

**Sampling and Monitoring Plan  
Pre-Final (90%) Design Submittal for  
the Final Groundwater Remedy,  
PG&E Topock Compressor Station,  
Needles, California**

Prepared for  
**Pacific Gas and Electric Company**

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**CH2MHILL®**

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B PG&E Program Quality Assurance Project Plan and Addendum

# Acronyms and Abbreviations

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µg/L	micrograms per liter
ARAR	applicable or relevant and appropriate requirement
ADEQ	Arizona Department of Environmental Quality
AOC	Area of Concern
AutoDV	automated data validation
BOD	Basis of Design
CACA	Corrective Action Consent Agreement
CD	Consent Decree
CFR	Code of Federal Regulations
CoC	chain of custody
COC	chemical of concern
COPC	chemical of potential concern
Cr(III)	trivalent chromium
Cr(T)	total chromium
Cr(VI)	hexavalent chromium
CSM	conceptual site model
DO	dissolved oxygen
DOI	U.S. Department of the Interior
DQO	data quality objective
DTSC	California Department of Toxic Substances Control
EIR	Environmental Impact Report
ELAP	California Environmental Laboratory Accreditation Program
Fe(II)	ferrous iron
Fe(III)	ferric iron
gpm	gallons per minute
HI	hazard index
HNWR	Havasu National Wildlife Refuge
IRL	Inner Recirculation Loop
IRZ	In-situ Reactive Zone
LCS	laboratory control sample
mg/L	milligrams per liter
Mn	manganese
MS	matrix spike

MSD	matrix spike duplicate
MWD	Metropolitan Water District
NELAP	National Environmental Laboratory Accreditation Program
NTH	National Trails Highway
O&M	operation and maintenance
OPS	Operating Properly and Successfully
ORP	oxidation reduction potential
P&ID	piping and instrumentation diagram
PAP	Perimeter Assessment Plan
PG&E	Pacific Gas and Electric Company
ppb	parts per billion
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
RAOs	Remedial Action Objectives
RD/RA	Remedial Design/Remedial Action
ROD	Record of Decision
RTC	Response to Comment
S(II-)	sulfide
SOP	Standard Operating Procedure
SWMU	Solid Waste Management Unit
SWRCB	State Water Resources Control Board
TCS	Topock Compressor Station
TDS	total dissolved solids
TOC	total organic carbon
TSS	total suspended solids
TWG	Technical Working Group
UNLV	University of Las Vegas
USC	United States Code
USEPA	U.S. Environmental Protection Agency
USGS	United States Geological Survey

# Introduction

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This Sampling and Monitoring Plan is Volume 2 of the Operation and Maintenance (O&M) Manual for the final groundwater remedy at the Pacific Gas and Electric Company (PG&E) Topock Compressor Station (TCS). This Plan is intended to satisfy the requirements under the Remedial Design/Remedial Action (RD/RA) Consent Decree (CD; DOI 2013) Stipulation 12(f)(5) and Appendix C Section 2.2.3(5); Corrective Action Consent Agreement (CACA; DTSC 1996) Attachment 6, Section B(9); Environmental Impact Report (EIR; DTSC 2011b) mitigation measure HYDRO-1; and Record of Decision (ROD; DOI 2010) applicable or relevant and appropriate requirements (ARARs) #81-82, #91-94, and 99 through 101.

In a coordinated effort, the United States Department of the Interior (DOI) and the California Department of Toxic Substance Control (DTSC) selected the final groundwater remedy to address chromium in groundwater resulting from discharges to Solid Waste Management Unit (SWMU) 1/Area of Concern (AOC) 1 and within AOC 10 (DOI 2010 and DTSC 2011a). When the selected final groundwater remedy is implemented, the current groundwater monitoring programs will be replaced by a new Corrective Measure/Remedial Action Monitoring Program with the focus of evaluating the performance of the remedy to attain the remedial action objectives (RAOs) and to comply with ARARs. The monitoring program will have several components: compliance monitoring, process control monitoring, and constituents of potential concern (COPCs) monitoring. These different monitoring program components will be used to evaluate remedy effectiveness and implementation, and to monitor contaminants in groundwater over time. Monitoring will also be used to ensure that the groundwater contaminant plume does not permanently expand or adversely impact potential receptors.

## 1.1 Compliance Monitoring During Remedy Implementation

The RAOs for the groundwater remedy are:

1. Prevent ingestion of groundwater as a potable water source having hexavalent chromium (Cr[VI]) in excess of the regional background concentration of 32 micrograms per liter (µg/L).
2. Prevent or minimize migration of total dissolved chromium (Cr[T]) and Cr(VI) in groundwater to ensure concentrations in surface water do not exceed water quality standards that support the designated beneficial uses of the Colorado River (11 µg/L Cr[VI]).
3. Reduce the mass of Cr(T) and Cr(VI) in groundwater at the site to achieve compliance with ARARs in groundwater. This RAO will be achieved through cleanup goal of regional background of 32 µg/L of Cr(VI).
4. Ensure that the geographic location of the target remediation area does not permanently expand following completion of the remedial action.

Compliance monitoring will focus on evaluating the groundwater remedy with regard to these RAOs. RAO 1, relating to prevention of ingestion of contaminated groundwater, will be met primarily through institutional controls. The Compliance Monitoring Program is designed to assess the groundwater remedy with regard to RAOs 2, 3, and 4, relating to controlling migration and reducing mass to an adequate degree.

## 1.2 Process Control Monitoring During Remedy Implementation

Process control monitoring is conducted to assess the extent that the groundwater remedy is functioning as designed. The process control monitoring will focus on issues such as assessing carbon dosing to maintain an effective In-situ Reactive Zone (IRZ) and the generation and attenuation of in-situ by-products.

In addition, water level monitoring will also be conducted to assess the adequacy of gradient control measures. Although gradient control is not an RAO in itself, maintaining groundwater gradients in certain areas, such as the freshwater injection barrier and the East Ravine Extraction Wells, will enhance plume control and plume remediation.

In above-ground support systems, process control monitoring involves sampling from pipes and tanks to monitor changes in water quality for extracted water that will be treated, amended and/or re-injected and to monitor the effectiveness of the carbon amendment system.

### 1.2.1 Summary of In Situ Remediation Chemistry

IRZ components of the design involve biologically-mediated treatment of Cr(VI). This section summarizes the in situ processes and chemical reactions within and downgradient of the IRZ that form the basis for the monitoring requirements of this system.

IRZ treatment is achieved through the stimulation of native microorganisms by the delivery of a degradable source of organic carbon, providing an electron donor for microbial growth. The goal of this process is to provide a sufficient quantity of electron donor to overcome the aquifer's supply of aerobic electron acceptors (primarily oxygen and nitrate) so that Cr(VI) will be reduced by microbes (i.e., used as an electron acceptor) to its trivalent form (Cr(III)). Cr(VI) is relatively soluble (present in solution at neutral pH as the chromate anion,  $\text{CrO}_4^{2-}$ ); whereas Cr(III) is relatively insoluble and precipitates out of solution as Cr(III)-hydroxide and mixed metal-hydroxide phases.

The utilization of electron acceptors in the system will generally be governed by the principles of thermodynamic equilibrium and redox kinetics. Dissolved oxygen (DO) and nitrate are thermodynamically more favorable electron acceptors than Cr(VI), while Cr(VI) is thermodynamically a more favorable electron acceptor than manganese oxides, iron oxides, and sulfate. However, given the relative availability of the electron acceptors and spatial heterogeneities of the subsurface aquifer environment, many of these reactions can occur simultaneously under field conditions. For example, iron and manganese reduction can proceed concurrently and sulfate reduction can begin before iron oxides are depleted, depending on the strength of the reducing environment. The strength of the reducing environment can be tuned by adjusting the concentration of organic carbon injected. This can help minimize the reduction of manganese, iron, and sulfate while still achieving adequate Cr(VI) reduction and removal. However, in order to create a reducing environment sufficient for the sustained removal of Cr(VI), some manganese, iron, and sulfate reduction will occur. Some iron reduction is actually desirable, as it provides stored Cr(VI) reduction capacity within the aquifer. These principles are discussed in more detail in Appendix B of the Basis of Design Report/90% Design Submittal (the 90% BOD Report) to which this O&M Manual is Appendix L.

The oxidation-reduction (redox) reactions fostered in the IRZ may temporarily mobilize certain naturally-occurring metals within the treatment zone, including iron, manganese, arsenic, and barium. Reduction of insoluble manganese(III/IV)-oxides generates manganese(II), which is soluble. Similarly, reduction of iron(III)-oxides releases ferrous iron (Fe(II)), which in the process releases arsenic that was adsorbed and coprecipitated within the iron oxides. Barium, which may be largely present in the soil as barite ( $\text{BaSO}_4$ ), can be released during sulfate reduction. Although the release of manganese, arsenic, and iron will be unavoidable, the system will be operated to limit sulfate reduction, which will substantially limit—and likely avoid—the release of barium. The concentrations of these by-products will attenuate downgradient of the treatment zone through various reactions, including sorption, reoxidation, and precipitation/coprecipitation, as discussed in more detail in Appendix B of the 90% BOD Report.

Monitoring will be performed to assess the performance of the treatment remedy. Total organic carbon (TOC), Cr(VI), DO, nitrate, and sulfate will be monitored within the treatment zone to assess the effectiveness of organic carbon distribution. The concentrations of by-products (manganese, iron, arsenic, and barium) will also be monitored within, and downgradient of, the treatment zone to assess by-product generation and attenuation.

### 1.2.2 Adaptive Operations Approach

In the field, variations in Cr(VI) concentration distributions, lithology and hydrogeology will be encountered. To deal with the uncertainty in these parameters in implementation, the remedial system was designed to be flexible and the remedy will be implemented with an adaptive operational strategy. During system installation and baseline sampling, additional data will be collected that will refine the current conceptual model. Where appropriate, the data may be used to refine the design, for example of remedial well screens and perhaps

locations. The data will also be used to update the solute transport model (see Appendix B of the 90% BOD Report, Section 12) and refine remedy projections. During remedy implementation, monitoring data will be collected and used to guide the operations of the system, including changes in operational flowrates, injection parameters, and potentially remediation well locations. Additional monitoring well locations may also be needed as data are collected during remedy construction and implementation. This monitoring program provides a plan for data collection, interpretation, and guidance for adapting operations as the remedy is implemented.

### **1.2.3 Short-Term Goals—Operating Properly and Successfully and Five-Year Reviews**

In addition to the RAOs, short-term goals and criteria are being developed in coordination with DTSC and DOI to facilitate future evaluations of remedy performance, including assessments of whether the remedy is Operating Properly and Successfully (OPS). In addition to the RAOs for the project listed in Section 1.1, this Sampling and Monitoring Plan details explicit, discrete, and measurable goals and metrics that will be incorporated into the evaluation of whether the remedy is OPS. OPS is defined as:

1. The remedy is operating as designed;
2. The information obtained from remedy operation indicates that the remedy is protective of human health and the environment; and
3. The remedy is likely to be able to achieve the cleanup levels or performance goals delineated in the DTSC Statement of Basis (DTSC 2011a) and the DOI ROD (DOI 2010) for the groundwater remedy at the PG&E Topock site.

In general, OPS is expected within 1 to 2 years of remedy start-up. Some components of the system, for instance the National Trails Highway (NTH) In-situ Reactive Zone (IRZ), may be determined to be OPS earlier. Five-Year Reviews will also be conducted by DTSC and DOI to assess remedy performance. The short-term metrics and criteria provided throughout this volume and also summarized in Table 2.1-5 in Section 2 will be appropriate metrics for evaluating remedy performance for Five-Year Reviews.

# Monitoring Goals and Data Quality Objectives

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The Compliance Monitoring Program and Process Control Monitoring Program are described in more depth in this section. The monitoring goals and data quality objectives (DQOs) for the remedy establish the process elements and decision points that will be considered during remedy implementation. These objectives guide data collection to assess operations of the remedial components and to optimize the remedial performance. This monitoring plan establishes the following components for each of the DQOs, as summarized in Table 2.1-1 (tables are located at the end of each section):

- Problem statements and decision statements (Section 2)
- Inputs to the decisions and study area boundaries (Sections 3 and 4)
- Decision rules (Section 2)
- Limits of decision errors and optimization of design for data collection (Sections 3 and 4)

For the remedy, the decision rules are effectively an adaptive operations framework that outlines how the data collected will be used to make operational adjustments. The DQOs and decision rules/operations framework dovetail with the Contingency Plan, presented in Volume 3 of this Operation and Maintenance (O&M) Manual. The Contingency Plan includes a failure modes analysis that anticipates potential operational issues that may occur with the remedy. The DQOs guide the adaptive operations elements to mitigate for these operational issues. Mitigations identified in the failure modes analysis that are not covered by design or adaptive operations may require additional contingency actions, as outlined in the plan.

Data from the monitoring programs will be received on a schedule indicated by the initial monitoring frequency outlined in Table 2.1-2. These data will be interpreted as they are received to inform any potential modifications to system operations. The sampling program will be re-evaluated after two years of operation. If warranted, the sampling program may be re-evaluated sooner based on knowledge gained as the remedy is operated. Proposed changes to the monitoring program will be communicated as recommendations provided in quarterly progress reports, in accordance with the anticipated reporting procedures and schedules described in Section 6.5 and Exhibit 6.5-1.

## 2.1 Remedy Compliance Monitoring Program

The goal of the Compliance Monitoring Program will be to assess the operation of the remedy with regard to RAOs 2, 3, and 4. The program will involve periodic monitoring of groundwater collected from within and outside of the Cr(VI) plume (see Figure 2.1-1; figures are located at the end of each section) and from surface water sampling locations along the Colorado River (Figure 2.1-2). New monitoring well locations are being proposed to supplement the existing network and are highlighted on Figure 2.1-3. The RAOs and DQOs for compliance monitoring are described in detail below and summarized in Table 2.1-1. Note that RAO 1, which involves prevention of the ingestion of water with elevated Cr(VI), requires no action within the Compliance Monitoring Program described here, since the proper institutional controls will be used to meet this RAO.

***Compliance DQO-1 (RAO 2) Problem Statement: Prevent or minimize migration of Cr(T) and Cr(VI) in groundwater to ensure concentrations in surface water do not exceed water quality standards that support the designated beneficial uses of the Colorado River (11 µg/L Cr(VI)).***

RAO 2 will be satisfied during remedy operation by the in-situ treatment of Cr(VI) in groundwater; the treatment will minimize and prevent Cr(VI) and Cr(T) from reaching the Colorado River. The problem statement for this DQO is to implement the remedy in compliance with RAO 2 (Table 2.1-1). As the remedy is implemented, data will be collected under this DQO to answer the question, should operations or remedy components be modified to meet the RAO? To answer this question, surface water sampling will be conducted within the study area using the surface water sampling network. The surface water sampling locations define the study area boundaries and are shown on Figure 2.1-2 and listed in Table 2.1-2. As part of the Compliance Monitoring Program, surface water

samples will be collected periodically from the Colorado River from multiple locations upstream, midstream, and downstream of the zone where treated groundwater discharges to the river (see Section 3.1).

During initial start-up of the NTH IRZ, prior to operation of the River Bank Extraction Wells, Cr(VI) in the floodplain downgradient of the NTH IRZ will not be treated. Modeling results indicate that operations of the NTH IRZ during this period are protective of the Colorado River—i.e., the Cr(VI) plume does not migrate a significant distance in the floodplain during start-up, and the portion of the plume located downgradient of the NTH IRZ does not migrate past the capture zone of the River Bank Extraction Wells. To verify these predictions, quarterly sampling of the NTH IRZ downgradient monitoring well network and the surface water sampling locations will be conducted, as indicated on Table 2.1-2.

Although RAO 2 is specifically intended to address Cr(VI), the IRZ by-products arsenic and manganese will also be monitored. The surface water quality criteria for Cr(VI) is 11 µg/L and 150 µg/L for arsenic (Source: Table 2 of the ROD, ARAR #3, Federal Water Pollution Control Act. 33 USC 1251-1387, 40 CFR 131.38). There are no surface water quality criteria for Cr(T) and manganese. Elevated concentrations of Cr(VI), manganese, and arsenic can be potentially attributed to the Topock site if midstream and/or downstream surface water concentrations show statistically significant increases above upstream concentrations observed during the same sampling event. Decision error will be limited through collection of samples upriver and downriver of potentially affected areas to accurately attribute concentration changes to the Topock site and performing quarterly to semi-annual data collection throughout the lifetime of the remedy operations (analytes and frequencies specified in Section 3.2 and Table 2.1-3).

The surface water data will be used to evaluate the following decision rules:

- If Cr(VI), arsenic, or manganese concentrations increase in surface water samples, or are detected at locations that were previously non-detect, and are attributable to the Topock site, operational changes will be implemented per the process control decision rules outlined in Section 2.2 and presented in Figures 2.2-3, 2.2-5, and 2.2-8.
- If Cr(VI), arsenic, or manganese concentrations do not return to baseline as a result of the operational adjustments, the recommendations in the Contingency Plan measures (see Volume 3) will be implemented.

***Compliance DQO-2 (RAO 3) Problem Statement: Reduce the mass of Cr(T) and Cr(VI) in groundwater at the site to achieve compliance with ARARs in groundwater. This RAO will be achieved through cleanup goal of regional background of 32 µg/L of Cr(VI).***

The problem statement for this DQO is to implement the remedy in compliance with RAO 3 (Table 2.1-1). As the remedy is implemented, data will be collected under this DQO to answer the question, should operations or remedy components be modified to meet the RAO? As inputs to this decision, groundwater samples will be collected periodically from the compliance monitoring program well network inside the plume (the network is described in Section 3), which is the study area for this DQO. The compliance monitoring wells inside the plume are shown on Figure 2.1-1 and listed in Table 2.1-3 according to their intended function within the monitoring program.

As part of the data quality objectives for RAO 3, wells located within the plume boundary (defined by the current 32 µg/L Cr(VI) plume boundary) will be monitored for Cr(VI), and concentration trends will be reviewed to assess progress toward this RAO per the process outlined in IRL-DQO 1 in Section 2.2.2 and Freshwater DQO-1 in Section 2.2.4. Tables 2.1-4 and 2.1-5 include anticipated Cr(VI) concentration trends toward treatment to less than 32 µg/L for wells located within the plume boundary. As the remedy progresses, if the observed concentration trends are not consistent with anticipated Cr(VI) attenuation timeframes (i.e., if the monitoring results indicate that Cr(VI) attenuation is actually taking substantially longer than anticipated), then operational changes to the remediation system will be evaluated and implemented as presented in the process control decision rules/operational framework described in Section 2.2 and presented in Figures 2.2-2 through 2.2-9. If operational adjustments are not successful in improving system performance, the Contingency Plan will be implemented as described in Volume 3 of this O&M Manual. Decision error will be limited by collecting monitoring data at multiple points distributed laterally and vertically across the plume (Figure 2.1-1), spanning a range in anticipated cleanup



timeframes (Tables 2.1-3, 2.1-4 and 2.1-5). In addition, decision error will be limited by monitoring at a frequency consistent with anticipated cleanup timeframes.

Data will also be evaluated to determine when the appropriate time for monitored natural attenuation (MNA) arises. Per the Statement of Basis (DTSC 2011a) and ROD (DOI 2010), MNA is included as a long-term component of the groundwater remedy to address residual Cr(VI) that may remain in recalcitrant portions of the aquifer following in-situ treatment with flushing. Decisions on specific areas of the plume appropriate for MNA will be made based on: data collected under this DQO evaluating effectiveness of the active remediation systems for mass removal; the types and options for active remediation system adjustments; and the location of proposed MNA areas relative to natural reductive zones in the aquifer. Decision error will be limited by collecting monitoring data at multiple points distributed laterally and vertically across the plume, spanning a range in anticipated cleanup timeframes as detailed in Tables 2.1-3, 2.1-4, and 2.1-5. In addition, decision error will be limited by monitoring at a frequency consistent with anticipated cleanup timeframes as detailed in Tables 2.1-3, 2.1-4, and 2.1-5.

***Compliance DQO-3 (RAO 4) Problem Statement: Ensure that the geographic location of the target remediation area does not permanently expand following completion of the remedial action.***

The problem statement for this DQO is to implement the remedy in compliance with RAO 4 (Table 2.1-1). As the remedy is implemented, data will be collected under this DQO to answer the question, should operations or remedy components be modified to meet the RAO? As inputs to this decision, groundwater samples will be collected periodically from the Compliance Monitoring Program well network outside the plume, according to the DQO for this RAO, as described in Section 3. The compliance monitoring wells outside the plume in the study area for this DQO are shown on Figure 2.1-1 and listed in Table 2.1-3. The data collected will be analyzed to ensure that the concentrations of Cr(VI) and remedy by-products, specifically manganese and arsenic, do not permanently increase outside of the baseline Cr(VI) plume. Monitoring for COPCs will also be conducted as described in Section 5.1 and summarized in Table 2.1-6. If needed, tracer studies comprised of injection into TCS injection wells could also be used to verify that TCS injection is not resulting in expansion of the Cr(VI) plume.

Upgradient of the plume, if concentrations of Cr(VI), manganese, or arsenic increase above anticipated concentrations, operational adjustments for the Inner Recirculation Loop (IRL) injections and freshwater injections will be considered and groundwater modeling will be used to assess effects of the considered operational changes, as outlined in Figures 2.2-4 and 2.2-9. Based on the modeling assessment, the need for additional data collection and the benefits and timing of the operational adjustments will be reviewed and changes presented and implemented if warranted. The Process Control Monitoring Program and decision rules/operational framework are outlined in Sections 2.2.2 and 2.2.4, Figures 2.2-4 and 2.2-9. If operational adjustments are implemented, the effects will be assessed in the context of the overall plume remediation using the field data and re-calibrated groundwater modeling projections.

If Cr(VI) concentrations show an increasing trend downgradient of the NTH IRZ compliance wells located outside of the baseline Cr(VI) plume in the floodplain, operational adjustments will be considered as outlined in Section 2.2.1, Figure 2.2-2 and in the Contingency Plan. Similarly, if by-product concentrations increase beyond expectations downgradient of the NTH IRZ in compliance wells located outside of the baseline Cr(VI) plume in the floodplain, operational adjustments will be considered as outlined in Section 2.2.1.

Decision errors will be limited through:

- Collection of samples from outside of the baseline hexavalent chromium plume (Table 2.1-3 and Figure 2.1-1).
- Sampling at a frequency base on the anticipated arrival time of water affected by various components of the remedy (Tables 2.1-3, 2.1-4, and 2.1-5)
- Quarterly collection of manual water level data and continuous collection of pressure transducer data to assess hydraulic performance, ensuring plume control (Table 2.1-3).
- Comparison of Cr(VI) and by-products dynamics with solute transport model predictions to assess performance.

## 2.2 Process Control Monitoring Program

The objective of the Process Control Monitoring Program will be to assess the extent to which the groundwater remedy is functioning as designed based on the DQOs. The process control monitoring network is shown on Figure 2.2-1.

### 2.2.1 National Trails Highway In-situ Reactive Zone (NTH IRZ)

***NTH IRZ DQO-1 Problem Statement: The carbon substrate amendment system must be working to amend the organic carbon substrate into the recirculated groundwater.***

The decision statement for this DQO is: is the carbon amendment system working properly? As inputs to this decision, samples will be collected from the MW-20 Bench and Transwestern Bench distribution systems and analyzed for TOC. The study area is the carbon distribution system. Samples will be collected from sampling ports located in each forcemain following the location where organic carbon substrate is added and passes through a static mixer (Exhibits 2.2-1 and 2.2-2; see also Section 4.2.6). Samples will also be collected from injection vaults (Exhibit 2.2-1), as needed. If TOC concentrations do not match the target mixing concentrations for a given injection, troubleshooting will be conducted to identify and repair any problems with the carbon amendment system.

During system start-up, samples will be collected frequently, approximately weekly or biweekly, until data suggest that the amendment system is working properly. Once the system operations are verified, sampling frequency will be reduced to quarterly or semi-annually. If semi-annual monitoring is proposed, sampling events may be performed on a quarterly basis with half of the injection well vaults sampled on alternating quarters. This would ensure that information on the system is collected quarterly, even if any given injection vault would only require semi-annual sampling. Frequent collection during start up at key system locations will limit decision error.

***NTH IRZ DQO-2 Problem Statement: The NTH IRZ must be complete and maintain Cr(VI) treatment over time.***

The decision statements for this DQO are (Table 2.1-1):

- Should operations of the NTH IRZ be modified?
- Should NTH IRZ recirculation and organic carbon injections be started or stopped?
- Should the NTH IRZ design be modified?
- Should the monitoring well layout be modified?

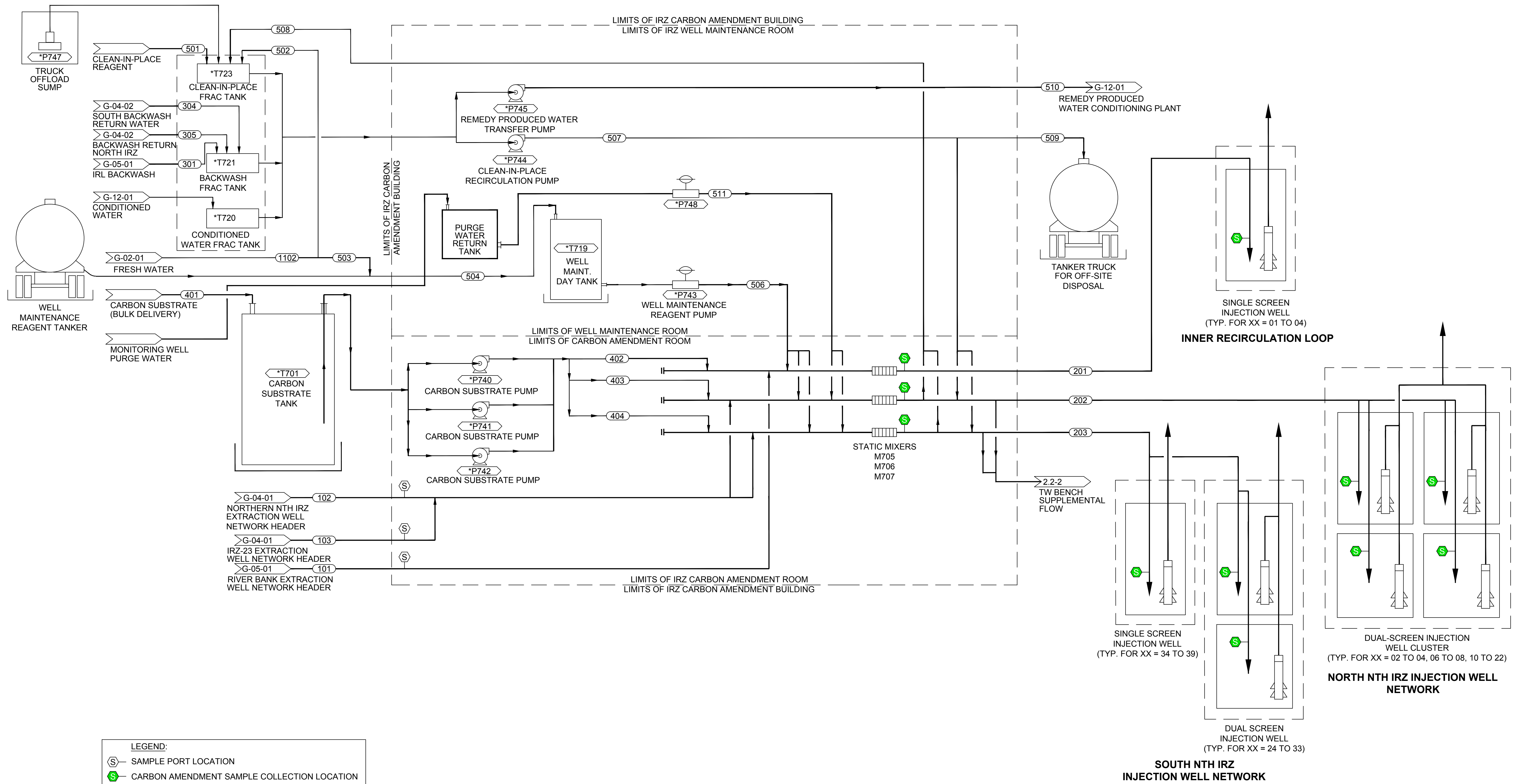
The decision rules/operational framework for the NTH IRZ is shown on Figure 2.2-2. Operation of the NTH IRZ will involve extraction of groundwater from NTH IRZ Extraction Wells, amendment with organic carbon substrate, and re-injection into NTH IRZ Injection Wells to generate an IRZ to treat Cr(VI). DQO-2 for the NTH IRZ is to ensure that the IRZ has been sufficiently established in the subsurface as a result of the IRZ system operations.

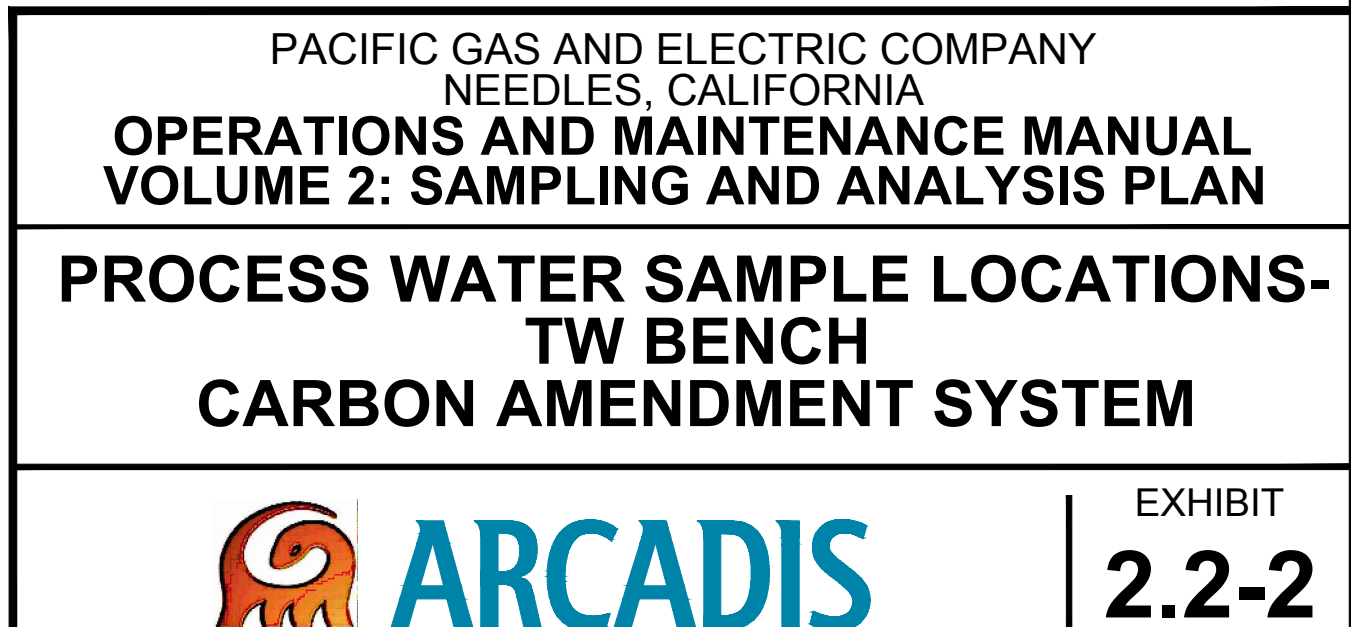
As inputs to the decisions listed above, monitoring data from dose response wells, located in proximity to the NTH IRZ Injection Wells in the study area, will be collected. The dose response wells are shown on Figure 2.2-1 and identified on Table 2.1-2. The details of the sampling program for these wells are presented in Section 4.2.1 and summarized on Table 4.2-1. It is important to note that, although Cr(VI) concentrations will be used as a line of evidence for establishment of a treatment zone, decreases in dissolved Cr(VI) alone in the short-term are not necessarily a definitive metric for treatment. Multiple lines of evidence will be used to evaluate the establishment of the treatment zone, including the following:

- TOC: The distribution of TOC is the primary mode of generating reducing conditions for treatment of Cr(VI) in groundwater.
- Dissolved iron: Dissolved iron is a Cr(VI) reductant that is generated under iron reducing conditions stimulated by the injection of organic carbon. If dissolved iron is distributed in the aquifer where TOC is not, Cr(VI) reducing conditions will still be established. As such, dissolved iron serves as a secondary indicator of the establishment of an IRZ.

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- Cr(VI): the presence or absence of Cr(VI) in groundwater will also serve as a direct indicator of whether Cr(VI) treatment at a given location is occurring or necessary.

The process for evaluating the data collected from the monitoring wells and making operational adjustments according to the decision rules/operational framework is presented in a flowchart on Figure 2.2-2. As detailed on Figure 2.2-2, a combination of TOC, dissolved iron, and Cr(VI) data from dose response monitoring wells will be evaluated to determine if the IRZ has been established. TOC concentrations will be compared to the target concentration range established based on experience, pilot testing results, and solute transport modeling, provided in Table 2.2-1. The anticipated concentrations vary with distance from injection points, with higher concentrations anticipated close to injection points and lower concentrations anticipated further from injection points. If TOC concentrations are within the anticipated range, then operations will continue. If TOC concentrations are below the anticipated range, Cr(VI) and dissolved iron data will also be evaluated. If dissolved iron is above baseline and Cr(VI) is treated to less than 32 parts per billion (ppb), then the IRZ operation will be considered successful. If TOC concentrations are below the anticipated range, dissolved iron does not increase above baseline, and Cr(VI) is not treated, operational adjustments will be considered, as shown on Figure 2.2-2.

In addition, downgradient Cr(VI) concentrations (see also Section 4.2.2) will be evaluated as shown on Figure 2.2-2. The monitoring wells downgradient of the NTH IRZ, which define the study area boundaries, are shown on Figure 2.2-1 and identified on Table 2.1-2. The details of the sampling program for these wells are presented in Section 4.2.2 and summarized on Table 4.2-1. If Cr(VI) concentrations are not decreasing within expectations as outlined in Tables 2.1-4 and 2.1-5, then operational adjustments will be considered as shown on Figure 2.2-2. Table 2.2-1 includes anticipated timeframes for decrease of Cr(VI) to below 32 µg/L at monitoring wells downgradient of the NTH IRZ based on the results of solute transport modeling. Tables 2.1-4 and 2.1-5 provide additional information on anticipated Cr(VI) concentration trends at specific monitoring locations.

Short-term operational adjustments that may be made to improve TOC distribution and establishment of the IRZ include adjustment of the TOC injection concentration, dosing frequency or duration, injection and extraction rates, target injection intervals, or river bank extraction rates. Increasing the injection concentration and adjusting the dosing parameters would be implemented if data indicate that injected water is reaching the location, but there is not sufficient carbon remaining in solution to establish Cr(VI)-reducing conditions. A decrease in nitrate without increase in TOC or dissolved iron is an indication of this case. If injected water is not reaching the monitoring location as indicated by a lack of change in Cr(VI), nitrate and dissolved metals, an increase in flow rate could be used to improve distribution. The targeted treatment intervals may need to be adjusted if it appears that some intervals within a given injection location require more reagent distribution than others or if some intervals are already completely treated while others are not. River bank extraction rates may be adjusted if the hydraulic gradient being induced downgradient of the IRZ is preventing lateral distribution at the injection points. Adjustments to the river bank extraction rates would have to be balanced with the evaluation of the extraction for performance, as outlined in Section 2.2.2.

If short-term operational adjustments are not sufficient to improve the performance of the NTH IRZ, long-term operational changes such as adding the provisional injection wells and changing reagents will be considered (see Boxes 13 and 14 of Figure 2.2-2). The addition of provisional injection wells would decrease the required TOC injection concentration to achieve complete distribution. Selection of a carbon substrate with slower degradation rates (e.g., whey or molasses) could increase the distribution distances. If long-term operational changes are not sufficient to improve the performance of the NTH IRZ, further contingency measures will be implemented (see Contingency Plan in Volume 3).

It is anticipated that the IRZ operations will be cycled; for example the IRZ would be operated for six months to establish reducing conditions and then will be turned off for 18 months during which time residual reducing capacity generated during injections will continue to treat Cr(VI) in groundwater. The decision process for turning the IRZ operations on and off is illustrated starting on Box 27 of Figure 2.2-2. Residual reducing capacity could potentially be stored during injections as reduced iron from iron reduction, sulfide from sulfate reduction, or as biomass from microbial growth. For dose response wells, dissolved iron concentrations, Cr(VI) concentrations

below 32 µg/L, and other redox indicators such as nitrate and sulfate will be used to evaluate the establishment and maintenance of an adequate reducing capacity within the treatment zone. If these parameters collected from dose response wells indicate reducing conditions have been established, IRZ operations will be shut down and monitoring of these parameters will continue. As the data indicate that reducing conditions are lost, e.g., through a decrease in dissolved iron concentrations, an increase in Cr(VI) concentrations, or an increase in other redox indicators such as nitrate, the IRZ operations will be resumed. The monitoring data will provide information all along the IRZ, and it is possible that treatment may be complete and operations will be shut down in some areas, while additional treatment and operation will be needed in other areas.

Decision error will be limited through:

- Placement of monitoring locations at the weaker points of the IRZ (mid-point between injection locations) and downgradient (Sections 4.2.1 and 4.2.2, Figure 2.2-1, Table 2.1-2)
- Collection of a variety of parameters to evaluate establishment of hexavalent chromium reducing conditions (Table 4.2-1 in Section 4)
- Monthly to quarterly sampling during start-up and operational changes (Table 4.2-1)

***NTH IRZ DQO-3 Problem Statement: By-product generation and migration from the NTH IRZ must be controlled.***

The decision statements for this DQO are:

- Should operations of the NTH IRZ be modified based on by-product concentration trends?
- Should design of the NTH IRZ design be modified based on by-product concentration trends?

The decision rules/operational framework for the NTH IRZ by-product evaluation is also shown on Figure 2.2-2. DQO-3 for the NTH IRZ is to ensure that by-product generation from the NTH IRZ is adequately controlled. Inputs to these decisions are monitoring data from dose response wells to evaluate the generation of by-products within the IRZ (see also Section 4.2.1) and data from monitoring wells located downgradient of the IRZ in the mid-floodplain and monitoring wells located proximal to the river bank extraction system to monitor by-product attenuation and migration in the study area (see also Sections 4.2.2 and 4.2.3). By-product data collection will include sampling for dissolved arsenic, dissolved manganese, dissolved iron, and dissolved barium, as detailed in Section 4.

By-product concentration data will be compared to the anticipated concentration range and timing based on solute transport modeling as presented in Table 2.2-1. If by-product concentrations are above the anticipated range, operational adjustments will be made as discussed in the next paragraph. The maximum anticipated concentrations listed in Table 2.2-1 for NTH IRZ downgradient monitoring wells and River bank extraction monitoring wells will also be used as by-product action levels. The decision flowchart outlining agency notification requirements should action levels be exceeded is provided as Figure 2.2-11. If the constituent is detected in samples above the action level, the sample will be reanalyzed if within holding time. If the holding time has been exceeded, a new sample will be collected and re-analyzed within 45 days. If the re-sample confirms the exceedance, the DTSC will be notified and operational adjustments will be made as discussed in the next paragraph.

Short-term operational adjustments that may be made to improve by-product generation and migration include adjustment of the TOC injection concentration, dosing frequency or duration, injection and extraction rates, target injection intervals, or river bank extraction rates. Decreasing the injection TOC concentration and adjusting the dosing parameters could decrease the generation of the by-products. Adjustments to the TOC injections to minimize by-product generation would have to be balanced with maintaining Cr(VI) treatment, as outlined in NTH IRZ DQO-2. River bank extraction rates may be adjusted if the hydraulic gradient downgradient being induced is having detrimental influence on downgradient by-product migration. Adjustments to the river bank extraction rates would have to be balanced with the evaluation of the extraction for performance, as outlined in Section 2.2.2.



If short-term operational adjustments are not sufficient to improve by-product generation and migration from the NTH IRZ, long-term operational changes such as adding the provisional injection wells will be considered (see Box 14 of Figure 2.2-2). The addition of provisional injection wells would decrease the required TOC injection concentrations and decrease by-product generation.

If short-term and long-term operational adjustments are not sufficient to improve by-product generation and migration from the NTH IRZ, the river bank extraction system operation may be adjusted to ensure that by-products do not cause unacceptable impacts to the river, as indicated in Box 17 on the operational flowchart in Figure 2.2-2. The DQOs to evaluate operation of the river bank extraction system are presented in Section 2.2.2.

Decision errors will be limited by:

- Placement of monitoring wells at a variety of locations lateral and downgradient of injection wells (Sections 4.2.1 and 4.2.2, Figure 2.2-1, Table 2.1-2)
- Sampling frequency which ensures observation of concentration changes, based on anticipated timeframe for concentration changes (Tables 4.2-1, 2.1-4 and 2.1-5)

***NTH IRZ DQO-4 Problem Statement: Extraction on the north end of the NTH IRZ will be conducted to control Cr(VI) with the NTH and river bank extraction systems.***

The decision statement for this DQO is: Should extraction operations be modified to control hexavalent chromium migration on the north end of the NTH IRZ? The decision rules/operational framework for the NTH northern extraction is shown on Figure 2.2-3. On the northern end of the NTH IRZ, potential migration of Cr(VI) in groundwater will be controlled via extraction, rather than the establishment of an IRZ. As inputs to the decision, data will be collected on this end of the IRZ, the study area, to assess the ability of extraction to control Cr(VI) migration. This objective will be assessed through evaluation of data collected from northern NTH IRZ extraction monitoring wells (see also Section 4.2.3), the extraction wells themselves (see also Section 4.2.5), and the surface water sampling locations (see also Section 3.1). The monitoring well and surface water sampling locations are listed on Table 2.1-2 and shown on Figures 2.2-1 and 2.1-2, and the sampling programs are detailed in Sections 3 and 4.

The analytical and water level data collected will be used to adjust the flow model and a lines-of-evidence approach will be used to evaluate the hydraulic control of the Cr(VI) plume, as discussed in further detail in Section 4.3. The river bank extraction system operation will also be evaluated and adjusted to address control of the Cr(VI) plume. If it is assessed that control is not likely to be achieved, operational adjustments to the extraction rates of the northern NTH IRZ extraction wells or River Bank Extraction Wells will be considered, as detailed in the decision rules on Figure 2.2-3 (Box 5). If short-term operational adjustments do not adequately enhance the likelihood of Cr(VI) plume control, the installation of provisional wells will be considered (see Box 6 of Figure 2.2-3). The Contingency Plan will be implemented if performance is not improved by the operational adjustments or addition of provisional wells.

Decision error will be limited through:

- A multiple lines of evidence performance assessment (Sections 4.2.3 and 4.3).
- Use of existing and additional monitoring wells for data collection (Table 2.1-2).
- Quarterly data collection at start-up to ensure the system is working properly (Table 4.2-1).

***NTH IRZ DQO-5 Problem Statement: Extraction will be conducted to minimize extraction of organic carbon and reduced metal by-products, e.g. iron and manganese.***

The decision statement for this DQO is: Should operations be adjusted to minimize extraction of dissolved metals? The decision rules/operational framework for evaluating extracted water quality from the NTH IRZ is shown on Figure 2.2-2. The extraction of residual organic carbon substrate or reduced metals, such as iron and manganese, from NTH IRZ Extraction Wells may increase the potential for fouling of the NTH IRZ Injection Wells receiving the extracted water. Extraction wells IRZ-9 and IRZ-23 are the most likely to extract organic carbon or reduced metal by-products, given their proximity to the IRZ Injection Wells. As inputs to the decision, samples will be collected

from the extraction wells and analyzed for organic carbon, iron, and manganese, among other water quality parameters, as outlined in Section 4.2.5 and summarized in Table 4.2-1.

Operational adjustments to address extracted organic carbon or reduced metals caused by injections in nearby injection wells include reducing TOC injection concentrations and changing injection or extraction flow rates, as detailed in the decision rules on Figure 2.2-2. By reducing TOC injection concentrations, the organic carbon substrate may be consumed before reaching the extraction well. Decreasing the injection flow rates or extraction flow rates would decrease the lateral hydraulic gradient and reduce the potential for extraction of water with residual organic carbon or reduced metal by-products by the extraction wells. Extraction wells may also need to be taken off-line for variable periods of time to control these impacts, or to maintain the well. These operational adjustments, including the shutdown of any given injection or extraction well, would be coupled with an assessment of the strength of the IRZ and Cr(VI) treatment in that area per NTH IRZ DQO-2. However, it is anticipated that if treated water is being extracted, the IRZ would be established in the area and continued operation would not be needed. In addition, the overall flow balance of the system will be considered when adjusting the injection and extraction flows to ensure that carbon distribution is still occurring in areas that need treatment.

Decision errors will be limited through:

- Water quality monitoring at each NTH IRZ extraction well (Section 4.2-5, Table 4.2-1).
- Quarterly or more frequent monitoring initially to evaluate extracted water quality (Table 4.2-1).

## 2.2.2 Inner Recirculation Loop (IRL)

The intent of the IRL is to: (1) induce a hydraulic gradient that will flush the Cr(VI) plume toward the NTH IRZ; (2) facilitate the cleanup of the Colorado River floodplain; and (3) provide secondary protection for the Colorado River by controlling the migration of potential byproducts generated by the NTH IRZ.

***IRL DQO-1 Problem Statement: Inner loop recirculation will be operated to facilitate flushing of the Cr(VI) plume through the NTH IRZ.***

The decision statement for this DQO is: should IRL operation be modified to facilitate flushing of the hexavalent chromium plume? The decision rules/operational framework for evaluating the development of hydraulic gradients to facilitate Cr(VI) plume flushing is illustrated on the right-hand side of the decision rules in Figure 2.2-4. Data will be compared to the anticipated concentration range and timing based on solute transport modeling as presented in Tables 2.2-1, 2.1-4 and 2.1-5.

Inputs to the decision include hydraulic gradient data, solute transport modeling, and hexavalent chromium concentration data. The hydraulic gradient will be evaluated through analysis of water levels collected across the site, including at IRL injection dose response wells where water level mounding is anticipated and at extraction wells where groundwater drawdown is anticipated (see also Section 4.3). The study area is across the site, as indicated by the IRL water level monitoring network listed in Table 2.1-2. Observed hydraulic gradients will be compared on a site-wide basis to anticipated gradients as simulated with flow modeling that will be periodically updated as field data are collected. Specific metrics for defined well pairs located in the floodplain will address hydraulic control created by the River Bank Extraction Wells as discussed in Section 4.3.

In addition, Cr(VI) concentration changes from IRL injection downgradient monitoring wells will be compared to anticipated concentration changes and timeframes predicted from solute transport modeling, as summarized in Table 2.2-1. The IRL injection downgradient monitoring wells are shown on Figure 2.2-1 and identified on Table 2.1-2. The details of the sampling program for these wells are presented in Section 4.2.2 and summarized on Table 4.2-1. If the change in hydraulic gradient and the changes in downgradient monitoring well Cr(VI) concentration trends are not within expectations, short-term adjustments to improve performance, such as increasing injection rates or adjusting the flow balance across the IRL, will be considered for implementation (see Boxes 29 and 30 on Figure 2.2-4). Changes to freshwater injection rates will be considered in concert with changes to River Bank Extraction Well flow rates (see Section 2.2.4). Longer-term changes may include installation of additional injection wells, such as provisional well IRL-5 (see Box 28 on Figure 2.2-4) if short-term operational adjustments are found



to be insufficiently effective. An increase in injection rates in a given well or the addition of a well will require either decreasing injection rates in other wells or increased extraction rates from the River Bank Extraction Wells or freshwater source and may require additional extraction capacity. The changes will be made and flow rates will be balanced across the system to optimize the hydraulic gradient across the system. If the desired hydraulic gradients cannot be achieved and Cr(VI) concentrations are not declining within expectations such that the remedy duration is projected to be of an unacceptable duration, the Contingency Plan will be implemented.

Decision errors will be limited through:

- Placement of monitoring wells within the plume in locations to collect data on flushing of hexavalent chromium concentration trends (Figure 2.2-1, Tables 2.1-2, 2.1-4, 2.1-5).
- Sample collection frequency based on solute transport modeling predictions (See Tables 2.1-4 and 2.1-5)
- Evaluation of timeframe predictions based on model re-calibration with installation and operational data.

***IRL DQO-2 Problem Statement: Cr(VI) in groundwater extracted from the River Bank Extraction Well system must be treated if levels exceed the target Cr(VI) concentration.***

The decision statements for this DQO are;

- Does water extracted from the river bank contain Cr(VI) above background and require treatment?
- If hexavalent chromium treatment is required, should carbon-amended injection well operations be modified to ensure Cr(VI) treatment?
- Are constituents in extracted water degrading injection well performance?

Inputs to the decision include Cr(VI) and extracted water quality data. The study area is the extracted water and monitoring wells, and the IRL injection wells and dose response wells. The decision rules evaluating data and making operational changes to the IRL carbon injections is presented on the left-hand side of Figure 2.2-4. Inputs to the decision-making are analytical data collected from the river bank extracted water (see Section 4.2.5). If Cr(VI) is present in groundwater extracted from the River Bank Extraction Wells at a blended concentration that exceeds the target clean-up level of 32 µg/L, the recirculated groundwater will be amended with carbon substrate and process control monitoring will be conducted to enhance treatment. Cr(VI) concentration data will be collected from the extracted groundwater. If the Cr(VI) concentration in the extracted water is greater than 32 µg/L, then the carbon amendment system will be turned on or continue to operate if already on. If the Cr(VI) concentration is less than 32 µg/L, the carbon amendment system will be turned off or remain off.

If the carbon amendment system is active, data will be collected from the IRL injection dose response monitoring wells, listed in Table 2.1-2 and shown on Figure 2.2-1, to evaluate Cr(VI) treatment and by-product generation. The sampling program for these wells, which define the study area boundaries, is detailed in Section 4.2.1 and summarized on Table 4.2-1. If TOC concentrations are less than anticipated and Cr(VI) is not treated to less than 32 µg/L in samples collected from dose response wells, then operational adjustments such as increasing TOC injection concentrations or changing dosing parameters will be made. If by-product concentrations are above the anticipated range, the TOC concentration will be decreased or dosing parameters will be adjusted.

The process/decision rules for evaluating extracted water quality data is presented on the left-hand side of Figure 2.2-4. Inputs to the decision-making include analytical data collected from the river bank extracted water (see Section 4.2.5). If concentrations of reduced metals are elevated and it is affecting injection well performance (see O&M Manual Volume 1, Section 4 for details on evaluating injection well performance), then adjustments will be made to improve injection well performance. Short-term operational changes that will be considered include increasing the backwashing and chemical rehabilitation frequency, and adjusting extraction rates or the flow balance if concentrations of fouling constituents vary among wells. Adjustments of the extraction rates would have to be weighed against the hydraulic control needs and performance of the River Bank Extraction Wells as discussed in IRL DQO-3, below. The addition of low concentrations of TOC to maintain a slightly reduced water chemistry signature in the injection well may also be applied; this will be coupled with the complementary

monitoring associated with TOC addition as described in the previous paragraph. If injection well maintenance becomes unacceptably costly or burdensome due to the re-injection of reduced metals, treatment for removal of those metals prior to re-injection may be considered. Should this occur, the regulatory agencies and Tribes will be informed prior to commitment.

Decision errors will be limited through:

- Collection of water quality data from individual extraction wells and from the combined stream (Section 4.2-5, Table 4.2-1)
- Monitoring in the immediate vicinity of injection wells to ensure injected water is treated adequately (Section 4.2-1, Table 4.2-1, Figure 4.2-1)
- Monthly to quarterly data collection at start-up, followed by continued quarterly monitoring to quickly address water quality changes (Table 4.2-1)

***IRL DQO-3 Problem Statement: Control migration of Cr(VI).***

***IRL DQO-4 Problem Statement: Control the migration of by-products.***

The decision statement for these DQOs are:

- Should operations of River Bank Extraction Wells be modified to improve control of hexavalent chromium and in situ by-products in the Floodplain?
- Are currently operating screen intervals of the River Bank Extraction Wells sufficient to control the hexavalent chromium or by-products, above ambient levels, in the Floodplain?

The decision rules/operational framework for the River Bank Extraction Wells are shown on Figure 2.2-5. The study area for this DQO is groundwater beneath the floodplain and Arizona and the surface water. As inputs to the decisions, Cr(VI) and by-product concentration trends will be monitored in floodplain process control monitoring wells and Arizona wells. Cr(VI) and by-products data from the river bank extraction monitoring well network (see also Section 4.2.3) and surface water sampling network (see also Section 3) will be used to evaluate the adequacy of the system's control of the Cr(VI) plume and by-product migration. The monitoring well and surface water sampling locations are listed on Table 2.1-2 and shown on Figure 2.2-1, and the sampling programs are detailed in Sections 3 and 4.

The analytical and water level data collected will be used to adjust the flow model and a lines-of-evidence approach will be used to evaluate the control of Cr(VI) and/or by-products, as discussed in further detail in Section 4.3. If control of Cr(VI) and by-products is assessed as not likely to be achieved, operational adjustments will be made, as shown on Figure 2.2-5. Operations may be improved by adjusting extraction rates or taking further contingency measures, such as adding provisional extraction wells. If it is determined from the evaluation of concentrations and hydraulic control evaluation that control for Cr(VI) and/or by-products is needed in the shallow unit, extraction from intervals in the shallow unit will be considered as part of contingency plan implementation. If less extraction is needed to maintain hydraulic control of the target capture zone as defined in Section 4.3, extraction rates may be decreased.

If extraction rates need to be increased, the IRL injection system may need to be modified to accommodate increased injection rates (see Boxes 9 through 11 on Figure 2.2-5). Wells may be rehabilitated or the flow balance adjusted in the short term, while the addition of provisional injection wells can be considered in the long term if short-term increases in injection capacity are determined to be insufficient. If operational adjustments do not result in adequate control of the Cr(VI), additional contingency measures may be implemented.

***IRL DQO-5 Problem Statement: The naturally-occurring reducing rind will be monitored for changes in water quality.***

The decision statement for this DQO is: Do changes in the water quality parameters in the rind warrant additional investigation? Geochemical parameters indicative of reducing conditions in the floodplain reducing rind include low DO, low oxidation reduction potential (ORP), dissolved manganese and iron concentrations above detection

limits, dissolved arsenic, and potentially low concentrations of dissolved nitrate. The analytes in the groundwater are indicative of reducing conditions generated by the rind. These analytes will be monitored to assess the character of the reducing rind during remedy operations as inputs to the decision (see also Section 4.2.3 and Table 4.2-1). The study area is the floodplain groundwater. The data will be monitored over time to assess changes in the groundwater quality. Trends will also be evaluated in light of other various factors that could cause changes. For instance, implementation of the remedy will involve changes to the flow regime (flow rates and directions) within the floodplain, which may cause shifts in the steady state concentrations of redox indicators. In addition, baseline analyte concentrations within floodplain monitoring wells are highly variable. Therefore, although the greatest emphasis will be placed on shallow monitoring wells within the NTH IRZ downgradient and river bank extraction monitoring well networks, the entire dataset will be considered when evaluating the overall impact to the reducing rind, and multiple lines of investigation will be evaluated to understand the data trends. This will be necessary to provide the proper context on any apparent impacts for a given well in the network. For example, water quality may be highly variable in any given monitoring well in the floodplain, particularly when the flow regime is changed. Accordingly, changes in concentrations of redox parameters in any given well over a short timeframe may or may not be indicative of overall impacts to the reducing rind; the change will need to be assessed within the context of the entire dataset, and within the context of solute transport model predictions (Appendix B of the 90% BOD Report). The presence and effectiveness of the engineered reducing zone will also be considered when evaluating changes to the natural reducing zone. If broad changes to the reducing conditions occur, further investigations may be warranted. The types of additional investigations conducted will be dependent on the nature of the observations. These additional investigations may include (but would not be limited to) supplementary groundwater sampling for additional analytes and/or increased monitoring frequency, installation of provisional wells, and/or sampling of aquifer solids and solid-phase analyses. Decision errors will be limited through assessing multiple lines of geochemical evidence for assessing reducing rind impacts.

***IRL DQO-5 Problem Statement: The river bank extracted groundwater will be monitored for changes in water quality over time.***

The decision statement for this DQO is: Is there a change in water quality in extracted river bank water injected into IRL injection wells that merits agency notification? The inputs to the decision will be water quality data collected from the combined stream of extracted river bank water and analyzed for the suite of constituents per Table 5.2-4 in Section 5. For the purposes of the DQO, data are collected from the river bank extracted water, and the extracted water stream is therefore the “study area” for this DQO.

Action levels will serve as a mechanism to notify the agencies of changes in injected water quality. Initial concentrations of the combined extracted river bank water will be established at start-up and will guide the establishment of action levels. Data collected within the first six months of operation of the River Bank Extraction Wells will be considered initial extracted water concentrations. Section 4.2.6 details the planned sampling frequency for inorganic and organic constituents. For inorganic constituents, samples will be collected monthly for the first six months prior to switching to a quarterly frequency, providing six samples for the establishment of initial extracted water concentrations. The maximum concentration detected in the six samples will serve as the initial extracted water concentration for establishing action levels, as described in the next paragraph. The organic suite will be sampled once in the first year of operation. The majority of constituents included in the organic suite are anticipated to be non-detect, in which case the initial extracted water concentration would be established as less than the reporting limit. If an organic analyte is detected in the first samples collected, three additional samples will be collected for that analyte within the first six months of operations, and the initial extracted concentration will be established as the maximum concentration detected.

Action levels for agency notifications will be established for metals, herbicides, pesticides, volatile organic compounds (VOCs), polycyclic aromatic hydrocarbons (PAHs), and radionuclides. Exceptions to this rule include arsenic and manganese, for which monitoring will be implemented to satisfy the DQOs established in Section 2—i.e., Freshwater DQO-2 (see Section 2.2.4) and Compliance DQO-3 (see Section 2.1) and for which action levels were not set. Action levels will also be established for field constituents, anions, and other general chemistry

constituents that have an MCL/SMCL. This framework for establishing action levels is summarized in a flowchart format on Figure 2.2-10.

If the constituent is present in the initial samples of the extracted water, then the action level will be established as a 25% increase over the maximum initial extracted water concentration. If the constituent is not detected in the initial samples, then the action level will be established as a 25% increase over the reporting limit used for the analysis of the set of initial samples. If a site-wide background concentration representative of site-wide groundwater is available for a given constituent and is higher than a 25% increase over the maximum initial extracted water concentration, the action level will be 75% of the site-wide background concentration.

The decision flowchart outlining agency notification requirements is provided as Figure 2.2-11. If the constituent is detected in a sample above the action level, the sample will be reanalyzed if within holding time. If the holding time has been exceeded, a new sample will be collected and re-analyzed within 45 days. If the re-sample confirms the exceedance, the agencies will be notified and next steps will be considered. Next steps could include statistical analysis of the data to determine if the increase in concentration of the constituent is significant and/or additional monitoring of the extracted water source and groundwater monitoring wells.

### 2.2.3 Topock Compressor Station (TCS) Recirculation Loop

***TCS DQO-1 Problem Statement: TCS injection wells will be operated to treat Cr(VI) in groundwater beneath the TCS.***

The decision statement for this DQO is: should TCS loop injection well operations be modified to promote better hexavalent chromium treatment? The decision rules/operational framework for the TCS Injection Wells is shown on Figure 2.2-6. As inputs to the decision data will be collected from the TCS Recirculation Loop dose response monitoring wells (the study area), listed in Table 2.1-2 and shown on Figure 2.2-1. The sampling program for these wells, which define the study area boundaries, is detailed in Section 4.2.1 and summarized on Table 4.2-1. If TOC concentrations are less than anticipated and Cr(VI) is not treated to less than 32 µg/L in samples collected from dose response wells, than operational adjustments such as increasing TOC injection concentrations or changing dosing parameters will be considered. If by-product concentrations are above the anticipated range, consideration will be given to decreasing the TOC concentration or adjusting the dosing parameters.

In addition, the TCS injection wells will only be operated if the freshwater injection at FW-02 is operating at an effective injection rate to control potential Cr(VI) or in-situ by-product migration from the TCS injections. Results of the modeling effort indicate that the potential for westward flow from the TCS Injection Wells, and the resulting westward expansion of the plume, is sufficiently mitigated by the natural eastward flow gradient and the injection of fresh water at FW-2, located outside of the plume footprint, at a nominal rate of 50 gallons per minute (gpm) (i.e., more than double the combined nominal TCS injection flow rate of 24 gpm). Monitoring will be conducted to verify the model predictions, and lines of evidence that will be used to evaluate groundwater flow and plume control in the area west of the TCS Injection Wells will include: trends in analytical data (e.g., Cr(VI), by-products, and potentially TOC) collected from the TCS Recirculation Loop by-product monitoring wells located to the west of the TCS Injection Wells (Table 2.1-2); and comparison of groundwater elevation data/observed hydraulic gradients to model-predicted gradients. The concentration trend analysis will include an evaluation of consecutive monitoring events post-remedy startup to determine whether a statistically significant increase with time is observed relative to historical data at each TCS Recirculation Loop by-product monitoring well; trends in Cr(VI), by-product, and TOC concentrations will be considered within expectations if no statistically significant increase is observed. In addition, tracer testing may be implemented if other lines of evidence are inconclusive. The sampling program for the TCS Recirculation Loop by-product monitoring wells is summarized on Table 4.2-1. The process for data evaluation and operational adjustments is presented on the Figure 2.2-6 flowchart. Tracer injections may also be used if other lines of evidence are inconclusive. If the lines of evidence suggest that freshwater injection at FW-02 is not sufficient to control potential Cr(VI) or in-situ by-product migration from the TCS injections, then operational adjustments (e.g., adjusting injection rates) will be considered as shown on Figure 2.2-6. The Contingency Plan will be implemented if performance is not improved by the operational adjustments. Decision errors will be limited through monitoring does response wells to ensure they system is working properly.

***TCS DQO-2 Problem Statement: TCS Recirculation Loop Transwestern Bench Extraction Wells will be operated to remove Cr(VI) mass from the high concentration area in the vicinity of the TCS and control migration toward the East Ravine.***

The decision statement for this DQO is: should extraction system operations or configuration be changed to optimize Cr(VI) migration control? The decision rules/operational framework for the TCS Recirculation Loop Transwestern Bench extraction are shown on Figure 2.2-7. As inputs to the decision, data will be collected from the extracted groundwater and the Transwestern Bench extraction monitoring well network (the study area), listed in Table 2.1-2 and shown on Figure 2.2-1. These sampling programs are detailed in Sections 4.2.5 and 4.2.4, respectively, and summarized on Table 4.2-1. Multiple lines of evidence will be used to evaluate and optimize the hydraulic control of the Transwestern Bench extraction system, as outlined in Section 4.3 and shown on Figure 2.2-7. If additional control is needed, operational changes will be made such as increasing extraction rates or adding provisional extraction wells (see Boxes 5 and 6, Figure 2.2-7). Increased extraction rates would be attempted in the short term, while the addition of provisional extraction wells would be considered if short-term extraction rate increases were found to be insufficiently effective.

Decision errors will be limited through assessment and optimization of extraction effectiveness through multiple lines of evidence.

***TCS DQO-3 Problem Statement: East Ravine Extraction Wells will be operated to remediate Cr(VI) and control migration towards the river.***

The decision statement for this DQO is: Should extraction systems be changed to optimize Cr(VI) treatment and migration control? The decision rules/operational framework for the TCS Recirculation Loop East Ravine extraction system is shown on Figure 2.2-8. Inputs to the decision include analytical data and solute transport modeling. The study area includes and East Ravine extraction network, monitoring network, and surface water. Analytical data collected from East Ravine Extraction Wells (see also Section 4.2.5), monitoring wells (see also Section 4.2.4) and surface water sampling locations (see also Section 3), as well as water level data collected from the East Ravine extraction monitoring well network, will be used to adjust the flow model. These sampling locations are listed in Table 2.1-2, and the sampling programs are detailed in Sections 3 and 4. A lines-of-evidence approach will be used to evaluate the potential migration of Cr(VI), as discussed in further detail in Section 4.3. The proposed East Ravine Extraction Wells will be within the fractured bedrock; therefore, sufficient well depth will be important to (1) address depth of potential Cr(VI) in groundwater, and (2) allow for sufficient available drawdown in order to maximize groundwater extraction.

If hydraulic control is assessed to be inadequate, operational changes will be made such as adding provisional extraction wells to increase extraction rates if the existing extraction wells are operating at maximum capacity. However, if the East Ravine Extraction Wells are not operating at maximum capacity, increasing extraction rates in existing wells will be attempted (see Boxes 5 and 6 on Figure 2.2-8). If operational adjustments do not result in hydraulic control of the Cr(VI) plume, the Contingency Plan will be implemented.

If extraction rates are increased, the IRL injection system may need to be modified to accommodate increased injection rates (see Boxes 8 through 10 on Figures 2.2-7 and 2.2-8). Wells may be rehabilitated or the flow balance adjusted in the short term, while the addition of provisional injection wells can be considered in the long term if short-term increases in injection capacity are determined to be insufficient. Decision errors will be limited through evaluation of plume control.

## **2.2.4 Freshwater Injection**

***Freshwater DQO-1 Problem Statement: Freshwater injections will be operated to facilitate flushing of the Cr(VI) plume through the NTH IRZ and to contain carbon-amended water and in-situ by-products from the IRL.***

The decision statement for this DQO is: Should freshwater injection well operations be modified to facilitate flushing of the Cr(VI) plume and inner recirculation loop carbon-amended injection water? Inputs to the decision include Cr(VI) and extracted water quality data. The study area is the extracted water and monitoring wells, and the IRL injection wells and dose response wells. The decision rules for evaluating the development of hydraulic

gradients to facilitate Cr(VI) plume flushing is illustrated on Figure 2.2-9. Water level data will be collected across the site, and IRL injection downgradient monitoring wells (see also Section 4.2.2) will be used to assess Cr(VI) concentration changes. Monitoring well locations are listed in Table 2.1-2. Data collected will be compared to model output, and if necessary the model will be adjusted to better reflect field data. The model will then be used to project remedial timeframes, and the need for adjustments will be considered in the light of projected changes to the remedial timeframe or weaknesses in the remediation system. If needed, operational adjustments to the freshwater injections including increasing injection rates or adjusting the flow balance in the short term, as well as additional contingency measures such as adding injection wells, will be considered for implementation. Increasing injection rates in a given well will require either decreasing injection rates in other wells or increasing the extraction rate from the freshwater source. Changes to freshwater injection rates will be considered in concert with changes to River Bank Extraction Well flow rates (see Section 2.2.2).

Arsenic and manganese concentrations will be compared to expected concentrations in the IRL by-product monitoring wells, as summarized in Table 2.2-1. IRL by-product monitoring well locations, which define the study area boundaries, are shown in Figure 2.2-1 and listed in Table 2.1-2. The sampling program for these wells is detailed in Section 4.2.2. If concentration trends are not within expectations, short-term adjustments will be considered for implementation, similar to those listed above.

Decision errors will be limited through:

- Placement of monitoring wells within the plume in locations to collect data on flushing of hexavalent chromium concentration trends.
- Sample collection frequency based on solute transport modeling predictions (See Table 2.1-3, 2.1-4, and 2.1-5)
- Evaluation of timeframe predictions base on model re-calibration with installation and operational data.

***Freshwater DQO-2 Problem Statement: Freshwater injection will be operated to manage migration of arsenic injected from the freshwater source.***

The decision statement for this DQO is: should injection operations be modified to manage migration of arsenic injected from the freshwater source? The data collection program and decision rules for this DQO are based upon remedy requirements put forth by the State Water Resources Control Board (SWRCB) in a letter dated November 20, 2013 (the State Board letter; SWRCB 2013). The study area for this DQO is the vicinity of the injection wells that receive freshwater. Inputs to the decision are dissolved arsenic concentrations collected from the freshwater arsenic monitoring wells specified in Table 2.1-2. Additional water level data, analytical data, and operational data may also be used. Injection wells that may receive freshwater during the course of the remedy include proposed injection wells FW-1, FW-2, IRL-1, IRL-2, IRL-3, and IRL-4. Per the State Board letter, freshwater arsenic monitoring wells are planned as shown on Figure 2.2-1. Details on the locations of the freshwater arsenic monitoring wells are provided in Section 4.2.7.

Decision rules for management of arsenic injected from freshwater are presented on the right side of Figure 2.2-9. If the leading edge of the arsenic plume, i.e., arsenic concentrations at the concentration in the injected freshwater, is detected at monitoring wells located 150 feet from injection locations receiving freshwater, action will be triggered. First, samples will be collected to verify the detection within 45 days. If the detection is confirmed, the DTSC and DOI will be notified and response actions will be taken. Response actions will include re-assessment of the modeling calculations in conjunction with an evaluation of interim actions that can be taken to limit migration of the arsenic plume, if needed. These interim actions may include control of arsenic through operational adjustments, such as rebalancing freshwater and river bank water injections (flow rates, number, and/or location of injection wells receiving freshwater versus river bank water), aeration of freshwater prior to injection to reduce arsenic mobility, or triggering of the contingent arsenic treatment system (see Section 2.3 of Volume 3 of this O&M Manual). For MW-BB located at 90 feet from IRL-2, arrival of water with arsenic at the injected concentration in advance of model predicted arrival would trigger action. If arsenic concentrations in

advance of model predictions are triggered at MW-BB, updated model predictions will be used to assess whether the observed arsenic concentrations are anticipated to attenuate to less than 10 µg/L by 225 feet.

If dissolved arsenic is detected above the water quality objective of 10 µg/L at a 225-foot monitoring well due to injection of freshwater, then a verification sample will be collected and analyzed within 45 days. If the re-sample result confirms the exceedance, freshwater injection at the corresponding injection location will be shut down within 24 hours of receipt of the confirmation data, the DTSC and DOI will be notified, and the contingency plan will be implemented (Section 2.3 of Volume 3 of this O&M Manual). Implementation of the contingency plan may consist of pre-treatment for arsenic or evaluation of bringing online the contingent freshwater source (Site B well).

Note, the data collection and data evaluation described in this section apply to the 150- and 225-foot freshwater arsenic monitoring wells when freshwater is being injected at the associated injection well. When river bank water is injected, by-products (including arsenic) monitoring and data evaluation, will be conducted in accordance with Freshwater DQO-1. If arsenic concentrations and exceedances in the freshwater arsenic monitoring well network are related to the injection of river bank water or carbon amendment, rather than freshwater injection, the response actions would be modifications to the river bank injection or carbon amendment, rather than shutdown or modification of the freshwater injection.

***Freshwater DQO-3 Problem Statement: The freshwater source will be monitored for changes in water quality over time.***

The decision statement for this DQO is: Has there been a change in water quality in the freshwater source such that the agencies should be notified? The inputs to the decision will be water quality data collected from the freshwater source, i.e. the study area, and analyzed for the suite of constituents per Table 5.2.-4 in Section 5. For the purposes of the DQO, data is collected from the freshwater source, and the freshwater source stream is therefore the “study area” for this DQO.

Analytical data collected from the freshwater source will be used to track injected water quality based on action levels. Action levels will serve as a mechanism to notify the agencies of changes in water quality. Final action levels will be determined using initial data collected during startup of the freshwater injection system. These action levels will be selected according to the logic illustrated on Figure 2.2-10 and will be based on initial freshwater source data according to the same procedure as described above for IRL DQO-5. An action level for arsenic is not established given that this constituent will be evaluated under Freshwater DQO-2 according to SWRCB requirements. The decision flowchart outlining agency notification requirements and next steps is provided in Figure 2.2-11, as described above for IRL DQO-5. Next steps could include statistical analysis of the data to determine if the increase in concentration of the constituent is significant and/or additional monitoring of the freshwater source and groundwater monitoring wells.

Table 2.1-1  
Data Quality Objectives  
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Volume 2: Sampling and Monitoring Plan  
PG&E Topock Compressor Station, Needles, California

	1. State the Problem	2. Decision Statements	3. Inputs to the Decision	4. Study Area Boundaries	5. Decision Rules	6. Limits of Decision Errors	7. Optimize the Design for Data Collection
<b>COMPLIANCE</b>							
1) Surface Water (RAO 2)	The remedy must be implemented in compliance with RAO 2 (prevent or minimize migration of total chromium and hexavalent chromium to ensure concentrations in surface water do not exceed water quality standards).	Modify operations or remedy components to meet the RAO?	Surface water sampling results (Section 3.2, Table 2.1-3)	Surface water sampling location network.	<p>If Cr(VI), arsenic, or manganese concentrations increase in surface water samples and are attributable to the Topock site, operational changes will be implemented per the process control decision rules. (Figures 2.2-3, 2.2-5, 2.2-8)</p> <p>If Cr(VI), arsenic, or manganese concentrations do not return to baseline as a result of the operational adjustments, the contingency plan will be implemented.</p>	Limit decision error through: - Collection of samples upriver and downriver of potentially affected areas to accurately attribute concentration changes to the Topock site (Figure 2.1-1). - Quarterly to semi-annual data collection throughout the lifetime of remedy operations (Table 2.1-3).	See Section 3.1
2) Inside the Plume (RAO 3)	The remedy must be implemented in compliance with RAO 3 (reduce the mass of total chromium and hexavalent chromium in groundwater at the site to achieve compliance with ARARs in groundwater).	Modify operations or remedy components to meet the RAO?	hexavalent chromium concentration data from monitoring wells in the interior of the plume (Table 2.1-3).	Interior of the plume	<p>If hexavalent chromium concentrations are not decreasing within expected timeframes, operational changes (potentially including the addition of provisional IRZ wells) will be implemented per the process control decision rules (Figures 2.2-2 through 2.2-9).</p> <p>If operational changes do not improve the hexavalent chromium concentration trends, the contingency plan will be implemented.</p>	Limit decision error through: - Groundwater monitoring at multiple points distributed laterally and vertically across plume, spanning a range in anticipated cleanup timeframes (Figures 2.2-1, Tables 2.1-3, 2.1-4, 2.1-5). - Monitoring with a frequency consistent with anticipated cleanup timeframes (Table 2.1-3).	See Section 3.1
3) Outside the Plume (RAO 4)	The remedy must be implemented in compliance with RAO 4 (the target remediation area does not permanently expand following completion of the remedial action)	Modify operations or remedy components to meet the RAO?	hexavalent chromium and byproduct concentration data from monitoring wells outside of the baseline plume (Table 2.1-3)	Outside of the Plume	<p>If Cr(VI), arsenic or manganese concentrations increase and persist above long term expectations outside the baseline hexavalent chromium plume, operational changes will be implemented per the process control decision rules (Figures 2.2-1, 2.1-4, 2.2-9).</p> <p>If operational changes do not improve the Cr(VI), arsenic or manganese concentrations outside the baseline hexavalent chromium plume, the contingency plan will be implemented.</p>	Limit decision error through: - Collection of samples from outside of the baseline hexavalent chromium plume (Table 2.1-3, Figure 2.2-1). - Sampling frequency based on anticipated arrival times of water affected by various components of the remedy (Table 2.1-3). - Quarterly collection of water level data and continuous collection of transducer data to assess hydraulic performance, ensuring plume control (Table 2.1-3). - Comparison of Cr(VI) and byproduct dynamics with solute transport model predictions to assess performance .	See Section 3.1



Table 2.1-1  
Data Quality Objectives  
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	1. State the Problem	2. Decision Statements	3. Inputs to the Decision	4. Study Area Boundaries	5. Decision Rules	6. Limits of Decision Errors	7. Optimize the Design for Data Collection
<b>PROCESS CONTROL</b>							
<b>National Trails Highway In-Situ Reactive Zone (NTH IRZ)</b>							
	1 The carbon substrate amendment system must be working to amend the organic carbon substrate into the recirculated groundwater.	Is the carbon amendment system working properly?	Organic carbon samples collected from the MW-20 Bench and Transwestern Bench distribution systems (Exhibits 2.2-1 and 2.2-2).	Distribution systems.	If carbon amendment systems are not delivering desired TOC concentrations, troubleshooting and repair, if needed, will be conducted.	Limit decision error through: - Collection of samples at key system locations (Section 4.2.7, Exhibits 2.2-1 and 2.2-2). - Monthly data collection at start-up to ensure system is working properly and routine sampling thereafter (Section 2.2.1).	See Section 4
	2 The NTH IRZ must be complete and maintain hexavalent chromium treatment over time.	Modify operations of the NTH IRZ?  Start or stop NTH IRZ recirculation and organic carbon injections?  Modify the NTH IRZ design?  Modify the monitoring well layout?	Organic carbon, Cr(VI), and dissolved metals analytical data from NTH IRZ dose response and downgradient monitoring wells (Table 4.2-1).	Floodplain (NTH IRZ dose response and downgradient monitoring wells)	See decision rules/operational framework in Figure 2.2-2. If operational adjustments in Figure 2.2-2 are not sufficient to control hexavalent chromium migration in the Floodplain, refer to inner recirculation loop riverbank extraction decision rules on Figure 2.2-5	Limit decision error through: - Placement of monitoring well locations at the weak points of the IRZ (mid-point between injection locations) and downgradient (Section 4.2.1, 4.2.2, Figure 2.2-1, Table 2.1-2). - Collection of a variety of parameters to evaluate establishment of hexavalent chromium reducing conditions (Table 4.2-1). - Monthly to quarterly sampling during start-up and operational changes (Table 4.2-1).	See Section 4.2.6
	3 Byproduct generation and migration from the NTH IRZ must be controlled.	Modify NTH IRZ operations based on byproduct concentration trends?  Modify NTH IRZ design based on byproduct concentration trends?	Organic carbon and byproduct concentration data collected from dose response wells, downgradient monitoring wells, and Riverbank extraction monitoring wells located in the Floodplain (Table 4.2-1).	Floodplain downgradient of NTH IRZ (NTH IRZ dose response wells, downgradient monitoring wells, and Riverbank extraction monitoring wells)	See decision rules/operational framework in Figure 2.2-2. If operational adjustments in Figure 2.2-2 are not sufficient to control by-product generation and migration, refer to inner recirculation loop riverbank extraction decision rules on Figure 2.2-5	Limit decision error through: - Placement of monitoring wells at a variety of locations lateral and downgradient of injection wells (Sections 4.2.1, 4.2.2, Figure 2.2-1, Table 2.1-2). - Design sampling frequency to ensure observation of concentration changes, based on anticipated timeframe for concentration changes (Table 2.1-4, 2.1-5, 4.2-1).	See Section 4.2.1, 4.2.2
	4 Extraction on the north end of the NTH IRZ will be conducted to control hexavalent chromium with the NTH and Riverbank extraction systems.	Should extraction operations be modified to control hexavalent chromium migration on the north end of the NTH IRZ?	hexavalent chromium and water level data from monitoring wells on the north end of the NTH (Table 4.2-1). Groundwater modeling capture estimates. Surface water sampling hexavalent chromium data.	North end of the NTH IRZ (Northern extraction monitoring wells)	See decision rules/operational framework in Figure 2.2-3.	Limit decision error through: - A multiple lines of evidence performance assessment (Section 4.3). - Use of existing and additional monitoring wells for data collection. - <del>Monthly to</del> Quarterly data collection at start-up to ensure system is working properly.	Section 4.3
	5 Extraction will be conducted to minimize extraction of TOC and reduced metal by-products, e.g. iron and manganese.	Should operations be adjusted to minimize extraction of <del>treated</del> dissolved metals?	Water quality data collected from the NTH IRZ extraction wells (Table 4.2-1).	NTH IRZ	See decision rules/operational framework in Figure 2.2-2.	Limit decision error through: - Water quality monitoring at each NTH IRZ extraction well (Table 4.2-1, Section 4.2.5). - Quarterly or more frequent monitoring initially to evaluate extracted water quality (Table 4.2-1).	See Section 4.2.5

Table 2.1-1  
Data Quality Objectives  
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	1. State the Problem	2. Decision Statements	3. Inputs to the Decision	4. Study Area Boundaries	5. Decision Rules	6. Limits of Decision Errors	7. Optimize the Design for Data Collection
<b>Inner Recirculation Loop (IRL)</b>							
	1 Inner loop recirculation will be operated to facilitate flushing of the hexavalent chromium plume through the NTH IRZ.	Should inner recirculation loop injection well operations be modified to facilitate flushing of the hexavalent chromium plume?	Water level data and hexavalent chromium concentration data from across the site (Figure 2.2-1, Table 2.1-3).	Project Area	See decision rules/operational framework in Figure 2.2-4.	Limit decision error through: - Placement of monitoring wells within the plume in locations to collect data on flushing of hexavalent chromium concentration trends (Figure 2.2-1, Tables 2.1-2, 2.1-4, 2.1-5). - Sampling collection frequency based on solute transport modeling predictions (Tables 2.1-4, 2.1-5, 4.2-1). - Evaluation of timeframe predictions based on model re-calibrated with installation and operational data.	See Section 4
	2 Hexavalent chromium in groundwater extracted from the Riverbank extraction well system must be treated if levels exceed the target hexavalent chromium concentration.	Does water extracted from the Riverbank contain hexavalent chromium above background and require treatment?  If hexavalent chromium treatment is required, should carbon-amended injection well operations be modified to ensure hexavalent chromium treatment?  Are constituents in extracted water degrading injection well performance?	Water quality analytical data from samples collected from Riverbank extracted water (Section 4.2.3).  Organic carbon, Cr(VI), and dissolved metals analytical data from dose response wells (Section 4.2.1).  Injection well performance (O&M Manual Volume 1, Section 4).	Riverbank Extraction Monitoring Wells and Extraction Wells  Inner Recirculation Loop Dose Response Wells	See decision rules/operational framework in Figure 2.2-4.	Limit decision error through: - Collection of water quality data from individual extraction wells and from the combined stream (Section 4.2.5, Table 4.2-1). - Monitoring in the immediate vicinity of injection wells to ensure injected water is treated adequately (Section 4.2.1, Table 4.2-1). - Monthly to quarterly data collection at start-up, followed by continued quarterly monitoring to quickly address water quality changes (Table 4.2-1).	See Section 4
	3 Control migration of Cr(VI).	Should operations of Riverbank extraction wells be modified to improve control of hexavalent chromium in the Floodplain?  Are currently operating screen intervals of the Riverbank extraction wells sufficient to control the hexavalent chromium in the Floodplain?	Water level and hydraulic gradient data (contour maps and well pair analysis) (Section 4.3.3.1). Hexavalent chromium concentration trends in groundwater (Section 4.3.3.3). Groundwater modeling (Section 4.3.3.2). Surface water sampling hexavalent chromium data (4.3.3.3).	Focus on Riverbank extraction monitoring network and surface water sampling locations. Data from sitewide water level monitoring may also be used.	See decision rules/operational framework in Figure 2.2-5.	Limit decision error through: - A multiple lines of evidence performance assessment (Section 4.3). - Use of existing and additional monitoring wells for data collection (Table 2.1-2).	See Section 4.3

Table 2.1-1  
Data Quality Objectives  
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Volume 2: Sampling and Monitoring Plan  
PG&E Topock Compressor Station, Needles, California

	1. State the Problem	2. Decision Statements	3. Inputs to the Decision	4. Study Area Boundaries	5. Decision Rules	6. Limits of Decision Errors	7. Optimize the Design for Data Collection
<b>Inner Recirculation Loop (IRL) continued</b>							
	4 Control the migration of by-products.	Should operations of Riverbank extraction wells be modified to improve control of in situ by-products in the Floodplain?  Are currently operating screen intervals of the Riverbank extraction wells sufficient to control in situ by-products, above ambient levels, in the Floodplain?	Water level and hydraulic gradient data (contour maps and well pair analysis) (Section 4.3.3.1). Byproduct concentration trends in groundwater (Section 4.3.3.3). Groundwater modeling (Section 4.3.3.2). Surface water sampling for dissolved arsenic and manganese (Table 2.1-2).	Focus on Riverbank extraction monitoring network and surface water sampling locations. Data from sitewide water level monitoring may also be used.	See decision rules/operational framework in Figure 2.2-5.	Limit decision error through: - A multiple lines of evidence performance assessment (Section 4.3). - Use of existing and additional monitoring wells for data collection (Table 2.1-2).	See Section 4.3
	5 The naturally-occurring reducing rind will be monitored for changes in water quality	Do changes in the water quality parameters in the rind warrant additional investigation?	Geochemical data and water levels from fluvial monitoring wells (Section 2.2.2)	Floodplain Fluvial Aquifer	See section 2.2.2	Limit decision error through: - Assessing multiple geochemical lines of evidence for assessing reducing rind impacts (Section 2.2.2).	See Section 4
	6 The Riverbank extracted groundwater will be monitored for changes in water quality over time.	Is there a change in water quality in extracted Riverbank water injected into IRL injection wells that merits agency notification?	Riverbank extraction stream groundwater quality data (Section 4.2.6)	Riverbank Extraction pipeline	See Figures 2.2-10 and 2.2-11	Limit decision error through: -Collection of quarterly to biannual from the riverbank extraction stream (Section 4.2.6) -Establishment of action levels	See Section 4.2.6
<b>Topock Compressor Station (TCS) Recirculation Loop</b>							
	1 TCS injection wells will be operated to treat hexavalent chromium in groundwater beneath the compressor station	Should TCS loop injection well operations be modified to promote better hexavalent chromium treatment?	Organic carbon, Cr(VI), and dissolved metals analytical data from monitoring wells downgradient of the injection wells (Section 4.2.1).	TCS loop dose response and downgradient monitoring wells	See decision rules/operational framework in Figure 2.2-6.	Limit decision error through: - Monitoring of dose response wells to ensure system is working properly (Section 4.2.1, Table 4.2-1).	See Section 4
	2 TCS loop Transwestern bench extraction wells will be operated to remove hexavalent chromium mass from the high concentration area in the vicinity of the TCS and control migration toward the East Ravine.	Should extraction system operations or configuration be changed to optimize hexavalent chromium migration control?	hexavalent chromium analytical and water level data from TCS loop embayment extraction monitoring wells Groundwater modeling. (Section 4.3)	TCS Loop Transwestern bench extraction monitoring wells	See decision rules/operational framework in Figure 2.2-7.	Limit decision error through: - Assessment and optimization of extraction effectiveness through multiple lines of evidence.	See Section 4.3

Table 2.1-1  
Data Quality Objectives  
Groundwater Remedy Operation and Maintenance Manual  
Volume 2: Sampling and Monitoring Plan  
PG&E Topock Compressor Station, Needles, California

	1. State the Problem	2. Decision Statements	3. Inputs to the Decision	4. Study Area Boundaries	5. Decision Rules	6. Limits of Decision Errors	7. Optimize the Design for Data Collection
<b>Topock Compressor Station (TCS) Recirculation Loop continued</b>							
	3 East Ravine extraction wells will be operated to remediate hexavalent chromium and control migration towards the river	Should extraction system operations or configuration be changed to optimize hexavalent chromium treatment and migration control?	hexavalent chromium analytical data from East Ravine monitoring and extraction wells Water level data from monitoring well network Surface water sampling hexavalent chromium data. (Section 4.3)	TCS Loop East Ravine extraction monitoring wells and surface water	See decision rules/operational framework in Figure 2.2-8.	Limit decision error through: - A multiple lines of evidence evaluation of plume control (Section 4.3).	See Section 4.3
<b>Freshwater Injection</b>							
	1 Freshwater injections will be operated to facilitate flushing of the hexavalent chromium plume through the NTH IRZ and to contain carbon-amended water and in-situ by-products from the inner recirculation loop	Should freshwater injection well operations be modified to facilitate flushing of the hexavalent chromium plume and inner recirculation loop carbon-amended injection water?	Water level data from across the site and analytical data from freshwater injection observation wells (Figure 2.2-1, Table 2.1-3)	Project Area	See decision rules/operational framework in Figure 2.2-9.	Limit decision error through: - Placement of monitoring wells within the plume in locations to collect data on flushing of hexavalent chromium concentration trends (Figure 2.2-1, Table 2.1-3). - Sampling collection frequency based on solute transport modeling predictions (Table 2.1-3, 2.1-4, 2.1-5). - Evaluation of timeframe predictions based on model re-calibrated with installation and operational data.	See Section 4
	2 Freshwater injection will be operated to manage migration of arsenic injected from the freshwater source.	Should injection operations be modified to manage migration of arsenic injected from the freshwater source?	Dissolved arsenic concentrations collected from the freshwater arsenic monitoring wells (Table 4.2-1).	Vicinity of injection wells receiving freshwater.	See decision rules/operational framework in Figure 2.2-9.	Limit decision error through: -sampling at specified distances 150 and 225 feet from injection locations, where possible (Section 4.2.7, Table 2.1-2)	Monitoring network based on modeling per State Board letter dated November 20, 2013.
	3 The freshwater source will be monitored for changes in water quality over time.	Has there been a change in water quality in the freshwater source such that the agencies should be notified?	Freshwater source water quality data (Section 4.2.6)	Freshwater pipeline	See Figures 2.2-10 and 2.2-11	Limit decision error through: -Collection of quarterly to biannual samples from the freshwater source (Section 4.2.6) -Establishment of action levels (Figure 2.2-10)	See Section 4.2.6

Table 2.1-2  
Monitoring Program Wells and Surface Water Sampling Points  
Groundwater Remedy Operation and Maintenance Manual  
Volume 2: Sampling and Monitoring Plan  
PG&E Topock Compressor Station, Needles, California

Location ID	Screened/ Monitored Interval (Model Layers)	Screened/Monitored Interval (Monitoring Zones)	Compliance Monitoring		Process Control Monitoring																Potentially Monitored Continuously via Transducer	Analyte Sampling Frequencies																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																		
	Layer 1 Layer 2 Layer 3 Layer 4 Layer 5	SA-Fluvial MA-Fluvial DA-Fluvial PA-Alluvial SA-Alluvial MA-Alluvial DA-Alluvial BR-Tmc BR-pTbr	Location relative to Chromium plume			National Trails Highway In-Situ Reactive Zone				Inner Recirculation Loop (IRL)				Topock Compressor Station (TCS) Loop								Fresh- water Injection	Hexavalent Chromium	Total Chromium	Total Organic Carbon	Dissolved Arsenic	Dissolved Manganese	Dissolved Iron	Dissolved Barium	Nitrate	Nitrite and Ammonium <sup>11</sup>	Molyb- denum	Selen- ium	Sulfate	Total Dissolved Solids	Alkalinity	Cations/ Anions																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																			
			Outside Plume <sup>10</sup>	Inside Plume	Surface Water	Dose Response Wells <sup>1</sup>	Downgradient Monitoring Wells Riverbank and Northern NTH Extraction Wells	Riverbank Extraction Monitoring Wells	Northern NTH IRZ Extraction Monitoring Wells	Dose Response Wells <sup>1</sup>	Downgradient Monitoring Well	Byproduct Monitoring Well	Water Level Monitoring Well (for IRL and Freshwater Injections)	Dose Response Wells <sup>1</sup>	Downgradient Monitoring Well	Byproduct Monitoring Well	Transwestern Bench and East Ravine Extraction Wells	Transwestern Bench Extraction Monitoring Wells	East Ravine Extraction Monitoring Wells	Arsenic Monitoring Wells																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																				
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	Layer 1 Layer 2 Layer 3 Layer 4 Layer 5					SA-Fluvial MA-Fluvial DA-Fluvial PA-Alluvial SA-Alluvial MA-Alluvial DA-Alluvial BR-Tmc BR-pTbr					Location relative to Chromium plume			National Trails Highway In-Situ Reactive Zone				Inner Recirculation Loop (IRL)				Topock Compressor Station (TCS) Loop						Fresh- water Injection	Hexavalent Chromium  Total Chromium  Total Organic Carbon  Dissolved Arsenic  Dissolved Manganese  Dissolved Iron  Dissolved Barium  Nitrate  Nitrite and Ammonium <sup>11</sup>  Molyb- denum  Selen- ium  Sulfate  Total Dissolved Solids  Alkalinity  Cations/ Anions																		
											Outside Plume <sup>10</sup>  Inside Plume  Surface Water			Dose Response Wells <sup>1</sup>  Downgradient Monitoring Wells Riverbank and Northern NTH Extraction Wells Riverbank Extraction Monitoring Wells Northern NTH IRZ Extraction Monitoring Wells				Dose Response Wells <sup>1</sup>  Downgradient Monitoring Well Byproduct Monitoring Well Water Level Monitoring Well (for IRL and Freshwater Injections)				Dose Response Wells <sup>1</sup>  Downgradient Monitoring Well Byproduct Monitoring Well Transwestern Bench and East Ravine Extraction Wells Transwestern Bench Extraction Monitoring Wells East Ravine Extraction Monitoring Wells						Arsenic Monitoring Wells																			
MW-36-070		X					X						X			X												X	Q	SA	Q	Q	Q	Q	Q	Q	As needed <sup>2</sup>				As needed	As needed	As needed	As needed			
MW-36-090			X	X				X					X			X												X	Q	SA	Q	Q	Q	Q	Q	Q				As needed	As needed	As needed	As needed				
MW-36-100				X	X			X					X			X												X	Q	SA	Q	Q	Q	Q	Q	Q				As needed	As needed	As needed	As needed				
MW-37D			X																X										SA	SA			SA	SA	SA	SA <sup>3</sup>	Q			A		A	As needed	As needed	As needed	As needed	
MW-37S	X									X				X					X										SA	SA			SA	SA	SA	SA <sup>3</sup>	Q			A		A	As needed	As needed	As needed	As needed	
MW-38D				X																									BE	BE		As needed	BE	BE	BE	BE											
MW-38S	X	X								X																			BE	BE			BE	BE	BE	BE											
MW-39-040	X						X							X															Q	SA		Q	Q	Q	Q	Q	As needed <sup>2</sup>				As needed	As needed	As needed	As needed			
MW-39-050		X						X						(X)					X		X							X	Q	SA		Q	Q	Q	Q	Q	Q				As needed	As needed	As needed	As needed			
MW-39-060			X											(X)					X		X							X	Q	SA		Q	Q	Q	Q	Q				As needed	As needed	As needed	As needed				
MW-39-070				X										(X)					X		X							X	Q	SA		Q	Q	Q	Q	Q				As needed	As needed	As needed	As needed				
MW-39-080			X	X										(X)					X		X							X	Q	SA		Q	Q	Q	Q	Q				As needed	As needed	As needed	As needed				
MW-39-100				X															X		X							X	Q	SA		Q	Q	Q	Q	Q				As needed	As needed	As needed	As needed				
MW-40D				X																									BE	BE																	
MW-40S	X	X								X						X													BE	BE																	
MW-41D					X											X											X		SA	SA		SA		SA	SA	SA <sup>3</sup>	As needed				As needed	As needed	As needed	As needed			
MW-41M				X												X											X		SA	SA		SA		SA	SA	SA <sup>3</sup>	Q				As needed	As needed	As needed	As needed			
MW-41S	X									X						X											X		SA	SA		SA		SA	SA	SA <sup>3</sup>	Q				As needed	As needed	As needed	As needed			
MW-42-030	X	X					X									X				X		X						X	Q	SA		Q	Q	Q	Q	Q	A			A	As needed	As needed	As needed	As needed			
MW-42-055			X					X								X				X		X						X	Q	SA		Q	Q	Q	Q	Q	As needed <sup>2</sup>				As needed	As needed	As needed	As needed			
MW-42-065				X				X								X				X		X						X	Q	SA		Q	Q	Q	Q	Q	As needed <sup>2</sup>				As needed	As needed	As needed	As needed			
MW-43-025	X						X									X				X		X						X	Q	SA		Q	Q	Q	Q	Q	A			A	As needed	As needed	As needed	As needed			
MW-43-075			X						X							X				X		X						X	Q	SA		Q	Q	Q	Q	Q	As needed <sup>2</sup>				As needed	As needed	As needed	As needed			
MW-43-090				X	X				X							X				X		X						X	Q	SA		Q	Q	Q	Q	Q	As needed <sup>2</sup>				As needed	As needed	As needed	As needed			
MW-44-070		X						X								X				X		X						X	Q	SA		Q	Q	Q	Q	Q	A			A	As needed	As needed	As needed	As needed			
MW-44-115				X												X				X		X						X	Q	SA		Q	Q	Q	Q	Q	A			A	As needed	As needed	As needed	As needed			
MW-44-125				X	X											X				X		X						X	Q	SA		Q	Q	Q	Q	Q	A			A	As needed	As needed	As needed	As needed			
MW-45-095 <sup>6</sup>				X					X													X						X	Q	SA		Q	Q	Q	Q	Q	Q				A	As needed	As needed	As needed	As needed		
MW-46-175			X	X												X				X		X						X	Q	SA		Q	Q	Q	Q	Q	A			A	As needed	As needed	As needed	As needed			
MW-46-205				X												X				X		X						X	Q	SA		Q	Q	Q	Q	Q	A			A	As needed	As needed	As needed	As needed			
MW-47-055	X									X				(X)					X										M(yr), Q	Q (yr), SA		M(yr), Q	M(yr), Q	M(yr), Q	M(yr), Q	M(yr), Q	M(yr), Q	Q(yr)			A	As needed	As needed	As needed	As needed		
MW-47-115		X												X					X										M(yr), Q	Q (yr), SA		M(yr), Q	M(yr), Q	M(yr), Q	M(yr), Q	M(yr), Q	M(yr), Q	Q(yr)			A	As needed	As needed	As needed	As needed		
MW-48					X											X													Q	SA							A			A	As needed	As needed	As needed	As needed			
MW-49-135	X															X												X	Q	SA		Q	Q	Q	Q	Q	Q				A	As needed	As needed	As needed	As needed		
MW-49-275			X													X												X	Q	SA		Q	Q	Q	Q	Q	Q				As needed	As needed	As needed	As needed			
MW-49-365				X																																											



Table 2.1-2  
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Location ID	Screened/ Monitored Interval (Model Layers)	Screened/Monitored Interval (Monitoring Zones)	Compliance Monitoring		Process Control Monitoring														Fresh- water Injection	Potentially Monitored Continuously via Transducer	Analyte Sampling Frequencies																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																												
			Location relative to Chromium plume			National Trails Highway In-Situ Reactive Zone				Inner Recirculation Loop (IRL)				Topock Compressor Station (TCS) Loop							Analyte Sampling Frequencies																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																												
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			Location relative to Chromium plume			National Trails Highway In-Situ Reactive Zone				Inner Recirculation Loop (IRL)				Topock Compressor Station (TCS) Loop				Fresh- water Injection	Hexavalent Chromium	Total Chromium	Total Organic Carbon	Dissolved Arsenic	Dissolved Manganese	Dissolved Iron	Dissolved Barium	Nitrate	Nitrite and Ammonium <sup>11</sup>	Molyb- denum	Selen- ium	Sulfate	Total Dissolved Solids	Alkalinity	Cations/ Anions					
			Outside Plume <sup>10</sup>	Inside Plume	Surface Water	Dose Response Wells <sup>1</sup>	Downgradient Monitoring Wells	Riverbank and Northern NTH Extraction Wells	Riverbank Extraction Monitoring Wells	Northern NTH IRZ Extraction Monitoring Wells	Dose Response Wells <sup>1</sup>	Downgradient Monitoring Well	Byproduct Monitoring Well	Water Level Monitoring Well (for IRL and Freshwater Injections)	Dose Response Wells <sup>1</sup>	Downgradient Monitoring Well																		Byproduct Monitoring Well	Transwestern Bench and East Ravine Extraction Wells	Transwestern Bench Extraction Monitoring Wells	East Ravine Extraction Monitoring Wells	Arsenic Monitoring Wells
MW-W			X				X					X									X	Q	SA	Q	Q	Q	Q	Q	Q <sup>2</sup>		A	A	As needed	As needed	As needed	As needed		
MW-X			X						X				X									X	A	A	A	As needed	As needed	As needed	As needed	As needed				As needed	As needed	As needed	As needed	
MW-Y			X						X				X									X	A	A	A	As needed	As needed	As needed	As needed				As needed	As needed	As needed	As needed		
MW-Z			X										X										SA	SA	SA	SA	SA	SA <sup>3</sup>	As needed				As needed	As needed	As needed	As needed		
MW-AA			X										X								X					Q												
MW-BB			X										X								X					Q												
MW-CC			X										X								X					Q												
MW-DD			X										X								X					Q												
MW-FF			X										X								X					Q												
MW-GG			X										X								X					Q												
MW-HH				X									X								X					Q												
MW-II				X									X				X				X				As needed	Q		A	A	A			A					
MW-10D				X									X				X						A	A	As needed	A	A	A	A	A			A					
MW-11D				X									X				X						BE	BE	As needed	BE	BE	BE	BE									
MW-70BR-D				X									X				X			X		X		Q	BE	SA						A						
Provisional Monitoring Wells																																						
MW-V			X								X			X			X					SA	SA	As needed	A	A	A	A										
MW-EE <sup>12</sup>			X								X			X					X						Q													
Unspecified slant wells			X								X			X						X		SA	SA					As needed		As needed	As needed	As needed	As needed	As needed	As needed	As needed		
Extraction Wells																																						
IRZ-1								X												X	M(Q), Q		M(Q), Q	M(Q), Q	M(Q), Q	M(Q), Q	M(Q), Q	M(Q), Q						As needed	As needed	As needed		
IRZ-5								X												X	M(Q), Q		M(Q), Q	M(Q), Q	M(Q), Q	M(Q), Q	M(Q), Q	M(Q), Q						As needed	As needed	As needed		
IRZ-9								X												X	M(Q), Q		M(Q), Q	M(Q), Q	M(Q), Q	M(Q), Q	M(Q), Q	M(Q), Q						As needed	As needed	As needed		
IRZ-23								X												X	M(Q), Q		M(Q), Q	M(Q), Q	M(Q), Q	M(Q), Q	M(Q), Q	M(Q), Q						As needed	As needed	As needed		
RB-1								X												X	M(Q), Q		M(Q), Q	M(Q), Q	M(Q), Q	M(Q), Q	M(Q), Q	M(Q), Q						As needed	As needed	As needed		
RB-2								X												X	M(Q), Q		M(Q), Q	M(Q), Q	M(Q), Q	M(Q), Q	M(Q), Q	M(Q), Q						As needed	As needed	As needed		
RB-3								X												X	M(Q), Q		M(Q), Q	M(Q), Q	M(Q), Q	M(Q), Q	M(Q), Q	M(Q), Q						As needed	As needed	As needed		
RB-4								X												X	M(Q), Q		M(Q), Q	M(Q), Q	M(Q), Q	M(Q), Q	M(Q), Q	M(Q), Q						As needed	As needed	As needed		
RB-5								X												X	M(Q), Q		M(Q), Q	M(Q), Q	M(Q), Q	M(Q), Q	M(Q), Q	M(Q), Q						As needed	As needed	As needed		
TWB-1																	X			X	M(Q), Q		M(Q), Q	M(Q), Q	M(Q), Q	M(Q), Q	M(Q), Q	M(Q), Q						As needed	As needed	As needed		
TWB-2																	X			X	M(Q), Q		M(Q), Q	M(Q), Q	M(Q), Q	M(Q), Q	M(Q), Q	M(Q), Q						As needed	As needed	As needed		
ER-1																	X			X	M(Q), Q		M(Q), Q	M(Q), Q	M(Q), Q	M(Q), Q	M(Q), Q	M(Q), Q						As needed	As needed	As needed		
ER-2																	X			X	M(Q), Q		M(Q), Q	M(Q), Q	M(Q), Q	M(Q), Q	M(Q), Q	M(Q), Q						As needed	As needed	As needed		
ER-3																	X			X	M(Q), Q		M(Q), Q	M(Q), Q	M(Q), Q	M(Q), Q	M(Q), Q	M(Q), Q						As needed	As needed	As needed		
ER-4																	X			X	M(Q), Q		M(Q), Q	M(Q), Q	M(Q), Q	M(Q), Q	M(Q), Q	M(Q), Q						As needed	As needed	As needed		
ER-6																	X			X	M(Q), Q		M(Q), Q	M(Q), Q	M(Q), Q	M(Q), Q	M(Q), Q	M(Q), Q						As needed	As needed	As needed		
Surface Water Sampling Locations																																						
C-NR4 (River channel)					X				X													Q	SA			Q	Q			A		A	A					
C-NR3 (River channel)					X				X													Q	SA			Q	Q			A		A	A					
C-NR1 (River channel)					X				X													Q	SA			Q	Q			A		A	A					
C-CON (River channel)					X				X													Q	SA			Q	Q			A		A	A					
C-MAR (River channel)					X				X													Q	SA			Q	Q			A		A	A					
C-R27 (River channel)					X				X													Q	SA			Q	Q			A		A	A					
C-BNS (River channel)					X				X													Q	SA			Q	Q			A		A	A					
C-R-22A (River channel)					X				X										X			Q	SA			Q	Q			A		A	A					
C-I-3 (River channel)					X				X										X			Q	SA			Q	Q			A		A	A					
C-TAZ (River channel)					X				X										X			Q	SA			Q	Q			A		A	A					
RBB (Shoreline)					X				X													Q	SA			Q	Q			A		A	A					
R-19 (Shoreline)					X				X													Q	SA			Q	Q			A		A	A					
R-28 (Shoreline)					X				X													Q	SA			Q	Q			A		A	A					
R-63 (Shoreline)					X				X										X			Q	SA			Q	Q			A		A	A					
SW-1 (East Ravine)					X				X										X			Q	SA			Q	Q			A		A	A					
SW-2 (East Ravine)					X				X										X			Q	SA			Q	Q			A		A	A					

Notes appear on the following page.

Table 2.1-2  
Monitoring Program Wells and Surface Water Sampling Points  
Groundwater Remedy Operation and Maintenance Manual  
Volume 2: Sampling and Monitoring Plan  
PG&E Topock Compressor Station, Needles, California

Location ID	Screened/ Monitored Interval (Model Layers)	Screened/Monitored Interval (Monitoring Zones)	Compliance Monitoring		Process Control Monitoring											Potentially Monitored Continuously via Transducer	Analyte Sampling Frequencies																
			Location relative to Chromium plume			National Trails Highway In-Situ Reactive Zone				Inner Recirculation Loop (IRL)				Topock Compressor Station (TCS) Loop					Fresh- water Injection														
	Layer 1 Layer 2 Layer 3 Layer 4 Layer 5	SA-Fluvial MA-Fluvial DA-Fluvial PA-Alluvial SA-Alluvial MA-Alluvial DA-Alluvial BR-Tmc BR-pTbr	Outside Plume <sup>10</sup>  Inside Plume  Surface Water	Dose Response Wells <sup>1</sup>  Downgradient Monitoring Wells Riverbank and Northern NTH Extraction Wells Riverbank Extraction Monitoring Wells Northern NTH IRZ Extraction Monitoring Wells	Dose Response Wells <sup>1</sup>  Downgradient Monitoring Well Byproduct Monitoring Well Water Level Monitoring Well (for IRL and Freshwater Injections)	Dose Response Wells <sup>1</sup>  Downgradient Monitoring Well Byproduct Monitoring Well Transwestern Bench and East Ravine Extraction Wells Transwestern Bench Extraction Monitoring Wells East Ravine Extraction Monitoring Wells	Arsenic Monitoring Wells	Hexavalent Chromium	Total Chromium	Total Organic Carbon	Dissolved Arsenic	Dissolved Manganese	Dissolved Iron	Dissolved Barium	Nitrate		Nitrite and Ammonium <sup>11</sup>	Molyb- denum	Selen- ium	Sulfate	Total Dissolved Solids	Alkalinity	Cations/ Anions										

**Notes:**  
Sampling program will be re-evaluated after two years of operation.  
<sup>1</sup> Dose Response Wells are defined as within the carbon footprint as predicted by the fate and transport model.  
<sup>2</sup> Baseline data indicate no detectable nitrate.  
<sup>3</sup> If associated injection well is amended with carbon  
<sup>4</sup> A deeper boring and replacement monitoring well will be constructed at this location if the alluvium is deeper in this area.  
<sup>5</sup> Well was influenced by historical in-situ pilot testing and may be sampled periodically to evaluate persistence of byproducts/reducing conditions.  
<sup>6</sup> Two wells MW-45-095a and MW-45-095b exist at this location and are screened within the same interval. MW-45-095a is currently active and MW-45-095b is considered inactive.  
<sup>7</sup> Well is currently inactive.  
<sup>8</sup> As approved in the first quarter of 2013, packers have been removed and single zone micro-purge sampling is being performed at 165 feet in MW-58BR and at 255 feet in MW-64BR.  
<sup>9</sup> If sampling at TW-1 fails to provide adequate data, TW-1 will be removed from the monitoring program in the future and, if necessary, replaced.  
<sup>10</sup> Parentheses (X) indicate hexavalent chromium has previously been detected at concentrations greater than 32 micrograms per liter at this location.  
<sup>11</sup> Ammonium and nitrite will be monitored for the first year. If not detected within the first year of monitoring, sampling for these analytes will be discontinued. If increases in ammonium or nitrite concentrations are detected in dose response wells, recommendations for continued sampling and potential expansion of the monitoring network for these analytes will be provided.  
<sup>12</sup> Pending/future provisional

**Frequencies:**  
T: Potentially monitored continuously via transducer  
M: Monthly  
Q: Quarterly  
SA: Semi-Annually  
A: Annually  
BE: Biennially  
(yr): Frequency for the first year/month/quarter, frequency reduction to be considered thereafter

Table 2.1-3  
Compliance Monitoring Program  
Groundwater Remedy Operation and Maintenance Manual  
Volume 2: Sampling and Monitoring Plan  
PG&E Topock Compressor Station, Needles, California

Well ID	Process Control Monitoring Well Category	Analyte Sampling Frequencies <sup>3</sup>			
		Cr(VI)	Cr(T)	Dissolved Byproducts	Water Levels
Compliance Monitoring Wells: Outside Plume					
MW-A	Northern NTH Extraction	Q	SA	---	Q, T
MW-B	Northern NTH Extraction	Q	SA	---	Q, T
MW-I	IRL Byproduct	SA	SA	SA (Mn, As)	Q
MW-J	IRL Byproduct	SA	SA	SA (Mn, As)	Q
MW-O	Riverbank Extraction	Q(yr), SA	Q(yr), SA	Q(yr), SA (Mn, As)	Q, T
MW-P	IRL Dose Response	Q	Q(yr), SA	---	Q
MW-Q	IRL Dose Response	Q	Q(yr), SA	---	Q
MW-S	Water Level Monitoring	A <sup>4</sup>	A <sup>4</sup>	---	Q
MW-U	Water Level Monitoring	BE <sup>5</sup>	BE <sup>5</sup>		Q
MW-V	TCS Loop Byproduct (provisional)	SA	SA	A (As, Mn)	Q
MW-W	Riverbank Extraction; NTH IRZ Downgradient	Q	SA	Q (Mn, As)	Q, T
MW-X	Riverbank Extraction	Q	SA	As needed	Q, T
MW-Y	Riverbank Extraction	Q	SA	As needed	Q, T
MW-Z	Water Level Monitoring	SA	SA		Q
MW-AA	Arsenic Monitoring	---	---	Q (As)	Q
MW-BB	Arsenic Monitoring	---	---	Q (As)	Q
MW-CC	Arsenic Monitoring	---	---	Q (As)	Q
MW-DD	Arsenic Monitoring	---	---	Q (As)	Q
MW-EE	Arsenic Monitoring (pending/future provisional)	---	---	Q (As)	Q
MW-FF	Arsenic Monitoring	---	---	Q (As)	Q
MW-GG	Arsenic Monitoring	---	---	Q (As)	Q
CW-01D	Water Level Monitoring	A <sup>4</sup>	A <sup>4</sup>	---	Q
CW-01M	Water Level Monitoring	A <sup>4</sup>	A <sup>4</sup>	---	Q
CW-02D	IRL Byproduct; Arsenic Monitoring	SA <sup>4</sup>	SA <sup>4</sup>	SA (Mn, As)	Q
CW-02M	IRL Byproduct; Arsenic Monitoring	SA <sup>4</sup>	SA <sup>4</sup>	SA (Mn, As)	Q
CW-03D	IRL Byproduct	SA <sup>4</sup>	SA <sup>4</sup>	SA (Mn, As)	Q
CW-03M	IRL Byproduct	SA <sup>4</sup>	SA <sup>4</sup>	SA (Mn, As)	Q
CW-04D	Water Level Monitoring	A <sup>4</sup>	A <sup>4</sup>	---	Q
CW-04M	Water Level Monitoring	A <sup>4</sup>	A <sup>4</sup>	---	Q
MW-13	IRL Downgradient	SA	SA	---	Q
MW-14*	IRL Dose Response	Q	Q(yr), SA	---	Q
MW-15*	Water Level Monitoring	BE <sup>5</sup>	BE <sup>5</sup>	---	Q
MW-21	NTH IRZ Dose Response	M(yr), Q	Q(yr), SA	---	Q
MW-22 <sup>8</sup>	NTH IRZ Downgradient; Riverbank Extraction	M(yr), Q	Q(yr), SA	SA (Mn, As)	Q, T
MW-23-080*	East Ravine Extraction	Q	SA	---	Q, T
MW-24BR*	Water Level Monitoring	Q <sup>5</sup>	Q <sup>5</sup>	---	Q
MW-27-020	Riverbank Extraction	Q	SA	Q (Mn, As)	Q, T
MW-27-060	Riverbank Extraction	Q	SA	Q (Mn, As)	Q, T
MW-27-085	Riverbank Extraction	Q	SA	Q (Mn, As)	Q, T
MW-28-025	Riverbank Extraction	Q	SA	Q (Mn, As)	Q, T
MW-28-090	Riverbank Extraction	Q	SA	Q (Mn, As)	Q, T
MW-29	Riverbank Extraction	Q	SA	Q (Mn, As)	Q, T
MW-30-030	NTH IRZ Downgradient; Riverbank Extraction	Q	SA	Q (Mn, As)	Q, T
MW-30-050*	NTH IRZ Downgradient; Riverbank Extraction	Q	SA	Q (Mn, As)	Q, T
MW-31-135*	Water Level Monitoring	BE <sup>7</sup>	BE <sup>7</sup>	---	Q
MW-32-20	NTH IRZ Downgradient; Riverbank Extraction	Q	SA	Q (Mn, As)	Q, T
MW-32-35	NTH IRZ Downgradient; Riverbank Extraction	Q	SA	Q (Mn, As)	Q, T
MW-33-040	NTH IRZ Downgradient; Riverbank Extraction	Q	SA	Q (Mn, As)	Q, T
MW-33-090	NTH IRZ Downgradient; Riverbank Extraction	Q	SA	Q (Mn, As)	Q, T
MW-33-150	NTH IRZ Downgradient; Riverbank Extraction	Q	SA	Q (Mn, As)	Q, T
MW-33-210	NTH IRZ Downgradient; Riverbank Extraction	Q	SA	Q (Mn, As)	Q, T
MW-34-055	Riverbank Extraction	Q	SA	Q (Mn, As)	Q, T
MW-34-080*	Riverbank Extraction	Q	SA	Q (Mn, As)	Q, T
MW-35-60*	Northern NTH Extraction	Q	SA	---	Q, T
MW-35-135*	Northern NTH Extraction	Q	SA	---	Q, T
MW-36-020	NTH IRZ Downgradient; Riverbank Extraction	Q	SA	Q (Mn, As)	Q, T
MW-36-040	NTH IRZ Downgradient; Riverbank Extraction	Q	SA	Q (Mn, As)	Q, T
MW-36-050	NTH IRZ Downgradient; Riverbank Extraction	Q	SA	Q (Mn, As)	Q, T
MW-36-070	NTH IRZ Downgradient; Riverbank Extraction	Q	SA	Q (Mn, As)	Q, T
MW-36-090*	NTH IRZ Downgradient; Riverbank Extraction	Q	SA	Q (Mn, As)	Q, T
MW-37S	IRL Downgradient	SA	SA	---	Q
MW-39-040	NTH IRZ Downgradient; Riverbank Extraction	Q	SA	Q (Mn, As)	Q, T
MW-39-050*	NTH IRZ Downgradient; Riverbank Extraction	Q	SA	Q (Mn, As)	Q, T
MW-39-060*	NTH IRZ Downgradient; Riverbank Extraction	Q	SA	Q (Mn, As)	Q, T
MW-39-070*	NTH IRZ Downgradient; Riverbank Extraction	Q	SA	Q (Mn, As)	Q, T
MW-39-080*	NTH IRZ Downgradient; Riverbank Extraction	Q	SA	Q (Mn, As)	Q, T
MW-40S	Water Level Monitoring	BE <sup>5</sup>	BE <sup>5</sup>	---	Q
MW-41D	IRL Downgradient	SA	SA	---	Q

Table 2.1-3  
Compliance Monitoring Program  
Groundwater Remedy Operation and Maintenance Manual  
Volume 2: Sampling and Monitoring Plan  
PG&E Topock Compressor Station, Needles, California

Well ID	Process Control Monitoring Well Category	Analyte Sampling Frequencies <sup>3</sup>			
		Cr(VI)	Cr(T)	Dissolved Byproducts	Water Levels
MW-41M	IRL Downgradient	SA	SA	---	Q
MW-41S	IRL Downgradient	SA	SA	---	Q
MW-42-030	NTH IRZ Downgradient; Riverbank Extraction	Q	SA	Q (Mn, As)	Q, T
MW-42-055	NTH IRZ Downgradient; Riverbank Extraction	Q	SA	Q (Mn, As)	Q, T
MW-42-065	NTH IRZ Downgradient; Riverbank Extraction	Q	SA	Q (Mn, As)	Q, T
MW-43-025	NTH IRZ Downgradient; Riverbank Extraction	Q	SA	Q (Mn, As)	Q, T
MW-43-075	NTH IRZ Downgradient; Riverbank Extraction	Q	SA	Q (Mn, As)	Q, T
MW-43-090	NTH IRZ Downgradient; Riverbank Extraction	Q	SA	Q (Mn, As)	Q, T
MW-44-070	NTH IRZ Downgradient; Riverbank Extraction	Q	SA	Q (Mn, As)	Q, T
MW-46-205	NTH IRZ Downgradient; Riverbank Extraction	Q	SA	Q (Mn, As)	Q, T
MW-47-055*	NTH IRZ Dose Response	M(yr), Q	Q(yr), SA	---	Q
MW-47-115	NTH IRZ Dose Response	M(yr), Q	Q(yr), SA	---	Q
MW-48	TWB Extraction	Q	Q	---	Q
MW-49-135	Riverbank Extraction	Q	SA	Q(yr), SA (Mn, As)	Q, T
MW-49-275	Riverbank Extraction	Q	SA	Q(yr), SA (Mn, As)	Q, T
MW-49-365	Riverbank Extraction	Q	SA	Q(yr), SA (Mn, As)	Q, T
MW-50-095*	Water Level Monitoring	SA <sup>5</sup>	A <sup>5</sup>	---	Q
MW-52D	NTH IRZ Downgradient; Riverbank Extraction	Q	SA	Q (Mn, As)	Q, T
MW-52M	NTH IRZ Downgradient; Riverbank Extraction	Q	SA	Q (Mn, As)	Q, T
MW-52S	NTH IRZ Downgradient; Riverbank Extraction	Q	SA	Q (Mn, As)	Q, T
MW-53D	NTH IRZ Downgradient; Riverbank Extraction	Q	SA	Q (Mn, As)	Q, T
MW-53M	NTH IRZ Downgradient; Riverbank Extraction	Q	SA	Q (Mn, As)	Q, T
MW-53S <sup>10</sup>	NTH IRZ Downgradient; Riverbank Extraction	Q	SA	Q (Mn, As)	Q, T
MW-54-085	Riverbank Extraction	A	A	Q(yr), SA (Mn, As)	Q, T
MW-54-140	Riverbank Extraction	A	A	Q(yr), SA (Mn, As)	Q, T
MW-54-195	Riverbank Extraction	A	A	Q(yr), SA (Mn, As)	Q, T
MW-55-045	Riverbank Extraction	A	A	Q(yr), SA (Mn, As)	Q, T
MW-55-120	Riverbank Extraction	A	A	Q(yr), SA (Mn, As)	Q, T
MW-56D	Riverbank and East Ravine Extraction	A	A	Q(yr), SA (Mn, As)	Q, T
MW-56M	Riverbank and East Ravine Extraction	A	A	Q(yr), SA (Mn, As)	Q, T
MW-56S	Riverbank and East Ravine Extraction	A	A	Q(yr), SA (Mn, As)	Q, T
MW-57-185	East Ravine Extraction	Q	SA	---	Q, T
MW-58-065	East Ravine Extraction	Q	SA	---	Q, T
MW-58-115	East Ravine Extraction	Q	SA	---	Q, T
MW-58-205	East Ravine Extraction	Q	SA	---	Q, T
MW-58BR <sup>11</sup>	East Ravine Extraction	Q	SA	---	Q
MW-58-115	East Ravine Extraction	Q	SA	---	Q, T
MW-58-205	East Ravine Extraction	Q	SA	---	Q, T
MW-60BR-245*	Water Level Monitoring	BE	BE	---	Q
MW-62-190*	East Ravine Extraction	Q	SA	---	Q, T
MW-63-065	East Ravine Extraction	Q	SA	---	Q, T
MW-64-150	East Ravine Extraction	Q	SA	---	Q, T
MW-64-205	East Ravine Extraction	Q	SA	---	Q, T
MW-64-260	East Ravine Extraction	Q	SA	---	Q, T
MW-64BR* <sup>11</sup>	East Ravine Extraction	Q	SA	---	Q
MW-66BR-270	Water Level Monitoring	A <sup>6</sup>	A <sup>6</sup>	---	Q
MW-68BR-280	TWB Extraction	Q	SA	---	Q, T
MW-70-105	East Ravine Extraction	Q	SA	---	Q, T
MW-71-35	NTH IRZ Dose Response	M(yr), Q	Q(yr), SA	---	Q
MW-72BR-200	East Ravine Extraction	Q	SA	---	Q
MW-74-240	Water Level Monitoring	A <sup>6</sup>	A <sup>6</sup>	---	Q
OW-01D	Arsenic Monitoring	SA <sup>4</sup>	SA <sup>4</sup>	Q (As)	Q
OW-01M	Arsenic Monitoring	SA <sup>4</sup>	SA <sup>4</sup>	Q (As)	Q
OW-01S	Arsenic Monitoring	SA <sup>4</sup>	SA <sup>4</sup>	Q (As)	Q
OW-02D	Arsenic Monitoring	SA <sup>4</sup>	SA <sup>4</sup>	Q (As)	Q
OW-02M	Arsenic Monitoring	SA <sup>4</sup>	SA <sup>4</sup>	Q (As)	Q
OW-02S*	Arsenic Monitoring	SA <sup>4</sup>	SA <sup>4</sup>	Q (As)	Q
OW-05D	Water Level Monitoring	SA <sup>4</sup>	SA <sup>4</sup>	---	Q
OW-05M	Water Level Monitoring	SA <sup>4</sup>	SA <sup>4</sup>	---	Q
OW-05S*	Water Level Monitoring	SA <sup>4</sup>	SA <sup>4</sup>	---	Q
PGE-07(BR)	Water Level Monitoring	Q	Q	---	Q
PGE-08	Water Level Monitoring	A	A	---	Q
PT-5M	NTH IRZ Downgradient; Riverbank Extraction	Q	SA	Q (Mn, As)	Q, T
PT-5S	NTH IRZ Downgradient; Riverbank Extraction	Q	SA	Q (Mn, As)	Q, T
TW-4*	NTH IRZ Dose Response	M(yr), Q	Q(yr), SA	Q (Mn, As)	Q, T
TW-5	Water Level Monitoring	BE	BE	---	Q, T
Unspecified slant wells	Riverbank Extraction (provisional)	Q	SA	Q (Mn, As)	Q, T

Table 2.1-3  
Compliance Monitoring Program  
Groundwater Remedy Operation and Maintenance Manual  
Volume 2: Sampling and Monitoring Plan  
PG&E Topock Compressor Station, Needles, California

Well ID	Process Control Monitoring Well Category	Analyte Sampling Frequencies <sup>3</sup>			
		Cr(VI)	Cr(T)	Dissolved Byproducts	Water Levels
Compliance Monitoring Wells: Inside Plume					
MW-C	NTH IRZ Dose Response	M(yr), Q	Q(yr), SA	---	Q
MW-D	NTH IRZ Dose Response	M(yr), Q	Q(yr), SA	---	Q
MW-E	NTH IRZ Dose Response	M(yr), Q	Q(yr), SA	---	Q
MW-F	NTH IRZ Dose Response	M(yr), Q	Q(yr), SA	---	Q
MW-G	NTH IRZ Dose Response	M(yr), Q	Q(yr), SA	---	Q
MW-H	NTH IRZ Downgradient; Riverbank Extraction	Q	SA	---	Q, T
MW-K	TWB Extraction	Q	SA	---	Q, T
MW-L	Water Level Monitoring	BE <sup>7</sup>	BE <sup>7</sup>	---	Q
MW-M	IRL Downgradient	SA	SA	---	Q
MW-N	Water Level Monitoring	BE <sup>7</sup>	BE <sup>7</sup>	---	Q
MW-R	IRL Downgradient	SA	SA	---	Q
MW-T	East Ravine Extraction	Q	SA	---	Q, T
MW-HH	Arsenic Monitoring	---	---	Q (As)	Q
MW-II	Arsenic Monitoring; TCS Loop Byproduct	---	---	Q (As), A (Mn)	Q
MW-9	TCS Loop Byproduct	A	A	A (As, Mn)	Q
MW-10	TCS Loop Byproduct	A <sup>7</sup>	A <sup>7</sup>	A (As, Mn)	Q
MW-10D	TCS Loop Byproduct	A	A	A (As, Mn)	Q
MW-11	TCS Loop Byproduct	BE <sup>7</sup>	BE <sup>7</sup>	BE (As, Mn)	Q
MW-11D	TCS Loop Byproduct	BE	BE	BE (As, Mn)	Q
MW-12	TWB Extraction	Q	SA	---	Q, T
MW-19	Water Level Monitoring	BE <sup>7</sup>	BE <sup>7</sup>	---	Q
MW-20-070	NTH IRZ Dose Response	M(yr), Q	SA	---	Q
MW-20-100	NTH IRZ Dose Response	M(yr), Q	SA	---	Q
MW-20-130	NTH IRZ Dose Response	M(yr), Q	SA	---	Q
MW-23-060	East Ravine Extraction	Q	SA	---	Q, T
MW-24A	Water Level Monitoring	Q	Q	---	Q
MW-24B	Water Level Monitoring	BE <sup>7</sup>	BE <sup>7</sup>	---	Q
MW-25	Water Level Monitoring	BE <sup>7</sup>	BE <sup>7</sup>	---	Q
MW-26	NTH IRZ Dose Response	M(yr), Q	Q(yr), SA	---	Q
MW-31-060	Water Level Monitoring	BE <sup>7</sup>	BE <sup>7</sup>	---	Q
MW-34-100	Riverbank Extraction	Q	SA	---	Q, T
MW-36-100	NTH IRZ Downgradient; Riverbank Extraction	Q	SA	---	Q, T
MW-37D	IRL Downgradient	SA	SA	---	Q
MW-38D	TCS Loop Byproduct	BE <sup>7</sup>	BE <sup>7</sup>	BE (As, Mn)	Q
MW-38S	TCS Loop Byproduct	BE <sup>7</sup>	BE <sup>7</sup>	BE (As, Mn)	Q
MW-39-100	NTH IRZ Downgradient; Riverbank Extraction	Q	SA	---	Q, T
MW-40D	Water Level Monitoring	BE <sup>7</sup>	BE <sup>7</sup>	---	Q
MW-44-115	NTH IRZ Downgradient; Riverbank Extraction	Q	SA	---	Q, T
MW-44-125	NTH IRZ Downgradient; Riverbank Extraction	Q	SA	---	Q, T
MW-45-095 <sup>9</sup>	Riverbank Extraction	Q	SA	---	Q, T
MW-46-175	NTH IRZ Downgradient; Riverbank Extraction	Q	SA	---	Q, T
MW-50-200	Water Level Monitoring	BE <sup>7</sup>	BE <sup>7</sup>	---	Q
MW-51	NTH IRZ Dose Response	M(yr), Q	Q(yr), SA	---	Q
MW-57-050	East Ravine Extraction	Q	SA	---	Q, T
MW-57-070	East Ravine Extraction	Q	SA	---	Q, T
MW-59-100	TWB Extraction	Q	SA	---	Q, T
MW-60-125	Water Level Monitoring	BE <sup>7</sup>	BE <sup>7</sup>	---	Q
MW-61-110	East Ravine Extraction	Q	SA	---	Q
MW-62-065	East Ravine Extraction	Q	SA	---	Q
MW-62-110	East Ravine Extraction	Q	SA	---	Q
MW-65-160	Water Level Monitoring	SA <sup>4</sup>	A <sup>4</sup>	---	Q
MW-65-225	Water Level Monitoring	A <sup>4</sup>	A <sup>4</sup>	---	Q
MW-66-165	TCS Dose Response	Q	Q(yr), SA	---	Q
MW-66-230	TCS Dose Response	Q	Q(yr), SA	---	Q
MW-67-185	TCS Downgradient and TWB Extraction	Q	SA	---	Q, T
MW-67-225	TCS Downgradient and TWB Extraction	Q	SA	---	Q, T
MW-67-260	TCS Downgradient and TWB Extraction	Q	SA	---	Q, T
MW-68-180	TWB Extraction	Q	SA	---	Q, T
MW-68-240	TWB Extraction	Q	SA	---	Q, T
MW-69-195	Water Level Monitoring	BE <sup>7</sup>	BE <sup>7</sup>	---	Q
MW-70-105	East Ravine Extraction	Q	SA	---	Q, T
MW-70BR-D	East Ravine Extraction	Q	SA	---	Q, T
MW-72-80	East Ravine Extraction	Q	SA	---	Q, T
MW-73-80	East Ravine Extraction	Q	SA	---	Q, T
PT-5D	NTH IRZ Downgradient; Riverbank Extraction	Q	SA	---	Q, T
PT-8D	Water Level Monitoring	BE <sup>7</sup>	BE <sup>7</sup>	---	Q
PT-9D	Water Level Monitoring	BE <sup>7</sup>	BE <sup>7</sup>	---	Q
PT-9M	Water Level Monitoring	BE <sup>7</sup>	BE <sup>7</sup>	---	Q

Table 2.1-3  
Compliance Monitoring Program  
Groundwater Remedy Operation and Maintenance Manual  
Volume 2: Sampling and Monitoring Plan  
PG&E Topock Compressor Station, Needles, California

Well ID	Process Control Monitoring Well Category	Analyte Sampling Frequencies <sup>3</sup>			
		Cr(VI)	Cr(T)	Dissolved Byproducts	Water Levels
PT-9S	Water Level Monitoring	BE <sup>7</sup>	BE <sup>7</sup>	---	Q
TW-1	TCS Dose Response	Q	Q(yr), SA	---	Q
TW-2D	NTH IRZ Dose Response	M(yr), Q	Q(yr), SA	---	Q, T
TW-2S	NTH IRZ Dose Response	M(yr), Q	Q(yr), SA	---	Q, T
TW-3D	NTH IRZ Dose Response	M(yr), Q	Q(yr), SA	---	Q, T
Surface Water Monitoring Locations					
C-NR4 (River channel)	Riverbank Extraction	Q	SA	Q (Mn, As)	Q
C-NR3 (River channel)	Riverbank Extraction	Q	SA	Q (Mn, As)	Q
C-NR1 (River channel)	Riverbank Extraction	Q	SA	Q (Mn, As)	Q
C-CON (River channel)	Riverbank Extraction	Q	SA	Q (Mn, As)	Q
C-MAR (River channel)	Riverbank Extraction	Q	SA	Q (Mn, As)	Q
C-R27 (River channel)	Riverbank Extraction	Q	SA	Q (Mn, As)	Q
C-BNS (River channel)	Riverbank Extraction	Q	SA	Q (Mn, As)	Q
C-R-22A (River channel)	Riverbank and East Ravine Extraction	Q	SA	Q (Mn, As)	Q
C-I-3 (River channel)	Riverbank and East Ravine Extraction	Q	SA	Q (Mn, As)	Q
C-TAZ (River channel)	Riverbank and East Ravine Extraction	Q	SA	Q (Mn, As)	Q
RBB (Shoreline)	Riverbank Extraction	Q	SA	Q (Mn, As)	Q
R-19 (Shoreline)	Riverbank Extraction	Q	SA	Q (Mn, As)	Q
R-28 (Shoreline)	Riverbank Extraction	Q	SA	Q (Mn, As)	Q
R-63 (Shoreline)	Riverbank and East Ravine Extraction	Q	SA	Q (Mn, As)	Q
SW-1 (East Ravine)	Riverbank and East Ravine Extraction	Q	SA	Q (Mn, As)	Q
SW-2 (East Ravine)	Riverbank and East Ravine Extraction	Q	SA	Q (Mn, As)	Q

Notes:

Asterisk (\*) indicates Cr(VI) has previously been detected at concentrations greater than 32 micrograms per liter at this location.

<sup>1</sup> Sampling program will be re-evaluated after two years of operation.

<sup>2</sup> Timeframes are based on nominal baseline values and current solute transport model predictions. These estimates may be updated as the system is installed and baseline sampling is conducted, and continually adjusted during the remedy as the solute transport model is refined. The basis for these ranges and maximum thresholds are described in the text.

<sup>3</sup> Unless otherwise indicated, sampling frequencies are based on the Process Control Monitoring Program sampling frequencies.

<sup>4</sup> Based on Process Control Monitoring Program sampling frequency for analytes other than Cr(VI) and Cr(T).

<sup>5</sup> Based on current sampling frequency

<sup>6</sup> Not regularly sampled currently and not in Process Control Monitoring Program for sample collection.

<sup>7</sup> Based on anticipated treatment timeframe

<sup>8</sup> A deeper boring and replacement monitoring well will be constructed at this location if the alluvium is deeper in this area.

<sup>9</sup> Two wells MW-45-095a and MW-45-095b exist at this location and are screened within the same interval. MW-45-095a is currently active and MW-45-095b is considered inactive.

<sup>10</sup> Well is not operational.

<sup>11</sup> As approved in the first quarter of 2013, packers have been removed and single zone micro-purge sampling is being performed at 165 feet in MW-58BR and at 255 feet in MW-64BR.

Frequencies:

T: Potentially monitored continuously via transducer

M: Monthly

Q: Quarterly

SA: Semi-Annually

A: Annually

BE: Biennially

(yr): Frequency for the first year

Analytes:

Cr(VI): Chromium (VI)

Cr(T): Total dissolved chromium

Mn: Manganese

As: Arsenic

Abbreviations:

ER East Ravine

IRL Inner Recirculation Loop

IRZ In-situ Reactive Zone

NTH National Trails Highway

TCS Topock Compressor Station

Table 2.1-4  
*Model Predicted Concentration Trends - First Year*  
Groundwater Remedy Operation and Maintenance Manual  
Volume 2: Sampling and Monitoring Plan  
PG&E Topock Compressor Station, Needles, California

Monitoring Wells (Inside Plume)	Model Predicted Cr(VI) Concentration Trend
<b>6 months after Freshwater, IRL Loop, and TCS Loop Start-up</b>	
<b>NTH IRZ Dose Response Wells</b>	
MW-C	Less than 32 ppb
MW-D	Less than 32 ppb
MW-E	Less than 32 ppb
MW-F	Less than 32 ppb
MW-G	Less than 32 ppb
MW-20-070	Less than 32 ppb
MW-20-100	Less than 32 ppb
MW-20-130	Less than 32 ppb
MW-26	Less than 32 ppb
MW-51	Less than 32 ppb
TW-2D	Less than 32 ppb
TW-2S	Less than 32 ppb
TW-3D	Less than 32 ppb
<b>NTH IRZ Downgradient Monitoring Wells</b>	
MW-H	Increase before decreasing below 32 ppb
MW-36-100	Increasing
MW-39-100	Increasing
MW-44-115	Increasing
MW-44-125	Increasing
MW-46-175	Increasing
PT-5D	May increase before decreasing
<b>Riverbank Monitoring Wells</b>	
MW-34-100	Steady
MW-45-095	Increasing
<b>IRL Downgradient Monitoring Wells</b>	
MW-M	Decreasing
MW-R	Less than 32 ppb
MW-37D	Decreasing
<b>TCS Dose Response and Downgradient MWs</b>	
MW-66-165	Less than 32 ppb
MW-66-230	Less than 32 ppb
MW-67-185	Decreasing
MW-67-225	Decreasing
MW-67-260	May increase before decreasing
TW-1	Less than 32 ppb
<b>TWB Extraction Monitoring Wells</b>	
MW-K	Increasing
MW-12	Increasing
MW-59-100	Decreasing
MW-68-180	Decreasing
MW-68-240	May increase before decreasing

Table 2.1-4  
*Model Predicted Concentration Trends - First Year*  
 Groundwater Remedy Operation and Maintenance Manual  
 Volume 2: Sampling and Monitoring Plan  
 PG&E Topock Compressor Station, Needles, California

Monitoring Wells (Inside Plume)	Model Predicted Cr(VI) Concentration Trend
<b>East Ravine Extraction Monitoring Wells</b>	
MW-57-050	Increasing
MW-57-070	Increasing
MW-61-110	Increasing
MW-62-065	Decreasing
MW-62-110	Decreasing
MW-70-105	Decreasing
MW-70BR-D	Decreasing
MW-72-80	Decreasing
MW-73-80	Less than 32 ppb
<b>Other Monitoring Wells</b>	Generally sampled biennially, data will not be available for trending until two years of FW/IRL/TCS operation
<b>12 months after Freshwater, IRL Loop, and TCS Loop Start-up</b>	
<b>NTH IRZ Dose Response Wells</b>	
MW-C	Less than 32 ppb
MW-D	Less than 32 ppb
MW-E	Less than 32 ppb
MW-F	Less than 32 ppb
MW-G	Less than 32 ppb
MW-20-070	Less than 32 ppb
MW-20-100	Less than 32 ppb
MW-20-130	Less than 32 ppb
MW-26	Less than 32 ppb
MW-51	Less than 32 ppb
TW-2D	Less than 32 ppb
TW-2S	Less than 32 ppb
TW-3D	Less than 32 ppb
<b>NTH IRZ Downgradient Monitoring Wells</b>	
MW-H	Less than 32 ppb
MW-36-100	Increasing
MW-39-100	Decreasing
MW-44-115	Decreasing
MW-44-125	Decreasing
MW-46-175	Less than 32 ppb
PT-5D	Decreasing
<b>Riverbank Monitoring Wells</b>	
MW-34-100	Steady
MW-45-095	Increasing
<b>IRL Downgradient Monitoring Wells</b>	
MW-M	Decreasing
MW-R	Less than 32 ppb
MW-37D	Decreasing



Table 2.1-4  
*Model Predicted Concentration Trends - First Year*  
 Groundwater Remedy Operation and Maintenance Manual  
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 PG&E Topock Compressor Station, Needles, California

Monitoring Wells (Inside Plume)	Model Predicted Cr(VI) Concentration Trend
<b>TCS Dose Response and Downgradient MWs</b>	
MW-66-165	Less than 32 ppb
MW-66-230	Less than 32 ppb
MW-67-185	Decreasing
MW-67-225	Decreasing
MW-67-260	Decreasing
TW-1	Less than 32 ppb
<b>TWB Extraction Monitoring Wells</b>	
MW-K	Increasing
MW-12	Increasing
MW-59-100	Decreasing
MW-68-180	Decreasing
MW-68-240	Decreasing
<b>East Ravine Extraction Monitoring Wells</b>	
MW-57-050	Increasing
MW-57-070	Increasing
MW-61-110	Increasing
MW-62-065	Decreasing
MW-62-110	Decreasing
MW-70-105	Less than 32 ppb
MW-70BR-D	Decreasing
MW-72-80	Less than 32 ppb
MW-73-80	Less than 32 ppb
<b>Other Monitoring Wells</b>	Generally sampled biennially, data will not be available for trending until two years of FW/IRL/TCS operation

**Abbreviations:**

Cr(VI)	hexavalent chromium
FW	Freshwater
IRL	Inner Recirculation Loop
IRZ	In situ Reactive Zone
NTH	National Trails Highway
ppb	parts per billion
TCS	Topock Compressor Station
TWB	Transwestern Bench

Table 2.1-5  
*Model Predicted Concentration Trends - Five Year Reviews*  
Groundwater Remedy Operation and Maintenance Manual  
Volume 2: Sampling and Monitoring Plan  
PG&E Topock Compressor Station, Needles, California

Monitoring Wells (Inside Plume)	Model Predicted Cr(VI) Concentration Trend
<b>First 5-Year Review</b>	
<b>NTH IRZ Dose Response Wells</b>	
MW-C	Less than 32 ppb
MW-D	Less than 32 ppb
MW-E	Less than 32 ppb
MW-F	Less than 32 ppb
MW-G	Less than 32 ppb
MW-20-070	Less than 32 ppb
MW-20-100	Less than 32 ppb
MW-20-130	Less than 32 ppb
MW-26	Less than 32 ppb
MW-51	Less than 32 ppb
TW-2D	Less than 32 ppb
TW-2S	Less than 32 ppb
TW-3D	Less than 32 ppb
<b>NTH IRZ Downgradient Monitoring Wells</b>	
MW-H	Less than 32 ppb
MW-36-100	Increasing
MW-39-100	Decreasing
MW-44-115	Decreasing
MW-44-125	Decreasing
MW-46-175	Less than 32 ppb
PT-5D	Decreasing
<b>Riverbank Monitoring Wells</b>	
MW-34-100	Steady
MW-45-095	Increasing
<b>IRL Downgradient Monitoring Wells</b>	
MW-M	Decreasing
MW-R	Less than 32 ppb
MW-37D	Decreasing
<b>TCS Dose Response and Downgradient MWs</b>	
MW-66-165	Less than 32 ppb
MW-66-230	Less than 32 ppb
MW-67-185	Decreasing
MW-67-225	Decreasing
MW-67-260	Decreasing
TW-1	Less than 32 ppb
<b>TWB Extraction Monitoring Wells</b>	
MW-K	Increasing
MW-12	Increasing
MW-59-100	Decreasing
MW-68-180	Decreasing
MW-68-240	Decreasing
<b>East Ravine Extraction Monitoring Wells</b>	
MW-57-050	Increasing
MW-57-070	Increasing
MW-61-110	Increasing
MW-62-065	Decreasing
MW-62-110	Decreasing
MW-70-105	Less than 32 ppb
MW-70BR-D	Decreasing
MW-72-80	Less than 32 ppb
MW-73-80	Less than 32 ppb
<b>Other Monitoring Wells</b>	
	Generally sampled biennially, data will not be available for trending until two years of FW/IRL/TCS operation

Table 2.1-5  
*Model Predicted Concentration Trends - Five Year Reviews*  
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Monitoring Wells (Inside Plume)	Model Predicted Cr(VI) Concentration Trend
<b>Second 5-Year Review</b>	
<b>NTH IRZ Dose Response Wells</b>	
MW-C	Less than 32 ppb
MW-D	Less than 32 ppb
MW-E	Less than 32 ppb
MW-F	Less than 32 ppb
MW-G	Less than 32 ppb
MW-20-070	Less than 32 ppb
MW-20-100	Less than 32 ppb
MW-20-130	Less than 32 ppb
MW-26	Less than 32 ppb
MW-51	Less than 32 ppb
TW-2D	Less than 32 ppb
TW-2S	Less than 32 ppb
TW-3D	Less than 32 ppb
<b>NTH IRZ Downgradient Monitoring Wells</b>	
MW-H	Less than 32 ppb
MW-36-100	Decreasing
MW-39-100	Less than 32 ppb
MW-44-115	Decreasing
MW-44-125	Decreasing
MW-46-175	Less than 32 ppb
PT-5D	Less than 32 ppb
<b>Riverbank Monitoring Wells</b>	
MW-34-100	Steady
MW-45-095	Decreasing
<b>IRL Downgradient Monitoring Wells</b>	
MW-M	Decreasing
MW-R	Less than 32 ppb
MW-37D	Less than 32 ppb
<b>TCS Dose Response and Downgradient MWs</b>	
MW-66-165	Less than 32 ppb
MW-66-230	Less than 32 ppb
MW-67-185	Less than 32 ppb
MW-67-225	Less than 32 ppb
MW-67-260	Less than 32 ppb
TW-1	Less than 32 ppb
<b>TWB Extraction Monitoring Wells</b>	
MW-K	Decreasing
MW-12	Decreasing
MW-59-100	Decreasing
MW-68-180	Decreasing
MW-68-240	Decreasing
<b>East Ravine Extraction Monitoring Wells</b>	
MW-57-050	Decreasing
MW-57-070	Decreasing
MW-61-110	Less than 32 ppb
MW-62-065	Decreasing
MW-62-110	Decreasing
MW-70-105	Less than 32 ppb
MW-70BR-D	Less than 32 ppb
MW-72-80	Less than 32 ppb
MW-73-80	Less than 32 ppb

Table 2.1-5  
*Model Predicted Concentration Trends - Five Year Reviews*  
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Monitoring Wells (Inside Plume)	Model Predicted Cr(VI) Concentration Trend
<b>Other Monitoring Wells</b>	
MW-L	Decreasing
MW-N	Decreasing
MW-10	Decreasing or less than 32 ppb
MW-11	Decreasing
MW-19	Decreasing
MW-24B	Decreasing
MW-25	Decreasing
MW-31-060	Decreasing
MW-38D	Decreasing
MW-38S	Decreasing
MW-40D	Decreasing
MW-50-200	Decreasing
MW-60-125	Less than 32 ppb
MW-65-160	Less than 32 ppb
MW-65-225	Less than 32 ppb
MW-69-195	Less than 32 ppb
PT-8D	Decreasing
PT-9D	Decreasing
PT-9M	Decreasing
PT-9S	Decreasing
MW-HH	Less than 32 ppb
MW-II	Less than 32 ppb
MW-9	Less than 32 ppb
MW-24A	Decreasing
MW-10D	Less than 32 ppb
MW-11D	Decreasing
<b>Third 5-Year Review</b>	
<b>NTH IRZ Dose Response Wells</b>	
MW-C	Less than 32 ppb
MW-D	Less than 32 ppb
MW-E	Less than 32 ppb
MW-F	Less than 32 ppb
MW-G	Less than 32 ppb
MW-20-070	Less than 32 ppb
MW-20-100	Less than 32 ppb
MW-20-130	Less than 32 ppb
MW-26	Less than 32 ppb
MW-51	Less than 32 ppb
TW-2D	Less than 32 ppb
TW-2S	Less than 32 ppb
TW-3D	Less than 32 ppb
<b>NTH IRZ Downgradient Monitoring Wells</b>	
MW-H	Less than 32 ppb
MW-36-100	Less than 32 ppb
MW-39-100	Less than 32 ppb
MW-44-115	Less than 32 ppb
MW-44-125	Less than 32 ppb
MW-46-175	Less than 32 ppb
PT-5D	Less than 32 ppb
<b>Riverbank Monitoring Wells</b>	
MW-34-100	Decreasing
MW-45-095	Less than 32 ppb

Table 2.1-5  
*Model Predicted Concentration Trends - Five Year Reviews*  
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PG&E Topock Compressor Station, Needles, California

Monitoring Wells (Inside Plume)	Model Predicted Cr(VI) Concentration Trend
<b>IRL Downgradient Monitoring Wells</b>	
MW-M	Decreasing or less than 32 ppb
MW-R	Less than 32 ppb
MW-37D	Less than 32 ppb
<b>TCS Dose Response and Downgradient MWs</b>	
MW-66-165	Less than 32 ppb
MW-66-230	Less than 32 ppb
MW-67-185	Less than 32 ppb
MW-67-225	Less than 32 ppb
MW-67-260	Less than 32 ppb
TW-1	Less than 32 ppb
<b>TWB Extraction Monitoring Wells</b>	
MW-K	Decreasing
MW-12	Decreasing
MW-59-100	Decreasing
MW-68-180	Decreasing
MW-68-240	Decreasing
<b>East Ravine Extraction Monitoring Wells</b>	
MW-57-050	Decreasing
MW-57-070	Decreasing
MW-61-110	Less than 32 ppb
MW-62-065	Decreasing
MW-62-110	Decreasing
MW-70-105	Less than 32 ppb
MW-70BR-D	Less than 32 ppb
MW-72-80	Less than 32 ppb
MW-73-80	Less than 32 ppb
<b>Other Monitoring Wells</b>	
MW-L	Decreasing
MW-N	Decreasing
MW-10	Less than 32 ppb
MW-11	Decreasing
MW-19	Decreasing
MW-24B	Decreasing
MW-25	Decreasing
MW-31-060	Decreasing
MW-38D	Decreasing
MW-38S	Decreasing
MW-40D	Less than 32 ppb
MW-50-200	Decreasing
MW-60-125	Less than 32 ppb
MW-65-160	Less than 32 ppb
MW-65-225	Less than 32 ppb
MW-69-195	Less than 32 ppb
PT-8D	Decreasing
PT-9D	Decreasing
PT-9M	Decreasing
PT-9S	Decreasing
MW-HH	Less than 32 ppb
MW-II	Less than 32 ppb
MW-9	Less than 32 ppb
MW-24A	Decreasing
MW-10D	Less than 32 ppb
MW-11D	Decreasing

Table 2.1-5  
*Model Predicted Concentration Trends - Five Year Reviews*  
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Volume 2: Sampling and Monitoring Plan  
PG&E Topock Compressor Station, Needles, California

Monitoring Wells (Inside Plume)	Model Predicted Cr(VI) Concentration Trend
<b>Fourth 5-Year Review</b>	
<b>NTH IRZ Dose Response Wells</b>	
MW-C	Less than 32 ppb
MW-D	Less than 32 ppb
MW-E	Less than 32 ppb
MW-F	Less than 32 ppb
MW-G	Less than 32 ppb
MW-20-070	Less than 32 ppb
MW-20-100	Less than 32 ppb
MW-20-130	Less than 32 ppb
MW-26	Less than 32 ppb
MW-51	Less than 32 ppb
TW-2D	Less than 32 ppb
TW-2S	Less than 32 ppb
TW-3D	Less than 32 ppb
<b>NTH IRZ Downgradient Monitoring Wells</b>	
MW-H	Less than 32 ppb
MW-36-100	Less than 32 ppb
MW-39-100	Less than 32 ppb
MW-44-115	Less than 32 ppb
MW-44-125	Less than 32 ppb
MW-46-175	Less than 32 ppb
PT-5D	Less than 32 ppb
<b>Riverbank Monitoring Wells</b>	
MW-34-100	Decreasing
MW-45-095	Less than 32 ppb
<b>IRL Downgradient Monitoring Wells</b>	
MW-M	Less than 32 ppb
MW-R	Less than 32 ppb
MW-37D	Less than 32 ppb
<b>TCS Dose Response and Downgradient MWs</b>	
MW-66-165	Less than 32 ppb
MW-66-230	Less than 32 ppb
MW-67-185	Less than 32 ppb
MW-67-225	Less than 32 ppb
MW-67-260	Less than 32 ppb
TW-1	Less than 32 ppb
<b>TWB Extraction Monitoring Wells</b>	
MW-K	Decreasing
MW-12	Decreasing
MW-59-100	Decreasing
MW-68-180	Less than 32 ppb
MW-68-240	Less than 32 ppb
<b>East Ravine Extraction Monitoring Wells</b>	
MW-57-050	Decreasing
MW-57-070	Decreasing
MW-61-110	Less than 32 ppb
MW-62-065	Decreasing
MW-62-110	Decreasing
MW-70-105	Less than 32 ppb
MW-70BR-D	Less than 32 ppb
MW-72-80	Less than 32 ppb
MW-73-80	Less than 32 ppb

Table 2.1-5  
*Model Predicted Concentration Trends - Five Year Reviews*  
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Monitoring Wells (Inside Plume)	Model Predicted Cr(VI) Concentration Trend
<b>Other Monitoring Wells</b>	
MW-L	Decreasing or less than 32 ppb
MW-N	Decreasing
MW-10	Less than 32 ppb
MW-11	Less than 32 ppb
MW-19	Less than 32 ppb
MW-24B	Decreasing
MW-25	Decreasing
MW-31-060	Decreasing
MW-38D	Less than 32 ppb
MW-38S	Less than 32 ppb
MW-40D	Less than 32 ppb
MW-50-200	Decreasing
MW-60-125	Less than 32 ppb
MW-65-160	Less than 32 ppb
MW-65-225	Less than 32 ppb
MW-69-195	Less than 32 ppb
PT-8D	Decreasing
PT-9D	Decreasing
PT-9M	Decreasing
PT-9S	Decreasing
MW-HH	Less than 32 ppb
MW-II	Less than 32 ppb
MW-9	Less than 32 ppb
MW-24A	Less than 32 ppb
MW-10D	Less than 32 ppb
MW-11D	Less than 32 ppb
<b>Fifth 5-Year Review</b>	
<b>NTH IRZ Dose Response Wells</b>	
MW-C	Less than 32 ppb
MW-D	Less than 32 ppb
MW-E	Less than 32 ppb
MW-F	Less than 32 ppb
MW-G	Less than 32 ppb
MW-20-070	Less than 32 ppb
MW-20-100	Less than 32 ppb
MW-20-130	Less than 32 ppb
MW-26	Less than 32 ppb
MW-51	Less than 32 ppb
TW-2D	Less than 32 ppb
TW-2S	Less than 32 ppb
TW-3D	Less than 32 ppb
<b>NTH IRZ Downgradient Monitoring Wells</b>	
MW-H	Less than 32 ppb
MW-36-100	Less than 32 ppb
MW-39-100	Less than 32 ppb
MW-44-115	Less than 32 ppb
MW-44-125	Less than 32 ppb
MW-46-175	Less than 32 ppb
PT-5D	Less than 32 ppb
<b>Riverbank Monitoring Wells</b>	
MW-34-100	Less than 32 ppb
MW-45-095	Less than 32 ppb

Table 2.1-5  
*Model Predicted Concentration Trends - Five Year Reviews*  
Groundwater Remedy Operation and Maintenance Manual  
Volume 2: Sampling and Monitoring Plan  
PG&E Topock Compressor Station, Needles, California

Monitoring Wells (Inside Plume)	Model Predicted Cr(VI) Concentration Trend
<b>IRL Downgradient Monitoring Wells</b>	
MW-M	Less than 32 ppb
MW-R	Less than 32 ppb
MW-37D	Less than 32 ppb
<b>TCS Dose Response and Downgradient MWs</b>	
MW-66-165	Less than 32 ppb
MW-66-230	Less than 32 ppb
MW-67-185	Less than 32 ppb
MW-67-225	Less than 32 ppb
MW-67-260	Less than 32 ppb
TW-1	Less than 32 ppb
<b>TWB Extraction Monitoring Wells</b>	
MW-K	Decreasing or less than 32 ppb
MW-12	Less than 32 ppb
MW-59-100	Decreasing
MW-68-180	Less than 32 ppb
MW-68-240	Less than 32 ppb
<b>East Ravine Extraction Monitoring Wells</b>	
MW-57-050	Decreasing
MW-57-070	Decreasing
MW-61-110	Less than 32 ppb
MW-62-065	Decreasing
MW-62-110	Decreasing
MW-70-105	Less than 32 ppb
MW-70BR-D	Less than 32 ppb
MW-72-80	Less than 32 ppb
MW-73-80	Less than 32 ppb
<b>Other Monitoring Wells</b>	
MW-L	Less than 32 ppb
MW-N	Decreasing
MW-10	Less than 32 ppb
MW-11	Less than 32 ppb
MW-19	Less than 32 ppb
MW-24B	Decreasing
MW-25	Decreasing
MW-31-060	Less than 32 ppb
MW-38D	Less than 32 ppb
MW-38S	Less than 32 ppb
MW-40D	Less than 32 ppb
MW-50-200	Decreasing
MW-60-125	Less than 32 ppb
MW-65-160	Less than 32 ppb
MW-65-225	Less than 32 ppb
MW-69-195	Less than 32 ppb
PT-8D	Decreasing
PT-9D	Decreasing
PT-9M	Decreasing
PT-9S	Decreasing
MW-HH	Less than 32 ppb
MW-II	Less than 32 ppb
MW-9	Less than 32 ppb
MW-24A	Less than 32 ppb
MW-10D	Less than 32 ppb
MW-11D	Less than 32 ppb



Table 2.1-5  
*Model Predicted Concentration Trends - Five Year Reviews*  
Groundwater Remedy Operation and Maintenance Manual  
Volume 2: Sampling and Monitoring Plan  
PG&E Topock Compressor Station, Needles, California

Monitoring Wells (Inside Plume)	Model Predicted Cr(VI) Concentration Trend
<b>Sixth 5-Year Review</b>	
<b>NTH IRZ Dose Response Wells</b>	
MW-C	Less than 32 ppb
MW-D	Less than 32 ppb
MW-E	Less than 32 ppb
MW-F	Less than 32 ppb
MW-G	Less than 32 ppb
MW-20-070	Less than 32 ppb
MW-20-100	Less than 32 ppb
MW-20-130	Less than 32 ppb
MW-26	Less than 32 ppb
MW-51	Less than 32 ppb
TW-2D	Less than 32 ppb
TW-2S	Less than 32 ppb
TW-3D	Less than 32 ppb
<b>NTH IRZ Downgradient Monitoring Wells</b>	
MW-H	Less than 32 ppb
MW-36-100	Less than 32 ppb
MW-39-100	Less than 32 ppb
MW-44-115	Less than 32 ppb
MW-44-125	Less than 32 ppb
MW-46-175	Less than 32 ppb
PT-5D	Less than 32 ppb
<b>Riverbank Monitoring Wells</b>	
MW-34-100	Less than 32 ppb
MW-45-095	Less than 32 ppb
<b>IRL Downgradient Monitoring Wells</b>	
MW-M	Less than 32 ppb
MW-R	Less than 32 ppb
MW-37D	Less than 32 ppb
<b>TCS Dose Response and Downgradient MWs</b>	
MW-66-165	Less than 32 ppb
MW-66-230	Less than 32 ppb
MW-67-185	Less than 32 ppb
MW-67-225	Less than 32 ppb
MW-67-260	Less than 32 ppb
TW-1	Less than 32 ppb
<b>TWB Extraction Monitoring Wells</b>	
MW-K	Less than 32 ppb
MW-12	Less than 32 ppb
MW-59-100	Less than 32 ppb
MW-68-180	Less than 32 ppb
MW-68-240	Less than 32 ppb
<b>East Ravine Extraction Monitoring Wells</b>	
MW-57-050	Less than 32 ppb
MW-57-070	Less than 32 ppb
MW-61-110	Less than 32 ppb
MW-62-065	Decreasing
MW-62-110	Decreasing
MW-70-105	Less than 32 ppb
MW-70BR-D	Less than 32 ppb
MW-72-80	Less than 32 ppb
MW-73-80	Less than 32 ppb

Table 2.1-5  
*Model Predicted Concentration Trends - Five Year Reviews*  
Groundwater Remedy Operation and Maintenance Manual  
Volume 2: Sampling and Monitoring Plan  
PG&E Topock Compressor Station, Needles, California

Monitoring Wells (Inside Plume)	Model Predicted Cr(VI) Concentration Trend
<b>Other Monitoring Wells</b>	
MW-L	Less than 32 ppb
MW-N	Decreasing
MW-10	Less than 32 ppb
MW-11	Less than 32 ppb
MW-19	Less than 32 ppb
MW-24B	Less than 32 ppb
MW-25	Decreasing
MW-31-060	Less than 32 ppb
MW-38D	Less than 32 ppb
MW-38S	Less than 32 ppb
MW-40D	Less than 32 ppb
MW-50-200	Less than 32 ppb
MW-60-125	Less than 32 ppb
MW-65-160	Less than 32 ppb
MW-65-225	Less than 32 ppb
MW-69-195	Less than 32 ppb
PT-8D	Decreasing
PT-9D	Decreasing
PT-9M	Decreasing
PT-9S	Less than 32 ppb
MW-HH	Less than 32 ppb
MW-II	Less than 32 ppb
MW-9	Less than 32 ppb
MW-24A	Less than 32 ppb
MW-10D	Less than 32 ppb
MW-11D	Less than 32 ppb
<b>Seventh 5-Year Review</b>	
<b>NTH IRZ Dose Response Wells</b>	
MW-C	Less than 32 ppb
MW-D	Less than 32 ppb
MW-E	Less than 32 ppb
MW-F	Less than 32 ppb
MW-G	Less than 32 ppb
MW-20-070	Less than 32 ppb
MW-20-100	Less than 32 ppb
MW-20-130	Less than 32 ppb
MW-26	Less than 32 ppb
MW-51	Less than 32 ppb
TW-2D	Less than 32 ppb
TW-2S	Less than 32 ppb
TW-3D	Less than 32 ppb
<b>NTH IRZ Downgradient Monitoring Wells</b>	
MW-H	Less than 32 ppb
MW-36-100	Less than 32 ppb
MW-39-100	Less than 32 ppb
MW-44-115	Less than 32 ppb
MW-44-125	Less than 32 ppb
MW-46-175	Less than 32 ppb
PT-5D	Less than 32 ppb
<b>Riverbank Monitoring Wells</b>	
MW-34-100	Less than 32 ppb
MW-45-095	Less than 32 ppb

Table 2.1-5  
*Model Predicted Concentration Trends - Five Year Reviews*  
Groundwater Remedy Operation and Maintenance Manual  
Volume 2: Sampling and Monitoring Plan  
PG&E Topock Compressor Station, Needles, California

Monitoring Wells (Inside Plume)	Model Predicted Cr(VI) Concentration Trend
<b>IRL Downgradient Monitoring Wells</b>	
MW-M	Less than 32 ppb
MW-R	Less than 32 ppb
MW-37D	Less than 32 ppb
<b>TCS Dose Response and Downgradient MWs</b>	
MW-66-165	Less than 32 ppb
MW-66-230	Less than 32 ppb
MW-67-185	Less than 32 ppb
MW-67-225	Less than 32 ppb
MW-67-260	Less than 32 ppb
TW-1	Less than 32 ppb
<b>TWB Extraction Monitoring Wells</b>	
MW-K	Less than 32 ppb
MW-12	Less than 32 ppb
MW-59-100	Less than 32 ppb
MW-68-180	Less than 32 ppb
MW-68-240	Less than 32 ppb
<b>East Ravine Extraction Monitoring Wells</b>	
MW-57-050	Less than 32 ppb
MW-57-070	Less than 32 ppb
MW-61-110	Less than 32 ppb
MW-62-065	Less than 32 ppb
MW-62-110	Decreasing
MW-70-105	Less than 32 ppb
MW-70BR-D	Less than 32 ppb
MW-72-80	Less than 32 ppb
MW-73-80	Less than 32 ppb
<b>Other Monitoring Wells</b>	
MW-L	Less than 32 ppb
MW-N	Decreasing
MW-10	Less than 32 ppb
MW-11	Less than 32 ppb
MW-19	Less than 32 ppb
MW-24B	Less than 32 ppb
MW-25	Less than 32 ppb
MW-31-060	Less than 32 ppb
MW-38D	Less than 32 ppb
MW-38S	Less than 32 ppb
MW-40D	Less than 32 ppb
MW-50-200	Less than 32 ppb
MW-60-125	Less than 32 ppb
MW-65-160	Less than 32 ppb
MW-65-225	Less than 32 ppb
MW-69-195	Less than 32 ppb
PT-8D	Less than 32 ppb
PT-9D	Less than 32 ppb
PT-9M	Less than 32 ppb
PT-9S	Less than 32 ppb
MW-HH	Less than 32 ppb
MW-II	Less than 32 ppb
MW-9	Less than 32 ppb
MW-24A	Less than 32 ppb
MW-10D	Less than 32 ppb
MW-11D	Less than 32 ppb

Notes appear on the following page.

