the methodology did not distinguish between Cr(III) and Cr(VI) and results reported as Cr(VI) for upstream and downstream locations are consistent with previous river sampling results reported for Cr(III).

The USFWS method consisted of homogenizing the sediments in the laboratory and extracting pore water samples from the homogenized sediment slurry. By collecting the pore water in this manner, the method probably measured chromium in the dissolved and colloidal states. Additionally, the samples were analyzed by a research-level, non-EPA approved cation exchange method. This method is not comparable to the direct measurement of Cr(VI) using EPA Method 7199 and is likely to include Cr(III) in the results. Under the USGS method, all river sediment samples tested yielded detectable Cr(VI), ranging from 0.5 to 6.1 micrograms per liter (μg/L) in concentration, which indicates the unlikely universal presence of Cr(VI) in pore water upgradient, adjacent to, and downgradient of the site. The presence of organic-bound or colloidal fractions of Cr(III) (both very likely possibilities for pore water sampled from a sediment slurry) would have yielded false-positive Cr(VI) values in this case; the analytical method would have recorded those fractions as Cr(VI) instead of Cr(III). The USFWS results, particularly the ubiquitous presence of Cr(VI) upstream and downstream of the site, appear to be questionable. The USFWS reported that the chromium detected in their pore water samples was likely to be Cr(III) rather than Cr(VI) (presentation by Carrie Marr to the Consultative Workgroup, June 16, 2005).

# Potential Pore Water Sampling and Seepage Investigation Methodology

Per the DTSC letter dated June 9, 2005, additional pore water sampling and measurements are requested to supplement the existing data set.

The selection of a pore water sampling method will commence with a discussion of data quality objectives. At a minimum, these objectives will address:

- the appropriate methodology for collection of undisturbed samples
- the appropriate methodology for maintaining sample redox conditions
- the appropriate sample volume
- the appropriate sample matrices (sediment and pore water sample or pore water only)
- the appropriate sampling depth
- the appropriate timing of the sampling

PG&E will discuss these issues with DTSC during the scheduled scoping meeting on June 29, 2005.

## Site Conditions and Logistical Considerations

Pore water sampling is generally performed as part of an ecological risk assessment on the benthic community, where microbial, meiofaunal and macrofaunal receptors are the subject of analysis. These studies primarily focus on toxicity testing. The term "pore water" has a specific meaning to toxicologists; it refers to interstitial water in the uppermost 10 cm where the benthic organisms live. However, for the purposes of this memorandum, pore water is characterized as water beneath the river that primarily comprises groundwater. Pore water samples provide basic information on groundwater quality in river substrate, and should not be used to estimate mass fluxes.

The physical location of the sediment, its particle size distribution and level of compaction, and the final use of the data typically dictate the type of sampler used and the collection methodology that is chosen (EPA 2001). Site conditions of particular importance include the depth of the water body overlying the sediment and the strength of the current present.

The potential sampling locations at the Topock site will be subject to water turbulence and high water velocities (2 to 3 ft/sec) where it may be difficult for a boat or diver to maintain a fixed position. The Colorado River level at the Topock site varies almost continuously in response to the variable release of water from Davis Dam, and to a lesser degree in response to changes in Lake Havasu level. Seasonally, the average river level at the I-3 gauge varies by about 5 feet. Daily variations at I-3 can exceed 4 feet.

As part of the Interim Measures (IM), at DTSC direction, PG&E has operated groundwater extraction at the MW-20 bench in the floodplain area of the site since March 2004. Currently, the IM extraction well (TW-2D) is pumping at approximately 70 gallons per

minute. In May 2005, the monthly average groundwater gradient at three well pairs was directed landward at magnitudes generally between 2 and 3.5 times greater than the target value of 0.001 feet/foot. It is anticipated that an average landward gradient will be maintained within the TW-2D capture zone throughout the period during which future pore water sampling takes place.

In response to the daily river level fluctuations, the local groundwater gradient is expected to be directed towards and away from the sediment/river interface several times each day. Thus, daily river fluctuations should be considered when selecting an appropriate sampling schedule. This short-term temporal variability suggests that a time-integrated sampling method may result in collection of more representative pore water data. If the U.S. Bureau of Reclamation (BOR) were able to stabilize the river levels before and during the sampling period, the concerns associated with daily river fluctuations could be negated.

The reach of Colorado River near the Topock site is subject to a significant amount of boat traffic. Any sampling strategy must address the health and safety of personnel during sampling, boaters and the security of any dedicated equipment deployed on the river bottom.

