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February 11, 2004

Mr. Aaron Yue
Project Coordinator
California Department of Toxic Substances Control, Region 4
Geology and Corrective Action Branch
5796 Corporate Avenue
Cypress, California 90630

Subject: Draft Interim Measures Workplan
PG&E Topock Compressor Station, Needles, California

Dear Mr. Yue:

This letter transmits the Draft Interim Measures Workplan for the Topock project. In compliance with your directive, this Workplan has been completed in accordance with the guidelines provided in Chapter 4 of the DTSC Corrective Action Orientation Manual (DTSC, 1994).

In addition, in a letter dated February 9, 2004, DTSC directed PG&E to prepare immediately an Interim Measures Workplan No. 2 to address pumping, transport and disposal of groundwater from existing monitoring wells at the MW-20 cluster. The Interim Measures Workplan No. 2 will be submitted on February 17, 2004, as specified in your letter.

If you have any questions, please do not hesitate to call me.

Sincerely,

Robert C. Doss

Enclosure:
Draft Interim Measures Workplan

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*Draft*

# Interim Measures Workplan

# Topock Compressor Station
# Needles, California

Prepared for

**Department of Toxic Substances Control**

On behalf of

**Pacific Gas & Electric Company**

February 2004

CH2MHILL

*Draft*

# Interim Measures Workplan

# Topock Compressor Station
# Needles, California

**February 2004**

**Prepared for**

Department of Toxic Substances Control

**On behalf of**

Pacific Gas & Electric Company

**Prepared by**

CH2M HILL

This document was prepared by CH2M HILL under the supervision of:

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February 2004

I certify that the information contained in or accompanying this submittal is true, accurate, and complete. As to those portions of this submittal for which I cannot personally verify the accuracy, I certify that this submittal and all attachments were prepared at my direction in accordance with procedures designed to assure that qualified personnel properly gathered and evaluated the information submitted. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Robert C. Doss

Robert C. Doss, P.E.
Principal, Site Remediation
Pacific Gas & Electric Company
February 11, 2004

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# Acronyms and Abbreviations

| | |
|---|---|
| BLM | Bureau of Land Management |
| BN/SF | Burlington Northern/Santa Fe Railroad |
| CACA | Corrective Action Consent Agreement |
| Cal/EPA | California Environmental Protection Agency |
| CEQA | California Environmental Quality Act |
| CHSC | California Health and Safety Code |
| CMS | Corrective Measures Study |
| cm/sec | centimeters per second |
| CRBRWQCB | Regional Water Quality Control Board, Colorado River Basin Region |
| Cr(T) | total chromium |
| Cr(VI) | hexavalent chromium |
| CWG | Consultative Workgroup |
| DEM | digital elevation model |
| DTSC | Department of Toxic Substances Control |
| gpm | gallons per minute |
| IDW | investigation-derived waste |
| IM | Interim measures |
| IMWP | Interim Measures Work Plan |
| µg/L | micrograms per liter |
| MCL | maximum contaminant level |
| mg/L | milligrams per liter |
| MWD | Metropolitan Water District |
| PG&E | Pacific Gas and Electric Company |
| RCRA | Resource Conservation and Recovery Act |
| RFI | RCRA Facility Investigation |
| ROW | right-of-way |

| | |
|---|---|
| TDS | total dissolved solids |
| USGS | United States Geological Survey |
| USFWS | United States Fish and Wildlife Service |
| WDR | Waste Discharge Requirements |

# 1.0 Introduction

Pacific Gas and Electric Company (PG&E) is addressing chromium in groundwater at the Topock Compressor Station under the oversight of the California Environmental Protection Agency (Cal/EPA) Department of Toxic Substances Control (DTSC). In a letter dated January 22, 2004, DTSC directed PG&E to prepare immediately an Interim Measures (IM) Workplan to mitigate potential impacts of chromium in groundwater on the Colorado River pursuant to the Section IV.A. of the Corrective Consent Agreement between DTSC and PG&E. This Interim Measures Workplan (IMWP) describes components of an interim remedial measure at the Topock site.

At the direction of DTSC, this IMWP has been completed in accordance with the guidelines provided in Chapter 4 of the DTSC Corrective Action Orientation Manual (DTSC, 1994). The IMWP includes the following main components: 1) project background and objectives of the interim measure (IM); 2) the conceptual site model; 3) an evaluation of IM alternatives; 4) a description and rationale for the selection of the proposed IM; 5) design basis and concept; 6) project management and schedule; and 7) a description of required related activities, including additional data collection, waste management, permitting, and monitoring.

Assisting DTSC and PG&E with the planning and review of interim remedial measures are the members of the Topock Consultative Workgroup (CWG), constituted under California's Site Designation Process, and consisting of representatives of DTSC, the Colorado River Basin Regional Water Quality Control Board (CRBRWQCB), Metropolitan Water District of Southern California (MWD) and the various federal agencies who own or manage land overlying the chromium plume. If required, further details necessary to implement IM activities will be submitted following review of this document by the CWG and DTSC and upon IMWP approval by the DTSC.

## 1.1 Project Background

The Topock Compressor Station is located in San Bernardino County, approximately 15 miles to the southeast of Needles, California (Figure 1-1). In February 1996, PG&E and DTSC entered into a Corrective Action Consent Agreement (CACA) pursuant to Section 25187 of the California Health and Safety Code (CHSC). Under the terms of the CACA, PG&E was directed to conduct a Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) and to implement corrective measures to address constituents of concern released in the Bat Cave Wash Area near the PG&E Topock Compressor Station. The primary constituents of concern at Topock are hexavalent chromium [Cr(VI)] and total chromium [Cr(T)]. The source was Cr(VI) salts used historically as a corrosion inhibitor in the station's cooling towers. DTSC is the lead administering agency for the project.

PG&E is currently proceeding with the corrective measures process to select and implement a long-term remedy for the site. PG&E submitted the Corrective Measures Study (CMS) Workplan in December 2002, pursuant to the RCRA corrective action process and in accordance with the DTSC CACA. The DTSC approved the CMS Workplan in June 2003.

Beginning in August 2003, DTSC and PG&E began working in a collaborative process with affected and interested agencies through a CWG. CWG members include:

- CRBRWQCB
- United States Fish and Wildlife Service (USFWS)
- United States Bureau of Land Management (BLM)
- United States Bureau of Reclamation
- MWD
- United States Geological Survey (USGS).

At the direction of DTSC and in accordance with recommendations of the CRBRWQCB, PG&E agreed in August 2003 to conduct a pilot study of groundwater extraction and treatment. The primary purpose of the groundwater extraction/treatment pilot study is to initiate hydraulic control of the chromium plume. The proposed pilot system consists of groundwater extraction from one extraction well located on PG&E property (TW-1), conveyance of extracted groundwater to a treatment system, treatment using chemical reduction/precipitation, and filtration and reuse/discharge of the treated water to the cooling towers and the evaporation ponds. The secondary objectives of the pilot study are to gather information on the hydrogeologic properties of the shallow aquifer and to test the treatment system effectiveness. Startup of the pilot system is estimated to take place in early July 2004.

## 1.2 Overall Approach to Site Remediation

IM is part of the overall corrective measures process for the site. It is a step in establishing a long-term approach for site remediation. PG&E will integrate the IM and the results of the pilot study into the recommended long-term corrective measure for the site.

The groundwater extraction/treatment pilot study is currently in the design phase, with permitting and procurement phases underway. Implementation of the pilot study on PG&E property will be conducted concurrently with implementation of the IM on lands adjacent to the Colorado River. Components of these two projects will occur in parallel, followed by the implementation of supplemental field studies. The results of the pilot study, the IM, and supplemental field studies will be incorporated in the evaluation of the final remedy and in the preparation of the CMS report.

### 1.2.1 Interim Measures Objectives and Target Zone

To ensure success of this IM, a clear objective is required to guide implementation activities and to evaluate the performance of the IM. In defining the IM objective, it is critical to define the target area or zone that will be addressed during the implementation of the IM. This target zone will be used to monitor the effectiveness of the performance of the IM.

The CWG has determined that the objective of the IM is defined as follows:

> ***Initiate hydraulic control of the plume boundaries near the Colorado River to achieve a net reversal of gradient away from the Colorado River.***

Hydraulic control will be achieved by pumping groundwater near the eastern edge of the plume to mitigate potential impacts to the Colorado River. Treatment of the groundwater will be designed to meet the discharge requirements and employ the best available treatment technologies. Details of how the preferred IM alternative will meet this objective will be described later in the Workplan.

The target zone of capture for the IM has been identified based on the December 2003 groundwater monitoring results. Figure 1-2 shows the Cr(VI) results from the December 2003 sampling event, the estimated extent of the plume, and the target zone of capture for the IM.

# 2.0 Conceptual Site Model

A conceptual site model has been developed to understand the flow patterns of the chromium plume. The model is a work in progress that is refined and updated as new information becomes available from the ongoing and future investigations. This section briefly describes the geological, hydrogeological, and geochemical conditions at the site based on the conceptual site model. The focus of this section is on the floodplain study area between Interstate 40 and the Colorado River, corresponding to the target zone of capture for the IM (Figure 1-2).

## 2.1 Geology and Hydrogeology

The site is characterized by arid conditions (with precipitation averaging less than 5 inches/year) and high temperatures. Vegetation is very sparse except in the river floodplain and where dense stands of tamarisk and occasional mesquite trees occur. The local near-surface geology consists of recent and older river deposits in the flood plain area progressing westward to older alluvial deposits derived from the local mountains. The alluvial deposits and fluvial deposits in the flood plain comprise the principal groundwater aquifer at the site. The main surface water drainage into the Colorado River is from Bat Cave Wash, an ephemeral streambed that flows only briefly following rain events. The Bat Cave Wash drainage originates in the Chemehuevi Mountains west of the site and extends to the Colorado River. This north-tending wash received the original discharges of cooling water-containing chromium, as described below. Topography near the site is abrupt, rising from around 450 ft above mean sea level at the Colorado River to over 1,200 feet above mean sea level within a mile to the south and southwest.

Hydrogeologic cross-sections have been prepared for the locations shown on Figure 2-1. Figure 2-2 shows a north-south hydrogeologic cross-section parallel to the Colorado River and Figure 2-3 shows a southwest–northeast hydrogeologic cross-section perpendicular to the River.

Groundwater occurs primarily in unconsolidated alluvial sediments that underlie the study area north of the mountains. The saturated unconsolidated sediments are referred to as the Alluvial Aquifer. The main water-bearing zone of the subsurface is within sands and gravels associated with river and alluvial deposition.

Recent unconsolidated fluvial sediments, consisting primarily of sand, silt, and clay, occur along the floodplain area of the Colorado River. These sediments include Colorado River dredge materials blanketing the floodplain. The fluvial sediments are mostly saturated and are hydraulically connected to the Alluvial Aquifer.

The unconsolidated alluvial sediments cover the majority of the study area and consist of poorly sorted sand and gravel with minor silt and clay deposits. The aquifer is highly heterogeneous as is typical of most alluvial aquifers. The saturated thickness of the Alluvial Aquifer is approximately 100 feet near the River and thins to the west, pinching out along the bedrock outcrops west and south. Sediments comprising the Alluvial Aquifer are very porous and permeable with hydraulic conductivity ranging from $1.0 \times 10^{-4}$ centimeters per second (cm/sec) to $1.0 \times 10^{-2}$ cm/sec (0.3 to 30 feet per day).

On the basis of screen elevations from these well clusters, the alluvium may be divided into upper, middle, and lower subzones. The majority of site wells are in the upper alluvium subzone. These subzones do not represent distinct lithostratographic units but rather provide a framework for understanding the three-dimensional aspects of the groundwater flow system and contaminant distributions at the site.

Underlying the alluvium at the Topock Site is the Red Fanglomerate, a Miocene deposit of cemented sandy gravel (Ecology and Environment, 2003). The fanglomerate has been identified in several site wells, though the depth of the alluvium-fanglomerate contact varies. The Bouse Formation has been mapped nearby, and where present it lies between the fanglomerate and the alluvium. It has not been positively identified in the boring logs of site wells, though distinction from the alluvium may not be apparent. The Bouse Formation was deposited in brackish or salt water, and where present, may be a source of salts in site groundwater (see Section 2.2).

The basement bedrock of the area is composed of metadiorite and gneiss evident in the surrounding mountains. In both the fanglomerate and bedrock, groundwater occurs in secondary fractures. Local wells in these zones (PGE-7, PGE-8, MW-23, and MW-24BR) yield very little to moderate volumes of water.

Groundwater is encountered as little as 4 feet below ground surface in shallow wells in the current floodplain to over 200 feet at MW-16 in the western portion of the site. Horizontal groundwater gradients are slight, from $10^{-4}$ to $10^{-3}$. The gradients suggest a north-northeast flow direction, and the distribution of chromium in groundwater samples supports these flow directions. Water levels in well clusters at MW-20, -24, -32, -33, and -34 all display upward gradients on the order of $10^{-2}$, about 10 to 20 times the magnitude of the horizontal gradients. This is consistent with the typical conceptual model of regional groundwater flow systems in arid basins, where groundwater recharge occurs primarily at the margins of the basin and groundwater discharges to streams or springs near the center of the basins.

Interaction of groundwater with the Colorado River is complex. The daily fluctuations in river stage cause the surface water-groundwater interaction at this site to be very dynamic. Pressure transducers have been installed in newer wells close to the River to monitor more closely the changes in water levels and to define better the surface water-groundwater interaction.

## 2.2 Groundwater Geochemistry

Groundwater in the Needles-Topock vicinity has high total dissolved solids (TDS) concentrations. TDS concentrations in groundwater can be over 40,000 mg/L. Samples collected from most of the monitoring wells have TDS in the range of 1,000 to 3,000 mg/L. However, groundwater sampled in bedrock/fanglomerate wells and deep alluvium wells displays higher values (8,000 to 12,000 mg/L). In contrast, water from the Colorado River has TDS concentrations ranging from 400-800 mg/L.

Sources of salts are connate water in bedrock, remnants of the Bouse Formation, where it still exists, evaporite salts associated with recent fluvial sands, dredge spoils, salts exuded by tamarisk (*Tamarix* sp.), and potentially by historic PG&E cooling water discharges, reported to be about 6,600 mg/L (PG&E, 1997b). As a result, the concentration of TDS in groundwater varies considerably across the site.

Results of groundwater sampling show major ions are dominated by sodium and chloride, with sulfate also significant in some wells (up to 1,300 mg/L). Indications of reduction-oxidation (redox) conditions reflect oxidizing conditions in which Cr(VI) is stable in the Alluvial Aquifer. Dissolved oxygen concentrations range from 3.0 to 7.2 mg/L, nitrate is stable up to 77 mg/L and field oxidation reduction potential (ORP) measurements up to 170 millivolts (indicative of oxidizing conditions). More reducing conditions are observed in monitoring wells in the floodplain. Under reducing conditions, Cr(VI) may convert to the relatively immobile trivalent Cr(III) state. It is important to note that the oxidation or reduction of chromium in water is typically dominated by the solid-phase aquifer material and soil structure, and not by the water itself. The hydrochemical nature of the groundwater and geochemical conditions of the site will be verified following further data collection during IM implementation and the pilot study (see also Section 5).

## 2.3 Nature and Extent of Chromium in Groundwater

Routine sitewide monitoring of the Topock site began in 1997. Currently, there is a network of approximately 35 wells from which groundwater samples are collected and analyzed for the constituents of concern. Monitoring wells have been installed near and along Bat Cave Wash and to the east of the wash to characterize the Cr(VI) distribution in groundwater. The most recent installations included five wells located parallel to, and within, the Colorado River flood plain to better define the leading edge and vertical extent of the chromium plume.

The majority of the monitoring wells are screened in the uppermost portion of the unconsolidated alluvium. In addition, seven nearby surface water monitoring stations are located along the Colorado River and its tributaries. Figure 2-4 shows the locations of the wells and river stations. In accordance with the CACA, constituents of concern on the site are: total [Cr(T)], Cr(VI), nickel, copper, zinc, pH, and electrical conductivity (DTSC, 1996). Groundwater and surface water are routinely monitored for these constituents. In addition, groundwater and surface water are sampled periodically for general chemistry parameters including iron, lead, manganese, and TDS (See also Section 5).

Given the historic chromium disposal location near MW-10, the current distribution of Cr(VI) in groundwater at concentrations greater than the State of California maximum contaminant level (MCL) for drinking water for Cr(T) of 0.05 mg/L is consistent with flow patterns suggested by groundwater elevation contours. Figure 2-4 illustrates this distribution with analytical results from the December 2003 sampling round (wells with orange symbols indicate concentrations greater than 0.05 mg/L Cr(VI)).

The reporting limit for analysis of Cr(VI) in groundwater used in the RCRA Facility Investigation (RFI) and prior monitoring was 0.010 mg/L as specified in the approved RFI workplan (PG&E, 1997). Beginning in September 2003, as directed by the DTSC, a reporting limit of 0.002 mg/L is being used for Cr(VI) analyses for all surface water samples and groundwater samples collected from wells that have historically not reported detectable Cr(VI) concentrations above the reporting limit of 0.010 mg/L.

As described in the previous section, analytical results from site investigations and groundwater monitoring show that most of the chromium found in groundwater is in the hexavalent form. The highest concentrations of chromium in the groundwater are in the area of the MW-20 well cluster (Figure 2-4). Vertical profiles of Cr(VI) concentrations show variations at the MW-20 and MW-30 cluster. As seen from the cross-section in Figure 2-3, the highest concentration of Cr(VI) occurs in the upper aquifer subzone (at the water table).

