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February 22, 2012

Ms. Lauri Kemper, Assistant Executive Officer
Ms. Lisa Dernbach, Senior Engineering Geologist
California Regional Water Quality Control Board, Lahontan Region
2501 Lake Tahoe Boulevard
South Lake Tahoe, California 96150

Subject: Proposed Work Plan for Evaluation of Background Chromium in the Upper Aquifer of the Hinkley Valley, Pacific Gas and Electric Company's Hinkley Compressor Station, Hinkley, California

Dear Ms. Kemper and Ms. Dernbach:

Pacific Gas and Electric Company (PG&E) is pleased to submit this draft Work Plan for Evaluation of Background Chromium in the Groundwater of the Upper Aquifer in the Hinkley Valley (Work Plan). The Work Plan proposes the collection and evaluation of additional data to expand on the 2007 *Groundwater Background Study Report, Hinkley Compressor Station, Hinkley, California*.

In 2011, Water Board staff submitted the 2007 study to three technical individuals with expertise in the fields of hydrogeology, statistics, and laboratory analysis. Many of the concerns raised by the peer reviewers were shared by PG&E and their technical staff, and this Work Plan addresses the comments that were provided by the reviewers. PG&E anticipates the Work Plan will undergo independent peer review, and we look forward to receiving that input and working with the Water Board to finalize the scope of work. Since the cleanup goal for the Hinkley chromium groundwater plume is background (presently as defined by the 2007 study), it is critical to address the peer review comments of the 2007 study, and to further assess the background conditions in Hinkley in a manner that fosters consensus.

Please feel free to call me if you have any questions regarding the information presented in the attached report.

Sincerely,

Kevin M. Sullivan
Hinkley Remediation Project Manager

Work Plan for Evaluation of Background Chromium in the Groundwater of the Upper Aquifer in the Hinkley Valley, Pacific Gas and Electric Company, Hinkley California

Stantec PN: 185702482

Stantec

February 22, 2012

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Prepared by:	Reviewed by:
Chris R. Maxwell, P.G. Principal Geologist	William DeBoer Geologic Associate

Information, conclusions, and recommendations provided by Stantec in this document has been prepared under the supervision of and reviewed by the licensed professional whose signature appears below.

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Chris R. Maxwell, P.G., #7269
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Executive Summary

On February 28, 2007, Pacific Gas and Electric Company (PG&E) submitted the *Groundwater Background Study Report, Hinkley Compressor Station, Hinkley, California* (CH2M HILL, 2007). The report presented the data, analysis, and conclusions of a study completed by PG&E to estimate the 95 percent upper tolerance limit (95UTL) concentrations of total dissolved chromium (CrT) and hexavalent chromium (Cr6) in groundwater of the upper aquifer in the Hinkley Valley. The study was conducted following Lahontan Regional Water Quality Control Board (Water Board) staff approval of the *Revised Background Study Work Plan, PG&E Compressor Station, Hinkley, California* (CH2M HILL, 2004). The approved work plan incorporated comments from Water Board staff, and input from three University of California (UC) peer reviewers.

The February 2007 Background Study Report concluded that the 95UTL concentrations for CrT and Cr6 in groundwater of the Hinkley Valley are 3.23 micrograms per liter (µg/L) and 3.09 µg/L, respectively. These values were intended to describe the upper range of chromium concentrations that are unrelated to the historic release of chromium at the PG&E Compressor Station (*i.e.,* background concentrations). On November 18, 2008, the Water Board adopted amended Cleanup and Abatement Order (CAO) No. R6V-2008-0002A1. The amended CAO requires, for the purposes of evaluating remediation strategies, that the maximum background concentrations of CrT and Cr6 shall be 3.2 and 3.1 µg/L, respectively.

Since adoption of the amended CAO in November 2008, PG&E has installed approximately 157 new short-screened (*i.e.,* typically 10 to 20 feet in length) monitoring wells in the Upper Aquifer at 85 locations, in an effort to further define the distribution of chromium at concentrations above the established background values. Assuming the established background values are representative of conditions in the upper aquifer, the lateral boundaries of the PG&E plume are now depicted as approximately five (5) miles long (north to south) and up to two and three-quarters (2.75) miles wide (east to west). This area is three (3) miles further to the north and one (1) mile further to the east than was depicted in November 2008. The change in plume depiction is based on the inclusion of data from the new short-screen monitoring wells installed by PG&E since November 2008 in areas where data did not previously exist (primarily north of Thompson Road and east of Summerset Road). Cr6 concentrations for the majority of these new data are less than 5.0 µg/L.

Peer Review of the Background Study Report

In 2011, Water Board staff submitted the February 2007 Background Study Report to three technical individuals with expertise in the fields of hydrogeology, statistics, and laboratory analysis. Peer reviewer comments were provided by Water Board staff on October 14, 2011. Many of the concerns raised by the reviewers were shared by PG&E and their technical staff; other concerns can be resolved by considering the entirety of the work performed before, during, and after the background study. The peer reviewer comments, along with PG&E responses, are included in this document as Appendix A. The scope of work proposed herein was developed in consideration of these comments. Peer reviewer comments can generally be summarized as follows:

Sampling was Performed Using Wells not constructed for Discrete Sampling in the Upper Aquifer – Data was collected from long-screened domestic or agricultural wells, for which in most cases PG&E does not have documentation of well construction. It is likely the majority of these wells have very long screens, some of which penetrate both the upper and lower aquifers. Data collected from these long-screened wells is not comparable to data collected from the monitoring wells installed by PG&E to evaluate the boundaries of the chromium plume, which have short screens (typically 10 to 20 feet) and do not penetrate multiple aquifers.

The Spatial Distribution of Wells was Uneven – The background study relied on samples collected from existing domestic and agricultural wells, many of which are clustered in specific geographic areas. The clustering of wells in some areas, and the absence of wells in others, may have resulted in spatial bias of the 95UTL values (*i.e.,* statistical weight was given to a few geographic areas of the Hinkley Valley).

The Statistical Analysis of Data was Inappropriate – Several issues were identified pertaining to how the groundwater data was statistically evaluated. Some wells were sampled four times in the study (quarterly for one year), while others were sampled only one or two times. The average concentration for each well (regardless of the number of samples collected) was used to develop single 95UTL values for the entire population of wells.

Laboratory Analytical Methods were Inconsistent and Quality Control was Inadequate – Several concerns were noted with the laboratory analysis for CrT and Cr6, including potential quality control issues with one of the two laboratories used during the study. Three different Environmental Protection Agency (EPA) laboratory methods for Cr6 were used for the study (218.6, 7199, and 7196A), and the varying methods could provide different results – especially at the low detection concentrations.

Areas thought to be Outside the Plume May Have Been Effected by Historic Pumping for Agriculture – Groundwater affected by the chromium plume has historically been used to irrigate crops in the Hinkley Valley, both by farmers in the past and by PG&E as part of the historic and current remedial actions. There is a concern raised by reviewers that historic agricultural pumping by farmers in areas outside the current plume boundary may have pulled the plume to these areas in the past.

Chromium Data Collected Since the Prior Background Study Report

The Hinkley Valley is approximately five and one-half (5.5) miles north to south, and three (3) miles east to west at its widest point. With the installation and sampling of approximately 157 monitoring wells since November 2008, PG&E has assessed chromium concentrations across the majority of the valley, including wells at the far northern extent near Red Hill (where chromium concentrations exceed the established maximum background values). If these established maximum background values are accurate, and if one assumes that all detections above these values are attributable to PG&E's chromium plume, then PG&E's plume would essentially extend from the compressor station in the south to the northern end of the valley.

However, there are lines of evidence suggesting that maximum background values for Cr6 and CrT could be higher in some areas of the Hinkley Valley than the levels established in the 2007 background study. These include:

- ☐ The absence of a south to north concentration gradient north of Thompson Road (*i.e.,* wells throughout the northern part of the basin contain similar chromium concentrations, rather than decreasing concentrations in the downgradient direction);
- ☐ The tendency for Cr6 and CrT to be present at concentrations above established background levels primarily in wells installed at or near the water table; and,
- ☐ The presence of chromium at concentrations above established background levels in at least one domestic well (34-65) that is hydraulically upgradient of PG&E's plume. Three samples collected in 2011 from well 34-65 exhibited Cr6 concentrations above 3.1 µg/L. After thoroughly assessing the potential for this well to be affected by the chromium plume, PG&E and the Water Board staff concluded that it was infeasible for the plume to have migrated to this location (based on several factors, including historic and current groundwater flow direction, and the projection of the Lockhart Fault between the plume and the well).

Proposed Additional Evaluation of Background Chromium Conditions

This Work Plan proposes the collection and evaluation of additional data to further assess background chromium concentrations in the groundwater of the Hinkley Valley. The scope of work proposed herein expands upon the prior background study, and addresses the comments that were provided by the peer reviewers.

The proposed scope consists of the installation and sampling of short screen monitoring wells in the upper aquifer. New short-screened monitoring wells will be installed and sampled outside the boundaries of PG&E's chromium plume (as defined by the established background levels). Well locations will be based upon a grid pattern. The number of locations for new wells will depend upon access, and is estimated to be between 25 and 40. Considering multiple wells will be installed at most locations (each screened in a discrete interval of the upper aquifer), the total number of new wells will likely be greater than 50.

A select number of the new short-screen monitoring wells will be located in immediate proximity to long-screen wells sampled during the prior background study. Sampling of both the new short-screen wells and the existing long-screen wells sampled during the 2007 study will provide data to assess background chromium concentration variability in the upper aquifer, and allow comparison with the findings of the prior study.

New monitoring wells will be sampled quarterly for at least one year (4 samples), with all wells sampled an equal number of times and during the same quarters (*i.e.,* sampling will generally not be initiated until all the wells are in-place and ready for sampling). Using these new data, statistical analyses will be performed with the objective of identifying 95UTL values for maximum background CrT and Cr6 concentrations. Average results will not be used as part of the statistical evaluation.

Schedule

Upon completion of the study, PG&E will prepare a technical report that presents the methods, data, statistical analysis, and conclusions of the assessment. Considering the time required to complete biological clearance and secure property access, install numerous new short-screened monitoring wells, and collect at least four quarters of groundwater data, the timeframe to perform the study and prepare a technical report will be at least two years. PG&E will provide semi-annual progress reports to the Water Board, beginning 180 days following approval of this Work Plan. Each report will provide an update to the schedule for completion of the study and submittal of a technical report.