Table 2.1-5  
*Model Predicted Concentration Trends - Five Year Reviews*  
 Groundwater Remedy Operation and Maintenance Manual  
 Volume 2: Sampling and Monitoring Plan  
 PG&E Topock Compressor Station, Needles, California

Monitoring Wells (Inside Plume)	Model Predicted Cr(VI) Concentration Trend
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**Abbreviations:**

Cr(VI)	hexavalent chromium
FW	Freshwater
IRL	Inner Recirculation Loop
IRZ	In situ Reactive Zone
NTH	National Trails Highway
ppb	parts per billion
TCS	Topock Compressor Station
TWB	Transwestern Bench

Table 2.1-6  
Monitoring Program Wells and Surface Water Sampling Points for COPC Monitoring  
Groundwater Remedy Operation and Maintenance Manual  
Volume 2: Sampling and Monitoring Plan  
PG&E Topock Compressor Station, Needles, California

Location ID	Nitrate	Molybdenum	Selenium
Existing Monitoring Wells			
CW-02D		A	
CW-02M	As needed		
CW-03D		A	
CW-03M		A	
MW-10	A	A	
MW-12	A	A	A
MW-13	SA		
MW-14	Q <sup>3</sup>	A	A
MW-20-070	M(yr), Q		
MW-20-100	M(yr), Q		
MW-20-130	A	A	A
MW-21			A
MW-22	A	A	A
MW-23-060	A	A	A
MW-23-080	A	A	A
MW-24A	A	A	A
MW-24B	A	A	A
MW-26	A	A	A
MW-27-020	Q		
MW-27-060	As needed		
MW-27-085	As needed	A	A
MW-28-025	Q		
MW-28-090	A	A	A
MW-29	Q		
MW-30-030	Q		
MW-30-050	Q		
MW-32-020	As needed <sup>2</sup>		
MW-25	A	A	A
MW-32-035	A	A	A
MW-33-040	A	A	A
MW-33-090	A	A	A
MW-33-150	A	A	A
MW-33-210	Q		
MW-34-055	A	A	A
MW-34-080	A	A	A
MW-34-100	A	A	A
MW-35-060	A	A	A
MW-35-135	A	A	A
MW-36-020	As needed <sup>2</sup>		
MW-36-040	As needed <sup>2</sup>	A	A
MW-36-050	As needed <sup>2</sup>		
MW-36-070	As needed <sup>2</sup>		
MW-36-090	Q		
MW-36-100	Q	A	A
MW-37D	A	A	A
MW-37S	A	A	A
MW-38D		A	
MW-38S	A	A	
MW-39-040	As needed <sup>2</sup>		
MW-39-050	Q		
MW-39-060	Q		
MW-39-070	Q		
MW-39-080	Q		
MW-39-100	Q		
MW-40S	A	A	A
MW-40D	A	A	A
MW-41D	As needed		
MW-41M	Q		
MW-41S	Q		
MW-41S	A	A	A
MW-41M	A	A	A
MW-41D	A	A	A
MW-42-030	A	A	A

- CW-02D
- Blue highlight indicates wells included in the COPC Perimeter Assessment Plan (PAP)
- 
- Gray highlight indicates avg. concentration above threshold (10 mg/L for Nitrate, 70 ug/L for Molybdenum, 50 ug/L for Selenium)
- SA
- Light gray font indicates wells monitored for nitrate under compliance or process control programs, at frequency indicated
- Note - all PAP wells will be sampled for nitrate at least annually

Table 2.1-6  
Monitoring Program Wells and Surface Water Sampling Points for COPC Monitoring  
Groundwater Remedy Operation and Maintenance Manual  
Volume 2: Sampling and Monitoring Plan  
PG&E Topock Compressor Station, Needles, California

Location ID	Nitrate	Molybdenum	Selenium
MW-42-055	As needed <sup>2</sup>	A	A
MW-42-065	As needed <sup>2</sup>		
MW-43-025	A	A	A
MW-43-075	As needed <sup>2</sup>	A	A
MW-43-090	As needed <sup>2</sup>		
MW-44-070	A	A	A
MW-44-115	A	A	A
MW-44-125	A	A	A
MW-45-095	Q		
MW-46-175	A	A	A
MW-46-205	A	A	A
MW-47-055	M(yr), Q		
MW-47-115	M(yr), Q		
MW-49-135	Q		
MW-49-275	Q		
MW-49-365	As needed		
MW-50-200	A	A	A
MW-51	A	A	A
MW-52D	As needed <sup>2</sup>		
MW-52M	As needed <sup>2</sup>		
MW-52S	As needed <sup>2</sup>		
MW-53D	As needed <sup>2</sup>		
MW-53M	As needed <sup>2</sup>		
MW-53S	As needed <sup>2</sup>		
MW-54-085	As needed	A	
MW-54-140	As needed	A	
MW-54-195	As needed	A	
MW-55-045	As needed		
MW-55-120	As needed		
MW-56D	As needed		
MW-56M	As needed		
MW-56S	As needed		
MW-57-070		A	
MW-57-185		A	
MW-58-BR		A	
MW-59-100		A	
MW-60-125		A	
MW-61-110		A	
MW-62-065		A	
MW-62-110		A	
MW-62-190		A	
MW-63-065		A	
MW-64-BR		A	
MW-65-160		A	
MW-65-225		A	
MW-66-165	A	A	A
MW-66-230	A	A	
MW-67-185	A	A	A
MW-67-225	A	A	A
MW-67-260	A	A	
MW-68-180	A	A	
MW-68-240		A	
MW-69-195	A	A	
MW-70-105		A	
MW-71-35	A	A	
MW-72-80		A	
MW-73-80		A	
MW-74-240		A	
OW-02S		A	
PT-5D	Q		
PT-5M	Q		
PT-5S	As needed		
PT-9D	A	A	A
PT-9M	A	A	A

CW-02D Blue highlight indicates wells included in the COPC Perimeter Assessment Plan (PAP)

Gray highlight indicates avg. concentration above threshold (10 mg/L for Nitrate, 70 ug/L for Molybdenum, 50 ug/L for Selenium)

SA Light gray font indicates wells monitored for nitrate under compliance or process control programs, at frequency indicated  
Note - all PAP wells will be sampled for nitrate at least annually

Table 2.1-6  
Monitoring Program Wells and Surface Water Sampling Points for COPC Monitoring  
Groundwater Remedy Operation and Maintenance Manual  
Volume 2: Sampling and Monitoring Plan  
PG&E Topock Compressor Station, Needles, California

Location ID	Nitrate	Molybdenum	Selenium
PT-9S	A	A	A
TW-1	A		A
Proposed Monitoring Wells			
C	As needed <sup>2</sup>		
D	As needed <sup>2</sup>		
E	As needed <sup>2</sup>		
F	As needed <sup>2</sup>		
G	A	A	A
H	Q		
I	As needed	A	A
J	As needed	A	A
M	As needed		
O	As needed		
P	Q <sup>3</sup>		
Q	Q <sup>3</sup>		
R	As needed		
U	A	A	A
V	A	A	A
W	A	A	A
Surface Water Sampling Locations			
C-NR4 (River channel)	A	A	A
C-NR3 (River channel)	A	A	A
C-NR1 (River channel)	A	A	A
C-CON (River channel)	A	A	A
C-MAR (River channel)	A	A	A
C-R27 (River channel)	A	A	A
C-BNS (River channel)	A	A	A
C-R-22A (River channel)	A	A	A
C-I-3 (River channel)	A	A	A
C-TAZ (River channel)	A	A	A
RBB (Shoreline)	A	A	A
R-19 (Shoreline)	A	A	A
R-28 (Shoreline)	A	A	A
R-63 (Shoreline)	A	A	A
SW-1 (East Ravine)	A	A	A
SW-2 (East Ravine)	A	A	A

**Notes**  
Sampling program will be re-evaluated after two years of operation.  
<sup>1</sup> Dose Response Wells are defined as within the carbon footprint as predicted by the fate and transport model.  
<sup>2</sup> Baseline data indicates no detectable nitrate.  
<sup>3</sup> If associated injection well is amended with carbon

**Frequencies:**  
M: Monthly  
Q: Quarterly  
SA: Semi-Annually  
A: Annually

**CW-02D** Blue highlight indicates wells included in the COPC Perimeter Assessment Plan (PAP)

Gray highlight indicates avg. concentration above threshold (10 mg/L for Nitrate, 70 ug/L for Molybdenum, 50 ug/L for Selenium)

**SA** Light gray font indicates wells monitored for nitrate under compliance or process control programs, at frequency indicated  
Note - all PAP wells will be sampled for nitrate at least annually

Table 2.2-1  
 Process Control Monitoring Program Anticipated Concentration Ranges and Timeframes  
 Groundwater Remedy Operation and Maintenance Manual  
 Volume 2: Sampling and Monitoring Plan  
 PG&E Topock Compressor Station, Needles, California

	Currently-Anticipated Concentration Range/Trend (Maximum) <sup>1,2</sup>				Currently-Anticipated Timeframe for Cr(VI) Concentration Decreases <sup>1</sup>	Currently-Anticipated Byproduct Arrival Timeframe <sup>1</sup>
	Total Organic Carbon (ppm)	Dissolved Manganese (ppm)	Dissolved Iron (ppm) <sup>6</sup>	Dissolved Arsenic (ppb)		
National Trails Highway In-Situ Reactive Zone						
Dose Response Monitoring Wells	15 - 50 <sup>3</sup>	1 - 2.5 (5)	1 - 2.5 (5)	2 - 10 (15)	< 6 months	< 6 months
Downgradient Monitoring Wells	0.5 - 15	1 - 2.5 (5)	1 - 2.5 (5)	2 - 10 (15)	2-10 years	2-10 years <sup>4</sup>
Riverbank Extraction Monitoring Wells	0.5 - 10	0.1 - 2 (3)	0.1 - 2 (3)	2 - 5 (8)	---	10 - 30 years <sup>5</sup>
Northern Extraction Monitoring Wells	N/A	N/A	N/A	2 - 4 (5)	---	No anticipated change
Inner Recirculation Loop						
Dose Response MonitoringWells	0 - 50	1 - 2.5 (5)	1 - 2.5 (5)	1 - 16 (20)	---	< 6 months
Downgradient Monitoring Wells	0.5 - 2.0	0.1 - 1 (3)	0.1 - 1 (3)	2 - 4 (5)	< 10 years	2-10 years
Byproduct Monitoring Wells	N/A	< 0.5 (1.3)	< 0.5 (1.3)	2 - 4 (5)	---	No anticipated change
Topock Compressor Station Recirculation Loop						
Dose Response Monitoring Wells	50 - 1,000	1 - 2.5 (5)	1 - 2.5 (5)	1 - 10 (15)	< 6 months	< 6 months
Downgradient Monitoring Wells	1 - 25	0.1 - 2 (3)	0.1 - 2 (3)	2 - 4 (5)	2 - 10 years	2-10 years
Byproduct Monitoring Wells	N/A	N/A	N/A	2 - 4 (5) <sup>7</sup>	0.5 - 20 years	No anticipated change <sup>7</sup>
Transwestern Bench Extraction Monitoring Wells	N/A	N/A	N/A	N/A	2 - 30 years	---
East Ravine Extraction Monitoring Wells	N/A	N/A	N/A	N/A	< 30 years	---
Freshwater Injection						
Arsenic Monitoring Wells	N/A	N/A	N/A	150 ft: 10-12 ppb 225 ft: <10 ppb	---	Injected water: months Arsenic: no arrival predicted

**Notes:**

<sup>1</sup> Concentration ranges and arrival/attenuation timeframes are based on nominal baseline values and current solute transport model predictions. These estimates may be updated as the system is installed and baseline sampling is conducted, and continually adjusted during the remedy as the solute transport model is refined. The basis for these ranges and maximum thresholds are described in the text.

<sup>2</sup> Concentration ranges and maximum thresholds do not apply to individual wells that already exhibit natural baseline levels above the given ranges/thresholds.

<sup>3</sup> Total organic carbon concentration range applies to dose response wells midway between injection points. Higher concentrations are anticipated in the immediate vicinity of injection wells depending on injection concentrations.

<sup>4</sup> Greater than 10 year byproduct arrival time expected for more distant wells, such as MW-43, MW-52, and MW-53.

<sup>5</sup> Range does not apply to Arizona wells MW-54, MW-55, and MW-56, which are not anticipated to receive byproducts.

<sup>6</sup> Solute transport modeling for iron was not conducted. It is therefore assumed that iron will follow concentration trends similar to manganese, which is a conservative assumption given that iron typically attenuates more quickly than manganese downgradient of an in-situ reactive zone.

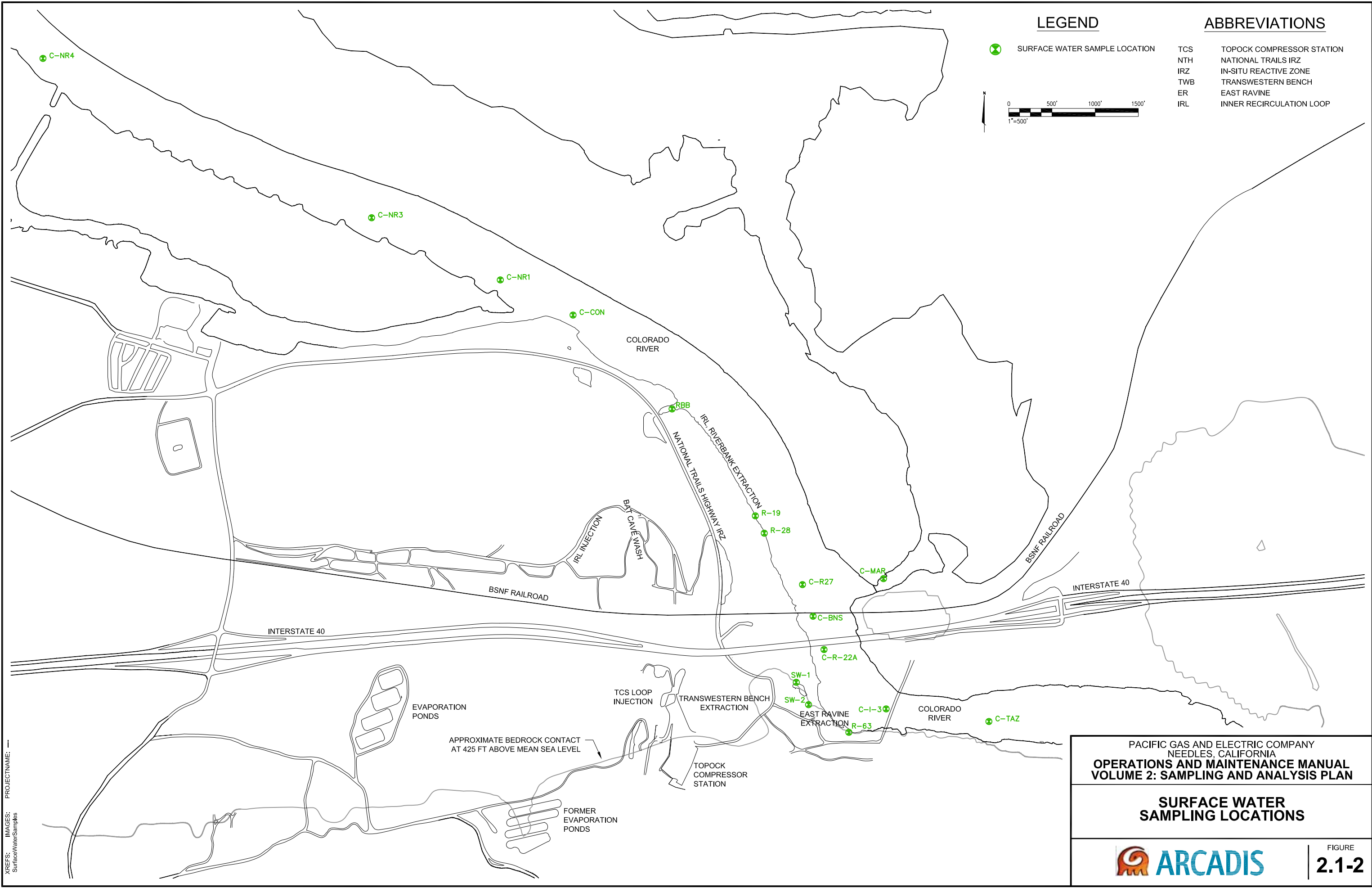
<sup>7</sup> Note that the anticipated concentration range and maximum for dissolved arsenic, as listed in this table, are exclusive of monitoring wells located in the vicinity of FW-2 (MW-09 and MW-II). Simulated arsenic concentrations at these locations (MW-09 and MW-II) are impacted by naturally occurring arsenic levels in injected freshwater.

**Abbreviations:**

< less than  
 Cr(VI) hexavalent chromium  
 ppb parts per billion  
 ppm parts per million  
 N/A not applicable

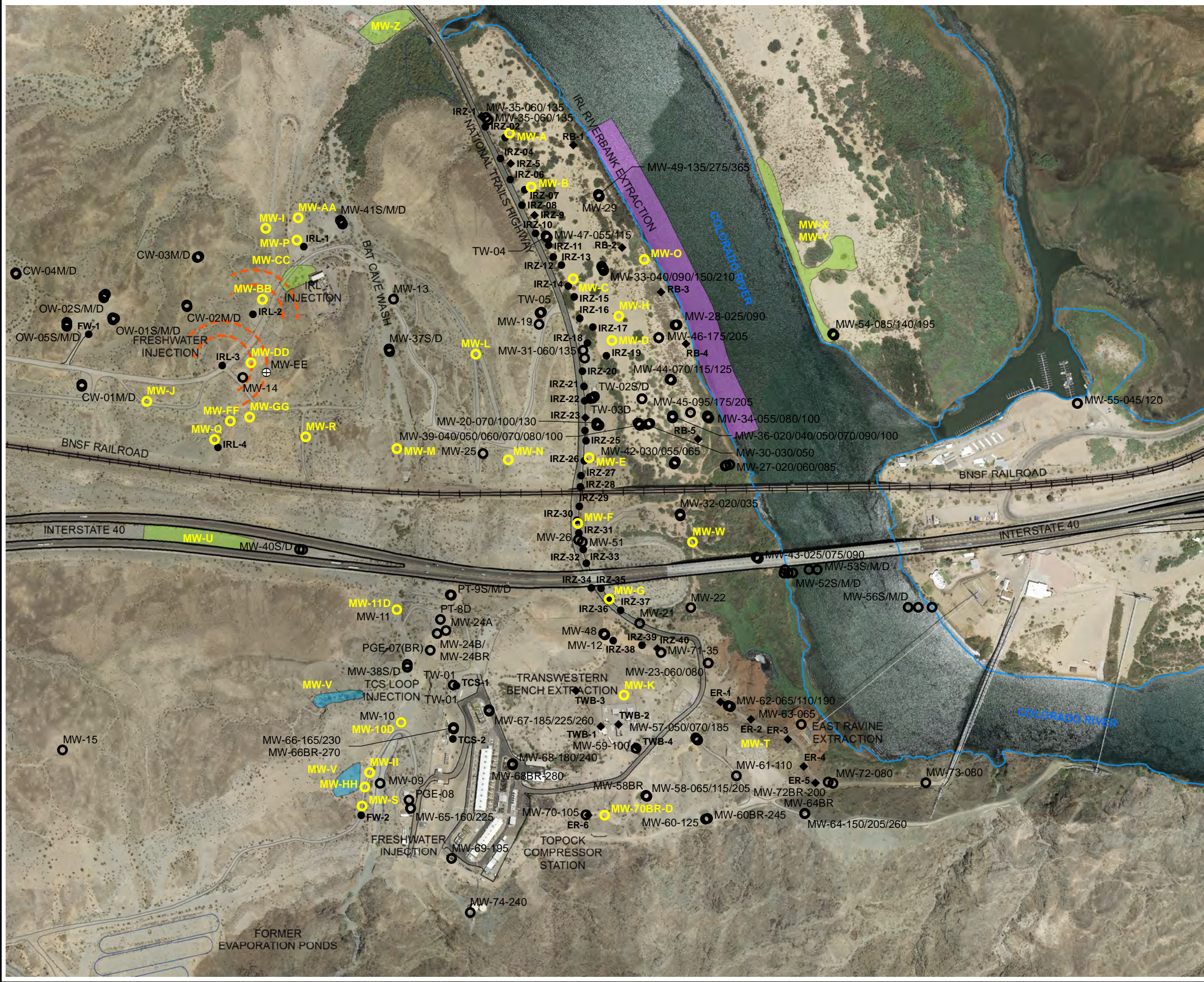








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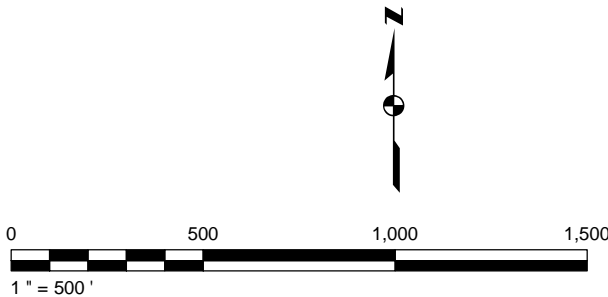


**LEGEND**

- ⊕ PENDING/FUTURE PROVISIONAL MONITORING WELL
- EXISTING MONITORING WELL LOCATION
- PROPOSED MONITORING WELL LOCATION
- PROPOSED INJECTION WELL LOCATION
- ◆ PROPOSED EXTRACTION WELL LOCATION
- - - ARC FOR IRL-2 AND IRL-3 ARSENIC MONITORING WELLS
- AREA FOR POTENTIAL SLANT WELL SCREENS
- AREA FOR PROVISIONAL MONITORING WELL
- AREA FOR PLANNED MONITORING WELL

**ABBREVIATIONS**

- TCS TOPOCK COMPRESSOR STATION
- NTH NATIONAL TRAILS HIGHWAY
- IRZ IN-SITU REACTIVE ZONE
- TWB TRANSWESTERN BENCH
- ER EAST RAVINE
- IRL INNER RECIRCULATION LOOP



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OPERATIONS AND MAINTENANCE MANUAL  
VOLUME 2: SAMPLING AND ANALYSIS PLAN

**PROPOSED MONITORING WELLS**



FIGURE  
**2.1-3**



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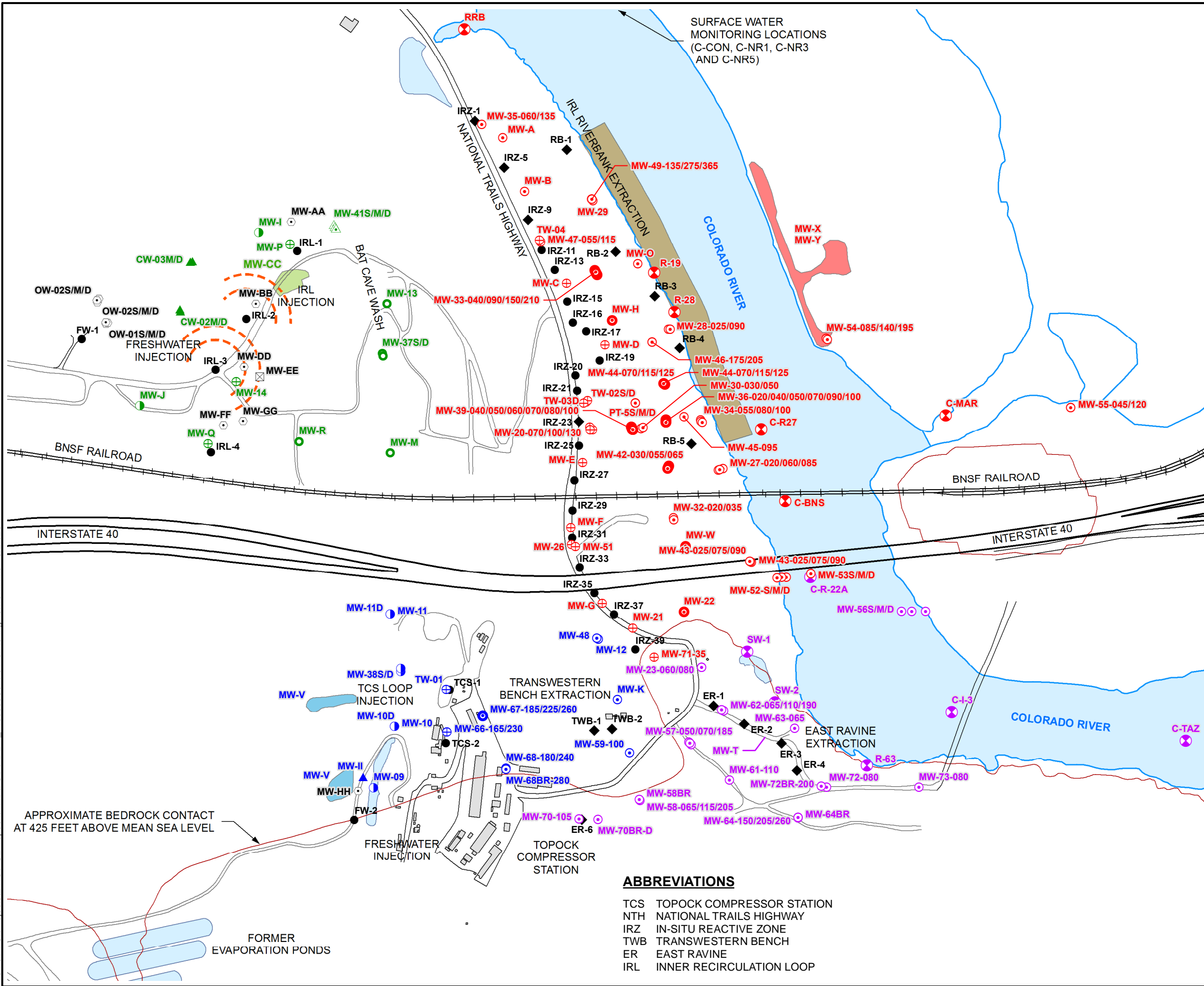


Figure 2.2-2. NTH IRZ Injection Decision Rules/Operational Framework

OPERATIONS AND MAINTENANCE MANUAL, VOLUME 2:  
SAMPLING AND MONITORING PLAN

PG&E TOPOCK COMPRESSOR STATION  
NEEDLES, CALIFORNIA

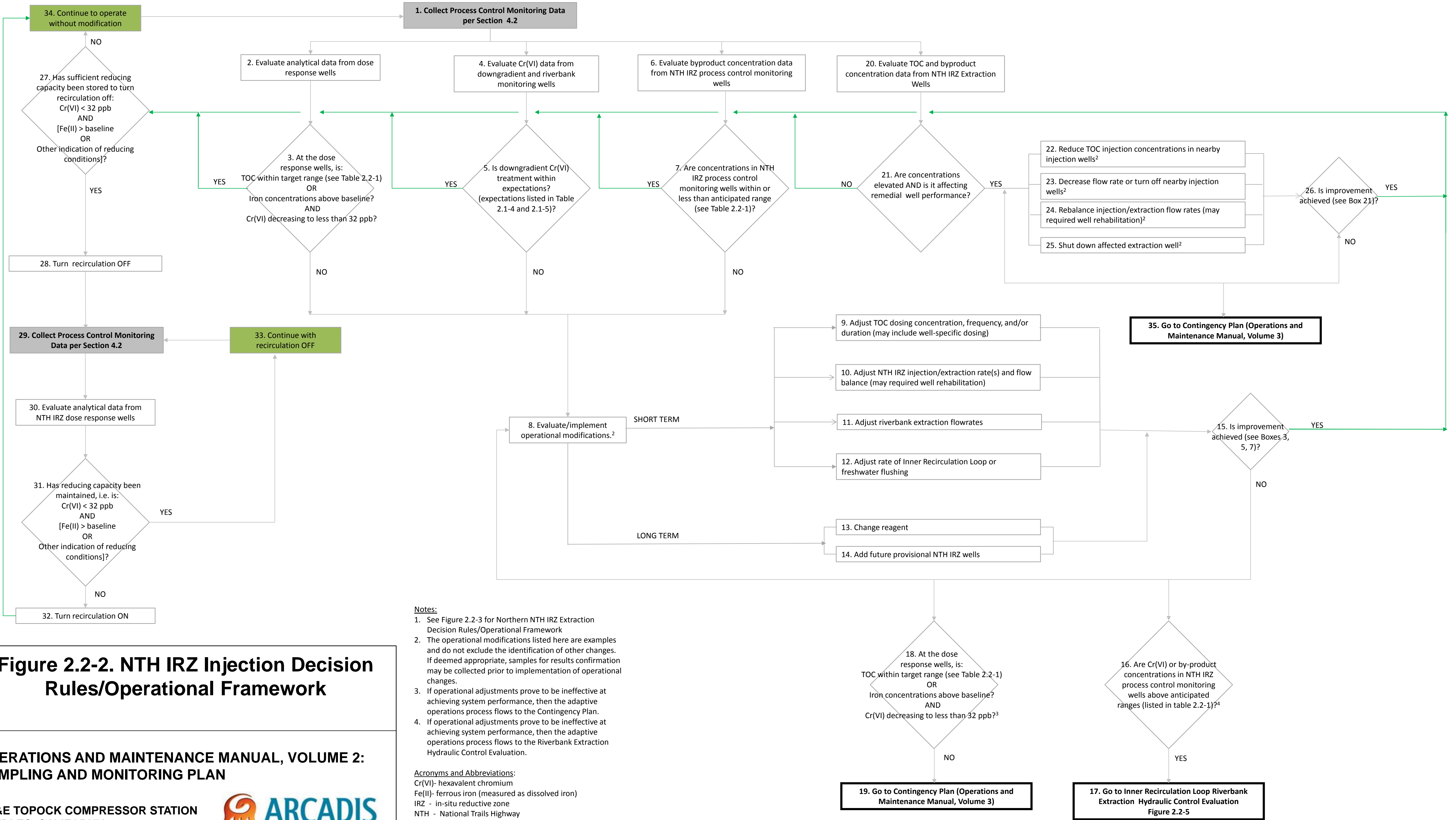


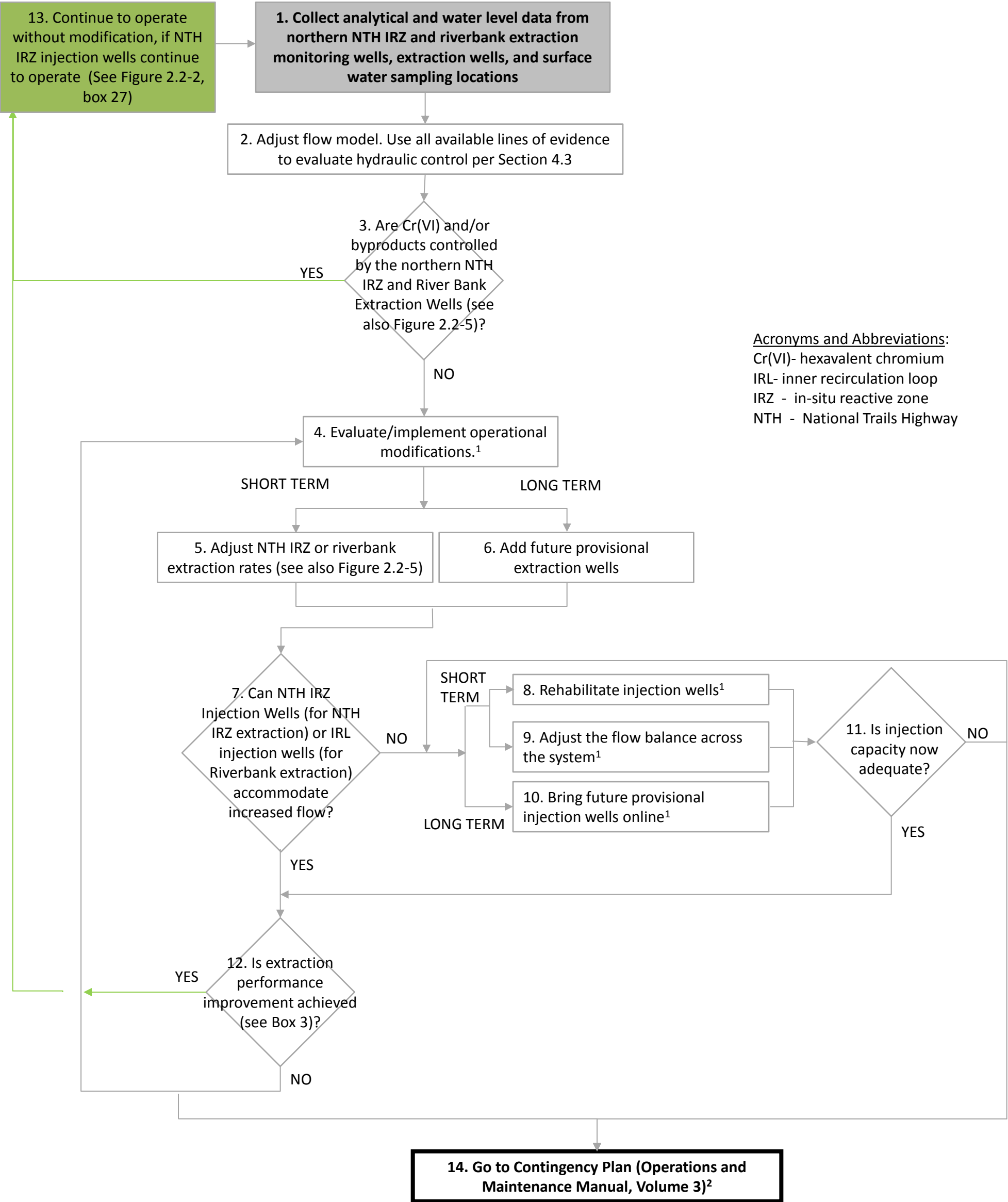
Notes:

1. See Figure 2.2-3 for Northern NTH IRZ Extraction Decision Rules/Operational Framework
2. The operational modifications listed here are examples and do not exclude the identification of other changes. If deemed appropriate, samples for results confirmation may be collected prior to implementation of operational changes.
3. If operational adjustments prove to be ineffective at achieving system performance, then the adaptive operations process flows to the Contingency Plan.
4. If operational adjustments prove to be ineffective at achieving system performance, then the adaptive operations process flows to the Riverbank Extraction Hydraulic Control Evaluation.

Acronyms and Abbreviations:

Cr(VI)- hexavalent chromium  
Fe(II)- ferrous iron (measured as dissolved iron)  
IRZ - in-situ reductive zone  
NTH - National Trails Highway  
ppb - parts per billion  
TOC - total organic carbon





**Figure 2.2-3. Northern NTH IRZ Extraction Rules/Operational Framework**

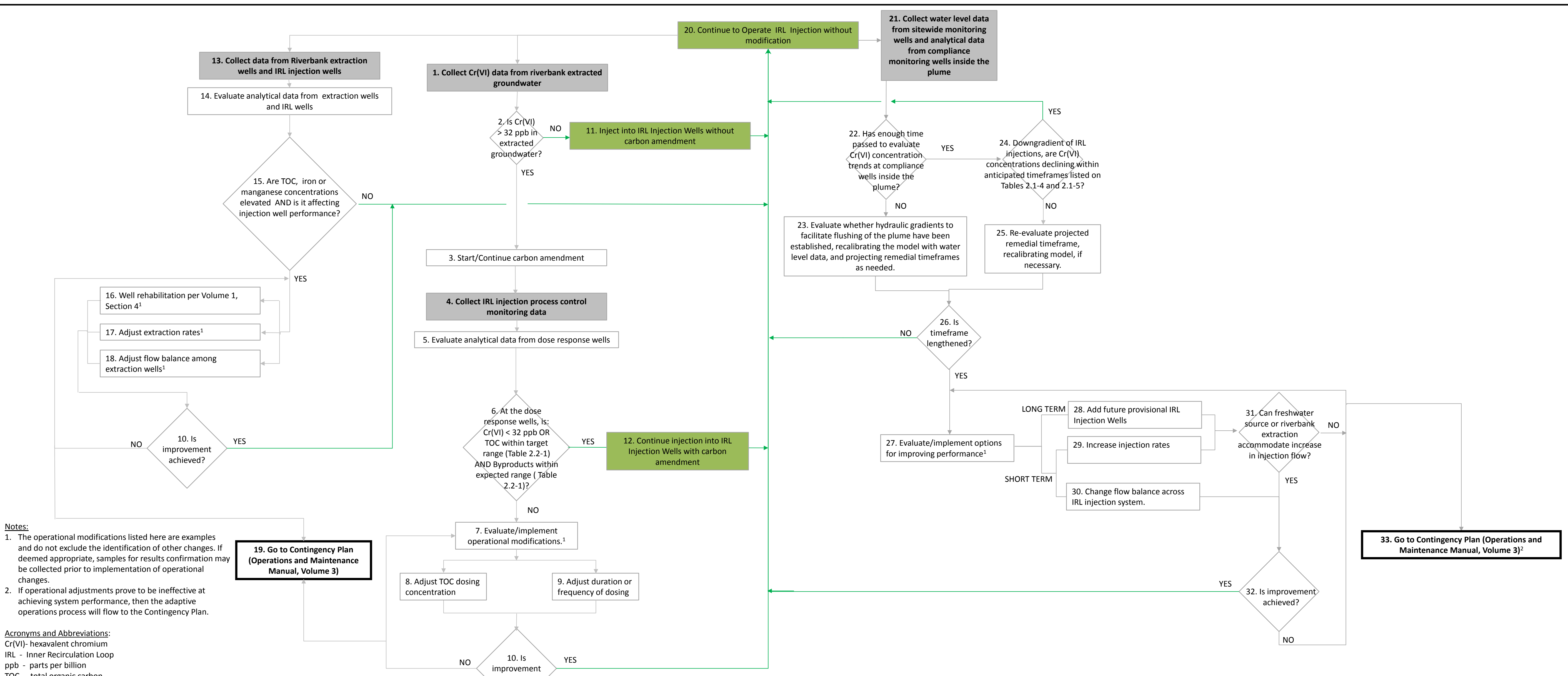
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SAMPLING AND MONITORING PLAN**

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**Notes:**  
1. The operational modifications listed here are examples and do not exclude the identification of other changes. If deemed appropriate, samples for results confirmation may be collected prior to implementation of operational changes.  
2. If operational adjustments prove to be ineffective at achieving system performance, then the adaptive operations process will flow to the Contingency Plan





**Notes:**

1. The operational modifications listed here are examples and do not exclude the identification of other changes. If deemed appropriate, samples for results confirmation may be collected prior to implementation of operational changes.
2. If operational adjustments prove to be ineffective at achieving system performance, then the adaptive operations process will flow to the Contingency Plan.

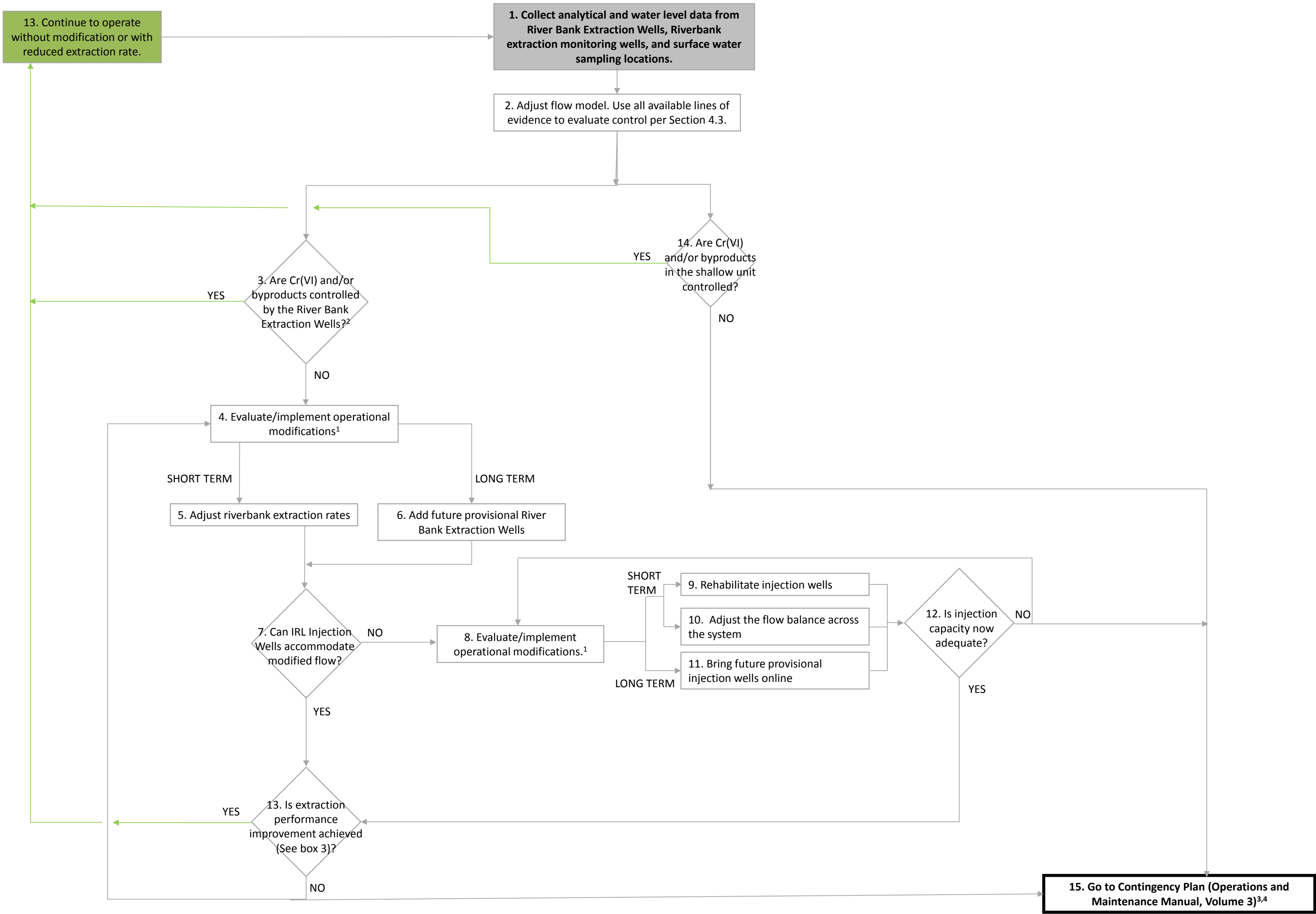
- Notes:
- 1. The operational modifications listed here are examples and do not exclude the identification of other changes. If deemed appropriate, samples for results confirmation may be collected prior to implementation of operational changes.
  - 2. The lines of evidence to evaluate hydraulic capture are presented in Section 4.3, Vol. 2 O&M Manual.
  - 3. Potential actions under the contingency plan include opening shallow screen intervals for extraction.
  - 4. If operational adjustments prove to be ineffective at achieving system performance, then the adaptive operations process will flow to the Contingency Plan

Acronyms and Abbreviations:  
Cr(VI)- hexavalent chromium  
IRL - Inner Recirculation Loop

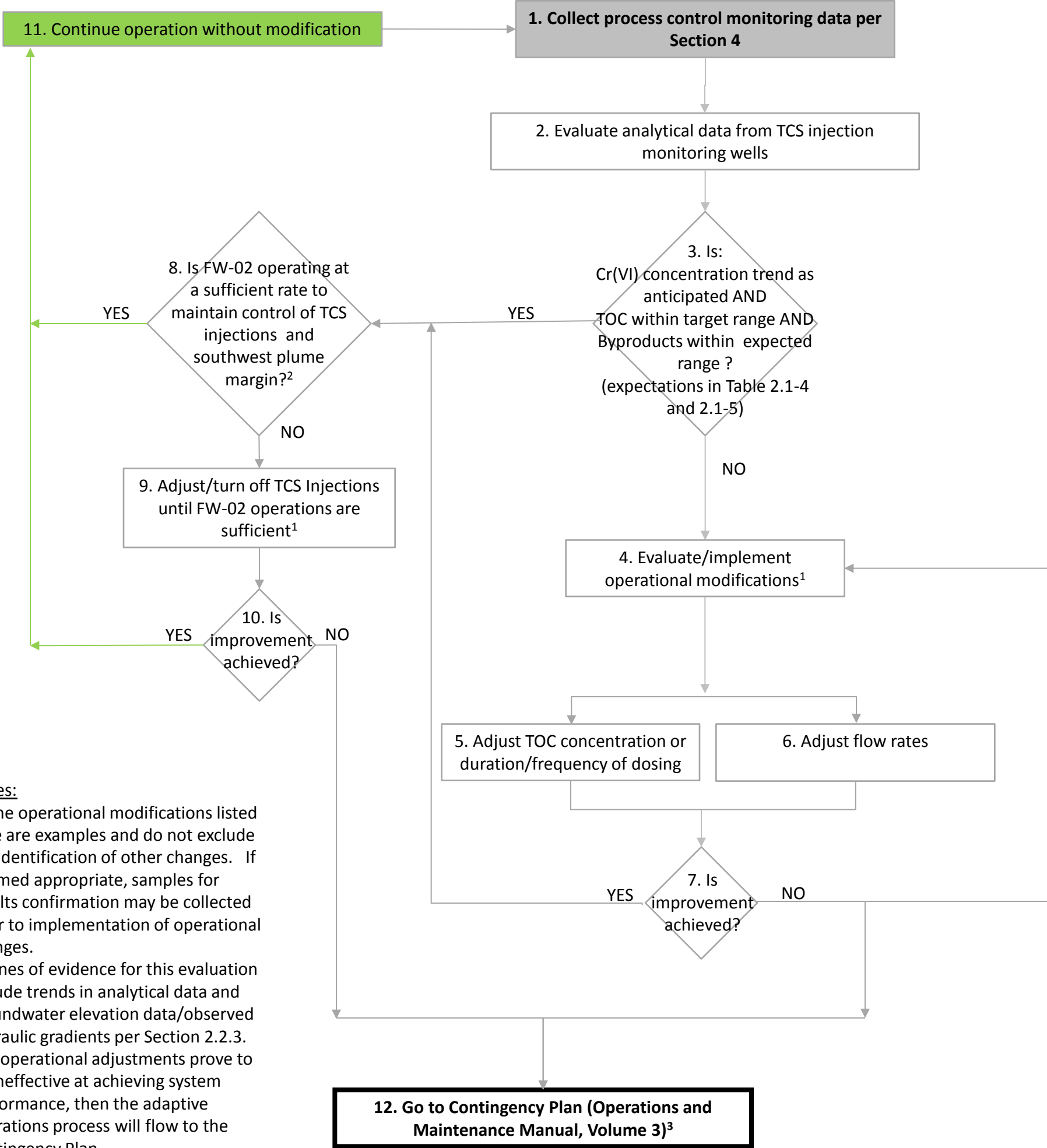
**Figure 2.2-5. Inner Recirculation Loop Extraction Decision Rules/Operational Framework**

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SAMPLING AND MONITORING PLAN**

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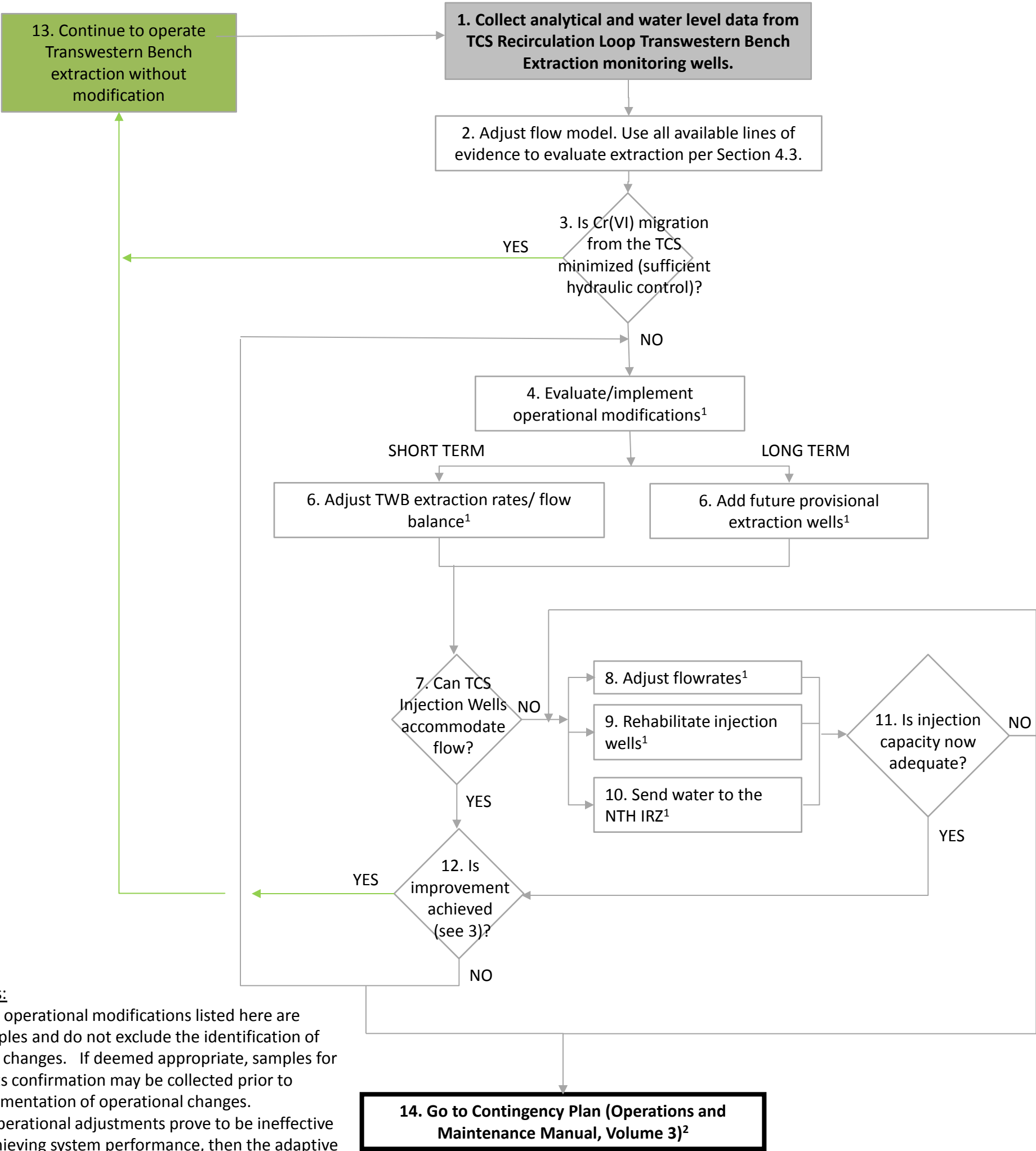




**Notes:**  
1. The operational modifications listed here are examples and do not exclude the identification of other changes. If deemed appropriate, samples for results confirmation may be collected prior to implementation of operational changes.  
2. Lines of evidence for this evaluation include trends in analytical data and groundwater elevation data/observed hydraulic gradients per Section 2.2.3.  
3. If operational adjustments prove to be ineffective at achieving system performance, then the adaptive operations process will flow to the Contingency Plan

**Acronyms and Abbreviations:**  
TCS - Topock Compressor Station  
TOC - total organic carbon

**Figure 2.2-6. TCS Recirculation Loop Injection Decision Rules/Operational Framework**



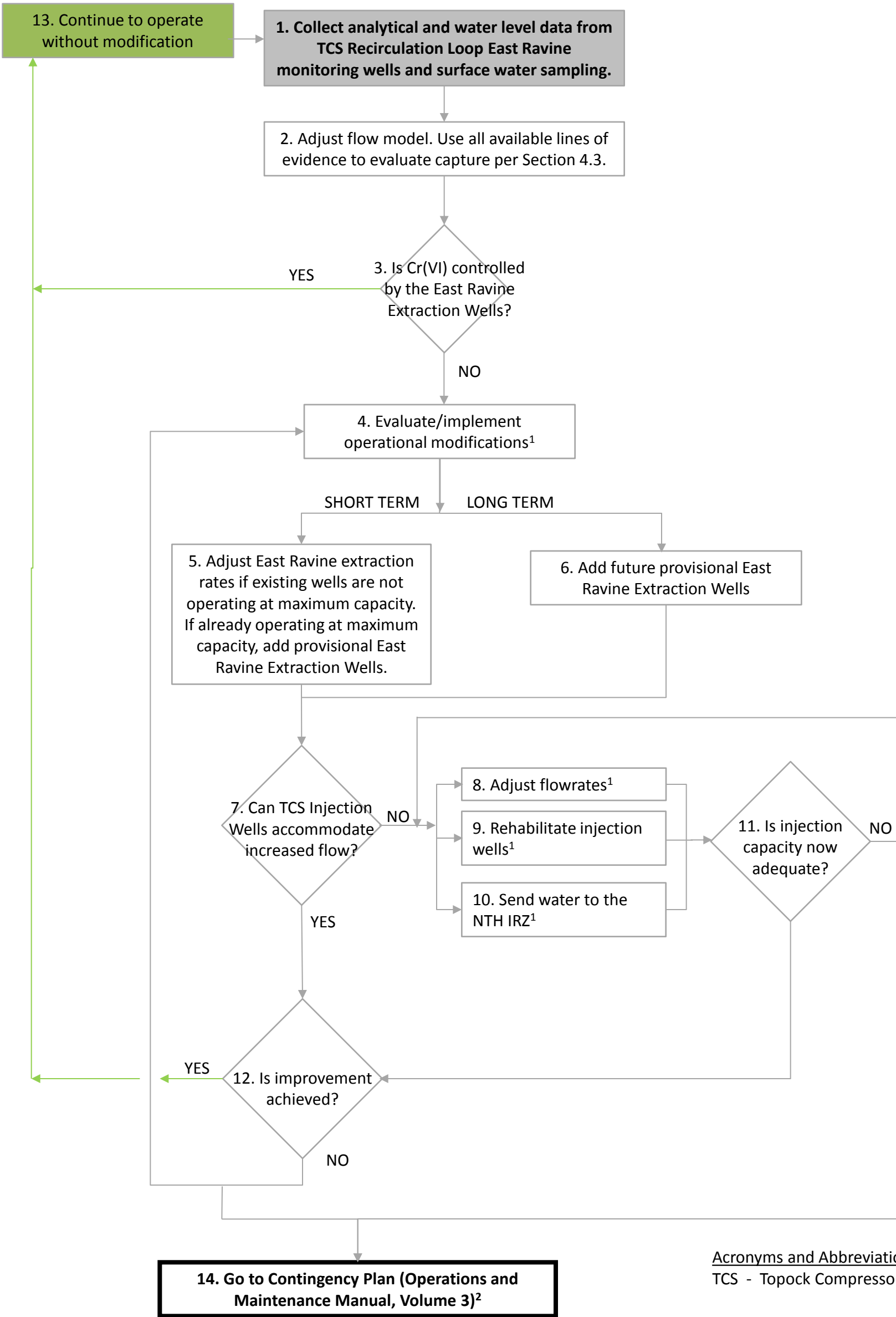
**Figure 2.2-7. TCS Recirculation Loop Transwestern Bench Extraction Decision Rules/Operational Framework**

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NEEDLES, CALIFORNIA**



Acronyms and Abbreviations:  
Cr(VI)- hexavalent chromium  
NTH - National Trails Highway  
IRZ - in-situ reactive zone  
TCS - Topock Compressor Station  
TWB - Transwestern Bench



**Figure 2.2-8. TCS Recirculation Loop East Ravine Extraction Decision Rules/Operational Framework**

**OPERATIONS AND MAINTENANCE MANUAL, VOLUME 2: SAMPLING AND MONITORING PLAN**

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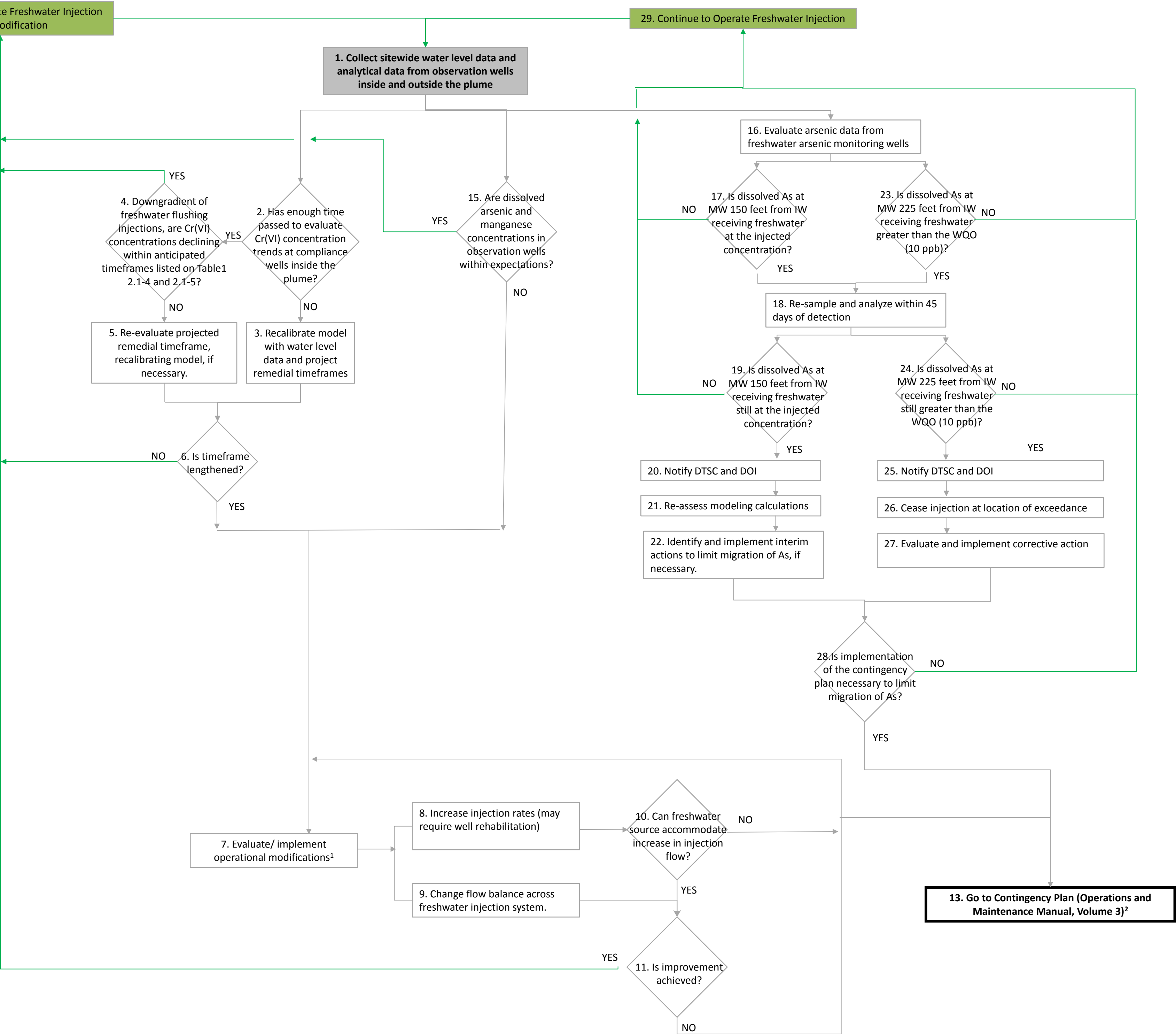


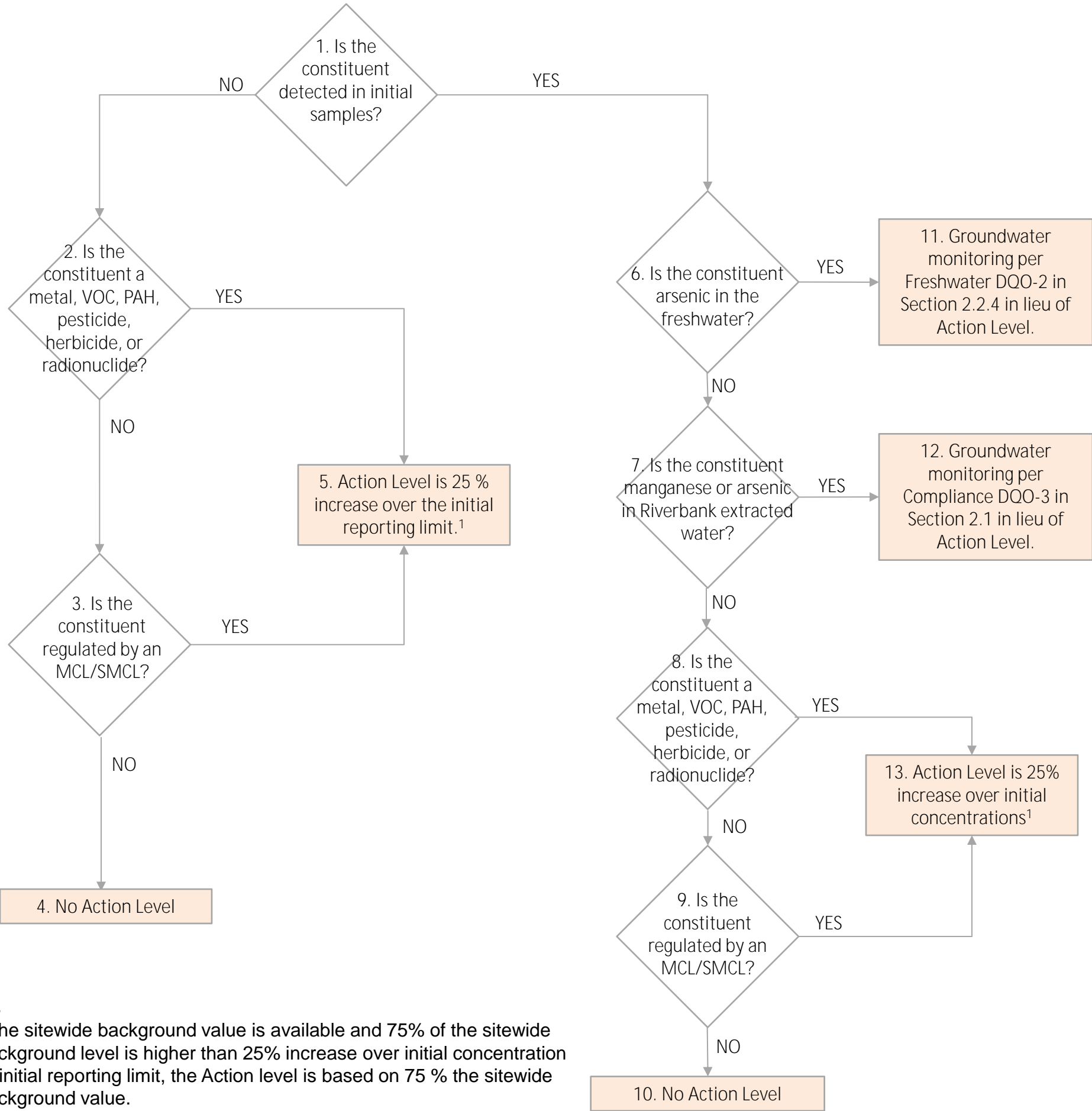
**Notes:**  
1.The operational modifications listed here are examples and do not exclude the identification of other changes. If deemed appropriate, samples for results confirmation may be collected prior to implementation of operational changes.  
2.If operational adjustments prove to be ineffective at achieving system performance, then the adaptive operations process will flow to the Contingency Plan.

**Notes:**

1. The operational modifications listed here are examples and do not exclude the identification of other changes. If deemed appropriate, samples for results confirmation may be collected prior to implementation of operational changes.
2. If operational adjustments prove to be ineffective at achieving system performance, then the adaptive operations process will flow to the Contingency Plan

**Acronyms and Abbreviations:**  
As - arsenic, Cr(VI) - hexavalent chromium, DOI- Department of the Interior  
DTSC - Department of Toxic Substances Control, IW - injection well, MW - monitoring well, ppb - parts per billion, WQO – water quality objective



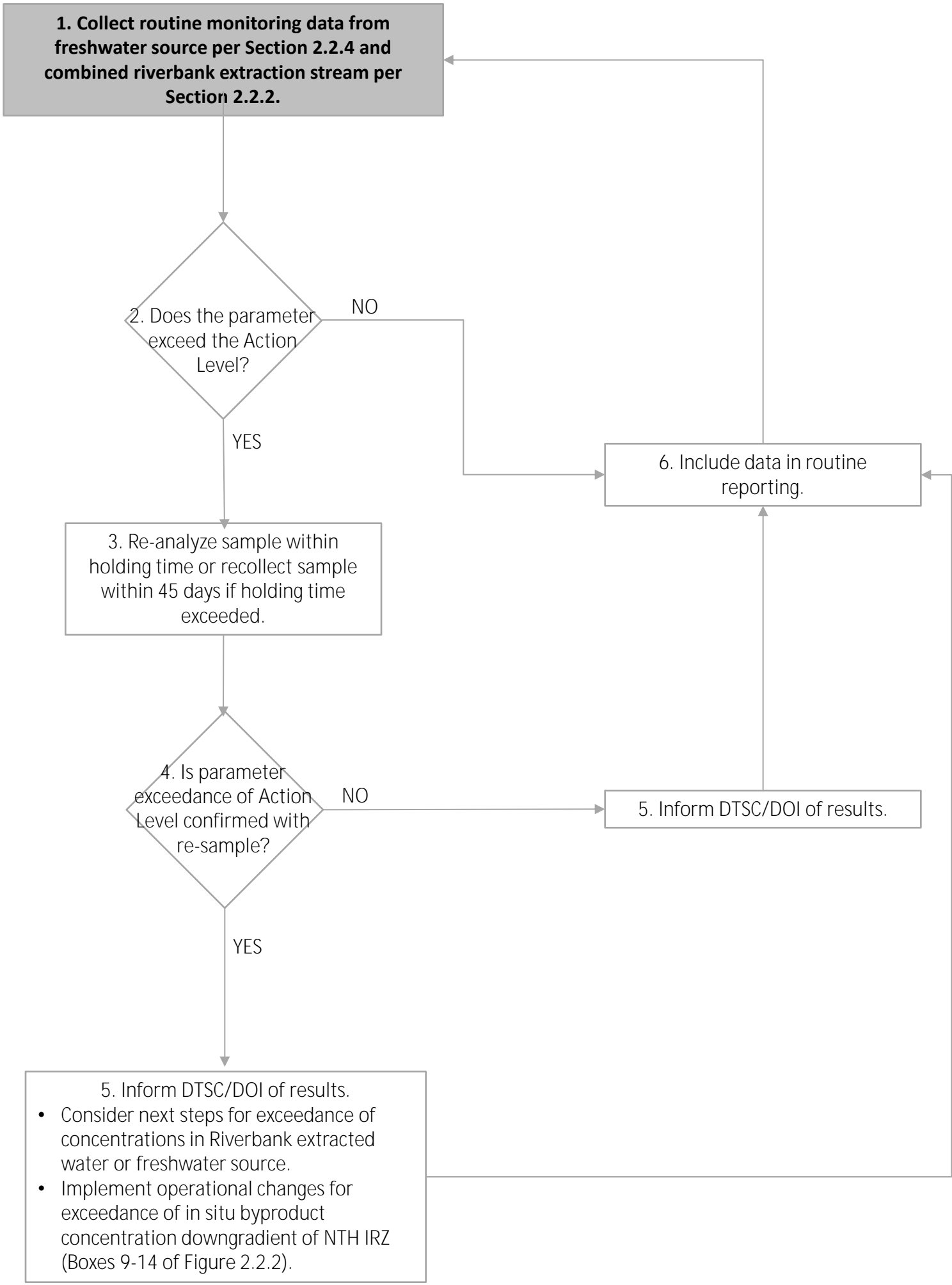


- Notes**
- 1. If the sitewide background value is available and 75% of the sitewide background level is higher than 25% increase over initial concentration or initial reporting limit, the Action level is based on 75 % the sitewide background value.
  - 2. Procedures for establishing initial concentrations are detailed in Section 2.2.2 and 2.2.4.

**Abbreviations**

DQO – data quality objective  
MCL - maximum contaminant level  
PAH – polycyclic aromatic hydrocarbon  
SMCL - secondary maximum contaminant level  
TSS - total suspended solids  
VOC – volatile organic compound

**Figure 2.2-10. Action Levels**  
**Injection of Freshwater and Water Extracted from**  
**the Riverbank**



**Figure 2.2-11. Protocol for Notification of Confirmed Exceedance of Action Levels**



## Remedy Compliance Monitoring

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As described in Section 2, groundwater and surface water will be periodically sampled to ensure that RAO-2, -3, and -4 are being met as part of the compliance monitoring program. This section will describe the sampling locations, anticipated changes in concentrations and timeframes, and sampling analytes and frequencies for the monitoring program.

### 3.1 Monitoring Locations, Anticipated Concentration Changes, and Timeframes

The compliance monitoring program will include 156 pre-existing monitoring intervals, 35 proposed locations and 5 provisional locations, and 16 surface water sampling locations. For the compliance monitoring program, monitoring wells and surface water sampling locations are shown on Figures 2.1-1 and 2.1-2, respectively, and listed in Tables 2.1-2 and 2.1-3. Monitoring well locations are also located on maps representing the current Cr(VI) plume, at different depth intervals, in Figures 3.1-1, 3.1-2, 3.1-3, and 3.1-4. Figures 3.1-5, 3.1-6, 3.1-7, and 3.1-8 show the well network overlaid with the predicted manganese distribution at 30 years. Figures 3.1-9, 3.1-10, 3.1-11, and 3.1-12 show the well network overlaid with the predicted arsenic distribution at 30 years. Predicted manganese and arsenic distributions are based on the results of the base case solute transport model, described in Appendix B of the 90% BOD Report. This section describes the optimized monitoring program for the Compliance DQOs detailed in Section 2.1.

The surface water sampling network includes ten river channel sampling points, four shoreline sampling points located along the Colorado River, and two surface water sampling points in the East Ravine. In channel surface water samples are collected with a peristaltic pump from a boat at two depths: 1 foot from the river bottom and 1 foot from the water surface. Shoreline samples are collected with a bailer or sampling pole from 4 to 6 inches below the water surface. These details are described in the Depth-Specific Surface Water Sampling SOP (SOP-A4). All of these locations are currently being sampled quarterly as part of the ongoing Interim Measures Performance Monitoring Program; therefore no new locations are being proposed. Locations C-NR1, C-NR3, C-NR4, C-CON, and RBB are located upriver from the site, with C-CON and RBB capturing the potential effects of small surface water inlets to the main channel. Similarly, C-MAR is located at the outlet of the Topock Marsh to characterize surface water inputs that may affect water quality downstream of the site. Shoreline sampling points R-19, R-28, R-63, C-R27, C-BNS, and C-R-22A are located on the river bank downgradient of the River Bank Extraction Wells and the TCS Recirculation Loop East Ravine Extraction Wells. Finally, river channel points C-I-3 and C-TAZ will be sampled to monitor for changes in river chemistry in the body of the river channel directly downstream of the site.

The outer compliance monitoring well network consists of wells that lie outside of the Cr(VI) plume boundary, defined as the 32 µg/L Cr(VI) concentration contour (Figure 2.1-1, Table 2.1-3), based on the most recent groundwater monitoring data. The outer compliance well network has been designed to obtain adequate coverage surrounding the plume, while taking full advantage of the pre-existing monitoring well network and minimizing the need for additional wells. New monitoring wells proposed as part of the Process Control Monitoring Program (Section 4) will also be used for compliance monitoring. The majority of the existing wells are located on the eastern portion of the site within the floodplain, downgradient of the Cr(VI) plume, since this area will need to be monitored most intensively to assess the potential Cr(VI) plume migration into the river. Outer compliance wells are also located to the northwest of the plume, in the vicinity of the IRL and freshwater injection areas (Figure 2.1-1). Other regions to the north, west, and south of the plume do not have high well densities due to a lack of suitable installation areas (e.g., culturally-sensitive land to the northwest and complex topography and access restrictions in the southwest).

The outer compliance wells will be sampled for Cr(VI) and Cr(T) to evaluate RAO 3. In addition, several of the outer compliance wells and surface water points will also be sampled for by-products. All of the river bank extraction monitoring wells listed within the Process Control Monitoring Program will be sampled for manganese

and arsenic as part of the Compliance Monitoring Plan; anticipated by-product concentrations and arrival timeframes for this area are discussed in Section 4. By-products will also be monitored in wells in the vicinity of the IRL injection wells northwest of the plume. Solute transport model results indicate that arsenic and/or manganese generated by IRL injections will not reach these wells within the remedial timeframe; therefore the wells will be monitored to assess this prediction (manganese predictions shown with monitoring well network on Figures 3.1-5 through 3.1-8). Outer compliance wells closer to injection points, located in the vicinity of the IRL Injection Wells (Figure 2.1-1), will be monitored to assess the likelihood of arsenic and manganese concentrations exceeding anticipated ranges as determined by solute transport model results. Anticipated by-product concentrations and arrival timeframes for these wells are discussed in Section 4.

The inner compliance network consists of wells that currently lie inside of the Cr(VI) plume boundary based on the most recent groundwater monitoring data. These wells are also shown on Figure 2.1-1 as well as Figures 3.1-1, 3.1-2, 3.1-3, and 3.1-4. Wells from across the site within the plume will be used to monitor Cr(VI) concentrations as the remedy proceeds and demonstrate removal of Cr(VI) and Cr(T) from groundwater. To increase spatial coverage within the center of the plume where the existing monitoring well network did not provide coverage, new monitoring well locations are being proposed as part of the Compliance Monitoring Program (including MW-L, MW-M, and MW-N; Figure 2.1-1, Table 2.1-2). As the Cr(VI) plume shrinks, wells will be re-categorized as outer compliance monitoring wells, and their functions will change accordingly. In this way, the compliance well network will evolve as the remedy proceeds.

The currently anticipated Cr(VI) remediation timeframe for the well classifications is listed in Tables 2.1-4 and 2.1-5. The anticipated concentrations and timeframes are based on nominal baseline values and current solute transport model predictions, as presented in Appendix B of the 90% BOD Report. These estimates will be updated as the design is completed, as the system is installed, and as baseline sampling is conducted. The estimates will also be adjusted during remedy implementation as data are collected during operations and the solute transport model is refined. Cr(VI) remediation timeframes vary from less than six months for wells in the vicinity of carbon injection points, to approximately 30 years for zones just upgradient of the IRZ that will be the last to be flushed as the plume is flushed towards the NTH IRZ line.

## 3.2 Sampling Analytes and Frequencies

Sampling analytes and frequencies for the Compliance Monitoring Program are summarized in Table 2.1-3. The sampling program presented is an initial program. As data are collected during remedy installation and initial operations, the conceptual site model (CSM) will be updated. The monitoring program may be refined based on baseline data prior to remedy operation, and the sampling program will be revisited and refined after the first two years of operation.

All compliance monitoring wells and surface water sampling locations will be sampled for Cr(VI) and Cr(T). Field sampling will follow the protocol outlined in Section 7 of this plan and will also include collection of field parameters (pH, DO, ORP, temperature, and specific conductance). Regardless of sampling frequency specified in the Compliance Monitoring Program, baseline data will be collected from all monitoring wells in the program for the full suite of analytes listed in Table 4.2-1 in Section 4 where these data do not already exist.

For wells that are also sampled for process control monitoring, the sampling frequencies follow the frequencies proposed within the Process Control Monitoring Program (Section 4; see Table 4.2-1). Outer compliance wells that are not part of the Process Control Monitoring Program will either be sampled annually or at their current sampling frequency, as outlined in Table 2.1-3. Inner compliance wells not within the Process Control Monitoring Program will be sampled at the frequency listed in Table 2.1-3, depending on the anticipated Cr(VI) concentration trends as summarized in Tables 2.1-4 and 2.1-5.

Water level measurements will be collected at all locations on a quarterly basis for comparison against groundwater flow model predictions. The frequency of water level collection will be re-assessed after the first two years of operation. These results will be used to measure hydraulic gradients and directions as lines of evidence in the assessment of hydraulic plume control, as discussed in Section 4.3. In addition, water levels will potentially be

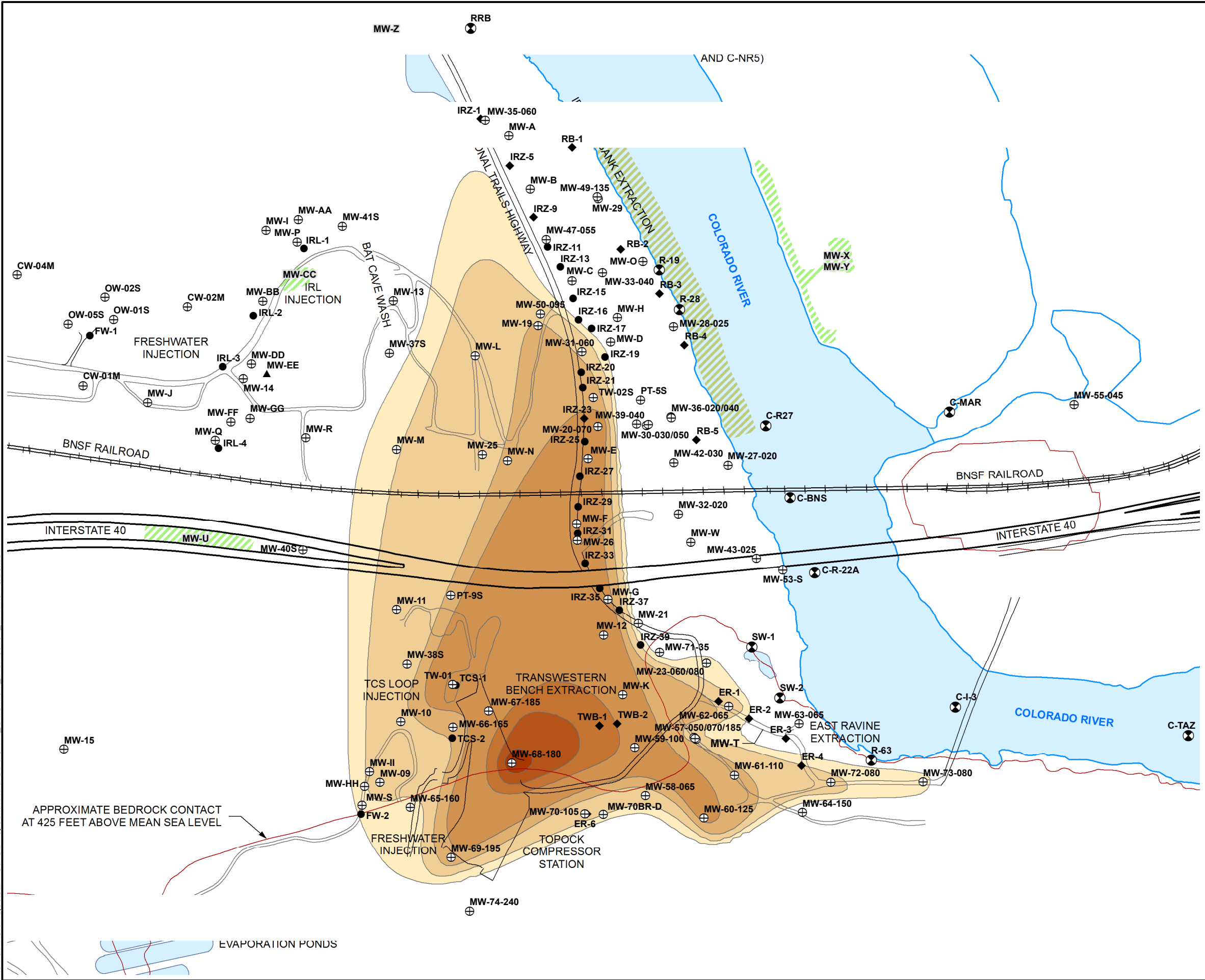


monitored on a continuous basis via in-well transducers in specific wells noted on Tables 2.1-2 and 2.1-3. These wells are selected based on their assigned function within the groundwater remedy (i.e., groundwater monitoring associated with groundwater extraction systems).

Outer compliance wells near and downgradient of carbon injection points will be monitored for the IRZ by-products manganese and arsenic to assess whether concentrations remain within expected ranges. Monitoring frequencies will follow the same frequencies outlined for Cr(VI).

Locations, analytes, and sampling frequencies within the Compliance Monitoring Program overlap substantially with the Process Control Monitoring Program, outlined in Section 4. In these cases, the same analytical results are intended to be used for both compliance and process-control monitoring.

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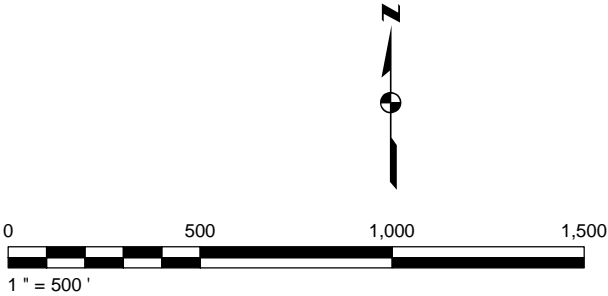
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- ⊗ SURFACE WATER SAMPLE LOCATION
- REMEDIATION WELL (INJECTION)
- ◆ REMEDIATION WELL (EXTRACTION)
- ▨ AREA FOR POTENTIAL SLANT WELL SCREENS
- ▨ AREA FOR PLANNED MONITORING WELL

**CHROMIUM CONCENTRATION (ppb)**

- 32 - 100
- 100 - 500
- 500 - 1000
- 1000 - 5000
- 5000 - 10000
- 10000 - 15000
- >15000

**ABBREVIATIONS**

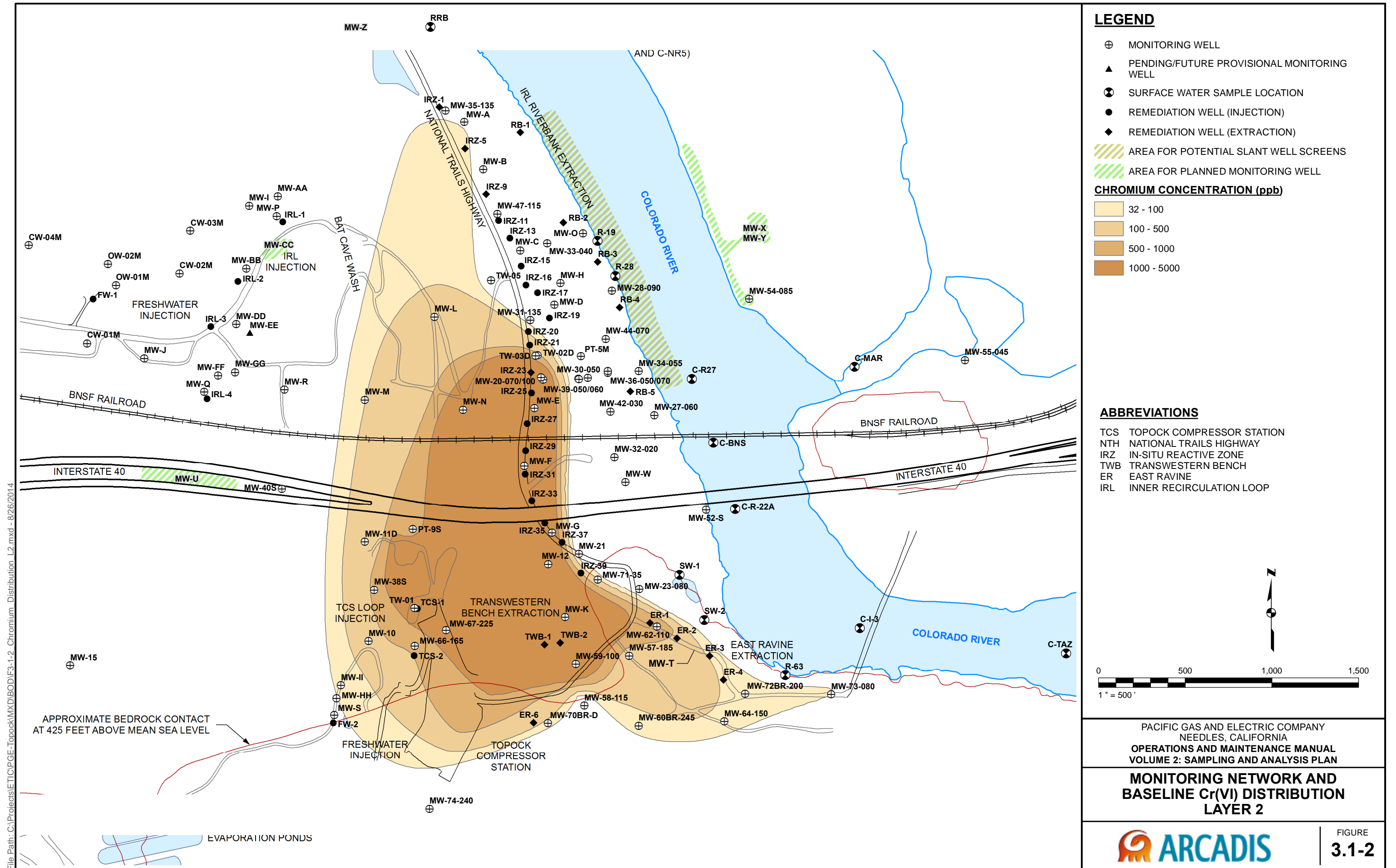
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- NTH NATIONAL TRAILS HIGHWAY
- IRZ IN-SITU REACTIVE ZONE
- TWB TRANSWESTERN BENCH
- ER EAST RAVINE
- IRL INNER RECIRCULATION LOOP



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OPERATIONS AND MAINTENANCE MANUAL  
VOLUME 2: SAMPLING AND ANALYSIS PLAN

**MONITORING NETWORK AND  
BASELINE Cr(VI) DISTRIBUTION  
LAYER 1**

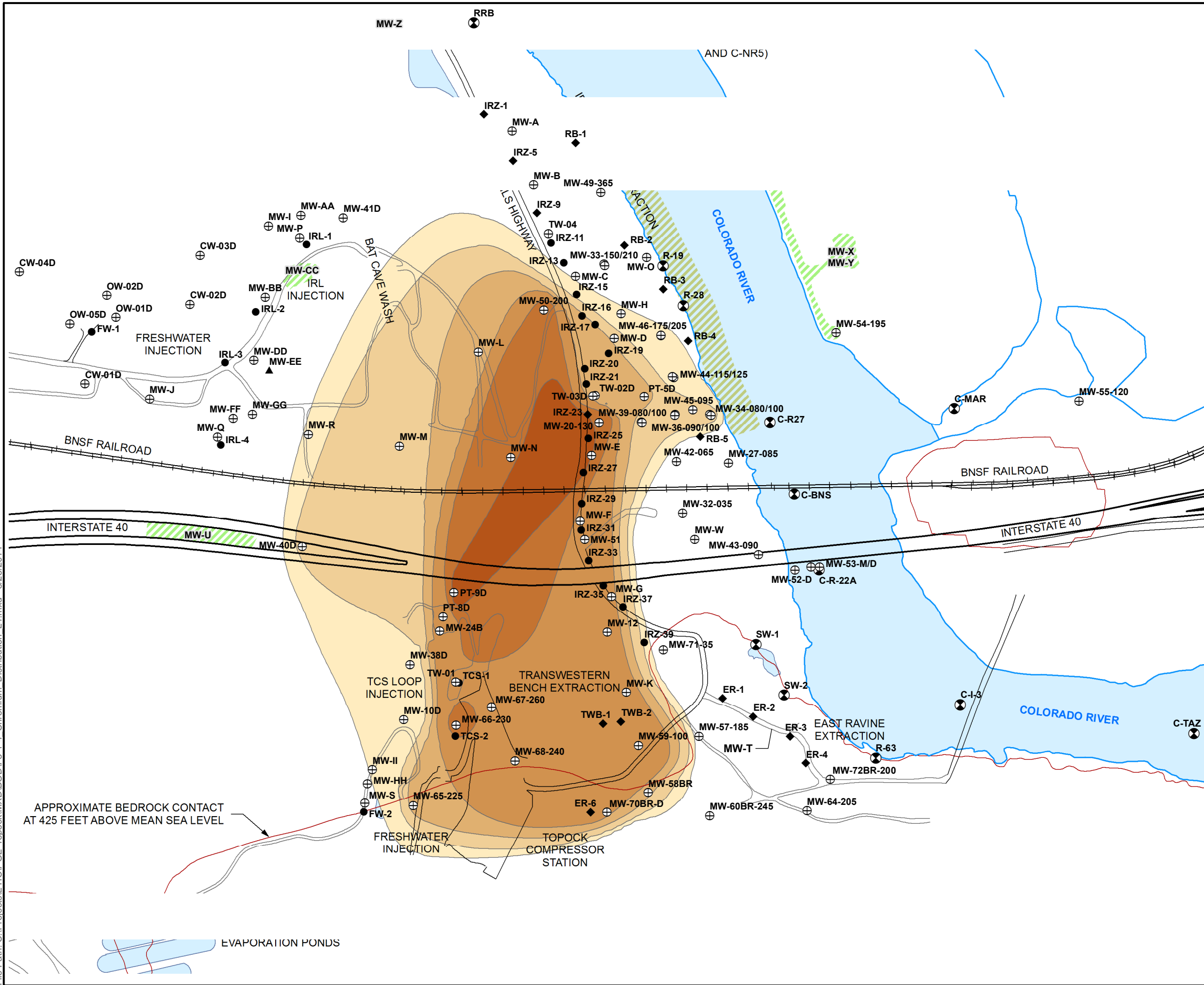








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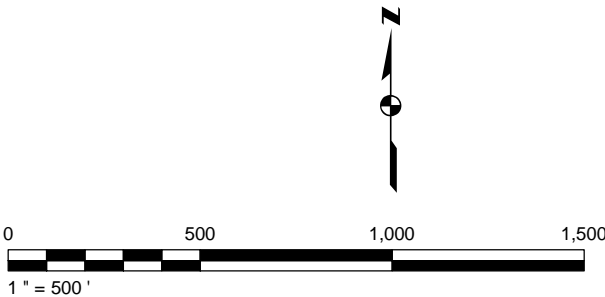
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- ⊗ SURFACE WATER SAMPLE LOCATION
- REMEDIATION WELL (INJECTION)
- ◆ REMEDIATION WELL (EXTRACTION)
- ▨ AREA FOR POTENTIAL SLANT WELL SCREENS
- ▨ AREA FOR PLANNED MONITORING WELL

**CHROMIUM CONCENTRATION (ppb)**

- 32 - 100
- 100 - 500
- 500 - 1000
- 1000 - 5000
- 5000 - 10000
- 10000 - 15000

**ABBREVIATIONS**

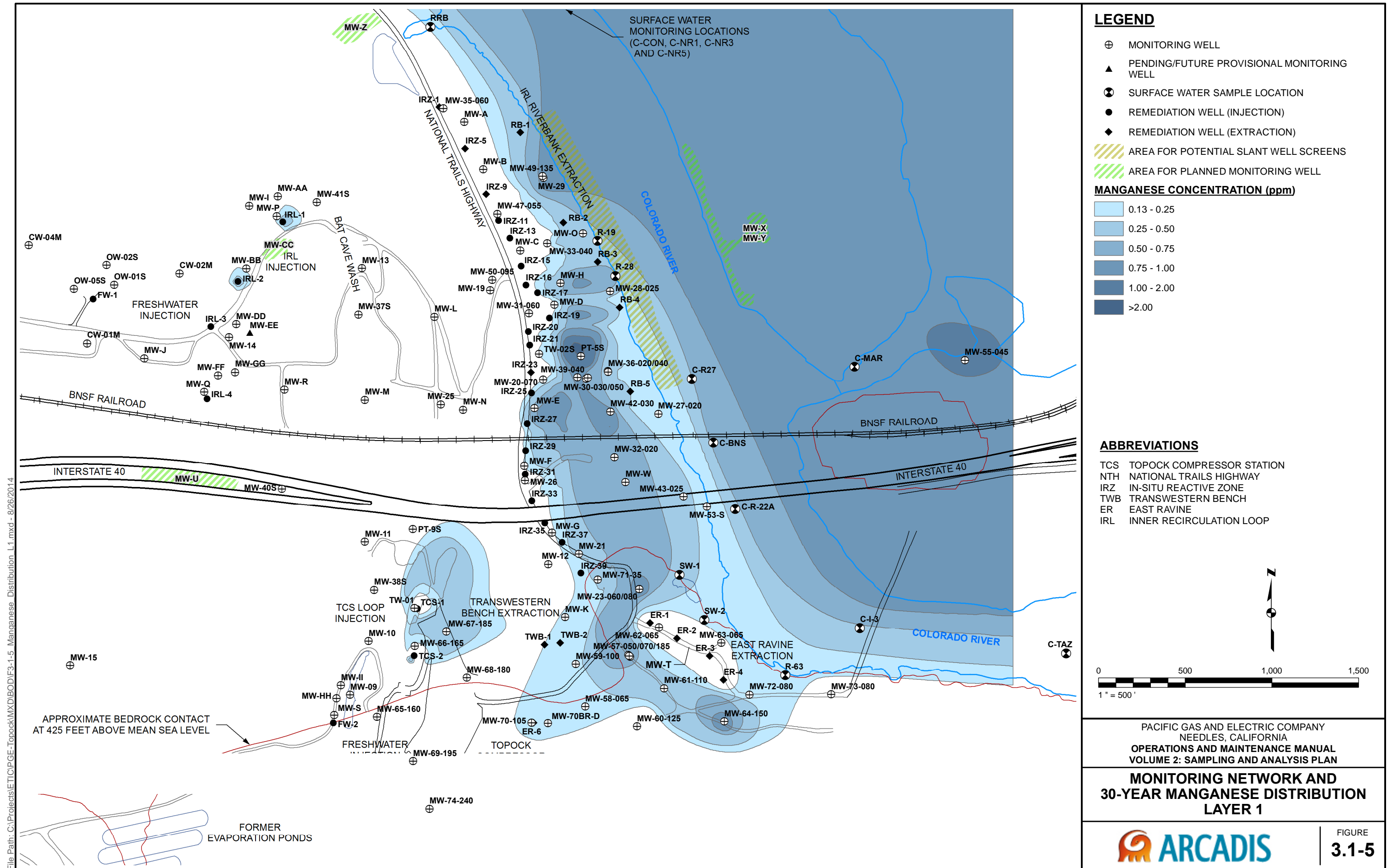
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- TWB TRANSWESTERN BENCH
- ER EAST RAVINE
- IRL INNER RECIRCULATION LOOP



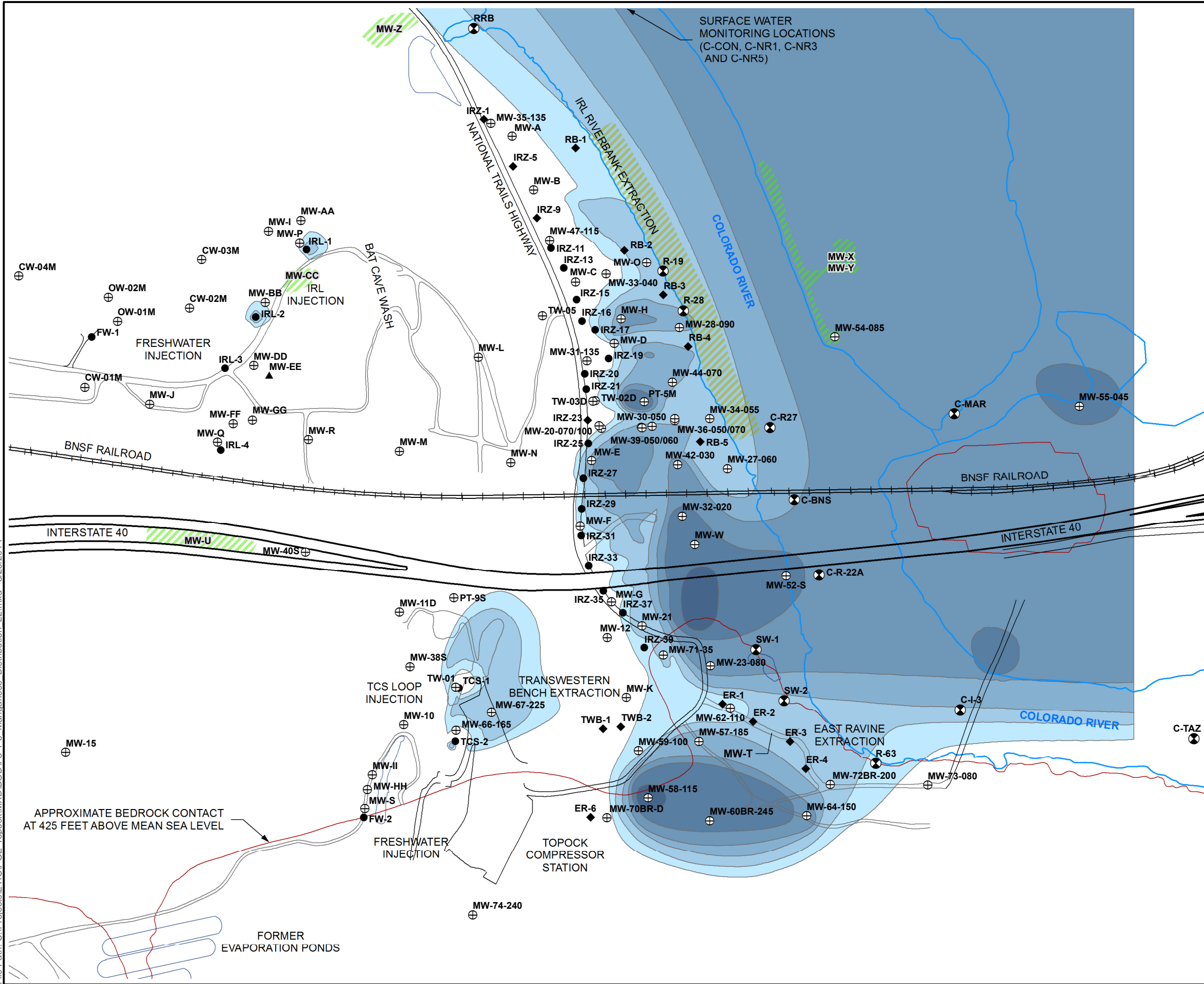
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**MONITORING NETWORK AND  
BASELINE Cr(VI) DISTRIBUTION  
LAYER 4**





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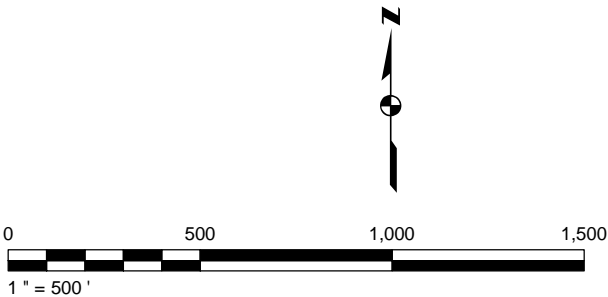
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- ⊗ SURFACE WATER SAMPLE LOCATION
- REMEDIATION WELL (INJECTION)
- ◆ REMEDIATION WELL (EXTRACTION)
- ▨ AREA FOR POTENTIAL SLANT WELL SCREENS
- ▨ AREA FOR PLANNED MONITORING WELL

**MANGANESE CONCENTRATION (ppm)**

- 0.13 - 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- 1.00 - 2.00
- >2.0

**ABBREVIATIONS**

- TCS TOPOCK COMPRESSOR STATION
- NTH NATIONAL TRAILS HIGHWAY
- IRZ IN-SITU REACTIVE ZONE
- TWB TRANSWESTERN BENCH
- ER EAST RAVINE
- IRL INNER RECIRCULATION LOOP



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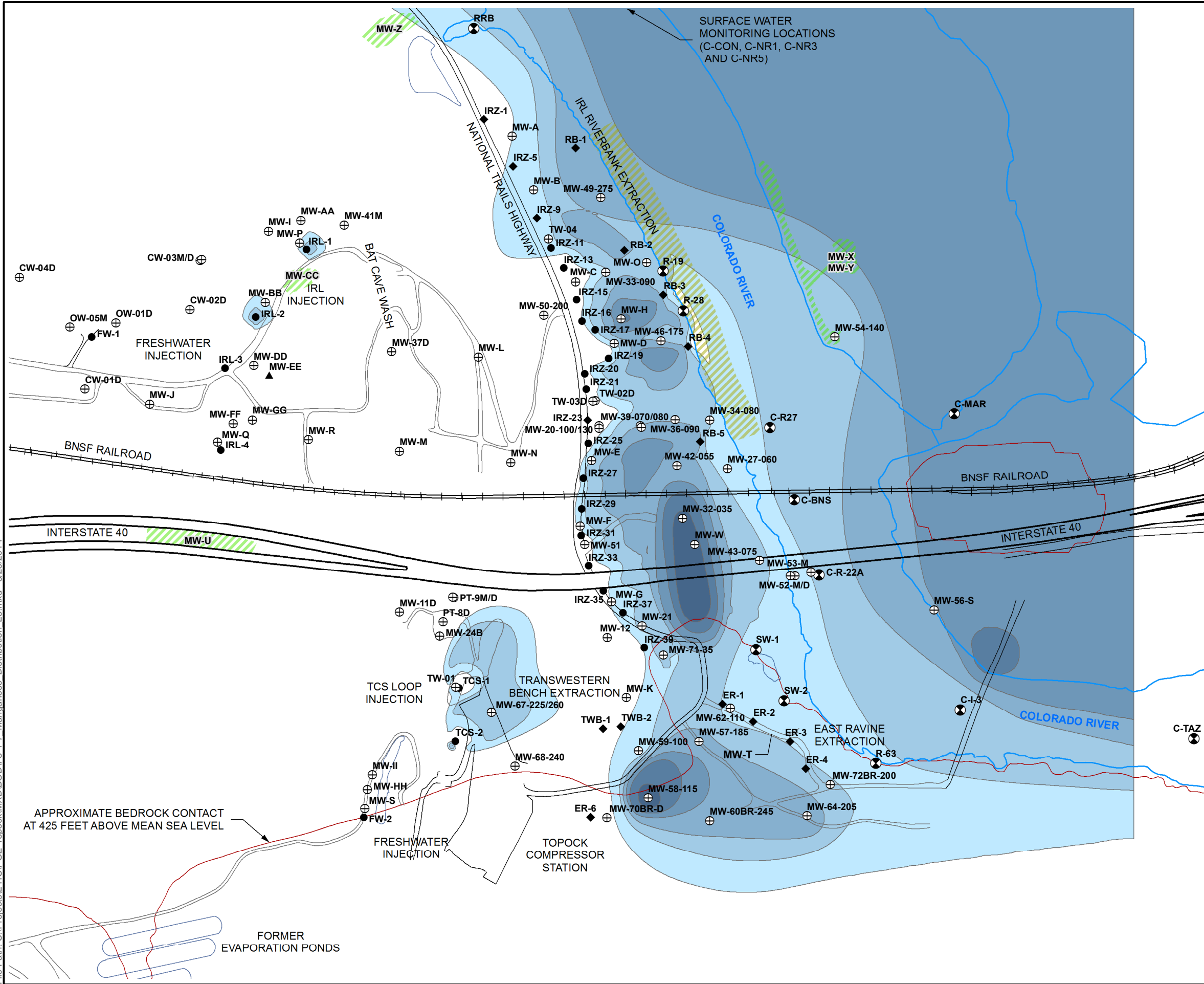
**MONITORING NETWORK AND  
30-YEAR MANGANESE DISTRIBUTION  
LAYER 2**



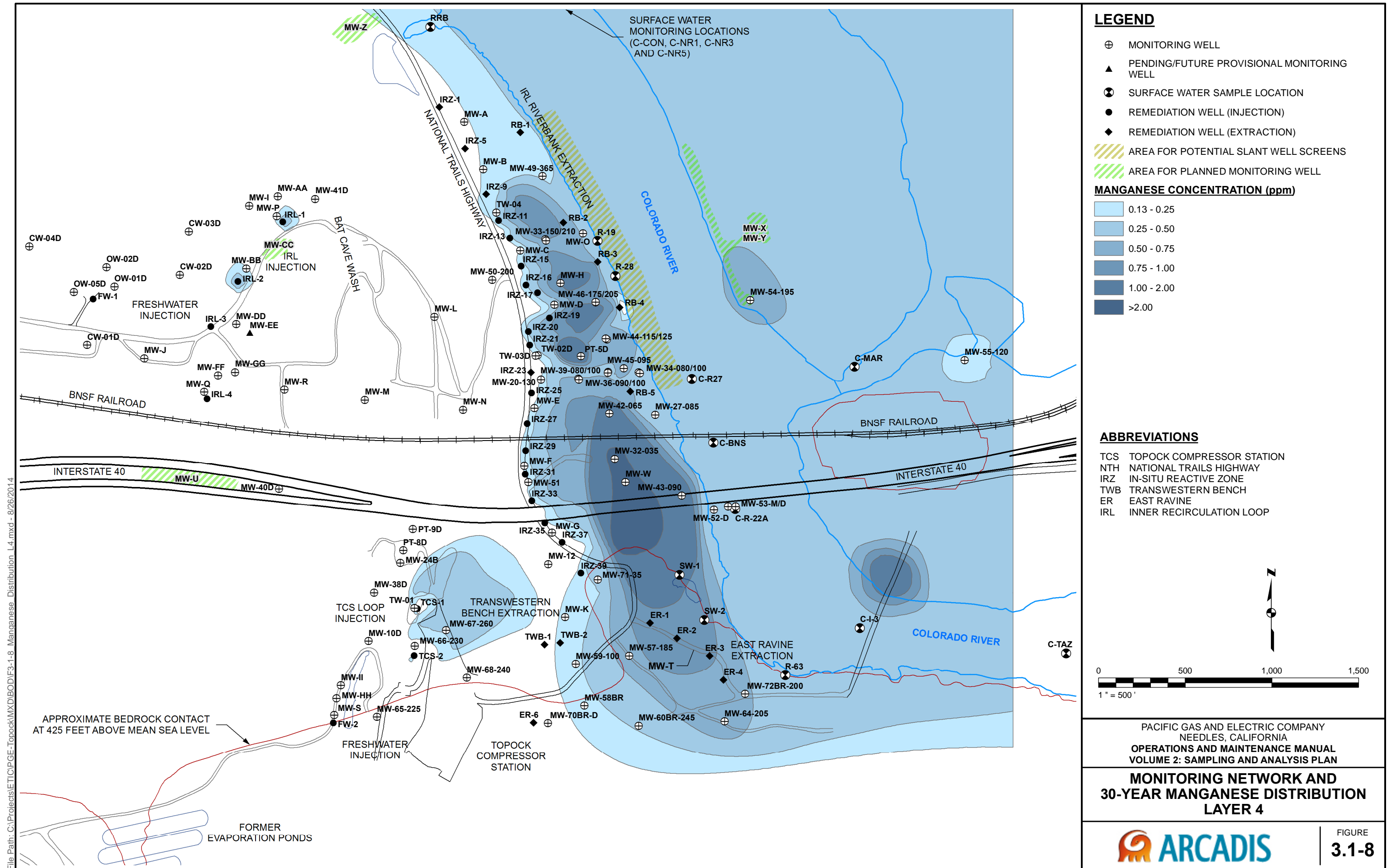
FIGURE  
**3.1-6**



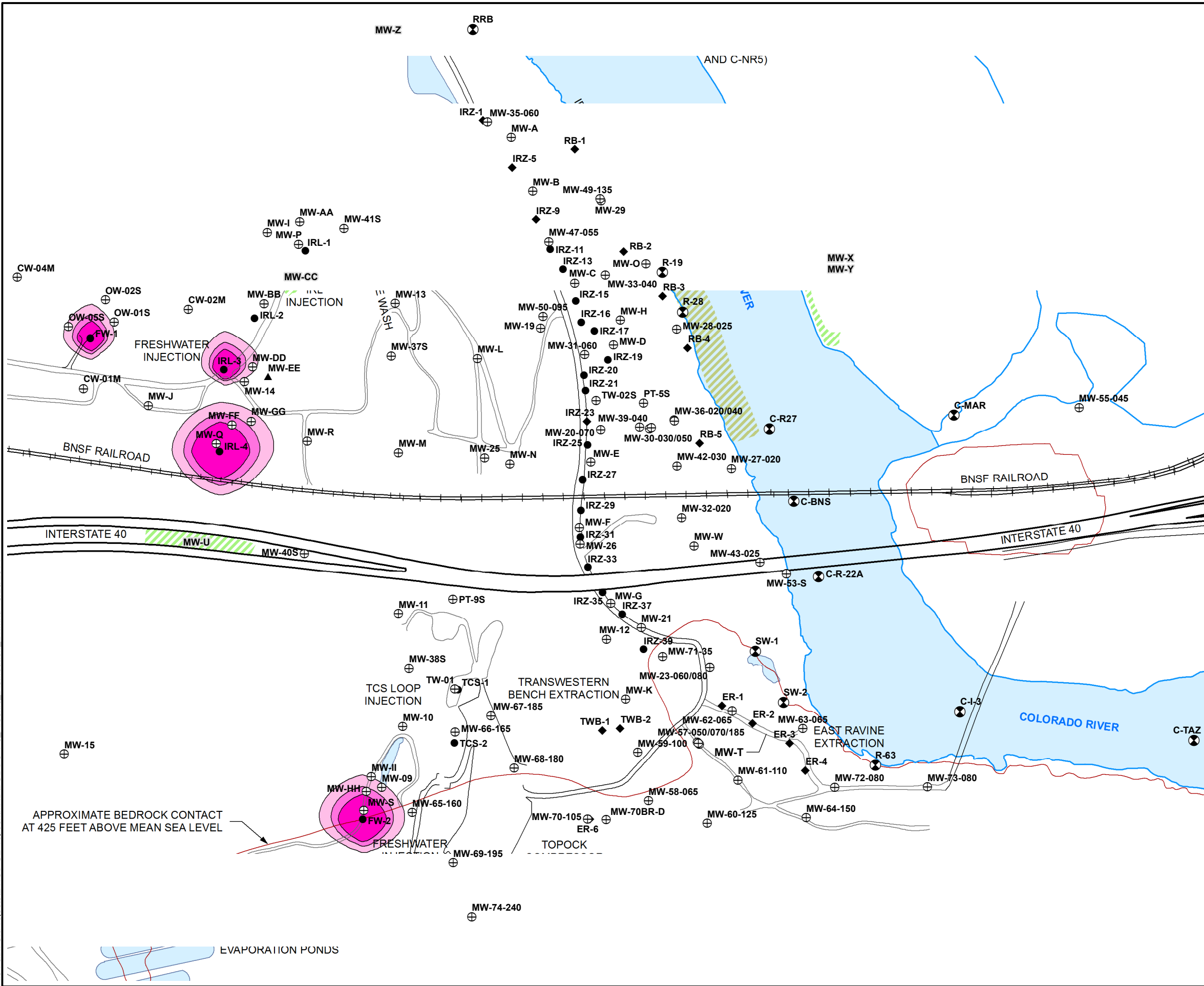
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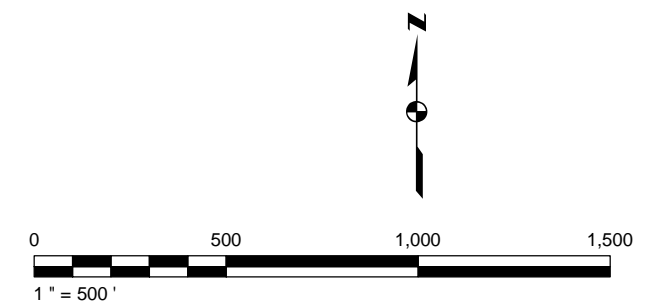
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- ▲ PENDING/FUTURE PROVISIONAL MONITORING WELL
- ⊗ SURFACE WATER SAMPLE LOCATION
- REMEDIATION WELL (INJECTION)
- ◆ REMEDIATION WELL (EXTRACTION)
- ▨ AREA FOR POTENTIAL SLANT WELL SCREENS
- ▨ AREA FOR PLANNED MONITORING WELL

## ARSENIC CONCENTRATION (ppb)

- 5 - 10
- 10 - 12
- 12 - 15

## ABBREVIATIONS

- TCS TOPOCK COMPRESSOR STATION
- NTH NATIONAL TRAILS HIGHWAY
- IRZ IN-SITU REACTIVE ZONE
- TWB TRANSWESTERN BENCH
- ER EAST RAVINE
- IRL INNER RECIRCULATION LOOP



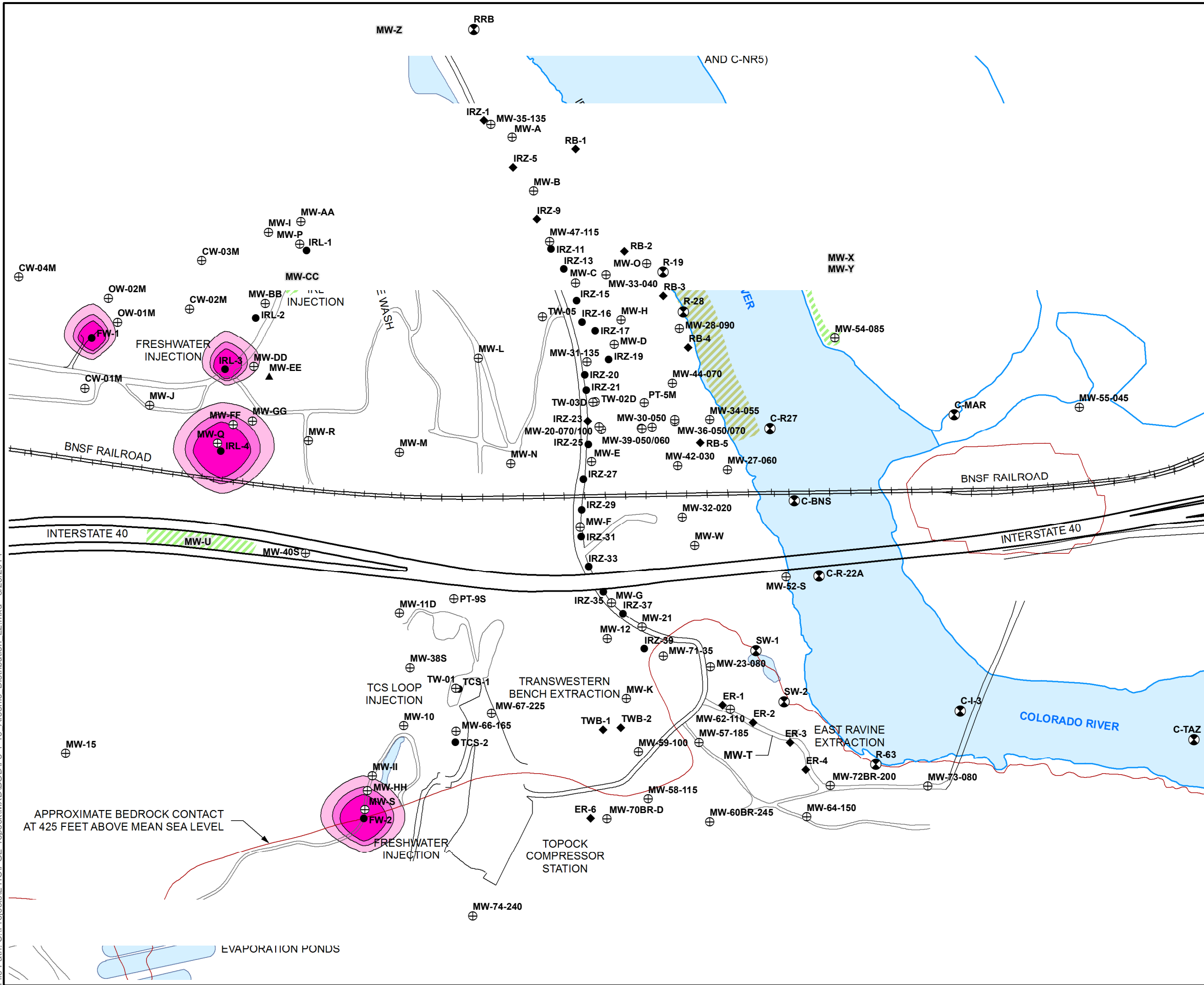
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## MONITORING NETWORK AND 30-YEAR ARSENIC DISTRIBUTION LAYER 1



FIGURE  
3.1-9

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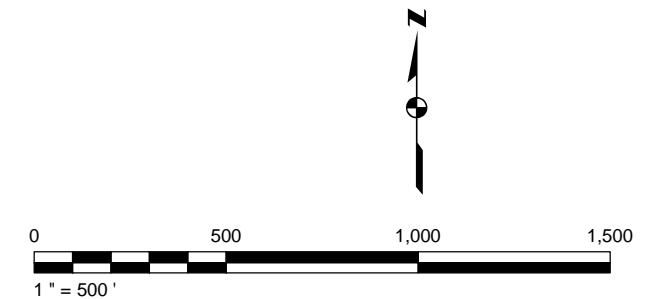
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- ⊗ SURFACE WATER SAMPLE LOCATION
- REMEDIATION WELL (INJECTION)
- ◆ REMEDIATION WELL (EXTRACTION)
- ▨ AREA FOR POTENTIAL SLANT WELL SCREENS
- ▨ AREA FOR PLANNED MONITORING WELL

## ARSENIC CONCENTRATION (ppb)

- 5 - 10
- 10 - 12
- 12 - 15

## ABBREVIATIONS

- TCS TOPOCK COMPRESSOR STATION
- NTH NATIONAL TRAILS HIGHWAY
- IRZ IN-SITU REACTIVE ZONE
- TWB TRANSWESTERN BENCH
- ER EAST RAVINE
- IRL INNER RECIRCULATION LOOP



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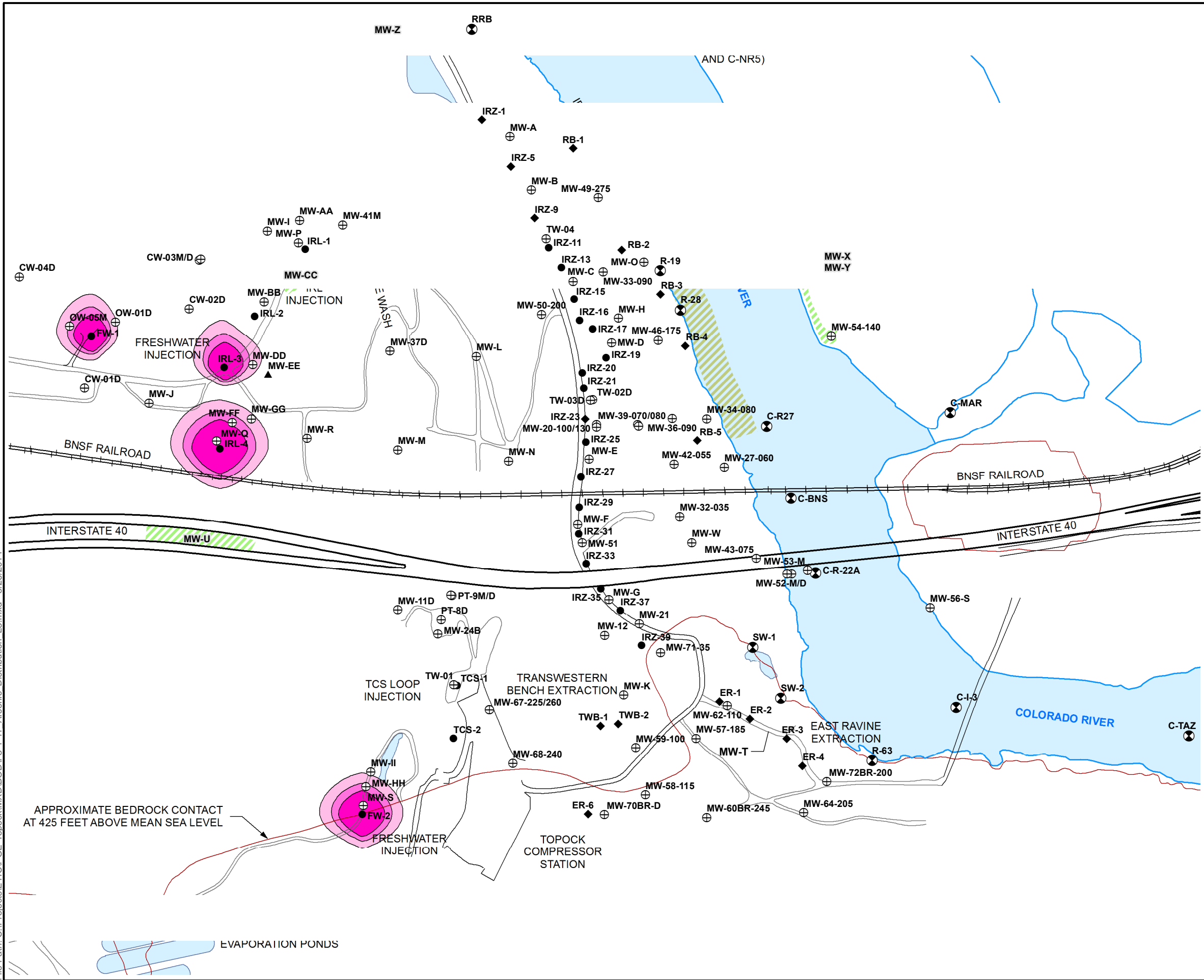
## MONITORING NETWORK AND 30-YEAR ARSENIC DISTRIBUTION LAYER 2



FIGURE  
3.1-10



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## LEGEND

- ⊕ MONITORING WELL
- ▲ PENDING/FUTURE PROVISIONAL MONITORING WELL
- ⊗ SURFACE WATER SAMPLE LOCATION
- REMEDIATION WELL (INJECTION)
- ◆ REMEDIATION WELL (EXTRACTION)
- ▨ AREA FOR POTENTIAL SLANT WELL SCREENS
- ▨ AREA FOR PLANNED MONITORING WELL

## ARSENIC CONCENTRATION (ppb)

- 5 - 10
- 10 - 12
- 12 - 15

## ABBREVIATIONS

- TCS TOPOCK COMPRESSOR STATION
- NTH NATIONAL TRAILS HIGHWAY
- IRZ IN-SITU REACTIVE ZONE
- TWB TRANSWESTERN BENCH
- ER EAST RAVINE
- IRL INNER RECIRCULATION LOOP

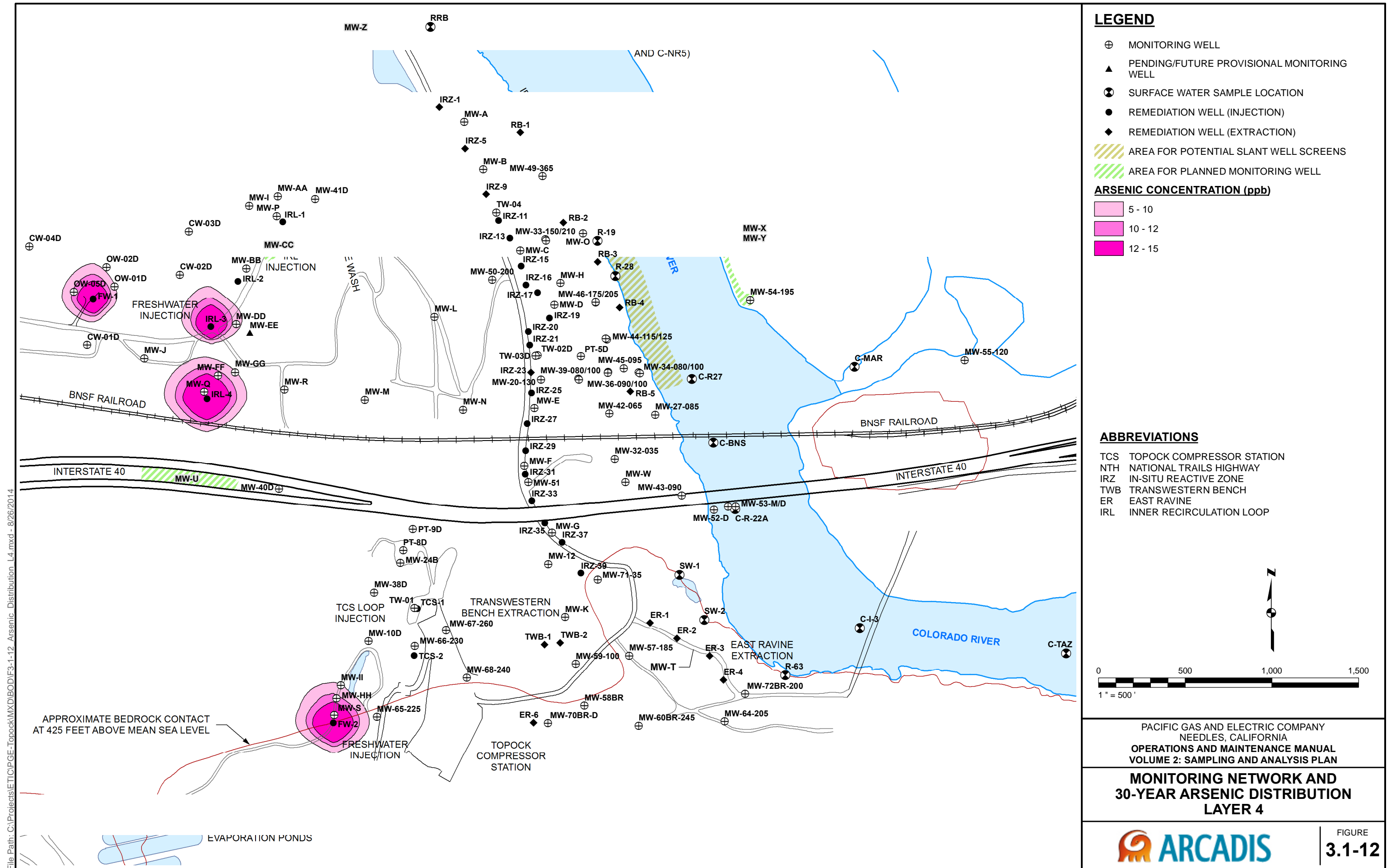
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NEEDLES, CALIFORNIA  
OPERATIONS AND MAINTENANCE MANUAL  
VOLUME 2: SAMPLING AND ANALYSIS PLAN

## MONITORING NETWORK AND 30-YEAR ARSENIC DISTRIBUTION LAYER 3



FIGURE  
3.1-11



## In-Situ Remediation Performance Monitoring

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Process control monitoring will involve sampling of groundwater and surface water to verify that the different components of the remedy are functioning as anticipated and to guide adaptive operations. The following sections describe the locations and functions of different monitoring wells, the construction of new monitoring wells, analytes to be monitored and their collection frequencies, and anticipated concentration changes and timeframes.

### 4.1 Anticipated Concentration Ranges and Timeframes

To guide the operations of the remedy, this section will establish the anticipated timeframes over which changes in concentrations of Cr(VI), by-products, and other water quality parameters is expected to occur. These expectations are based on solute transport modeling completed in support of the design, as summarized in Appendix B of the 90% BOD Report. The anticipated concentrations and timeframes are based on nominal baseline values and current solute transport model predictions. These estimates will be updated as the design is completed, as the system is installed, and as baseline sampling is conducted. The estimates will also be adjusted during remedy implementation as data are collected during operations and the solute transport model is refined. The timeframes set forth will be also used to evaluate progress toward achieving RAO 3 regarding reduction of Cr(VI) and Cr(T) mass in groundwater, in accordance with compliance DQO-2. The anticipated concentrations and timeframes will also serve as triggers for implementing adaptive operations as laid out in the decision rules/operational flowcharts in Section 2.2.

Table 2.2-1 summarizes the anticipated timeframes for the arrival of the treated groundwater for various components of the Process Control Monitoring Program. These estimates were based on the solute transport modeling and provide part of the basis for the sampling frequencies of the Process Control Monitoring Program.

For the IRZ portions of the remedy, Table 2.2-1 also summarizes the predicted concentration ranges and timeframes for TOC that will be distributed by in-situ injections and for by-products (arsenic, iron, and manganese) that will be generated by in-situ treatment. Note, barium concentrations are not predicted and are not anticipated to be significant unless strong sulfate reducing conditions develop.

In addition to anticipated concentration ranges for by-products, Table 2.2-1 also lists maximum concentrations in parentheses for manganese, iron, and arsenic. The purpose of these thresholds is to provide flexibility for individual wells that may exhibit behavior deviating from the average. Although it is expected that the majority of the wells will exhibit by-product concentrations within the anticipated ranges, it is possible that any given well may exhibit deviations outside of those ranges based on spatial variability in the hydraulic and geochemical characteristics of the aquifer that may cause locally high by-product concentrations. If a relatively small number of monitoring wells fall above the anticipated range but below the maximum, operational adjustments may not be necessary as long as the majority of the wells still fall within the anticipated range.

#### **TOC**

TOC will be analyzed to evaluate the distribution of organic carbon substrate in the subsurface within the IRZs. For dose response wells located at the midpoint between injection locations along the NTH IRZ, TOC concentrations of 15 to 50 milligrams per liter (mg/L) are targeted. For monitoring wells located closer to injection points within the NTH IRZ, IRL injection area, and TCS injection area, higher concentrations are anticipated and may exceed the average target injection concentrations depending on how continuously the substrate is applied. TOC arrival, and Cr(VI) removal, are anticipated to be observed in all dose response wells within the first six months of operation.

#### **Arsenic**

Baseline concentrations and anticipated concentration ranges for arsenic are given in Table 2.2-1. The anticipated ranges are based on a combination of generalized baseline concentrations and solute transport model predictions. The simulated arsenic concentrations considered in this analysis for the IRZs are a function of by-

product generation from carbon injections into the IRZs and are independent from arsenic concentrations associated with the freshwater source (HNWR-1A) that will be injected into the upland injection wells receiving freshwater. Solute transport model results used in determining anticipated concentration ranges included the base-case parameter model run (i.e., all parameters for sorption, precipitation, and generation are set at their nominal values) and one sensitivity model run testing an increased arsenic generation rate (Appendix B of the 90% BOD Report). Some wells exhibit baseline concentrations above these ranges and are anticipated to remain above the anticipated ranges during remedy implementation.

At freshwater injection locations—assumed to include FW-1, FW-2, IRL-3, and IRL-4 for the nominal design scenario—levels of naturally occurring arsenic in the freshwater source were also considered and simulated. The modeling results indicate that arsenic levels from freshwater injection generally remain at concentrations less than the injected concentration beyond 150 feet from injection locations (Figures 3.1-9 through 3.1-12). Model results indicate arrival of arsenic at concentrations at the injected concentration at some 150-foot monitoring locations toward the end of the modeled timeframe. For comparison against baseline data and model predictions, concentration maps for arsenic will be prepared periodically using color dots or concentration shading to illustrate the distribution of this by-product in groundwater.

**NTH IRZ monitoring wells.** Although arsenic concentrations are expected to increase due to IRZ operations, arsenic is expected to attenuate rapidly outside of the IRZ footprint. In NTH IRZ dose response wells, concentrations are expected to be between 2 and 10 µg/L, with a maximum of 15 µg/L. This concentration range accounts for background values in the 2 to 5 µg/L range, combined with maximum modeled arsenic concentrations between 5 and 10 µg/L in the immediate vicinity of injection wells (based on the base-case modeling runs, as well as the increased-generation sensitivity runs presented in Appendix B of the 90% BOD Report). Downgradient of the IRZ, by-product arsenic concentrations are not expected to exceed 5 µg/L; however, baseline concentrations are higher in some locations due to the naturally reducing conditions within the floodplain. A similar anticipated concentration range of 2 to 10 µg/L is expected for most wells, based on observed baseline concentrations and uncertainty in how those baseline concentrations may change as Interim Measure No. 3 pumping is switched off and the flow regime changes. Timing of by-product arrival in dose response wells is expected to roughly coincide with TOC arrival (within the first six months of operation).

The anticipated concentration range is lower in river bank extraction monitoring wells (2 to 5 µg/L for most wells, with a maximum of 8 µg/L), since no by-product arsenic is expected to reach these wells, and since baseline concentrations are generally lower than in the mid-floodplain.

**TCS injection monitoring wells.** Since similar TOC concentrations will be used in the NTH IRZ and TCS Recirculation Loop injections, a similar concentration range for arsenic of 1 to 10 µg/L is expected in the TCS Recirculation Loop dose response wells, while arsenic is not expected to increase significantly above baseline in downgradient monitoring wells (MW-67 cluster; Table 2.2-1).

### ***Iron and Manganese***

Anticipated concentration ranges for iron and manganese are based on a combination of generalized baseline values and by-product concentration predictions determined from solute transport modeling. Solute transport model results used in determining anticipated concentration ranges included the base-case parameter model run and parameter sensitivity analysis runs, including a run with an increased manganese generation rate and a run considering TOC injection in the IRL, as described in Appendix B of the 90% BOD Report. Solute transport modeling for iron was not conducted. It is therefore assumed that iron will follow concentration trends similar to manganese, which is a conservative assumption given that iron typically attenuates more quickly than manganese downgradient of an IRZ. For comparison against baseline data and model predictions, concentration maps for iron and manganese will be prepared periodically using color dots or concentration shading to illustrate the distribution of this by-product in groundwater.

**Dose response wells.** Based on the solute transport modeling results, including the base-case parameter run (Figures 3.1-5 through 3.1-8) and the increased-generation parameter sensitivity run (Appendix B of the 90% BOD

Report), IRZ dose response wells are expected to see a range in dissolved manganese concentrations between 1 and 2.5 mg/L, with an maximum concentration of 5 mg/L. As described above, this maximum value reflects potential spatial variability in hydraulic properties and solid phase manganese distributions within the aquifer. Such variability may cause manganese concentrations in any given well to increase above the anticipated range, even though on average the majority of the wells are expected to lie within the anticipated range. Arrival of TOC and by-products and the treatment of Cr(VI) at these dose response wells is expected within the first six months of operation.

**Downgradient and river bank extraction monitoring wells.** Monitoring wells downgradient of the NTH IRZ are expected to see a similar range in manganese concentrations, based on baseline and modeled by-product concentrations (base-case and increased manganese generation runs). Manganese and iron concentrations in the vicinity of the IRL Injection Wells will depend strongly on the concentration and duration of TOC dosing. A solute transport model parameter sensitivity run was conducted that included phased TOC injection into the IRL (Appendix B of the 90% BOD Report). Based on this run, manganese concentrations in dose response wells (P, Q, MW-14) are expected within 1 to 2.5 mg/L (maximum of 5 mg/L).

## 4.2 Sampling Locations, Analytes and Frequencies

Analytes and monitoring frequencies are outlined below according to location and category within the Process Control Monitoring Program. The sampling program presented is an initial program optimized for the process control DQOs detailed in Section 2.2. As data are collected during remedy installation and initial operations, the CSM will be updated. The monitoring program may be refined based on baseline data prior to remedy operation, and the sampling program will be revisited and refined after the first two years of operation.

All sampling events, regardless of the analytes being sampled, will also include collection of field parameters (pH, DO, ORP, temperature, and specific conductance). Field sampling will follow the protocols outlined in Section 7 of this manual. Regardless of sampling frequency specified in the Process Control Monitoring Program, baseline data will be collected from all monitoring wells in the program for the full suite of analytes listed in Table 4.2-1 where these data do not already exist or have not been collected within the past two years.

### 4.2.1 IRZ, IRL, and TCS Dose Response Monitoring Wells

Wells that will receive organic carbon injections as part of the IRZ remedy will include NTH IRZ Injection Wells (Figure 2.2-1), TCS Injection Wells (TCS-1 and -2), and potentially the IRL Injection Wells (IRL-1 through -4). Dose response monitoring wells are identified (Table 2.1-2) within the immediate vicinity of these IRZ injection wells, within the anticipated IRZ footprint. The dose response wells are used to verify that the NTH IRZ is completely established and that Cr(VI) treatment is initiated and maintained over time.

To establish the NTH IRZ, the organic carbon substrate will be distributed laterally from the injection points. Monitoring wells located in between the injection points will be used to assess the completeness of the organic carbon distribution and/or establishment of Cr(VI) reducing conditions. It will be the most difficult to establish the IRZ at locations roughly halfway between the injection points given that these locations are the farthest from the injection points. As such, additional monitoring locations (MW-C, -D, -E, -F, and -G) are proposed in the spaces between approximately every other pair of injection wells. The placement in every other space allows for data collection along the full extent of the IRZ, providing a balance in data density appropriate for evaluating the effect of potentially varying hydrogeological environments while minimizing the total number of locations required (i.e., the number of boreholes would be roughly doubled if a monitoring well was placed between every space). In addition, many pre-existing monitoring wells in the near vicinity of injection wells (within approximately 60 feet) will be used to provide additional data on TOC distribution, Cr(VI) treatment, and by-product generation closer to the injection points where reducing conditions are expected to be stronger and develop faster.

For the IRL Injection Wells, organic carbon will be amended if Cr(VI) concentrations in the injection water are above 32 µg/L. New monitoring wells (MW-P and MW-Q) will be installed within 50 to 100 feet of the injection wells to monitor water levels, TOC distribution, and by-product generation within the injection zone, and to verify



the treatment of Cr(VI). MW-14 located further downgradient of IRL-3 may also be used to monitor dose response, if IRL-3 injections are amended with carbon.