# 3.0 Evaluation of Interim Measures Alternatives

IM includes extraction, treatment, and discharge of groundwater. As such, the IM alternatives consist of three components: (1) extraction well siting; (2) treatment system location; and (3) discharge management. The following subsections contain descriptions of the components for each alternative and evaluations of each alternative against specified criteria.

## 3.1 Extraction Well Siting Alternatives

To achieve the IM objective effectively and expeditiously, extraction well siting has been separated into several phases. Figure 3-1 presents a schematic diagram illustrating the proposed activities in each phase. The first phase involves siting, installing and testing a groundwater extraction well. As discussed during the Topock CWG meeting of January 29, 2004, seven locations for potential test well installation have been identified (Figure 1-2). In their meeting of February 2, 2004 the technical subgroup of the CWG concurred in the proposal to site the first well (TW-2) at Location A and begin extracting groundwater as the first step of the IM. PG&E plans to complete well TW-2 at this location in an expedited manner.

The testing of well TW-2 will provide valuable hydraulic information important to understanding groundwater flow under pumping conditions and also will be used to further calibration of the groundwater model. Data sufficiency and additional activities to collect additional data are further described in Section 5.

The second phase involves operating the groundwater extraction well and evaluating its effectiveness in achieving the objective of hydraulic control and net gradient reversal. As shown on Figure 3-1, the process of implementing the IM is designed to be iterative. If evaluation of groundwater extraction indicates the IM objectives are not being met, an additional well will be sited, installed, tested and additional groundwater extraction initiated. This iterative process will continue until groundwater extraction is sufficient to hydraulically control the plume boundaries near the Colorado River and achieve a net reversal of gradient.

Evaluation of the hydraulic control and gradient reversal will be a critical step in this process. The groundwater flow model has been a tool to assist with siting of the first groundwater extraction well TW-2. However, as identified in Section 5, additional hydraulic information is required near the proposed groundwater extraction location to update the model. Additional model calibration following installation and testing of TW-2 will improve the predictive capabilities of the model and improve the ability to determine whether hydraulic control and gradient reversal have been obtained. Further discussion of the IM and the design basis are described in Sections 4 and 8.

Seven locations for possible extraction wells have been identified as shown on Figure 1-2. If additional pumping is required, various pumping scenarios will be considered. Possible scenarios include:

- TW-2 (MW-20 bench)
- TW-2 plus additional extraction wells on MW-20 bench (*e.g.*, locations B or C in Figure 1-2)
- Combination of TW-1 (PG&E property) and TW-2 (MW-20 bench)
- Floodplain extraction wells
- Upgradient extractions wells (*e.g.*, locations D, E or F)

The last phase, Phase 3, of IM involves proceeding to the final remedy. Data and information obtained during IM and additional data collection will be integrated to prepare a final remedy for the site.

## 3.2 Treatment System Location Alternatives

Extracted groundwater will be treated onsite. The primary objective of groundwater treatment is to reduce the concentrations of Cr(VI) in extracted water to within levels established by regulatory agencies, considering the method of disposal or reuse for the treated water. Chemical reduction and precipitation followed by microfiltration, selected for the pilot system, will also be employed for the IM. Reverse osmosis may be used for reducing TDS, depending on the discharge option selected for the treated water. The treatment system alternatives considered for the IM relate to siting the treatment plant.

Selection of the treatment plant location is dependent on several key criteria. Among the most important considerations include siting the plant close to the point(s) of extraction to limit the conveyance of untreated water over a long distance. Additional factors include the proximity or location of the treated water reuse/disposal facility and property ownership, which both affect permitting and costs. The alternative siting locations identified include:

- PG&E Compressor Station property.
- MWD land.
- BLM lands near MW-20.

A discussion of these three treatment plant location options is presented in the following sections.

### 3.2.1 Treatment Plant Sited at PG&E Compressor Station Property

The current pilot study includes extraction at TW-1, treatment, and reuse and disposal of treated water, all occurring within PG&E's Topock Compressor Station property.

The proposed IM extraction wells are located up to 2,000 feet north of the PG&E Compressor Station Property. Siting a treatment plant at the PG&E property to treat water from TW-2 and other IM wells includes the following activities:

- Conveyance of extracted water from the IM well(s) to PG&E property, for which permits and/or grants of right of way for the conveyance piping and electrical power supply and control wiring conduits would be required from the BLM, U. S. Fish and Wildlife Service, California Department of Transportation, and the Burlington Northern Santa Fe Railroad.
- Tie in to existing cooling system and other infrastructure systems at the Compressor Station.
- Installation of additional infrastructure for treatment facilities may be required if the pumping rates were to increase substantially.

### 3.2.2 Treatment Plant Sited on Metropolitan Water District Land

MWD owns land located approximately 600 feet northwest of the proposed extraction well(s). There are no existing structures or facilities at the MWD property. Siting of a treatment plant at the MWD property would involve:

- Conveyance of extracted water from the IM well(s) to the MWD property, for which BLM right-of-way permits for the conveyance piping and electrical power supply and control wiring conduits would be required.
- Grading and construction of supporting infrastructure (roads, utilities) required to site a treatment plant on this parcel.

### 3.2.3 Treatment Plant Sited on BLM Land

A third potential location for siting of a treatment plant adjacent to the proposed extraction well(s) on BLM land at the MW-20 bench. Siting on BLM land would involve:

- Conveyance of extracted water from the IM well(s) to the MW-20 bench, for which BLM right-of-way permits for the conveyance piping and electrical power supply and control wiring conduits may be required, depending on the distance traversed by such piping or conduits.
- Installation of enhanced security features for the plant and a foundation to support and secondarily contain the equipment, due to its proximity to a county road.
- Permitting requirements for the siting of treatment facilities adjacent to the proposed test/extraction well locations may require the preparation of an Environmental Impact Statement pursuant to the National Environmental Policy Act, as well as a federal ROW grant.
- Siting and installing discharge facilities away from the BLM land, due to the lack of space for such facilities on BLM land and the potential inadvisability of siting recharge facilities near the center of the Cr(VI) plume.

### 3.2.4 Evaluation of Treatment System Location Alternatives

Each treatment plant location alternative was evaluated qualitatively with respect to its effectiveness, implementability, cost, and schedule constraints. These criteria are described below:

- **Effectiveness**—refers to the ability of the treatment plant siting option to meet design criteria or regulatory requirements. An important aspect of the alternative screening evaluation is the effectiveness of each alternative in protecting human health and the environment. Both short-term and long-term effectiveness is evaluated to ensure that the treatment plant can be used over the long term.
- **Implementability**—evaluates both the technical and administrative factors that can affect the likelihood of constructing, operating, and maintaining a treatment plant siting option. Technical factors include the availability and capacity of infrastructure, availability of specialized equipment and technicians, storage requirements, and miscellaneous service requirements. Administrative factors refer to the ability to obtain approvals and permits from regulatory agencies.
- **Cost**—Cost criterion is used to provide for comparative estimates between options.
- **Schedule**—refers to the time required to permit, construct, and startup and operate the system to meet design-operating criteria.

In accordance with the DTSC Corrective Action Manual, this section of the work plan evaluates the alternatives. Each of the three treatment plant siting alternatives is evaluated against the effectiveness, implementability, cost and schedule criteria. Because the same treatment process option (chemical reduction/precipitation followed by microfiltration) is consistently applied through all the alternatives, the evaluation focuses on the administration and schedule.

#### 3.2.4.1 Treatment Plant Sited at PG&E Compressor Station Property

Advantages of siting a treatment plant at the PG&E property include an available reuse option for treated water in the plant, supporting infrastructure, and security. Siting of the treatment plant on the PG&E property would be suitable. The discharge conveyance pipeline would be constructed entirely on PG&E property. Treated water management entirely on the PG&E property is limited by the water quality needs at the cooling towers and the existing capacity of the evaporation ponds.

Between PG&E's property and the proposed test/extraction well locations lie several high-pressure gas transmission lines, a Burlington Northern Santa Fe (BN/SF) Railroad right of way, Interstate Highway 40, Historic U. S. Route 66 and the Havasu National Wildlife Refuge (HNWR) managed by the USFWS. Siting the IM conveyance piping (as well as power supply and control wiring conduits) across these properties requires issuance of a federal right-of-way grant as well as Caltrans and BN/SF Railroad encroachment permits. Approval from the State Historic Preservation Office may be required for impacts to Historic Route 66 and the BN/SF railway corridor.

#### 3.2.4.2 Treatment Plant Sited on MWD Land

Siting a treatment plant on MWD land would significantly reduce the length of pipe (and control/power conduits) necessary to convey untreated extracted groundwater to those facilities, compared to conveying water to PG&E property (from 2,000 feet to approximately 600 feet). In addition, because of the available space, the MWD property offers greater flexibility to expand the treatment and reuse/disposal options if pumping rates exceed 20 gallons per minute (gpm).

Siting a treatment plant on MWD property also offers advantages over siting on BLM land related to visual impacts and site security. Facilities located on MWD property would present reduced visual impact to public recreation areas, due to its natural topographic screening, than would those facilities located adjacent to the proposed test/extraction well site. Further, siting the treatment facilities on MWD property allows more area for the installation of the necessary security measures than could be provided at a site adjacent to the test/extraction well location (and along the shoulder of a public road).

Siting the treatment plant on MWD land avoids or minimizes the intersection of conveyance piping or conduit with high-pressure gas pipelines, and avoids potential impacts to Historic Route 66, the BN/SF railroad corridor, and the sensitive ecosystems of the Havasu National Wildlife Refuge. Facilities on MWD land would have the benefit of existing topographic features that provide a natural barrier to accidental releases to the Colorado River, and would pose a reduced risk of potential impact to the riparian habitat of the Colorado River floodplain, as compared to facilities located adjacent to the floodplain near the proposed test/extraction well locations

#### 3.2.4.3 Treatment Plant Sited on BLM Land

The advantages of siting a treatment plant BLM land include minimizing the conveyance of untreated groundwater from the extraction well to the treatment plant. However, space is limited and cannot accommodate treated water management. Conveyance piping would still be required from the treatment plant to the reuse or disposal area. Permitting requirements for this option are anticipated to be significant, and preparation of an Environmental Impact Statement may be required.

## 3.3 Discharge Management Alternatives

Treated water requires reuse or disposal. A number of reuse and disposal options were considered given siting, regulatory, and property considerations. These include:

- Expanded/New Evaporation Ponds
- Reuse at the Compressor Station
- Re-injection into the Shallow Aquifer
- Phytoirrigation/Infiltration Basins
- Off-Site Disposal of Extracted Water

A brief description of each treated water reuse/disposal option is presented in the following sections.

### 3.3.1 Expanded/New Evaporation Ponds

Surface impoundments created by berms and lined with impervious materials are used to contain treated water allowing the water to evaporate. Suitable area and level terrain must be available to make this a viable option. A water balance is required to design the number and size of the ponds. PG&E is currently using lined evaporation ponds to manage discharges from the compressor station. Expanding or enlarging the existing ponds is a potential option provided additional space is available and permits can be obtained.

New evaporation ponds could be constructed at a location close to the point of extraction and treatment. Additional field information required for pond siting and design include: (1) Soil data collection, including analysis of soil physical properties and infiltration and hydraulic testing of the vadose zone, to determine bulk soil hydraulic conductivity and to identify the suitable impermeable layer; and (2) field surveying to determine grading requirements and final pond location.

### 3.3.2 Reuse at the Compressor Station

Non-potable water can be used at the compressor station in the existing cooling towers. High TDS water, such as is likely to be produced by any of the potential extraction wells, causes scaling and corrosion. Reverse osmosis can be used to reduce the TDS of the water and make it suitable for use in the cooling towers; however, this process produces a concentrate stream that might be as much as half the volume of water treated. The use of higher extraction rates than those originally contemplated for the pilot test (for which this reuse option was evaluated), or the extraction of water with higher TDS concentrations than those evaluated for the pilot test, will require expansion of the evaporation ponds or the implementation of other means to dispose of RO concentrate. The capacity for water reuse at the compressor station is therefore limited by the capacity of the existing evaporation ponds to accept treated water. The IM water could be substituted for the pilot study water unless higher volumes of water are extracted or if TW-2 water has higher TDS concentrations. This will require expansion of the evaporation ponds or some other means of disposal of reverse osmosis concentrate. The capacity for water reuse at the compressor station is therefore limited by the capacity of the existing evaporation ponds to accept treated water.

### 3.3.3 Re-injection of Treated Water

Treated water maybe returned to the aquifer at the water table using infiltration basins/galleries or injection wells.

#### 3.3.3.1 Infiltration Basins/Galleries

An infiltration basin is a bermed area where re-injection is accomplished by applying water and allowing it to infiltrate passively into the subsurface and through the vadose zone to the water table. An infiltration gallery is similar to an infiltration basin but is constructed below the ground surface and covered with soil. Infiltration basins are simpler to construct and maintain than infiltration galleries. Both infiltration basins and galleries may require extensive maintenance to prevent clogging, sustain optimal infiltration rates, and prevent berm erosion.

Additional field information required for siting and design of infiltration basin/galleries include analysis of soil physical properties and infiltration and hydraulic testing of the vadose zone to determine bulk soil hydraulic conductivity and to ensure that no impermeable layers are present in the recharge area.

#### 3.3.3.2 Injection Wells

Re-injection of treated water can involve conveyance and injection of water at the water table using wells. Re-injection can create mounding of the water table, which may affect groundwater flow. Any re-injection system must be evaluated and sited such that it does not adversely affect the movement of Cr(VI) in the shallow aquifer. The location of the injection wells would have to be acceptable to the regulatory agencies, and landowners. Re-injection would require that a sufficient number of injection wells be installed to handle the volume of treated water. Periodic maintenance of the injection wells would be required to prevent clogging and to sustain the required injection rates. Fieldwork, including installation, sampling, and testing of a pilot well, is necessary to site and design injection wells.

### 3.3.4 Phytoirrigation/Infiltration Basins

Phytoirrigation consists of reusing treated water to produce a crop or provide additional treatment of secondary constituents. Treated water is conveyed to a suitable land area where irrigation and crop production can be implemented. Infiltration is a component of this option, as crop evapotranspiration varies over the growing season depending on prevailing climatic conditions. During cooler months, evapotranspiration will be limited and infiltration will be the dominant process. However, the bulk of the annually irrigated water transpires into the atmosphere thereby limiting the amount of percolation to the groundwater. Phytoirrigation systems may include the application of water at or below the surface, if needed. Designs using deep root vegetation are particularly advantageous because such systems have high water use potential, deep rooting, and low operations and maintenance costs.

Characterizing irrigation-water quality parameters is required for designing a phytoirrigation system. Irrigation water quality affects plant selection and determines treatment needs such as adjustment for mineral deposition, and may also determine the most appropriate type of irrigation (drip, sprinkler, flood, etc.) system.

### 3.3.5 Off-site Disposal of Extracted Water

This hybrid alternative would eliminate the requirement of a treatment plant and the difficulties of siting. It offers unique advantages, as discussed below. For this alternative, extracted groundwater could be stored in tanks located next to or near the IM well(s). Trucks would pump or vacuum the water from the tanks on a regular basis and haul it to a disposal facility. The alternative would involve the following:

- Build a foundation for storage tanks with secondary spill, overfill and leak containment of potentially hazardous waste. Perform necessary grading, install power system (permanent or temporary facilities) and provide safety instrumentation to alert and prevent leaks and spills. Construct fencing and lighting for security.
- Obtain applicable permits or ROW grants to site the facilities.

### 3.3.6 Evaluation of Discharge Management Alternatives

Each reuse/disposal option was evaluated qualitatively with respect to its effectiveness, implementability, cost, and schedule constraints on a broad basis. The criteria are defined below.

- **Effectiveness**—refers to the ability of the reuse/disposal option to meet design criteria or regulatory requirements. An important aspect of the alternative screening evaluation is the effectiveness of each alternative in protecting human health and the environment. Both short-term and long-term effectiveness is evaluated to ensure that the reuse/disposal can be used over the long-term.
- **Implementability**—is evaluated both the technical and administrative factors that can affect the likelihood of constructing, operating, and maintaining a water reuse/disposal option. Technical factors include the availability and capacity of infrastructure, availability of specialized equipment and technicians, storage requirements, and miscellaneous service requirements. Administrative factors refer to the ability to obtain approvals and permits from regulatory agencies.
- **Cost**—Cost criterion is used to provide for comparative estimates between options.
- **Schedule**—refers to the time required to permit, construct, and start-up and operate the system to meet design-operating criteria.

This evaluation is summarized in Table 3-1 and discussed below.

#### 3.3.6.1 Expanded/New Evaporation Ponds

Expanding or enlarging the existing ponds currently used by the compressor station is a likely treated water reuse/disposal option for the pilot study extraction at well TW-1. Pond expansion or enlargement would be required to manage additional flows from IM extraction wells. Such expansion or enlargement is subject to the availability of physical space.

Locating new evaporation ponds on MWD lands is a preferred option to accommodate extracted water from proposed IM well TW-2. This will limit the distance for conveying treated water, especially if the treatment plant is also located on MWD land.

Table A1 (Appendix A) shows a water balance for this option assuming a treated water flow rate of 20 gpm. Based on this flow rate and the prevailing climatic conditions in the area, an additional 3.5 to 4 acres of ponds would be required to effectively accommodate the assumed 20 gpm flow rate.