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List of Acronyms

AU	agricultural unit
BDRK	bedrock
CAO	Cleanup and Abatement Order
CCL	confining clay layer
Cr3	trivalent chromium
Cr6	hexavalent chromium
CrT	total chromium
DCU	deep clay unit
DVD	Desert View Dairy
DWR	Department of Water Resources
ft-bgs	feet below ground surface
ft/ft	feet per foot
LA	lower aquifer
LTU	Land Treatment Unit
MCL	maximum contaminant level
µg/L	micrograms per liter
MWA	Mojave Water Agency
ND	non-detect
NHVB	North Hinkley Valley Basin
PVC	polyvinyl chloride
SED	sedimentary deposits
SHVB	South Hinkley Valley Basin
TDS	total dissolved solid
UA	upper aquifer
UC	University of California
USEPA	U.S. Environmental Protection Agency
USGS	United States Geological Survey
Water Board	Regional Water Quality Control Board
WBRK	weathered bedrock material
95 UTL	95 percent upper tolerance limit

1.0 Introduction

On February 28, 2007, Pacific Gas and Electric Company (PG&E) submitted the *Groundwater Background Study Report, Hinkley Compressor Station, Hinkley, California* (CH2M HILL, 2007). The report concluded that the 95 percent upper tolerance limit (95UTL) concentrations for background (non-PG&E plume) concentrations of total dissolved chromium (CrT) and hexavalent chromium (Cr6) in the Hinkley Valley are 3.23 micrograms per liter (µg/L) and 3.09 µg/L, respectively. On November 18, 2008, the Lahontan Regional Water Quality Control Board (Water Board) adopted amended Cleanup and Abatement Order (CAO) No. R6V-2008-0002A1 requiring that the values of 3.2 µg/L for CrT and 3.1 µg/L for Cr6 be used to represent maximum background chromium conditions in remedial evaluations for the Site.

In 2011, Water Board staff provided the 2007 Background Study Report to three individuals for peer review. In summary, the peer reviewers expressed concern regarding the methods and findings of the study and suggested the established CrT and Cr6 background values may not be supported by the technical data. In summary, the concerns included:

- ☐ ***Sampling was Performed Using Wells not Constructed for Discrete Sampling in the Upper Aquifer*** – Data was collected for the study from long-screened domestic or agricultural wells, for which in most cases PG&E does not have any documentation of well construction. Data collected from these long-screened wells is not comparable to data collected from monitoring wells installed by PG&E to evaluate the boundaries of the chromium plume, which have short-screens (typically 10 to 20 feet) and do not penetrate multiple aquifers;

- ☐ ***The Spatial Distribution of Wells was Uneven*** – The background study relied on samples collected from existing domestic and agricultural wells, many of which are clustered in specific geographic areas. The clustering of wells in some areas, and the absence of wells in others, may have resulted in spatial bias;

- ☐ ***The Statistical Analysis of Data was Inappropriate*** – Several issues were identified pertaining to how the groundwater data was statistically evaluated. Wells were not sampled an equal number of times; the average concentration for each well was used to develop single 95UTL values;

- ☐ ***Laboratory Analytical Methods were Inconsistent and Quality Control was Inadequate*** – There were potential quality control issues with one of the two laboratories used during the study, and three different Environmental Protection Agency (EPA) laboratory methods for Cr6 were used (218.6, 7199, and 7196A). The varying methods could provide different results – especially at the low detection concentrations; and,

- ☐ ***Areas thought to be Outside the Plume May Have Been Affected by Historic Pumping for Agriculture*** – Groundwater affected by the chromium plume has historically been used to irrigate crops in the Hinkley Valley, both by farmers in the past and by PG&E as part of the historic and current remedial actions. There is a potential that historic agricultural pumping by farmers in areas outside the current plume boundary may have pulled the plume to these areas in the past.

In response to the peer reviewer comments and in consideration of data collected since the 2007 Background Study Report was prepared, PG&E has prepared this *Work Plan for Evaluation of Background Chromium in the Groundwater of the Upper Aquifer in the Hinkley Valley* (Work Plan). This Work Plan proposes additional assessment to more thoroughly evaluate the background concentrations of CrT and Cr6 in the Hinkley Valley. Background concentrations are defined here as any and all chromium concentrations that are present in groundwater in the Hinkley Valley as a result of natural and anthropogenic sources unrelated to releases from PG&E's compressor station.

Figure 1 shows the site location. Figure 2 shows the site layout, including select monitoring well locations and lines of geologic cross-section illustrated in this report. Table 1 lists the groundwater laboratory analyses and methods that may be conducted during the investigation.

As discussed in Section 3, new short-screened monitoring wells will be installed and sampled at 25 to 40 locations outside the boundaries of the chromium plume as it is currently depicted using the established background values. New monitoring wells will be sampled quarterly for at least one year (4 samples), and data will be statistically evaluated. A select number of the short-screen wells will be placed in immediate proximity to long screen wells sampled during the prior background study.

Section 4 discusses several factors to consider in assessing background chromium in the groundwater of the upper aquifer in the Hinkley Valley. Items discussed in Section 4 are: (1) sediment mineralogy and groundwater geochemistry; (2) tracers in groundwater, including chromium isotopes; and, (3) chromium at the water table and the potential effects of unsaturated zone and capillary fringe pore water.

2.0 Background Information

The following provides background information for the proposed scope of work.

2.1 GEOLOGIC AND HYDROLOGIC SETTING

The geologic and hydrologic conditions of the Hinkley Valley and surrounding areas likely have a substantial effect on background chromium in groundwater. Several historic and recent reports submitted to the Water Board by PG&E provide a discussion on the geologic and hydrologic setting for the Hinkley Valley and surrounding areas. These reports include:

- *Revised Background Study Work Plan* (CH2M HILL, September 2004);
- *Groundwater Background Study Report* (CH2M HILL, February 2007);
- *Feasibility Study and Remedial Action Plan (Haley and Aldrich, August 2010)*;
- *Technical Report – Response to Investigation Order No. R6V-2011-0043 – Delineation of Chromium in the Lower Aquifer* (Stantec, August 2011);
- *Technical Report – Response to Investigation Order No. R6V-2011-0043 – Delineation of Chromium in the Upper Aquifer* (Stantec, September 2011); and,
- *Technical Memorandum – Update to Upper Aquifer Groundwater Investigation Activities* (Stantec, February 2012).

The documents prepared by Stantec in 2011 and 2012 present the findings of recent investigations performed by PG&E. The following incorporates information from these documents, to provide a comprehensive overview of the geologic and hydrologic setting as they relate to the studies proposed herein.

2.1.1 Geology

Figure 3 illustrates the geology of the Hinkley Valley and surrounding areas as interpreted by others. The Hinkley Valley is an alluvial basin bounded by mapped and/or inferred fault structures and bedrock highlands. Exposed bedrock surrounding the Hinkley Valley includes:

- ***East*** – Mesozoic igneous and metamorphic rocks (primarily quartz diorite gneiss, quartz monzonite/diorite, and latite/felsite) and Tertiary volcanic rocks (intrusive dacite and andesitic to rhyolitic tuff breccia);

- ***South*** – Tertiary sedimentary and volcanoclastic rocks;
- ***Southwest*** – Mesozoic diorite, gabbro, and older granitic and metamorphic rocks (gneiss, schist, and marble); and,
- ***Northwest*** – Mesozoic quartz monzonite and quartz diorite gneiss.

The Lockhart Fault has been inferred by others to be present along the western margin of the valley, and may be a bounding geologic structure for the Hinkley Valley basin. The Mt. General Fault has been mapped by others along the eastern margin of the valley, and may also be a bounding geologic structure.

A generalized stratigraphic column for the geology of the Hinkley Valley is provided on Figure 4, including descriptions of the various geologic units encountered during the most recent investigations by PG&E (Stantec, 2011 and 2012). The study area includes the South Hinkley Valley Basin (SHVB) and the North Hinkley Valley Basin (NHVB). The conceptual geographic boundary for these two basins is illustrated on Figure 5.

2.1.1.1 Upper Aquifer Sediments

The following discusses the upper aquifer geologic units, from oldest to youngest (bottom to top of the stratigraphic column – Figure 4). Geologic cross-sections along the north-south (A-A') and east-west (B-B') axes of the valley are provided as Figures 6 and 7, respectively. The lines of section are shown on Figure 2.

- **Consolidated Bedrock (BDRK)** – In some areas, the base of the upper aquifer is defined by consolidated bedrock. A relatively thin layer of weathered bedrock materials (WBRK) is typically found overlying the rock. The BDRK unit is the base of the upper aquifer where the Lower Aquifer Confining Clay Layer (LA CCL) is absent. Bedrock encountered during PG&E investigations is typically granite, diorite, gneiss, and silicic limestone. Other types of bedrock encountered in the Hinkley Valley are discussed in Section 2.1.1 above, including volcanic rocks.
- **Lower Aquifer Confining Clay Layer (LA CCL, the "Blue Clay")** – The base of the upper aquifer is defined in most areas by the LA CCL, which was deposited in a shallow lacustrine environment. In most areas, the clay was deposited directly on top of BDRK (or WBRK). In some areas, sedimentary deposits are present beneath the LA CCL (lower aquifer sedimentary deposits – LA SED).
- **Upper Aquifer Lower Zone (A2 Zone)** – The blue clay was eroded by streams that generally trended from south to north as they flowed through the SHVB and into the NHVB. The streams deposited sandy materials on top of the LA CCL, which are the sediments of the A2 zone. The sandy materials are much thicker and coarser grained in some areas than in others.

In the NHVB, the A2 zone is relatively thin, and is absent in some areas. A deeper unit consisting of brown and red-brown clay with minor sand lenses and clasts of weathered bedrock is present below the A2 sandy sediments (primarily in the NHVB). This unit is referred to herein as the A2 Deep Clay Unit (A2 DCU), and appears to reside directly over BDRK in most areas where the A2 DCU is present.

- ☐ **Upper Aquifer Confining Clay Layer (UA CCL, the "Brown Clay")** – A second clay (UA CCL) unit was deposited on top of the A2 zone sands, also likely in a lacustrine environment. The bottom of the UA CCL defines the top of the A2 zone, and the top of the UA CCL defines the base of the A1 zone (see below). Note that the thickness and topography reflect both the deposition of the clay and the subsequent erosion that occurred during the deposition of the A1 sediments. The UA CCL is absent in some areas, and the A1 and A2 deposits may be in direct contact.

- ☐ **Upper Aquifer Shallow Zone (A1 Zone)** – The UA CCL was subsequently eroded by streams, similar to the depositional environment of the A2 zone. The streams that deposited A1 sediments also generally trended from south to north, as they flowed through the SHVB and into the NHVB.

  The primary route of the A1 zone streams appears to have been in the eastern part of the SHVB, extending northward to the Gorman Agricultural Unit (AU) and through the bedrock choke point at the north end of the SHVB. This is in contrast to the A2 sediments, which appear to have been deposited primarily in the SHVB. The areas of thick A1 sediments coincide with thin UA CCL sediments in this area.

  In contrast to the A2 sediments, the streams that deposited the A1 sandy sediments appear to have extended significantly northward into the NHVB. The current thickness of saturated A1 sandy sediments ranges from 30 to 50 feet in the central portion of the NHVB. When groundwater levels were historically higher (20 to 30 feet higher in 1960 compared to current levels), the A1 saturated sediments were upwards of 50 to 80 feet thick in some areas.

  Where bedrock is relatively shallow, the UA CCL is not present and the UA has been separated using the following nomenclature: a shallow (S) zone that is primarily silt and sand with some clay, and a deeper (D) zone that is primarily silt and clay. Depending on location, these sediments may have similar age to the A1 or A2 zones. Shallow bedrock is typically found near the east, west, and north margins of the basin and at the boundary between the SHVB and NHVB basins (at the "choke point" near the Desert View Dairy [DVD] and Gorman AU).