## Sampling Equipment and Methods

Generally, the isolation of sediment pore water can be accomplished by a variety of methods, which can be grouped into two general categories: field-based (i.e., *in situ*) and laboratory-based (i.e., *ex situ*). In situ methods of pore water collection are generally superior to ex situ methods in that, properly handled, they are less likely to alter the chemistry of the sample (SETAC 2001). There is no single superior method for isolation of pore water.

The principal *in situ* methods of pore water collection use either diffusion-type or direct push techniques. Table 1 summarizes some of the considerations of each technique.

Initially developed by the USGS, diffusion samplers have been successfully used for a variety of state and federal agency (USGS, military, and USEPA) environmental studies, including groundwater monitoring for VOCs and pore water sampling for inorganic solutes (Vroblesky, et al 2002). The duration of equilibration for diffusion-type samplers, where pore waters diffuse through dialysis membranes or very fine nylon mesh, usually ranges from hours to months; typical deployment periods are from one to two weeks (SETAC, 2001). The optimal equilibration time is a function of sediment type and particle size, the contaminants of concern, and the ambient temperature.

When assessing pore water sampling methods, it is important to note that the available methods described in USEPS (2001) and SETAC (2001) produce information regarding the chemistry of the interstitial fluids but are not suitable for assessing the volume or mass flux of water across the groundwater-surface water interface. There are additional methods that are designed to measure groundwater seepage that have been developed primarily for lacustrine or marine environments, where the influence of currents is minimal. Because of the nature of the high energy currents at this project site, however, the quantification of groundwater seepage using conventional methods is considered to be impractical.

## Pore Water Sampling Methods Applicable to Topock Site

For the Topock site, the evaluation of pore water sampling methods must consider the following objectives and constraints:

- The sample must be as undisturbed (close to in place redox conditions) as possible
- Sample volume has to be large enough for analytical and quality assurance/quality control needs
- Samples must be indicative of the dissolved Cr(VI) fraction in pore water and should not be biased by chromium in solid or colloidal form Cr(III)
- The dynamic nature of the river level complicates the collection of pore water samples that are representative of groundwater rather than river water; river flow and stage need to be accounted for and incorporated in the selection of the method and timing when pore water samples are collected.

Based on the requirements/limitations of the available pore water sampling techniques, and the site-specific conditions (high river current, daily/seasonal river stage fluctuations), two different sampling methods have been identified as applicable for a pore water investigation at the Topock site. The methods are outlined below and described in more detail in the attached Table 1.

**Passive Diffusion (Integrated) Sampling.** To best determine the average concentration present in pore water in a dynamic hydrologic environment, a sampling method that integrates concentrations over a period of time is advantageous. The method for collecting an integrated pore water sample would involve the use of passive diffusion samplers, buried in the sediments at the bottom of the river that collect integrated samples over a period of up to a week. Advantages of this sampling technique include the time-integrated nature of the sampling and the placement of the samplers which are isolated from the overlying river water. Disadvantages include the difficulty of placing and retrieving the samplers (divers must be deployed in swift current in two mobilizations).

**Drive-Point (Discrete) Sampling.** With this methodology, drive-point samplers are advanced into the river sediments for collection of the pore water sample via a purge pump (i.e., a peristaltic pump). Advantages include low risk to personnel, somewhat deeper depth capabilities for sample collection, and the collection of water quality field parameters during sampling. Disadvantages include discrete sampling events that do not capture average conditions, difficulty in sealing the drive points from the river water infiltration, and difficulty in advancing drive points in coarse river bottom material.

## Sampling Locations and Timing

For this evaluation, the number, location, and sample collection timing for a pore water investigation were assessed. The sampling locations would be based on site and river features, the hydraulic conditions observed and modeled for the active IM system, and the locations of the current surface water monitoring program. The preliminary sampling locations envisioned for a pore water investigation would include a set of appropriate **background stations** (assume four), located upstream of Bat Cave Wash, and suitable set of **downstream stations** (assume four), located between the Burlington Northern & Santa Fe (BN&SF) railroad bridge and downstream (east) of the I-3 gas-transmission crossing. Refer

to attached Figure 1 for the general areas where background and downstream pore water samples would be selected.

Similar to the sampling plan proposed for the augmented surface water sampling activity, the pore water sampling locations would be sited in approximately the mid-channel area of the river (not the shoreline). The final locations would be based on actual channel depth and morphology for each target location, and the condition of river sediment that would be suitable for pore water sampling (e.g., sandy and silty sediments). One pore water sampling location adjacent to the central bridge piling of the BN&SF railroad would be included to assess pore water conditions at this location. To assist in the selection of pore water sampling locations, water depths and channel morphology will be evaluated during PG&E's upcoming July 2005 river channel surface water sampling activity. It is anticipated that mid-channel sites suitable for the pore water investigation can be refined based on the results of river depth profiling.