#### 3.3.6.2 Reuse at the Compressor Station

Reuse at the compressor station likely will require secondary treatment of the treated water by reverse osmosis. It is limited to approximately 20 gpm flow. It requires that TW-1, the pilot study extraction well, not be used in order to accommodate the volume of extracted water from well TW-2.

#### 3.3.6.3 Re-Injection of Treated Water at the Water Table

Discharge of treated groundwater through injection well(s) or infiltration basins/galleries can create a mounding of the water table, which may affect groundwater flow and possibly plume configuration. Additional hydraulic information gathered during implementation of IM will be used to refine the groundwater flow model. This model will provide information to define optimal locations for the injection well(s) such that the recharge system does not adversely affect the movement of Cr(VI) in the subsurface.

Recharge of treated groundwater through an infiltration gallery/basin or injection well(s) at the Topock site would require the issuance of waste discharge requirements by the CRBRWQCB. The CRBRWQCB would consider the beneficial uses of the groundwater and requirements to protect the beneficial uses before issuing the WDRs. The waste discharge requirements would establish cleanup levels and other discharge restrictions or prohibitions necessary to protect beneficial uses of the groundwater.

The land area for infiltration basins/galleries is likely to be considerably less that that required for evaporation ponds as water is both percolating and evaporating out of the basins. Provided that this method can be permitted and a suitable location can be found, this option is compatible with extraction at proposed extraction well TW-2. A water balance for the infiltration basin presented in Table A2 (Appendix A) indicates that a basin of approximately 0.5 to 0.75 acres would be required for a flow rate of 20 gpm. This is based on an assumed sustainable infiltration/percolation rate of 0.14 feet per day ($5 \times 10^{-5}$ cm/s). The infiltration rate /percolation rate values will need to be confirmed by field studies prior to final design. Maintenance would be required to ensure that these infiltration rates are sustainable over the long term.

Recharge of treated groundwater through an injection well at the Topock site would also be subject to requirements of the federal Underground Injection Control program. Under the Underground Injection Control program, injection wells must be authorized by permit by rule if the injection results in the movement of fluid containing any contaminant into an underground source of drinking water, and if contaminants present in injection fluids cause a violation of any primary drinking water standards (MCLs) or adversely affect the health of persons. An injection well at the Topock site would be categorized as a Class V well because injected water would not be classified as hazardous. The substantive requirements of the Underground Injection Control Program include construction, operating and closure requirements for injection wells to protect sources of drinking water.

#### 3.3.6.4 Phytoirrigation/Infiltration Basins

The phytoirrigation option is an enhancement of the infiltration basin concept. The benefits of using plants in this option includes: (1) enhancement of water transpiration beyond that achievable with evaporation ponds or infiltration basins alone and (2) potentially enhanced infiltration rates because vegetation can increase infiltration rates over soil alone. Plant roots tend to help reduce surface sealing and maintain a relatively constant infiltration rate.

Area requirements for this option are expected to be in the 0.25- to 0.5-acre range based on the assumptions listed in Table A4. As with the infiltration basins, maintenance would be required to ensure that these infiltration rates are sustainable over the long-term.

#### 3.3.6.6 Off-site Disposal of Extracted Water

This alternative would increase vehicle traffic in the area. It may require road rehabilitation and reinforcement at the Red Rock Bridge. The potential loads of the vehicles and the tanks require a geotechnical evaluation of the MW-20 bench. It may be possible for this option to be implemented expeditiously. The costs for trucking and waste disposal fees are expected to be high.

# 4.0 Description of Interim Measure

This section presented the tasks and activities necessary to complete the IM. On January 22, 2004, DTSC directed PG&E to prepare an IMWP that is conceptual in nature; many of these concepts have been previously introduced and discussed during Topock CWG teleconferences of January 22, 2004, January 26, 2004, January 29, 2004, and February 2, 2004. Based on the evaluation of alternatives, the following IM is proposed to mitigate potential impacts of chromium in groundwater on the Colorado River. The proposed IM represents the preferred option, from a logistical, engineering and regulatory perspective, for siting the extraction well and treatment system and discharging the treated water.

## 4.1 Extraction Well Siting

Potential extraction well locations A through G (Figure 1-2) are being considered. The primary area of focus is denoted as location A, as shown on Figure 1-2. After installation and development of test well TW-2 at the A location, CH2M HILL will collect depth-specific groundwater samples for water quality analysis. Aquifer testing with pumping will be conducted for two days and pumped water will be temporarily stored prior to testing and analysis. A submersible pump will be installed prior to beginning operation of the extraction well. Data will be analyzed and the results reported to DTSC and the CWG for review and comment. PG&E will wait for approval from the DTSC to commence long-term extraction. Additional extraction wells will be installed as needed to achieve the project objectives.

See Section 5 for descriptions of the testing program associated with TW-2 and additional data collection efforts proposed to support IM.

## 4.2 Treatment System Location

PG&E has requested access to MWD property north of the PG&E Topock Compressor Station, for the construction and operation of facilities to treat groundwater. Siting such facilities on MWD property may offer significant advantages from logistical, technical and regulatory perspectives, and may help expedite the installation and operation of critical remedial facilities.

If access to this property is granted, the treatment system equipment will be located on MWD property located about 600 feet northwest from the location A. The treatment system will consist of:

- Chromium reduction using ferrous chloride.
- Iron oxidation from ferrous to ferric using forced aeration.
- Particulate removal using microfiltration.
- Reverse osmosis for salt removal (optional pending disposal evaluation).

The initial siting of the pilot test treatment system on PG&E property to treat groundwater extracted from well TW-1, will give PG&E the flexibility to treat water from TW-2 temporarily until land access and permits are granted and a treatment facility can be built near TW-2.

It is anticipated that if treated water is no longer reused in the station's cooling towers, the reverse osmosis unit may be bypassed. For more process details and component equipment descriptions, see the *Draft Technical Memorandum, Groundwater Pilot Study, Topock Compressor Station, Needles, California (CH2M HILL, 2003).*

## 4.3 Discharge Management

A phased approach is proposed to facilitate implementation of IM in an expedient manner. PG&E believes this proposed phased approach will meet the needs to implement hydraulic control (via groundwater extraction) while addressing the engineering and permitting challenges of alternative approaches.

- Phase I: Phase I involves the transport of extracted water by truck from the TW-2 well to the PG&E property. At the PG&E property, the groundwater will be treated and used as make-up water in the cooling towers of the PG&E plant. Phase I will begin following start-up of the pilot groundwater treatment system located at the PG&E site. The transport of extracted water by truck is considered a temporary measure that will be continued until the long-term management options are permitted and constructed.
- Phase II: Phase II involves conveying extracted water from the TW-2 well to the PG&E property by pipeline. At the PG&E property, the groundwater will be treated and used as make-up water in the cooling towers of the PG&E plant. Phase II will begin following the permitting and construction of the pipeline between TW-2 and the PG&E property.
- Phase III: Phase III involves conveying extracted water from the TW-2 well to the MWD property for treatment and discharge through an infiltration basin/gallery or injection well. Implementation of this phase is contingent upon MWD granting access to build a treatment plant and infiltration basin on MWD property. PG&E will also apply for applicable permits to build a pipeline on BLM property. Phase III will provide additional management strategies for treated groundwater that will be needed for expansion of the extraction well field beyond the TW-2 well. Permitting for Phase III will be pursued concurrently with the permitting of Phase II. Phase III will begin when Phase II is operating at capacity, and following permitting and construction of Phase III facilities (consisting of the pipeline from TW-2 to the MWD property, a groundwater treatment system at the MWD property, and an infiltration basin).

# 5.0 Data Sufficiency and Additional Testing

This section describes the data collection efforts to support IM. Existing site data have been reviewed to evaluate data sufficiency for design and implementation of IM. IM is expected to include siting one or more extraction wells and collection of data to further calibrate the groundwater model. The IM approach is an iterative process that will proceed until the objectives of the IM are fulfilled. As such, the design of the IM, and hence evaluation of data sufficiency, must take into account the ability to evaluate the performance of the IM (see Section 8). For example, model calibration will be critical for evaluating the IM and will be a focus for data sufficiency. Though not the focus of the IM workplan, data requirements have been taken into consideration to achieve the long-term project objectives and the design and implementation of the final corrective action.

The data sufficiency review included:

- Hydraulic properties (*e.g.*, hydraulic conductivity).
- Groundwater levels and flow direction/gradients.
- Lithology and hydrostratigraphy.
- Distribution of constituents of concern and general groundwater chemistry.
- Geographical information (*e.g.*, survey information, mapping, topography).

This section identifies areas where additional data are needed and provides recommendations for collecting the data. Each recommendation is evaluated and prioritized to facilitate planning of the IM. Figure 5-1 is a schematic representation of the additional data collection requirements, differentiating the higher priority activities from those that are of lower priority. PG&E intends to collect additional data in support of the CMS, but those specific activities will be described in a future workplan.

## 5.1 Hydraulic Information Along the Colorado River

Hydraulic data including water levels and well hydraulic parameters have been collected across the site and adjacent to the Colorado River at monitoring wells, extraction wells, water supply wells. Water levels, for example, are measured quarterly (or more frequently at selected locations) at over 50 locations. Eight locations (seven wells and one river location) are equipped with pressure transducers for even more frequent monitoring.

Conceptually, the site may be divided into two subzones, an alluvial subzone and a floodplain subzone. The alluvial aquifer contains predominantly alluvial deposits and contains the majority of the chromium-affected groundwater. The floodplain subzone is an environment modified by the Colorado River in terms of topography, lithology, biotic influences (predominantly plant life) and hydrogeology. The following are recommendations for gathering additional hydraulic information along the boundary between the alluvial subzone and within the floodplain subzone.

### 5.1.1 Installation and Testing of TW-2

Test well TW-2 is proposed for extracting groundwater at the MW-20 bench (as described in Section 3). In additional to serving as the IM extraction well, TW-2 also will be used for gathering additional hydraulic information near the MW-20 cluster. Data gathering needs are based on the following:

- The aquifer at the MW-20 bench may include fluvial sediments, which may warrant more characterization.
- Hydraulic testing in the MW-20 cluster and the floodplain wells has been limited to slug tests or low-rate (<5 gpm) pumping tests.
- The effects on groundwater gradient from long-term pumping in this area (approximately 600 feet from the Colorado River) have not been fully evaluated.

The following is recommended to gather additional hydraulic information at the MW-20 bench:

- A pilot boring will be advanced at the MW-20 bench to a total depth of 150 feet below ground surface or 10 feet into bedrock, whichever is encountered first.
- Continuous core will be collected while advancing the pilot boring and will be preserved to permit pore water analyses for key water quality parameters and isotopes.
- Downhole geophysical logging will be conducted within the uncased borehole.
- The pilot boring will be completed as test well TW-2, an 8-inch-diameter well screened across the entire saturated thickness of the alluvial/fluvial aquifer.
- Hydraulic testing will be conducted at TW-2 including a 2-hour step drawdown test and a 2-day constant rate pumping test at a pumping rate determined from the results of the step drawdown test (estimated to be approximately 50 gpm).
- Water levels in monitoring wells near TW-2 will be measured with transducers during the pumping test.
- Velocity logging and depth specific sampling will be conducted to evaluate production and water chemistry (geochemistry and contaminant distribution) within the aquifer.

*Priority: It is recommended that the installation and testing of TW-2 at the MW-20 bench be given top priority in the data collection effort.*

### 5.1.2 Hydraulic Testing at Shoreline Wells

Chromium has been sporadically detected in samples from wells MW-30-50, and MW-34-80, along the floodplain of the Colorado River. Hydraulic data in the shoreline region will be collected to supplement the groundwater extraction and testing activity at the MW-20 bench.

Twelve shoreline wells have been completed along the floodplain of the Colorado River. Hydraulic testing at the shoreline wells has been limited to slug tests. Though slug tests provide valuable information, more vigorous hydraulic testing can provide broader information on the aquifer properties within the floodplain subzone. It is recommended that short-duration pumping tests or "purge tests" be conducted at each well in the MW-30, MW-32, MW-33, and MW-34 well clusters.

Existing hydraulic testing data including development records and slug test results for each well will be evaluated and a suitable test prepared for each well. Many of the floodplain wells have low yield (*i.e.*, only a few gpm) and pumping rates will be limited to a few gpm to prevent immediate dewatering of the well. Other wells will have more significant yield and a more significant pumping test (up to 10 gpm) and even a step drawdown test may be possible. Drawdown will be monitored using pressure transducers in the pumping well, in the other well in the cluster, and in nearby monitoring wells as suitable during pumping and subsequent recovery.

*Priority: Hydraulic testing at shoreline wells can be conducted after the installation of the initial IM extraction well (i.e., TW-2). The data are important for ongoing evaluation of the IM and to meet long-term objectives.*

## 5.2 Additional Hydraulic Testing at Wells in the Alluvial Aquifer

Opportunities exist to collect additional hydraulic data at existing wells within the alluvial aquifer. Additional hydraulic information is essential for calibrating the groundwater flow model, an important tool for evaluating the success of the IM. The following provides recommendations for additional hydraulic testing within the alluvial aquifer.

### 5.2.1 Additional Hydraulic Testing at TW-1

In November 2003, TW-1, a fully penetrating 5-inch diameter test well, was completed on the northern edge of the PG&E Topock Compressor Station. Preliminary hydraulic testing was completed in January 2004 including a step drawdown test and velocity logging. Additional hydraulic testing including a constant rate pumping test, could be conducted at this well. Three additional monitoring wells should be installed near TW-1 to provide the most valuable results during the pumping test, though drawdown was observed in both MW-10 and MW-24B during the preliminary hydraulic testing.

The following activities are required to complete the hydraulic testing at TW-1:

- Install three monitoring wells near TW-1 to use as observation wells during hydraulic testing.
- Continuously core the deepest borehole of the three wells to correlate with geophysical logs.
- Conduct a 3- to 5-day continuous discharge test in TW-1 at 50 gpm.
- Use MW-10, MW-24 cluster, and new observation wells to monitor water levels during testing.

*Priority: The data gained from this test will be valuable for calibrating the groundwater flow model. However, testing at TW-1 is not critical for implementing IM and can be reviewed following completion and testing of TW-2.*

### 5.2.2 Hydraulic Testing at PT-1

In 1986, well PT-1 was completed within the alluvium to a depth of approximately 280 feet. The well is located several thousand feet to the west of the compressor station near the new evaporation ponds. Hydraulic testing of this well yielded hydraulic conductivity values significantly greater than elsewhere within the alluvium. It is proposed that a constant rate pumping test be conducted at PT-1 to verify the high hydraulic conductivity values at this location. There are several monitoring wells completed nearby at different depths that will provide valuable data for estimating vertical hydraulic conductivity.

The following activities are required for hydraulic testing at PT-1:

- Service well PT-1 including uncovering well (currently covered with asphalt).
- Conduct a 2-day continuous discharge test in PT-1 at 50 gpm.
- Use MW-10, MW-24 cluster, and new observation wells to monitor water levels during testing.

*Priority: The data gained from this test will be valuable for calibrating the groundwater flow model. However, testing at PT-1 is not critical for implementing IM and can be reviewed following completion and testing of TW-2.*

## 5.3 Lithology

Over 50 monitoring and extraction wells have been completed at the site over several decades. The lithologic information available from each well completion varies depending in part on when the well was installed and the purpose for the well installation. For example, wells PGE-6 and PGE-7 were installed in 1964 as groundwater extraction wells. The lithologic information from these wells includes only basic descriptions of sediments and major contacts (*i.e.*, bedrock). Wells completed more recently, such as TW-1, have much more detailed logging and lithologic characterization supervised by registered geologists, including downhole geophysics, core collection, grain size analyses, and velocity logging.

This section provides recommendations for collecting additional lithologic data to assist in further calibration of the groundwater model.

### 5.3.1 Cased-hole Geophysics

To augment the data available from older borings with limited lithologic data and to facilitate correlation of lithologic information between borings, often completed by different contractors over several decades, it is proposed that cased-hole geophysics be conducted at several wells. Cased-hole geophysics, including gamma ray and induction logging, can be conducted in the existing wells with a reasonable level of effort (pumps and sampling equipment must be removed and truck access is required). The results can be interpreted with and compared to geophysical logging results from borings that have been thoroughly logged (*e.g.*, TW-1). The goal is to use this information to interpret lithologic units (*e.g.*, the older, more compact alluvium and bedrock noted in geophysical logs from TW-1) throughout the study area. The following eleven wells are proposed for cased-hole geophysics: PT-1, MW-15, MW-16, MW-17, MW-21, MW-24BR, MW-25, MW-30-50, MW-33-90, MW-34-80, and the Park Moabi water supply well (note that limited truck access may restrict access to shoreline wells).

*Priority: This task is not critical to the design or implementation of IM, but will provide valuable information for the evaluation of IM. The priority of this activity should be reviewed following installation and testing of TW-2.*

### 5.3.2 Continuous Coring at TW-1 and TW-2

Continuous coring provides high-quality subsurface sediment samples. Often sediments and bedrock are described from drill cuttings that can result in lithologic interpretations that do not fully represent the subsurface deposits. Mud-rotary drill cuttings, for example, can underestimate the portion of gravel and fines (silts and clays) in the formation.

It is proposed that a boring at both the TW-1 and TW-2 locations be completed with a sonic drilling method that permits continuous collection of large diameter core. The core collected by this method will be intact and will have minimal exposure to drilling fluid and formation water. This core, therefore, can be preserved and pore water analyzed for key chemical parameters and isotopes. Core intervals also will be selected for grain size analysis.

At the TW-1 location, three monitoring wells have been proposed for hydraulic testing of TW-1. It is proposed that the deepest of these monitoring wells be drilled by a sonic drilling method with continuous core collection.