2.1.1.2 Lower Aquifer Sediments

The Lower Aquifer sediments are those unconsolidated materials below the LA CCL (Blue Clay) and above the consolidated bedrock. PG&E has installed several monitoring wells into the lower aquifer, and these investigations are documented in several reports, the most recent being the *Technical Report –*

Response to Investigation Order No. R6V-2011-0043 – Delineation of Chromium in the Lower Aquifer (Stantec, 2011).

In most areas where the lower aquifer has been investigated by PG&E, the materials are primarily WBRK that immediately overlies the consolidated rock. The thickness of weathered rock varies from a few feet to tens of feet. In some areas of the Hinkley Valley (primarily east of Summerset Road), the lower aquifer is reported to include relatively thick sections of coarse-grained sediments (LA SED) that lie between the overlying LA CCL and the consolidated rock.

2.1.2 Hydrology

The following provides a discussion of groundwater hydrology for the Hinkley Valley basin.

2.1.2.1 Regional Hydrology

As designated by the California Department of Water Resources (DWR), the Hinkley Valley lies within the Harper Valley Groundwater Basin. The Harper Valley Basin is bounded: (1) to the east by non-water-bearing rocks of Fremont Peak, Black Mountain, Gravel Hills, and the Mud Hills; and (2) to the west by a combination of surface drainage divides; portions of the Harper, Kramer Hills, and Lockhart Faults; and non-water-bearing rocks of the Kramer Hills and other low-lying basement hills (DWR, 2004). The Harper Valley Groundwater Basin (Number 6-47) comprises approximately 410,000 acres or 640 square miles.

The United States Geological Survey (USGS) considers the entire Mojave River groundwater basin to be a topographically closed basin that drains towards various playas (USGS, 2004). The primary source of natural recharge to the basin is the Mojave River. The river contributes more than 80 percent of the natural recharge to the basin. The climate of the Mojave Desert is typical of arid regions characterized by low precipitation, low humidity, and high summer temperatures. As a result, there is essentially little to no groundwater recharge from precipitation due to the high rate of evapotranspiration. The typical amount of rainfall is approximately less than 5 inches per year, and the evaporation rates are approximately over 100 inches per year. In the vicinity of the site, the regional groundwater flow direction is to the north, from the Mojave River towards Harper Lake.

2.1.2.2 Groundwater Occurrence and Flow

The depth-to-groundwater in the upper aquifer, as measured in the investigation wells installed by PG&E throughout the Hinkley Valley, ranges from approximately 65 to 100 feet below ground surface (ft-bgs). The saturated Upper Aquifer thickness ranges from approximately 15 feet where bedrock is relatively shallow, to upwards of 100 feet thick where the top of the LA CCL is relatively deep (170 to 180 ft-bgs).

The horizontal component of groundwater flow at the site is similar to the regional flow direction. Groundwater in the Upper and Lower Aquifers generally flows in a north-northwesterly direction, from the compressor station to the northern end of the Hinkley Valley. Horizontal gradients in the upper aquifer, in the absence of pumping or injection, generally range from 0.002 to 0.004 feet per foot (ft/ft). Based on tracer studies completed by PG&E as part of remedial activities, groundwater velocity (not influenced by gradients induced by pumping or injection) ranges from approximately 1 to 3 feet per day.

Groundwater flow in the shallow and deep portions of the Upper Aquifer is shown on Figures 8 and 9, respectively. Groundwater flow in both zones is influenced by PG&E's remedial pumping at the DVD Land Treatment Unit (LTU), and at several AUs located in the vicinity of the DVD LTU.

2.1.2.3 USGS Tritium Studies

The USGS has performed analysis of the tritium composition of water to evaluate sources and movement of groundwater in the Mojave groundwater basin (USGS, 2004). The USGS considered groundwater containing detectable tritium as water that recharged the aquifer after 1952. The compressor station is located in an area with detectable tritium (see Figure 10), suggesting groundwater in this area is from recent recharge along the Mojave River. The downgradient areas exhibit conditions of older groundwater (where tritium was not detected).

2.1.3 Hydrologic Effects of Fault Structures

The Lockhart Fault is considered to be a partial barrier to groundwater flow, as discussed by Mendez and Christensen (1997) in California's groundwater Bulletin 118 (DWR, 2003). Figure 11 shows the mapped and projected/inferred location of several fault structures, including the Lockhart Fault, which is a northwest-trending, right-lateral, strike-slip fault. The Lockhart Fault and other strike-slip faults in the Mojave River groundwater basin are described to be "…barriers or partial barriers to groundwater flow…resulting in stair-step like drops in the water table across the fault zones," (USGS, 2001).

The location of the Lockhart Fault is approximate and based on published reports (California Division of Mines and Geology, 1994; USGS, 2001). The section of fault that is inferred or projected to be present in the Hinkley Valley is estimated to be of Quaternary-age, with no evidence of historic or Holocene Fault movement or surface offset within the study area (Jennings, 1994).

The Mt. General Fault is mapped and inferred in some areas to be located along the eastern flank of the Hinkley Valley. To date, PG&E has not installed many monitor wells on the eastern side of the inferred or mapped portions of the fault. The hydrologic effect of the fault on the saturated alluvial sediments, if any, has not been fully assessed by PG&E.

2.1.4 Historic Changes in Groundwater Levels

The Hinkley Valley lies within the Basin and Range groundwater system, which is naturally arid with high evapotranspiration rates, such that little to no precipitation infiltrates to the water table. The dominant natural hydrogeologic processes are recharge to the groundwater system from the Mojave River from the south (upgradient), and groundwater flow towards Harper Lake in the north (downgradient) – where the groundwater evaporates.

Historically, depth-to-groundwater in much of the valley was less than 60 feet. Groundwater flow has been significantly influenced by groundwater withdrawals for irrigation (Durbin and Hardt, 1974). Pumping, primarily for the irrigation of alfalfa, began in the early 1930s and peaked in the mid-1950s, when about 278,000 acre-feet per year were extracted for irrigation. The irrigation pumping significantly dewatered the shallow aquifer; water level changes from 1930 to 1970 were over 60 feet in the center of the valley (DWR, 1967; Mojave Water Agency, 1983). Pumping included wells screened in the upper and lower aquifers, and in some areas, wells were likely extended into the bedrock.

Water levels exhibited a significant downward trend from 1950 to at least 1970. These long-term trends effectively reduced well yields. As a result, much of the irrigated land was abandoned during the next three decades. In the early 1990s, only about 130,000 acre-feet per year were extracted for irrigation, less than 50 percent of mid-1950s withdrawal rates.

In the 1990s several parties in the downstream areas of the Mojave River filed suit against several parties in the upstream areas over declining groundwater levels in the downstream areas. The Mojave Water Agency (MWA) took on the role of mediator, and eventually a Stipulated Agreement (Agreement) was signed by most parties throughout the Mojave River watershed. The Agreement mandated reduced annual pumping volumes throughout the basin. Since implementation of these efforts, coupled with periodic discharges by the MWA of surface water from Silverwood Lake into various recharge basins (one of the basins is located about one (1) mile southeast of the compressor station), groundwater levels have risen approximately 5 to 15 feet in most parts of the Hinkley Valley.

2.2 2007 BACKGROUND STUDY

The 2007 background study consisted of a statistical analysis of chromium concentrations in groundwater samples obtained from 48 long-screened private supply wells. Well construction information for these wells was in many cases unavailable, as the information is private (CH2M HILL, 2007). The maximum detected CrT value was 3.15 µg/L at well BGS-32. The maximum detected Cr6 value was 2.69 µg/L at well BGS-47. The lowest chromium concentrations in the prior background study (several results were below the laboratory method reporting limit) were typically observed in samples collected near the Mojave River.

Construction details and well logs were available for only 20 of the 48 wells that were sampled during the study. The available information indicates that wells were often screened across both the Upper and Lower Aquifers with well screens up to 320 feet long. It is likely some wells extend into BDRK. According to the available logs, only four wells were screened exclusively across the Upper Aquifer.

In the *Revised Background Chromium Study Work Plan, PG&E Compressor Station, Hinkley, California* (CH2M HILL, 2004), depth-specific groundwater sample collection was planned at up to 41 wells. However, depth-specific groundwater samples were collected at only one well, located adjacent to the Mojave River and south of the Hinkley Compressor Station. Lack of access for depth-discrete sampling devices in private domestic wells identified for this activity prevented further sample collection.

The 2007 background study also included collection of groundwater samples for analysis of chromium isotopes and various geochemical parameters, including base ions and cations. Neither the isotope nor geochemical data conclusively demonstrated a clear correlation between any of these parameters and background versus PG&E-related sources of chromium.

On October 14, 2011, the Water Board issued peer review comments on the 2007 Background Study Report. The peer review was provided by three individuals: Dr. Yoram Rubin, a professor at University of California Berkeley specializing in hydrogeology and geostatistics; James Jacobs, PG, CHG of the Clearwater Group; and Dr. Stuart Nagourney, a chemistry professor at The College of New Jersey (Water Board, 2011). The peer reviewer comments are summarized in Section 1 of this report. The comments, along with PG&E’s responses, are provided in Appendix A. The scope of work proposed in this Work Plan address the issues raised by the reviewers.

2.3 CHROMIUM STUDIES PERFORMED BY OTHERS

The following discusses chromium information that has been collected by others, including studies in the Mojave River Basin. In summary, these studies indicate that Cr6 is present in groundwater of the Mojave River Basin over a relatively wide range of concentrations. Table 2 provides a listing of references for independent chromium studies, many of which were conducted in the western Mojave Desert. Table 2 also includes a summary of the findings of each study, and the CrT and/or Cr6 concentration(s) that were reported.

Chromium is the seventeenth most abundant element in the earth’s crust (Hem, 1989) and occurs naturally in groundwater in alluvial aquifers of the western part of the Mojave Desert (Ball and Izbicki, 2004), in the southwestern United States (Robertson, 1975, 1991), and in other parts of the United States (Izbicki et al., 2008). Background chromium exists in the environment in several forms, most notably as trivalent chromium (Cr3), which typically exists as a simple cation or as various hydroxide ions, and Cr6, which typically exists as the chromate or dichromate oxide anions (Hem, 1989).

Chromium concentrations exceeding the California maximum contaminant level (MCL) of 50 µg/L have been reported to naturally occur in the groundwater of alkaline and oxic alluvial aquifers in the western Mojave Desert, with lower concentrations found in less alkaline groundwater (Izbicki, 2008). Cr6 was detected above 1 µg/L by California's Department of Public Health in 3,156 out of 5,943 (about 53%) of the potable water supply sources tested throughout California between 1997 and 2008 (SWRCB, 2009).

California water suppliers (including the Mojave Basin municipalities that manage drinking water) collect samples from their systems and report results to their customers in annual water quality reports. Table 2 lists data from recent annual reports for municipalities throughout the western Mojave Desert. Because there is no California MCL for Cr6 (only for CrT), some municipalities typically report results only for CrT, and many municipalities do not regularly analyze for chromium. Some municipalities use laboratory methods with reporting limits as high as 10 µg/L (City of Hesperia Water District, 2010).