For the TCS IRZ, pre-existing monitoring wells located less than 100 feet from injection wells TCS-1 and -2 will function as dose response wells.

IRZ dose response wells will be monitored for the following constituents:

- **TOC, Cr(VI), and dissolved iron:** These three parameters are critical for monitoring the establishment of the IRZ at the dose response wells. TOC will be sampled to evaluate and verify distribution of organic carbon substrate in subsurface, Cr(VI) will be sampled to evaluate reduction of Cr(VI), and dissolved iron will be sampled to evaluate the generation of the Cr(VI) reductant ferrous iron through the stimulation of iron reduction. As discussed in Section 4.1, the changes at the dose response wells are anticipated to happen within the first six months of operation. As such, at the NTH IRZ, where IRZ establishment and maintenance is most critical (see NTH IRZ DQO-2), dose response well monitoring will be conducted monthly for the first year, which is planned to include a six-month period of operation followed by a six-month period of shutdown. If results are within expectations, the sampling frequency may be reduced to quarterly thereafter. For the TCS Recirculation Loop and the IRL, the dose response well monitoring frequency will be quarterly, less than for the NTH IRZ given the less critical nature of establishing a complete IRZ in these areas. Given the timeframes required for the establishment of microbial communities and the transport of injection reagents and by-products from the injection wells to the dose response wells, monitoring more frequently than monthly at the dose response wells will likely not be necessary. However, more frequent sampling may be considered within the first year if it is deemed valuable based on the initial results obtained at dose response wells.
- **Cr(T):** This parameter will be sampled to verify that chromium is precipitating out of groundwater following reduction. Results to date have not indicated any issues with precipitation of Cr(III) formed by reduction, and as such the Cr(T) sampling frequency is less than the Cr(VI) sampling frequency (i.e., quarterly for the first year, followed by semi-annually for the IRZ dose response wells).
- **In-situ by-products (arsenic, manganese, iron, barium):** These parameters will also be monitored at the dose response wells to evaluate by-product generation and to refine the estimates used to predict by-product generation in the solute transport model (see Appendix B of the 90% BOD Report). By-products are also an indication of the establishment of reducing conditions. Sampling for by-products will be conducted at the same frequency as sampling for TOC and Cr(VI). As noted above, sampling more frequently than monthly during startup will likely not be useful given transport timeframes, but may be considered if deemed valuable based on the results obtained.
- **Nitrate:** The removal of nitrate from solution is a primary indicator of the establishment of reducing conditions that are sufficient for the reduction of Cr(VI). Nitrate is a good indicator of the arrival of treated water and may provide information on whether the hydraulics of injection versus the amount of organic carbon delivered is controlling treatment effectiveness. Nitrate will be sampled at the same frequency as TOC and Cr(VI) in the IRZ dose response wells.
- **Sulfate:** Sulfate will be monitored at the same frequency as the other analytes in the NTH IRZ dose response wells to ensure that the reducing environment is such that excessive sulfate reduction and release of barium does not occur.
- **General water quality parameters:** Cations and anions may be useful to evaluate the potential for mineral deposit formation and may serve as tracers of injected solution. Alkalinity may be measured to monitor changes due to microbial activity and the potential for mineral deposits formation, i.e. as carbonate minerals. Total dissolved solids (TDS) may be measured as an additional water quality indicator for evaluation of changes in water chemistry. These parameters may be used to answer specific questions that arise, but will not be monitored on a routine basis at dose response wells to ensure the effectiveness of the IRZs.

- **Other nitrogen compounds:** In addition, nitrite and ammonium (potential by-products of incomplete nitrate reduction and ammonification, respectively) will also be sampled at dose response wells where reactions producing these analytes could potentially occur. If no ammonium or nitrite is detected within the first year of monitoring, sampling for these analytes will be discontinued. If increases ammonium or nitrite concentrations are detected in dose response wells as, recommendations for continued sampling and potential expansion of the monitoring network for these analytes will be provided.

#### 4.2.2 IRZ, IRL, and TCS Downgradient Monitoring Wells

For the NTH IRZ, downgradient monitoring wells (Figure 2.2-1; Table 2.1-2) will be on the edge or outside of the anticipated TOC footprint to observe downgradient Cr(VI) and by-product concentration trends. Downgradient of the NTH IRZ line, downgradient monitoring wells are located midway between the NTH and the river bank, running roughly along a north-south transect. Existing monitoring wells will provide adequate downgradient coverage, with the exception of: the region between IRZ-17 and extraction well RB-3 where well MW-H is being proposed; and the area west of the southern portion of the IRZ line where MW-W is being proposed.

For the IRL IRZ, downgradient monitoring wells will be located within 300 to 900 feet downgradient of the IRL Injection Wells. This will include existing well clusters between IRL-1 through -4 and the NTH IRZ line and proposed monitoring wells (MW-R and MW-M ) to obtain better downgradient coverage to the southeast, if needed to monitor carbon injections at IRL-4. MW-I and MW-J are being proposed as by-product monitoring wells for the IRL injections. These locations were selected because they were the optimal locations that were located more than 200 feet from injection points upgradient of IRL-1 and IRL-4 on the ends of the IRL injection line. Other locations considered within varying distances and directions from IRL-1 and IRL-4 were not as optimal based on topographic, access, and cultural considerations. Existing well clusters (CW-02 and CW-03) will also serve as by-product monitoring wells upgradient of the IRL injection points to monitor for Cr(VI) and potential injection by-products.

For the TCS IRZ, the pre-existing well cluster MW-67 will be used to monitor downgradient of the TCS injection zone. Because of the location of the injection wells within the interior of the plume upgradient of the extraction zones, more extensive downgradient monitoring will not be necessary.

Downgradient monitoring wells will be monitored for the following constituents:

- **Cr(VI), nitrate, and Cr(T):** These constituents will be sampled to evaluate the arrival of treated water. The frequency of sampling varies depending on the anticipated arrival of treated water at downgradient wells in the different systems. These wells double as inner compliance monitoring wells, and the anticipated arrival times are summarized in Table 2.1-4 and 2.1-5. Cr(T) will be sampled on a less frequent basis at the downgradient monitoring wells, similar to at the dose response wells.
- **TOC:** This will be sampled to verify the downgradient edge of TOC distribution (NTH IRZ and TCS Recirculation Loop downgradient wells only). Sampling frequency will be the same as for Cr(VI) and nitrate.
- **In-situ by-products:** These constituents will be sampled to evaluate the downgradient migration of by-products generated by the IRZ. Sampling frequency will be the same as for Cr(VI) and nitrate.
- **Sulfate and general water quality parameters:** As for the dose response wells, sulfate and general water quality parameters will be sampled on an as-needed frequency to answer specific questions as they arise.

#### 4.2.3 River Bank Extraction and Northern NTH Extraction Monitoring Wells

The NTH IRZ downgradient monitoring wells (Figure 2.2-1; Table 2.1-2) will also serve as river bank extraction monitoring wells, along with additional proposed and pre-existing wells closer to the river bank. The goal of these wells will be to monitor water levels and water quality specifically as it relates to water that will be extracted by the River Bank Extraction Wells or potentially discharged to the river. As such, the river bank extraction monitoring program includes newly installed wells and one proposed well located in between River Bank Extraction Wells (MW-O), as well as surface water sampling points to monitor the effects of groundwater discharge on river water quality. Monitoring wells on the Arizona side of the river (existing well clusters MW-54,

MW-55, and MW-56, and proposed wells MW-X and MW-Y) will also be included in the river bank extraction monitoring well network. These will serve as sentinel wells to assess the potential for Cr(VI) and by-product concentrations to increase above baseline in this area.

In response to agency comments on the monitoring well network proposed in the 60% design, future provisional locations for angled (i.e., slant) well construction on the California bank of the Colorado River have also been added. As discussed with the agencies during development of the 90% BOD Report (See Section 3.6 of the 90% BOD Report), elevated detections of Cr(VI) in monitoring wells MW-X and MW-Y, which will be constructed on the Arizona side of the river, would trigger a discussion as to whether the slant well(s) should be constructed.

River bank extraction monitoring wells will be monitored for the same constituents as the IRZ downgradient monitoring wells and at a similar frequency. In addition to evaluating the arrival of treated groundwater and by-products, the data from these locations will be used to evaluate hydraulic control and the condition of the reducing rind, as described in IRL DQO-5.

Monitoring wells, including the MW-35 cluster and proposed wells MW-A and MW-B, will be located on the northern end of the NTH IRZ network in the vicinity of extraction wells IRZ-1, -5, and -9. Monitoring in this area, which will focus on Cr(VI) and water levels, will be used to assess hydraulic control of the Cr(VI) plume on the northern end of the NTH IRZ and will be conducted on a monthly basis for the first quarter of operation, as the new hydraulic regime is established, and quarterly thereafter.

#### **4.2.4 Transwestern Bench and East Ravine Extraction Monitoring Wells**

As part of the TCS Recirculation Loop, water containing elevated Cr(VI) will be extracted from the Transwestern Bench and East Ravine areas. The monitoring network (Figure 2.2-1; Table 2.1-2) will primarily include pre-existing wells surrounding the extraction wells on all sides within approximately 500 feet. MW-K is proposed to enhance monitoring coverage to the east of the Transwestern Bench extraction. A piezometer (MW-T) will be located along the line of East Ravine Extraction Wells.

Wells will be sampled on a quarterly basis for Cr(VI) and on a semi-annual basis for Cr(T). More distant wells will also be monitored, including MW-73-080, which has shown elevated Cr(VI) concentrations, and the Arizona wells, but at a lower frequency.

#### **4.2.5 Extraction Wells**

In addition to the monitoring wells, the remedy extraction wells in the NTH IRZ, IRL, and Transwestern Bench Recirculation Loop will also be sampled as a part of the process control monitoring. Individual extraction wells will be sampled, as well as the combined stream of extracted groundwater. In addition to monitoring for water quality parameters, water level measurements will be collected with a probe in two locations: within the well via a stilling tube and within the filter pack via a piezometer.

Samples collected from all of the extraction wells and combined extracted groundwater streams for the NTH IRZ will be analyzed for Cr(VI). The data will be used to evaluate hydraulic control of the plume (Section 4.3) and to determine if treatment is required prior to re-injection in the IRL (Section 2.2.2).

Because several of the NTH IRZ Extraction Wells are located close to the injection wells, the extraction wells will be sampled for dissolved and total iron and manganese and TOC which may be extracted from nearby injection locations and which may cause fouling. Oxidation of dissolved iron and/or manganese may form mineral deposits and cause fouling of pipelines and injection wells. Excess TOC can cause biological growth in pipelines and extraction wells, causing fouling.

Additional water quality parameters can be used to evaluate the potential for precipitate formation that could lead to fouling and will be evaluated if needed for troubleshooting.

#### **4.2.6 Combined Extraction Streams and Freshwater Source**

Samples for IRL DQO-5 will be collected from the sampling port located in the River Bank Extraction Well network header where it enters the IRZ Carbon Amendment Building, upstream of the static mixer, as shown on Exhibit

2.2-1. Samples for Freshwater DQO-3 will be collected from the freshwater source prior to the injection location. The monitoring program will include a wide range of constituents, both organic and inorganic, that have never been tracked at the Topock site but could be undesirable if present in the injected water. Inorganics will include metals, common anions and cations, total dissolved and suspended solids, stable isotopes of oxygen and hydrogen, et cetera. These analyses provide a means for tracking overall changes in injected water quality with time. Samples will be analyzed for the constituents listed in Table 5.2-4 in Section 5.

Because of the lack of nearby sources, the likelihood of organic contaminants being present in the freshwater source or extracted river bank water is small; therefore, the frequency of analysis for organics and pesticides will be lower than for metals and common ions. Monitoring frequency for the inorganic suite will be monthly for the first six months and quarterly for the remainder of the first year of operation, assuming the water quality is generally stable at that time (if the water quality appears to be changing rapidly, monthly sampling would be continued beyond the first 6 months). Following the first year, monitoring frequency will switch to semi-annual. Monitoring frequency for the organic analytical suite will be annual for the first two years, switching to every other year in subsequent years.

## 4.2.7 Freshwater Arsenic Monitoring Wells

Freshwater arsenic monitoring wells (Table 2.1-2) are proposed at locations as shown on Figure 2.2-1. Per the State Board letter, these wells are located at 150 and 225 feet, with a few exceptions based on DTSC direction related to accessibility, constructability, and cultural considerations. Existing monitoring wells were utilized, where possible. New monitoring wells are proposed where existing monitoring wells did not exist at the requisite distances from the injection well.

The locations for freshwater arsenic monitoring per the State Board letter requirements are as follows:

- New well location MW-AA will serve as the 150-foot monitoring location for IRL-1.
- Existing well cluster MW-41S/M/D will be used for the 225-foot monitoring location for IRL-1.
- New well location MW-BB will serve as the 150-foot monitoring location for IRL-2. In this case, the 150-foot monitoring well was shifted closer to the injection well (approximately 90 feet from the injection well), where construction is feasible. If this location is determined insufficient by the regulatory agencies, then a well would be constructed at another location along the arc or an angled well will be evaluated<sup>1</sup> and considered for MW-BB.
- New well location MW-CC will serve as the 225-foot monitoring location for IRL-2. The green shaded area on Figure 2.2-1 shows the current planned area for installation of this location. MW-CC will be placed in the road if feasible. If it cannot be placed in the road, then an angled well will be installed from the IM3 facility area that extends to the 225 foot arc<sup>1</sup>.
- New well location MW-DD or another location along the 150-foot arc will serve as the 150-foot monitoring location for IRL-3.
- New well location MW-EE Figure 2.2-1 is currently under consideration to serve as the 225-foot monitoring location for IRL-3. The location shown on the Figure 2.2-1 is a future provisional placeholder. If an alternative, acceptable location is identified, the status will be changed to “planned” and it will be installed with other remedy facilities. If an acceptable location cannot be identified, and in light of Tribal opposition to the location identified, DTSC will consider this well as “future provisional” with construction on hold until such time that arsenic concentrations are detected at the injected concentration in samples collected from MW-DD, considering arsenic transport data as observed at all other arsenic monitoring wells during remedy operation as appropriate.

<sup>1</sup> The use of conventional, vertical wells is preferred over angled wells since vertical wells allow placement of all well screens from one location to meet the specific distance required by the State Water Board letter. This and other potential technical issues may be further evaluated with the regulatory agencies prior to substituting vertical wells for angled wells.

- New well locations MW-FF and MW-GG will serve as the 150- and 225-foot monitoring locations, respectively, for IRL-4.
- New well locations MW-HH and MW-II will serve as the 150- and 225-foot monitoring locations, respectively, for FW-2.

In addition, arcs indicating potential locations are drawn for the 150- and 225-foot monitoring well locations on Figure 2.2-1 related to IRL-2 and IRL-3. If more suitable locations can be found along these arcs prior to construction, the locations of the monitoring wells may be moved along these arcs.

Sampling for arsenic will be conducted at these monitoring locations on a quarterly frequency, as indicated in Table 2.1-2.

#### 4.2.8 Carbon Amendment System Sampling Locations

Samples will be collected from sampling points located throughout the carbon amendment system to evaluate its effectiveness. At the MW-20 Bench, the carbon substrate will be fed into three conveyance forcemains (one to the IRL Injection Wells, one to the northern NTH IRZ injection leg, and one to the southern NTH IRZ injection leg), each equipped with an in-line static mixer. As shown in Exhibit 2.2-1, samples for each line will be collected from sampling ports located just downstream of each mixer (M-IRZ00-705, M-IRZ00-706, and M-IRZ00-707). At the Transwestern Bench, carbon substrate is fed into one conveyance forcemain equipped with a static mixer (M-IRZ00-907), and samples will be collected from a port located just downstream of this mixer (Exhibit 2.2-2). In addition, sampling ports are available within each injection vault to sample the distribution of organic carbon to individual injection wells (Exhibits 2.2-1 and 2.2-2), as needed.

#### 4.2.9 Water Level Monitoring

Water levels will be measured in all monitoring wells, injection wells, and extraction wells in support of addressing the hydraulic and hydrogeologic components of remedy assessment. The measurements will be made either by manual methods or by use of dedicated, in-well pressure transducers in specific wells noted on Tables 2.1-2 and 2.1-3 and selected based on their assigned function within the groundwater remedy (i.e., groundwater monitoring associated with groundwater extraction systems). The water level measurements will be converted to elevations referenced to sea level so that the water levels can be integrated site-wide for interpretation of potentiometric levels and hydraulic gradients. Corrections to the water levels necessary due to salinity and temperature effects will be made as appropriate following standard operating procedures (SOP-A22, Procedures for Calculation of Freshwater Equivalent Heads Standard Operating Procedures for PG&E Topock Program ). Tables 2.1-3 and 4.2-1 indicate the frequency of water level measurements.

Monitoring at the site has shown that water levels in monitoring wells located near the Colorado River fluctuate in a sinusoidal pattern with a frequency of approximately one day. Wells located closest to the river exhibit a daily fluctuation magnitude of between 1 and 2 feet per day (compared to a daily river stage fluctuation of up to 3 feet). However, this oscillation does not prohibit assessment of longer-term trends. To do this, averaging of water levels over a selected period of time will be implemented to define a representative water level for assessments including mapping. This will be done for all data from wells located within proximity of the river that produces such effects. The use of pressure transducers in monitoring wells will facilitate the implementation of this method.

### 4.3 Hydraulic Control Evaluation

#### 4.3.1 Objective and Approach

The objective of RAO 2 is to limit Cr(VI) dissolved in groundwater at the site from migrating into the Colorado River. The remedy addresses this requirement through in-situ and groundwater pumping. The groundwater extraction wells are to be installed as part of the NTH IRZ (River Bank Extraction Wells) and the TCS Loop (East Ravine Extraction Wells). The hydraulic control evaluation is to assess the performance of the groundwater extraction well element of the remedy. The approach and methodology for this assessment will be consistent with regulatory guidance prepared and distributed by the U.S. Environmental Protection Agency (USEPA), including the

document *A Systematic Approach for Evaluation of Capture Zones at Pump and Treat Systems*, dated January 2008 (USEPA 2008).

The approach is considered iterative because assessments will be conducted periodically as additional data are collected as part of performance and compliance monitoring. These additional data will also be used to continually refine the CSM and to make operational improvements to the remedy. Thus, as additional data are collected at the site, additional monitoring locations and/or additional types of information will be identified to address any identified data gaps and ambiguities.

The approach includes these three basic steps consistent with the USEPA guidance:

1. Define what requires hydraulic control in conjunction with the CSM and the RAOs.
2. Interpret the actual zone of hydraulic control.
3. Demonstrate consistency between required control and the actual zone of hydraulic control.

This approach reflects the process of assessing information to determine what requires hydraulic control, analyzing performance data to determine the dimensions of the actual zone of hydraulic control created by groundwater extraction, and assessing whether the requirements are met by the created zone. The ability to perform these steps successfully depends in large part on whether the appropriate information has been collected at the site. These three steps are discussed in the following sections.

#### **4.3.2 Definition of Hydraulic Control Requirements in Conjunction with CSM and RAOs**

The current extent of Cr(VI) concentrations in groundwater that exceed 32 µg/L, the regional background concentration, is illustrated in Figure 2.1-1. The RAOs that apply to hydraulic control of Cr(VI) in groundwater are stated in Section 2.1:

*RAO 2: Prevent or minimize migration of Cr(T) and Cr(VI) in groundwater to ensure concentrations in surface water do not exceed water quality standards that support the designated beneficial uses of the Colorado River (11 µg/L Cr[VI]).*

*RAO 4: Ensure that the geographic location of the target remediation area does not permanently expand following completion of the remedial action.*

Based on RAO 2, one objective of hydraulic control of Cr(VI) in groundwater at the site is to protect the designated beneficial uses of the Colorado River. The degree to which Cr(VI) in groundwater requires containment with respect to the numeric level associated with the designated beneficial uses (11 µg/L Cr[VI]) has not been quantified. However, due to several factors, it can be assumed that the amount of mass of Cr(VI) that could migrate from groundwater into the Colorado River to result in a detectable concentration of Cr(VI) above 11 µg/L would translate to a concentration of Cr(VI) in groundwater significantly above the 11 µg/L surface water quality standard and the 32 µg/L regional background level.

Based on RAO 4, a second objective of hydraulic control of Cr(VI) in groundwater is to protect the groundwater basin as a resource. The groundwater remedy design is a combination of in-situ groundwater treatment and hydraulic control, and is intended to remediate the Cr(VI) plume through implementation of IRZs as well as the hydraulic control in specific areas. While some portions of the Cr(VI) plume (i.e., Cr[VI] concentrations exceeding 32 µg/L) will be controlled by extraction wells, the remedy is designed to treat remaining Cr(VI) greater than 32 µg/L that may not be hydraulically controlled. With this considered, and for the purpose of providing a metric for hydraulic control assessments, the Target Capture Zone will include portions of the Cr(VI) plume that are not reduced by the IRZ, including: (1) where Cr[VI] is greater than 32 µg/L within the floodplain and to the east of the planned IRZ wells; and (2) where Cr[VI] is greater than 32 µg/L within bedrock in the East Ravine area. Note that achieving this metric will not be necessary for groundwater extraction to achieve RAO 2 as discussed herein.

### 4.3.3 Interpretation of the Actual Zone of Hydraulic Control

Numerous factors influence the resulting dimensions of the actual zone of hydraulic control created by groundwater extraction. These factors indicate the potential complexity of determining the zone of hydraulic control created by groundwater extraction, because the subsurface—and the response to it being stressed by pumping—is complex, due in large part to natural heterogeneities. In other words, interpreting the zone of hydraulic control is difficult due to inherent uncertainties. Consequently, a single line of evidence is not considered sufficient to demonstrate plume control because the uncertainties inherent to any single method are likely too great. Therefore, plume control is best demonstrated through multiple lines of evidence.

There are a number of methods or tools available to assess plume control. Each of these methods is considered a separate line of evidence. The lines of evidence considered for this assessment are grouped into four main categories and are discussed in the following sections.

1. Interpretation of water levels
  - Groundwater flow direction based on water level pairs / three-point gradient analysis
  - Groundwater flow direction based on water level contour maps
2. Calculations
  - Simple analytical modeling
  - Groundwater discharge comparison: aquifer seepage versus pumping
  - Numerical modeling
3. Concentration trends
  - Contaminant concentrations in wells downgradient of extraction wells
4. Field methods
  - Tracer testing

#### 4.3.3.1 Interpretation of Water Level Data

Lines of evidence involving the interpretation of water levels are the most common for hydraulic control assessments. The particular lines of evidence in this group are: (1) gradient analyses using either well pairs or three-point gradient assessments that can provide information regarding lateral flow directions in the vicinity of extraction wells; and (2) construction of water level contour maps, either hand-drawn or automated, to interpret capture zones.

##### ***Water Level Pairs / Three-Point Gradient Analysis***

Assessment of water levels via water level pairs is performed to determine a sufficient hydraulic gradient that would be reflective of hydraulic plume control. In order to provide quantifiable metrics for the hydraulic control analysis associated with the river bank extraction wells, groundwater flow model runs were conducted to calculate anticipated average hydraulic gradients for select floodplain monitoring well pairs under differing extraction rate scenarios.

In model layers 3 and 4 (the deep portion of the aquifer where the river bank wells are screened and where the majority of the floodplain Cr(VI) plume exists), 6 well pairs in each model layer were selected to define the expected average hydraulic gradient differences for four scenarios: (1) ambient (non-pumping), (2) nominal river bank extraction (150 gpm), (3) decreased river bank extraction (75 gpm), and (4) increased river bank extraction (300 gpm). In all scenarios, the simulated flow conditions had the NTH IRZ turned off as this is the remedy operating condition for 75% of the time (6 months ON/ 18 months OFF). The “decreased river bank extraction” scenario (75 gpm) represents an approximation of the threshold where complete hydraulic plume control is achieved above this pumping rate and hydraulic plume control is potentially compromised below this rate. Thus, the well pair average hydraulic gradients simulated for this pumping scenario represent thresholds for hydraulic plume control. To provide a factor of “safety” or increased confidence, the same assessment was performed with a scenario of an extraction rate twenty percent greater than the 75 gpm threshold rate (90 gpm) and the well pair

average hydraulic gradients from this pumping scenario correspond to proposed gradients for this line of evidence as follows.

#### ***Model Layer 3***

- MW-33-090 / MW-O: 0.0024 ft/ft
- MW-H / MW-46-175: 0.0026 ft/ft
- MW-D / MW-46-175: 0.0034 ft/ft
- MW-36-090 / MW-34-080: 0.0017 ft/t
- MW-39-080 / MW-36-090: 0.0020 ft/ft

#### ***Model Layer 4***

- MW-33-210 / MW-O: 0.0023 ft/ft
- MW-H / MW-46-205: 0.0024 ft/ft
- MW-D / MW-46-205: 0.0031 ft/ft
- MW-36-100 / MW-34-100: 0.0019 ft/t
- MW-39-100 / MW-36-100: 0.0018 ft/ft

In addition, river stage measurements will be used and compared to water levels in monitoring wells representing the water table to evaluate the effect of the River Bank and East Ravine Extraction Wells on minimizing the potential discharge of groundwater containing Cr(VI) into the river.

#### ***Water Level Contour Maps***

With a sufficient number of monitoring locations, the water level elevation data can be spatially integrated by contouring, either manually or via an automated method. Hand contouring will be performed as the preferred method to produce water level elevation contour lines.

For water level values at extraction wells, well efficiency effects will be considered. First, step tests will be performed at some extraction wells. Such test data will then be used to estimate well efficiency and, thus, a corrected water level will be calculated. Second, in lieu of having piezometers immediately adjacent to extraction wells, piezometers will be installed within the filter pack (outside of the extraction well casing) in some wells, and the difference between the water levels in the piezometer and in the extraction well casing during pumping will also aid in proper correction for well efficiency effects.

#### **4.3.3.2 Calculations**

Lines of evidence involving calculations generally range from a simple groundwater flux/pumping rate calculation to simple analytical models, to complex numerical flow models, including: (1) simple analytical modeling using an equation representing a well pumping from an aquifer to estimate the dimensions of a capture zone; (2) groundwater discharge comparison; and (3) numerical modeling.

#### ***Simple Analytical Modeling***

A simple equation representing a well pumping from an aquifer, such as that presented in the USEPA (USEPA 2008) guidance document, can be used as a line of evidence for assessing hydraulic plume control. The equation is an expression of Darcy's Law with a 'factor,' as recommended by the USEPA guidance, to account for other potential contributions of water to the extraction location. The addition of the factor increases the requisite extraction rate to achieve a capture zone of a given width. The equation can be used to determine the maximum width of the zone of hydraulic control created when pumping at a certain extraction rate from an aquifer with certain properties.

This method is based on assumptions similar to those used for Darcy's Law itself, but nonetheless is considered a useful line of evidence. It should be noted that this assessment method is based on a single pumping well. The operation of multiple pumping wells will create four zones of hydraulic control that, with sufficient individual extraction rates, will each be larger in dimension due to the superposition of drawdown effects. Thus, this line of



evidence should be viewed as conservative (i.e., understates the dimensions of the zone of hydraulic control) with respect to the potential for intersecting pumping cones.

### ***Groundwater Discharge Comparison***

This line of evidence relies on: (1) an estimation of groundwater discharge through the cross-sectional area of a plume where the groundwater extraction system is located; and (2) the measured rates of groundwater extracted by the pumping wells. If the groundwater extraction rate of the plume control system exceeds the estimated natural groundwater discharge through the portion of the aquifer requiring hydraulic control, then the containment system is shown to be successfully controlling the contaminant plume. The limitations of this method are similar to the limitations associated with the previous calculation method for estimating the dimensions of a zone of hydraulic control (e.g., most notably, the variability of hydraulic conductivity), and thus groundwater discharge comparisons will only be used as one of multiple lines of evidence.

### ***Numerical Modeling***

The most robust line of evidence involving calculations is numerical modeling. MODFLOW, a three-dimensional groundwater flow simulation program developed by the United States Geological Survey (USGS)—and currently being used to simulate groundwater flow at the site and to assist in the design of the remedy—will continue to be used to evaluate hydraulic control. MODFLOW will generate a simulated flow field, and groundwater flow paths can then be assessed using path line or particle-tracking procedures such as the MODPATH or MODALL simulations. Due to the limitations associated with locating monitoring wells downgradient of the River Bank and East Ravine Extraction Wells (i.e., the presence of the Colorado River), the use of numeric modeling will be an important line of evidence.

#### **4.3.3.3 Concentration Trends**

Although the concentration trends line-of-evidence approach is completely different from other approaches (i.e., water levels analysis or hydraulic calculations), it can be integrated with those other lines of evidence. In the concentration trends approach, assessment of hydraulic plume control is performed by evaluating the contaminant concentration trends in wells downgradient of the extraction wells as well as surface water samples from the river. If the analysis of water level data indicates that an extraction system is likely to be preventing any further migration of a plume, then this should also be evident in the concentration response. There are two principles that are applied for this line of evidence:

1. If hydraulic plume control is likely achieved, wells that are not currently impacted by contaminants (e.g., sentinel wells in Arizona) will remain without impacts over time as long as the dimensions of the zone of hydraulic control do not expand beyond the locations of the sentinel wells to the extent that the sentinel wells are within the capture zone.
2. If hydraulic plume control is likely achieved, wells located downgradient of the capture system, but still within the plume, will show decreasing concentrations over time. At the Topock site, there currently are no monitoring wells that are within the Cr(VI) plume but downgradient of the expected dimensions of the zone of hydraulic control. Therefore, this principle is not expected to be applied for the concentration trends line of evidence.

Due to various stresses that will be placed on the aquifer over time from changes in injection and extraction along with natural stresses such as changes in river stage and other various natural phenomena, the timing of groundwater sample collection will be assessed with the transient water level data collected via pressure transducers in order to potentially alter the timing of sample collection to better reflect water quality variability as a function of seasonal variations in river stage and corresponding groundwater level changes.

#### **4.3.3.4 Field Methods**

The one field method that establishes the actual path of groundwater migration is injecting a tracer into an aquifer and observing that tracer at some location downgradient of the injection point. The use of tracers has several advantages. However, as outlined in the USEPA (USEPA 2008) guidance document, the use of tracer

testing can have significant limitations. For this reason, tracer testing will be considered as a line of evidence for hydraulic control assessments as a method to address particular uncertainties at specific locations rather than as a general, widespread indicator.

#### **4.3.4 Demonstration of Consistency Between Required Control and the Actual Zone of Hydraulic Control**

The final step in the assessment process is evaluating consistency between the requirement for hydraulic control and the interpreted zone of hydraulic control created by groundwater extraction. This step comprises four main components illuminated by key questions:

1. Assess the requirements and objectives. Does the current system achieve RAOs with respect to hydraulic plume control?
2. Assess uncertainties in the interpretation of the zone of hydraulic control. Are alternative interpretations possible that would change the conclusions as to whether or not sufficient plume control is achieved? In other words, are there data gaps that could be practicably filled?
3. Assess the need for additional characterization and/or monitoring. Is there a need for additional plume delineation or additional monitoring locations to increase the confidence in whether or not actual hydraulic plume control is sufficient?
4. Evaluate the need to reduce or increase extraction rates. Should extraction rates, number of extraction wells, and/or locations be modified based on the results of the analysis?

This assessment will be presented in a way consistent with the recommended approach as outlined in the USEPA (USEPA 2008) guidance document (pp. 26-29). PG&E will present an overview of the assessment in a table that juxtaposes each of the steps and lines of evidence with the conclusions relevant to each of the steps/lines of evidence (consistent with Exhibit 9 of the guidance document, p. 29). This will include references to appropriate maps, model outputs, and other graphics as necessary to provide the basis for the conclusions. It is expected that demonstrations of hydraulic control at the Topock site will rely more on some lines of evidence (e.g., numerical modeling) than others because of the nature of the site and challenges presented by the relative location of the extraction wells to the Colorado River (i.e., the river precludes the installation of wells and collection of data in areas normally investigated for such demonstrations). However, all site data available will be used in support of the assessments in an iterative way to identify any data gaps that create uncertainty in the conclusions and to fill those data gaps as practicable and necessary.

Table 4.2-1  
Process Control Monitoring Program Analytes and Sampling Frequencies  
Groundwater Remedy Operation and Maintenance Manual  
Volume 2: Sampling and Monitoring Plan  
PG&E Topock Compressor Station, Needles, California

Analytes:	TOC	Cr(VI)	Cr(T)	Dissolved Mn/Fe/As/Ba	Nitrate	Sulfate	Alkalinity, Cations, Anions, TDS	Total Fe/Mn	Water Level
<b>National Trails Highway In-Situ Reactive Zone<sup>5</sup></b>									
<i>Dose Response Monitoring Wells</i>	M(yr), Q	M(yr), Q	Q(yr), SA	M(yr), Q	M(yr), Q	M(yr), Q	as needed	---	Q
<i>Downgradient Monitoring Wells</i>	Q	Q	SA	Q	Q <sup>3</sup>	as needed	as needed	---	Q
<i>Riverbank Extraction Monitoring Wells<sup>4</sup></i>	Q	Q	SA	Q	Q <sup>3</sup>	as needed	as needed	---	Q / T
<i>Northern NTH Extraction Monitoring Wells</i>	---	Q	SA	---	---	---	---	---	Q / T
<i>Surface Water</i>	---	Q	SA	Q	---	---	---	---	Q
<i>Northern NTH and Riverbank Extraction Wells</i>	M(Q), Q	M(Q), Q	---	M(Q), Q	---	---	as needed	as needed	Q / T
<i>Combined Extraction Stream</i>	M(Q), Q	M(Q), Q	---	M(Q), Q	---	as needed	as needed	as needed	---
<b>Inner Recirculation Loop<sup>5</sup></b>									
<i>Dose Response Monitoring Wells</i>	Q <sup>1</sup>	Q	Q(yr), SA	Q	Q <sup>1</sup>	as needed	as needed	---	Q
<i>Downgradient Monitoring Wells</i>	---	SA	SA	SA	SA <sup>1</sup>	as needed	as needed	---	Q
<i>Byproduct Monitoring Wells</i>	SA <sup>1</sup>	SA	SA	SA	SA <sup>1</sup>	as needed	as needed	---	Q
<i>Sitewide Monitoring Well Network</i>	---	---	---	---	---	---	---	---	Q
<b>Topock Compressor Station Recirculation Loop<sup>5</sup></b>									
<i>Dose Response Monitoring Wells</i>	Q	Q	Q(yr), SA	Q	Q	as needed	as needed	---	Q
<i>Downgradient Monitoring Wells</i>	SA	SA	SA	SA	SA	as needed	as needed	---	Q
<i>Byproduct Monitoring Wells</i>	as needed	A or BE	A or BE	A or BE	---	---	---	---	Q
<i>Transwestern Bench Extraction Monitoring Wells</i>	---	Q	SA	---	---	---	---	---	Q / T
<i>East Ravine Extraction Monitoring Wells<sup>4</sup></i>	---	Q	SA	---	---	---	---	---	Q / T
<i>TW Bench Extraction Wells, East Ravine Extraction Wells</i>	M(Q), Q	M(Q), Q	---	M(Q), Q	---	---	as needed	as needed	Q / T
<i>Combined Extraction Stream</i>	M(Q), Q	M(Q), Q	---	M(Q), Q	---	---	as needed	as needed	--
<b>Freshwater Injection<sup>5</sup></b>									
<i>Arsenic Monitoring Wells</i>	---	---	---	Q <sup>2</sup>	---	---	---	---	Q

**Notes:**

Sampling program will be re-evaluated after two years of operation.

<sup>1</sup> If associated injection wells receive carbon injections

<sup>2</sup> Arsenic only (other species if present in injected water above background)

<sup>3</sup> Frequency may be less for shallow wells in the natural reducing rind where nitrate concentrations are non-detect at baseline

<sup>4</sup> Frequency will be less for Arizona wells MW-54, MW-55, and MW-56, with annual monitoring for Cr(VI).

<sup>5</sup> Data collection for each part of the system will begin when operation of that part of the system starts.

<sup>6</sup> Annually for MW-09, MW-10, and MW-10D.

**Frequencies:**

T: Potentially monitored continuously via transducer

M: Monthly

Q: Quarterly

SA: Semi-Annually

A: Annually

BE: Biennially

(yr): Frequency for the first year, frequency reduction to be considered after first year

**Analytes:**

TOC: Total organic carbon

Cr(VI): Chromium (VI)

Cr(T): Total dissolved chromium

Mn: Manganese

Fe: Iron

As: Arsenic

Ba: Barium

TDS: Total dissolved solids

## Other Sampling and Monitoring

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### 5.1 Monitoring for COPCs

The RCRA Facility Investigation/Remedial Investigation Volume 2 Report and Volume 2 Addendum (CH2M HILL 2009a, 2009b) described that, in addition to Cr(VI), three constituents in groundwater—namely molybdenum, selenium, and nitrate—are potentially related to past releases from SWMU 1/AOC 1. Although the groundwater risk assessment concluded that these three constituents were not present in groundwater at levels of potential concern to future human health or the environment (ARCADIS 2009), DTSC and DOI directed that molybdenum, selenium, and nitrate be monitored in the site-wide groundwater monitoring program and that their associated impacts be considered in future soil and soil to groundwater risk evaluations (DTSC 2009, DOI 2009). The agencies concluded that although the non-cancer hazards associated with these constituents are much lower than those associated with Cr(VI), these constituents do have risks above a hazard index (HI) of 1 and they do contribute to a hazard quotient greater than 1 at localized areas within the plume.

This section provides a description of the monitoring program proposed for these three non-chromium COPCs.

#### 5.1.1 Sampling Locations

The sampling locations for the non-chromium COPCs were selected based on the distribution of these compounds in groundwater. Figures 5.1-1 through 5.1-3 show the average concentrations of one or more COPCs in groundwater. Monitoring wells where COPCs exceed background were included in the monitoring program. In addition, monitoring wells that will be downgradient from areas where COPC concentrations are elevated above background when the remedy is active were also included. Because the remedy is designed to move groundwater across the IRZ, most of these downgradient wells are located on the floodplain or near National Trails Highway. This monitoring network is designed to track COPC concentrations in areas where they are currently elevated as well as areas where they may be transported during the remedial action. The monitoring locations and frequencies for the non-chromium COPCs are shown in Table 2.1-2. Per DTSC's request (60% BOD Report Response to Comment (RTC) #710 DTSC-223; see Appendix I of the 90% BOD Report for a complete listing of comments, responses to comments, and resolution on the 60% design documents), a separate COPC monitoring table (Table 2.1-6 in Section 2) was prepared with input from DTSC to provide more information about which wells have elevated concentrations of COPCs and to include wells where nitrate will be sampled for process control monitoring.

Based on monitoring data collected to date, molybdenum is the COPC for which elevated concentrations above background are most widespread (Figure 5.1-1). Many of the bedrock wells in the East Ravine have molybdenum concentrations above background. Molybdenum is also more widespread in the alluvial aquifer, particularly in the deep zone. There are 72 wells identified for molybdenum sampling.

Selenium is elevated above background in just a few wells scattered across the site and only in the alluvial aquifer. The highest concentrations are in the vicinity of the compressor station (Figure 5.1-2). It is not elevated in bedrock wells. There are 41 wells identified for selenium sampling.

Nitrate is distributed similarly to selenium, with highest concentrations near the compressor station and a few sporadic other locations (Figure 5.1-3). Because nitrate is a sensitive geochemical indicator parameter, extensive nitrate monitoring is proposed to be performed as part of the process control monitoring for the final remedy (see Section 4.0). The 47 sampling locations where nitrate is assigned an annual monitoring frequency in Table 2.1-4 are intended primarily for monitoring nitrate as a non-chromium COPC. The sampling locations where nitrate is assigned a more frequent monitoring interval are intended for process control monitoring.

If there is a need to perform another risk assessment in the future, it is recommended that a wider network of wells be included for non-chromium COPC monitoring. The network proposed herein is specifically designed to

monitor the highest concentrations of these compounds and will therefore not accurately reflect their average concentrations across the site.

### 5.1.2 COPC Perimeter Assessment Plan

The Perimeter Assessment Plan (PAP) has been developed in response to comments from DTSC requesting that threshold concentrations and a decision tree be developed for COPC monitoring. Because COPCs will be moved around by the pumping and injection necessary to push the chromium plume through the IRZ, COPC concentrations in interior wells are expected to change throughout the course of the remedial action. Some wells will show increases in COPC concentrations and some will show decreases. It is therefore not practical or useful to establish numerical COPC threshold values for wells in the interior of the chromium plume.

Ultimately, the remedial action should not result in elevated concentrations of COPCs being spread beyond the chromium plume footprint (it is recognized that there are areas where elevated COPCs already exist outside the boundary of the chromium plume). The PAP is designed to monitor the edges of the chromium plume and the elevated COPC areas outside the chromium plume to provide assurance that elevated concentrations of COPCs are being contained with the area of active remediation. The PAP is modeled after the IM-3 Performance Monitoring Program, which was designed to monitor the edge of the chromium plume in the northern part of the floodplain. The wells that will be included in the PAP for monitoring of molybdenum, selenium, and nitrate are shown on Figures 5.1-4, 5.1-5, and 5.1-6, respectively.

Note that bedrock wells in the East Ravine are not included in the PAP. This is due to the fact that there is no injection in the East Ravine that would spread COPCs. The East Ravine will be remediated using extraction wells, so all gradients will be inward with regard to the current COPC distribution. If COPC concentrations were to go up in an East Ravine well, there would be no appropriate mitigating measures that could be made to address it, other than continuing the pump and treat process until the concentrations eventually went back down. This would be analogous to the situation with increasing chromium concentrations in well MW-34-100 during the first few years of IM-3 operations. After continued IM-3 pumping, concentrations in MW-34-100 eventually began to decline.

The PAP decision tree is shown in Figure 5.1-7. This is modeled after the PMP decision tree. It incorporates notifications and actions to be taken when a PAP well exceeds a trigger level. Trigger levels would be established prior to the startup of the remedial action, when additional COPC data will be available for the existing PAP wells and several rounds of samples will be available for the yet to be installed PAP wells.

Trigger levels will be based on Shewhart control limits calculated from the most recent eight sample results, consistent with what is currently done for wells with Cr(VI) concentrations above 20 µg/L in the IM3 Performance Monitoring Program. For the PAP, Shewhart control limits would be calculated for all wells. Initially, some control limits may need to be calculated using fewer than eight samples for newly installed wells where sampling may have recently been initiated. Control limits would be updated on at least an annual basis. If the Shewhart control limit is higher than the ARAR concentration in a well where the baseline concentration (defined based on the median of the available data) is below the ARAR, then the ARAR concentration would be used as the trigger level. For all other wells, the Shewhart control limit would be the trigger level. In wells where baseline concentrations are less than ARAR concentrations, this approach provides a conservative means of establishing a trigger value that will bring attention to rising COPC concentration before the ARAR concentration is reached. In wells where baseline concentrations are above ARAR concentration, the Shewhart control limit provides a means of identifying wells where a statistically significant increase in concentration has occurred.

### 5.1.3 Sampling Frequencies

An annual sampling frequency is proposed for the non-chromium COPCs. This is considered to be adequate for tracking the changes in the distribution of these constituents during the remedial action. Trend analysis will be conducted using the data collected and monitoring frequency can be increased or decreased if needed in any wells or areas.

## 5.2 Monitoring of Freshwater Source (HNWR-1A)

This section describes the program that will be implemented to monitor the quality of water produced by the Havasu National Wildlife Reserve (HNWR) well HNWR-1A during the implementation of the Topock remedial action. The purpose of this monitoring program is to ensure that the quality of the fresh water meets the desired water quality for the freshwater injection system at the Topock site (i.e., desired quality to prevent well and aquifer plugging and to protect the receiving aquifer water quality). A detailed discussion of the desired water quality for injection is included in the 90% BOD Report (Section 3.3, Freshwater Supply).

The existing, nearby HNWR-1 well has been sampled and analyzed by Pacific Gas and Electric Company (PG&E) between November 2010 and January 2013 (see Table 5.2-1), and again in October 2013 and February 2014 during the field implementation of the Alternative Freshwater Source Evaluation (see Table 5.2-2). The analytical suite has included a broad range of compounds, both organic and inorganic. Arsenic and Cr(VI) were the only two compounds that exceeded the Maximum Contaminant Levels (10 µg/L). The naturally occurring arsenic concentration in well HNWR-1 ranges from 14 to 16 µg/L, below the site background concentration of 24.3 µg/L but above the concentration in existing wells near the freshwater injection area. The Cr(VI) concentration ranges from 14 to 20 µg/L, which is well below the site background concentration of 31.8 µg/L.

PG&E has sampled the new well HNWR-1A during the field implementation of the Alternative Freshwater Source Evaluation (see Table 5.2-3). Similar to HNWR-1, arsenic and Cr(VI) were the only two compounds that exceeded the Maximum Contaminant Levels. The naturally occurring arsenic concentration ranges from 12 to 13 µg/L, below the site background concentration of 24.3 µg/L. The Cr(VI) concentration ranges from 16 to 18 µg/L, which is well below the site background concentration of 31.8 µg/L (see Table 5.2-3).

Generally, the water from HNWR-1 and HNWR-1A contain concentrations of selenium, molybdenum, and nitrate that are significantly lower than those found at the Topock site. In HNWR-1A, the selenium concentration ranges from 0.88 to 1.0 µg/L; the molybdenum concentration ranges from 9.3 to 9.8 µg/L; and the nitrate concentration is 2.6 mg/L (see Table 5.2-3).

### 5.2.1 Proposed Analytes and Frequencies

The monitoring program for HNWR-1A is designed to track concentrations of the COC and COPCs associated with Topock as well as to provide periodic monitoring for a wide range of potential contaminants, both organic and inorganic, that have never been detected at the Topock site but could be undesirable or harmful if present in the injected water. Because of the lack of nearby sources, the likelihood of organic contaminants being present in HNWR-1A is small; therefore, the frequency of analysis for organics and pesticides will be lower than for metals and common ions.

The monitoring program will include metals, common anions and cations, total dissolved and suspended solids, total organic carbon, and stable isotopes of oxygen and hydrogen. These analyses provide a means for tracking overall changes in water quality with time. In addition, one of the common cations, manganese (Mn), has been found to be an important factor in partial plugging of injection wells at the Topock site, so it will be important to track Mn concentrations in order to maintain the performance of the injection wells. The proposed analytes list for HNWR-1A is provided in Table 5.2-4.

Monitoring frequency for the inorganic suite will be monthly for the first 6 months and quarterly for the remainder of the first year of operation, assuming the water quality is generally stable at that time (if the water quality appears to be changing rapidly, monthly sampling would be continued beyond the first 6 months). Following the first year, monitoring frequency will switch to semi-annual. Monitoring frequency for the organic analytical suite will be annual for the first 2 years, switching to every other year in subsequent years.

It is not anticipated that the freshwater flow rate would be varied on any regular basis; however, if there was a future reconfiguration of the remedy that caused a significant increase in freshwater pumping rate, the need for additional sampling frequency would be evaluated based on the data available at that time. Further, the

monitoring frequency can be adjusted as needed based on actual data and information collected at the supply well (HNWR-1A) as well as at the monitoring locations for the freshwater injection points.

## 5.2.2 Source Water Assessment

In response to comments received at the May 16, 2012 Technical Working Group (TWG) meeting on protection of the water quality at HNWR-1A and the potential need for additional monitoring wells for source protection, a source water assessment was conducted to identify potential sources of contaminants within the radius of influence of a supply well (HNWR-1A). Arizona guidelines provide a method of calculating the appropriate radius for this assessment, based on a simple equation that represents the area from which water would be drawn over a specific period of time. Arizona uses a travel time of five years for public water supply assessments.

The calculated fixed-radius equation from Arizona guidance (ADEQ 1999) is as follows:

$$r = \sqrt{\left(\frac{Qt}{\pi nH}\right)}$$

Where:

Q = well's discharge in cubic feet per year (31,620,321 ft<sup>3</sup>/yr)

t = time of travel in years (5 years for public supply wells in Arizona)

π = 3.1416

n = aquifer porosity (11 percent)

H = screen length in feet (110 feet)

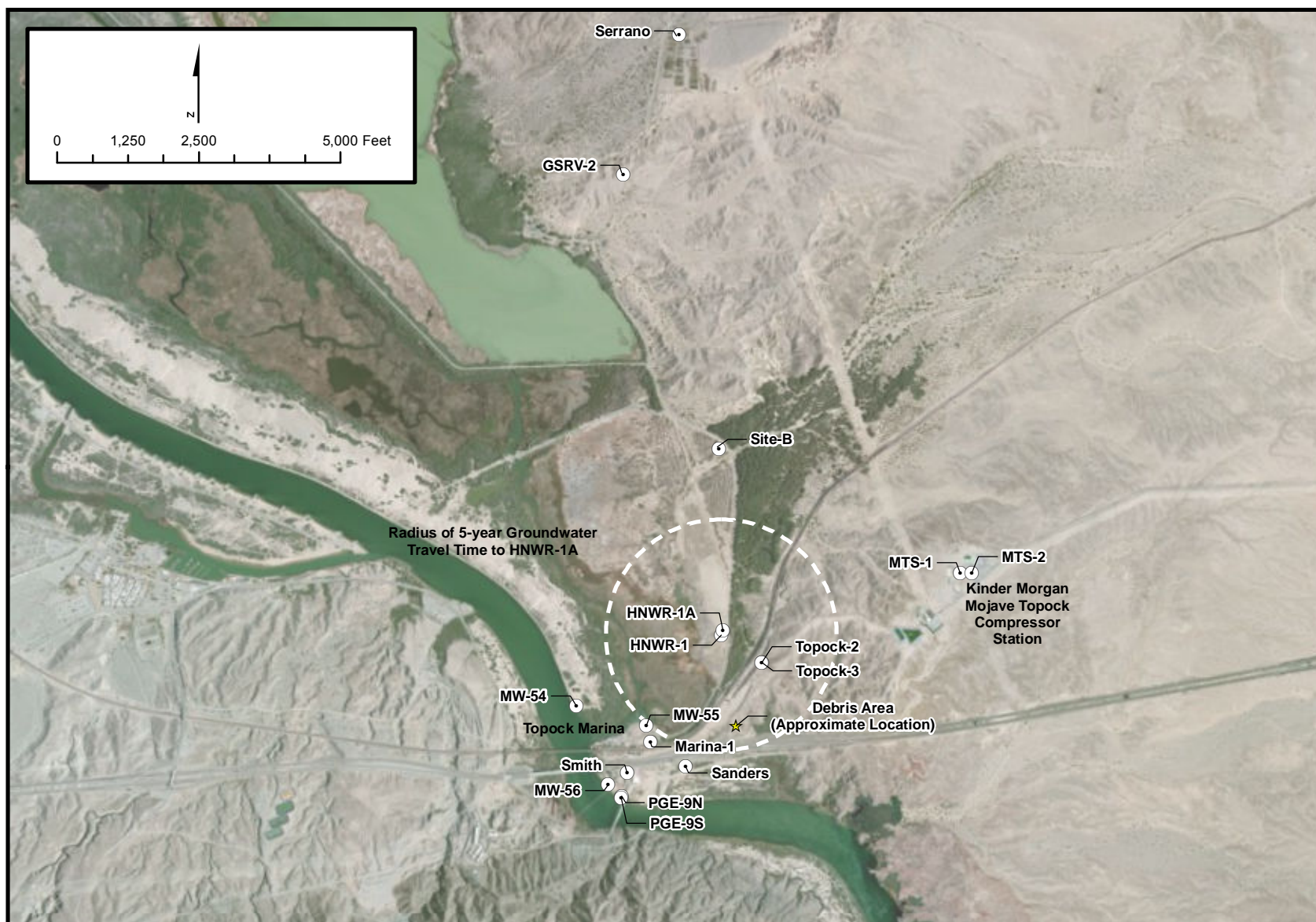
r = radius (defines the boundary of the delineated source water protection area in feet around the well)

For the HNWR-1A well, with a screened interval spanning 110 feet and pumping at the current design (modeled) flow rate of 450 gpm, this equation resolves to a radius of 2,039 feet. This radius extends to within 1,200 feet of the Kinder Morgan Mojave Topock Compressor Station in Arizona<sup>2</sup> (see Exhibit 5.2-1). As shown in Exhibit 5.2-1, the majority of the property in this radius is undeveloped (most is HNWR land); known/planned developments in the area include the Topock Marina on Historic Route 66, Topock Mobile Home Park, nearby private properties, Southwest Water Company, BNSF Railroad, Interstate 40, and Kinder Morgan Mojave Topock Compressor Station. Also within this radius is an area that consists of rusty cans and other metal debris scattered on the land surface<sup>3</sup>.

Water produced by HNWR-1 is expected to be a mix of water recharged from the Colorado River and groundwater flowing down from the Sacramento Valley to the east (CH2M HILL 2012c). Note that groundwater travel time from the river to a well located at the distance of HNWR-1 well is likely many months to a few years. Depending on the transport properties, some contaminants move much slower than the water. All contaminants are subject to dispersion and dilution between the river and a well. So if a contaminant is found in the river, there is ample time to stop pumping or institute additional monitoring before it shows up in a well near the river, and the concentration of the contaminant in the well is likely to be considerably less than in the river.

<sup>2</sup> Per DTSC's request in 60% BOD Report RTC #156 DTSC-56 (see Appendix I of the 90% BOD Report), an internet search regarding the former underground storage tanks (USTs) at the Topock Marina was conducted. There were four USTs at the Marina; the first one was permanently removed in October 1990, two were permanently removed in January 1993, and the fourth was permanently removed in November 2010. There was a release reported in October 1990; that case was closed in March 1998.

<sup>3</sup> As detailed in 60% BOD Report RTC #158 DTSC-57, a question was raised in a public meeting about a rumored former "Topock Dump" located within this radius that reportedly contained trash from local residents. PG&E was not aware of any such former dump. A member of the Fort Mojave Indian Tribe who has lived in the area for many years indicated that the area of debris and can scatter was the only "dump" that he knew of in the area and speculated that it might have been trash left from a railroad work camp. DTSC visited the cited area in Arizona and it did not appear to be a significant threat to groundwater resources. PG&E agrees that this debris does not appear to represent a threat to groundwater.



## LEGEND

- Existing Well

## Notes:

- It is likely that an abandoned well owned by Southwest Gas, was once located at the site where Topock-2 and 3 wells currently exist.

## EXHIBIT 5.2-1 RADIUS OF 5 YEAR GROUNDWATER TRAVEL TIME TO HNWR-1A

GROUNDWATER REMEDY OPERATION AND  
MAINTENANCE MANUAL  
VOLUME 2: SAMPLING AND MONITORING PLAN  
PG&E TOPOCK COMPRESSOR STATION,  
NEEDLES CALIFORNIA



There are currently no monitoring wells in Sacramento Wash. The property upstream in Sacramento Wash is undeveloped for miles. The ADEQ conducted a survey of water quality in the Sacramento Valley in 1999 (ADEQ 2001). This survey found fluoride, chloride, and TDS to be the only constituents present in slightly elevated concentrations in the Topock area. Considering the lack of existing contaminant sources in the Sacramento Valley (Exhibit 5.2-1), the installation of monitoring wells in Sacramento Wash upstream of HNWR-1A for source water protection is not considered warranted. The Topock-2 and -3 wells are located between HNWR-1A and the area with rusty can and other metal debris, so in the unlikely event that groundwater contaminants are migrating from the dump area, they would be expected to be detected first at Topock-2 and -3. In response to DTSC's request (60% RTC #709 DTSC-222), PG&E will provide water quality information from Topock-2 and -3 wells as PG&E receives the information from Southwest Water.

As mentioned previously, the majority component of the water produced from HNWR-1 should originate from the Colorado River. The travel time of constituents in river water to a nearby well may take many years, depending on their mobility (CH2M HILL 2012c); therefore, river water quality is a good indicator and should be used for source water protection of HNWR-1A. There is an abundance of water quality data available for the Colorado River. The river in the immediate vicinity of the site and downstream is monitored by the Metropolitan Water District of Southern California (MWD). MWD samples for a wide range of parameters, including emerging contaminants. In addition, the Lower Colorado River Regional Water Quality Database ([http://www.snwa.com/apps/wq\\_database/index.cfm](http://www.snwa.com/apps/wq_database/index.cfm)) contains more than 2 million records covering nearly 1,000 different parameters, including depth, temperature, pH, conductivity, dissolved oxygen, nutrients, metals, and organics. Information in the database is provided by Southern Nevada Water Authority, City of Las Vegas, Clark County Water Reclamation District, University of Nevada Las Vegas (UNLV), U.S. Bureau of Reclamation Denver, U.S. Bureau of Reclamation Lower Colorado River, City of Henderson, MWD, Clark County Regional Flood Control District, and the Colorado River Regional Sewer Coalition. Considering the large volume of good quality data available on water quality in the Lower Colorado River, additional river sampling for the purposes of source water protection of HNWR-1A is not considered warranted.

At DTSC's request and per resolution of 60% RTC #161 DTSC-60, the MW-55 well cluster will be sampled periodically as data at this location could have some value in detecting contaminants originating from any sources in the developed area around the Topock Marina (see Table 5.2-5).

## 5.3 Process Control Monitoring for Remedy-produced Water Management System

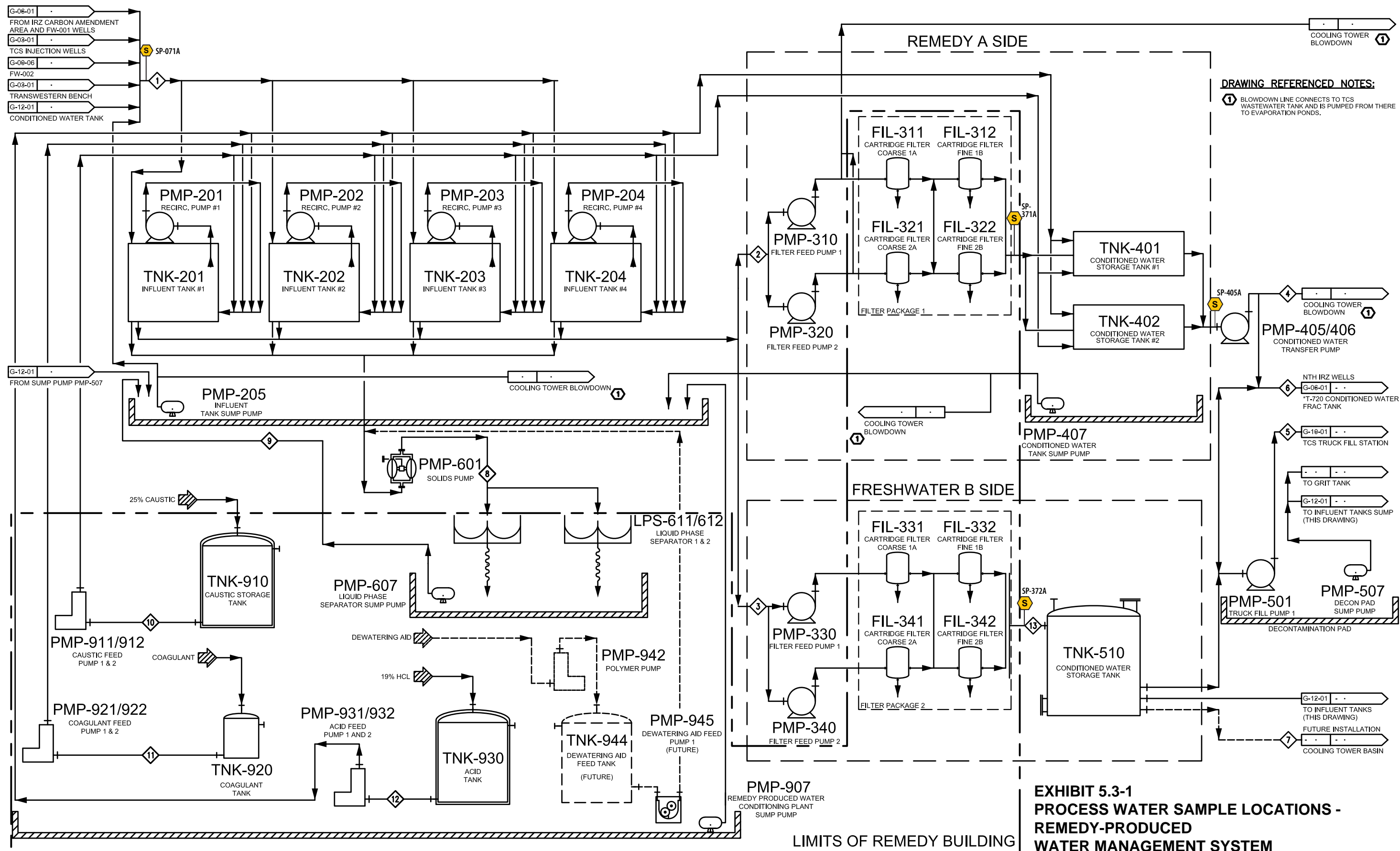
This section describes the program that will be implemented to monitor the quality of water at the Remedy-produced Water Management System during the implementation of the Topock remedial action. The primary objective for process control monitoring is to evaluate effluent water quality and its possible effects with regard to the reuse options (Cooling Tower makeup and re-injection to the NTH IRZ wells), and allow for process optimization/adjustment. Periodic monitoring of influent water will also assist with process optimization.

### 5.3.1 Sampling Locations

Samples will be collected from the following areas of the Remedy-produced Water Management System:

- Interconnecting piping sampling port to the four influent tanks
- Remedy A Side and Freshwater B Side filter system effluent sampling ports
- Conditioned water tank farm (TNK-401 and TNK-402) discharge piping sampling port

Sample locations are identified on the piping and instrumentation diagram (P&ID) shown on Exhibit 5.3-1. Samples will be collected only during regular daytime working hours on the weekdays and while the Remedy-produced Water Management System is in service.



**DRAWING REFERENCED NOTES:**  
 ① BLOWDOWN LINE CONNECTS TO TCS WASTEWATER TANK AND IS PUMPED FROM THERE TO EVAPORATION PONDS.

**EXHIBIT 5.3-1  
 PROCESS WATER SAMPLE LOCATIONS -  
 REMEDY-PRODUCED  
 WATER MANAGEMENT SYSTEM**  
 GROUNDWATER REMEDY DRAFT OPERATION AND MAINTENANCE MANUAL  
 VOLUME 2: SAMPLING AND MONITORING PLAN  
 PG&E TOPOCK COMPRESSOR STATION,  
 NEEDLES, CALIFORNIA

### 5.3.2 Sampling Analytes and Frequencies

The monitoring program will include metals, common anions and cations, total dissolved and suspended solids, and total organic carbon. The proposed analytical suite for process control monitoring is provided in Table 5.3-1.

Samples will be collected for the inorganic analytical suite annually. Field parameters will be measured on a daily or weekly basis as shown on Table 5.3-1. The monitoring frequency can be adjusted as needed based on actual data and information collected during operation of the Remedy-produced Water Management System.

## 5.4 Monitoring for Domestic/Private Wells

Per 60% RTC #709 DTSC-222, DTSC directed PG&E to implement a domestic/private water well monitoring program to evaluate potential effects the remedy could impart to private wells both chemically and hydraulically. Specific wells mentioned in the 60% directive include: a) those located in the vicinity of the groundwater remedy (e.g., Marina-1, Sanders, and Smith wells) to ensure the viability of the wells is not jeopardized by the remedy; b) well GRSV-2 (also known as RPGS)/MTS-1/MTS-2 to assess potential effects to the Arizona freshwater pumping well; c) Topock-2 and -3 wells; and d) Park Moabi wells. In compliance with the above directive, PG&E researched the logistics associated with sampling the above wells and provided a summary in Exhibit 5.4-1.

### 5.4.1 Sampling Locations and Logistics

On the California side of the Colorado River, PG&E has been and will continue to collect and report data from the two Park Moabi wells. On the Arizona side of the Colorado River, PG&E has received permission to sample Marina-1 from the Topock Marina owner, and MTS-1 and MTS-2 from Kinder Morgan. PG&E has and will continue to reach out to the owners of the GSRV-2, Sanders, and Smith wells. It appears that the Smith well has been disconnected at the ground surface (i.e., the connection pipe was severed). The status of the Sanders well is unknown.

PG&E is making arrangements to assess the condition and sampling logistics of the Marina-1, MTS-1, and MTS-2 wells. If the Marina-1 well cannot be sampled, PG&E may propose to sample PGE-9S or 9N in its place.

Topock-2 and -3 wells are currently being sampled and reported by Southwest Water as the water purveyor. As a customer of Southwest Water, PG&E receives the water quality information and will provide it to the agencies.

### 5.4.2 Sampling Analytes and Frequencies


With the exception of the Park Moabi wells, PG&E proposes to initially conduct a baseline sampling event for the proposed sampling locations prior to remedy startup, and subsequent sampling every two years with options to modify frequency based on better understanding of actual flow dynamics and chemical transport as the remedy progresses. Please note that PG&E will continue to sample Park Moabi wells on an annual basis until remedy start-up, then will switch to the proposed biennial frequency for consistency with other wells. Table 5.4-1 presents the analytical suites for the domestic/private wells.



Well ID	Well Installation Date	Well Owner	No. of Previous Samples	Last Sample Date	Well Status/Sampling Logistics (September 2014)
Arizona					
GSRV-2	2/9/2000	RPGS LLC	13	7/10/2007	Well can be sampled with owner's permission.
Marina-1	2014	Topock Marina	0	NA	Fire water supply well. Well can be sampled with owner's permission, and will require management of large volume of purge water. Depends on water quality, the purge water can be discharged to ground near the well, transported to TCS evaporation ponds (if allowed), or transported offsite for disposal.
MTS-1	NA	Kinder Morgan	1	8/26/1991	PG&E has contacted and obtained permission from Kinder Morgan to sample well.
MTS-2	NA	Kinder Morgan	0	NA	PG&E has contacted and obtained permission from Kinder Morgan to sample well.
PGE-9S	4/22/1997	PG&E	2	7/20/2005	Inactive. Well can be sampled and will require management of large volume of purge water. Depends on water quality, the purge water can be discharged to ground near the well, transported to TCS evaporation ponds (if allowed), or transported offsite for disposal.
PGE-9N	4/4/1997	PG&E	10	5/3/2006	Inactive. Well can be sampled and will require management of large volume of purge water. Depends on water quality, the purge water can be discharged to ground near the well, transported to TCS evaporation ponds (if allowed), or transported offsite for disposal.
Smith	2/21/1998	Private Owner	0	NA	PG&E continues to reach out to well owner. Well is disconnected.
Sanders	6/6/2005	Private Owner	8	5/2/2006	PG&E continues to reach out to well owner. Current well status is unknown.
Topock 2	9/29/1980	SW Water Company	13	6/30/2006	Active well. Well can be sampled with owner's permission. PG&E will provide water quality obtained from Southwest Water to the agencies.
Topock 3	5/17/1974	SW Water Company	5	8/11/2005	Active well. Well can be sampled with owner's permission. PG&E will provide water quality obtained from Southwest Water to the agencies.
California					
Park Moabi – 3 (PM-3)	8/15/1986	San Bernardino County	50	12/19/2013	Active well. Well is sampled annually by PG&E.
Park Moabi – 4 (PM-4)	10/3/2006	San Bernardino County	10	12/19/2013	Active well. Well is sampled annually by PG&E.



**LEGEND**

 Private Well

0

0.25

0.5

1 Miles

N

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

**EXHIBIT 5.4-1**  
**STATUS OF PRIVATE WATER WELLS IN THE AREA AND SAMPLING LOGISTICS**  
GROUNDWATER REMEDY  
OPERATION AND MAINTENANCE MANUAL  
VOLUME 2: SAMPLING AND MONITORING PLAN  
PG&E TOPOCK COMPRESSOR STATION  
NEEDLES, CALIFORNIA

**CH2MHILL**

TABLE 5.2-1

## HNWR-1 Analytical Results (November 2010 through January 2013)

Groundwater Remedy Operation and Maintenance Manual

Volume 2: Sampling and Monitoring Plan

PG&amp;E Topock Compressor Station, Needles, California

Location:		HNWR-01	HNWR-01	HNWR-01	HNWR-01	HNWR-01	HNWR-01
Sample Date:		11/10/2010	2/23/2012	3/14/2012	4/4/2012	6/27/2012	1/22/2013
Parameter	Units						
Field							
Dissolved oxygen	mg/L	5.33	3.52	3.29	3.72	---	---
Oxidation reduction potential	mV	159	172	200	112	33.5	---
pH	pH units	7.84	7.68	7.61	8.07	7.51	---
Salinity	%	0.42	0.0662	0.0537	0.0509	0.439	---
Specific conductance	µS/cm	870	1,024	830	787	6,791	---
Temperature	°C	35.9	38.3	38.1	38.0	37.9	---
Turbidity	NTU	5.10	5.10	2.50	---	8.00	---
Anions							
Bromide	mg/L	---	---	---	---	---	---
Chloride	mg/L	---	130	130	130	130	---
Fluoride	mg/L	3.80	---	---	---	4.00	3.90
Nitrate (as nitrogen)	mg/L	2.50	2.60	2.50	2.50	2.60	---
Nitrite as Nitrogen	mg/L	---	---	---	---	---	---
Sulfate	mg/L	47.0	45.0	44.0	45.0	44.0	---
General Chemistry							
Alkalinity, bicarb as CaCO3	mg/L	---	110	110	110	100	---
Alkalinity, carb as CaCO3	mg/L	---	ND (5.0)	ND (5.0)	ND (5.0)	ND (5.0)	---
Alkalinity, hydroxide	mg/L	---	ND (5.0)	ND (5.0)	ND (5.0)	ND (5.0)	---
Alkalinity, total as CaCO3	mg/L	100	110	110	110	100	---
Ammonia as nitrogen	mg/L	ND (0.1)	0.13	0.12	0.15	ND (0.1)	---
Cyanide	mg/L	---	---	ND (0.01)	ND (0.01)	ND (0.01)	---
Deuterium	0/00	-75.3	-73.8	---	---	-77.1	---
Oxygen 18	0/00	-10.3	-10.2	---	---	-10.2	---
pH	pH units	---	---	---	---	---	---
Soluble silica	mg/L	28.6	---	---	---	25.9	---
Specific conductance	µS/cm	740	---	---	---	---	---
Total dissolved solids	mg/L	490 J	480	510	430	440	---
Total Kjeldahl Nitrogen	mg/L	ND (0.4)	---	---	---	---	---
Total organic carbon	mg/L	ND (1.0)	ND (1.0)	ND (1.0)	ND (1.0)	ND (1.0)	---
Total suspended solids	mg/L	---	---	ND (10)	---	ND (10)	---
Herbicides							
2,4,5-T	µg/L	---	---	ND (2.7)	ND (0.26)	---	---
2,4,5-TP (Silvex)	µg/L	---	---	ND (2.7)	ND (0.26)	---	---
2,4-D	µg/L	---	---	ND (2.7)	ND (0.26)	---	---
2,4-DB	µg/L	---	---	ND (2.7)	ND (0.26)	---	---
4-Nitrophenol	µg/L	---	---	ND (2.7)	---	---	---

TABLE 5.2-1

## HNWR-1 Analytical Results (November 2010 through January 2013)

Groundwater Remedy Operation and Maintenance Manual

Volume 2: Sampling and Monitoring Plan

PG&amp;E Topock Compressor Station, Needles, California

Location:		HNWR-01	HNWR-01	HNWR-01	HNWR-01	HNWR-01	HNWR-01
Sample Date:		11/10/2010	2/23/2012	3/14/2012	4/4/2012	6/27/2012	1/22/2013
Parameter	Units						
Herbicides							
Dalapon	µg/L	---	---	ND (4.4)	ND (0.42)	---	---
Dicamba	µg/L	---	---	ND (2.7)	ND (0.26)	---	---
Dichlorprop	µg/L	---	---	ND (2.7)	ND (0.26)	---	---
Dinoseb	µg/L	---	---	ND (2.7)	ND (0.26)	---	---
MCPA	µg/L	---	---	ND (2.7)	ND (0.26)	---	---
MCPP	µg/L	---	---	ND (2.7)	ND (0.26)	---	---
Pentachlorophenol	µg/L	---	---	ND (2.7)	ND (0.26)	---	---
Metals							
Aluminum, dissolved	µg/L	ND (50)	---	ND (50)	ND (50)	ND (50)	---
Antimony, dissolved	µg/L	ND (10)	ND (10)	ND (10)	ND (0.5)	ND (0.5)	---
Arsenic	µg/L	---	---	---	---	---	16.0
Arsenic, dissolved	µg/L	15.0	15.0	16.0	15.0	16.0	16.0
Barium, dissolved	µg/L	130	110	110	110	110	---
Beryllium, dissolved	µg/L	ND (1.0)	ND (1.0)	ND (1.0)	ND (1.0)	ND (1.0)	---
Boron, dissolved	µg/L	380	---	---	---	---	---
Cadmium, dissolved	µg/L	ND (3.0)	ND (3.0)	ND (3.0)	ND (3.0)	ND (3.0)	---
Calcium, dissolved	µg/L	23,000	19,000 J	19,000	20,000	---	---
Chromium, Hexavalent	µg/L	17.5	15.0	18.0	14.0	15.0	---
Chromium, total dissolved	µg/L	19.2	16.0	18.0	17.0	18.0	---
Cobalt, dissolved	µg/L	ND (3.0)	ND (3.0)	ND (3.0)	ND (3.0)	ND (3.0)	---
Copper, dissolved	µg/L	ND (5.0)	ND (5.0)	ND (5.0)	ND (5.0)	ND (5.0)	---
Iron, dissolved	µg/L	ND (20)	37.0	ND (20)	25.0	38.0	---
Lead, dissolved	µg/L	ND (10)	ND (10)	ND (10)	ND (10)	ND (10)	---
Magnesium, dissolved	µg/L	4,000	3,100	3,200 J	3,100 J	---	---
Manganese, dissolved	µg/L	ND (10)	1.90	0.64	1.70	1.70	---
Mercury, dissolved	µg/L	ND (0.2)	ND (0.2)	ND (0.2)	ND (0.2)	ND (0.2)	---
Molybdenum, dissolved	µg/L	11.0	9.40	10.0	9.00	9.10	---
Nickel, dissolved	µg/L	ND (5.0)	ND (5.0)	ND (5.0)	ND (5.0)	ND (5.0)	---
Potassium, dissolved	µg/L	5,100	4,400	4,000	3,700	---	---
Selenium, dissolved	µg/L	0.73	0.87	0.75	0.75	0.71	---
Silver, dissolved	µg/L	ND (3.0)	ND (3.0)	ND (3.0)	ND (3.0)	ND (3.0) J	---
Sodium, dissolved	µg/L	130,000	130,000	130,000	130,000	---	---
Soluble silica	mg/L	---	---	---	---	---	---
Thallium, dissolved	µg/L	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	---
Vanadium, dissolved	µg/L	20.0	21.0	22.0 J	20.0	20.0	---
Zinc, dissolved	µg/L	ND (10)	ND (10)	16.0	ND (10)	ND (10)	---



TABLE 5.2-1

## HNWR-1 Analytical Results (November 2010 through January 2013)

Groundwater Remedy Operation and Maintenance Manual

Volume 2: Sampling and Monitoring Plan

PG&amp;E Topock Compressor Station, Needles, California

	Location:	HNWR-01	HNWR-01	HNWR-01	HNWR-01	HNWR-01	HNWR-01
	Sample Date:	11/10/2010	2/23/2012	3/14/2012	4/4/2012	6/27/2012	1/22/2013
Parameter	Units						
Perchlorate							
Perchlorate	µg/L	---	---	ND (2.0)	ND (2.0)	---	---
Pesticides							
4,4-DDD	µg/L	---	---	ND (0.053)	ND (0.052)	---	---
4,4-DDE	µg/L	---	---	ND (0.053)	ND (0.052)	---	---
4,4-DDT	µg/L	---	---	ND (0.053)	ND (0.052)	---	---
Aldrin	µg/L	---	---	ND (0.027)	ND (0.026)	---	---
alpha-BHC	µg/L	---	---	ND (0.027)	ND (0.026)	---	---
alpha-Chlordane	µg/L	---	---	ND (0.027)	ND (0.026)	---	---
beta-BHC	µg/L	---	---	ND (0.027)	ND (0.026)	---	---
delta-BHC	µg/L	---	---	ND (0.027)	ND (0.026)	---	---
Dieldrin	µg/L	---	---	ND (0.053)	ND (0.052)	---	---
Endo sulfan I	µg/L	---	---	ND (0.027)	ND (0.026)	---	---
Endo sulfan II	µg/L	---	---	ND (0.053)	ND (0.052)	---	---
Endosulfan sulfate	µg/L	---	---	ND (0.053)	ND (0.052)	---	---
Endrin	µg/L	---	---	ND (0.053)	ND (0.052)	---	---
Endrin aldehyde	µg/L	---	---	ND (0.053)	ND (0.052)	---	---
gamma-BHC	µg/L	---	---	ND (0.027)	ND (0.026)	---	---
gamma-Chlordane	µg/L	---	---	ND (0.027)	ND (0.026)	---	---
Heptachlor	µg/L	---	---	ND (0.027)	ND (0.026)	---	---
Heptachlor Epoxide	µg/L	---	---	ND (0.027)	ND (0.026)	---	---
Methoxy chlor	µg/L	---	---	ND (0.27)	ND (0.26)	---	---
Toxaphene	µg/L	---	---	ND (2.7) J	ND (2.6) J	---	---
Polyaromatic Hydrocarbons							
1-Methyl naphthalene	µg/L	---	---	ND (0.22)	ND (0.2)	---	---
2-Methyl naphthalene	µg/L	---	---	ND (0.22)	ND (0.2)	---	---
Acenaphthene	µg/L	---	---	ND (0.22)	ND (0.2)	---	---
Acenaphthylene	µg/L	---	---	ND (0.22)	ND (0.2)	---	---
Anthracene	µg/L	---	---	ND (0.22)	ND (0.2)	---	---
B(a)P Equivalent	µg/L	---	---	ND (0.19)	ND (0.18)	---	---
Benzo (a) anthracene	µg/L	---	---	ND (0.22)	ND (0.2)	---	---
Benzo (a) pyrene	µg/L	---	---	ND (0.22)	ND (0.2)	---	---
Benzo (b) fluoranthene	µg/L	---	---	ND (0.22)	ND (0.2)	---	---
Benzo (ghi) perylene	µg/L	---	---	ND (0.22)	ND (0.2)	---	---
Benzo (k) fluoranthene	µg/L	---	---	ND (0.22)	ND (0.2)	---	---
Chrysene	µg/L	---	---	ND (0.22)	ND (0.2)	---	---
Dibenzo (a,h) anthracene	µg/L	---	---	ND (0.22)	ND (0.2)	---	---

TABLE 5.2-1

## HNWR-1 Analytical Results (November 2010 through January 2013)

Groundwater Remedy Operation and Maintenance Manual

Volume 2: Sampling and Monitoring Plan

PG&amp;E Topock Compressor Station, Needles, California

Location:		HNWR-01	HNWR-01	HNWR-01	HNWR-01	HNWR-01	HNWR-01
Sample Date:		11/10/2010	2/23/2012	3/14/2012	4/4/2012	6/27/2012	1/22/2013
Parameter	Units						
Polyaromatic Hydrocarbons							
Fluoranthene	µg/L	---	---	ND (0.22)	ND (0.2)	---	---
Fluorene	µg/L	---	---	ND (0.22)	ND (0.2)	---	---
Indeno (1,2,3-cd) pyrene	µg/L	---	---	ND (0.22)	ND (0.2)	---	---
Naphthalene	µg/L	---	---	ND (0.22)	ND (0.2)	---	---
PAH High molecular weight	µg/L	---	---	ND (0.0)	ND (0.0)	---	---
PAH Low molecular weight	µg/L	---	---	ND (0.0)	ND (0.0)	---	---
Phenanthrene	µg/L	---	---	ND (0.22)	ND (0.2)	---	---
Pyrene	µg/L	---	---	ND (0.22)	ND (0.2)	---	---
Polychlorinated Biphenyls							
Aroclor 1016	µg/L	---	---	ND (0.53)	ND (0.52)	---	---
Aroclor 1221	µg/L	---	---	ND (1.1)	ND (1.0)	---	---
Aroclor 1232	µg/L	---	---	ND (0.53)	ND (0.52)	---	---
Aroclor 1242	µg/L	---	---	ND (0.53)	ND (0.52)	---	---
Aroclor 1248	µg/L	---	---	ND (0.53)	ND (0.52)	---	---
Aroclor 1254	µg/L	---	---	ND (0.53)	ND (0.52)	---	---
Aroclor 1260	µg/L	---	---	ND (0.53)	ND (0.52)	---	---
Radiochemistry							
Gross Alpha	pCi/L	---	---	---	---	---	---
Gross Beta	pCi/L	---	---	---	---	---	---
Total Petroleum Hydrocarbons							
Orthophosphate, dissolved	mg/L	---	---	---	---	---	---
TPH as diesel	µg/L	---	---	190	ND (51) J	---	---
TPH as gasoline	µg/L	---	---	ND (100)	ND (100)	---	---
TPH as motor oil	µg/L	---	---	ND (53)	ND (51)	---	---
Volatile Organic Compounds							
1,1,1,2-Tetrachloroethane	µg/L	---	---	ND (1.0)	ND (1.0)	---	---
1,1,1-Trichloroethane	µg/L	---	---	ND (1.0)	ND (1.0)	---	---
1,1,2,2-Tetrachloroethane	µg/L	---	---	ND (1.0)	ND (1.0)	---	---
1,1,2-Trichloroethane	µg/L	---	---	ND (1.0)	ND (1.0)	---	---
1,1,2-Trichlorotrifluoroethane (Freon 113)	µg/L	---	---	ND (1.0)	ND (1.0)	---	---
1,1-Dichloroethane	µg/L	---	---	ND (1.0)	ND (1.0)	---	---
1,1-Dichloroethene	µg/L	---	---	ND (1.0)	ND (1.0)	---	---
1,1-Dichloropropene	µg/L	---	---	ND (1.0)	ND (1.0)	---	---
1,2,3-Trichlorobenzene	µg/L	---	---	ND (1.0)	ND (1.0)	---	---
1,2,3-Trichloropropane	µg/L	---	---	ND (1.0)	ND (1.0)	---	---
1,2,4-Trichlorobenzene	µg/L	---	---	ND (1.0)	ND (1.0)	---	---



TABLE 5.2-1

## HNWR-1 Analytical Results (November 2010 through January 2013)

Groundwater Remedy Operation and Maintenance Manual

Volume 2: Sampling and Monitoring Plan

PG&amp;E Topock Compressor Station, Needles, California

Location:		HNWR-01	HNWR-01	HNWR-01	HNWR-01	HNWR-01	HNWR-01
Sample Date:		11/10/2010	2/23/2012	3/14/2012	4/4/2012	6/27/2012	1/22/2013
Parameter	Units						
Volatile Organic Compounds							
1,2,4-Trimethylbenzene	µg/L	---	---	ND (1.0)	ND (1.0) J	---	---
1,2-Dibromo-3-chloropropane	µg/L	---	---	ND (2.0)	ND (2.0)	---	---
1,2-Dibromoethane	µg/L	---	---	ND (1.0)	ND (1.0)	---	---
1,2-Dichlorobenzene	µg/L	---	---	ND (1.0)	ND (1.0)	---	---
1,2-Dichloroethane	µg/L	---	---	ND (1.0)	ND (1.0)	---	---
1,2-Dichloropropane	µg/L	---	---	ND (1.0)	ND (1.0)	---	---
1,3,5-Trimethylbenzene	µg/L	---	---	ND (1.0)	ND (1.0) J	---	---
1,3-Dichlorobenzene	µg/L	---	---	ND (1.0)	ND (1.0)	---	---
1,3-Dichloropropane	µg/L	---	---	ND (1.0)	ND (1.0)	---	---
1,4-Dichlorobenzene	µg/L	---	---	ND (1.0)	ND (1.0)	---	---
2,2-Dichloropropane	µg/L	---	---	ND (1.0)	ND (1.0)	---	---
2-Chlorotoluene	µg/L	---	---	ND (1.0)	ND (1.0)	---	---
4-Isopropyltoluene	µg/L	---	---	ND (1.0)	ND (1.0)	---	---
Acetone	µg/L	---	---	ND (10)	ND (10)	---	---
Acrolein	µg/L	---	---	ND (20)	ND (20)	---	---
Acrylonitrile	µg/L	---	---	ND (20)	ND (20)	---	---
Benzene	µg/L	---	---	ND (1.0)	ND (1.0)	---	---
Bromobenzene	µg/L	---	---	ND (1.0)	ND (1.0)	---	---
Bromochloromethane	µg/L	---	---	ND (1.0)	ND (1.0)	---	---
Bromodichloromethane	µg/L	---	---	ND (1.0)	ND (1.0)	---	---
Bromoform	µg/L	---	---	ND (1.0)	ND (1.0)	---	---
Bromomethane	µg/L	---	---	ND (1.0)	ND (1.0)	---	---
Carbon disulfide	µg/L	---	---	ND (1.0)	ND (1.0)	---	---
Carbon tetrachloride	µg/L	---	---	ND (1.0)	ND (1.0)	---	---
Chloro methane	µg/L	---	---	ND (1.0)	ND (1.0)	---	---
Chlorobenzene	µg/L	---	---	ND (1.0)	ND (1.0)	---	---
Chloroethane	µg/L	---	---	ND (1.0)	ND (1.0)	---	---
Chloroform	µg/L	---	---	ND (1.0)	ND (1.0)	---	---
cis-1,2-Dichloroethene	µg/L	---	---	ND (1.0)	ND (1.0)	---	---
cis-1,3-Dichloropropene	µg/L	---	---	ND (1.0)	ND (1.0)	---	---
Dibromochloromethane	µg/L	---	---	ND (1.0)	ND (1.0)	---	---
Dibromomethane	µg/L	---	---	ND (1.0)	ND (1.0)	---	---
Dichlorodifluoromethane	µg/L	---	---	ND (1.0)	ND (1.0)	---	---
Ethyl- benzene	µg/L	---	---	ND (1.0)	ND (1.0)	---	---
Hexachlorobutadiene	µg/L	---	---	ND (1.0)	ND (1.0)	---	---
Isopropylbenzene	µg/L	---	---	ND (1.0)	ND (1.0)	---	---
Methyl ethyl ketone	µg/L	---	---	ND (10)	ND (10)	---	---

TABLE 5.2-1

## HNWR-1 Analytical Results (November 2010 through January 2013)

Groundwater Remedy Operation and Maintenance Manual

Volume 2: Sampling and Monitoring Plan

PG&amp;E Topock Compressor Station, Needles, California

Location:		HNWR-01	HNWR-01	HNWR-01	HNWR-01	HNWR-01	HNWR-01
Sample Date:		11/10/2010	2/23/2012	3/14/2012	4/4/2012	6/27/2012	1/22/2013
Parameter	Units						
Volatile Organic Compounds							
Methyl isobutyl ketone	µg/L	---	---	ND (10)	ND (10)	---	---
Methyl tert-butyl ether (MTBE)	µg/L	---	---	ND (1.0)	ND (1.0) J	---	---
Methylene chloride	µg/L	---	---	ND (5.0)	ND (5.0)	---	---
N-Butylbenzene	µg/L	---	---	ND (1.0)	ND (1.0)	---	---
N-Propylbenzene	µg/L	---	---	ND (1.0)	ND (1.0)	---	---
p-Chlorotoluene	µg/L	---	---	ND (1.0)	ND (1.0)	---	---
sec-Butylbenzene	µg/L	---	---	ND (1.0)	ND (1.0)	---	---
Styrene	µg/L	---	---	ND (1.0)	ND (1.0) J	---	---
tert-Butylbenzene	µg/L	---	---	ND (1.0)	ND (1.0)	---	---
Tetrachloroethene	µg/L	---	---	ND (1.0)	ND (1.0)	---	---
Toluene	µg/L	---	---	ND (2.5)	ND (2.5)	---	---
trans-1,2-Dichloroethene	µg/L	---	---	ND (1.0)	ND (1.0)	---	---
trans-1,3-Dichloropropene	µg/L	---	---	ND (1.0)	ND (1.0)	---	---
Trichloroethene	µg/L	---	---	ND (1.0)	ND (1.0)	---	---
Trichlorofluoromethane (Freon 11)	µg/L	---	---	ND (1.0)	ND (1.0)	---	---
Vinyl chloride	µg/L	---	---	ND (1.0)	ND (1.0)	---	---
Xylene, m,p-	µg/L	---	---	ND (1.0)	ND (1.0)	---	---
Xylene, o-	µg/L	---	---	ND (1.0)	ND (1.0)	---	---
Xylenes, total	µg/L	---	---	ND (2.0)	ND (2.0)	---	---

## Notes:

--- not collected or not available.  
 % percent  
 0/00 differences from global standards in ppt.  
 °C degrees Celcius.  
 J analyte was present, but reported value was estimated.  
 mg/L milligrams per liter.  
 mV millivolts.  
 ND parameter not detected at the listed reporting limit.  
 NTU nephelometric turbidity units.  
 µg/L micrograms per liter.  
 µS/cm microSiemens per centimeter.

TABLE 5.2-2

## HNWR-1 Analytical Results (October 2013 through February 2014)

Groundwater Remedy Operation and Maintenance Manual

Volume 2: Sampling and Monitoring Plan

PG&amp;E Topock Compressor Station, Needles, California

	Location:	HNWR-01	HNWR-01	HNWR-01	HNWR-01	HNWR-01	HNWR-01	HNWR-01
	Sample Date:	10/22/2013	2/11/2014	2/12/2014	2/12/2014	2/12/2014	2/13/2014	2/14/2014
	Time (hours):	--	1	6	12	24	48	72
Parameter	Units							
Anions								
Bromide	mg/L	ND (0.5)	ND (0.5)	---	---	---	---	ND (0.5)
Chloride	mg/L	140	140	---	---	---	---	140
Fluoride	mg/L	3.90	4.00	4.00	4.00	4.00	3.80	3.90
Nitrate (as nitrogen)	mg/L	2.50	2.60	2.70	2.70	2.70	2.50	2.50
Nitrite as Nitrogen	mg/L	ND (2.5)	ND (1.0)	---	---	---	---	ND (1.0)
Sulfate	mg/L	45.0	45.0	---	---	---	---	51.0
General Chemistry								
Deuterium	0/00	---	-73.6	-73.4	-73.4	-73.4	-74.3	-72.5
Oxygen 18	0/00	---	-10.1	-10.4	-10.4	-10.4	-10.5	-10.4
pH	pH units	---	7.90 J	---	---	---	---	7.70 J
Total organic carbon	mg/L	---	ND (1.0)	---	---	---	---	ND (1.0)
Herbicides								
2,4,5-T	µg/L	---	ND (0.012)	---	---	---	---	ND (0.012)
2,4,5-TP (Silvex)	µg/L	---	ND (0.016)	---	---	---	---	ND (0.016)
2,4-D	µg/L	---	ND (0.065)	---	---	---	---	ND (0.065)
2,4-DB	µg/L	---	ND (0.32)	---	---	---	---	ND (0.32)
Dalapon	µg/L	---	ND (2.4) J	---	---	---	---	ND (2.4) J
Dicamba	µg/L	---	ND (0.037)	---	---	---	---	ND (0.037)
Dichlorprop	µg/L	---	ND (0.012)	---	---	---	---	ND (0.012)
Dinoseb	µg/L	---	ND (0.04)	---	---	---	---	ND (0.04)
MCPA	µg/L	---	ND (0.29) J	---	---	---	---	ND (0.29) J
MCPP	µg/L	---	ND (0.3) J	---	---	---	---	ND (0.3) J
Metals								
Antimony, dissolved	µg/L	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)
Arsenic, dissolved	µg/L	14.0	16.0	16.0	16.0	16.0	15.0	14.0
Barium, dissolved	µg/L	110	120	120	120	120	130	120
Beryllium, dissolved	µg/L	ND (1.0)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)
Cadmium, dissolved	µg/L	ND (3.0)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)
Calcium, dissolved	µg/L	---	19,000	---	---	---	---	23,000
Chromium, Hexavalent	µg/L	20.0	20.0	20.0	20.0	20.0	19.0	19.0
Chromium, total dissolved	µg/L	17.0	18.0	19.0	19.0	19.0	17.0	16.0
Cobalt, dissolved	µg/L	ND (3.0)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)
Copper, dissolved	µg/L	ND (5.0)	ND (1.0)	ND (1.0)	ND (1.0)	ND (1.0)	ND (1.0)	ND (1.0)
Iron, dissolved	µg/L	---	ND (20)	---	---	---	---	ND (20)
Lead, dissolved	µg/L	ND (10)	ND (1.0)	ND (1.0)	ND (1.0)	ND (1.0)	ND (1.0)	ND (1.0)
Magnesium, dissolved	µg/L	---	3,200	---	---	---	---	4,200

TABLE 5.2-2

## HNWR-1 Analytical Results (October 2013 through February 2014)

Groundwater Remedy Operation and Maintenance Manual

Volume 2: Sampling and Monitoring Plan

PG&amp;E Topock Compressor Station, Needles, California

	Location:	HNWR-01	HNWR-01	HNWR-01	HNWR-01	HNWR-01	HNWR-01	HNWR-01
	Sample Date:	10/22/2013	2/11/2014	2/12/2014	2/12/2014	2/12/2014	2/13/2014	2/14/2014
	Time (hours):	--	1	6	12	24	48	72
Parameter	Units							
Metals								
Manganese, dissolved	µg/L	---	ND (0.5)	---	---	---	---	ND (0.5)
Mercury, dissolved	µg/L	ND (0.2)	ND (0.2)	ND (0.2)	ND (0.2)	ND (0.2)	ND (0.2)	ND (0.2)
Molybdenum, dissolved	µg/L	9.10	9.00	9.40	9.40	9.40	9.20	8.90
Nickel, dissolved	µg/L	ND (5.0)	ND (1.0)	ND (1.0)	ND (1.0)	ND (1.0)	ND (1.0)	ND (1.0)
Potassium, dissolved	µg/L	---	4,100	---	---	---	---	4,600
Selenium, dissolved	µg/L	0.68	0.79	0.77	0.77	0.77	0.76	0.75
Silver, dissolved	µg/L	ND (3.0)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)
Sodium, dissolved	µg/L	---	130,000	---	---	---	---	140,000
Soluble silica	mg/L	27.0	24.0	25.0 J	25.0 J	25.0 J	25.0	27.0
Thallium, dissolved	µg/L	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)
Vanadium, dissolved	µg/L	20.0	18.0	19.0	19.0	19.0	17.0	16.0
Zinc, dissolved	µg/L	12.0	ND (10)	ND (10)	ND (10)	ND (10)	ND (10)	ND (10)
Perchlorate								
Perchlorate	µg/L	---	ND (2.0)	---	---	---	---	ND (2.0)
Pesticides								
4,4-DDD	µg/L	---	ND (0.05)	---	---	---	---	ND (0.052)
4,4-DDE	µg/L	---	ND (0.05)	---	---	---	---	ND (0.052)
4,4-DDT	µg/L	---	ND (0.05)	---	---	---	---	ND (0.052)
Aldrin	µg/L	---	ND (0.025)	---	---	---	---	ND (0.026)
alpha-BHC	µg/L	---	ND (0.025)	---	---	---	---	ND (0.026)
alpha-Chlordane	µg/L	---	ND (0.025)	---	---	---	---	ND (0.026)
beta-BHC	µg/L	---	ND (0.025)	---	---	---	---	ND (0.026)
delta-BHC	µg/L	---	ND (0.025)	---	---	---	---	ND (0.026)
Dieldrin	µg/L	---	ND (0.05)	---	---	---	---	ND (0.052)
Endo sulfan I	µg/L	---	ND (0.025)	---	---	---	---	ND (0.026)
Endo sulfan II	µg/L	---	ND (0.05)	---	---	---	---	ND (0.052)
Endosulfan sulfate	µg/L	---	ND (0.05)	---	---	---	---	ND (0.052)
Endrin	µg/L	---	ND (0.05)	---	---	---	---	ND (0.052)
Endrin aldehyde	µg/L	---	ND (0.05)	---	---	---	---	ND (0.052)
gamma-BHC	µg/L	---	ND (0.025)	---	---	---	---	ND (0.026)
gamma-Chlordane	µg/L	---	ND (0.025)	---	---	---	---	ND (0.026)
Heptachlor	µg/L	---	ND (0.025)	---	---	---	---	ND (0.026)
Heptachlor Epoxide	µg/L	---	ND (0.025)	---	---	---	---	ND (0.026)
Methoxy chlor	µg/L	---	ND (0.25)	---	---	---	---	ND (0.26)
Toxaphene	µg/L	---	ND (2.5)	---	---	---	---	ND (2.6)

TABLE 5.2-2

## HNWR-1 Analytical Results (October 2013 through February 2014)

Groundwater Remedy Operation and Maintenance Manual

Volume 2: Sampling and Monitoring Plan

PG&amp;E Topock Compressor Station, Needles, California

Location:		HNWR-01	HNWR-01	HNWR-01	HNWR-01	HNWR-01	HNWR-01	HNWR-01
Sample Date:		10/22/2013	2/11/2014	2/12/2014	2/12/2014	2/12/2014	2/13/2014	2/14/2014
Time (hours):		--	1	6	12	24	48	72
Parameter	Units							
Polyaromatic Hydrocarbons								
1-Methyl naphthalene	µg/L	---	ND (0.2)	---	---	---	---	ND (0.21)
2-Methyl naphthalene	µg/L	---	ND (0.2)	---	---	---	---	ND (0.21)
Acenaphthene	µg/L	---	ND (0.2)	---	---	---	---	ND (0.21)
Acenaphthylene	µg/L	---	ND (0.2)	---	---	---	---	ND (0.21)
Anthracene	µg/L	---	ND (0.2)	---	---	---	---	ND (0.21)
Benzo (a) anthracene	µg/L	---	ND (0.2)	---	---	---	---	ND (0.21)
Benzo (a) pyrene	µg/L	---	ND (0.2)	---	---	---	---	ND (0.21)
Benzo (b) fluoranthene	µg/L	---	ND (0.2)	---	---	---	---	ND (0.21)
Benzo (ghi) perylene	µg/L	---	ND (0.2)	---	---	---	---	ND (0.21)
Benzo (k) fluoranthene	µg/L	---	ND (0.2)	---	---	---	---	ND (0.21)
Chrysene	µg/L	---	ND (0.2)	---	---	---	---	ND (0.21)
Dibenzo (a,h) anthracene	µg/L	---	ND (0.2)	---	---	---	---	ND (0.21)
Fluoranthene	µg/L	---	ND (0.2)	---	---	---	---	ND (0.21)
Fluorene	µg/L	---	ND (0.2)	---	---	---	---	ND (0.21)
Indeno (1,2,3-cd) pyrene	µg/L	---	ND (0.2)	---	---	---	---	ND (0.21)
Naphthalene	µg/L	---	ND (0.2)	---	---	---	---	ND (0.21)
Phenanthrene	µg/L	---	ND (0.2)	---	---	---	---	ND (0.21)
Pyrene	µg/L	---	ND (0.2)	---	---	---	---	ND (0.21)
Polychlorinated Biphenyls								
Aroclor 1016	µg/L	---	ND (0.5)	---	---	---	---	ND (0.52)
Aroclor 1221	µg/L	---	ND (1.0)	---	---	---	---	ND (1.0)
Aroclor 1232	µg/L	---	ND (0.5)	---	---	---	---	ND (0.52)
Aroclor 1242	µg/L	---	ND (0.5)	---	---	---	---	ND (0.52)
Aroclor 1248	µg/L	---	ND (0.5)	---	---	---	---	ND (0.52)
Aroclor 1254	µg/L	---	ND (0.5)	---	---	---	---	ND (0.52)
Aroclor 1260	µg/L	---	ND (0.5)	---	---	---	---	ND (0.52)
Radiochemistry								
Gross Alpha	pCi/L	---	7.42	---	---	---	---	6.34 J
Gross Beta	pCi/L	---	ND (4.0)	---	---	---	---	ND (4.0)
Total Petroleum Hydrocarbons								
Orthophosphate, dissolved	mg/L	---	ND (0.02)	---	---	---	---	ND (0.02)
TPH as diesel	µg/L	---	ND (50)	---	---	---	---	ND (50)
TPH as gasoline	µg/L	---	ND (100)	---	---	---	---	ND (100)
TPH as motor oil	µg/L	---	ND (50)	---	---	---	---	ND (50)

TABLE 5.2-2

**HNWR-1 Analytical Results (October 2013 through February 2014)**

Groundwater Remedy Operation and Maintenance Manual

Volume 2: Sampling and Monitoring Plan

*PG&E Topock Compressor Station, Needles, California*

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Notes:

--- not collected or not available.  
0/00 differences from global standards in ppt.  
J analyte was present, but reported value was estimated.  
mg/L milligrams per liter.  
ND parameter not detected at the listed reporting limit.  
NTU nephelometric turbidity units.  
pCi/L picocuries per liter.  
µg/L micrograms per liter.

TABLE 5.2-3

HNWR-1A Analytical Results (June 2014)

Groundwater Remedy Operation and Maintenance Manual

Volume 2: Sampling and Monitoring Plan

PG&amp;E Topock Compressor Station, Needles, California

Location:		HNWR-01A	HNWR-01A	HNWR-01A	HNWR-01A	HNWR-01A	HNWR-01A
Sample Date:		6/24/2014	6/24/2014	6/24/2014	6/24/2014	6/24/2014	6/24/2014
Flow Rate (gpm):		500	700	900	1100	1300	1500
Parameter	Units						
Anions							
Bromide	mg/L	---	---	ND (0.5)	---	---	---
Chloride	mg/L	---	---	180	---	---	---
Fluoride	mg/L	---	---	3.90	---	---	---
Nitrate (as nitrogen)	mg/L	---	---	2.60	---	---	---
Nitrite as Nitrogen	mg/L	---	---	ND (1.0)	---	---	---
Orthophosphate, dissolved	mg/L	---	---	ND (0.02)	---	---	---
Sulfate	mg/L	---	---	56.0	---	---	---
General Chemistry							
Deuterium	0/00	---	---	-73.1	---	---	---
Oxygen 18	0/00	---	---	-10.1	---	---	---
pH	pH units	---	---	7.70 J	---	---	---
Total organic carbon	mg/L	---	---	ND (1.0)	---	---	---
Herbicides							
2,4,5-T	µg/L	---	---	ND (0.09) J	---	---	---
2,4,5-TP (Silvex)	µg/L	---	---	ND (0.07) J	---	---	---
2,4-D	µg/L	---	---	ND (0.4) J	---	---	---
2,4-DB	µg/L	---	---	ND (3.0) J	---	---	---
Dalapon	µg/L	---	---	ND (10) J	---	---	---
Dicamba	µg/L	---	---	ND (0.08) J	---	---	---
Dichlorprop	µg/L	---	---	ND (0.5) J	---	---	---
Dinoseb	µg/L	---	---	ND (0.2) J	---	---	---
MCPA	µg/L	---	---	ND (10) J	---	---	---
MCPP	µg/L	---	---	ND (10) J	---	---	---
Metals							
Antimony, dissolved	µg/L	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)
Arsenic, dissolved	µg/L	12.0	12.0	12.0	12.0	13.0	12.0
Barium, dissolved	µg/L	110	110	110	110	110	110
Beryllium, dissolved	µg/L	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)
Cadmium, dissolved	µg/L	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)
Chromium, Hexavalent	µg/L	17.0	17.0	17.0	17.0	17.0	18.0
Chromium, total dissolved	µg/L	16.0	15.0	16.0	16.0	16.0	16.0
Cobalt, dissolved	µg/L	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)
Copper, dissolved	µg/L	ND (1.0)	ND (1.0)	ND (1.0)	ND (1.0)	ND (1.0)	ND (1.0)
Lead, dissolved	µg/L	ND (1.0)	ND (1.0)	ND (1.0)	ND (1.0)	ND (1.0)	ND (1.0)
Mercury, dissolved	µg/L	ND (0.2)	ND (0.2)	ND (0.2)	ND (0.2)	ND (0.2)	ND (0.2)
Molybdenum, dissolved	µg/L	9.80	9.30	9.50	9.50	9.70	9.50

TABLE 5.2-3

HNWR-1A Analytical Results (June 2014)

Groundwater Remedy Operation and Maintenance Manual

Volume 2: Sampling and Monitoring Plan

PG&amp;E Topock Compressor Station, Needles, California

Location:		HNWR-01A	HNWR-01A	HNWR-01A	HNWR-01A	HNWR-01A	HNWR-01A
Sample Date:		6/24/2014	6/24/2014	6/24/2014	6/24/2014	6/24/2014	6/24/2014
Flow Rate (gpm):		500	700	900	1100	1300	1500
Parameter	Units						
Metals							
Nickel, dissolved	µg/L	ND (1.0)	ND (1.0)	ND (1.0)	ND (1.0)	ND (1.0)	ND (1.0)
Selenium, dissolved	µg/L	0.97	0.88	1.00	0.95	0.99	0.98
Silver, dissolved	µg/L	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)
Soluble silica	mg/L	24.0	24.0	29.0 J	24.0	24.0	24.0
Thallium, dissolved	µg/L	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)
Vanadium, dissolved	µg/L	18.0	17.0	18.0	18.0	18.0	18.0
Zinc, dissolved	µg/L	30.0	22.0	19.0	16.0	14.0	16.0
Perchlorate							
Perchlorate	µg/L	---	---	ND (2.0)	---	---	---
Pesticides							
4,4-DDD	µg/L	---	---	ND (0.051)	---	---	---
4,4-DDE	µg/L	---	---	ND (0.051)	---	---	---
4,4-DDT	µg/L	---	---	ND (0.051)	---	---	---
Aldrin	µg/L	---	---	ND (0.026)	---	---	---
alpha-BHC	µg/L	---	---	ND (0.026)	---	---	---
alpha-Chlordane	µg/L	---	---	ND (0.026)	---	---	---
beta-BHC	µg/L	---	---	ND (0.026)	---	---	---
delta-BHC	µg/L	---	---	ND (0.026)	---	---	---
Dieldrin	µg/L	---	---	ND (0.051)	---	---	---
Endo sulfan I	µg/L	---	---	ND (0.026)	---	---	---
Endo sulfan II	µg/L	---	---	ND (0.051)	---	---	---
Endosulfan sulfate	µg/L	---	---	ND (0.051)	---	---	---
Endrin	µg/L	---	---	ND (0.051)	---	---	---
Endrin aldehyde	µg/L	---	---	ND (0.051)	---	---	---
gamma-BHC	µg/L	---	---	ND (0.026)	---	---	---
gamma-Chlordane	µg/L	---	---	ND (0.026)	---	---	---
Heptachlor	µg/L	---	---	ND (0.026)	---	---	---
Heptachlor Epoxide	µg/L	---	---	ND (0.026)	---	---	---
Methoxy chlor	µg/L	---	---	ND (0.26)	---	---	---
Toxaphene	µg/L	---	---	ND (2.6)	---	---	---
Polychlorinated Biphenyls							
Aroclor 1016	µg/L	---	---	ND (0.51)	---	---	---
Aroclor 1221	µg/L	---	---	ND (1.0)	---	---	---
Aroclor 1232	µg/L	---	---	ND (0.51)	---	---	---
Aroclor 1242	µg/L	---	---	ND (0.51)	---	---	---
Aroclor 1248	µg/L	---	---	ND (0.51)	---	---	---



TABLE 5.2-3

HNWR-1A Analytical Results (June 2014)

Groundwater Remedy Operation and Maintenance Manual

Volume 2: Sampling and Monitoring Plan

PG&amp;E Topock Compressor Station, Needles, California

Location:		HNWR-01A	HNWR-01A	HNWR-01A	HNWR-01A	HNWR-01A	HNWR-01A
Sample Date:		6/24/2014	6/24/2014	6/24/2014	6/24/2014	6/24/2014	6/24/2014
Flow Rate (gpm):		500	700	900	1100	1300	1500
Parameter	Units						
Polychlorinated Biphenyls							
Aroclor 1254	µg/L	---	---	ND (0.51)	---	---	---
Aroclor 1260	µg/L	---	---	ND (0.51)	---	---	---
Radiochemistry							
Gross Alpha	pCi/L	---	---	4.57	---	---	---
Gross Beta	pCi/L	---	---	5.52	---	---	---
Semivolatile Organic Compounds							
2,4,5-Trichlorophenol	µg/L	---	---	ND (10)	---	---	---
2,4,6-Trichlorophenol	µg/L	---	---	ND (10)	---	---	---
2,4-Dichlorophenol	µg/L	---	---	ND (10)	---	---	---
2,4-Dimethylphenol	µg/L	---	---	ND (10) J	---	---	---
2,4-Dinitrophenol	µg/L	---	---	ND (52)	---	---	---
2,4-Dinitrotoluene	µg/L	---	---	ND (10)	---	---	---
2,6-Dinitrotoluene	µg/L	---	---	ND (10)	---	---	---
2-Chloro naphthalene	µg/L	---	---	ND (10)	---	---	---
2-Chlorophenol	µg/L	---	---	ND (10) J	---	---	---
2-Methyl naphthalene	µg/L	---	---	ND (10) J	---	---	---
2-Methylphenol	µg/L	---	---	ND (10) J	---	---	---
2-Nitroaniline	µg/L	---	---	ND (52)	---	---	---
2-Nitrophenol	µg/L	---	---	ND (10) J	---	---	---
3,3-Dichlorobenzidene	µg/L	---	---	ND (21)	---	---	---
3-Nitroaniline	µg/L	---	---	ND (52)	---	---	---
4,6-Dinitro-2-methylphenol	µg/L	---	---	ND (52)	---	---	---
4-Bromophenyl phenyl ether	µg/L	---	---	ND (10)	---	---	---
4-Chloro-3-methylphenol	µg/L	---	---	ND (52)	---	---	---
4-Chloroaniline	µg/L	---	---	ND (21) J	---	---	---
4-Chlorophenyl phenyl ether	µg/L	---	---	ND (10)	---	---	---
4-Methylphenol	µg/L	---	---	ND (10) J	---	---	---
4-Nitroaniline	µg/L	---	---	ND (21)	---	---	---
4-Nitrophenol	µg/L	---	---	ND (52)	---	---	---
Acenaphthene	µg/L	---	---	ND (10)	---	---	---
Acenaphthylene	µg/L	---	---	ND (10)	---	---	---
Anthracene	µg/L	---	---	ND (10)	---	---	---
Benzo (a) anthracene	µg/L	---	---	ND (10)	---	---	---
Benzo (a) pyrene	µg/L	---	---	ND (10)	---	---	---
Benzo (b) fluoranthene	µg/L	---	---	ND (10)	---	---	---
Benzo (ghi) perylene	µg/L	---	---	ND (10)	---	---	---

TABLE 5.2-3

HNWR-1A Analytical Results (June 2014)

Groundwater Remedy Operation and Maintenance Manual

Volume 2: Sampling and Monitoring Plan

PG&amp;E Topock Compressor Station, Needles, California

Location:		HNWR-01A	HNWR-01A	HNWR-01A	HNWR-01A	HNWR-01A	HNWR-01A
Sample Date:		6/24/2014	6/24/2014	6/24/2014	6/24/2014	6/24/2014	6/24/2014
Flow Rate (gpm):		500	700	900	1100	1300	1500
Parameter	Units						
Semivolatile Organic Compounds							
Benzo (k) fluoranthene	µg/L	---	---	ND (10)	---	---	---
Benzoic acid	µg/L	---	---	ND (52)	---	---	---
Benzyl alcohol	µg/L	---	---	ND (21) J	---	---	---
bis (2-chloroethoxy) methane	µg/L	---	---	ND (10) J	---	---	---
bis (2-chloroethyl) ether	µg/L	---	---	ND (10) J	---	---	---
bis (2-chloroisopropyl) ether	µg/L	---	---	ND (10) J	---	---	---
bis (2-ethylhexyl) phthalate	µg/L	---	---	ND (10)	---	---	---
Butylbenzylphthalate	µg/L	---	---	ND (10)	---	---	---
Chrysene	µg/L	---	---	ND (10)	---	---	---
Dibenzo (a,h) anthracene	µg/L	---	---	ND (10)	---	---	---
Dibenzofuran	µg/L	---	---	ND (10)	---	---	---
Diethyl phthalate	µg/L	---	---	ND (10)	---	---	---
Dimethyl phthalate	µg/L	---	---	ND (10)	---	---	---
Di-n-butyl phthalate	µg/L	---	---	ND (10)	---	---	---
Di-n-octyl phthalate	µg/L	---	---	ND (10)	---	---	---
Fluoranthene	µg/L	---	---	ND (10)	---	---	---
Fluorene	µg/L	---	---	ND (10)	---	---	---
Hexachlorobenzene	µg/L	---	---	ND (10)	---	---	---
Hexachloroethane	µg/L	---	---	ND (10)	---	---	---
Indeno (1,2,3-cd) pyrene	µg/L	---	---	ND (10)	---	---	---
Isophorone	µg/L	---	---	ND (10)	---	---	---
Nitrobenzene	µg/L	---	---	ND (10) J	---	---	---
n-Nitroso-di-n-propylamine	µg/L	---	---	ND (10) J	---	---	---
N-nitrosodiphenylamine	µg/L	---	---	ND (10)	---	---	---
Pentachlorophenol	µg/L	---	---	ND (52)	---	---	---
Phenanthrene	µg/L	---	---	ND (10)	---	---	---
Phenol	µg/L	---	---	ND (10) J	---	---	---
Pyrene	µg/L	---	---	ND (10)	---	---	---
Total Petroleum Hydrocarbons							
TPH as diesel	µg/L	---	---	ND (52)	---	---	---
TPH as gasoline	µg/L	---	---	ND (100)	---	---	---
TPH as motor oil	µg/L	---	---	ND (52)	---	---	---
Volatile Organic Compounds							
1,1,1,2-Tetrachloroethane	µg/L	---	---	ND (1.0)	---	---	---
1,1,1-Trichloroethane	µg/L	---	---	ND (1.0)	---	---	---
1,1,2,2-Tetrachloroethane	µg/L	---	---	ND (1.0)	---	---	---

TABLE 5.2-3

HNWR-1A Analytical Results (June 2014)

Groundwater Remedy Operation and Maintenance Manual

Volume 2: Sampling and Monitoring Plan

PG&amp;E Topock Compressor Station, Needles, California

Location:		HNWR-01A	HNWR-01A	HNWR-01A	HNWR-01A	HNWR-01A	HNWR-01A
Sample Date:		6/24/2014	6/24/2014	6/24/2014	6/24/2014	6/24/2014	6/24/2014
Flow Rate (gpm):		500	700	900	1100	1300	1500
Parameter	Units						
Volatile Organic Compounds							
1,1,2-Trichloroethane	µg/L	---	---	ND (1.0)	---	---	---
1,1,2-Trichlorotrifluoroethane (Freon 113)	µg/L	---	---	ND (1.0)	---	---	---
1,1-Dichloroethane	µg/L	---	---	ND (1.0)	---	---	---
1,1-Dichloroethene	µg/L	---	---	ND (1.0)	---	---	---
1,1-Dichloropropene	µg/L	---	---	ND (1.0)	---	---	---
1,2,3-Trichlorobenzene	µg/L	---	---	ND (1.0)	---	---	---
1,2,3-Trichloropropane	µg/L	---	---	ND (1.0)	---	---	---
1,2,4-Trichlorobenzene	µg/L	---	---	ND (1.0)	---	---	---
1,2,4-Trimethylbenzene	µg/L	---	---	ND (1.0)	---	---	---
1,2-Dibromo-3-chloropropane	µg/L	---	---	ND (2.0)	---	---	---
1,2-Dibromoethane	µg/L	---	---	ND (1.0)	---	---	---
1,2-Dichlorobenzene	µg/L	---	---	ND (1.0)	---	---	---
1,2-Dichloroethane	µg/L	---	---	ND (1.0)	---	---	---
1,2-Dichloropropane	µg/L	---	---	ND (1.0)	---	---	---
1,3,5-Trimethylbenzene	µg/L	---	---	ND (1.0)	---	---	---
1,3-Dichlorobenzene	µg/L	---	---	ND (1.0)	---	---	---
1,3-Dichloropropane	µg/L	---	---	ND (1.0)	---	---	---
1,4-Dichlorobenzene	µg/L	---	---	ND (1.0)	---	---	---
2,2-Dichloropropane	µg/L	---	---	ND (1.0)	---	---	---
2-Chlorotoluene	µg/L	---	---	ND (1.0)	---	---	---
4-Isopropyltoluene	µg/L	---	---	ND (1.0)	---	---	---
Acetone	µg/L	---	---	ND (10)	---	---	---
Acrolein	µg/L	---	---	ND (20)	---	---	---
Acrylonitrile	µg/L	---	---	ND (20)	---	---	---
Benzene	µg/L	---	---	ND (1.0)	---	---	---
Bromobenzene	µg/L	---	---	ND (1.0)	---	---	---
Bromochloromethane	µg/L	---	---	ND (1.0)	---	---	---
Bromodichloromethane	µg/L	---	---	ND (1.0)	---	---	---
Bromoform	µg/L	---	---	ND (1.0)	---	---	---
Bromomethane	µg/L	---	---	ND (1.0)	---	---	---
Carbon disulfide	µg/L	---	---	ND (1.0)	---	---	---
Carbon tetrachloride	µg/L	---	---	ND (0.5)	---	---	---
Chloro methane	µg/L	---	---	ND (1.0)	---	---	---
Chlorobenzene	µg/L	---	---	ND (1.0)	---	---	---
Chloroethane	µg/L	---	---	ND (1.0)	---	---	---
Chloroform	µg/L	---	---	ND (1.0)	---	---	---
cis-1,2-Dichloroethene	µg/L	---	---	ND (1.0)	---	---	---

TABLE 5.2-3

HNWR-1A Analytical Results (June 2014)

Groundwater Remedy Operation and Maintenance Manual

Volume 2: Sampling and Monitoring Plan

PG&amp;E Topock Compressor Station, Needles, California

Location:		HNWR-01A	HNWR-01A	HNWR-01A	HNWR-01A	HNWR-01A	HNWR-01A
Sample Date:		6/24/2014	6/24/2014	6/24/2014	6/24/2014	6/24/2014	6/24/2014
Flow Rate (gpm):		500	700	900	1100	1300	1500
Parameter	Units						
Volatile Organic Compounds							
cis-1,3-Dichloropropene	µg/L	---	---	ND (1.0)	---	---	---
Dibromochloromethane	µg/L	---	---	ND (1.0)	---	---	---
Dibromomethane	µg/L	---	---	ND (1.0)	---	---	---
Dichlorodifluoromethane	µg/L	---	---	ND (1.0)	---	---	---
Ethyl- benzene	µg/L	---	---	ND (1.0)	---	---	---
Hexachlorobutadiene	µg/L	---	---	ND (1.0)	---	---	---
Isopropylbenzene	µg/L	---	---	ND (1.0)	---	---	---
Methyl ethyl ketone	µg/L	---	---	ND (10)	---	---	---
Methyl isobutyl ketone	µg/L	---	---	ND (10)	---	---	---
Methyl tert-butyl ether (MTBE)	µg/L	---	---	ND (1.0)	---	---	---
Methylene chloride	µg/L	---	---	ND (5.0)	---	---	---
Naphthalene	µg/L	---	---	ND (1.0)	---	---	---
N-Butylbenzene	µg/L	---	---	ND (1.0)	---	---	---
N-Propylbenzene	µg/L	---	---	ND (1.0)	---	---	---
p-Chlorotoluene	µg/L	---	---	ND (1.0)	---	---	---
sec-Butylbenzene	µg/L	---	---	ND (1.0)	---	---	---
Styrene	µg/L	---	---	ND (1.0)	---	---	---
tert-Butylbenzene	µg/L	---	---	ND (1.0)	---	---	---
Tetrachloroethene	µg/L	---	---	ND (1.0)	---	---	---
Toluene	µg/L	---	---	ND (2.5)	---	---	---
trans-1,2-Dichloroethene	µg/L	---	---	ND (1.0)	---	---	---
trans-1,3-Dichloropropene	µg/L	---	---	ND (1.0)	---	---	---
Trichloroethene	µg/L	---	---	ND (1.0)	---	---	---
Trichlorofluoromethane (Freon 11)	µg/L	---	---	ND (1.0)	---	---	---
Vinyl chloride	µg/L	---	---	ND (0.5)	---	---	---
Xylene, m,p-	µg/L	---	---	ND (1.0)	---	---	---
Xylene, o-	µg/L	---	---	ND (1.0)	---	---	---
Xylenes, total	µg/L	---	---	ND (2.0)	---	---	---

### TABLE 5.2-3

HNWR-1A Analytical Results (June 2014)

Groundwater Remedy Operation and Maintenance Manual

Volume 2: Sampling and Monitoring Plan

*PG&E Topock Compressor Station, Needles, California*

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#### Notes:

---	not collected or not available.
0/00	differences from global standards in ppt.
gpm	gallons per minute.
J	analyte was present, but reported value was estimated.
mg/L	milligrams per liter.
ND	parameter not detected at the listed reporting limit.
NTU	nephelometric turbidity units.
pCi/L	picocuries per liter.
µg/L	micrograms per liter.

TABLE 5.2-4

**Analytical Suite for Freshwater Supply Well (HNWR-1A) and Extracted River Bank Water Samples**

*Groundwater Remedy Operation and Maintenance Manual*

*Volume 2: Sampling and Monitoring Plan*

*PG&E Topock Compressor Station, Needles, California*

**INORGANIC ANALYTICAL SUITE – Monthly for the first six months, Quarterly for next 6 months (if the water quality appears to be changing rapidly, monthly sampling would be continued beyond the first 6 months). Following the 1st year, switch to Semi-Annual.**

Field Parameters			
Dissolved oxygen	pH	Specific conductance	Turbidity
Oxidation reduction potential	Salinity	Temperature	
Anions (Method E300.0)			
Chloride	Fluoride	Nitrate (as nitrogen)	Sulfate
Radionuclides			
Gross alpha (SM7110C)	Gross beta (E900.0)		
General Chemistry (Methods SM2320-B, SM4500-NH3, SM4500-CN, SM4500-Si C/D, SM2540-C, SM2540, SM5310, CF-IRMS)			
Alkalinity, total as CaCO <sub>3</sub>	Deuterium	Soluble silica	Total organic carbon (TOC)
Ammonia as nitrogen	Oxygen 18	Total dissolved solids (TDS)	Total suspended solids (TSS)
Cyanide			
Metals (Methods SW6010C, SW6020A, SW7470A, E218.6)			
Aluminum, dissolved	Calcium, dissolved	Magnesium, dissolved	Silver, dissolved
Antimony, dissolved	Chromium, Hexavalent	Manganese, dissolved	Sodium, dissolved
Arsenic, dissolved	Chromium, total dissolved	Mercury, dissolved	Thallium, dissolved
Barium, dissolved	Cobalt, dissolved	Molybdenum, dissolved	Vanadium, dissolved
Beryllium, dissolved	Copper, dissolved	Nickel, dissolved	Zinc, dissolved
Boron, dissolved	Iron, dissolved	Potassium, dissolved	
Cadmium, dissolved	Lead, dissolved	Selenium, dissolved	
ORGANIC ANALYTICAL SUITE –Annually for 1 <sup>st</sup> two years, every other year in subsequent years			
Herbicides (Method SW8151A)			
2,4,5-T	2,4-DB	Dicamba	MCPA
2,4,5-TP (Silvex)	4-Nitrophenol	Dichlorprop	MCPP
2,4-D	Dalapon	Dinoseb	Pentachlorophenol
Pesticides (Method SW8081A)			
4,4-DDD	alpha-Chlordane	Endo sulfan II	gamma-Chlordane
4,4-DDE	beta-BHC	Endosulfan sulfate	Heptachlor
4,4-DDT	delta-BHC	Endrin	Heptachlor epoxide
Aldrin	Dieldrin	Endrin aldehyde	Methoxychlor
alpha-BHC	Endo sulfan I	gamma-BHC	Toxaphene
Polyaromatic Hydrocarbons (Method SW8270SIM)			
1-Methyl naphthalene	Benzo (a) anthracene	Chrysene	Naphthalene
2-Methyl naphthalene	Benzo (a) pyrene	Dibenzo (a,h) anthracene	Phenanthrene
Aenaphthene	Benzo (b) fluoranthene	Fluoranthene	Pyrene
Acenaphthylene	Benzo (ghi) perylene	Fluorene	
Anthracene	Benzo (k) fluoranthene	Indeno (1,2,3-cd) pyrene	
Volatile Organic Compounds (Method SW8260B or C)			
1,1,1,2-Tetrachloroethane	1,3,5-Trimethylbenzene	Carbon tetrachloride	Methylene chloride
1,1,1-Trichloroethane	1,3-Dichlorobenzene	Chloro methane	N-Butylbenzene
1,1,2,2-Tetrachloroethane	1,3-Dichloropropane	Chlorobenzene	N-Propylbenzene
1,1,2-Trichloroethane	1,4-Dichlorobenzene	Chloroethane	o-Xylene
1,1,2-Trichlorotrifluoroethane	2,2-Dichloropropane	Chloroform	p-Chlorotoluene
1,1-Dichloroethane	2-Chlorotoluene	cis-1,2-Dichloroethene	sec-Butylbenzene
1,1-Dichloroethene	4-Isopropyltoluene	cis-1,3-Dichloropropene	Styrene
1,1-Dichloropropene	Acetone	Dibromochloromethane	tert-Butylbenzene
1,2,3-Trichlorobenzene	Acrolein	Dibromomethane	Tetrachloroethene
1,2,3-Trichloropropane	Acrylonitrile	Dichlorodifluoromethane	Toluene
1,2,4-Trichlorobenzene	Benzene	Ethylbenzene	trans-1,2-Dichloroethene
1,2,4-Trimethylbenzene	Bromobenzene	Hexachlorobutadiene	trans-1,3-Dichloropropene
1,2-Dibromo-3-chloropropane	Bromochloromethane	Isopropylbenzene	Trichloroethene
1,2-Dibromoethane	Bromodichloromethane	m,p-Xylenes	Trichlorofluoromethane (Freon 11)
1,2-Dichlorobenzene	Bromoform	Methyl ethyl ketone	Vinyl chloride
1,2-Dichloroethane	Bromomethane	Methyl isobutyl ketone	Xylenes, total
1,2-Dichloropropane	Carbon disulfide	Methyl tert-butyl ether (MTBE)	

TABLE 5.2-5

**Analytical Suite for MW-55 Cluster Samples**

*Groundwater Remedy Operation and Maintenance Manual  
Volume 2: Sampling and Monitoring Plan  
PG&E Topock Compressor Station, Needles, California*

INORGANIC ANALYTICAL SUITE – Initially Annual			
<b>Field Parameters</b>			
Dissolved oxygen	pH	Specific conductance	Turbidity
Oxidation reduction potential	Salinity	Temperature	
<b>Anions (Method E300.0)</b>			
Chloride	Fluoride	Nitrate (as nitrogen)	Sulfate
<b>Radionuclides</b>			
Gross alpha (SM7110C)	Gross beta (E900.0)		
<b>General Chemistry (Methods SM2320-B, SM4500-NH<sub>3</sub>, SM4500-CN, SM4500-Si C/D, SM2540-C, SM2540, SM5310, CF-IRMS)</b>			
Alkalinity, total as CaCO <sub>3</sub>	Deuterium	Soluble silica	Total organic carbon (TOC)
Ammonia as nitrogen	Oxygen 18	Total dissolved solids (TDS)	Total suspended solids (TSS)
Cyanide			
<b>Metals (Methods SW6010C, SW6020A, SW7470A, E218.6)</b>			
Aluminum, dissolved	Calcium, dissolved	Magnesium, dissolved	Silver, dissolved
Antimony, dissolved	Chromium, Hexavalent	Manganese, dissolved	Sodium, dissolved
Arsenic, dissolved	Chromium, total dissolved	Mercury, dissolved	Thallium, dissolved
Barium, dissolved	Cobalt, dissolved	Molybdenum, dissolved	Vanadium, dissolved
Beryllium, dissolved	Copper, dissolved	Nickel, dissolved	Zinc, dissolved
Boron, dissolved	Iron, dissolved	Potassium, dissolved	
Cadmium, dissolved	Lead, dissolved	Selenium, dissolved	
ORGANIC ANALYTICAL SUITE – Initially Biennial			
<b>Herbicides (Method SW8151A)</b>			
2,4,5-T	2,4-DB	Dicamba	MCPA
2,4,5-TP (Silvex)	4-Nitrophenol	Dichlorprop	MCPP
2,4-D	Dalapon	Dinoseb	Pentachlorophenol
<b>Pesticides (Method SW8081A)</b>			
4,4-DDD	alpha-Chlordane	Endo sulfan II	gamma-Chlordane
4,4-DDE	beta-BHC	Endosulfan sulfate	Heptachlor
4,4-DDT	delta-BHC	Endrin	Heptachlor epoxide
Aldrin	Dieldrin	Endrin aldehyde	Methoxychlor
alpha-BHC	Endo sulfan I	gamma-BHC	Toxaphene
<b>Polyaromatic Hydrocarbons (Method SW8270SIM)</b>			
1-Methyl naphthalene	Benzo (a) anthracene	Chrysene	Naphthalene
2-Methyl naphthalene	Benzo (a) pyrene	Dibenzo (a,h) anthracene	Phenanthrene
Aenaphthene	Benzo (b) fluoranthene	Fluoranthene	Pyrene
Acenaphthylene	Benzo (ghi) perylene	Fluorene	
Anthracene	Benzo (k) fluoranthene	Indeno (1,2,3-cd) pyrene	
<b>Volatile Organic Compounds (Method SW8260B or C)</b>			
1,1,1,2-Tetrachloroethane	1,3,5-Trimethylbenzene	Carbon tetrachloride	Methylene chloride
1,1,1-Trichloroethane	1,3-Dichlorobenzene	Chloro methane	N-Butylbenzene
1,1,2,2-Tetrachloroethane	1,3-Dichloropropane	Chlorobenzene	N-Propylbenzene
1,1,2-Trichloroethane	1,4-Dichlorobenzene	Chloroethane	o-Xylene
1,1,2-Trichlorotrifluoroethane	2,2-Dichloropropane	Chloroform	p-Chlorotoluene
1,1-Dichloroethane	2-Chlorotoluene	cis-1,2-Dichloroethene	sec-Butylbenzene
1,1-Dichloroethene	4-Isopropyltoluene	cis-1,3-Dichloropropene	Styrene
1,1-Dichloropropene	Acetone	Dibromochloromethane	tert-Butylbenzene
1,2,3-Trichlorobenzene	Acrolein	Dibromomethane	Tetrachloroethene
1,2,3-Trichloropropane	Acrylonitrile	Dichlorodifluoromethane	Toluene
1,2,4-Trichlorobenzene	Benzene	Ethylbenzene	trans-1,2-Dichloroethene
1,2,4-Trimethylbenzene	Bromobenzene	Hexachlorobutadiene	trans-1,3-Dichloropropene
1,2-Dibromo-3-chloropropane	Bromochloromethane	Isopropylbenzene	Trichloroethene
1,2-Dibromoethane	Bromodichloromethane	m,p-Xylenes	Trichlorofluoromethane (Freon 11)
1,2-Dichlorobenzene	Bromoform	Methyl ethyl ketone	Vinyl chloride
1,2-Dichloroethane	Bromomethane	Methyl isobutyl ketone	Xylenes, total
1,2-Dichloropropane	Carbon disulfide	Methyl tert-butyl ether (MTBE)	

TABLE 5.3-1

**Analytical Suite for Process Control Monitoring – Remedy-produced Water Management**

*Groundwater Remedy Operation and Maintenance Manual*

*Volume 2: Sampling and Monitoring Plan*

*PG&E Topock Compressor Station, Needles, California*

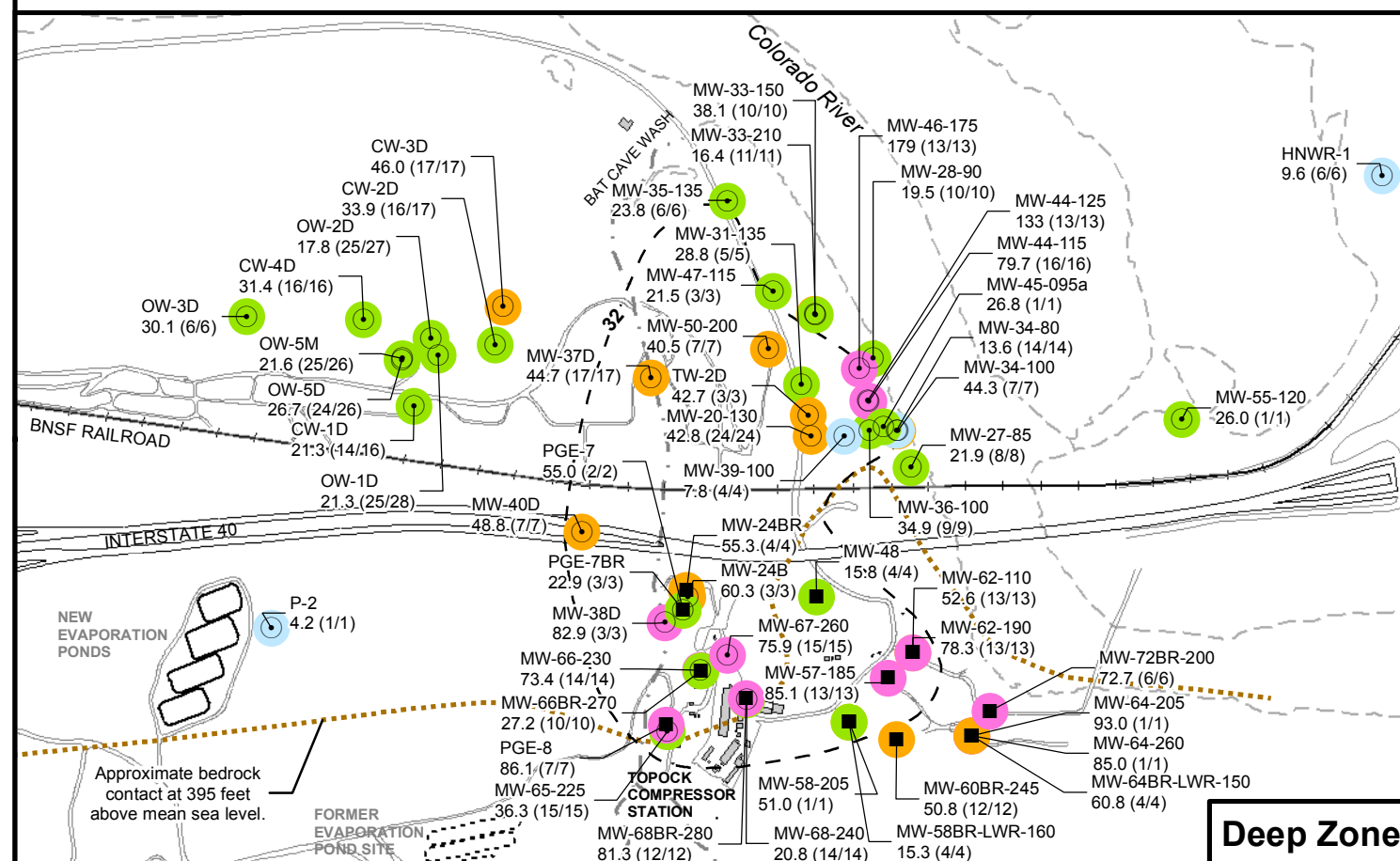
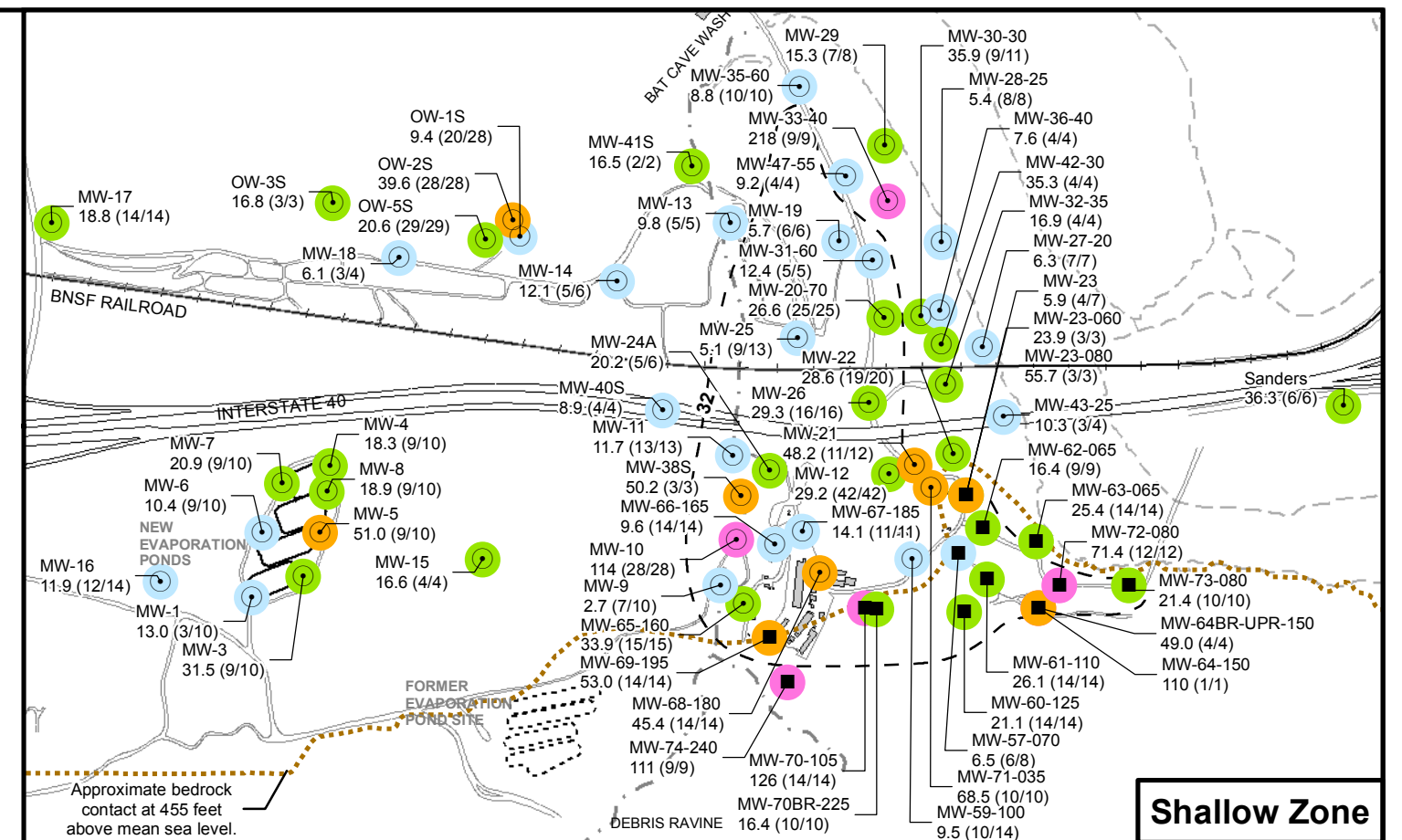
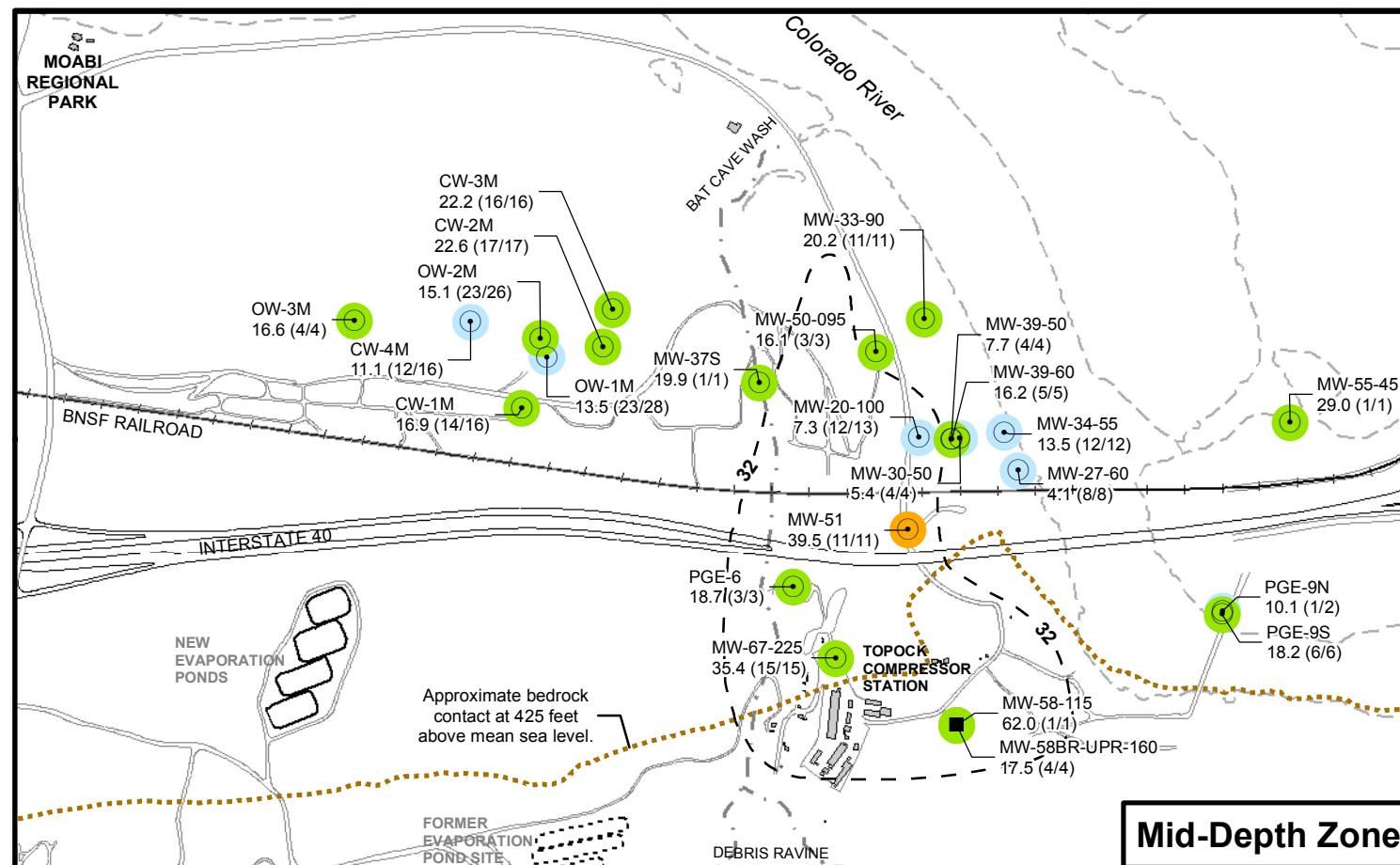
FIELD PARAMETERS			
<b>All Sample Locations – Daily</b>			
Temperature	pH	Specific conductance	Turbidity
<b>Influent Sample Location – Weekly</b>			
Oxidation reduction potential	Salinity		
<b>All Sample Locations – Weekly</b>			
Total Chromium	Dissolved Iron	Dissolved Manganese	Hexavalent Chromium
<b>INORGANIC ANALYTICAL SUITE – Initial Frequency Quarterly from Influent and Conditioned Water Tanks</b>			
<b>Anions</b> (Method E300.0)			
Chloride	Fluoride	Nitrate (as nitrogen)	Sulfate
<b>General Chemistry</b> (Methods SM2320-B, SM4500-NH3, SM4500-CN, SM4500-Si C/D, SM2540-C, SM2540, SM5310, CF-IRMS)			
Alkalinity, total as CaCO <sub>3</sub>	Deuterium	Soluble silica	Total organic carbon (TOC)
Ammonia as nitrogen	Oxygen 18	Total dissolved solids (TDS)	Total suspended solids (TSS)
Cyanide			
<b>Metals</b> (Methods SW6010C, SW6020A, SW7470A, E218.6)			
Aluminum, dissolved	Calcium, dissolved	Magnesium, dissolved	Silver, dissolved
Antimony, dissolved	Chromium, Hexavalent	Manganese, dissolved	Sodium, dissolved
Arsenic, dissolved	Chromium, total dissolved	Mercury, dissolved	Thallium, dissolved
Barium, dissolved	Cobalt, dissolved	Molybdenum, dissolved	Vanadium, dissolved
Beryllium, dissolved	Copper, dissolved	Nickel, dissolved	Zinc, dissolved
Boron, dissolved	Iron, dissolved	Potassium, dissolved	
Cadmium, dissolved	Lead, dissolved	Selenium, dissolved	



TABLE 5.4-1

**Analytical Suite for Domestic/Private Wells Samples**  
*Groundwater Remedy Operation and Maintenance Manual*  
*Volume 2: Sampling and Monitoring Plan*  
*PG&E Topock Compressor Station, Needles, California*

SAMPLING FREQUENCY (Baseline prior to remedy start-up, then biennial)			
Field Parameters			
Dissolved oxygen	pH	Specific conductance	Turbidity
Oxidation reduction potential	Salinity	Temperature	
Anions (Method E300.0)			
Chloride	Fluoride	Nitrate (as nitrogen)	Sulfate
General Chemistry (Methods SM2320-B, SM4500-NH3, SM4500-CN, SM4500-Si C/D, SM2540-C, SM2540, SM5310, CF-IRMS)			
Alkalinity, total as CaCO <sub>3</sub>	Ammonia as nitrogen	Total Dissolved Solids (TDS)	
Metals (Methods SW6010C, SW6020A)			
Arsenic, dissolved	Chromium, total dissolved	Manganese, dissolved	Selenium, dissolved
Calcium, dissolved	Iron, dissolved	Molybdenum, dissolved	Sodium, dissolved
Chromium, hexavalent	Magnesium, dissolved	Potassium, dissolved	



## LEGEND

- ⊙ Groundwater Well completed in Alluvial Aquifer (Shallow, Mid-depth or Deep Zones)
- Groundwater Well completed in Bedrock

## Dissolved Molybdenum Average Concentrations

MW-17 ← Well ID  
 5.8 (8/16) ← (No. of detections / No. of samples)  
 ↑ Average concentration, micrograms per liter (µg/L)  
 1997 - 2013 groundwater sampling

- ⊙ ≤ 15.0 µg/L
- ⊙ 15.0 - 36.3 µg/L
- ⊙ 36.4 - 70.0 µg/L
- ⊙ > 70.0 µg/L

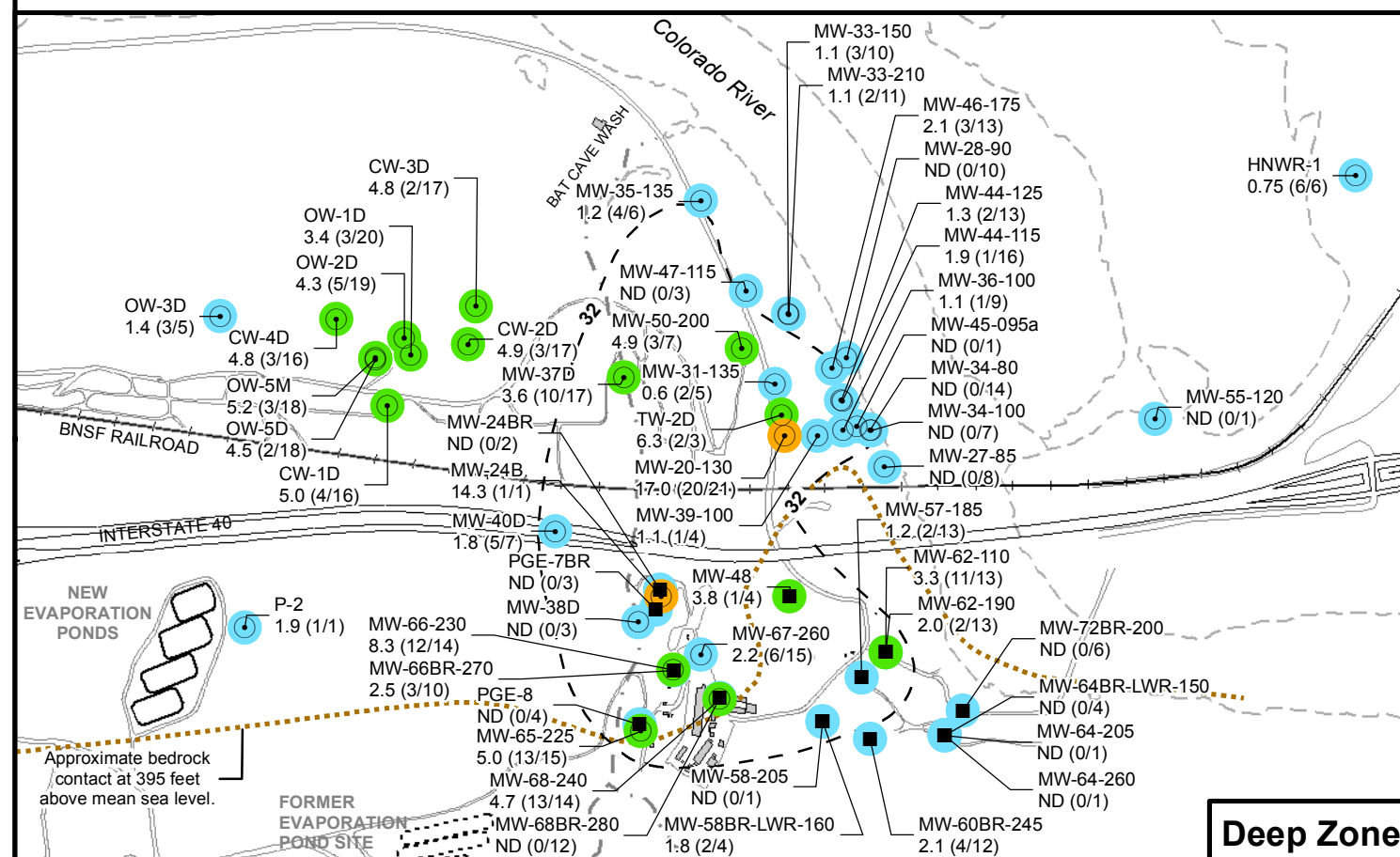
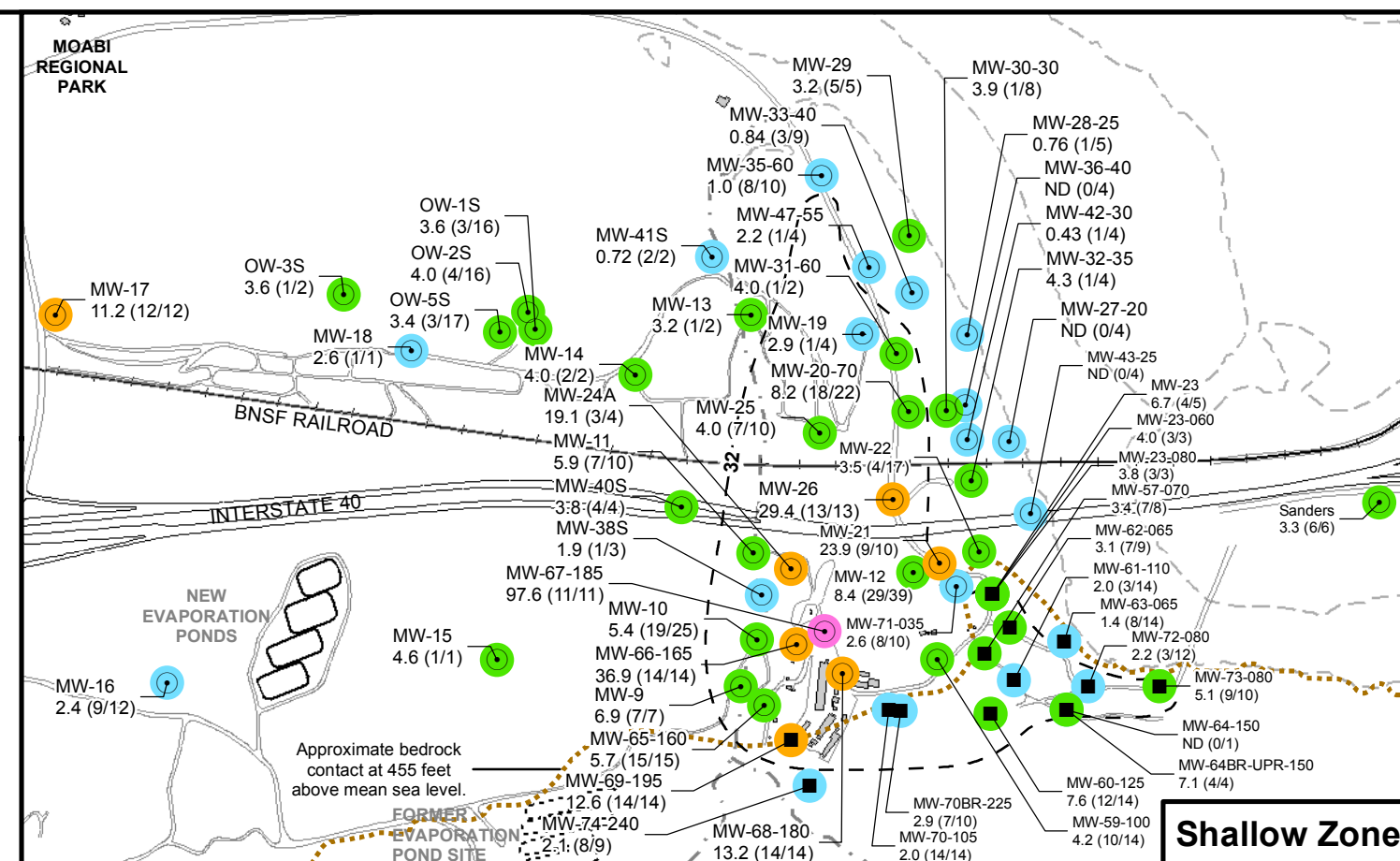
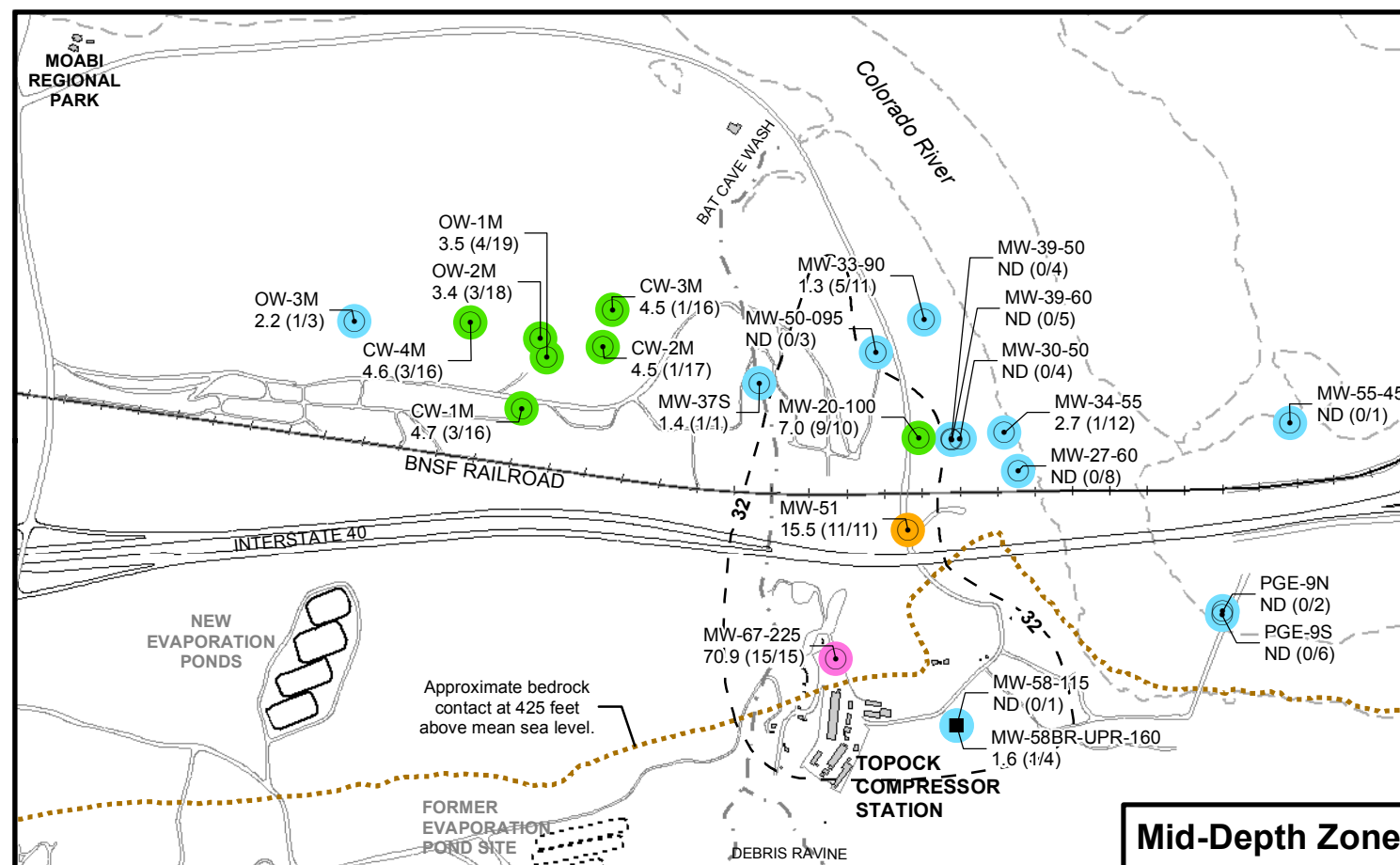
## Notes:

- Molybdenum Background Study Upper Tolerance Limit (UTL) = 36.3 µg/L
- In computing averages, non-detects were assigned half of the reporting limit concentration. Some averages may be elevated due solely to high reporting limits for non-detect samples. Refer to the complete data set in Appendix A1 of the BOD Report for verification.