A deep monitoring well has been proposed near MW-31 on the MW-20 bench (approximately 300 feet north of the MW-20 cluster). It is proposed that this well be drilled by a sonic drilling method with continuous core collection. TW-2 will be installed in a larger diameter borehole (approximately 12-14-inch diameter) using a mud rotary drill method.

*Priority: The continuous coring at TW-1 and TW-2 are important, not critical, to the design and implementation of IM, but may be valuable to fully evaluate IM and design a final remedy for the site.*

## 5.4 Geographic Information

The following geographic information has been identified as insufficient for design and implementation of the IM.

### 5.4.1 Topography and Digital Elevation Model

Regional topography for the site is available from USGS quad maps, and a local topographic map created from an aerial survey conducted in 1997 is available. The topographic information is sufficient for most required applications (*e.g.*, mapping, modeling) across most of the site. However, much of the site includes terrain where a 100-foot change in ground surface elevation over 1000 feet is not uncommon. It is proposed that a digital elevation model (DEM) be created from aerial data in this area to increase the accuracy and resolution of the topography along the river floodplain.

*Priority: This task can be completed immediately and concurrent with other tasks.*

### 5.4.2 Survey

Wells at the site have been completed and surveyed by several contractors over the course of site activities. Several well elevations and hence water level elevations have been called into question during data interpretation and model calibration. Because water level differences between wells can often be small yet significant in hydrogeologic interpretations, an accurate survey of well elevations is essential. It is proposed that all the wells at the site be resurveyed to ensure all wells are on the same datum and elevations have been determined with the best accuracy possible.

*Priority: This task can be completed immediately and concurrent with other tasks.*

## 5.5 Groundwater Chemistry and Sampling

The following activities are planned to augment data and understanding of the distribution of chromium at the site. These data gathering efforts focus both on better understanding of the distribution of chromium by installing new monitoring locations and evaluating data at existing monitoring locations.

### 5.5.1 Evaluation of Low-flow Sampling

PG&E proposes to evaluate the groundwater quality results obtained from the low-flow method and well volume methods from groundwater monitoring. A "comparison field test" of groundwater sampling methods for select wells in the river floodplain was recommended during recent technical discussions involving DTSC, PG&E, and members of the CWG.

PG&E submitted a brief workplan to DTSC in February 2004 (CH2M HILL, 2004) proposing that a groundwater sampling method evaluation involve the following activities:

1. Conduct a comparison field test of the low-flow and well-volume purging and sampling methods on the 10 floodplain wells in the monthly program. Samples will be collected and analyzed for hexavalent chromium [Cr(VI)] using Method SW 7199 and total chromium [Cr(T)] using Method SW 6010B. The comparison sampling is proposed to be conducted during the upcoming monthly monitoring event, scheduled for February 18-19, 2004.

2. Based on comparison test results, evaluate all sampling methods applicable for the monitoring wells and field conditions in the floodplain area. Sampling methods to be evaluated include the **low-flow**, the traditional **three-well volume**, and potentially, a modified, **packer-assisted well volume** purging techniques.

3. Prepare an evaluation report for DTSC and CWG review, that summarizes the results of the comparison test and presents recommendations for the sampling methods to be used for ongoing monitoring of the floodplain wells.

*Priority: This activity will take place immediately and is not contingent on the planning, design, or implementation of the IM.*

### 5.5.2 Installation of New Monitoring Wells for Further Delineation

The following new monitoring wells have been considered by DTSC, PG&E and the CWG during recent technical discussions:

- Deep monitoring well (lower alluvium) in Bat Cave Wash near MW-13
- Shallow monitoring well (upper alluvium) in Bat Cave Wash to the west of TW-1
- Shallow and deep monitoring well between the MW-30 and MW-34 clusters
- Deep monitoring well (lower alluvium) near MW-31 on the MW-20 bench

It is recommended that a deep monitoring well near MW-31 be installed as part of the implementation of the IM. PG&E also proposes to install a monitoring well or cluster of wells between the MW-30 and MW-34 pair to support the IM. The siting of additional wells should be further evaluated, as applicable.

*Priority: Installation of these wells is not critical to the design or implementation of IM, but may be required to fully evaluate IM and design a final remedy for the site.*

### 5.5.3 Colorado River Floodplain Studies

Several studies are proposed to understand better the interaction between the groundwater system and the Colorado River. The interaction between the surface and groundwater systems is complicated at this site because of significantly contrasting salinities, high rates of evapotranspiration along the floodplain, and water levels in the Colorado River that fluctuate daily several feet due to flow control for power generation. The following studies are proposed:

1. A multi-parameter downhole probe (*e.g.*, In-Situ Troll 9000) will be installed in several floodplain wells for approximately 1 week (1 or 2 probes alternating among wells). The probe measures and logs multiple parameters including water level, atmospheric pressure, pH, electrical conductivity, ORP, dissolved oxygen, and temperature. Together with the existing pressure transducers monitoring and recording water levels in other monitoring wells and the river, these data will provide valuable information regarding flow and interactions between the groundwater system and the Colorado River.

2. Chromium concentrations typically have been below detection limits in wells near the Colorado River. However, recently, Cr(T) and Cr(VI) have been sporadically detected in several wells. It has been speculated that these sporadic detections could be a function of river level fluctuations and hence gradient reversals between the groundwater system and the river. In addition to the additional hydraulic testing at the “floodplain” wells and the low-flow sampling evaluation also presented in this workplan, it is proposed that for one day the MW-34 well pair be sampled hourly from 8 AM until 4 PM for dissolved Cr(T) and Cr(VI). The Cr(VI) samples must be shipped to the laboratory by 4 PM to ensure analysis is completed within 24 hours.

3. A substantial portion of the floodplain adjacent to the Colorado River is covered with vegetation including grasses and salt-tolerant bushes such as tamarisk (salt cedar) and mesquite. Evapotranspiration by these plants may limit groundwater discharge to the Colorado River. It is proposed that a program be implemented to collect transpirate

within the floodplain. Analysis of the transpirate, including isotopic analysis, can assist in determining whether the source of the transpirate is groundwater or water from the Colorado River.

4. Groundwater flow near the Colorado River can be difficult to quantify because of the daily fluctuations of the Colorado River. Samples of groundwater discharge to the river can be collected using flux chambers installed in the sediments along the floodplain. The water samples collected from the flux chambers can be analyzed for chromium, routine chemistry, and isotopes to identify the source of water discharging to the river.

*Priority: The studies along the floodplain of the Colorado River are not essential for implementation of IM, but are important for understanding the interactions between groundwater and the river. This understanding is also important for optimizing any groundwater extraction taking place near the Colorado River (e.g., at TW-2).*

### 5.5.4 Evaluation of Water Chemistry at the MW-20 Bench

Water chemistry at the MW-20 bench has been characterized from the existing monitoring wells. Additional sampling and characterization from a fully penetrating extraction well is essential for the design of the water treatment plant. Following the completion and development of TW-2, water samples should be collected for:

- pH, specific conductance, ORP, and dissolved oxygen.
- Turbidity, total suspended solids, and total dissolved solids.
- Alkalinity, bicarbonate (calculated), carbonate (calculated), major ions (cations and anions) (calculated) carbon dioxide (calculated).
- Calcium, magnesium, sodium, potassium, barium, and strontium.
- Iron (total), iron (dissolved), and manganese (total).
- Sulfate, chloride, and fluoride.
- Silica (reactive), heterotrophic plate count, total organic carbon, and color.
- Total dissolved chromium, Cr(VI).

*Priority: This activity will take place immediately after installation and development of TW-2.*

# 6.0 Project Management

CH2M HILL will manage the IM activities. The proposed project management approach is intended to:

1. Ensure a direct, continuous line of communication among DTSC, the PG&E project team and all stakeholders in the Consultative Technical Workgroup(CWG).
2. Facilitate effective and efficient coordination and management of the various tasks.
3. Implement this IM on time and in compliance with the requirements of the DTSC.

The progress and performance of the project will be monitored through:

- Project team meetings.
- Regular meetings with DTSC representatives.
- Regular meetings and conference calls with the CWG.
- Ad hoc meetings with DTSC and other stakeholders to resolve project issues and concerns.

# 7.0 Project Schedule

The figure below shows the proposed project schedule with estimated duration of many critical activities. Examples of the activities with uncertain duration include permitting and land access, and document reviews. Future expansion of the groundwater extraction system is not shown in this schedule. Critical assumptions include:

- Well siting activities are underway.
- The ROW grant amendment for well siting and testing from BLM can be approved in 30 days.
- IM permitting begins before IMWP is complete.
- Documentation and review for National Environmental Protection Agency and California Environmental Protection Agency (CEQA) (requires 4 months).
- MWD will grant land access in 30 calendar days after receipt of CEQA determination.
- Treatment plant, piping and facilities planning, design and procurement begins six to eight weeks prior to receipt of ROW grants and CEQA approval.
- Technical assumptions will be made regarding the design and size of the facilities to allow the permit applications to be submitted more quickly. Design of the facilities may be revised to suit the project needs after analysis of data and field reconnaissance.

| Task Name | Duration | Start | Finish |
|---|---|---|---|
| **Interim Measures** | **259 days** | **Thu 01/22/04** | **Wed 01/26/05** |
| DTSC Issues Notification Letter | 1 day | Thu 01/22/04 | Thu 01/22/04 |
| Draft IM Workplan | 20 edays | Thu 01/22/04 | Wed 02/11/04 |
| Review | 30 edays | Wed 02/11/04 | Fri 03/12/04 |
| Final IM Workplan | 28 days | Mon 03/15/04 | Wed 04/21/04 |
| **TW-2 Well Siting** | **46 days** | **Mon 02/02/04** | **Mon 04/05/04** |
| BLM ROW Grant Amendment | 6 days | Mon 02/02/04 | Mon 02/09/04 |
| Review & Approval | 20 days | Tue 02/10/04 | Mon 03/08/04 |
| CEQA Categorical Exemption | 20 days | Tue 02/10/04 | Mon 03/08/04 |
| Install, Develop, Sample & Test | 20 days | Tue 03/09/04 | Mon 04/05/04 |
| **Permitting & Access** | **155 days** | **Tue 02/03/04** | **Fri 09/10/04** |
| BLM ROW/NEPA | 16 wks | Tue 04/20/04 | Wed 08/11/04 |
| MWD ROW/CEQA | 16 wks | Tue 04/20/04 | Wed 08/11/04 |
| MWD ROW Process | 220 edays | Tue 02/03/04 | Fri 09/10/04 |
| IM WDRs | 66 days | Tue 04/20/04 | Thu 07/22/04 |
| **Piping & Facilities** | **135 days** | **Fri 07/16/04** | **Wed 01/26/05** |
| Design/Procurement | 12 wks | Fri 07/16/04 | Fri 10/08/04 |
| Piping & Utilities to MWD | 3 wks | Mon 10/11/04 | Fri 10/29/04 |
| Treatment Plant | 12 wks | Mon 10/11/04 | Wed 01/05/05 |
| Disposal Facility | 8 wks | Mon 10/11/04 | Tue 12/07/04 |
| Treatment Plant Startup | 15 days | Thu 01/06/05 | Wed 01/26/05 |
| | | | |

Note: Days represent business days; “edays” are calendar days.

# 8.0 Design Basis

The process used to design the IM wells and facilities will rely on industry standard practices, information available from technical literature, and use the experience of the project team members. The decision process flowchart shown on Figure 3-1 illustrates the key decision criteria and factors for deciding whether to install additional wells and where to site them. Regular monitoring and data evaluation will document this element of the IM.

For the IM treatment system, the planned treatment system capacity is 20 gpm maximum from well TW-2 based on the limits of the cooling system and evaporative ponds at the Station. The system capacity may be increased based on the results of aquifer testing at TW-2, groundwater monitoring, IM operations, and the availability of suitable water management options.

Significant assumptions include:

- A pumping rate of no more than 20 gpm will meet the IM objectives.
- Chromium concentrations of treated water are within limits acceptable for the reuse/discharge options selected.
- The Station is capable of resuing treated water with up to 1,500 mg/L TDS.
- The assimilative capacity of existing evaporation ponds for receiving reverse osmosis concentrate is not exceeded.
- No reduction in TDS is required for the infiltration basin.

If these assumptions are not valid, there may significant effects on the project in terms of cost, schedule, permitting, infrastructure, and land requirements. A brief discussion on the impacts of changes in the assumptions outlined above on each component of the IM system is provided below:

## 8.1 Extraction System

Additional extraction wells or increased pumping rates potentially could require additional treatment and disposal capacity. Construction of these expanded facilities could increase pipelines (size and length) and electrical power requirements. Evaluation of data collected during installation and testing of TW-2 will reduce some of this uncertainty. A larger impact of increase flow is on the size of the treatment and disposal system. In the event of increased capacity requirements, treatment and disposal facilities would be enlarged. Additional foundations to support equipment would be required. The capacity of an infiltration basin to accommodate 20 gpm (calculated to be approximately one-half acre) would be expanded proportionally to the flow rate; this may involve additional land requirements and associated access permits.

## 8.2 Treatment System

If the treatment system does not produce effluent at concentrations within the limits permitted for the reuse or discharge option selected, the treatment process may have to be modified. Results from the pilot study system treating groundwater extracted TW-1 will yield more information on treatment effectiveness. Other possible treatment options might include the addition of ion exchange or reverse osmosis facilities.

## 8.3 Reuse/Disposal System

In the event that water quality requirements for reuse at the Station become more stringent, additional salt removal processes will be required. Potentially applicable processes include higher efficiency membranes, such as high-rejection RO membranes. The disposal of reverse osmosis concentrate in the existing evaporation ponds appears to be feasible based on current information. When the quality of water from TW-2 is known, additional treatment might become necessary to further reduce the volume of the reverse osmosis concentrate stream. Several options exist to effect such a reduction, depending on the quality of water extracted from TW-2.

# 9.0 Design Concept

The principal concept for managing treated groundwater at the Topock site is that, to the extent possible, the water will be used and disposed of at the Topock Station. Significant uncertainties about the water quality and volume have led to the design of a robust treatment system, but disposal options have been left open pending permitting, aquifer characterization and access approvals. These uncertainties may make it necessary to resort to off-site disposal because of technical, regulatory or administrative considerations.

Figure 9-1a and9-1b illustrates the basic concept for the proposed IM, showing each major element of the IM. The first element is the extraction well to a treatment plant located on MWD property, together with the reuse option (initially, reuse at the Compressor Station, followed by use of an infiltration basin on MWD property).

The first major element is the extraction well, followed by conveyance to the treatment plant. Initially, the treatment plant will located at the Compressor Station, but later would r be relocated onto MWD property if access can be obtained. The initial treatment system effluent would be treated further by reverse osmosis; the permeate (clean) stream will be reused onsite. Initially the concentrated waste stream from the RO unit will be discharged into existing onsite evaporation ponds. Other options such as infiltration galleries also will be pursued, as discussed in Section 3.3.

Additional design elements will be prepared and submitted to DTSC as soon as possible after data becomes available. To the extent possible, PG&E will use elements from the design of the pilot system in designing the IM system, making modifications based on site specific water quality and pilot system operating experience.

Major components of the IM treatment system include:

- Influent tank.
- Chromium reduction reactors and chemical feed systems.
- Iron oxidation reactors and blower.
- Microfiltration unit and feed tank.
- Backwash storage tank.
- Clarifier.
- Reverse osmosis unit and concentrate storage tanks.
- Infiltration basin and feed tank.
- Control system.
- Electrical power supply.

PG&E anticipates that electric service to the treatment system will be supplied from power lines which cross MWD property as shown on Figure 9-2. The facility will be built on a reinforced concrete foundation with secondary containment. A pre-fabricated operation building or trailer will be placed on site for process monitoring, data evaluation, and storage of equipment and supplies. The facility will be secured with chain link fencing and a locking gate. Additional security features may be provided depending on permit requirements.

Facilities will be constructed using a design-build approach, thereby shortening the design period and the overall implementation period. The facilities will be built using a 30 percent design package with the following components

- Site Plan
- Process and Instrumentation Diagrams
- Civil Site Plan and Details
- Infiltration Pond Plan and Sections
- Structural Plan and Standard Details
- Mechanical Layout and Standard Details
- Electrical One-line Diagram

A design basis memorandum including process description, mass balance calculations, and process control philosophy will accompany the design package. Construction specifications will follow standard industry practice and important elements will be described in notes. PG&E may add additional specifications and drawings at their discretion. Equipment specifications will be prepared as necessary for procurement.

# 10.0 Waste Management Practices

Waste will be generated during project activities. For the purpose of this section, waste will be defined as treatment process residuals and investigation-derived waste (IDW).

## 10.1 Treatment Process Residuals

Treatment process residuals include:

- RO concentrate stream
- Ferric hydroxide sludge (containing chromium)

RO concentrate will be stored in tanks and pumped or trucked to a storage tank at the Station, from where it will be pumped to the evaporation ponds. All water pumped to the ponds is monitored for compliance with the Station's waste discharge requirements. The RO concentrate stream is expected to range from 25 to 50 percent of the treatment system influent stream, depending upon influent salt concentrations and requirements for permeate stream quality.

The microfiltration units will be backwashed periodically to remove accumulated ferric hydroxide solids. Filter backwash will be collected in a clarifier where solids are settled, and clear liquid will be decanted for recycling in the process. Residual solids will be dewatered on- or off-site and will be disposed of according to federal and state regulations.