Drinking water extracted from the upper and middle portions of the Mojave River Basin (generally Apple Valley to Barstow) exhibits Cr6 in supply wells at levels higher than those encountered during the 2007 background study in Hinkley. Cr6 concentrations ranged up to 6.3 µg/L in the Apple Valley South system (Golden State Water Company, 2010a-b) to 16.1 µg/L in Hesperia (City of Hesperia Water District, 2010).

Results of the drinking water supply reports listed in Table 2 are consistent with scientific studies conducted by the USGS that have identified the presence of background Cr6 in the western Mojave Desert (Ball and Izbicki, 2004; Izbicki et al., 2008; Izbicki, 2008; Nishikawa et al., 2004; Robertson, 1975 and 1991). A study of groundwater conducted by the USGS in 2008 to "…provide a spatially unbiased assessment of the quality of untreated groundwater used for public water supplies within the Mojave study unit…" found that Cr6 was detected in over half of the wells that were analyzed (15 out of 22) at concentrations ranging from 1 to 16 µg/L (Schmitt et al., 2008).

2.4 CHROMIUM CONCENTRATIONS ABOVE ESTABLISHED BACKGROUND LEVELS IN THE HINKLEY VALLEY

Three samples collected in 2011 from domestic well 34-65 exhibited chromium concentrations above the background levels found in the 2007 study. After thoroughly assessing the potential for this well to be affected by PG&E's chromium plume, PG&E and the Water Board staff concluded that it was infeasible for the plume to have migrated to this location (based on several factors including historic and current groundwater flow direction, and the presence of the Lockhart Fault between the plume and the well).

3.0 Collection and Analysis of Chromium Data from Short Screened Wells

The purpose of the work scope proposed in Section 3 is to collect a sufficiently robust set of groundwater samples, using new short-screened monitoring wells, to perform an appropriate statistical analysis on the range and maximum expected values of background chromium concentrations of the upper aquifer.

The 2007 background study (CH2M HILL, 2007) utilized existing long-screened private domestic and agricultural wells for the collection of groundwater samples. This approach was selected in lieu of installing new short-screened monitoring wells, primarily in consideration of time and property access constraints. The peer reviewers commented, and PG&E concurs, that the data collected from the long-screened wells may not be fully representative of background chromium conditions in the upper aquifer in the Hinkley Valley.

This work plan proposes the installation of short-screened monitoring wells on a gridded pattern in the upper aquifer, for sampling and laboratory analysis. The proposed layout of wells addresses peer reviewer comments regarding the need for data from short-screened monitoring wells rather than long-screened wells, and the need for a more evenly spaced distribution of sample locations.

3.1 INSTALLATION OF SHORT SCREENED MONITORING WELLS

Figure 13 illustrates a grid of 32 conceptual locations where short-screened monitoring wells could be installed for collection of new groundwater samples (one well location per grid). The grid size is one square mile (a BLM Section). Grids were placed outside the existing boundaries of the chromium plume, based on the established background values of 3.1 µg/L for Cr6 and 3.2 µg/L for CrT. Areas where surface geologic information suggests saturated alluvium is not present (*i.e.,* shallow bedrock) were not included.

Monitoring wells are proposed as close as reasonably possible to the center point of each grid. Locations may be adjusted within each grid in consideration of property access and other access limitations (such as biologically or culturally sensitive areas). At a select number of locations, short-screen wells will be installed in immediate proximity to long-screen wells that were sampled during the prior study.

Proposed monitoring well drilling and installation procedures are provided in Appendix B and summarized as follows.

A borehole will be advanced at each well location to the total depth of the upper aquifer, to be defined by the blue clay or bedrock – whichever is encountered first. The borehole will be continuously cored from the water table (estimated at 65 to 75 ft-bgs) to total depth.

A 4-inch-diameter polyvinyl chloride (PVC) monitoring well with 15-feet of screen length will be set at the water table for each location. Additional two and one-half inch diameter PVC monitoring wells may be installed at each location at depth in the upper aquifer (*i.e.,* below the water table), depending upon the thickness and nature of the encountered saturated alluvial sediments. The number of monitoring wells installed by PG&E at each location during recent investigations has ranged from one (single 4-inch well across the water table) to three (single 4-inch well across the water table, and two 2½- inch wells nested in an adjacent borehole at depth within the upper aquifer). Up to 96 monitoring wells could be installed under this element of the study, assuming up to three monitoring wells are installed at each location and access is obtained for all 32 grids.

Following installation, the new monitoring wells will be developed, surveyed, and sampled. The procedures for these activities are detailed in Appendix B, along with methods for the management of investigations-derived materials (soils generated during drilling and groundwater generated during development and sampling).

3.2 LABORATORY ANALYSIS OF GROUNDWATER SAMPLES

Groundwater samples will be collected from these new wells for Cr6 and CrT analysis using the methods listed on Table 1. Select samples may also be analyzed for additional parameters, and these parameters and the analytical methods are also listed on Table 1.

On December 29, 2011, the Water Board issued Investigation Order R6V-2011-0105. The Order required submittal of technical information in response to several questions raised by the peer reviewers with respect to the laboratory analyses used in the 2007 background study. The Order, and PG&E responses submitted to the Water Board on January 20, 2011, are included with this report as Appendix C. The laboratory analysis to be conducted as part of this proposed study will be conducted consistent with this work plan and PG&E's responses to the Order.

3.3 STATISTICAL ANALYSIS OF CHROMIUM DATA

A minimum of four quarterly sampling events will be conducted as part of the evaluations. In general, sampling will not be initiated until all of the new wells are installed, so the sampling time frame and the number of samples collected is the same for all the wells. For each event, the statistical methodology proposed will be used to determine 95UTL values for CrT and Cr6 that are representative of each sampling event. Multiple sample results from individual wells will not be averaged (as was done for the 2007 study).

3.3.1 J-Flag and Non-Detect Values

All J-flagged detections will be assumed to be quantitative, and the J-flag value will be used accordingly in the statistical analysis of the data.

If the chromium detection rate is 85 percent or greater for the entire data set during a single sampling event, non-detect (ND) values will be substituted with half the detection limit. If the chromium detection rate is 50 percent or greater, but less than 85 percent, then the ND values will not be used in the testing for normality; rather, an adjustment will be applied to the sample mean and standard deviation using Cohen's Method (USEPA, 2009). If the chromium detection rate is less than 50 percent, then the data set will be assumed to be non-normally distributed, and a non-parametric method will be used to compute the 95UTL.

3.3.2 Testing for Normality

The population distribution will be tested for normality if the chromium detection frequency is 50 percent or greater. If the chromium detection frequency is between 50 percent and 85 percent, the population distribution will be determined from the detections only. If the chromium detection frequency is 85 percent or greater, all of the data points will be used (ND values will be substituted with one-half the detection limit.

The method for testing the data set for normality will be the Shapiro-Wilk test, as recommended by the USEPA (2009, p.8-13). If the data are not found to be normally distributed, then a series of transformations will be attempted until the data pass the normality test at 5 percent significance. The series of transformations will be square root, cube root, and logarithmic in that order (Box and Cox, 1964). In the event that none of the transformations lead to normally distributed data (that is, a data set that passes the Shapiro-Wilk normality test), then a non-parametric method will be used.

3.3.3 Outliers

Following the establishment of normality (if normality is determined), a test will be run to identify statistical outliers. If there are 25 data points or less, then Dixon's test for outliers will be used (USEPA, 2009, p.12-14). If there are more than 25 data points, then Rosner's test for outliers will be used (USEPA, 2009, p.12-14).

3.3.4 Calculation of the 95UTL Values

Once the questions of non-detections, outliers, and normality are resolved, the 95UTL will be computed. 95 UTL values will be determined with and without outliers in the data set, if present. If parametric methods are justified, the UTL will be computed from the sample mean (x) and sample standard deviation (s), using the formula:

$$\text{UTL} = x + s\,\kappa$$

The tolerance factor κ can be found on a table provided by the USEPA for the appropriate confidence level and capture (95% and 95% in this case), and the sample size. If Cohen's adjustment was needed, then x and s will be the adjusted values. If transformations were required, then the UTL will be computed using the mean and standard deviation of the transformed data. The resulting UTL will be back-transformed.

3.3.5 Evaluation of Multiple Data Populations

The new data set will be statistically evaluated to assess the potential for multiple populations of chromium data. This effort will include a linear analysis, in which a change in slope of the chromium concentrations suggests different data populations. If the analyses suggest multiple chromium data populations are present, the data will be evaluated spatially to assess the potential for other lines of evidence (such as location or geology,) that would provide a direct correlation with the observed populations.

4.0 Background Chromium in Groundwater

This section discusses several factors that will be considered when assessing background chromium concentrations in the groundwater of the upper aquifer in the Hinkley Valley. Items discussed in Section 4 include:

1. Sediment mineralogy and groundwater geochemistry;
2. Tracers and chromium isotopes in groundwater; and,
3. Chromium concentrations at the water table, and the potential effects of unsaturated zone and capillary fringe pore water.

4.1 MINERALOGY AND GROUNDWATER GEOCHEMISTRY

The following provides a discussion of mineralogical and groundwater geochemical factors that will be considered during the study.

4.1.1 Mineralogy

The USGS conducted a geohydrochemical study in the southern portion of the western Mojave Desert (Ball and Izbicki, 2004; Izbicki, et al., 2008) that investigated the relationship between the chromium content of rocks and alluvial sediments with concentrations of CrT and Cr6 in groundwater. The basement rocks in the Hinkley Valley contain various concentrations of mafic minerals (pyroxene, amphibole, mica) that appear as dark grains in the rock and associated alluvium. In general, the materials with higher mafic mineral content exhibit higher chromium concentrations. The chromium in these minerals is predominantly in the trivalent state.

Manganese is also associated with the mafic minerals, and the weathered surface of rocks and minerals typically contains secondary manganese oxide mineral coatings. Oxidation of Cr3 to Cr6 can occur when water is in contact with these solids under oxic conditions. A slight amount of Cr3 is dissolved and becomes oxidized on the surface of the manganese oxides, creating Cr6, while manganese is reduced and partially dissolves. With the oxidizing of Cr3, more dissolution occurs at the mafic mineral surface and the process continues, concentrating Cr6 in the surrounding water.

In the presence of manganese oxides, chromium-containing mafic minerals can produce natural Cr6 in unsaturated zone pore water and groundwater. Analysis of the various geologic materials found in the Hinkley Valley aquifer matrix may provide an improved understanding of the origin and distribution of natural Cr6 in groundwater. The range of natural chromium sources and concentrations known to exist in alluvial basin settings from other Mojave desert studies (Ball and Izbicki, 2004; Izbicki et al., 2008) can be summarized as follows:

- The highest chromium concentrations are generally found in basaltic, ultramafic and mafic rock debris that contains chromite and relatively high mafic mineral content;
- Lower chromium concentrations are generally found in felsic rock debris (granitic, dioritic, and associated source rocks);
- The lowest chromium concentrations are associated with highly weathered, non-mafic rocks, which are often found in fluvial deposits; and,
- The chromium content tends to be higher in fine-grained sediment and soil than in coarser-grained deposits.

The geologic conditions in the Hinkley Valley are complex, due to different bedrock types (source rock for the aquifer alluvial materials), regional and local faulting, and the various geologic environments under which the unconsolidated aquifer sediments were deposited. Bedrock in the Hinkley Valley provides the source material for some of the unconsolidated alluvium through which groundwater flows. The majority of bedrock in the valley is described as plutonic and metamorphic rocks (identified as bc, basement complex, on Figure 3).