Approximate outline of Cr(VI) in Alluvial Aquifer depth zone ≥ 32 µg/L, Fourth Quarter 2013

## FIGURE 5.1-1 MOLYBDENUM CONCENTRATIONS IN GROUNDWATER, JULY 1997 - DECEMBER 2013

GROUNDWATER REMEDY OPERATION AND  
 MAINTENANCE MANUAL  
 VOLUME 2: SAMPLING AND MONITORING PLAN  
 PG&E TOPEAK COMPRESSOR STATION,  
 NEEDLES, CALIFORNIA



## LEGEND

- Groundwater Well completed in Alluvial Aquifer (Shallow, Mid-depth or Deep Zones)
- Groundwater Well completed in Bedrock

## Dissolved Selenium Average Concentrations

- MW-17      Well ID
- 5.8 (8/16)      (No. of detections / No. of samples)
- ↑      Average concentration, micrograms per liter (µg/L)  
1997 - 2011 groundwater sampling
- ≤ 3.0 µg/L
  - 3.0 - 10.3 µg/L
  - 10.4 - 50.0 µg/L
  - > 50.0 µg/L

Approximate outline of Cr(VI) in Alluvial Aquifer depth zone ≥ 32 µg/L, Fourth Quarter 2011

## Notes:

- Selenium Background Study Upper Tolerance Limit (UTL) = 10.3 µg/L
- Selenium applicable or relevant and appropriate requirement (ARAR) = 50.0 µg/L
- In computing averages, non-detects were assigned half of the reporting limit concentration. Some averages may be elevated due solely to high reporting limits for non-detect samples. Refer to the complete data set in Appendix A1 of the BOD Report for verification.

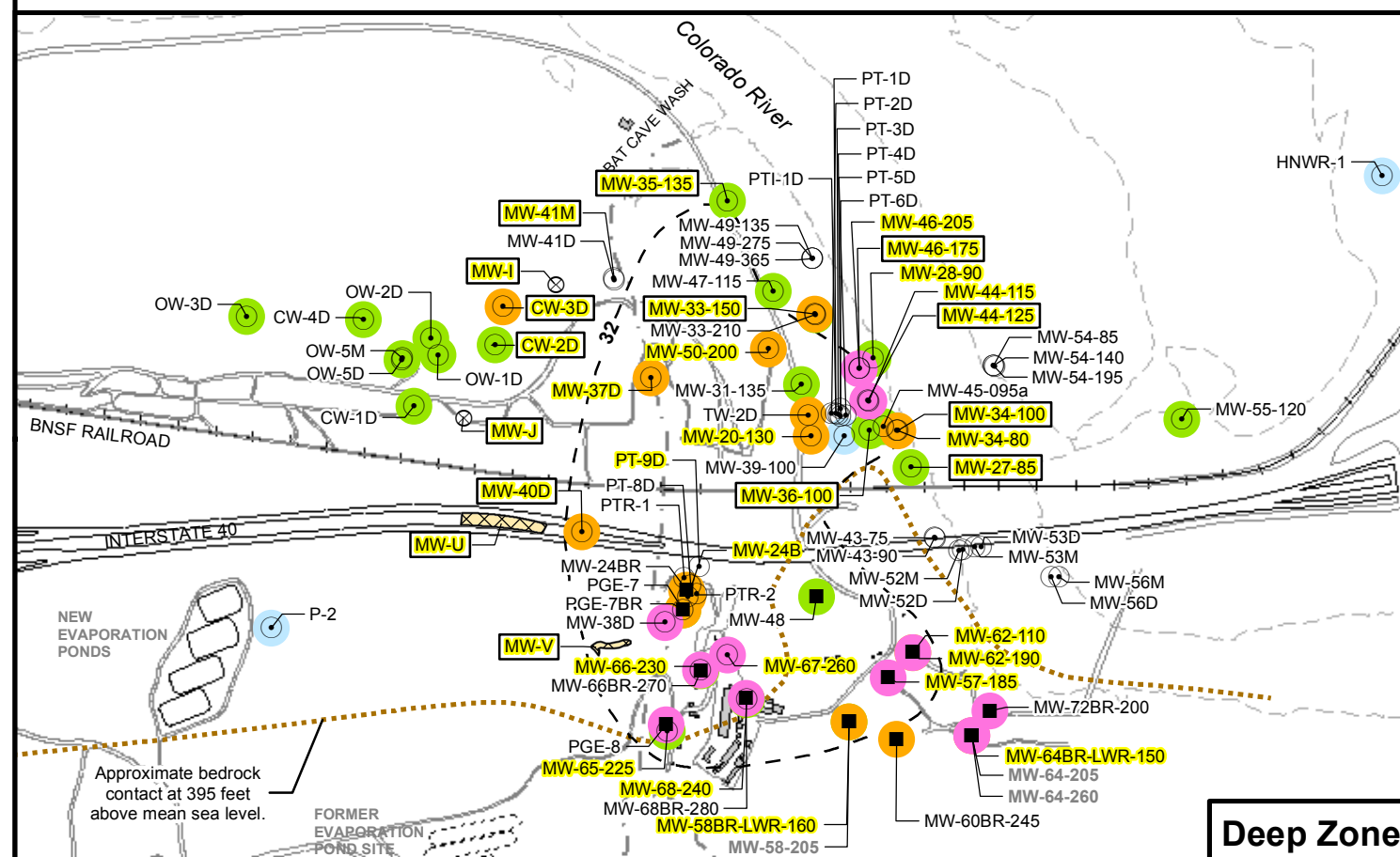
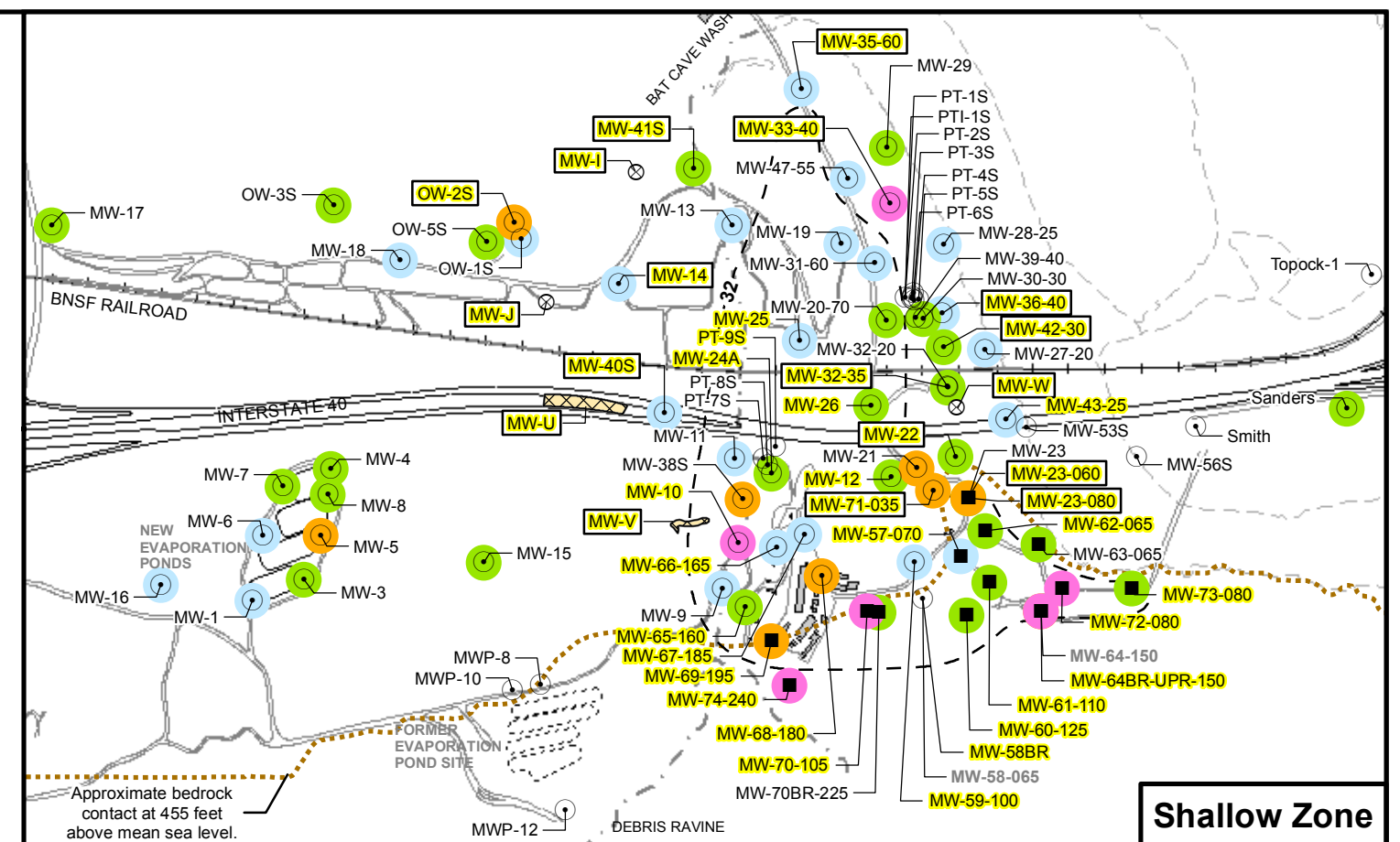
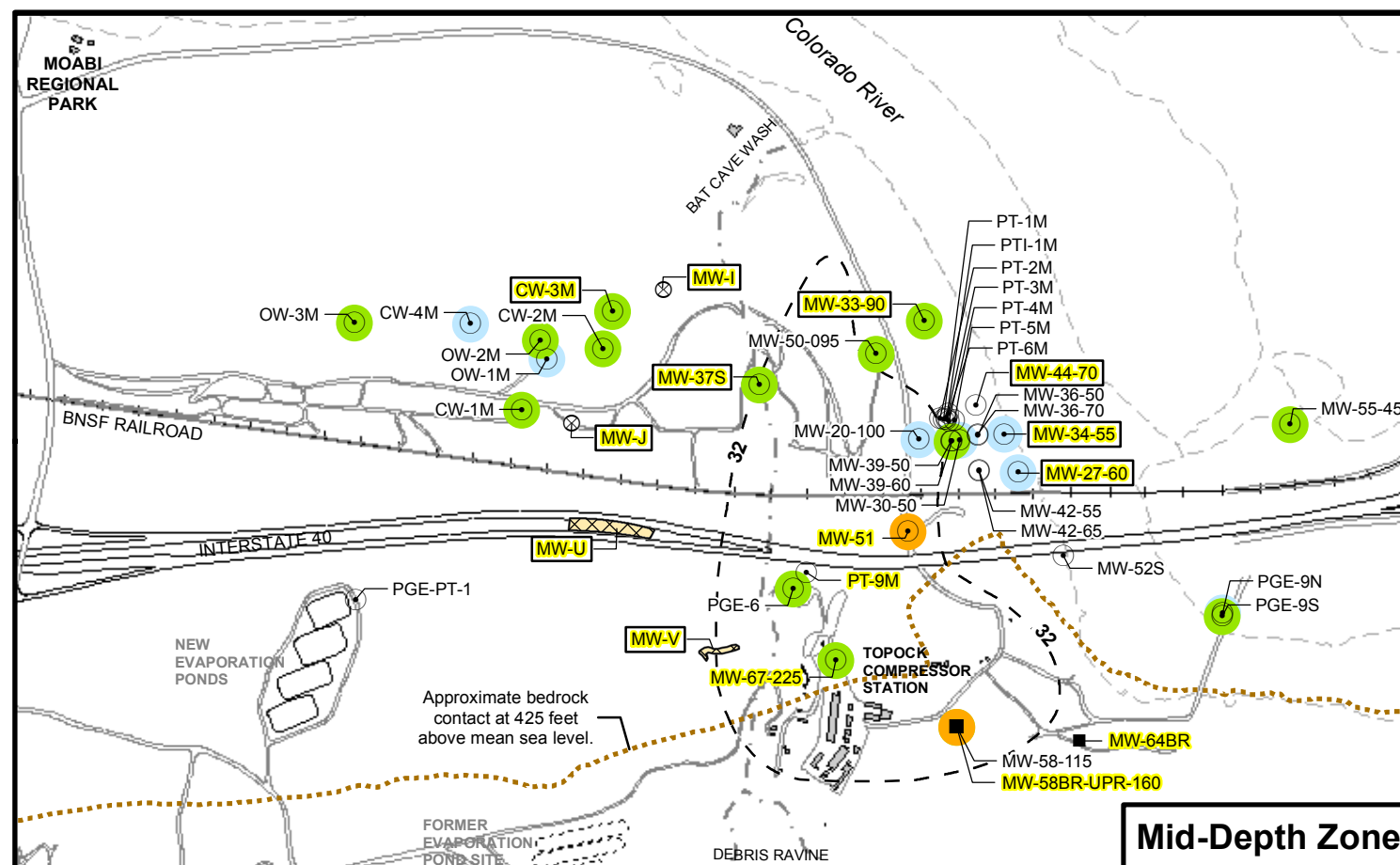
## FIGURE 5.1-2 SELENIUM CONCENTRATIONS IN GROUNDWATER, JULY 1997 - DECEMBER 2013

GROUNDWATER REMEDY OPERATION AND  
MAINTENANCE MANUAL  
VOLUME 2: SAMPLING AND MONITORING PLAN  
PG&E TOPOCK COMPRESSOR STATION,  
NEEDLES, CALIFORNIA

CH2MHILL








## LEGEND

- |   |   |
|---|---|
| ⊙ | Groundwater Well completed in Alluvial Aquifer (Shallow, Mid-depth or Deep Zones) |
| ■ | Groundwater Well completed in Bedrock   |
| ⊗ | Proposed New Groundwater Well   |
| ⊠ | Proposed New Groundwater Well - Location Indefinite                               |

### Dissolved Molybdenum Average Concentrations

- MW-17      ←      Well ID
- ⊙ No Data
- ⊙ ≤ 15.0 µg/L
- ⊙ 15.0 - 36.3 µg/L
- ⊙ 36.4 - 70.0 µg/L
- ⊙ > 70.0 µg/L

**Yellow** highlighted well with border indicates the well is included in COPC Perimeter Assessment Program.  
**Yellow** highlighted well indicates wells proposed for Mo monitoring.  
 Gray well names indicates wells no longer exist or dry.

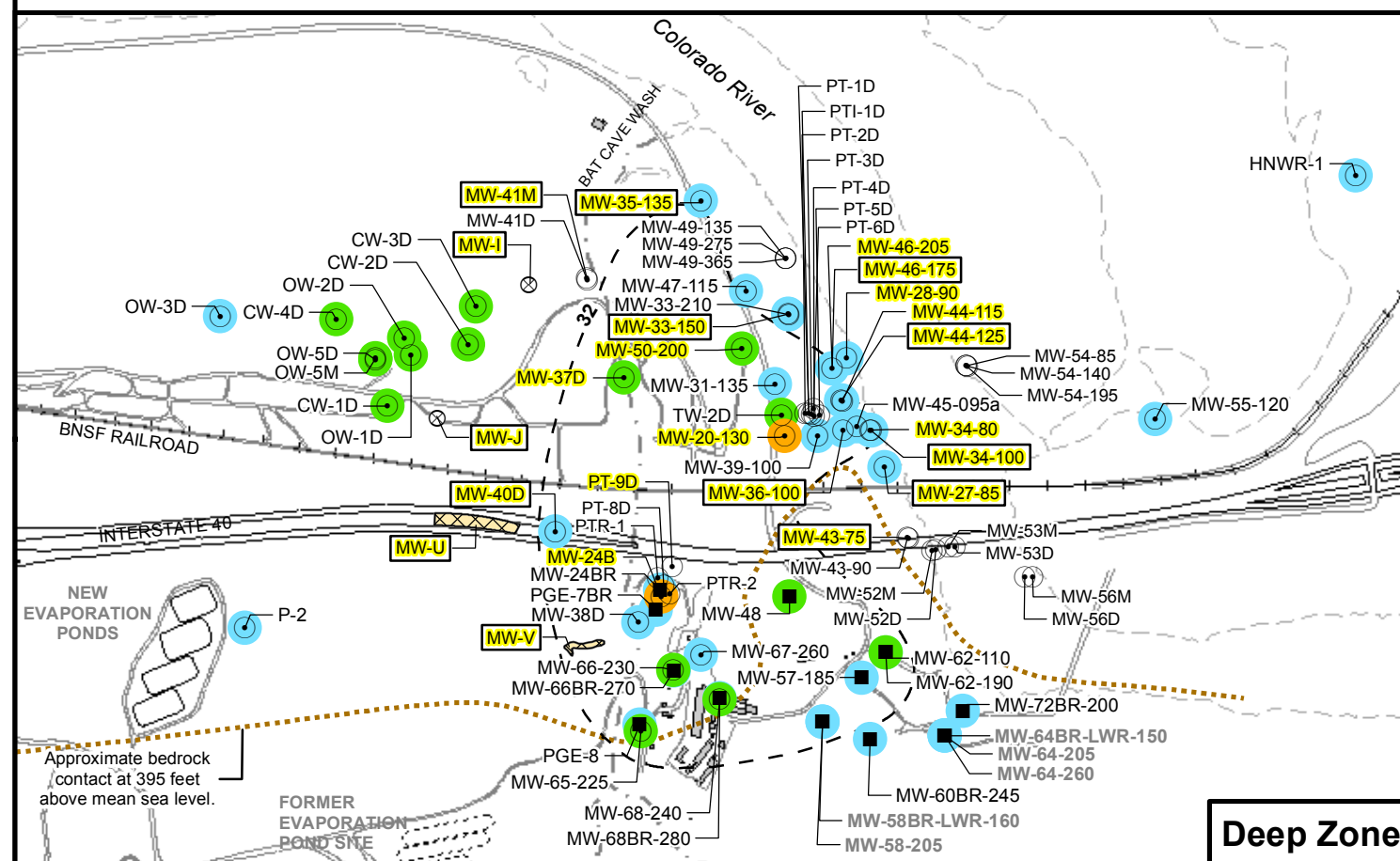
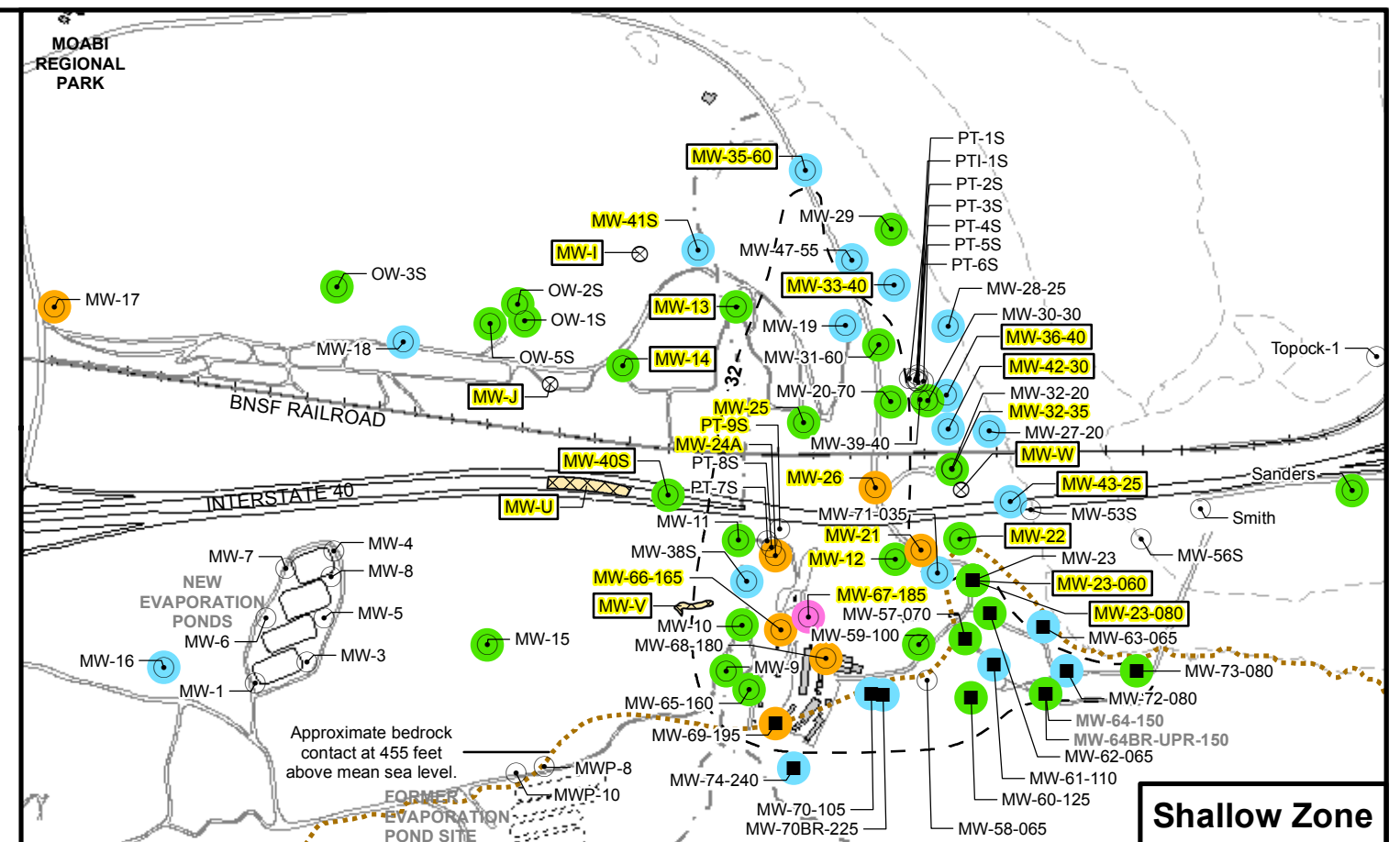
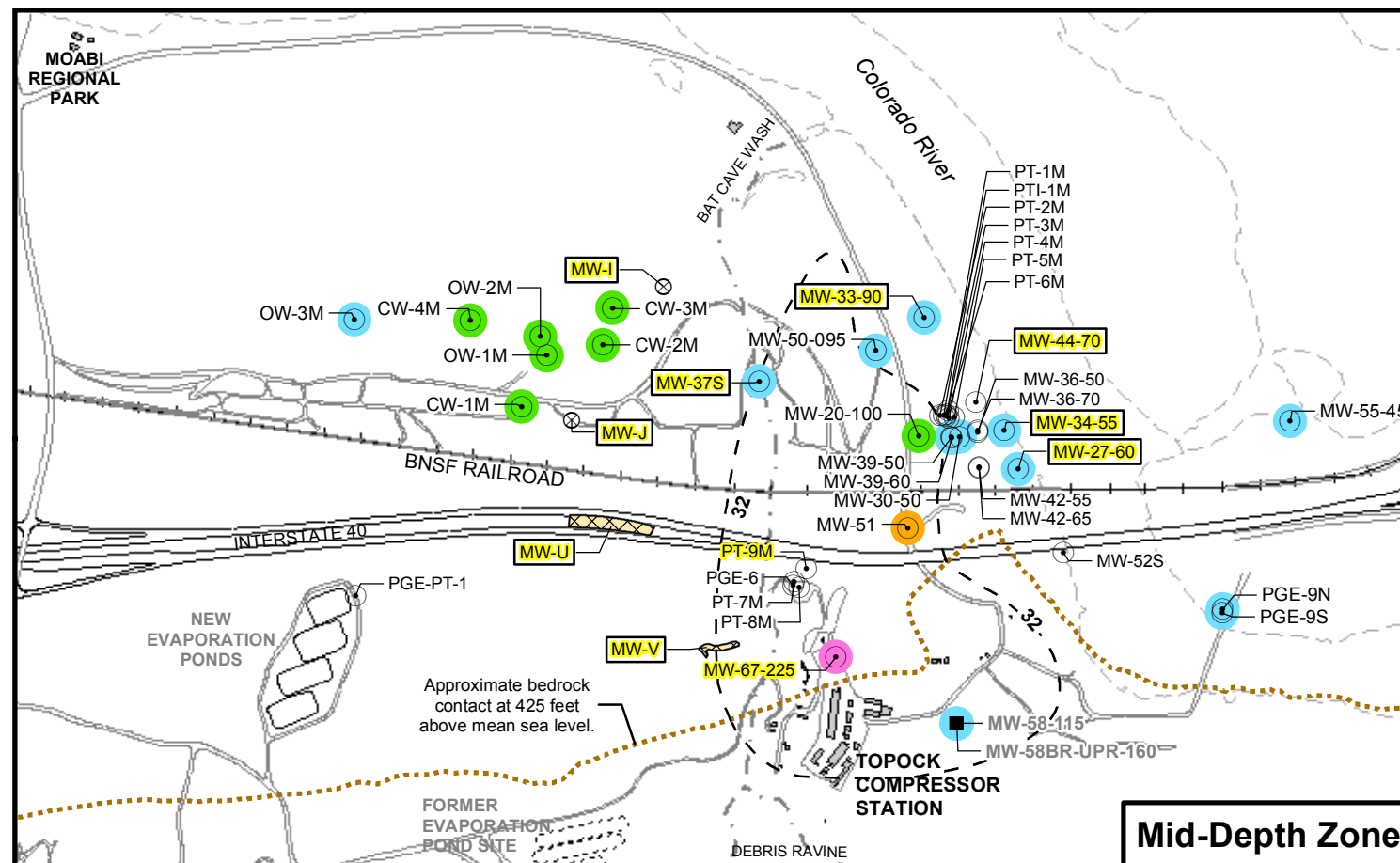
 Approximate outline of Cr(VI) in Alluvial Aquifer depth zone  $\geq 32 \mu\text{g/L}$ , Fourth Quarter 2013

Notes:

1. Includes data through February 2013 for the East Ravine-Topock Compressor Station wells.
2. Molybdenum Background Study Upper Tolerance Limit (UTL) = 36.3 µg/L
3. In computing averages, non-detects were assigned half of the reporting limit concentration. Some averages may be elevated due solely to high reporting limits for non-detect samples. Refer to the complete data set in Appendix A1 for verification.

**FIGURE 5.1-4**  
**MOLYBDENUM**  
**MONITORING LOCATIONS**  
GROUNDWATER REMEDY OPERATION  
AND MAINTENANCE MANUAL,  
VOLUME 2 SAMPLING AND MONITORING PLAN  
PG&E TOPOCK COMPRESSOR STATION,  
NEEDLES, CALIFORNIA





## LEGEND

- ⊙ Groundwater Well completed in Alluvial Aquifer (Shallow, Mid-depth or Deep Zones)
- Groundwater Well completed in Bedrock
- ⊗ Proposed New Groundwater Well
- ⊗ Proposed New Groundwater Well - Location Indefinite

## Dissolved Selenium Average Concentrations

MW-17 ← Well ID

- ⊙ No Data
- ⊙ ≤ 3.0 µg/L
- ⊙ 3.0 - 10.3 µg/L
- ⊙ 10.4 - 50.0 µg/L
- ⊙ > 50.0 µg/L

Yellow highlighted well with border indicates the well is included in COPC Perimeter Assessment Program.

Yellow highlighted well indicates wells proposed for Mo monitoring.

Gray well names indicates wells no longer exist or dry.

## Notes:

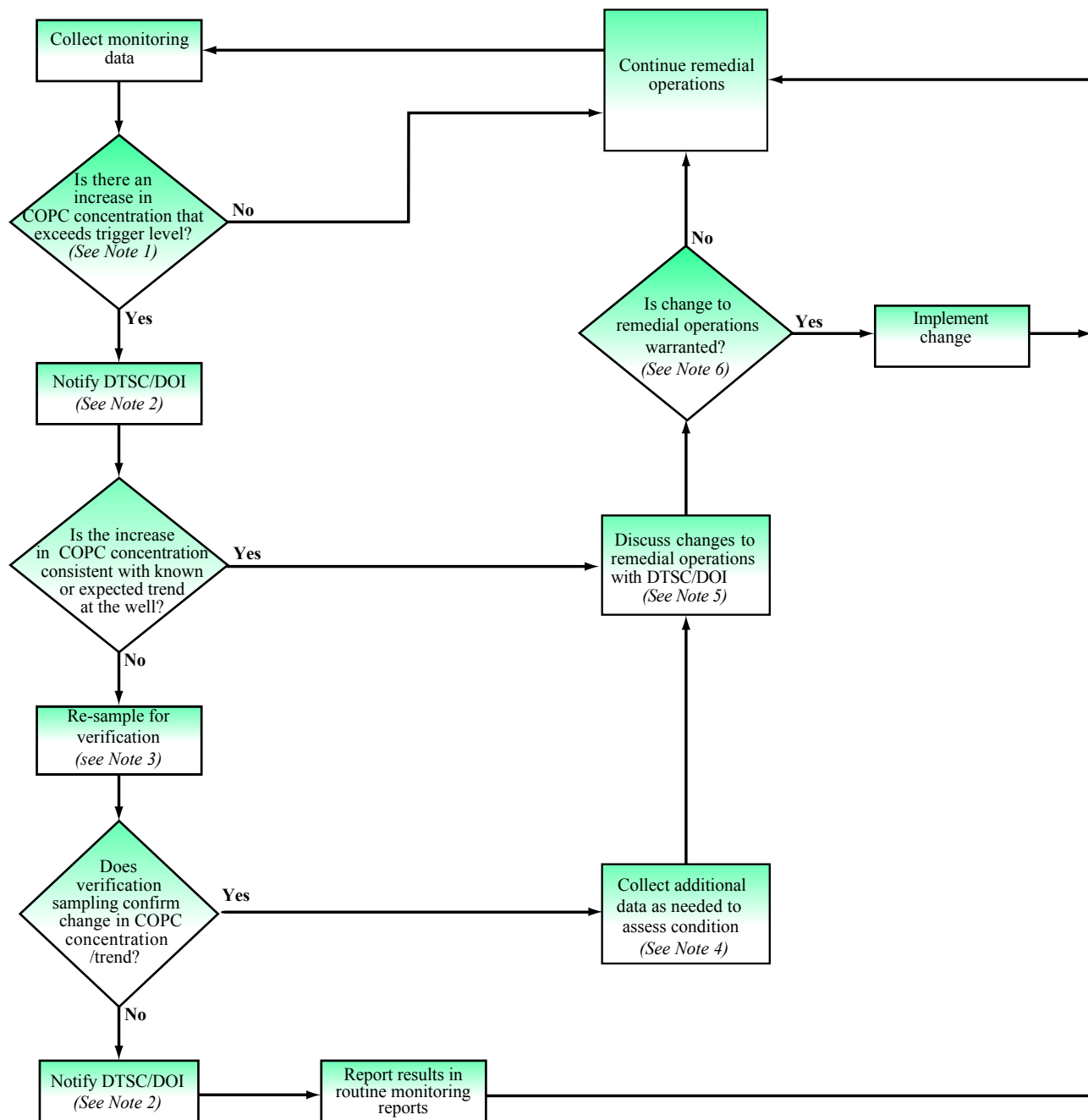
1. Includes data through February 2012 for the East Ravine-Topock Compressor Station wells.
2. Selenium Background Study Upper Tolerance Limit (UTL) = 10.3 µg/L
3. Selenium applicable or relevant and appropriate requirement (ARAR) = 50.0 µg/L
4. In computing averages, non-detects were assigned half of the reporting limit concentration. Some averages may be elevated due solely to high reporting limits for non-detect samples. Refer to the complete data set in Appendix A1 for verification.

Approximate outline of Cr(VI) in Alluvial Aquifer depth zone ≥ 32 µg/L, Fourth Quarter 2011

**FIGURE 5.1-5**  
**SELENIUM MONITORING LOCATIONS**  
GROUNDWATER REMEDY OPERATION  
AND MAINTENANCE MANUAL,  
VOLUME 2 SAMPLING AND MONITORING PLAN  
PG&E TOPOCK COMPRESSOR STATION,  
NEEDLES, CALIFORNIA







NOTES:

1. The wells subject to this contingency plan are defined in Table 2.1-4 and shown on Figures 5.1-4, 5.1-5, and 5.1-6.
2. Notification will be provided within 5 days following receipt of validated laboratory results.
3. Re-sampling to occur with 45 days of receipt of validated laboratory results

4. Data needed to assess trend or condition may include increased sampling frequency at triggered well, increased sampling at adjacent wells (i.e., lateral, vertical), or collection of additional data to assess change in geochemical conditions.
5. Assess the gradient direction near the triggered well and evaluate potential for remedial measure optimization accordingly. Optimization may include changes to pumping or injection rates,
6. Changes to manage COPCs will be balanced against optimization for chromium removal

**FIGURE 5.1-7  
COPC PERIMETER  
ASSESSMENT PLAN**

GROUNDWATER REMEDY OPERATION  
AND MAINTENANCE MANUAL,  
VOLUME 2 SAMPLING AND MONITORING  
PLAN

PG&E TOPOCK COMPRESSOR STATION  
NEEDLES, CALIFORNIA

# Data Management, Documentation, and Reporting

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## 6.1 Data Validation

Data validation procedures are provided in Sections 6.3 and 6.4 of the PG&E Program Quality Assurance Program Plan (QAPP) (CH2M HILL 2012b). In summary, laboratory data will be imported into the project database and the data will be validated by the project chemist or designee. A combination of automated data validation (AutoDV) and manual validation will be performed on the project data. A data quality evaluation form will be generated for all sample results. Data quality evaluation results will be summarized and included in the quarterly progress reports to the agencies. The summary will list and discuss data that do not meet the data quality objectives specified in the QAPP, if any.

## 6.2 Data Evaluation

Analytical results will be evaluated for attainment of the RAOs presented in Section 1.1.1 and to determine remedy performance. Data evaluation summaries will be provided in quarterly progress reports following implementation of the remedy.

## 6.3 Data Management

Three types of data are expected to be collected during implementation of the remedy: field measurement/process monitoring data, onsite laboratory data, and offsite laboratory data. The management of each type of data is described below. Exhibit 6.3-1 presents a simplified data management process for the project.

### Field Measurement/Process Monitoring Data

Field measurements will be collected from the monitoring and remediation well network, the carbon amendment facilities, and the remedy-produced water conditioning plant. Measurements will be conducted in accordance with the Standard Operating Procedure (SOPs) (as described in Section 7.1), and are recorded manually in a field logbook, field sampling form, and/or process monitoring checklist, or recorded automatically by stationary or handheld data loggers and transmitted to a database using a telemetry system. Periodic field audits by experienced staff will be conducted to verify that SOPs are being followed. Equipment calibration will follow manufacturers' recommendation to ensure data quality. Manually recorded data will be entered into a field database. In addition, process monitoring and control data generated in facilities/plants will be automatically recorded into a data historian that resides in the plant control system. The data will be maintained in a database and reviewed by an experienced field staff member or chemist. Historical trends, water quality data, and well construction details will also be made available to the field crew so that anomalous data (compared to historical values) can be identified in a timely manner and field verified/corrected after consulting with an experienced scientist or chemist, as appropriate.

### Onsite Laboratory Data

Certain testing for process control monitoring will be performed at an onsite laboratory in accordance with site-specific SOPs (see Section 7.1 and Appendix A). Onsite lab measurements include Cr(VI), Cr(T), ferrous iron (Fe(II)), conductivity, turbidity, pH, nitrate, sulfate, alkalinity, total organic carbon, orthophosphate, manganese, and total dissolved solids. Additional measurements could be added in the future.

The onsite lab data will be recorded in a bench log book and entered into a spreadsheet and/or database periodically. Although the onsite data will not be validated using the same procedures as the offsite lab data, they will be reviewed, and anomalous results will be reviewed, and if needed, reanalyzed at the direction of the project chemist.

Onsite laboratory samples will periodically be analyzed in conjunction with offsite analysis, and the data will be reviewed/compared for quality and accuracy.

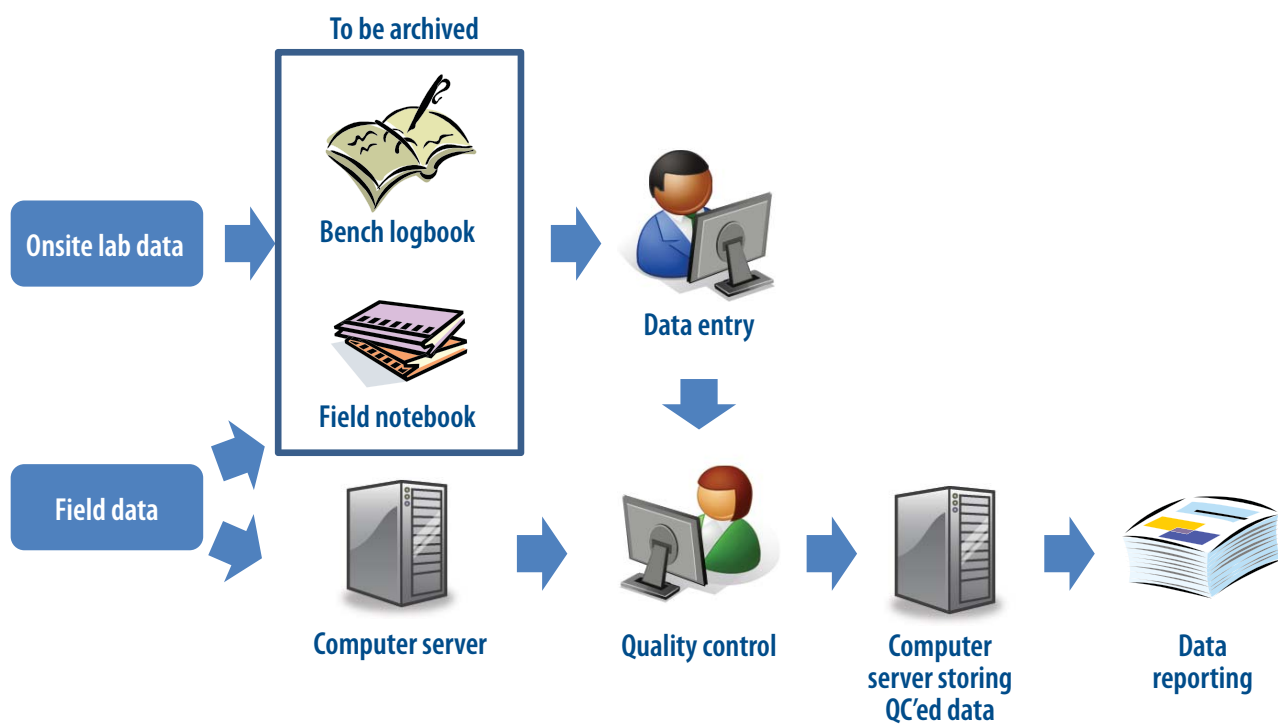
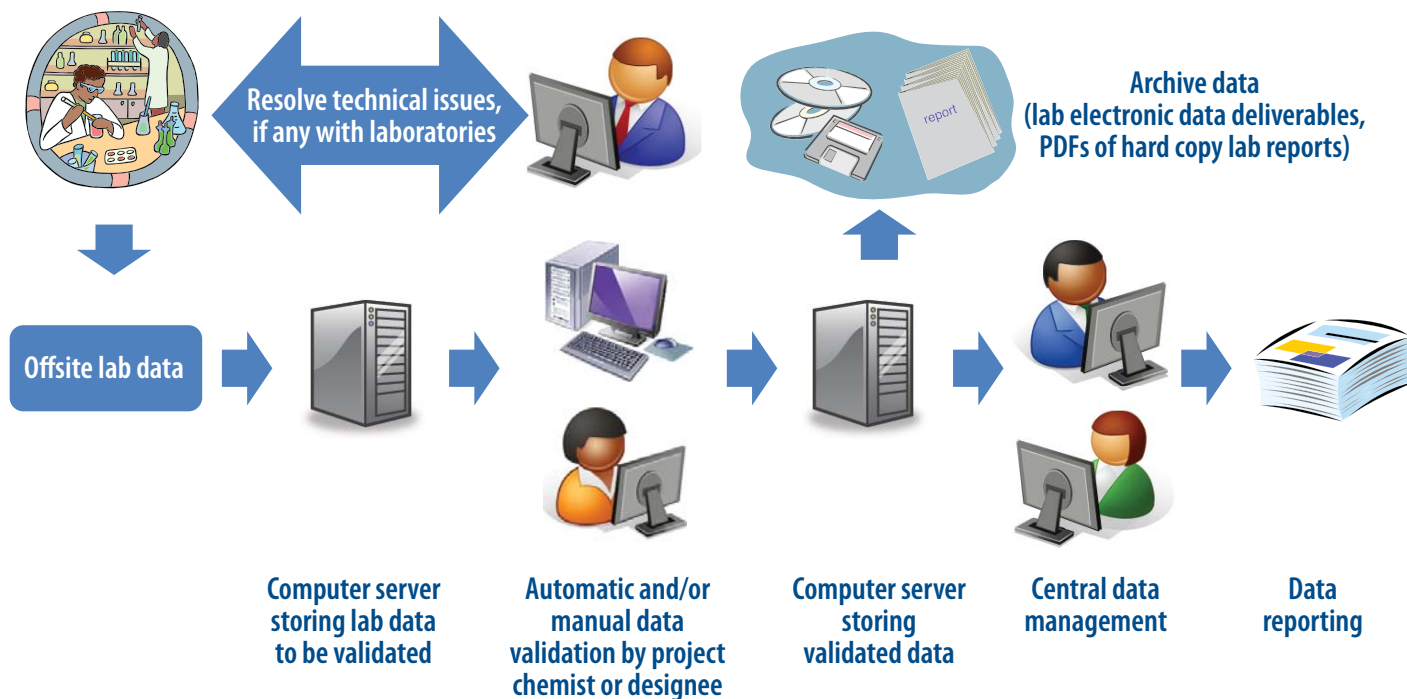


Exhibit 6.3-1  
Simplified Data Management Process  
Groundwater Remedy Operation and Maintenance Manual  
Volume 2: Sampling and Monitoring Plan  
PG&E Topock Compressor Station, Needles, California

## Offsite Laboratory Data

The data flow (electronic and hard copy) from offsite laboratory to the project chemist is tracked to ensure that the data are reviewed and validated in a timely manner. The project chemist will discuss and resolve technical issues, if any, with the laboratory. The laboratory will maintain electronic and hardcopy records sufficient to re-create each analytical event. At a minimum, the laboratory will maintain the following records:

- Raw data, including instrument printouts, bench work sheets, and chromatograms, with compound identification and quantitation reports.
- Laboratory-specific, written SOPs for each analytical method and quality assurance/quality control (QA/QC) function implemented during the analysis of project samples.

In compliance with Section XXV of the CD (DOI 2013), PG&E will maintain offsite laboratory records for 10 years following receipt of certification of completion. At the conclusion of the record retention period, PG&E will notify DOI and DTSC in writing at least 90 days prior to the destruction of any records and will provide DOI and DTSC with the opportunity to take possession of any records.

## Maintenance/Calibration Records

It is the responsibility of the plant/system operators to incorporate regular preventative maintenance into the routine work schedule based on guidelines presented in this plan, and the maintenance recommendations provided in the manufacturer's manual for each piece of equipment in the plant. Computerized maintenance management programs will be implemented at the facility, as appropriate, to keep track of maintenance requirements. In those cases, operators will access the program to determine required maintenance tasks. Records documenting completion of preventative maintenance tasks will be kept onsite.

Hardcopy and electronic versions will be archived in project files, on electronic archive tapes, and/or on other electronic storage media for the duration of remedy operation as specified below in Section 6.4. All electronic data will be subject to routine back-up until it is archived for long-term retention.

## 6.4 Recordkeeping

In compliance with Section XII of the 1996 CACA (DTSC 1996) and Section XXV of the RD/RA CD (DOI 2013), PG&E will maintain all records for 10 years following receipt of certification of completion. At the conclusion of the record retention period, PG&E will notify DOI and DTSC in writing at least 90 days prior to the destruction of any records and will provide DOI and DTSC with the opportunity to take possession of any records.

## 6.5 Reporting

In compliance with Attachment 7 of the 1996 CACA (DTSC 1996), Section XXIV and Appendix C of the CD Scope of Work and Section 5 of the RD/RA CD (DOI 2013), progress reports will be submitted monthly during RA construction and quarterly after the remedy has been implemented and demonstrated to be operating as intended. Exhibit 6.5-1 presents a quarterly report template that was developed with guidance from the *O&M Report Template for Ground Water Remedies (with Emphasis on Pump and Treat Systems)* (USEPA 2005). A monthly construction report template is included in the Construction/Remedial Action Work Plan (CH2M HILL 2014b) that is being submitted concurrently with the 90% design documents (see Exhibit 2.3-2 of the Work Plan). It is noted that the agencies may request additional information or reports as the remedy progresses.

Communications on changes to the monitoring program or operational adjustments will be communicated with the agencies in the quarterly reports (see Exhibit 6.5-1).

# PG&E Topock Compressor Station Groundwater Remediation Project

## Quarterly Progress Report for Remedy Operation and Maintenance

### [Indicate Reporting Period]



#### Table of Contents

#### 1.0 Introduction

PG&E is implementing the groundwater remedy to address chromium in groundwater at Solid Waste Management Unit (SWMU) 1/Area of Concern (AOC) 1 and AOC 10 near the Topock Compressor Station, in conformance with the requirements of the Resource Conservation and Recovery Act (RCRA) Corrective Action and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). The groundwater remedy includes:

- Construction of an In-situ Reactive Zone (IRZ) along National Trails Highway (NTH) using a line of wells that may be used as both injection and extraction wells to circulate groundwater and distribute an organic carbon source to promote bacteriological reduction of the Cr(VI) to Cr(III).
- Flushing accomplished through a combination of fresh water injection and injection of carbon-amended water in wells upgradient of the plume.
- Extraction wells near the Colorado River to provide hydraulic capture of the plume, accelerate cleanup of the floodplain, and enhance the flow of contaminated groundwater through the IRZ line.
- Bedrock extraction wells in the eastern (downgradient) end of the East Ravine to provide hydraulic capture of contaminated groundwater in bedrock.
- Institutional controls to restrict surface land uses and prevent the use of groundwater.
- Monitored natural attenuation (MNA) as a long-term component to address residual Cr(VI) that may remain in recalcitrant portions of the aquifer after enhanced in-situ treatment.

The Remedial Action Objectives (RAOs) for the groundwater remedy are to:

1. Prevent ingestion of groundwater as a potable water source having Cr(VI) in excess of the regional background concentration of 32 micrograms per liter ( $\mu\text{g/L}$ ).
2. Prevent or minimize migration of total chromium (Cr[T]) and Cr(VI) in groundwater to ensure concentrations in surface water do not exceed water quality standards that support the designated beneficial uses of the Colorado River (11  $\mu\text{g/L}$  Cr[VI]).
3. Reduce the mass of Cr(T) and Cr(VI) in groundwater at the site to achieve compliance with ARARs in groundwater. This RAO will be achieved through the cleanup goal of the regional background concentration of 32  $\mu\text{g/L}$  of Cr(VI).
4. Ensure that the geographic location of the target remediation area does not permanently expand following completion of the remedial action.

The completion criteria or performance standards for the groundwater remedy is mainly driven by RAO #3, reducing Cr(VI) concentrations throughout the plume to concentrations of 32  $\mu\text{g/L}$  or less. Attainment of the completion criteria or achievement of performance standards, Cr(VI) concentrations of 32  $\mu\text{g/L}$  or less, is intended to be applied throughout the area of contaminated groundwater. In establishing this criterion, the following are recognized:

- Attaining the cleanup criteria of 32  $\mu\text{g/L}$  Cr(VI) in groundwater may be through active remediation or through natural attenuation.
- Different areas of the plume may reach the cleanup criteria of 32  $\mu\text{g/L}$  Cr(VI) in groundwater at different times

In compliance with the 1996 CACA (Attachment 6, Part B, Section 12 and Attachment 7) and the RD/RA CD, Appendix C, Section 5 this quarterly report describes activities taken to implement the Corrective Measure/Remedial Action since last

EXHIBIT 6.5-1

#### Quarterly Progress Report Template

Groundwater Remedy Operation and Maintenance Manual

Volume 2: Sampling and Monitoring Plan

PG&E Topock Compressor Station, Needles, California

PAGE 1 OF 2

# Sampling Methods and Procedures

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Sampling and field measurements will be performed in accordance with the Standard Operating Procedures presented in Appendix A. Required sample containers, preservation requirements, sample storage, and QC methods and requirements are described in further detail in the PG&E Program QAPP (CH2M HILL 2012b) and QAPP Addendum (see Appendix B).

In continued efforts to integrate sustainability practices into remedial implementation (see Section 4 of the 90% BOD Report), trials of alternative sampling and data collection methods are being conducted at Topock to further reduce the overall sampling and project footprint and minimize potential impacts to sensitive resources (e.g., reduce trips to well sites, reduce purge water generation and management, reduce time spent at well sites, etc.). Sections 7.1 and 7.2 discuss these ongoing trial efforts. Trial results have been and will continue to be evaluated and new information incorporated into the sampling and monitoring for the final remedy, as appropriate. Additional SOPs may be developed and added to the lists below, or existing SOPs may be modified and amended. The latest version of the SOPs will be available to the sampling crews at the Operations Facility (located at the Transwestern Bench), and in project files onsite.

## 7.1 Field/On-site Lab Measurements

Field measurements will be collected in accordance with the following SOPs (included in Appendix A). Additional SOPs may be added as appropriate.

- SOP-A7 – Water Level Measurements
- SOP-A8 – Field Water Quality Measurements Using a Flow-through Cell
- SOP-A9 – Calibration of Field Instruments
- SOP-A11 – Total Depth Measurements
- SOP-A12 – Field Water Quality Measurements for Grab Samples
- SOP-A22 – Procedures for Calculation of Freshwater Equivalent Heads
- SOP-B16 – Field-Portable X-Ray Fluorescence Soil Sampling
- SOP-C1 – Solinst Pressure Transducers
- SOP-C2 – Pressure Transducer Upload to Topock Database

In addition, on-site laboratory measurements will be performed to assist with remedy process evaluation and monitoring of in-plant treatment performance (e.g., within the remedy-produced water conditioning plant); these measurements are not intended for formal reporting, but rather to provide operators with operational information to adjust or optimize system performance as needed. Only validated results from certified laboratories will be used for reporting purposes. Onsite lab measurements will be conducted in accordance with the following SOPs (included in Appendix A); additional SOPs may be added as appropriate:

- SOP-L1 – Hexavalent Chromium Analysis by Hach Method 1560
- SOP-L2 – Ferrous Iron Analysis by Hach Method 8146
- SOP-L3 – Total Chromium Analysis by Hach Method 8024
- SOP-L4 – Conductivity Analysis by Hach Method 8160
- SOP-L8 – Matrix Spike Preparation
- SOP-L9 – pH Measurement
- SOP-L10 – Hach Model 2100P Turbidimeter Calibration and Analysis Procedures
- SOP-L13 – Nitrate Analysis by Hach Method 8171
- SOP-L14 – Sulfate Analysis by Hach Method 8051
- SOP-L15 – Alkalinity Analysis
- SOP-L16 – Total Organic Carbon Analysis by Hach Method 10129
- SOP-L17 – Orthophosphate Analysis by Hach Method 8048

- SOP-L18 – Manganese Analysis by Hach Method 8149
- SOP-L19 – Total Dissolved Solids Analysis

Equipment-specific and site-specific training will initially be provided by senior on-site personnel (experienced field personnel) familiar with the necessary techniques for proper use and calibration of on-site equipment. Field personnel will be trained on the appropriate procedures by the experienced field personnel using SOPs and equipment manufacturer's manuals as primary references. Periodic audits and training will be conducted by the project manager and project chemist. This practice will continue for remedy monitoring.

### **Field versus Standard Laboratory-certified Analyses**

The following discussion is presented in response to a comment received on the 30% design document regarding comparison of field vs. laboratory measurement for Cr(VI).

The Hualapai comment stated that "Comparison of data from the Upland ISPT suggests field-analyzed Cr(VI) concentrations were greater than laboratory-analyzed Cr(VI) concentrations. This appears to be linked to high TOC concentrations in the water samples (Figure 2)." There could be many possible reasons that the subject Cr(VI) data may appear to suggest that additional reduction is occurring after field collection; however, if samples were filtered and preserved in the field, no additional reduction should occur. Regardless, based on examination of the cited data, possible reasons for the elevated field results and potential remedial solution(s) include, but are not limited to, the following:

- The samples analyzed in the field were probably not filtered and low levels of suspended matter (turbidity) caused elevated results. The remedial solution is to filter all Cr(VI) samples in the field (this will be accomplished by following SOP-L1, Hexavalent Chromium Analysis by Hach Method 1560).
- Although the field Cr(VI) colorimetric method is considered fairly robust, there is always the remote possibility of a false positive reaction occurring. The remedial solution requires identifying the issue first. Once identified, a series of steps can be performed to clarify/overcome the issue. Analyzing a matrix spike can often clarify the problem and analyzing a serial dilution can often overcome the issue. This is addressed in SOP-L1, Hexavalent Chromium Analysis by Hach Method 1560.
- If the samples collected for laboratory analysis were not field filtered and preserved, there is a possibility of further reduction prior to the analysis. The remedial solution is to follow SOP A6, Sample Field Filtration and Preservation for Metals Analyses and follow proper transport and storage procedures.

As for the Technical Review Committee (TRC) comment regarding "Other potentially unstable constituents," because sulfide ( $S^{2-}$ ) is so unstable in the environment and is difficult to use in a systematic way, it will not be used for monitoring the remedial system on a regular basis and will primarily be a field analysis if used for "additional knowledge." However, if preserved at the time of collection, it can be transported to a lab for analysis without additional reactions occurring. Unlike Cr(VI) and  $S^{2-}$ , Fe(II) cannot be preserved and has a very short holding time. However, by filtering and preserving the sample we remove all the ferric iron Fe(III) (primarily found in a solid form) and only have Fe(II) remaining, thus allowing Fe(II) to easily be transported and analyzed in the lab.

### **Data Telemetry System**

To reduce the sampling footprint and minimize potential impacts to sensitive resources, trials of data telemetry systems have been conducted at Topock since 2011 with an eye towards integration into remedial implementation (see Exhibit 7.1-1). Telemetry systems can provide near-real-time access to data with data transmission intervals as short as one minute via cellular or satellite signals. Units can generate email alerts when user-defined minimum or maximum parameters, such as temperature or pressure, are exceeded or if a system fails to transmit data according to schedule. The trial consists of five telemetry units from two separate manufacturers deployed at five different well cluster locations on the site. Three of the units are from YSI's EcoNet remote telemetry line of devices while the remaining two are Solinst STS-9100 telemetry devices. All five





EXHIBIT 7.1-1  
**Pictures of Telemetry Units Used During Trial**  
*Groundwater Remedy Operation and Maintenance Manual  
Volume 2: Sampling and Monitoring Plan  
PG&E Compressor Station, Needles, California*

telemetry systems are solar-powered. While the current telemetry trial includes only these devices, additional systems or sensors may be added in the future due to the rapidly evolving nature of telemetry technology. In addition to water level measurement transducers, the ongoing trial is testing telemetry of other in-well water quality data relevant to in-situ remediation. A multi-parameter water quality probe has been used for in-well measurements when not in use above-ground for water quality measurement during well purging. This “sonde” type probe fits inside 2-inch monitoring wells or in flow-through cells and measures specific conductance, dissolved oxygen, ORP, and pH, as well as measuring temperature and pressure like typical water level transducers.

To date, the telemetry system trial has demonstrated success in:

- Automating the data retrieval process, allowing for efficient data collection, management, and access
- Reducing field labor, on-site footprint and fuel use, and activity in the vicinity of floodplain nesting habitat (because telemetry-equipped wells are accessed for quarterly salinity profiling or as-needed equipment maintenance, not for routine manual downloads)
- Increasing data quality/reliability (because transducer equipment failure is evident from telemetry data, rather than detected only after weekly or monthly manual downloads)
- Compatibility with existing and planned future infrastructure
- Use of various power source options, including solar-charged 12V marine batteries which minimize the amount of conduit runs and the number of field visits for battery maintenance
- Blending in with the natural surroundings so as to minimize visual impact to the site

## 7.2 Surface Water, Groundwater, and Process Water Sampling

Surface water, groundwater, and process water sampling will be performed in accordance with the following SOPs (included in Appendix A) (note that SOP-A7, SOP-A8, SOP-A9, and SOP-A11 are listed above in Section 7.1 and are also applicable to surface water/groundwater/process water sampling). Additional SOPs may be added as appropriate.

- SOP-A1 – Purging and Sampling of Groundwater Monitoring Wells, Well-Volume Method
- SOP-A2 – Purging and Sampling of 1-inch-diameter Groundwater Monitoring Wells, Modified Well-Volume Method
- SOP-A3 – Purging and Sampling of Active and Inactive Water Supply Wells
- SOP-A4 – Depth-Specific Surface Water Sampling (supersedes SOP-A12)
- SOP-A5 – Groundwater Sampling from Sonic Drilling Boreholes
- SOP-A6 – Sample Field Filtration and Preservation for Metals Analyses
- SOP-A10 – Decontamination of Water Sampling Equipment
- SOP-A13 – Spill Prevention, Containment, and Control Measures for Monitoring Well Sampling
- SOP-A14 – Pore Water Sampling
- SOP-A16 – Access Routes
- SOP-A17 – Groundwater and Surface Water Mobile Integrated Sample Tracking
- SOP-A18 – Purging and Sampling of Groundwater Wells Minimal Drawdown Method
- SOP-A19 – Sampling of Groundwater Monitoring Wells Hydrasleeve No Purge Method
- SOP-A23 – Sample Handling and Custody

- Remedy-SOP-01 – Process Water Sampling
- Remedy-SOP-02 – Safe Fueling and Fuel Handling Policy

In continued efforts to integrate sustainability practices into remedial implementation (see Section 4 of the 90% BOD Report), PG&E has conducted a trial of alternative groundwater sampling approaches at Topock to further reduce the overall sampling footprint (e.g., reduce purge water generation and management, reduce time spent at each well, minimize potential impacts to sensitive resources) while maintaining or increasing data quality.

The trial began in third quarter 2012 (September) and continued through first quarter 2013; it involves testing of two alternative sampling approaches at 18 site wells: the no-purge HydraSleeve™ sampling system and the minimal drawdown (low flow purging) sampling technique. Additional information about these two approaches can be found in numerous publications and public websites including but not limited to the following:

- HydraSleeve™ sampling system ([www.hydrasleeve.com](http://www.hydrasleeve.com)): A joint study completed by the U.S. Army Corps of Engineers, the Air Force Center for Environmental Excellence and the Air Force Real Property Agency in 2005 (Parsons 2005)
- Minimal drawdown (low flow purging or micro-purge) sampling technique: USEPA guidance on sampling procedures including the *Groundwater Issue Paper: Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures* (Puls and Barcelona 1996) and the *Groundwater Sampling Guidelines for Superfund and RCRA Project Managers* (USEPA 2002)

Trial results were compared to the current standard three-volume purge technique, and evaluated for use in monitoring of the final groundwater remedy. The 2013 Annual Groundwater Monitoring Report (CH2M HILL 2014a; available on the project website at <http://dtsc-topock.com/>) presented the trial results (see Recommendations section and Appendix H) along with detailed correlations between the two alternative sampling methods and the current three-volume purge method.

Based on the trial results, PG&E recommended to DTSC the use of micro-purge as the default sampling method for the existing groundwater monitoring and compliance monitoring programs. While micro-purge was recommended for groundwater/compliance monitoring, HydraSleeve and other grab sampling methods are also seen as useful tools for process monitoring during remedy implementation. DTSC completed review of PG&E's recommendations on June 26, 2014, and approved the use of micro-purge techniques for wells with screen length of up to 20-foot saturated thickness in alluvial and fluvial sediments (upland and floodplain locations) (DTSC 2014). Additional trials using alternative sampling techniques will be conducted at monitoring wells with 30- to 50-foot screen lengths, and at bedrock open borehole wells located in TCS or the East Ravine. Implementation of the micro-purge technique commenced in the third quarter of 2014. SOPs associated with these alternative techniques have been included in Appendix A.

## 7.3 Sample Containers, Preservation, and Storage

The contracted analytical laboratory will provide the required sample containers for all samples including QC samples. All containers will have been cleaned and certified free of the analytes of concern for this project. No sample containers will be reused. The contracted laboratory will add preservatives, if required, prior to shipping the sample containers to the field or supply the preservative as appropriate. The laboratory, upon receipt of the samples, will verify and record the adequacy of preservation and will add additional preservative, if necessary.

The containers, minimum sample quantities, required preservatives, and maximum holding times for many parameters are shown in Table 7.3-1. Table 7.3-1 includes a list of sample containers, preservation, and holding times for analytes anticipated to be monitored during operation and maintenance of the remedy (see Sections 2 through 4).

## 7.4 Sampling Documentation and Shipment

Pre-preserved sample containers will be received from the laboratory. The laboratory markings will indicate the type of preservative in the container. The date and time of sampling and the initials of the sampler will be recorded on the pre-printed label immediately prior to collection. The waterproof labels will be placed carefully on the proper container, and if waterproof labels are unavailable, they will be secured using clear tape to protect the label. When shipping samples using a freight carrier such as Federal Express, the ice used in shipping containers will be double-bagged and laser printed labels and indelible ink pens will be used to complete sample labels to ensure that the samples arrive at the laboratory dry and appropriately marked. If a laboratory courier is used, no bagging of ice is necessary. Vital information regarding the collection of each sample will be recorded in a field logbook, field sampling form, and/or chain-of-custody (CoC) form, as appropriate.

Logbooks will be bound with consecutively numbered pages. All entries will be legibly written in black or blue ink and signed and dated by the individual making the entries. Factual and objective language will be used. All entries will be complete and accurate to allow reconstruction of each field activity. A line will be placed through any portion of a field notebook that is unused. One line strike-through will be used to show corrections to entries. The strike-through will be initialed and dated. No correction fluid will be used. The following information for each sample will be recorded in the field logbook, field sampling form, or CoC form, whichever is appropriate:

- Sampling location and description (sketch and measured distances from reference points will be recorded if there is no established identification for the sample location)
- Sample ID
- Sampler's name
- Date and time of sampling
- Sample designation (e.g., composite, grab, etc.)
- Sample matrix
- Type and ID of sampling equipment
- Field measurement data (e.g., pH, temperature, conductivity)
- Field observations that may be relevant to the analysis or sample integrity (e.g., odor, color, and weather conditions)
- Associated QC blanks
- Shipping details (if the laboratory is providing courier service, the courier must sign and date the CoC forms; copies of the signed CoC forms should be transmitted to the office as soon as practical; if FedEx, UPS, or other courier is used, include shipping information for each shipment)
- Destination laboratory

Sample coolers will be transported to the laboratory immediately after sample collection. An overnight courier may be used to transport the samples. Intermediate stops will be avoided, except for emergencies, in which case the situation will be noted in the field notebooks. The laboratory will be notified that samples are being shipped.

## 7.5 Quality Control

Laboratory QC checks indicate the state of control that prevailed at the time of sample analysis. QC checks that involve field samples, such as matrix and surrogate spikes and field duplicates, also provide an indication of the presence of matrix effects. Field-originated blanks provide a way to monitor potential contamination that field samples are subjected to. The QAPP and QAPP Addendum specify requirements for method blanks, laboratory control samples (LCSs), surrogate spikes, and matrix spike/matrix spike duplicates (MS/MSDs) that must be followed by subcontracting laboratories.

A laboratory QC batch is defined as a method blank, LCS, MS/MSD, or a sample duplicate (depending upon the method) and 20 or fewer environmental samples of similar matrix that are extracted or analyzed together. For gas chromatography/mass spectrometry volatile analyses, a method blank, LCS, and MS/MSD must be analyzed in each 12-hour calibration period. The number of environmental samples allowed in the laboratory QC batch is defined by the remaining time in the method-prescribed 12-hour calibration period divided by the analytical run time. Each preparation or analytical batch will be identified in a way that will associate environmental samples with the appropriate laboratory QC samples.

The laboratory will maintain a quality assurance manual or equivalent document. The manual will include all of the requirements provided in the California Environmental Laboratory Accreditation Program (ELAP), and, if applicable, the National Environmental Laboratory Accreditation Program (NELAP).

The laboratory will also maintain SOPs for all analytical methods and laboratory operations. The format for SOPs will conform with the following:

- *Test Methods for Evaluating Solid Waste, Physical and Chemical Methods, SW-846, Third Edition, Update III, Section 1* (USEPA 1996)
- “Good Laboratory Practices” in *Principles and Guidance to Regulations for Ensuring Data Integrity in Automated Laboratory Operations* (USEPA 1995)

All SOPs will have a unique identification number that is traceable to previous revisions of the same document.

TABLE 7.3-1  
**Sample Containers, Preservation, and Holding Times**  
*Groundwater Remedy Operation and Maintenance Manual*  
*Volume 2: Sampling and Monitoring Plan*  
*PG&E Topock Compressor Station, Needles, California*

Analyte	Method	Container and Minimum Quantity		Preservation	Holding Time
		Water	Soil/Sediment		
Metals (except hexavalent chromium)	SW6010B, SW6020A, EPA200.7, EPA200.8, SM3120B, EPA245.1, SW7000 series methods	1-liter P or G	8-oz P, G, or T	Water: Add HNO <sub>3</sub> to pH<2; soil/sediment: None	28 days for mercury; 180 days for all others
Hexavalent Chromium	SW7199	Not applicable	4-oz P, G, or T	Soil/sediment: Chill to 4°C (±2°C)	Soil: 30 days to extraction, 7 days to analysis
Hexavalent Chromium	EPA218.6	250-mL P	Not applicable	Chill to ≤6°C Laboratory or field filtration within 24 hours. After filtration adjust the pH to 9–9.5 by adding (NH <sub>4</sub> ) <sub>2</sub> SO <sub>4</sub> /NH <sub>4</sub> OH buffer solution	28 days
Hexavalent Chromium	SM3500-Cr B	250-mL P	Not applicable	Chill to ≤6°C Laboratory or field filtration within 24 hours. After filtration adjust the pH to 9–9.5 by adding (NH <sub>4</sub> ) <sub>2</sub> SO <sub>4</sub> /NH <sub>4</sub> OH buffer solution	28 days
Pesticides	SW8081A or B	Two 1-liter Amber G	8-oz G or T	Chill to 4°C (±2°C)	Water: 7 days to extraction; 40 days to analysis Soil: 14 days to extraction; 40 days to analysis 90 days to extraction if frozen to -10°C (±2°C)
VOCs	SW8260B or C Preparation methods: SW5035B (Soil) SW5030B (Water)	Three 40-mL G-TLC	Three 40-mL G-TLC	Water: Add HCl to pH<2; chill to 4°C (±2°C) Soil/sediment: Chill to 4°C (±2°C) or: <ul style="list-style-type: none"> <li>Frozen in 48 hours</li> <li>Frozen onsite</li> <li>Sodium bisulfate</li> <li>Methanol</li> </ul>	Water: 14 days (preserved); 7 days (unpreserved) Soil: 48 hours unless preserved with 48 hours 14 days if solid samples preserved by the following methods: <ul style="list-style-type: none"> <li>4°C/frozen in 48 hours</li> <li>Frozen onsite</li> <li>Sodium bisulfate</li> <li>Methanol</li> </ul>

**TABLE 7.3-1**  
**Sample Containers, Preservation, and Holding Times**  
*Groundwater Remedy Operation and Maintenance Manual*  
*Volume 2: Sampling and Monitoring Plan*  
*PG&E Topock Compressor Station, Needles, California*

Analyte	Method	Container and Minimum Quantity		Preservation	Holding Time
		Water	Soil/Sediment		
Herbicides	SW8151A	Two 1-liter Amber G	8-oz G or T	Chill to 4°C (± 2°C)	Water: 7 days to extraction; 40 days to analysis Soil: 14 days to extraction; 40 days to analysis
PAH	SW8270SIM	Two 1-liter Amber G	8-oz G or T	Chill to 4°C (±2°C)	Water: 7 days to extraction; 40 days to analysis Soil: 14 days to extraction; 40 days to analysis
Ammonia	EPA350.1 Revision 2 or SM4500-NH3	1-liter P or G	4-oz P, G, or T	Water: Add H <sub>2</sub> SO <sub>4</sub> to pH<2; chill to ≤6°C Soil/sediment: 4°C (±2°C)	Water: 28 days Soil: Not available
Anions	EPA300.0 or SM4500	500-mL P or G	4-oz P, G, or T	Chill to ≤6°C (none required for chloride and fluoride) Ortho-Phosphate requires filtering within 15 minutes after sample collection	Bromide, chloride, fluoride, sulfate, and iodide in 28 days Nitrate and ortho-Phosphate in water 48 hours
Alkalinity (total, bicarbonate, carbonate, hydroxide)	EPA310.2 or SM2320 B	500-mL P or G	Not applicable	Chill to ≤6°C	14 days
TDS	SM2540 C	500-mL P or G	Not applicable	Chill to ≤6°C	7 days
TSS	SM2540 D	500-mL P or G	Not applicable	Chill to ≤6°C	7 days
Turbidity	EPA180.1 Revision 2 or SM2130	500-mL P or G	Not applicable	Chill to ≤6°C	48 hrs
Specific Conductance	EPA120.1 Revision 1, or SM2510 SW9050	500-mL P or G	4-oz P, G, or T	Chill to ≤6°C Soil/sediment: Chill to 4°C (±2°C)	28 days
pH	SM4500H+B or SW9040	500-mL P or G	4-oz P, G, or T	Chill to ≤6°C	15 minutes
TOC/DOC	SM 5310 C	500-mL G or 40-mL VOA	4-oz P, G, or T	Water: For 500-ml: Add H <sub>2</sub> SO <sub>4</sub> to pH<2; chill to ≤6°C For 40-mL VOA: Add H <sub>2</sub> PO <sub>4</sub> to pH<2; chill to ≤6°C	28 days
TOC	Walkley Black	Not applicable	4-oz P, G, or T	Chill to ≤6°C	28 days
Sulfide	SM4500-S <sup>2</sup>	500-mL P or G	Not applicable	Add zinc acetate and NaOH to pH>9, chill to ≤6°C	7 days



TABLE 7.3-1

**Sample Containers, Preservation, and Holding Times**

*Groundwater Remedy Operation and Maintenance Manual  
Volume 2: Sampling and Monitoring Plan  
PG&E Topock Compressor Station, Needles, California*

Analyte	Method	Container and Minimum Quantity		Preservation	Holding Time
		Water	Soil/Sediment		
Ferrous Iron (Fe +2)	SM3500D	500-mL P or G	Not applicable	Chill to ≤6°C	24 hours
Dissolved Silica	EPA200.7 or SM4500-Si or SM3120 B	500-mL P only	Not applicable	Chill to ≤6°C	28 days
18O and deuterium	Laboratory SOP (continuous flow mass spectrometer [CF-IRMS])	100-mL P or 40-mL VOA	Not applicable	Chill to ≤6°C	6 months
Cyanide	EPA335.4 (R1) or SM4500-CN C/D/E (water)	500-mL P or G	4-oz P, G, or T	Water: Add NaOH to pH>12; chill to ≤6°C	Water and soil: 14 days
	SW9010B, SW9012, or SW9014 (soil)			Soil/sediment: Chill to 4°C (±2°C)	

**Notes:**

>	= greater than	NH <sub>4</sub> OH	= ammonium hydroxide
<	= less than	(NH <sub>4</sub> ) <sub>2</sub> SO <sub>4</sub>	= ammonium sulfate
≤	= less than or equal to	oz	= ounce
DOC	= dissolved organic compounds	P	= polyethylene
G	= glass	PAH	= polynuclear aromatic hydrocarbons
G-TLC	= glass with Teflon lined cap	SIM	= selected ion monitoring
H <sub>2</sub> PO <sub>4</sub>	= phosphoric acid	SO <sub>4</sub>	= sulfate
H <sub>2</sub> SO <sub>4</sub>	= sulfuric acid	T	= brass sleeves in the sample barrel (sometimes called California brass)
HCl	= hydrochloric acid	TDS	= total dissolved solids
HNO <sub>3</sub>	= nitric acid	TOC	= total organic compounds
mL	= milliliters	TSS	= total suspended solids
NaOH	= sodium hydroxide	VOA	= volatile organic analytic
NH <sub>4</sub>	= ammonium	VOC	= volatile organic compound

Source: CH2M HILL. 2012b. *PG&E Program Quality Assurance Project Plan*. Revision 2. August.

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**Appendix A**  
**Standard Operating Procedures for Groundwater,  
Surface Water, and Process Water Sampling**

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# SOPs for Groundwater, Surface Water, and Process Water Sampling

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This appendix contains the following SOPs for the Final Groundwater Remedy at Topock Compressor Station:

- Remedy-SOP-01 – Process Water Sampling
- Remedy-SOP-02 – Safe Fueling and Fuel Handling Policy
- SOP-A1 – Purging and Sampling of Groundwater Monitoring Wells, Well-Volume Method
- SOP-A2 – Purging and Sampling of 1-inch-diameter Groundwater Monitoring Wells, Modified Well-Volume Method
- SOP-A3 – Purging and Sampling of Active and Inactive Water Supply Wells
- SOP-A4 – Depth-Specific Surface Water Sampling (supersedes SOP-A12)
- SOP-A5 – Groundwater Sampling from Sonic Drilling Boreholes
- SOP-A6 – Sample Field Filtration and Preservation for Metals Analyses
- SOP-A7 – Water Level Measurements
- SOP-A8 – Field Water Quality Measurements Using a Flow-through Cell
- SOP-A9 – Calibration of Field Instruments
- SOP-A10 – Decontamination of Water Sampling Equipment
- SOP-A11 – Total Depth Measurements
- SOP-A12 – Field Water Quality Measurements for Grab Samples
- SOP-A13 – Spill Prevention, Containment, and Control Measures for Monitoring Well Sampling
- SOP-A14 – Pore Water Sampling
- SOP-A16 – Access Routes
- SOP-A17 – Groundwater and Surface Water Mobile Integrated Sample Tracking
- SOP-A18 – Purging and Sampling of Groundwater Wells Minimal Drawdown Method
- SOP-A19 – Sampling of Groundwater Monitoring Wells Hydrasleeve No Purge Method
- SOP-A22 – Procedures for Calculation of Freshwater Equivalent Heads
- SOP-A23 – Sample Handling and Custody
- SOP-B16 – Field-Portable X-Ray Fluorescence Soil Sampling
- SOP-C1 – Solinst Pressure Transducers
- SOP-C2 – Pressure Transducer Upload to Topock Database
- SOP-L1 – Hexavalent Chromium Analysis by Hach Method 1560
- SOP-L2 – Ferrous Iron Analysis by Hach Method 8146
- SOP-L3 – Total Chromium Analysis by Hach Method 8024
- SOP-L4 – Conductivity Analysis by Hach Method 8160
- SOP-L8 – Matrix Spike Preparation
- SOP-L9 – pH Measurement
- SOP-L10 – HACH Model 2100P Turbidimeter Calibration and Analysis Procedures
- SOP-L13 – Nitrate Analysis by Hach Method 8171
- SOP-L14 – Sulfate Analysis by Hach Method 8051
- SOP-L15 – Alkalinity Analysis
- SOP-L16 – Total Organic Carbon Analysis by Hach Method 10129
- SOP-L17 – Orthophosphate Analysis by Hach Method 8048
- SOP-L18 – Manganese Analysis by Hach Method 8149
- SOP-L19 – Total Dissolved Solids Analysis

# Standard Operating Procedure

## PG&E Topock Groundwater Remedy

### Operation and Maintenance Plan

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Title: Process Water Sampling

Number: Remedy-SOP-01\_Rev0

Created Date: June 19, 2012

## 1 Background and Scope

Pacific Gas and Electric Company (PG&E) is implementing a groundwater remedy near the intersection of Park Moabi Road and Interstate 40, approximately 12 miles southeast of Needles, California at the PG&E Topock Compressor Station (TCS). This standard operating procedure (SOP) addresses the procedures to be used for collection of process water samples from the groundwater remediation system.

## 2 Required Documents

1. Event-specific sampling and analysis plan (SAP), work plan, or field instructions.
2. Applicable project work plan, monitoring plan, quality assurance project plan (QAPP), and/or Operation and Maintenance (O&M) Manual.
3. Topock Program Health and Safety Plan (HSP).
4. Blank sampling log and field notebook.

## 3 Preparation, Setup, and Sampling Procedures

1. Review event-specific SAP or event-specific field instructions, O&M Manual, and HSP.
2. Review sampling procedures and equipment and planned sample ports with field crew.
3. Inventory sample bottles, review required analyses, and understand lab courier schedule.
4. Prepare sampling log (use field notebook and summarize relevant information on sampling form).
5. Gather sample containers and equipment and mobilize to the first sample location.
6. Open the sampling port and allow enough water to flow to flush the 'off main pipe'.
7. Remove the cap of the sample container and collect the sample. Continue one container at a time, beginning with the containers for metals [including Cr(VI) and Cr(T)] and then the containers for general chemistry parameters.
8. After all containers for that sampling location have been filled, complete the sampling log sheet.
9. Repeat steps 5 through 8 for each sampling location.

Refer to the O&M Manual for sample handling and management, equipment decontamination, and waste management procedures.

# Standard Operating Procedure

## PG&E Topock Groundwater Remedy

### Operation and Maintenance Plan

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Title: Safe Fueling and Fuel Handling Policy

Number: Remedy-SOP-02\_Rev0

Created Date: July 15, 2013

## 1 Background and Scope

Pacific Gas and Electric Company (PG&E) is implementing a groundwater remedy near the intersection of Park Moabi Road and Interstate 40, approximately 12 miles southeast of Needles, California at the PG&E Topock Compressor Station (TCS). The objective of this Standard Operating Procedure (SOP) is to describe the policy required to refuel vehicles, fuel tanks, and equipment/portable containers safely during work on and off the project site.

## 2 Approvals

Each vendor/contractor must obtain approval from PG&E Topock Site Operations Manager, and or Sr. Environmental Inspector of a) the planned fueling and re-fueling methods for the contracted activities to be performed at the site, and b) the commercial fuel supplier prior to first use for contracted activities.

## 3 Safety Guidelines During Fueling Operations

PG&E requires all vendors/contractors to follow appropriate procedures during fueling/refueling activities in order to avoid spills and incidents. The following general guidelines will be followed unless pre-approved otherwise:

### Preparation, Pre-Fueling and Fueling Guidelines

- Turn off all equipment or engines before refueling.
- When fueling at a pump, remain attentive to the fuel nozzle.
- When not fueling at a fixed pump, stage splash pad containment as needed.
- Identify and locate fire extinguisher prior to fueling.
- Do not become distracted while fueling by electronic devices, reading materials, or conversations with bystanders.
- Use only UL-approved containers for portable gasoline storage cans.
- When filling a portable container, always place the container on level ground and keep the pump nozzle in contact with the container when refueling to avoid a static electricity ignition of fuel vapors. Fill slowly to avoid spillage and skin/clothing contact and use a funnel if needed.
- When fueling from a portable container, stage splash containment as needed.
- Only store fuel in locations approved by PG&E, and never near any ignition sources.



- In the event of a fire, make use of fire extinguisher that is available. If fire cannot be contained, relocate yourself to a safe location and call 911.

#### General Remote Fueling Considerations

- Position the fuel supply source as close to the equipment to be fueled as is practicable and safe.
- Inspect fuel conveyance hose/equipment and all connections and fittings for signs of wear or defects prior to the initiation of fuel pumping or pouring. If pouring fuel from a portable container, a funnel constructed of suitable material must be used to avoid splashing.
- Stage splash containment and fire extinguisher as needed.
- Ensure the area is free from ignition sources (i.e., hot equipment/work, sources of spark or static electricity).
- Once fueling is complete, deactivate the fuel supply pump prior to removing the fill nozzle from the equipment, and ensure that residual fuel has been emptied from the conveyance hose (as appropriate based on design of the equipment used).
- Inspect work area for any signs of spills, and remove spill pad(s), as appropriate.

### 3 Communication and Contingency Action

If a spill occurs the appropriate clean-up actions should commence as efficiently and safely as possible. Use a natural fiber push broom and/or a spark resistant shovel or scoop.

In addition, the reason for the spill will be investigated, and the team will modify the fueling procedure or conduct equipment repairs as determined appropriate to minimize the potential for future spills. Further, PG&E Site Operations Manager/Sr. Environmental Inspector must be notified immediately.

### 4 Waste Management

All waste generated during refueling, such as oily absorbent pads, must be transported and disposed of as directed by PG&E immediately following generation. Do not dispose of any oil/fuel contaminated pads or rags in the soil roll-off bins or waste dumpsters.

## **SOP-A1**

### **Purging and Sampling of Groundwater Monitoring Wells**

#### **Well-Volume Method**

### **Standard Operating Procedures for PG&E Topock Program**

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This standard operating procedure (SOP) addresses the procedures and equipment to be used for purging and sampling all groundwater monitoring wells at the Topock site with casing diameters in excess of 1-inch. This SOP will be used for sampling groundwater monitoring wells using a dedicated electric submersible pump with a single discharge rate, a dedicated electric pump with a controllable discharge rate, or a portable electric pump with a controllable discharge rate. A peristaltic pump or inertial pump (Waterra or similar) can be used if an electrical submersible pump is not appropriate. A well-volume based purging and sampling method will be used for these wells. This SOP does not apply to FLUTe wells, or Blatypus pump equipped wells (MW-58BR). Those wells will be sampled according to the relevant Field Activities Work Plan (available from on-site field coordinator).

#### **REQUIRED DOCUMENTS:**

- Event-specific planned sample table (PST).
- Applicable project work plan or monitoring plan. Refer to Topock Program Sampling, Analysis, and Field Procedures Manual and QAPP (Procedures Manual), Operation and Maintenance Manual (O&M Manual), as required.
- Topock Program Health and Safety Plan (HSP)
- Applicable SOP's
- Well construction logs/specifications
- Mobile Integrated Sample Tracking (MIST) handheld database
- Previous sampling logs or tabular historic field data tables
- Current site access map
- Blank sampling logs, maps, sample labels, chains of custody (COC's), and the designated groundwater sampling field notebook

#### **REQUIRED EQUIPMENT:**

- 2 or more (i.e. one is backup) YSI-556 WQ instruments with flow through cells, or equivalent.
- Hach 2100P turbidimeter or equivalent.
- 200 foot (or longer as needed) water level indicator (WLI).
- Trimble Rugged Reader hand held instrument for MIST data collection.
- Two, 200 gallon capacity purge tanks.

- Utility vehicles (UTV's) as necessary.
- Back-up 2-inch pump and controller.
- Honda 2000 watt generator or alternate power source.

#### **PREPARATION & SETUP:**

- Review event-specific PST or event-specific field instructions, previous sampling logs, Procedures Manual, HSP, and groundwater sampling supplies and equipment check list. (NOTE: the PST should also be reviewed for required “non-analytical event activities” such as water level measurements or other data collection that is planned in association with the groundwater sampling event).
- Acquire the existing field logbook for groundwater sampling and initiate entries.
- Inspect all equipment and verify that the field water quality (WQ) meters have been calibrated prior to use according to the manufacturer's instructions and SOP-A9, *Calibration of Field Instruments*.
- Inventory sample bottles, build sample sets for the required analytes at each sample location, ensure a sufficient supply of lab de-ionized water for equipment blanks, and confirm the lab courier schedule.
- Field-check sampling equipment and supplies: water level indicator (WLI), WQ meters, flow-through cell, pump controller, power supply, pump discharge/sampling tubing, N-dex gloves, D.I water sprayers, 5 gallon buckets, paper towels, 0.45 micron in-line filters, etc.

#### **FIELD PROCEDURES:**

- **Prior to opening any monitor well, remove all pens, lighters, calculators, or any other loose items from vest pockets, or from any other location where they could fall into the well.**
- Upon arrival at the monitoring well, at least 2 members of the sampling team must confirm the well ID. Wells should be clearly marked on the well monument. If the well cannot be positively identified by the marking, measure total depth of the well and compare to the well installation details to confirm the correct location. Report worn or unclear well markings to the on-site field coordinator.
- Place spill containment according to SOP A-13, *Spill Prevention, Containment, and Control Measures for Monitoring Well Sampling*.
- Collect an “EB”, equipment blank, ***prior to pump installation*** if necessary according to the PST.
- Open the protective casing lid and, ***prior to moving it***, note the exact configuration of the transducer installation if present. Measure static WL according to SOP-A7, *Water level Measurements*, moving the transducer if necessary, and record WL value in MIST and on the sampling log.

- If the well is equipped with a transducer and does not have a dedicated pump installed, remove the transducer from the well according to SOP-C1, *Solinst Pressure Transducers*.
- If the well does not have a dedicated pump installed, but does have dedicated sample tubing, attach the dedicated tubing to the appropriate pump and install decontaminated pump at the same intake/sampling depth as used in prior events. There is a marking on the purge tubing which corresponds with the monitor well top of casing (TOC) to facilitate this requirement. Purge and sample the well as described below.
- If the well does not have a dedicated pump *or* tubing, or has not been previously sampled, use new low-density polyethylene tubing and install the pump with the intake 15 feet below the surface of the static water column, or at the depth prescribed by the Project Manager (PM) or Field Team Manager (FTM), and record the intake depth in MIST and on the field data sheet. Purge and sample the well as described below.
- If the well *does* have a dedicated pumping system, connect the discharge tubing and purge and sample the well as described below.
- Collect daily equipment blanks and duplicate samples as required by the PST and instructed by the field team leader.

#### **PURGING AND SAMPLING PROCEDURES:**

- Prepare the groundwater sampling log. Use the static water level and the total depth provided on the field data sheet and in the PST to calculate the volume of one casing of standing water in the well.
- Calculate 3 casing volumes for the minimum required purge amount and record on sampling log.
- Evaluate previous purge rates, amount of drawdown, stability of field parameters, and total purge volume prior to sample collection from previous sampling records and historical data tables (Appendix B of *Monitoring Plan for Groundwater and Surface Water Monitoring Program*). If the well has not been previously sampled, estimate the expected purge rate using previous sampling information from nearby wells.
- If the pumping rate is in excess of one gpm, install the provided flow splitter so that the pumping rate does not need to be decreased to collect the sample. If the flow rate is at two gpm or above, install a second flow splitter to control the flow through the flow through cell.
- Install the pump as previously described. Immediately after installation, stuff a large trash bag, or place another barrier into the well bore around the pump discharge tubing. This will help to prevent foreign objects from falling into the well.
- Ensure that all tubing connections are properly tightened and then start the pump. Check for any leaks, monitor drawdown, and calculate/set the purge rate. The purge rate can be determined using the fill-time of a graduated container, or using a flow meter if available. The well specific purge rate and pump setting should be available on the previous purge form. Record pump setting (i.e. hertz) on sampling log if available.
- Purge water should be contained in a portable purge water storage tank. If approved by well owner and the governing regulatory agencies, water may be discharged directly to

the ground (this presently applies to PM-03 and PM-04 water supply wells), as directed by the FTM.

- Continue purging, measuring WL and field indicator parameters periodically (time, pH, conductivity, turbidity, dissolved oxygen, temperature, salinity, TDS, ORP, appearance, and any odors present). Time the readings such that there are a minimum of 4 sets of data collected over the course of the full purge.
- If significant drawdown is observed or turbidity increases dramatically, decrease the purge rate and measure/record new purge rate. Significant drawdown is considered to be 5 percent of the total height of the water column or to the top of screen. Record time for all measurements collected. Note and provide qualifying remarks if parameter readings are anomalous or unstable due to instrument problems and change out the instrument.
- During the purge, compare the field parameters to historical purge data. If the parameters are significantly different (greater than 50% difference for SC, pH, and/or ORP) re-confirm the ID of the well. If the well ID is re-confirmed by 2 crew members, and the readings continue to be significantly different than prior readings, set up a second WQ instrument in series to confirm readings. If the anomalous readings are confirmed by the second instrument, contact the field coordinator to resolve the issue. If the second WQ instrument produces readings that are comparable to historic values, note an instrument change and use the second instrument's readings.
- Continue purging until **3-casing volumes** have been removed *and* field parameters stabilize. Indicator parameters are considered stabilized when 3 consecutive readings made several minutes apart fall within the following EPA stabilization criteria:
  - pH +/- 0.1 pH units
  - Specific conductance +/- 3%
  - ORP +/- 10 millivolts
  - Turbidity +/- 10% NTU units (when turbidity is >10 NTUs)
  - Dissolved oxygen +/- 0.3 mg/L
  - Temperature +/- 2° Celsius
- When the requirements above have been satisfied and the purge cycle is complete, disconnect the flow through cell and prepare to collect samples directly from the pump discharge tubing for analyses according to event-specific PST.
- If flow splitters have been used, do not change the flow rate, and collect the sample from the dedicated sampling port of the first splitter in line.
- Prepare sample containers and collect gas-sensitive analytes first. The preferred collection order will be volatile organic compounds (VOCs), semi-volatile organic compound (SVOCs), metals (including hexavalent chromium [Cr(VI)] and total chromium [Cr(T)]; see SOP-A6), then general chemistry (cations, anions, stable isotopes).
- For filtered samples, attach a 0.45 micron in-line filter to the pump discharge and allow approximately 500 mL of sample to pass through the filter before beginning sample collection in accordance with SOP A-6, *Field filtration* and the QAPP.

- When sample collection is complete, record sample information, final WL, and purge volume data in MIST and on the field sampling log.
- If transient pump previously installed, remove the pump from the well, detach the dedicated tubing and carefully drain any residual water to the purge water tank. Install appropriate tubing cap to prevent any residual water from leaking from the sample tubing. Store the dedicated tubing in a sealed, labeled trash bag. Decontaminate the pump according to SOP A-10, *Decontamination of Water Sampling Equipment*.
- If well was equipped with a transducer, replace the transducer in exactly the same configuration in which it was found and in accordance with SOP-C1, *Solinst Pressure Transducers*.
- Close and secure well protection lid.
- Follow appropriate SOPs, O&M Manual, and the Program Procedures Manual for sample handling and management, equipment decontamination, and investigation-derived waste (IDW) management.

#### **LOW VOLUME AND POOR RECOVERY WELLS:**

Some groundwater monitoring wells under the GMP may exhibit slow or poor recovery upon purging. These monitoring wells may not recharge sufficiently during purging, and may run completely dry without an opportunity to collect the required series of groundwater stabilization parameters, or requisite samples. The following procedures will be followed for collecting representative groundwater samples from wells that go dry during purging.

#### **PREPARATION & SETUP:**

Follow the steps above.

#### **PURGING AND SAMPLING PROCEDURES FOR LOW RECOVERY WELLS:**

- Prepare the groundwater sampling log. Use the static water level and the total depth provided on the field data sheet (comparing to the previous values used on the PST) to calculate the volume of one casing of standing water in the well.
- Calculate 3 casing volumes for the minimum required purge amount, and record on purge log.
- Evaluate previous purge rates, amount of drawdown, stability of field parameters, and total purge volume prior to sample collection from previous sampling records and historical data tables (Appendix B of *Monitoring Plan for Groundwater and Surface Water Monitoring Program*). If the well has not been previously sampled, estimate the expected purge rate using previous sampling information from nearby wells.
- Connect the dedicated purge tubing if available or use new tubing if necessary. Install the pump as previously described and start the purge. Monitor drawdown, and calculate/set the purge rate. Record the pump setting (i.e. hertz) on the sampling log if available.

- Continue purging, measuring WL and field indicator parameters periodically (time, pH, conductivity, turbidity, dissolved oxygen, temperature, salinity, TDS, ORP, and any odors present). Space the readings such that there are a minimum of 4 sets of data collected over the course of the available purge volume.
- During the purge, compare the field parameters to previous purge data. If the parameters are significantly different (greater than 50% difference for SC, pH, and/or ORP) confirm the ID of the well. If the well ID is confirmed by 2 crew members, and the readings continue to be significantly different than prior readings, set up a second WQ instrument in series to confirm readings. If the anomalous readings are confirmed by the second instrument, contact the field coordinator to resolve the issue. If the second WQ instrument produces readings that are comparable to historic values, note an instrument change and use the second instrument's readings.
- Continue purging until **3-casing volumes** have been removed *and* field parameters stabilize, or until the well purges dry. If 3 casing volumes are removed, sample as described above. If the well runs dry, continue as instructed below.
- If previously installed, remove the pump from the well and decontaminate according to SOP A-10, *Decontamination of Water Sampling Equipment*. The pump may also be left in place to facilitate subsequent purging and sampling.
- Record the final water level, time, the volume of water discharged and the elapsed time for the dewatering of the well.
- Allow the well to recharge to 80 percent of the original height of the water column. Ideally, this should be within 24 hours of the monitoring well being purged dry. The recovery period to achieve 80 percent of the height of the water column could take longer than 24 hours in some instances (MW-48).
- *At MW-24BR only*, return to the well the following day and continue purging until a total of 190 gallons have been removed, then sample normally.
- Once recovery has reached 80%, or 48 hours have elapsed (whichever comes first), a bailer can be used for sample collection. Collect samples for analyses according to PST. Prepare sample containers and collect gas-sensitive analytes first. The preferred collection order will be volatile organic compounds (VOCs), semi-volatile organic compound (SVOCs), metals (including hexavalent chromium [Cr(VI)] and total chromium [Cr(T)]), then general chemistry (cations, anions, stable isotopes).
- If an insufficient volume of water is available to fill all of the sample containers, first contact laboratory personnel to determine the minimum allowable volumes needed for the required analyses. (*Talk to FTM as the FTM may have already contact lab personnel and may have the instructions for you.*) Then verify the critical analyte list with the PM or the FTM and prioritize the sample collection to obtain the critical analytes for the main contaminants of concern first. Continue collecting samples until all samples have been collected, or the groundwater supply is exhausted. Unfiltered samples are to be filled by transferring water directly from the bailer to the sample container.
- For filtered samples, attach a 0.45 micron in-line filter to the bailer and allow approximately 200 mls of sample to pass through the filter before beginning sample



collection in accordance with SOP A-6 *Field filtration*. If gravity flow is insufficient to filter the sample, use a pressurized bailer and filter for sample filtration.

- When sample collection is complete, record sample information, final WL, and purge volume data in MIST and on the field sampling log.
- If well was equipped with a transducer, replace the transducer in exactly the same configuration in which it was found and according to SOP-C1, *Solinst Pressure Transducers*.
- Close and secure well protection lid.
- Follow appropriate SOPs, O&M Manual, and Procedures Manual for sample handling and management, equipment decontamination, and investigation-derived waste (IDW) management.

## **SOP-A2**

### **Purging and Sampling of 1-inch-diameter Groundwater Monitoring Wells Modified Well-Volume Method Standard Operating Procedures for PG&E Topock Program**

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This standard operating procedure (SOP) addresses the procedures and equipment to be used for purging and sampling all groundwater monitoring wells at the Topock site with 1-inch casing diameters. This SOP will be used for sampling groundwater monitoring wells using dedicated tubing and a peristaltic pump. A well-volume based purging and sampling method will be used for such wells.

#### **REQUIRED DOCUMENTS:**

- Event-specific planned sample table (PST).
- Applicable project work plan or monitoring plan. Refer to Topock Program Sampling, Analysis, Field Procedures Manual and QAPP (Procedures Manual), and Operations and Maintenance Manual (O&M Manual), as required.
- Topock Program Health and Safety Plan (HSP)
- Applicable SOP's
- Well construction logs/specifications
- Mobile Integrated Sample Tracking (MIST) handheld database
- Previous sampling logs or tabular historic field data
- Current site access map
- Blank sampling logs, maps, sample labels, chains of custody (COC's), and the designated groundwater sampling field notebook

#### **REQUIRED EQUIPMENT:**

- 2 or more YSI-556 water quality (WQ) instruments with flow through cells, or equivalent.
- Hach 2100P turbidimeter or equivalent.
- 200 foot Water level indicator (WLI).
- Trimble Rugged Reader hand held instrument for MIST data collection.
- 30 gallon purge water tank.
- Decontamination spray bottles
- Utility vehicles (UTV's) as necessary.
- 12 volt peristaltic pump.

- 12 volt power source.

#### **PREPARATION & SETUP:**

- Review event-specific PST or event-specific field instructions, previous sampling logs, Procedures Manual, O&M Manual, HSP, and groundwater sampling supplies and equipment check list. (NOTE: the PST should also be reviewed for required “non-analytical event activities” such as water level measurements or other data collection to be performed in association with the groundwater sampling event).
- Acquire the existing field logbook for groundwater sampling and initiate entries.
- Inspect all equipment and verify that the field WQ meters have been calibrated prior to use according to the manufacturer’s instructions and SOP-A9, *Calibration of Field Instruments*.
- Inventory sample bottles, build sample sets for the required analytes at each sample location, ensure a sufficient supply of lab de-ionized water for equipment blanks, and confirm the lab courier schedule.
- Field-check sampling equipment and supplies: WLI, WQ meters, flow-through cell, peristaltic pump, power supply, pump discharge/sampling tubing, N-dex gloves, deionized water sprayers, 5 gallon buckets, paper towels, 0.45 micron in-line filters, etc.
- Field-check and setup sampling equipment: WLI, WQ meters, flow-through cell, pump and power supply, pump discharge/sampling tubing, etc. Install dedicated tubing and connect to peristaltic pump. Connect peristaltic pump to 12 volt power supply.

#### **FIELD PROCEDURES:**

- **Prior to opening any monitor well, remove all pens, lighters, calculators, or any other loose items from vest pockets, or from any other location where they could fall into the well.**
- Upon arrival at the monitoring well, at least 2 members of the sampling team must confirm the well ID. Wells should be clearly marked on the well monument. If the well cannot be positively identified by the marking, measure total depth of the well and compare to the well installation details to confirm the correct location.
- Place spill containment according to SOP A-13, *Spill Prevention, Containment, and Control Measures for Monitoring Well Sampling*.
- Open the protective casing lid and, *prior to moving it*, note the exact configuration of the transducer installation if present. Measure static water level (WL) according to SOP-A7, *Water Level Measurements*, moving the transducer if necessary, and record WL value in MIST on the sampling log.
- If the well is equipped with a transducer, remove the transducer from the well according to SOP-C1, *Solinst Pressure Transducers*.
- Collect daily equipment blanks and duplicate samples as required by the PST and instructed by the field team leader.

- SOP-A2\_1-INCH MW P\_AND\_S\_REV5

- Temperature  $\pm 2^{\circ}$  Celsius
- When the requirements above have been satisfied and the purge cycle is complete, disconnect the flow through cell and prepare to collect samples directly from the pump discharge tubing for analyses according to event-specific PST. For all samples, decrease the discharge rate as necessary to reduce water turbulence at the pump discharge point. Prepare sample containers and collect gas-sensitive analytes first. The preferred collection order will be volatile organic compounds (VOCs), semi-volatile organic compound (SVOCs), metals (including hexavalent chromium [Cr(VI)] and total chromium [Cr(T)]; see SOP-A6), then general chemistry (cations, anions, stable isotopes).
- For filtered samples, attach a 0.45 micron in-line filter to the pump discharge and allow approx. 500 mls of sample to pass through the filter before beginning sample collection in accordance with SOP A-6, *Field filtration*.
- When sample collection is complete, record sample information, final WL, and purge volume data in MIST and on the field sampling log.
- If previously installed, remove the pump from the well, detach the dedicated tubing and carefully drain any residual water to the purge water tank. Fold both ends of the purge tubing and secure with wire ties as a further deterrent to leakage. Store the dedicated tubing in a sealed, labeled trash bag. Decontaminate the pump according to SOP A-10, *Decontamination of Water Sampling Equipment*.
- If well was equipped with a transducer, replace the transducer in exactly the same configuration in which it was found and according to SOP-C1, *Solinst Pressure Transducers*.
- Close and secure well protection lid.
- Follow SOPs in Program Procedures Manual and O&M Manual for sample handling and management, equipment decontamination, and investigation-derived waste (IDW) management.

#### **LOW VOLUME AND POOR RECOVERY WELLS:**

Some groundwater monitoring wells under the GMP may exhibit slow or poor recovery upon purging. These groundwater monitoring wells may not recover sufficiently during purging and run completely dry without an opportunity to collect the required series of groundwater stabilization parameters, or run dry prior to sampling. The following procedures should be followed for collection representative groundwater samples from wells that go dry during purging activities in preparation for groundwater sampling.

#### **PREPARATION & SETUP:**

Follow steps above.

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### **PURGING AND SAMPLING PROCEDURES FOR LOW RECOVERY WELLS:**

- Prepare the groundwater sampling log. Use the static water level determined above and the total depth provided on the field data sheet and in the PST to calculate the volume of one casing of standing water in the well.
- Calculate 3 casing volumes for the minimum required purge amount, and record on purge log.
- Evaluate previous purge rates, amount of drawdown, stability of field parameters, and total purge volume prior to sample collection from previous sampling records and historical data tables (Appendix B of *Monitoring Plan for Groundwater and Surface Water Monitoring Program*). If the well has not been previously sampled, estimate the expected purge rate using previous sampling information from nearby wells.
- Connect the dedicated purge tubing if available, or use new tubing if necessary. Install the pump as previously described and start the purge. Monitor drawdown, and calculate/set the purge rate.
- Continue purging, measuring WL and field indicator parameters periodically (time, pH, conductivity, turbidity, dissolved oxygen, temperature, salinity, TDS, ORP, and any odors present). Space the readings such that there are a minimum of 5 sets of data collected over the course of the available purge volume.
- During the purge, compare the field parameters to previous purge data. If the parameters are significantly different (greater than 50% difference for SC, pH, and/or ORP) confirm the ID of the well. If the well ID is confirmed by 2 crew members, and the readings continue to be significantly different than prior readings, set up a second WQ instrument in series to confirm readings. If the anomalous readings are confirmed by the second instrument, contact the field coordinator to resolve the issue. If the second WQ instrument produces readings that are comparable to historic values, note an instrument change and use the second instrument's readings.
- Continue purging until **3-casing volumes** have been removed **and** field parameters stabilize, or until the well purges dry. If 3 casing volumes are removed, sample as described above. If the well runs dry, continue as instructed below.
- If previously installed, remove the pump from the well and decontaminate according to SOP A-10, *Decontamination of Water Sampling Equipment*. The pump may also be left in place to facilitate subsequent purging and sampling.
- Record the final water level, time, the volume of water discharged and the elapsed time for the dewatering of the well.
- Allow the well to recharge to 80 percent of the original height of the water column. Ideally, this should be within 24 hours of the monitoring well being purged dry. The recovery period to achieve 80 percent of the height of the water column could take longer than 24 hours in some instances (MW-48).
- Once recovery has reached 80%, or 48 hours have elapsed (whichever comes first), a bailer can be used for sample collection. Collect samples for analyses according to PST. Prepare sample containers and collect gas-sensitive analytes first. The preferred collection order will be volatile organic compounds (VOCs), semi-volatile organic

compound (SVOCs), metals (including hexavalent chromium [Cr(VI)] and total chromium [Cr(T)]), then general chemistry (cations, anions, stable isotopes).

- If an insufficient volume of water is available to fill all of the sample containers, first contact laboratory personnel to determine the minimum allowable volumes needed for the required analyses, then verify the critical analyte list with the PM or the FTM and prioritize the sample collection to obtain the critical analytes for the main contaminants of concern first. Continue collecting samples until all samples have been collected, or the groundwater supply is exhausted. Unfiltered samples are to be filled by transferring water directly from the bailer to the sample container.
- For filtered samples, attach a 0.45 micron in-line filter to the bailer and allow approx. 200 mls of sample to pass through the filter before beginning sample collection in accordance with SOP A-6, *Field filtration*. If gravity flow is insufficient to filter the sample, use a pressurized bailer and filter for sample filtration.
- When sample collection is complete, record sample information, final WL, and purge volume data in MIST and on the field sampling log.
- If well was equipped with a transducer, replace the transducer in exactly the same configuration in which it was found and according to SOP-C1, *Solinst Pressure Transducers*.
- Close and secure well protection lid.
- Follow Procedures Manual and the O&M Manual for sample handling and management, equipment decontamination, and investigation-derived waste (IDW) management.



## **SOP-A3**

### **Purging and Sampling of Active and Inactive Water Supply Wells Standard Operating Procedures for PG&E Topock Program**

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This standard operating procedure (SOP) addresses the procedures and equipment to be used for purging and sampling active and inactive water supply wells in the vicinity of the Topock site. This procedure also applies to the collection of water quality samples from long-screen extraction, injection, and test wells. Active and inactive water supply wells with functional dedicated pumps and a sampling port will be sampled directly from the sampling port. Inactive supply wells without functional pumps will be sampled using a temporary submersible pump following the well-volume sampling procedure.

#### **REQUIRED DOCUMENTS:**

- Event-specific planned sample table (PST).
- Applicable project work plan or monitoring plan. Refer to Topock Program Sampling, Analysis, Field Procedures Manual (Procedures Manual), Operation and Maintenance Manual (O&M Manual), QAPP and Addendum to the QAPP, as required.
- Topock Program Health and Safety Plan (HSP)
- Applicable SOP's
- Well construction logs/specifications
- Mobile Integrated Sample Tracking (MIST) handheld database
- Previous sampling logs or tabular historic field data
- Current site access map
- Blank sampling logs, maps, sample labels, chains of custody (COC's), and the designated groundwater sampling field notebook

#### **REQUIRED EQUIPMENT:**

- 2 or more YSI-556 water quality (WQ) instruments with flow through cells, or equivalent.
- Hach 2100P turbidimeter or equivalent.
- 200 foot Water level indicator (WLI).
- Trimble Rugged Reader hand held instrument for MIST data collection.
- 200 gallon capacity purge tanks (2).
- Utility vehicles (UTV's) as necessary.
- Back-up 2 inch pump and controller.
- Honda 2000 watt generator or alternate power source.

### **PREPARATION AND SETUP:**

- Review event-specific PST or event-specific field instructions, previous sampling logs, Procedures Manual, O&M Manual, QAPP and the Addendum to the QAPP, HSP, and groundwater sampling supplies and equipment check list.
- Acquire the existing field logbook for surface water sampling and initiate entries.
- Inspect all equipment and verify that the field WQ meters have been calibrated prior to use according to the manufacturer's instructions and SOP-A9, *Calibration of Field Instruments*.
- Inventory sample bottles, build sample sets for the required analytes at each sample location, ensure a sufficient supply of lab de-ionized water for equipment blanks, and confirm the lab courier schedule.
- Field-check sampling equipment and supplies: WLI, WQ meters, flow-through cell, pump controller, power supply, pump discharge/sampling tubing, N-dex gloves, D.I water sprayers, paper towels, etc.

### **PURGING AND SAMPLING PROCEDURES FOR ACTIVE WATER SUPPLY WELLS:**

- **Prior to opening any well, remove all pens, lighters, calculators, or any other loose items from vest pockets, or from any other location where they could fall into the well.**
- Upon arrival at the well, at least 2 members of the sampling team must confirm the well ID. If the well cannot be clearly identified by the marking, measure total depth of the well and compare to the well installation details to confirm the correct location.
- Access the well and, *prior to moving it*, note the exact configuration of the transducer installation if present. If the well has been inactive for more than 24 hours, a water level measurement can be taken. Measure static water level (WL) according to SOP-A7, *Water Level Measurements*, moving the transducer if necessary, and record WL value in MIST on the sampling log.
- If the well is equipped with a transducer and transducer removal is required for sampling, follow SOP-C1, *Solinst Pressure Transducers*.
- If it is known that 3-casing volumes have been purged from the well in the last 24-hour period, purging will not be necessary prior to sampling. Connect one end of a new or dedicated piece of LDPE tubing to the pump discharge port and connect the other to the inlet of the flow through cell. If it is not possible to connect the flow-through cell, a clean 5-gallon bucket may be used by filling the bucket with purge water and inserting the instrument probes directly into the bucket. If a bucket is used, turbulence in the bucket should be minimized to the extent possible.
- Carefully open the valve at the sampling port until the desired flow rate is achieved, then allow the flow through cell to fill and the parameters to stabilize before collecting a single set of water quality parameters. Record in MIST and on the field data sheet. Note and provide qualifying remarks if parameter readings are anomalous or unstable due to instrument problems. Purge water should be contained in a portable purge water storage tank. If approved by well owner and the governing regulatory agencies, water may be discharged directly to the ground, as directed by the Field Team Manager (FTM).

- Observations on sample appearance and clarity during purging and at sampling are required! For standardization, use a clear glass jar to collect and record observations of discharge water appearance during purging. Also note characteristics such as any odors associated with the discharge water.
- Compare the field parameters to historical purge data. If the parameters are significantly different (greater than 50% difference for SC, pH, and/or ORP) confirm the ID of the well. If the well ID is confirmed by 2 crew members, and the readings continue to be significantly different than prior readings, set up a second WQ instrument in series to confirm readings. If the anomalous readings are confirmed by the second instrument, contact the field coordinator to resolve the issue. If the second WQ instrument produces readings that are comparable to historic values, note an instrument change and use the second instrument's readings.
- Disconnect the flow through cell and collect samples for analyses according to the PST. Sample containers are to be filled by transferring water directly from the pump discharge or sampling spigot to the appropriate sample container.
- For filtered samples, attach a 0.45 micron in-line filter to the pump discharge and allow approx. 500 mls of sample to pass through the filter before beginning sample collection in accordance with SOP A-6, *Field filtration*.
- When sample collection is complete, record sample information, final WL, and purge volume data on field log. If the pump is equipped with a flow meter, record the flow rate as well.
- If well was equipped with a transducer, replace transducer according to SOP-C1, *Solinst Pressure Transducers*.
- Close and secure well including access gates or fences.
- Follow SOPs in Program Procedures and O&M Manual for sample handling and management, equipment decontamination, and investigation-derived waste (IDW) management.

#### **PURGING AND SAMPLING PROCEDURES FOR INACTIVE WATER SUPPLY WELLS:**

Inactive water wells may include: (1) wells with functioning dedicated pumps, (2) wells without dedicated pumps, and (3) wells with non-functioning dedicated pumps. A well-pump subcontractor may be required to install temporary pumps for purging wells without pumps and non-functioning dedicated pumps.

- **Prior to opening any monitor well, remove all pens, lighters, calculators, or any other loose items from vest pockets, or from any other location where they could fall into the well.**
- Upon arrival at the well, at least 2 members of the sampling team must confirm the well ID. Wells will be clearly marked on the well monument. If the well cannot be clearly identified by the marking, measure total depth of the well and compare to the well installation details to confirm the correct location.
- Access the well and, *prior to moving it*, note the exact configuration of the transducer installation if present. If the well has been inactive for more than 24 hours, a water level

measurement can be taken. Measure static WL according to SOP-A7, *Water Level Measurements*, moving the transducer if necessary, and record WL value in MIST on the sampling log.

- If the well is equipped with a transducer and transducer removal is required for sampling, follow SOP-C1, *Solinst Pressure Transducers*.
- If the well has had well volumes purged in the last 24 hours, then it is an active well and purging before *sampling may be limited to volume sufficient for field parameter measurement*.
- If it is determined that 3-casing volumes *have not* been purged in the last 24-hours, calculate 3-casing volumes using measured WL depth, casing diameter, and total well depth information. If it is not possible to measure the depth to water or total depth of the well, use well records or prior knowledge to calculate 3-casing volumes.
- Start purging using the functional dedicated equipment, if available. Check for any leaks, monitor drawdown, and calculate/set the purge rate.
- If dedicated equipment is not present or nonfunctional, a portable pump installed by subcontractor may be used for purging and sampling. Install a decontaminated pump at the same intake/sampling depth used in prior events and record intake depth. If the well has not been previously sampled, install the pump with the intake in the middle of the screened interval, or the midpoint of the saturated interval if the water level is lower than the top of the screen, or at the depth proscribed by the Project Manager or FTM.
- Purge water should be contained in a portable purge water storage tank. If approved by well owner and the governing regulatory agencies, water may be discharged directly to the ground, (at present this is only the case at PM-03 and PM-04 supply wells), as directed by the Field Team Manager.
- Continue purging, measuring WL and field indicator parameters periodically (time, pH, conductivity, turbidity, dissolved oxygen, temperature, salinity, TDS, ORP, and any odors present). Time the readings such that there are a minimum of 5 sets of data collected over the course of the full purge.
- Decrease the purge rate and measure/record new purge rate if significant drawdown is observed or turbidity increases dramatically. Significant drawdown is considered to be 5 percent of the total height of the water column or to the top of screen. Record time for all measurements collected. Note and provide qualifying remarks if parameter readings are anomalous or unstable due to instrument problems.
- During the purge, compare the field parameters to previous purge data. If the parameters are significantly different (greater than 50% difference for SC, pH, and/or ORP) confirm the ID of the well. If the well ID is confirmed by 2 crew members, and the readings continue to be significantly different than prior readings, set up a second WQ instrument in series to confirm readings. If the anomalous readings are confirmed by the second instrument, contact the field coordinator to resolve the issue. If the second WQ instrument produces readings that are comparable to historic values, note an instrument change and use the second instrument's readings.

- Continue purging until *3-casing volumes* have been removed *and* field parameters stabilize. Indicator parameters are considered stabilized when 3 consecutive readings made several minutes apart fall within the following EPA stabilization criteria:
  - pH +/- 0.1 pH units
  - Specific conductance +/- 3%
  - ORP +/- 10 millivolts
  - Turbidity +/- 10% NTU units (when turbidity is >10 NTUs)
  - Dissolved oxygen +/- 0.3 mg/L
  - Temperature +/- 2° Celsius
- When the requirements above have been satisfied and the purge cycle is complete, disconnect the flow through cell and prepare to collect samples directly from the pump discharge tubing for analyses according to event-specific PST. For all samples, decrease the discharge rate as necessary to reduce water turbulence at the pump discharge point. Prepare sample containers and collect gas-sensitive analytes first. The preferred collection order will be volatile organic compounds (VOCs), semi-volatile organic compound (SVOCs), metals (including hexavalent chromium [Cr(VI)] and total chromium [Cr(T)]; see SOP-A6), then general chemistry (cations, anions, stable isotopes).
- For filtered samples, attach a 0.45 micron in-line filter to the pump discharge and allow approx. 500 mls of sample to pass through the filter before beginning sample collection in accordance with SOP A-6, *Field filtration*.
- When sample collection is complete, record sample information, final WL, and purge volume data in MIST and on the field sampling log.
- If previously installed, remove the pump from the well and decontaminate according to SOP A-10, *Decontamination of Water Sampling Equipment*.
- If well was equipped with a transducer, replace the transducer in exactly the same configuration in which it was found and according to SOP-C1, *Solinst Pressure Transducers*.
- Close and secure well, including fences and gates.
- Follow SOPs in Program Procedures and O&M Manual for sample handing and management, equipment decontamination, and investigation-derived waste (IDW) management.

## SOP-A4

### Depth-Specific River Water Sampling Standard Operating Procedures for PG&E Topock Program

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This standard operating procedure (SOP) addresses the procedures and equipment to be used for river channel and shoreline surface water sampling at the Topock site. This SOP should be used for depth-specific river channel surface water sampling and single depth shoreline sampling stations on the Colorado River.

#### REQUIRED DOCUMENTS

- 1) Event-specific planned sample table (PST) or Mobile Integrated Sample Tracking (MIST) handheld database, Plan Versus Actual Report, Delegation of Authority, and Contingency Plan.
- 2) Applicable project work plan or monitoring plan. Refer to the PG&E Program Quality Assurance Project Plan, (QAPP) or the Addendum to the PG&E Program Quality Assurance Project Plan for the Topock Groundwater Remedy, as required.
- 3) Topock Program Health and Safety Plan (HSP).
- 4) Blank sampling logs, MIST database and field notebook. Purge and sampling information will be recorded on hard copy purge form and MIST handheld database.

#### PREPARATION & SETUP

- 1) Review event-specific SAP or event-specific field instructions, previous sampling logs, Field Procedures Manual, previous lessons learned, and HSP. (NOTE: the PST should also be reviewed for required “non-analytical event activities” in association with the river sampling event).
- 2) Initiate field logbook for sampling activity.
- 3) Inspect all equipment and calibrate field water quality (WQ) meters according to SOP-A9, *Calibration of Field Instruments*.
- 4) Inventory sample bottles and labels, required analyses, and confirm the lab courier schedule.
- 5) Field-check and set up sampling equipment: WQ meters, health and safety apparatuses (life vest, rescue rope, life preserver), water depth meter or depth-finder, peristaltic pump, filters, sufficient tygon and silicone tubing, polypropylene rope, sampling equipment, etc.
- 6) Prepare an ambient blank sample at the beginning of each day. Fill a 250 mL sample container with deionized water. This bottle is to remain open near the sampler for the duration of the day’s sampling activities. At the end of the day close the sample container. Send the blank samples to the analytical lab for Cr(VI) analysis (by method 218.6), be sure to write “**hold**” on the COC. The blanks will only to be analyzed if there are anomalous results from the river samples.

## IN-CHANNEL SAMPLING PROCEDURES

- 6) Prepare river water sampling log (use attached form).
- 7) The sampling team will travel to each river sampling station in a motorized boat. A safety inspection of the boat will be performed by the field crew prior to boarding (check for fire extinguisher, etc.). Samples will be collected from selected stations on the river approximately one-third the river width from the California shoreline.
- 8) Collect an equipment blank sample prior to sampling by running deionized water through a new/dedicated segment of tubing.
- 9) An industry standard (Trimble or similar) resource grade handheld DGPS unit (GeoXT or similar) will be used with real-time correction (wide area augmentation system) to locate the river channel sampling stations within a 1 meter radius (68% of the time, commonly referred to 1 sigma accuracy). At each location, two anchors should be positioned upstream at least 10 feet from each other (Attachment A). Record the GPS coordinates on the sampling log. In the event a sampling station is too shallow to safely approach by boat, the next closest location with adequate depth will be sampled and a remark noted on the sampling log with the new GPS coordinates.
- 10) Record the depth of the river at each sampling station using the depth-finder or a weighted tape. If a weighted tape is used, read the tape at the river water surface when the weight touches the river floor. Record river depth on the sample log.
- 11) Samples will be collected from two depths at each river channel sampling station: 1 foot from the bottom of the river, and 1 foot from the water surface.
- 12) Samples are to be collected using a variable-speed peristaltic pump with 1/4-inch tygon tubing attached to a weighted polypropylene rope (Attachment A) and a segment of silicone tubing for use in the peristaltic pump. Alternatively, a weighted pole can be used in place of the polypropylene rope. Dedicated tubing will be used for each sample depth at each sample station. Once the sampling depths have been calculated for each station, pre-cut two pieces of tygon tubing and attach them to the rope so that their intakes are at the proper sampling depths. Lower the weighted rope and tubing until the weight touches the river bottom and the tubing intakes are at the correct depths. Confirm river depth using the depth-finder or weighted tape. Attach the discharge end of the sample tubing to the flow cell of the water quality meter. Start the peristaltic pump and allow the flow cell to fill and the water to equilibrate for approximately 3 minutes, or until the temperature readings remain stable for 30 seconds (+/- 1 °C). Record the time, pH, conductivity, turbidity, dissolved oxygen, temperature, salinity, TDS, and ORP on the field log. Note and provide qualifying remarks if parameter readings are anomalous or unstable due to an instrument problem. Turn off the peristaltic pump, remove tubing from the flow cell, and restart the pump. Attach a 0.45 micron filter when sampling for Cr(T) by USEPA SW-846 Method 6020A or for Cr(VI) by USEPA Method 218.6. Refer to SOP-A6, *Sample Field Filtration and Preservation for Metals Analyses*. Pump approximately 500 ml through the system and begin filling the applicable sample bottles. Remove the filter prior to filling sample bottles for the other analyses, which do not require filtration. Ensure that the samples do not contact any source of metal. Place the samples on ice immediately after collection. Record all sample information on the field log.



- 13) Collect remaining samples for analyses according to the PST. Use a new piece of tygon tubing and change out the flexible silicone tubing in the peristaltic pump for each depth, at each location.
- 14) Follow the appropriate SOPs in the Field Procedures Manual, Operation and Maintenance (O&M) Manual, and QAPP for sample handling and management, equipment decontamination, and investigation-derived waste (IDW) management.

## SHORELINE SAMPLING PROCEDURES

- 15) Prepare surface water sampling log (use attached form dated March 2005).
- 16) An industry standard (Trimble or similar) resource grade handheld DGPS unit (GeoXT or similar) will be used with real-time correction (wide area augmentation system) when available to locate the surface water sampling locations within a 1 meter radius (68% of the time, commonly referred to 1 sigma accuracy).
- 17) If sampling at locations RRB or I-3 (or any other river station where water levels are required), measure river WL according to SOP-A7, *Water level Measurements*. Record WL value on sampling log.

RRB: Water level measurement will be taken at the "X" on the bridge.

I-3: There is a bolt and nut in the metal bridge, water level is recorded to the base of the nut (see photo)



- 18) Where possible, place water quality meter probes in the Colorado River in a secure place near-shore for approximately 3 minutes, until the temperature reading stabilizes prior to reading field parameters from sample. Proceed with sampling activities while the temperature of the probes is equilibrating.
- 19) Collect samples for analyses according to event-specific PST.

**RRB:** Samples are collected using a disposable bailer and directly filling the sample bottles. An attempt will be made to ensure the water is collected from several inches beneath the surface of the water. If the water is too shallow to use a bailer, than the surface water sampling pole can be used. Make a notation on the sample log that the sample was not collected from the recommended depth.

**I-3:** Samples are collected using a disposable bailer and directly filling the sample bottles. An attempt will be made to ensure the water is collected from several inches beneath the surface of the water.

**All other locations:**

If collecting sample from the shore, samples are collected using a surface water sampling pole that is extended as far as possible in a safe manner (ideally 4 feet from the shoreline) and the sample collected approximately 6 inches below the surface, or by wading out and dipping the sampling bottle approximately 6 inches beneath the surface. The Sampling containers are connected to the sampling pole and filled directly from the river. If it is not possible to connect the sampling bottle directly to the sampling pole, a portable sampling bottle will be used. The portable sampling bottle will be decontaminated between locations in accordance with SOP-A10, *Decontamination of Water Sampling Equipment* and protected from ambient conditions as prescribed therein. Prior to filling the portable sampling bottle it will be rinsed with surface water at the sampling location.

If the shoreline samples are collected from a boat, the boat must be able to pull within 4 feet of the shore at the sample location. Samples are collected using a peristaltic pump by lowering the intake tubing 4-inches below the water surface. New or dedicated tubing must be used at each sampling location.

Samples that are to be filtered as part of the analytical suite will be field filtered at the support vehicle using a portable peristaltic pump to transfer water from the collection vessel through a 0.45 micron filter in accordance with SOP-A6 and discharged into the laboratory supplied sample container. At minimum, the required sample volume and an additional 500 milliliters will be collected to ensure there is sufficient volume for filtration.

- 20) Record sample information on field log.
- 21) Fill a clean bucket with Colorado River water collected approximately 6 inches below surface using a bailer or by directly filling the bucket (invert until desired depth) for measurement of water quality field parameters. Where possible (all locations except RRB), flowing water is collected for a one-time temperature stable reading of the following field parameters:
  - pH
  - Specific conductance
  - ORP
  - Turbidity
  - Dissolved oxygen
  - Temperature
- 22) Measure field parameters by removing the water quality probes from the river and inserting the Horiba probes directly into the bucket. The Hach vial shall be filled from the bucket. Record all parameters on the field sheet. Record time for all measurements collected. Note and provide qualifying remarks if parameter readings are anomalous or unstable due to instrument problem.

- 13) Follow the appropriate SOPs in the Field Procedures Manual, the O&M Manual, and QAPP for sample handling and management, equipment decontamination, and investigation-derived waste (IDW) management.

## SOP-A5

### Groundwater Sampling from Sonic Drilling Boreholes Standard Operating Procedures for PG&E Topock Program

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This standard operating procedure (SOP) addresses the procedures and equipment to be used for purging and collection of grab groundwater samples from boreholes during sonic drilling. When a pump sampling system (Prosonic "Isoflow") is available and feasible, Isoflow sampling is the preferred method. When Isoflow sampling is not available or not feasible then a bailer method will be used for grab groundwater sampling while drilling.

#### REQUIRED DOCUMENTS

- 1) Event-specific sampling and analysis plan (SAP), Work Plan or event-specific field instructions. Planned borehole depth, proposed well construction/ specifications, and field sampling summary table, if available.
- 2) Applicable project work plan or monitoring plan. Refer to Topock Program Sampling, Analysis, Field Procedures Manual (Procedures Manual), Operation and Maintenance (O&M) Manual, QAPP, and the Addendum to the QAPP, as required.
- 3) Topock Program Health and Safety Plan (HSP)
- 4) Previous sampling, drilling, or well construction logs from other boreholes or wells in the vicinity, if available
- 5) Blank sampling log and field notebook

#### PREPARATION & SETUP

- 1) Review event-specific Work Plan or event-specific field instructions, Procedures Manual, O&M Manual, QAPP and the Addendum to the QAPP, and HSP.
- 2) Initiate field logbook for sampling activity.
- 3) Review sampling procedures and equipment, and planned sample depths with drilling contractor and field crew.
- 4) Inspect all required field equipment and calibrate field water quality (WQ) meters according to SOP-A9, *Calibration of Field Instruments*.
- 5) Inventory sample bottles, review required analyses, and understand lab courier schedule.
- 6) Field-check and setup sampling equipment: Decontaminated Isoflow pump or stainless steel bailer, rig hoist, generator, containers for purge water management, water level (WL) meter, WQ meters, flow-through cell, pump control and power supply, pump discharge/sampling tubing, health and safety equipment, etc.



will be volatile organic compounds (VOCs), semi-volatile organic compound (SVOCs), metals (including hexavalent chromium [Cr(VI)] and total chromium [Cr(T)]), then general chemistry (cations, anions, stable isotopes). Sample containers are to be filled by transferring water directly from the pump discharge to the appropriate sample container.

- 12) Record sample information, final WL, and purge volume data on field log.
- 13) Oversee the driller's removal and decontamination of the Isoflow sampling pump.
- 14) Oversee the driller in resuming drilling and soil sampling.
- 15) Follow SOPs in Program Procedures Manual and O&M Manual for sample handling and management, equipment decontamination, and investigation-derived waste (IDW) management.

### **PURGING AND SAMPLING PROCEDURES FOR BAILER SAMPLING FROM BOREHOLE**

- 7) Prepare groundwater sampling log (use field notebook and summarize relevant information on sampling form).
- 8) Collect the grab groundwater sample by bailing the open hole interval below the sonic casing after removing a 10 to 20-foot sonic core run.
- 9) Sound the bottom of the borehole after removing the core barrel. Measure initial static WL according to SOP-A7, *Water Level Measurements*. Record WL value on sampling log.
- 10) Calculate 1-casing volume using measured WL depth, casing diameter, and total well depth information. Insert the decontaminated stainless steel bailer into the borehole and begin bailing a minimum of one casing volume. Purge water should be contained in a portable water storage tank, as directed by the Field Team Manager.
- 11) Measure water quality parameters using a clean 5-gallon bucket and inserting the instrument probes directly into the bucket. If the bucket is used, turbulence in the bucket should be minimized to the extent possible. Record time for all measurements collected. Record the following water quality data on the field data sheet: pH, specific conductance, ORP, turbidity, TDS, dissolved oxygen, sample appearance, and odor. Parameter stabilization is not a requirement for sampling from open boreholes. Typically, TDS is used as a reliable indicator for borehole sampling at the site, given the known increasing concentration with depth across the site.
- 12) Collect samples for analyses according to event-specific SAP. Prepare sample containers and collect gas-sensitive analytes first. The preferred collection order will be volatile organic compounds (VOCs), semi-volatile organic compound (SVOCs), metals (including hexavalent chromium [Cr(VI)] and total chromium [Cr(T)]), then general chemistry (cations, anions, stable isotopes). Sample containers are to be filled by transferring water directly from the bailer to the appropriate sample container. For all samples, handle the bailer with care and decant from the bailer slowly to minimize the potential for aeration and turbulence as containers are filled.
- 13) Record sample information, final WL, and purge volume data on field log.

- 14) Follow SOPs in Program Procedures Manual and O&M Manual for sample handling and management, equipment decontamination, and IDW management.



## **SOP-A6**

### **Sample Field Filtration and Preservation for Metals Analyses Standard Operating Procedures for PG&E Topock Program**

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This standard operating procedure (SOP) addresses the procedures and equipment to be used for collecting groundwater / surface water samples for field filtered metals analyses at the Topock site. Refer to SOP- A1, A2, A3, or A4 for specific groundwater and surface water sampling methods.

#### **REQUIRED DOCUMENTS**

- 1) Event-specific planned sample table (PST).
- 2) Applicable project work plan or monitoring plan. Refer to the PG&E Program Quality Assurance Project Plan, (QAPP) or the Addendum to the PG&E Program Quality Assurance Project Plan for the Topock Groundwater Remedy, as required.
- 3) Topock Program Health and Safety Plan (HSP).
- 4) Previous sampling logs or tabular table of historic field data.
- 5) Blank sampling logs and field notebook.

#### **PREPARATION & SETUP**

- 1) Review event-specific PST or event-specific field instructions, previous sampling logs, Procedures Manual, Operation and Maintenance (O&M) Manual, and HSP.
- 2) Initiate field logbook for sampling activity.
- 3) Inventory sample containers and labels, required analyses, and lab courier schedule.
- 4) Field-check and setup sampling equipment: field filters, buffering solution, acid, and sample containers.

#### **FIELD-FILTRATION AND SAMPLE COLLECTION PROCEDURES FOR GROUNDWATER FROM MONITORING AND EXTRACTION WELLS**

- 1) Follow SOPs A1 and A2.

#### **Sample Collection**

- 1) Once parameters are stabilized and a minimum 3-casing volumes have been removed from the well, disconnect the tubing from the flow-through cell and connect the inline 0.45 micron filter. (Note: do not change the pump rate, continue to purge from the well at the same rate as used during the stabilization of the parameters.)
- 2) Allow 500 milliliters (mL) to flow through the inline filter, prior to sample collection. Fill the sample container by transferring water directly from the filter discharge to the appropriate sample container.

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*Total Chromium and Metals analyzed by the 6000 / 7000 Series of SW 846 Methods and metals analyzed by EPA Methods of the 200 Series*

- i. Fill a laboratory provided pre-preserved sample container (250 or 500 mL poly containing  $\text{HNO}_3$ ). CARE MUST BE TAKEN NOT TO OVERFILL THE CONTAINER.

**In the event that no pre-preserved sample containers are available, the sampling team will need to follow the following protocol.**

- ii. If you are preserving the container in the field, check the pH of the sample with laboratory provided pH paper. If the pH of the sample is greater than 2, add 5 drops of  $\text{HNO}_3$ . Close the container, shake and check the pH. Continue adding  $\text{HNO}_3$  in 5-drop increments until the pH is less than 2.
- iii. Record the total amount of  $\text{HNO}_3$  added to the sample and the pH on the chain of custody and field form. Seal, label, and place the sample on ice.

*Hexavalent Chromium Method SM3500 and EPA 218.6*

- i. Fill a laboratory provided pre-preserved sample container (250 mL poly containing  $(\text{NH}_4)_2\text{SO}_4/\text{NH}_4\text{OH}$  buffer solution) to the top of the container neck.
- ii. Seal, label, and place the sample on ice.

**In the event that no pre-preserved sample containers are available, the sampling team will need to follow the following protocol.**

- i. If you are preserving the container in the field, fill a laboratory provided sample container (250 mL poly) to approximately 235 mL, leaving headspace for the addition of buffer solution.
- ii. Add 5 mL of laboratory provided buffer solution using a pipette. Place the lid on the sample container and shake gently. Check the pH using laboratory provided pH strips.
- iii. If the pH is less than 9.3, add one drop of 20% NaOH, close container, gently shake, and check the pH. Continue until the pH is between 9.3 and 9.7.
- iv. When the pH of the sample is between 9.3 and 9.7, record the total amount of pH buffer and NaOH added to the sample and the pH of the sample on the chain of custody and field form. Seal, label, and place the sample on ice.

3) Discard used pH paper(s) and filter in IDW bin.

4) Record sample information, final WL, and purge volume data on field log.

## SOP-A7

### Water Level Measurements

### Standard Operating Procedures for PG&E Topock Program

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This standard operating procedure (SOP) addresses the procedures and equipment to be used for manually measuring the depth to water at surface water locations, groundwater monitoring wells, and production wells.

#### **REQUIRED DOCUMENTS:**

- Event-specific planned sample table (PST).
- Applicable project work plan or monitoring plan. Refer to Topock Program Sampling, Analysis, Field Procedures Manual (Procedures Manual), Operation and Maintenance (O&M) Manual, QAPP, and Addendum to the QAPP, as required.
- Topock Program Health and Safety Plan (HSP)
- Well construction logs/specifications
- Current site access map
- Previous water level data
- Water level data collection sheet and field notebook
- Blank sampling logs, if applicable

#### **PREPARATION & SETUP:**

- Review event-specific PST or event-specific field instructions, previous sampling logs, Field Procedures Manual, O&M Manual, and HSP.
- Ensure that the water level indicator (WLI) has been decontaminated (check for label/tag) or decontaminate as needed following SOP-A10, *Decontamination of Water Sampling Equipment*.
- Initiate field logbook for sampling activity.
- Inspect all equipment and calibrate WLIs if multiple meters are being used according to SOP-A9, *Calibration of Field Instruments*.
- If a transducer is present in the well and it is necessary to remove the transducer to allow well access, first note the exact position of the transducer and refer to SOP-C1, *Solinst Pressure Transducers*, before proceeding.

### **REQUIRED EQUIPMENT/SUPPLIES:**

- 200-foot or 400-foot WLI
- A set of spare batteries for the field equipment
- Well access keys, including gate keys if necessary
- De-ionized (DI) water spray bottle
- Nitrile gloves, paper towels, clipboard

### **MEASUREMENT PROCEDURES:**

1. Prepare groundwater sampling log or water level data collection form.
2. Decontaminate the lower 5 feet of the water level probe before using by rinsing thoroughly with DI water according to SOP-A10, *Decontamination of Water Sampling Equipment*.
3. Place WLI probe into well, or measure from surface water monitoring point and lower the probe until the tone sounds. Raise the probe out of the water and gently shake the line to remove any retained water. Adjust the WLI sensitivity if necessary. (The groundwater onsite is highly conductive and may cause a constant tone from the WLI. This means that the sensitivity is set too high; turn the knob to the left to decrease sensitivity. Conversely, if measuring surface water which typically has very low conductance, and you are having difficulty getting a tone, the sensitivity may be set too low; increase the sensitivity by turning the knob to the right.) Slowly lower the probe once again just until the tone sounds. Note depth to water (DTW) value at the measuring point on the PVC well casing. If there is no mark on the PVC casing, measure DTW at the northern edge of the PVC casing. Repeat the measurement 3 times to confirm DTW, and record to the nearest hundredth of a foot on the sampling log. Record well identification, time, date, DTW, and WLI number.
4. Replace pressure transducer if removed. Ensure that transducer is placed exactly as it was before removal.
5. Compare DTW measurement with previous data and note discrepancies on the sampling form. Repeat the previous steps as necessary if an unexpected discrepancy is noted.
6. Decontaminate any portion of the instrument that came in contact with water by rinsing thoroughly with DI water, or wiping with a DI water moistened paper towel according to SOP-A10, *Decontamination of Water Sampling Equipment*.
7. Close and secure well.

Note: Field water level measurements will be loaded into the PG&E database regularly. Once loaded into the database, manual water levels will be adjusted to groundwater elevations and converted to freshwater equivalent heads following the procedures outlined in SOP-A22, *Procedures for Calculation of Freshwater Equivalent Heads*.

## SOP-A8

### Field Water Quality Measurements Using a Flow-through Cell Standard Operating Procedures for PG&E Topock Program

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This Standard Operating Procedure (SOP) provides general guidelines for using the YSI-556® water quality (WQ) meter and flow-through cell, or similar device for field measurements of pH, specific conductance, turbidity, dissolved oxygen, oxidation-reduction potential (ORP), and temperature of groundwater samples. Also addressed are procedures for measuring water sample turbidity using the Hach turbidity meter. All instruments will be calibrated daily in accordance with the manufacturer's instructions and SOP-A9, *Calibration of Field Instruments*.

#### **REQUIRED DOCUMENTS:**

- Event-specific planned sample table (PST).
- Applicable project work plan or monitoring plan. Refer to Topock Program Sampling, Analysis, Field Procedures Manual (Procedures Manual), Operation and Maintenance (O&M) Manual, QAPP, and the Addendum to the QAPP, as required.
- Topock Program Health and Safety Plan (HSP)
- Applicable SOP's
- Well construction logs/specifications
- Mobile Integrated Sample Tracking (MIST) handheld database
- Previous sampling logs or tabular historic field data
- Current site access map
- Blank sampling logs, maps, sample labels, chains of custody (COC's), and the designated groundwater sampling field notebook

#### **REQUIRED EQUIPMENT:**

- YSI-556 WQ meter or equivalent
- YSI-556 flow through cell or equivalent
- Hach 2100P turbidimeter or equivalent
- Trimble Rugged Reader hand held device with the CH2M HILL event specific MIST electronic data collection database loaded
- Spare batteries for each piece of equipment

### **PREPARATION & SETUP:**

- Review event-specific PST or event-specific field instructions, previous sampling logs, Procedures Manual, and HSP.
- Acquire the existing field logbook for the specific field activity and initiate entries.
- Inspect all equipment : YSI-556 WQ meter or similar device, flow-through cell, o-rings, and fittings , Hach turbidity meter, distilled water in spray bottle.
- Prior to each day's use, clean the probes and flow-through cell and calibrate the field water quality (WQ) meters according to SOP-A9, *Calibration of Field Instruments* and the manufacturer's instructions.

### **YSI-556 WQ Meter (or equivalent):**

- Attach the probe body securely to the flow through cell. Attach the pump discharge line to the bottom fitting of the flow through cell, and a second discharge line to the top fitting of the flow through cell. Route the flow through cell discharge line to the purge water storage tank and secure.
- Prior to starting the pump, place the flow through cell into a 5 gallon bucket, ensure that all fittings are properly tightened and that spill containment is in place in accordance with SOP A-13, *Spill Prevention, Containment, and Control Measures for Monitoring Well Sampling*.
- Start the pump and allow the flow through cell to fill. Check for excessive leakage from the cell. A small amount of leakage is typical and allowable, and will be caught by the 5 gallon bucket. If leakage is excessive, stop the pump, remove the probe body from the flow through cell and inspect the O-ring and threads for damage. Replace if necessary, re-attach to flow through cell, and restart the pump.
- Ensure that there are no air bubbles entering the flow through cell since this will skew the dissolved oxygen and ORP readings.
- Allow instrument readings to stabilize and collect water quality data in MIST and on the field data sheet. Time the readings such that there at least 5 sets of readings collected over the length of the full purge.
- When sampling is complete, carefully remove the fittings and drain the flow through cell into the bucket. Rinse the instrument probes and flow through cell thoroughly with de-ionized water in accordance with SOP A-10, *Decontamination of Water Sampling Equipment*, catching the rinsate in the bucket.
- Mount the specially cut "dumping lid" on the bucket, and carefully pour the contents into the purge water storage tank.
- Carefully clean and store the WC instrument in accordance with the manufacturer's recommendations in preparation for the next use.

### **HACH 2100P TURBIDIMETER:**

- Turn the turbidity meter on and select the auto-range mode.

- Inspect the measurement vial for scratches, dirt or staining. Replace or clean as necessary.
- Fill the measurement vial with water and carefully wipe dry.
- If bubbles cling to the side of the vial, gently swirl the sample to sweep them loose.
- Place the measurement vial in the instrument, close the lid and press the measure button.
- Record the value on the sample sheet and in MIST.
- Clean and store the instrument and vial. Fill the vial with DI water for storage, this prevents water spotting.



## SOP-A9

### Calibration of Field Instruments

### Standard Operating Procedures for PG&E Topock Program

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This standard operating procedure (SOP) addresses the procedures and equipment to be used for calibration of field instruments at the Topock site. This SOP will be used for calibration of water level meters, YSI-556 water quality (WQ) meter, In-Situ Troll 9500 WQ meter, and Hach turbidity meter.

#### **Required Documents:**

- Event-specific planned sample table (PST).
- Applicable project work plan or monitoring plan. Refer to Topock Program Sampling, Analysis, Field Procedures Manual (Procedures Manual), Operation and Maintenance (O&M) Manual, QAPP, and Addendum to the QAPP, as required.
- Equipment Manufacturers' Manuals
- Previous Calibration Records
- Field Equipment Binder (documents equipment servicing, calibration, etc...)
- Blank Calibration Sheets (see attached)
- Zobells ORP vs. temperature chart

#### **YSI-556 WQ Meter Calibration Equipment List:**

- pH 4, 7, and 10 buffer solutions
- 1000 micro-mhos/cm conductivity solution
- Zobell's ORP check solution
- Spare batteries
- DI water sprayer
- Rinsate bucket
- Calibration vessels

#### **In-situ Troll 9500 WQ Meter Calibration Equipment List:**

- Quick-cal. solution
- DI water sprayer
- Spare batteries
- Rinsate bucket
- Calibration vessels
- Dissolved oxygen bubbler

### **Hach Turbidity Meter Calibration Equipment List:**

- LabDI water, NTU = <1
- Standard Hach solutions, NTU= 10 and NTU=100
- Spare Batteries
- Paper towels or cloth rag

### **Preparation and Setup:**

- Acquire the existing field logbook for the specific sampling activity and initiate entries.
- Always use fresh, unexpired solutions for calibration.
- Calibration should be performed prior to use each day, but, with the exception of dissolved oxygen (DO) on the YSI-556, may also be completed in the afternoon of the day before use.
- DO calibration on the YSI-556 is dependent on the current barometric pressure and should be calibrated immediately before use.
- The Rugged Dissolved Oxygen (RDO) sensor on the Troll 9500 is very resistant to drift and only requires a 100% saturated water calibration once every 3 months. The 0% oxygen calibration is only required once every 3 months as well.
- Review Field Equipment Binder and equipment servicing records to anticipate next service.
- All equipment and solutions are stored in an air-conditioned office onsite to maintain their integrity.
- The YSI-556, and In-Situ Troll 9500 WQ meters and Hach turbidity meter will be used as the principal field instruments for measuring water quality parameters during groundwater and surface water sampling.