## 10.2 Investigation-derived Wastes

Each type of IDW will be stored in its own container. IDW to be generated during the field activities and their respective containers are as follows:

| IDW Type | Typical Container Description |
|---|---|
| Soil cuttings | 20 cubic yard steel containers |
| Drilling mud | 9,240 gallon steel tank |
| Development and decontamination water | 21,000 gallon steel tank |

The drilling mud container will be placed on a liner and the liquid containers will be secondarily contained with a liner and temporary berm. Soil cuttings typically are spread on PG&E property and drilling mud and development and decontamination water are disposed of off site. Sampling and analytical suites follow this expected management approach. The table below lists IDW streams, the number of samples and analytical methods.

| IDW Stream | Number of samples per container | Analytes |
|---|---|---|
| Soil cuttings | 3 point composite | Title 22 metals by SW Methods 6010/7000 and Cr(VI)by SW Method 7196 |
| Drilling mud | 3 point composite | Title 22 metals by SW Methods 6010/7000 and Cr(VI)by SW Method 7196 |
| Development and decontamination water | 1 bailer sample per tank | Chromium, copper, nickel, zinc by SW Methods 6010/7000, Cr(VI) by SW Method 7196, pH and electrical conductivity |

CH2M HILL will submit all samples to Truesdail Laboratories, Inc. in Tustin, California for analysis. Analytical results will be turned around on a standard basis, unless circumstances require a rush analysis. Analytical results will be transmitted to PG&E for disposition of the IDW.

### Waste Management

Analytical results, bin/tank numbers, and approximate volumes will be provided to the PG&E to facilitate disposal of the IDW. PG&E maintains contracts with several disposal facilities and will arrange for disposal.

## 10.3 Other Wastes

Personal protective equipment and disposable sampling equipment, it will be double-bagged and disposed of in dumpsters at the station. Soil excavated during construction (*e.g.*, trenching, grading) will be placed in temporary stockpiles nearby and used as backfill. If soil is excavated from areas known or suspected to contain Cr(VI), then soil will be sampled and analyzed for Cr(VI) and will be disposed of according to the results of that analysis.

# 11.0 Required Permits

The primary required permits and the nature of the permit are listed in the table below.

| Permits | Agency/Permit Type | Administrative | Discretionary |
|---|---|---|---|
| CEQA/NEPA | DTSC and Bureau of Land Management | | ♦ |
| Right of way grant | Bureau of Land Management | | ♦ |
| Property access | Metropolitan Water District of Southern California | | ♦ |
| Building permit | San Bernardino County Building Department | ♦ | |
| Conditional land use permit | San Bernardino County Planning Department | | ♦ |
| Grading/excavation permit | San Bernardino County Building Department | ♦ | |
| Hazardous materials use permit (conditional authorization) | San Bernardino County Fire Department | ♦ | |
| Waste discharge requirements | Colorado River Regional Water Quality Control District | | ♦ |
| Well permit | San Bernardino County Public Health Department | ♦ | |

# 12.0 Sampling and Monitoring

Additional sampling and monitoring to be conducted as part of IM or concurrent with implementation of IM includes:

- Low-flow/well-volume purging comparison testing.
- Characterization and isotopic analysis of transpirate on floodplain.
- Analysis of TW-2 cores (*e.g.*, grain size analyses, isotopic analyses).
- Sampling of TW-2.
- Additional groundwater level and field parameter monitoring in floodplain wells.
- Hourly sampling for chromium and Cr(VI)in MW-34 wells.

Each of these sampling and monitoring activities have each been described in Section 5 and will be further detailed in the revised IMWP or separate work plans to be submitted to DTSC.

# 13.0 References


American Society of Testing and Materials, 2002. *Standard Practice for Low-Flow Purging and Sampling for Wells and Devices Used for Ground-Water Quality Investigations*, D 6771-02.

CH2M HILL, 2003. *Draft Technical Memorandum, Groundwater Pilot Study, Topock Compressor Site, Needles, California.* September.

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Department of Toxic Substances Control, 1994. Correction Action Orientation Manual, Cal-EPA – DTSC Draft Working Copy, June 1994.

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Ecology and Environment Inc. (E&E) ,2000. *Draft RCRA Facility Investigation (RFI) Report: Bat Cave Wash Area, PG&E Company's Topock Compressor Station*. April 17.

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Puls, R. and M. Barcelona, 1996. *Ground Water Issue, Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures*. U.S. EPA/540/S-95/504, April 1996.

Yeskis, D. and B. Zavala, 2002. *Ground-Water Sampling Guidelines for Superfund and RCRA Project Managers*. U.S. EPA/542-S-02-001, TSP Ground Water Forum Issue Paper, May 2002.

Tables

Table 3-1

Screening of Treated Water Reuse/Disposal Technologies and Process Options

Topock Compressor Station, Topock, CA

| Reuse Option | Description | Effectiveness | Implementability | Cost | Schedule | Screening Comments |
|---|---|---|---|---|---|---|
| Expanded or New Evaporation Ponds | • Evaporation ponds with sufficient area are used to manage treated water disposal via evaporation. | • Very effective providing that area and terrain are suitable for ponds. | • Relatively easy to implement depending on extraction location and if the conveyance pipeline does not take long to permit. | • Moderate depending on area requirements/pipeline needs. | • 4 to 6 months to construct and 6 or more months to permit. | **Preferred option for extraction at TW-1** |
| Infiltration Basins | • Surface infiltration basins allow water to percolate to groundwater. | • Potentially very effective reuse option provided water quality meets basin recharge objectives. Replaces much of the water extracted limiting water removal from the basin. | • Relatively easy to implement depending on extraction location and if the conveyance pipeline does not take long to permit. Must be sited away from extraction wells. | • Low to Moderate due to size or infiltration basins. Requires periodic maintenance to ensure infiltration rates meet design rates increases overall costs. | • 4 to 6 months to construct and 6 or more months to permit | **Preferred option for extraction at TW-2** |
| Reuse at Compressor Station | • Treated water is reused at the plant as cooling water. | • Effective provided compressor station can use all water and water quality is suitable for plant use. | • Not difficult to implement but does require permitting and approval for railway and roadway crossings depending where implemented. | • Moderate to high due to additional treatment needs to meet compressor station water quality and pipeline length. | • 3 to 4 months to implement and 6 to 12 months to permit | **Viable option only if water is extracted at TW-1 and water quality is suitable.** |
| Reinjection | • Injection of treated water into groundwater using wells. | • Could be very effective provided subsurface aquifer can effectively accommodate water quantities and water quality meets basin requirements. | • Implementation is dependent on suitable aquifer properties. | • Moderate to high depending on the number and depth of injection wells and piping needs. | • 2 to 4 months to construct and 6 or more months to permit | **Considered the most challenging reuse/disposal option.** |
| Phytoirrigation | • Treated water is conveyed to an phytoirrigation area planted with salt tolerant vegetation. May reduce or eliminate the need for secondary treatment of salts/total dissolved solids. | • Very effective means of transpiring water. | • Not difficult to implement provided suitable land is available and does not require lengthy approval time. | • Moderate depending on area required, location and pipeline needs | • 4 to 6 months to construct and 6 or more months to permit | **Considered a viable options if area is too large or if surface sealing is an issue for infiltration basin alone.** |

Figures

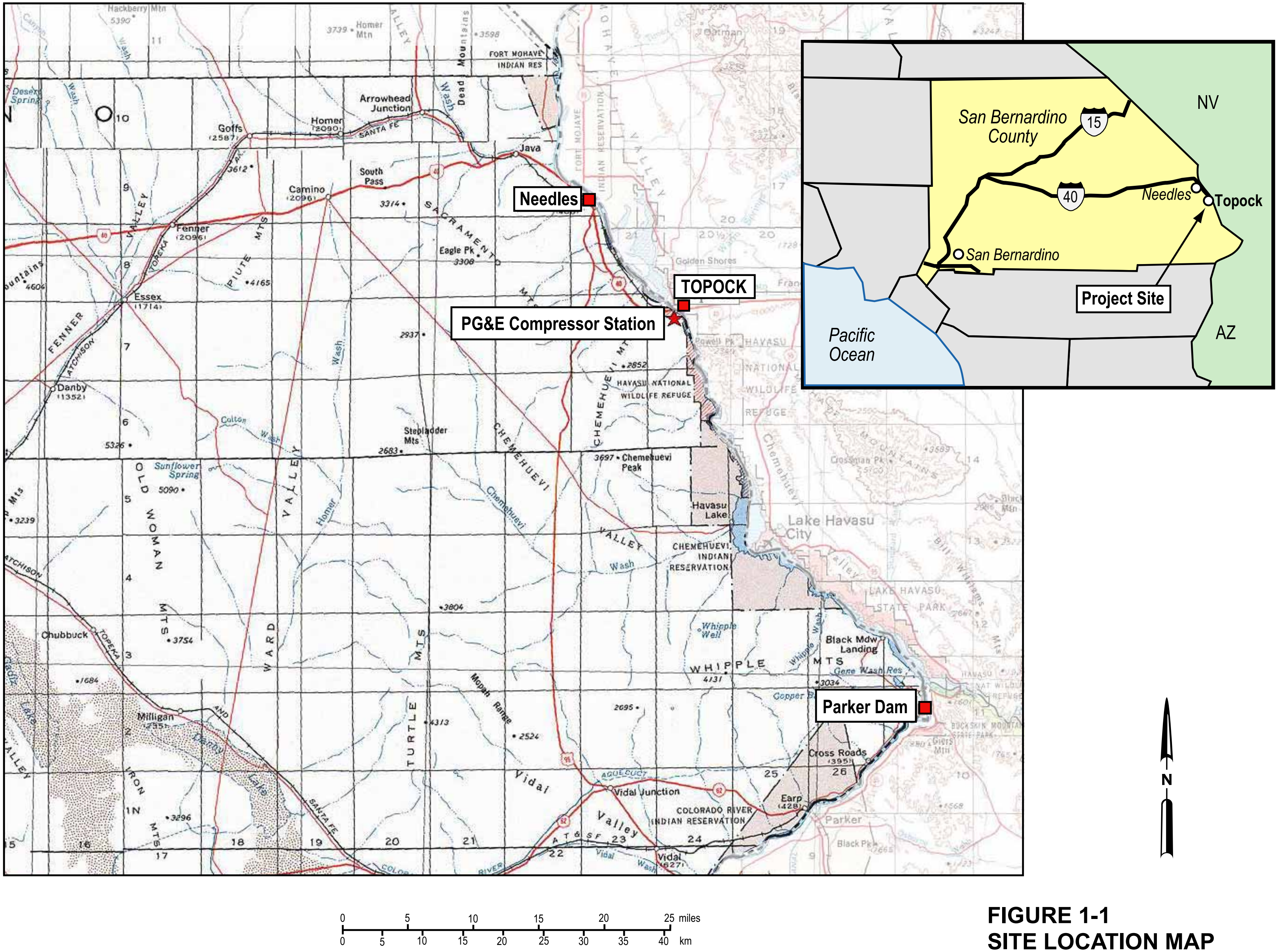


**FIGURE 1-1**
**SITE LOCATION MAP**
INTERIM MEASURES WORK PLAN
PG&E TOPOCK COMPRESSOR STATION

CH2MHILL

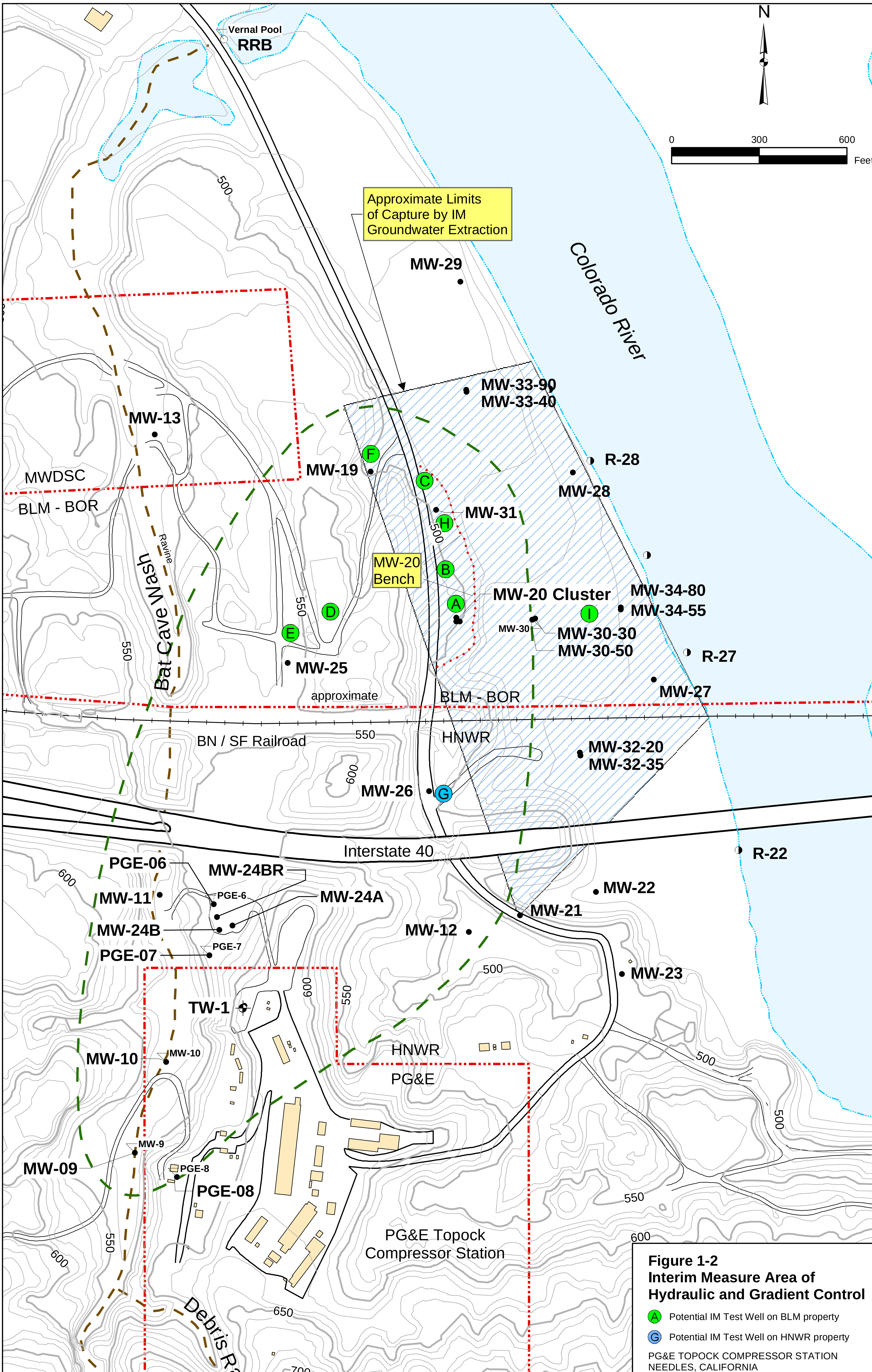


**Figure 1-2**
**Interim Measure Area of Hydraulic and Gradient Control**

PG&E TOPOCK COMPRESSOR STATION
NEEDLES, CALIFORNIA

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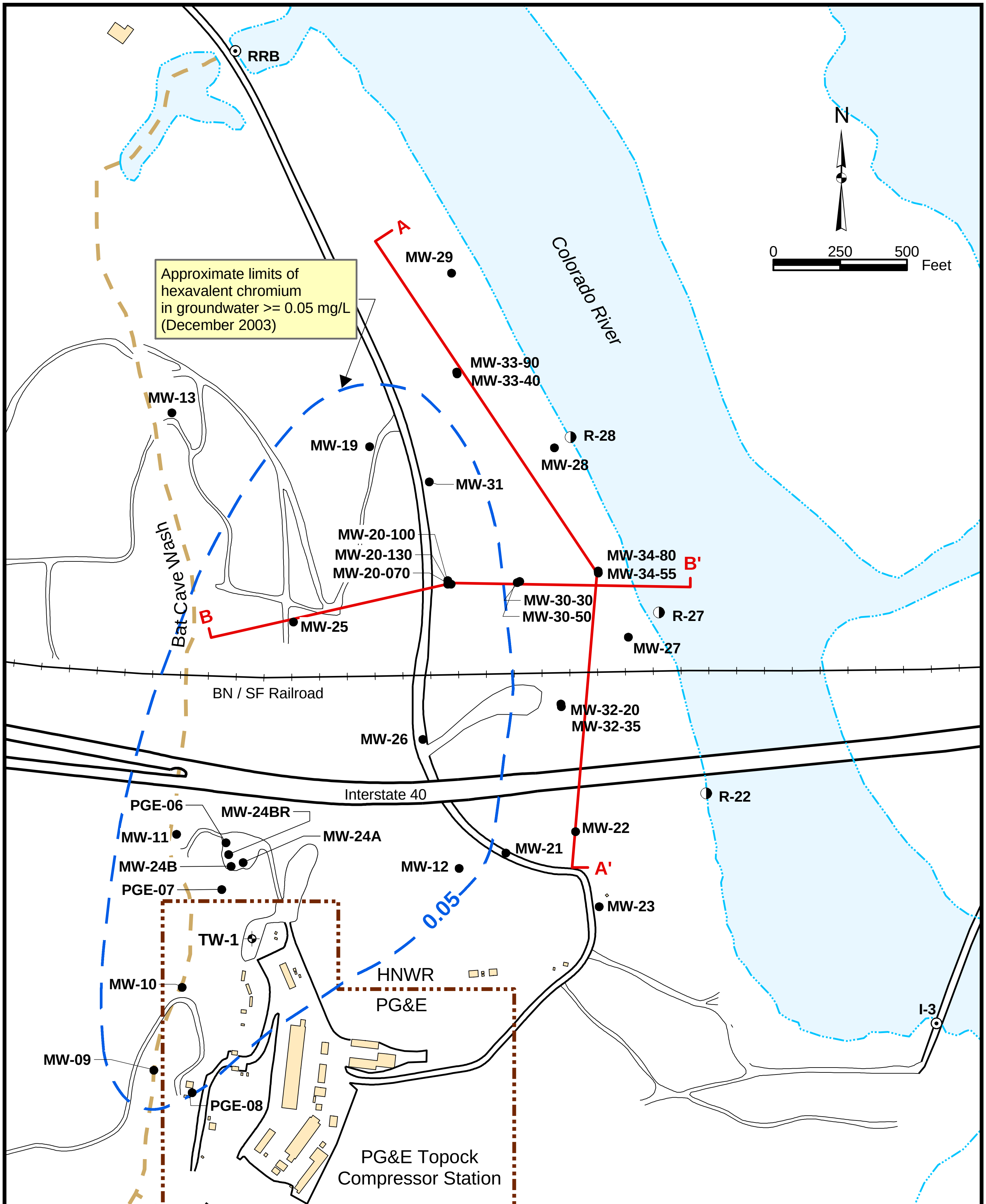