Where core holes have been drilled to bedrock by PG&E, the encountered materials have been described primarily as granite, diorite, monzonite, and gneiss. Bedrock on the eastern side of Hinkley Valley, in the area of Mount General, includes tertiary volcanic rocks (Tv on Figure 3). Granitic and metamorphic rocks typically contain varying ranges of mafic minerals such as pyroxene, amphibole, and mica. Volcanic rocks, such as basalt and andesite, can also contain an abundance of mafic minerals.

In addition to the bedrock, materials in the Hinkley Valley also include semi-consolidated sediments typically referred to as "older sediments." As shown on Figure 3, these older sedimentary materials on the periphery of the PG&E chromium plume include older alluvium (Qoa), playa deposits (Qp), and old lake and lakeshore deposits (Qol). As shown on Figure 3, the ancient shoreline of Harper Lake extends well into the northern portion of the Hinkley Valley.

4.1.2 Groundwater Geochemistry

The presence of Cr6 in groundwater from natural sources is partly a function of groundwater geochemistry. Hexavalent chromium requires oxic conditions to be stable in water. If conditions become mildly reducing, Cr6 is readily reduced to relatively insoluble Cr3, which precipitates out of solution. There is no single redox state of a solution, as many processes that influence redox occur simultaneously in natural waters. Conditions to be considered include:

1) The presence of dissolved manganese and/or iron in groundwater is indicative of conditions conducive to the reduction of Cr3 to Cr6;
2) The presence of total organic carbon in groundwater is indicative of the potential to reduce Cr6 and other mineral species, usually by microbial assisted methods; and,
3) Redox conditions that are nitrate-reducing will not support the presence of Cr6. If nitrate is absent and any or all of the other redox indicators are present, Cr6 would not be expected to persist.

4.2 TRACERS (INCLUDING CHROMIUM ISOTOPES)

A "tracer" is any chemical constituent that provides an indication of the original source of, or geochemical influence on, the groundwater sample. Tracers fall into the three broad categories: general chemical parameters (major ions, total dissolved solid or TDS, and pH), conservative trace elements (for example, boron or bromide), and stable isotopes (for example, ^{18}O, ^{2}H, ^{53}Cr). It is possible that multiple lines of evidence can be drawn from these parameters (in connection with geologic and hydraulic data) to indicate a source of chromium in individual samples.

The two most abundant isotopes of chromium in nature are ^{52}Cr (83.8 percent) and ^{53}Cr (9.5 percent), with the superscript indicating the atomic mass (Izbicki et al., 2008). Recent scientific literature has shown that comparison of the relative amounts of these two isotopes in water samples can be useful in distinguishing natural and anthropogenic sources of chromium (Ellis et al., 2002, 2004; Izbicki et al., 2008). A water sample is prepared and analyzed with a mass spectrometer to measure the ratio of $^{53}Cr/^{52}Cr$. This ratio is compared to the ratio reported for an international chromium standard, and the difference in the sample ratio from the standard is reported in parts per thousand (ppt, equivalent to a percent difference multiplied by 10) and expressed as δ53Cr.

Natural chromium contained in solid mineral phases is in the form of Cr3, and has a $\delta^{53}Cr$ of around 0 parts per thousand (ppt). When this chromium is released by weathering and oxidized to Cr6 in solution, the $\delta^{53}Cr$ is still 0 ppt. However, when the water containing Cr6 flows through a groundwater system, a portion of the Cr6 is reduced back to Cr3. Because the lighter ^{52}Cr is more easily reduced, the remaining Cr6 in the groundwater becomes slightly enriched in ^{53}Cr along the flow path, and this mechanism increases the $\delta^{53}Cr$ value above 0 ppt. This process of reactions favoring one isotope over another is known as isotopic fractionation. The more partial the reduction occurs, the higher the $\delta^{53}Cr$ value is expected. Reported values for $\delta^{53}Cr$ in Mojave Desert samples have been observed as high as 5.1 ppt (Izbicki et al., 2008).

Anthropogenic Cr6 in the form of chromate solution has a $\delta^{53}Cr$ value of around 0 ppt, similar to natural mineral sources. Plume samples by definition have chromium elevated above background concentrations, such that the relative amount of Cr6 reduction is smaller than what occurs with natural concentrations in groundwater. In other words, the higher concentrations of Cr6 in the plume tend to overwhelm and mask the small degree of isotopic fractionation that occurs due to the propensity of ^{52}Cr to be chemically reduced to Cr3. As a result, plume $\delta^{53}Cr$ values tend to be lower than those observed in natural groundwater.

4.2.1 Previous Results for Isotopic analysis

The first set of Hinkley chromium isotope data was collected by the USGS in 2006, and has since been submitted for publication (Izbicki et al., 2011). The data are illustrated on Figure 14. The study identified 10 wells within the plume area. Cr6 concentrations ranged from 15.4 to 2,660 µg/L, and $\delta^{53}Cr$ signatures were measured at 0 to 1.9 ppt. Samples from three wells that were defined as outside the plume exhibited Cr6 concentrations from 0.8 to 3.7 µg/L, and δ^{53}Cr signatures ranging from 2.7 to 4.1 ppt (at that time, the interim maximum Cr6 background value was 4.0 µg/L).

The isotope data generally support the hypothesis that natural Cr6 has a higher isotopic signature than anthropogenic sources, due to its greater degree of partial reduction. Within the plume, the δ^{53}Cr values generally increased northward, consistent with observed decreasing Cr6 concentrations. The authors pointed out that the data do not follow the same pattern of fractionation observed in laboratory-controlled reduction experiments (Ellis et al., 2002 and 2004), and offered that the data suggested a combination of reduction and mixing with low-Cr groundwater (i.e., dilution). The results were not conclusive at the relatively low chromium concentrations that are considered to be in the likely range of background conditions for the Hinkley Valley. The USGS concluded that additional samples in the Cr6 concentration range of ND to 5 µg/L would be needed to improve resolution of the data interpretations at these low chromium levels.

Additional data were collected by PG&E between 2008 and 2011, primarily in areas east and north of the DVD, where Cr6 is detected at relatively low concentrations. The previous and new data are shown together on Figure 15.

Some sample results suggest a source(s) of Cr6 other than the PG&E plume. For example, samples from wells MW-96S, MW-97S, and MW-97D have lower δ^{53}Cr values than other nearby wells, suggesting that chromium in these samples may be derived from source rocks to the east (Note: Cr6 results for these three wells are less than 3.1 µg/L). These three (3) wells are located close to a bedrock outcrop. The lower δ^{53}Cr values suggest the bedrock may be contributing Cr6. The differences noted in the three (3) samples as compared to other samples suggest that chromium isotopes may be useful in the differentiation of chromium from different sources.

4.2.2 Other Natural Tracers

There are several naturally occurring parameters that could provide an indication of groundwater origin and/or flow path. One of these parameters alone may not fully elucidate origin or flow path, but multiple parameters could provide helpful insight to assist in the overall evaluation of correlations between local conditions and background chromium in groundwater.

Oxygen and Hydrogen - In addition to chromium isotopes, stable isotopes of oxygen (^{18}O) and hydrogen (^{2}H, also known as deuterium) together can prove valuable as a tracer for identifying waters by their historic flow paths (such as groundwater that has been subject to partial evaporation). The data illustrated in Figure 16 suggest that waters were derived from different sources, possibly including agricultural irrigation. Combined with the chromium isotope data, along with other geochemical data such as general minerals (see below), ^{18}O and deuterium may help to distinguish water types.

Boron – This parameter is a conservative element found in nearly all natural waters. Under normal pH range (up to pH 10), boron exists in solution as an uncharged ion ($H_3BO_3^0$), and is not prone to adsorption like many charged species. With its high solubility, boron moves conservatively through groundwater systems, similar to ^{18}O and deuterium, and therefore its concentration can be tied to water sources and potential water mixing.

Dissolved Silica – This parameter (expressed as SiO_2 in laboratory reports) is a neutral ion over nearly the entire pH spectrum (in the form of $H_4SiO_4^0$). Though there are limits on its solubility, silica can be useful in identifying and verifying different sources of water in mixed geologic systems.

General Minerals - The general mineral "fingerprint" of groundwater can be used, when combined with other more specific tracers, to assess different origins and flow paths of waters. Data evaluation tools such as Piper and Stiff Diagrams can be used to assess the potential for distinct populations, including mixing of groundwater from different recharge areas.

4.3 CHROMIUM CONCENTRATIONS AT THE WATER TABLE

Dissolved natural Cr6 concentrations in groundwater have been observed in the Mojave Desert (Ball and Izbicki, 2004; Izbicki et al., 2008; and Izbicki, 2008), in the Paradise Valley near Phoenix, Arizona (Robertson, 1975), and in arid basins elsewhere in the Southwestern United States (Robertson, 1991). In the western Mojave Desert, background Cr6 concentrations have been observed to vary with depth, with generally higher concentrations found at the water table and decreasing concentrations (often to below detection limits) encountered at greater depths.

Figure 17 (from Izbicki 2008) illustrates the vertical profiles for background chromium along with other constituents in water obtained from core samples from the western Mojave Desert. In the Izbicki study, the highest concentrations of Cr6, specific conductance, and certain trace metals occurred either just above or at the water table. The authors cited the leaching of background Cr6 from unsaturated zone soil by infiltration (from agricultural irrigation) as the likely mechanism for the higher Cr6 concentrations observed at the water table. Deeper in the saturated zone, the Cr6 concentrations were observed to decrease, as the water became less affected by agricultural practices, and was less oxic (Izbicki et al., 2008).

A later study conducted by the USGS and funded by the Water Board, specifically focused on the source of Cr6 in shallow water table wells near El Mirage in the Mojave Desert (Izbicki et al., 2008). In the study, authors suggested that high-nitrate concentrations in dairy wastewater may interfere with the bacterially mediated reduction of Cr6 to Cr3, thereby allowing chromium in the form of Cr6 to move through the unsaturated zone to the water table.

These USGS studies have important implications for the interpretation of Cr6 data from the Hinkley site. In areas where irrigation has been conducted, the upper aquifer could exhibit higher concentrations of Cr6 associated with the infiltration of irrigation water from agriculture irrigation, as noted by the USGS (Izbicki et al., 2008). Wells screened deeper in the upper aquifer may have lower concentrations of Cr6, because these portions of the aquifer have less influence from irrigation water, and/or due to the presence of reducing conditions.

5.0 Schedule

PG&E is prepared to initiate the work scope detailed in this Work Plan within 90 days of receiving written approval from the Water Board to proceed. Upon completion of the study, PG&E will prepare a technical report that presents the methods, data, statistical analysis, and conclusions of the assessment. Considering the time required to obtain biological clearances and secure property access, install numerous new short screen monitoring wells, and collect at least four quarters of groundwater data, the timeframe to complete the study and prepare a technical report will be at least 2 years. PG&E will provide semi-annual progress reports to the Water Board beginning 180 days following approval of this Work Plan. Each report will provide an update to the schedule for completion of the study and submittal of a technical report.