### **Calibration Procedures:**

#### **YSI-556 WQ Meter:**

- Check expiration date of calibration solutions and discard if expired.
- Dissolved oxygen (DO) calibration: Remove the protective probe cover and thoroughly rinse probes and probe cover with DI water. Gently shake the probe body to remove excess water. Pour about ¼ to ½ inch of water into the protective probe cover and screw slightly onto the probe body. The idea is that the ambient atmospheric pressure be maintained within the vessel, while retaining the water saturated air necessary for calibration. Turn the YSI-556 instrument on, it will be in “run” mode. Using the navigation buttons on the face of the instrument, hit “escape”, then scroll down to “calibrate” and hit the “enter” key to begin calibration. Select DO, 2 mil PE (the probe style), then DO %. Enter the current barometric pressure in millimeters of Hg. Of the two YSI-556’s on site, one has an on board barometer and the other doesn’t. When calibrating the instrument with no barometer, simply enter the barometric pressure displayed by the other instrument. The barometric pressure is also available at various web sites and also at airports. Press the “enter” key again to begin the calibration. Wait for 10 to 15 minutes

for the DO probe to stabilize. When satisfied that the reading is stable, press the “enter” key a final time to lock in the calibration. Record the temp., barometric pressure, and DO value on the calibration sheet.

- pH calibration: Thoroughly rinse the probes and calibration cups with DI water and gently shake off the excess liquid. Pour a sufficient volume of pH buffer 4 into a calibration cup and insert the probe body, ensuring that the pH probe is fully immersed, and stir gently. Using the navigation keys as above, “escape” from “run” mode and enter “calibration” mode. You may still be in calibration mode if you’ve just completed the DO calibration. Scroll down to the “pH” entry and push the “enter” key to begin the pH probe calibration process. Select a “3 point calibration”, and enter the first pH buffer value (usually 4.00). Allow several minutes for the probe to stabilize, then press the “enter” key to lock in the calibration. Enter the calibration value on the calibration form. Repeat the above steps for the remaining 2 pH buffers, 7.00 and 10.00, rinsing the probe and calibration cup with DI water between buffers. Dispose of used solutions in the rinsate bucket and thoroughly rinse the calibration vessels with DI water.
- Specific conductance (SC) calibration: Thoroughly rinse the probes and calibration cups with DI water and gently shake off the excess liquid. Pour a sufficient volume of 1000 micro-mhos/cm specific conductivity (SC) solution into a calibration cup and insert the probe body, ensuring that the conductivity probe is fully immersed, and stir gently. The SC probe has sensors located very high in the probe, so near full submergence is required. Using the navigation keys as above, “escape” from “run” mode and enter “calibration” mode. You may still be in calibration mode if you’ve just completed the DO or pH calibrations. Scroll down to the “conductivity” entry and push the “enter” key to begin the SC probe calibration process. Select “specific conductance” and enter the SC solution value (usually 1.000 milli-mhos/cm) making sure of the correct units. The instrument may measure in milli-mhos/cm or micro-mhos/cm, and the calibration standard is commonly referenced in micro-mhos/cm (1.000 milli-mhos = 1000 micro-mhos). Allow several minutes for the probe to stabilize, then press the “enter” key to lock in the calibration. Enter the calibration value on the calibration form. Dispose of used solutions in the rinsate bucket and thoroughly rinse the calibration cups with DI water.
- ORP calibration: Thoroughly rinse the probes and calibration cups with DI water and gently shake off the excess liquid. Pour a sufficient volume of Zobells ORP solution into a calibration cup and insert the probe body, ensuring that the pH/ORP probe is fully immersed, and stir gently. Using the navigation keys as above, “escape” from “run” mode and enter “calibration” mode. You may still be in calibration mode if you’ve just completed the DO, pH or SC calibrations. Scroll down to the “ORP” entry and push the “enter” key to begin the ORP probe calibration process. Consult the Zobells ORP vs. temp. table provided with the ORP solution, and enter the temperature corrected ORP value into the instrument. Allow several minutes for the probe to stabilize, then press the “enter” key to lock in the calibration. Enter the calibration value on the calibration form. Dispose of used solutions in the rinsate bucket and thoroughly rinse the calibration vessels with DI water.
- Proceed with field measurements as needed while noting:
  - probes must be rinsed thoroughly with DI water after each well.

- probes must always be submersed in liquid (DI water or pH 7 buffer when not in use).
- absolutely no air bubbles or leaks should be present in the flow-through cell, repair and/or replace as needed.
- ensure all readings have stabilized prior to recording a measurement.
- all field parameters must be compared with historic data and documented on the field data sheet.

**In-Situ Troll 9500 WQ multisensor probe:**

- Check expiration date of calibration solutions and discard if expired.
- Connect the Troll 9500 to a data collection device (Trimble Recon or equivalent) and start the Win-situ 4 or Pocket-situ 4 program. Tap to highlight the “COM-1-19200” on the start-up screen, then tap “Find” at the bottom left of the screen to connect to the Troll 9500.
- While waiting for the device to connect, spray the Troll 9500 multi-sensors thoroughly with DI water and shake gently over the rinsate bucket to remove excess water. Fill the In-Situ calibration vessel to the “fill” line with “Quick Cal” solution and gently screw the calibration vessel onto the probe body.
- After the data collection device “finds” the Troll 9500, tap “parameters” near the top of the screen and wait for the device to change screens, then tap “Quick Cal” at the bottom right of the screen. After the screen changes, ensure that the correct parameters are checked (pH, SC, and ORP, but *not* DO), then tap “Next” to access the calibration screen.
- Tap “Run” in the middle left of the screen to start the calibration stabilization process. A tone will sound when the pH, ORP, SC, and temperature stabilize to nominal values. The calibration values can be accepted at this point, but it is better to continue to wait until a second tone sounds to indicate that the calibration values are completely stable.
- Tap the “Accept” button at the bottom of the screen to lock the calibration values. After accepting the calibration you will be asked if you want to view the calibration reports. Tap “yes”, review, and document on the field calibration data sheet.

Dissolved oxygen (DO) calibration: (Note: DO calibration is only required once every 3 months) Remove the protective probe cover and thoroughly rinse probes and probe cover with DI water.

- Fill the In-Situ DO calibration bubbler with room temperature potable water and activate the pump to begin oxygenation of the water. Place the multi-sensor into the bubbler and ensure that the Rugged Dissolved Oxygen (RDO) sensor is not in the direct stream of the rising bubbles.
- Connect the Troll 9500 to a data collection device (Trimble Recon or equivalent) and start the Win-situ 4 or Pocket-situ 4 program. Tap to highlight the “COM-1-19200” on the start-up screen, then tap “Find” at the bottom left of the screen to connect to the Troll 9500.
- After the data collection device “finds” the Troll 9500, tap “parameters” near the top of the screen and wait for the device to change screens, then double tap on “DO” in

the parameter list. This will open the DO calibration menu. Tap "Calibrate" to continue.

- You will be asked if you want to edit the barometric pressure, tap "Yes", review and record the barometric pressure on the field calibration sheet. Tap "Next" to continue.
- The next screen will show three choices for calibration: "Calibrate", "Restore defaults then calibrate", and "Restore defaults and don't calibrate". Select option one or option two.
- Tap "Run" to begin the 100% DO saturation calibration routine. A tone will sound when the DO and temperature stabilize to nominal values. The calibration values can be accepted at this point, but it is better to continue to wait until a second tone sounds to indicate that the calibration values are completely stable.
- Tap "Accept" to lock in the 100% DO saturation calibration.
- Tap "Next" to continue. You will then be asked if you want to conduct a 0% DO calibration (Note: This calibration is only required once every 3 months). If you are completing a 100% saturated water calibration only, hit "Next", then "Next" again to complete the single point calibration.
- If you want to complete the 0% calibration as well, immerse the probe in the 0% DO solution (Sodium sulfite ( $\text{Na}_2\text{SO}_3$ ), Catalog No. 0017670) and tap "Next", then "Run". The calibration routine will run as before. When the readings are stable hit "Accept", then review the calibration report and record on the field calibration data sheet. This will complete the DO calibration routine.
- Close the calibration report, tap "Parameters", then "Profiler" to enter run mode.
- If you intend to collect electronic data, name the file and hit "Next" to proceed to the live parameters screen. In this screen you may choose to collect continuous or snapshot data.
- If you do not intend to collect electronic data simply hit "Next" to go to the live parameters screen and record the data by hand as necessary.
- Proceed with field measurements as needed while noting:
  - probes must be rinsed thoroughly with DI water after each well.
  - probes must always be submersed in liquid (DI water when not in use).
  - absolutely no air bubbles or leaks should be present in the flow-through cell, repair and/or replace as needed.
  - ensure all readings have stabilized prior to recording a measurement.
  - all field parameters must be compared with historic data and documented on the field data sheet.

#### **Hach Turbidity Meter:**

- Perform a check as per manufacturer's instructions with Hach DI water and standard solutions. Wipe each calibration vial carefully to remove any dust and place into instrument.
- Press the measure button and record the result on the calibration sheet. Record reading, time, and date on calibration sheet for both DI water and standard solution.

- If the readings are within 10%, proceed with turbidity measurements; If not within this range, troubleshoot and repeat as needed.

**Water-level Meters:**

When using multiple water-level meters at the site it is necessary to calibrate each against the other at least once during the sampling event using the following procedure:

- At a well with shallow depth to water (less than 20 feet), without dedicated tubing, piping, pump, or transducer, lower each water level meter into the well and record the reading to the nearest hundredth of a foot on the calibration sheet along with water-level meter number, time, and date.
- Repeat step #1 at a well with deep depth to water (greater than 70 feet).

## **SOP-A10**

### **Decontamination of Water Sampling Equipment Standard Operating Procedures for PG&E Topock Program**

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This standard operating procedure (SOP) addresses the procedures and equipment to be used for decontamination of sampling equipment at the Topock site.

#### **REQUIRED DOCUMENTS:**

- Event-specific planned sample table (PST).
- Applicable project work plan or monitoring plan. Refer to Topock Program Sampling, Analysis, Field Procedures Manual and QAPP (Procedures Manual), and Operation and Maintenance (O&M) Manual, as required.
- Topock Program Health and Safety Plan (HSP)
- Applicable SOP's

#### **REQUIRED EQUIPMENT AND SUPPLIES:**

- 2 each decontamination vessels
- Potable water source
- Purified water source
- 120 volt power source
- 12 volt power source
- Alconox or Liquinox detergent
- Scrub brushes, nitrile gloves, and spray bottle
- Spill containment
- Pump specific submersible pump controllers

#### **PREPARATION AND SET-UP:**

- Acquire the existing field logbook for specific activity and initiate entries.
- Inspect all equipment necessary to carry out decontamination activities.
- Place spill containment in accordance with *SOP A-13 Spill Prevention, Containment, and Control Measures for Monitoring Well Development, Purging, and Sampling*.
- Fill a clean tub, bucket, PVC pipe, or similar vessel about 2/3 full of potable water and add the appropriate amount of Alconox or Liquinox detergent. If a new or clean vessel is not available a trash bag can be used to line the vessel prior to use.

- Fill a second tub, bucket, PVC pipe, or similar vessel about 2/3 full with clean potable water.
- Have purified water ready for final decon rinse use.

#### **FIELD EQUIPMENT DECONTAMINATION PROCEDURES:**

- Water-level Indicators: Any portion of a water-level indicator that contacts the groundwater must be decontaminated after use by rinsing with purified water, or wiping thoroughly with a paper towel moistened with purified water.
- Instrument probes: Water quality instrument probes (e.g., pH or specific ion electrodes, etc.) that come into contact with groundwater will be decontaminated by rinsing thoroughly with purified water.
- Submersible pumps - Grundfos Rediflo2: TransientRediflo2 submersible pumps will be decontaminated after each use with the following procedure:
  - If attached, detach the discharge tubing from the pump. Carefully drain any excess water to a bucket or the purge water tank. If dedicated, install the dedicated tubing cap to prevent leakage. Coil and store the dedicated tubing in a sealed and marked trash bag. If the tubing is not dedicated, discard.
  - Immerse the pump completely in an Alconox or Liquinox and potable water solution and run the pump at low to medium speed for one minute. A scrub brush will then be used to clean the outside of the pump body using the detergent solution.
  - Allow the pump to drain back into soapy water vessel, then immerse completely in clear potable water and run the pump at low to medium speed for one minute to rinse it. Ensure that the body of the pump is properly rinsed as well.
  - Allow the pump to drain back into clear water vessel, then rinse the pump body thoroughly by pouring purified or bottled water over the entire pump, ensuring that the purified water runs through the internal pump stages as well. Place the pump in a clean plastic bag and store in a plastic tub with the pump reel.
  - If the pump is not to be used immediately, or is to be stored, tag the pump or plastic tub as "decontaminated" with the date and team members initials.
  - If the decontamination vessels contain less than 2 gal. of volume each be sure to change all decontamination fluids for new solutions *after each use*.
- Submersible pumps - 12V GeoSub, Typhoon, Mega-Monsoon: Transient DC-powered submersible pumps will be *decontaminated* after each use as above *or* using the following procedures. Pressurized gas powered bladder pumps will be decontaminated after each use using the following procedures:
  - If attached, detach the discharge tubing from the pump. Carefully drain any excess water to a bucket or the purge water tank. If dedicated, install the dedicated



tubing cap to prevent leakage. Coil and store the dedicated tubing in a sealed and marked trash bag. If the tubing is not dedicated, discard.

- Using the tools provided, disassemble the pump body to expose the pumping mechanism. Immerse all parts in an Alconox or Liquinox and potable water solution and scrub thoroughly with a clean scrub brush. Gently shake the pump parts to remove excess soapy water, taking care not to spill or splash any fluids outside of the decon. vessel. Immerse all pump parts in clean potable water and rinse thoroughly. Gently shake the pump parts to remove excess rinse water, taking care not to spill or splash any fluids outside of the decon. vessel. Carefully pour purified (or bottled) water over and through all pump parts. Gently shake the pump parts to remove excess purified rinse water, taking care not to spill or splash any fluids outside of the decon. vessel. Reassemble the pump and place in a clean plastic bag, then store in a plastic tub with the pump reel.
- Bladder pumps do not typically include a reel and will be stored in a clean plastic bag only.
- If the pump is not to be used immediately, or is to be stored, tag the pump or plastic tub as decontaminated with the date and team members initials.
- If the decontamination vessels contain less than 2 gallons of volume each, be sure to change all decontamination fluids for new solutions *after each use*.
- Water-level Indicators: Any portion of a water-level indicator that contacts the groundwater must be decontaminated after use by rinsing with purified water, or wiping thoroughly with a paper towel moistened with purified water.
- Instrument probes: Water quality instrument probes (e.g., pH or specific ion electrodes, etc.) that come into contact with groundwater will be decontaminated by rinsing thoroughly with purified water.
- Follow SOPs in Program Procedures Manual and O&M Manual for handling of investigation-derived waste (IDW). Such IDW is typically disposed to the process stream at IM-3. See an IM-3 operator for assistance in off-loading the decon fluids.

## SOP-A11

### Total Depth Measurements

### Standard Operating Procedures for PG&E Topock Program

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This standard operating procedure (SOP) addresses the procedures and equipment to be used for manually measuring the total depth at groundwater monitoring wells and production wells.

#### REQUIRED DOCUMENTS

- 1) Event-specific sampling and analysis plan (SAP).
- 2) Applicable project work plan or monitoring plan. Refer to Topock Program Sampling, Analysis, Field Procedures Manual and QAPP (Procedures Manual), and Operation and Maintenance (O&M) Manual, as required.
- 3) Topock Program Health and Safety Plan (HSP)
- 4) Well construction logs/specifications
- 5) Previous total depth data
- 6) Blank sampling logs and field notebook

#### PREPARATION & SETUP

- 1) Review event-specific SAP or event-specific field instructions, previous sampling logs, Procedures Manual, O&M Manual, and HSP.
- 2) Ensure that the measurement probe (weighted tape measure) has been decontaminated (check for label/tag) or decontaminate as needed following SOP-A10 *Decontamination of Water Sampling Equipment*.
- 3) Ensure the tape measure is not crimped and that it will hang free and clear of any obstructions enabling it to fully extend to the bottom of the well.
- 4) Initiate field logbook for sampling activity.
- 5) If a transducer is present in the well and it is necessary to remove transducer to allow well access, refer to SOP-C1, *Solinst Pressure Transducers*.
- 6) Calibrate wrist-watch to the atomic clock at the Topock Compressor Station.

#### MEASUREMENT PROCEDURES

- 7) Prepare Total Depth measurement log (use attached form dated March 2005).
- 8) Decontaminate the entire length of the measuring tape before using, according to SOP-A10, *Decontamination of Water Sampling Equipment*.
- 9) Place measurement tape into well and lower until the bottom of the probe touches the bottom of the well. Note total depth (TD) measurement to mark on well casing, if there is no mark on casing measure to the north. Repeat 3 times and record final TD to the

nearest hundredth of a foot on the log. Also note the condition of the well bottom (i.e. hard bottom, soft bottom). Record well identification, time, date, TD, and measurement tape identification.

- 10) Compare TD measurement with previous data and note discrepancies on the sampling form. Repeat step #8 if an unexpected discrepancy is noted.
- 11) Decontaminate the entirety of the measuring tape, or any portion of the instrument that came in contact with water, following SOP-A10, *Decontamination of Water Sampling Equipment*.

## SOP-A12

### Field Water Quality Measurements for Grab Samples Standard Operating Procedures for PG&E Topock Program

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This standard operating procedure (SOP) provides general guidelines for using the YSI-556 water quality (WQ) meter or similar device for field measurements of grab groundwater samples for pH, specific conductance, turbidity, dissolved oxygen, oxidation-reduction potential, and temperature. This SOP specifically covers collection of WQ measurements when a flow-through cell cannot be used (for example, surface water sample collection, active extraction well sampling, screening samples collected during drilling operations, grab samples from a well using a bailer, groundwater sample using a Hydrasleeve sampler, etc.). Instruments will be calibrated daily in accordance with the manufacturer's instructions and SOP-A9, *Calibration of Field Instruments*.

#### **REQUIRED DOCUMENTS:**

- Event-specific planned sample table
- Monitoring Plan for Groundwater and Surface Water Monitoring Program (current revision)
- Topock Program Sampling, Analysis, Field Procedures Manual (Procedures Manual), Operation and Maintenance (O&M) Manual, and Quality Assurance Project Plan and Addendum to the QAPP for site-wide groundwater monitoring requirements
- Topock Program Health and Safety Plan
- Manufacturer's instructions for the YSI-556 WQ meter or equivalent
- SOP-A9, *Calibration of Field Instruments*
- SOP-A10, *Decontamination of Water Sampling Equipment*
- Well construction logs/specifications
- Previous sampling logs or tabular historic field data
- Current site access map
- Blank sampling logs
- Groundwater sampling field notebook

#### **REQUIRED EQUIPMENT:**

- YSI-556 WQ meter or equivalent
- YSI-556 storage cap or equivalent
- De-ionized water in a spray bottle
- Electronic data collection unit with a Topock-event-specific database
- Bucket and pouring lid

#### **PREPARATION AND SETUP:**

- Review event-specific planned sample table or event-specific field instructions, previous sampling logs, the Procedures Manual and O&M Manual, and the Health and Safety Plan.

- Acquire the existing field logbook for the specific field activity, and initiate entries documenting field activities.
- Inspect all equipment: YSI-556 WQ meter or similar device, de-ionized water in spray bottle, and electronic data collection unit.
- Prior to each day's use, calibrate the YSI-556 WQ, and clean the probes and storage cup of the field WQ meters according to SOP-A9, *Calibration of Field Instruments*, and the manufacturer's instructions. Document that instrument calibration has occurred and that parameters are calibrated to within the specifications in SOP-A9 in the field logbook.

#### **MEASUREMENT MEASUREMENT PROCEDURES:**

1. Transfer a small volume of sample water – enough to immerse all probes – into the WQ instrument storage cup or a small container. (The instrument storage cup is preferred as it can be sealed and will reduce risk for small volume water spills.)
2. Submerge the probes of the WQ meter into the water.
3. Allow instrument readings to stabilize, and collect WQ data in the electronic data collection unit and on the field data sheet.
4. Note in the field forms that the dissolved oxygen and oxidation-reduction potential results are approximate because a flow-through cell could not be used.
5. Water used for the WQ reading will be emptied into the purged wastewater tank.
6. When sampling is complete, rinse the instrument probes and the storage cup or small container with de-ionized water in accordance with SOP-A10, *Decontamination of Water Sampling Equipment*, catching the rinsate in the bucket.
7. Mount the specially cut “pouring lid” on the bucket, and carefully pour the contents into the purge water storage tank.
8. After sampling is complete, carefully clean and store the WQ instrument in accordance with the manufacturer's recommendations in preparation for the next use.

## **SOP-A13**

### **Spill Prevention, Containment, and Control Measures for Monitoring Well Development, Purging, and Sampling Standard Operating Procedures for PG&E Topock Program**

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This standard operating procedure (SOP) addresses the procedures and equipment to be used for spill prevention, containment, and control associated with monitor well activities at the Topock site. This SOP applies to containment and control of potential spills from purge and equipment decontamination water generated during the development, purging, and sampling of monitoring wells.

#### **REQUIRED DOCUMENTS:**

- Topock Program Health and Safety Plan (HSP).
- Emergency Notification Binder.
- SOP-A16 Access Routes and Sensitivity to Biological and Cultural Resources.
- SOP-B6 Disposal of Waste Fluid and Solids (IDW).

#### **REQUIRED EQUIPMENT:**

- Large (10' by 11' by 4" deep) bermed spill containment pad. This pad is to be placed on the ground beneath the truck or UTV mounted purge water tank. It will be placed so that the work area at the rear of the vehicle is covered and so that small spills or drips from the purge tank or work area are captured.
- Medium (4' by 8' by 4" deep) bermed spill containment pad. This pad is used at the FLUTE wells, Blatypus wells, and peristaltic wells, or for additional work space at any well.
- Small (4' by 4' by 4" deep) bermed spill containment. This pad fits inside the UTV beds beneath the purge tank when sampling using UTVs (flood plain and special access wells, see SOP-A16).
- Small (2' by 4' by 4" deep) bermed "pizza cut" spill containment pad for placement around well heads.
- Additional spill containment pads as necessary or as directed by the field team leader.
- Purge water tanks as appropriate for the task.
- Extra spring clamps, fittings, paper towels, and tools, etc...
- Small trash bags for temporary storage of dedicated transducers removed from wells.
- Trash pump, for transferring purge and decon. water at IM-3.
- 4 or more 5-gallon buckets and specially cut "pouring lid"
- Hydrophilic sorbent material (absorbent pads, booms, or mats)
- Plastic sheeting
- Shovel and/or other hand tools
- Plastic bags or buckets for storage and disposal of used sorbent material

### **PREPARATION & SETUP:**

- Review this and other applicable SOP's, as well as the Emergency Notification Binder.
- Inspect all required spill containment pads for holes or tears that would compromise their effectiveness. Report such damage to the CH2M HILL Topock site coordinator or field team leader. Repair or replace damaged spill containment pads before use.
- Load spill containment equipment onto appropriate vehicle(s) and secure.

### **GENERAL SPILL PREVENTION PRACTICES:**

- Topock is a "No Spill" site. We have all the necessary spill containment equipment, *use it!*
- Place all items exposed to purge or decon water on the spill containment pads, not directly on the ground.
- No drops of well or purge water should ever hit the ground. Use 5-gallon buckets and spill containment pads to prevent any water from sampling equipment reaching the ground.
- Double check all fittings and connections for tightness before activating any pump.
- Check all fittings and connections for leaks immediately after starting the pump.
- Place the flow through cell and associated fittings in a 5 gal. bucket. There is often a small amount of leakage from the cell.
- If a spill does occur, immediately stop the pump, or take such action as is necessary to safely mitigate the volume or severity of the spill.
- Report all spills to the CH2M HILL site coordinator or field team leader immediately, no matter how small.
- Only use restroom facilities at the CH2M HILL job trailer or the IM3 facility.

### **SPILL RESPONSE ACTIONS:**

In the event purge water is spilled outside of containment basins, the field team will take the following actions:

### **PROCEDURES:**

- Stop the pump or take what action is necessary to safely stop or mitigate the volume or severity of the spill.
- Notify the CH2M HILL Site Coordinator or field team leader immediately, no matter how small the spill, and follow their instructions. PG&E and CH2M HILL staff may want to photo document the incident, so do not proceed with any clean-up until cleared to do so.
- The CH2M HILL Site Coordinator will perform the notifications as required in the Emergency Notification Binder and complete the Notification Documentation Form provided in the Binder.
- When cleared to do so, use sorbent material and bermed spill containment to absorb and contain the spilled purge water if possible.

- Transfer any contained purge water into the purge water tank.
- When cleared to do so, manually dig up any saturated soil and place in 5-gallon bucket(s) or other appropriate containers for disposal.
- Dispose of containerized soil, used sorbent material, and gloves in accordance with SOP-B6, *Disposal of Waste Fluids and Solids (IDW)*.

### **CONTAINMENT SCENARIO 1: SAMPLING OF UTV ACCESS WELLS USING DEDICATED OR TRANSIENT PUMPS:**

For monitor well sampling at UTV access wells with dedicated or transient pumps, purge water is pumped to a tank placed on 4' X 4' spill containment pad in the back of the UTV. The UTV is parked on a 10' X 11' spill containment pad adjacent to the monitoring well to be sampled. Purge water is pumped directly to a YSI flow through cell contained in a 5 gal. bucket in the work area, and then into the purge tank through a discharge tube at the appropriate purge rate for that well. The small amount of leakage from the YSI flow cell is contained in a 5-gallon bucket and is manually transferred into the purge water tank using the special "pouring lid" to prevent spills.

#### **Potential Spill Scenarios:**

- Overfill of UTV-mounted purge water tank
- Failing to place lid on purge tank before mobilizing to next well
- Spills at time of tubing disconnection from tank or during manual transfer into tank from bucket
- Spills from tubing disconnection or leakage from flow cell
- Spills from tubing disconnection at well head between dedicated and non-dedicated tubing
- Spilled bucket of purge water from flow cell
- During removal of dedicated transducers from wells

#### **PROCEDURES:**

- Before mobilization to any well, place appropriately sized tanks on small 4' X 4' bermed spill containment pads in UTV beds.
- Evaluate the remaining capacity of the tank prior to initiating well purging to ensure that there is sufficient capacity to hold the amount of purge water anticipated to be generated during purging of the well. Offload if needed following procedures under Containment Scenario 4.
- At the well, deploy the large 10' X 11' bermed spill containment pad adjacent to the well. Park the UTVs with purge water tanks on the spill pad and as close to the well head as possible, while still leaving room to work. Deploy a second or third spill containment pad as necessary to ensure adequate coverage. There should be no exposed soil between the work area and the well.
- Place the small 2' X 4' "pizza cut" bermed spill containment around well head.



- For a dedicated pump well: Attach the transfer tubing to the existing dedicated pump tubing at the top of the well so that the tubing connection is located *inside* the well protective casing and any leakage will be contained within the well head.
- Secure the transfer tubing to the bottom connection of the flow cell using hose clamps. Attach the flow through cell discharge tubing to the top fitting of the flow through cell and place the cell into a 5 gal. bucket to contain any leakage from the cell.
- Route the discharge tubing to the purge tank opening and secure using spring clamps.
- Stuff a large, unused trash bag into the top of the protective casing above the tubing connection so that any leakage or spray will be contained inside the protective casing.
- For a transient pump well: Attach the new or well specific dedicated discharge tubing to a decontaminated transient submersible pump and install into well following *SOP-A1 Purging and Sampling of Groundwater Monitoring Wells*. Transport the pump to the well head in a 5 gal. bucket to contain leakage of any residual water. With no tubing connections at the top of the well, no additional spill containment is necessary at the well head.
- All equipment is to be placed on the 10' X 11' bermed spill containment pad prior to the start of purging.
- Double check all tubing connections for tightness before activating the pump.
- Double check that discharge tubing is properly secured with spring clamp at purge water tank.
- Immediately after starting the pump, check all tubing connections for leakage.
- During purging, field staff will monitor the transfer of water into the purge water tank. When the tank reaches 80% full, discontinue purging to that tank. Depending on the situation, either stop the pump and properly dispose the purge water according to the SOP's in Program Procedures Manual and Operation and Maintenance (O&M) Manual for handling of investigation-derived waste (IDW), or briefly stop the pump and switch to a different purge tank. Such IDW is typically disposed to the process stream at IM-3, see Containment Scenario 4 below for instructions.
- At the completion of purging, stop the pump and carefully disconnect the discharge tubing from both ports of the flow through cell, working inside the bucket and over containment, and allow the tubing and flow cell to drain inside of the bucket.
- Working over containment, clamp the pump discharge tubing inside a 5 gal. bucket and start the pump at low speed. Collect the sample directly from the pump discharge line, allowing excess flow to pump into the 5 gallon bucket.
- When sampling is complete, stop the pump and carefully disconnect and drain all other tubing while working over spill containment to ensure that any drips of purge water are contained on the pad.
- If a transient pump was installed, double fold the end of the dedicated down-hole tubing and secure with wire-ties to prevent leakage during pump removal. Carefully remove the

pump from the well while wiping the water and power lines as they emerge with a paper towel, and coiling the tubing neatly. As the pump clears the well, place it immediately in a 5 gal. bucket, over containment, to drain.

- Disconnect the dedicated tubing from the pump and double fold the end of the tubing, securing with wire ties to prevent leakage of the residual water still contained in the tubing. Place the tubing in its designated storage bag. At the end of the day, use compressed air from the sampling truck to carefully push the residual water out of the dedicated tubing and into the purge tank.
- Place the specially cut “pouring lid” on any 5 gallon buckets containing purge water and carefully pour contents into the purge water tank.
- If any purge water is present on the containment pad, either wipe up the water using paper towels, or collect it a bucket and dump it to the purge tank. Dispose the wet paper towels with the rest of the contaminated trash.
- Close purge water tank openings and ensure that the tank is well secured to the UTV.
- Before mobilization, check back of UTVs for any drips that may have occurred and wipe up with a paper towel if needed.
- Pull the UTV off of the spill containment pad, fold the pad, load, and secure.
- Mobilize to the next well to be sampled and repeat the preceding steps.
- When the UTV-mounted purge water tank is 80% full, continue with procedures under Containment Scenario 4 to dump the water at IM-3.

## **CONTAINMENT SCENARIO 2: SAMPLING UTV ACCESS WELLS USING A PERISTALTIC PUMP:**

For monitor well sampling using a peristaltic pump, purge water is placed in a small UTV or truck mounted purge tank, or 5 gallon bucket with lid. The purge tank or bucket is situated adjacent to the monitoring well to be sampled. Purge water is pumped directly to a YSI flow cell in a 5 gal. bucket, then to a 5-gallon bucket with lid, or purge tank for storage. The purge water in the bucket is manually dumped to the purge tank using the specially cut “pouring lid” to prevent spills.

### **Potential Spill Scenarios:**

- Spills at time of hose disconnection from pump mechanism
- Spills during manual transfer into purge tank from bucket
- Spills from leakage from flow cell
- During removal or placement of tubing
- Disrupted bucket of purge water

## **PROCEDURES:**

- Before mobilization to any well, place appropriately sized tank on small 4' X 4' bermed spill containment pad in UTV bed.
- Evaluate the remaining capacity of the tank prior to initiating well purging to ensure that there is sufficient capacity to hold the amount of purge water anticipated to be generated during purging of the well. Offload if needed following procedures under Containment Scenario 4.
- At the well, deploy the large 10' X 11' bermed spill containment pad adjacent to the well. Park the UTV with the purge water tank on the spill pad and as close to the well as possible, while still leaving room to work. Deploy a second or third spill containment pad as necessary to ensure adequate coverage. There should be no exposed soil between the work area and the well head.
- Place the small 2' X 4' "pizza cut" bermed spill containment around well head. With no tubing connections at the well, there is no need for additional spill containment at the well-head.
- Install the dedicated down-hole tubing. Take care to ensure that any residual water in the tubing is contained on spill pads. In the slant wells (MW-52's, 53's and 56's) the dedicated tubing is stored in the well itself.
- Attach the peristaltic pump-head tubing to both the dedicated down-hole tubing and the pump discharge tubing, and use a wire-tie to secure each. Clamp the pump-head tubing into the peristaltic pump, ensuring that it is not pinched in the clamp (this could wear a hole), and place the pump on the 10' X 11' bermed spill containment pad.
- Attach the pump discharge tubing to the bottom connection of the flow cell and secure with a wire-tie. Attach the flow cell discharge tubing to the top fitting of the cell, secure with a wire-tie and place the cell into a 5 gal. bucket to contain any leakage.
- Route the discharge tube to a 5-gallon bucket or purge tank and secure with a spring clamp. Make sure additional empty purge buckets are available.
- All equipment is to be placed on the 10' X 11' bermed spill containment pad prior to the start of purging.
- Double check all tubing connections for tightness before activating the pump.
- Double check that discharge tubing is properly secured with spring clamp at purge water tank or bucket.
- Immediately after starting the pump, check all tubing connections for leakage.
- During purging, field staff will monitor the transfer of water into the bucket or purge water tank. If purging to a 5 gallon bucket, briefly shut down the pump and move the discharge line to another 5 gal. bucket when the bucket reaches 50% full, then use the specially cut "pouring lid" to transfer the water from the purge bucket to the purge tank. If purging to the UTV mounted purge tank, discontinue purging to that tank when the tank reaches 80% full. Depending on the situation, either stop the pump and properly

dispose the purge water according to the SOP's in Program Procedures Manual and O&M Manual for handling of investigation-derived waste (IDW), or briefly stop the pump and switch to a different purge bucket or tank. Such IDW is typically disposed to the process stream at IM-3. Refer to Containment Scenario 4 below for instructions.

- At the completion of purging, stop the pump and carefully disconnect the discharge tubing from the flow through cell, working inside the bucket and over containment, and allow the tubing and flow cell to drain inside of the bucket.
- Working over containment, clamp the pump discharge tubing inside a 5 gal. bucket and start the pump. Collect the sample directly from the pump discharge line, allowing excess flow to pump into the 5 gallon bucket.
- When sampling is complete, stop the pump and carefully disconnect and drain all other tubing while working over spill containment to ensure that any drips of purge water are contained on the pad.
- Remove the dedicated tubing from the well and carefully drain any remaining water into purge tank. Working over containment, coil the tubing and place it into the marked ziplock bag from which it was removed.
- Place the specially cut "pouring lid" on any 5 gallon buckets containing purge water and carefully pour contents into the purge water tank.
- If any purge water is present on the containment pad, either wipe up the water using paper towels, or collect it a bucket and dump it to the purge tank. Dispose the wet paper towels with the rest of the contaminated trash.
- Close purge water tank openings and ensure that the tank is well secured to the UTV.
- Before mobilization, check back of UTVs for any drips that may have occurred and wipe up with a paper towel if needed.
- Pull the UTV off of the spill containment pad, fold the pad, load, and secure.
- Mobilize to the next well to be sampled and repeat the preceding steps.
- When the UTV-mounted purge water tank is 80% full, continue with procedures under Containment Scenario 4.

### **CONTAINMENT SCENARIO 3: SAMPLING TRUCK ACCESS MONITOR WELLS:**

For monitor well sampling in upland, truck accessed areas of the site, purge water is placed in a 400-gallon truck-mounted tank. Purge water is pumped directly into this tank via a transfer tube at rates up to 10 gpm. Purge water leakage from the YSI flow cell is contained in a 5-gallon bucket and is manually transferred into the purge water tank using the specially cut "pouring lid". For upland wells that are UTV access only, follow procedures under Containment Scenarios 1 or 2, as applicable.

#### **Potential Spill Scenarios:**

- Overfill of truck-mounted purge water tank

- Spills at time of hose disconnection from tank or during manual transfer into tank from bucket
- Spills from hose disconnection at well head between dedicated and non-dedicated tubing
- Spills from hose disconnection or leakage from flow cell
- During removal of dedicated transducers in wells
- Disrupted bucket of purge water
- During removal or placement of pump and/or tubing
- Spills or leaks from “splitter” if used at wells with higher velocity purge rates

**PROCEDURES:**

- Evaluate the remaining capacity of the tank prior to initiating well purging to ensure that there is sufficient capacity to hold the amount of purge water anticipated to be generated during purging of the well. Offload if needed following procedures under Containment Scenario 4.
- At the well, deploy the large 10' X 11' bermed spill containment pad adjacent to the well. Park the sampling truck on the spill pad and as close to the well as possible, while still leaving room to work. Deploy a second or third spill containment pad as necessary to ensure adequate coverage. There should be no exposed soil between the work area and the well head.
- Place the small 2' X 4' “pizza cut” bermed spill containment around well head.
- For a dedicated pump well: Attach the transfer tubing to the existing dedicated pump tubing at the top of the well using the riser and valve provided.
- If a splitter is used to split the flow between the flow cell and the purge tank at high flow wells, wrap the splitter with a fresh trash bag such that any leakage or spray will be contained inside the well head or on containment. Route the high flow purge line to the purge tank and secure.
- For a transient pump well: Working over containment, attach the well specific dedicated discharge tubing to a decontaminated transient submersible pump and install into well following *SOP-A1 Purging and Sampling of Groundwater Monitoring Wells*. Transport the pump to the well head in a 5 gal. bucket to contain leakage of any residual water. With no tubing connections at the top of the well, no additional spill containment is necessary at the well head.
- Secure the transfer tubing to the bottom connection of the flow cell using hose clamps. Attach the flow through cell discharge tubing to the top fitting of the flow through cell and place the cell into a 5 gal. bucket to contain any leakage from the cell.
- Route the flow cell discharge tubing to the purge tank opening and secure using spring clamps.
- All equipment is to be placed on the 10' X 11' bermed spill containment pad prior to the start of purging.
- Double check all tubing connections for tightness before activating the pump.

- Double check that discharge tubing is properly secured with spring clamp at purge water tank.
- Immediately after starting the pump, check all tubing connections for leakage.
- During purging, field staff will monitor the transfer of water into the purge water tank. When the tank reaches 90% full, discontinue purging to that tank. Stop the pump and properly dispose the purge water according to the SOP's in Program Procedures Manual and O&M Manual for handling of investigation-derived waste (IDW). Such IDW is typically disposed to the process stream at IM-3. Refer to Containment Scenario 4 below for instructions. Resume pumping to the empty tank.
- At the completion of purging, stop the pump and carefully disconnect the discharge tubing from the flow through cell, working inside the bucket and over containment, and allow the tubing and flow cell to drain inside of the bucket.
- Clamp the pump discharge line to the sink at the rear of the sampling truck and start the pump at low speed. Collect the sample over containment directly from the pump discharge line, allowing excess flow to pump into the sink.
- When sampling is complete, stop the pump and carefully disconnect and drain all other tubing while working over spill containment to ensure that any drips of purge water are contained on the pad.
- If a transient pump was installed, double fold the end of the dedicated down-hole tubing and secure with wire-ties to prevent leakage during pump removal. Carefully remove the pump from the well while wiping the water and power lines as they emerge with a paper towel, and coiling the tubing neatly. As the pump clears the well, place it immediately in a 5 gal. bucket, over containment, to drain.
- Disconnect the dedicated tubing from the pump and double fold the end of the tubing, securing with wire ties to prevent leakage of the residual water still contained in the tubing. Place the tubing in its designated storage bag. At the end of the day, use compressed air from the sampling truck to carefully push the residual water out of the dedicated tubing and into the purge tank.
- Place the specially cut "pouring lid" on any 5 gallon buckets containing purge water and carefully pour contents into the purge water tank.
- If any purge water is present on the spill containment pad, either wipe up the water using paper towels, or collect it a bucket and dump it to the purge tank. Dispose the wet paper towels with the rest of the contaminated trash.
- Ensure that all water is pumped from sink into the truck-mounted tanks. Inspect back of truck and sink and wipe off any purge water drops with paper towel.
- Before mobilization, ensure that all tank openings are secure, and wipe up any drips that may have occurred in the work area.
- Mobilize to the next well to be sampled and repeat the preceding steps.

- When the truck mounted purge water tank is 90% full, continue with procedures under Containment Scenario 4 below.

**CONTAINMENT SCENARIO 4: TRANSFER OF PURGE WATER FROM TRUCK MOUNTED TANK OR UTV MOUNTED TANK TO IM-3:**

When the truck or UTV mounted purge water tank requires emptying, the following procedures will be used. Purge water is transferred into a 5,500-gallon storage tank at the IM3 Treatment Plant, at rates up to 20 gpm. The 5,500-gallon tank is located within a permanent containment structure.

**Potential Spill Scenarios:**

- Overfill of tank at final storage location
- Pump or transfer hose leakage during pumping into tank or at time of hose disconnection.

**PROCEDURES:**

- See an IM-3 plant operator for assistance in transferring purge water.
- Park the truck or UTV on the bermed spill containment pad at the IM-3 transfer location.
- Follow the instructions of the IM-3 plant operator and use the trash pump to transfer purge water from the purge tank to the receiving tank. The IM-3 plant operator and field staff will be present during the entire transfer to monitor the water level in the receiving tank and to ensure no leakage or spills occur. If the receiving tank approaches being full, discontinue transfer operations.
- At the completion of transfer operations, take care when removing the transfer hose from the truck or UTV mounted purge water tank opening, since some residual water will be present in the hose.
- Secure tank openings on the truck-mounted or UTV-mounted purge water tank.
- Proceed to the next well for sampling.

**SOP-A14**  
**Pore Water Sampling**  
**Standard Operating Procedures for PG&E Topock Program**

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This standard operating procedure (SOP) addresses the procedures and equipment to be used for pore water sampling at the Topock site. This SOP should be used for pore water sampling stations on the Colorado River.

**REQUIRED DOCUMENTS**

- 1) Event-specific sampling and analysis plan (SAP).
- 2) Pore Water and Seepage Study Work Plan. Refer to Topock Program Sampling, Analysis, Field Procedures Manual and QAPP (Field Procedures Manual), and Operation and Maintenance (O&M) Manual, as required.
- 3) Topock Program Health and Safety Plan (HSP).
- 4) Blank sampling logs and field notebook.

**PREPARATION & SETUP**

- 1) Review event-specific SAP or event-specific field instructions, Work Plan, O&M Manual, and HSP.
- 2) Initiate field logbook for sampling activity.
- 3) Inspect all equipment and calibrate field water quality (WQ) meters according to SOP-A9, *Calibration of Field Instruments*.
- 4) Inventory sample bottles, required analyses, and confirm the lab courier schedule.
- 5) Field-check and set up sampling equipment: drive point sampler, WQ meters, health and safety apparatuses (life vest, rescue rope, life preserver), water depth meter or depth-finder, weighted tape, peristaltic pump, filters, sufficient tygon and silicone tubing, sampling equipment, etc.
- 6) Conduct tailgate meeting to discuss health and safety issues and event objectives.

**SAMPLING PROCEDURES**

- 1) Prepare pore water sampling log (use attached form).
- 2) The sampling team will travel to each pore water sampling station in a motorized boat. A safety inspection of the boat will be performed by the field crew prior to boarding (check for fire extinguisher, etc.). Samples will be collected from selected stations along transects across the river.
- 3) An industry standard (Trimble or similar) resource grade handheld DGPS unit (GeoXT or similar) will be used with real-time correction (wide area augmentation system) to locate the sampling stations within a 1 meter radius (68% of the time, commonly referred



to 1 sigma accuracy). At each location, two anchors should be positioned upstream at least 10 feet from each other. Record the GPS coordinates on the sampling log. In the event a sampling station is too shallow to safely approach by boat, the next closest location with adequate depth will be sampled and a remark noted on the sampling log with the new GPS coordinates.

- 4) Record the depth of the river at each sampling station using the depth-finder or a weighted tape. If a weighted tape is used, read the tape at the river water surface when the weight touches the river floor. Record river depth on the sample log.
- 5) Samples will be collected at a depth below the river bottom determined from the pilot study.
- 6) Samples are to be collected using a drive point sampler and variable-speed peristaltic pump with 3/4-inch tygon tubing. Dedicated tubing will be used for each sample. Once the sampling depths have been calculated for each station, pre-cut two pieces of tygon tubing and attach them to the drive point sampler. Lower the sampler and tubing until the tip of the sampler touches the river bottom. Then hand-drive the sampler into the river sediment until desired depth is achieved. Attach the discharge end of the sample tubing to the flow cell of the water quality meter. Start the peristaltic pump and purge 3 sampler volumes. Record the time, pH, conductivity, turbidity, dissolved oxygen, temperature, salinity, TDS, and ORP on the field log. Note and provide qualifying remarks if parameter readings are anomalous or unstable due to an instrument problem. Turn off the peristaltic pump, remove tubing from the flow cell, and restart the pump. Attach a 0.45 micron filter when sampling for Cr(T) by USEPA Method 6010B or for Cr(VI) by USEPA Method 7199. Refer to SOP-A6 in the Field Procedures Manual for filtration procedures. Pump approximately 500 ml through the system and begin filling the applicable sample bottles. Remove the filter prior to filling sample bottles for the other analyses, which do not require filtration. Record all sample information on the field log.
- 7) Collect remaining samples for analyses according to the event-specific SAP. Use a new piece of tygon tubing and change out the flexible silicone tubing in the peristaltic pump at each location.
- 8) Follow the Field Procedures Manual and O&M Manual for sample handling and management, equipment decontamination, and investigation-derived waste (IDW) management.
- 9) Decontaminate the sampling apparatus after each sample is collected. The decontamination will be a triple rinse with 5-gallon buckets containing soapy water, potable water, and deionized (DI) water, respectively. First, the apparatus will be placed in the soapy water and the outside scrubbed. Then pump approximately 3 sampler volumes through the apparatus using the peristaltic pump and dedicated tubing used. Re-circulate the water back into the 5-gallon bucket. Repeat the rinse with the potable and deionized water.
- 10) Collect an equipment rinse blank after the first decontamination of the day. Collect the sample by attaching the decontaminated sampling apparatus to a length of clean

peristaltic tubing. Run deionized water through the sampler and collect a sample to be shipped to the analytic laboratory for hexavalent chromium analysis.

## SOP-A16

### Access Routes

### Standard Operating Procedures for PG&E Topock Program

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This standard operating procedure (SOP) addresses the procedures to be used when accessing wells or other sampling stations at the Topock site. This SOP should be used for all travel to collect data on site. All field personnel and subcontractors are required to read this SOP and sign on the Employee Signoff Form. Although no groundwater sampling is currently planned to be conducted at any SWFL habitat wells during SWFL nesting season, the procedures below will be used if such sampling does become necessary.

#### **OVERVIEW:**

Figure 1 at the end of this SOP shows the Topock project groundwater and surface water data collection locations. The map also shows the access routes used for sampling and transducer downloads. These lines indicate vehicle access on existing roads, and indicate where utility vehicle (UTV) or foot access is used at locations where pickup truck access is not allowed. Purple lines on the map indicate where either pickup trucks or UTVs are used. Blue lines indicate routes with allowed access by UTV but not by pickup truck. Black dotted lines indicate foot access routes. Where the black dots overlay the blue routes on the floodplain area, the access is on foot or by electric UTV during the southwestern willow flycatcher (SWFL) nesting season (May 1<sup>st</sup> through September 30<sup>th</sup>), and by any UTV outside of nesting season. The access routes with specific mitigation measures or access procedures discussed herein are highlighted in green.

There are 3 access procedures that are to be followed depending on when/where fieldwork is to occur:

A = Universal for the site

B = SWFL habitat during SWFL summer nesting season (May 1<sup>st</sup> through September 30<sup>th</sup>)

C = Upland close to cultural resources (Year-round)

A site sensitivity orientation is to be provided to all field personnel regarding cultural and biological resources and the spiritual importance of the geographic area and the river to local tribes. The orientation will emphasize the need to stay within the established, marked access routes and work areas, and to prevent enlargement of previously used areas.

### **A SITES ACCESS PROCEDURES – APPLIES TO ALL SITES:**

Personnel must obey the following procedures when accessing all data collection sites (refer to Figure 1):

- Access by vehicles is restricted to established roads or tracks. For off-road access the number of vehicles used should be minimized.
- All vehicles are to observe a 10-mph speed limit on Historic Route 66 (H-66), drive in the center of H-66 to avoid wear on the H-66 shoulders, and not cut corners when exiting H-66 to access well locations.
- All vehicles are to travel slowly off-road (5 mph speed where possible) to give time to observe and avoid wildlife and minimize noise, dust, and vehicle rutting.
- Most off-road access is to be by low-impact utility vehicles (UTV's) which carry sampling or data collection equipment as well as purge water tanks.
- Access beyond the purple lines on the map is by UTV (blue lines). Dotted black lines indicate access by foot or electric UTV. Access follows consistent routes or paths.
- Minimize time near possible wildlife habitat.
- Coordinate with on-site field client representative (FCR) to prevent unauthorized access to site areas.

These minimum procedures are followed for all data collection locations. More rigorous procedures are to be used at locations where potential concerns have been identified.

### **B SITES ACCESS PROCEDURES:**

Field crews are to follow the following mitigation measures for the floodplain wells listed below during the SWFL nesting season, May 1<sup>st</sup> through September 30<sup>th</sup>. The universal A sites measures that were outlined above will also apply at these locations. Site B locations include:

- Well clusters MW-27, MW-34, and shoreline location R-27 on the Bureau of Land Management (BLM) managed area
- Well clusters MW-22, MW-43, MW-52, MW-53, and shoreline location R-22 on the Havasu National Wildlife Refuge (HNWR) area

Well sampling, transducer data collection, and any other work activities will not occur during the biennial protocol survey for SWFL's. Upon completion of the surveys, the onsite biologist will approve/disapprove of work activities depending on the survey results. If a SWFL is not detected, then the biologist will permit the activities. If a SWFL is detected, then the biologist will not permit the work activities, and the regulatory agencies will be consulted.

### **Specialized Field Equipment:**

An electric UTV will be utilized while accessing B sites on BLM and HNWR property during the nesting season. The electric UTV will minimize noise and enable the sampling crew to minimize the number of trips needed to transport equipment to a well cluster in SWFL habitat.

Power supply outlets have been installed at PE-1 and a leak detection vault north of MW-39. By using this power supply to power the groundwater pumps instead of a generator, the sampling operation is virtually noiseless when sampling the MW-34 monitor well cluster.

New ½" I.D. LDPE tubing will be used to connect the pumps at the well head to the purge tanks at the staging areas. Spill containment will be placed under any hose connections where multiple hose segments are required to reach more distant wells. The hose will be cleared of all water after sampling is completed. Clearing water from the hose will be accomplished by lifting the hose to shoulder height to drain the water into the purge water storage tank.

New dedicated pumps were installed in late 2005 in MW-27, MW-34, and MW-43 well clusters. Therefore, pumps and decontamination equipment will no longer need to be transported to these wells, decreasing the overall impact associated with sampling at these locations.

### **Access Procedures for Wells on BLM Property:**

Well clusters MW-27, MW-30, MW-34, MW-36, MW-39, MW-42 and MW-45 will be accessed directly by UTV's from the south access, under the railroad tracks. For sampling the MW-34 cluster, an electric UTV will be used to carry equipment and access the wells, and a second UTV with the purge tank will park in the staging area at the PE-1 location. New or dedicated ½" ID LDPE tubing and a power cord will be stretched from the well heads to the purge tank and power source at PE-1. For sampling the MW-27 cluster and R-27 when necessary, the electric UTV will be used to carry equipment and access the wells, and a second UTV with the purge tank will park in the staging area just north of the railroad bridge between MW-42 and MW-27. New or dedicated ½" ID LDPE tubing and a power cord will be stretched from the well heads to the purge tank and generator at the staging area.

### **Access Procedures for Wells on HNWR Property:**

Monitor well clusters MW-22, MW-43, MW-52, and MW-53 and shoreline station R-22 are located on HNWR property, south of the railroad bridge. UTV mounted equipment is to be staged at the cleared and graded area to the west of well cluster MW-32 (Figure 1). All power generation equipment and purge water storage tanks are staged at this location. The electric UTV will be used to carry equipment and access the wells, and a second UTV with the large purge tank will park in the staging area described above. New or dedicated ½" ID LDPE tubing and a power cord will be stretched from the well heads to the purge tank and power source at the staging area. For MW-22 and the MW-52 and MW-53 clusters, a peristaltic pump and battery are used for purging directly to a small tank on the electric UTV.

### **Sampling Procedures for B Site Wells:**

The following list summarizes the modified “nesting season” sampling procedures for the B site monitoring wells with dedicated pumps. These modified procedures will be followed each year during May 1<sup>st</sup> through September 30<sup>th</sup>:

- A biologist or authorized individual will pre-survey the planned work area for the presence of nesting listed-bird species, and sampling will proceed if the survey results are negative. BLM and DTSC will be contacted and sampling will not proceed if the pre-survey finds nesting listed-bird species.
- New sampling procedures and biological resource sensitivity will be reviewed at each field event kickoff briefing.
- The UTVs will maintain low speeds and low revolutions per minute to minimize noise. The target speed will be 5 mph on the floodplain, per BLM direction. The UTVs will maintain a reduced speed to the extent possible while avoiding getting lodged or stuck.
- A biologist will accompany the sampling team upon startup of activities and will provide a reconnaissance “sweep” during the sampling event.
- A generator will be operated at the staging areas only when there is no nearby power supply (HNWR).
- Water level measurements are to be taken at the beginning and end of the purge only. No measurements will be taken during the purge.
- Spill prevention, containment, and control measures outlined in SOP-A13 will be implemented.
- At all times, conversation noise and abrupt or unnecessary movements will be avoided, and equipment noise will be minimized. Equipment will be muffled or padded during transport and setup to avoid clanging or other impact noises from bottles and metal components.
- A biologist’s report of the sampling activities will be completed within a week of the sampling and submitted to DTSC and BLM.

### **C SITES ACCESS PROCEDURES:**

Field crews are to implement the following mitigation measures for the upland wells listed below to prevent impact from data collection on cultural or biological resources.

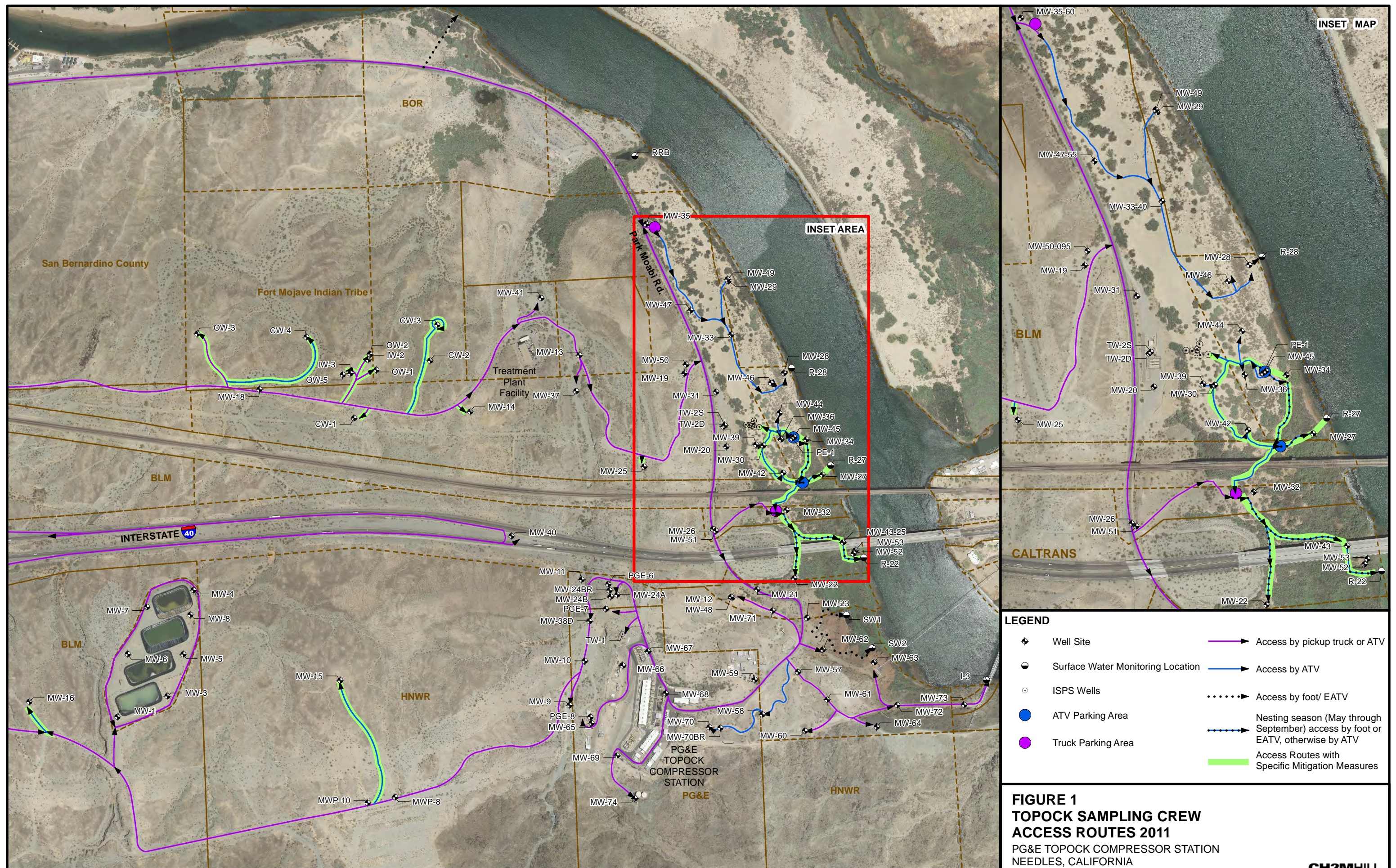
- East Mesa wells (IW-2, IW-3, OW-1, OW-2, and OW-5 well clusters)
- West Mesa wells (OW-3 well cluster)
- Compliance wells (CW-1, CW-2, CW-3, and CW-4 well clusters).
- Monitoring wells MW-14, MW-15, MW-16, MW-18, and MW-25.

The goal of these additional precautions is to prevent any excursion onto areas that were not previously disturbed and minimize the impact of field work. Unlike the B sites access procedures that were developed for use on the floodplain only during the summer SWFL nesting season, the precautions for these upland area C sites will be applied on a year-round

basis. The universal A sites measures that were outlined above will also apply at these locations year round.

- Personnel and vehicles are required to stay within the areas that were previously disturbed. The work areas are delineated where possible using straw “wattles”, these barriers are not to be crossed with any vehicle.
- For the less frequent quarterly or semiannual access to wells MW-15, MW-16, MW-18, and MW-25, crews must stay on the clearly defined gravel access roads to each well.
- Use lathe stakes to mark boundaries during construction and well installation, rather than orange plastic fencing. These boundary stakes will be maintained, and if needed a similar marker for both access routes and work area boundaries may be substituted in the future. Any replacement should have limited visual impacts, such as straw wattles to prevent travel off existing designated work areas. Specific areas where these boundary markings are maintained include:
  - Access route on and off H-66 and edges of the East Mesa.
  - Access route from H-66 and a turnaround/work area near OW-3 on the West Mesa.
  - Access route from H-66 and a turnaround/work area near CW-4 in the unnamed wash.
  - Access routes past CW-2 and turnaround area at CW-3.
  - Defined access turn-off from H-66 to CW-1 and MW-14.
- Drive one-way on the CW-2 and CW-3 access track and turn vehicles only at the established turnaround at CW-3.
- Drive in only the active channel area of the wash when accessing CW-4. Follow the previous access path, marked where possible with straw wattles.
- Stay on established roads to access MW-15 and MW-16.







## **SOP-A17**

### **Groundwater and Surface Water Mobile Integrated Sample Tracking Standard Operating Procedures for PG&E Topock Program**

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This standard operating procedure (SOP) addresses the procedures and tools to be used for collecting and managing field data as well as managing analytical samples collected in the field associated with the Topock Monitoring Programs. This SOP is a guideline to be used during the collection of surface water and groundwater data. This includes the Groundwater Monitoring Program (GMP), Compliance Monitoring Program (CMP), and River Monitoring Program (RMP) samples.

#### **REQUIRED DOCUMENTS**

- 1) Event-specific sampling and analysis plan (SAP).
- 2) Applicable project work plan or monitoring plan. Refer to Topock Program Sampling, Analysis, Field Procedures Manual, and Operation and Maintenance (O&M) Manual, as required.
- 3) Mobile Integrated Sample Tracking (MIST) Operators Manual
- 4) PG&E Programs Data Management Plan
- 5) Topock Quality Assurance Program Plan (QAPP)

#### **FIELD DATABASE PREPARATION & SETUP**

This section describes the upfront planning a preparation steps necessary to properly set-up a groundwater or surface water sampling event using the Topock Field Database. This SOP provides the how-to information for properly entering information into the field database.

- 1) Ensure that you have the latest version of the Topock field database. This actually consists of two database files. The "Front end" that is the interface for information entry and management and the "backend" that stores the field data and sampling information.
- 2) Set up the "Project Name" in the field database using the established Topock Event nomenclature, year-program-event number. For example, if you are preparing the field database for the 144<sup>th</sup> GMP sampling event, which will occur in 2008, the event title will be 2008-GMP-144.
- 3) Sample IDs will be entered into the database using the following convention: well ID-event number. For example, well MW-34-100 sampled during event 2008-GMP-144 would be named MW-34-100-144.
- 4) Analyses will be entered into the field database in accordance with the most recent SAP and any modifying documents or correspondences. Modifying documents may include the most recent Contract Work Assignment, correspondences from the regulatory agencies and client, and additional direction from project managers.

## QUALITY CONTROL PROCEDURES PRIOR TO SAMPLING EVENT

The following steps describe the QC procedures prior to the initiation of sampling activities necessary to ensure all the required samples are collected.

- 1) Prepare a planned sample table (PST) from the database including all locations and analyses for the sampling event to be performed. An example of the PST is included as an attachment to this SOP.
- 2) The PST is to be reviewed by the project manager (PM) responsible for the upcoming event and the designated QC manager. If the PM and the QC manager concur with the PST, both will sign the form indicating that the samples listed are complete in accordance with all guidance documents.
- 3) When the PST is reviewed and accepted, prepare the event paperwork from the field database. This includes sample labels, purge forms and blank chains of custody. In addition, a list of bottles can be generated to be used to order sample bottles from the analytical laboratories. Compare the forms against the approved PST for completeness and accuracy.

## USING THE MIST HANDHELD UNIT AND FIELD DATABASE

The Topock monitoring program uses the CH2M HILL proprietary Mobile Integrated Sample Tracking (MIST) system for field data acquisition and analytical sample tracking. This SOP provides an outline of steps for using the system. Details for using the MIST system are provided in the MIST operator's manual.

1. Load the appropriate field database onto the computer that is to be used for sample tracking during the field sampling event. Follow the steps in the users manual to properly prepare the database for upload into the handheld unit (Recon).
2. Load the data for the upcoming sampling event(s) onto the MIST handheld computer. Boot the system and check to ensure that the complete sampling set is included.
3. Upon arrival at a monitoring well or other sample location select the correct sample location ID manually or scan the radio frequency identification (RFID) tag if the location is so equipped. The RFID tag is a black disc approximately the size of a quarter that is attached to the well casing. Upon scanning the RFID tag, the well ID and construction information will appear on the Recon screen. **Confirm that you are at the location you intend to sample. If the well cannot be properly identified via RFID tag and or clear marking, the location is to be identified by measuring the total depth of the well.** Wells sampled on a monthly sampling frequency are indicated by a colored band around the top of the well casing.
4. Purge and sample the location in accordance with the appropriate sampling SOP (see SOPs A-1 through A-4 for sampling procedures). Record the well and purge information in the MIST unit as directed by the MIST Operator's Manual. In addition, record all field data on a hardcopy purge form. The hardcopy forms will serve as backup in case the data on the handheld unit is lost.

5. When the necessary purge volume has been purged, use the MIST unit to confirm that the field parameters are stable in accordance with site SOPs. If the parameters are not stable, continue purge. If stabilization is achieved, collect the analytical samples.
6. The MIST handheld unit will provide a table of samples to be collected at the location. The table will also indicated required preservation and filtration. Confirm that the appropriate bottle, preservative and filtration is used for each analyte. Confirm the collection of the bottle for each analyte by entering the sample time and date. Doing so indicates that the sample has been collected and it will be recorded as such in the database.
7. After the completion of each sample location, run the "Sprite Backup" tool on the Recon unit to ensure that no data is lost in the event of power loss or other unforeseen mishap. Backup the Recon before changing battery units as well.
8. At the end of sampling each day, the data in the handheld unit is to be uploaded to the field database as directed by the MIST Operator's Manual. Once the upload is completed, run the automated COC forms from the field database.

## POST SAMPLING QUALITY CONTROL

This section describes the quality control steps required at the end of each sampling day. In addition, proper sample packing and shipment are discussed.

1. After the field data has been collected and uploaded into the field database as described above, COCs forms are to be generated from the field database. Compare the COC forms to the sample bottles collected to confirm all samples are properly recorded in the COC forms.
2. Compare the COC forms to the PST to confirm that all samples were collected. Certain quality control samples may be required to be held by the lab and not analyzed unless there is a data discrepancy. Confirm that these samples are labeled "Hold" in the comments column of the COC form. If there are any deviations from the PST that are intentional record the reasons for the change on the appropriate purge form and daily log. **If there are any sampling inconsistencies that cannot be explained, the location that needs additional or other samples will need to be re-sampled. The Sampling coordinator, Project Chemist and Project Manager should be notified as soon as possible, at a minimum on each day of the sampling event, of any inconsistencies that are identified.**
3. The field database has an additional tool to compare planned samples versus samples that were actually collected. Run the Planned vs. Actual (PvA) at the end of each day to confirm that all samples were collected as planned. If there are any deviations from the PST that are intentional record the reasons for the change on the appropriate purge form and daily log. **If there are any sampling inconsistencies that cannot be explained, the location that needs additional or other samples will need to be re-sampled. The Sampling coordinator, Project Chemist and Project Manager should be notified as soon as possible, at a minimum on each day of the sampling event, of any inconsistencies that are identified.**

4. At the end of each day, forward the purge forms and COCs to the sampling task lead via email or fax. The sampling task lead is responsible for additional review of the purge and sampling information for the following:
  - Appropriate purge and sampling techniques were used.
  - The purge was complete.
  - The purge parameters are in-line with historic purge data.
  - The correct samples were collected from each location.

If there are discrepancies in the purge or sample the location may need to be re-sampled.

## **SOP-A18**

### **Purging and Sampling of Groundwater Monitoring Wells Minimal Drawdown Method Standard Operating Procedures for PG&E Topock Program**

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This standard operating procedure (SOP) addresses the procedures and equipment to be used for purging and sampling all groundwater monitoring wells approved for the minimal drawdown sampling approach. This SOP will be used for sampling groundwater monitoring wells using an adjustable rate, positive displacement pump.

#### **REQUIRED DOCUMENTS:**

- Event-specific planned sample table (PST).
- Applicable project work plan or monitoring plan. Refer to Topock Program Sampling, Analysis, Field Procedures Manual and QAPP (Procedures Manual), and Operation and Maintenance (O&M) Manual, as required.
- Topock Program Health and Safety Plan (HSP)
- Applicable SOP's
- Well construction logs/specifications
- Mobile Integrated Sample Tracking (MIST) handheld database
- Previous sampling logs or tabular historic field data tables
- Current site access map
- Blank sampling logs, maps, sample labels, chains of custody (COC's), and the designated groundwater sampling field notebook

#### **REQUIRED EQUIPMENT:**

- 2 or more (i.e. one is backup) WQ instruments with flow through cells, or equivalent.
- Hach 2100P turbidimeter or equivalent.
- 200 foot (or longer as needed) water level indicator (WLI).
- Trimble Rugged Reader hand held instrument for MIST data collection.
- Two, 200 gallon capacity purge tanks.
- Utility vehicles (UTV's) as necessary.
- Honda 2000 watt generator or alternate power source.
- Adjustable-rate, positive-displacement pump
- Sample containers, cooler and ice

### **PREPARATION & SETUP:**

- Review event-specific PST or event-specific field instructions, previous sampling logs, Procedures Manual, O&M Manual, HSP, and groundwater sampling supplies and equipment check list. (NOTE: the PST should also be reviewed for required “non-analytical event activities” such as water level measurements or other data collection that is planned in association with the groundwater sampling event).
- Acquire the existing field logbook for groundwater sampling and initiate entries.
- Inspect all equipment and verify that the field water quality (WQ) meters have been calibrated prior to use according to the manufacturer’s instructions and SOP-A9, *Calibration of Field Instruments*.
- Inventory sample bottles, build sample sets for the required analytes at each sample location, ensure a sufficient supply of lab de-ionized water for equipment blanks, and confirm the lab courier schedule.
- Field-check sampling equipment and supplies: water level indicator (WLI), WQ meters, flow-through cell, pump controller, power supply, pump discharge/sampling tubing, N-dex gloves, D.I water sprayers, 5 gallon buckets, paper towels, 0.45 micron in-line filters, etc.

### **FIELD PROCEDURES:**

- **Prior to opening any monitor well, remove all pens, lighters, calculators, or any other loose items from vest pockets, or from any other location where they could fall into the well.**
- Upon arrival at the monitoring well, at least 2 members of the sampling team must confirm the well ID. Wells should be clearly marked on the well monument. If the well cannot be positively identified by the marking, measure total depth of the well and compare to the well installation details to confirm the correct location. Report worn or unclear well markings to the on-site field coordinator.
- Place spill containment according to SOP A-13 *Spill Prevention, Containment, and Control Measures for Monitoring Well Development, Purging, and Sampling*.
- If using a transient pump, collect an “EB”, equipment blank, ***prior to pump installation*** if necessary according to the PST.
- Open the protective casing lid and, ***prior to moving it***, note the exact configuration of the transducer installation if present. Measure static WL according to SOP-A7, *Water level Measurements*, moving the transducer if necessary, and record WL value in MIST and on the sampling log.
- If the well is equipped with a transducer and does not have a dedicated pump installed, remove the transducer from the well according to SOP-C1, *Solinst Pressure Transducers*.
- If the well does not have a dedicated pump installed, but does have dedicated sample tubing, attach the dedicated tubing to the appropriate pump and install decontaminated pump at the same intake/sampling depth as used in prior events. There is a marking on

the purge tubing which corresponds with the monitor well top of casing (TOC) to facilitate this requirement. Purge and sample the well as described below.

- If the well does not have a dedicated pump *or* tubing, or has not been previously sampled, use new low-density polyethylene tubing and install the pump with the intake at approximately the midpoint of the well screen. Purge and sample the well as described below.
- If the well *does* have a dedicated pumping system, connect the discharge tubing and purge and sample the well as described below.
- Collect daily equipment blanks and duplicate samples as required by the PST and instructed by the field team leader.

### **PURGING AND SAMPLING PROCEDURES:**

- Install the pump in the well. Slowly lower the pump (with the attached tubing and safety line) into the well to the desired depth. The pump will be set near the middle of the well screen, if possible. At a minimum, the pump intake will not be positioned lower than 2 feet from the bottom of the well. The depth to the pump intake will be recorded on the Groundwater Sampling Form. If there is less than 3 feet of available water, the groundwater well will be purged and sampled using a bottom-loading bailer.
- Measure the water level in the well after pump insertion. Leave the water level probe in the well to facilitate continued water level monitoring during purging activities.
- Start purging the well at a low flow rate between 0.2 and 0.5 liters per minute. Measure the purge rate using a container of known volume, and record this information on the Groundwater Sampling Form
- The water level should be monitored during purging, and ideally, the purge rate should equal the well recharge rate so there is limited drawdown in the well. (The water level should stabilize for the specific purge rate). The purge rate may be increased above 0.2 and 0.5 liters per minute as long as a constant water level in the well can be maintained. There should be at least 1 foot of water over the pump intake. This assures that there is no risk of the pump suction being broken, or of entrainment of air in the sample. Record adjustments in the purge rate and changes in depth to water on the field data sheet. Purge rates should, if needed, be decreased to the minimum capabilities of the pump (0.1 to 0.2 liters per minute) to avoid affecting well drawdown. If using a pulse style pump, measure the water level at the end of the pressure cycle when the water level has recovered as much as it will, before again filling the pump during the fill cycle. This method will generate consistent drawdown data.
- During purging, the water quality parameters will be measured periodically (every 3 to 5 minutes) until the parameters have stabilized as shown below. If parameter stabilization has not occurred after 4 hours, purging activities will be considered complete.
  - pH +/- 0.1 pH units
  - Specific conductance +/- 3%
  - ORP +/- 10 millivolts
  - Turbidity +/- 10% NTU units (when turbidity is >10 NTUs)

- Dissolved oxygen                    +/- 0.3 mg/L
  - Temperature                        +/- 2° Celsius
- 
- When the requirements above have been satisfied and the purge cycle is complete, disconnect the flow through cell and prepare to collect samples directly from the pump discharge tubing for analyses according to event-specific PST. Prepare sample containers and collect gas-sensitive analytes first. The preferred collection order will be volatile organic compounds (VOCs), semi-volatile organic compound (SVOCs), metals (including hexavalent chromium [Cr(VI)] and total chromium [Cr(T)]; see SOP-A6), then general chemistry (cations, anions, stable isotopes).
  - For filtered samples, attach a 0.45 micron in-line filter to the pump discharge and allow approximately 500 mL of sample to pass through the filter before beginning sample collection in accordance with SOP A-6 *Field filtration* and the QAPP.
  - When sample collection is complete, record sample information, final WL, and purge volume data in MIST and on the field sampling log.
  - If transient pump previously installed, remove the pump from the well, detach the dedicated tubing and carefully drain any residual water to the purge water tank. Fold both ends of the purge tubing and secure with wire ties as a further deterrent to leakage. Store the dedicated tubing in a sealed, labeled trash bag. Decontaminate the pump according to SOP A-10, *Decontamination of Water Sampling Equipment*.
  - If well was equipped with a transducer, replace the transducer in exactly the same configuration in which it was found and in accordance with SOP-C1, *Solinst Pressure Transducers*.
  - Close and secure well protection lid.
  - Follow SOPs in Program Procedures Manual and O&M Manual for sample handling and management, equipment decontamination, and investigation-derived waste (IDW) management.



**SOP-A19**  
**Sampling of Groundwater Monitoring Wells**  
**HydraSleeve No Purge Method**  
**Standard Operating Procedures for PG&E Topock Program**

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This standard operating procedure (SOP) addresses the procedures and equipment to be used for sampling all groundwater monitoring wells approved for the HydraSleeve sampling approach.

**REQUIRED DOCUMENTS:**

- Event-specific planned sample table (PST).
- Applicable project work plan or monitoring plan. Refer to Topock Program Sampling, Analysis, Field Procedures Manual and QAPP (Procedures Manual), and Operation and Maintenance (O&M) Manual, as required.
- Topock Program Health and Safety Plan (HSP)
- Applicable SOP's
- Well construction logs/specifications
- Mobile Integrated Sample Tracking (MIST) handheld database
- Previous sampling logs or tabular historic field data tables
- Current site access map
- Blank sampling logs, maps, sample labels, chains of custody (COC's), and the designated groundwater sampling field notebook

**REQUIRED EQUIPMENT:**

- 2 or more (i.e. one is backup) YSI-556 WQ instruments, or equivalent.
- Hach 2100P turbidimeter or equivalent.
- 200 foot (or longer as needed) water level indicator (WLI).
- Trimble Rugged Reader hand held instrument for MIST data collection.
- HydraSleeve samplers (from supplier)
- Pointed plastic discharge tube (included with sampler)
- Polypropylene strapping (from supplier)
- Stainless steel weights
- Small cable ties
- String reel

- Utility knife
- Scissors (stainless steel)
- Well caps with small eyelet on bottom allowing a string to be tied off
- Sample containers, cooler and ice

### **PREPARATION & SETUP:**

- Review event-specific PST or event-specific field instructions, previous sampling logs, Procedures Manual, HSP, and groundwater sampling supplies and equipment check list. (NOTE: the PST should also be reviewed for required “non-analytical event activities” such as water level measurements or other data collection that is planned in association with the groundwater sampling event).
- Acquire the existing field logbook for groundwater sampling and initiate entries.
- Inspect all equipment and verify that the field water quality (WQ) meters have been calibrated prior to use according to the manufacturer’s instructions and SOP-A9, *Calibration of Field Instruments*.
- Inventory sample bottles, build sample sets for the required analytes at each sample location, ensure a sufficient supply of lab de-ionized water for equipment blanks, and confirm the lab courier schedule.
- Field-check sampling equipment and supplies: water level indicator (WLI), WQ meters, HydraSleeve supplies, N-dex gloves, D.I water sprayers, 5 gallon buckets, paper towels, 0.45 micron in-line filters, etc.

### **FIELD PROCEDURES:**

- **Prior to opening any monitor well, remove all pens, lighters, calculators, or any other loose items from vest pockets, or from any other location where they could fall into the well.**
- Upon arrival at the monitoring well, at least 2 members of the sampling team must confirm the well ID. Wells should be clearly marked on the well monument. If the well cannot be positively identified by the marking, measure total depth of the well and compare to the well installation details to confirm the correct location. Report worn or unclear well markings to the on-site field coordinator.
- Place spill containment according to SOP A-13 *Spill Prevention, Containment, and Control Measures for Monitoring Well Development, Purging, and Sampling*.
- Open the protective casing lid and, ***prior to moving it***, note the exact configuration of the transducer installation if present. Measure static WL according to SOP-A7, *Water level Measurements*, moving the transducer if necessary, and record WL value in MIST and on the sampling log.
- If the well is equipped with a transducer and does not have a dedicated pump installed, remove the transducer from the well according to SOP-C1, *Solinst Pressure Transducers*.

## **PURGING AND SAMPLING PROCEDURES:**

### **HydraSleeve Deployment**

1. Remove HydraSleeve sampler from package and pinch the top to create an opening. See Attachment 1 for a representation of an unfilled HydraSleeve sampler.
2. Use a HydraSleeve Spring Clip to fasten the pre-looped string to the top of the HydraSleeve sampler. Fold the two holes at the bottom of the HydraSleeve together and attach a weight using a HydraSleeve Stainless Steel weight clip. Attach the weight clip to the pre-measured string.
3. If using two HydraSleeve samplers, follow steps 1 and 2 above for placing the second sampler below the first on the pre-measured string.
4. Lower the sampler into the well until the pre-marked hanging location is level with the ground surface.
5. Following placement in the well, fasten the end of the string to the locking tab on the well casing, secure with a cable tie and the well lock.
6. Place cap back onto well.
7. Secure monitoring well and area prior to demobilization.

### **HydraSleeve Sample Recovery**

Once a sufficient period of time has elapsed so that re-equilibration of the water within the well with surrounding groundwater conditions has occurred (typically a minimum of 48 hours), the HydraSleeve samplers can be recovered and samples collected for analysis.

For standard HydraSleeve sampler recovery, the following procedures will be performed at each well:

1. Measure the depth to water to the nearest 0.01 foot.
2. Remove all securing cable ties and remove the sampler from the well. The best method is to pull the HydraSleeve sampler upward continuously from its starting point, at a rate of one to two feet per second or faster, until the sampler is full, which is a vertical distance of 36 to 72 inches for a 36-inch long sampler.
3. The condition of the sampler should be recorded in the field sampling sheets, including the presence of any headspace within the sampler.

## HydraSleeve Sample Collection

Samples for chemical analysis will be collected from the HydraSleeve samplers immediately following removal from the well. The following sampling procedures will be used at each well:

1. Identification labels for sample bottles will be filled out for each sample.
2. Hang the filled HydraSleeve from the hanger device after removal from the well.
3. Squeeze the full sampler just below its top to expel water resting above the flexible check valve.
4. Push the pointed discharge tube perpendicularly through the outer polyethylene sleeve approximately three to four inches above the bottom of the HydraSleeve.
5. Transfer the sample from both HydraSleeve samplers into a 2.5 liter compositing container. Pinching the sample sleeve just above the discharge tube will control the flow of the sample. The sample sleeve can also be squeezed, forcing fluid up through the discharge tube, similar to squeezing a tube of toothpaste.
  - The preferred collection order will be volatile organic compounds (VOCs), semi-volatile organic compound (SVOCs), metals (including hexavalent chromium [Cr(VI)] and total chromium [Cr(T)]; see SOP-A6), then general chemistry (cations, anions, stable isotopes).
  - For filtered samples, transfer the sample out of the compositing container using a peristaltic pump through a 0.45 micron in-line and allow approximately 250 mL of sample to pass through the filter beginning sample collection. The limited volume in the HydraSleeve sampler requires that less sample be run through the filter than is dictated in SOP A-6 *Field filtration* and the QAPP.
6. If sample volume allows, transfer water into a container to obtain field parameter readings with a YSI-556 WQ or equivalent instrument (note in the field forms the results are approximate because a flow-through cell could not be used). Field parameter readings are to be recorded on the groundwater sample form.
7. Excess sampler water will be emptied into the purged waste water tank.
8. Samples will be preserved and managed as detailed in the QAPP. Time of sampling will be recorded in the field logbook, field sample sheets, sample labels, MIST and chains of custody.
9. After the samples have been collected, immediately place the sample bottles in an ice-filled cooler. Before decontamination of field equipment, the well cap will be replaced and locked.
10. If redeployment of a new HydraSleeve sampler is not intended, sampling equipment, except for string, stainless steel weight and rubber stopper, will be discarded as with other PPE trash, and the blank string with weight will be Stored for later use. However, if deployment of a new sampler is required, the new

sampler will be reattached to the existing string and stainless steel weight. The sampler can then be deployed in the well for the next sampling event.

11. If well was equipped with a transducer, replace the transducer in exactly the same configuration in which it was found and in accordance with SOP-C1, *Solinst Pressure Transducers*.
12. Prior to leaving the site, field documentation, including the chain-of-custody form, will be completed.
13. Secure monitoring well and area prior to demobilization.
14. Follow SOPs in Program Procedures Manual and O&M Manual for sample handling and management, equipment decontamination, and investigation-derived waste (IDW) management.

## Attachment 1 Representation of HydraSleeve Sampler



## **SOP-A22**

### **Procedures for Calculation of Freshwater Equivalent Heads Standard Operating Procedures for PG&E Topock Program**

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This Standard Operating Procedure (SOP) provides instructions for adjusting measured groundwater elevations to freshwater equivalent heads.

#### **INTRODUCTION**

Salinity is directly related to water density, which in turn affects the height to which water will rise in a well under static conditions. "Groundwater head" represents the energy state of a groundwater system and groundwater flows from a high energy state to a lower one. Groundwater head takes density, fluid pressure, and elevation into account. When water in a system has the same density, the elevations of water in the wells simply represent the groundwater head distribution. Because there is a range of groundwater salinity at the Pacific Gas and Electric Company (PG&E) Topock Compressor Station (the site), accurate measurements of head require adjustment to a standard density, commonly called a "freshwater equivalent head." Water density also has temperature dependence, with density decreasing with increasing temperature. Salinity and temperature adjustments are currently performed for all water levels in the PG&E database (manual water-level measurements and the pressure transducer measurements).

The most commonly used standard density is that of freshwater. Where densities vary, as they do at Topock, the head in each well is recalculated to the value it would be if freshwater were present. In this way, these freshwater equivalent heads can be compared directly with one another, and groundwater gradients can be mapped. The heads have not been "corrected" (an often-used term), but rather have been converted to an equivalent common standard to provide an accurate comparison.

#### **PARAMETERS MEASURED FOR CALCULATION OF DENSITY**

The parameters shown in Table 1 are typically measured in the field or laboratory and may be used to determine the density of the water column, as discussed in the following sections.

TABLE 1  
Parameters Used for Calculating Density

Parameter	Units	Typical Range	Description
Specific Conductance	μS/cm @ 25°C	<b>FW:</b> 0-1,500 μS/cm <b>BW:</b> 1,500-15,000 μS/cm <b>SW:</b> 15,000 to 150,000 μS/cm <b>BR:</b> >150,000 μS/cm	The conductivity normalized to a temperature of 25°C. The term electrical conductivity is often used interchangeably, although this parameter is not corrected to 25°C.
Salinity	%	<b>FW:</b> 0-0.1% <b>BW:</b> 0.1-1% <b>SW:</b> 1-10% <b>BR:</b> >10%	A measure of the dissolved salts in water on a mass-per-mass basis.
Total Dissolved Solids	mg/L	<b>FW:</b> 0-1,000 mg/L <b>BW:</b> 1,000-10,000 mg/L <b>SW:</b> 10,000-100,000 mg/L <b>BR:</b> >100,000 mg/L	A measure of the mass of dissolved solids in water on a mass-per-volume basis.

**Notes:**

°C = degrees Celsius

μS/cm = microSiemens per centimeter

mg/L = milligrams per liter

BR = brine

BW = brackish water

FW = freshwater

SW = saltwater

## CALCULATION OF DENSITY

The density of well water must be determined before adjusting hydraulic heads to freshwater equivalent heads. However, the density of water is rarely directly measured; rather, either the salinity or specific conductance (SC) of the water is measured in the field, or the SC or total dissolved solids (TDS) are measured in the laboratory, and a density is calculated from these values.

Salinity and TDS measurements share similar properties, and conversion between the two parameters can be performed using the following formula:

$$\text{Salinity}(\%) = \frac{\text{TDS}}{10,051.1} \quad (1)$$

where:

*TDS* = the total dissolved solids of the water in milligrams per liter (mg/L).

Salinity and TDS are typically laboratory-based measurements. If salinity or TDS are provided as field measurements, these measurements are likely based upon a linear, non-site-specific conversion from an SC measurement.

Specific conductance (electrical conductivity [EC] at 25°C) is the most commonly available measurement. Specific conductance is a measure of a water's ability to conduct electricity and can be used to estimate the density of the water. The following formula is used to convert SC to TDS:



$$TDS \text{ (mg / L)} = SC \cdot K \quad (2)$$

where:

SC = specific conductance of the water in microsiemens per cm ( $\mu\text{S/cm}$ ).

K = a dimensionless constant typically ranging from 0.55 to 0.8.

The dimensionless constant K is often assumed to be 0.65 for typical groundwater. This value is used for site calculations at the compressor station.

## DATABASE SETUP

Within the Topock database, manual and transducer water-level data are stored in the tables *tblWaterLevel* (Figure 1) and *tblIPT* (Figure 2), respectively. Salinity and temperature data used to adjust the water levels are also stored for each measurement in these tables. The design of both tables is shown below. The information shown is associated with each water-level measurement in the database.

FIGURE 1  
tblWaterLevel Table

tblWaterLevel : Table			
	Field Name	Data Type	Description
	LocID	Text	Location ID (e.g., well, boring, station)
	SampleDate	Date/Time	Date of measurement
	SampleTime	Date/Time	Time of measurement
	EventCode	Text	Monitoring event code
	SrcCode	Text	Data source (e.g., CH2M HILL, PG&E, Legacy, etc.)
	MeasPtElev	Number	Elevation (ft AMSL) from which depth to water was measured (e.g., top of PVC)
	DTW	Number	Depth to water (ft)
	RawSalinity	Number	Raw salinity measurement (e.g., salinity, field measured specific conductance, lab TDS, etc.)
	RawSalinityDate	Date/Time	Date of salinity measurement, if applicable
	CalcCode	Text	Code identifying the type of raw salinity and conversion used to convert to salinity
	CalcComment	Text	Comment on salinity conversion
	Salinity	Number	Final salinity of water column (%)
	Temperature	Number	Temperature of water column (°F)
	TemperatureComment	Text	Comment on temperature conversion
	RawWElev	Number	Unadjusted groundwater elevation (ft AMSL)
	CorrectWElev	Number	Final salinity and temperature adjusted groundwater elevation (ft AMSL)
	Comments	Text	General comment
	dbdate	Date/Time	db upload date

FIGURE 2  
tblIPT Table

tblIPT : Table			
	Field Name	Data Type	Description
	LocID	Text	Location ID (e.g., well, boring, station)
	Date	Date/Time	Date of measurement
	Time	Date/Time	Time of measurement
	ElapsedTime	Number	Elapsed time since transducer test began (minutes)
	Temp	Number	Temperature (°C)
	PressHead	Number	Raw pressure head (ft)
	Offset_ft	Number	Offset or elevation of transducer above datum (ft)
	Salinity	Number	Salinity of water column (%)
	SalCorr	Number	Salinity correction to be applied (ft)
	TempCorr	Number	Temperature correction to be applied (ft)
	HydHead	Number	Final salinity and temperature adjusted hydraulic head (ft AMSL)
	Comment	Text	Comment regarding measurement
	DST	Number	True (-1) if PDT; FALSE (0) if standard PST
	Exclude	Number	True (-1) if data point to be excluded; FALSE (0) if valid data

In *tblWaterLevel*, the field *CalcCode* identifies what value is stored in the *RawSalinity* field and how the final salinity value is determined. Possible conversion codes and the corresponding conversions to salinity (in percent [%]) include:

<b>FEC2SAL</b>	Field-measured EC <sup>1</sup> (microSiemens per centimeter [ $\mu\text{S}/\text{cm}$ ]) converted to salinity (%) [ $\text{SAL}=\text{EC}*0.65/10051.1$ ]
<b>LEC2SAL</b>	Laboratory-measured EC <sup>1</sup> ( $\mu\text{S}/\text{cm}$ ) converted to salinity (%) [ $\text{SAL}=\text{EC}*0.65/10051.1$ ]
<b>FTDS2SAL</b>	Field-measured TDS (milligrams per liter [ $\text{mg}/\text{L}$ ]) converted to salinity (%) [ $\text{SAL}=\text{TDS}/10051.1$ ]
<b>LTDS2SAL</b>	Laboratory-measured TDS ( $\text{mg}/\text{L}$ ) converted to salinity (%) [ $\text{SAL}=\text{TDS}/10051.1$ ]
<b>LSAL</b>	Laboratory-measured salinity (%) [no conversion]
<b>FSAL</b>	Field-measured salinity (%) [no conversion]
<b>PSAL</b>	Salinity (%) measured during previous event [no conversion]

## DETERMINATION OF DENSITY AS A FUNCTION OF TEMPERATURE

The density of water is also dependent upon temperature. Table 2 summarizes the density of freshwater at various temperatures.

TABLE 2  
Relationship Between Temperature and Density of Freshwater

Temp. (°C)	Density (g/cm <sup>3</sup> )	Temp. (°C)	Density (g/cm <sup>3</sup> )	Temp. (°C)	Density (g/cm <sup>3</sup> )
1	0.999900	11	0.999605	21	0.997992
2	0.999941	12	0.999498	22	0.997770
3	0.999965	13	0.999377	23	0.997538
4	0.999973	14	0.999244	24	0.997296
5	0.999965	15	0.999099	25	0.997044
6	0.999941	16	0.998943	26	0.996783
7	0.999902	17	0.998774	27	0.996512
8	0.999849	18	0.998595	28	0.996232
9	0.999781	19	0.998405	29	0.995944
10	0.999700	20	0.998203	30	0.995646

Source: *Win-Situ 4 User Manual* (In-Situ, 2003)

The United States Geological Survey paper *Quality Assurance and Analysis of Water Levels in Wells on Pahute Mesa and Vicinity, Nevada Test Site* (WRIR 00-4014), available at <http://water.usgs.gov/pubs/wri/WRIR00-4014/text/waterlevel.htm#Temperature%20Effects>, summarizes the methodology to correct groundwater elevations for temperature-dependent density.

<sup>1</sup> The term EC, as used here, is actually SC because Topock field meters automatically convert to conductance at 25°C.

## **SALINITY AND TEMPERATURE ADJUSTMENTS FOR GROUNDWATER ELEVATIONS**

Manual and transducer water-level data at Topock have been adjusted for salinity and temperature since January 2003. The salinity- and temperature-adjusted water elevations are stored in the *CorrectWElev* field in *tblWaterLevel* (manual water-level data) and in the *HydHead* field in *tblIPT* (transducer data). It is assumed that:

- The salinity of the water column in wells is constant throughout the water column.
- The bottom of the well is the measurement point, and the entire water column is adjusted for salinity and temperature by the processes in this SOP.

The salinity adjustment (*SalCorr*), measured in feet (ft), for each water elevation is calculated as follows:

$$SalCorr (ft) = Column \times SAL \times 0.0071 \quad (3)$$

where:

*SAL* = the salinity of the water column in percent (%).

*Column* = the height of the water column to be adjusted in feet (ft).

The temperature-dependent density of water within the well is determined using the following empirical equation:

$$Density (g/cm^3) = 4.78 \times 10^{-8} T^3 - 8.15 \times 10^{-6} T^2 + 6.16 \times 10^{-5} T + 1.00 \quad (4)$$

where:

*T* = temperature in degrees Celsius (°C).

The temperature adjustment (*TempCorr*) for each water elevation is calculated as follows:

$$TempCorr (ft) = Column \times [1 / Density] - Column \quad (5)$$

For manual water-level data, the temperature- and salinity-adjusted groundwater elevation is calculated as follows:

$$CorrectElev (ft AMSL) = RawElev + SalCorr + TempCorr \quad (6)$$

where:

*RawElev* = the groundwater elevation in feet above mean sea level (ft AMSL) with no adjustment for temperature or salinity.

For transducer data, the temperature- and salinity-adjusted groundwater elevation is calculated as follows:

$$HydHead (ft AMSL) = PressHead + Offset + SalCorr + TempCorr \quad (7)$$

where:

*PressHead* = the height of the water column above the transducer in ft

*Offset* = the elevation of the transducer above the datum in ft AMSL.

## SOP-A23

### Sample Handling and Custody Standard Operating Procedures for PG&E Topock Program

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#### PURPOSE

The purpose of this standard operating procedure (SOP) is to delineate protocols for sample handling and custody for the PG&E Topock Program environmental monitoring activities associated with the Topock Compressor Station (TCS) in Needles, California. An example chain-of-custody (CoC) form and sample custody seals are provided as part of this procedure (see Attachment 1). Other formats with essentially identical information are acceptable.

#### SCOPE

This procedure applies to all CH2M HILL personnel and subcontractors engaged in collecting environmental samples for the Topock environmental program.

#### GENERAL

An essential part of the sampling activities of any environmental project is assuring the integrity of the sample from collection through data reporting. This SOP will address all sample custody issues up through sample relinquishment to the courier to deliver samples to the laboratory final destination. Sample labels, CoC forms and custody seals are used to document identification and handling/control (custody) of samples from the time of collection through the completion of chemical analysis. Accountability of the history of a sample must be available to demonstrate that the data are a true representation of the environment. The CoC record is used as evidence to demonstrate that a sample was not tampered with or altered in any way that might bias the analytical accuracy of the laboratory results since the time of its collection. It is extremely important that chain-of-custody records be complete, accurate, and consistent. In some projects, including this one, sample custody records and analytical data may be used in litigation. In all cases of custody, the accuracy and completeness of records is critical for evidentiary use whether as part of the normal data validation procedure or in a litigious project environment. All sampling activities for the Topock environmental program must adhere to the procedures in this SOP in order to ensure complete, accurate, and consistent project data.

#### DEFINITIONS

1. Custody: A sample is under custody if it is in physical possession or under control so as to prevent tampering or alteration of its characteristics. A sample is considered to be in an individual's custody if it is (1) in the physical possession of the responsible party, (2) in view of the responsible party after being in their possession, or (3) placed by the responsible party in a designated, secure area that is controlled with restricted access.
2. Sample Label: A record attached to samples to ensure legal documentation of traceability. Attachment 1 includes an example of the sample labels that are used.
3. Chain-of-Custody Record: Legal documentation of custody of sample materials and instructions for the analytical laboratory. Attachment 1 includes an example of a CoC form.

## RESPONSIBILITIES

### Project Manager

The *Project Manager* (PM) shall ensure that staff conducting these procedures are properly trained. Prior to the sampling event, the PM shall review and approve the planned sample table (PST). In addition, sampling staff must consult the PM if any complications arise with following these critical sample handling and custody procedures.

### Project Chemist

The *Project Chemist* shall review and approve the PST. In addition the chemist shall be consulted in the event any questions surface concerning sample handling and custody procedures.

### Field Team Leader/Sampling Coordinator

The *Field Team Leader/ Sampling Coordinator*(FTL/SC) shall assure that the systems are maintained to create CoC forms from the sample-tracking database. In addition, the FTL/SC is responsible for production of CoC forms and sample labels for the field crews. The FTL/SC shall also take responsibility for or delegate the packing of the sample shipping coolers, ensure that the CoC forms are correct, and ship the samples (or transfer to laboratory sample pickup) as described in this SOP. The FTL/SC shall determine or seek guidance as to which samples are potentially hazardous and the appropriate shipping method, if needed.

### Sample Collector

The *Sample Collector* shall ensure that the samples are correctly collected (following the appropriate SOP), labeled, and stored until the FTL/SC takes custody of the samples for shipping to the laboratory. The Sample Collector shall maintain custody of the samples until said time that the FTL/SC takes custody. The Sample Collector shall be responsible for informing the FTL/SC of sampling conditions. (Note: The FTL/SC, Sample Collector, and Sample Shipper may be the same person.)

### Sample Custodian

The *Sample Custodian* is any individual who is responsible for the custody of samples and completion of associated documentation and may include the FTL/SC, Sample Collector, or on large events, a separate Sample Shipper.

## PROCEDURE

### Sample Custody

Sample custody procedures are designed to ensure that sample integrity is maintained from collection to the final receipt of the analytical report. A critical aspect of sound sample collection and analysis protocols is the maintenance of strict CoC procedures, as described in this SOP. CoC procedures include tracking and documentation during sample collection and shipment.

As noted above, a sample is considered to be in an individual's custody if it is (1) in the physical possession of the responsible party, (2) in view of the responsible party after being in their possession, or (3) placed by the responsible party in a designated, secure area that is controlled with restricted access.

Custody will be documented throughout all sampling activities by the electronic sample-tracking database or on the official CoC record for each day of sampling. The electronic data will be used to generate the official CoC if an electronic sample-tracking database program is used. In either case the official CoC will accompany the samples from the site to the laboratory. The sampling team member who relinquishes the samples to the courier or laboratory personnel is required to sign, date, and note on the CoC the time when relinquishing samples from his or her immediate custody. Once signed by the FTL/SC/Sample Collector and the laboratory courier, a copy of the CoC will be made and kept with the other sampling related paperwork. Any discrepancies in the custody procedure noted and corrected must be communicated to the PM and project chemist immediately to determine possible corrective action(s).

Samples will be shipped to subcontractor laboratories via laboratory courier. In some cases, samples may be hand-delivered to the laboratory; hand delivery will be noted on the CoC form. In the event the laboratory is not within driving distance, an overnight air courier will be used. Bills of lading will be used in addition to other custody documentation during this time and will be retained as part of the permanent sample custody documentation. The subcontractor laboratory is responsible for sample custody once samples are relinquished to their custody and at that point laboratory SOPs for custody must be followed. Final completed CoCs from the field and shipping efforts as well as internal laboratory custody records will be provided with the final laboratory data submission.

### **Sample Labels**

A sample label must be attached to all sample containers prior to collecting the sample. (**Note:** Do not attach new labels to pre-weighed soil volatile organic compound or gasoline range organic vials; use the labels attached by the laboratory. Additional labels may be affixed to the recloseable plastic bag if needed). The label may be generated along with the CoC form using a sample-tracking database (use waterproof labels), or may be hand-generated using a blank sample label purchased or provided by the laboratory with the sample bottles. For certain types of samples (for example, Summa™ soil gas canisters), blank labels are provided by the laboratory when the lab provides sample containers. All sample labels generated will contain the following information in indelible ink:

- Unique Sample ID
- Analyses requested
- Preservative used
- Date and time of sample collection
- Sampler's initials

Once the sample has been collected and the sample labeling is complete, the Sample Collector will place the samples in recloseable plastic bags and place in a cooler on ice. Labeling for other types of containers (such as soil gas and air samples) will follow the same labeling procedure except that the labels are attached to the sample containers (summa canisters, filters or tubes) via a sample tag attached to the container by the laboratory.

### **Chain-of-Custody Record**

CoC forms are legal documents that record the custody of the sample from collection through reporting. If the sampling event is using an electronic sample-tracking database, the CoC will be

generated at the end of the day; if not, CoC form(s) will be filled out for each sample at each sampling location to maintain a record of sample collection, shipment of samples, and receipt of samples by the laboratory.

The FTL/SC or Sample Collector will generate the CoC form. Information entered on the CoC includes:

- Project name and project number or task order
- CH2M HILL address and contact information
- Name and address of laboratory to receive the samples
- Unique sample ID
- Matrix type
- Analyses requested
- Field quality control (QC) for matrix spike and matrix spike duplicate (MS/MSD) samples, if applicable
- Container type, size and number (recommended\*)
- Preservatives used (recommended\*)
- Turn-around-time for laboratory analysis
- Comments to Laboratory, if applicable
- Date of collection
- Time of collection (24-hour format)

The FTL/SC or Sample Collector shall verify that the CoC record is complete, accurate in all aspects, and consistent with all other sample documentation (for example, number of samples, sample labels, purge forms, field logs). The FTL/SC or Sample Collector will sign the "Relinquished By" fields on the CoC record, marking the date and time custody is transferred to the laboratory courier or other common carrier service (e.g., FedEx, UPS, U.S. Postal Service, Golden State).

If using a common carrier service, the Sample Shipper will perform the following duties:

- Obtain any required signatures from sampling team.
- Record the carrier service and airbill number on the CoC.
- Sign and enter the date and time relinquished to the common carrier service or courier.

**Corrections:** If there are any corrections to the CoC form needed, corrections will be made by a single-line strike mark through the incorrect item, and then entering the correct entry adjacent to the strikeout item. Corrections will be initialed and dated by the person making the change. After the form has been inspected and determined to be satisfactorily complete, the Sample Shipper will sign, date, and note the time of transferal and will reference a shipper tracking number on the form (if applicable). If the samples are being shipped by common carrier service, the CoC form will be placed in a recloseable plastic bag and placed inside the cooler after the

sample packer has detached or made an appropriate copy of the form. Field copies of the completed CoC forms are maintained in project files by on site personnel.

### **Overnight Sample Storage**

In some cases, samples cannot be shipped immediately to a laboratory and must be temporarily stored in a secured onsite facility. There are two locations where secured refrigeration is available onsite.

The IM-3 field lab has limited space for samples in its refrigerator and can be used to temporarily store samples associated with the IM-3 operations. The facility is manned 24 hours a day 7 days a week and has restricted access.

The Topock field office trailer has a refrigerator that is dedicated to short-term sample storage, as well as two freezers that can be used for samples that require freezing. The field trailer is locked during non-business hours and the refrigerator is locked when staff are not present.

The samples placed in the refrigerators cannot be in coolers, but should be stored in recloseable plastic bags, grouped by sample location and laboratory. The refrigerators must be maintained at a temperature between 2° and 6°C.

### **Custody Seals**

For normal shipping (samples sent via laboratory courier) no custody seals are required. For shipping via common carrier service, the shipping cooler must have two custody seals: one on the front and one on the side of the cooler, signed, dated, and marked with the time the cooler was sealed (the signed CoC should be in a recloseable plastic bag, taped to the inside of the cooler's lid). In addition, each custody seal will be covered with transparent packing tape.

### **RECORDS**

The FTL is responsible for the distribution of the CoC record:

- Original: Sealed in plastic bag and taped inside the top of the shipping container (if shipped via common carrier service) or handed to the laboratory representative.
- Copies to Project Chemist and PM or Task Manager





**Attachment 1**  
**Sample Chain-of-Custody Form and**  
**Sample Custody Seal**

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Project Name PG&E Topock	Container:	8oz soil jar	8oz soil jar	8oz soil jar	8oz soil jar	3-40ml vials	8oz soil jar	8oz soil jar	8oz soil jar			
Location Topock	Preservatives:	4°C	4°C	4°C	4°C	1-MEOH 2-DI H2O <0°C	4°C	4°C	4°C			
Project Manager	Filtered:	NA	NA	NA	NA	NA	NA	NA	NA			
QC Manager	Holding Time:	14	14	14	14	14	14	14	14			
Project Number		Hexavalent Chromium (SW7199/3060A)	Title 22 Metals (SW6010B/SW7471A)	PH (SW9045)	Dioxins/Furans (SW8290)	TPH-Purgable (SW8015B)	TPH-Extractable (SW8015B)	SVOC (8270C)	PAHs (SW8270Sim)		Number of Containers	COMMENTS
Project												
Turnaround Time 10 Days												
Shipping Date:												
DATE	TIME	Matrix										

Signatures		Date/Time	Shipping Details		ATTN:  Sample Custody  and  Marlon	Special Instructions:
Approved by	_____	_____	Method of Shipment: Lab Courier			Report Copy to  Shawn Duffy 530-229-3303 sduffy@ch2m.com
Sampled by	_____	_____	On Ice: yes / no			
Relinquished by	_____	_____	Airbill No:			
Received by	_____	_____	Lab Name: ADVANCED TECHNOLOGY LABORATO			
Relinquished by	_____	_____	Lab Phone: (702) 307-2659			
Received by	_____	_____				

<b>CH2MHILL CUSTODY SEAL</b>				<b>CH2MHILL CUSTODY SEAL</b>			
	_____	_____	_____		_____	_____	_____
	Date				Date		
	Signature	_____	_____		Signature	_____	_____
<b>CH2MHILL CUSTODY SEAL</b>				<b>CH2MHILL CUSTODY SEAL</b>			
	_____	_____	_____		_____	_____	_____
	Date				Date		
	Signature	_____	_____		Signature	_____	_____
<b>CH2MHILL CUSTODY SEAL</b>				<b>CH2MHILL CUSTODY SEAL</b>			
	_____	_____	_____		_____	_____	_____
	Date				Date		
	Signature	_____	_____		Signature	_____	_____
<b>CH2MHILL CUSTODY SEAL</b>				<b>CH2MHILL CUSTODY SEAL</b>			
	_____	_____	_____		_____	_____	_____
	Date				Date		
	Signature	_____	_____		Signature	_____	_____
<b>CH2MHILL CUSTODY SEAL</b>				<b>CH2MHILL CUSTODY SEAL</b>			
	_____	_____	_____		_____	_____	_____
	Date				Date		
	Signature	_____	_____		Signature	_____	_____
<b>CH2MHILL CUSTODY SEAL</b>				<b>CH2MHILL CUSTODY SEAL</b>			
	_____	_____	_____		_____	_____	_____
	Date				Date		
	Signature	_____	_____		Signature	_____	_____
<b>CH2MHILL CUSTODY SEAL</b>				<b>CH2MHILL CUSTODY SEAL</b>			
	_____	_____	_____		_____	_____	_____
	Date				Date		
	Signature	_____	_____		Signature	_____	_____

## SOP-B16

### Field-portable X-Ray Fluorescence Soil Sampling Standard Operating Procedures for PG&E Topock Program

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This SOP describes the analysis of *in-situ* and *ex-situ* soil samples using a field portable X-Ray Fluorescence instrument (XRF). SOP-B2 and SOP-B3 in the *Sampling, Analysis, and Field Procedures Manual, PG&E Topock Program* (CH2M HILL, 2005) provide additional guidance for soil characterization and logging.

#### Required Documents

- 1) Event-specific planned sample table (PST).
- 2) Applicable project work plan or monitoring plan. Refer to the Procedures Manual, Operation and Maintenance (O&M) Manual and QAPP as required.
- 3) Topock Program Health and Safety Plan (HSP).
- 4) Field notebook.
- 5) Database generated chain-of-custody.
- 6) XRF Functional Check Log

#### Preparation and Setup

- 1) Review event-specific PST or event-specific field instructions, previous sampling logs, Procedures Manual, and HSP.
- 2) Coordinate with the Project Chemist for coolers, sample containers, and courier pickup of the samples.
- 3) Initiate field logbook for sampling activity.
- 4) Initiate electronic file for X-Ray Fluorescence (XRF) instrument download.
- 5) Review sampling procedures and planned sample depths with field crew.
- 6) Field-check and set up equipment for functional checks, sampling, decontamination, spill prevention, and health and safety.

#### Equipment List

- Niton XRF Meter and stand
- Spare battery chargers
- Field notebook
- Trowel for smoothing soil surfaces
- Reusable plastic bags or stainless steel tray
- Disposable Sample cups with X-ray film and lids

- X-Ray window film (Mylar, Kapton, Spectrolene, polypropylene, or equivalent; 2.5 – 6.0 micrometers (um) thick)
- Disposable scoops, stainless steel spoons or other appropriate mixing tools
- Appropriate quality control (QC)/quality assurance (QA) standards, and blank sand
- Chemwipes
- Decontamination equipment (Alconox<sup>®</sup> solution (or equivalent) in spray bottle, brushes, buckets, rinse water spray bottle) for mixing tools and trowels
- Protective waterproof gloves (nitrile or latex)

### **XRF SOIL ANALYSIS DOCUMENTATION**

The XRF sample results will be recorded by the associated software in an excel format. The files will be downloaded at the end of each day and emailed to the project chemist for review. Any additional sample logging and sample collection should follow the protocol and procedures found in the *Sampling, Analysis, and Field Procedures Manual, PG&E Topock Program* (CH2M HILL, 2005). Detailed notes should be recorded in the sampler's field notebook or in a log generated from the field database. Items to be documented on the sampling log include (note: include as much of the following information in the XRF software as possible):

- 1) Record type of boring or excavation equipment and the total boring or excavation depth.
- 2) If multiple samples are being collected at one location at a variety of depths, record all sample depths.
- 3) Record date and time of sample collection in addition to the full sample ID that is listed in the PST.
- 4) Sampling difficulties shall be noted (i.e. difficult slope or abnormal debris in sample location).
- 5) Analysis start time and the source count time (i.e. 60 sec, 90 sec, or 120 sec etc.) will be documented on sample collection sheet. Note: analysis and count time are automatically recorded in the XRF software.

### **Field-portable X-Ray Fluorescence Soil Sampling- COLLECTION OF SAMPLES FOR ANALYSIS**

#### ***In-Situ* Sample Preparation**

When the soil moisture is less than 20 percent, the error associated with moisture may be minimal. If areas are encountered where the moisture content is greater than 20 percent (moisture is visible), consult with the project chemist for options available for proceeding with field analysis.

For *in-situ* analysis,

- 1) Large or non-representative debris must be removed from the selected location. This debris includes rocks, gravel, vegetation and concrete.

- 2) The location chosen for analysis should be homogenized by mixing in place an area approximately 4" by 4" by 3" deep, using a clean (or decontaminated) stainless steel or disposable spoon. The location should then be smoothed and firmly tamped to provide as flat and smooth an area as possible.
- 3) A section of x-ray window film should be stretched over the area to be tested to maintain a dust free environment for the nose of the instrument. (Note: use in-situ analysis for metals only samples).
- 4) To initiate a reading, the nose of the XRF will be positioned against the x-ray film, squeezing the shutter release, and firmly pressing the instrument flat against the surface. Source count times for *in-situ* analysis usually range from one to two minutes, varying among instruments and depending on requirement detection limits.
- 5) After the *in-situ* field screening is performed, inspect the nose of the instrument for contamination, which may affect future analysis. If necessary, clean it with a soft cloth or tissue.

For confirmation samples, or where samples for organic analysis are to be collected the soil samples should be treated as *ex-situ* samples, below.

### ***Ex-Situ* Sample Preparation**

For *ex-situ* analysis,

There are several possible correct methods for the *ex-situ* analysis of samples. The area that previously would have been homogenized for the *in-situ* analysis should be scooped out and placed into a clean (or decontaminated) stainless steel or disposable pan (do not use plastic if organic analysis will be performed on any of this homogenized sample), using a stainless steel or disposable spoon or spatula (do not use plastic if organic analysis are associated with the homogenized sample). The sample should then be thoroughly mixed (homogenized) using the same spoon or spatula.

- 1) The preferred method is to setup the portable field stand in an area where the XRF can be stationed and left in place for the day. Use the Niton software and a laptop computer to setup the method criteria and control the XRF instrument during the soil analysis.
  - a) Starting with the previously homogenized sample, use the supplied soil sieves, bowl, and mortar to generate a finely ground well homogenized sample. (Note: This step is not required if the soil sample was passed through a sieve during the homogenization step.)
  - b) Transfer the prepared sample into a new sample cup (order replacement supplies from Niton), place the X-ray film over the cup and snap the lid in place. Place the sample cup in the portable field test stand (The XRF points upward, the sample rests on top of the XRF with the X-ray film directly in contact with the nose of the XRF - cup lid facing down).
  - c) Using the computer, start the analysis. The source count time should be at least two minutes for chromium. Consult previous analysis to determine if multiple scan frequencies are required (or contact the project chemist).
  - d) Prepare the next sample while the XRF is analyzing the current sample.

- 2) An alternative method to using the portable field stand is to identify the sample for XRF analysis and homogenize the sample (as described above).
  - a) Transfer the sample to a re-sealable plastic bag and firmly molded into a flat smooth surface.
  - b) Use the Niton software and a laptop computer or the included PDA to setup the method criteria.
  - c) To start the analysis, position the nose of the XRF against the flat smooth surface of the sample and squeeze the shutter release (or press the start button on the laptop or PDA). Be sure to maintain constant pressure against the sample. If contact is broken, the analysis will need to be restarted. The source count time for *ex-situ* analysis usually range from one to two minutes, depending on the required detection limits (see *c* above for count times).
  - d) After the *ex-situ* field screening is performed, inspect the nose of the instrument for contamination, which may affect future analysis. If necessary, clean it with a soft cloth or tissue.
- 3) Transfer the sample to a labeled glass jar for shipment to the confirmation laboratory (if applicable).

### Sample Analysis

In today's modern XRF models:

- 1) An X-ray source is used for detection. Expose the sample to the X-ray source for a minimum of one minute. Longer exposure times may be needed depending on the media that is being analyzed and the required detection levels. The time needed for analysis will be determined in the field by analyzing standards that have concentrations of the metals of concern near the required detection levels. Better detection limits can usually be obtained by homogenizing the sample, increasing the exposure time, and using two or more scan frequencies (Use a minimum of a two minute exposure for Chromium analysis).
- 2) When the XRF instrument displays the results they include the analyte, the result, and a percent confidence (displayed as a  $\pm$  value). The result is displayed as non-detect for analytes that do not meet the percent confidence established in the instrument. The lower the required detection levels, the longer the analysis time required to meet the percent confidence.
- 3) Download saved data from XRF instrument daily (if data is collected in PDA). Forward the data files to the project chemist daily.
- 4) All samples collected for off-site confirmation will also be analyzed using the XRF and treated as *ex-situ* samples.

Using older models:

- 1) Expose the sample to the energy source for a minimum of one minute. Longer exposure times may be needed depending on the media that is being analyzed as well as the age of the detector (non X-ray detectors). The time needed for analysis will be determined in the field by analyzing standards that have concentrations of the metals of concern near the required detection levels. Better detection limits can usually be obtained by homogenizing the sample, increasing the exposure time. (Use a minimum of a two minute exposure for Chromium)



- 2) When the XRF instrument indicates the results for the suite of analyzed elements and their concentrations, it includes a standard deviation for the reported concentrations. An analyte concentration is considered **not detected** if the result value is **less than two times the standard deviation**. The lower the required detection levels, the longer the analysis time required to reduce the result's standard deviation.
- 3) Record the readings (electronically or documented on the sampling log). Review the standard deviations for the elements of interest and determine if a longer analysis time is needed to reduce the standard deviations, thereby allowing the desired accuracy and precision for the concentrations. The standards will be analyzed using increasingly longer times until the required detection level is achieved.
- 4) Record values in field notebooks.
- 5) Download saved data from XRF instrument daily.
- 6) Samples collected for off-site confirmation will also be analyzed using the XRF and will be treated as *ex-situ* samples.

### **Calibration**

Two forms of calibration are important with XRF testing: an energy calibration and a sample matrix calibration.

#### **Energy Calibration**

The Niton XLi 702 automatically re-calibrates the energy scale when powered on. The energy scale can also be re-calibrated by pressing "Reset" on the instrument. The energy calibration should be performed every two hours.

#### **Sample Matrix Calibration**

Modern XRF instruments, such as the Niton Xli 702, do not require site specific calibrations to account for sample matrix effects. EPA Method 6200 allows both fundamental parameters and Compton normalization as two techniques to eliminate site specific calibrations. Niton uses the Compton normalization method to automatically correct for sample specific matrix effects. The XRF is calibrated internally at the factory on NIST standard reference soil samples. Ensure the annual factory calibration certification is on file. This internal calibration is used for subsequent field work, without need for adjustment or recalibration at other sites.

### **Quality Assurance and Quality Control (Functional Checks)**

Even though no onsite calibration will be performed, the method does require QA/QC Functional check testing protocols. The QA/QC that will be used to document that the XRF is operating properly will have the following steps:

- A startup operations check
- Analysis of a blank sample (clean sand)
- Analysis of standard sample(s)
- Analysis of duplicate samples
- QA/QC procedures will be compliant with manufacture's instructions.

- 1) At the beginning of each day perform QA/QC functional check procedure or when the instrument is turned on after more than 2 hours of down time or if the operating environment changes, such as a temperature change of more than 20 degrees Fahrenheit.
- 2) Two types of blanks should be analyzed, an instrument blank and a method blank. An instrument blank sample (silicon dioxide, provided by Niton) will be analyzed at the start and end of each day and once every 20 samples, to confirm proper zero calibration of the XRF. The blank will be analyzed following the procedure for the *ex-situ* sample analysis. A method blank is used to monitor for any field induced contamination. The method blank should follow any preparation procedures performed on the samples, such as mixing or *exsitu* analysis. **A method blank will be analyzed each day.**
- 3) A set of three to ten QC samples will be collected from the site during the initial field activities. These samples will be well homogenized, and a portion sent to the off-site laboratory for characterization. The remaining sample will be collected in re-sealable bags, labeled and stored with the XRF for use as standards. Three to five of the on-site standards will be analyzed at the start of each day. The results of the standards will be plotted against the original XRF results and a correlation value calculated. A correlation coefficient of 0.90 or greater must be achieved to meet the project objectives. A running log of all on-site standards analyzed will be maintained. One of the standards will be analyzed after every 20 samples. The readout from the XRF **must be within 20 percent RPD of the known QC sample concentration.**
- 4) The last QA/QC step will be to analyze duplicate samples (two separate aliquots) at a rate of 1 in 10. These duplicate measurements must be within 35 percent of each other for the analysis to continue. If the sample results are not in agreement, then the reason for this discrepancy must be determined.
- 5) The Niton XL3t 600 displays both concentration and precision for each sample analyte measurement. The precision displayed by the Niton's 95% (2-sigma) confidence intervals; where as the precision calculated in EPA method 6200 is at a 68% (1-sigma) level. The Niton also calculates and displays detection limits for analytes if the concentration is below three standard deviations. This bypasses the need for replicate measurements on low level standards.

*Note: VOC, SVOC, and other organic samples can not be collected from the homogenized soil if plastic is used for homogenizing or after XRF analysis, if contacted by plastic.*

## SOP-C1

### Solinst Pressure Transducers Standard Operating Procedures for PG&E Topock Program

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This standard operating procedure (SOP) addresses the procedures, equipment, and documentation needed when using Solinst Levellogger pressure transducers (PTs) at the Topock site.

#### **REQUIRED SOFTWARE:**

Solinst Levellogger software – latest version

#### **REQUIRED DOCUMENTATION:**

- Solinst User Guide – Levellogger Series – Software Version 4 (November 5, 2013) (User Guide 1) or more recent updates
- Solinst User Guide – Leveloader Gold (October 23, 2013) (User Guide 2) or more recent updates
- Performance Monitoring Program Transducer Download Log (attached)
- Compliance Monitoring Program Transducer Download Log (attached)
- Groundwater Sampling Log (attached)

#### **REQUIRED EQUIPMENT/SUPPLIES:**

- One or more Solinst Levellogger PT
- One or more Solinst Leveloader
- One or more Solinst Barologger
- Solinst Optical Connector
- Solinst Direct Read Cable
- Solinst Direct Read Connector
- Solinst PC Interface Cable
- PVC well cap with slot cut in the side for PT or Solinst 2-inch well cap or expanding locking well cap
- Deionized water
- Paper towels
- Personal computer (PC) with internet access
- Camera for documenting PT installations
- Water-level meter
- Assemble a tool kit containing:
  - Replacement PT O-rings
  - Replacement PT locating pins
  - Wire ties (also called zip-ties or cable ties)
  - C-flex tubing

**\*\*\*Note: Read the user guides for equipment before working with the transducer network at Topock.\*\*\***

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## **SOFTWARE SETUP:**

1. Install the Levellogger software on the PC as described in the User Guide 1, Section 3.0.
2. Configure the Levellogger program and install drivers as described in User Guide 1, Section 4.0.

## **TRANSDUCER SETUP:**

**\*\*\*Note: If reprogramming a PT that has previously been used at Topock, verify all data have been downloaded from the device before proceeding with transducer setup to prevent unintentional loss of data.\*\*\***

### **With a PC:**

1. Open the Levellogger program previously installed on the PC.
2. Connect the PT to the computer using either an optical reader or a PC interface cable.
3. Connect to the PT as directed in User Guide 1, Section 5.0.
4. Download data from the PT as described in the “Downloading Data from a Transducer” section below, this will prevent unintentional loss of any data stored on the PT.
5. Update the PT settings in the “Datalogger” section of the Datalogger Settings Tab in the Levellogger program (shown in User Guide 1, Section 5.0) as follows:
  - a) Location: Well name (for example, MW-34-100)
  - b) Project ID: PG&E Topock
  - c) Ch1: Level
    - Identification: Level
    - Unit: ft
    - Offset (ft): 0
  - d) Ch2: Temperature
    - Identification: Temperature
    - Unit: °C
  - e) Datalogger Sampling Mode
    - Sampling Type: Linear
    - Sampling Rate: 30 minutes
  - f) Datalogger Memory Mode: Continuous
  - g) Start/Stop Datalogger:
    - Click the *Start Now* button to load the above settings into the PT, then click the *Stop Now* button when it becomes an available option to stop the logger.
    - Next, set to *Future Start* at the next round half hour after approximate anticipated PT installation time (for example, if PT installation is expected at around 8:00 to 8:15 a.m., set *Future Start* for 8:30:00 a.m.).
    - **Note:** The *Future Start* setting can be added in the field with the instructions below if the approximate installation time is not known.
6. Disconnect the PT and install in monitoring well as described below.
7. Setting the time on the PT: Sync to the Levelloader as described in the “With a Levelloader Gold (Handheld) Device” section below.

### **With a Leveloader Gold (Handheld) Device:**

1. Power on the Leveloader device.
2. Connect the PT to the Leveloader via a direct-read connector (when already installed in the well) or optical connector.
3. On the main Leveloader Screen, select *Connect to Logger*.
4. Download data from the PT as described in the “Downloading Data from a Transducer” section below; this will prevent unintentional loss of any data stored on the PT.
5. Return to the main menu.
6. Scroll down to *Edit Levelogger* and click *OK*.
  - a) If the PT is currently logging, a prompt will appear to push both the up and down arrows simultaneously to stop the logging before edits can be made. Edit each category by scrolling to it and clicking *OK* as shown in User Guide 2, Section 8.4. Use the values listed in the “With a PC” section above for each category.
  - b) The final step of any edit is to scroll to and highlight *Submit* and press *OK*.
  - c) Setting the time on the PT: It is best practice to sync the time whenever an edit is made to the PT.
    - The time will sync by clicking *Edit* with the time entry selected.
    - **Note:** The PT time is set to Pacific Standard Time year-round. This means that the time shown on the Leveloader and the time on the PT will be 1 hour behind the actual time during the daylight saving time period (second Sunday in March through the first Sunday in November).

### **TRANSDUCER INSTALLATION:**

Proper installation of PTs is very important. The PTs measure the height of water above the sensor, or pressure head. Following calibration, the height of water (pressure head) is converted into a groundwater elevation (or hydraulic head, which is pressure head plus the elevation). Improper installations can result in errors in PT readings completely invalidating data. Some goals for PT installation are:

1. Install the PT so that it is possible to remove and reinstall it easily in the same location.
2. Install the PT from a solid mount so that it will not move due to gravity, opening or closing of the well, etc.
3. Install the PT at least 5 feet below the current depth to groundwater.
4. If a PT is to be installed near a pumping well, request the estimated pumping water-level depth before installation. Install the PT to at least 5 feet below the estimated maximum pumping depth to water (DTW).

### **Installation Procedure:**

1. The PT will be installed using one of the following methods:
  - A slotted PVC cap and a positive stop on the PT direct-read cable. The PT is either positioned to the side of the PVC cap, where there is room, or on top of the PVC cap. Positioning instructions should be written on the PVC cap with permanent marker (see Figure 1 below).
    - The positive stop is typically a 1- to 2-inch piece of white c-flex tubing cut along the long axis and secured around the direct read cable with two wire ties.

- 
- A Solinst well cap for 2-inch-diameter wells. The PT and attached direct-read cable are threaded through the large hole on top of the Solinst well cap. The large end of the direct-read cable fits snugly into the hole on top of the well cap (see Figure 2 below).
  - Hanging the PT securely from the bottom of the expandable locking well cap in flush-mount wells (this applies to all flush-mount wells with PT installations). The method of attachment to the expandable locking well cap will depend on the cap itself and should be discussed with the field coordinator prior to installation.
  - If necessary, the PT can be hung on other brackets or hangers already installed at the well head (for example, pump brackets).
2. The PT should be attached to a large object prior to bringing it to the well to prevent the PT from being accidentally lost down the well. The most common object is a large, orange plastic disk.
  3. The PT should then be lowered down the well and securely positioned at a predetermined depth.
    - The depth of the installation depends on the DTW and the pressure range of the sensor. F30/M10 (30 feet/10 meter) PTs have a pressure range of ~30 feet and should be installed at least 5 feet below the water table but not more than ~25 feet below the water table. A PT with a range of F15/M5 should be installed no more than ~10 feet below the water table.
    - The submersion depth of the PT can be monitored by using the Real Time data view described below.
    - If wells will be used for monitoring pumping tests, water levels could drop significantly (that is, do not install the PT only 5 feet below the water table if expected drawdown is 10 feet).
    - If the direct-read cable used for the installation is longer than needed, secure the extra length neatly inside of the secured/locked well vault with wire ties.
  4. Record time-synchronized manual water level and PT pressure readings:
    - Measure DTW below top of casing (BTOC) at the measuring point (see SOP A-7, Water Level Measurements, for detailed instructions). Record this information along with the date and time in the field logbook or the appropriate transducer download log.
    - Record real-time pressure in feet measured by the PT in the field logbook or transducer download log as described below:
      - a) Connect the PT direct-read cable to the Leveloader device (or PC using instructions in the "PT Setup" section above) with a direct-read connector.
        - o The direct-read connector has a tendency to become loose at the connection to the Leveloader; verify full connection prior to connecting to the PT.
      - b) Select *Connect to Logger* and click OK.
      - c) If the PT does not connect or shows a data corrupt error, see "Transducer Troubleshooting" section below.
      - d) When PT is connected, select *Real Time - View Only* and click OK.
      - e) Record the real-time value for pressure measured in feet.



**Figure 1 - Installation of PT with PVC Cap and Positive Stop**



**Figure 2 - Installation of PT with Solinst Well Cap**



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### **TEMPORARY PT REMOVAL/REINSTALLATION DURING WELL SAMPLING:**

1. Open well protection lid and inspect PT installation. Note the PT installation setup to ensure the PT will be reinstalled in exactly the same place. Take a photograph before PT removal to document PT position.
2. Before removing the PT, measure DTW BTOC according to SOP-A7, Water Level Measurements. Record the exact time to the nearest minute and the DTW BTOC in the transducer section of the groundwater sampling log.
3. Remove the PT, coil the cable, and store in a manner to prevent contamination of the cable and probe. Record the time of removal on the sampling field sheet.
  - A clean, plastic garbage bag or leaf bag can be used to store the PT. Alternately, the PT can be stored in the bag used to contain the well-specific pump tubing.
  - If the PT becomes dirty or contaminated, rinse with purified water or wipe thoroughly with a purified water moistened paper towel to decontaminate per SOP A-10, Decontamination of Water Sampling Equipment.
4. When groundwater sampling is completed, reinstall the PT, restoring the correct setup of the PT mounting hardware as documented in the setup photograph. Record the time of reinstallation on the sampling log.
5. Measure the DTW BTOC at least 5 minutes after reinstalling the PT according to SOP-A7, Water Level Measurements. Record the time and DTW BTOC on the sampling log.

### **DOWNLOADING DATA FROM A TRANSDUCER:**

Data downloads should be conducted at least monthly to provide data for analysis and evaluation and to ensure the PT is working properly.

- Data should be screened in the field to ensure that data extend to the download date (that is, is still recording) and that the data make sense (that is, the sensor has not “maxed out” its pressure range and data are garbled, which can happen when a PT fails).
- Battery life should be checked to ensure the PT will continue to operate well into the future.

### **Downloading the Data from the Transducer with a Leveloader Gold Device:**

This procedure will be used when downloading data from a PT.

1. Open well protection lid and inspect PT installation. Note the PT installation setup to ensure the PT will remain in exactly the same place. Take a photograph to document PT position.
2. Measure the DTW BTOC according to SOP-A7, Water Level Measurements. Record the exact time to the nearest minute and the DTW BTOC on the appropriate transducer download log.
3. Connect the direct-read cable to the Leveloader device with a direct-read connector.
  - You can also connect directly to the PT with an optical connector.
4. Select *Connect to Logger* and click *OK*.
  - If the PT does not connect or shows a “data corrupt” error, see “Transducer Troubleshooting” section below.
5. Select *Real Time – View Only* and click *OK*.
6. Record the real-time value for pressure/depth on the appropriate transducer download log.
7. Click the *Menu* button to return to the main menu.



8. Select *Data from Logger* and click *OK*.
9. Record the Levellogger serial number (shown as, e.g., #1013653 or similar at the top of the screen) and battery remaining percentage (shown on the top of the screen) on the appropriate transducer download log.
10. Click the *Save Log* button to begin the download.
11. When download is complete, click the *Menu* button to return to the main menu.
12. Select *View Stored Data* and click *OK*.
  - Scroll as necessary to the last log collected and check the serial number to ensure that the log was properly recorded to the Leveloader.
13. Click the *Menu* button to return to the main menu, then click *Return* to disconnect from the Levellogger.
14. Disconnect the Leveloader from the PT direct read cable. Replace all PT hanging mounting hardware as it was before the download, referring to the photograph taken previously if needed.
15. Record the File Number on the appropriate transducer download log in the format: Unit Number-File Number (for example, 4-25).

**Saving the Data from the Leveloader to PC:**

1. Connect the Leveloader device to a PC with a USB or RS-232 connection cable.
2. Connect the Leveloader as directed in User Guide 2, Section 9.0.
3. Select the files to save to the PC and download as shown in User Guide 2, Section 9.0.
  - Note: when downloading from a Leveloader, all logs are automatically selected.
  - It is helpful to save all files from a download event in an event-specific folder.
4. Confirm that a separate file for each well downloaded on the field log has been transferred to the PC folder.

**Downloading Data from a Transducer with a PC:**

This procedure will be used when downloading data from a PT in the office.

1. Open the Levellogger software.
2. Connect the PT to the computer using either an optical reader or a PC interface cable.
3. Connect to the Levellogger as directed in User Guide 1, Section 5.0.
4. Download data from the PT according to User Guide 1, Section 7.1.2.
  - Select to download *All Data*.
5. Save to a file on your PC according to User Guide 1, Section 7.1.3.
  - It is helpful to save all files from a download event in an event-specific folder.

**Packaging and Sending Data for Incorporation in the Topock Transducer Database:**

1. Scan the transducer download log to a PDF file and save it to your computer in the same folder as the downloaded data files.
2. Download the data from the onsite Barologger using instructions for downloading data from a PT above. Save these data in the same folder as the other downloaded data files.

- The Barologger data must be collected after all other field data have been collected.
3. Create a .zip file of the folder (right click >Send to> Compressed (zipped) folder).
  4. Send the .zip file via email to the current database manager and transducer data lead(s).
    - The Field Coordinator or Project Manager can supply these contacts if needed.

### **TRANSDUCER TROUBLESHOOTING:**

Occasionally, a PT will fail to connect to the Leveloader device in the field or show a data corrupt error message. Follow these steps to troubleshoot the problem:

1. Remove the PT from the well.
2. Disconnect the PT from the direct read cable.
3. Clean the optical “eyes” on the top of the PT.
  - Work over the tool tray or another container because the small locating pin on the cable sometimes falls out and can be lost. If the pin is lost or broken, replacements are available in the tool kit.
4. If the small “O” rings around the optical eyes look flattened out, replace them with spares from the tool kit.
5. Test for a proper connection before re-installing.
6. If the PT continues to fail to connect, clean the eyes again.
7. If the PT fails to connect after a second cleaning, attach the optical connector and attempt to connect.
8. If the PT connects with the optical connector then a defective direct-read PT cable is indicated; replace the cable.
  - Mark the direct-read PT cable with the well number and date as “bad” and discard the cable as appropriate.
9. If the PT still fails to connect, the PT has failed and will need to be replaced.
10. Mark the PT with the well number and date as “bad” and take the failed PT back to the field office and attempt to connect to the PT with the optical reader to a PC (this works sometimes to get the data). Inform the Field Coordinator and Project Manager if equipment has failed.

### **POINTS OF CONTACT FOR QUESTIONS CONCERNING THESE PROCEDURES:**

Project Manager: Jay Piper: (702) 953-120, jay.piper@ch2m.com

Field Coordinator: Barry Collom: (541) 740-3250, barry.collom@ch2m.com

## Attachments

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- Performance Monitoring Program Transducer Download Log
- Compliance Monitoring Program Transducer Download Log
- Groundwater Sampling Log

## PG&E Topock - PMP Monthly Transducer Download

Personnel:

Water Level Meter S/N:

Manually Recorded Data				Transducer Data			File Number (unit-file)	Comments/Notes
Well ID	Date	Time	Water Level (ft btoc)	Serial Number	Pressure Reading	Battery Capacity		
I-3								
MW-12								
MW-20-130								
MW-20-070								
MW-20-100								
MW-21								
MW-22								
MW-23-060								
MW-23-080								
MW-25								
MW-26								
MW-27-020								
MW-27-060								
MW-27-085								
MW-27-085B								
MW-28-25								
MW-28-90								
MW-30-50								
MW-31-135								
MW-31-135B								
MW-31-060								
MW-32-35								

## PG&E Topock - PMP Monthly Transducer Download

Personnel:

Water Level Meter S/N:

Manually Recorded Data				Transducer Data			File Number (unit-file)	Comments/Notes
Well ID	Date	Time	Water Level (ft btoc)	Serial Number	Pressure Reading	Battery Capacity		
MW-33-40								
MW-33-90								
MW-33-150								
MW-33-150B								
MW-34-55								
MW-34-80								
MW-34-100								
MW-34-100B								
MW-35-060								
MW-35-135								
MW-36-020								
MW-36-040								
MW-36-050								
MW-36-070								
MW-36-090								
MW-36-100								
MW-39-040								
MW-39-050								
MW-39-060								
MW-39-070								
MW-39-080								
MW-39-100								

## PG&E Topock - PMP Monthly Transducer Download

Personnel:

Water Level Meter S/N:

Manually Recorded Data				Transducer Data			File Number (unit-file)	Comments/Notes
Well ID	Date	Time	Water Level (ft btoc)	Serial Number	Pressure Reading	Battery Capacity		
MW-42-030								
MW-42-065								
MW-43-025								
MW-43-090								
MW-44-070								
MW-44-115								
MW-44-125								
MW-45-095a								
MW-45-095aB								
MW-46-175								
MW-47-055								
MW-47-115								
MW-49-135								
MW-50-095								
MW-51								
MW-54-085								
MW-54-140								
MW-54-195								
MW-55-045								
MW-55-120								
RRB								
PT2D								

## PG&E Topock - PMP Monthly Transducer Download

Personnel:

Water Level Meter S/N:

Manually Recorded Data				Transducer Data			File Number (unit-file)	Comments/Notes
Well ID	Date	Time	Water Level (ft btoc)	Serial Number	Pressure Reading	Battery Capacity		
PT5D								
PT6D								

Notes:

1- Transducer time = Pacific Standard Time (PST).

**This means all transducers are behind by 1 hour during summer months compared with the actual time.**

PG&E Topock - OW/CW Transducer Download											
Date:		Personnel:				WL Readings Taken Using:					
Note: Take water levels for solinst transducers to top of well cap.											
Record top of PVC waterlevel and then top of Solinst cap waterlevel for all new Solinst installations using solinst caps											
Manually Recorded Data				Transducer Data							
Well ID	Date	Time (PST)	Water Level (ft btoc)	Serial Number	Pressure Reading	Memory	Battery	Comments	New PT SN	Solinst Log #	Comments/Field Notes
Barologger-5								Solinst			
Barologger-30								Solinst			
OW-1S								solinst			
OW-2S								Solinst			
OW-5S								Solinst			
OW-5M								Solinst			
OW-5D								Solinst			
								solinst			
								solinst			
								solinst			
								solinst			
								solinst			
								solinst			
Notes:											
1- Transducer time = Pasific Standard Time (PST).											
This means all transducers are behind by 1 hour during summer months compared with the actual time.											



Project Name \_\_\_\_\_

Job Number \_\_\_\_\_

Sampling Event \_\_\_\_\_

Date \_\_\_\_\_

Sampler \_\_\_\_\_ Field Team \_\_\_\_\_ Field Conditions \_\_\_\_\_

Page \_\_\_\_\_ of \_\_\_\_\_

Well/Sample Number \_\_\_\_\_

QC Sample ID \_\_\_\_\_

QC Sample Time \_\_\_\_\_

Purge Start Time \_\_\_\_\_

Purge Method: \_\_\_\_\_ Ded. Pump \_\_\_\_\_

Flow Cell: Y / N

Min. Purge Volume (gal)/(L) \_\_\_\_\_ Purge Rate (gpm)/(mLpm) \_\_\_\_\_ Pump Make and Model \_\_\_\_\_

Water Level	Time	Vol. Purged gallons / liters	pH	Conductivity $\mu$ S/cm	Turbidity NTU	Diss. Oxygen mg/L	Temp. °C	Eh/ORP mv	Comments (See description below)
<b>Parameter Stabilization Criteria</b>			+/- 0.1 pH units	+/- 3%	+/- 10% NTU units when >10 NTUs	+/- 0.3 mg/L	+/- 2°C	+/- 10 mV	
Did last three Parameters Stabilize prior to sampling?									
Previous Field measurement (11/14/2013)									
Are measurements consistent with previous?									

Sample Time \_\_\_\_\_ Sample Location: \_\_\_\_\_ pump tubing \_\_\_\_\_ well port \_\_\_\_\_ spigot \_\_\_\_\_ bailer \_\_\_\_\_ other \_\_\_\_\_

Comments: \_\_\_\_\_

Initial Depth to Water (ft BTOC): \_\_\_\_\_

WQ METER MAKE and SERIAL NUMBER: \_\_\_\_\_

Field measured confirmation of Well Depth (ft btoc): \_\_\_\_\_

Measure Point: Well TOC Steel Casing

WATER LEVEL METER SERIAL NUMBER: \_\_\_\_\_

WD (Well Depth - from database) ft btoc \_\_\_\_\_

SWH (Standing Water Height) = WD-Initial Depth \_\_\_\_\_

D (Volume as per diameter) 2"= 0.17, 4"= 0.66, 1"=0.041 \_\_\_\_\_

One Casing Volume = D\*SWH \_\_\_\_\_

Three Casing Volumes = \_\_\_\_\_

Color: clear, grey, yellow, brown, black, cloudy, green

Odor: none, sulphur, organic, other

Solids: Trace, Small Qu, Med Qu, Large Qu, Particulate, Silt, Sand

Initial DTW / Before Removal		If Transducer			
		Approx. 5 min After Reinstallation		Time of Removal _____	
Time	Initial DTW	Time	Final DTW	Time of Reinstallation _____	
Comments:					

Project Name \_\_\_\_\_

Job Number \_\_\_\_\_

Sampling Event \_\_\_\_\_

Date \_\_\_\_\_

Sampler \_\_\_\_\_ Field Team \_\_\_\_\_ Field Conditions \_\_\_\_\_

Page \_\_\_\_\_ of \_\_\_\_\_

Well/Sample Number \_\_\_\_\_

QC Sample ID \_\_\_\_\_

QC Sample Time \_\_\_\_\_

Purge Start Time \_\_\_\_\_

Purge Method: \_\_\_\_\_ Ded. Pump \_\_\_\_\_

Flow Cell: Y / N

Min. Purge Volume (gal)/(L) \_\_\_\_\_ Purge Rate (gpm)/(mLpm) \_\_\_\_\_ Pump Make and Model \_\_\_\_\_

Water Level	Time	Vol. Purged gallons / liters	pH	Conductivity $\mu$ S/cm	Turbidity NTU	Diss. Oxygen mg/L	Temp. °C	Eh/ORP mv	Comments (See description below)
<b>Parameter Stabilization Criteria</b>			+/- 0.1 pH units	+/- 3%	+/- 10% NTU units when >10 NTUs	+/- 0.3 mg/L	+/- 2°C	+/- 10 mV	
Did last three Parameters Stabilize prior to sampling?									
Previous Field measurement (11/14/2013)									
Are measurements consistent with previous?									

Sample Time \_\_\_\_\_ Sample Location: \_\_\_\_\_ pump tubing \_\_\_\_\_ well port \_\_\_\_\_ spigot \_\_\_\_\_ bailer \_\_\_\_\_ other \_\_\_\_\_

Comments: \_\_\_\_\_

Initial Depth to Water (ft BTOC): \_\_\_\_\_

WQ METER MAKE and SERIAL NUMBER: \_\_\_\_\_

Field measured confirmation of Well Depth (ft btoc): \_\_\_\_\_

Measure Point: Well TOC Steel Casing

WATER LEVEL METER SERIAL NUMBER: \_\_\_\_\_

WD (Well Depth - from database) ft btoc \_\_\_\_\_

SWH (Standing Water Height) = WD-Initial Depth \_\_\_\_\_

D (Volume as per diameter) 2"= 0.17, 4"= 0.66, 1"=0.041 \_\_\_\_\_

One Casing Volume = D\*SWH \_\_\_\_\_

Three Casing Volumes = \_\_\_\_\_

Color: clear, grey, yellow, brown, black, cloudy, green

Odor: none, sulphur, organic, other

Solids: Trace, Small Qu, Med Qu, Large Qu, Particulate, Silt, Sand

Initial DTW / Before Removal		If Transducer			
		Approx. 5 min After Reinstallation		Time of Removal _____	
Time	Initial DTW	Time	Final DTW	Time of Reinstallation _____	
Comments:					

PG&E Topock - OW/CW Transducer Download											
Date:		Personnel:				WL Readings Taken Using:					
Note: Take water levels for solinst transducers to top of well cap.											
Record top of PVC waterlevel and then top of Solinst cap waterlevel for all new Solinst installations using solinst caps											
Manually Recorded Data				Transducer Data							
Well ID	Date	Time (PST)	Water Level (ft btoc)	Serial Number	Pressure Reading	Memory	Battery	Comments	New PT SN	Solinst Log #	Comments/Field Notes
Barologger-5								Solinst			
Barologger-30								Solinst			
OW-1S								solinst			
OW-2S								Solinst			
OW-5S								Solinst			
OW-5M								Solinst			
OW-5D								Solinst			
								solinst			
								solinst			
								solinst			
								solinst			
								solinst			
								solinst			
Notes:											
1- Transducer time = Pasific Standard Time (PST).											
This means all transducers are behind by 1 hour during summer months compared with the actual time.											

## PG&E Topock - PMP Monthly Transducer Download

Personnel:

Water Level Meter S/N:

Manually Recorded Data				Transducer Data			File Number (unit-file)	Comments/Notes
Well ID	Date	Time	Water Level (ft btoc)	Serial Number	Pressure Reading	Battery Capacity		
I-3								
MW-12								
MW-20-130								
MW-20-070								
MW-20-100								
MW-21								
MW-22								
MW-23-060								
MW-23-080								
MW-25								
MW-26								
MW-27-020								
MW-27-060								
MW-27-085								
MW-27-085B								
MW-28-25								
MW-28-90								
MW-30-50								
MW-31-135								
MW-31-135B								
MW-31-060								
MW-32-35								

## PG&E Topock - PMP Monthly Transducer Download

Personnel:

Water Level Meter S/N:

Manually Recorded Data				Transducer Data			File Number (unit-file)	Comments/Notes
Well ID	Date	Time	Water Level (ft btoc)	Serial Number	Pressure Reading	Battery Capacity		
MW-33-40								
MW-33-90								
MW-33-150								
MW-33-150B								
MW-34-55								
MW-34-80								
MW-34-100								
MW-34-100B								
MW-35-060								
MW-35-135								
MW-36-020								
MW-36-040								
MW-36-050								
MW-36-070								
MW-36-090								
MW-36-100								
MW-39-040								
MW-39-050								
MW-39-060								
MW-39-070								
MW-39-080								
MW-39-100								

## PG&E Topock - PMP Monthly Transducer Download

Personnel:

Water Level Meter S/N:

Manually Recorded Data				Transducer Data			File Number (unit-file)	Comments/Notes
Well ID	Date	Time	Water Level (ft btoc)	Serial Number	Pressure Reading	Battery Capacity		
MW-42-030								
MW-42-065								
MW-43-025								
MW-43-090								
MW-44-070								
MW-44-115								
MW-44-125								
MW-45-095a								
MW-45-095aB								
MW-46-175								
MW-47-055								
MW-47-115								
MW-49-135								
MW-50-095								
MW-51								
MW-54-085								
MW-54-140								
MW-54-195								
MW-55-045								
MW-55-120								
RRB								
PT2D								

## PG&E Topock - PMP Monthly Transducer Download

Personnel:

Water Level Meter S/N:

Manually Recorded Data				Transducer Data			File Number (unit-file)	Comments/Notes
Well ID	Date	Time	Water Level (ft btoc)	Serial Number	Pressure Reading	Battery Capacity		
PT5D								
PT6D								

Notes:

1- Transducer time = Pacific Standard Time (PST).

**This means all transducers are behind by 1 hour during summer months compared with the actual time.**

## SOP-C2

### Pressure Transducer Upload to Topock Database Standard Operating Procedures for PG&E Topock Program

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This standard operating procedure (SOP) details field instructions for uploading pressure transducer (PT) data collected using Solinst Levellogger PTs to the Pacific Gas and Electric Company (PG&E) Topock site database.

#### **DATA TRANSFER, COMPENSATION, AND UPLOADING:**

Data files are transferred from the field in a Solinst proprietary format (.lev or .xle) or in a comma-delimited (.csv) file. The .xle files must be opened using the Solinst Levellogger software version 4.0 or newer versions—older versions of the Solinst Levellogger software will not recognize the .xle formats. Lev files are compatible with all available versions. A Barologger file (.lev format) will also be included to barometrically compensate the transducer data files. The .lev and .xle files are compensated using the Solinst software and the .csv files are compensated in the Topock Transducer\_loading database.

#### **.lev and .xle Files:**

1. Open the Solinst Levellogger program and import the Barologger file by clicking the *Open* icon on the *Data Control* tab and double-clicking on the Barologger data file which, for example, is named as follows:

1024290\_BAROLOGGER\_5MIN\_2014\_04\_01\_.lev

where:

- The transducer serial number is 1024290.
- The pressure head levels in feet were collected at 5-minute intervals.
- The last measurement was taken on April 1, 2014.

2. Import the .xle or .lev transducer data file by clicking the *Open* icon on the *Data Control* tab and double-clicking on the data file. The transducer data files are named, for example, as follows:

2005344\_MW-36-50.xle

where:

- The transducer serial number is 2005344.
- The well name MW-36-50.

*Note: The header information (listing information including the location name and PT settings) will appear on the left of the imported file. The serial number and location should match what is in the filename.*

3. Go to the *Data Compensation* tab and click through the following three steps:
  - a. Select the Levellogger file(s) to compensate by marking the checkbox next to the file name.



- b. Make sure “Barometric Compensation” has a checkmark.
- c. Select the Barologger file by highlighting the filename.
4. Click *Finish* to compensate. The compensated transducer file will be saved in the same folder as the transducer data files with “Compensated” at the end of the original filename, as in the following example:

2005344\_MW-36-50Compensated.xle

*Note: Compensation cannot be completed if the transducer data file's date and time is not within 3 hours of the Barologger file's date and time. Some files may need to be compensated with multiple Barologger files or, if the transducer data were downloaded after the Barologger data, the measurements taken after the Barologger's last date/time field should not be uploaded into the database.*

5. A dialog box will open when compensation is complete. Click *Finish and Open*.
6. Export the compensated transducer data file as a .csv file by clicking the export button on the *Data Control* tab and selecting data; save the files in the same directory using the same name as the compensated files:

2005344\_MW-36-50Compensated.csv

7. Repeat process for next transducer file.

*Note: Multiple transducer data files can be compensated at the same time by repeating the importing step before going to the data compensation step; however, the compensated files will not automatically open. The compensated files will have to be imported into the Solinst Levellogger software and then exported into a .csv file one at a time.*

8. Once all of the transducer data files have been converted to .csv files, the files can be viewed from File Explorer, which will sort the files in alpha-numeric order. The files should then be imported into the database in this order to ensure all files are imported and to assist in making sure there are no duplicates, misnaming, missed files, etc.
9. Open the first file in a text editor or Microsoft Excel. The first dozen or so lines are header lines that should be noted. The header lines identify the transducer serial number and location (should be the well or *LocID*) Double check the same *LocID* exists in the file name.
10. Select all the numeric data (excluding header lines) and copy to the clipboard.
11. Open the Topock Transducer\_loading frontend database. The Transducer Control Form (*frmTransducerCalibrationSummary*) should automatically open. Click *View Temp Table for LEV files* (should be empty), select the entire row, and paste the data.
12. Enter the following information onto the Transducer Control Form:
  - Select the *LocID* for the transducer from dropdown menu.
  - Enter the filename of the .csv file to be imported.
  - Enter your name or initials.

*Note: This information, as well as the date of loading and last date-time of the .csv file, will be stored in the LoadingInfo field. If questions or problems arise following upload, it*

is the *LoadingInfo* field that can be used to purge bad data or apply corrections if, for example, the data are inadvertently uploaded with the wrong *LocID*.

13. Enter any comments or descriptions regarding the upload (optional).
14. With the data in *tblPT\_Temp* and the fields filled out in the *Data Upload* section, press the *Upload Lev Transducer Data*. This will transfer the data from the temporary table to the table *tblPT* while appending *LocID* and *LoadingInfo*.
15. As the upload process continues, a prompt to confirm the appending of records to *tblPT* will appear. Select *Yes* unless a mistake has been made (this may be the only chance to stop the upload). If some of the records already exist in *tblPT* (that is, were uploaded during a previous upload session), a second prompt box stating that some records will not be uploaded due to primary key violations (the database will not let records with duplicate *LocID*, *Date & Time* be uploaded to *tblPT*). If it makes sense that records are duplicates, proceed with the upload to append only new data to the database.
16. Repeat process for next well Levellogger file.