Regarding the timing for the pore water investigation, the daily and seasonal river flow and stage data are important factors that will be incorporated in the final sampling design. During times of rising or seasonally high river levels, increased recharge of river water could impact pore water chemistry. To best sample groundwater conditions immediately beneath the river, the pore water sampling activities should be scheduled to coincide with the end of the low river water period, which typically occurs in the November-December timeframe.

# Permit Requirements

Following specific project scoping with DTSC, PG&E would contact the appropriate regulatory authorities to secure approval to proceed with the work. These entities may include:

- U.S. Bureau of Reclamation
- U.S. Army Corps of Engineers
- Regional Water Quality Control Board – Colorado River Basin Region
- U.S. Fish and Wildlife Service
- California Department of Fish and Game
- Arizona Department of Environmental Quality
- U.S. Bureau of Land Management

# Anticipated Schedule

The proposed approach includes the following tasks and anticipated schedule:

- Work plan preparation: Draft to be submitted to DTSC on July 13, 2005
- Final Work Plan to be submitted 2 weeks after receipt of DTSC comments

Permitting will commence following submittal of the Draft Work Plan. Equipment and specialized subcontractor procurement, subject to advanced lead time, will commence following DTSC acceptance of the Final Work Plan. Based on the objectives, the sampling

will coincide with the end of the low river water period, which typically occurs in the November-December timeframe.

# References


CH2M HILL. 2004. *Sampling and Analysis Plan, Groundwater and Surface Water Monitoring. PG&E Topock Compressor Station, Needles, California*. July 14.

_____. 2005a. *Draft RCRA Facility Investigation (RFI) Report, PG&E Topock Compressor Station, Needles, California.* February 28.

_____. 2005b. Revised *Monitoring Plan for Groundwater and Surface Water Monitoring Program, PG&E Topock Compressor Station, Needles, California.* Revision 0. May 16.

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Ecology and Environment, Inc. 2004. RCRA Facility Investigation (RFI) Report, Bat Cave Wash Area, Pacific Gas and Electric Company's Topock Compressor Station, Needles, California. February.

U.S. Environmental Protection Agency (USEPA). 2001. Methods for Collection, Storage, and Manipulation of Sediments for Chemical and Toxicological Analyses: Technical Manual. EPA 823-B-01-002. October 2001.

U.S. EPA CLU-IN website (www.clu-in.org)

SETAC. 2001. Porewater Toxicity Testing: Biological, Chemical, and Ecological Considerations with a Review of Methods and Applications, and Recommendations for Future areas of Research. SETAC Technical Workshop. Society for Environmental Toxicology and Chemistry, Pensacola, FL.

Vroblesky, D. A., M. D. Petkewich, and T. R. Campbell. 2002. Field Tests of Diffusion Samplers for Inorganic Constituents in Wells and at a Ground-Water-Discharge Zone. U.S. Geological Survey Water-Resources Investigations Report 02-4031.