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TABLES

Work Plan for Evaluation of Background
Chromium in the Groundwater of the Upper Aquifer in the Hinkley Valley
Pacific Gas and Electric Company
Stantec PN# 185702482
February 22, 2012

Table 1
Proposed Laboratory Analysis Methods
Pacific Gas and Electric Company - Hinkley Chromium Remediation Project
Hinkley, California

GROUNDWATER ANALYTES	
Analyte	**Laboratory Analytical Method**
General Chemistry	
Na	SW 846 Method 6010B or C
K	SW 846 Method 6010B or C
Ca	SW 846 Method 6010B or C
Mg	SW 846 Method 6010B or C
Fe	SW 846 Method 6010B or C
Mn	SW 846 Method 6020A
NH3	SM[1] 4500-NH3
NO3	USEPA Method 300.0
TKN	SM[1] 4500-N_{org} B
Cl	USEPA Method 300.0
Alkalinity	SM[1] 2320 B
SO4	USEPA Method 300.0
SiO2	SM[1] 4500-Si C or D
TDS	SM[1] 2540 C
TOC	SM[1] 5310
PO4	SM[1] 4500-P E or F
Natural Tracers	
δ^{53}Cr	SW846 6800 or equivalent
δ^{18}O	CF-IRMS
δ^{2}H	CF-IRMS
B	SW 846 Method 6020A
Metals	
Title 22 Suite (includes CrT)	SW 846 6010B or C, 6020A, 7470 (Title 22 Metals incl. CrT)
Cr(VI)	USEPA Method 218.6 (Cr6)

[1] SM - Standard Methods 18th, 19th, or 20th edition

Table 2
Published Studies by Others
Pacific Gas and Electric Company - Hinkley Chromium Remediation Project
Hinkley, California

Study/Report	Naturally Occurring Total Chromium (µg/L)	Naturally Occurring Hexavalent Chromium (µg/L)	Description
[a]USGS Western Mojave Desert	NM	Cr6 Range = ND to 61 µg/L	Approximately 200 wells were sampled. In addition, depth discrete samples were collected, which indicated that Cr6 concentrations could vary from <0.1 to 36 µg/L in a single well due to variable redox conditions. Cr6 concentrations were low near mountain recharge areas where pH values were neutral and low in discharge areas where there was low dissolved oxygen. The highest Cr6 concentrations (up to 61 µg/L) were reported for wells completed within alluvium derived from mafic rocks, with lower concentrations (up to 36 µg/L) reported for alluvium derived from less mafic granitic, volcanic and metamorphic rocks.
[b]USGS Western Mojave Desert, Sheep Creek Fan and Surprise Springs Area	NM	Cr6 Range = 0.2 to 60 µg/L	Results for 157 public supply, irrigation and observation wells in the Western part of the Mojave desert were included. Cr6 did not exceed 5 µg/L at pH < 7.5 in any geologic conditions. Cr6 range for all wells was 0.2 - 60 µg/L. Study indicated that majority of chromium detected was in the form of Cr6. Cr6 distribution in soil samples was found to be greatest above and near the water table, and concentrations rapidly decreased with depth. This observation was supported with chromium groundwater sample results.
[c]ADEQ Sacramento Valley Arizona Study	Confidence Interval Range of 1 to 83 µg/L	NM	Regional Arizona Department of Environmental Quality (ADEQ) groundwater study of basin in NW Arizona (immediately east of the Mojave Basin) comprising 1,500 square miles east of the Colorado River. The upper 95% confidence interval for CrT was 83 µg/L, and the lower 95% confidence interval for CrT was 1 µg/L.
[d]USGS Regional Aquifer System Analysis Program	CrT Range = ND to 300 µg/L	NM	436 samples were collected from 72 basins in central and southern Arizona, southeastern California and Nevada, and western New Mexico. Results for 5 percent of samples collected were greater than 50 µg/L. Range in CrT concentrations was 0 to 300 µg/L, standard deviation = 30.7 µg/L.
[e]CA State Water Resources Control Board, GAMA Program	NM	53% of wells > than 1.0	California Department of Health Services data for 1997-2008 were evaluated. 3,156 out of 5,943 tested public water wells (active and standby) throughout CA have detected Cr6 at concentrations greater than the laboratory reporting limit of 1 µg/L. Los Angeles, San Bernardino, and Fresno counties had the highest number of detections greater than 1 µg/L.
[f]Joshua Tree and Copper Mountain Groundwater Sub-Basins, San Bernardino County	NM	Cr6 Range = 0.6 to 36.6 µg/L	Cr6 concentrations for 6 wells (23 samples total) ranged from 0.6 to 36.6 µg/L, with a median of 13.1 µg/L.
[g]Cadiz and Fenner Valleys, Mojave Desert (south eastern CA)	NM	Cr6 Range = 15 to 26 µg/L	Chromium concentrations were generally uniform throughout study area, indicating that Cr6 was naturally occurring.

Table 2
Published Studies by Others
Pacific Gas and Electric Company - Hinkley Chromium Remediation Project
Hinkley, California

Study/Report	Naturally Occurring Total Chromium (µg/L)	Naturally Occurring Hexavalent Chromium (µg/L)	Description
Los Angeles Waterworks, District No. 40 Antelope Valley, 2009 Annual Water Quality Report	NM	Cr6 Range = ND to 12.1 µg/L	Public water supply system. Range in Cr6 concentrations was ND to 12.1 µg/L.
[h]Twentynine Palms Water District	NM	Cr6 Range = ND to 29 µg/L	Public water supply system. Range in Cr6 concentrations was ND to 29 µg/L.
[i]Golden State Water Company, Barstow	NM	Cr6 Range = ND to 1.1 µg/L	Public water supply system. Range in concentrations was ND to 1.1 µg/L in 2006 samples reported in 2008. 2010 report did not include data for Cr6 or CrT.
[j]Golden State Water Company, Victorville Desert View Water System	NM	Cr6 Range = 5.0 to 5.1 µg/L	Public water supply system. Range in concentrations was 5.0 to 5.1 µg/L.
[k]Golden State Water Company, Victorville Apple Valley South Water System	NM	Cr6 Range = ND to 6.3 µg/L	Public water supply system. Range in concentrations ND to 6.3 µg/L.
[l]Golden State Water Company, Lucerne Water System	NM	Cr6 Range = ND to 4.6 µg/L	Public water supply system. Range in concentrations ND to 4.6 µg/L.
City of Hesperia Water District, 2009 Consumer Confidence Report	NM	Cr6 Range = ND to 19 µg/L	Public water supply system. Range in concentrations ND to 19 µg/L. Laboratory reporting limit of 10 µg/L. Range in 2008 report concentrations was ND to 16.1 µg/L.
2009 Summary of Water Quality Data Rosamond Community Services District Water System	NM	Cr6 Mean = 9.0 µg/L	Public water supply system. No range reported. 2008 report indicated a mean of 9.0 µg/L, based on samples from 2006.

Table 2
Published Studies by Others
Pacific Gas and Electric Company - Hinkley Chromium Remediation Project
Hinkley, California

Study/Report	Naturally Occurring Total Chromium (µg/L)	Naturally Occurring Hexavalent Chromium (µg/L)	Description
[m]Victorville Water District	NM	Cr6 Range = ND to 9.3 µg/L	Public water supply system. Range in concentrations ND to 9.3 µg/L.
nTopock Background Study	CrT Mean = 9.37	Cr6 Mean = 7.8	Six sampling events (25 wells) were used to develop background concentrations from mostly long screened supply wells in the greater Topock area. Fluvial materials were commonly associated with reducing conditions and low to non-detect chromium concentrations, therefore the UTLs may be conservatively low for wells screened in the alluvial aquifer under oxic conditions.
nTopock Background Study, UTL	CrT UTL = 34.1	Cr6 UTL = 31.8	

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[a] Ball James W., and Izbiki, J.A., 2004. Occurrence of Hexavalent Chromium in Groundwater in the Western Mojave Desert, California

[b] Izbiki, James A., Ball, James W., Bullen, Thomas, D., Sutley, Stephen J. Sutley. 2008. Chromium, Chromium Isotopes, and Selected Trace Elements, Western Mojave Desert, USA

[c] Arizona Department of Environmental Quality (ADEQ) Open File Report June 2001. Ambient Groundwater Quality of the Sacramento Valley Basin: A 1999 Baseline Study

[d] Robertson, Frederick N. 1991. Geochemistry of Ground Water in Alluvial Basins of Arizona, and Adjacent Parts of Nevada, New Mexico, and California. U.S. Geological Survey Professional Paper 1406-C.

[e] State Water Resources Control Board Division of Water Quality GAMA Program. September 2009. Groundwater Information Sheet Chromium VI.

[f] Evaluation of Geohydraulic Framework, Recharge Estimates, and Ground-Water Flow of the Joshua Tree Area, San Bernardino County, California. 2004. Nishikawa, Tracy., Izbiki, John A., Hevesi, Joesph A., Stamos, Christina L., and Martin, Peter.

[g] Metropolitan Water District of Southern California (MWD) and Bureau of Land Management. 2001. Cadiz Groundwater Storage and Dry-Year Supply Program, Final EIR/EIS response to Comments.

[h] Twentynine Palms Water District. 2010. June 2009 Consumer Confidence Report. June

[i] Golden State Water Company. 2008 and 2010. Water Quality Report. Barstow Water System.

[j] Golden State Water Company. 2010. Water Quality Report. Desert View Water System.

[k] Golden State Water Company. 2010. Water Quality Report. Apple Valley South Water System.

[l] Golden State Water Company. 2010. Water Quality Report. Lucerne Water System.