**FIGURE 2-1**
**LOCATION OF HYDROGEOLOGIC SECTIONS**

PG&E TOPOCK COMPRESSOR STATION
NEEDLES, CALIFORNIA

**CH2MHILL**

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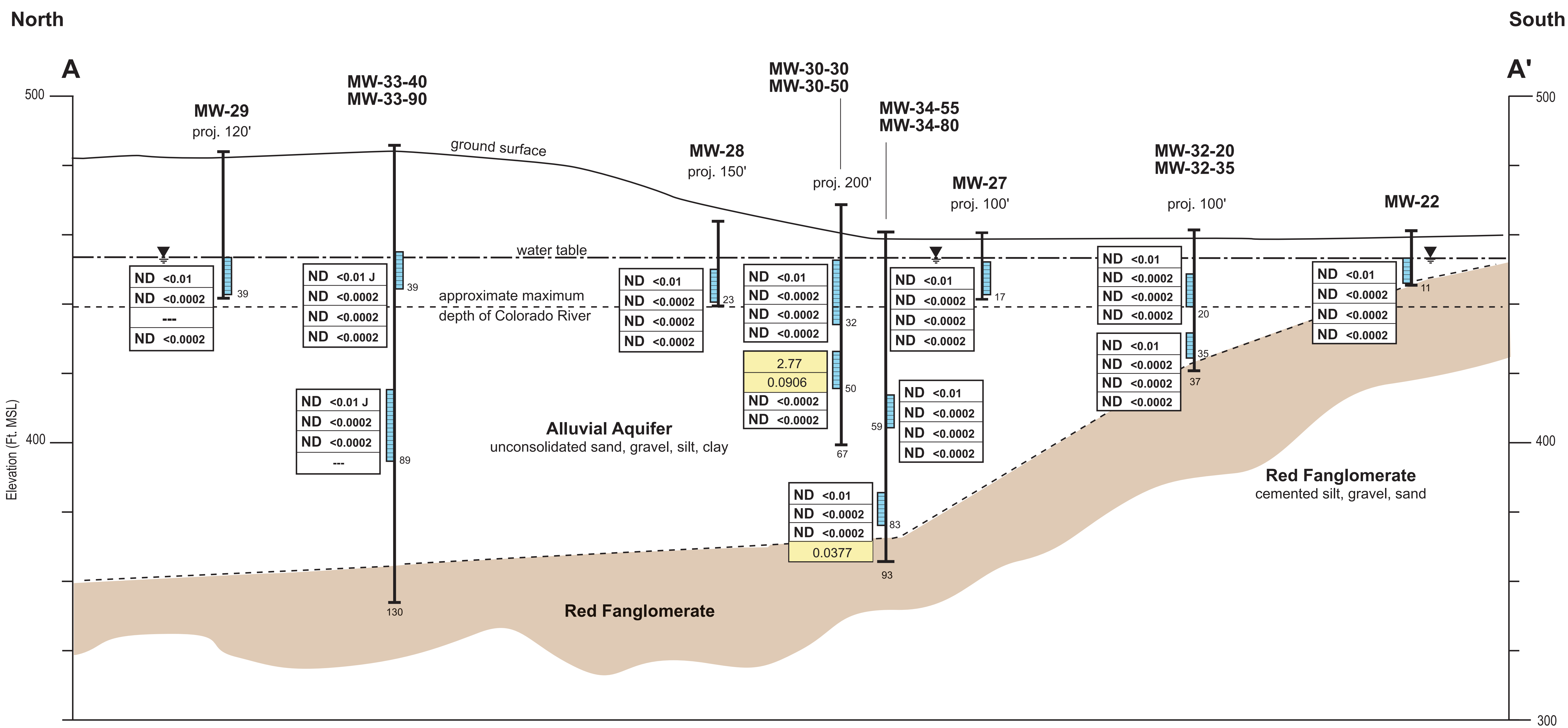


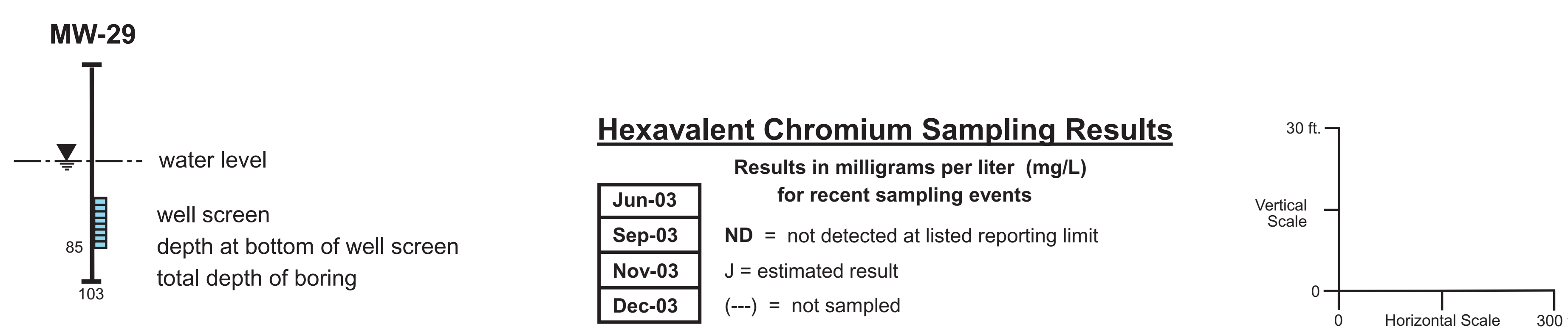


**FIGURE 2-2**
**HYDROGEOLOGIC SECTION A - A'**
**GROUNDWATER SAMPLING RESULTS**
**JUNE - DECEMBER 2003**
INTERIM MEASURES WORK PLAN
PG&E TOPOCK COMPRESSOR STATION

CH2MHILL

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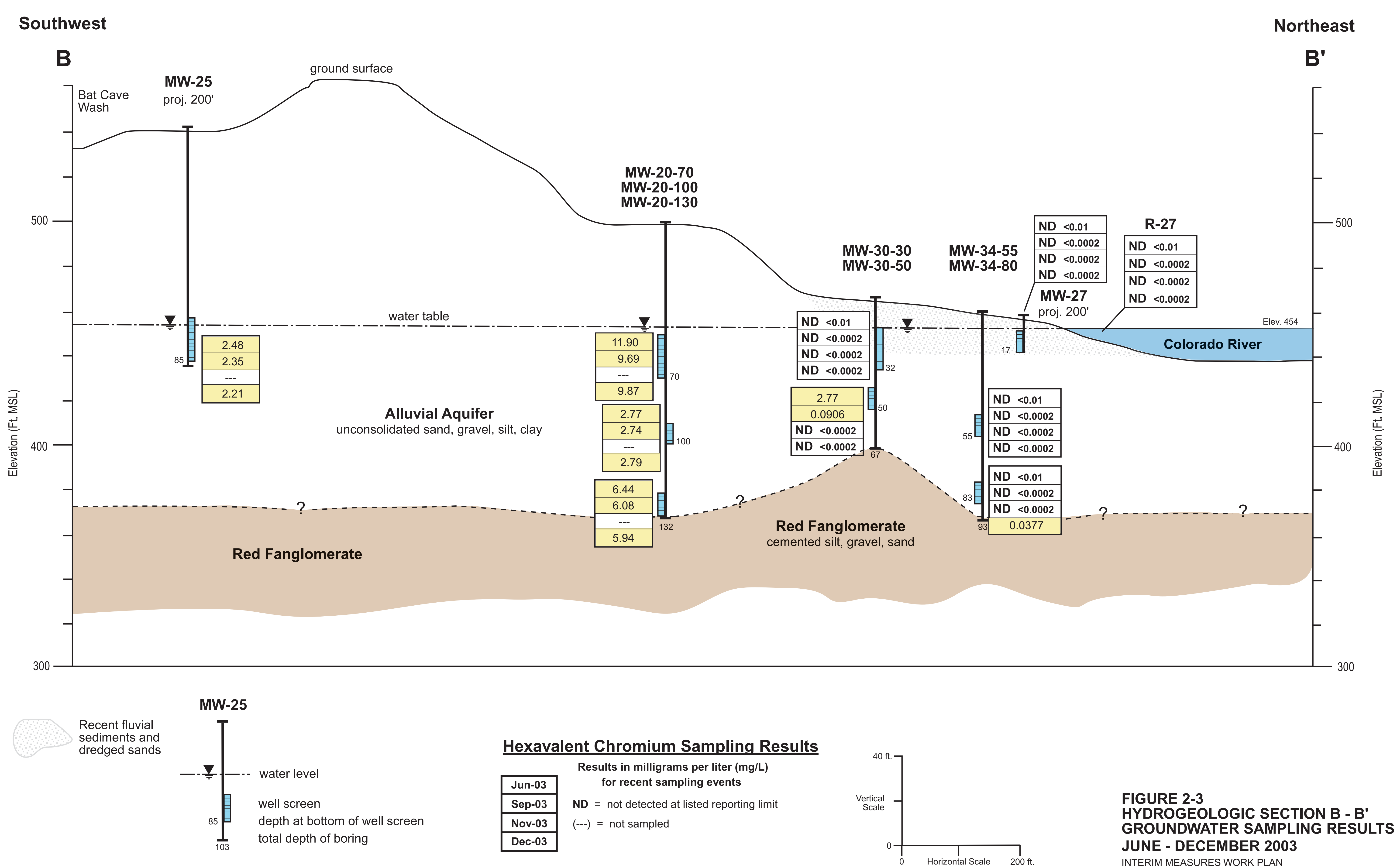


**FIGURE 2-3**
**HYDROGEOLOGIC SECTION B - B'**
**GROUNDWATER SAMPLING RESULTS**
**JUNE - DECEMBER 2003**
INTERIM MEASURES WORK PLAN
PG&E TOPOCK COMPRESSOR STATION

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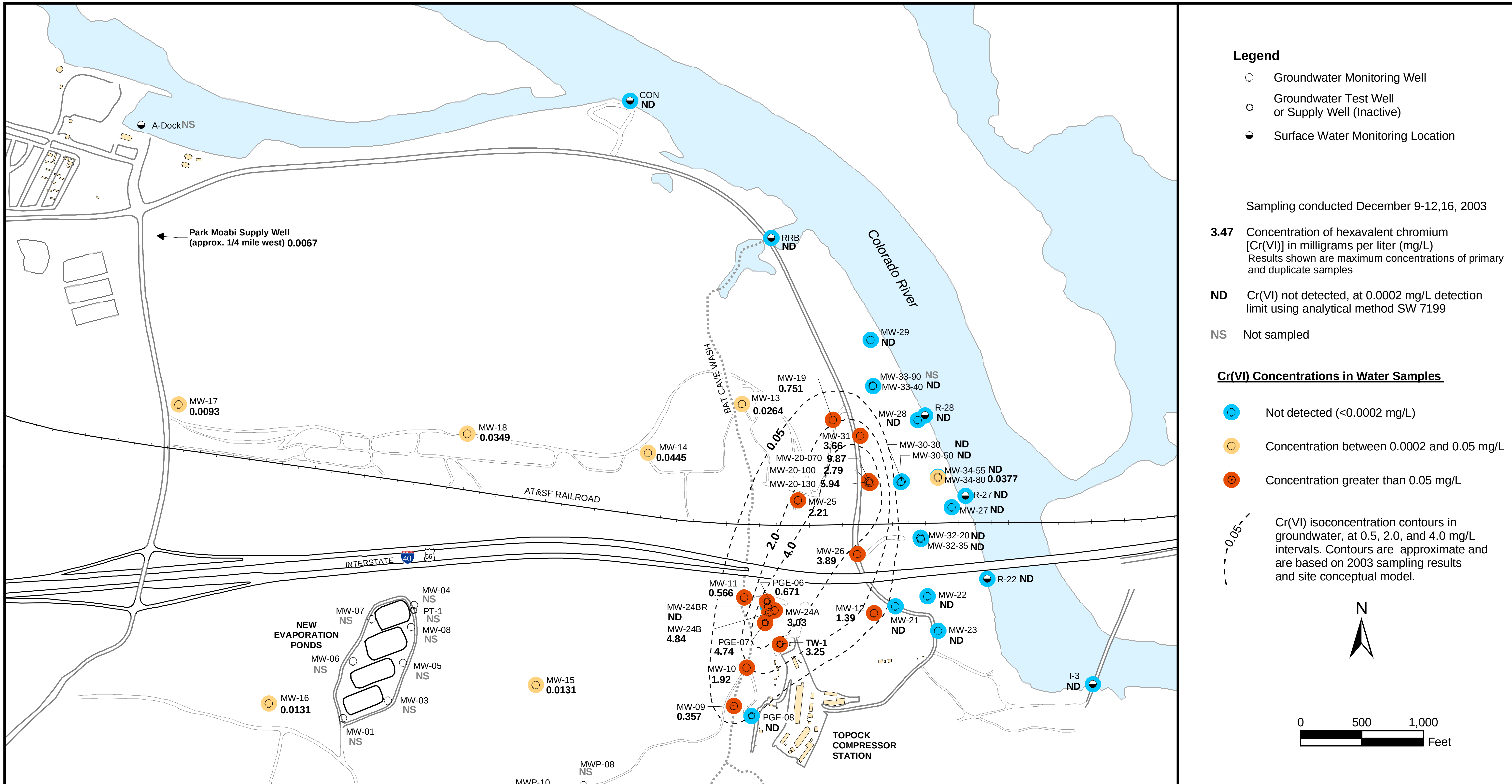


**Figure 2-4**
**Hexavalent Chromium Sampling Results**
**December 2003**
**Groundwater and Surface Water Monitoring**

INTERIM MEASURES WORK PLAN
PG&E TOPOCK COMPRESSOR STATION
NEEDLES, CALIFORNIA

CH2MHILL

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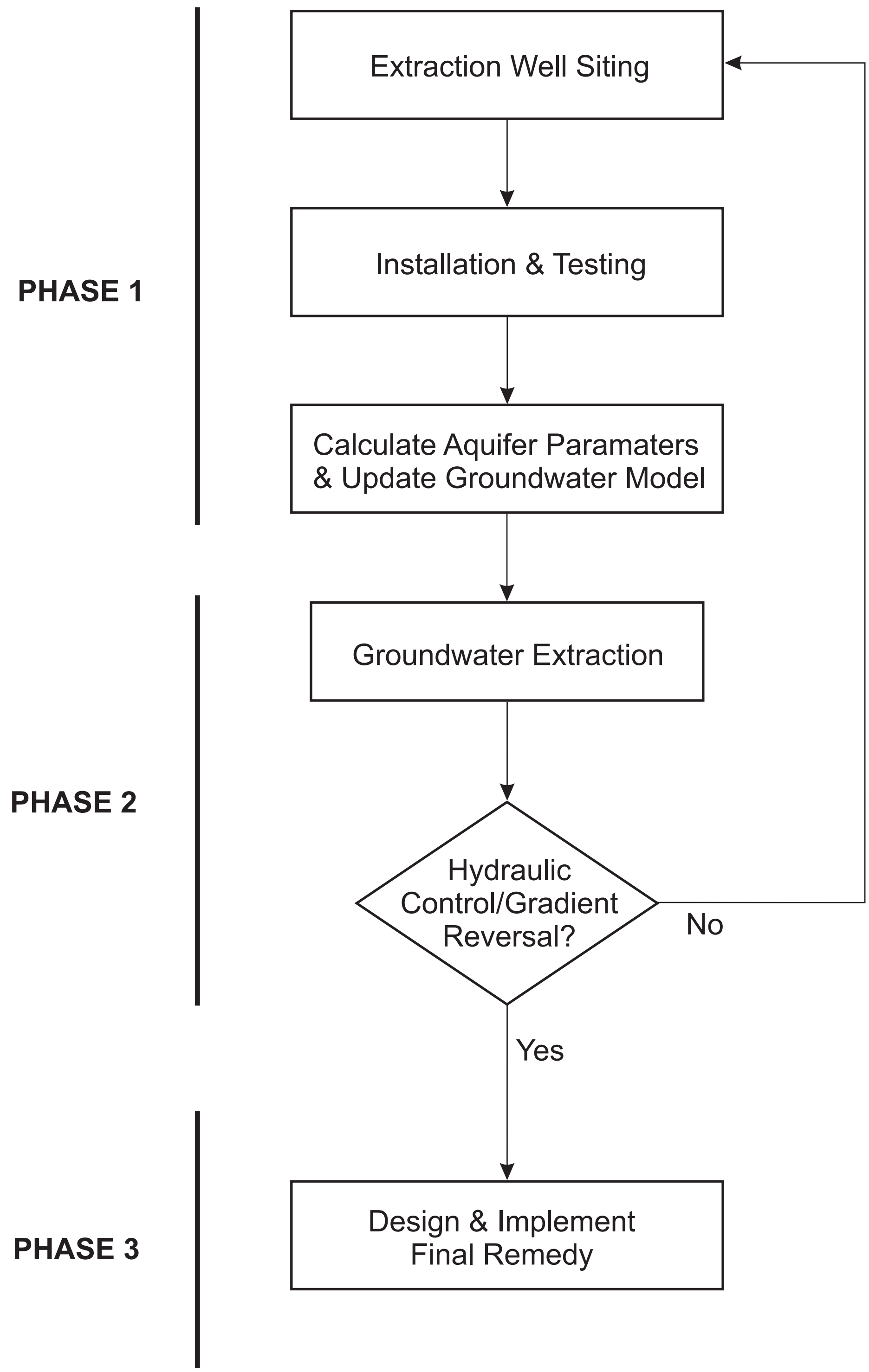