#### .csv Files:

When .csv files are to be loaded into the database barometric compensation is performed within the database rather than using the Solinst Levellogger program. The procedures below describe this process.

1. Open the Solinst Levellogger program, Import the Barologger file by clicking the *Open* icon on the *Data Control* tab and double clicking on the Barologger data file which is named as follows:

1024290\_BAROLOGGER\_5MIN\_2014\_04\_01\_.lev

where:

- The serial number is 1024290.
- The levels were collected in 5-minute intervals.
- The last measurement was taken on April 1, 2014.

2. Export the Barologger file as a .csv file by clicking the export button on the *Data Control* tab and selecting data; save the file in the same directory using the same name as the Barologger file:

1024290\_BAROLOGGER\_5MIN\_2014\_04\_01\_.csv

3. Open the Barologger .csv file in a text editor or in Microsoft Excel. Select all the numeric data (excluding header lines) and copy to the clipboard.
4. Open the Topock Transducer\_loading frontend database. The Transducer Control Form (*frmTransducerCalibrationSummary*) should automatically open. Open table *tblPT\_Barologger*, select a new row, and paste the data.
5. If some of the records already exist in *tblPT\_Barologger* (that is, were uploaded during a previous upload session), a prompt box will appear stating that some records will not be uploaded due to primary key violations (the database will not let records with duplicate *Date & Time* be uploaded to *tblPT\_Barologger*). If it makes sense that records are duplicates, proceed with the upload appending only new data records by pressing *OK*. A

second prompt box will open asking if you want to suppress further error messages, click *Yes*.

6. Open the transducer .csv file in a text editor or Microsoft Excel. Select all the numeric data (excluding header lines) and copy to the clipboard.
7. Empty the table *tblIPT\_Transducer\_YSI* by running the query *qryManualCompensation01\_YSI*, open table *tblIPT\_Transducer\_YSI*, select the entire row, and paste the data.
8. Compensate the transducer file and append the compensated data to the *tblIPT\_Temp* table by running the query *qryManualCompensation02\_append\_YSI*. A prompt to confirm the appending of records will appear. Select *Yes*. A second prompt will confirm the appending and have the number of rows appended. This number should match the number of records in *tblIPT\_Transducer\_YSI*. If the numbers do not match, check that the time is in 5-minute intervals and that the date time records in the Barologger table extend as far as the transducer records.
9. Adjust for daylight savings as appropriate by running the query *qupdLevTime*.
10. Enter the following information onto the Transducer Control Form:
  - Select the *LocID* for the transducer from the drop-down menu.
  - Enter the filename of the .csv file to be imported.
  - Enter your name or initials.

Note: This information, as well as the date of loading and last date-time of the .csv file, will be stored in the *LoadingInfo* field. If questions or problems arise following upload, it is the *LoadingInfo* field that can be used to purge bad data or apply corrections if, for example, the data are inadvertently uploaded with the wrong *LocID*.

- Enter any comments or descriptions regarding the upload (optional).
11. With the data in *tblIPT\_Temp* and the fields filled out in the *Data Upload* section, press the *Upload Lev Transducer Data*. This will transfer the data from the temporary table to the table *tblIPT* while appending *LocID* and *LoadingInfo*.
  12. As the upload process continues, a prompt to confirm the appending of records to *tblIPT* will appear. Select *Yes* unless a mistake has been made (this may be the only chance to stop the upload). If some of the records already exist in *tblIPT* (that is, were uploaded during a previous upload session), a second prompt box stating that some records will not be uploaded due to primary key violations (the database will not let records with duplicate *LocID*, Date & Time be uploaded to *tblIPT*). If it makes sense that records are duplicates, proceed with the upload to append only new data to the database.
  13. Repeat process for next well .csv file.

#### **POINTS OF CONTACT FOR QUESTIONS CONCERNING THESE PROCEDURES:**

Project Manager: Jay Piper: (702) 953-120, jay.piper@ch2m.com

Database Manager: Sarah Mader (510) 327-2275, sarah.mader@e2.com

# Standard Operating Procedure – Laboratory PG&E Topock Program

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Title: Hexavalent Chromium Analysis by Hach Method 1560

Number: SOP-L01\_Rev3

Revision Date: 4/1/2014

## Scope

Standard Operating Procedure (SOP) for the analysis of hexavalent chromium ( $\text{Cr}^{+6}$ ).

## Equipment and Supplies

- Safety glasses
- Latex gloves
- Hach DR 4000V spectrophotometer or equivalent.
- Vacuum filter apparatus: 47 mm magnetic filter funnels, 1,000 mL Erlenmeyer flask, and vacuum pump. Use a 0.45  $\mu\text{m}$ , 47 mm diameter filter membrane.
- 0.45  $\mu\text{m}$  filter disc fitted to a disposable 50 mL syringe (syringe filter).
- pH meter.
- Reaction vessel and cap or means of sealing the reaction vessel (Hach sample cell, 50 mL beaker, vial capable of holding 30 mL and parafilm if the vessel doesn't have a cap).
- 1 packet of ChromaVer® 3 Reagent per sample.
- 2.5 mg/L hexavalent chromium ( $\text{Cr}^{+6}$ ) (working) standard.

## Procedure

1. Collect the sample(s) following the appropriate SOP (see list below). Samples should be analyzed as soon as possible (within 24 hours). **Note: all samples must be filtered.**
  - SOP-A1 – Purging and Sampling of Groundwater Monitoring Wells, Well-Volume Method
  - SOP-A2 – Purging and Sampling of 1-inch-diameter Groundwater Monitoring Wells, Modified Well-Volume Method
  - SOP-A3 – Purging and Sampling of Active and Inactive Water Supply Wells
  - SOP-A4 – Depth-Specific Surface Water Sampling
  - SOP-A5 – Groundwater Sampling from Sonic Drilling Boreholes
  - SOP-A14 – Pore Water Sampling
  - Remedy-SOP-01 – Process Water Sampling

2. Filtering can be performed using an inline filter at the time of sampling (see SOP-A6, Sample Field Filtration and Preservation for Metals Analyses) or in the laboratory by vacuum filter:
  - Set up the vacuum filter apparatus.
  - Filter ~100 mL of sample.
3. Measure the pH of the raw sample (**Record the results in the Cr<sup>+6</sup> bench log book**).
4. Verify the spectrophotometer is set for **Hexavalent Chromium (Cr<sup>+6</sup>)** (Hach DR/4000V program **1560**) and verify all reagents are for 25 mL sample size (or adjust accordingly).
5. Transfer 25 mL of filtered sample into a reaction vessel (sample cell, beaker, etc.)
6. Add one packet of ChromaVer® 3 Reagent to the sample.
7. Invert sample 4–5 times or swirl the sample until powdered reagent is dissolved.
8. Start timer (8 mins.).
9. Run a blank: Use a 25 mL aliquot of filtered sample to “zero” the spectrophotometer.
  - Transfer 25 mL of raw filtered sample into the pour-thru-cell funnel.
  - Allow the meter to stabilize and press the Zero button.
10. After 8 minute timer, pour the sample with the reagent added into a syringe filter to remove the excess reagent powder. Transfer the sample into the pour-thru-cell funnel (sample port of the Hach DR/4000V).
11. Record the instrument reading in the Cr<sup>+6</sup> bench log book.
12. If the result is out of range for the spectrophotometer, reanalyze the sample using a dilution.

Note: if a dilution is required, the spectrophotometer should be zeroed using sample from the same dilution.

Common dilutions:

- 1:2 dilution: 25 mL of sample are diluted with 25 mL of deionized (DI) water; multiply the instrument reading (result) by 2 for the adjusted value.

$$\begin{array}{r} \text{Example: instrument reading is} \quad 0.304 \\ \quad \quad \quad \quad \quad \quad \quad \quad \underline{\times 2} \\ \quad \quad \quad \quad \quad \quad \quad \quad = .608 \text{ mg/L (final result)} \end{array}$$

- 1:5 dilution: 10 mL of sample are diluted with 40 mL of DI water; multiply the instrument reading (result) by 5 for the adjusted value.

$$\begin{array}{r} \text{Example: instrument reading is} \quad 0.304 \\ \quad \quad \quad \quad \quad \quad \quad \quad \underline{\times 5} \\ \quad \quad \quad \quad \quad \quad \quad \quad = 1.52 \text{ mg/L (final result)} \end{array}$$

- 1:10 dilution: 10 mL of sample are diluted with 90 mL of DI water; multiply the instrument reading (result) by 10 for the adjusted value.

- 1:20 dilution: 5 mL of sample are diluted with 95 mL of DI water; multiply the instrument reading (result) by 20 for the adjusted value.

#### Quality Control (QC)

- With the first analysis of hexavalent chromium each shift, **analyze a CCV** (Continuing Calibration Verification) standard as a **Quality Control** check:
  - Carefully measure 24 mL of DI water into a reaction vessel (sample cell, beaker, etc.).
  - Add 1 mL of 2.5 mg/L hexavalent chromium ( $\text{Cr}^{+6}$ ) standard.
  - Add the hexavalent chromium reagent pillow at the same time as your samples. (ChromaVer® 3 Reagent).
  - Invert the CCV sample 4–5 times, or swirl the sample, until powdered reagent is dissolved.
  - Use the same 8 minute timer for CCV and field samples. **Note:** The blank for the CCV should be DI water.
  - **Record the CCV results in the  $\text{Cr}^{+6}$  bench log book.** If the instrument reading is not between 0.075 mg/L and 0.125 mg/L, re-prepare the standard and reanalyze.
- Periodic **Matrix Spikes (MSs)** should be analyzed. Any time a sample result appears anomalous, consider analyzing an MS of that sample.
  - Determine what dilution if any is required for the matrix spike (note: you will be adding 0.1 mg/L to the sample concentration [the instrument reading]).
  - Carefully measure 24 mL of filtered sample (diluted if required) into a reaction vessel (sample cell, beaker, etc.)
  - Add 1 mL of 2.5 mg/L hexavalent chromium ( $\text{Cr}^{+6}$ ) standard to the 24 mL of filtered sample (this solution is called the MS).
  - Add ChromaVer® 3 Reagent to the MS.
  - Invert sample 4 – 5 times – or swirl the sample; until powdered reagent is dissolved.
  - Start timer (8 min)
  - Use a 25 mL aliquot of filtered sample to Zero the Spectrometer. (Blank)
    - Transfer 25 mL of raw filtered sample into the pour-thru-cell funnel.
    - Allow the meter to stabilize and press the Zero button.
  - After 8 minute timer, pour the sample into a syringe filter to remove the excess reagent powder. Transfer the sample into the pour-thru-cell funnel (sample port of the Hach DR/4000V).
  - Record the instrument reading in the  $\text{Cr}^{+6}$  bench log book.

- Check the recovery of the MS:

Example:      Matrix Spike (0.117 mg/L) - Sample (0.006 mg/L) = 0.111 mg/L

Concentration of Spike Standard = 0.100 mg/L

% recovery is =  $0.111/0.100 = 111\%$

**MS % recovery must be between 75 – 125% or you will need to reanalyze.**

- If the CCV or MS are still not between 0.075 mg/L and 0.125 mg/L after reanalyses, call the Project Chemist (Shawn Duffy) at 530-229-3303.

#### Known Interferences

- Iron may interfere at levels above 1 mg/L.
- Highly buffered samples or extreme sample pH may exceed the buffering capacity of the reagents.

# Standard Operating Procedure – Laboratory PG&E Topock Program

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Title: Ferrous Iron Analysis by Hach Method 8146

Number: SOP-L02\_Rev02

Revision Date: 4/1/2014

## Scope

Standard operating procedure (SOP) for analysis of ferrous iron ( $\text{Fe}^{+2}$ ).

## Equipment and Supplies

- Safety glasses
- Latex gloves
- Hach DR 4000V spectrophotometer or equivalent.
- pH meter.
- Reaction vessel and cap or means of sealing the reaction vessel (Hach sample cell, 50 mL beaker, vial capable of holding 30 mL and parafilm if the vessel doesn't have a cap).
- 1 packet of Ferrous Iron Reagent per sample.
- 0.45  $\mu\text{m}$  filter disc fitted to a disposable 50 mL syringe (syringe filter).

## Procedure

1. Collect the sample(s) following the appropriate SOP (see list below). Ferrous iron samples should be analyzed as soon as possible (within 6 hours).
  - SOP-A1 – Purging and Sampling of Groundwater Monitoring Wells, Well-Volume Method
  - SOP-A2 – Purging and Sampling of 1-inch-diameter Groundwater Monitoring Wells, Modified Well-Volume Method
  - SOP-A3 – Purging and Sampling of Active and Inactive Water Supply Wells
  - SOP-A4 – Depth-Specific Surface Water Sampling
  - SOP-A5 – Groundwater Sampling from Sonic Drilling Boreholes
  - SOP-A14 – Pore Water Sampling
  - Remedy-SOP-01 – Process Water Sampling
2. Measure the pH of the raw sample. (Record the results in the  $\text{Fe}^{+2}$  bench log book.)
3. Verify the spectrophotometer is set for Ferrous Iron (Hach DR/4000V, program 2150) and verify all reagents are for 25 mL sample size (or adjust accordingly).
4. Transfer 25 mL of the sample into a reaction vessel (sample cell, beaker, etc.).
5. Add one packet of Ferrous Iron Reagent.



6. Invert sample 4–5 times or swirl the sample until powdered reagent is dissolved.
7. Start timer (3 mins.).
8. Run a blank: Use a syringe filter to filter 25 mL of the raw sample and use to “zero” the spectrophotometer.
  - Transfer 25 mL of raw filtered sample into the pour-thru-cell funnel.
  - Allow the meter to stabilize and press the Zero button.
9. After 3 minute timer, use a syringe filter to filter the sample with the reagent added and transfer the sample into the pour-thru-cell funnel (the sample port of the Hach DR/4000V).
10. Record the instrument reading in the Fe+2 bench log book.
11. If the result is out of range for the spectrophotometer, reanalyze the sample using a dilution.

Note: if a dilution is required, the spectrophotometer should be zeroed using sample from the same dilution.

Common dilutions:

- 1:2 dilution: 25 mL of sample are diluted with 25 mL of deionized (DI) water; multiply the instrument reading (result) by 2 for the adjusted value.

$$\begin{array}{rcl} \text{Example: instrument reading is} & 0.304 & \\ & \underline{\times 2} & \\ & = .608 \text{ mg/L (final result)} & \end{array}$$

- 1:5 dilution: 10 mL of sample are diluted with 40 mL of DI water; multiply the instrument reading (result) by 5 for the adjusted value.

$$\begin{array}{rcl} \text{Example: instrument reading is} & 0.304 & \\ & \underline{\times 5} & \\ & = 1.52 \text{ mg/L (final result)} & \end{array}$$

- 1:10 dilution: 10 mL of sample are diluted with 90 mL of DI water; multiply the instrument reading (result) by 10 for the adjusted value.
- 1:20 dilution: 5 mL of sample are diluted with 95 mL of DI water; multiply the instrument reading (result) by 20 for the adjusted value.

# Standard Operating Procedure – Laboratory PG&E Topock Program

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Title: Total Chromium Analysis by Hach Method 8024

Number: SOP-L03\_Rev01

Revision Date: 4/1/2014

## Scope

Standard operating procedure (SOP) for analysis of total chromium ( $\text{Cr}^{+3}$ ).

## Equipment and Supplies

- Safety glasses
- Latex gloves
- Hach DR 4000V spectrophotometer or equivalent.
- Vacuum filter apparatus: 47 mm magnetic filter funnels, 1,000 mL Erlenmeyer flask, and vacuum pump. Use a 0.45  $\mu\text{m}$ , 47 mm diameter filter membrane.
- 0.45  $\mu\text{m}$  filter disc fitted to a disposable 50 mL syringe (syringe filter).
- pH meter.
- Hach sample cell or vial capable of holding 30 mL.
- 1 packet of ChromaVer® 3 Reagent per sample.
- 1 packet of Chromium 1 Reagent per sample.
- 1 packet of Chromium 2 Reagent per sample.
- 1 packet of Acid Reagent per sample.
- 2.5 mg/L Chromium, Total ( $\text{Cr}^{+3}$ ) (working) standard.
- Hot plate and water bath or heating block.
- Ice bath (baking pan with water and ice - approximately 1" deep)

## Procedure

1. Collect the sample(s) following the appropriate SOP (see list below). The samples should be analyzed within 24 hours if possible. Note: all samples must be filtered.
  - SOP-A1 – Purging and Sampling of Groundwater Monitoring Wells, Well-Volume Method
  - SOP-A2 – Purging and Sampling of 1-inch-diameter Groundwater Monitoring Wells, Modified Well-Volume Method
  - SOP-A3 – Purging and Sampling of Active and Inactive Water Supply Wells

- SOP-A4 – Depth-Specific Surface Water Sampling
  - SOP-A5 – Groundwater Sampling from Sonic Drilling Boreholes
  - SOP-A14 – Pore Water Sampling
  - Remedy-SOP-01 – Process Water Sampling
2. Filtering can be performed using an inline filter at the time of sampling (see SOP-A6, Sample Field Filtration and Preservation for Metals Analyses) or in the laboratory by vacuum filter:
    - Set up the vacuum filter apparatus.
    - Filter ~100 mL of sample.
  3. Turn on the hot plate and set to 390°F.
    - Make sure the water bath is ~ ½ inch below the top.
  4. Measure the pH of the raw sample. (**Record the results in the Cr<sup>+3</sup> bench log book.**)
  5. Verify the spectrophotometer is set for **Chromium, Total (Cr<sup>+3</sup>)** (Hach DR/4000V program **1580**) and verify all reagents are for 25 mL sample size (or adjust accordingly).
  6. Transfer 25 mL of filtered sample into a sample cell or vial.
  7. Add Chromium 1 Reagent to each of the sample cells/vials.
  8. Invert samples 4–5 times or swirl the sample until powdered reagent is dissolved.
  9. Place the samples into the sample rack in the hot water bath (water should be boiling) and start the 5-minute “Heat” timer.
  10. After 5 minutes, remove the sample cells/vials and cool to room temperature in an ice bath.
  11. Add Chromium 2 Reagent to each of the sample cells/vials.
  12. Invert samples 4–5 times or swirl the sample until powdered reagent is dissolved.
  13. Add Acid Reagent to each of the sample cells.
  14. Invert samples 4–5 times or swirl the sample until powdered reagent is dissolved.
  15. Add ChromaVer® 3 Reagent to each of the sample cells/vials; invert samples 4–5 times or swirl the sample until powdered reagent is dissolved.
  16. Start the 5-min. “wait” timer.
  17. Run a blank: Use a 25 mL aliquot of filtered sample to “zero” the spectrophotometer:
    - Transfer 25 mL of raw filtered sample into the pour-thru-cell funnel.
    - Allow the meter to stabilize and press the Zero button.
  18. After 5 minute “wait” timer, pour the sample with the reagent added into a syringe filter to remove the excess reagent powder. Transfer the sample into the pour-thru-cell funnel (sample port of the Hach DR/4000V).
  19. Record the instrument reading in the Cr<sup>+3</sup> bench log book.

20. If the result is out of range for the spectrophotometer, reanalyze the sample using a dilution.

Note: if a dilution is required, the Spectrometer should be zeroed using sample from the same dilution.

Common dilutions:

- 1:2 dilution: 25 mL of sample are diluted with 25 mL of deionized (DI) water; multiply the instrument reading (result) by 2 for the adjusted value.

$$\begin{array}{rcl} \text{Example: instrument reading is} & 0.304 & \\ & \underline{\times 2} & \\ & = .608 \text{ mg/L (final result)} & \end{array}$$

- 1:5 dilution: 10 mL of sample are diluted with 40 mL of DI water; multiply the instrument reading (result) by 5 for the adjusted value.

$$\begin{array}{rcl} \text{Example: instrument reading is} & 0.304 & \\ & \underline{\times 5} & \\ & = 1.52 \text{ mg/L (final result)} & \end{array}$$

- 1:10 dilution: 10 mL of sample are diluted with 90 mL of DI water; multiply the instrument reading (result) by 10 for the adjusted value.
- 1:20 dilution: 5 mL of sample are diluted with 95 mL of DI water; multiply the instrument reading (result) by 20 for the adjusted value.

**Quality Control (QC)**

- With the first analysis of Chromium, Total each shift, **analyze a CCV** (Continuing Calibration Verification) standard as a **Quality Control** check:
  - Carefully measure 24 mL of DI water into a reaction vessel (sample cell).
  - Add 1 mL of 2.5 mg/L Chromium, Total ( $\text{Cr}^{+3}$ ) standard.
  - Add the Chromium 1 Reagent at the same time as your samples.
  - Follow the remaining procedures as listed above for the samples (hot water bath, cool with ice, add additional reagents, filter, and analyze). **Note:** The Blank for the CCV should be DI water.
  - **Record the CCV results in the  $\text{Cr}^{+3}$  bench log book.** If the instrument reading is not between 0.075 mg/L and 0.125 mg/L, re-prepare the standard and reanalyze.
- Periodic **Matrix Spikes (MSs)** should be analyzed. Any time a sample result appears anomalous, consider analyzing a matrix spike of that sample.
  - Determine what dilution, if any, is required for the matrix spike (note: you will be adding 0.1 mg/L to the sample concentration [the instrument reading]).
  - Carefully measure 24 mL of filtered sample (diluted if required) into a reaction vessel (sample cell/vial).

- Add 1 mL of 2.5 mg/L Chromium, Total ( $\text{Cr}^{+3}$ ) standard to the 24 mL of filtered sample (this solution is called the MS).
- Add the Chromium 1 Reagent at the same time as your samples.
- Follow the remaining procedures as listed above for the samples (hot water bath, cool with ice, add additional reagents, filter and analyze).
- Run a blank: Use a 25 mL aliquot of filtered sample to zero the spectrophotometer:
  - o Transfer 25 mL of raw filtered sample into the pour-thru-cell funnel.
  - o Allow the meter to stabilize and press the Zero button.
- After the 5-minute “wait” timer, pour the sample into a syringe filter to remove the excess reagent powder. Transfer the sample into the pour-thru-cell funnel (sample port of the Hach DR/4000V).
- Record the instrument reading in the  $\text{Cr}^{+3}$  bench log book.
- Check the recovery of the MS.

Example:      Matrix Spike (0.117 mg/L) - Sample (0.006 mg/L) = 0.111 mg/L

Concentration of Spike Standard is = 0.100 mg/L

% recovery is =  $0.111/0.100 = 111\%$

**MS % recovery must be between 75 – 125% or you will need to reanalyze.**

- If the CCV or MS are still not between 0.075 mg/L and 0.125 mg/L after reanalyses, call the Project Chemist (Shawn Duffy) at 530-229-3303.

#### Known Interferences

- High concentrations of organic material may inhibit complete oxidation of trivalent chromium.
- Highly buffered samples or extreme sample pH may exceed the buffering capacity of the reagents.

# Standard Operating Procedure – Laboratory PG&E Topock Program

Title: Conductivity Analysis by Hach Method 8160

Number: SOP-L04\_Rev01

Revision Date: 04/01/2014

## Scope

Standard operating procedure (SOP) for analysis of conductivity.

Conductivity is the measure of the ability of a solution to conduct an electric current and is dependent on temperature. The conductivity can then be multiplied by an empirically derived factor to calculate the approximate amount of total dissolved solids (TDS) in the sample.

## Equipment and Supplies

- Safety glasses
- Latex gloves
- Hach sensION 378 Multiparameter Meter or equivalent
- Hach Quick Reference Guide booklet for the sensION156 and sensION378 Multiparameter Meters (54650-23)
- Conductivity Standards – 1000  $\mu\text{S}/\text{cm}$  (Hach 14400-42) (Ensure that the conductivity standard solution is not expired.)
- Deionized (DI) water
- 100 mL beakers
- Calibration sheet
- Kimwipes
- Magnetic stir plate and magnetic stir bar.

## Procedure

1. Collect the sample(s) following the appropriate SOP (see list below). Samples should be analyzed as soon as possible (within 24 hours).
  - SOP-A1 – Purging and Sampling of Groundwater Monitoring Wells, Well-Volume Method
  - SOP-A2 – Purging and Sampling of 1-inch-diameter Groundwater Monitoring Wells, Modified Well-Volume Method
  - SOP-A3 – Purging and Sampling of Active and Inactive Water Supply Wells
  - SOP-A4 – Depth-Specific Surface Water Sampling
  - SOP-A5 – Groundwater Sampling from Sonic Drilling Boreholes

- SOP-A14 – Pore Water Sampling
  - Remedy-SOP-01 – Process Water Sampling
2. Verify the meter is in COND mode.
  3. Rinse the conductivity probe with DI water and shake it to remove excess water. (Check to make sure there are no bubbles in probe cell.) The meter should read below 10  $\mu\text{S}/\text{cm}$ .
  4. Confirm the calibration by checking the conductivity of the 1000  $\mu\text{S}/\text{cm}$  standard at the beginning of each shift.
    - a. Pour ~50 mL of 1000  $\mu\text{S}/\text{cm}$  standard in a 100 mL beaker.
    - b. Add a clean stir rod to the standard.
    - c. Start the stir plate at a moderate rate (fast enough to stir the sample, but not fast enough to cause a vortex to form).
    - d. Allow the meter to stabilize.
    - e. After the reading stabilizes, record value on the calibration sheet.
  5. If not within 10% of the true value (900 to 1100  $\mu\text{S}/\text{cm}$ ), recalibrate the meter following the steps on page 5 of the Hach **Quick Reference Guide** booklet for the **sensION156** and **sensION378** Multiparameter Meters (54650-23).

Be sure to clean the probe cell first. If DI water does not clean the cell, try cleaning the cell as follows: Wash with warm water and laboratory soap and rinse with copious amounts of DI water before use. Alternatively a 3% HCl acid solution may be used. Solvents such as acetone or ethanol should only be used as a last resort, and the cell should not be immersed for longer than 5 minutes. Always completely rinse with DI water. Re-calibrate after these cleanings.
  6. If the standard results are within 10% of the true value (900 to 1100  $\mu\text{S}/\text{cm}$ ), continue with analysis for each of the samples. (Ensure the temperature of the sample is between 20°C and 25°C.)
  7. Pour a fresh portion (~ 50-mL) of the sample into a clean 100 mL beaker.
  8. Add a clean stir rod to the sample.
  9. Start the stir plate at a moderate rate (fast enough to stir the sample, but not fast enough to cause a vortex to form).
  10. Place probe in sample.
  11. Allow the meter to stabilize.
  12. Record the conductivity result on the Conductivity bench sheet and include the units. (Note: The meter automatically changes the units from  $\mu\text{S}/\text{cm}$  to  $\text{mS}/\text{cm}$  above 1999  $\mu\text{S}/\text{cm}$ .) The result is automatically corrected to the reference temperature of 20°C.
  13. Rinse the probe and cell with DI water after each sample.

### Calculations

- To convert from mS/cm to  $\mu\text{S/cm}$  multiply the result by 1000.
- $\text{TDS, mg/L (ppm)} \cong \text{Conductivity } (\mu\text{S/cm}) * 0.63.$

### References

American Public Health Association (APHA), American Water Works Association (AWWA), and Water Environment Federation (WEF). 1998. *Standard Methods for the Examination of Water and Wastewater*. 20<sup>th</sup> Edition. Method 2510.

Hach Company. 2003. *Water Analysis Handbook*. 4<sup>th</sup> Edition. Method 8160.



# Standard Operating Procedure – Laboratory PG&E Topock Program

Title: Spike Preparation  
Number: SOP-L08\_Rev01  
Revision Date: 06/05/2014

## Scope

Standard operating procedure (SOP) for preparing “working concentration” spike solutions for the analysis of reagent spikes (Continuing Calibration Verifications or CCVs) and sample matrix spikes (MSs).

## Equipment and Supplies

- Safety glasses
- Latex gloves
- 100 mL or 1000 mL volumetric flask with cap
- 1 mL or 5 mL pipette
- Deionized (DI) water
- Glass standards bottle or 1 liter poly bottle and labels
- Chemical standard:
  - a. Hexavalent Chromium: 50 mg/L hexavalent chromium standard; also see SOP-L01, Hexavalent Chromium Analysis by Hach Method 1560
  - b. Total Chromium: 50 mg/L total chromium standard; also see SOP-L03, Total Chromium Analysis by Hach Method 8024
  - c. Manganese: 25 mg/L manganese standard; also see SOP-L18, Manganese Analysis by Hach Method 8149
  - d. Nitrate: 100 mg/L nitrate standard; also see SOP-L13, Nitrate Analysis by Hach Method 8171
  - e. Sulfate: 1000 mg/L sulfate standard and 1 packet of SulfaVer® 4 Reagent; also see SOP-L14, Sulfate Analysis by Hach Method 8051
  - f. Total Organic Carbon (TOC): 1000 mg/L TOC standard (potassium hydrogen phthalate [KHP]); also see SOP-L16, Total Organic Carbon Analysis by Hach Method 10129

## Procedures

- a. Hexavalent Chromium
  - 1. Add ~50 mL of DI water to a 100 mL volumetric flask.
  - 2. Add 5 mL of a 50 mg/L hexavalent chromium standard using a 1 mL pipette.
  - 3. Bring the volume of the flask to 100 mL using DI water.

4. Cap, and mix thoroughly.
  5. The resultant concentration of the standard is 2.5 mg/L. This standard solution can be used to prepare an MS and/or a CCV standard as outlined in SOP-L01, Hexavalent Chromium Analysis by Hach Method 1560.
  6. Transfer the 2.5 mg/L working standard to a glass standards bottle and label.
  7. Verify the concentration by following the CCV procedure as detailed in SOP-L01, Hexavalent Chromium Analysis by Hach Method 1560.
- b. Total Chromium
1. Add ~50 mL of DI water to a 100 mL volumetric flask.
  2. Add 5 mL of a 50 mg/L total chromium standard using a 1 mL pipette.
  3. Bring the volume of the flask to 100 mL using DI water.
  4. Cap, and mix thoroughly.
  5. The resultant concentration of the standard is 2.5 mg/L. This standard solution can be used to prepare an MS and/or a CCV standard as outlined in SOP-L03, Total Chromium Analysis by Hach Method 8024.
  6. Transfer the 2.5 mg/L working standard to a glass standards bottle and label.
  7. Verify the concentration by following the CCV procedure as detailed in SOP-L03, Total Chromium Analysis by Hach Method 8024.
- c. Manganese
1. Add ~25 mL of DI water to a 50 mL volumetric flask.
  2. Add 2 mL of a 25 mg/L manganese standard using a 1 mL pipette.
  3. Bring the volume of the flask to 50 mL using DI water.
  4. Cap, and mix thoroughly.
  5. The resultant concentration of the standard is 1 mg/L. This standard solution can be used to prepare an MS and/or a CCV standard as outlined in SOP-L18, Manganese Analysis by Hach Method 8149.
  6. Transfer the 1 mg/L working standard to a glass standards bottle and label.
  7. Verify the concentration by following the CCV procedure as detailed in SOP-L18, Manganese Analysis by Hach Method 8149.
- d. Nitrate
1. Add ~50 mL of DI water to a 100 mL volumetric flask.
  2. Add 25 mL of a 100 mg/L nitrate standard using a 5 mL pipette.
  3. Bring the volume of the flask to 100 mL using DI water.

4. Cap, and mix thoroughly.
  5. The resultant concentration of the standard is 25 mg/L. This standard solution can be used to prepare an MS and/or a CCV standard as outlined in SOP-L13, Nitrate Analysis by Hach Method 8171.
  6. Transfer the 25 mg/L working standard to a glass standards bottle and label.
  7. Verify the concentration by following the CCV procedure as detailed in SOP-L13, Nitrate Analysis by Hach Method 8171.
- e. Sulfate
1. Add ~500 mL of DI water to a 1000 mL volumetric flask.
  2. Add 70 mL of a 1000 mg/L sulfate standard using graduated cylinder.
  3. Bring the volume of the flask to 1000 mL using DI water.
  4. Cap, and mix thoroughly.
  5. The resultant concentration of the standard is 70 mg/L. This working standard can be used at this concentration for a CCV standard as outlined in SOP-L14, Sulfate Analysis by Hach Method 8051.
  6. Transfer the 70 mg/L working standard to a 1 liter poly bottle and label.
  7. Verify the concentration by following the CCV procedure as detailed in SOP-L14, Sulfate Analysis by Hach Method 8051.
- f. TOC
1. Add ~500 mL of DI water to a 1000 mL volumetric flask.
  2. Add 10 mL of a 1000 mg/L TOC standard (KHP) using a 5 mL pipette.
  3. Bring the volume of the flask to 1000 mL using DI water.
  4. Cap, and mix thoroughly.
  5. Transfer the 10 mg/L working standard to a glass standards bottle and label.
  6. The resultant concentration of the standard is 10 mg/L. This standard solution can be used to prepare an MS and/or a CCV standard as outlined in SOP-L16, TOC Analysis.
  7. Transfer the 10 mg/L working standard to a 1 liter poly bottle and label.
  8. Verify the concentration by following the CCV procedure as detailed in SOP-L16, TOC Analysis by Hach Method 10129.

# Standard Operating Procedure – Laboratory PG&E Topock Program

Title: pH Measurement  
Number: SOP-L09\_Rev01  
Revision Date: 04/01/2014

## Scope

Standard operating procedure (SOP) for pH measurement.

## Equipment and Supplies

- Safety glasses
- Latex gloves
- Hach sensION 378 Multiparameter Meter or equivalent

Note: Store the pH electrode in the pH 4 or 7 buffer solution when it's not in use, or use the manufacturer's storage solution. Replace the storage solution every week.

- Hach Quick Reference Guide for sensION156 and sensION378 Multiparameter Meters (54650-23).
- pH buffer solutions for pH 4, 7 and 10. (Make sure the buffer solutions are not expired.)
- 100 mL beakers
- De-ionized (DI) water (squirt bottle)
- Calibration beakers. (Calibration beakers are provided by the instrument manufacturer and have sealable lids that allow the calibrations standards to be reused. Do not pour the calibration standards back into the original bottles. Replace the working buffer solution at least twice a week or if re-calibrating the meter is required.)
- Calibration sheet
- Kimwipes
- Magnetic stir plate and magnetic stir bar.

## Procedure

1. Collect the sample(s) following the appropriate SOP (see list below). Samples should be analyzed as soon as possible (within 24 hours).
  - SOP-A1 – Purging and Sampling of Groundwater Monitoring Wells, Well-Volume Method
  - SOP-A2 – Purging and Sampling of 1-inch-diameter Groundwater Monitoring Wells, Modified Well-Volume Method

- SOP-A3 – Purging and Sampling of Active and Inactive Water Supply Wells
- SOP-A4 – Depth-Specific Surface Water Sampling
- SOP-A5 – Groundwater Sampling from Sonic Drilling Boreholes
- SOP-A14 – Pore Water Sampling
- Remedy-SOP-01 – Process Water Sampling

**Notes prior to beginning calibration:**

- The pH meter must be calibrated at the beginning of each day and any time the pH reading does not make sense.
  - Make sure the electrode is rinsed well between samples.
  - Make sure the buffers and samples are at a constant temperature before beginning the calibration or analysis procedure (pH is affected by temperature).
2. To start the calibration pour fresh portions (~ 50-mL) of the pH 4, 7 and 10 buffers into the calibration beakers (buffers should be replaced at least twice per week). Rinse each calibration beaker 3 times with small portions of buffer before filling the beaker with the portion to be analyzed.
  3. Add a clean stir rod to each standard.
  4. Start the stir plate at a moderate rate (fast enough to stir the sample, but not fast enough to cause a vortex to form).
  5. Turn the pH meter on.
  6. Make sure the meter is in pH mode.
  7. Rinse the electrode with DI water.
  8. Follow the calibration procedures on page 3 in the Hach **Quick Reference Guide for sensION156 and sensION378** Multiparameter Meters (54650-23).
    - Be careful not to hit the electrode end against the sides of the beaker.
  9. If the pH probe does not recognize the pH 4 buffer within 2 – 3 minutes, re-rinse the electrode with DI water, dry with a Kimwipe and try again. If you've cleaned the probe three times and the pH meter still doesn't recognize the pH 4 buffer, call the Project Chemist (Shawn Duffy) at 530-229-3303.
  10. Rinse the electrode with DI water between each buffer solution.
  11. After calibrating with the pH 4, 7 and 10 buffers, record the Slope value on the calibration sheet and press Enter to accept and return to the reading mode.
  12. Rinse the electrode with DI water.
  13. To analyze samples, pour a fresh portion (~ 50-mL) of the sample into a clean 100 mL beaker.

14. Add a clean stir bar.
15. Start the stir plate at a moderate rate (fast enough to stir the sample, but not fast enough to cause a vortex to form).
16. Place the pH meter electrode in the sample.
17. Allow the meter to stabilize, record the pH in the appropriate bench log book.
18. If the meter does not stabilize during a pH measurement a new calibration may be needed. Rinse the electrode with DI water and re-start the calibration.

# Standard Operating Procedure

## PG&E Topock Program

Title: Hach Model 2100P Turbidimeter Calibration and Analysis

Number: SOP-L10 Rev01

Revision Date: 04/01/2014

### Scope

Standard Operating Procedure (SOP) for the analysis of turbidity. This SOP covers the calibration and operating procedures for the Hach Model 2100P turbidimeter.

### Precautions/Hazards

- Operators should not attempt the full calibration task until they have been properly trained.
- Hazards include exposure to Formazin and silicone oil (please refer to material safety data sheets [MSDSs] for all chemicals).

### Equipment and Supplies List

- Safety glasses
- Latex gloves
- Kimwipes
- Oiling cloths
- Hach Model 2100P portable turbidimeter
- Model 2100P Turbidimeter Instrument and Procedure Manual (Cat. No. 46500-88)
- Carrying case
- Four AA alkaline batteries
- Sample cells with caps
- Check and calibration log
- Turbidimeter kit (small blue tool box located in cabinet under counter below mixer)
- Reagents:
  - Formazin Primary Standards: Hach Part # 26594-05, StablCal® Standards, <0.1, 20, 100, 800 NTU ampoules
  - Gelex Secondary Standards: Hach Part # 24641-05
  - Silicone oil: Hach Part # 1269-36

### Daily Gelex Check Procedure

1. Turn on turbidimeter and select automatic range mode. You should see “AUTO RNG” on display.
2. Thoroughly clean the outside of all three Gelex vials with Kimwipes, apply one drop of silicone oil to each vial, and wipe with oiling cloth.
  - Dirty, scratched, or damaged cells can cause inaccurate readings. Handle cells only by the top to minimize dirt, scratches and fingerprints in the light path.
  - The silicone oil is used to eliminate the effects of fine scratches in the glass cell. If the vial has any large visible scratches, notify the supervisor so a replacement Gelex set can be ordered.
  - Avoid excess coating of oil. Oil is not needed if the sample cells are properly maintained.
3. Beginning with Gelex standard 0-10 NTU, place Gelex cell into compartment so that the diamond aligns with orientation mark on the turbidimeter. Close the lid.
4. When taking a reading, place the instrument on a level, stationary surface. It should not be held in the hand during measurement.
5. Press the Read button.
6. If 9.99 or 99.9 are flashing on display, press ‘Range’ button to change range of meter.
7. Record the displayed value in the check and calibration log.
8. Repeat steps 2 through 5 for remaining Gelex standards.

If any of the Gelex standards are +/- 5% from assigned value, the turbidimeter must be calibrated.

### Turbidimeter Calibration Procedure

For expediency you will be referred to the instrument manual (Section 3.6, pages 35-54) to perform these procedures.

1. Prepare Formazin standards, located in the turbidimeter kit (small blue tool box located in cabinet under counter below mixer), according to procedure on page 37, **Section 3.6.1.3 of Model 2100P Turbidimeter Instrument and Procedure Manual.**
2. Cap the sample cells to prevent spillage of Formazin into the instrument.
3. Begin calibration procedure on page 42, **Section 3.6.3 of Model 2100P Turbidimeter Instrument and Procedure Manual.**
4. After the turbidimeter has accepted the calibration, assign new values to all Gelex standards using the Daily Gelex Check Procedure above.



## Sample Analysis Procedure

1. Transfer sample into a vial dedicated to turbidity measurements “cell.” **Do not dilute the samples.**
  - Always use clean sample cells in good condition. Properly clean cells between measurements. Do not use a brush on the sample cell, always use Kimwipes or equivalent optical wipes to dry the cells.
  - Dirty, scratched, or damaged cells can cause inaccurate readings. Handle cells only by the top to minimize dirt, scratches and fingerprints in the light path.
2. Cap the sample cell to prevent spillage of sample into the instrument.
3. Avoid settling of sample prior to measurement. Allow samples to degas but do not allow settling of solids.
4. Thoroughly clean the outside of cell with Kimwipes, apply one drop of silicone oil if needed, and wipe with oiling cloth. Oil is not needed if the sample cells are properly maintained.
  - The silicone oil is used to eliminate the effects of fine scratches in the glass cell. If the vial has any large visible scratches, discard and use another cell.
  - **Avoid excess coating of oil.**
5. Place the sample cell into the compartment so that the diamond aligns with orientation mark on the turbidimeter. Close the lid.
6. Place the instrument on a level, stationary surface. It should not be held in the hand during measurement.
7. Press the Read button.
8. If 9.99 or 99.9 are flashing on display, press ‘Range’ button to change range of meter.
9. Record the displayed value in the bench logbook.
10. Do not leave a sample cell in the cell compartment for extended periods of time. This may compress the spring in the cell holder.
11. Always close the sample compartment lid during storage. Remove sample cell and batteries from instrument if the instrument is stored for extended time period (more than a month).

## Quality Control

- QC activities that will help ensure the accuracy and precision of this method include:
  - **Using optically matched (or single) cells for Low Level Turbidity** - Precise measurements of low turbidity (< 2 NTU) samples require using a single cell for all measurements or using optically matched cells – *see Hach instruction manual Section 2.3.3 pages 22-25.*
  - **Use dedicated cells** – The use of cells dedicated to turbidity measurement is recommended.

- **Removing trapped gases** - *See Hach instruction manual Section 2.3.3 pages 22-25.* This would only be a problem for samples that exhibit foaming or where gas bubbles are observed.
- **Do not dilute the samples.**
- The calibration of the turbidimeter must be verified, using the more convenient Gelex® secondary standards, at the beginning of each day and any time the turbidity reading does not make sense. The turbidimeter must be fully calibrated using Formazin primary standards every three months as per manufacturer standards, and also whenever the daily Gelex check standards fail to meet the +/- 5% quality control (QC) criteria.

# Standard Operating Procedure – Laboratory PG&E Topock Program

Title: Nitrate Analysis by Hach Method 8171

Number: SOP-L13\_Rev00

Revision Date: 4/1/2014

## Scope

Standard operating procedure (SOP) for analysis of nitrate ( $\text{NO}_3^-$ -N).

## Equipment and Supplies

- Safety glasses
- Latex gloves
- Hach DR 4000V spectrophotometer or equivalent
- pH meter
- Reaction vessel and cap or means of sealing the reaction vessel– (Hach sample cell, 50 mL beaker, vial capable of holding 30 mL, and parafilm if the vessel doesn't have a cap)
- 1 packet of NitraVer® 5 Reagent per sample
- 25 mg/L nitrate ( $\text{NO}_3^-$ -N) (working) standard
- 0.45  $\mu\text{m}$  filter disc fitted to a disposable 50 mL syringe (syringe filter)
- Deionized (DI) water
- Timer

## Procedure

1. For each lot of reagents, analyze a reagent blank. Transfer 25 mL of DI water into a reaction vessel and follow steps 4 through 12 below. Sample concentration may need to be adjusted based on the reagent's contribution. If the concentration is greater than 0.25 mg/L call the Project Chemist (Shawn Duffy) at 530-229-3303.
2. Collect the sample(s) following the appropriate SOP (see below). Nitrate samples should be analyzed as soon as possible (within 24 hours).
  - SOP-A1 – Purging and Sampling of Groundwater Monitoring Wells, Well-Volume Method
  - SOP-A2 – Purging and Sampling of 1-inch-diameter Groundwater Monitoring Wells, Modified Well-Volume Method
  - SOP-A3 – Purging and Sampling of Active and Inactive Water Supply Wells
  - SOP-A4 – Depth-Specific Surface Water Sampling
  - SOP-A5 – Groundwater Sampling from Sonic Drilling Boreholes

- SOP-A14 – Pore Water Sampling
  - Remedy-SOP-01 – Process Water Sampling
3. Measure the pH of the raw sample. Record the results in the NO<sub>3</sub><sup>-</sup>-N Bench Logbook.
  4. Verify the spectrophotometer is set for Nitrate (Hach DR/4000V, program 2520) and verify all reagents are for 25 mL sample size (or adjust accordingly).
  5. Transfer 25 mL of the sample into a reaction vessel. (Note: the sample cell or vessel must be able to be sealed with a cap or parafilm.)
  6. Add 1 packet of NitraVer® 5 Reagent.
  7. Start the 1 minute timer.
  8. Shake the sample for the entire 1 minute, using a 90° rotation of the wrist and back to the original position with a timing of once per second.
  9. After the 1 minute shake time set the sample down and start the 5 minute reaction timer.
  10. Run a blank: Use a syringe filter to filter 25 mL of the raw sample, and then use the raw sample to “zero” the spectrophotometer. Note: if the sample needs dilution, then use the same dilution water for the blank.
    - Transfer 25 mL of raw filtered sample into the pour-through-cell funnel.
    - Allow the meter to stabilize and press the Zero button.
  11. After 5 minute timer, use a syringe filter to filter the sample with the reagent added and transfer the sample into the pour-through-cell funnel (the sample port of the Hach DR/4000V). Analyze within 2 minutes.
  12. Record the instrument reading in the NO<sub>3</sub><sup>-</sup>-N Bench Logbook.
  13. If the result is out of range for the spectrophotometer, reanalyze the sample using a dilution.

Note: if a dilution is required, the spectrophotometer should be zeroed using a sample from the same dilution.

Common dilutions:

- 1:2 dilution: 25 mL of sample are diluted with 25 mL of DI water; multiply the instrument reading (result) by 2 for the adjusted value.

$$\begin{array}{rcl} \text{Example: instrument reading is} & 3.54 & \\ & \times 2 & \\ & \hline & = 7.08 \text{ mg/L (final result)} & \end{array}$$

- 1:5 dilution: 10 mL of sample are diluted with 40 mL of DI water; multiply the instrument reading (result) by 5 for the adjusted value.

$$\begin{array}{rcl} \text{Example: instrument reading is} & 3.54 & \\ & \times 5 & \\ & \hline & = 17.7 \text{ mg/L (final result)} & \end{array}$$

- 1:10 dilution: 10 mL of sample are diluted with 90 mL of DI water; multiply the instrument reading (result) by 10 for the adjusted value.
- 1:20 dilution: 5 mL of sample are diluted with 95 mL of DI water; multiply the instrument reading (result) by 20 for the adjusted value.

#### Quality Control (QC)

- With the first analysis of Nitrate each shift, **analyze a Continuing Calibration Verification (CCV) standard** as a **Quality Control** check:
  - Carefully measure 24 mL of DI water into a sample cell.
  - Add 1 mL of 25 mg/L Nitrate ( $\text{NO}_3^-$ -N) standard.
  - Add 1 packet of NitraVer® 5 Reagent at the same time you add the reagent to your samples.
  - Follow the remaining procedures as listed above for the samples (steps 7 through 12). The Blank for the CCV should be DI water.
  - **Record the CCV results in the  $\text{NO}_3^-$ -N Bench Logbook.** If the instrument reading is not between 0.75 mg/L and 1.25 mg/L re-prepare the standard and reanalyze.
- Periodic **Matrix Spikes (MSs)** should be analyzed. Any time a sample result appears anomalous, consider analyzing an MS of that sample.
  - Determine what dilution, if any, is required for the MS (Note: you will be adding 1.0 mg/L to the sample concentration [the instrument reading]). If you have difficulty determining the dilution needed, call the Project Chemist (Shawn Duffy) at 530-229-3303.
  - Carefully measure 24 mL of filtered sample (diluted if required) into a reaction vessel (sample cell/vial).
  - Add 1 mL of 25 mg/L Nitrate ( $\text{NO}_3^-$ -N) standard to the 24 mL of filtered sample—this is your MS.
  - Add 1 packet of NitraVer® 5 Reagent at the same time you add the reagent to your samples.
  - Follow the remaining procedures as listed above for the samples (steps 7 through 12), use a 25 mL aliquot of the same dilution water for the blank (use to zero the spectrophotometer).
  - Record the instrument reading in the  $\text{NO}_3^-$ -N Bench Logbook.
  - Check the recovery of the MS:
 

Example:      Matrix Spike (3.17 mg/L) - Sample (2.06 mg/L) = 1.11 mg/L

Concentration of MS Standard = 1.00 mg/L

% recovery is =  $1.11/1.00 = 111\%$

**Note: MS % recovery must be between 75 – 125% or you will need to reanalyze.**

If the CCV or MS are still not between 0.075 mg/L and 0.125 mg/L after reanalyses, call the Project Chemist (Shawn Duffy) at 530-229-3303.

#### Known Interferences

- Chloride concentrations above 100 mg/L will cause low results.
- Ferric iron at all levels
- Highly buffered samples or extreme sample pH may exceed the buffering capacity of the Reagents.

# Standard Operating Procedure – Laboratory PG&E Topock Program

Title: Sulfate Analysis by Hach Method 8051

Number: SOP-L14\_Rev0

Revision Date: 4/1/2014

## Scope

Standard operating procedure (SOP) for analysis of sulfate ( $\text{SO}_4^{2-}$ ).

## Equipment and Supplies

- Safety glasses
- Latex gloves
- Hach DR 4000V spectrophotometer or equivalent
- Vacuum filter apparatus: 47 mm magnetic filter funnels, 1000 mL Erlenmeyer flask, and vacuum pump. Use a 0.45  $\mu\text{m}$ , 47 mm diameter filter membrane.
- pH meter
- Reaction vessel and cap (Hach sample cell)
- 1 packet of SulfaVer® 4 Reagent per sample
- 70 mg/L Sulfate ( $\text{SO}_4^{2-}$ ) (working) standard
- Timer
- Deionized (DI) water

## Procedure

1. For each lot of reagent, analyze a reagent blank. Transfer 25 mL of DI water into a reaction vessel and follow steps 4 through 11 below. Sample concentration may need to be adjusted based on the reagents contribution. (Do not dilute or filter this sample.)
2. Collect the sample(s) following the appropriate SOP (see below). Sulfate samples should be analyzed within 24 hours. If the sample is held for more than 24 hours, store at 4°C and allow the sample to equilibrate to room temperature prior to analysis.
  - SOP-A1 – Purging and Sampling of Groundwater Monitoring Wells, Well-Volume Method
  - SOP-A2 – Purging and Sampling of 1-inch-diameter Groundwater Monitoring Wells, Modified Well-Volume Method
  - SOP-A3 – Purging and Sampling of Active and Inactive Water Supply Wells
  - SOP-A4 – Depth-Specific Surface Water Sampling
  - SOP-A5 – Groundwater Sampling from Sonic Drilling Boreholes

- SOP-A14 – Pore Water Sampling
  - Remedy-SOP-01 – Process Water Sampling.
3. Measure the pH of the raw sample (record the results in the  $\text{SO}_4^{2-}$  Bench Logbook).
  4. Verify the spectrophotometer is set for Sulfate (Hach DR 4000V, program 3450) and verify all reagents are for 25 mL sample size (or adjust accordingly).
    - **Note: Turbid or colored samples must be filtered.**
      - Filtering can be performed using an inline filter at the time of sampling (see SOP-A6, Sample Field Filtration and Preservation for Metals Analyses) or in the laboratory by vacuum filter.
      - Set up the vacuum filter apparatus.
      - Filter ~100 mL of sample.
  5. Due to the high concentration of sulfate, all samples will start with a 1:25 dilution.
    - Add 1 mL of sample to 24 mL of DI water.
    - Mix the sample by swirling or shaking the sample.
  6. Add 1 packet of SulfaVer® 4 Reagent.
  7. Swirl to mix until the reagent powder is dissolved. (Note that the reaction will generate a white particulate that can be confused with the Reagent powder so pay close attention to what the Reagent powder looks like.)
  8. Start the 5-minute reaction timer. **Do not disturb the sample cell during this time.**
  9. After the 5 minutes has elapsed, run a blank. If the sample was filtered, use the filtered sample to “zero” the spectrophotometer.
    - **Note: do not use flow-through cell or Sipper Cell Modules.**
    - Wait until the 5 minute timer beeps before placing the blank into the cell holder and zeroing the instrument.
  10. Analyze the samples immediately. **Note: do not filter at this stage.**
  11. Record the instrument reading in the Lab  $\text{SO}_4^{2-}$  Bench Logbook.
  12. Multiply the instrument reading by the dilution factor (25) and record in the result column.

If the result is out of range for the spectrophotometer, reanalyze; if still out of range call the Project Chemist (Shawn Duffy) at 530-229-3303.

Note: if an additional dilution is required, the spectrophotometer should be zeroed using a sample from the same dilution.

#### Quality Control (QC)

- With the first analysis of sulfate each shift, **analyze a Continuing Calibration Verification (CCV) standard as a Quality Control check:**
  - Transfer 25 mL of 70 mg/L Sulfate standard into a sample cell.



- Add 1 packet of SulfaVer® 4 Reagent at the same time you add the reagent to your samples.
- Follow steps 7 through 11 listed above (swirl, timer, blank, analyze, record). **Note:** The Blank for the CCV should be DI water.
- **Record the CCV results in the  $\text{SO}_4^{2-}$  Bench Logbook.** If the instrument reading is not between 52.5 mg/L and 87.5 mg/L, re-prepare the standard and reanalyze.

If the CCV is still not between 52.5 mg/L and 87.5 mg/L after reanalyses, call the Project Chemist (Shawn Duffy) at 530-229-3303.

#### Known Interferences

- Calcium at concentrations greater than 20,000 mg/L as  $\text{CaCO}_3$ .
- Chloride at concentrations greater than 40,000 mg/L as Cl.
- Magnesium at concentrations greater than 10,000 mg/L as  $\text{CaCO}_3$ .
- Silica at concentrations greater than 500 mg/L as  $\text{SiO}_2$ .

# Standard Operating Procedure – Laboratory PG&E Topock Program

Title: Alkalinity Analysis

Number: SOP-L15\_Rev0

Revision Date: 4/1/2014

## Scope

Standard operating procedure (SOP) for analysis of alkalinity.

## Equipment and Supplies

- Safety glasses
- Latex gloves
- pH meter
- Phenolphthalein Indicator Solution
- Bromcresol Green-Methyl Red Indicator Solution
- Sulfuric acid standard solution, 0.020 N (Titrant)
- Buret, buret clamp and stand
- 250-mL Erlenmeyer flask
- Graduated cylinder – 50-mL or 100-mL
- Magnetic stir plate and magnetic stir bar

## Procedure

1. Collect the sample(s) following the appropriate SOP (see below). Alkalinity samples should be analyzed within 24 hours. If the sample is held for more than 24 hours, store at 4°C and allow the sample to equilibrate to room temperature prior to analysis.
  - SOP-A1 – Purging and Sampling of Groundwater Monitoring Wells, Well-Volume Method
  - SOP-A2 – Purging and Sampling of 1-inch-diameter Groundwater Monitoring Wells, Modified Well-Volume Method
  - SOP-A3 – Purging and Sampling of Active and Inactive Water Supply Wells
  - SOP-A4 – Depth-Specific Surface Water Sampling
  - SOP-A5 – Groundwater Sampling from Sonic Drilling Boreholes
  - SOP-A14 – Pore Water Sampling
  - Remedy-SOP-01 – Process Water Sampling
2. Measure the pH of the raw sample (record the results in the Alkalinity Bench Logbook).

3. Fill the buret to the zero mark with 0.020 N Sulfuric Acid standard solution (Titrant).
4. Use the graduated cylinder to transfer 50 mL of the sample into an Erlenmeyer flask.
5. Add a clean stir bar.
6. Start the stir plate at a moderate rate (fast enough to stir the sample, but not fast enough to cause a vortex to form).

If the pH of the raw sample was greater than 8.3, proceed to Phenolphthalein Step (step 7 below). If the pH was equal to or less than 8.3, proceed directly to the Total Alkalinity Step (step 10).

#### **Phenolphthalein Step:**

7. Add six drops of Phenolphthalein Indicator Solution. Allow to mix with sample. Sample will be pink if Phenolphthalein alkalinity is present. If the sample does not turn pink, proceed to Total Alkalinity Step (step 10).
8. Slowly open the stop-cock allowing the Titrant to drip into the sample and mix. Stop the flow of Titrant as soon as the sample color changes from pink to colorless. (Note: the end point has not been reached until the sample remains colorless.)

#### **Calculate:**

**mg/L phenolphthalein alkalinity as  $\text{CaCO}_3$  = mL Titrant used  $\times$  20.**

9. Record the phenolphthalein alkalinity in the Alkalinity Bench Logbook. Proceed to Total Alkalinity Step.

#### **Total Alkalinity Step:**

10. Add six drops of Bromcresol Green-Methyl Red Indicator Solution. Allow to mix with sample. There is no color change at this stage.
11. Slowly open the stop-cock allowing the Titrant to drip into the sample and mix. Stop the flow of Titrant as soon as the sample color changes from colorless to a light pink. (Note: the end point has not been reached until the sample remains light pink.)

#### **Calculate:**

**mg/L Total alkalinity as  $\text{CaCO}_3$  = total mL Titrant used  $\times$  20.**

12. Record the Total alkalinity in the Alkalinity Bench Logbook.

**Note:** if the sample's pH was 8.3 or less, the Total Alkalinity = Bicarbonate Alkalinity. If the pH was greater than 8.3, use the table below<sup>1</sup> to calculate the Carbonate, Bicarbonate, and Hydroxide Alkalinity.

<sup>1</sup> Table source: Hach Water Analysis Handbook, Fourth Edition, Rev. 2. Alkalinity, Buret Titration Method 8221. DOC316.53.01151.

Total alkalinity primarily includes hydroxide, carbonate, and bicarbonate alkalinities. The concentration of these types in a sample may be determined when the phenolphthalein and total alkalinities are known ( [Alkalinity relationship](#) table).

**Table 35 Alkalinity relationship**

Row	Result of Titration	Hydroxide Alkalinity Equals:	Carbonate Alkalinity Equals:	Bicarbonate Alkalinity Equals:
1	Phenolphthalein Alkalinity equal to 0	0	0	Total Alkalinity
2	Phenolphthalein Alkalinity equal to Total Alkalinity	Total Alkalinity	0	0
3	Phenolphthalein Alkalinity less than one-half of Total Alkalinity	0	Phenolphthalein Alkalinity times 2	Total Alkalinity minus two times Phenolphthalein Alkalinity
4	Phenolphthalein Alkalinity equal to one-half of Total Alkalinity	0	Total Alkalinity	0
5	Phenolphthalein Alkalinity greater than one-half of Total Alkalinity	2 times Phenolphthalein Alkalinity minus Total Alkalinity	2 times the difference between Total and Phenolphthalein Alkalinity	0

Use the [Alkalinity relationship](#) table with the following procedure:

1. Does the phenolphthalein alkalinity equal zero? If yes, use Row 1.
2. Does the phenolphthalein alkalinity equal total alkalinity? If yes, use Row 2.
3. Divide the total alkalinity by 2 to calculate one-half the total alkalinity.
4. Select Row 3, 4 or 5 based on comparing the result of step c (one-half total alkalinity) with the phenolphthalein alkalinity.
5. Perform the required calculations if any.
6. Check your results. The sum of the three alkalinity types will equal the total alkalinity.

If you have any questions, call the Project Chemist (Shawn Duffy) at 530-229-3303.

#### Known Interferences

- Highly colored or turbid samples may mask the color change at the end points.

# Standard Operating Procedure – Laboratory PG&E Topock Program

Title: Total Organic Carbon Analysis by Hach Method 10129

Number: SOP-L16\_Rev00

Revision Date: 6/5/2014

## Scope

Standard operating procedure (SOP) for analysis of total organic carbon (TOC).

## Equipment and Supplies

- Safety glasses
- Latex gloves
- Hach DR 4000V spectrophotometer or equivalent
- Spectrophotometer manufacturer's manual
- Test 'N Tube™ adapter for the spectrophotometer
- pH meter and pH paper (capable of measuring down to pH 2)
- TOC Bench Logbook
- Chemical oxygen demand (COD) Reactor or similar digestion block
- Stir plate and magnet stir bar
- Low Range TOC Acid Digestion Solution vials (Acid Digestion vials)
- Low Range TOC Indicator Ampules (indicator ampules)
- Sulfate Buffer Solution
- TOC Persulfate Powder Pillow
- Pipet: 0.1 – 1.0 mL, and a 1 – 5 mL or 1 – 10 mL.
- 50 mL Erlenmeyer flask
- 0.45 µm filter disc fitted to a disposable 50 mL syringe (syringe filter)
- Deionized (DI) water
- Kimwipes
- Paper towels
- Timer
- Fine point Sharpie (indelible ink pen)
- Small funnel (comes with each batch of TOC Acid Digestion vials)
- Test tube rack
- 10 mg/L TOC Working Standard

## Procedure

1. Collect the sample(s) following the appropriate SOP (see below). TOC samples should be analyzed as soon as possible (within 48 hours if possible).
  - SOP-A1 – Purging and Sampling of Groundwater Monitoring Wells, Well-Volume Method
  - SOP-A2 – Purging and Sampling of 1-inch-diameter Groundwater Monitoring Wells, Modified Well-Volume Method

- SOP-A3 – Purging and Sampling of Active and Inactive Water Supply Wells
  - SOP-A4 – Depth-Specific Surface Water Sampling
  - SOP-A5 – Groundwater Sampling from Sonic Drilling Boreholes
  - SOP-A14 – Pore Water Sampling
  - Remedy-SOP-01 – Process Water Sampling
2. Measure the pH of the raw sample. Record the results in the TOC Bench Logbook.
  3. Turn on the COD reactor and make sure it's set at 105°C.
  4. Transfer 10 mL of sample into a 50 mL Erlenmeyer flask containing a magnetic stir bar.
  5. Add 0.4 mL of Sulfate Buffer Solution (use pH paper to verify the pH is 2.0 or below – if needed add additional buffer, 0.1 mL at a time until pH ≤2).
  6. Place the flask on a stir plate and set at a moderate speed for 10 minutes (swirls the sample but does not form a vortex). Steps 7 through 10 may be performed while the flask is being stirred.
  7. Remove the number of Low Range TOC Acid Digestion Solution vials you'll need from the manufacture's packaging and place in the test tube rack (remember one for the reagent blank).
  8. Label the Acid Digestion vials for the samples, including the reagent blank.
  9. Using the funnel provided with the Acid Digestion vials, add the contents of one TOC Persulfate Powder Pillow to each vial (labeled in step 7).
  10. Using a pipet add 3 mL of organic-free water (use DI water) to the reagent blank vial.
  11. After the 10 minutes for stirring the 50 mL Erlenmeyer flask have elapsed, use a pipet to transfer 3 mL of prepared sample (sample in the Erlenmeyer flask) to the labeled vial(s) with the persulfate powder already added.
  12. Holding the blue Indicator Ampule by the top, carefully rinse with DI water and wipe dry with a Kimwipe.
  13. Lower the unopened ampule into one of the labeled Acid Digestion vials. Align the score mark (the score mark is in the narrowed "neck" of the ampule) with the top of the vial and snap off the top of the ampule allowing the ampule to drop into the Acid Digestion vial.
    - **Do not** tip or tilt the vial after the ampule is in the vial. **You do not want the indicator solution mixing with the sample.**
  14. Repeat steps 12 and 13 for each sample and the reagent blank.
  15. Cap the vials tightly and place in the COD Reactor. Start the reactor timer (2 hours). Verify the reactor is at 105°C.
  16. After the 2 hour timer, remove the vials from the COD Reactor and place in the test tube rack, being careful to handle the vials by their caps which will have remained cool.

17. Allow the vials to cool for one hour.
18. Verify the Test 'N Tube™ adapter is installed in the spectrophotometer (see the manufacturer's manual for instructions).
19. Verify that the spectrophotometer is set for Low Range TOC (Hach DR/4000V, program 3655).
20. Holding the vial by its cap wipe the reagent vial with a damp paper towel and then with a dry Kimwipe to remove any fingerprints or other marks.
21. Use the reagent blank to "zero" the spectrophotometer.
  - Place the vial in the adapter and close the light shield.
  - Allow the meter to stabilize and press the Zero button.
22. After the spectrophotometer has been zeroed, repeat step 20 for each vial, place the vial in the adapter, close the light shield, allow the meter to stabilize, and record the instrument reading in the TOC Bench Logbook.
23. If the result is out of range for the spectrophotometer, reanalyze the sample using a dilution.

Common dilutions:

- 1:2 dilution: 25 mL of sample are diluted with 25 mL of DI water; multiply the instrument reading (result) by 2 for the adjusted value.

$$\begin{array}{rcl} \text{Example: instrument reading is} & 3.54 & \\ & \times 2 & \\ & \hline & = 7.08 \text{ mg/L (final result)} & \end{array}$$

- 1:5 dilution: 10 mL of sample are diluted with 40 mL of DI water; multiply the instrument reading (result) by 5 for the adjusted value.

$$\begin{array}{rcl} \text{Example: instrument reading is} & 3.54 & \\ & \times 5 & \\ & \hline & = 17.7 \text{ mg/L (final result)} & \end{array}$$

- 1:10 dilution: 10 mL of sample are diluted with 90 mL of DI water; multiply the instrument reading (result) by 10 for the adjusted value.
- 1:20 dilution: 5 mL of sample are diluted with 95 mL of DI water; multiply the instrument reading (result) by 20 for the adjusted value.

**Quality Control (QC)**

- With the first analysis of TOC each shift, **analyze a Continuing Calibration Verification (CCV) standard** as a **Quality Control** check:
  - Carefully measure 9 mL of the DI water into a 50 mL Erlenmeyer flask containing a magnetic stir bar.
  - Add 1 mL of 10 mg/L TOC Working Standard to the DI water – this is your CCV.
  - Follow steps 5 – 22 with your "other" samples.

- Check the recovery of the CCV. The concentration should be between 0.75 and 1.25 mg/L.
- Periodic **Matrix Spikes (MSs)** should be analyzed. Any time a sample result appears anomalous, consider analyzing an MS of that sample.
  - Determine what dilution, if any, is required for the MS (Note: you will be adding 1.0 mg/L to the sample concentration [the instrument reading]). If you have difficulty determining the dilution needed, call the Project Chemist (Shawn Duffy) at 530-229-3303.
  - Carefully measure 9 mL of the sample (diluted if required) into a 50 mL Erlenmeyer flask containing a magnetic stir bar.
  - Add 1 mL of 10 mg/L TOC standard to the sample – this is your MS.
  - Follow steps 5 – 22 with your “other” samples.
  - Check the recovery of the MS:

Example:      Matrix Spike (1.60 mg/L) - Sample (0.36 mg/L) = 1.24 mg/L

Concentration of MS Standard = 1.0 mg/L

% recovery is =  $1.24/1.00 = 124\%$

**Note: MS % recovery must be between 75 – 125% or you will need to reanalyze.**

If the CCV or MS are still not between 0.75 mg/L and 1.25 mg/L after reanalyses, call the Project Chemist (Shawn Duffy) at 530-229-3303.

#### Known Interferences

- Many metals can cause interference at concentrations above 10 mg/L.
- Manganese above 1 mg/L.
- Alkalinity greater than 600 mg/L (reduce the pH to <7 with sulfuric acid); call the Project Chemist (Shawn Duffy) at 530-229-3303 before proceeding.
- Chloride above 500 mg/L.



# Standard Operating Procedure – Laboratory PG&E Topock Program

Title: Orthophosphate Analysis by Hach Method 8048

Number: SOP-L17\_Rev00

Revision Date: 6/3/2014

## Scope

Standard operating procedure (SOP) for analysis of orthophosphate ( $\text{PO}_4^{3-}$ ).

## Equipment and Supplies

- Safety glasses
- Latex gloves
- Hach DR 4000V spectrophotometer or equivalent
- pH meter
- $\text{PO}_4^{3-}$  Bench Logbook
- Reaction vessel and cap or means of sealing the reaction vessel– (Hach sample cell, 50 mL beaker, vial capable of holding 30 mL, and parafilm if the vessel doesn't have a cap)
- 1 packet of PhosVer 3 Reagent per sample
- 5 mg/L phosphate ( $\text{PO}_4^{3-}$ ) (working) standard
- 0.45  $\mu\text{m}$  filter disc fitted to a disposable 50 mL syringe (syringe filter)
- Deionized (DI) water

## Procedure

1. Collect the sample(s) following the appropriate SOP (see below). Orthophosphate samples should be analyzed as soon as possible (within 24 hours).
  - SOP-A1 – Purging and Sampling of Groundwater Monitoring Wells, Well-Volume Method
  - SOP-A2 – Purging and Sampling of 1-inch-diameter Groundwater Monitoring Wells, Modified Well-Volume Method
  - SOP-A3 – Purging and Sampling of Active and Inactive Water Supply Wells
  - SOP-A4 – Depth-Specific Surface Water Sampling
  - SOP-A5 – Groundwater Sampling from Sonic Drilling Boreholes
  - SOP-A14 – Pore Water Sampling
  - Remedy-SOP-01 – Process Water Sampling

2. Measure the pH of the raw sample in accordance with SOP-L9—pH Measurement. Record the results in the PO<sub>4</sub><sup>3-</sup> Bench Logbook.
3. Verify that the spectrophotometer is set for Reactive Phosphorus (Hach DR/4000V, program 3025) and verify all reagents are for 25 mL sample size (or adjust accordingly).
4. Transfer 25 mL of the sample into a reaction vessel. (Note: the sample cell or vessel must be able to be sealed with a cap or parafilm.)
5. Transfer 25 mL of DI water into a reaction vessel (this will be the “Blank”).
6. Add 1 packet of PhosVer 3 Reagent to the blank and to each sample.
7. Shake the blank and the sample(s), using a 90° rotation of the wrist and back to the original position with a timing of once per second; until the powder is dissolved.
8. Start the 2 minute reaction timer.
9. After the 2 minute timer, use a syringe filter to filter any reagent powder that has not dissolved from the blank and then use the blank to “zero” the spectrophotometer.
  - Transfer the blank into the pour-through-cell funnel.
  - Allow the meter to stabilize and press the Zero button.
10. After the spectrophotometer has been zeroed, use a syringe filter to filter any reagent powder that has not dissolved from the sample(s) and transfer the sample into the pour-through-cell funnel (the sample port of the Hach DR/4000V). Analyze as soon as possible.
11. Record the instrument reading in the PO<sub>4</sub><sup>3-</sup> Bench Logbook.
12. If the result is out of range for the spectrophotometer, reanalyze the sample using a dilution.

Common dilutions:

- 1:2 dilution: 25 mL of sample are diluted with 25 mL of DI water; multiply the instrument reading (result) by 2 for the adjusted value.

$$\begin{array}{r} \text{Example: instrument reading is} \quad 3.54 \\ \quad \quad \quad \quad \quad \quad \quad \times 2 \\ \hline \quad \quad \quad \quad \quad \quad \quad = 7.08 \text{ mg/L (final result)} \end{array}$$

- 1:5 dilution: 10 mL of sample are diluted with 40 mL of DI water; multiply the instrument reading (result) by 5 for the adjusted value.

$$\begin{array}{r} \text{Example: instrument reading is} \quad 3.54 \\ \quad \quad \quad \quad \quad \quad \quad \times 5 \\ \hline \quad \quad \quad \quad \quad \quad \quad = 17.7 \text{ mg/L (final result)} \end{array}$$

- 1:10 dilution: 10 mL of sample are diluted with 90 mL of DI water; multiply the instrument reading (result) by 10 for the adjusted value.
- 1:20 dilution: 5 mL of sample are diluted with 95 mL of DI water; multiply the instrument reading (result) by 20 for the adjusted value.

## Quality Control (QC)

- With the first analysis of orthophosphate each shift, **analyze a Continuing Calibration Verification (CCV) standard** as a **Quality Control** check:
  - Carefully measure 24 mL of DI water into a sample cell.
  - Add 1 mL of 5 mg/L Phosphate ( $\text{PO}_4^{3-}$ ) standard.
  - Add 1 packet of PhosVer 3 Reagent (include the CCV with your other samples).
  - Follow the remaining procedures as listed above for the samples (steps 6 through 10).
  - **Record the CCV results in the  $\text{PO}_4^{3-}$  Bench Logbook.** If the instrument reading is not between 0.15 mg/L and 0.25 mg/L, re-prepare the standard and reanalyze.
- Periodic **Matrix Spikes (MSs)** should be analyzed. Any time a sample result appears anomalous, consider analyzing an MS of that sample.
  - Determine what dilution, if any, is required for the MS (Note: you will be adding 0.2 mg/L to the sample concentration [the instrument reading]). If you have difficulty determining the dilution needed, call the Project Chemist (Shawn Duffy) at 530-229-3303.
  - Carefully measure 24 mL of filtered sample (diluted if required) into a reaction vessel (sample cell/vial).
  - Add 1 mL of 5 mg/L Phosphate ( $\text{PO}_4^{3-}$ ) standard to the 24 mL of filtered sample—this is your MS.
  - Add 1 packet of PhosVer 3 Reagent at the same time you add the reagent to your “other” samples.
  - Follow the remaining procedures as listed above for the samples (steps 6 through 10).
  - Record the instrument reading in the  $\text{PO}_4^{3-}$  Bench Logbook.
  - Check the recovery of the MS:
 

Example:      Matrix Spike (1.60 mg/L) - Sample (1.36 mg/L) = 0.24 mg/L

Concentration of MS Standard = .20 mg/L

% recovery is =  $0.24/0.20 = 120\%$

**Note: MS % recovery must be between 75 – 125% or you will need to reanalyze.**

If the CCV or MS are still not between 0.075 mg/L and 0.125 mg/L after reanalyses, call the Project Chemist (Shawn Duffy) at 530-229-3303.

## Known Interferences

- Metal concentrations above 100 mg/L.
- Highly buffered samples or extreme sample pH may exceed the buffering capacity of the Reagents (sample pH should be between 2 and 10).

# Standard Operating Procedure – Laboratory PG&E Topock Program

---

Title: Manganese Analysis by Hach Method 8149

Number: SOP-L18\_Rev00

Revision Date: 5/30/2014

## Scope

Standard Operating Procedure (SOP) for the analysis of manganese (Mn).

## Equipment and Supplies

- Safety glasses
- Latex gloves
- Hach DR 4000V spectrophotometer or equivalent
- Fume hood
- Vacuum filter apparatus: 47 mm magnetic filter funnels, 1,000 mL Erlenmeyer flask, and vacuum pump (use a 0.45 µm, 47 mm diameter filter membrane)
- 0.45 µm filter disc fitted to a disposable 50 mL syringe (syringe filter)
- pH meter
- Reaction vessel and cap or means of sealing the reaction vessel (Hach sample cell and Parafilm if the vessel doesn't have a cap)
- Deionized (DI) water
- 1 packet of Ascorbic Acid Reagent powder per sample
- Rochelle Salt Solution
- Alkaline-Cyanide Reagent Solution
- 0.1% PAN Indicator Solution
- 1 mg/L Manganese (working) standard
- Manganese Bench Log Book
- HNO<sub>3</sub> pH<3 (preservative if the samples can't be analyzed within 24 – 48 hours)

## Safety

Caution and special procedures must be maintained when performing this analysis. The alkaline cyanide solution contains cyanide so **the waste must be collected and disposed of as a Reactive waste.**

To prevent the release of hydrogen cyanide gas, the cyanide waste should be stored in a caustic solution with pH >11. The waste must be stored as a base until properly disposed of.

Because the analysis has the potential of releasing hydrogen cyanide gas, **all solutions/reagents must be added in a fume hood.**

#### Procedure

1. Collect the sample(s) following the appropriate SOP (see list below). Samples should be analyzed as soon as possible. If the samples can't be analyzed within 24 – 48 hours, preserve with HNO<sub>3</sub> pH<3 until ready to analyze. Before starting the analyzing adjust the pH to a pH 4 – 5. **Note: all samples must be filtered prior to preservation/analysis.**
  - SOP-A1 – Purging and Sampling of Groundwater Monitoring Wells, Well-Volume Method
  - SOP-A2 – Purging and Sampling of 1-inch-diameter Groundwater Monitoring Wells, Modified Well-Volume Method
  - SOP-A3 – Purging and Sampling of Active and Inactive Water Supply Wells
  - SOP-A4 – Depth-Specific Surface Water Sampling
  - SOP-A5 – Groundwater Sampling from Sonic Drilling Boreholes
  - SOP-A14 – Pore Water Sampling
  - Remedy-SOP-01 – Process Water Sampling
2. Filtering can be performed using an inline filter at the time of sampling (see SOP-A6, Sample Field Filtration and Preservation for Metals Analyses) or in the laboratory by vacuum filter:
  - Set up the vacuum filter apparatus.
  - Filter ~100 mL of sample.
3. Measure the pH of the raw sample in accordance with SOP-L9— pH Measurement (**Record the results in the Mn Bench Log Book**). Adjust the pH (see step #1 above).
4. Verify that the spectrophotometer is set for **Manganese (Mn) (Hach DR/4000V program 2260)** and verify all reagents are for 10 mL sample size (or adjust accordingly).
5. In the fume hood, transfer 10 mL of filtered sample into a reaction vessel. Use DI water for a blank.
6. Add one packet of Ascorbic Acid Reagent powder to each sample (including the blank). Swirl to mix.
7. Add ten drops of Rochelle Salt Solution to each sample (including the blank). Swirl to mix.
8. Add 15 drops of Alkaline-Cyanide Reagent Solution to each sample (including the blank). Swirl to mix.
9. Add 21 drops of PAN Indicator Solution, 0.1%, to each sample (including the blank). Swirl to mix.
10. Start the 2 minute reaction timer.

11. After the 2 minute timer has sounded, use the blank to “zero” the spectrophotometer.
12. After zeroing the spectrophotometer analyze each sample.
13. Record the instrument reading in the Mn Bench Log Book.
14. If the result is out of range for the spectrophotometer, reanalyze the sample using a dilution.

Common dilutions:

- 1:2 dilution: 25 mL of sample are diluted with 25 mL of DI water; multiply the instrument reading (result) by 2 for the adjusted value.

$$\begin{array}{rcl} \text{Example: instrument reading is} & 0.304 & \\ & \underline{\times 2} & \\ & = .608 \text{ mg/L (final result)} & \end{array}$$

- 1:5 dilution: 10 mL of sample are diluted with 40 mL of DI water; multiply the instrument reading (result) by 5 for the adjusted value.

$$\begin{array}{rcl} \text{Example: instrument reading is} & 0.304 & \\ & \underline{\times 5} & \\ & = 1.52 \text{ mg/L (final result)} & \end{array}$$

- 1:10 dilution: 10 mL of sample are diluted with 90 mL of DI water; multiply the instrument reading (result) by 10 for the adjusted value.
- 1:20 dilution: 5 mL of sample are diluted with 95 mL of DI water; multiply the instrument reading (result) by 20 for the adjusted value.

**Quality Control (QC)**

- With the first analysis of manganese each shift, **analyze a CCV** (Continuing Calibration Verification) standard as a **Quality Control** check:
  - Carefully measure 9 mL of DI water into a reaction vessel.
  - Add 1 mL of 1 mg/L Mn Standard. Swirl to mix.
  - Analyze with the samples - follow steps 6 – 13 above.
  - **Record the CCV results in the Mn Bench Log Book.** If the instrument reading is not between 0.075 mg/L and 0.125 mg/L, re-prepare the standard and reanalyze.
- Periodic **Matrix Spikes (MSs)** should be analyzed. Any time a sample result appears anomalous, consider analyzing an MS of that sample.
  - Determine what dilution if any is required for the matrix spike (note: you will be adding 0.1 mg/L to the sample concentration [the instrument reading]).
  - Carefully measure 9 mL of filtered sample (diluted if required) into a reaction vessel.
  - Add 1 mL of 1 mg/L Mn Standard to the 9 mL of filtered sample. Swirl to mix (this solution is called the MS).
  - Analyze with the other samples - follow steps 6 – 13 above.

- Record the instrument reading in the Mn Bench Log Book.
- Check the recovery of the MS:

Example: Matrix Spike (0.117 mg/L) - Sample (0.006 mg/L) = 0.111 mg/L

Concentration of Spike Standard = 0.100 mg/L

% recovery is =  $0.111/0.100 = 111\%$

**MS % recovery must be between 75 – 125% or you will need to reanalyze.**

- If the CCV or MS are still not between 0.075 mg/L and 0.125 mg/L after reanalyses, call the Project Chemist (Shawn Duffy) at 530-229-3303.

# Standard Operating Procedure – Laboratory PG&E Topock Program

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Title: Total Dissolved Solids Analysis

Number: SOP-L19\_Rev00

Revision Date: 5/29/2014

## Scope

This Standard Operating Procedure (SOP) covers the determination of Total Dissolved Solids (TDS) in groundwater or process water samples. The practical range of the method is 10 mg/L to 20,000 mg/L.

## Summary

A sample is passed through a filter, weighed, and then placed in an oven at 180°C until dried. The sample is allowed to cool in a desiccator, and then weighed to determine the dry weight of the original sample.

## Safety

Extreme caution should be used when working around the drying oven (risk of severe burns).

Because of the high temperature of the drying oven the associated glassware is more prone to break on impact (risk of broken glass).

## Equipment and Supplies

- Safety glasses
- Latex gloves
- Drying oven (capable of 180°C)
- Analytical balance (capable of measuring weights of 0.1 mg)
- Vacuum pump or other source of applying a vacuum
- Vacuum filter apparatus and filters (glass fiber filter discs, 47 mm, without organic binder, Reeve Angel type 934-AH, Gelman type A/E, or equivalent)
- 250 mL Pyrex glass beakers or equivalent
- Deionized (DI) water
- Conductivity meter
- Desiccator (capable of holding 5 – 6 250 mL Pyrex glass beakers)
- Oven mitt or metal tongs (to transfer the hot beakers from the drying oven to the desiccator)
- Graduated cylinder(s) 20 mL, 50 mL, 100 mL



- TDS Bench Log Book

## Procedure

1. Preparation of the evaporation vessels (beaker) must be performed ahead of time:
  - Thoroughly clean and dry a 250 mL Pyrex glass beaker.
  - Heat the clean vessel to 180° +/- 2°C for one hour.
  - Carefully transfer the hot beaker to the desiccator with the oven mitt or tongs for cooling and storage until needed.
2. Collect the sample(s) following the appropriate SOP (see list below). The samples should be analyzed within 7 days.
  - SOP-A1 – Purging and Sampling of Groundwater Monitoring Wells, Well-Volume Method
  - SOP-A2 – Purging and Sampling of 1-inch-diameter Groundwater Monitoring Wells, Modified Well-Volume Method
  - SOP-A3 – Purging and Sampling of Active and Inactive Water Supply Wells
  - SOP-A4 – Depth-Specific Surface Water Sampling
  - SOP-A5 – Groundwater Sampling from Sonic Drilling Boreholes
  - SOP-A14 – Pore Water Sampling
  - Remedy-SOP-01 – Process Water Sampling
3. Measure the Conductivity using SOP-L4 – Conductivity Analysis by Hach Method 8160. Refer to Table 1 for sample volume.

**Table 1**

*Conductivity vs. Sample Volume Table*

<b>Conductivity of Sample</b>	<b>Sample Volume to Use for TDS</b>
<1,500 µS/cm	100 mL
≥1,500 µS/cm and <4,700 µS/cm	50 mL
≥4,700 µS/cm	20 mL

4. Filter the sample in the laboratory using a vacuum filter:
  - Assemble the vacuum filter holder/flask assembly using a clean vacuum flask.
  - Place a 47-mm filter disc (see Equipment and Supplies section above for type of filter) in the filter holder and add the funnel.
  - With vacuum applied to the flask, wash the filter with three separate 20-mL volumes of DI water.

- Continue applying vacuum for two to three minutes after the water has passed through the filter to ensure that all traces of the water are removed from the filter.
  - Disconnect the vacuum and discard the water from the flask.
  - Reconnect the filter holder/flask assembly to the vacuum.
  - Shake the sample vigorously.
  - Use a clean graduated cylinder to transfer the volume of sample determined from Table 1 above to the filter apparatus. Record the volume used in the TDS Bench Log Book.
  - Filter the sample through the glass fiber filter.
  - Rinse the filter with three 10 mL portions of DI water and continue to apply vacuum for about 3 minutes after filtration is complete to remove as much water as possible.
5. Retrieve a clean 250 mL Pyrex glass beaker from the desiccator and weigh to the nearest tenth of a milligram (0.1 mg); record the weight in the TDS Bench Log Book.
  6. Transfer the filtered sample from the vacuum flask to the beaker. Rinse the flask with three 10 mL portions of DI water and pour into the beaker with the sample.
  7. Place the sample in the drying oven; verify the oven is set at 180° +/- 2°C.
  8. Allow the sample to reach complete dryness (4 hours or more).
  9. Cool in a desiccator to approximately room temperature, and weigh the beaker (record the weight in the TDS Bench Log Book).
  10. Repeat steps 7 through 9 (drying, cooling, desiccating, and weighing until a constant weight is obtained or until the change in weight is less than 0.5 mg between the consecutive cycles) and record the final weight in the TDS Bench Log Book.
  11. Calculate the TDS using the formula shown below and record in the TDS Bench Log Book.

$$\text{mg total dissolved solids/L} = \frac{(A - B) \times 1000}{\text{sample volume, mL}}$$

where:

$A$  = final weight of dried sample + dish (mg)  
 $B$  = weight of dish (mg).

**Appendix B**  
**PG&E Program Quality Assurance Project Plan**  
**and Addendum**

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*Revision 2*

# **PG&E Program Quality Assurance Project Plan**

Prepared for  
**Pacific Gas and Electric Company**

August 2012

**CH2MHILL®**

155 Grand Ave. Suite 1000  
Oakland, CA 94612

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Approved \_\_\_\_\_ Date \_\_\_\_\_  
CH2M HILL PG&E Program Quality Officer

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## Appendices

Appendix A Reporting Limits, Accuracy, and Precession Limits

# Acronyms and Abbreviations

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%D	percent difference or drift
%R	percent recovery
°C	degrees Celsius
µg/L	microgram(s) per liter
µmhos/cm	micromhos per centimeter
AB	ambient blank
AFCEE	Air Force Center for Engineering and the Environment (formerly the Air Force Center for Environmental Excellence)
ASTM	American Society for Testing and Materials
AutoDV	automated data validation
BTEX	benzene, toluene, ethylbenzene, and xylene
CAS	Chemical Abstract Service
CF-IRMS	continuous-flow isotope ratio mass spectrometry
CHHSL	California Human Health Screening Levels
CoC	chain-of-custody
COPC	contaminate of potential concern
DOC	dissolved organic carbon
DQO	data quality objective
DTSC	California Department of Toxic Substance Control
EB	equipment rinsate blank
EDD	electronic data deliverable
EPA	U.S. Environmental Protection Agency
FB	field blank
FD	field duplicate
ICAL	initial calibration
ICP	inductively coupled plasma
ICP-MS	inductively coupled plasma/mass spectrometry
ID	identifier
IDW	investigation-derived waste
IPC	instrument performance check

LCS	laboratory control sample
MCT	matrix concentration threshold
MDL	method detection limit
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
ml	milliliter
MS	matrix spike
MSA	method of standard addition
MSD	matrix spike duplicate
MQO	method quality objective
PARCC	precision, accuracy, representativeness, completeness, and comparability
PCB	polychlorinated biphenyls
pCi/L	picocuries per liter
PDF	portable document format
PG&E	Pacific Gas and Electric Company
PNA	polynuclear aromatic hydrocarbon
PPE	personal protective equipment
PST	planned sample table
QA	quality assurance
QAPP	quality assurance project plan
QC	quality control
RCRA	Resource Conservation and Recovery Act
RL	reporting limit
RPD	relative percent difference
RRF	relative response factor
RSD	relative standard deviation
RT	retention time
SAP	sampling and analysis plan
SIM	selected ion monitoring
SOP	standard operating procedure
STLC	soluble threshold limit concentration
SVOC	semivolatile organic compound
TB	trip blank

TCLP	toxicity characteristic leaching procedure
TDS	total dissolved solids
TKN	total Kjeldahl nitrogen
TOC	total organic carbon
TPH	total petroleum hydrocarbon
TSS	total suspended solids
TTLC	total threshold limit concentration
VOA	volatile organic analysis
VOC	volatile organic compound

## SECTION 1

# Introduction

---

This *Pacific Gas and Electric Company Program Quality Assurance Project Plan (QAPP)*, Revision 2 was prepared to ensure that data of appropriate quality are collected and used for multiple sites for Pacific Gas and Electric Company (PG&E) projects that CH2M HILL supports. Each project will have a sampling and analysis plan (SAP), this QAPP, and QAPP addenda required to meet the project-specific requirements.

## 1.1 Background

CH2M HILL has been providing services to PG&E since the 1970s. Currently, CH2M HILL and affiliate companies are working at approximately 35 sites for PG&E. CH2M HILL provides services for the following:

- **Site management.** Projects include soil and groundwater monitoring, site characterization, and remediation design systems.
- **Remediation construction.** Projects include soil excavation, disposal, and treatment system construction.
- **Ecosystems and permitting.** Projects include proponent's environmental assessments, California Environmental Quality Act documentation, and other permitting and planning projects.
- **Engineering design.** Projects include computer-aided design and support and structural analysis.

## 1.2 PG&E Program Objectives

### 1.2.1 PG&E Program Objectives and Scope

This QAPP presents the quality assurance (QA) and quality control (QC) requirements designed to ensure that environmental data collected for the PG&E Program will be of the appropriate quality to achieve the objectives defined in the project-specific SAPs or QAPP addenda, unless otherwise defined. Specific protocols for sampling, sample handling and storage, chain-of-custody (CoC), laboratory analyses, data handling, and data evaluation and assessment are discussed. Requirements for performance evaluations, corrective actions, and preventive maintenance of equipment are specified. The elements included in this QAPP are consistent with those specified in the *EPA Requirements for Quality Assurance Project Plans* (U.S. Environmental Protection Agency [EPA], 2001a) and *EPA Requirements for Quality Management Plans* (EPA, 2001b) (note that the latter was reissued in March 2006). The objectives of this QAPP are as follows:

- Ensure that data collection and measurement procedures are standardized among all participants.

- Monitor the performance of the various measurement systems within the PG&E Program to maintain statistical control and provide rapid feedback so that corrective measures, if needed, can be implemented before data quality is compromised.
- Periodically assess the performance of these measurement systems and their components.
- Verify that reported data are sufficiently complete, comparable, representative, unbiased, and precise so that they are suitable for their intended use.

This QAPP is intended for use by CH2M HILL and its subcontractors that provide services associated with the environmental data collection effort. The QAPP supplements all SAPs and any other project-specific documents. The PG&E Program quality officer and the program chemist are primarily responsible for implementation of this QAPP.

### **1.2.2 PG&E Program QAPP versus SAPs and QAPP Addenda**

Elements such as the general description, sources of contamination, information from previous investigations, and proposed investigations are addressed in project or site-specific SAPs or QAPP addenda. PG&E Project-specific QAPP addenda will cover items not included in this QAPP or any in conflict with it. The guidance set forth in this QAPP will be followed in the absence of site specific SAPs or QAPP addenda.

The PG&E project-specific SAPs or QAPP addenda should specify project-specific analytes and analytical methods that differ from the QAPP. The project manager or a designee will determine the reporting limit (RL) requirements, evaluate the QAPP specifications to make certain they meet those requirements, and address any differences in a QAPP addendum. The QAPP addendum will be included as part of the project-specific documents when project requirements dictate variance from the QAPP.

Project-specific preliminary cleanup goals or action levels will be included in the SAPs or QAPP addenda, if available. The project-specific documents will indicate sources for the preliminary cleanup goals or action levels. In cases where available technology does not offer analytical methods that are sufficiently sensitive to detect concentrations at or below the reference levels cited by the source, the method RLs will be used as the preliminary cleanup goals or action levels. All goals are subject to revision and will be documented.

Appendix A presents the analytical requirements for Reporting Limits, Accuracy, and Precision Limits.

### **1.2.3 Analytical Project Planning**

The PG&E Program has a laboratory procurement process, modeled after the Air Force Center for Engineering and the Environment (AFCEE) (formerly the Air Force Center for Environmental Excellence), EPA, the U.S. Navy, and other federal programs. The process balances the PG&E Program quality, defensible data, and costs. The model has identified three steps in planning the analytical needs of a project:

- 1. Determine the requirements.** To determine project-specific requirements, the program chemist should attend kick-off meetings (or equivalent) to understand the project goals and help develop the analytical scope of work.

2. **Determine the laboratory needs and select the laboratory.** Factors influencing the selection of analytical, geotechnical, radiochemistry laboratories include the matrices sampled; laboratory capabilities, recent performance, and location; and price. The program chemist ensures that the laboratory selected is appropriate to meet project objectives. The more information regarding the project objectives given to the chemists, the better chance they have to control liabilities related to analytical work.
3. **Decide what level of data validation is required to provide defensible data at the appropriate level of QC.** See Section 6.3 for descriptions of the data validation process. When a request for proposal is received from PG&E, there is a kickoff meeting of key people, including the project manager, the responsible contract administrator, the program chemist (or sometimes a project-specific chemist), a representative from project delivery, and others, depending on the type of project. Laboratory scope is discussed and a plan is determined that will provide the appropriate analytical services.

### 1.2.4 Data Quality Objectives

The specific needs for the data collected during each activity will be examined to ensure that project objectives for each investigation will be optimally achieved. A graded approach will be used in developing the project data quality objectives (DQO) to ensure that the DQO process will be appropriate for the nature, size, cost, and risk associated with the task or project. All projects will begin by examining EPA's seven-step DQO process (EPA, 2000); based on the level of project complexity and intended use of the data, the level of detail and applicability of the seven-step process will be assessed. The DQO process should consider the following steps (if applicable):

1. **State the problem.** Concisely describe the problem to be investigated. This determines the need for data collection. Review existing information to define the problem.
2. **Identify the decision.** Identify the decision that will solve the problem by using the data to be collected.
3. **Identify the inputs to the decision.** Identify the information and environmental measurements that are needed to support the decision.
4. **Define the study boundaries.** Specify the times, spatial areas, and other conditions (e.g., target analytes) that determine when and where data should be collected.
5. **Develop a decision rule.** For each decision, define the conditions that would cause the decision maker to choose between alternate actions (the decision rule is usually in the form of an "if...then" statement).
6. **Specify tolerable limits for decision errors.** Define how much uncertainty can be tolerated by the decision maker. Determine the acceptable error rates based on the consequences of making an incorrect decision.
7. **Optimize the design.** Evaluate information from the previous steps and choose the most resource-efficient design for data collection that will support a reliable decision.

## SECTION 2

# PG&E Program Organization and Responsibility

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## 2.1 PG&E Program Organization

The PG&E Program management team has been structured with a program manager, program quality control manager, program health and safety manager and a program chemist to ensure that the goals of the PG&E Program are met.

## 2.2 Project/Task Organization

The organization chart and descriptive text identifying task managers and individuals charged with specific responsibilities for each project can be found in project-specific SAPs. Lines of authority and the scope of authority given to each key member of the project team, including the authority to initiate and approve corrective actions, are discussed in the SAPs. All subcontractors and scopes of work are also identified in the project- or site-specific SAPs.

## 2.3 Training and Certification Requirements

All personnel engaged in field activities will have completed the Occupational Safety Health Administration, 40-hour health and safety training that meet the requirements of Title 29 Code of Federal Regulations Section 1910.120 and Title 8 Code of California Regulations Section 5192. All CH2M HILL personnel working on the PG&E Program will read applicable project-specific health and safety plans. Documentation will be maintained to demonstrate that all requirements of the plan are followed.

All laboratories contracted for analytical services will be certified under the California Department of Health Environmental Laboratory Accreditation Program, when appropriate and where accreditation is afforded under the California program. No analyses may be performed or reported if accreditation is revoked. Any loss or suspension of accreditation must be communicated to CH2M HILL within 24 hours of notification. Laboratory managers will ensure that all laboratory personnel have been properly trained and are qualified to perform the assigned tasks.



# Sampling Procedures

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## 3.0 Standard Operating Procedures

All sample collection and related activities will follow the appropriate standard operating procedure (SOP). SOPs are located in the project work plan, SAP, QAPP addendum, or other project documents.

## 3.1 Sampling Design

The number and location of samples are specific to each site and are discussed in the project-specific SAPs. The rationale for the sampling design is also described in the SAPs as part of the project DQOs. The sampling design is a function of the medium sampled, information about the sampling site, the type of data to be collected, and how the data are to be used.

All projects should use the field database and provide a planned sample table (PST), CoC forms, and other database-generated paperwork whenever possible. All samples collected for offsite laboratories will be documented on a CoC form.

The procedures described in the following sections may be superseded or supplemented by the project-specific SAPs or QAPP addenda.

## 3.2 Sampling Method Requirements

This section addresses the requirements for soil and groundwater sampling. Many projects will require site-specific SOPs because of unique conditions that should be addressed in the project-specific work plan, SAP, QAPP addenda or other project-specific documents. Small projects will need to have sampling SOPs, but may find an existing SOP that can be adopted for the specific needs of the project.

### 3.2.1 Field Calibration

Field equipment will be calibrated before the start of work and recorded in the field notebook or daily calibration log. Any instrument drift from prior calibration should be noted. Calibration will be in accordance with procedures and schedules in the particular instrument's operations manual.

Calibrated equipment will be uniquely identified by using the manufacturer's serial number or other means. A label with the identification number and the date when the next calibration is due (scheduled calibrations) will be physically attached to the equipment. If this is not possible, records traceable to the equipment (e.g., showing the equipment identification) will be readily available for reference. Instrument identification and the results of calibrations and records of repairs will also be recorded in the logbook or daily calibration log.

Scheduled periodic testing equipment calibration does not relieve field personnel of the responsibility of using properly functioning equipment. If equipment malfunction is suspected, the device shall be removed from service, tagged so that it is not inadvertently used, and the appropriate personnel notified so that a recalibration can be performed or substitute equipment can be obtained. Equipment that fails calibration or becomes inoperable during use will be removed from service and either segregated to prevent inadvertent use or tagged to indicate it is out of calibration. Such equipment will be repaired and satisfactorily recalibrated. Equipment that cannot be repaired will be replaced.

### **3.2.2 Soil Sampling**

Sampling locations will be specified in the project-specific SAPs, but the exact locations will be determined in the field based on such factors as accessibility and topography. The exact locations will be recorded in the field logbook or on the field sampling form when sampling is completed. A sketch of the sampling location will be entered into the logbook, if necessary, with reference points labeled including distances to the sampling location. Location of the sampling point by a global positioning system may be required.

Soil sampling using decontaminated equipment will be performed as described in the following sections. Each sample container will be closed as soon as it is filled; it will be chilled and processed for shipment to an offsite laboratory to allow laboratory analysis within the applicable holding time.

**ALL SOILS SAMPLE RESULTS WILL BE REPORTED IN DRY WEIGHT UNLESS OTHERWISE SPECIFIED IN THE SAP.**

#### **3.2.2.1 Surface Soil Sampling**

Surface soil sampling will follow the project-specific SOPs, but generally, samples will be collected as grab samples at the depth interval specified in the project-specific SAP for each location. Samples will be collected using a decontaminated stainless steel or nonmetallic hand trowel or equivalent equipment (sampling equipment should be chosen based on the analyte of concern for the specific sample). A Terra Core sampler, EasyDraw Syringe, cutoff disposable syringe or equivalent equipment will be used for volatile organic compounds (VOC), as described in Section 3.2.1.4. Samples to be analyzed for VOCs will be collected first. Samples to be analyzed for all other analytes should be placed in a sample-dedicated, 1-gallon, disposable pail or a decontaminated stainless steel bowl. The samples will be homogenized (using the trowel), and transferred to the appropriate containers. To prevent potential contaminant migration from the sample, sample containers will be filled to the top, taking care to prevent soil from remaining in the lid threads prior to being sealed.

#### **3.2.2.2 Subsurface Soil Sampling**

Subsurface soil sampling will follow the project-specific SOPs, but generally, samples will be collected by boring to the depth specified in the project-specific SAP using an appropriately sized hand auger or equivalent equipment. Once the specified depth is reached, the hand auger will be removed, and accumulated soil will be set aside in a sample-dedicated disposable pail or tarp. A different, clean hand auger will be inserted into the hole to collect the sample (decontamination of the boring implement is sufficient if multiple boring implements are not available). Other sampling devices, such as push tubes or split-spoon

samplers, may be used. A Terra Core sampler, EasyDraw Syringe, cutoff disposable syringe, or equivalent equipment will be used for VOCs, as described below. Samples to be analyzed for VOCs will be collected first. Samples to be analyzed for all other analytes should be placed in a sample-dedicated, 1-gallon, disposable pail or a decontaminated stainless steel bowl. The samples will be homogenized (using the trowel) and transferred to the appropriate containers. To prevent potential contaminant migration from the sample, sample containers will be filled to the top, taking care to prevent soil from remaining in the lid threads prior to being sealed.

### 3.2.2.3 Confirmation Sampling for Soil Excavation

This procedure is outlined in the project-specific SOPs. Confirmation sampling will be performed prior to closure of any excavation. Confirmation samples are usually collected from the bottom and sides of the excavation. The number and type of samples collected should be of sufficient quantity to be representative of the excavated site. The project- or site-specific SAP should address the number, type, and quantity of samples to be collected. All confirmation samples should be analyzed by the analytical methodology specified herein or in the project-specific QAPP addendum (collection of soil samples for determination of VOCs shall be in accordance with Section 3.2.1.4.). Field or laboratory screening data should not be used to verify that contamination has been removed below project action levels unless specifically approved by the overseeing regulatory agency.

### 3.2.2.4 Soil Sampling for Volatile Organic Compounds

See project-specific SOP for procedure. Guidelines for collecting soil samples for VOC analysis are provided in Method SW5035B. These sampling techniques are applicable to analysis by methods SW8260B or C and SW8015B or D (volatile parameters). Sampling for VOCs may be accomplished by using an EasyDraw Syringe, a Terra Core sampler, a cutoff plastic syringe, or any equivalent sampling device.

VOC samples will be collected into pre-tarred vials with or without preservatives. Preserved samples will be chilled and sent to the lab in accordance with the appropriate SOP.

Unpreserved VOC samples will be frozen or chilled in the field. If chilled to 4 degrees Celsius ( $^{\circ}\text{C}$ ) ( $\pm 2^{\circ}\text{C}$ ), the samples will be shipped by overnight express delivery (or courier) the same day they are collected. If frozen, appropriate measures should be taken to ensure that frozen samples remain frozen until receipt by the laboratory. If samples remain frozen, the laboratory has 14 days from date of collection to analyze the samples. If samples thaw to temperatures higher than  $4^{\circ}\text{C}$  ( $\pm 2^{\circ}\text{C}$ ), they must be analyzed within 48 hours of collection. If the temperature does not exceed  $4^{\circ}\text{C}$  ( $\pm 2^{\circ}\text{C}$ ), the laboratory may (1) freeze the samples between  $-7$  and  $-20^{\circ}\text{C}$  within 48 hours of collection and keep them frozen or (2) preserve them in sodium bisulfate or methanol within 48 hours of collection. Either of these procedures will extend the holding time to 14 days.

**Sampling Using Cutoff Syringe.** A disposable syringe capable of measuring 1 to 5 milliliters (ml) ( $\pm 0.5$  ml) is required. Calibration in the field will be needed for the specific soil type and the type of syringe to determine the proper setting on the syringe to collect the samples. For example, the plunger is set to 5 ml, and the sample is collected and weighed; if 5 grams ( $\pm 0.5$  gram) are not obtained, the process is repeated until the correct plunger setting is identified. The same procedure is repeated for the 1-gram sample. Once the volume setting

is identified, all soils of similar type will be collected at this volume. Samples can be collected with or without field preservation. When field preservation is chosen, the samples are collected into vials pre-preserved with methanol or sodium bisulfate. Otherwise, samples can be collected into vials without preservative, and preservation can be performed by the laboratory upon receipt of the samples within 48 hours of collection.

**Sampling with Terra Core Sampler or EasyDraw Syringe.** The sample is collected into the Terra Core or equivalent sampler following the manufacturer's instructions. A minimum of three samples will be collected. Two aliquots are needed for low-level analysis and reanalysis if necessary. The third aliquot is needed for extraction in methanol by the laboratory in case high-concentration analysis is indicated. Exposure to air must be minimized.

**Sampling with Field Preservation.** Before using this option, determine if the soil is amenable to the sodium bisulfate preservative. Soil samples that contain carbonate minerals may effervesce upon contact with the preservative. If the amount of gas generated is small (little if any effervescence with the preservative), field preservation may be used. If rapid or vigorous gas generation is observed, the sample should be collected without field preservation. If the sample is amenable to field preservation, it is collected using one of the methods listed above and quickly transferred into a VOC vial with preservative. The vial should be quickly sealed to avoid significant loss of volatiles components. The laboratory will supply a minimum of three preweighed VOC vials with 5 ml of aqueous sodium bisulfate preservative as described in Method SW5035B, as well as a single preweighed VOC vial without the preservative for each sample to be analyzed for VOCs. Two 5-gram aliquots in bisulfate are required for low-concentration analysis and reanalysis, when necessary. One 5-gram aliquot without sodium bisulfate is required for extraction in methanol by the laboratory in case high-concentration analysis is indicated by a low-concentration or screening analysis of the sample. One 1-gram sample in bisulfate is needed because the possibility exists that neither the 5-gram sample intended for low-concentration analysis, nor the 5-gram sample intended for high-concentration analysis, will have all target analyte concentrations within the calibration range. Exposure of the sample to air must be minimized.

If VOC analyses are the only analyses being performed for samples collected from any location; an additional 2- or 4-ounce soil sample must also be collected to analyze for percent moisture.

**Sampling without Field Preservation.** The samples will be collected using one of the methods listed above and quickly transferred into a minimum of three preweighed, vials without preservative supplied by the laboratory. These preweighed vials may be empty, they may contain reagent water, or they may be preserved with methanol, depending on whether the contaminant concentration is at low- or high-level concentration. Two 5-gram aliquots are needed for low-concentration analysis and reanalysis, when necessary. In addition, one 5-gram aliquot is required for extraction in methanol by the laboratory in case high-concentration analysis is indicated by a low-concentration or screening analysis of the sample. One 1-gram sample is also recommended because the possibility exists that neither the 5-gram sample intended for low-concentration analysis, nor the 5-gram sample intended for high-concentration analysis, will have all target analyte concentrations within the calibration range. Exposure of the sample to air must be minimized. Freezing the samples

between -7 and -20° C within 48 hours and keeping them frozen until analysis allows a 14-day holding time.

If VOC analyses are the only analyses being performed for samples collected from any location; an additional 2- or 4-ounce soil sample must also be collected to analyze for percent moisture.

### 3.2.3 Groundwater Sampling

#### 3.2.3.1 Water Level Measurement

See project specific SOP for procedure. Field meter probes and water level sounding equipment will be decontaminated before and after each use at each well. Water levels in wells that are known or suspected to be least contaminated will be measured first. Water levels in wells that are known or suspected to have the highest contamination will be measured last.

If well heads are accessible, all wells will be sounded from the top of the casing to determine the depth to water and total well depth prior to purging. An electronic sounder, accurate to  $\pm 0.01$  foot, will be used to measure depth to water in each well. Annual calibration documentation shall be maintained on file. The serial number of the meters shall be recorded in the sampling logbook. When using an electronic sounder, the probe will be lowered down the casing to the top of the water column, and the graduated markings on the probe wire or tape will be used to measure the depth to water from the surveyed point on the rim of the well casing. (Typically, the measuring device emits a constant tone when the probe is submerged in standing water. Most electronic level sounders have a visual indicator consisting of a small light bulb or diode that turns on when the probe encounters water.) The total well depth will be sounded from the surveyed top of the casing by lowering the weighted probe to the bottom of the well. The weighted probe will sink into silt, if present, at the bottom of the well screen. The total well depth will be measured by recording the depth to the nearest 0.1 foot.

#### 3.2.3.2 Well Purging

See project specific SOPs for procedure. All wells will be purged prior to sampling. All equipment that will contact the sample during purging and sampling will be decontaminated prior to each use.

**Low-flow Purge.** One option for well sampling is low-stress (low-flow) purging using a pump capable of a purge rate of 1 liter per minute or less. Typically, a pneumatic or small electric submersible pump is used. The water level should be monitored approximately every 5 minutes. The flow rate should be started at the minimum flow capacity of the pump, then gradually increased until initial drawdown is observed. The flow rate should then be reduced slightly to achieve a stabilized pumping level. This reduced rate should become the maximum purge rate for the well. Each adjustment to the flow rate and the water level measured after each adjustment should be recorded. The flow rate should not exceed 1 liter per minute. Care should be taken to maintain pump suction and avoid entrapment of air in the tubing.

**Casing Volume Purge.** Another option for well sampling is three casing volume (macro-purging) using a pump capable of purging 1 to 5 gallons per minute, usually an electrical



submersible pump. Purging will be conducted at a flow rate sufficient to remove water from the entire screened interval of the well. However, the purge rate should not result in substantial drawdown, which is defined as 5 percent of the water column or the top of the screened interval. Purging will consist of the removal of a minimum of three casing volumes of water.

For low-yield wells (wells that exhibit less than 80 percent recovery [%R], within 2 hours), one casing volume of water shall be removed. If pump capability allows, the well will be purged at a rate of less than 1 gallon per minute. The well will then be allowed to recover to 80 percent and sampled within 24 hours of purging.

**Water Quality Parameter Stabilization.** To ensure representative sampling, water quality parameters (dissolved oxygen, pH, redox potential, specific conductance, and turbidity) must be stable before samples are collected, regardless of purge technique. Parameters will be measured approximately every 3 to 5 minutes, depending on the rate and duration of the purge. Purging is considered complete when the following water quality parameters are stable (i.e., for three consecutive readings):

- The pH varies by no more than 0.1 pH unit.
- Specific conductance readings are within 10 percent of the average.
- The redox potential varies by no more than 10 millivolts.
- The dissolved oxygen readings are within 10 percent of the average.

The water used to make measurements will not be used to fill sample bottles.

If the macro-purge technique is used, three casing volume well purges must be complete **and** the water quality parameters must be stable before the sample is collected. The total amount of water purged will be recorded in the field logbook or well-specific purge and sample collection form.

**Grab-sample Collection.** In some instances, it is appropriate to collect a grab sample from a monitoring well. For example, when a low-yield well has been purged and allowed to recharge. A bailer can be used to collect the sample without additional purge, eliminating the need to deploy a well pump for sample collection.

If a bailer is used to collect samples, a sufficient volume of water must be collected to fill the sample bottles and perform one measurement of water quality parameters. The water quality parameters will be recorded in the field logbook or well-specific purge and sample collection form.

### 3.2.3.3 Well Sampling

See project specific SOPs for procedure. Prior to sampling each well, the water level will be measured and the well purged, as previously described. All wells will be sampled within 24 hours of purging. Wells without a dedicated pump will be sampled using a bailer of appropriate material, such as Teflon or stainless steel. Wells with a dedicated pump will be sampled directly from the tap closest to the well head. All aerators, strainers, and hoses will be removed from the tap prior to sample collection. The flow will be adjusted so that a gentle stream is obtained. To minimize volatilization, a flow rate of less than 100 milliliters per minute is recommended for samples to be analyzed for VOCs.

At each sampling location, sample bottles designated for a particular analysis will be filled sequentially before bottles designated for other analyses are filled. Vials for VOCs will be filled first to minimize aeration of water in the well. All vials for VOCs will be provided, pre-preserved by the subcontract laboratory. The vials will be filled directly from the tap. Each vial will be inverted and checked for air bubbles and checked for headspace. If a pea-size or larger air bubble appears, the cap can be removed and additional sample added to eliminate the air space. If there is any likelihood of contamination being introduced into the sample, the vial contents will be emptied into the container used to measure purge volumes, the vial discarded, and a new sample collected in a new vial.

If a duplicate sample is to be collected, all sample bottles designated for a particular analysis for both duplicates will be filled sequentially before bottles for another analysis are filled. For example, duplicate samples will be collected sequentially for semivolatile organic compounds (SVOC), followed by duplicate samples collected sequentially for metals. EPA recommends the following collection order:

1. Volatile organic compounds and total organic compounds
2. Dissolved gasses and total organic carbon
3. Semivolatile compounds – Acid/Base extractables, pesticides, and PCBs
4. Metals and general chemistry
5. Radionuclides

It is considered good management practice to plan sample collection from the least to the most contaminated area of the site to decrease the risk of cross contamination (assuming no other factors that drive the priority of sampling location order).

Groundwater samples will be transferred from the bailer, tap, or pump tubing directly into the appropriate pre-preserved sample containers, if required. When transferring samples, care must be taken not to touch any nondedicated equipment to the sample container. The containers will be chilled and processed for shipment to the laboratory.

### 3.3 Equipment Decontamination

See project specific SOPs for procedure. Sampling equipment must be consistently decontaminated to ensure the quality of the samples collected. All equipment that comes into contact with potentially contaminated soil or water samples will be decontaminated. Disposable equipment intended for one use will not be decontaminated but will be packaged for appropriate disposal. In addition, equipment that is dedicated for repeated use at only one location does not need to be decontaminated. Equipment decontamination will occur prior to each use.

The following decontamination sequence is recommended:

1. Nonphosphate detergent and tap water wash, using a brush if necessary
2. Tap water rinse
3. Two rinses with deionized/distilled water

4. Organic-free water rinse (high-performance liquid chromatography grade) for organic samples

Large and bulky sampling equipment might need to be steam cleaned. Equipment will be decontaminated in a predesignated area on pallets or plastic sheeting. The cleaned equipment will be wrapped or covered to prevent contamination and stored in an uncontaminated area.

## 3.4 Disposal of Investigation-derived Wastes

The disposal of investigation-derived waste (IDW) should be addressed in the project-specific SAP. Each project or task can have different IDW disposal requirements, depending on site-specific conditions and the work performed. The following potentially contaminated IDW might be generated during field activities:

- **Used personal protective equipment (PPE) and disposable equipment.** Used PPE will be double-bagged and placed in a municipal refuse dumpster onsite. PPE and disposable equipment that is still serviceable will be rendered unusable before disposal into the dumpster.
- **Decontamination fluids.** Decontamination fluids include dilute nitric acid, deionized water, residual contaminants, and water with nonphosphate detergent. These fluids will be collected and disposed of in accordance with site requirements and applicable regulatory requirements
- **Soil cuttings.** Soil cuttings generated during subsurface sampling will be collected and disposed of in accordance with site requirements and applicable regulatory requirements.
- **Purged groundwater and excess groundwater collected for sample container filling.** These wastes will be collected and disposed of in accordance with site requirements and applicable regulatory requirements.

Each project SAP should address IDW. Any samples collected for waste characterization should include IDW in the sample identifier (ID).

## 3.5 Field Quality Control Samples

QC samples will be collected to monitor accuracy, precision, and the potential presence of field contamination for analytical methods to be performed in the offsite laboratory. All field QC samples, except matrix spike/matrix spike duplicates (MS/MSD), will be sent blind to the laboratory along with regular field samples. These blind samples will be labeled similar to regular field samples to disguise them. Sampling frequencies may vary according to the project needs, as defined in the project-specific SAP or QAPP addendum. The recommended frequency of collection for QC samples is discussed in the following sections and should be reviewed and updated to achieve project-specific DQOs.



### 3.5.1 Field Duplicate Samples

A field duplicate (FD) is an independent sample collected as close as possible to the original sample, from the same source, and under identical conditions. FDs are used to document sampling and analytical precision. FDs will be collected at a minimum frequency of 10 percent or one per sampling event, whichever is more frequent, for each matrix and type of analysis. The sampling procedures described in Section 3.2 will be followed. The sampling locations for FD samples will be recorded in the field logbook or field sampling form, or both.

### 3.5.2 Equipment Blanks

Equipment blanks (EB) will be collected to evaluate field sampling and decontamination procedures by pouring deionized or organic free water over the decontaminated equipment. EBs will be collected at a frequency of one EB per day for each non-dedicated equipment type per sampling team. The EBs will be preserved, packaged, and shipped in the same manner described for the environmental samples. A separate sample ID will be assigned to each EB sample, and the sample will be submitted blind to the laboratory. EBs will be analyzed in the offsite laboratory for the same parameters specified for the corresponding matrix or for the main contaminate of potential concern (COPC).

### 3.5.3 Field Blanks

Field blanks (FB) (also known as ambient blanks [AB]) are collected to evaluate (or to monitor) whether contaminants have been introduced during sampling because of ambient conditions. FBs will be collected by pouring deionized water (or organic free water for organic samples) into a sample container at the sampling location and leaving the sample exposed to the atmosphere during the time a sample is collected. FBs will be collected at a frequency of one per location that warrants concern because of environmental conditions or project-specific QC concerns, as determined by the project chemist or project manager. Generally, FBs need to be collected if the analyte concentrations are high enough to allow mobile contaminants to affect the sample results and field conditions such as upwind environments cannot be controlled. FB will be analyzed for the same parameters specified for the associated samples.

### 3.5.4 Trip Blanks

Trip blanks (TB) are used to monitor contamination during sample shipping and handling and for cross contamination through VOC migration among the collected samples. They are prepared in the laboratory by pouring American Society for Testing and Materials (ASTM) Type II or organic-free water into a VOC sample container. They are then sealed, transported to the field, stay sealed while VOC samples are taken, and transported back to the laboratory in the same cooler as the VOC samples. One TB should accompany each VOC sample cooler.

### 3.5.5 Matrix Spike/Matrix Spike Duplicate

A MS/MSD consists of duplicate field sample aliquots spiked by the laboratory with analytes of concern to evaluate the effects of the matrix on the recoveries of these analytes. For every 20 field samples of each matrix collected at each site, additional duplicate aliquots

of one of the samples should be collected for each analysis and designated on the CoC form for use as an MS/MSD by the laboratory. Separate line entries are not required for matrix spikes. The increased number of sample containers should be noted. The duplicate aliquots for MS/MSD analyses should be collected simultaneously or in immediate succession with the parent sample. They will be treated in exactly the same manner as the parent sample during storage and shipment. The sampling locations for the MS/MSD will be documented in the field logbook or the field sampling form, or both if the MS/MSD are specifically requested by the project; if not, document the extra volume on the CoC and in the field logbook or on the field sampling form.

### **3.5.6 Split Samples**

Split samples may be collected periodically for comparison of data between analytical laboratories. A split sample is collected from a thoroughly homogenized original sample and is used to document analytical precision. Split samples will be collected for each matrix and for each analytical method, except those for volatiles when project objectives dictate the need. The sampling procedures described in Section 3.2 or those described in the project- or site-specific SAPs or QAPP addenda will be followed. The sampling locations will be recorded in the field logbook or field sampling form, or both. Split samples will be sent to a second certified laboratory, and results will be compared with those from the primary laboratory.

# Sample Handling and Custody

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## 4.1 Sample Documentation and Tracking

Projects with large sampling events should take advantage of the field database to provide a PST, CoCs, and sample container labels. The use of Mobil Integrated Sample Tracking (MIST) and the field database are recommended. All projects must keep sample documentation.

The laboratories will provide pre-preserved sample containers with labels identifying the preservative, unless approved by the project chemist. Laser-printed labels and indelible ink pens will be used whenever possible to complete sample labels. Immediately prior to sample collection, the sample ID, date, time of sampling and sampler's initials will be recorded onto the waterproof label. Samples will be placed into resealable bags, and ice used in shipping containers double bagged. Vital information regarding the collection of each sample will be recorded into a field logbook, field sampling form, or CoC form.

A separate logbook will be used for each project. It will be bound with consecutively numbered pages. All entries will be legibly written in black ink and signed and dated by the individual making the entries. Factual and objective language will be used. All entries will be complete and accurate to allow reconstruction of each field activity. A line will be placed through any portion of a field notebook that is unused. One line strike-through will be used to show corrections to entries. The strike-through will be initialed and dated. No correction fluid will be used. The following information for each sample will be recorded into the field logbook, field sampling form, or CoC form, whichever is appropriate:

- Sampling location and description. (Sketch and measured distances from reference points will be recorded if there is no established identification for the sample location.)
- Sample ID.
- Sampler's name.
- Date and time of sampling.
- Sample designation as composite or grab.
- Sample matrix.
- Type and ID of sampling equipment.
- Field measurement data (e.g., pH, temperature, conductivity).
- Field observations that may be relevant to the analysis or sample integrity (e.g., odor, color, and weather conditions).
- Associated QC blanks.

- Preservative used.
- CoC form number, custody seal number, and lot numbers of sample containers (when appropriate).
- Shipping details. (If the laboratory is providing courier service, the courier must sign and date the CoC forms. Copies of the signed CoC forms should be transmitted to the office as soon as practical. If Federal Express, United Parcel Service, or other courier is used, include shipping information for each shipment.)
- Destination laboratory.

## 4.2 Containers and Preservatives

The contracted analytical laboratory will provide the required sample containers for all samples including QC samples. All sample containers for PG&E projects will be pre-cleaned and certified to EPA standards. No sample containers will be reused. The contracted laboratory will add preservatives, if required, prior to shipping the sample containers to the field or supply the preservative as appropriate. The laboratory, upon receipt of the samples, will verify and record the adequacy of preservation and will add additional preservative, if necessary. For VOCs, the sample label or CoC will indicate the presence of preservative and the laboratory will verify and record the pH after the analysis. The containers, minimum sample quantities, required preservatives, and maximum holding times for many parameters are shown in Table 4-1 (tables appear at the end of the section in which they are first referenced). The project- or site-specific SAP or QAPP addendum will contain the specific containers required for each project if they differ from the containers listed in Table 4-1.

## 4.3 Chain-of-Custody

Collecting data of known quality begins at the point of sample collection. Legally defensible data are generated by using proven evidentiary procedures. These procedures are described in the following sections and must be followed to preserve and ensure the integrity of all samples from the time of collection through analysis. Sample custody records must be maintained in the field and subcontractor laboratory. A sample is considered to be in custody if it is either in physical possession or view, locked up, or kept in a secured and restricted area. Until the samples are shipped, custody will be the responsibility of the sampling team leader.

CoC forms document sample collection and shipment to the laboratory. CoC form(s) will be completed for each sampling event. The original copy will be provided to the laboratory with the sample shipping cooler, and a copy will be retained in the field documentation files. The CoC form will identify the contents of each shipment and maintain the custodial integrity of the samples. All CoC forms will be signed and dated by the responsible sampling team personnel, as applicable. The “Relinquished By” field will be signed by the responsible sampling team personnel, with the date, time, and air bill number noted on the CoC form. The laboratory will provide a PDF copy of the CoC forms, with the sample login information included, within 48 hours of sample receipt, along with information related to

the condition of receipt of the samples. The laboratory will also include the original or a copy with the final hardcopy report (the final “hardcopy” can be in a paper or PDF format or both, depending on project-specific requirements).

A self-adhesive custody seal will be placed across the lid and side of each sample to maintain its integrity until the laboratory opens it. The shipping coolers containing the samples will be sealed with a custody seal any time they are not in an individual’s possession or view before shipping. All custody seals will be signed and dated by the responsible sampling team personnel.

At a minimum, the CoC form must include the following information:

- Project information such as project number or identification of investigation monitoring program, Project Manager, etc.
- Unique sample ID
- Date and time of sample collection
- Source of sample (including name, location, sample type, and matrix)
- Number of containers
- Designation of MS/MSD (if applicable)
- Preservative used
- Analyses required
- Name of sampler
- Custody transfer signatures, dates, and times of sample transfers from the field to transporters and to the laboratories
- Bill of lading or transporter tracking number (if applicable)

## 4.4 Laboratory Responsibilities

After the samples reach the laboratory, they shall be checked against information on the CoC form for anomalies. The condition, temperature, and appropriate preservation of samples shall be checked and documented on the CoC form or a sample receipt checklist. Checking an aliquot of each sample container, at the time of receipt, using litmus paper is an acceptable procedure to determine the pH of all sample containers received, except VOCs. The pH check should be conducted in the sample receiving area or in the appropriate laboratory department. Samples for VOC analysis require that the pH check be performed after the vial has been opened for analysis; the pH shall be recorded at the time of analysis in the department log books. Anomalies in the received samples and their resolution shall be documented in laboratory records and summarized in the final analytical report case narrative. All sample information shall then be entered into a tracking system, and unique analytical sample IDs shall be assigned. A copy of this information shall be reviewed by the laboratory for accuracy. Sample holding time tracking begins with the collection of samples and continues until the analysis is complete.

Samples not preserved or analyzed in accordance with the requirements in this QAPP or the project-specific SAP or QAPP addendum may be resampled and analyzed at no additional cost to CH2M HILL. Any subcontracted analyses shall be documented on a CoC form by the laboratory and noted in the case narrative. Internal laboratory CoC procedures shall also be documented and implemented by the laboratory. Sample custody within the laboratory will, at a minimum, include storage of samples in a secure, restricted access area when not in use; samples must be checked out and checked back in by the analysts who use them. Internal custody records must be maintained by the laboratory as part of the documentation file for each sample. Specific instructions concerning the analysis specified for each sample shall be communicated to the analysts. Analytical batches shall be created, and laboratory QC samples shall be introduced into each batch.

While in the laboratory; samples shall be stored in controlled-access, temperature-applicable areas. Refrigerators, coolers, and freezers shall be monitored for temperature 7 days a week. Acceptance criterion for the temperatures of the refrigerators and coolers is  $4^{\circ}\text{C} \pm 2^{\circ}\text{C}$ . Acceptance criterion for the temperatures of the freezers shall be between  $-7^{\circ}\text{C}$  and  $-20^{\circ}\text{C}$ . All of the cold-storage areas shall be monitored by using thermometers that have been calibrated with a National Institute of Standards and Technology approved traceable thermometer. As indicated by the calibration results, correction factors shall be applied to each thermometer.

Records that include acceptance criteria shall be maintained. Samples for volatile organics analysis shall be stored separately from other samples, standards, and sample extracts. Samples shall be stored after analysis until disposed of in accordance with applicable local, state, and federal regulations. Disposal records shall be maintained by the laboratory.

The following information shall be documented on the CoC form, the sample receipt form, or the sample login form (or on more than one of these forms, as applicable):

- Date samples received
- CH2M HILL sample ID
- Laboratory sample ID
- Analytical tests requested for the sample batch
- Sample matrix
- Number of samples in the batch
- Container description and location in the laboratory
- Verification of sample preservation

All of the information must be retained and traceable in the laboratory sample tracking system, with summary information provided in the analytical reports.

SOPs describing sample control and custody shall be maintained by the laboratory.

## **4.5 Sample Packaging and Transport**

The following sections provide guidelines for sample packaging and transport that may be superseded, amended, or replaced in the project- or site-specific SAPs or QAPP addenda.



### 4.5.1 Sample Container Preparation

The following procedures shall be implemented:

- Labels will be checked for completeness and comparability with the COC.
- Container lids will be checked for tightness; if the container is not full, the sampler will note the COC, field notebook, or field sampling form.
- Sample bottles will be double-bagged in heavy-duty plastic. Glass sample containers will be covered with bubble wrap to prevent breakage.

### 4.5.2 Shipping Cooler Preparation

The following procedures shall be implemented:

- All previous labels and broken custody seals used on the sample shipping cooler will be removed.
- Drain plugs will be sealed with fiberglass or similar tape (outside and inside) to prevent melting ice from leaking.
- A cushioning layer of packing material, such as bubble wrap (approximately 1 inch thick), will be placed at the bottom of the cooler to prevent breakage during shipment.
- The cooler will be lined with a large plastic bag (same type used to contain samples).
- All ice will be double-bagged in zip-lock plastic bags.

### 4.5.3 Placing Samples in the Cooler

The following procedures shall be implemented:

- The CoC form will be placed in a zip-lock bag and taped inside the top of the cooler if shipment is to be made through commercial carrier.
- Samples will be placed in an upright position in the cooler. Sample containers will never be placed onto their side, except for a soil VOC that is to be frozen.
- Ice will be placed on top of samples and between samples. Ideally, ice will be placed in resealable plastic bags in duplicate to minimize leakage of ice melt into the cooler.
- Void space between samples should be filled with packing material or ice packs (vermiculite is not acceptable packing material unless required by DOT).

### 4.5.4 Closing the Cooler

The following procedures shall be implemented if the cooler is to be shipped by commercial carrier:

- The cooler lid will be taped with strapping tape, encircling the cooler several times.
- Custody seals should also be affixed to the cooler lid to further ensure the integrity of the samples. Custody seals should be initialed and dated.

### **4.5.5 Transport**

Sample coolers will be transported to the laboratory immediately after sample collection. An overnight courier may be used to transport the samples. Intermediate stops should be avoided, except for emergencies, in which case, the situation should be noted in the field notebooks. The laboratory should be notified that samples are being shipped.



**TABLE 4-1**

Sample Containers, Preservation, and Holding Times

PG&amp;E Program Quality Assurance Project Plan

Analyte	Method	Container and Minimum Quantity		Preservation	Holding Time
		Water	Soil/Sediment		
Metals (except hexavalent chromium)	SW6010B or C, SW6020A, EPA200.7, EPA200.8, SM3120B, EPA245.1, SW7000 series methods	1-liter P or G	8-oz/P, G, or T	Water: Add HNO <sub>3</sub> to pH<2; soil/sediment: None	28 days for mercury; 180 days for all others
Hexavalent Chromium	SW7199		4-oz/P, G, or T	Soil/sediment: Chill to 4°C (±2°C)	Soil: 30 days to extraction, 7 days to analysis
Hexavalent Chromium	EPA218.6	250-ml P	Not applicable	chill to ≤6°C Laboratory or field filtration within 24 hours. After filtration adjust the pH to 9–9.5 by adding (NH <sub>4</sub> ) <sub>2</sub> SO <sub>4</sub> /NH <sub>4</sub> OH buffer solution	28 days
Hexavalent Chromium	SM3500-Cr B	250-ml P	Not applicable	chill to ≤6°C Laboratory or field filtration within 24 hours. After filtration adjust the pH to 9–9.5 by adding (NH <sub>4</sub> ) <sub>2</sub> SO <sub>4</sub> /NH <sub>4</sub> OH buffer solution	28 days
Purgeable TPH	SW8015B, C or D Preparation methods: SW5035B (soil) SW5030B (water)	Three 40-ml G-TLC	Three 40-ml G-TLC	Water: Add HCl to pH<2; chill to 4°C (±2°C) Soil/sediment: Chill to 4°C (±2°C) or: <ul style="list-style-type: none"> <li>• Frozen in 48 hours</li> <li>• Frozen onsite</li> <li>• Sodium bisulfate</li> <li>• Methanol</li> </ul>	Water: 14 days (preserved); 7 days (unpreserved) Soil: 48 hours unless preserved within 48 hours 14 days if solid samples preserved by the following methods: <ul style="list-style-type: none"> <li>• 4°C/frozen in 48 hours</li> <li>• Frozen onsite</li> <li>• Sodium bisulfate</li> <li>• Methanol</li> </ul>

**TABLE 4-1**

Sample Containers, Preservation, and Holding Times  
*PG&E Program Quality Assurance Project Plan*

Analyte	Method	Container and Minimum Quantity		Preservation	Holding Time
		Water	Soil/Sediment		
Extractable TPH	SW8015B, C or D	Two 1-liter G	8-oz/G or T	Chill to 4°C (±2°C)	Water: 7 days to extraction; 40 days to analysis Soil: 14 days to extraction; 40 days to analysis
Pesticides	SW8081A or B	Two 1-liter G	8-oz/G or T	Chill to 4°C (±2°C)	Water: 7 days to extraction; 40 days to analysis Soil: 14 days to extraction; 40 days to analysis 90 days to extraction if frozen to -10°C (±2°C)
PCB	SW8082 or SW8082A	Two 1-liter G	8-oz/G or T	Chill to 4°C (±2°C)	Water: 7 days to extraction; 40 days to analysis Soil: 14 days to extraction; 40 days to analysis 90 days to extraction if frozen to -10°C (±2°C)
VOCs	SW8260B or C Preparation methods: SW5035B (Soil) SW5030B (Water)	Three 40-ml G-TLC	Three 40-ml G-TLC	Water: Add HCl to pH<2; chill to 4°C (±2°C) Soil/sediment: Chill to 4°C (±2°C) or: <ul style="list-style-type: none"> <li>• Frozen in 48 hours</li> <li>• Frozen onsite</li> <li>• Sodium bisulfate</li> <li>• Methanol</li> </ul>	Water: 14 days (preserved); 7 days (unpreserved) Soil: 48 hours unless preserved with 48 hours 14 days if solid samples preserved by the following methods: <ul style="list-style-type: none"> <li>• 4°C/frozen in 48 hours</li> <li>• Frozen onsite</li> <li>• Sodium bisulfate</li> <li>• Methanol</li> </ul>
SVOC	SW8270C or D	Two 1-liter G	8-oz G or T	Chill to 4°C (±2°C)	Water: 7 days to extraction; 40 days to analysis Soil: 14 days to extraction; 40 days to analysis
Herbicides	SW8151A	Two 1-liter G	8-oz G or T	Chill to 4°C (± 2°C)	Water: 7 days to extraction; 40 days to analysis Soil: 14 days to extraction; 40 days to analysis

**TABLE 4-1**

Sample Containers, Preservation, and Holding Times  
*PG&E Program Quality Assurance Project Plan*

Analyte	Method	Container and Minimum Quantity		Preservation	Holding Time
		Water	Soil/Sediment		
PNA	SW8270SIM	Two 1-liter G	8-oz G or T	Chill to 4°C (±2°C)	Water: 7 days to extraction; 40 days to analysis Soil: 14 days to extraction; 40 days to analysis
Carbon Dioxide, Methane, Ethane, and Ethane	RSK-175	Three 40-ml G-TLC	Not applicable	Add HCl to pH<2; chill to 4°C (±2°C)	Water: 14 days
Carbon Dioxide	SM5400-CO2	1-liter P or G		≤6°C	14 days
Ammonia	EPA350.1 Revision 2 or SM4500-NH3	1-liter P or G	4-oz P, G, or T	Water: Add H <sub>2</sub> SO <sub>4</sub> to pH<2; chill to ≤6°C Soil/sediment: 4°C (±2°C)	Water: 28 days Soil: Not available
Anions	EPA300.0 or SM4500	500-ml P or G	4-oz P, G, or T	Chill to ≤6°C (none required for chloride and fluoride) ortho-Phosphate requires filtering within 15 minutes after sample collection	Bromide, chloride, fluoride, sulfate, and iodide in 28 days Nitrate and ortho-Phosphate in water 48 hours
Metabolic Acids	EPA300.M	500-ml P or G		Chill to ≤6°C	Water: 28 days
Alkalinity (total, bicarbonate, carbonate, hydroxide)	EPA310.2 or SM2320 B	500-ml P or G		Chill to ≤6°C	14 days
TDS	SM2540 C	500-ml P or G		Chill to ≤6°C	7 days
TSS	SM2540 D	500-ml P or G		Chill to ≤6°C	7 days
Turbidity	EPA180.1 Revision 2 or SM2130	500-ml P or G		Chill to ≤6°C	48 hrs
Color	SM2120 E	125-ml P or G		Chill to ≤6°C	48 hours
Specific Conductance	EPA120.1 Revision 1, or SM2510 SW9050	500-ml P or G	4-oz P, G, or T	Chill to ≤6°C Soil/sediment: Chill to 4°C (±2°C)	28 days
Hardness	SM2340 B or C	500-ml P or G		Chill to ≤6°C	6 months
pH	SM4500H+B or SW9040	500-ml P or G	4-oz P, G, or T	Chill to ≤6°C	15 minutes
BOD	SM5210 B	500-ml P or G		Chill to ≤6°C	48 hours

**TABLE 4-1**

Sample Containers, Preservation, and Holding Times  
 PG&E Program Quality Assurance Project Plan

Analyte	Method	Container and Minimum Quantity		Preservation	Holding Time
		Water	Soil/Sediment		
TOC/DOC	SM 5310 C	500-ml G or 40-ml VOA	4-oz P, G, or T	Water: For 500-ml: Add H <sub>2</sub> SO <sub>4</sub> to pH<2; chill to ≤6°C For 40-ml VOA: Add H <sub>2</sub> PO <sub>4</sub> to pH<2; chill to ≤6°C	28 days
TOC	Walkley Black	Not applicable	4-oz P, G, or T	Chill to ≤6°C	28 days
Perchlorate	EPA314.0	500-ml P or G	4-oz P, G, or T	Chill to ≤6°C	28 days
Sulfide	SM4500-S <sup>2</sup>	500-ml P or G		Add zinc acetate and NaOH to pH>9, chill to ≤6°C	7 days
Acid Volatile Sulfide	E821/R-91-100	Check with Laboratory prior to sample collection			
TKN	EPA351.1/2 or SM4500	500-ml P or G	4-oz P, G, or T	Add H <sub>2</sub> SO <sub>4</sub> to pH<2; chill to ≤6°C	28 days
Ferrous Iron (Fe +2)	SM3500D	500-ml P or G		Chill to ≤6°C	24 hours
Dissolved Silica	EPA200.7 or SM4500-Si or SM3120 B	500-ml P only		Chill to ≤6°C	28 days
18 O and deuterium	Laboratory SOP (continuous flow mass spectrometer – CF-IRMS)	100-ml P or 40-ml VOA		Chill to ≤6°C	6 months
Cyanide	EPA335.4 (R1) or SM4500-CN C/D/E (water) SW9010B, SW9012, or SW9014 (soil)	500-ml P or G	4-oz P, G, or T	Water: Add NaOH to pH>12; chill to ≤6°C Soil/sediment: Chill to 4°C (±2°C)	Water and soil: 14 days
Gross Alpha	SM7110C	500 ml P or G		Add HNO <sub>3</sub> to pH<2	6 months
Gross Beta	E900.0	500-ml P or G		Add HNO <sub>3</sub> to pH<2	6 months
Radium-226	E903.1	500-ml P or G	4-oz P, G, or T	Add HNO <sub>3</sub> to pH<2; soil/sediment: None	6 months
Radium-228	E904.0	500-ml P or G	4-oz P, G, or T	Add HNO <sub>3</sub> to pH<2; soil/sediment: None	6 months
Strontium	E905.0	500-ml P or G	4-oz P, G, or T	Add HNO <sub>3</sub> to pH<2; soil/sediment: None	6 months
Tritium	E906.0	500-ml P or G	4-oz P, G, or T	Add HNO <sub>3</sub> to pH<2; soil/sediment: None	6 months
Uranium	R908.0 or 200.8	500-ml P or G	4-oz P, G, or T	Add HNO <sub>3</sub> to pH<2; soil/sediment: None	6 months

**TABLE 4-1**

Sample Containers, Preservation, and Holding Times

*PG&E Program Quality Assurance Project Plan*

Analyte	Method	Container and Minimum Quantity		Preservation	Holding Time
		Water	Soil/Sediment		
Dioxins and furans	SW8290	Two 1-liter Amber G	8-oz G	Chill to 4°C (±2°C)	Water and Soil: 30 days to extraction; 45 days after extraction to analysis Soils: 365 days to extraction if frozen to -10°C (±2°C)
Dioxins and furans (Drinking water)	EPA1316B	Two 1-liter Amber G		Chill to 4°C (±2°C)	7 Days to extraction 40 days after extraction to analysis
Asbestos	Water: EPA 100.1/100.2-TEM	1-liter sonicated P		Chill to 4°C (±2°C)	Water: 48 hour holding time
	Soil: PLM/BULK (present/absent); CARB435/PLM; TEM		4-oz G	Chill to 4°C (±2°C)	Soil: 1 year

**TABLE 4-1**

Sample Containers, Preservation, and Holding Times

*PG&E Program Quality Assurance Project Plan*

Analyte		Method	Container and Minimum Quantity		Preservation	Holding Time
			Water	Soil/Sediment		
Notes:						
>	=	greater than				
<	=	less than				
≤	=	less than or equal to				
BTEX	=	benzene, toluene, ethylbenzene, and xylene				
CF-IRMS	=	continuous-flow isotope ratio mass spectrometry				
DOC	=	dissolved organic compounds				
G	=	glass				
G-TLC	=	glass with teflon-lined cap				
H <sub>2</sub> PO <sub>4</sub>	=	phosphoric acid				
H <sub>2</sub> SO <sub>4</sub>	=	sulfuric acid				
HCl	=	hydrochloric acid				
HNO <sub>3</sub>	=	nitric acid				
NaOH	=	sodium hydroxide				
NH <sub>4</sub>	=	ammonium				
NH <sub>4</sub> OH	=	ammonium hydroxide				
(NH <sub>4</sub> ) <sub>2</sub> SO <sub>4</sub>	=	ammonium sulfate				
oz	=	ounce				
P	=	polyethylene				
PCB	=	polychlorinated biphenyls				
PLM	=	Polarized light microscopy				
PNA	=	polynuclear aromatic hydrocarbons				
SIM	=	selected ion monitoring				
SO <sub>4</sub>	=	sulfate				
T	=	brass sleeves in the sample barrel (sometimes called California brass)				
TDS	=	total dissolved solids				
TEM	=	Transmission Electron Microscopy				
TKN	=	total kjeldahl nitrogen				
TLC	=	teflon lined closure				
TOC	=	total organic compounds				
TPH	=	total petroleum hydrocarbons				
TSS	=	total suspended solids				

# Method Quality Objectives and Quality Assurance Program

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Programmatic method quality objectives (MQOs) are defined in this section but may differ in individual projects, as specified in the project-specific QAPP addenda. MQOs are the basis for ensuring that the quality of the data collection meets the project-specific DQOs of the plan. They specify the type, quality, and quantity of QA/QC data to be collected and how the data are to be used to make the appropriate decisions for the project. The final output of the data must meet the qualitative and quantitative needs of the project.

## 5.1 Data Categories

Both screening and definitive data may be generated. Screening data are generated by rapid analytical methods, and calibration and QC requirements are less rigid than those required for definitive data. Quantitation from a screening method is usually imprecise. Definitive data are generated by rigorous analytical methods using standardized calibration and QC and are reported on specified deliverables. The data are analyte-specific, and both identification and quantitation are confirmed.

In general, screening data will be confirmed by definitive data for use in decision making for the PG&E Program. However, screening data may be used for decision making purposes on a project-specific basis, depending upon the DQOs. The project-specific documents will describe the advantages of collecting screening data that might be less precise but will more adequately define the characteristics of the site by increasing the number of samples collected. This approach can reduce overall error in the data collection process.

## 5.2 Precision, Accuracy, Representativeness, Completeness, and Comparability

Data quality will be evaluated for precision, accuracy, representativeness, completeness, and comparability (PARCC). Both definitive and screening data will be subject to PARCC requirements. PARCC objectives for screening methods may be identical to those for definitive data, or they may be less stringent depending on the project-specific objectives. Sampling frequencies may vary according to the project needs, as defined in the project-specific SAPs or QAPP addenda.

### 5.2.1 Precision

Precision is a measure of reproducibility of analytical results. It can be defined as the degree of mutual agreement among individual measurements obtained under similar conditions. Total precision is a function of the variability associated with both sampling and analysis. Precision will be evaluated as the relative percent difference (RPD) between field duplicate

sample results or between the MS and MSD results. Field duplicates will comprise 10 percent of the sampling effort. MS/MSD samples will be analyzed at a 5-percent frequency. The MS/MSD samples will be field designated, if so required by project specific requirements. Laboratory-generated precision control limits can be used for data evaluation; however, all precision control limits listed in Appendix A and Tables 5-3 through 5-15 must be met.

### **5.2.2 Accuracy**

Accuracy is the degree of agreement between a measured value and the “true” or expected value. It represents an estimate of total error from a single measurement, including both systematic error, or bias, and random error that may reflect variability due to imprecision. Accuracy is evaluated in terms of percent recovery (%R) determined from results of MS/MSD and laboratory control sample (LCS) analyses. Surrogate recoveries from samples analyzed for organic parameters are also used to assess accuracy. Laboratory-generated accuracy control limits can be used for data evaluation; however, the accuracy control limits listed in Appendix A and Tables 5-3 through 5-15 must be met.

### **5.2.3 Representativeness**

Representativeness is the degree to which sample data accurately reflect the characteristics of a population of samples. It is achieved through a well-designed sampling program and by using standardized sampling strategies and techniques and analytical procedures. Factors that can affect representativeness include site homogeneity, sample homogeneity at a single point, and available information around which the sampling program is designed.

### **5.2.4 Completeness**

Completeness is the number of valid measurements compared with the total number of measurements generated. Completeness will be determined for each method, matrix, and analyte combination. The completeness goals of each project are optimized to meet the DQOs. The goals for the PG&E Program are 95 percent for aqueous samples and 90 percent for soil samples.

### **5.2.5 Comparability**

Comparability is the confidence with which one data set can be compared to another. It is achieved by maintaining standard techniques and procedures for collecting and analyzing samples and reporting the analytical results in standard units. Results of performance evaluation samples and systems audits will provide additional information for assessing comparability of data among subcontracting laboratories.

## **5.3 Method Detection Limits, Reporting Limits, and Instrument Calibration Requirements**

### **5.3.1 Method Detection Limits**

The method detection limit (MDL) is the minimum concentration of a substance that can be measured and reported with 99 percent confidence that the analyte concentration is greater



than zero. Each participating laboratory will determine the MDL for each method, matrix, and analyte for each instrument that will be used to analyze samples. The MDLs will be initially determined prior to analyzing samples and again at least once every 12 months; a quarterly MDL verification can be substituted for the annual MDL study. The following steps should be followed:

1. Estimate the MDL using one of the following:
  - The concentration value that corresponds to an instrument signal/noise ratio in the range of 2.5 to 5
  - The concentration equivalent of three times the standard deviation of replicate measurement of the analyte in reagent water
  - The region of the standard curve where there is a significant change in sensitivity (i.e., a break in the slope of the standard curve)
2. Prepare (e.g., extract and digest) and analyze seven samples of an MS (ASTM Type II water for aqueous methods; Ottawa sand for soil methods; 1-mm glass beads, or smaller, for metals) containing the analyte of interest at a concentration three to five times the estimated MDL.
3. Determine the variance for each analyte by using Equations 1 and 2:

$$S^2 = \frac{1}{n-1} \left[ \sum_{i=1}^n (x_i - \bar{x})^2 \right] \quad (1)$$

where:

$S^2$  = variance  
 $x_i$  = the  $i$ th measurement of the variable  $x$  and  
 $\bar{x}$  = the average value of  $x$

$$\bar{x} = \frac{1}{n} \sum_{i=1}^n x_i \quad (2)$$

4. Determine the standard deviation(s) for each analyte by using Equation 3:

$$s = (S^2)^{1/2} \quad (3)$$

5. Determine the MDL for each analyte by using Equation 4:

$$\text{MDL} = 3.14(s) \quad (4)$$

Note: 3.14 is the one-sided t-statistic at the 99-percent confidence level appropriate for determining the MDL using seven samples.

6. If the spike level used in Step 2 is more than 10 times the calculated MDL, repeat the process using a smaller spiking level.

CH2M HILL requires a verification check be performed on the calculated MDLs for each target compound (AFCEE, 2006). The MDL check standard shall be spiked at approximately two times the current reported MDL. The MDL is verified if the check standard produces a

response at least 3 times above the instrument's noise level and greater than the blank associated with the MDL verification study. If the verification response is too low, spike at a successively higher concentration until verification criteria are met, and use the first successful concentration as the reported MDL. The MDL verification check will be sent to CH2M HILL for review and approval.

### **5.3.2 Reporting Limits**

In general, RLs must be greater than two times the calculated MDL. RLs used by the laboratory should not be greater than the reporting limit objectives listed in Appendix A.

When calibrating instruments, a standard at a concentration equal to or less than the RL must be included. In the project-specific SAP or QAPP addendum, reporting of analytical data will be addressed. One of the following options will be selected when establishing reporting requirements for each project:

- Analytes at concentrations greater than the laboratory MDL but less than the RL will be flagged "J" and reported as an estimate. Analytes that are not detected at or above the laboratory MDL will be flagged "U" and reported as not detected at the RL.
- Only analytes at a concentration greater than the project-specific RL will be reported. Analytes detected at less than the RL will be flagged "U" and reported as not detected at the RL.

For consistency, RLs and sample results shall be reported to two significant figures if less than 10 micrograms per liter ( $\mu\text{g/L}$ ) (parts per billion) and to three significant figures otherwise.

RLs shall be reported on a dry-weight basis for soil samples.

### **5.3.3 Instrument Calibration**

Laboratory instruments shall be calibrated by qualified personnel prior to sample analysis according to the procedures specified for each method. Calibration shall be verified at method-specified intervals throughout the analysis sequence. The frequency and acceptance criteria for calibration are specified for each analytical method in Tables 5-3 through 5-15, with supplemental requirements defined in the following sections for organic methodologies. When multipoint calibration is specified, the concentrations of the calibration standards should bracket those expected in the samples. Samples should be diluted, if necessary, to bring analyte responses within the calibration range. Data that exceed the calibration range cannot be reported by the laboratory. The initial calibration (ICAL) curve shall be verified as accurate with a standard purchased or prepared from an independent second source. ICAL verification involves the analysis of a standard containing all the target analytes, typically in the middle of the calibration range, each time the ICAL is performed. Quantitation based on extrapolation is not desirable.

#### **Calibration requirements**

In the initial calibration (for all instruments), a standard at a concentration equal to or less than the RL must be included.