[m] Victorville Water District June 2011, The Water Resource 2010 Consumer Confidence Report

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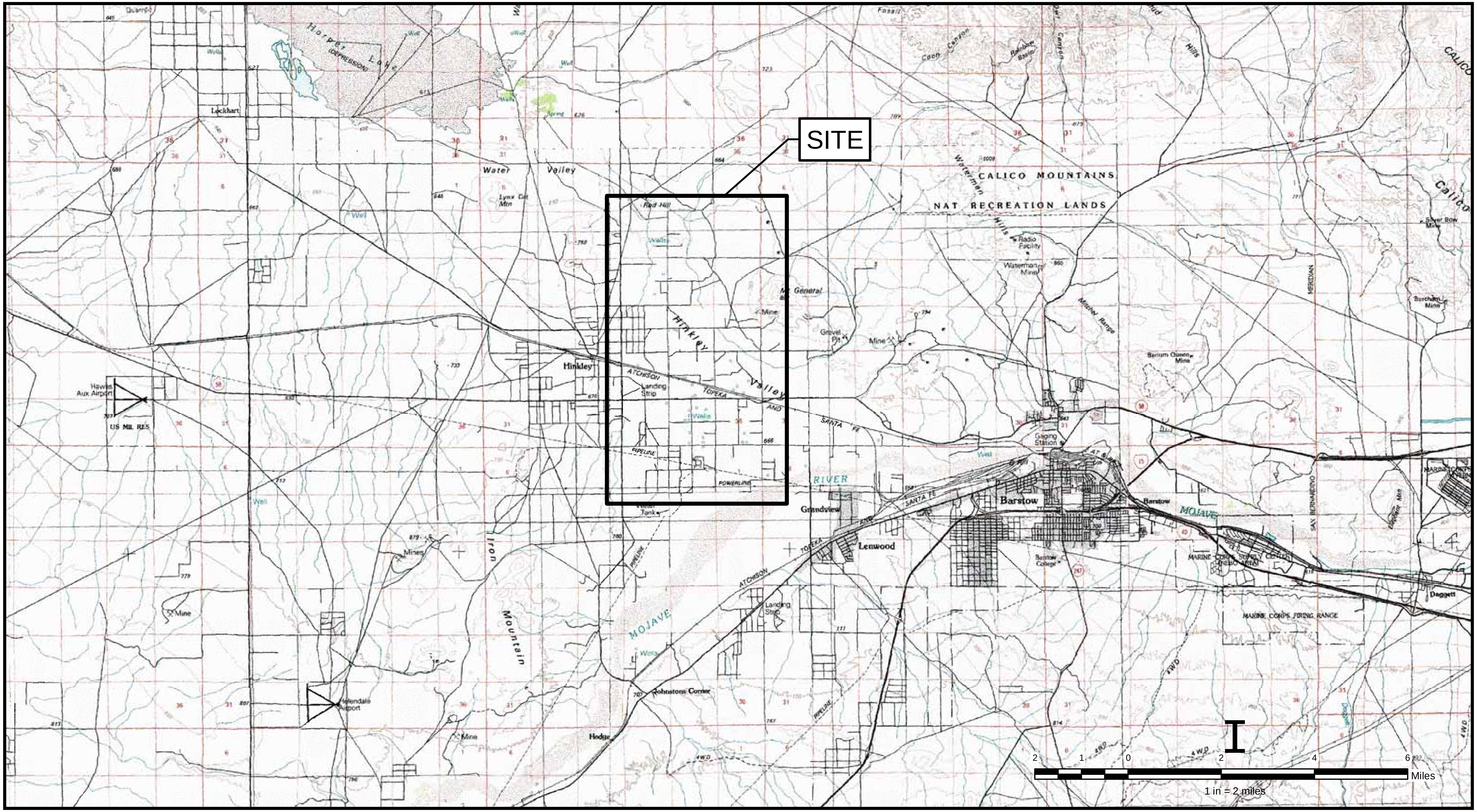
Abbreviations:

µg/L = micro-grams per liter
CrT = total chromium, dissolved
Cr6 = hexavalent chromium, dissolved
ND = not detected at laboratory reporting limits
NM = not measured
UTL= upper tolerance limit
USGS = United States Geological Survey

FIGURES

Work Plan for Evaluation of Background
Chromium in the Groundwater of the Upper Aquifer in the Hinkley Valley
Pacific Gas and Electric Company
Stantec PN# 185702482
February 22, 2012

Z:\PG&E\MXD_Files\January 2012\Background Study\Figure 1 (Site Location Map) (2012-2-17).mxd



Source: USGS, 1993

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FOR:
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Groundwater Remediation Project
Hinkley, California

SITE LOCATION MAP

FIGURE:
1

JOB NUMBER:	DRAWN BY:	CHECKED BY:	APPROVED BY:	DATE:
185702482	TF	BD	CM	02/17/12

Path: Z:\PG&E\MXD_Files\January 2012\Background Study\Figure 2 (Site Layout) (2012-2-17)dsize.mxd

NOTES:
Projection: CA State Plane NAD83 Feet Zone V
Outside Data Sources: Arcadis and CH2MHill, December 2011

Wells by Well Type

- ● Groundwater Monitoring Well
- ⊕ Domestic Supply Well
- ◒ Agricultural Supply Well
- ⊡ Groundwater Extraction Well
- ⊞ Multi-Use, Test Well, Inactive Groundwater Extraction Well
- ⯐ Freshwater Injection Well
- ▲ IRZ Injection Well
- ◬ IRZ Recirculation Well
- ▨ PGE Property Boundaries

● Upper Aquifer Chromium Investigation Monitoring Wells Installed Since December 2010 (MW-94 through MW-154)

⊕ Chromium Investigation Borings Advanced Since December 2010 (120-SB1, 120-SB2, D-B1, E-B1)

Note:
Only wells and borings included on geologic sections and those completed since December 2010 are labeled

Chromium Plume (Fourth Quarter 2011)
Concentration of Hexavalent Chromium (ug/l)

- 50 ug/l
- 10 ug/l
- 3.1 ug/l (Dashed Where Inferred)

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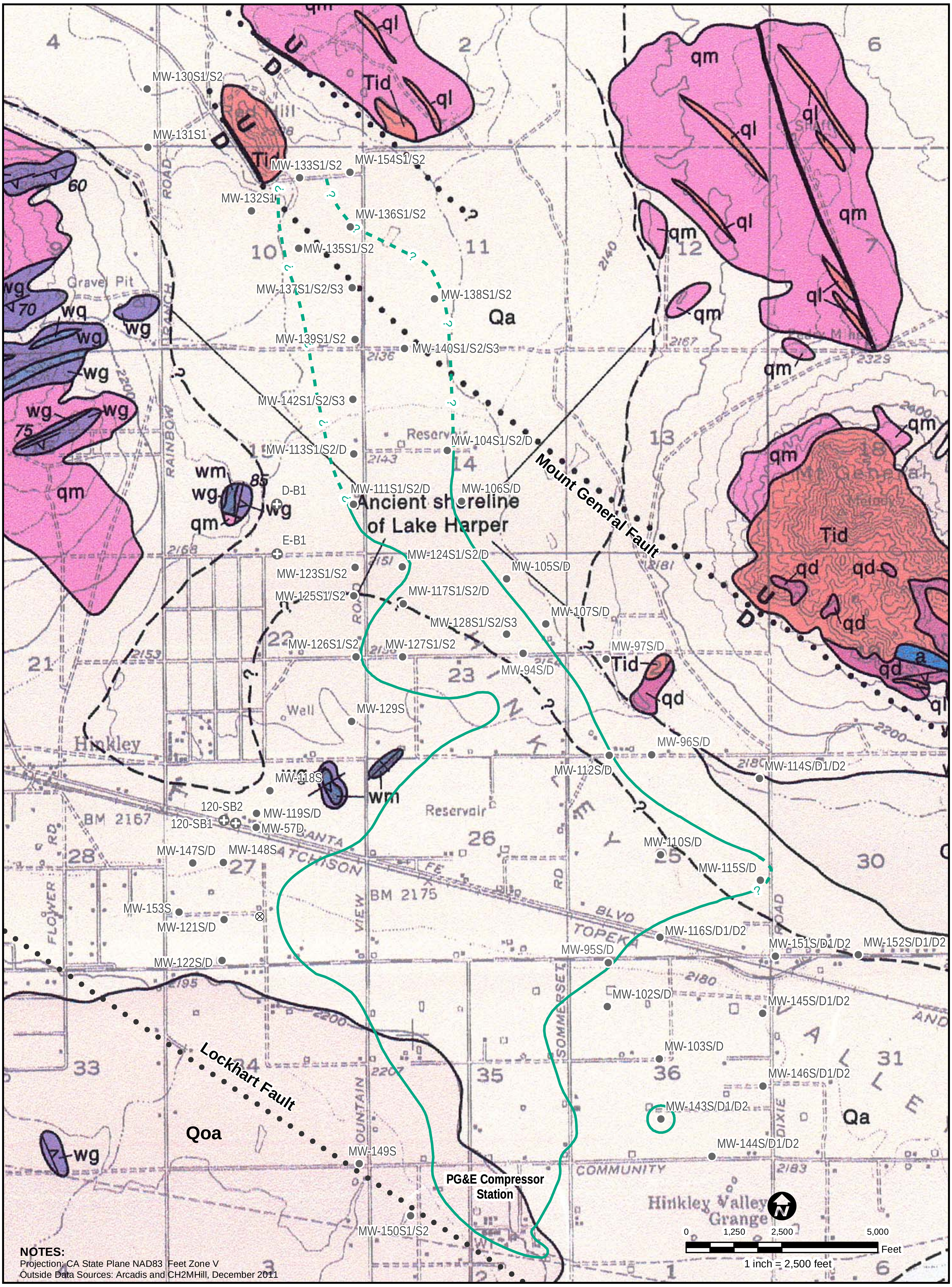
FOR: Pacific Gas & Electric Groundwater Remediation Project Hinkley, California		SITE LAYOUT AND LINES OF GEOLOGIC SECTION		FIGURE: 2
JOB NUMBER: 185702482	DRAWN BY: TF	CHECKED BY: BD	APPROVED BY: CM	DATE: 02/17/12

Z:\PG&E\MXD_Files\January 2012\Background Study\Figure 3 (Geologic Map of Hinkley Valley) (2012-2-17)11x17.mxd



NOTES:
Projection: CA State Plane NAD83 Feet Zone V
Outside Data Sources: Arcadis and CH2MHill, December 2011

Mesozoic Igneous Rocks
- ql - Quartz Latite
- a - Aplite
- qd - Quartz Diorite
- qm - Quartz Monzonite

Older Metamorphic Rocks
- wm - Marble
- wq - Quartzite
- wg - Quartz Diorite Gneiss

Quarternary Deposits
- Qa - Alluvial Sand of Valley Areas
- Qoa - Older Alluvial Gravel

Chromium Plume (Fourth Quarter 2011)
Concentration of Hexavalent Chromium (ug/l)
3.1 ug/l
(Dashed Where Inferred)

Fault Features
Fault Features; Dotted where concealed; Arrows indicate relative movement
U = Upthrown Side
D = Downthrown Side

● Upper Aquifer Chromium Investigation Monitoring Wells Installed Since December 2010 (MW-94 through MW-154)

⊕ Chromium Investigation Borings Advanced Since December 2010 (120-SB1, 120-SB2, D-B1, E-B1)

Note:
1) Topographic base map used on this Dibblee geologic map is from 1956. Road names and other features shown may have changed and current information is shown on Figure 2
2) Location of Lockhart Fault from USGS

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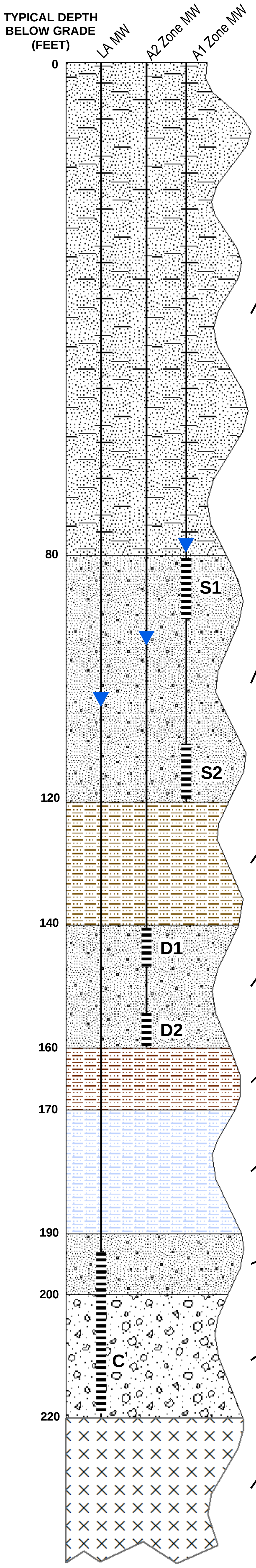
FOR:		GEOLOGIC MAP OF THE HINKLEY VALLEY AND SURROUNDING AREAS		FIGURE:
Pacific Gas & Electric Groundwater Remediation Project Hinkley, California				3
JOB NUMBER: 185702482	DRAWN BY: TF	CHECKED BY: BD	APPROVED BY: CM	DATE: 02/17/12

Path: Z:\PG&E\MXD_Files\January 2012\Background Study\Figure 4 (Site Stratigraphy) (2012-2-17)11x17.mxd



UNSATURATED ZONE (UZ)

Sand and silt with some gravel and clay. Total depth is typically 75 to 85 feet below ground surface (bgs). The UZ is thinner where bedrock is shallow. Depositional environment is inferred to be fluvial and alluvial fans.