**FIGURE 3-1**

**PROCESS FLOW OF THE INTERIM MEASURES**

INTERIM MEASURES WORKPLAN
PG&E TOPOCK COMPRESSOR STATION

CH2MHILL

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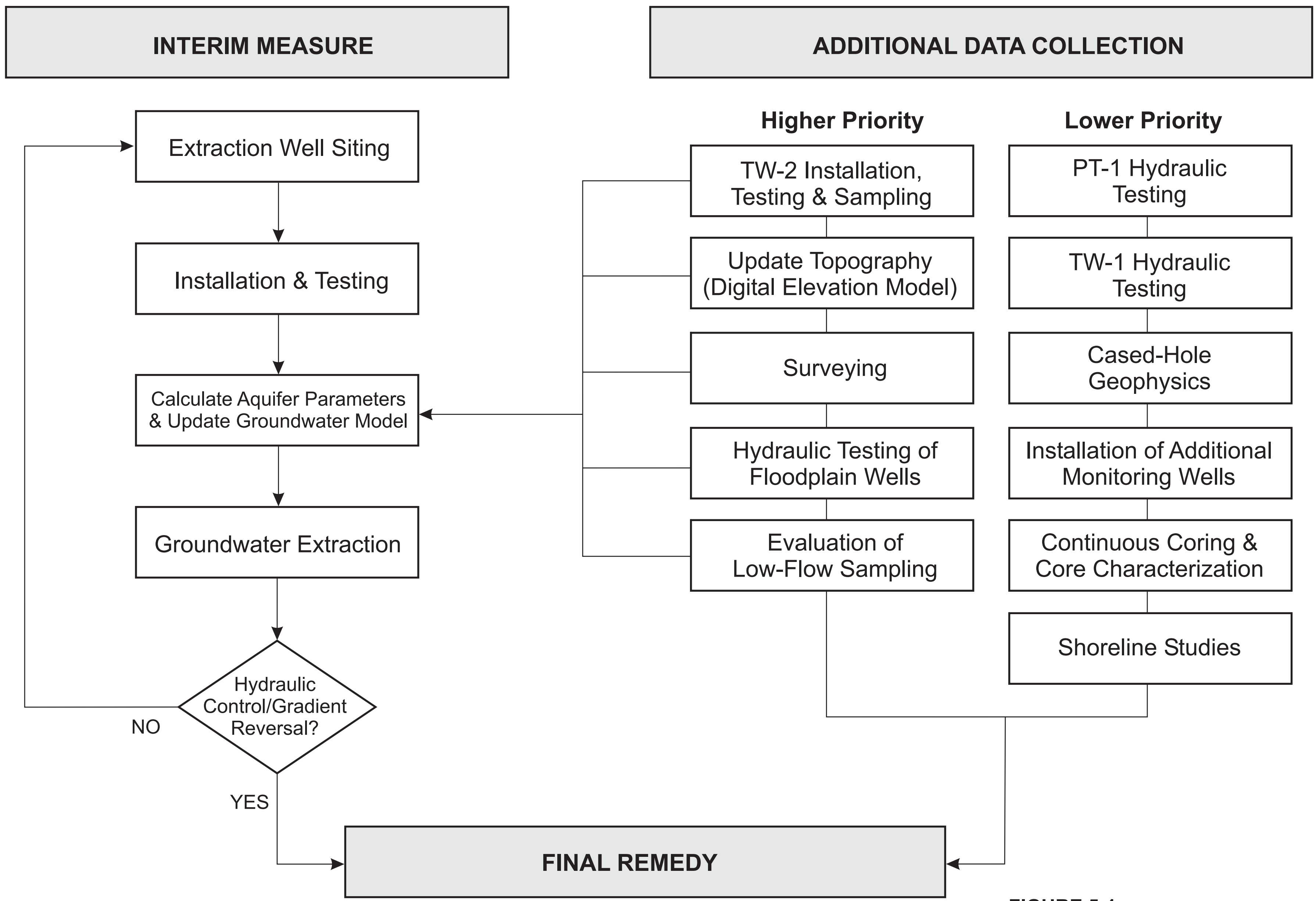
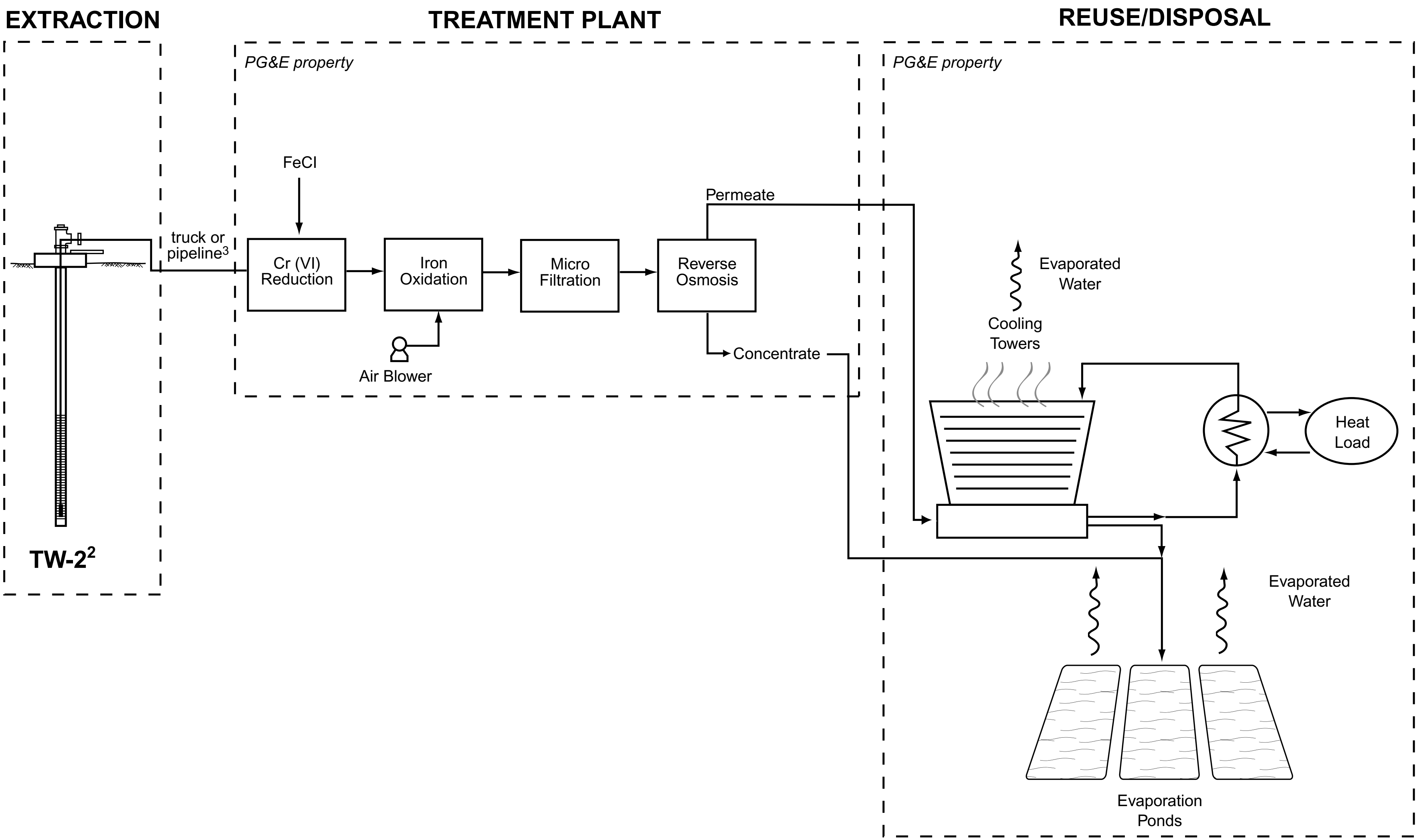



**FIGURE 5-1**
**INTERIM MEASURES PROCESS AND ADDITIONAL DATA COLLECTION**

INTERIM MEASURES WORKPLAN
PG&E TOPOCK COMPRESSOR STATION

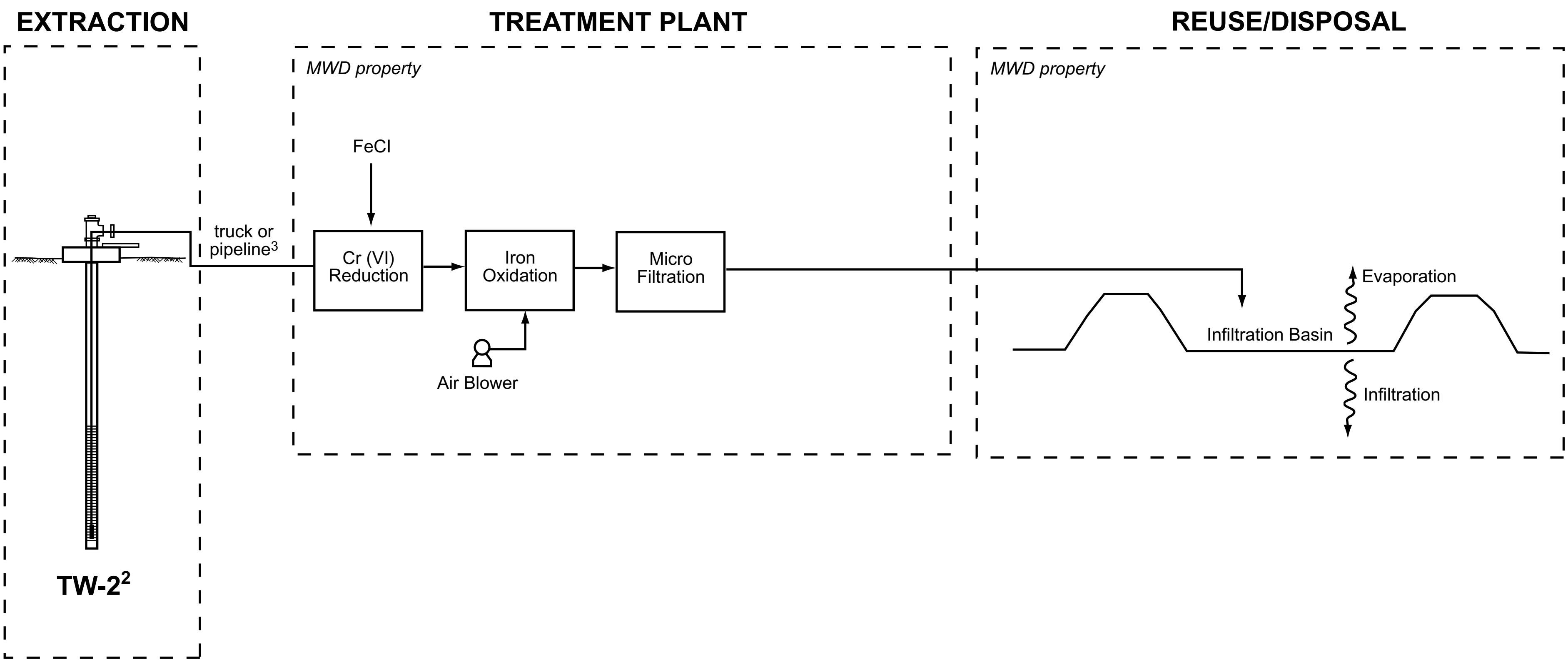



Notes:
1. Assumes Pilot Study treatment system at compressor station operates at 5 to 20 gallons per minute starting mid-summer 2004.
2. Other wells may be installed as described in Section 3.
3. To be conveyed by truck or pipeline.

**FIGURE 9-1a**
**TEMPORARY INTERIM MEASURE CONCEPTUAL SCHEMATIC DIAGRAM**
PG&E TOPOCK COMPRESSOR STATION
NEEDLES, CALIFORNIA

CH2MHILL

184004.PS.06_E092003003SFO_Temp Interim Meas Diagram_2/6/04_ccc




Notes:
1. Assumes Pilot Study treatment system at compressor station operates at 5 to 20 gallons per minute starting mid-summer 2004.
2. Other wells may be installed as described in Section 3.
3. To be conveyed by truck or pipeline.

**FIGURE 9-1b**
**COMPLETED INTERIM MEASURE CONCEPTUAL SCHEMATIC DIAGRAM**
PG&E TOPOCK COMPRESSOR STATION
NEEDLES, CALIFORNIA

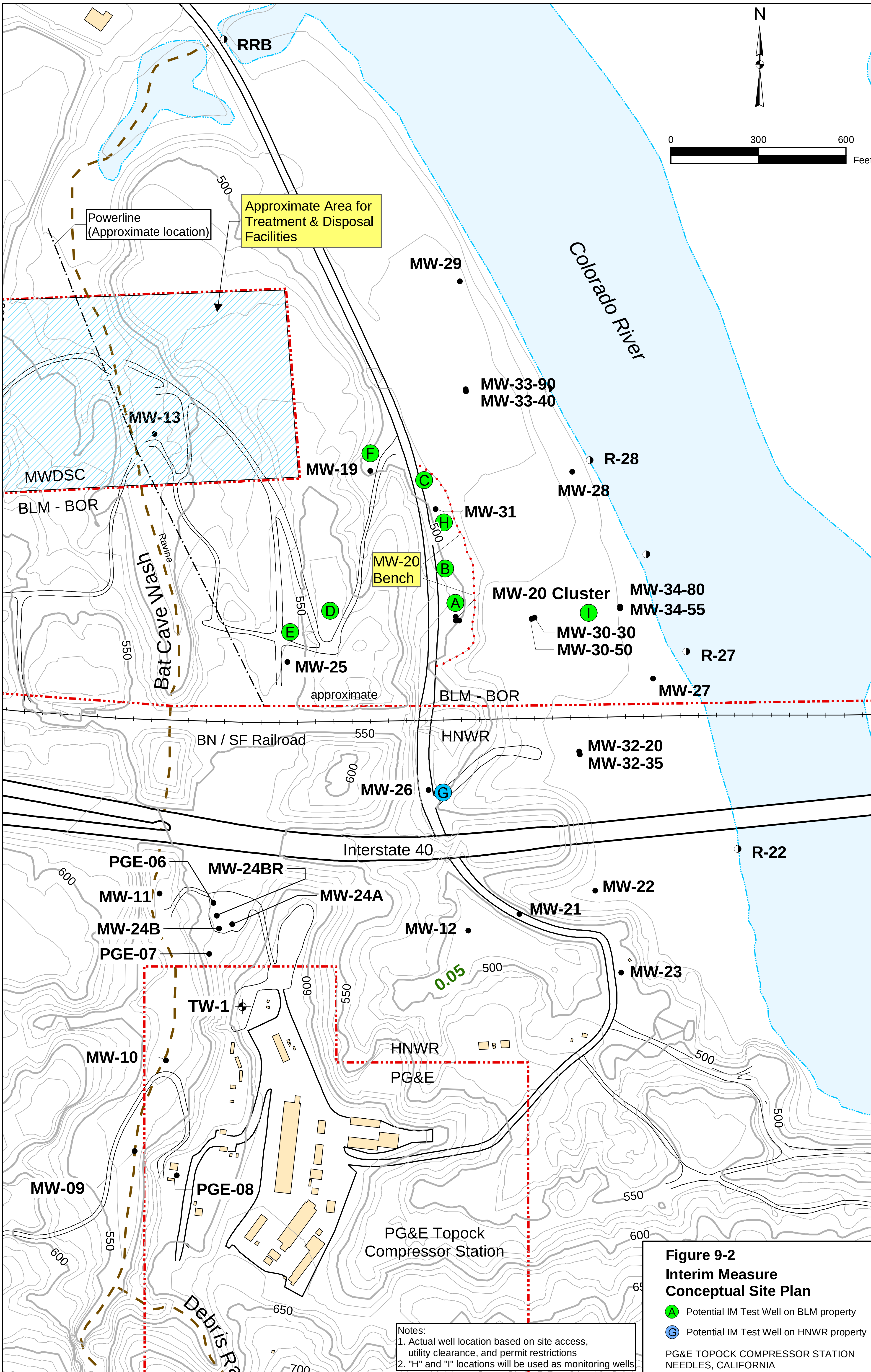



**Figure 9-2**
**Interim Measure Conceptual Site Plan**

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# Appendix A
# Calculations

Table A1
Water Balance for Treatment Plant Evaporation Ponds
Topock Compressor Station, Topock, CA

| | Month | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | June 30 | July 31 | August 31 | September 30 | October 31 | November 31 | December 31 | January 31 | February 28 | March 31 | April 30 | May 31 |
| Pond Area (acre) | 3.6 | | | | | | | | | | | |
| Pond Area ($ft^2$) | 157,500 | | | | | | | | | | | |
| Treatment Plant Monthly Discharge ($ft^3$) | 115,508 | 119,358 | 119,358 | 115,508 | 119,358 | 119,358 | 119,358 | 119,358 | 107,807 | 119,358 | 115,508 | 119,358 |
| Rain (in): | 0.02 | 0.02 | 0.04 | 0.15 | 0.26 | 0.73 | 0.8 | 1.41 | 1.34 | 0.88 | 0.7 | 0.27 |
| Rain ($ft^3$) | 263 | 263 | 525 | 1969 | 3413 | 9581 | 10500 | 18506 | 17588 | 11550 | 9188 | 3544 |
| Total Inputs ($ft^3$) | 115,771 | 119,621 | 119,883 | 117,477 | 122,771 | 128,940 | 129,858 | 137,865 | 125,395 | 130,908 | 124,696 | 122,902 |
| Evaporation (in): | 16.44 | 17.59 | 14.81 | 12.56 | 8.75 | 5.55 | 4 | 3.71 | 4.92 | 7.3 | 9.36 | 13.9 |
| Evaporation ($ft^3$): | 215,775 | 230,869 | 194,381 | 164,850 | 114,844 | 72,844 | 52,500 | 48,694 | 64,575 | 95,813 | 122,850 | 182,438 |
| Volume End-of-month ($ft^3$) | -100,004 | -111,248 | -74,498 | -47,373 | 7,927 | 56,096 | 77,358 | 89,171 | 60,820 | 35,096 | 1,846 | -59,535 |
| Beginning-of-month Depth (in) | 1 | -6.6 | -15.1 | -20.8 | -24.4 | -23.8 | -19.5 | -13.6 | -6.8 | -2.2 | 0.5 | 0.6 |
| End-of-month Depth (in) | -6.6 | -15.1 | -20.8 | -24.4 | -23.8 | -19.5 | -13.6 | -6.8 | -2.2 | 0.5 | 0.6 | -3.9 |