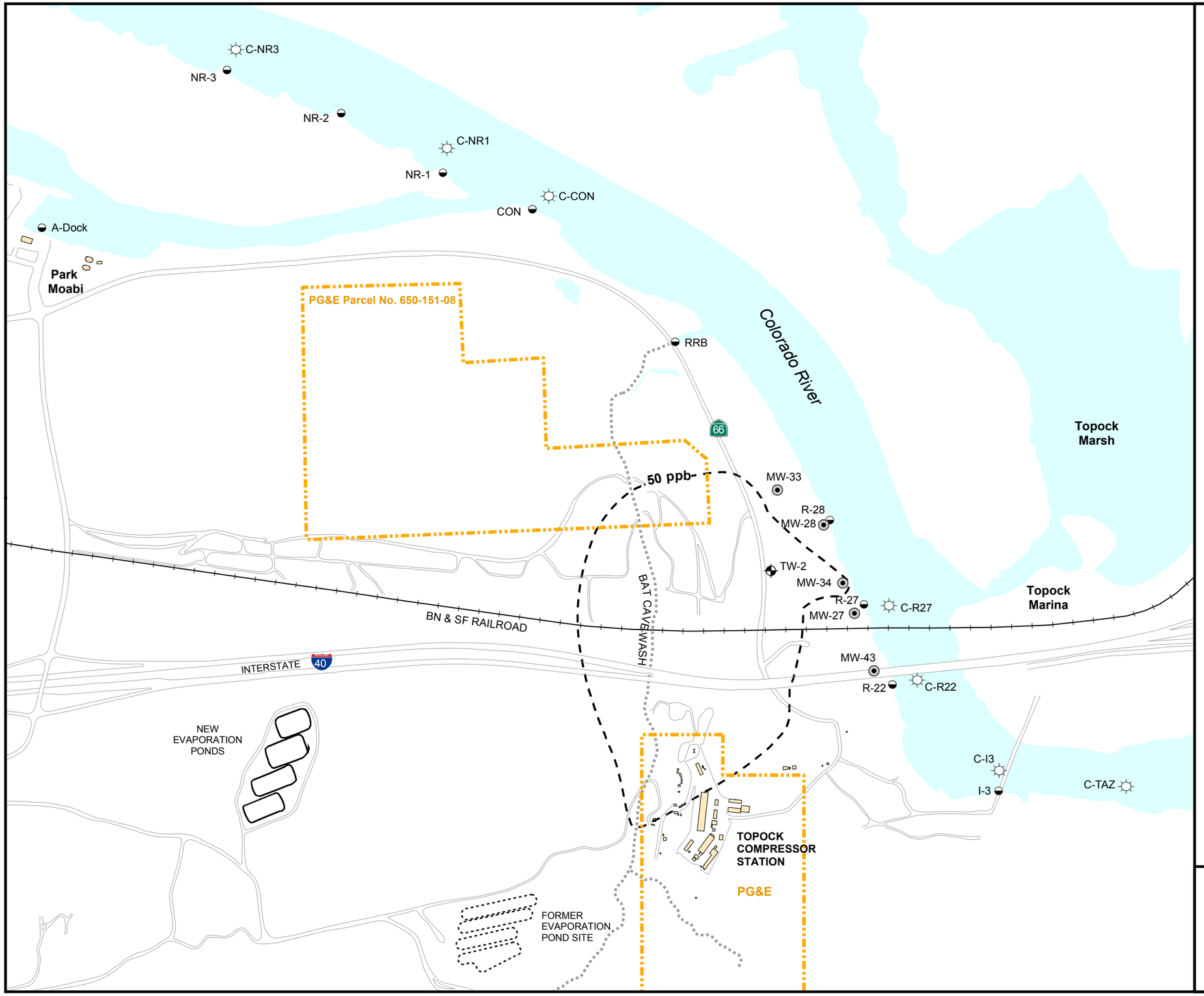
**TABLE 1**
**Summary of Sampling Methods Applicable for a Pore Water Invetsigation at Topock Site**
**PG&E Topock Compressor Station, Needles, California**

| Sampler Method | Sample Type | Sampler Deployment Method for River Sites | Sample Collection | Typical Sample Depth (cm) | Sample Volume (mL) | Remarks | Advantages | Disadvantages or Limitations |
|---|---|---|---|---|---|---|---|---|
| Passive Diffusion Sampler | Time-Integrated | Diffusion sampler buried in sediment by diver team | Passive diffusion sampler: membrane-covered jar or dialysis bag | 10 - 50 | 10 - 100 | Requires support boat and custom underwater sampling equipment to facilitate diver access to river bottom sampling locations | Provides time-integrated pore water sample (more applicable for site with dynamic hydraulic regime); placement of sampler is isolated from river water | Requires two diver mobilizations to install and retrieve sampler; sampler may be lost in high current river or not easily found |
| Drive-Point Sampler (piezometer) | Discrete | Drive-point sampling rod with internal piezometer casing hand-driven from boat | Driven piezometer screen purged with peristaltic pump | 10 - 100 | 1 - 500 | Requires stable boat or platform for sampler installation and collection | Can collect water quality field parameters during sampling; low risk to sampling personnel | Discrete sampling does not capture average conditions; repositioning and resampling at sampling location would be required if shallow refusal or no sample recovered |

NOTES:

This table summarizes the two sampling methods applicable for pore water sampling of mid-channel sampling sites in Colorado River at Topock site.

Alternative pore water sampling methods not applicable to Topock site not retained in this evaluation




N

0 800 1,600 Feet

1 inch equals 800 feet

**Legend**

- Floodplain Sentry Monitoring Well Cluster
- IM Extraction Well
- Approximate limits of hexavalent chromium greater than 50 ppb in Alluvial Aquifer March 2005

**2005 Surface Water Monitoring Program**

- River channel surface water sampling location
- Shoreline surface water sampling location

DRAFT 6/27/05

# FIGURE 1
# PROPOSED SURFACE WATER MONITORING LOCATIONS, JUME 2005

GROUNDWATER MONITORING PROGRAM
PG&E TOPOCK COMPRESSOR STATION
NEEDLES, CALIFORNIA

CH2MHILL

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