Initial calibration must be re-established if the following conditions exist:

- The last calibration was established more than 1 year prior to the start of a sample's analysis [gas chromatography, gas chromatography-mass spectrometry, inductively coupled plasma, and inductively coupled plasma-mass spectrometry (ICPMS)]
- The last calibration was established more than 2 weeks prior to the start of a sample's analysis for hexavalent chromium by ion chromatography.
- Two consecutive continuing calibration standards fail
- The operating conditions change; for example, any of the following:
  - Major maintenance is performed
  - The fluid or gas “carrier” type changes
  - The instrument requires relocation
  - The analytical column is replaced

### 5.3.3.1 Initial Calibration Models for the Determination of Organic Compounds

Organic methodologies often provide multiple options for ICAL curve fits and associated acceptance criteria for use. The following sections describe the required laboratory practices that will be employed by the laboratory. The hierarchy that the laboratory will use when selecting the calibration curve fit for use in quantitation of sample results is described in the following section.

**Calibration Techniques.** The following procedures will be implemented:

- The analyst will verify that correct instrument operating conditions and routine maintenance as specified in the method and laboratory SOP are employed. All maintenance activities will be documented in a laboratory notebook for troubleshooting and scheduling of future routine, periodic maintenance.
- Ensure that the instrument is free of contamination prior to calibration. **Do not** perform any blank subtraction.
- The entire ICAL must be performed and meet method performance criteria prior to sample analyses. The calibration standards must be analyzed in sequential order from the lowest to highest concentration. If **one** calibration standard fails to meet criteria, it may be reanalyzed at the end of the calibration sequence. Justification for removing a calibration point from the selected curve fit includes circumstances such as, improper purge, injection failure, nonspiked level, or other obvious failures. The failure of multiple standards suggests an instrument problem or operator error and corrective action is required.
- Only the lowest or the highest calibration points can be removed from the calibration curve without justification. If the lowest calibration point is removed, the RL for that compound increases to the level of the next lowest calibration point. Approval to elevate RLs greater than the project-specific objectives **must** be approved by the program or project chemist. If the highest calibration point is removed, the linear range is shortened for that compound.

- The lowest calibration point in the calibration curve must be at or below the required RL.
- The other standard concentrations must define the working range of the instrument or the expected range of concentrations found in the samples.
- Either external or internal calibration can be employed for methods not involving mass spectrometry detectors. Internal calibration must be used when a mass spectrometry detector is employed.
- A minimum of five calibration points must be used for the calibration curve for gas chromatography/mass spectrometry and gas chromatography methods.
- Most compounds tend to be linear, and a linear approach should be favored when linearity is suggested by the calibration data. Nonlinear calibration should be considered only when a linear approach cannot be applied. It is not acceptable to use an alternate calibration procedure when a compound fails to perform in the usual manner. When this occurs it is indicative of instrument issues or operator error.
- If a nonlinear calibration curve fit is employed, a minimum of six calibration levels must be used for second-order (quadratic) curves, and a third order polynomial requires a minimum of seven calibration levels.
- When more than five levels of standards are analyzed in anticipation of using second- or third-order calibration curves, all calibration points **must** be used regardless of the calibration option employed. The highest or lowest calibration point may be excluded to narrow the calibration range and meet the requirements for a specific calibration option. Otherwise, unjustified exclusion of calibration data is expressly forbidden.
- Using the average (mean) relative standard deviation (RSD) of all analytes to meet ICAL criteria is **not** acceptable.

**Calibration Options.** This section describes the acceptable calibration options and the hierarchy that the laboratory should use when selecting a specific option. The choice of calibration option may also be based on previous experience or prior knowledge of detector response.

The following are calibration options:

- **Linear calibration using average calibration or response factors.** Calibration factors for external calibrations or response factors for internal calibrations must have RSDs not exceeding 20 percent or 15 percent, respectively, for quantitation. A minimum response factor of 0.05 for most target analytes or 0.01 for the least responsive target analytes must be achieved to ensure detectability.
- **Linear calibration using a linear regression equation ( $y=mx+b$ ).** The correlation coefficient must equal 0.995 or better. The line should **not** be forced through the origin. The equation and a plot of the linear regression must be included in the raw data generated by the laboratory and made available in the data package upon request.
- **Nonlinear calibration.** This model may be a second-order or third-order polynomial. The model must be continuous without a break in the function and should **not** be forced through the origin. The coefficient of determination of the nonlinear regression must be

0.99 or better. The equation and a plot of the nonlinear regression must be included in the raw data generated by the laboratory and made available in the data package upon request. This method of calibration **must** be approved by the program or project chemist prior to analysis and is intended for nonlinear responding compounds only.

### 5.3.3.2 Continuing Calibration

Periodic verification of the ICAL is essential in generating analytical data of known quality. The continuing calibration verification analyses ensure that the instrument has not been adversely affected by the sample matrix or other instrument failures that would increase or decrease the sensitivity or accuracy of the method. The laboratory will perform continuing calibration for all methods in accordance with the specific requirements in the method and laboratory SOP.

Method SW8000B allowed the use of the average of all analytes percent difference or drift (%D) to meet the continuing calibration requirements for the method. Method SW8000B will not be allowed for the PG&E Program QAPP. Using the average (mean) %D to meet continuing calibration criteria is **not** acceptable. All analytes must meet the continuing calibration criteria for %D (see Method SW8000C).

## 5.4 Elements of Analytical Quality Control

Laboratory QC checks indicate the state of control that prevailed at the time of sample analysis. QC checks that involve field samples, such as matrix and surrogate spikes and field duplicates, also provide an indication of the presence of matrix effects. Field-originated blanks (see Section 3.5) provide a way to monitor potential contamination that field samples are subjected to. The QAPP specifies requirements for method blanks, LCSs, surrogate spikes, and MS/MSD that must be followed by subcontracting laboratories.

A laboratory QC batch is defined as a method blank, LCS, MS/MSD, or a sample duplicate (depending upon the method) and 20 or fewer environmental samples of similar matrix that are extracted or analyzed together. For gas chromatography/mass spectrometry volatile analyses, a method blank, LCS, and MS/MSD must be analyzed in each 12-hour calibration period. The number of environmental samples allowed in the laboratory QC batch is defined by the remaining time in the method-prescribed 12-hour calibration period divided by the analytical run time. Each preparation or analytical batch should be identified in a way that will associate environmental samples with the appropriate laboratory QC samples.

### 5.4.1 Method Blanks

Method blanks are used to monitor each preparation or analytical batch for interference or contamination from glassware, reagents, and other potential contaminant sources in the laboratory. A method blank is an analyte-free matrix (laboratory reagent water for aqueous samples or Ottawa sand for soil samples) to which all reagents are added in the same amount or proportions as are added to samples. It is processed through the entire sample preparation and analytical procedures along with the samples in the batch. There should be at least one method blank per preparation or analytical batch. If a target analyte is found at a concentration that exceeds the RL, corrective action must be performed to identify and eliminate the contamination source. **All** associated samples must be re-prepared or



reanalyzed, or both, after the contamination source has been eliminated if the compounds detected in the associated blank are also present in the field samples. No analytical data may be corrected for the concentration found in the blank (no blank correction).

### 5.4.2 Laboratory Control Sample

An LCS consists of an analyte-free matrix (laboratory reagent water for aqueous samples and Ottawa sand or glass beads for soil samples) spiked with known amounts of analytes that come from a source different than that used for calibration standards. A **complete target analyte list** for each method specified in the QAPP will be spiked into the LCS. The spike levels should be less than or equal to the midpoint of the calibration range. If LCS results are outside the specified control limits, corrective action must be taken, including sample re-preparation or reanalysis, or both, if appropriate. Documentation of the re-preparation or reanalysis, or both, must be provided in the analytical report. If more than one LCS is analyzed in a preparation or analytical batch, the results for each of the LCSs analyzed must be reported. Any LCS recoveries that are above or below the QC limits affect the accuracy for the entire batch and require corrective action.

### 5.4.3 Surrogates

Surrogates are organic analytes that behave similarly as the analytes of interest but are not expected to occur naturally in the samples. They are spiked into the standards, the samples, and QC samples prior to sample preparation. Surrogate recoveries are used as an indicator of accuracy, method performance, and extraction efficiency. If surrogate recoveries are outside the specified control limits, corrective action must be taken, including sample re-preparation or reanalysis, or both, if appropriate. Documentation of the re-preparation or reanalysis, or both, must be provided in the analytical report.

### 5.4.4 Matrix Spike/Matrix Spike Duplicate

An MS is a sample matrix fortified with known quantities of specific compounds; it is subjected to the same preparation and analytical procedures as the native sample. Target analytes are spiked into the sample. MS recoveries are used to evaluate the effect of the sample matrix on the recovery of the analytes of interest. An MSD is a second fortified sample matrix. The RPD between the results of duplicate MSs measures the precision of sample results. One MS/MSD (MSD where appropriate) per 20 project-specific samples will be analyzed. A complete target analyte list for each method specified in the QAPP will be spiked into the MS/MSD (with the exception of PCBs; see Appendix A -notes). Project-specific samples designated on the CoC form will be spiked. The spike levels will be less than or equal to the midpoint of the calibration range. Exceedances of control limits should be flagged in the analytical report.

#### 5.4.4.1 Matrix Spike for Hexavalent Chromium Analyses

Interference from groundwater is known to reduce the sensitivity of Method EPA218.6. This can result in an incorrect assessment of the analyte identification or the specific RL if the “Matrix Spike and Dilution Protocol” is not followed. Samples being analyzed by Method EPA218.6 may be required to follow the protocol in the following section.

**Matrix Spike and Dilution Protocol.** Matrix interference has been encountered that affects the sensitivity for hexavalent chromium by ion chromatography methods. CH2M HILL shall direct the laboratories to perform an additional QA/QC analyses to aid in assessing any effect on method sensitivity for each project due to the sample matrix.

For nondetect sample results, the laboratory will analyze an MS by spiking the samples with 1 µg/L of hexavalent chromium to ensure that identification is accurate and verify that false negatives are detected. For samples with detected results, the laboratory will analyze an MS by spiking the sample with hexavalent chromium at a level not less than 25 percent of the sample concentration. Laboratories will follow the standard protocol of 1 MS and 1 laboratory sample duplicate per 20 samples, unless directed by the project chemist to analyze the MS more frequently.

If the MS is not recovered or the peak is outside of the established retention time window for either detected or nondetect results, the laboratory will make a fivefold dilution of two aliquots of the sample. The first aliquot will be analyzed without the spike; the second aliquot will be spiked with hexavalent chromium at a concentration consistent with the concentrations previously listed and the recovery and peak retention times evaluated. If this MS recovery is not within laboratory QC limits or the peak is not within the laboratory retention time window, the laboratory will dilute two additional aliquots of the sample tenfold, spike one of the aliquots, and analyze the sample/MS. This procedure will be performed at successively greater dilutions of 25:1, 50:1, or 100:1 until the peak identified in the post spike analysis is within the established retention time window for hexavalent chromium and the recovery of the spike is within the laboratory QC limits listed in Appendix A.

The detected result that is reported by the laboratory on the final data package will be chosen from the dilution where both the peak detected in the unspiked and the spiked sample are within the appropriate retention time and the MS is recovered within the QC control limits. The RLs will be raised to the level of the appropriate dilution.

For nondetect results, the dilution selected by the laboratory for reporting will be taken from the smallest dilution that yields an MS recovery within QC control limits and within the appropriate retention time window.

#### 5.4.5 Internal Standards

Internal standards are compounds that have similar properties as the analytes of interest but are not expected to occur naturally in the samples. Some methods require the use of internal standards to compensate for losses during injection or purging or losses due to viscosity. A measured amount of the internal standard is added to the standards, the samples, and QC samples following preparation. When the internal standard results exceed the control limits, corrective action must be taken, including sample reanalysis, if appropriate. Corrective action must be documented in the analytical report.

#### 5.4.6 Laboratory Sample Duplicate

For some methods, a laboratory duplicate is performed instead of a matrix spike duplicate. A laboratory sample duplicate is a sample duplicate selected by the laboratory. It is subjected to the same preparation and analytical procedures as the native sample. The RPD

between the results of the native sample and laboratory sample duplicate measures the precision of sample results. The data collected may also yield information regarding whether the sample matrix is homogenous or heterogeneous.

#### **5.4.7 Interference Check Samples**

Interference check samples are used in inductively coupled plasma (ICP) analyses to verify background and interelement correction factors. They consist of two solutions, A and AB. Solution A contains the interfering analytes, and Solution AB contains the analytes of interest and the interfering analytes. Both solutions are analyzed at the beginning and at the end of each analytical sequence. When the interference check sample results exceed the control limits, corrective action must be taken, including sample reanalysis, if appropriate.

#### **5.4.8 Retention Time Windows**

Retention time windows for gas and liquid chromatographic analyses must be established by replicate injections of the calibration standard over multiple days as described in SW846 8000B, analytical method, or appropriate laboratory SOP. The absolute retention time of the calibration verification standard at the start of each analytical sequence will be the centerline of the window. For an analyte to be reported as positive, its elution time must be within the retention time window.

### **5.5 Additional Quality Control Requirements**

#### **5.5.1 Holding Time**

The holding time requirements specified in this QAPP (see Table 4.1) must be met. For methods requiring both sample preparation and analysis, the preparation holding time will be calculated from the time of sampling to the completion of preparation. The analysis holding time will be calculated from the time of completion of preparation to the time of completion of the analysis, including required dilutions, confirmation analysis, and reanalysis. For methods requiring analysis only, the holding time is calculated from the time of sampling to completion of the analysis, including required dilutions, confirmation analysis, and reanalysis.

#### **5.5.2 Confirmation**

Confirmation analysis must be performed as specified for specific organic methods when the result is at or above the RL. Both the primary and confirmation results will be reported. Unless one of the analysis is specifically designated as the confirmation by the method, the more concentrated result will be reported as the sample result and the lesser concentration result as the confirmation. All calibration and QC requirements must be met when confirmation analysis is performed.

#### **5.5.3 Cleanup Procedures to Minimize Matrix Effects**

To maintain the lowest possible RLs, appropriate cleanup procedures should be employed when it is indicated by the method to remove or minimize matrix interference. Methods for sample cleanup include, but are not limited to, gel permeation chromatography, silica gel,



alumina, florisil, mercury (sulfur removal), sulfuric acid, and acid/base partitioning. Method blanks, MS/MSDs, and LCSs must be subjected to the same cleanup procedures performed on the samples to monitor the efficiencies of these procedures.

#### **5.5.4 Sample Dilution**

Dilution of a sample results in elevated RLs and ultimately affects the usability of the data related to potential actions at the sampling site. It is important to minimize dilutions and maintain the lowest possible RLs. When dilutions are necessary because of high concentrations of target analytes, lesser dilutions should also be reported to fully characterize the sample for each analyte. The level of the lesser dilution should be such that it will provide the lowest possible RLs without having a lasting deleterious effect on the analytical instrumentation.

When a sample exhibits characteristics of matrix interference that are identified through analytical measurement or visual observation, appropriate cleanup procedures specified in Section 5.5.3 must be proven ineffective or inappropriate prior to proceeding with dilution and analysis. Any analyses conducted at a dilution where all analytes will be reported as non-detect above the QAPP RL, must be discussed with the project chemist prior to finalizing the report.

#### **5.5.5 Standard Materials and Other Supplies and Consumables**

Standard materials must be of known high purity and traceable to an approved source. Pure standards must not exceed the manufacturer's expiration date or 1 year after receipt if no expiration date is provided. Solutions prepared by the laboratory from the pure standards must be used within the expiration date specified in the laboratory's SOP.

All other supplies and consumables must be inspected prior to use to ensure that the supplies meet the requirements specified in the appropriate SOP. The laboratory's inventory and storage system should ensure their use within the manufacturer's expiration date and storage under proper conditions.

#### **5.5.6 Manual Integration**

The laboratory is required to provide all analysts performing methods that rely on interpretation of chromatographic data with training on appropriate software or manual integration practices. The laboratory also will make every effort to minimize the use of manual integration of data. If the need arises to use manual integration to correct a software autointegration error, the manual integration will be clearly identified in the instrument data. Before and after enlargements of the region of the chromatogram where the manual integration was performed will be provided on an appropriate scale that allows an independent reviewer to evaluate the need and quality of the manual integration. The analyst will also document the reason for the manual integration on the chromatogram along with their date and initials. The laboratory manager or designee will approve the manual integration by dating and initialing the chromatogram.

### 5.5.7 Laboratory Quality Assurance Program

The laboratory will maintain a quality assurance manual or equivalent document. The manual must include all of the requirements provided in the California Environmental Laboratory Accreditation Program (ELAP), and, if applicable, the National Environmental Laboratory Accreditation Program (NELAP). The manual will define the laboratory's internal procedures for QA/QC as follows:

- QA policies, objectives, and requirements
- Organization and personnel
- Document control
- SOPs (analytical methodology and administrative)
- Data generation
- Software verification
- Quality assurance
- Quality control
- Nonconformance/corrective action procedures
- Data review

#### 5.5.7.1 Laboratory Standard Operating Procedures

The laboratory will maintain SOPs for all analytical methods and laboratory operations. The format for SOPs will conform with the following:

- *Test Methods for Evaluating Solid Waste, Physical and Chemical Methods, SW-846, Third Edition, Update III, Section 1* (EPA, 1996)
- "Good Laboratory Practices" in *Principles and Guidance to Regulations for Ensuring Data Integrity in Automated Laboratory Operations* (EPA, 1995)

All SOPs must have a unique identification number that is traceable to previous revisions of the same document. SOP review must be completed annually.

#### 5.5.7.2 Demonstration of Capability

Laboratory QA department personnel will maintain records documenting the ability of each analyst to perform applicable method protocols. Documentation will include annual checks for each method and analyst. In addition, internal, blind performance evaluation samples for each method and matrix demonstrating overall laboratory performance must be submitted annually. The laboratory may receive additional blind performance evaluation samples in conjunction with the PG&E Program.

## 5.6 Analytical Procedures

The allowed sample preparation methods are presented in Table 5-2. Any changes or alternatives to this list will be included in site-specific SAPs or QAPP addenda. Analytical and preparation methods for SW7000 series are provided in Table 5-2 as alternate methods to SW6020 (with the exception of mercury and soil hexavalent chromium, the SW 7000 series must be approved by the project chemist). These methods will be allowed, provided the RL

objectives are met. After a method is chosen, it must be used throughout the duration of a specific project to maintain data comparability.

This QAPP includes common analytical procedures that may be required for the PG&E Program. Appendix A, Tables A -1 through A -3 contain representative lists of the analytes of concern, the methods to be used, and the RL objectives. Some of the listed analytes may not necessarily be of concern for a particular project; project-specific SAPs or QAPP addenda will list the analytes of concern. The RLs included herein reflect quantifiable levels that are attainable with a specified degree of confidence using the specified methods. The RLs should meet most preliminary cleanup goals or action levels. If changes to the methods or RLs are necessary to meet cleanup goals, the QAPP will be updated or amended by addendum.

General QC requirements are discussed in Section 5.3.3. The calibration and QC requirements specified for each method will be followed and are included in Appendix A and Tables 5-3 through 5-15. Appropriate corrective action will be taken when acceptance criteria are not met. If corrective action is not effective, and data quality is potentially degraded, the occurrence must be documented in a corrective action report and in the data package case narrative. The laboratory manager or a designated person must notify the project chemist.

Analytical services will be provided by laboratories contracted by CH2M HILL or its subcontractors. Analytical laboratories will be accredited, in accordance with the California ELAP, for all parameters where accreditation is available. Subcontract laboratories will be required to follow the SAP and QAPP addenda that are applicable to specific projects or activities and must be approved by the CH2M HILL project chemist.

Field measurements will be performed or supervised directly or indirectly by CH2M HILL field personnel.

## 5.7 Title 22 Metals

The California Code of Regulations - Title 22, Division 4.5 – Environmental Health Standards for the Management of Hazardous waste has a waste characterization protocol that specifies the following stepped procedure for determining hazardous waste disposal:

1. If the sample is suspected of containing high levels of metals, analyze for the Title 22 metals – total threshold limit concentration (TTLC) (see Appendix A, Table A-3).
2. Compare the TTLC sample results with column G of Appendix A, Table A-3.
3. If the TTLC sample results are greater than the concentrations listed in column G of Appendix A, Table A-3, extract and analyze the samples using the waste extraction test (WET) [only required for analytes that exceed the concentrations listed in column G of Appendix A, Table A-3].
4. If the soluble threshold limit concentration (STLC) sample result, from the waste extraction test extraction, is greater than the concentration listed in column H of Appendix A, Table A-3 for any of the Resource Conservation and Recovery Act metals listed in column E of Appendix A, Table A-3., extract the sample by toxicity

characteristic leaching procedure (TCLP) Method 1311 and analyze for the specific metals that exceeded the STLC threshold.

**TABLE 5-1**

Maximum Concentrations for Title 22 – Organic Compounds – SW8000 Series  
*PG&E Program Quality Assurance Project Plan*

Constituent	CAS	Method
Mirex	2385-85-5	SW8081
Methyl chloromethyl ether (Chloromethyl methyl ether)	107-30-2	SW8021B
2-Acetylaminofluorene (2-AAF)	53-96-3	SW8270C
Acrylonitrile	107-13-1	SW8260B
4-Aminodiphenyl (4-Aminobiphenyl)	92-67-1	SW8270C
Benzidine and its salts	92-87-5	SW8270C
bischloromethyl ether (BCME)	542-88-1	SW8270C
1,2-Dibromo-3-chloropropane (DBCP)	96-12-8	SW8270C
4-Dimethylaminoazobenzene (DAB)	60-11-7	SW8270C
Ethyleneimine (EL)	151-56-4	
ALPHA-NAPHTHYLAMINE (1-NA)	134-32-7	SW8270C
BETA-NAPHTHYLAMINE (2-NA)	91-59-8	SW8270C
4-Nitrobiphenyl (4-NBP)	92-93-3	SW8270C
N-Nitrosodimethylamine (DMN)	62-75-9	SW8270C
beta-Propiolactone (BPL)	57-57-8	SW8260B

Note:

If the sample contains any of the compounds listed in this table at a single or combined concentration equal to or exceeding 0.001 percent by weight, the sample is considered to be toxic under CA Title 22 Section 66261.24 (Characteristic of Toxicity)

**TABLE 5-2**  
Extraction and Digestion Methods  
*PG&E Program Quality Assurance Project Plan*

Analytical Method	Parameter	Preparatory Methods
SW6010B	Trace metals by ICP	SW3005A, SW3010A, SW3015, SW3050B, SW3051
SW6020	Trace metals by ICP-MS	SW3005A, SW3010A, SW3015, SW3050B, SW3051
SW7000 Series <sup>a</sup>	Various elements (unless specified separately) Does Not include Mercury or soil Hexavalent chromium	SW3015, SW3020A, SW3050B, SW3051
EPA200.7 and EPA200.8	Trace metals by ICP/ICP-MS	See analytical method
SW7470A, SW7471A, and EPA245.1	Mercury by cold vapor atomic adsorption	See analytical method
SW7196A, SW7199, and EPA218.6	Hexavalent chromium	See analytical method for water, Use SW3060A for soil preparation prior to SW7199
SW8015B or D	TPH volatile and extractable (water and soil)	Volatiles: SW5030BB, SW5031, SW5035 Extractables: SW3510C, SW3520C, SW3545C, SW3541, SW3545, SW3550B
SW8081A	Organochlorine pesticides (water and soil)	SW3510C, SW3520C, SW3540C, SW3541, SW3545, SW3550B
SW8082	PCBs (water and soil)	SW3510C, SW3520C, SW3540C, SW3541
SW8151A	Chlorinated herbicides (water and soil)	SW3510C, SW3520C, SW3540C, SW3541, SW3550B
SW8260B	Volatile organics (water and soil)	SW3585, SW5021, SW5030B, SW5031, SW5032, SW5035
SW8270C and SW8270C SIM	Semivolatile organics (water and soil)	SW3510C, SW3520C, SW3535, SW3540C, SW3541, SW3545, SW3550B
Laboratory SOP (CF-IRMS)	Stable isotopes	See laboratory SOP
Various <sup>b</sup>	General chemistry	See analytical method

<sup>a</sup>Must be approved by the project chemist.

<sup>b</sup>EPA120.1/SW9050, EPA150.1/SW9040, EPA160.1, EPA160.2, EPA180.1, EPA300.0/SW9056, EPA310.1, EPA350.3, EPA354.1, EPA365.1, EPA370.1, EPA376.1/2, SM3500, EPA335.2, SW9010B, SW9014, and EPA415.2.

Note:

ICP-MS = inductively coupled plasma/mass spectrometry

**TABLE 5-3**

Surrogate Recovery for Organic Compounds – SW8000 Series  
*PG&E Program Quality Assurance Project Plan*

Compound	Liquid Matrix % Recovery		Solids Matrix % Recovery	
	Lower Limit	Upper Limit	Lower Limit	Upper Limit
SW8015-E <sup>a</sup>				
Benzo (a) pyrene	70	125	60	125
Bromobenzene	50	140	50	150
Hexacosane	60	140	60	140
Octacosane	26	152	25	162
Triacontane	40	140	30	150
Ortho-Terphenyl	57	132	47	142
Fluorobenzene	75	125	65	135
SW8015-P				
Bromofluorobenzene	70	130	64	148
Chlorobenzene <sup>b</sup>	74	138	64	148
Trifluorotoluene	70	130	70	130
SW8021				
Trifluorotoluene	65	125	65	125
SW8082 <sup>c</sup>				
Decachlorobiphenyl	29	133	26	125
Tetrachloro-m-xylene	50	120	48	121
SW8260B <sup>d</sup>				
1,2-Dichloroethane-d4	72	119	52	149
4-Bromofluorobenzene	76	119	65	135
Dibromofluoromethane	85	115	65	135
Toluene-d8	81	120	75	125
SW8270C				
1,2-Dichlorobenzene-d4 <sup>e, f</sup>	27	100	25	110
2,4,6-Tribromophenol <sup>g</sup>	42	124	36	126
2-Chlorophenol-d4 <sup>e, g</sup>	34	98	30	100
2-Fluorobiphenyl <sup>f</sup>	48	120	43	125
2-Fluorophenol <sup>g</sup>	20	120	37	125
Nitrobenzene-d5 <sup>f</sup>	41	120	37	125
Phenol-d5 <sup>g</sup>	20	120	40	125
Terphenyl-d14 <sup>f</sup>	51	135	32	125
SW8270SIM				
1,2-Dichlorobenzene-d4	27	100	25	110
2-Fluorobiphenyl	34	135	34	135
Nitrobenzene-d5	25	135	25	135
Terphenyl-d14	34	167	14	129

**TABLE 5-3**  
 Surrogate Recovery for Organic Compounds – SW8000 Series  
*PG&E Program Quality Assurance Project Plan*

Compound	Liquid Matrix % Recovery		Solids Matrix % Recovery	
	Lower Limit	Upper Limit	Lower Limit	Upper Limit
SW8081A				
Decachlorobiphenyl	29	135	26	125
Tetrachloro-m-xylene	33	138	36	124
SW8151A				
2,4-dichlorophenylacetic acid	50	130	51	146

<sup>a</sup>Choose two from the list

<sup>b</sup>Required by method

<sup>c</sup>Use tetrachloro-m-xylene as a surrogate if DCBP is used as an IS.

<sup>d</sup>Choose three from the list

<sup>e</sup>Approved alternatives

<sup>f</sup>Base fraction

<sup>g</sup>Acid fraction

**TABLE 5-4**  
 Calibration and QC Requirements for Metals – SW6010B and EPA200.7  
*PG&E Program Quality Assurance Project Plan*

QC Check	Frequency	Criteria	Corrective Action
ICAL (a blank and at least one standard)	When modifications are made to the system, or when continuing calibration verification fails.	If more than one standard is used, correlation coefficient must be >0.995.	Not applicable.
Second-Source Calibration Verification	Immediately following each ICAL.	All analytes within $\pm 10\%$ of expected value for SW6010B and within $\pm 5\%$ of expected value for EPA200.7.	Correct problem and repeat ICAL.
Calibration Blank	After every second-source or continuing calibration verification analysis.	No analytes detected at or above the RL.	Correct the problem and reanalyze previous 10 samples.
Continuing Calibration Verification	After every 10 samples and at the end of the analysis sequence.	All analytes within $\pm 10\%$ of expected value for SW6010B and within $\pm 10\%$ of expected value for EPA200.7.	Recalibrate and reanalyze all samples since the last acceptable continuing calibration verification.
Method Blank	At least one per analytical batch.	No analytes detected at or above the RL.	Correct the problem, re-prepare, and reanalyze all associated samples.
Interference Check Standard	At the start and end of each analytical sequence or twice during an 8-hour period, whichever is more frequent.	All analytes within $\pm 20\%$ of expected value.	Correct the problem, recalibrate, and reanalyze ICS and all affected samples.



**TABLE 5-4**

Calibration and QC Requirements for Metals – SW6010B and EPA200.7

*PG&E Program Quality Assurance Project Plan*

<b>QC Check</b>	<b>Frequency</b>	<b>Criteria</b>	<b>Corrective Action</b>
MS/MSD	One set per 20 project-specific samples. MSD is optional if a laboratory sample duplicate is performed.	All analytes within limits specified in Appendix A.	None.
Laboratory Sample Duplicate	Once per analytical batch if MSD not performed.	Concentration of reported analytes are >5 times the RL in either sample and RPD >20%.  One sample result <RL and a difference of $\pm 2$ times the RL.	None.
LCS	At least one per analytical batch.	All analytes within limits specified in Appendix A.	Correct the problem, re-prepare and reanalyze the LCS and all samples in the analytical batch.
Postdigestion Spike Addition	When MS/MSD fails.	Recovery within 75 to 125% of expected value.	None.
Dilution Test	Each <u>new</u> sample matrix. Or when the PDS fails	Result from 1:5 dilution must be within $\pm 10\%$ of the undiluted sample result (applies only if undiluted sample result is at least 25 times the RL).	Perform postdigestion spike addition.
Linear Range Calibration Check Standard	Once per quarter.	All analytes within $\pm 10\%$ of expected value.	Correct problem and reanalyze or reset linear range.

**TABLE 5-5**

Calibration and QC Requirements for Metals – SW6020 and EPA200.8

*PG&E Program Quality Assurance Project Plan*

<b>QC Check</b>	<b>Frequency</b>	<b>Criteria</b>	<b>Corrective Action</b>
ICAL (a blank and at least one standard)	Before initial sample analysis, when modifications are made to the analytical system, or when continuing calibration verification fails.	Not applicable	Not applicable
Second-source Calibration Verification	Immediately following each ICAL.	All analytes within $\pm 10\%$ of expected value.	Correct problem and repeat ICAL.
Calibration Blank	After every Second-source or Continuing calibration verification analysis.	No analytes detected at or above the RL.	Correct the problem and reanalyze previous 10 samples.



**TABLE 5-5**  
 Calibration and QC Requirements for Metals – SW6020 and EPA200.8  
*PG&E Program Quality Assurance Project Plan*

QC Check	Frequency	Criteria	Corrective Action
Continuing Calibration Verification	After every 10 samples and at the end of the analysis sequence.	All analytes within $\pm 10\%$ of expected value.	Recalibrate and reanalyze all samples since the last acceptable continuing calibration verification.
Method Blank	At least one per analytical batch.	No analytes detected at or above the RL.	Correct the problem, re-prepare, and reanalyze all associated samples.
Interference Check Standard	At the start and end of each analytical sequence or twice during an 8-hour period, whichever is more frequent.	All analytes within $\pm 20\%$ of expected value.	Correct the problem, recalibrate and reanalyze ICS and all affected samples.
MS/MSD	One set per 20 project-specific samples. MSD is optional if a laboratory sample duplicate is performed.	All analytes within limits specified in Appendix A.	None.
Laboratory Sample Duplicate	Once per analytical batch if MSD not performed.	Concentration of reported analytes are $>5$ times the RL in either sample and RPD $>20\%$ .  One sample result $<RL$ and a difference of $\pm 2$ times the RL.	None.
LCS	At least one per analytical batch.	All analytes within limits specified in Appendix A.	Correct the problem, re-prepare, and reanalyze the LCS and all samples in the analytical batch.
Postdigestion Spike Addition	When MS/MSD fails.	Recovery within 75 to 125% of expected value.	None.
Dilution Test	Each <u>new</u> sample matrix. Or when the PDS fails	Result from 1:5 dilution must be within $\pm 10\%$ of the undiluted sample result (applies only if undiluted sample result is at least 25 times the RL).	Perform postdigestion spike addition.

**TABLE 5-6**

Calibration and QC Requirements for Metals – SW7000 Series and EPA245.1

*PG&E Program Quality Assurance Project Plan*

<b>QC Check</b>	<b>Frequency</b>	<b>Criteria</b>	<b>Corrective Action</b>
Multipoint ICAL (a blank and at least five standards)	Before initial sample analysis, when modifications are made to the analytical system, or when continuing calibration verification fails.	Correlation coefficient of linear regression is $\geq 0.995$ .	Correct the problem and repeat the ICAL.
Second-source Calibration Verification	Immediately following each ICAL.	All analytes within $\pm 20\%$ of expected value.	Correct the problem and repeat ICAL.
Calibration Blank	After every second-source or continuing calibration verification analysis.	No analytes detected at or above the RL.	Correct the problem, then reanalyze previous 10 samples.
Continuing Calibration Verification	After every 10 samples and at the end of the analysis sequence.	All analytes within $\pm 20\%$ of expected value.	Recalibrate and reanalyze all samples since the last acceptable continuing calibration verification.
Method Blank	At least one per analytical batch.	No analytes detected at or above the RL.	Correct the problem, re-prepare, and reanalyze all associated samples.
MS/MSD	One set per 20 project-specific samples. MSD is optional if a laboratory sample duplicate is performed.	All analytes within limits specified in accuracy and precision table.	None.
Laboratory Sample Duplicate	Once per analytical batch if MSD not performed.	Concentration of reported analytes are $>5$ times the RL in either sample and RPD $>20\%$ .  One sample result $<RL$ and a difference of $\pm 2$ times the RL.	None.
LCS	At least one per analytical batch.	All analytes within limits specified Appendix A.	Correct the problem, re-prepare, and reanalyze the LCS and all samples in the analytical batch.
Recovery Test (PDS)	When MS/MSD fails.	Recovery within 85 to 115% of expected value.	Analyze all samples by MSA.
Dilution Test	Each new sample matrix. Or when the PDS fails	Result from 1:5 dilution must be within $\pm 10\%$ of the undiluted sample result (applies only if undiluted sample result is at least 25 times the RL).	Perform recovery test.

Note:

MSA = method of standard addition

**TABLE 5-7**Calibration and QC Requirements for General Chemistry and Other Parameters<sup>a</sup>*PG&E Program Quality Assurance Project Plan*

<b>QC Check</b>	<b>Frequency</b>	<b>Criteria</b>	<b>Corrective Action</b>
Multipoint ICAL (a blank and at least five standards); Does Not Apply to Titrimetric Method	Before initial sample analysis, when modifications are made to the analytical system, or when continuing calibration verification fails.	Correlation coefficient of linear regression is $\geq 0.995$ .	Correct the problem and repeat the ICAL.
Second-source calibration verification	Immediately following each ICAL.	Analytes within $\pm 15\%$ of expected value ( $\pm 10\%$ for SW9056/EPA300.0).	Correct the problem and repeat ICAL.
Calibration blank; does not apply to titrimetric method	After every second-source or continuing calibration verification analysis.	No analytes detected at or above the RL.	Correct the problem, then reanalyze previous 10 samples.
Continuing calibration verification	After every 10 samples and at the end of the analysis sequence.	Within $\pm 15\%$ of expected value ( $\pm 10\%$ for SW9056/EP300.0).	Recalibrate and reanalyze all samples since the last acceptable continuing calibration verification.
Method blank	At least one per analytical batch.	No analytes detected at or above the RL.	Correct the problem, re-prepare, and reanalyze all associated samples.
MS/MSD	One set per 20 project-specific samples. MSD is optional if a laboratory sample duplicate is performed.	All analytes within limits specified in Appendix A.	None.
Laboratory Sample Duplicate	Once per analytical batch if MSD not performed.	Concentration of reported analytes are $>5$ times the RL in either sample and RPD $>20\%$ .  One sample result $<RL$ and a difference of $\pm 2$ times the RL.	None.
LCS	At least one per analytical batch.	All analytes within limits specified in Appendix A.	Correct the problem, re-prepare, and reanalyze the LCS and all samples in the analytical batch.
IPC (EPA314.0 only)	Daily, before sample analysis.	Conductance within 10% of original value (original value within $\pm 10\%$ of MCT).  $PD_{A/H} < 25\%$ , instrument response within $\pm 20\%$ of expected response.  Retention time shifts $< 5\%$ , or overall retention time $< 80\%$ of original recorded value.	Prepare fresh IPC solution.  Redetermined MCT or correct problem and reanalyze IPC.  Correct problem, clean or replace column.

**TABLE 5-7**Calibration and QC Requirements for General Chemistry and Other Parameters<sup>a</sup>*PG&E Program Quality Assurance Project Plan*

<b>QC Check</b>	<b>Frequency</b>	<b>Criteria</b>	<b>Corrective Action</b>
ICAL Verification (ICCS) (EPA314.0 only)	Daily, before sample analysis or when eluent is changed.	Instrument response within $\pm 25\%$ of expected value using a standard at or below the RL.	Correct problem then repeat ICAL.
Pretreated Laboratory Reagent Blank (EPA314.0 only)	Required in any analytical batch which includes samples that have been pretreated to reduce the common anion levels.	Perchlorate must be $\leq \frac{1}{2}$ RL.	Correct problem, re-prepare, and analyze method blank and all samples processed with the contaminated blank.
Low-level MDL Check Standard (EPA314.0 only)	Weekly and with ICAL.	Must meet QC acceptance criteria, 50 to 150% of its true concentration.	Reanalyze low-level MDL check standard, if still out of criteria, repeat ICAL.

<sup>a</sup>Unless calibration and QC requirements are specified for an individual method.

Notes:

ICCS = initial calibration check standard

IPC = instrument performance check

MCT = matrix conductivity threshold

**TABLE 5-8**

Calibration and QC Requirements for Hexavalent Chromium – SW7199 and EPA218.6

*PG&E Program Quality Assurance Project Plan*

<b>QC Check</b>	<b>Frequency</b>	<b>Criteria</b>	<b>Corrective Action</b>
Multipoint ICAL (a blank and at least five standards)	Before initial sample analysis, when modifications are made to the analytical system, or when continuing calibration verification fails.	Correlation coefficient of linear regression is $\geq 0.999$ .	Correct the problem and repeat the ICAL.
Second-source Calibration Verification	Immediately following each ICAL.	All analytes within $\pm 10\%$ of expected value.	Correct the problem and repeat ICAL.
Calibration Blank	After every second-source or continuing calibration verification analysis.	No analytes detected at or above the RL.	Correct the problem, then reanalyze previous 10 samples.
Continuing Calibration Verification	After every 10 samples and at the end of the analysis sequence.	All analytes within $\pm 10\%$ of expected value for SW7199 and within $\pm 5\%$ of expected value for EPA218.6.	Recalibrate and reanalyze all samples since the last acceptable continuing calibration verification.
Low-level Calibration verification at the RL of 0.2 $\mu\text{g/L}$	Immediately following each ICAL.	Result within $\pm 20\%$ of expected value.	Correct the problem and repeat ICAL.
Duplicate Sample Injections (SW7199 only)	Every sample.	RPD between injections must be $< 20\%$ .	Correct the problem, re-prepare, and reanalyze all associated samples.

**TABLE 5-8**

Calibration and QC Requirements for Hexavalent Chromium – SW7199 and EPA218.6

*PG&E Program Quality Assurance Project Plan*

<b>QC Check</b>	<b>Frequency</b>	<b>Criteria</b>	<b>Corrective Action</b>
Method Blank	At least one per analytical batch.	No analytes detected at or above the RL.	Correct the problem, re-prepare, and reanalyze all associated samples.
MS	One per 20 project-specific samples.	All analytes within limits specified in Appendix A.	None.
Laboratory Sample Duplicate	Once per analytical batch if MSD not performed.	Concentration of reported analytes are >5 times the RL in either sample and RPD >20%.  One sample result <RL and a difference of $\pm 2$ times the RL.	None.
LCS	At least one per analytical batch.	All analytes within limits specified in Appendix A.	Correct the problem, re-prepare, and reanalyze the LCS and all samples in the analytical batch.
pH Buffer Solution Modification	As needed because of sample matrices that cause the analytical column to overload. All QC samples and analyses will use the modified buffered solution when needed.	A modified pH-adjustment buffer that contains 10 times less ammonium sulfate (33 g/L) but the same concentration of ammonium hydroxide as the buffer prescribed in SW7199/ EPA218.6.	None.
MS Dilute and Spike (see Section 5.3.3.1)	As directed in Section 5.3.3.1.	Spike recovery 85 to 115% and peak within RT window.	Dilute two aliquots 1:5, spike one with 1 $\mu\text{g/L}$ of hexavalent chromium and analyze the other unspiked. Continue the procedure using successively greater dilutions of two aliquots until RT and recovery criteria are met.

Note:

RT = retention time

**TABLE 5-9**

Soil Preparation Method SW3060A for Method SW7199  
*PG&E Program Quality Assurance Project Plan*

QC Check	Frequency	Criteria	Corrective Action
2.5 grams sample to a final volume of 100 ml must be used for each sample	Each sample in the preparation batch.	Follow method preparation for all samples, method blank, and QC samples.	
Method Blank	One per preparation batch.	No analytes detected at or above the RL.	Correct the problem, re-prepare, and reanalyze all associated samples.
LCS	One per preparation batch.	Spike at concentration specified in method. Recovery range 80 to 120%.	Correct the problem, re-prepare, and reanalyze the LCS and all samples in the analytical batch.
Soluble Matrix Spike	One per preparation batch.	Spike at concentration specified in method. Recovery range 75 to 125%.	None.
Insoluble Matrix Spike	One per preparation batch.	Spike at concentration specified in method. Recovery range 75 to 125%.	None.
Post Digestion Spike	One per preparation batch.	Spike at concentration specified in method. Recovery range 85 to 115%.	None.

**TABLE 5-10**

Calibration and QC Requirements for Stable Isotopes<sup>a</sup>  
*PG&E Program Quality Assurance Project Plan*

QC Check	Frequency	Criteria	Corrective Action
Instrument Standardization	Daily, prior to sample analysis.	Laboratory SOP.	Perform instrument maintenance.
Laboratory Sample Duplicate	Every sample analyzed five times.	Laboratory SOP.	Perform instrument maintenance and reanalyze samples.

<sup>a</sup><sup>18</sup>O and deuterium

**TABLE 5-11**

Calibration and QC Requirements for TPH, BTEX, Herbicides, and Dissolved Gases – SW8015B, SW8021B, SW8151A, and RSK-175S

*PG&E Program Quality Assurance Project Plan*

<b>QC Check</b>	<b>Frequency</b>	<b>Criteria</b>	<b>Corrective Action</b>
Multipoint ICAL (minimum 5 points)	Prior to sample analysis, or when calibration verification fails.	If the %RSD is $\leq 20\%$ , the average RRF may be used for quantitation; otherwise use calibration curve with coefficient of correlation or determination $\geq 0.99$ .	Correct the problem and repeat the ICAL.
Continuing Calibration Verification	At the start of each analytical sequence and after every 10 samples, and at the end of the sequence.	Analytes within $\pm 15\%$ of expected value.	Correct the problem, recalibrate, and reanalyze all samples since the last acceptable continuing calibration verification.
Method Blank	At least one per analytical batch.	No analytes detected at or above the RL.	Correct the problem, re-prepare, and reanalyze all associated samples.
Surrogate Spike	Every standard, sample, method blank, MS/MSD, and LCS.	All surrogates in samples, method blank, MS/MSD, and LCS within limits specified in Appendix A.	Correct the problem and reanalyze (re-prepare if necessary).
MS/MSD	One set per 20 samples.	Full target list spike required within limits specified in Appendix A. Not applicable for RSK-175.	None.
LCS	At least one per analytical batch.	Full target list spike required within limits specified in Appendix A.	Correct the problem, re-prepare, and reanalyze the LCS and all samples in the analytical batch.
Second Detector or Second Column Confirmation (does not apply to SW8015B or RSK-175)	All samples with results above the RL objectives must be confirmed within the holding time.	Confirmation to be done using a second detector, or second column of dissimilar phase and retention characteristics (or gas chromatography/mass spectrometry if sample concentration is sufficiently high). All calibration and QC acceptance criteria specified for primary analysis must be met in the confirmation analysis.	Failure to perform confirmation will result in potential resampling and analysis at no cost to the project.

Note:

RRF = relative response factor

**TABLE 5-12**

Calibration and QC Requirements for Pesticides and PCBs – SW8081A and SW8082  
*PG&E Program Quality Assurance Project Plan*

QC Check	Frequency	Criteria	Corrective Action
Multipoint ICAL (minimum 5 points) for single-response pesticides; single-point calibration for toxaphene and chlordane; multipoint calibration for Aroclors 1016 and 1260 only, but include midpoint standard for all other Aroclors for pattern recognition; if a specific Aroclor is found in any sample, quantitation for that Aroclor must be done using 5-point calibration	Prior to sample analysis or when calibration verification fails.	To use average RRF for quantitation of any analyte, % RSD must be $\leq 20\%$ ; otherwise use calibration curve with coefficient of correlation or determination $\geq 0.99$ .	Correct the problem and repeat the ICAL.
Second-source calibration verification – pesticides and Aroclors 1016 and 1260 (or Aroclors identified in samples)	Once for each multipoint ICAL.	All analytes within $\pm 15\%$ of expected value.	Correct the problem, then recalibrate and reanalyze all samples since the last acceptable continuing calibration verification.
Continuing calibration verification – pesticides and Aroclors 1016 and 1260 (or Aroclors identified in samples)	At the start of each analytical sequence; after every 12 hours or 10 samples, whichever is more frequent; and at the end of the sequence.	All analytes within $\pm 15\%$ of expected value.	Correct the problem, then recalibrate and reanalyze all samples since the last acceptable continuing calibration verification.
Endrin/DDT breakdown check (not applicable when analyzing for Aroclors/PCBs only)	At start of each 12-hour period.	Breakdown of either endrin or DDT $\leq 15\%$ .	Evaluate injector port and take corrective action; recalibrate and reanalyze affected samples if necessary.
Method Blank	At least one per analytical batch.	No analytes detected at or above the RL.	Correct the problem, re-prepare, and reanalyze all associated samples.
Surrogate Spike	Every standard, sample, method blank, MS/MSD, and LCS.	At least one of the surrogates in samples, method blank, MS/MSD, and LCS within limits specified in Appendix A.	Correct the problem and reanalyze (re-prepare if necessary).
MS/MSD	One set per 20 project-specific samples.	Full target list spike required within limits specified in corresponding Appendix A.	None.
LCS	At least one per analytical batch.	Full target list spike required within limits specified in corresponding Appendix A.	Correct the problem, re-prepare, and reanalyze the LCS and all samples in the analytical batch.



**TABLE 5-12**

Calibration and QC Requirements for Pesticides and PCBs – SW8081A and SW8082

*PG&E Program Quality Assurance Project Plan*

QC Check	Frequency	Criteria	Corrective Action
Second Column Confirmation	All samples with results above the RL objectives must be confirmed within the holding time.	Confirmation to be done using second column of dissimilar phase and retention characteristics (or gas chromatography/mass spectrometry if sample concentration is sufficiently high). All calibration and QC acceptance criteria specified for primary analysis must be met in the confirmation analysis.	Failure to perform confirmation will result in potential resampling and analysis at no cost to the project.

Note:

DDT = dichloro-diphenyl-trichloroethane

**TABLE 5-13**

Calibration and QC Requirements for VOCs – SW8260B

*PG&E Program Quality Assurance Project Plan*

QC Check	Frequency	Criteria	Corrective Action
BFB Tuning	Prior to ICAL and calibration verification (every 12 hours).	Refer to criteria listed in the method.	Retune instrument and verify.
Multipoint ICAL (minimum 5 points)	Prior to sample analysis, or when calibration verification fails.	<p>SPCCs average RRF <math>\geq 0.30a</math> and %RSD for RRFs for CCCs <math>\leq 30\%</math> and one of the following options:</p> <p>Option 1</p> <p>Linear – RSD for each analyte <math>&lt; 15\%</math>. Use of the mean %RSD for all analytes <math>\leq 15\%</math> may <b>not</b> be used.</p> <p>Option 2</p> <p>Linear – least squares regression <math>r \geq 0.995</math>.</p> <p>Option 3</p> <p>Nonlinear – coefficient of determination <math>\geq 0.99</math> (6 standards to be used for a second order; 7 standards to be used for a third order).</p>	Correct the problem and repeat the ICAL.
Second-source Calibration Verification	Once for each multipoint ICAL.	All analytes within $\pm 25\%$ of expected value.	Correct the problem and repeat ICAL.

**TABLE 5-13**

Calibration and QC Requirements for VOCs – SW8260B  
 PG&E Program Quality Assurance Project Plan

QC Check	Frequency	Criteria	Corrective Action
Continuing Calibration Verification	At the start of each analytical sequence and every 12 hours thereafter.	SPCCs average RF $\geq 0.30c$ and %D for RFs for CCCs $\leq 20\%$ .  All other analytes within $\pm 20\%$ of expected value.	Correct the problem, recalibrate, and reanalyze all samples since the last acceptable continuing calibration verification.
Retention Time Window Calculated for Each Analyte	Each analyte.	Relative retention time of each analyte within $\pm 0.06$ relative retention time units of the ICAL.	Not applicable (used for identification of analyte).
Internal Standards	Each sample and QC sample, method blank, MS/MSD and LCS.	Continuing calibration verification retention time within $\pm 30$ seconds from retention time of the ICAL midpoint standard.  Sample retention time within $\pm 30$ seconds from retention time of the daily continuing calibration verification.  Continuing calibration verification EICP area within $-50\%$ to $+100\%$ of the internal standard responses in the ICAL midpoint standard.  Sample EICP area within $-50\%$ to $+100\%$ of the daily continuing calibration verification.	Inspect mass spectrometer and gas chromatography for malfunctions; reanalyze all affected samples.
Method Blank	At least one per analytical batch.	No analytes detected at or above the RL.	Correct the problem, re-prepare, and reanalyze all associated samples.
Surrogate Spike	Every standard, sample, method blank, MS/MSD and LCS.	All surrogates in samples, method blank and LCS within limits Appendix A.	Correct the problem and reanalyze (re-prepare if necessary).
MS/MSD	One set per 20 project-specific samples.	Full target list spike required within limits specified in Appendix A.	None.
LCS	At least one per analytical batch.	Full target list spike required within limits specified in Appendix A.	Correct the problem, re-prepare, and reanalyze the LCS and all samples in the analytical batch.

<sup>a</sup>SPCC average RRF  $\geq 0.10$  for bromoform, chloromethane, and 1,1-dichloroethane.

Notes:

BFB = bromofluorobenzene

CCC = calibration check compounds

EICP = extracted ion current profile SPCC

**TABLE 5-14**

Calibration and QC Requirements for Semivolatile Organic Compounds – SW8270C

*PG&E Program Quality Assurance Project Plan*

QC Check	Frequency	Criteria	Corrective Action
DFTPP Tuning	Prior to ICAL and calibration verification (every 12 hours).	Refer to criteria listed in the method.	Retune instrument and verify.
Multipoint ICAL (minimum 5 points)	Prior to sample analysis, or when calibration verification fails.	<p>SPCCs average RF <math>\geq 0.050</math> and %RSD for RFs for CCCs <math>\leq 30\%</math> and one of the following options:</p> <p>Option 1:</p> <p>Linear – RSD for each analyte <math>&lt; 15\%</math>. Use of the mean %RSD for all analytes <math>\leq 15\%</math> may <b>not</b> be used.</p> <p>Option 2:</p> <p>Linear – least squares regression <math>r \geq 0.995</math>.</p> <p>Option 3:</p> <p>Nonlinear – coefficient of Determination <math>\geq 0.99</math> (6 standards to be used for a second order; 7 standards to be used for a third order).</p>	Correct the problem and repeat the ICAL.
Second-source Calibration Verification	Once for each multipoint ICAL.	All analytes within $\pm 25\%$ of expected value.	Correct the problem and repeat ICAL.
Continuing Calibration Verification	At the start of each analytical sequence and every 12 hours thereafter.	<p>SPCCs average RF <math>\geq 0.050</math> and %D for RFs for CCCs <math>\leq 20\%</math>.</p> <p>All other analytes within <math>\pm 20\%</math> of expected value.</p>	Correct the problem, recalibrate, and reanalyze all samples since the last acceptable continuing calibration verification.
Retention Time Window Calculated for Each Analyte	Each analyte.	Relative retention time of each analyte within $\pm 0.06$ relative retention time units of the ICAL.	Not applicable (used for identification of analyte).
Internal Standards	Each sample and QC sample, method blank, MS/MSD and LCS.	<p>Continuing calibration verification retention time within <math>\pm 30</math> seconds from retention time of the ICAL midpoint standard.</p> <p>Sample retention time within <math>\pm 30</math> seconds from retention time of the daily continuing calibration verification.</p> <p>Continuing calibration verification EICP area within <math>-50\%</math> to <math>+100\%</math> of the internal standard responses in the ICAL midpoint standard.</p>	Inspect mass spectrometer and gas chromatography for malfunctions; reanalyze all affected samples.

**TABLE 5-14**

Calibration and QC Requirements for Semivolatile Organic Compounds – SW8270C  
*PG&E Program Quality Assurance Project Plan*

QC Check	Frequency	Criteria	Corrective Action
		Sample EICP area within -50% to +100% of the daily continuing calibration verification.	
Method Blank	At least one per analytical batch.	No analytes detected at or above the RL.	Correct the problem, re-prepare, and reanalyze all associated samples.
Surrogate Spike	Every standard, sample, method blank, MS/MSD and LCS.	At least two surrogates per fraction in samples, method blank and LCS within limits specified in Appendix A.	Correct the problem and reanalyze (re-prepare if necessary).
MS/MSD	One set per 20 project-specific samples.	Full target list spike required within limits specified in Appendix A.	None.
LCS	At least one per analytical batch.	Full target list spike required within limits specified in Appendix A.	Correct the problem, re-prepare, and reanalyze the LCS and all samples in the analytical batch.
Note:			
DFTPP = decafluorotriphenylphosphene			

**TABLE 5-15**

Calibration and QC Requirements for Polynuclear Aromatic Hydrocarbons – SW8270C SIM  
*PG&E Program Quality Assurance Project Plan*

QC Check	Frequency	Criteria	Corrective Action
DFTPP Tuning	Prior to ICAL and calibration verification (every 12 hours).	Refer to criteria listed in the method.	Retune instrument and verify.
Multipoint ICAL (minimum 5 points)	Prior to sample analysis, or when calibration verification fails.	SPCCs average RF $\geq 0.050$ and %RSD for RFs for CCCs $\leq 30\%$ and one of the following options:  Option 1 RSD for each analyte $< 15\%$ .  Option 2 Least squares regression $r \geq 0.990$ .  Option 3 Nonlinear – Coefficient of Determination $\geq 0.99$ (6 standards to be used for a second order; 7 standards to be used for a third order).	Correct the problem and repeat the ICAL.

**TABLE 5-15**

Calibration and QC Requirements for Polynuclear Aromatic Hydrocarbons – SW8270C SIM  
 PG&E Program Quality Assurance Project Plan

QC Check	Frequency	Criteria	Corrective Action
Second-source Calibration Verification	Once for each multipoint ICAL.	All analytes within $\pm 30\%$ of expected value.	Correct the problem and repeat ICAL.
Continuing Calibration Verification	At the start of each analytical sequence and every 12 hours thereafter.	All analytes within $\pm 20\%$ of expected.	Correct the problem, recalibrate, and reanalyze all samples since the last acceptable continuing calibration verification.
Retention Time Window Calculated for Each Analyte	Each analyte.	Relative retention time of each analyte within $\pm 0.06$ relative retention time units of the ICAL.	Not applicable (used for identification of analyte).
Internal Standards	Each sample and QC sample, method blank, MS/MSD, and LCS.	<p>Continuing calibration verification retention time within <math>\pm 30</math> seconds from retention time of the ICAL midpoint standard.</p> <p>Sample retention time within <math>\pm 30</math> seconds from retention time of the daily continuing calibration verification.</p> <p>Continuing calibration verification EICP area within -50% to +100% of the internal standard responses in the ICAL midpoint standard.</p> <p>Sample EICP area within -50% to +100% of the daily continuing calibration verification.</p>	Inspect mass spectrometer and gas chromatography for malfunctions; reanalyze all affected samples.
Method Blank	At least one per analytical batch.	No analytes detected at or above the RL.	Correct the problem, re-prepare, and reanalyze all associated samples.
Surrogate Spike	Every standard, sample, method blank, MS/MSD and LCS.	At least two surrogates in samples, method blank and LCS within limits specified in Appendix A.	Correct the problem and reanalyze (re-prepare if necessary).
MS/MSD	One set per 20 project-specific samples.	Full target list spike required within limits specified in Appendix A.	None.
LCS	At least one per analytical batch.	Full target list spike required within limits specified in Appendix A.	Correct the problem, re-prepare, and reanalyze the LCS and all samples in the analytical batch.

# Data Reduction, Validation, and Reporting

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## 6.1 Laboratory Data Management

Data reduction will be performed manually or by using appropriate computer software. Quantitation procedures specified for each method must be followed. If data reduction is performed manually, the documentation must include the formulas used. Computer software used for data reduction must have been previously verified by the laboratory for accuracy. Documentation of the software verification must be maintained in the laboratory. All data reduction documentation must allow re-creation of the calculations.

All data will undergo a minimum of three levels of review at the laboratory prior to release. The analyst performing the tests shall initially review 100 percent of the data. After the analyst's review has been completed, 100 percent of the data shall be reviewed independently by a senior analyst or by the section supervisor for accuracy, completeness and compliance with calibration, QC requirements, and holding times. Analyte identification and quantitation must be verified. Calibration and QC results will be compared with the applicable control limits. RLs should be reviewed to make sure they meet the project objectives. Results of multiple dilutions should be reviewed for consistency. Any discrepancies must be resolved and corrected. Laboratory qualifiers will be applied when there are nonconformances that could potentially affect data usability. These qualifiers must be properly defined as part of the deliverables. All issues that are relevant to the quality of the data must be addressed in a case narrative. The laboratory QC manager will review a minimum of 10 percent of data or deliverables generated for the PG&E Program against the project-specific requirements. A final data review will be conducted by the laboratory manager or client services representative to ensure that all required analyses were performed and that all documentation is complete.

The hardcopy and electronic data deliverable (EDD) laboratory reports for all samples and analyses will contain the information necessary to perform data evaluation.

The PG&E Program will request four types of deliverables from the laboratory, depending upon the DQOs of the individual project. The following is a synopsis of when it is appropriate to use each type deliverable:

- **Level 1.** Appropriate for screening-level sampling results. Noncritical project decisions are made using this data.
- **Level 2.** Appropriate for investigative sampling results that will be replaced with confirmatory data or results used for disposal purposes. Less critical project decisions are made using this data.

- **Level 3.** Appropriate for investigative, confirmatory, or closure results. Critical project decisions may be made using this data.
- **Level 4.** Appropriate for investigative, confirmatory, or closure results. Critical decisions may be made using this data and should be used for projects that require a high degree of confidence in the accuracy of the data.

Hardcopy deliverables (and a electronic copy in portable document format [PDF]), in summary format, equivalent to those specified in the latest versions of EPA *Contract Laboratory Program Statements of Work for Organics and Inorganics Analyses* are preferred. The laboratory data report should be organized in a format that facilitates identification and retrieval of data. Alternate reporting formats require approval from the program chemist or project chemist.

A Level 1 report will include, at a minimum, the following information (when applicable):

- Cover letter with the following information:
  - Title of report and laboratory unique report identification (e.g., sample delivery group number)
  - Project name and site location
  - Name and location of laboratory and second-site or subcontracted laboratory
  - Client name and address
  - Statement of authenticity and official signature and title of person authorizing release of the report
- Table of contents
- Summary of samples received that correlates field sample IDs with the laboratory IDs
- Laboratory qualifier flags and definitions
- Field identification number
- Date received
- Date prepared
- Date analyzed (and time of analysis if the holding time is less than or equal to 48 hours)
- Preparation and analytical methods
- Result for each analyte (dry-weight basis for soils)
- Percent solids results for soil samples
- Dilution factor (provide both diluted and undiluted results when available)
- Sample-specific RL adjusted for sample size, dilution/concentration

- Sample-specific MDL adjusted for sample size, dilution/concentration (when project objectives require reporting less than the RL)
- Units of measure
- Applicable flags for data associated with QC that are outside of control limits
- CoC forms

A Level 2 report will consist of all the elements included in a Level 1 deliverable plus the following:

- Case narrative that addresses the following:
  - Sample receipt discrepancies (e.g., bubbles in VOA samples or temperature exceedances)
  - Descriptions of all nonconformances in the sample receipt, handling, preparation, analytical and reporting processes, and the corrective action taken for each occurrence
  - Identification and justification for sample dilution
  - Serial dilution recoveries, if applicable (required in hardcopy format only)
  - Postdigestion spike recoveries, if applicable (required in hardcopy format only)
- Surrogate %Rs
- MS/MSD and LCS spike concentrations, native sample results, spiked sample results, %R, and RPDs between the MS and MSD results; associated QC limits must also be provided
- Method blank results
- Analytical batch reference number that cross references samples to QC sample analyses
- Completed sample receipt checklist

A Level 3 report will consist of all the elements included in Level 1 and 2 reports plus the following:

- Analytical sequence or laboratory run log that contains sufficient information to correlate samples reported in the summary results to the associated method QC information, such as initial and continuing calibration analyses
- Confirmation results
- Calibration blank results for inorganic analyses (required in hardcopy format only)
- ICP and ICP/MS interference check sample results that include true concentrations, measured concentrations, and the calculated %R of the elements included (required in hardcopy format only)
- Method of standard addition results, if applicable (required in hardcopy format only)



- Internal standard recovery and retention time information, as applicable
- ICAL summary, including standard concentrations, response factors, average response factors, RSDs or correlation coefficients, and calibration plots or equations, if applicable (required in hardcopy format only)
- Continuing calibration verification summary, including expected and recovered concentrations and percent differences (required in hardcopy format only)
- Instrument tuning and mass calibration information for gas chromatography/mass spectrometry and ICP/MS analyses
- Any other method-specific QC sample results

A Level 4 report will include all elements for Levels 1 through 3 and all of the associated raw data. It is imperative that the relative scale used for all chromatographic and other instrument data be supplied in a scale that facilitates review from hardcopy. Enlargements of sufficient size and clarity for complex areas of sample chromatograms will be provided. Additional information to be supplied includes the following:

- Sample preparation logs that include the following:
  - Preparation start and end times
  - Beginning and ending temperatures (e.g., water baths and digestion blocks)
- Each algorithm and an example calculation for at least one sample for each matrix analyzed
- Reconstructed total ion chromatograms or selected ion current profiles for each sample (or blank) analyzed and mass spectra(s) for each compound identified including the following:
  - Raw compound spectra
  - Enhanced or background spectra
  - Laboratory generated library spectra (for tentatively identified compounds, provide the reference mass spectra from software spectra library)
- Ion ratio information for dioxin/furan methods

## 6.2 Hardcopy and Electronic Deliverables

Within the timeframe specified in the laboratory statement of work, contract, or purchase order from sample receipt, the laboratory shall deliver two hardcopies and one PDF of documentation, as specified in this QAPP. In addition, the laboratory shall deliver one electronic copy of the data (i.e., EDD), as specified in the format described in Table 6-1 (or as directed in the project-specific addendum), on CD-ROM or by e-mail (in ASCII format) within the same timeframe (LabSpec-7 format [see Table 6-1]).

All electronic data files shall match the final hardcopy results. CH2M HILL requires receipt of final hardcopy results with electronic files.

All raw data will be maintained in the laboratory and will be available upon request, if not required by the project-specific deliverable. Complete documentation of sample preparation and analysis and associated QC information will be maintained in a manner that allows easy retrieval if additional validation or information is required. Appropriate back-up procedures must be implemented by the laboratory for data that are stored electronically. All data generated using gas chromatography/mass spectrometry must be maintained on COD-ROM or equivalent format and provided to CH2M HILL upon request. All documentation must be retained for a minimum of 5 years after data acquisition.

The primary responsibility for implementing these procedures in the laboratory will reside with the laboratory manager or equivalent. The laboratory manager will approve laboratory reports before submittal.

### 6.3 Data Validation and Verification

Depending on the project-specific objectives, the analytical results of the data collection effort will be validated by CH2M HILL. In general, there will be different levels of validation employed for the PG&E Program that correspond to the reports described in Section 6.1. In some instances a Level 3 or Level 4 data package may be obtained from the laboratory, but only a Level 1 or Level 2 validation may be conducted. Specific validation levels will be identified in the site-specific SAP or QAPP addendum. Validation of Levels 1 through 4 will always be performed by the project chemist or designee. The levels are summarized as follows:

- Level 1     Import the laboratory results into the project database; use automated data validation (AutoDV), as applicable, to the project database. Verify that samples were analyzed by the methods requested, and review the data for outliers and anomalies. Prepare a brief summary validation report.
- Level 2     Import the laboratory results into the project database; use AutoDV as applicable, to the project database. Verify that samples were analyzed by the methods requested, review the laboratory case narrative for events in the laboratory that affect the accuracy or precision of the data, review QC indicator data, and perform a cursory review of the data. Prepare a summary validation report.
- Level 2B    Import the Laboratory results into the project database; use AutoDV, as applicable, to the project database. Verify that samples were analyzed by the methods requested, review the laboratory case narrative for events in the laboratory that affect the accuracy or precision of the data, review QC indicator data, and perform a cursory review of the data. Review specific raw data, as specified in the QAPP addendum, and compare the current data with historical data. Prepare a summary validation report.
- Level 3     Import the laboratory results into the project database; use AutoDV, as applicable, to the project database. Validate the analytical data, as described in the following sections, without reviewing any raw data or analyte verification. Prepare a summary validation report.

- Level 3B Import the laboratory results into the project database; use AutoDV, as applicable, to the project database. Validate the analytical data as described in the following sections with review of specific raw data, as specified in the QAPP addendum, and compare the current data with historical data. Prepare a summary validation report.
- Level 4 Import the laboratory results into the project database; use AutoDV, as applicable, to the project database. Validate analytical data as described in the following sections, including a review of the analytical raw data, and compare the current data with historical data. Prepare a summary validation report.

## 6.4 Level 3 and 4 Validation Procedures

Personnel involved in the data validation function will be independent of any data generation effort. The project chemist will have responsibility for oversight of the data validation effort. Data validation will be performed when the final data packages are received from the laboratory. Data validation will be performed on an analytical batch basis within each analytical report using the summary results of calibration and laboratory QC and the results from associated field samples. Data packages will be reviewed for all constituents of concern. Raw data will be reviewed when deemed necessary by the project chemist or as specified in QAPP addenda. Data validation procedures will include the following:

- Review of the data package for completeness
- Review of CoC records for discrepancies that might degrade data quality
- Review for compliance with holding time and QC frequency requirements
- Evaluation of all calibration and QC summary results against the project requirements
- Verification of analyte identification and calculations for at least 10 percent of the data
- Qualification of the data using appropriate qualifier flags, as necessary, to reflect data usability limitations
- Initiation of corrective actions, as necessary, based on the data review findings

Data validation will be patterned after the *Contract Laboratory National Functional Guidelines for Inorganic Data Review* (EPA, 2002) and *Contract Laboratory National Functional Guidelines for Organic Data Review* (EPA, 1999), substituting the calibration and QC requirements specified in this QAPP for those specified in the guidelines. The national functional guidelines will primarily be used as a guidance document for the application of data qualification criteria. The level of validation will be defined in the SAP or QAPP addendum.

The flagging criteria presented in Tables 6-2 and 6-3 will be used; the qualifier flags are defined in Table 6-4. Qualifier flags, if required, will be applied to the electronic sample results. A summary table of the data qualifications will be provided in the validation report. If multiple flags are required for a result, the most severe flag will be applied to the electronic result. The hierarchy of flags, from the most severe to the least severe, will be as follows: R, UJ, J, U.

A validation report will be generated for each method and sample delivery group. A copy of the validation report will be retained with the data package in the project chemistry file. The project chemist will be notified of any significant data quality problems.

**TABLE 6-1A**  
Data Guidelines for Electronic Data Deliverables  
*PG&E Program Quality Assurance Project Plan*

Field Number	Field Name	Data Type	Data Length	Requirement	Valid Values <sup>a</sup>	Description and Comments
1	VersionCode	Text	15	R	Yes	Code identifying the version of the EDD deliverable.
2	LabName	Text	10	R	Yes	Identification code for the laboratory performing the work. This value is used to distinguish between different facilities.
3	SDG	Text	15	R	No	Sample delivery group designation; always populated for all samples, including QC.
4	FieldID	Text	30	R	No	Client sample ID as appears on CoC forms with optional laboratory-assigned suffixes or prefixes to make it unique. If the sample ID on the CoC form and the prefix or suffix is more than 20 characters, abbreviate the value but make it unique. For laboratory QC samples (e.g., method blanks and laboratory control samples), use a unique laboratory sample ID.
5	NativeID	Text	30	R	No	Client sample ID, <b>exactly</b> as on CoC forms. <b>No prefix or suffix allowed</b> in client sample IDs. Used to identify the native sample from which other samples are derived (e.g., QAQCType = LR, MS, or SD). For laboratory QC samples (i.e., method blanks and laboratory control samples), use the FieldID value that was assigned. However, for laboratory blank spike duplicate samples, use the FieldID value that was assigned to the associated laboratory blank spike sample.
6	QAQCType	Text	2	R	Yes	<p>The code for the sample type. Any field sample that is not used as laboratory QC and is not otherwise marked on the CoC forms should have the designation of "N" (normal field sample). No suffix allowed (i.e., do not add numbers as suffixes to the QAQCType values as called for in the ERPIMS guidelines).</p> <p>If all analyses for a given sample are diluted, the first dilution should be designated as the normal sample. If more dilutions are required, the next dilution should be designated as the first true dilution with a QAQCType value of "LR" and a LRType value of "DL" (see LRType,).</p>

**TABLE 6-1A**  
Data Guidelines for Electronic Data Deliverables  
*PG&E Program Quality Assurance Project Plan*

Field Number	Field Name	Data Type	Data Length	Requirement	Valid Values <sup>a</sup>	Description and Comments
7	LRTYPE	Text	3	C	Yes	<p>This is the code for laboratory replicate sample type. Values are as follows:</p> <ul style="list-style-type: none"> <li>• Blank (if QAQCType value is not LR)</li> <li>• DL (dilution)</li> <li>• RE (re-analysis)</li> <li>• D (inorganic duplicate)</li> <li>• CF (confirmation)</li> </ul> <p>For multiple dilutions or reanalyses of the same sample, append the replicate number after the LRTYPE value (e.g., RE, RE2, and RE3).</p>
8	Matrix	Text	5	R	Yes	Sample matrix code. Valid values are as follows: "AIR", "WATER", or "SOIL" unless otherwise provided by the project data manager and marked on CoC forms. The use of other terms ( e.g., "liquid" or "solid") for laboratory QC is not allowed.
9	LabSampleID	Text	12	R	No	Laboratory sample ID assigned by the laboratory. Prefix or suffix is allowed. Dilutions or re-extractions are noted here. For example, "D97-11111RE" is acceptable.
10	AnalysisMethod	Text	20	R	Yes	Analysis method code. This is the ID of the analytical method performed on the sample. For example, "SW8260A." Generic names such as "EPA" should not be used.
11	ExtractionMethod	Text	20	R	Yes	Preparation method code. A value in this field is required. If the preparation is described in the method, use "METHOD". If there is no separate preparation required, use "NONE". Total and dissolved metal analyses are differentiated by the value in this column. Total, TCLP, and SPLP analyses are differentiated by the value in the LeachMethod column (see below).
12	SampleDate	Date		C	No	Date of sample collection. A value is required for all samples sent to the laboratory and samples derived from those samples. Format = mm/dd/yyyy.
13	SampleTime	Time		C	No	Time of sample collection. A value is required for all samples sent to the laboratory and samples derived from those samples. Twenty-four-hour format (hh:mm).
14	ReceiveDate	Date		C	No	Date of sample receipt in the laboratory. A value is required for all samples sent to the laboratory and samples derived from those samples. Format = mm/dd/yyyy.

**TABLE 6-1A**  
Data Guidelines for Electronic Data Deliverables  
*PG&E Program Quality Assurance Project Plan*

Field Number	Field Name	Data Type	Data Length	Requirement	Valid Values <sup>a</sup>	Description and Comments
15	ExtractDate	Date		C	No	Date of sample preparation (extraction or digestion). A value is required if the ExtractionMethod field value is other than "NONE". Format = mm/dd/yyyy
16	ExtractTime	Time		C	No	Time of sample preparation. A value is required if the ExtractionMethod field value is other than "NONE". Twenty-four-hour format (hh:mm).
17	AnalysisDate	Date		R	No	Date of sample analysis. A value is required for all records. Format = mm/dd/yyyy
18	AnalysisTime	Time		R	No	Time of sample analysis. A value is required for all records. Twenty-four-hour format (hh:mm).
19	PercentSolids	Number		R	No	Percent solids within the sample; should be zero for water samples.
20	LabLotCtlNum	Text	10	C	No	ID for an autonomous group of environmental samples and associated QC samples prepared together. For example, the value can be a digestion or extraction batch ID. If there is no separate extraction or preparation performed, the field is left blank.
21	CAS	Text	20	R	No	CAS registry number of analyte, if available.
22	ParamID	Text	12	R	Yes	Parameter ID code for the parameter listed in the Analyte field.
23	Analyte	Text	60	R	No	Name of analyte, chemical name.
24	Result	Text	10	R	No	Result of the analysis. Surrogate analytes are reported in units of percent. All others are reported in sample concentration units. If undetected, report the adjusted MDL or adjusted RL, depending on the project. (Reported as a text field to preserve significant figures.)
25	ExpectedValue	Number		C	No	Report "100" for surrogates; report "0" for blanks; spike level plus parent result for LCS, and MS/MSD; parent value for laboratory duplicate.
26	Units	Text	10	R	Yes	Units of measure used in the analysis. Report "PERCENT" for surrogate analytes; report concentration units for all others.
27	Dilution	Number		R	No	Total dilution reported in the analysis. Default value is "1". This value reflects changes to sample preparation amounts as defined by the method (e.g., less sample used for standard VOC analysis).

**TABLE 6-1A**  
Data Guidelines for Electronic Data Deliverables  
*PG&E Program Quality Assurance Project Plan*

Field Number	Field Name	Data Type	Data Length	Requirement	Valid Values <sup>a</sup>	Description and Comments
28	MDL	Number		C	No	Minimum detection limit adjusted for preparation and dilution. This value may be the method detection limit or the instrument detection limit, depending on the method and the project requirements. This value is <b>not</b> adjusted for percent moisture.
29	RL	Number		C	No	Reporting limit adjusted for preparation and dilution. Value is <b>not</b> adjusted for percent moisture. Equivalent to PQL.
30	LabQualifier	Text	6	R	No	Laboratory qualifier for the results, as reported on the hardcopy. Use "=" as first (or only) qualifier value for detected results if there are no other qualifiers for the result.
31	Surrogate	Text	1	R	Yes	If the chemical is a surrogate = Y; if not = N.
32	Comments	Text	240	O	No	Comment field.
33	ParValUncert	Text	16	C	No	Radiological parameter value uncertainty.
34	Recovery	Number		C	No	Percent recovery for MS, SD, LCS, LCSD, and surrogate compounds.
35	LowerControlLimit	Number		C	No	Lower control limit value for spiked compounds, expressed in units of percent. A value in this field is required if there is a value in the Recovery field (Field 34).
36	UpperControlLimit	Number		C	No	Upper control limit value for spiked compounds, expressed in units of percent. A value in this field is required if there is a value in the Recovery field (Field 34).
37	Basis	Text	1	R	Yes	Weight basis for soil (or solid) sample analysis; D = dry-weight basis, W = wet-weight basis, and X = not applicable.
38	ConcQual	Text	1	R	Yes	Concentration qualifier. Use "=" for detects, "J" for estimated value (value between detection limit and reporting limit), "U" for undetected result, and "E" for exceeded result.
39	MDLAdjusted	Number		C	No	Minimum detection limit adjusted for preparation, dilution <b>and percent moisture</b> . See the description of the MDL field (Field 28) for an explanation of the contents of this field.
40	RLAdjusted	Number		C	No	Reporting limit adjusted for preparation, dilution <b>and percent moisture</b> . Equivalent to PQL



**TABLE 6-1A**  
Data Guidelines for Electronic Data Deliverables  
*PG&E Program Quality Assurance Project Plan*

Field Number	Field Name	Data Type	Data Length	Requirement	Valid Values <sup>a</sup>	Description and Comments
41	SampleDescription	Text	30	C	No	Full sample ID as it appears on CoC forms. In some cases, this may be the name of the sampling location instead of the sample. Required for all samples that are either collected in the field and specified on CoC forms, or derived from samples that are collected in the field and specified on COC forms.
42	LeachMethod	Text	20	R	Yes	Analytical method used for leaching the sample; applies to TCLP, SPLP, or other leaching or pre-extraction leaching procedures. Use "NONE" if the sample was not leached.
43	LeachDate	Date		C	No	Date that the leaching method was performed (use the start date for multistate leaching procedures). Value is required if the LeachMethod field value is other than "NONE". Format = mm/dd/yyyy.
44	LeachTime	Time		C	No	Time that the leaching procedure started. Value is required if the LeachMethod field value is other than "NONE". Twenty-four-hour format (hh:mm).
45	LeachLot	Text	10	C	No	ID of an autonomous group of environmental samples and associated QC samples <b>leached</b> at the same time. Value is required if the LeachMethod field value is other than "NONE". If the sample was not leached, the field is left blank.
46	AnalysisLot	Text	10	R	No	ID of an autonomous group of environmental samples and associated QC samples <b>analyzed</b> together. A value in this field is required (i.e., it should not be blank).
47	CalRefID	Text	10	C	No	ID of a group of environmental and QC samples linked by a common set of calibration records. All results with the same CalRefID value will have had the same initial calibration run.

<sup>a</sup>For a list of valid values see Table 6-1B.

Notes:

The EDD file from the laboratory will be a comma-delimited ASCII file in the format listed above. There will be one EDD file per hardcopy report and the filename of the EDD file will be in the format REPORTID.csv, where REPORTID is the hardcopy report ID of sample delivery group.

C = Conditionally Required

EPRIMS = Environmental Restoration Program Information Management System

R = Required

**TABLE 6-1B**

Values for Data Guidelines for Electronic Data Deliverables

*PG&E Program Quality Assurance Project Plan*

Field Name	Valid Values	Meaning
VersionCode	4.20AFCEE3	Format 4.20, AFCEE data values. LabQualifier field contains the laboratory qualifier values defined in the AFCEE QAPP, Version 3.0.
VersionCode	4.20EPACLP	Format 4.20, EPA data values. LabQualifier field contains the standard EPA CLP laboratory qualifiers.
QAQCType	N	Normal, environmental sample
QAQCType	LB	Laboratory method blank
QAQCType	MS	Laboratory matrix spike sample
QAQCType	SD	Laboratory matrix spike duplicate
QAQCType	LR	Laboratory replicate (dilution, re-analysis, duplicate)
QAQCType	BS	Laboratory method blank spike
QAQCType	BD	Laboratory method blank spike duplicate
LRTYPE	DL	First dilution sample
LRTYPE	DL2	Second dilution sample
LRTYPE	DL3	Third dilution sample
LRTYPE	RE	First re-analysis/re-extraction sample
LRTYPE	RE2	Second re-analysis/re-extraction sample
LRTYPE	RE3	Third re-analysis/re-extraction sample
LRTYPE	D	Inorganic duplicate sample
LRTYPE	CF	First confirmation analysis sample
LRTYPE	CF2	Second confirmation analysis sample
LRTYPE	CF3	Third confirmation analysis sample
AnalysisMethod	SW8260A	Volatiles by method 8260A in EPA SW846.
AnalysisMethod	SW8270	Semivolatiles by method 8270 in EPA SW846.
AnalysisMethod	SW6010	ICP metals by method 6010 in EPA SW846.
AnalysisMethod	SW7060	GFAA arsenic by method 7060 in EPA SW846.
ExtractionMethod	FLDFLT	Field filtration for dissolved metals analysis
ExtractionMethod	C3050	CLP-modified SW3050 acid digestion for metals analysis in soil samples.
ExtractionMethod	SW1311	TCLP extraction
ExtractionMethod	DISWAT	Distilled water extraction for analytes in soil samples.
ExtractionMethod	SW3510	Separatory funnel extraction
ExtractionMethod	SW3540	Soxhlet extraction
ExtractionMethod	TOTAL	Digestion of unfiltered waters for total metals analysis

**TABLE 6-1B**

Values for Data Guidelines for Electronic Data Deliverables  
*PG&E Program Quality Assurance Project Plan*

Field Name	Valid Values		Meaning
ParamID	ACE	Acetone	
ParamID	AS	Arsenic	
ParamID	BHCGAMMA	gamma-BHC (Lindane)	
ParamID	BZ	Benzene	
ParamID	CDS	Carbon disulfide	
ParamID	PB	Lead	
ParamID	PHENOL	Phenol	
ParamID	SE	Selenium	
ParamID	TCE	Trichloroethene	

TABLE 6-2

Flagging Conventions for Organic Methods

PG&amp;E Program Quality Assurance Project Plan

Quality Control Check	Evaluation	Flag	Samples Affected
Holding Time	Holding time exceeded for extraction or analysis	J = positive results; UJ = nondetects	Sample
	Holding time exceeded by a factor of two	J = positive results; R = nondetects	
Sample Preservation SW8260B	Sample not preserved	J = positive results; UJ = nondetects	Sample
Sample Integrity SW8260B	Bubbles in VOA vial used for analysis	J = positive hits; UJ = nondetects	Sample
Temperature	>6°C	J = positive results; UJ = nondetects	All samples in same cooler
ICAL	RRF <0.050, <0.010 for poor responders (SW8260B and SW8270C)	J = positive results, R = nondetects	All associated samples in analysis batch
	%RSD >20.0% (SW8260B and SW8270C), or >20% (SW8015B, SW8081A, SW8082, and SW8151A), <b>AND</b> calibration curve not used; <b>OR</b> calibration curve used, but with coefficient of correlation or determination <0.99	J = positive results, UJ = nondetects	
Calibration Verification (second-source and continuing calibration verification)	RRF <0.050, <0.010 for poor responders (SW8260B and SW8270C)	J = positive results, R = nondetects	All associated samples in analysis batch
	%D >25.0% (SW8260B and SW8270C) or >15% (SW8015B, SW8081A, SW8082, SW8151A)	J = positive results, UJ = nondetects	
	%R >UT	J = positive results	All associated samples in analytical batch
	%R <LT	J = positive results, UJ = nondetects	
Laboratory Control Sample	%R >UT	J = positive results	All samples in preparation batch
	%R < LT	J = positive results, UJ = nondetects	
	%R <10%	J = positive results; R = nondetects	
Calibration Blank Method Blank	Convert blank concentration to soil units, if applicable; multiply the highest blank concentration by five	U = positive sample results <5x highest blank concentration	All samples in preparation batch or analytical batch, whichever one applies, associated with method blank or calibration blank

**TABLE 6-2**

Flagging Conventions for Organic Methods  
*PG&E Program Quality Assurance Project Plan*

Quality Control Check		Evaluation	Flag	Samples Affected
Equipment Blank				All samples, same site, matrix and date (water) or all samples, same site, matrix (soil) associated with equipment blank
Field Blank				
Ambient Blank				
Trip Blank				All samples shipped in the same cooler as the trip blank
MS/MSD				
%R	%R >UT	J = positive results		MS analytes in parent sample and field duplicate, if any.
	%R <LT	J = positive results; UJ = nondetects		
	%R <10%	J = positive results; R = nondetects		
RPDs	RPD >UT	J = positive results		MS analytes in parent sample and field duplicate, if any.
Surrogates				
SW8260B; SW8015B; SW8015B SW8081 SW8082; SW8151A; SW8310, SW8270CSIM	%R >UT	J = positive results		All analytes in sample
	%R <LT and none <10%	J = positive results; UJ = nondetects		
	%R <10%	J = positive results; R = nondetects		
SW8270C	2 or more surrogates in same fraction with %R >UT	J = positive results		All analytes in same fraction in sample
	2 or more surrogates in same fraction with %R <LT but not <10%	J = positive results; UJ = nondetects		
	2 or more surrogates in same fraction with %R <LT and <10%	J = positive results; R = nondetects		
Internal Standards (SW8260B; SW8270C, SW8270CSIM)	Area >UT	J = positive results; UJ = nondetects		Associated analytes in sample
	Area <LT but not <10%	J = positive results;		
	Area <10%	J = positive results; R = nondetects		

**TABLE 6-2**

Flagging Conventions for Organic Methods  
*PG&E Program Quality Assurance Project Plan*

Quality Control Check	Evaluation	Flag	Samples Affected
Field Duplicates	Concentration of reported analytes are >5 times the RL in either sample and RPD >UT (30% for water samples; 50% for soil samples)	J = positive results	Field duplicate pair
	One or both sample results <5 times the RL and a difference of $\pm 2$ times the RL for water ( $\pm 4$ times for soil).	J = positive; UJ = nondetect	
Confirmation (SW8015B; SW8021B, SW8081A; SW8151A;)	RPD between primary and confirmation results > 25%	J = positive results	Sample

**Notes:**

All QA/QC criteria are included in Tables 5-3 through 5-15 and Appendix A and will be used for validation criteria.

Organic methods include SW8015B, SW8081A, SW8082, SW8151A, SW8260B, SW8270C, and SW8270C SIM.

Spike recovery limits do not apply when sample concentration exceeds the spike concentration by a factor of four or more.

For methods requiring confirmation, the qualifications apply to primary analysis results (either of the two columns/detectors may be designated as the primary column/detector).

Where one MS recovery meets acceptance criteria and the other MS of the pair does not, professional judgment may be used to determine if the parent sample should be qualified for matrix effects by comparing the MS recoveries to other QC results within the batch or sample site.

Qualifier may not apply in cases where a surrogate coelutes with a nontarget analyte.

Qualifier may not apply in cases where low surrogate recoveries are due to sample dilution.

< = less than

> = greater than

%R = percent recovery

LT = lower tolerance

UT = upper tolerance

**TABLE 6-3**

Flagging Conventions – Minimum Data Evaluation Criteria for Inorganic Methods  
PG&E Program Quality Assurance Project Plan

Quality Control Check	Evaluation	Flag	Samples Affected
Holding Time	Holding time exceeded for extraction, digestion, or analysis	J = positive results; R = nondetects for mercury; UJ = nondetects for all other analytes	Sample
	Holding time for digestion or analysis exceeded by a factor of two	J = positive results; R = nondetects	
Sample Preservation	Sample preservation requirements not met (If sample preservation was not done in the field, but was performed at the laboratory upon sample receipt, no flagging is required)	J = positive results; R = nondetects	Sample
Temperature	>6°C ( not applicable to metals except mercury)	J = positive results; UJ = nondetects	Samples in same cooler
ICAL (Multipoint only)	Correlation coefficient $\leq 0.995$	J = positive; UJ = nondetects	All associated samples in analytical batch
Calibration verification (ICAL verification, continuing calibration verification)	%R >UT	J = positive results	All associated samples in analytical batch
	%R <LT	J = positive results, UJ = nondetects	
Interference check sample (SW6010B/SW6020 only)	%R >UT	J = positive results	All associated samples in analytical batch
	%R <LT	J = positive results; UJ = nondetects	
Laboratory Control Sample	%R >UT	J = positive results	All samples in preparation batch
	%R <LT	J = positive results; UJ = nondetects	
	%R <10%	J = positive results; R = nondetects	
Calibration Blank (ICB,CCB)	Multiply the highest blank concentration by five	U = positive sample results <5x highest blank concentration	All samples in preparation batch or analytical batch, whichever one applies, associated with method blank or calibration blank
Method Blank			
Equipment Blank			All samples, same site, matrix and date
MS/MSD	%R >UT	J = positive results	MS analytes in parent sample and field duplicate if applicable
	%R <LT	J = positive results; UJ = nondetects	
	%R <10%	J = positive results; R = nondetects	
	RPD >UT	J = positive results	

**TABLE 6-3**

Flagging Conventions – Minimum Data Evaluation Criteria for Inorganic Methods  
*PG&E Program Quality Assurance Project Plan*

Quality Control Check	Evaluation	Flag	Samples Affected
MS Dilute and Spike for hexavalent chromium by Methods SW7199 or EPA218.6 (see Section 5.3.3.1)	Spike recovery 85-115% and peak within recovery time window. If criteria are not met, the laboratory is required to dilute two aliquots 1:5, spike one with 1 µg/L of hexavalent chromium and analyze the other unspiked. Continue the aforementioned procedure using successively greater dilutions of two aliquots until recovery time and recovery criteria are met.	<p>Choose the dilution where the RT/recovery criteria are met.</p> <p>If RT/recovery criteria are met at a 1:1 dilution, data qualification is not required for detected or nondetected results.</p> <p>If RT/recovery criteria met at dilution greater than a 1:1, elevate the RL for nondetected results and qualify the data U at a level equal to the RL multiplied by the dilution factor of the acceptable analysis (apply ValAdj validation reason).</p> <p>If RT/recovery criteria are not met:</p> <p>a) Analysis performed only at a 1:1 dilution:  J positive results (apply LabA&amp;P validation reason)  UJ or R nondetects determined in conjunction with Project Chemist (apply LabA&amp;P validation reason)</p> <p>b) Analysis performed at subsequent dilutions and criteria are still not met:  J flag positive apply LabA&amp;P validation reason)  Elevate RL - UJ or R nondetects, determined in conjunction with project chemist (apply LabA&amp;P validation reason)</p>	Sample
Post digestion Spikes/Recovery Test (Metals only) (Step 1 - following MS/MSD, only required if the MS/MSD fails)	Spike results indicate performance of Dilution Test required (i.e. MS/MSD Failed), but Dilution Test not done.	J = positive results, UJ = nondetects	All samples in digestion batch if Dilution test not performed
	%R >UT	J = positive	
	%R <LT	J = positive results, UJ = nondetects	



**TABLE 6-3**

Flagging Conventions – Minimum Data Evaluation Criteria for Inorganic Methods  
*PG&E Program Quality Assurance Project Plan*

Quality Control Check	Evaluation	Flag	Samples Affected
Dilution Test (Step 2 - following Post digestion spike, only required if the PDS fails)	If concentration is >25 times the RL and percent difference >UT	J = positive results UJ = nondetects	Analytes in parent sample if analytical spike not performed
MSA (GFAA only) for samples where postdigestion spike (performed as a result of unacceptable serial dilution) fails	$r < 0.995$	J = positive results	Sample
Field Duplicates Laboratory Sample Duplicates	Concentration of reported analytes are >5 times the RL in either sample and RPD >20%  One or both sample results <5 times the RL and a difference of $\pm 2$ times the RL	J = positive results  J = positive results; UJ = nondetects	Field duplicate pair

Notes:

< = less than

> = greater than

All QA/QC criteria are included in Tables 5-3 through 5-15 and Appendix A and will be used for validation criteria.

Spike recovery limits do not apply when sample concentration exceeds the spike concentration by a factor of four or more.

CCB = continuing calibration blank

ICB = Initial calibration blank

LabA&P = laboratory accuracy and precision criteria not met

LT = lower tolerance

MSA = method of standard addition

UT = upper tolerance

ValAdj = Value reported by laboratory adjusted because of matrix issues.

**TABLE 6-4**

Qualifier Flag Definitions

*PG&E Program Quality Assurance Project Plan*

Flag	Definition
J	Analyte was present but reported value may not be accurate or precise.
R	The result has been rejected.
U	Analyte was analyzed for but not detected at the specified detection limit.
UU	Analyte was not detected above the detection limit objective; however, the reported detection limit is approximate and might not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.

# Performance Evaluations

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To assess sample and data collection procedures, performance evaluations will be conducted that include of technical systems audits and performance audits.

## 7.1 Technical Systems Audits

### 7.1.1 Laboratory Audits

The laboratories participating in the data collection effort will be prequalified by the project management teams. A surveillance audit program that requires routine technical system audits will be instituted. Laboratory prequalification and the surveillance audits may also be undertaken by regulatory agencies. Laboratory prequalification audits may be performed as onsite audits, desk audits, or a combination of both, depending on the scale and sensitivity of the project.

#### 7.1.1.1 Onsite Laboratory Prequalification Audit

An onsite laboratory prequalification audit in conjunction with a desk audit (see Section 7.1.1.2) is the preferred audit when using a new laboratory. The onsite laboratory audit will start with a pre-audit meeting during which the auditor will discuss with the laboratory staff the purpose of the audit, the schedule and areas to be audited, and the procedures that will be followed. The meeting may include a brief tour of the laboratory. The audit will then be conducted. The auditor will assemble the findings at the conclusion of the audit and discuss the findings with laboratory staff.

Critical items that will be addressed in a technical system audit include, but may not be limited to, the following:

- Calibration procedures and documentation
- Treatment and handling of standards
- Completeness of data forms, notebooks, and other reporting requirements
- Data review and verification procedures
- Data storage, filing, and recordkeeping procedures
- Sample custody procedures
- QC procedures, tolerances, and documentation
- Operating conditions of facilities and equipment
- Documentation of staff training and instrument maintenance activities
- Systems and operations overview

A written audit report will be sent to the laboratory within a specified time. A copy of the audit report will be sent to the project manager, and a copy will be retained in the project files.

The need for follow-up action will be determined based on the laboratory's responses. If an audit identifies an unacceptable condition or unacceptable data, the laboratory will be responsible for developing and initiating corrective action to resolve the situation. The project manager will be notified if the nonconformance impacts the project and requires resources not normally available to the project team. In such cases, the project manager will decide whether resources to pursue corrective action will be made available.

#### **7.1.1.2 Desk Prequalification Audit**

In part, a prequalification audit is performed to provide a perspective of the laboratory operations and the internal auditing and data review processes. Noncritical samples, split samples, or performance evaluation samples will be sent to the laboratory as part of the prequalification audit to ascertain the laboratory's ability to produce quality data. Generally, this process starts by sending guidance documents (e.g., QAPP, SAP, and SOW) to the laboratory for review. After a review and confirmation, the laboratory will follow the guidance documents to the best of their ability and to the project chemist's satisfaction. The auditor will request copies of accreditation audits (e.g., ELAP, NELAP, or AFCEE), SOPs, an example data package, and the laboratory's quality assurance manual. After a review of the laboratory's documentation (including instrument output, analytical reports, and other documentation specific to a batch of samples), samples can be sent to the laboratory. The data will be validated by using the Level 4 protocol described in Section 6.3 and reviewing the laboratory's QC documentation. The corrective actions described in Section 7.1.1.1 may also apply.

### **7.1.2 Field Audits**

Field audits will be performed annually to verify the performance of field procedures. The audit will evaluate the following:

- Sample containers and preservatives
- Sample collection and identification procedures
- Sample custody, handling, and shipping procedures
- Equipment decontamination procedures
- Calibration of field instruments and performance of field tests
- Documentation of field activities, maintenance of field records, and document control

## **7.2 Performance Audits**

### **7.2.1 Performance Evaluations**

Laboratories are required to participate in a performance evaluation program, in accordance with the California ELAP. Any method or analyte failure in a performance evaluation that affects the certification status of the laboratory with the National Environmental Laboratory Accreditation Program or the state of California must be immediately communicated to the program chemist.

Blind performance evaluation samples will be submitted to the laboratories as deemed necessary by the project chemist or project team.

### **7.2.2 External Audits**

Announced and unannounced audits of the field operations and laboratories may be conducted by CH2M HILL during any stage of the project.

### **7.2.3 Internal Audits**

Annual audits of the laboratory shall be conducted by the laboratory's quality assurance officer. The audits shall verify, at a minimum, that written SOPs are being followed; standards are traceable to certified sources; documentation is complete; data review is being done effectively and is properly documented; and data reporting, including electronic and manual data transfer, is accurate and complete. All audit findings shall be documented in QA reports to management. Necessary corrective actions shall be taken within a reasonable timeframe. The quality assurance office shall verify that such actions are effective and complete and document their implementation in an audit closeout report to management.

# Preventive Maintenance

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The primary objective of preventive maintenance is to promote the timely and effective completion of a data collection effort. The maintenance program should be designed to minimize the downtime of crucial sampling and analytical equipment caused by component failures. The maintenance program should establish the following:

- Maintenance responsibilities
- Maintenance schedules
- An adequate inventory of critical spare parts and equipment

## 8.1 Maintenance Responsibilities

Laboratory instrument maintenance is the responsibility of the participating laboratory. Generally, the laboratory manager or supervisor is responsible for the instruments in their work areas; they will establish maintenance procedures and schedules for each instrument. Laboratories should maintain service agreements with instrument manufacturers or a reputable service company to minimize downtime if there is an instrument malfunction.

Maintenance responsibilities for field equipment are assigned to the field team leader for specific sampling tasks. However, the field team using the equipment is responsible for checking the status of the equipment prior to use and reporting any problems encountered. The field team is also responsible for ensuring that critical spare parts are included as part of the field equipment checklist. Nonoperational field equipment should be removed from service and a replacement obtained. All field instruments will be properly protected against inclement weather conditions during the field investigation.

## 8.2 Maintenance Schedules

The effectiveness of any maintenance program depends, to a large extent, on adherence to specific maintenance schedules for each piece of equipment. Nonroutine maintenance activities are conducted as needed. Manufacturers' recommendations should provide the primary basis for establishing maintenance schedules. Service contracts may be used to implement maintenance schedules.

Each analytical instrument should be assigned an instrument logbook; all maintenance activities for will be the documented instrument in the logbook. Logbooks should contain the following information:

- Date of service
- Person performing the service
- Type of service performed and the reason for service
- Replacement parts installed, if appropriate
- Date of next scheduled service
- Any other useful information

## 8.3 Spare Parts

An adequate inventory of spare parts is required to minimize equipment down time. The inventory will include the following:

- Parts and supplies that are subject to frequent failure
- Parts and supplies that have limited useful lifetimes
- Parts and supplies that cannot be obtained in a timely manner should failure occur

Field managers and laboratory managers are responsible for maintaining an adequate inventory of spare parts. In addition to spare parts and supply inventories, an in-house source of backup equipment and instrumentation should be available.

## **Data Assessment**

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### **9.1 Data Quality Assessment**

All laboratory data will be evaluated according to the QA acceptance criteria specified in Tables 5-3 through 5-15 and Appendix A. Limitations regarding data usability will be assigned, if appropriate, in accordance with the validation process described in Section 7. Field data will be evaluated according to the appropriate SOP.

### **9.2 Reconciliation with Project Objectives**

The PG&E Program includes projects and sites with varying tasks and objectives. The procedure for data reconciliation will be a function of the project-specific objectives and will be addressed in the project-specific documents.



## Corrective Action

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Corrective action may be required as a result of deviations from field or analytical procedures. Deficiencies identified in audits and data quality evaluations may also call for corrective action. All project personnel have the responsibility to identify, report, and solicit approval for corrective actions to resolve conditions that are adverse to data quality.

Tables 5-3 through 5-15 specify the corrective actions to be taken when deviations from calibration and QC acceptance criteria occur. Field and laboratory staff may encounter conditions requiring immediate corrective action that are not addressed in this QAPP, the SAPs, or QAPP addenda. These staff will document conditions and the results of corrective actions in a field logbook or laboratory nonconformance report and communicate their actions as soon as feasible to the appropriate people (field team leader, laboratory supervisor, project chemist, project manager, and if necessary, the PG&E Program quality manager) for immediate input. A mechanism must be in place to allow for supervisory review or client input, or both, for all deviations or deficiencies. A corrective action reporting system that requires immediate documentation of deviations or deficiencies and for supervisory review of the actions taken to correct them will be established. At a minimum, the corrective action report should include the following information:

- The type of deviation or deficiency
- The date of occurrence
- The impact of the deviation or deficiency, such as samples affected
- The corrective action taken
- Documentation that the process has been returned to control

The only time that a corrective action report may be waived is when a deviation or deficiency is immediately corrected and its impact is precluded. An example would be an unacceptable ICAL that is repeated before samples are analyzed.

Each corrective action report must be reviewed and approved by a person of authority, such as the field team leader or laboratory supervisor. The ultimate responsibility for the laboratory corrective action process is the QC manager, who must ensure that proper documentation, approval, and close out of all out-of-control or nonconformance events is performed. A nonconformance report will summarize each nonconformance condition. Corrective action reports that could potentially affect data quality must be brought to the attention of the project chemist. Report disposition will be the responsibility of the project chemist. The project manager may be notified about a particular report at the project chemist's discretion. Copies of corrective action reports must be maintained in the laboratory or field project files.

## SECTION 11

# Quality Assurance Reports

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Where specified in the SAP, work plan, or QAPP addendum, a QA report or data quality evaluation will be submitted by the project chemist to the project manager on a predetermined interval established in the SAP or QAPP addendum. The report will summarize the results of the data validation and the data assessment. The results should be presented in a manner that facilitates decision making. For example, temporal data may be more effectively presented if supplemented by a time plot. Any significant quality problems and recommended solutions should be included in the report. Limitations on data usability identified during data validation should be highlighted. Results of the data assessment should be reconciled with the project objectives.

# Data Management

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Electronic data associated with CH2M Hill projects will be used to generate validation reports, risk assessment calculations, modeling results, data summary tables, maps, and other figures. The data management will follow CH2M HILL standard procedures for environmental data collection. Other consultants or contractors may use other electronic data management programs, which will be described in the SAP or QAPP addendum. However, any system used must be capable of storing and managing the information as follows:

- Simple procedures to get rapid access to stored data
- Data entry methods of known accuracy and efficiency
- Well-documented validation procedures for electronic databases
- Sampling data management using unique sample IDs
- A sampling inventory of newly collected data and methods of sample inventory reconciliation
- Sample-specific attributes, including location IDs, sample type and media, and sample date
- Reporting and delivery formats to support data analysis and reduction

## 12.1 Archiving

Hardcopy and electronic versions will be archived in project files and on electronic archive tapes for the duration of the project, as specified in contractual agreements, or for a minimum of 5 years. All electronic data will be subject to routine back-up until it is archived for long-term retention.

## 12.2 Data Flow and Transfer

The data flow from the laboratory and field to the project staff and data users will be sufficiently documented to ensure that data are properly tracked, reviewed, and validated.

## 12.3 Record Keeping

In addition to the data management procedures for analytical data provided in Section 6.1, the laboratory will maintain electronic and hardcopy records sufficient to re-create each analytical event. At a minimum, laboratory will maintain the following records:

- Raw data, including instrument printouts, bench work sheets, and chromatograms, with compound identification and quantitation reports
- Laboratory-specific, written SOPs for each analytical method and QA/QC function implemental during the analysis of project samples

## SECTION 13

# References

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## **Appendix A**

### **Reporting Limits, Accuracy, and Precession Limits**

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Table A-1  
Reporting Limits, Accuracy, and Precession Limits for Soil  
PG&E Program Quality Assurance Project Plan

Method	Constituent	CAS	Units	QAPP RL	EPA Regional Screening Levels - May 2012		EPA Regional Screening Levels - 2008		DTSC CHHSL		Most Stringent Screening Level <sup>1</sup>	Does RL Exceed Screening Level?	LCS Accuracy Control Limits (%R)		MS/MSD Accuracy Control Limits (%R)		Precision Soil
					Residential	Commercial	Residential	Commercial	Residential	Commercial			Lower Limit	Upper Limit	Lower Limit	Upper Limit	
SW 9012 or SW 9014	Cyanide	57-12-5	mg/kg	0.25	47	610	1,600	20,000	--	--	0,047	NO	*	*	*	*	30
Walkley-Black	Total organic carbon	TOC	mg/kg	50	--	--	--	--	--	--	--	NO	75	125	75	125	35
SW 9050	Specific conductance	Conductance	µmhos/cm	5	--	--	--	--	--	--	--	NO	75	125	75	125	20
SW 9045	pH	pH units	pH units	0.1	--	--	--	--	--	--	--	NO	--	--	--	--	20
SM 2540 B/EPA 160.3	percent moisture	Moist	Percent	--	--	--	--	--	--	--	--	NO	--	--	--	--	20
EPA 300.0	Fluoride	Fluoride	mg/kg	2	--	--	4,700	61,000	--	--	4,700	NO	70	130	70	130	35
EPA 300.0	Chloride	Chloride	mg/kg	2	--	--	--	--	--	--	--	NO	70	130	70	130	35
EPA 300.0	Sulfate	Sulfate	mg/kg	2	--	--	--	--	--	--	--	NO	70	130	70	130	35
EPA 821/R-91-100	Sulfide, acid volatile	18496-25-8	mg/kg	80	--	--	--	--	--	--	--	NO	70	130	70	130	30
SW 7199	Chromium, hexavalent	18540-29-9	mg/kg	0.4	0.29	5.6	230	1,400	17	17	0.29	YES	85	115	85	115	20
SW 6010B or C/SW 6020A/EPA 200.7/EPA 200.8	Aluminum	7429-90-5	mg/kg	10	77,000	990,000	77,000	990,000	--	--	77,000	NO	85	115	75	125	20
SW 6010B or C/SW 6020A/EPA 200.7/EPA 200.8	Antimony	7440-36-0	mg/kg	2	31	410	31	410	30	380	30	NO	85	115	75	125	20
SW 6010B or C/SW 6020A/EPA 200.7/EPA 200.8	Arsenic	7440-38-2	mg/kg	0.5	0.39	1.6	0.39	1.6	0.07	0.42	0.07	YES	85	115	75	125	20
SW 6010B or C/SW 6020A/EPA 200.7/EPA 200.8	Barium	7440-39-3	mg/kg	1	15,000	190,000	15,000	190,000	5,200	63,000	5,200	NO	85	115	75	125	20
SW 6010B or C/SW 6020A/EPA 200.7/EPA 200.8	Beryllium	7440-41-7	mg/kg	0.5	160	2,000	160	2,000	150	1,700	150	NO	85	115	75	125	20
SW 6010B or C/SW 6020A/EPA 200.7/EPA 200.8	Cadmium	7440-43-9	mg/kg	0.5	70	800	70	810	1.7	7.5	1.7	NO	85	115	75	125	20
SW 6010B or C/EPA 200.7	Calcium	7440-70-2	mg/kg	100	--	--	--	--	--	--	--	NO	85	115	75	125	20
SW 6010B or C/SW 6020A/EPA 200.7/EPA 200.8	Chromium	7440-47-3	mg/kg	1	--	--	280	1,400	*	*	280	NO	85	115	75	125	20
SW 6010B or C/SW 6020A/EPA 200.7/EPA 200.8	Cobalt	7440-48-4	mg/kg	1	23	300	23	300	660	3,200	23	NO	85	115	75	125	20
SW 6010B or C/SW 6020A/EPA 200.7/EPA 200.8	Copper	7440-50-8	mg/kg	1	3,100	41,000	3,100	41,000	3,000	38,000	3,000	NO	85	115	75	125	20
SW 6010B or C/EPA 200.7	Iron	7439-89-6	mg/kg	10	55,000	720,000	55,000	720,000	--	--	55,000	NO	85	115	75	125	20
SW 6010B or C/SW 6020A/EPA 200.7/EPA 200.8	Lead	7439-92-1	mg/kg	1	400	800	400	800	150	3,500	150	NO	85	115	75	125	20
SW 6010B or C/EPA 200.7	Magnesium	7439-95-4	mg/kg	100	--	--	--	--	--	--	--	NO	85	115	75	125	20
SW 6010B or C/SW 6020A/EPA 200.7/EPA 200.8	Manganese	7439-96-5	mg/kg	1	--	--	1,800	23,000	--	--	1,800	NO	85	115	75	125	20
SW 7471A/EPA 245.5	Mercury	7439-97-6	mg/kg	0.1	10	43	6.7	28	18	180	6.7	NO	75	125	75	125	20
SW 6010B or C/SW 6020A/EPA 200.7/EPA 200.8	Molybdenum	7439-98-7	mg/kg	1	390	5,100	390	5,100	380	4,800	380	NO	85	115	75	125	20
SW 6010B or C/SW 6020A/EPA 200.7/EPA 200.8	Nickel	7440-02-0	mg/kg	1	1,500	20,000	1,600	20,000	1,600	16,000	1,500	NO	85	115	75	125	20
SW 6010B or C/EPA 200.7	Potassium	7440-09-1	mg/kg	100	--	--	--	--	--	--	--	NO	85	115	75	125	20
SW 6010B or C/SW 6020A/EPA 200.7/EPA 200.8	Selenium	7782-49-2	mg/kg	1	390	5,100	390	5,100	380	4,800	380	NO	85	115	75	125	20
SW 6010B or C/SW 6020A/EPA 200.7/EPA 200.8	Silver	7440-22-4	mg/kg	1	390	5,100	390	5,100	380	4,800	380	NO	85	115	75	125	20
SW 6010B or C/EPA 200.7	Sodium	7440-23-5	mg/kg	100	--	--	--	--	--	--	--	NO	85	115	75	125	20
SW 6010B or C/SW 6020A/EPA 200.7/EPA 200.8	Thallium	7440-28-0	mg/kg	2	0.78	10	5.1	66	5	63	0.78	YES	85	115	75	125	20
SW 6010B or C/SW 6020A/EPA 200.7/EPA 200.8	Vanadium	7440-62-2	mg/kg	1	--	--	550	7,200	530	6,700	530	NO	85	115	75	125	20
SW 6010B or C/SW 6020A/EPA 200.7/EPA 200.8	Zinc	7440-66-6	mg/kg	2	23,000	310,000	23,000	310,000	23,000	100,000	23,000	NO	85	115	75	125	20
SW 8015B or C or D	Motor Oil	TPH-motor oil	mg/kg	10	--	--	--	--	--	--	--	NO	60	120	60	120	50
SW 8015B or C or D	TPH-Diesel	TPH-diesel	mg/kg	10	--	--	--	--	--	--	--	NO	51	153	51	153	50
SW 8015B or C or D	TPH-Gasoline	TPH-gasoline	mg/kg	1	--	--	--	--	--	--	--	NO	57	146	57	146	50
SW 8081A or B	4,4'-DDD	72-54-8	ug/kg	4	2,000	7,200	2,000	7,200	2,300	9,000	2,000	NO	50	139	50	139	50
SW 8081A or B	4,4'-DDE	72-55-9	ug/kg	4	1,400	5,100	1,400	5,100	1,600	6,300	1,400	NO	68	126	68	126	50
SW 8081A or B	4,4'-DDT	50-29-3	ug/kg	4	1,700	7,000	1,700	7,000	1,600	6,300	1,600	NO	46	135	46	135	50
SW 8081A or B	Aldrin	309-00-2	ug/kg	4	29	100	29	100	33	130	29	NO	47	120	47	120	50
SW 8081A or B	alpha-HCH	319-84-6	ug/kg	4	77	270	77	270	--	--	77	NO	62	125	62	125	50
SW 8081A or B	alpha-Chlordane	5103-71-9	ug/kg	4	--	--	--	--	430	1,700	430	NO	63	121	63	121	50
SW 8081A or B	beta-HCH	319-85-7	ug/kg	4	270	960	320	1,300	--	--	270	NO	62	127	62	127	50
SW 8081A or B	delta-HCH	319-86-8	ug/kg	4	--	--	--	--	--	--	--	NO	57	130	57	130	50
SW 8081A or B	Dieldrin	60-57-1	ug/kg	4	30	110	30	110	35	130	30	NO	67	125	67	125	50
SW 8081A or B	Endosulfan I	959-98-8	ug/kg	4	--	--	--	--	--	--	--	NO	41	147	41	147	50
SW 8081A or B	Endosulfan II	33213-65-9	ug/kg	4	--	--	--	--	--	--	--	NO	37	141	37	141	50
SW 8081A or B	Endosulfan sulfate	1031-07-8	ug/kg	4	--	--	--	--	--	--	--	NO	62	135	62	135	50
SW 8081A or B	Endrin	72-20-8	ug/kg	4	18,000	180,000	18,000	180,000	21,000	230,000	18,000	NO	61	133	61	133	50
SW 8081A or B	Endrin aldehyde	7421-93-4	ug/kg	4	--	--	--	--	--	--	--	NO	37	147	37	147	50
SW 8081A or B	gamma-HCH (Lindane)	58-89-9	ug/kg	4	520	2,100	520	21,000	500	2,000	500	NO	59	123	59	123	50
SW 8081A or B	gamma-Chlordane	5103-74-2	ug/kg	4	--	--	--	--	430	1,700	430	NO	48	124	48	124	50
SW 8081A or B	Heptachlor	76-44-8	ug/kg	4	110	380	110	380	130	520	110	NO	51	140	51	140	50
SW 8081A or B	Heptachlor epoxide	1024-57-3	ug/kg	4	53	190	53	190	--	--	53	NO	66	130	66	130	50
SW 8081A or B	Methoxychlor	72-43-5	ug/kg	20	310,000	3,100,000	310,000	3,100,000	340,000	3,800,000	310,000	NO	57	143	57	143	50
SW 8081A or B	Toxaphene	8001-35-2	ug/kg	100	440	1,600	440	1,600	460	1,800	440	NO	31	136	31	136	50
SW 8082 or A	Aroclor-1016	12674-11-2	ug/kg	50	3,900	21,000	3,900	21,200	--	--	3,900	NO	41	138	41	138	50
SW 8082 or A	Aroclor-1221	11104-28-2	ug/kg	50	140	540	170	620	--	--	140	NO	45	136	45	136	50
SW 8082 or A	Aroclor-1232	11141-16-5	ug/kg	50	140	540	170	620	--	--	140	NO	4				

Table A-1  
Reporting Limits, Accuracy, and Precession Limits for Soil  
PG&E Program Quality Assurance Project Plan

Method	Constituent	CAS	Units	QAPP RL	EPA Regional Screening Levels - May 2012		EPA Regional Screening Levels - 2008		DTSC CHHSL		Most Stringent Screening Level <sup>1</sup>	Does RL Exceed Screening Level?	LCS Accuracy Control Limits (%R)		MS/MSD Accuracy Control Limits (%R)		Precision Soil
					Residential	Commercial	Residential	Commercial	Residential	Commercial			Lower Limit	Upper Limit	Lower Limit	Upper Limit	% RPD
SW 8151A	2,4-DB	94-82-6	ug/kg	500	490,000	4,900,000	490	4,900	--	--	490	YES	42	145	42	145	50
SW 8151A	2,4,5-T	93-76-5	ug/kg	500	610,000	6,200,000	610	6,200	7,700	6,100	610	NO	43	139	43	139	50
SW 8151A	2,4,5-TP	93-72-1	ug/kg	200	490,000	4,900,000	490	4,900	--	--	490	NO	46	128	46	128	50
SW 8151A	Dalapon	75-99-0	ug/kg	100	1,800,000	18,000,000	1,800	18,000	--	--	1,800	NO	22	125	22	125	50
SW 8151A	Dicamba	1918-00-9	ug/kg	500	1,800,000	18,000,000	1,800	18,000	--	--	1,800	NO	56	120	56	120	50
SW 8151A	Dichloroprop	120-36-5	ug/kg	500	--	--	--	--	--	--	--	NO	72	142	72	142	50
SW 8151A	Dinoseb	88-85-7	ug/kg	100	61,000	620,000	61	620	--	--	61	YES	20	131	20	131	50
SW 8151A	MCPA	94-74-6	ug/kg	1,000	31,000	310,000	31	310	--	--	31	YES	65	120	65	120	50
SW 8151A	MCPP	7085-19-0	ug/kg	1,500	--	--	61	620	--	--	61	YES	60	118	60	118	50
SW 8260B or C	1,1,1,2-Tetrachloroethane	630-20-6	ug/kg	5	1,900	9,300	2,000	9,800	--	--	1,900	NO	74	125	74	125	30
SW 8260B or C	1,1,1-Trichloroethane (TCA)	71-55-6	ug/kg	5	8,700,000	38,000,000	9,000,000	39,000,000	--	--	8,700,000	NO	68	130	68	130	30
SW 8260B or C	1,1,2,2-Tetrachloroethane	79-34-5	ug/kg	5	560	2,800	590	2,900	--	--	560	NO	59	140	59	140	30
SW 8260B or C	1,1,2-Trichloroethane	79-00-5	ug/kg	5	1,100	5,300	1,100	5,500	--	--	1,100	NO	62	127	62	127	30
SW 8260B or C	1,1,2-Trichlorotrifluoroethane (Freon 113)	76-13-1	ug/kg	5	43,000,000	180,000,000	43,000,000	180,000,000	--	--	43,000,000	NO	65	135	65	135	30
SW 8260B or C	1,1-Dichloroethane	75-34-3	ug/kg	5	3,300	17,000	3,400	17,000	--	--	3,300	NO	73	125	73	125	30
SW 8260B or C	1,1-Dichloroethylene	75-35-4	ug/kg	5	240,000	1,100,000	250,000	1,100,000	--	--	240,000	NO	65	136	65	136	30
SW 8260B or C	1,1-Dichloropropene	563-58-6	ug/kg	5	--	--	--	--	--	--	--	NO	70	135	70	135	30
SW 8260B or C	1,2,3-Trichlorobenzene	87-61-6	ug/kg	5	49,000	490,000	--	--	--	--	49,000	NO	62	133	62	133	30
SW 8260B or C	1,2,3-Trichloropropane	96-18-4	ug/kg	5	5	95	91	410	--	--	5	NO	63	130	63	130	30
SW 8260B or C	1,2,4-Trichlorobenzene	120-82-1	ug/kg	5	22,000	99,000	87,000	400,000	--	--	22,000	NO	65	131	65	131	30
SW 8260B or C	1,2,4-Trimethylbenzene	95-63-6	ug/kg	5	62,000	260,000	67,000	280,000	--	--	62,000	NO	65	135	65	135	30
SW 8260B or C	1,2-Dibromo-3-chloropropane	96-12-8	ug/kg	5	5.4	69	5.6	73	--	--	5.4	NO	49	135	49	135	30
SW 8260B or C	1,2-Dibromoethane (EDB)	106-93-4	ug/kg	5	34	170	34	170	--	--	34	NO	70	124	70	124	30
SW 8260B or C	1,2-Dichlorobenzene	95-50-1	ug/kg	5	1,900,000	9,800,000	2,000,000	10,000,000	--	--	1,900,000	NO	74	120	74	120	30
SW 8260B or C	1,2-Dichloroethane (EDC)	107-06-2	ug/kg	5	430	2,200	450	2,200	--	--	430	NO	72	137	72	137	30
SW 8260B or C	1,2-Dichloropropane	78-87-5	ug/kg	5	940	4,700	930	4,700	--	--	930	NO	71	120	71	120	30
SW 8260B or C	1,3,5-Trimethylbenzene	108-67-8	ug/kg	5	780,000	10,000,000	47,000	200,000	--	--	47,000	NO	65	133	65	133	30
SW 8260B or C	1,3-Dichlorobenzene	541-73-1	ug/kg	5	--	--	--	--	--	--	--	NO	72	124	72	124	30
SW 8260B or C	1,3-Dichloropropane	142-28-9	ug/kg	5	1,600,000	20,000,000	1,600,000	20,000,000	--	--	1,600,000	NO	76	123	76	123	30
SW 8260B or C	1,4-Dichlorobenzene	106-46-7	ug/kg	5	2,400	12,000	2,600	13,000	--	--	2,400	NO	72	125	72	125	30
SW 8260B or C	2,2-Dichloropropane	594-20-7	ug/kg	5	--	--	--	--	--	--	--	NO	67	134	67	134	30
SW 8260B or C	2-Butanone (MEK)	78-93-3	ug/kg	50	28,000,000	200,000,000	28,000,000	190,000,000	--	--	28,000,000	NO	40	135	40	135	30
SW 8260B or C	2-Chlorotoluene	95-49-8	ug/kg	5	1,600,000	20,000,000	1,600,000	20,000,000	--	--	1,600,000	NO	69	128	69	128	30
SW 8260B or C	4-Chlorotoluene	106-43-4	ug/kg	5	1,600,000	20,000,000	5,500,000	72,000,000	--	--	1,600,000	NO	73	126	73	126	30
SW 8260B or C	4-Isopropyltoluene	99-87-6	ug/kg	6	--	--	--	--	--	--	--	NO	75	133	75	133	30
SW 8260B or C	4-Methyl-2-pentanone	108-10-1	ug/kg	50	5,300,000	53,000,000	5,300,000	52,000,000	--	--	5,300,000	NO	65	135	65	135	30
SW 8260B or C	Acetone	67-64-1	ug/kg	50	61,000,000	630,000,000	61,000,000	610,000,000	--	--	61,000,000	NO	40	141	40	141	30
SW 8260B or C	Acrolein	107-02-8	ug/kg	100	150	650	160	680	--	--	150	NO	65	135	65	135	30
SW 8260B or C	Acrylonitrile	107-13-1	ug/kg	50	240	1,200	240	1,200	--	--	240	NO	65	135	65	135	30
SW 8260B or C	Benzene	71-43-2	ug/kg	5	1,100	5,400	1,100	5,600	--	--	1,100	NO	73	126	73	126	30
SW 8260B or C	Bromobenzene	108-86-1	ug/kg	5	300,000	1,800,000	94,000	410,000	--	--	94,000	NO	66	121	66	121	30
SW 8260B or C	Bromochloromethane	74-97-5	ug/kg	5	160,000	680,000	--	--	--	--	160,000	NO	71	127	71	127	30
SW 8260B or C	Bromodichloromethane	75-27-4	ug/kg	5	270	1,400	10,000	46,000	--	--	0,270	NO	72	128	72	128	30
SW 8260B or C	Bromoform	75-25-2	ug/kg	6	62,000	220,000	61,000	220,000	--	--	61,000	NO	66	137	66	137	30
SW 8260B or C	Bromomethane	74-83-9	ug/kg	5	7,300	32,000	7,900	35,000	--	--	7,300	NO	45	141	45	141	30
SW 8260B or C	Carbon disulfide	75-15-0	ug/kg	5	820,000	3,700,000	670,000	3,000,000	--	--	670,000	NO	65	135	65	135	30
SW 8260B or C	Carbon tetrachloride	56-23-5	ug/kg	5	610	3,000	250	1,300	--	--	250	NO	67	133	67	133	30
SW 8260B or C	Chlorobenzene	108-90-7	ug/kg	5	290,000	1,400,000	310,000	1,500,000	--	--	290,000	NO	75	123	75	123	30
SW 8260B or C	Chloroethane	75-00-3	ug/kg	5	15,000,000	61,000,000	15,000,000	62,000,000	--	--	15,000,000	NO	41	141	41	141	30
SW 8260B or C	Chloroform	67-66-3	ug/kg	2	290	1,500	300	1,500	--	--	290	NO	72	124	72	124	30
SW 8260B or C	Chloromethane	74-87-3	ug/kg	5	120,000	500,000	1,700	8,400	--	--	1,700	NO	51	129	51	129	30
SW 8260B or C	cis-1,2-Dichloroethene	156-59-2	ug/kg	5	160,000	2,000,000	780,000	10,000,000	--	--	160,000	NO	67	125	67	125	30
SW 8260B or C	cis-1,3-Dichloropropene	10061-01-5	ug/kg	5	--	--	--	--	--	--	--	NO	72	126	72	126	30
SW 8260B or C	Dibromochloromethane	124-48-1	ug/kg	5	680	3,300	5,800	21,000	--	--	0,680	NO	66	130	66	130	30
SW 8260B or C	Dibromomethane	74-95-3	ug/kg	5	25,000	110,000	780,000	10,000,000	--	--							



Table A-1  
Reporting Limits, Accuracy, and Precession Limits for Soil  
PG&E Program Quality Assurance Project Plan

Method	Constituent	CAS	Units	QAPP RL	EPA Regional Screening Levels - May 2012		EPA Regional Screening Levels - 2008		DTSC CHHSL		Most Stringent Screening Level <sup>1</sup>	Does RL Exceed Screening Level?	LCS Accuracy Control Limits (%R)		MS/MSD Accuracy Control Limits (%R)		Precision Soil
					Residential	Commercial	Residential	Commercial	Residential	Commercial			Lower Limit	Upper Limit	Lower Limit	Upper Limit	% RPD
SW 8260B or C	tert-Butylbenzene	98-06-6	ug/kg	5	--	--	--	--	--	--	--	NO	65	132	65	132	30
SW 8260B or C	Tetrachloroethene	127-18-4	ug/kg	5	22,000	110,000	570	2,700	--	--	570	NO	67	139	67	139	30
SW 8260B or C	Toluene	108-88-3	ug/kg	5	5,000,000	45,000,000	5,000,000	46,000,000	--	--	5,000,000	NO	71	127	71	127	30
SW 8260B or C	trans-1,2-Dichloroethene	156-60-5	ug/kg	5	150,000	690,000	110,000	500,000	--	--	110,000	NO	66	134	66	134	30
SW 8260B or C	trans-1,3-Dichloropropene	10061-02-6	ug/kg	5	--	--	--	--	--	--	--	NO	65	127	65	127	30
SW 8260B or C	Trichloroethene	79-01-6	ug/kg	5	910	6,400	2,800	14,000	--	--	0,910	NO	77	124	77	124	30
SW 8260B or C	Trichlorofluoromethane (Freon 11)	75-69-4	ug/kg	5	790,000	3,400,000	800,000	3,400,000	--	--	790,000	NO	49	139	49	139	30
SW 8260B or C	Vinyl Chloride	75-01-4	ug/kg	5	60	1,700	60	1,700	--	--	60	NO	58	126	58	126	30
SW 8260B or C	Xylenes, Total	1330-20-7	ug/kg	15	630,000	2,700,000	600,000	2,600,000	--	--	600,000	NO	65	125	65	125	50
SW 8260B or C	m-Xylene	108-38-3	ug/kg	10	590,000	2,500,000	4,500,000	19,000,000	--	--	590,000	NO	79	126	79	126	30
SW 8260B or C	p-Xylene	106-42-3	ug/kg	10	600,000	2,600,000	4,700,000	20,000,000	--	--	600,000	NO	79	126	79	126	30
SW 8260B or C	o-Xylene	95-47-6	ug/kg	5	690,000	3,000,000	5,300,000	23,000,000	--	--	690,000	NO	77	125	77	125	30
SW 8270C or D	1,2,4-Trichlorobenzene	120-82-1	ug/kg	330	22,000	99,000	87,000	400,000	--	--	22,000	NO	44	125	44	125	30
SW 8270C or D	1,2-Dichlorobenzene	95-50-1	ug/kg	330	1,900,000	9,800,000	2,000,000	10,000,000	--	--	1,900,000	NO	45	125	45	125	30
SW 8270C or D	1,3-Dichlorobenzene	541-73-1	ug/kg	330	--	--	--	--	--	--	--	NO	39	125	39	125	30
SW 8270C or D	1,4-Dichlorobenzene	106-46-7	ug/kg	330	2,400	12,000	2,600	13,000	--	--	2,400	NO	35	125	35	125	30
SW 8270C or D	2,4,5-Trichlorophenol	95-95-4	ug/kg	700	6,100,000	62,000,000	6,100,000	62,000,000	--	--	6,100,000	NO	49	125	49	125	30
SW 8270C or D	2,4,6-Trichlorophenol	88-06-2	ug/kg	330	44,000	160,000	44,000	160,000	--	--	44,000	NO	43	125	43	125	30
SW 8270C or D	2,4-Dichlorophenol	120-83-2	ug/kg	330	180,000	1,800,000	180,000	1,800,000	--	--	180,000	NO	45	125	45	125	30
SW 8270C or D	2,4-Dimethylphenol	105-67-9	ug/kg	330	1,200,000	12,000,000	1,200,000	12,000,000	--	--	1,200,000	NO	32	125	32	125	30
SW 8270C or D	2,4-Dinitrophenol	51-28-5	ug/kg	700	120,000	1,200,000	120,000	1,200,000	--	--	120,000	NO	25	132	25	132	30
SW 8270C or D	2,4-Dinitrotoluene	121-14-2	ug/kg	330	1,600	5,500	120,000	1,200,000	--	--	1,600	NO	48	125	48	125	30
SW 8270C or D	2,6-Dinitrotoluene	606-20-2	ug/kg	330	61,000	620,000	61,000	620,000	--	--	61,000	NO	48	125	48	125	30
SW 8270C or D	2-Chloronaphthalene	91-58-7	ug/kg	330	6,300,000	82,000,000	6,300,000	82,000,000	--	--	6,300,000	NO	45	125	45	125	30
SW 8270C or D	2-Chlorophenol	95-57-8	ug/kg	330	390,000	5,100,000	390,000	5,100,000	--	--	390,000	NO	44	125	44	125	30
SW 8270C or D	2-Methylnaphthalene	91-57-6	ug/kg	330	230,000	2,200,000	310,000	4,100,000	--	--	230,000	NO	47	125	47	125	30
SW 8270C or D	2-Methylphenol (o-Cresol)	95-48-7	ug/kg	330	3,100,000	31,000,000	3,100,000	31,000,000	--	--	3,100,000	NO	40	125	40	125	30
SW 8270C or D	2-Nitroaniline	88-74-4	ug/kg	700	610,000	6,000,000	--	--	--	--	610,000	NO	44	125	44	125	30
SW 8270C or D	2-Nitrophenol	88-75-5	ug/kg	700	--	--	--	--	--	--	--	NO	42	125	42	125	30
SW 8270C or D	3,3'-Dichlorobenzidine	91-94-1	ug/kg	1,300	1,100	3,800	1,100	3,800	--	--	1,100	YES	25	128	25	128	30
SW 8270C or D	3-Nitroaniline	99-09-2	ug/kg	700	--	--	18,000	82,000	--	--	18,000	NO	27	125	27	125	30
SW 8270C or D	4,6-Dinitro-2-methylphenol	534-52-1	ug/kg	1600	4,900	49,000	6,100	62,000	--	--	4,900	NO	29	137	29	137	30
SW 8270C or D	4-Bromophenyl phenyl ether	101-55-3	ug/kg	330	--	--	--	--	--	--	--	NO	46	125	46	125	30
SW 8270C or D	4-Chloro-3-methylphenol	59-50-7	ug/kg	600	6,100,000	62,000,000	--	--	--	--	6,100,000	NO	46	125	46	125	30
SW 8270C or D	4-Chloroaniline	106-47-8	ug/kg	700	2,400	8,600	9,000	32,000	--	--	2,400	NO	10	125	10	125	30
SW 8270C or D	4-Chlorophenyl phenyl ether	7005-72-3	ug/kg	330	--	--	--	--	--	--	--	NO	47	125	47	125	30
SW 8270C or D	4-Methylphenol (p-Cresol)	106-44-5	ug/kg	330	6,100,000	62,000,000	310,000	3,100,000	--	--	310,000	NO	41	125	41	125	30
SW 8270C or D	4-Nitroaniline	100-01-6	ug/kg	700	24,000	86,000	23,000	82,000	--	--	23,000	NO	34	125	34	125	30
SW 8270C or D	4-Nitrophenol	100-02-7	ug/kg	700	--	--	--	--	--	--	--	NO	25	138	25	138	30
SW 8270C or D	Acenaphthene	83-32-9	ug/kg	330	3,400,000	33,000,000	3,400,000	33,000,000	--	--	3,400,000	NO	46	125	46	125	30
SW 8270C or D	Acenaphthylene	208-96-8	ug/kg	330	--	--	--	--	--	--	--	NO	44	125	44	125	30
SW 8270C or D	Anthracene	120-12-7	ug/kg	330	17,000,000	170,000,000	17,000,000	170,000,000	--	--	17,000,000	NO	53	125	53	125	30
SW 8270C or D	Benzo (a) anthracene	56-55-3	ug/kg	330	150	2,100	150	2,100	--	--	150	YES	52	125	52	125	30
SW 8270C or D	Benzo (a) pyrene	50-32-8	ug/kg	330	15	210	15	210	38	130	15	YES	50	125	50	125	30
SW 8270C or D	Benzo (b) fluoranthene	205-99-2	ug/kg	330	150	2,100	150	2,100	--	--	150	YES	45	125	45	125	30
SW 8270C or D	Benzo (g,h,i) perylene	191-24-2	ug/kg	330	--	--	--	--	--	--	--	NO	38	126	38	126	30
SW 8270C or D	Benzo (k) fluoranthene	207-08-9	ug/kg	330	1,500	21,000	1,500	21,000	--	--	1,500	NO	45	125	45	125	30
SW 8270C or D	Benzoic acid	65-85-0	ug/kg	5,000	240,000,000	2,500,000,000	240,000,000	2,500,000,000	--	--	240,000,000	NO	25	125	25	125	30
SW 8270C or D	Benzyl alcohol	100-51-6	ug/kg	330	6,100,000	62,000,000	31,000,000	310,000,000	--	--	6,100,000	NO	25	125	25	125	30
SW 8270C or D	bis (2-chloroethoxy) methane	111-91-1	ug/kg	330	180,000	1,800,000	180,000	1,800,000	--	--	180,000	NO	43	125	43	125	30
SW 8270C or D	bis (2-chloroethyl) ether	111-44-4	ug/kg	330	210	1,000	190	900	--	--	190	YES	38	125	38	125	30
SW 8270C or D	bis (2-chloroisopropyl) ether	108-60-1	ug/kg	330	4,600	22,000	3,500	17,000	--	--	3,500	NO	25	125	25	125	30
SW 8270C or D	bis (2-ethylhexyl) phthalate	117-81-7	ug/kg	330													

Table A-1  
Reporting Limits, Accuracy, and Precession Limits for Soil  
PG&E Program Quality Assurance Project Plan

Method	Constituent	CAS	Units	QAPP RL	EPA Regional Screening Levels - May 2012		EPA Regional Screening Levels - 2008		DTSC CHHSL		Most Stringent Screening Level <sup>1</sup>	Does RL Exceed Screening Level?	LCS Accuracy Control Limits (%R)		MS/MSD Accuracy Control Limits (%R)		Precision Soil
					Residential	Commercial	Residential	Commercial	Residential	Commercial			Lower Limit	Upper Limit	Lower Limit	Upper Limit	% RPD
SW 8270C or D	Indeno (1,2,3-c,d) pyrene	193-39-5	ug/kg	330	150	2,100	150	2,100	--	--	150	YES	38	125	38	125	30
SW 8270C or D	Isophorone	78-59-1	ug/kg	330	510,000	1,800,000	510,000	1,800,000	--	--	510,000	NO	43	125	43	125	30
SW 8270C or D	Naphthalene	91-20-3	ug/kg	330	3,600	18,000	3,900	20,000	--	--	3,600	NO	40	125	40	125	30
SW 8270C or D	Nitrobenzene	98-95-3	ug/kg	330	4,800	24,000	31,000	280,000	--	--	4,800	NO	41	125	41	125	30
SW 8270C or D	n-Nitrosodi-n-propylamine	621-64-7	ug/kg	330	69	250	69	250	--	--	69	YES	40	125	40	125	30
SW 8270C or D	n-Nitrosodiphenylamine	86-30-6	ug/kg	330	99,000	350,000	99,000	350,000	--	--	99,000	NO	49	125	49	125	30
SW 8270C or D	Pentachlorophenol	87-86-5	ug/kg	700	890	2,700	3,000	9,000	4,400	13,000	0,890	NO	25	125	25	125	30
SW 8270C or D	Phenanthrene	85-01-8	ug/kg	330	--	--	--	--	--	--	--	NO	50	125	50	125	30
SW 8270C or D	Phenol	108-95-2	ug/kg	330	18,000,000	180,000,000	18,000,000	180,000,000	--	--	18,000,000	NO	39	125	39	125	30
SW 8270C or D	Pyrene	129-00-0	ug/kg	330	1,700,000	17,000,000	1,700,000	17,000,000	--	--	1,700,000	NO	46	125	46	125	30
SW 8270SIM	1-methylnaphthalene	90-12-0	ug/kg	5	16,000	53,000	22,000	99,000	--	--	16,000	NO	30	111	30	111	30
SW 8270SIM	2-methylnaphthalene	91-57-6	ug/kg	5	230,000	2,200,000	310,000	4,100,000	--	--	230,000	NO	30	111	30	111	30
SW 8270SIM	Acenaphthene	83-32-9	ug/kg	5	3,400,000	33,000,000	3,400,000	33,000,000	--	--	3,400,000	NO	28	110	28	110	30
SW 8270SIM	Acenaphthylene	208-96-8	ug/kg	5	--	--	--	--	--	--	--	NO	23	126	23	126	30
SW 8270SIM	Anthracene	120-12-7	ug/kg	5	17,000,000	170,000,000	17,000,000	170,000,000	--	--	17,000,000	NO	28	136	28	136	30
SW 8270SIM	Benzo (a) anthracene	56-55-3	ug/kg	5	150	2,100	150	2,100	--	--	150	NO	31	146	31	146	30
SW 8270SIM	Benzo (a) pyrene	50-32-8	ug/kg	5	15	210	15	210	38	130	15	NO	28	128	28	128	30
SW 8270SIM	Benzo (b) fluoranthene	205-99-2	ug/kg	5	150	2,100	150	2,100	--	--	150	NO	30	139	30	139	30
SW 8270SIM	Benzo (g,h,i) perylene	191-24-2	ug/kg	5	--	--	--	--	--	--	--	NO	21	149	21	149	30
SW 8270SIM	Benzo (k) fluoranthene	207-08-9	ug/kg	5	1,500	21,000	1,500	21,000	--	--	1,500	NO	42	129	42	129	30
SW 8270SIM	Chrysene	218-01-9	ug/kg	5	15,000	210,000	15,000	210,000	--	--	15,000	NO	39	134	39	134	30
SW 8270SIM	Dibenzo (a,h) anthracene	53-70-3	ug/kg	5	15	210	15	210	--	--	15	NO	30	138	30	138	30
SW 8270SIM	Fluoranthene	206-44-0	ug/kg	5	2,300,000	22,000,000	2,300,000	22,000,000	--	--	2,300,000	NO	30	142	30	142	30
SW 8270SIM	Fluorene	86-73-7	ug/kg	5	2,300,000	22,000,000	2,300,000	22,000,000	--	--	2,300,000	NO	27	116	27	116	30
SW 8270SIM	Indeno (1,2,3-c,d) pyrene	193-39-5	ug/kg	5	150	2,100	150	2,100	--	--	150	NO	17	164	17	164	30
SW 8270SIM	Naphthalene	91-20-3	ug/kg	5	3,600	18,000	3,900	20,000	--	--	3,600	NO	29	106	29	106	30
SW 8270SIM	Phenanthrene	85-01-8	ug/kg	5	--	--	--	--	--	--	--	NO	32	127	32	127	30
SW 8270SIM	Pyrene	129-00-0	ug/kg	5	1,700,000	17,000,000	1,700,000	17,000,000	--	--	1,700,000	NO	28	130	28	130	30

Notes:

\*\*Please keep in mind, Screening Levels are constantly revised by the EPA. The appropriate Screening levels are specific to the project, the location, the agency providing oversight, and the overall Goals of the project.\*\*

mg/kg = milligrams per kilogram  
ug/kg = micrograms per kilogram  
µmhos/cm = micromhos per centimeter

All soil results (with the exception of Waste characterization) must be reported as dry weight  
SW 7199 soil analysis must be accompanied by a SW 3060A extraction  
PCB - LCS, MS, and MSD only require Aroclor-1016 and Aroclor-1260 spikes

<sup>1</sup> For soil, most stringent of:  
EPA Regional Screening Levels - 2008 and May 2012  
CHHSL = California Human Health Screening Levels, January 2005  
DTSC = California Department of Toxic Substance Control, January 2005

Table A-2  
Reporting Limits, Accuracy, and Precession Limits for Groundwater  
PG&E Program Quality Assurance Project Plan

Method	Constituent	CAS	Units	QAPP RL	EPA Regional	EPA Regional	Federal Drinking	California	Most Stringent	Does RL Exceed	LCS Accuracy Control		MS/MSD Accuracy		Precision
					Screening Levels	Screening Levels	Water Standards	Drinking Water			Limits (%R)		Control Limits (%R)		Water
					May 2012	2008	MCLs	MCLs			Lower	Upper	Lower	Upper	% RPD
EPA 300.0M	Acetate	64-19-7	mg/L	0.1	--	--	--	--	--	NO	75	125	75	125	20
SM 2320 B	Alkalinity	Alkalinity	mg/L	5	--	--	--	--	--	NO	85	115	75	125	20
SM 4500-NH3 B, C, D, E, or G	Ammonia (as N)	7664-41-7	mg/L	0.5	--	--	--	--	--	NO	85	115	75	125	20
SM 2320 B	Bicarbonate	Bicarbonate	mg/L	5	--	--	--	--	--	NO	85	115	75	125	20
SM 5210 B	BOD	BOD	mg/L	--	--	--	--	--	--	NO	--	--	--	--	10
EPA 300.0	Bromide	Bromide	mg/L	0.5	--	--	--	--	--	NO	90	110	80	120	20
EPA 300.0M	Butyrate	107-92-6	mg/L	0.1	--	--	--	--	--	NO	75	125	75	125	20
SM 4500-CO <sub>2</sub>	Carbon dioxide	124-38-9	mg/L	5	--	--	--	--	--	NO	--	--	--	--	20
SM 2320 B	Carbonate	Carbonate	mg/L	5	--	--	--	--	--	NO	85	115	75	125	20
EPA 300.0/SM 4500-Cl B, C, E, or D	Chloride	Chloride	mg/L	0.5	--	--	--	--	--	NO	90	110	80	120	20
SM 2120 E	Color	Color	Color unit	1	--	--	--	--	--	NO	90	110	90	110	20
SM 4500-CN	Cyanide	57-12-5	mg/L	0.01	--	--	--	--	--	NO	85	115	75	125	20
EPA 300.0/SM 4500-F B, C, D, or E	Fluoride	Fluoride	mg/L	0.5	--	2.2	4	--	2.2	NO	90	110	80	120	20
SM 2340 B or C	Hardness	Hardness	mg/L	2	--	--	--	--	--	NO	75	125	75	125	20
SM 2320 B	Hydroxide alkalinity	Hydroxide	mg/L	5	--	--	--	--	--	NO	85	115	75	125	20
EPA 300.0M	Lactate	50-21-5	mg/L	0.1	--	--	--	--	--	NO	75	125	75	125	20
EPA 300.0	Nitrate (as N)	14797-55-8	mg/L	0.5	25	58	10	--	10	NO	90	110	80	120	20
EPA 353.2/SM 4500-NO <sub>3</sub> E, F or H	Nitrate/nitrite (as N)	NO3NO2N	mg/L	0.5	--	--	--	--	--	NO	85	115	75	125	20
EPA 300.0/SM 4500-NO <sub>2</sub> B, F or E	Nitrite (as N)	14797-65-8	mg/L	0.5	--	3.7	1	--	1	NO	90	110	80	120	20
SM 5310 B, C, or D	Organic carbon	DOC/TOC	mg/L	0.3	--	--	--	--	--	NO	85	115	75	125	10
EPA 300.0/SM 4500-P E or F	Ortho phosphate	Ortho Phosphate	mg/L	0.02	--	--	--	--	--	NO	90	110	80	120	20
EPA 314.0	Perchlorate	Perchlorate	µg/L	4	--	26	--	--	26	NO	85	115	85	115	20
SM 4500-H+ B SW 9040	pH	pH units	0.1	--	--	--	--	--	--	NO	--	--	--	--	20
EPA 300.0M	Propionate	79-09-4	mg/L	0.1	--	--	--	--	--	NO	75	125	75	125	20
EPA 300.0M	Pyruvate	127-17-3	mg/L	0.1	--	--	--	--	--	NO	75	125	75	125	20
SM 4500-SiO <sub>2</sub> E	Reactive silica	7631-86-9	mg/L	1	--	--	--	--	--	NO	75	125	75	125	20
SM 4500-SiO <sub>2</sub> C	Silica	7631-86-9	mg/L	0.04	--	--	--	--	--	NO	75	125	75	125	20
SILICA_CALC	Soluble silica	7631-86-9	mg/L	0.04	--	--	--	--	--	NO	75	125	75	125	20
EPA 120.1/SW 9050	Specific conductance	Conductance	µmhos/cm	2	--	--	--	--	--	NO	85	115	75	125	20
EPA 300.0/SM 4110 B	Sulfate	Sulfate	mg/L	0.5	--	--	--	--	--	NO	90	110	80	120	20
SM 4500-S <sup>-2</sup> F, E, D, or G	Sulfide	Sulfide	mg/L	0.05	--	--	--	--	--	NO	75	125	75	125	20
SM 2540 C	Total dissolved solids	TDS	mg/L	10	--	--	--	--	--	NO	75	125	--	--	10
SM 4500-N <sub>org</sub> B or C	Total kjeldahl nitrogen	7727-37-9	mg/L	--	--	--	--	--	--	NO	75	125	75	125	20
EPA 365.1/EPA 365.3 SM 4500-P E or F	Total phosphorous	Total Phosphorous	mg/L	0.02	--	--	--	--	--	NO	75	125	75	125	20
SM 2540 D	Total suspended solids	TSS	mg/L	4	--	--	--	--	--	NO	75	125	75	125	10
EPA 180.1/SM 2130 B	Turbidity	TURB	NTU	0.1	--	--	--	--	--	NO	--	--	--	--	20
SW 6020A/EPA 200.8	Aluminum	7429-90-5	ug/L	50	16,000	37,000	50*	1,000	50	NO	85	115	75	125	20
SW 6020A/EPA 200.8	Antimony	7440-36-0	ug/L	2	6	15	6	--	6	NO	85	115	75	125	20
SW 6020A/EPA 200.8	Arsenic	7440-38-2	ug/L	0.5 (0.1)	0.045	0.045	10	--	0.045	YES	85	115	75	125	20
SW 6020A/EPA 200.8	Barium	7440-39-3	ug/L	2	2,900	7,300	2,000	1,000	1,000	NO	85	115	75	125	20
SW 6020A/EPA 200.8	Beryllium	7440-41-7	ug/L	0.5	16	73	4	--	4	NO	85	115	75	125	20
SW 6010B or C/SW 6020A/EPA 200.7/EPA 200.8	Boron	7440-42-8	ug/L	50	?	?	?	?	?	?	85	115	75	125	20
SW 6020A/EPA 200.8	Cadmium	7440-43-9	ug/L	1	--	18	5	--	5	NO	85	115	75	125	20
SW 6010B/EPA 200.7	Calcium	7440-70-2	ug/L	100	--	--	--	--	--	NO	85	115	75	125	20
SW 6020A/EPA 200.8	Chromium	7440-47-3	ug/L	1	--	--	100	50	50	NO	85	115	75	125	20
EPA 218.6	Chromium, Hexavalent	18540-29-9	ug/L	0.2	0.031	110	100	--	0.031	YES	90	110	90	110	20
EPA 218.6 LL	Chromium, Hexavalent, LL	18540-29-9	ug/L	0.06	0.031	110	100	--	0.031	YES	90	110	90	110	20
SM 3500-Cr	Chromium, Hexavalent	18540-29-9	ug/L	10	0.031	110	100	--	0.031	YES	85	115	80	120	20
SW 6010B or C/SW 6020A/EPA 200.7/EPA 200.8	Cobalt	7440-48-4	ug/L	5	4.7	11	--	--	4.7	YES	85	115	75	125	20
SW 6010B or C/SW 6020A/EPA 200.7/EPA 200.8	Copper	7440-50-8	ug/L	1	620	1,500	1,000*	--	620	NO	85	115	75	125	20
SW 6010B or C/EPA 200.7	Iron	7439-89-6	ug/L	20	11,000	26,000	300*	--	300	NO	85	115	75	125	20
SW 6010B or C/SW 6020A/EPA 200.7/EPA 200.8	Lead	7439-92-1	ug/L	1	--	--	15	--	15	NO	85	115	75	125	20
SW 6010B or C/EPA 200.7	Magnesium	7439-95-4	ug/L	100	--	--	--	--	--	NO	85	115	75	125	20
SW 6020A/EPA 200.8	Manganese	7439-96-5	ug/L	0.5	--	880	50*	--	50	NO	85	115	75	125	20
SW 7070A/EPA 245.1/ EPA 6020A?	Mercury	7439-97-6	ug/L	0.2	0.63	0.63	2	--	0.63	NO	75	125	75	125	20
SW 6020A/EPA 200.8	Molybdenum	7439-98-7	ug/L	2	78	180	--	--	78	NO	85	115	75	125	20
SW 6020A/EPA 200.8	Nickel	7440-02-0	ug/L	2	300	730	100*	100	100	NO	85	115	75	125	20
SW 6010B or C/EPA 200.7	Potassium	7440-09-7	ug/L	100	--	--	--	--	--	NO	85	115	75	125	20
SW 6020A/EPA 200.8	Selenium	7782-49-2	ug/L	10	78	180	50	--	50	NO	85	115	75	125	20
SW 6020A/EPA 200.8	Silver	7440-22-4	ug/L	5	71	180	--	--	71	NO	85	115	75	125	20
SW 6010B or C/EPA 200.7	Sodium	7440-23-5	ug/L	100	--	--	--	--	--	NO	85	115	75	125	20
EPA 200.7/EPA 200.8	Strontium	7440-24-6	ug/L	50	9,300	22,000	--	--	9,300	NO	85	115	75	125	20
SW 6020A/EPA 200.8	Thallium	7440-28-0	ug/L	1	0.16	2.4	2	--	0.16	YES	85	115	75	125	20
SW 6020A/EPA 200.8	Uranium	7440-61-1	ug/L	5	230	--	30	--	30	NO	85	115	75	125	20
SW 6020A/EPA 200.8	Vanadium	7440-62-2	ug/L	5	--	2.6	--	--	2.6	YES	85	115	75	125	20

Table A-2  
Reporting Limits, Accuracy, and Precession Limits for Groundwater  
PG&E Program Quality Assurance Project Plan