*Notes:*
Treated water reuse/disposal flow rate assumed to be 20 gallon per minute (gpm_
Pan Evaporation is multiplied by 0.7 to account for observations that pan evaporation exceeds actual land evaporation.
Multiple Ponds will be used to account for differences in season evaporation
calculations assume no loss due to infiltration

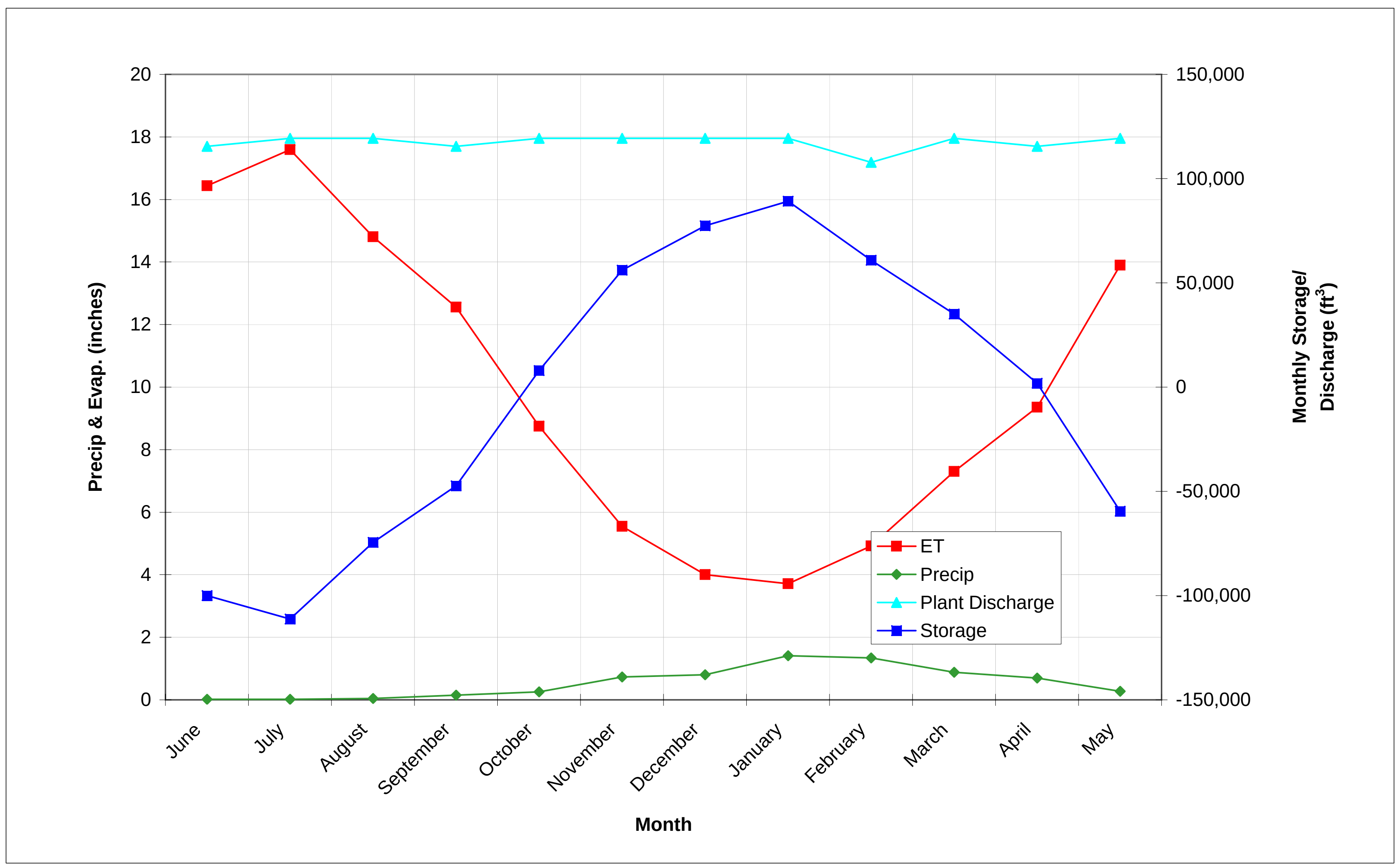

Table A2
Water Balance for Treatment Plant Evaporation Ponds/Infiltration Basins
Topock Compressor Station, Topock, CA

| | Month | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | June 30 | July 31 | August 31 | September 30 | October 31 | November 31 | December 31 | January 31 | February 28 | March 31 | April 30 | May 31 | |
| Pond Area (acre) | 0.53 | | | | | | | | | | | | |
| Pond Area (ft$^2$) | 23,250 | | | | | | | | | | | | |
| Treatment Plant Monthly Discharge (ft$^3$) | 115,508 | 119,358 | 119,358 | 115,508 | 119,358 | 119,358 | 119,358 | 119,358 | 107,807 | 119,358 | 115,508 | 119,358 | |
| Rain (in): | 0.02 | 0.02 | 0.04 | 0.15 | 0.26 | 0.73 | 0.8 | 1.41 | 1.34 | 0.88 | 0.7 | 0.27 | |
| Rain (ft$^3$) | 39 | 39 | 78 | 291 | 504 | 1414 | 1550 | 2732 | 2596 | 1705 | 1356 | 523 | |
| Total Inputs (ft$^3$) | 115,547 | 119,397 | 119,436 | 115,799 | 119,862 | 120,773 | 120,908 | 122,090 | 110,404 | 121,063 | 116,864 | 119,881 | |
| Evaporation (in): | 16.4 | 17.6 | 14.8 | 12.6 | 8.8 | 5.6 | 4.0 | 3.7 | 4.9 | 7.3 | 9.4 | 13.9 | |
| Evaporation (ft$^3$): | 31,853 | 34,081 | 28,694 | 24,335 | 16,953 | 10,753 | 7,750 | 7,188 | 9,533 | 14,144 | 18,135 | 26,931 | |
| Infiltration (ft) | 4.3 | 4.4 | 4.4 | 4.3 | 4.4 | 4.4 | 4.4 | 4.4 | 4.0 | 4.4 | 4.3 | 4.4 | |
| Infiltration (ft$^3$): | 98,858 | 102,154 | 102,154 | 98,858 | 102,154 | 102,154 | 102,154 | 102,154 | 92,268 | 102,154 | 98,858 | 102,154 | |
| Volume End-of-month (ft$^3$) | -15,164 | -16,837 | -11,412 | -7,395 | 755 | 7,866 | 11,005 | 12,748 | 8,604 | 4,766 | -129 | -9,203 | |
| Beginning-of-month Depth (in) | 1 | -6.8 | -15.5 | -21.4 | -25.2 | -24.8 | -20.8 | -15.1 | -8.5 | -4.1 | -1.6 | -1.7 | |
| End-of-month Depth (in) | -6.8 | -15.5 | -21.4 | -25.2 | -24.8 | -20.8 | -15.1 | -8.5 | -4.1 | -1.6 | -1.7 | -6.4 | -152.0 |

*Notes:*
Treated water reuse/disposal flow rate assumed to be 20 gallon per minute (gpm_
Pan Evaporation is multiplied by 0.7 to account for observations that pan evaporation exceeds actual land evaporation.
Multiple Ponds will be used to account for differences in season evaporation
infiltration rate was assumed to be 5 x 10$^{-5}$ cm/s (0.14 ft/d)

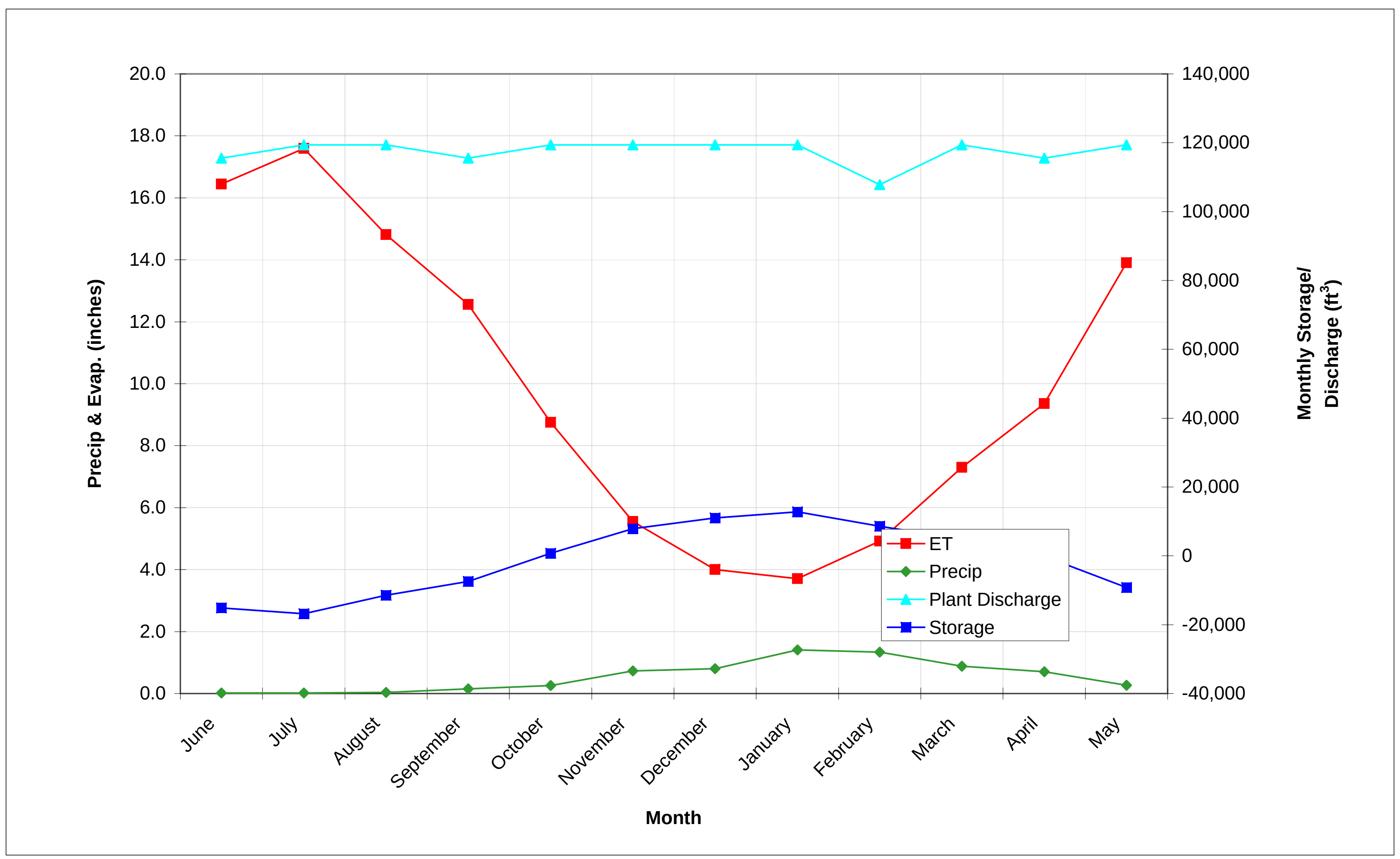

Table A3
Number of Trucks Required to Haul Water to Treatment Plant
Topock Compressor Station, Topock, CA

| Truck Capacity (Gallons) | Reuse/Disposal Flow Rate 20 gpm | 50 gpm |
| --- | --- | --- |
| | Number of Trucks (per day) | |
| 10,000 | 3 | 7 |
| 5,000 | 6 | 14 |
| 3,000 | 10 | 24 |

*Notes:*
gpm - gallons per minute

Table A4
Water Balance for Treatment Plant Phytoirrigation/Infiltration Basins
Topock Compressor Station, Topock, CA

| | Month | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | June | July | August | September | October | November | December | January | February | March | April | May |
| | 30 | 31 | 31 | 30 | 31 | 31 | 31 | 31 | 28 | 31 | 30 | 31 |
| Pond Area (acre) | 0.28 | | | | | | | | | | | |
| Pond Area ($ft^2$) | 12,100 | | | | | | | | | | | |
| Treatment Plant Monthly Discharge ($ft^3$) | 115,508 | 119,358 | 119,358 | 115,508 | 119,358 | 119,358 | 119,358 | 119,358 | 107,807 | 119,358 | 115,508 | 119,358 |
| Rain (in): | 0.02 | 0.02 | 0.04 | 0.15 | 0.26 | 0.73 | 0.8 | 1.41 | 1.34 | 0.88 | 0.7 | 0.27 |
| Rain ($ft^3$) | 20 | 20 | 40 | 151 | 262 | 736 | 807 | 1422 | 1351 | 887 | 706 | 272 |
| Total Inputs ($ft^3$) | 115,528 | 119,378 | 119,399 | 115,659 | 119,620 | 120,094 | 120,165 | 120,780 | 109,159 | 120,246 | 116,214 | 119,631 |
| Evapotranspiration (in): | 5.0 | 5.5 | 5.5 | 4.0 | 2.5 | 1.0 | 0.4 | 0.3 | 0.4 | 1.0 | 2.5 | 4.0 |
| Evapotranspiration ($ft^3$): | 5,042 | 5,546 | 5,546 | 4,033 | 2,521 | 1,008 | 403 | 252 | 403 | 1,008 | 2,521 | 4,033 |
| Evaporation (in): | 16.4 | 17.6 | 14.8 | 12.6 | 8.8 | 5.6 | 4.0 | 3.7 | 4.9 | 7.3 | 9.4 | 13.9 |
| Evaporation ($ft^3$): | 16,577 | 17,737 | 14,933 | 12,665 | 8,823 | 5,596 | 4,033 | 3,741 | 4,961 | 7,361 | 9,438 | 14,016 |
| Infiltration (ft) | 8.5 | 8.8 | 8.8 | 8.5 | 8.8 | 8.8 | 8.8 | 8.8 | 7.9 | 8.8 | 8.5 | 8.8 |
| Infiltration ($ft^3$): | 102,898 | 106,328 | 106,328 | 102,898 | 106,328 | 106,328 | 106,328 | 106,328 | 96,038 | 106,328 | 102,898 | 106,328 |
| Volume End-of-month ($ft^3$) | -8,988 | -10,232 | -7,408 | -3,936 | 1,949 | 7,162 | 9,401 | 10,459 | 7,757 | 5,549 | 1,357 | -4,746 |
| Beginning-of-month Depth (in) | 1 | -7.9 | -18.1 | -25.4 | -29.3 | -27.4 | -20.3 | -11.0 | -0.6 | 7.1 | 12.6 | 14.0 |
| End-of-month Depth (in) | -7.9 | -18.1 | -25.4 | -29.3 | -27.4 | -20.3 | -11.0 | -0.6 | 7.1 | 12.6 | 14.0 | 9.3 |

*Notes:*
Treated water reuse/disposal flow rate assumed to be 20 gallon per minute (gpm_
Pan Evaporation is multiplied by 0.7 to account for observations that pan evaporation exceeds actual land evaporation.
Multiple Ponds will be used to account for differences in season evaporation
infiltration rate was assumed to be 1 x $10^{-4}$ cm/s (0.28 ft/d) as plant roots can increase infiltration rates