Method	Constituent	CAS	Units	QAPP RL	EPA Regional	EPA Regional	Federal Drinking	California	Most Stringent	Does RL Exceed	LCS Accuracy Control		MS/MSD Accuracy		Precision
					Screening Levels	Screening Levels	Water Standards	Drinking Water			Limits (%R)		Control Limits (%R)		Water
					May 2012	2008	MCLs	MCLs			Lower	Upper	Lower	Upper	% RPD
									Screening Level <sup>1</sup>	Screening Level?	Limit	Limit	Limit	Limit	
SW 6010B or C/SW 6020A/EPA 200.7/EPA 200.8	Zinc	7440-66-6	ug/L	20	4,700	11,000	5,000*	--	4,700	NO	85	115	75	125	20
SW 8015B or C or D	Motor Oil	TPH-motor oil	mg/L	1	--	--	--	--	--	NO	50	150	50	150	30
SW 8015B or C or D	TPH-Diesel	TPH-diesel	mg/L	0.5	--	--	--	--	--	NO	61	143	61	143	30
SW 8015B or C or D	TPH-Gasoline	TPH-gasoline	mg/L	0.1	--	--	--	--	--	NO	67	136	67	136	30
SW 8081A or B	4,4'-DDD	72-54-8	ug/L	0.1	0.28	0.28	--	--	0.28	NO	50	139	50	139	30
SW 8081A or B	4,4'-DDE	72-55-9	ug/L	0.1	0.2	0.2	--	--	0.2	NO	48	137	48	137	30
SW 8081A or B	4,4'-DDT	50-29-3	ug/L	0.1	0.2	0.2	--	--	0.2	NO	47	138	47	138	30
SW 8081A or B	Aldrin	309-00-2	ug/L	0.1	0.00021	0.004	--	--	0.00021	YES	42	138	42	138	30
SW 8081A or B	alpha-HCH	319-84-6	ug/L	0.1	0.0062	0.011	--	--	0.0062	YES	60	128	60	128	30
SW 8081A or B	alpha-Chlordane	5103-71-9	ug/L	0.1	--	--	2	--	2	NO	63	123	63	123	30
SW 8081A or B	beta-HCH	319-85-7	ug/L	0.1	0.022	0.037	--	--	0.022	YES	66	126	66	126	30
SW 8081A or B	delta-HCH	319-86-8	ug/L	0.1	--	--	--	--	--	NO	46	136	46	136	30
SW 8081A or B	Dieldrin	60-57-1	ug/L	0.1	0.0015	0.0042	--	--	0.0015	YES	62	129	62	129	30
SW 8081A or B	Endosulfan I	959-98-8	ug/L	0.1	--	--	--	--	--	NO	49	120	49	120	30
SW 8081A or B	Endosulfan II	33213-65-9	ug/L	0.1	--	--	--	--	--	NO	42	130	42	130	30
SW 8081A or B	Endosulfan sulfate	1031-07-8	ug/L	0.1	--	--	--	--	--	NO	54	137	54	137	30
SW 8081A or B	Endrin	72-20-8	ug/L	0.1	1.7	11	2	--	1.7	NO	56	134	56	134	30
SW 8081A or B	Endrin aldehyde	7421-93-4	ug/L	0.1	--	--	--	--	--	NO	56	137	56	137	30
SW 8081A or B	gamma-HCH (lindane)	58-89-9	ug/L	0.1	0.036	0.061	0.2	--	0.036	YES	30	146	30	146	30
SW 8081A or B	gamma-Chlordane	5103-74-2	ug/L	0.1	--	--	2	--	2	NO	67	120	67	120	30
SW 8081A or B	Heptachlor	76-44-8	ug/L	0.1	0.0018	0.015	0.4	--	0.0018	YES	51	128	51	128	30
SW 8081A or B	Heptachlor Epoxide	1024-57-3	ug/L	0.1	0.0033	0.0074	0.2	--	0.0033	YES	62	131	62	131	30
SW 8081A or B	Methoxychlor	72-43-5	ug/L	0.5	27	180	40	--	27	NO	56	150	56	150	30
SW 8081A or B	Toxaphene	8001-35-2	ug/L	1	0.013	0.061	3	--	0.013	YES	41	126	41	126	30
SW 8082 or A	Aroclor-1016	12674-11-2	ug/L	0.5	0.96	0.96	0.5	--	0.5	NO	40	144	40	144	30
SW 8082 or A	Aroclor-1221	11104-28-2	ug/L	0.5	0.0043	0.0068	0.5	--	0.0043	YES	41	136	41	136	30
SW 8082 or A	Aroclor-1232	11141-16-5	ug/L	0.5	0.0043	0.0068	0.5	--	0.0043	YES	41	136	41	136	30
SW 8082 or A	Aroclor-1242	53469-21-9	ug/L	0.5	0.034	0.034	0.5	--	0.034	YES	39	150	39	150	30
SW 8082 or A	Aroclor-1248	12672-29-6	ug/L	0.5	0.034	0.034	0.5	--	0.034	YES	41	136	41	136	30
SW 8082 or A	Aroclor-1254	11097-69-1	ug/L	0.5	0.034	0.034	0.5	--	0.034	YES	29	141	29	141	30
SW 8082 or A	Aroclor-1260	11096-82-5	ug/L	0.5	0.034	0.034	0.5	--	0.034	YES	45	145	45	145	30
SW 8151A	2,4-D	94-75-7	ug/L	10	130	370	70	--	70	NO	39	120	39	120	30
SW 8151A	2,4-DB	94-82-6	ug/L	20	91	290	--	--	91	NO	44	120	44	120	30
SW 8151A	2,4,5-T	93-76-5	ug/L	20	120	370	--	--	120	NO	44	122	44	122	30
SW 8151A	2,4,5-TP	93-72-1	ug/L	10	84	290	--	--	84	NO	49	126	49	126	30
SW 8151A	Dalapon	75-99-0	ug/L	30	470	1,100	200	--	200	NO	40	120	40	120	30
SW 8151A	Dicamba	1918-00-9	ug/L	30	440	1,100	--	--	440	NO	60	120	60	120	30
SW 8151A	Dichloroprop	120-36-5	ug/L	20	--	--	--	--	--	NO	68	122	68	122	30
SW 8151A	Dinoseb	88-85-7	ug/L	3	11	37	7	--	7	NO	28	115	28	115	30
SW 8151A	MCPA	94-74-6	ug/L	100	5.7	18	--	--	5.7	YES	62	144	62	144	30
SW 8151A	MCPP	7085-19-0	ug/L	100	--	37	--	--	37	YES	60	133	60	133	30
SW 8260B or C	1,1,1,2-Tetrachloroethane	630-20-6	ug/L	0.5	0.5	0.52	--	--	0.5	NO	81	129	81	129	20
SW 8260B or C	1,1,1-Trichloroethane (TCA)	71-55-6	ug/L	1	7,500	9,100	200	200	200	NO	67	132	67	132	20
SW 8260B or C	1,1,2,2-Tetrachloroethane	79-34-5	ug/L	0.5	0.066	0.067	--	1	0.066	YES	63	128	63	128	20
SW 8260B or C	1,1,2-Trichloroethane	79-00-5	ug/L	1	0.24	0.24	5	5	0.24	YES	75	125	75	125	20
SW 8260B or C	1,1,2-Trichlorotrifluoroethane (Freon 113)	76-13-1	ug/L	1	53,000	59,000	--	1,200	1,200	NO	75	125	75	125	20
SW 8260B or C	1,1-Dichloroethane	75-34-3	ug/L	1	2.4	2.4	--	5	2.4	NO	69	133	69	133	20
SW 8260B or C	1,1-Dichloroethene	75-35-4	ug/L	1	260	340	7	6	6	NO	68	130	68	130	20
SW 8260B or C	1,1-Dichloropropene	563-58-6	ug/L	1	--	--	--	--	--	NO	73	132	73	132	20
SW 8260B or C	1,2,3-Trichlorobenzene	87-61-6	ug/L	1	5.2	--	--	--	5.2	NO	67	137	67	137	20
SW 8260B or C	1,2,3-Trichloropropane	96-18-4	ug/L	1	0.00065	0.0096	--	--	0.00065	YES	73	124	73	124	20
SW 8260B or C	1,2,4-Trichlorobenzene	120-82-1	ug/L	1	0.99	8.2	70	5	0.99	YES	66	134	66	134	20
SW 8260B or C	1,2,4-Trimethylbenzene	95-63-6	ug/L	1	15	15	--	--	15	NO	74	132	74	132	20
SW 8260B or C	1,2-Dibromo-3-Chloropropane	96-12-8	ug/L	2	0.00032	0.00032	0.2	--	0.00032	YES	50	132	50	132	20
SW 8260B or C	1,2-Dibromoethane (EDB)	106-93-4	ug/L	1	0.0065	0.0065	0.05	--	0.0065	YES	80	121	80	121	20
SW 8260B or C	1,2-Dichlorobenzene	95-50-1	ug/L	1	280	370	600	600	280	NO	71	122	71	122	20
SW 8260B or C	1,2-Dichloroethane (EDC)	107-06-2	ug/L	0.5	0.15	0.15	5	0.5	0.15	YES	69	132	69	132	20
SW 8260B or C	1,2-Dichloropropane	78-87-5	ug/L	1	0.38	0.39	5	5	0.38	YES	75	125	75	125	20
SW 8260B or C	1,3,5-Trimethylbenzene	108-67-8	ug/L	1	87	12	--	--	12	NO	74	131	74	131	20
SW 8260B or C	1,3-Dichlorobenzene	541-73-1	ug/L	1	--	--	--	--	--	NO	75	124	75	124	20
SW 8260B or C	1,3-Dichloropropane	142-28-9	ug/L	1	290	730	--	--	290	NO	73	126	73	126	20
SW 8260B or C	1,4-Dichlorobenzene	106-46-7	ug/L	0.5	0.42	0.43	75	5	0.42	YES	74	123	74	123	20
SW 8260B or C	2,2-Dichloropropane	594-20-7	ug/L	1	--	--	--	--	--	NO	69	137	69	137	20
SW 8260B or C	2-Butanone (MEK)	78-93-3	ug/L	10	4,900	7,100	--	--	4,900	NO	49	136	49	136	20
SW 8260B or C	2-Chlorotoluene	95-49-8	ug/L	1	180	730	--	--	180	NO	73	126	73	126	20
SW 8260B or C	4-Chlorotoluene	106-43-4	ug/L	1	190	2,600	--	--	190	NO	74	128	74	128	20



Table A-2  
Reporting Limits, Accuracy, and Precession Limits for Groundwater  
PG&E Program Quality Assurance Project Plan

Method	Constituent	CAS	Units	QAPP RL	EPA Regional	EPA Regional	Federal Drinking	California	Most Stringent	Does RL Exceed	LCS Accuracy Control		MS/MSD Accuracy		Precision
					Screening Levels	Screening Levels	Water Standards	Drinking Water			Limits (%R)		Control Limits (%R)		Water
								Standards			Screening Level <sup>1</sup>	Screening Level?	Lower Limit	Upper Limit	Lower Limit
SW 8260B or C	4-Isopropyltoluene	99-87-6	ug/L	1	--	--	--	--	--	NO	73	130	73	130	20
SW 8260B or C	4-Methyl-2-Pentanone	108-10-1	ug/L	10	1,000	2,000	--	--	1,000	NO	58	134	58	134	20
SW 8260B or C	Acetone	67-64-1	ug/L	10	12,000	22,000	--	--	12,000	NO	40	135	40	135	20
SW 8260B or C	Acrolein	107-02-8	ug/L	20	0.041	0.042	--	--	0.041	YES	75	125	75	125	20
SW 8260B or C	Acrylonitrile	107-13-1	ug/L	20	0.045	0.045	--	--	0.045	YES	75	125	75	125	20
SW 8260B or C	Benzene	71-43-2	ug/L	0.4	0.39	0.41	5	1	0.39	YES	81	122	81	122	20
SW 8260B or C	Bromobenzene	108-86-1	ug/L	1	54	20	--	--	20	NO	76	124	76	124	20
SW 8260B or C	Bromochloromethane	74-97-5	ug/L	1	83	--	--	--	83	NO	65	129	65	129	20
SW 8260B or C	Bromodichloromethane	75-27-4	ug/L	0.5	0.12	1.1	100	--	0.12	YES	76	121	76	121	20
SW 8260B or C	Bromoform	75-25-2	ug/L	1	7.9	8.5	100	--	7.9	NO	69	128	69	128	20
SW 8260B or C	Bromomethane	74-83-9	ug/L	3	7	8.7	--	--	7	NO	53	141	53	141	20
SW 8260B or C	Carbon Disulfide	75-15-0	ug/L	1	720	1,000	--	--	720	NO	75	125	75	125	20
SW 8260B or C	Carbon Tetrachloride	56-23-5	ug/L	1	0.39	0.2	5	0.5	0.2	YES	66	138	66	138	20
SW 8260B or C	Chlorobenzene	108-90-7	ug/L	0.5	72	91	100	--	72	NO	81	122	81	122	20
SW 8260B or C	Chloroethane	75-00-3	ug/L	1	21,000	21,000	--	--	21,000	NO	58	133	58	133	20
SW 8260B or C	Chloroform	67-66-3	ug/L	1	0.19	0.19	100	--	0.19	YES	69	128	69	128	20
SW 8260B or C	Chloromethane	74-87-3	ug/L	1	190	1.8	--	--	1.8	NO	56	131	56	131	20
SW 8260B or C	cis-1,2-Dichloroethene	156-59-2	ug/L	1	28	370	70	6	6	NO	72	126	72	126	20
SW 8260B or C	cis-1,3-Dichloropropene	10061-01-5	ug/L	0.5	--	--	--	--	--	NO	69	131	69	131	20
SW 8260B or C	Dibromochloromethane	124-48-1	ug/L	0.5	0.15	0.8	100	--	0.15	YES	66	133	66	133	20
SW 8260B or C	Dibromomethane	74-95-3	ug/L	1	7.9	370	--	--	7.9	NO	76	125	76	125	20
SW 8260B or C	Dichlorodifluoromethane (Freon 12)	75-71-8	ug/L	1	190	390	--	--	190	NO	53	153	53	153	20
SW 8260B or C	Ethylbenzene	100-41-4	ug/L	1	1.3	1.5	700	--	1.3	NO	73	127	73	127	20
SW 8260B or C	Hexachlorobutadiene	87-68-3	ug/L	0.6	0.26	0.86	--	--	0.26	YES	67	131	67	131	20
SW 8260B or C	Isopropylbenzene (Cumene)	98-82-8	ug/L	1	390	680	--	--	390	NO	75	127	75	127	20
SW 8260B or C	Methylene chloride	75-09-2	ug/L	1	9.9	4.8	5	5	4.8	NO	63	137	63	137	20
SW 8260B or C	Naphthalene	91-20-3	ug/L	1	0.14	0.14	--	--	0.14	YES	54	138	54	138	20
SW 8260B or C	n-Butylbenzene	104-51-8	ug/L	1	780	--	--	--	780	NO	69	137	69	137	20
SW 8260B or C	n-Propylbenzene	103-65-1	ug/L	1	530	--	--	--	530	NO	72	129	72	129	20
SW 8260B or C	sec-Butylbenzene	135-98-8	ug/L	1	--	--	--	--	--	NO	72	127	72	127	20
SW 8260B or C	Styrene	100-42-5	ug/L	1	1,100	1,600	100	100	100	NO	65	134	65	134	20
SW 8260B or C	tert-Butyl Methyl Ether (MTBE)	1634-04-4	ug/L	5	12	12	--	13	12	NO	65	123	65	123	20
SW 8260B or C	tert-Butylbenzene	98-06-6	ug/L	1	--	--	--	--	--	NO	70	129	70	129	20
SW 8260B or C	Tetrachloroethene	127-18-4	ug/L	1	9.7	0.11	5	5	0.11	YES	66	128	66	128	20
SW 8260B or C	Toluene	108-88-3	ug/L	1	860	2,300	1,000	150	150	NO	77	122	77	122	20
SW 8260B or C	trans-1,2-Dichloroethene	156-60-5	ug/L	1	86	110	100	10	10	NO	63	137	63	137	20
SW 8260B or C	trans-1,3-Dichloropropene	10061-02-6	ug/L	1	--	--	--	--	--	NO	59	135	59	135	20
SW 8260B or C	Trichloroethene	79-01-6	ug/L	1	0.44	1.7	5	5	0.44	YES	70	127	70	127	20
SW 8260B or C	Trichlorofluoromethane (Freon 11)	75-69-4	ug/L	1	1,100	1,300	--	150	150	NO	57	129	57	129	20
SW 8260B or C	Vinyl Chloride	75-01-4	ug/L	1	0.015	0.016	2	0.5	0.015	YES	50	134	50	134	20
SW 8260B or C	Xylenes, Total	1330-20-7	ug/L	2	190	200	10,000	1,750	190	NO	75	125	75	125	20
SW 8260B or C	m -Xylene	108-38-3	ug/L	2	190	1,400	--	--	190	NO	76	128	76	128	20
SW 8260B or C	o-Xylene	95-47-6	ug/L	1	190	1,400	--	--	190	NO	80	121	80	121	20
SW 8260B or C	p-Xylene	106-42-3	ug/L	1	190	1,500	--	--	190	NO	76	128	76	128	20
SW 8270C or D	1,2,4-Trichlorobenzene	120-82-1	ug/L	10	0.99	8.2	70	--	0.99	YES	37	120	37	120	20
SW 8270C or D	1,2-Dichlorobenzene	95-50-1	ug/L	10	280	370	600	--	280	NO	33	120	33	120	20
SW 8270C or D	1,3-Dichlorobenzene	541-73-1	ug/L	10	--	--	--	--	--	NO	32	120	32	120	20
SW 8270C or D	1,4-Dichlorobenzene	106-46-7	ug/L	10	0.42	0.43	75	--	0.42	YES	32	120	32	120	20
SW 8270C or D	2,4,5-Trichlorophenol	95-95-4	ug/L	50	890	3,700	--	--	890	NO	49	120	49	120	20
SW 8270C or D	2,4,6-Trichlorophenol	88-06-2	ug/L	10	3.5	6.1	--	--	3.5	YES	49	126	49	126	20
SW 8270C or D	2,4-Dichlorophenol	120-83-2	ug/L	10	35	110	--	--	35	NO	48	120	48	120	20
SW 8270C or D	2,4-Dimethylphenol	105-67-9	ug/L	10	270	730	--	--	270	NO	28	120	28	120	20
SW 8270C or D	2,4-Dinitrophenol	51-28-5	ug/L	10	30	73	--	--	30	NO	25	130	25	130	20
SW 8270C or D	2,4-Dinitrotoluene	121-14-2	ug/L	10	0.2	73	--	--	0.2	YES	51	120	51	120	20
SW 8270C or D	2,6-Dinitrotoluene	606-20-2	ug/L	10	15	37	--	--	15	NO	49	120	49	120	20
SW 8270C or D	2-Chloronaphthalene	91-58-7	ug/L	10	550	2,900	--	--	550	NO	49	120	49	120	20
SW 8270C or D	2-Chlorophenol	95-57-8	ug/L	10	71	180	--	--	71	NO	37	120	37	120	20
SW 8270C or D	2-Methylnaphthalene	91-57-6	ug/L	10	27	150	--	--	27	NO	46	120	46	120	20
SW 8270C or D	2-Methylphenol (o-Cresol)	95-48-7	ug/L	10	720	1,800	--	--	720	NO	38	120	38	120	20
SW 8270C or D	2-Nitroaniline	88-74-4	ug/L	50	150	--	--	--	150	NO	48	120	48	120	20
SW 8270C or D	2-Nitrophenol	88-75-5	ug/L	10	--	--	--	--	--	NO	39	123	39	123	20
SW 8270C or D	3,3'-Dichlorobenzidine	91-94-1	ug/L	20	0.11	0.15	--	--	0.11	YES	20	120	20	120	20
SW 8270C or D	3-Nitroaniline	99-09-2	ug/L	50	--	3.2	--	--	3.2	YES	20	126	20	126	20
SW 8270C or D	4,6-Dinitro-2-methylphenol	534-52-1	ug/L	50	1.2	3.7	--	--	1.2	YES	40	130	40	130	20
SW 8270C or D	4-Bromophenyl Phenyl Ether	101-55-3	ug/L	10	--	--	--	--	--	NO	52	120	52	120	20
SW 8270C or D	4-Chloro-3-methylphenol	59-50-7	ug/L	20	1,100	--	--	--	1,100	NO	47	120	47	120	20

Table A-2  
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PG&E Program Quality Assurance Project Plan

Method	Constituent	CAS	Units	QAPP RL	EPA Regional	EPA Regional	Federal Drinking	California	Most Stringent	Does RL Exceed	LCS Accuracy Control		MS/MSD Accuracy		Precision
					Screening Levels	Screening Levels	Water Standards	Drinking Water			Limits (%R)		Control Limits (%R)		Water
					May 2012	2008	MCLs	Standards			Lower	Upper	Lower	Upper	% RPD
									Screening Level <sup>1</sup>	Screening Level?	Limit	Limit	Limit	Limit	
SW 8270C or D	4-Chloroaniline	106-47-8	ug/L	20	0.32	1.2	--	--	0.32	YES	20	120	20	120	20
SW 8270C or D	4-Chlorophenyl phenyl ether	7005-72-3	ug/L	10	--	--	--	--	--	NO	50	120	50	120	20
SW 8270C or D	4-Methylphenol (p-Cresol)	106-44-5	ug/L	50	1,400	180	--	--	180	NO	32	120	32	120	20
SW 8270C or D	4-Nitroaniline	100-01-6	ug/L	50	3.3	3.2	--	--	3.2	YES	36	120	36	120	20
SW 8270C or D	4-Nitrophenol	100-02-7	ug/L	50	--	--	--	--	--	NO	20	120	20	120	20
SW 8270C or D	Acenaphthene	83-32-9	ug/L	10	400	2,200	--	--	400	NO	47	120	47	120	20
SW 8270C or D	Acenaphthylene	208-96-8	ug/L	10	--	--	--	--	--	NO	50	120	50	120	20
SW 8270C or D	Anthracene	120-12-7	ug/L	10	1,300	11,000	--	--	1,300	NO	54	120	54	120	20
SW 8270C or D	Benzo (a) anthracene	56-55-3	ug/L	10	0.029	0.029	--	--	0.029	YES	56	100	56	100	20
SW 8270C or D	Benzo (a) pyrene	50-32-8	ug/L	10	0.0029	0.0029	0.2	--	0.0029	YES	53	120	53	120	20
SW 8270C or D	Benzo (b) fluoranthene	205-99-2	ug/L	10	0.029	0.029	--	--	0.029	YES	45	124	45	124	20
SW 8270C or D	Benzo (g,h,i) perylene	191-24-2	ug/L	10	--	--	--	--	--	NO	38	123	38	123	20
SW 8270C or D	Benzo (k) fluoranthene	207-08-9	ug/L	10	0.29	0.29	--	--	0.29	YES	45	124	45	124	20
SW 8270C or D	Benzoic acid	65-85-0	ug/L	100	58,000	150,000	--	--	58,000	NO	20	120	20	120	20
SW 8270C or D	Benzyl alcohol	100-51-6	ug/L	20	1,500	18,000	--	--	1,500	NO	30	120	30	120	20
SW 8270C or D	bis (2-chloroethoxy) methane	111-91-1	ug/L	10	47	110	--	--	47	NO	46	120	46	120	20
SW 8270C or D	bis (2-chloroethyl) ether	111-44-4	ug/L	10	0.012	0.012	--	--	0.012	YES	37	120	37	120	20
SW 8270C or D	bis (2-chloroisopropyl) ether	108-60-1	ug/L	10	0.31	0.32	--	--	0.31	YES	26	131	26	131	20
SW 8270C or D	bis (2-ethylhexyl) phthalate	117-81-7	ug/L	10	0.071	4.8	6	--	0.071	YES	42	126	42	126	20
SW 8270C or D	Butyl benzylphthalate	85-68-7	ug/L	10	14	35	--	--	14	NO	46	120	46	120	20
SW 8270C or D	Chrysene	218-01-9	ug/L	10	2.9	2.9	--	--	2.9	YES	55	120	55	120	20
SW 8270C or D	Dibenzo (a,h) anthracene	53-70-3	ug/L	10	0.0029	0.0029	--	--	0.0029	YES	42	127	42	127	20
SW 8270C or D	Dibenzofuran	132-64-9	ug/L	10	5.8	--	--	--	5.8	YES	54	120	54	120	20
SW 8270C or D	Diethyl phthalate	84-66-2	ug/L	10	11,000	29,000	--	--	11,000	NO	41	120	41	120	20
SW 8270C or D	Dimethyl phthalate	131-11-3	ug/L	10	--	--	--	--	--	NO	25	127	25	127	20
SW 8270C or D	Di-n-butylphthalate	84-74-2	ug/L	10	670	3,700	--	--	670	NO	54	120	54	120	20
SW 8270C or D	Di-n-octylphthalate	117-84-0	ug/L	10	--	--	--	--	--	NO	37	137	37	137	20
SW 8270C or D	Fluoranthene	206-44-0	ug/L	10	630	1,500	--	--	630	NO	54	120	54	120	20
SW 8270C or D	Fluorene	86-73-7	ug/L	10	220	1,500	--	--	220	NO	50	120	50	120	20
SW 8270C or D	Hexachlorobenzene	118-74-1	ug/L	10	0.042	0.042	1	--	0.042	YES	52	120	52	120	20
SW 8270C or D	Hexachlorobutadiene	87-68-3	ug/L	10	0.26	0.86	--	--	0.26	YES	27	120	27	120	20
SW 8270C or D	Hexachloroethane	67-72-1	ug/L	10	0.79	4.8	--	--	0.79	YES	28	120	28	120	20
SW 8270C or D	Indeno (1,2,3-c,d) pyrene	193-39-5	ug/L	10	0.029	0.029	--	--	0.029	YES	43	125	43	125	20
SW 8270C or D	Isophorone	78-59-1	ug/L	10	67	71	--	--	67	NO	50	120	50	120	20
SW 8270C or D	Naphthalene	91-20-3	ug/L	10	0.14	0.14	--	--	0.14	YES	39	120	39	120	20
SW 8270C or D	Nitrobenzene	98-95-3	ug/L	10	0.12	3.4	--	--	0.12	YES	44	120	44	120	20
SW 8270C or D	n-Nitrosodi-n-propylamine	621-64-7	ug/L	10	0.0093	0.0096	--	--	0.0093	YES	34	128	34	128	20
SW 8270C or D	n-Nitrosodiphenylamine	86-30-6	ug/L	10	10	14	--	--	10	NO	48	120	48	120	20
SW 8270C or D	Pentachlorophenol	87-86-5	ug/L	50	0.17	0.56	1	--	0.17	YES	38	120	38	120	20
SW 8270C or D	Phenanthrene	85-01-8	ug/L	10	--	--	--	--	--	NO	51	120	51	120	20
SW 8270C or D	Phenol	108-95-2	ug/L	10	4,500	11,000	--	--	4,500	NO	20	120	20	120	20
SW 8270C or D	Pyrene	129-00-0	ug/L	10	87	1,100	--	--	87	NO	49	128	49	128	20
SW 8270SIM	1-methylnaphthalene	90-12-0	ug/L	0.2	0.97	2.3	--	--	0.97	NO	35	131	35	131	30
SW 8270SIM	2-methylnaphthalene	91-57-6	ug/L	0.2	27	150	--	--	27	NO	36	121	36	121	30
SW 8270SIM	Acenaphthene	83-32-9	ug/L	0.2	400	2,200	--	--	400	NO	39	125	39	125	30
SW 8270SIM	Acenaphthylene	208-96-8	ug/L	0.2	--	--	--	--	--	NO	43	140	43	140	30
SW 8270SIM	Anthracene	120-12-7	ug/L	0.2	1,300	11,000	--	--	1,300	NO	41	132	41	132	30
SW 8270SIM	Benzo (a) anthracene	56-55-3	ug/L	0.2	0.029	0.029	--	--	0.029	YES	58	141	58	141	30
SW 8270SIM	Benzo (a) pyrene	50-32-8	ug/L	0.2	0.0029	0.0029	0.2	--	0.0029	YES	31	142	31	142	30
SW 8270SIM	Benzo (b) fluoranthene	205-99-2	ug/L	0.2	0.029	0.029	--	--	0.029	YES	42	156	42	156	30
SW 8270SIM	Benzo (g,h,i) perylene	191-24-2	ug/L	0.2	--	--	--	--	--	NO	12	171	12	171	30
SW 8270SIM	Benzo (k) fluoranthene	207-08-9	ug/L	0.2	0.29	0.29	--	--	0.29	NO	49	165	49	165	30
SW 8270SIM	Chrysene	218-01-9	ug/L	0.2	2.9	2.9	--	--	2.9	NO	51	155	51	155	30
SW 8270SIM	Dibenzo (a,h) anthracene	53-70-3	ug/L	0.2	0.0029	0.0029	--	--	0.0029	YES	28	153	28	153	30
SW 8270SIM	Fluoranthene	206-44-0	ug/L	0.2	630	1,500	--	--	630	NO	47	158	47	158	30
SW 8270SIM	Fluorene	86-73-7	ug/L	0.2	220	1,500	--	--	220	NO	40	140	40	140	30
SW 8270SIM	Indeno (1,2,3-c,d) pyrene	193-39-5	ug/L	0.2	0.029	0.029	--	--	0.029	YES	20	167	20	167	30
SW 8270SIM	Naphthalene	91-20-3	ug/L	0.2	0.14	0.14	--	--	0.14	YES	39	125	39	125	30
SW 8270SIM	Phenanthrene	85-01-8	ug/L	0.2	--	--	--	--	--	NO	46	144	46	144	30
SW 8270SIM	Pyrene	129-00-0	ug/L	0.2	87	1,100	--	--	87	NO	39	158	39	158	30
CF-IRMS	D18O	D18O	0/00	--	--	--	--	--	--	NO	--	--	--	--	20
CF-IRMS	DD	DD	0/00	--	--	--	--	--	--	NO	--	--	--	--	20
SM 7110 C	Gross alpha	Gross alpha	pCi/L	3	--	--	15	15	15	NO	--	--	--	--	20
EPA 900.0	Gross beta	Gross beta	pCi/L	4	--	--	--	4	4	NO	--	--	--	--	20
EPA 903.1	Radium-226	013982-63-3	pCi/L	1	--	--	5	--	5	NO	--	--	--	--	20
EPA 904.0	Radium-228	015262-20-1	pCi/L	1	--	--	5	--	5	NO	--	--	--	--	20

Table A-2  
Reporting Limits, Accuracy, and Precession Limits for Groundwater  
PG&E Program Quality Assurance Project Plan

Method	Constituent	CAS	Units	QAPP RL	EPA Regional	EPA Regional	Federal Drinking	California	Most Stringent	Does RL Exceed	LCS Accuracy Control		MS/MSD Accuracy		Precision
					Screening Levels	Screening Levels	Water Standards	Drinking Water			Limits (%R)		Control Limits (%R)		Water
					May 2012	2008	MCLs	Standards			Lower	Upper	Lower	Upper	% RPD
EPA 905.0	Strontium	7440-26-4	pCi/L	2	--	--	--	8	8	NO	--	--	--	--	20
EPA 906.0	Tritium	10028-17-8	pCi/L	1,000	--	--	--	20,000	20,000	NO	--	--	--	--	20
EPA 908.0	Uranium	7440-61-1	pCi/L	1	--	--	--	20	20	NO	--	--	--	--	20
RSK-175	Carbon Dioxide	124-38-9	ug/L	5	--	--	--	--	--	NO	80	120	80	120	20
RSK-175	Ethane	74-84-0	ug/L	5	--	--	--	--	--	NO	80	120	80	120	20
RSK-175	Ethene	74-85-1	ug/L	5	--	--	--	--	--	NO	80	120	80	120	20
RSK-175	Methane	74-82-8	ug/L	5	--	--	--	--	--	NO	80	120	80	120	20

Notes:

\*\*Please keep in mind, Screening Levels are constantly revised by the EPA. The appropriate Screening levels are specific to the project, the location, the agency providing oversight, and the overall Goals of the project.\*\*

mg/L = milligrams per liter  
ug/L = micrograms per liter  
µmhos/cm = micromhos per centimeter  
pCi/L = picocuries per liter  
PCB - LCS, MS, and MSD only require Aroclor-1016 and Aroclor-1260 spikes

<sup>1</sup> For groundwater, most stringent of:  
EPA Regional Screening Levels - 2008 and May 2012  
Federal Drinking Water Standards, MCLs  
\*Secondary Federal Drinking Water Standards, MCLs  
California Drinking Water Standards, MCLs

**Table A-3**  
Maximum Concentrations for Title 22  
PG&E Program Quality Assurance Project Plan

CA TTCL/STLC										LCS Accuracy Control Limits (%R)		MS/MSD Accuracy Control Limits (%R)		Precision Soil	
Method	Constituent	CAS	Units	TCLP Regulatory Standards	Title 22 TTLC MCL (mg/kg)	If TTLC Concentration is ≥ this value STLC Analysis Must be performed		Most Stringent Screening Level	Does RL Exceed Screening Level?		Lower Limit	Upper Limit	Lower Limit	Upper Limit	% RPD
						Title 22 STLC MCL			RL						
SW6010B	Antimony	7440-36-0	mg/kg	--	500	150	15	15	5	NO	80	120	75	125	20
SW6010B	Arsenic	7440-38-2	mg/kg	5	500	50	5	5	5	NO	80	120	75	125	20
SW6010B	Barium	7440-39-3	mg/kg	100	10,000	1,000	100	100	10	NO	80	120	75	125	20
SW6010B	Beryllium	7440-41-7	mg/kg	--	75	7.5	0.75	0.75	1	YES	80	120	75	125	20
SW6010B	Cadmium	7440-43-9	mg/kg	1	100	10	1	1	1	NO	80	120	75	125	20
SW6010B	Chromium	7440-47-3	mg/kg	5	2,500	50	5	5	5	NO	80	120	75	125	20
SW3060A	Chromium, Hexavalent	18540-29-9	mg/kg	--	500	50	5	5	0.4	NO	80	120	75	125	20
SW6010B	Cobalt	7440-48-4	mg/kg	--	8,000	800	80	80	10	NO	80	120	75	125	20
SW6010B	Copper	7440-50-8	mg/kg	--	2,500	250	25	25	5	NO	80	120	75	125	20
SW6010B	Lead	7439-92-1	mg/kg	5	1,000	50	5	5	5	NO	80	120	75	125	20
SW7470A	Mercury	7439-97-6	mg/kg	0.2	20	2	0.2	0.2	0.1	NO	75	125	75	125	20
SW6010B	Molybdenum	7439-98-7	mg/kg	--	3,500	3,500	350	350	10	NO	80	120	75	125	20
SW6010B	Nickel	7440-02-0	mg/kg	--	2,000	200	20	20	5	NO	80	120	75	125	20
SW6010B	Selenium	7782-49-2	mg/kg	1	100	10	1	1	5	YES	80	120	75	125	20
SW6010B	Silver	7440-22-4	mg/kg	5	500	50	5	5	5	NO	80	120	75	125	20
SW6010B	Thallium	7440-28-0	mg/kg	--	700	70	7	7	5	NO	80	120	75	125	20
SW6010B	Vanadium	7440-62-2	mg/kg	--	2,400	240	24	24	5	NO	80	120	75	125	20
SW6010B	Zinc	7440-66-6	mg/kg	--	5,000	2,500	250	250	10	NO	80	120	75	125	20
SW8260B	Benzene	71-43-2	mg/L	0.5	--	--	--	0.5	--	YES	--	--	--	--	--
SW8260B	Carbon tetrachloride	56-23-5	mg/L	0.5	--	--	--	0.5	--	YES	--	--	--	--	--
SW8260B	Chlorobenzene	108-90-7	mg/L	100	--	--	--	100	--	YES	--	--	--	--	--
SW8260B	Chloroform	67-66-3	mg/L	6	--	--	--	6	--	YES	--	--	--	--	--
SW8260B	o-Cresol (2-Methylphenol)	95-48-7	mg/L	200	--	--	--	200	--	YES	--	--	--	--	--
SW8260B	m-Cresol	108-39-4	mg/L	200	--	--	--	200	--	YES	--	--	--	--	--
SW8260B	p-Cresol (4-Methylphenol)	106-44-5	mg/L	200	--	--	--	200	--	YES	--	--	--	--	--
SW8260B	Total Cresols		mg/L	200	--	--	--	200	--	YES	--	--	--	--	--
SW8260B	1,4-Dichlorobenzene	106-46-7	mg/L	7.5	--	--	--	7.5	--	YES	--	--	--	--	--
SW8260B	1,2-Dichloroethane (EDC)	107-06-2	mg/L	0.5	--	--	--	0.5	--	YES	--	--	--	--	--
SW8260B	1,1-Dichloroethylene	75-35-4	mg/L	0.7	--	--	--	0.7	--	YES	--	--	--	--	--
SW8260B	Hexachlorobutadiene	87-68-3	mg/L	0.5	--	--	--	0.5	--	YES	--	--	--	--	--
SW8260B	Tetrachloroethylene (PCE)	127-18-4	mg/L	0.7	2,040	--	204	0.7	--	YES	--	--	--	--	--
SW8260B	Vinyl chloride	75-01-4	mg/L	0.2	--	--	--	0.2	--	YES	--	--	--	--	--
SW8260B	Trichloroethylene (TCE)	79-01-6	mg/L	0.5	--	--	--	0.5	--	YES	--	--	--	--	--
SW8260B	2-Butanone (MEK)	78-93-3	mg/L	200	--	--	--	200	--	YES	--	--	--	--	--
SW8270C	2,4-Dinitrotoluene	121-14-2	mg/L	0.13	--	--	--	0.13	--	YES	--	--	--	--	--
SW8270C	Hexachlorobenzene	118-74-1	mg/L	0.13	--	--	--	0.13	--	YES	--	--	--	--	--
SW8270C	Hexachloroethane	67-72-1	mg/L	3	--	--	--	3	--	YES	--	--	--	--	--
SW8270C	Hexachlorobutadiene	87-68-3	mg/L	0.5	--	--	--	0.5	--	YES	--	--	--	--	--
SW8270C	Nitrobenzene	98-95-3	mg/L	2	--	--	--	2	--	YES	--	--	--	--	--
SW8270C	Pentachlorophenol	87-86-5	mg/L	100	17	--	1.7	1.7	--	YES	--	--	--	--	--
SW8270C	2,4,5-Trichlorophenol	95-95-4	mg/L	400	--	--	--	400	--	YES	--	--	--	--	--
SW8270C	2,4,6-Trichlorophenol	88-06-2	mg/L	2	--	--	--	2	--	YES	--	--	--	--	--
SW8270C	Pyridine	110-86-1	mg/L	5	--	--	--	5	--	YES	--	--	--	--	--
SW8270C	3,3-Dichlorobenzidine		mg/L	0.01	--	--	--	0.01	--	YES	--	--	--	--	--
SW8081A	Endrin	72-20-8	mg/L	0.02	0.2	--	0.02	0.02	--	YES	--	--	--	--	--
SW8081A	Heptachlor (and its epoxide)	76-44-8	mg/L	0.008	4.7	--	0.47	0.008	--	YES	--	--	--	--	--
SW8081A	Methoxychlor	72-43-5	mg/L	10	100	--	10	10	--	YES	--	--	--	--	--
SW8081A	Toxaphene	8001-35-2	mg/L	0.5	5	--	0.5	0.5	--	YES	--	--	--	--	--
SW8081A	Chlordane	57-74-9	mg/L	0.03	2.5	--	0.25	0.03	--	YES	--	--	--	--	--
SW8081A	Lindane	58-89-9	mg/L	0.4	4	--	0.4	0.4	--	YES	--	--	--	--	--
SW8081A	Aldrin	309-00-2	mg/L	--	1.4	--	0.14	0.14	--	YES	--	--	--	--	--



**Table A-3**  
Maximum Concentrations for Title 22  
PG&E Program Quality Assurance Project Plan

CA TTCL/STLC										LCS Accuracy Control Limits (%R)		MS/MSD Accuracy Control Limits (%R)		Precision Soil	
Method	Constituent	CAS	Units	TCLP Regulatory Standards	If TTLC Concentration is ≥ this value STLC Analysis Must be performed		Title 22 STLC MCL	Most Stringent Screening Level	Does RL Exceed Screening Level?	RL	Lower Limit	Upper Limit	Lower Limit	Upper Limit	% RPD
					Title 22 TTLC MCL (mg/kg)										
SW8081A	Kepone	143-50-0	mg/L	--	21	--	2.1	2.1	--	YES	--	--	--	--	--
SW8081A	4,4'-DDD	72-54-8	mg/L	--	1	--	0.1	0.1	--	YES	--	--	--	--	--
SW8081A	4,4'-DDE	72-55-9	mg/L	--	1	--	0.1	0.1	--	YES	--	--	--	--	--
SW8081A	4,4'-DDT	50-29-3	mg/L	--	1	--	0.1	0.1	--	YES	--	--	--	--	--
SW8081A	Dieldrin	60-57-1	mg/L	--	8	--	0.8	0.8	--	YES	--	--	--	--	--
SW8081A	Heptachlor	76-44-8	mg/L	--	4.7	--	0.47	0.47	--	YES	--	--	--	--	--
SW8151A	2,4-Dichlorophenoxyacetic acid (2,4-D)	94-75-7	mg/L	10	100	--	10	10	--	YES	--	--	--	--	--
SW8151A	2,4,5-Trichlorophenoxypropionic acid (2,4,5-TP) (Silvex)	93-72-1	mg/L	1	10	--	1	1	--	YES	--	--	--	--	--
SW8082	Polychlorinated biphenyls (PCB)		mg/L	--	50	--	5	5	--	YES	--	--	--	--	--
Dioxins	Dioxin (2,3,7,8-TCDD)	1746-01-6	mg/L	--	0.01	--	0.001	0.001	--	YES	--	--	--	--	--

**Notes:**

mg/L = milligrams per liter

mg/kg = milligrams per kilogram

TCLP = toxicity characteristic leaching procedure

STLC = soluble threshold limit concentration

TTLC = total threshold limit concentration

# Addendum to the PG&E Program Quality Assurance Project Plan for the Topock Groundwater Remedy

## PG&E Topock Compressor Station Needles, California

Prepared for  
Pacific Gas and Electric Company

Revision 1 (September 2014)

**CH2MHILL®**

155 Grand Avenue  
Suite 800  
Oakland, CA 94612

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# Addendum to the PG&E Program Quality Assurance Project Plan for the Topock Groundwater Remedy

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## 1.0 Introduction

This addendum to the *PG&E Program Quality Assurance Project Plan* (QAPP) Revision 2 (CH2M HILL 2012) has been prepared to address any variations from the QAPP or specifications associated with the Topock Groundwater Remedy (the project) that are not included or defined in the QAPP document. The laboratories will be required to adhere to the QAPP and then use the specific information outlined within this addendum to supersede the QAPP information.

In compliance with the 1996 Corrective Action Consent Agreement (CACA) (California Department of Toxic Substances Control [DTSC] 1996) and the Remedial Design/Remedial Action (RD/RA) Consent Decree (DOI 2013), the sampling and analytical procedures set forth in the QAPP (CH2M HILL 2012), this Addendum, as well as the Sampling and Monitoring Plan (Volume 2 of the Operation and Maintenance Manual) will be followed during remedy operation.

Over the decades-long operation and optimization of the remedy, updates to the aforementioned documents may be necessary for a variety of reasons (e.g., changes driven by field conditions, changes driven by regulations, etc.). As with current practice and required by the QAPP, Standard Operating Procedures (SOPs) will be reviewed on annual basis, at a minimum, and PG&E will inform the agencies of material and substantive changes to the SOPs, as well as the rationale for the changes, prior to implementation.

## 2.0 Project Organization and Responsibility

### 2.1 Project Organization

For information on project organization refer to the O&M Manual, Main Text Section L2.

### 2.2 Certification Requirements

All laboratories participating in analytical services will have a documented Quality System and be certified under the National Environmental Laboratory Accreditation Program (NELAP) or the State of California Environmental Laboratory Accreditation Program (ELAP). Laboratories in California will be required to be certified under the ELAP. Additional accreditation may also be required. The laboratory managers will be responsible for ensuring that all laboratory personnel have been properly trained and are qualified to perform their assigned tasks.

## 3.0 Sampling Procedures

### 3.1 Sampling Design

Sampling and monitoring activities are needed for compliance purposes and for effective operation and maintenance of the groundwater remedy. The rationale for the sampling design (sampling locations, frequency, and analytes) is included in the Sampling and Monitoring Plan.

### 3.2 Field Sampling Procedures

The groundwater remedy will use the project-specific field database, planned sample tables, chain-of-custody (CoC) forms, and other database-generated paperwork (e.g., purge forms, calibration log books). All sample collection and related activities will follow the SOPs provided in Appendix A of the Sampling and Monitoring Plan. Exhibit 3-1 lists the relevant SOPs for the remedy. Over the decades-long operation of the remedy, SOPs may be updated. The Field Lead and Project Chemist will ensure that the sampling is performed in accordance with the updated SOPs.

EXHIBIT 3-1

**List of PG&E Program SOPs Applicable to the Topock Groundwater Remedy**

*Addendum to the PG&E Program Quality Assurance Project Plan for the Topock Groundwater Remedy*

SOP	Title	Version	Date
SOP-A1	Purging and Sampling of Groundwater Monitoring Wells, Well-Volume Method	Rev 05	7/19/2012
SOP-A2	Purging and Sampling of 1-inch-diameter Groundwater Monitoring Wells, Modified Well-Volume Method	Rev 05	10/31/2012
SOP-A3	Purging and Sampling of Active and Inactive Water Supply Wells	Rev 05	10/31/2012
SOP-A4	Depth-Specific Surface Water Sampling	Rev 04	7/31/2012
SOP-A5	Groundwater Sampling from Sonic Drilling Boreholes	Rev 01	7/31/2012
SOP-A6	Sample Field Filtration and Preservation for Metals Analyses	Rev 04	7/31/2012
SOP-A7	Water Level Measurements	Rev 04	5/2/2014
SOP-A8	Field Water Quality Measurements Using a Flow-through Cell	Rev 01	9/23/2010
SOP-A9	Calibration of Field Instruments	Rev 05	3/22/2013
SOP-A10	Decontamination of Water Sampling Equipment	Rev 05	3/22/2013
SOP-A11	Total Depth Measurements	Rev 00	3/31/2005
SOP-A12	Field Water Quality Measurements for Grab Samples	Rev 00	5/2/2014
SOP-A13	Spill Prevention, Containment, and Control Measures for Monitoring Well Development, Purging, and Sampling	Rev 03	9/23/2010
SOP-A14	Pore Water Sampling	Rev 00	9/30/2005
SOP-A16	Access Routes	Rev 02	4/25/2012
SOP-A17	Groundwater and Surface Water Mobile Integrated Sample Tracking	Rev 02	12/5/2008
SOP-A18	Purging and Sampling of Groundwater Wells Minimal Drawdown Method	Rev 01	7/15/2012
SOP-A19	Sampling of Groundwater Monitoring Wells Hydrasleeve No Purge Method	Rev 00	7/15/2012
SOP-A22	Procedures for Calculation of Freshwater Equivalent Heads	Rev 01	4/22/2014
SOP-A23	Sample Handling and Custody	Rev 00	5/22/2014
SOP-L1	Hexavalent Chromium Analysis by Hach Method 1560	Rev 03	4/1/2014
SOP-L2	Ferrous Iron Analysis by Hach Method 8146	Rev 02	4/1/2014
SOP-L3	Total Chromium Analysis by Hach Method 8024	Rev 01	4/1/2014
SOP-L4	Conductivity Analysis by Hach Method 8160	Rev 01	4/1/2014
SOP-L8	Matrix Spike Preparation	Rev 01	6/5/2014
SOP-L9	pH Measurement	Rev 01	4/1/2014
SOP-L10	Hach Model 2100P Turbidimeter Calibration and Analysis Procedures	Rev 01	4/1/2014
SOP-L13	Nitrate Analysis by Hach Method 8171	Rev 00	4/1/2014
SOP-L14	Sulfate Analysis by Hach Method 8051	Rev 00	4/1/2014
SOP-L15	Alkalinity Analysis	Rev 00	4/1/2014
SOP-L16	Total Organic Carbon Analysis by Hach Method 10129	Rev 00	6/5/2014

EXHIBIT 3-1

**List of PG&E Program SOPs Applicable to the Topock Groundwater Remedy**

*Addendum to the PG&E Program Quality Assurance Project Plan for the Topock Groundwater Remedy*

SOP	Title	Version	Date
SOP-L17	Orthophosphate Analysis by Hach Method 8048	Rev 00	6/3/2014
SOP-L18	Manganese Analysis by Hach Method 8149	Rev 00	5/30/2014
SOP-L19	Total Dissolved Solids Analysis	Rev 00	5/29/2014
SOP-B16	Field-Portable X-Ray Fluorescence Soil Sampling	Rev 00	9/5/2008
SOP-C1	Solinst Pressure Transducers	Rev 01	5/2/2014
SOP-C2	Pressure Transducer Upload to Topock Database	Rev 01	5/2/2014
Remedy-SOP-01	Process Water Sampling	Rev 00	6/19/2012
Remedy-SOP-02	Safe Fueling and Fuel Handling Policy	Rev 00	7/5/2013

**Notes:**

The SOPs listed in this exhibit are provided in Appendix A of the Sampling and Monitoring Plan (Volume 2 of the O&M Manual).

Information from SOP-L5 was incorporated into SOP-L10; SOP-L5 was deleted.

Information from SOP-L11 was incorporated into SOP-L9; SOP-L11 was deleted.

Information from SOP-L12 was incorporated into SOP-L1 and SOP-L2; SOP-L12 was deleted.

### 3.3 Additional or Revised QC Steps for Hexavalent Chromium

The following quality control (QC) steps will be implemented for all samples related to the groundwater remedy:

1. Additional QC Step – All equipment blanks will be blind (versus being identified to the laboratory as “blank”, or “EB” for equipment blanks), with the exception of additional well-specific equipment blanks for the floodplain wells (see Step 2 in Section 3.4).
2. Additional QC Step – Certified filters will be purchased for groundwater and surface water samples. These filters are packaged with manufactures’ testing data and certification. If uncertified filters must be used, each lot (if lot information is available) will be analyzed for hexavalent chromium (Cr(VI)). If no lot number information is available, one filter per day will be analyzed for Cr(VI).
3. Revised QC Step – The following protocol for Cr(VI) has been established using the ammonium sulfate buffer solution for Cr(VI) sample preservation in the field:
  - Within 2 weeks prior to any field event requiring preservation for Cr(VI), fresh buffer solution will be made and the purity checked by the laboratory; the resulting chromatogram will be emailed to the CH2M HILL project chemist for verification.
  - All Cr(VI) samples will be field-filtered and preserved to a pH range of 9.3 to 9.7 with ammonium sulfate buffer solution.
  - The laboratory will confirm preservation at the time of sample receipt.
  - The Topock groundwater remedy will use EPA Methods E218.6 or SM3500-Cr (use of Methods SW7199 and SW7196 are restricted and must be approved by the project chemist) for Cr(VI) analyses. The use of these methods was approved by DTSC in 2008 (DTSC 2008).

### 3.4 Additional QC Steps for Hexavalent Chromium in Select Floodplain Well Samples

In addition to the QC steps discussed in Section 3.3, the additional QC steps outlined in this section will be followed during sampling of a) monitoring wells located in or near the floodplain (as defined in Exhibit 3-2) that are currently non-detect (or detected at less than 5 parts per billion) for Cr(VI), and b) future wells located in or

near the floodplain as determined by the CH2M HILL project chemist. As water quality changes, the list of wells in Exhibit 3-2 will be reviewed periodically (initially on an annual basis) and updated as applicable.

EXHIBIT 3-2

**Floodplain Wells Recommended for Additional Quality Control Steps**

*Addendum to the PG&E Program Quality Assurance Project Plan for the Topock Groundwater Remedy*

MW-21	MW-33-040	MW-43-075	MW-52S
MW-27-020	MW-34-055	MW-43-090	MW-53D
MW-27-060	MW-34-080	MW-44-070	MW-53M
MW-27-085	MW-36-070	MW-49-135	MW-54-85
MW-28-025	MW-39-040	MW-49-275	MW-54-140
MW-28-090	MW-42-055	MW-49-365	MW-54-195
MW-29	MW-42-065	MW-52D	MW-55-45
MW-32-020	MW-43-025	MW-52M	MW-55-120
MW-32-035			

The additional QC steps for the wells listed in Exhibit 3-2 are as follows:

- Two Cr(VI) sample containers will be filled for each floodplain well listed in Exhibit 3-2, field filtered, and preserved. The duplicate sample will be placed on hold at the laboratory and will not be analyzed unless needed to investigate an anomalous result.
  - Cr(VI) will be analyzed by method E218.6R.
  - The sample labels will have a designation of “1 of 2” and “2 of 2”.
  - The sample identifier (ID) will be recorded and the existence of two sample containers will be indicated on the CoC form.
- For each of the wells listed in Exhibit 3-2 that have non-dedicated pumps, an extra equipment blank will be collected after decontaminating the pump and prior to lowering the pump down the well. For example, if sampling has just been completed at MW-42-055 and the next well is MW-42-065, the sampling team will need to decontaminate the portable pump and then collect MW-42-065-XXX-EB before placing the pump in MW-42-065.
  - The well-specific equipment blanks (e.g., MW-42-065-XXX-EB) will be placed on hold and will not be analyzed unless needed to investigate an anomalous result.

The additional QC steps were put into place due to the sensitive nature of the sample locations, where low level detections could have large implications if shown to be correct. These additional QC steps are of little use for wells in the uplands where slight differences of a few ppb are of less concern, especially where the sample concentration is less than the background concentration. At the same time, samples with concentrations greater than 10 – 15 ppb can have sufficient variability within the analytical methods to exceed the possible influence from contamination sources or colloidal suspension concentrations.

Extra containers and EBs prescribed in Steps 1 and 2 above are collected to help determine the source for any possible anomalous results found in the wells listed in Exhibit 3-2. All the wells located near the river (specifically those around the active reducing zone) are susceptible to colloidal suspension of chromium which can cause a high variability between the Cr(T) and Cr(VI) results. The special EBs are collected to eliminate the possibility of cross-contamination between the wells (i.e., to verify that carry-over is not occurring).

Note that the MW-55 and MW-21 wells are not necessarily in the floodplain, but are located in areas “near” the river where the “normal” results are either non-detect or low concentrations. In the event results are “detected”

higher than normal or where the Cr(T) and Cr(VI) concentrations differed more than is considered normal, PG&E works to determine the likely causes and provide the analysis in the report where the results are reported.

### 3.5 Additional QC Steps for Cr(T) and Cr(VI) — River Samples

In addition to the QC steps discussed in Section 3.3, all river samples (shoreline and in-channel) will require the following additional QC steps:

1. For surface water sampling events; three analyte-specific sample containers will be collected from each sample location for both total chromium (Cr(T)) and Cr(VI). The laboratory will analyze the initial sample aliquot; if that result is an anomalous result (any detected concentration in the river will be considered anomalous), corrective action will be implemented and an additional aliquot of the original sample will be reanalyzed along with an aliquot from each of the additional sample volumes for comparison purposes. In addition, the agencies will be notified immediately if anomalous Cr(T) or Cr(VI) results are detected in river samples which require reanalysis.
  - Cr(VI) will be analyzed by method E218.6R. Cr(T) will be analyzed by SW-6020A.
  - The sample labels will have a designation of “1 of 3”, “2 of 3”, and “3 of 3”.
  - The sample ID will be recorded and the existence of three sample containers will be indicated on the CoC form.
2. Blank samples will be collected daily from two sets of randomly selected dedicated equipment (tubing).
3. In addition, one atmospheric (ambient) blank will be collected at the PG&E Topock site per day of river sampling. The atmospheric blank and the dedicated equipment blanks will be placed on hold at the laboratory, and analyzed only in event of river sample detections.
4. The laboratory is required to ensure that the buffer solution and initial calibration method blank concentrations are less than the method detection limit (MDL) prior to proceeding with sample analysis. In all cases in which corrective actions are applied, the CH2M HILL project chemist will be notified to aid in the corrective action process.
5. In the event corrective action is taken due to an anomalous result, the laboratory will document (in detail) the procedure in the analytical report’s case narrative. The narrative must include, at a minimum, the identity of each “anomalous” detection, the result from each analysis, the basis for what likely caused the detection if the detection is found unrelated to the actual sample (e.g., background contamination), and any future corrective action that will be implemented to resolve the identified problem(s).

### 3.6 Additional Laboratory QC Steps

To ensure precision and accuracy for the project, analytical laboratories will conduct the following additional QC steps for Cr(T) analyses, Cr(VI) analyses, and all other analyses.

#### All Cr(T) Analysis

1. The laboratory must use the average of three scans/injections to calculate relative standard deviation (RSD) for the analysis of all metals.
2. All reported detections must have a %RSD of less than or equal to 15% for the triplicate inductively coupled plasma/matrix spike injections.
3. All groundwater and soil samples will be digested using an appropriate method.
4. The laboratory may be asked to investigate situations where the Cr(T) and Cr(VI) results differ by more than 20% relative percent difference (RPD) for samples with concentrations > 4 ppb.



### **All Cr(VI) Analysis**

1. The laboratory will analyze a QC sample (low level check standard) after the initial calibration, at the reporting limit (RL) concentration.
2. The laboratory is required to ensure that the buffer solution, initial calibration blank, and method blank concentrations are less than the MDL prior to proceeding with sample analysis. Sample analysis will only proceed after the buffer solution and method blank concentrations are less than the MDL.
3. Initial calibration must be re-established if any of the following occur:
  - The last calibration was established more than 2 weeks prior to the start of a sample's analysis.
  - Two consecutive continuing calibration standards fail.
  - Any of the following operating conditions change:
    - Major maintenance is performed.
    - The system fluid is changed.
    - The instrument requires relocation.
    - The analytical column is replaced.
4. The laboratory will establish a retention time window and monitor the samples for exceedances.
5. If any calibration blank other than the initial calibration blank (see number 3 above) has a detection greater than the RL, and if there are detections in any sample, the laboratory records will document the concentrations and corrective action will be performed. The corrective action will include sample reanalysis and may also include change of reagents, eluate, and/or standards; and/or optimizing instrumentation. In all cases in which corrective actions are applied, the CH2M HILL project chemist will be notified to aid in the corrective action process.
6. If any calibration blank other than the initial calibration blank (see number 3 above) has a detection greater than the MDL but below the RL, and if there are detections in any sample, the laboratory records will document the concentrations and corrective action will be performed. However, the manner of reporting results will remain unchanged (i.e., results less than the RL will be reported as a non-detected result at 0.2 µg/L). Corrective action may include sample reanalysis; change of reagents, eluate and/or standards; and/or optimizing instrumentation. In all cases in which corrective actions are applied, the CH2M HILL project chemist will be notified to aid in the corrective action process.

### **All Other Analyses**

1. The laboratory will supply sample containers that are pre-cleaned and certified to EPA-specified standards for low level chemical analysis for all PG&E programs.
2. In all cases in which corrective actions are applied, the CH2M HILL project chemist will be notified to aid in the corrective action process.

## **4.0 Method Quality Objectives and Quality Assurance Program**

The data quality goal for the groundwater remedy is to achieve defensible data with the highest quality possible, given the variability of parameters for the groundwater remedy. The final output is a data set designed and validated to meet the qualitative and quantitative needs of the project. See Tables 4-1 through 4-3 for project-specific reporting level requirements and EPA/California screening-level information that may differ from the QAPP.

### **4.1 Analytical Requirements**

This Addendum specifies project-specific analytes and analytical methods that differ from the QAPP. All methods, analytes, or QC parameters specified in this Addendum that may differ from the QAPP supersede the criteria in the QAPP.

#### 4.1.1 Reporting Limits

RLs should be a minimum of two times greater than the calculated MDLs. RLs used by the laboratory should not be greater than the RL objectives listed in Tables 4-1 through 4-3. Note that in Table 4-1, the 0.4 mg/kg RL used for this project is currently the lowest RL achievable using SW7199/3060A and is well below the industrial soil screening level. Screening levels are established by use of statistical analysis and are not based on the analytical capabilities of laboratories or methods.

Only analytes detected at concentrations greater than the project-specific RL will be reported. Analytes detected at less than the RL will be flagged “U” and reported as not detected at the RL.

RLs and sample results shall be reported to two significant figures if less than 10 micrograms per liter (µg/L) (parts per billion) and to three significant figures otherwise.

#### 4.1.2 Calibration

In the initial calibration (for all instruments), a standard at a concentration equal to or less than the RL must be included.

Initial calibration must be re-established if any of the following conditions exist:

- The last calibration was established more than 1 year prior to the start of a sample’s analysis (gas chromatography, gas chromatography-mass spectrometry, inductively coupled plasma, and inductively coupled plasma-mass spectrometry)
- The last calibration was established more than 2 weeks prior to the start of a sample’s analysis (ion chromatography, and other “wet” chemistry analytical instruments)
- Two consecutive continuing calibration standards fail
- The operating conditions change; for example, any of the following:
  - Major maintenance is performed
  - The fluid or gas “carrier” type changes
  - The instrument requires relocation

#### 4.1.3 Matrix Spike for Hexavalent Chromium Analyses

Interference from Topock groundwater is known to reduce the sensitivity of Method EPA 218.6. This can result in an incorrect assessment of the analyte identification or the specific RL if the Matrix Spike and Dilution Protocol is not followed (see Section 5.4.4.1 of the QAPP). All Topock groundwater and surface water samples analyzed by Method EPA 218.6 will follow the Matrix Spike and Dilution Protocol.

#### 4.1.4 Matrix Spike and Dilution Protocol

Matrix interference has been encountered that affects the sensitivity for hexavalent chromium by ion chromatography methods. CH2M HILL shall direct the laboratories to perform an additional quality assurance/quality control (QA/QC) analyses to aid in assessing any effect on method sensitivity for each project due to the sample matrix. All Topock groundwater and surface water samples analyzed by Method EPA218.6 will follow the Matrix Spike and Dilution Protocol.

The analytes and analytical requirements are presented in Tables 4-1 through 4-3.

### 4.2 Data Validation

The validation for this QAPP addendum will follow the Level 3B designation from the QAPP and will be performed by the project chemist and designers.

## 5.0 Retention of Records

Hardcopy and electronic versions will be archived in project files, on electronic archive tapes, and/or other electronic storage media for the duration of remedy operation plus 10 years, as specified in contractual agreements. All electronic data will be subject to routine back-up until it is archived for long-term retention.

## 6.0 References

- California Department of Toxic Substances Control (DTSC). 1996. *Corrective Action Consent Agreement (Revised), Pacific Gas and Electric Company's Topock Compressor Station, Needles, California*. EPA ID No. CAT080011729. February 2.
- \_\_\_\_\_. 2008. Letter from Aaron Yue/DTSC to Yvonne Meeks/PG&E. Subject: "Analytical Method Change for Evaluation of Hexavalent Chromium at PG&E Topock Compressor Station, Needles, California (EPA ID No. CAT080011729)." January 18.
- CH2M HILL. 2007. *PG&E Topock – River Sampling and Lab Audit Project Audit Report* (Audit No. 3500753340-07-01).
- \_\_\_\_\_. 2012. *PG&E Program Quality Assurance Project Plan, Rev 2*. August.
- U.S. Environmental Protection Agency (EPA). 1996. *Test Methods for Evaluating Solid Waste, Physical and Chemical Methods, SW-846, 3<sup>rd</sup> Edition, Update 1-III*.
- \_\_\_\_\_. 2007. *Final Update Rule – Parts 122-503 of Title 40 of the Code of Federal Regulations (CFR)*.
- \_\_\_\_\_. 2012. *Final Update Rule – Parts 122-503 of Title 40 of the Code of Federal Regulations (CFR)*.
- U.S. Department of the Interior (DOI). 2013. Remedial Action/Remedial Design Consent Decree (CD) between the United States of America and Pacific Gas & Electric Company. Case 5:13-cv-00074-BRO-OP, Document 23. Entered November 21.



TABLE 4-1  
Reporting Limits, Accuracy, and Precession Limits for Soil  
PG&E Program Quality Assurance Project Plan Addendum

Method	Constituent	CAS	Units	QAPP RL <sup>1</sup>	EPA Regional Screening Levels - May 2012		EPA Regional Screening Levels - 2008		DTSC CHHSL		Most Stringent Screening Level <sup>2</sup>	Does RL Exceed Screening Level?	LCS Accuracy Control Limits (%R)		MS/MSD Accuracy Control Limits (%R)		Precision Soil
					Residential	Commercial	Residential	Commercial	Residential	Commercial			Lower Limit	Upper Limit	Lower Limit	Upper Limit	% RPD
SW 9012 or SW 9014	Cyanide	57-12-5	mg/kg	0.25	47	610	1,600	20,000	--	--	0,047	NO	*	*	*	*	30
Walkley-Black	Total organic carbon	TOC	mg/kg	50	--	--	--	--	--	--	--	NO	75	125	75	125	35
SW 9050	Specific conductance	Conductance	µmhos/cm	5	--	--	--	--	--	--	--	NO	75	125	75	125	20
SW 9045	pH	pH units	pH units	0.1	--	--	--	--	--	--	--	NO	--	--	--	--	20
SM 2540 B/EPA 160.3	percent moisture	Moist	Percent	--	--	--	--	--	--	--	--	NO	--	--	--	--	20
EPA 300.0	Fluoride	Fluoride	mg/kg	2	--	--	4,700	61,000	--	--	4,700	NO	70	130	70	130	35
EPA 300.0	Chloride	Chloride	mg/kg	2	--	--	--	--	--	--	--	NO	70	130	70	130	35
EPA 300.0	Sulfate	Sulfate	mg/kg	2	--	--	--	--	--	--	--	NO	70	130	70	130	35
EPA 821/R-91-100	Sulfide, acid volatile	18496-25-8	mg/kg	80	--	--	--	--	--	--	--	NO	70	130	70	130	30
SW 7199	Chromium, hexavalent	18540-29-9	mg/kg	0.4	0.29	5.6	230	1,400	17	17	0.29	YES	85	115	85	115	20
SW 6010B or C/SW 6020A/EPA 200.7/EPA 200.8	Aluminum	7429-90-5	mg/kg	10	77,000	990,000	77,000	990,000	--	--	77,000	NO	85	115	75	125	20
SW 6010B or C/SW 6020A/EPA 200.7/EPA 200.8	Antimony	7440-36-0	mg/kg	2	31	410	31	410	30	380	30	NO	85	115	75	125	20
SW 6010B or C/SW 6020A/EPA 200.7/EPA 200.8	Arsenic	7440-38-2	mg/kg	0.5	0.39	1.6	0.39	1.6	0.07	0.42	0.07	YES	85	115	75	125	20
SW 6010B or C/SW 6020A/EPA 200.7/EPA 200.8	Barium	7440-39-3	mg/kg	1	15,000	190,000	15,000	190,000	5,200	63,000	5,200	NO	85	115	75	125	20
SW 6010B or C/SW 6020A/EPA 200.7/EPA 200.8	Beryllium	7440-41-7	mg/kg	0.5	160	2,000	160	2,000	150	1,700	150	NO	85	115	75	125	20
SW 6010B or C/SW 6020A/EPA 200.7/EPA 200.8	Cadmium	7440-43-9	mg/kg	0.5	70	800	70	810	1.7	7.5	1.7	NO	85	115	75	125	20
SW 6010B or C/EPA 200.7	Calcium	7440-70-2	mg/kg	100	--	--	--	--	--	--	--	NO	85	115	75	125	20
SW 6010B or C/SW 6020A/EPA 200.7/EPA 200.8	Chromium	7440-47-3	mg/kg	1	--	--	280	1,400	*	*	280	NO	85	115	75	125	20
SW 6010B or C/SW 6020A/EPA 200.7/EPA 200.8	Cobalt	7440-48-4	mg/kg	1	23	300	23	300	660	3,200	23	NO	85	115	75	125	20
SW 6010B or C/SW 6020A/EPA 200.7/EPA 200.8	Copper	7440-50-8	mg/kg	1	3,100	41,000	3,100	41,000	3,000	38,000	3,000	NO	85	115	75	125	20
SW 6010B or C/EPA 200.7	Iron	7439-89-6	mg/kg	10	55,000	720,000	55,000	720,000	--	--	55,000	NO	85	115	75	125	20
SW 6010B or C/SW 6020A/EPA 200.7/EPA 200.8	Lead	7439-92-1	mg/kg	1	400	800	400	800	150	3,500	150	NO	85	115	75	125	20
SW 6010B or C/EPA 200.7	Magnesium	7439-95-4	mg/kg	100	--	--	--	--	--	--	--	NO	85	115	75	125	20
SW 6010B or C/SW 6020A/EPA 200.7/EPA 200.8	Manganese	7439-96-5	mg/kg	1	--	--	1,800	23,000	--	--	1,800	NO	85	115	75	125	20
SW 7471A/EPA 245.5	Mercury	7439-97-6	mg/kg	0.1	10	43	6.7	28	18	180	6.7	NO	75	125	75	125	20
SW 6010B or C/SW 6020A/EPA 200.7/EPA 200.8	Molybdenum	7439-98-7	mg/kg	1	390	5,100	390	5,100	380	4,800	380	NO	85	115	75	125	20
SW 6010B or C/SW 6020A/EPA 200.7/EPA 200.8	Nickel	7440-02-0	mg/kg	1	1,500	20,000	1,600	20,000	1,600	16,000	1,500	NO	85	115	75	125	20
SW 6010B or C/EPA 200.7	Potassium	7440-09-1	mg/kg	100	--	--	--	--	--	--	--	NO	85	115	75	125	20
SW 6010B or C/SW 6020A/EPA 200.7/EPA 200.8	Selenium	7782-49-2	mg/kg	1	390	5,100	390	5,100	380	4,800	380	NO	85	115	75	125	20
SW 6010B or C/SW 6020A/EPA 200.7/EPA 200.8	Silver	7440-22-4	mg/kg	1	390	5,100	390	5,100	380	4,800	380	NO	85	115	75	125	20
SW 6010B or C/EPA 200.7	Sodium	7440-23-5	mg/kg	100	--	--	--	--	--	--	--	NO	85	115	75	125	20
SW 6010B or C/SW 6020A/EPA 200.7/EPA 200.8	Thallium	7440-28-0	mg/kg	2	0.78	10	5.1	66	5	63	0.78	YES	85	115	75	125	20
SW 6010B or C/SW 6020A/EPA 200.7/EPA 200.8	Vanadium	7440-62-2	mg/kg	1	--	--	550	7,200	530	6,700	530	NO	85	115	75	125	20
SW 6010B or C/SW 6020A/EPA 200.7/EPA 200.8	Zinc	7440-66-6	mg/kg	2	23,000	310,000	23,000	310,000	23,000	100,000	23,000	NO	85	115	75	125	20
SW 8015B or C or D	Motor Oil	TPH-motor oil	mg/kg	10	--	--	--	--	--	--	--	NO	60	120	60	120	50
SW 8015B or C or D	TPH-Diesel	TPH-diesel	mg/kg	10	--	--	--	--	--	--	--	NO	51	153	51	153	50
SW 8015B or C or D	TPH-Gasoline	TPH-gasoline	mg/kg	1	--	--	--	--	--	--	--	NO	57	146	57	146	50
SW 8081A or B	4,4'-DDD	72-54-8	ug/kg	4	2,000	7,200	2,000	7,200	2,300	9,000	2,000	NO	50	139	50	139	50
SW 8081A or B	4,4'-DDE	72-55-9	ug/kg	4	1,400	5,100	1,400	5,100	1,600	6,300	1,400	NO	68	126	68	126	50
SW 8081A or B	4,4'-DDT	50-29-3	ug/kg	4	1,700	7,000	1,700	7,000	1,600	6,300	1,600	NO	46	135	46	135	50
SW 8081A or B	Aldrin	309-00-2	ug/kg	4	29	100	29	100	33	130	29	NO	47	120	47	120	50
SW 8081A or B	alpha-HCH	319-84-6	ug/kg	4	77	270	77	270	--	--	77	NO	62	125	62	125	50
SW 8081A or B	alpha-Chlordane	5103-71-9	ug/kg	4	--	--	--	--	430	1,700	430	NO	63	121	63	121	50
SW 8081A or B	beta-HCH	319-85-7	ug/kg	4	270	960	320	1,300	--	--	270	NO	62	127	62	127	50
SW 8081A or B	delta-HCH	319-86-8	ug/kg	4	--	--	--	--	--	--	--	NO	57	130	57	130	50
SW 8081A or B	Dieldrin	60-57-1	ug/kg	4	30	110	30	110	35	130	30	NO	67	125	67	125	50
SW 8081A or B	Endosulfan I	959-98-8	ug/kg	4	--	--	--	--	--	--	--	NO	41	147	41	147	50
SW 8081A or B	Endosulfan II	33213-65-9	ug/kg	4	--	--	--	--	--	--	--	NO	37	141	37	141	50
SW 8081A or B	Endosulfan sulfate	1031-07-8	ug/kg	4	--	--	--	--	--	--	--	NO	62	135	62	135	50
SW 8081A or B	Endrin	72-20-8	ug/kg	4	18,000	180,000	18,000	180,000	21,000	230,000	18,000	NO	61	133	61	133	50
SW 8081A or B	Endrin aldehyde	7421-93-4	ug/kg	4	--	--	--	--	--	--	--	NO	37	147	37	147	50
SW 8081A or B	gamma-HCH (Lindane)	58-89-9	ug/kg	4	520	2,100	520	21,000	500	2,000	500	NO	59	123	59	123	50
SW 8081A or B	gamma-Chlordane	5103-74-2	ug/kg	4	--	--	--	--	430	1,700	430	NO	48	124	48	124	50
SW 8081A or B	Heptachlor	76-44-8	ug/kg	4	110	380	110	380	130	520	110	NO	51	140	51	140	50
SW 8081A or B	Heptachlor epoxide	1024-57-3	ug/kg	4	53	190	53	190	--	--	53	NO	66	130	66	130	50
SW 8081A or B	Methoxychlor	72-43-5	ug/kg	20	310,000	3,100,000	310,000	3,100,000	340,000	3,800,000	310,000	NO	57	143	57	143	50
SW 8081A or B	Toxaphene	8001-35-2	ug/kg	100	440	1,600	440	1,600	460	1,800	440	NO	31	136	31	136	50
SW 8082 or A	Aroclor-1016	12674-11-2	ug/kg	50	3,900	21,000	3,900	21,200	--	--	3,900	NO	41	138	41	138	50
SW 8082 or A	Aroclor-1221	11104-28-2	ug/kg	50	140	540	170	620	--	--	140	NO	45	136	45	136	50
SW 8082 or A	Aroclor-1232	11141-16-5	ug/kg	50	140	540	170	620	--	--</							

TABLE 4-1  
Reporting Limits, Accuracy, and Precession Limits for Soil  
PG&E Program Quality Assurance Project Plan Addendum

Method	Constituent	CAS	Units	QAPP RL <sup>1</sup>	EPA Regional Screening Levels - May 2012		EPA Regional Screening Levels - 2008		DTSC CHHSL		Most Stringent Screening Level <sup>2</sup>	Does RL Exceed Screening Level?	LCS Accuracy Control Limits (%R)		MS/MSD Accuracy Control Limits (%R)		Precision Soil
					Residential	Commercial	Residential	Commercial	Residential	Commercial			Lower Limit	Upper Limit	Lower Limit	Upper Limit	% RPD
SW 8151A	2,4-DB	94-82-6	ug/kg	500	490,000	4,900,000	490	4,900	--	--	490	YES	42	145	42	145	50
SW 8151A	2,4,5-T	93-76-5	ug/kg	500	610,000	6,200,000	610	6,200	7,700	6,100	610	NO	43	139	43	139	50
SW 8151A	2,4,5-TP	93-72-1	ug/kg	200	490,000	4,900,000	490	4,900	--	--	490	NO	46	128	46	128	50
SW 8151A	Dalapon	75-99-0	ug/kg	100	1,800,000	18,000,000	1,800	18,000	--	--	1,800	NO	22	125	22	125	50
SW 8151A	Dicamba	1918-00-9	ug/kg	500	1,800,000	18,000,000	1,800	18,000	--	--	1,800	NO	56	120	56	120	50
SW 8151A	Dichloroprop	120-36-5	ug/kg	500	--	--	--	--	--	--	--	NO	72	142	72	142	50
SW 8151A	Dinoseb	88-85-7	ug/kg	100	61,000	620,000	61	620	--	--	61	YES	20	131	20	131	50
SW 8151A	MCPA	94-74-6	ug/kg	1,000	31,000	310,000	31	310	--	--	31	YES	65	120	65	120	50
SW 8151A	MCPP	7085-19-0	ug/kg	1,500	--	--	61	620	--	--	61	YES	60	118	60	118	50
SW 8260B or C	1,1,1,2-Tetrachloroethane	630-20-6	ug/kg	5	1,900	9,300	2,000	9,800	--	--	1,900	NO	74	125	74	125	30
SW 8260B or C	1,1,1-Trichloroethane (TCA)	71-55-6	ug/kg	5	8,700,000	38,000,000	9,000,000	39,000,000	--	--	8,700,000	NO	68	130	68	130	30
SW 8260B or C	1,1,2,2-Tetrachloroethane	79-34-5	ug/kg	5	560	2,800	590	2,900	--	--	560	NO	59	140	59	140	30
SW 8260B or C	1,1,2-Trichloroethane	79-00-5	ug/kg	5	1,100	5,300	1,100	5,500	--	--	1,100	NO	62	127	62	127	30
SW 8260B or C	1,1,2-Trichlorotrifluoroethane (Freon 113)	76-13-1	ug/kg	5	43,000,000	180,000,000	43,000,000	180,000,000	--	--	43,000,000	NO	65	135	65	135	30
SW 8260B or C	1,1-Dichloroethane	75-34-3	ug/kg	5	3,300	17,000	3,400	17,000	--	--	3,300	NO	73	125	73	125	30
SW 8260B or C	1,1-Dichloroethylene	75-35-4	ug/kg	5	240,000	1,100,000	250,000	1,100,000	--	--	240,000	NO	65	136	65	136	30
SW 8260B or C	1,1-Dichloropropene	563-58-6	ug/kg	5	--	--	--	--	--	--	--	NO	70	135	70	135	30
SW 8260B or C	1,2,3-Trichlorobenzene	87-61-6	ug/kg	5	49,000	490,000	--	--	--	--	49,000	NO	62	133	62	133	30
SW 8260B or C	1,2,3-Trichloropropane	96-18-4	ug/kg	5	5	95	91	410	--	--	5	NO	63	130	63	130	30
SW 8260B or C	1,2,4-Trichlorobenzene	120-82-1	ug/kg	5	22,000	99,000	87,000	400,000	--	--	22,000	NO	65	131	65	131	30
SW 8260B or C	1,2,4-Trimethylbenzene	95-63-6	ug/kg	5	62,000	260,000	67,000	280,000	--	--	62,000	NO	65	135	65	135	30
SW 8260B or C	1,2-Dibromo-3-chloropropane	96-12-8	ug/kg	5	5.4	69	5.6	73	--	--	5.4	NO	49	135	49	135	30
SW 8260B or C	1,2-Dibromoethane (EDB)	106-93-4	ug/kg	5	34	170	34	170	--	--	34	NO	70	124	70	124	30
SW 8260B or C	1,2-Dichlorobenzene	95-50-1	ug/kg	5	1,900,000	9,800,000	2,000,000	10,000,000	--	--	1,900,000	NO	74	120	74	120	30
SW 8260B or C	1,2-Dichloroethane (EDC)	107-06-2	ug/kg	5	430	2,200	450	2,200	--	--	430	NO	72	137	72	137	30
SW 8260B or C	1,2-Dichloropropane	78-87-5	ug/kg	5	940	4,700	930	4,700	--	--	930	NO	71	120	71	120	30
SW 8260B or C	1,3,5-Trimethylbenzene	108-67-8	ug/kg	5	780,000	10,000,000	47,000	200,000	--	--	47,000	NO	65	133	65	133	30
SW 8260B or C	1,3-Dichlorobenzene	541-73-1	ug/kg	5	--	--	--	--	--	--	--	NO	72	124	72	124	30
SW 8260B or C	1,3-Dichloropropane	142-28-9	ug/kg	5	1,600,000	20,000,000	1,600,000	20,000,000	--	--	1,600,000	NO	76	123	76	123	30
SW 8260B or C	1,4-Dichlorobenzene	106-46-7	ug/kg	5	2,400	12,000	2,600	13,000	--	--	2,400	NO	72	125	72	125	30
SW 8260B or C	2,2-Dichloropropane	594-20-7	ug/kg	5	--	--	--	--	--	--	--	NO	67	134	67	134	30
SW 8260B or C	2-Butanone (MEK)	78-93-3	ug/kg	50	28,000,000	200,000,000	28,000,000	190,000,000	--	--	28,000,000	NO	40	135	40	135	30
SW 8260B or C	2-Chlorotoluene	95-49-8	ug/kg	5	1,600,000	20,000,000	1,600,000	20,000,000	--	--	1,600,000	NO	69	128	69	128	30
SW 8260B or C	4-Chlorotoluene	106-43-4	ug/kg	5	1,600,000	20,000,000	5,500,000	72,000,000	--	--	1,600,000	NO	73	126	73	126	30
SW 8260B or C	4-Isopropyltoluene	99-87-6	ug/kg	6	--	--	--	--	--	--	--	NO	75	133	75	133	30
SW 8260B or C	4-Methyl-2-pentanone	108-10-1	ug/kg	50	5,300,000	53,000,000	5,300,000	52,000,000	--	--	5,300,000	NO	65	135	65	135	30
SW 8260B or C	Acetone	67-64-1	ug/kg	50	61,000,000	630,000,000	61,000,000	610,000,000	--	--	61,000,000	NO	40	141	40	141	30
SW 8260B or C	Acrolein	107-02-8	ug/kg	100	150	650	160	680	--	--	150	NO	65	135	65	135	30
SW 8260B or C	Acrylonitrile	107-13-1	ug/kg	50	240	1,200	240	1,200	--	--	240	NO	65	135	65	135	30
SW 8260B or C	Benzene	71-43-2	ug/kg	5	1,100	5,400	1,100	5,600	--	--	1,100	NO	73	126	73	126	30
SW 8260B or C	Bromobenzene	108-86-1	ug/kg	5	300,000	1,800,000	94,000	410,000	--	--	94,000	NO	66	121	66	121	30
SW 8260B or C	Bromochloromethane	74-97-5	ug/kg	5	160,000	680,000	--	--	--	--	160,000	NO	71	127	71	127	30
SW 8260B or C	Bromodichloromethane	75-27-4	ug/kg	5	270	1,400	10,000	46,000	--	--	0,270	NO	72	128	72	128	30
SW 8260B or C	Bromoform	75-25-2	ug/kg	6	62,000	220,000	61,000	220,000	--	--	61,000	NO	66	137	66	137	30
SW 8260B or C	Bromomethane	74-83-9	ug/kg	5	7,300	32,000	7,900	35,000	--	--	7,300	NO	45	141	45	141	30
SW 8260B or C	Carbon disulfide	75-15-0	ug/kg	5	820,000	3,700,000	670,000	3,000,000	--	--	670,000	NO	65	135	65	135	30
SW 8260B or C	Carbon tetrachloride	56-23-5	ug/kg	5	610	3,000	250	1,300	--	--	250	NO	67	133	67	133	30
SW 8260B or C	Chlorobenzene	108-90-7	ug/kg	5	290,000	1,400,000	310,000	1,500,000	--	--	290,000	NO	75	123	75	123	30
SW 8260B or C	Chloroethane	75-00-3	ug/kg	5	15,000,000	61,000,000	15,000,000	62,000,000	--	--	15,000,000	NO	41	141	41	141	30
SW 8260B or C	Chloroform	67-66-3	ug/kg	2	290	1,500	300	1,500	--	--	290	NO	72	124	72	124	30
SW 8260B or C	Chloromethane	74-87-3	ug/kg	5	120,000	500,000	1,700	8,400	--	--	1,700	NO	51	129	51	129	30
SW 8260B or C	cis-1,2-Dichloroethene	156-59-2	ug/kg	5	160,000	2,000,000	780,000	10,000,000	--	--	160,000	NO	67	125	67	125	30
SW 8260B or C	cis-1,3-Dichloropropene	10061-01-5	ug/kg	5	--	--	--	--	--	--	--	NO	72	126	72	126	30
SW 8260B or C	Dibromochloromethane	124-48-1	ug/kg	5	680	3,300	5,800	21,000	--	--	0,680	NO	66	130	66	130	30
SW 8260B or C	Dibromomethane	74-95-3	ug/kg	5	25,000	110,000											

TABLE 4-1  
Reporting Limits, Accuracy, and Precession Limits for Soil  
PG&E Program Quality Assurance Project Plan Addendum

Method	Constituent	CAS	Units	QAPP RL <sup>1</sup>	EPA Regional Screening Levels - May 2012		EPA Regional Screening Levels - 2008		DTSC CHHSL		Most Stringent Screening Level <sup>2</sup>	Does RL Exceed Screening Level?	LCS Accuracy Control Limits (%R)		MS/MSD Accuracy Control Limits (%R)		Precision Soil
					Residential	Commercial	Residential	Commercial	Residential	Commercial			Lower Limit	Upper Limit	Lower Limit	Upper Limit	% RPD
SW 8260B or C	tert-Butylbenzene	98-06-6	ug/kg	5	--	--	--	--	--	--	--	NO	65	132	65	132	30
SW 8260B or C	Tetrachloroethene	127-18-4	ug/kg	5	22,000	110,000	570	2,700	--	--	570	NO	67	139	67	139	30
SW 8260B or C	Toluene	108-88-3	ug/kg	5	5,000,000	45,000,000	5,000,000	46,000,000	--	--	5,000,000	NO	71	127	71	127	30
SW 8260B or C	trans-1,2-Dichloroethene	156-60-5	ug/kg	5	150,000	690,000	110,000	500,000	--	--	110,000	NO	66	134	66	134	30
SW 8260B or C	trans-1,3-Dichloropropene	10061-02-6	ug/kg	5	--	--	--	--	--	--	--	NO	65	127	65	127	30
SW 8260B or C	Trichloroethene	79-01-6	ug/kg	5	910	6,400	2,800	14,000	--	--	0,910	NO	77	124	77	124	30
SW 8260B or C	Trichlorofluoromethane (Freon 11)	75-69-4	ug/kg	5	790,000	3,400,000	800,000	3,400,000	--	--	790,000	NO	49	139	49	139	30
SW 8260B or C	Vinyl Chloride	75-01-4	ug/kg	5	60	1,700	60	1,700	--	--	60	NO	58	126	58	126	30
SW 8260B or C	Xylenes, Total	1330-20-7	ug/kg	15	630,000	2,700,000	600,000	2,600,000	--	--	600,000	NO	65	125	65	125	50
SW 8260B or C	m-Xylene	108-38-3	ug/kg	10	590,000	2,500,000	4,500,000	19,000,000	--	--	590,000	NO	79	126	79	126	30
SW 8260B or C	p-Xylene	106-42-3	ug/kg	10	600,000	2,600,000	4,700,000	20,000,000	--	--	600,000	NO	79	126	79	126	30
SW 8260B or C	o-Xylene	95-47-6	ug/kg	5	690,000	3,000,000	5,300,000	23,000,000	--	--	690,000	NO	77	125	77	125	30
SW 8270C or D	1,2,4-Trichlorobenzene	120-82-1	ug/kg	330	22,000	99,000	87,000	400,000	--	--	22,000	NO	44	125	44	125	30
SW 8270C or D	1,2-Dichlorobenzene	95-50-1	ug/kg	330	1,900,000	9,800,000	2,000,000	10,000,000	--	--	1,900,000	NO	45	125	45	125	30
SW 8270C or D	1,3-Dichlorobenzene	541-73-1	ug/kg	330	--	--	--	--	--	--	--	NO	39	125	39	125	30
SW 8270C or D	1,4-Dichlorobenzene	106-46-7	ug/kg	330	2,400	12,000	2,600	13,000	--	--	2,400	NO	35	125	35	125	30
SW 8270C or D	2,4,5-Trichlorophenol	95-95-4	ug/kg	700	6,100,000	62,000,000	6,100,000	62,000,000	--	--	6,100,000	NO	49	125	49	125	30
SW 8270C or D	2,4,6-Trichlorophenol	88-06-2	ug/kg	330	44,000	160,000	44,000	160,000	--	--	44,000	NO	43	125	43	125	30
SW 8270C or D	2,4-Dichlorophenol	120-83-2	ug/kg	330	180,000	1,800,000	180,000	1,800,000	--	--	180,000	NO	45	125	45	125	30
SW 8270C or D	2,4-Dimethylphenol	105-67-9	ug/kg	330	1,200,000	12,000,000	1,200,000	12,000,000	--	--	1,200,000	NO	32	125	32	125	30
SW 8270C or D	2,4-Dinitrophenol	51-28-5	ug/kg	700	120,000	1,200,000	120,000	1,200,000	--	--	120,000	NO	25	132	25	132	30
SW 8270C or D	2,4-Dinitrotoluene	121-14-2	ug/kg	330	1,600	5,500	120,000	1,200,000	--	--	1,600	NO	48	125	48	125	30
SW 8270C or D	2,6-Dinitrotoluene	606-20-2	ug/kg	330	61,000	620,000	61,000	620,000	--	--	61,000	NO	48	125	48	125	30
SW 8270C or D	2-Chloronaphthalene	91-58-7	ug/kg	330	6,300,000	82,000,000	6,300,000	82,000,000	--	--	6,300,000	NO	45	125	45	125	30
SW 8270C or D	2-Chlorophenol	95-57-8	ug/kg	330	390,000	5,100,000	390,000	5,100,000	--	--	390,000	NO	44	125	44	125	30
SW 8270C or D	2-Methylnaphthalene	91-57-6	ug/kg	330	230,000	2,200,000	310,000	4,100,000	--	--	230,000	NO	47	125	47	125	30
SW 8270C or D	2-Methylphenol (o-Cresol)	95-48-7	ug/kg	330	3,100,000	31,000,000	3,100,000	31,000,000	--	--	3,100,000	NO	40	125	40	125	30
SW 8270C or D	2-Nitroaniline	88-74-4	ug/kg	700	610,000	6,000,000	--	--	--	--	610,000	NO	44	125	44	125	30
SW 8270C or D	2-Nitrophenol	88-75-5	ug/kg	700	--	--	--	--	--	--	--	NO	42	125	42	125	30
SW 8270C or D	3,3'-Dichlorobenzidine	91-94-1	ug/kg	1,300	1,100	3,800	1,100	3,800	--	--	1,100	YES	25	128	25	128	30
SW 8270C or D	3-Nitroaniline	99-09-2	ug/kg	700	--	--	18,000	82,000	--	--	18,000	NO	27	125	27	125	30
SW 8270C or D	4,6-Dinitro-2-methylphenol	534-52-1	ug/kg	1600	4,900	49,000	6,100	62,000	--	--	4,900	NO	29	137	29	137	30
SW 8270C or D	4-Bromophenyl phenyl ether	101-55-3	ug/kg	330	--	--	--	--	--	--	--	NO	46	125	46	125	30
SW 8270C or D	4-Chloro-3-methylphenol	59-50-7	ug/kg	600	6,100,000	62,000,000	--	--	--	--	6,100,000	NO	46	125	46	125	30
SW 8270C or D	4-Chloroaniline	106-47-8	ug/kg	700	2,400	8,600	9,000	32,000	--	--	2,400	NO	10	125	10	125	30
SW 8270C or D	4-Chlorophenyl phenyl ether	7005-72-3	ug/kg	330	--	--	--	--	--	--	--	NO	47	125	47	125	30
SW 8270C or D	4-Methylphenol (p-Cresol)	106-44-5	ug/kg	330	6,100,000	62,000,000	310,000	3,100,000	--	--	310,000	NO	41	125	41	125	30
SW 8270C or D	4-Nitroaniline	100-01-6	ug/kg	700	24,000	86,000	23,000	82,000	--	--	23,000	NO	34	125	34	125	30
SW 8270C or D	4-Nitrophenol	100-02-7	ug/kg	700	--	--	--	--	--	--	--	NO	25	138	25	138	30
SW 8270C or D	Acenaphthene	83-32-9	ug/kg	330	3,400,000	33,000,000	3,400,000	33,000,000	--	--	3,400,000	NO	46	125	46	125	30
SW 8270C or D	Acenaphthylene	208-96-8	ug/kg	330	--	--	--	--	--	--	--	NO	44	125	44	125	30
SW 8270C or D	Anthracene	120-12-7	ug/kg	330	17,000,000	170,000,000	17,000,000	170,000,000	--	--	17,000,000	NO	53	125	53	125	30
SW 8270C or D	Benzo (a) anthracene	56-55-3	ug/kg	330	150	2,100	150	2,100	--	--	150	YES	52	125	52	125	30
SW 8270C or D	Benzo (a) pyrene	50-32-8	ug/kg	330	15	210	15	210	38	130	15	YES	50	125	50	125	30
SW 8270C or D	Benzo (b) fluoranthene	205-99-2	ug/kg	330	150	2,100	150	2,100	--	--	150	YES	45	125	45	125	30
SW 8270C or D	Benzo (g,h,i) perylene	191-24-2	ug/kg	330	--	--	--	--	--	--	--	NO	38	126	38	126	30
SW 8270C or D	Benzo (k) fluoranthene	207-08-9	ug/kg	330	1,500	21,000	1,500	21,000	--	--	1,500	NO	45	125	45	125	30
SW 8270C or D	Benzoic acid	65-85-0	ug/kg	5,000	240,000,000	2,500,000,000	240,000,000	2,500,000,000	--	--	240,000,000	NO	25	125	25	125	30
SW 8270C or D	Benzyl alcohol	100-51-6	ug/kg	330	6,100,000	62,000,000	31,000,000	310,000,000	--	--	6,100,000	NO	25	125	25	125	30
SW 8270C or D	bis (2-chloroethoxy) methane	111-91-1	ug/kg	330	180,000	1,800,000	180,000	1,800,000	--	--	180,000	NO	43	125	43	125	30
SW 8270C or D	bis (2-chloroethyl) ether	111-44-4	ug/kg	330	210	1,000	190	900	--	--	190	YES	38	125	38	125	30
SW 8270C or D	bis (2-chloroisopropyl) ether	108-60-1	ug/kg	330	4,600	22,000	3,500	17,000	--	--	3,500	NO	25	125	25	125	30
SW 8270C or D	bis (2-ethylhexyl																

TABLE 4-1  
Reporting Limits, Accuracy, and Precession Limits for Soil  
PG&E Program Quality Assurance Project Plan Addendum

Method	Constituent	CAS	Units	QAPP RL <sup>1</sup>	EPA Regional Screening Levels - May 2012		EPA Regional Screening Levels - 2008		DTSC CHHSL		Most Stringent Screening Level <sup>2</sup>	Does RL Exceed Screening Level?	LCS Accuracy Control Limits (%R)		MS/MSD Accuracy Control Limits (%R)		Precision Soil
					Residential	Commercial	Residential	Commercial	Residential	Commercial			Lower Limit	Upper Limit	Lower Limit	Upper Limit	% RPD
SW 8270C or D	Indeno (1,2,3-c,d) pyrene	193-39-5	ug/kg	330	150	2,100	150	2,100	--	--	150	YES	38	125	38	125	30
SW 8270C or D	Isophorone	78-59-1	ug/kg	330	510,000	1,800,000	510,000	1,800,000	--	--	510,000	NO	43	125	43	125	30
SW 8270C or D	Naphthalene	91-20-3	ug/kg	330	3,600	18,000	3,900	20,000	--	--	3,600	NO	40	125	40	125	30
SW 8270C or D	Nitrobenzene	98-95-3	ug/kg	330	4,800	24,000	31,000	280,000	--	--	4,800	NO	41	125	41	125	30
SW 8270C or D	n-Nitrosodi-n-propylamine	621-64-7	ug/kg	330	69	250	69	250	--	--	69	YES	40	125	40	125	30
SW 8270C or D	n-Nitrosodiphenylamine	86-30-6	ug/kg	330	99,000	350,000	99,000	350,000	--	--	99,000	NO	49	125	49	125	30
SW 8270C or D	Pentachlorophenol	87-86-5	ug/kg	700	890	2,700	3,000	9,000	4,400	13,000	0,890	NO	25	125	25	125	30
SW 8270C or D	Phenanthrene	85-01-8	ug/kg	330	--	--	--	--	--	--	--	NO	50	125	50	125	30
SW 8270C or D	Phenol	108-95-2	ug/kg	330	18,000,000	180,000,000	18,000,000	180,000,000	--	--	18,000,000	NO	39	125	39	125	30
SW 8270C or D	Pyrene	129-00-0	ug/kg	330	1,700,000	17,000,000	1,700,000	17,000,000	--	--	1,700,000	NO	46	125	46	125	30
SW 8270SIM	1-methylnaphthalene	90-12-0	ug/kg	5	16,000	53,000	22,000	99,000	--	--	16,000	NO	30	111	30	111	30
SW 8270SIM	2-methylnaphthalene	91-57-6	ug/kg	5	230,000	2,200,000	310,000	4,100,000	--	--	230,000	NO	30	111	30	111	30
SW 8270SIM	Acenaphthene	83-32-9	ug/kg	5	3,400,000	33,000,000	3,400,000	33,000,000	--	--	3,400,000	NO	28	110	28	110	30
SW 8270SIM	Acenaphthylene	208-96-8	ug/kg	5	--	--	--	--	--	--	--	NO	23	126	23	126	30
SW 8270SIM	Anthracene	120-12-7	ug/kg	5	17,000,000	170,000,000	17,000,000	170,000,000	--	--	17,000,000	NO	28	136	28	136	30
SW 8270SIM	Benzo (a) anthracene	56-55-3	ug/kg	5	150	2,100	150	2,100	--	--	150	NO	31	146	31	146	30
SW 8270SIM	Benzo (a) pyrene	50-32-8	ug/kg	5	15	210	15	210	38	130	15	NO	28	128	28	128	30
SW 8270SIM	Benzo (b) fluoranthene	205-99-2	ug/kg	5	150	2,100	150	2,100	--	--	150	NO	30	139	30	139	30
SW 8270SIM	Benzo (g,h,i) perylene	191-24-2	ug/kg	5	--	--	--	--	--	--	--	NO	21	149	21	149	30
SW 8270SIM	Benzo (k) fluoranthene	207-08-9	ug/kg	5	1,500	21,000	1,500	21,000	--	--	1,500	NO	42	129	42	129	30
SW 8270SIM	Chrysene	218-01-9	ug/kg	5	15,000	210,000	15,000	210,000	--	--	15,000	NO	39	134	39	134	30
SW 8270SIM	Dibenzo (a,h) anthracene	53-70-3	ug/kg	5	15	210	15	210	--	--	15	NO	30	138	30	138	30
SW 8270SIM	Fluoranthene	206-44-0	ug/kg	5	2,300,000	22,000,000	2,300,000	22,000,000	--	--	2,300,000	NO	30	142	30	142	30
SW 8270SIM	Fluorene	86-73-7	ug/kg	5	2,300,000	22,000,000	2,300,000	22,000,000	--	--	2,300,000	NO	27	116	27	116	30
SW 8270SIM	Indeno (1,2,3-c,d) pyrene	193-39-5	ug/kg	5	150	2,100	150	2,100	--	--	150	NO	17	164	17	164	30
SW 8270SIM	Naphthalene	91-20-3	ug/kg	5	3,600	18,000	3,900	20,000	--	--	3,600	NO	29	106	29	106	30
SW 8270SIM	Phenanthrene	85-01-8	ug/kg	5	--	--	--	--	--	--	--	NO	32	127	32	127	30
SW 8270SIM	Pyrene	129-00-0	ug/kg	5	1,700,000	17,000,000	1,700,000	17,000,000	--	--	1,700,000	NO	28	130	28	130	30

**Notes:**

\*\*Please keep in mind, Screening Levels are constantly revised by the EPA. The appropriate Screening levels are specific to the project, the location, the agency providing oversight, and the overall Goals of the project.\*\*

mg/kg = milligrams per kilogram  
ug/kg = micrograms per kilogram  
µmhos/cm = micromhos per centimeter

All soil results (with the exception of Waste characterization) must be reported as dry weight  
SW 7199 soil analysis must be accompanied by a SW 3060A extraction  
PCB - LCS, MS, and MSD only require Aroclor-1016 and Aroclor-1260 spikes

<sup>1</sup> Screening levels are established by use of statistical analysis and are not based on the analytical capabilities of laboratories or methods. The 0.4 mg/kg RL used for hexavalent chromium for this project is currently the lowest RL achievable using SW7199/3060A and is well below the industrial soil screening level.  
<sup>2</sup> For soil, most stringent of:  
EPA Regional Screening Levels - 2008 and May 2012  
CHHSL = California Human Health Screening Levels, January 2005  
DTSC = California Department of Toxic Substance Control, January 2005



TABLE 4-2  
Reporting Limits, Accuracy, and Precession Limits for Groundwater  
PG&E Program Quality Assurance Project Plan Addendum

Method	Constituent	CAS	Units	QAPP RL	EPA Regional	EPA Regional	Federal Drinking	California	Most Stringent	Does RL Exceed	Does RL Exceed	Does RL Exceed	Does RL Exceed	LCS Accuracy Control		MS/MSD Accuracy		Precision
					Screening Levels	Screening Levels	Water Standards	Drinking Water						Limits (%R)		Control Limits (%R)		
					May 2012	2008	MCLs	MCLs						Lower	Upper	Lower	Upper	
									Screening Level <sup>1</sup>	Screening Level?	Federal MCL Level?	California MCL Level?	Limit	Limit	Limit	Limit	% RPD	
EPA 300.0M	Acetate	64-19-7	mg/L	0.1	--	--	--	--	--	NO	NO	NO	75	125	75	125	20	
SM 2320 B	Alkalinity	Alkalinity	mg/L	5	--	--	--	--	--	NO	NO	NO	85	115	75	125	20	
SM 4500-NH3 B, C, D, E, or G	Ammonia (as N)	7664-41-7	mg/L	0.5	--	--	--	--	--	NO	NO	NO	85	115	75	125	20	
SM 2320 B	Bicarbonate	Bicarbonate	mg/L	5	--	--	--	--	--	NO	NO	NO	85	115	75	125	20	
SM 5210 B	BOD	BOD	mg/L	--	--	--	--	--	--	NO	NO	NO	--	--	--	--	10	
EPA 300.0	Bromide	Bromide	mg/L	0.5	--	--	--	--	--	NO	NO	NO	90	110	80	120	20	
EPA 300.0M	Butyrate	107-92-6	mg/L	0.1	--	--	--	--	--	NO	NO	NO	75	125	75	125	20	
SM 4500-CO <sub>2</sub>	Carbon dioxide	124-38-9	mg/L	5	--	--	--	--	--	NO	NO	NO	--	--	--	--	20	
SM 2320 B	Carbonate	Carbonate	mg/L	5	--	--	--	--	--	NO	NO	NO	85	115	75	125	20	
EPA 300.0/SM 4500-Cl B, C, E, or I	Chloride	Chloride	mg/L	0.5	--	--	--	--	--	NO	NO	NO	90	110	80	120	20	
SM 2120 E	Color	Color	Color unit	1	--	--	--	--	--	NO	NO	NO	90	110	90	110	20	
SM 4500-CN	Cyanide	57-12-5	mg/L	0.01	0.00014		0.2	0.15	0.00014	YES	NO	NO	85	115	75	125	20	
EPA 300.0/SM 4500-F B, C, D, or E	Fluoride	Fluoride	mg/L	0.5	--	2.2	4	--	2.2	NO	NO	NO	90	110	80	120	20	
SM 2340 B or C	Hardness	Hardness	mg/L	2	--	--	--	--	--	NO	NO	NO	75	125	75	125	20	
SM 2320 B	Hydroxide alkalinity	Hydroxide	mg/L	5	--	--	--	--	--	NO	NO	NO	85	115	75	125	20	
EPA 300.0M	Lactate	50-21-5	mg/L	0.1	--	--	--	--	--	NO	NO	NO	75	125	75	125	20	
EPA 300.0	Nitrate (as N)	14797-55-8	mg/L	0.5	25	58	10	--	10	NO	NO	NO	90	110	80	120	20	
EPA 353.2/SM 4500-NCs E, F or H	Nitrate/nitrite (as N)	NO3NO2N	mg/L	0.5	--	--	--	--	--	NO	NO	NO	85	115	75	125	20	
EPA 300.0/SM 4500-NO2 B, F or E	Nitrite (as N)	14797-65-8	mg/L	0.5	--	3.7	1	--	1	NO	NO	NO	90	110	80	120	20	
SM 5310 B, C, or D	Organic carbon	DOC/TOC	mg/L	0.3	--	--	--	--	--	NO	NO	NO	85	115	75	125	10	
EPA 300.0/SM 4500-P E or F	Ortho phosphate	Ortho Phosphate	mg/L	0.02	--	--	--	--	--	NO	NO	NO	90	110	80	120	20	
EPA 314.0	Perchlorate	Perchlorate	µg/L	4	--	26	--	--	26	NO	NO	NO	85	115	85	115	20	
SM 4500-H+ B SW 9040	pH	pH	pH units	0.1	--	--	--	--	--	NO	NO	NO	--	--	--	--	20	
EPA 300.0M	Propionate	79-09-4	mg/L	0.1	--	--	--	--	--	NO	NO	NO	75	125	75	125	20	
EPA 300.0M	Pyruvate	127-17-3	mg/L	0.1	--	--	--	--	--	NO	NO	NO	75	125	75	125	20	
SM 4500-SiO <sub>2</sub> E	Reactive silica	7631-86-9	mg/L	1	--	--	--	--	--	NO	NO	NO	75	125	75	125	20	
SM 4500-SiO <sub>2</sub> C	Silica	7631-86-9	mg/L	0.04	--	--	--	--	--	NO	NO	NO	75	125	75	125	20	
SILICA_CALC	Soluble silica	7631-86-9	mg/L	0.04	--	--	--	--	--	NO	NO	NO	75	125	75	125	20	
EPA 120.1/SW 905C	Specific conductance	Conductance	µmhos/cm	2	--	--	--	--	--	NO	NO	NO	85	115	75	125	20	
EPA 300.0/SM 4110 E	Sulfate	Sulfate	mg/L	0.5	--	--	--	--	--	NO	NO	NO	90	110	80	120	20	
SM 4500-S <sup>2</sup> F, E, D, or G	Sulfide	Sulfide	mg/L	0.05	--	--	--	--	--	NO	NO	NO	75	125	75	125	20	
SM 2540 C	Total dissolved solids	TDS	mg/L	10	--	--	--	--	--	NO	NO	NO	75	125	--	--	10	
SM 4500-N <sub>org</sub> B or C	Total kjeldahl nitrogen	7727-37-9	mg/L	--	--	--	--	--	--	NO	NO	NO	90	110	75	125	20	
EPA 365.1/EPA 365.3 SM 4500-P E or I	Total phosphorous	Total Phosphorous	mg/L	0.02	--	--	--	--	--	NO	NO	NO	75	125	75	125	20	
SM 2540 D	Total suspended solids	TSS	mg/L	4	--	--	--	--	--	NO	NO	NO	75	125	75	125	10	
EPA 180.1/SM 2130 E	Turbidity	TURB	NTU	0.1	--	--	--	--	--	NO	NO	NO	--	--	--	--	20	
SW 6020A/EPA 200.8	Aluminum	7429-90-5	ug/L	50	16,000	37,000	50*	1,000	50	NO	NO	NO	85	115	75	125	20	
SW 6020A/EPA 200.8	Antimony	7440-36-0	ug/L	2	6	15	6	--	6	NO	NO	NO	85	115	75	125	20	
SW 6020A/EPA 200.8	Arsenic	7440-38-2	ug/L	0.5 (0.1)	0.045	0.045	10	--	0.045	YES	NO	NO	85	115	75	125	20	
SW 6020A/EPA 200.8	Barium	7440-39-3	ug/L	2	2,900	7,300	2,000	1,000	1,000	NO	NO	NO	85	115	75	125	20	
SW 6020A/EPA 200.8	Beryllium	7440-41-7	ug/L	0.5	16	73	4	--	4	NO	NO	NO	85	115	75	125	20	
SW 6010B or C/SW 6020A/EPA 200.7/EPA 200.1	Boron	7440-42-8	ug/L	50	?	?	?	?	?	?	NO	NO	85	115	75	125	20	
SW 6020A/EPA 200.8	Cadmium	7440-43-9	ug/L	1	--	18	5	--	5	NO	NO	NO	85	115	75	125	20	
SW 6010B/EPA 200.7	Calcium	7440-70-2	ug/L	100	--	--	--	--	--	NO	NO	NO	85	115	75	125	20	
SW 6020A/EPA 200.8	Chromium	7440-47-3	ug/L	1	--	--	100	50	50	NO	NO	NO	85	115	75	125	20	
EPA 218.6	Chromium, Hexavalent	18540-29-9	ug/L	0.2	0.031	110	100	--	0.031	YES	NO	NO	90	110	90	110	20	
EPA 218.6 LL	Chromium, Hexavalent, LL	18540-29-9	ug/L	0.06	0.031	110	100	--	0.031	YES	NO	NO	90	110	90	110	20	
SM 3500-Cr	Chromium, Hexavalent	18540-29-9	ug/L	10	0.031	110	100	--	0.031	YES	NO	NO	85	115	80	120	20	
SW 6010B or C/SW 6020A/EPA 200.7/EPA 200.1	Cobalt	7440-48-4	ug/L	5	4.7	11	--	--	4.7	YES	NO	NO	85	115	75	125	20	
SW 6010B or C/SW 6020A/EPA 200.7/EPA 200.1	Copper	7440-50-8	ug/L	1	620	1,500	1,000*	--	620	NO	NO	NO	85	115	75	125	20	
SW 6010B or C/EPA 200.7	Iron	7439-89-6	ug/L	20	11,000	26,000	300*	--	300	NO	NO	NO	85	115	75	125	20	
SW 6010B or C/SW 6020A/EPA 200.7/EPA 200.1	Lead	7439-92-1	ug/L	1	--	--	15	--	15	NO	NO	NO	85	115	75	125	20	
SW 6010B or C/EPA 200.7	Magnesium	7439-95-4	ug/L	100	--	--	--	--	--	NO	NO	NO	85	115	75	125	20	
SW 6020A/EPA 200.8	Manganese	7439-96-5	ug/L	0.5	--	880	50*	--	50	NO	NO	NO	85	115	75	125	20	
SW 7070A/EPA 245.1/ EPA 6020A'	Mercury	7439-97-6	ug/L	0.2	0.63	0.63	2	--	0.63	NO	NO	NO	75	125	75	125	20	
SW 6020A/EPA 200.8	Molybdenum	7439-98-7	ug/L	2	78	180	--	--	78	NO	NO	NO	85	115	75	125	20	
SW 6020A/EPA 200.8	Nickel	7440-02-0	ug/L	2	300	730	100*	100	100	NO	NO	NO	85	115	75	125	20	
SW 6010B or C/EPA 200.7	Potassium	7440-09-7	ug/L	100	--	--	--	--	--	NO	NO	NO	85	115	75	125	20	
SW 6020A/EPA 200.8	Selenium	7782-49-2	ug/L	5	78	180	50	--	50	NO	NO	NO	85	115	75	125	20	
SW 6020A/EPA 200.8	Silver	7440-22-4	ug/L	5	71	180	--	--	71	NO								

TABLE 4-2  
Reporting Limits, Accuracy, and Precession Limits for Groundwater  
PG&E Program Quality Assurance Project Plan Addendum

Method	Constituent	CAS	Units	QAPP RL	EPA Regional	EPA Regional	Federal Drinking	California	Most Stringent	Does RL Exceed	Does RL Exceed	Does RL Exceed	LCS Accuracy Control		MS/MSD Accuracy		Precision
					Screening Levels	Screening Levels	Water Standards	Drinking Water					Limits (%R)		Control Limits (%R)		
					May 2012	2008	MCLs	MCLs	Screening Level <sup>1</sup>	Screening Level?	Federal MCL Level?	California MCL Level?	Lower Limit	Upper Limit	Lower Limit	Upper Limit	% RPD
SW 8081A or B	delta-HCH	319-86-8	ug/L	0.1	--	--	--	--	--	NO	NO	NO	46	136	46	136	30
SW 8081A or B	Dieldrin	60-57-1	ug/L	0.1	0.0015	0.0042	--	--	0.0015	YES	NO	NO	62	129	62	129	30
SW 8081A or B	Endosulfan I	959-98-8	ug/L	0.1	--	--	--	--	--	NO	NO	NO	49	120	49	120	30
SW 8081A or B	Endosulfan II	33213-65-9	ug/L	0.1	--	--	--	--	--	NO	NO	NO	42	130	42	130	30
SW 8081A or B	Endosulfan sulfate	1031-07-8	ug/L	0.1	--	--	--	--	--	NO	NO	NO	54	137	54	137	30
SW 8081A or B	Endrin	72-20-8	ug/L	0.1	1.7	11	2	--	1.7	NO	NO	NO	56	134	56	134	30
SW 8081A or B	Endrin aldehyde	7421-93-4	ug/L	0.1	--	--	--	--	--	NO	NO	NO	56	137	56	137	30
SW 8081A or B	gamma-HCH (lindane)	58-89-9	ug/L	0.1	0.036	0.061	0.2	--	0.036	YES	NO	NO	30	146	30	146	30
SW 8081A or B	gamma-Chlordane	5103-74-2	ug/L	0.1	--	--	2	--	2	NO	NO	NO	67	120	67	120	30
SW 8081A or B	Heptachlor	76-44-8	ug/L	0.1	0.0018	0.015	0.4	--	0.0018	YES	NO	NO	51	128	51	128	30
SW 8081A or B	Heptachlor Epoxide	1024-57-3	ug/L	0.1	0.0033	0.0074	0.2	--	0.0033	YES	NO	NO	62	131	62	131	30
SW 8081A or B	Methoxychlor	72-43-5	ug/L	0.5	27	180	40	--	27	NO	NO	NO	56	150	56	150	30
SW 8081A or B	Toxaphene	8001-35-2	ug/L	1	0.013	0.061	3	--	0.013	YES	NO	NO	41	126	41	126	30
SW 8082 or A	Aroclor-1016	12674-11-2	ug/L	0.5	0.96	0.96	0.5	--	0.5	NO	NO	NO	40	144	40	144	30
SW 8082 or A	Aroclor-1221	11104-28-2	ug/L	0.5	0.0043	0.0068	0.5	--	0.0043	YES	NO	NO	41	136	41	136	30
SW 8082 or A	Aroclor-1232	11141-16-5	ug/L	0.5	0.0043	0.0068	0.5	--	0.0043	YES	NO	NO	41	136	41	136	30
SW 8082 or A	Aroclor-1242	53469-21-9	ug/L	0.5	0.034	0.034	0.5	--	0.034	YES	NO	NO	39	150	39	150	30
SW 8082 or A	Aroclor-1248	12672-29-6	ug/L	0.5	0.034	0.034	0.5	--	0.034	YES	NO	NO	41	136	41	136	30
SW 8082 or A	Aroclor-1254	11097-69-1	ug/L	0.5	0.034	0.034	0.5	--	0.034	YES	NO	NO	29	141	29	141	30
SW 8082 or A	Aroclor-1260	11096-82-5	ug/L	0.5	0.034	0.034	0.5	--	0.034	YES	NO	NO	45	145	45	145	30
SW 8151A	2,4-D	94-75-7	ug/L	10	130	370	70	--	70	NO	NO	NO	39	120	39	120	30
SW 8151A	2,4-DB	94-82-6	ug/L	20	91	290	--	--	91	NO	NO	NO	44	120	44	120	30
SW 8151A	2,4,5-T	93-76-5	ug/L	20	120	370	--	--	120	NO	NO	NO	44	122	44	122	30
SW 8151A	2,4,5-TP	93-72-1	ug/L	10	84	290	--	--	84	NO	NO	NO	49	126	49	126	30
SW 8151A	Dalapon	75-99-0	ug/L	30	470	1,100	200	--	200	NO	NO	NO	40	120	40	120	30
SW 8151A	Dicamba	1918-00-9	ug/L	30	440	1,100	--	--	440	NO	NO	NO	60	120	60	120	30
SW 8151A	Dichloroprop	120-36-5	ug/L	20	--	--	--	--	--	NO	NO	NO	68	122	68	122	30
SW 8151A	Dinoseb	88-85-7	ug/L	3	11	37	7	--	7	NO	NO	NO	28	115	28	115	30
SW 8151A	MCPA	94-74-6	ug/L	100	5.7	18	--	--	5.7	YES	NO	NO	62	144	62	144	30
SW 8151A	MCPP	7085-19-0	ug/L	100	--	37	--	--	37	YES	NO	NO	60	133	60	133	30
SW 8260B or C	1,1,1,2-Tetrachloroethane	630-20-6	ug/L	0.5	0.5	0.52	--	--	0.5	NO	NO	NO	81	129	81	129	20
SW 8260B or C	1,1,1-Trichloroethane (TCA)	71-55-6	ug/L	1	7,500	9,100	200	200	200	NO	NO	NO	67	132	67	132	20
SW 8260B or C	1,1,2,2-Tetrachloroethane	79-34-5	ug/L	0.5	0.066	0.067	--	1	0.066	YES	NO	NO	63	128	63	128	20
SW 8260B or C	1,1,2-Trichloroethane	79-00-5	ug/L	1	0.24	0.24	5	5	0.24	YES	NO	NO	75	125	75	125	20
SW 8260B or C	1,1,2-Trichlorotrifluoroethane (Freon 113)	76-13-1	ug/L	1	53,000	59,000	--	1,200	1,200	NO	NO	NO	75	125	75	125	20
SW 8260B or C	1,1-Dichloroethane	75-34-3	ug/L	1	2.4	2.4	--	5	2.4	NO	NO	NO	69	133	69	133	20
SW 8260B or C	1,1-Dichloroethene	75-35-4	ug/L	1	260	340	7	6	6	NO	NO	NO	68	130	68	130	20
SW 8260B or C	1,1-Dichloropropene	563-58-6	ug/L	1	--	--	--	--	--	NO	NO	NO	73	132	73	132	20
SW 8260B or C	1,2,3-Trichlorobenzene	87-61-6	ug/L	1	5.2	--	--	--	5.2	NO	NO	NO	67	137	67	137	20
SW 8260B or C	1,2,3-Trichloropropane	96-18-4	ug/L	1	0.00065	0.0096	--	--	0.00065	YES	NO	NO	73	124	73	124	20
SW 8260B or C	1,2,4-Trichlorobenzene	120-82-1	ug/L	1	0.99	8.2	70	5	0.99	YES	NO	NO	66	134	66	134	20
SW 8260B or C	1,2,4-Trimethylbenzene	95-63-6	ug/L	1	15	15	--	--	15	NO	NO	NO	74	132	74	132	20
SW 8260B or C	1,2-Dibromo-3-Chloropropane	96-12-8	ug/L	2	0.00032	0.00032	0.2	--	0.00032	YES	YES	NO	50	132	50	132	20
SW 8260B or C	1,2-Dibromoethane (EDB)	106-93-4	ug/L	1	0.0065	0.0065	0.05	--	0.0065	YES	YES	NO	80	121	80	121	20
SW 8260B or C	1,2-Dichlorobenzene	95-50-1	ug/L	1	280	370	600	600	280	NO	NO	NO	71	122	71	122	20
SW 8260B or C	1,2-Dichloroethane (EDC)	107-06-2	ug/L	0.5	0.15	0.15	5	0.5	0.15	YES	NO	NO	69	132	69	132	20
SW 8260B or C	1,2-Dichloropropane	78-87-5	ug/L	1	0.38	0.39	5	5	0.38	YES	NO	NO	75	125	75	125	20
SW 8260B or C	1,3,5-Trimethylbenzene	108-67-8	ug/L	1	87	12	--	--	12	NO	NO	NO	74	131	74	131	20
SW 8260B or C	1,3-Dichlorobenzene	541-73-1	ug/L	1	--	--	--	--	--	NO	NO	NO	75	124	75	124	20
SW 8260B or C	1,3-Dichloropropane	142-28-9	ug/L	1	290	730	--	--	290	NO	NO	NO	73	126	73	126	20
SW 8260B or C	1,4-Dichlorobenzene	106-46-7	ug/L	0.5	0.42	0.43	75	5	0.42	YES	NO	NO	74	123	74	123	20
SW 8260B or C	2,2-Dichloropropane	594-20-7	ug/L	1	--	--	--	--	--	NO	NO	NO	69	137	69	137	20
SW 8260B or C	2-Butanone (MEK)	78-93-3	ug/L	10	4,900	7,100	--	--	4,900	NO	NO	NO	49	136	49	136	20
SW 8260B or C</																	

TABLE 4-2  
Reporting Limits, Accuracy, and Precession Limits for Groundwater  
PG&E Program Quality Assurance Project Plan Addendum

Method	Constituent	CAS	Units	QAPP RL	EPA Regional Screening Levels		Federal Drinking Water Standards	California Drinking Water Standards	Most Stringent Screening Level <sup>1</sup>	Does RL Exceed Screening Level?	Does RL Exceed Federal MCL Level?	Does RL Exceed California MCL Level?	LCS Accuracy Control Limits (%R)		MS/MSD Accuracy Control Limits (%R)		Precision Water
													Lower Limit	Upper Limit	Lower Limit	Upper Limit	
					May 2012	2008	MCLs	MCLs									% RPD
SW 8260B or C	Ethylbenzene	100-41-4	ug/L	1	1.3	1.5	700	--	1.3	NO	NO	NO	73	127	73	127	20
SW 8260B or C	Hexachlorobutadiene	87-68-3	ug/L	0.6	0.26	0.86	--	--	0.26	YES	NO	NO	67	131	67	131	20
SW 8260B or C	Isopropylbenzene (Cumene)	98-82-8	ug/L	1	390	680	--	--	390	NO	NO	NO	75	127	75	127	20
SW 8260B or C	Methylene chloride	75-09-2	ug/L	1	9.9	4.8	5	5	4.8	NO	NO	NO	63	137	63	137	20
SW 8260B or C	Naphthalene	91-20-3	ug/L	1	0.14	0.14	--	--	0.14	YES	NO	NO	54	138	54	138	20
SW 8260B or C	n-Butylbenzene	104-51-8	ug/L	1	780	--	--	--	780	NO	NO	NO	69	137	69	137	20
SW 8260B or C	n-Propylbenzene	103-65-1	ug/L	1	530	--	--	--	530	NO	NO	NO	72	129	72	129	20
SW 8260B or C	sec-Butylbenzene	135-98-8	ug/L	1	--	--	--	--	--	NO	NO	NO	72	127	72	127	20
SW 8260B or C	Styrene	100-42-5	ug/L	1	1,100	1,600	100	100	100	NO	NO	NO	65	134	65	134	20
SW 8260B or C	tert-Butyl Methyl Ether (MTBE)	1634-04-4	ug/L	5	12	12	--	13	12	NO	NO	NO	65	123	65	123	20
SW 8260B or C	tert-Butylbenzene	98-06-6	ug/L	1	--	--	--	--	--	NO	NO	NO	70	129	70	129	20
SW 8260B or C	Tetrachloroethene	127-18-4	ug/L	1	9.7	0.11	5	5	0.11	YES	NO	NO	66	128	66	128	20
SW 8260B or C	Toluene	108-88-3	ug/L	1	860	2,300	1,000	150	150	NO	NO	NO	77	122	77	122	20
SW 8260B or C	trans-1,2-Dichloroethene	156-60-5	ug/L	1	86	110	100	10	10	NO	NO	NO	63	137	63	137	20
SW 8260B or C	trans-1,3-Dichloropropene	10061-02-6	ug/L	1	--	--	--	--	--	NO	NO	NO	59	135	59	135	20
SW 8260B or C	Trichloroethene	79-01-6	ug/L	1	0.44	1.7	5	5	0.44	YES	NO	NO	70	127	70	127	20
SW 8260B or C	Trichlorofluoromethane (Freon 11)	75-69-4	ug/L	1	1,100	1,300	--	150	150	NO	NO	NO	57	129	57	129	20
SW 8260B or C	Vinyl Chloride	75-01-4	ug/L	0.5	0.015	0.016	2	0.5	0.015	YES	NO	NO	50	134	50	134	20
SW 8260B or C	Xylenes, Total	1330-20-7	ug/L	2	190	200	10,000	1,750	190	NO	NO	NO	75	125	75	125	20
SW 8260B or C	m -Xylene	108-38-3	ug/L	2	190	1,400	--	--	190	NO	NO	NO	76	128	76	128	20
SW 8260B or C	o-Xylene	95-47-6	ug/L	1	190	1,400	--	--	190	NO	NO	NO	80	121	80	121	20
SW 8260B or C	p-Xylene	106-42-3	ug/L	1	190	1,500	--	--	190	NO	NO	NO	76	128	76	128	20
SW 8270C or D	1,2,4-Trichlorobenzene	120-82-1	ug/L	10	0.99	8.2	70	--	0.99	YES	NO	NO	37	120	37	120	20
SW 8270C or D	1,2-Dichlorobenzene	95-50-1	ug/L	10	280	370	600	--	280	NO	NO	NO	33	120	33	120	20
SW 8270C or D	1,3-Dichlorobenzene	541-73-1	ug/L	10	--	--	--	--	--	NO	NO	NO	32	120	32	120	20
SW 8270C or D	1,4-Dichlorobenzene	106-46-7	ug/L	10	0.42	0.43	75	--	0.42	YES	NO	NO	32	120	32	120	20
SW 8270C or D	2,4,5-Trichlorophenol	95-95-4	ug/L	50	890	3,700	--	--	890	NO	NO	NO	49	120	49	120	20
SW 8270C or D	2,4,6-Trichlorophenol	88-06-2	ug/L	10	3.5	6.1	--	--	3.5	YES	NO	NO	49	126	49	126	20
SW 8270C or D	2,4-Dichlorophenol	120-83-2	ug/L	10	35	110	--	--	35	NO	NO	NO	48	120	48	120	20
SW 8270C or D	2,4-Dimethylphenol	105-67-9	ug/L	10	270	730	--	--	270	NO	NO	NO	28	120	28	120	20
SW 8270C or D	2,4-Dinitrophenol	51-28-5	ug/L	10	30	73	--	--	30	NO	NO	NO	25	130	25	130	20
SW 8270C or D	2,4-Dinitrotoluene	121-14-2	ug/L	10	0.2	73	--	--	0.2	YES	NO	NO	51	120	51	120	20
SW 8270C or D	2,6-Dinitrotoluene	606-20-2	ug/L	10	15	37	--	--	15	NO	NO	NO	49	120	49	120	20
SW 8270C or D	2-Chloronaphthalene	91-58-7	ug/L	10	550	2,900	--	--	550	NO	NO	NO	49	120	49	120	20
SW 8270C or D	2-Chlorophenol	95-57-8	ug/L	10	71	180	--	--	71	NO	NO	NO	37	120	37	120	20
SW 8270C or D	2-Methylnaphthalene	91-57-6	ug/L	10	27	150	--	--	27	NO	NO	NO	46	120	46	120	20
SW 8270C or D	2-Methylphenol (o-Cresol)	95-48-7	ug/L	10	720	1,800	--	--	720	NO	NO	NO	38	120	38	120	20
SW 8270C or D	2-Nitroaniline	88-74-4	ug/L	50	150	--	--	--	150	NO	NO	NO	48	120	48	120	20
SW 8270C or D	2-Nitrophenol	88-75-5	ug/L	10	--	--	--	--	--	NO	NO	NO	39	123	39	123	20
SW 8270C or D	3,3'-Dichlorobenzidine	91-94-1	ug/L	20	0.11	0.15	--	--	0.11	YES	NO	NO	20	120	20	120	20
SW 8270C or D	3-Nitroaniline	99-09-2	ug/L	50	--	3.2	--	--	3.2	YES	NO	NO	20	126	20	126	20
SW 8270C or D	4,6-Dinitro-2-methylphenol	534-52-1	ug/L	50	1.2	3.7	--	--	1.2	YES	NO	NO	40	130	40	130	20
SW 8270C or D	4-Bromophenyl Phenyl Ether	101-55-3	ug/L	10	--	--	--	--	--	NO	NO	NO	52	120	52	120	20
SW 8270C or D	4-Chloro-3-methylphenol	59-50-7	ug/L	20	1,100	--	--	--	1,100	NO	NO	NO	47	120	47	120	20
SW 8270C or D	4-Chloroaniline	106-47-8	ug/L	20	0.32	1.2	--	--	0.32	YES	NO	NO	20	120	20	120	20
SW 8270C or D	4-Chlorophenyl phenyl ether	7005-72-3	ug/L	10	--	--	--	--	--	NO	NO	NO	50	120	50	120	20
SW 8270C or D	4-Methylphenol (p-Cresol)	106-44-5	ug/L	50	1,400	180	--	--	180	NO	NO	NO	32	120	32	120	20
SW 8270C or D	4-Nitroaniline	100-01-6	ug/L	50	3.3	3.2	--	--	3.2	YES	NO	NO	36	120	36	120	20
SW 8270C or D	4-Nitrophenol	100-02-7	ug/L	50	--	--	--	--	--	NO	NO	NO	20	120	20	120	20
SW 8270C or D	Acenaphthene	83-32-9	ug/L	10	400	2,200	--	--	400	NO	NO	NO	47	120	47	120	20
SW 8270C or D	Acenaphthylene	208-96-8	ug/L	10	--	--	--	--	--	NO	NO	NO	50	120	50	120	20
SW 8270C or D	Anthracene	120-12-7	ug/L	10	1,300	11,000	--	--	1,300	NO	NO	NO	54	120	54	120	20
SW 8270C or D	Benzo (a) anthracene	56-55-3	ug/L	10	0.029	0.029	--	--	0.029	YES	NO	NO	56	100	56	100	20
SW 8270C or D	Benzo (a) pyrene	50-32-8	ug/L	10	0.0029	0.0029	0.2	--	0.0029	YES	YES	NO	53	120	53	120	20
SW 8270C or D	Benzo (b) fluoranthene	205-99-2	ug/L	10	0.029	0.029	--	--	0.029	YES	NO	NO	45	124	45	124	20
SW 8270C or D	Benzo (g,h,i) perylene	191-24-2	ug/L	10	--	--	--	--	--	NO	NO	NO	38	123	38	123	20
SW 8270C or D	Benzo (k) fluoranthene	207-08-9	ug/L	10	0.29	0.29	--	--	0.29	YES	NO	NO	45	124	45	124	20
SW 8270C or D	Benzoic acid	65-85-0	ug/L	100	58,000	150,000	--	--	58,000	NO	NO	NO	20	120	20	120	20
SW 8270C or D	Benzyl alcohol	100-51-6	ug/L	20	1,500	18,000	--	--	1,500	NO	NO	NO	30	120	30	120	20
SW 8270C or D	bis (2-chloroethoxy) methane	111-91-1	ug/L	10	47	110	--	--	47	NO	NO	NO	46	120	46	120	20
SW 8270C or D	bis (2-chloroethyl) ether	111-44-4	ug/L	10	0.012	0.012	--	--	0.012	YES	NO	NO	37	120	37	120	20
SW 8270C or D	bis (2-chloroisopropyl) ether	108-60-1	ug/L	10	0.31	0.32	--	--	0.31	YES	NO	NO	26	131	26	131	20
SW 8270C or D	bis (2-ethylhexyl) phthalate	117-81-7	ug/L	10	0.071	4.8	6	--	0.071	YES	YES	NO	42	126	42	126	20
SW 8270C or D	Butyl benzylphthalate	85-68-7	ug/L	10	14	35	--	--	14	NO	NO	NO	46	120	46	120	20
SW 8270C or D	Chrysene	218-01-9	ug/L	10	2.9	2.9	--	--	2.9	YES	NO	NO	55	120	55	120	20
SW 8270C or D	Dibenzo (a,h) anthracene	53-70-3	ug/L	10	0.0029	0.0029	--	--	0.0029	YES	NO	NO	42	127	42	127	20
SW 8270C or D	Dibenzofuran	132-64-9	ug/L	10	5.8	--	--	--	5.8	YES	NO	NO	54	120	54	120	20
SW 8270C or D	Diethyl phthalate	84-66-2	ug/L	10	11,000	29,000	--	--	11,000	NO	NO	NO	41	120	41	120	20
SW 8270C or D	Dimethyl phthalate	131-11-3	ug/L	10	--	--	--	--	--	NO	NO	NO	25	127	25	127	20
SW 8270C or D	Di-n-butylphthalate	84-74-2	ug/L	10	670	3,700	--	--	670	NO	NO	NO	54	120	54	120	20
SW 8270C or D	Di-n-octylphthalate	117-84-0	ug/L	10	--	--	--	--	--	NO	NO	NO	37	137	37	137	20
SW 8270C or D	Fluoranthene	206-44-0	ug/L	10	630	1,500	--	--	630	NO	NO	NO	54	120	54	120	20
SW 8270C or D	Fluorene	86-73-7	ug/L	10	220	1,500	--	--	220	NO	NO	NO	50	120	50	120	20
SW 8270C or D	Hexachlorobenzene	118-74-1	ug/L	10	0.042	0.042	1	--	0.042	YES	YES	NO	52	120	52	120	20
SW 8270C or D	Hexachlorobutadiene	87-68-3	ug/L	10	0.26	0.86	--	--	0.26	YES	NO	NO	27	120	27	120	20
SW 8270C or D	Hexachloroethane	67-72-1	ug/L	10	0.79	4.8	--	--	0.79	YES	NO	NO	28	120	28	120	20
SW 8270C or D	Indeno (1,2,3-c,d) pyrene	193-39-5	ug/L	10	0.029	0.029	--	--	0.029	YES	NO	NO	43	125	43	125	20

TABLE 4-2  
Reporting Limits, Accuracy, and Precession Limits for Groundwater  
PG&E Program Quality Assurance Project Plan Addendum

Method	Constituent	CAS	Units	QAPP RL	EPA Regional	EPA Regional	Federal Drinking	California	Most Stringent	Does RL Exceed	Does RL Exceed	Does RL Exceed	LCS Accuracy Control		MS/MSD Accuracy		Precision
					Screening Levels	Screening Levels	Water Standards	Drinking Water					Limits (%R)		Control Limits (%R)		
					May 2012	2008	MCLs	MCLs					Screening Level <sup>1</sup>	Screening Level?	Federal MCL Level?	California MCL Level?	
SW 8270C or D	Isophorone	78-59-1	ug/L	10	67	71	--	--	67	NO	NO	NO	50	120	50	120	20
SW 8270C or D	Naphthalene	91-20-3	ug/L	10	0.14	0.14	--	--	0.14	YES	NO	NO	39	120	39	120	20
SW 8270C or D	Nitrobenzene	98-95-3	ug/L	10	0.12	3.4	--	--	0.12	YES	NO	NO	44	120	44	120	20
SW 8270C or D	n-Nitrosodi-n-propylamine	621-64-7	ug/L	10	0.0093	0.0096	--	--	0.0093	YES	NO	NO	34	128	34	128	20
SW 8270C or D	n-Nitrosodiphenylamine	86-30-6	ug/L	10	10	14	--	--	10	NO	NO	NO	48	120	48	120	20
SW 8270C or D	Pentachlorophenol	87-86-5	ug/L	50	0.17	0.56	1	--	0.17	YES	YES	NO	38	120	38	120	20
SW 8270C or D	Phenanthrene	85-01-8	ug/L	10	--	--	--	--	--	NO	NO	NO	51	120	51	120	20
SW 8270C or D	Phenol	108-95-2	ug/L	10	4,500	11,000	--	--	4,500	NO	NO	NO	20	120	20	120	20
SW 8270C or D	Pyrene	129-00-0	ug/L	10	87	1,100	--	--	87	NO	NO	NO	49	128	49	128	20
SW 8270SIM	1-methylnaphthalene	90-12-0	ug/L	0.2	0.97	2.3	--	--	0.97	NO	NO	NO	35	131	35	131	30
SW 8270SIM	2-methylnaphthalene	91-57-6	ug/L	0.2	27	150	--	--	27	NO	NO	NO	36	121	36	121	30
SW 8270SIM	Acenaphthene	83-32-9	ug/L	0.2	400	2,200	--	--	400	NO	NO	NO	39	125	39	125	30
SW 8270SIM	Acenaphthylene	208-96-8	ug/L	0.2	--	--	--	--	--	NO	NO	NO	43	140	43	140	30
SW 8270SIM	Anthracene	120-12-7	ug/L	0.2	1,300	11,000	--	--	1,300	NO	NO	NO	41	132	41	132	30
SW 8270SIM	Benzo (a) anthracene	56-55-3	ug/L	0.2	0.029	0.029	--	--	0.029	YES	NO	NO	58	141	58	141	30
SW 8270SIM	Benzo (a) pyrene	50-32-8	ug/L	0.2	0.0029	0.0029	0.2	--	0.0029	YES	NO	NO	31	142	31	142	30
SW 8270SIM	Benzo (b) fluoranthene	205-99-2	ug/L	0.2	0.029	0.029	--	--	0.029	YES	NO	NO	42	156	42	156	30
SW 8270SIM	Benzo (g,h,i) perylene	191-24-2	ug/L	0.2	--	--	--	--	--	NO	NO	NO	12	171	12	171	30
SW 8270SIM	Benzo (k) fluoranthene	207-08-9	ug/L	0.2	0.29	0.29	--	--	0.29	NO	NO	NO	49	165	49	165	30
SW 8270SIM	Chrysene	218-01-9	ug/L	0.2	2.9	2.9	--	--	2.9	NO	NO	NO	51	155	51	155	30
SW 8270SIM	Dibenzo (a,h) anthracene	53-70-3	ug/L	0.2	0.0029	0.0029	--	--	0.0029	YES	NO	NO	28	153	28	153	30
SW 8270SIM	Fluoranthene	206-44-0	ug/L	0.2	630	1,500	--	--	630	NO	NO	NO	47	158	47	158	30
SW 8270SIM	Fluorene	86-73-7	ug/L	0.2	220	1,500	--	--	220	NO	NO	NO	40	140	40	140	30
SW 8270SIM	Indeno (1,2,3-c,d) pyrene	193-39-5	ug/L	0.2	0.029	0.029	--	--	0.029	YES	NO	NO	20	167	20	167	30
SW 8270SIM	Naphthalene	91-20-3	ug/L	0.2	0.14	0.14	--	--	0.14	YES	NO	NO	39	125	39	125	30
SW 8270SIM	Phenanthrene	85-01-8	ug/L	0.2	--	--	--	--	--	NO	NO	NO	46	144	46	144	30
SW 8270SIM	Pyrene	129-00-0	ug/L	0.2	87	1,100	--	--	87	NO	NO	NO	39	158	39	158	30
CF-IRMS	D18O	D18O	0/00	--	--	--	--	--	--	NO	NO	NO	--	--	--	--	20
CF-IRMS	DD	DD	0/00	--	--	--	--	--	--	NO	NO	NO	--	--	--	--	20
SM 7110 C	Gross alpha	Gross alpha	pCi/L	3	--	--	15	15	15	NO	NO	NO	--	--	--	--	20
EPA 900.0	Gross beta	Gross beta	pCi/L	4	--	--	--	4	4	NO	NO	NO	--	--	--	--	20
EPA 903.1	Radium-226	013982-63-3	pCi/L	1	--	--	5	--	5	NO	NO	NO	--	--	--	--	20
EPA 904.0	Radium-228	015262-20-1	pCi/L	1	--	--	5	--	5	NO	NO	NO	--	--	--	--	20
EPA 905.0	Strontium	7440-26-4	pCi/L	2	--	--	--	8	8	NO	NO	NO	--	--	--	--	20
EPA 906.0	Tritium	10028-17-8	pCi/L	1,000	--	--	--	20,000	20,000	NO	NO	NO	--	--	--	--	20
EPA 908.0	Uranium	7440-61-1	pCi/L	1	--	--	--	20	20	NO	NO	NO	--	--	--	--	20
RSK-175	Carbon Dioxide	124-38-9	ug/L	5	--	--	--	--	--	NO	NO	NO	80	120	80	120	20
RSK-175	Ethane	74-84-0	ug/L	5	--	--	--	--	--	NO	NO	NO	80	120	80	120	20
RSK-175	Ethene	74-85-1	ug/L	5	--	--	--	--	--	NO	NO	NO	80	120	80	120	20
RSK-175	Methane	74-82-8	ug/L	5	--	--	--	--	--	NO	NO	NO	80	120	80	120	20

Notes:

\*\*Please keep in mind, Screening Levels are constantly revised by the EPA. The appropriate Screening levels are specific to the project, the location, the agency providing oversight, and the overall Goals of the project.\*\*

mg/L = milligrams per liter

ug/L = micrograms per liter

umhos/cm = micromhos per centimeter

pCi/L = picocuries per liter

PCB - LCS, MS, and MSD only require Aroclor-1016 and Aroclor-1260 spike:

<sup>1</sup> Screening levels are established by use of statistical analysis and are not based on the analytical capabilities of laboratories or methods. For groundwater, most stringent of:

EPA Regional Screening Levels - 2008 and May 201:

Federal Drinking Water Standards, MCLs

\*Secondary Federal Drinking Water Standards, MCLs

California Drinking Water Standards, MCLs

TABLE 4-3  
Maximum Concentrations for Title 22  
PG&E Program Quality Assurance Project Plan Addendum

CA TTCL/STLC											LCS Accuracy Control Limits (%R)		MS/MSD Accuracy Control Limits (%R)		Precision Soil
Method	Constituent	CAS	Units	TCLP Regulatory Standards	Title 22 TTLC MCL (mg/kg)	If TTLC Concentration is ≥ this value STLC Analysis Must be performed	Title 22 STLC MCL	Most Stringent Screening Level	Does RL Exceed Screening Level?		Lower Limit	Upper Limit	Lower Limit	Upper Limit	% RPD
									RL	Screening Level?					
SW6010B	Antimony	7440-36-0	mg/L	--	500	150	15	15	0.04	NO	85	115	75	125	20
SW6010B	Arsenic	7440-38-2	mg/L	5	500	50	5	5	0.01	NO	85	115	75	125	20
SW6010B	Barium	7440-39-3	mg/L	100	10,000	1,000	100	100	0.04	NO	85	115	75	125	20
SW6010B	Beryllium	7440-41-7	mg/L	--	75	7.5	0.75	0.75	0.01	NO	85	115	75	125	20
SW6010B	Cadmium	7440-43-9	mg/L	1	100	10	1	1	0.02	NO	85	115	75	125	20
SW6010B	Chromium	7440-47-3	mg/L	5	2,500	50	5	5	0.02	NO	85	115	75	125	20
SW3060A	Chromium, Hexavalent	18540-29-9	mg/L	--	500	50	5	5	0.004	NO	90	110	90	110	20
SW6010B	Cobalt	7440-48-4	mg/L	--	8,000	800	80	80	0.1	NO	85	115	75	125	20
SW6010B	Copper	7440-50-8	mg/L	--	2,500	250	25	25	0.02	NO	85	115	75	125	20
SW6010B	Lead	7439-92-1	mg/L	5	1,000	50	5	5	0.02	NO	85	115	75	125	20
SW7470A	Mercury	7439-97-6	mg/L	0.2	20	2	0.2	0.2	0.004	NO	75	125	75	125	20
SW6010B	Molybdenum	7439-98-7	mg/L	--	3,500	3,500	350	350	0.04	NO	85	115	75	125	20
SW6010B	Nickel	7440-02-0	mg/L	--	2,000	200	20	20	0.04	NO	85	115	75	125	20
SW6010B	Selenium	7782-49-2	mg/L	1	100	10	1	1	0.2	NO	85	115	75	125	20
SW6010B	Silver	7440-22-4	mg/L	5	500	50	5	5	0.1	NO	85	115	75	125	20
SW6010B	Thallium	7440-28-0	mg/L	--	700	70	7	7	0.02	NO	85	115	75	125	20
SW6010B	Vanadium	7440-62-2	mg/L	--	2,400	240	24	24	0.1	NO	85	115	75	125	20
SW6010B	Zinc	7440-66-6	mg/L	--	5,000	2,500	250	250	0.4	NO	85	115	75	125	20
SW8081A	4,4'-DDD	72-54-8	mg/L	--	1	--	0.1	0.1	0.002	NO	50	139	50	139	30
SW8081A	4,4'-DDE	72-55-9	mg/L	--	1	--	0.1	0.1	0.002	NO	48	137	48	137	30
SW8081A	4,4'-DDT	50-29-3	mg/L	--	1	--	0.1	0.1	0.002	NO	47	138	47	138	30
SW8081A	Aldrin	309-00-2	mg/L	--	1.4	--	0.14	0.14	0.002	NO	42	138	42	138	30
SW8081A	Chlordane	57-74-9	mg/L	0.03	2.5	--	0.25	0.03	0.002	NO	63	123	63	123	30
SW8081A	Dieldrin	60-57-1	mg/L	--	8	--	0.8	0.8	0.002	NO	62	129	62	129	30
SW8081A	Endrin	72-20-8	mg/L	0.02	0.2	--	0.02	0.02	0.002	NO	56	134	56	134	30
SW8081A	Heptachlor	76-44-8	mg/L	--	4.7	--	0.47	0.47	0.002	NO	51	128	51	128	30
SW8081A	Heptachlor (and its epoxide)	76-44-8	mg/L	0.008	4.7	--	0.47	0.008	0.002	NO	62	131	62	131	30
SW8081A	Kepone	143-50-0	mg/L	--	21	--	2.1	2.1	1	NO					30
SW8081A	Lindane	58-89-9	mg/L	0.4	4	--	0.4	0.4	0.002	NO	30	146	30	146	30
SW8081A	Methoxychlor	72-43-5	mg/L	10	100	--	10	10	0.01	NO	56	150	56	150	30
SW8081A	Toxaphene	8001-35-2	mg/L	0.5	5	--	0.5	0.5	0.02	NO	41	126	41	126	30
SW8082	Polychlorinated biphenyls (PCB)		mg/L	--	50	--	5	5	1	NO	29	141	29	141	30
SW8151A	2,4,5-Trichlorophenoxypropionic acid (2,4,5-TP) (Silvex)	Vanadium	mg/L	1	10	--	1	1	0.2	NO	49	126	49	126	30
SW8151A	2,4-Dichlorophenoxyacetic acid (2,4-D)	94-75-7	mg/L	10	100	--	10	10	0.2	NO	39	120	39	120	30
SW8260B	1,1-Dichloroethylene	75-35-4	mg/L	0.7	--	--	--	0.7	0.02	NO	68	130	68	130	20
SW8260B	1,2-Dichloroethane (EDC)	107-06-2	mg/L	0.5	--	--	--	0.5	0.01	NO	69	132	69	132	20
SW8260B	1,4-Dichlorobenzene	106-46-7	mg/L	7.5	--	--	--	7.5	0.01	NO	74	123	74	123	20
SW8260B	2-Butanone (MEK)	78-93-3	mg/L	200	--	--	--	200	0.2	NO	49	136	49	136	20
SW8260B	Benzene	71-43-2	mg/L	0.5	--	--	--	0.5	0.008	NO	81	122	81	122	20
SW8260B	Carbon tetrachloride	56-23-5	mg/L	0.5	--	--	--	0.5	0.01	NO	66	138	66	138	20
SW8260B	Chlorobenzene	108-90-7	mg/L	100	--	--	--	100	0.01	NO	81	122	81	122	20
SW8260B	Chloroform	67-66-3	mg/L	6	--	--	--	6	0.02	NO	69	128	69	128	20
SW8260B	Hexachlorobutadiene	87-68-3	mg/L	0.5	--	--	--	0.5	0.012	NO	67	131	67	131	20
SW8260B	m-Cresol	108-39-4	mg/L	200	--	--	--	200	1	NO	29	141	29	141	20
SW8260B	o-Cresol (2-Methylphenol)	95-48-7	mg/L	200	--	--	--	200	1	NO	38	120	38	120	20
SW8260B	p-Cresol (4-Methylphenol)	106-44-5	mg/L	200	--	--	--	200	1	NO	32	120	32	120	20
SW8260B	Tetrachloroethylene (PCE)	127-18-4	mg/L	0.7	2,040	--	204	0.7	0.02	NO	66	128	66	128	20
SW8260B	Total Cresols		mg/L	200	--	--	--	200	10	NO					20
SW8260B	Trichloroethylene (TCE)	79-01-6	mg/L	0.5	--	--	--	0.5	0.02	NO	70	127	70	127	20
SW8260B	Vinyl chloride	75-01-4	mg/L	0.2	--	--	--	0.2	0.01	NO	50	134	50	134	20
SW8270C	2,4,5-Trichlorophenol	95-95-4	mg/L	400	--	--	--	400	1	NO	49	120	49	120	20

TABLE 4-3  
Maximum Concentrations for Title 22  
PG&E Program Quality Assurance Project Plan Addendum

										LCS Accuracy Control Limits (%R)		MS/MSD Accuracy Control Limits (%R)		Precision Soil	
CA TTCL/STLC															
Method	Constituent	CAS	Units	TCLP Regulatory Standards	If TTLC Concentration is ≥ this value STLC Analysis Must be performed		Title 22 STLC MCL	Most Stringent Screening Level	Does RL Exceed Screening Level?		Lower Limit	Upper Limit	Lower Limit	Upper Limit	% RPD
					Title 22 TTLC MCL (mg/kg)				RL						
SW8270C	2,4,6-Trichlorophenol	88-06-2	mg/L	2	--	--	--	2	0.2	NO	49	126	49	126	20
SW8270C	2,4-Dinitrotoluene	121-14-2	mg/L	0.13	--	--	--	0.13	0.1	NO	51	120	51	120	20
SW8270C	Hexachlorobenzene	118-74-1	mg/L	0.13	--	--	--	0.13	0.1	NO	52	120	52	120	20
SW8270C	Hexachlorobutadiene	87-68-3	mg/L	0.5	--	--	--	0.5	0.2	NO	27	120	27	120	20
SW8270C	Hexachloroethane	67-72-1	mg/L	3	--	--	--	3	0.2	NO	28	120	28	120	20
SW8270C	Nitrobenzene	98-95-3	mg/L	2	--	--	--	2	0.2	NO	44	120	44	120	20
SW8270C	Pentachlorophenol	87-86-5	mg/L	100	17	--	1.7	1.7	1	NO	38	120	38	120	20
SW8270C	Pyridine	110-86-1	mg/L	5	--	--	--	5	5	NO	27	120	27	120	20
Dioxins	Dioxin (2,3,7,8-TCDD)	1746-01-6	mg/L	--	0.01	--	0.001	0.001	0.001	NO					20

**Notes:**

mg/L = milligrams per liter

mg/kg = milligrams per kilogram

TCLP = toxicity characteristic leaching procedure

STLC = soluble threshold limit concentration

TTLC = total threshold limit concentration