UPPER AQUIFER SHALLOW ZONE (A1)

Sand and silt with some clay and minor fine gravel. Thickness ranges from about 15 to 60 feet, with the thickest sections in the investigation area being along Summerset Road in the South Hinkley Valley Basin (SHVB). These relatively thick A1 deposits extend northward beneath the Gorman Agricultural Unit (AU) and into the central portions of the North Hinkley Valley Basin (NHVB). Depositional environment is inferred to be fluvial with some alluvial fan in the western and eastern portions of the basins (where bedrock is relatively shallow).

UPPER AQUIFER CONFINING CLAY LAYER (UA CCL)

Brown clay with some silt and occasional lenses of fine sand ("the Brown Clay"). Thickness ranges from about five (5) to 50 feet, with the thickest sections being beneath the eastern and southern portions of the Desert View Dairy (DVD) in the SHVB. This unit is not present in some portions of the investigation area, where the A1 and underlying A2 units are in direct contact. The unit may also be absent in areas of shallow bedrock. Depositional environment is a freshwater shallow lake.

UPPER AQUIFER LOWER ZONE (A2)

Sand and silt with some gravel and clay. Thickness ranges from about 5 to 60 feet, with the thickest sections being to the east and southeast of the DVD. The A2 deposits are relatively thin, and in some cases not present, in the NHVB. The A2 deposits are absent in areas of shallow bedrock. Depositional environment is similar to the A1.

UPPER AQUIFER DEEP CLAY LAYER (A2 DCU)

Red and brown clay with some silt and occasional sand lenses, and may contain angular gravel size clasts of weathered bedrock. These deposits range in thickness from a few to 20 feet, and are mostly found in the NHVB. Depositional environment is similar to the UA CCL; some areas may include mud flows associated with local volcanic activity.

LOWER AQUIFER CONFINING CLAY LAYER (LA CCL)

Blue to green-gray clay with some silt and occasional minor sand lenses ("the Blue Clay"). Thickness typically ranges from a few feet to about 40 feet; thickness may reach 70 feet or more in the central portion of the SHVB. These deposits are absent in the western portions of the SHVB and the NHVB where bedrock is relatively shallow, and to the east of the DVD where bedrock is also shallow. Depositional environment is similar to the UA CCL.

LOWER AQUIFER SEDIMENTARY DEPOSITS (LA SED)

Mostly sand and fine gravel with some silt and clay; may contain clasts of weathered bedrock materials. Presence of this unit is limited to the central portions of the SHVB and NHVB where bedrock is the deepest. Depositional environment is fluvial.

WEATHERED BEDROCK (LA WBRK)

Weathered bedrock materials, which may include sand, silt and clay sized deposits mixed with bedrock clasts. In some areas this unit is highly calcareous (reactive to hydrochloric acid). Thickness typically ranges from a few feet to 30 feet. Groundwater flowing in the weathered bedrock is considered part of the lower aquifer.

CONSOLIDATED BEDROCK (BDRK)

Consolidated bedrock, consisting primarily of granitic and metamorphic rocks. Granitic rocks are typically monzonite to diorite. Metamorphic rocks include banded gneiss, marble, and quartzite. In the NHVB, bedrock may include volcanic rock. Mt. General, located to the east of the investigation area, is mapped by others as being primarily dacite.

Note: Typical Well Screens are Shown for Illustration / Naming Conventions

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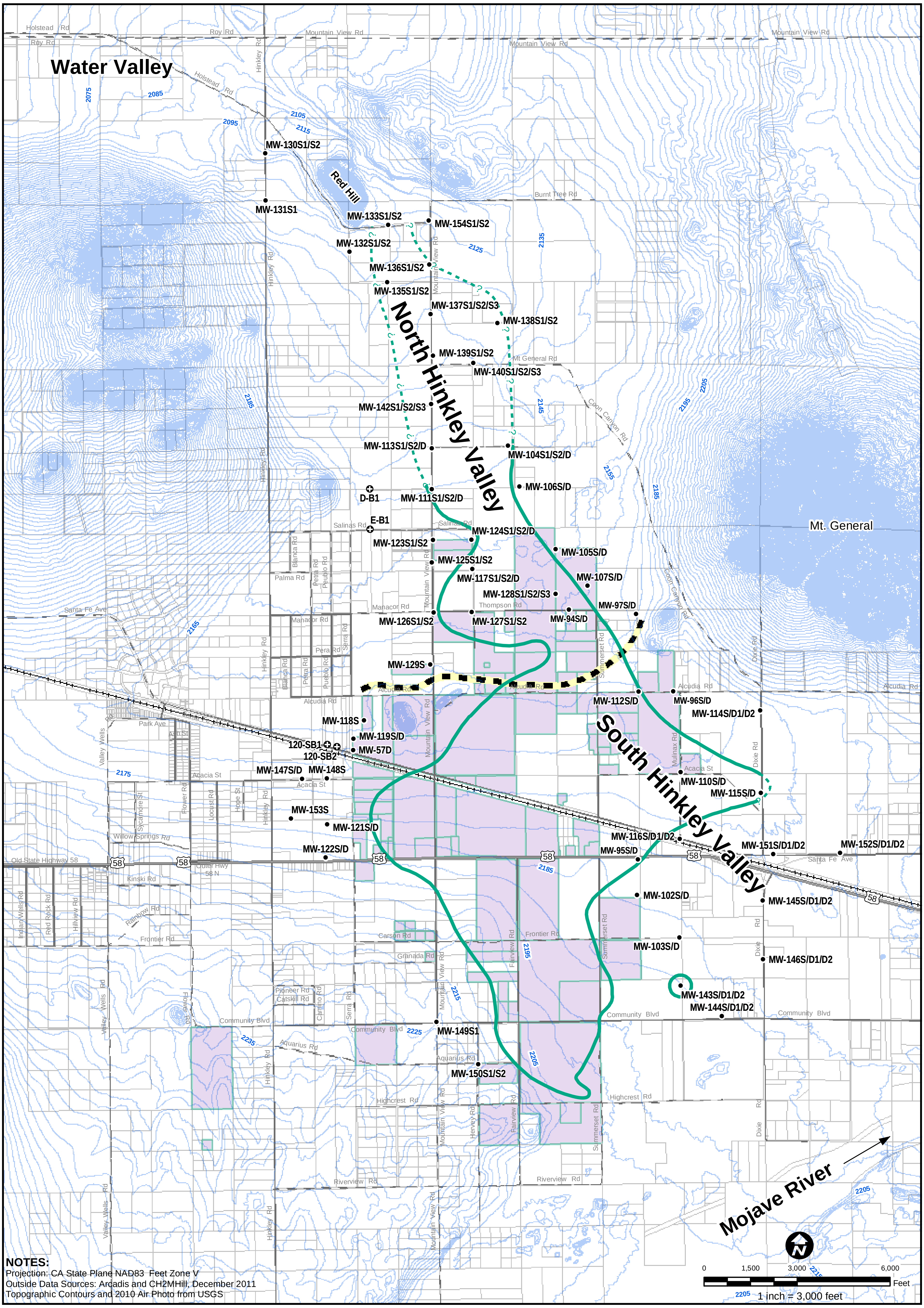
FOR:				FIGURE:
Pacific Gas & Electric Groundwater Remediation Project Hinkley, California		SITE STRATIGRAPHY		4
JOB NUMBER: 185702482	DRAWN BY: TF	CHECKED BY: BD	APPROVED BY: CM	DATE: 02/17/12

Z:\PG&E\MXD_Files\January 2012\Background Study\Figure 5 (Concept Boundaries) (2012-2-17)11x17.mxd



NOTES:
Projection: CA State Plane NAD83 Feet Zone V
Outside Data Sources: Arcadis and CH2MHill, December 2011
Topographic Contours and 2010 Air Photo from USGS

● Upper Aquifer Chromium Investigation Monitoring Wells Installed Since December 2010 (MW-94 through MW-154)

⊕ Chromium Investigation Borings Advanced Since December 2010 (120-SB1, 120-SB2, D-B1, E-B1)

⊗ Piezometer Completed During the Most Recent Investigation

— Ground Surface (5 ft AMSL)

▬ ▬ Conceptual Boundary for the North and South Hinkley Valley Basins

Chromium Plume (Fourth Quarter 2011)
Concentration of Hexavalent Chromium (ug/l)
〰 3.1 ug/l
(Dashed Where Inferred)

▨ PGE Property Boundaries

Note:
Monitoring Well MW-134 was subsiquently damaged during installation and destroyed. This well was replaced with MW-154.

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Hinkley, California

CONCEPTUAL BOUNDARY FOR THE NORTH AND SOUTH HINKLEY VALLEY BASINS

FIGURE:
5

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185702482	TF	BD	CM	02/17/12

Z:\PG&E\MXD_Files\January 2012\Background Study\Figure 6 (X-Section a) (2012-2-17)d size.mxd

Geologic Contacts

- ▨ Unsaturated Zone (UZ)
- ▨ Upper Aquifer Shallow Zone (A1)
- ▨ Upper Aquifer Confining Clay layer (UA CCL) "The Brown Clay"
- ▨ Upper Aquifer Lower Zone (A2)
- ▨ Upper Aquifer Deep Clay Layer (A2 DCU)
- ▨ Upper Aquifer / Lower Aquifer (LA CCL) "The Blue Clay"
- ▨ Lower Aquifer - Weathered Bedrock (LA WBR)
- × × × Bedrock (BDRK)

20x Vertical Exaggeration

0 500 1,000 2,000 3,000 Feet

1 inch = 1,000 feet

Legend

- — Well / Borehole
- ▬ Screen Interval
- — Ground Surface
- (10 FT S) Projected Distance From Line of Cross Section
- ▼ Water Level A1 Zone Well (October 2011) (MW-143, MW-144, MW-145, December 2011)
- ▽ Water Level A2 Zone Well (October 2011) (MW-143, MW-144, MW-145, December 2011)
- **1.70 / 2.70** Cr6 / CrT - (Hexavalent Chromium / Total Chromium) Concentrations in micrograms per liter (µg/L) (4th Quarter 2011, or if 4th Quarter 2011 data unavailable then most recent)
- **NA/NA** Not Available. Well has either not been sampled or has been sampled but validated results are not yet available as of the date February 2012 Technical Memorandum
- **ND** Not Detected

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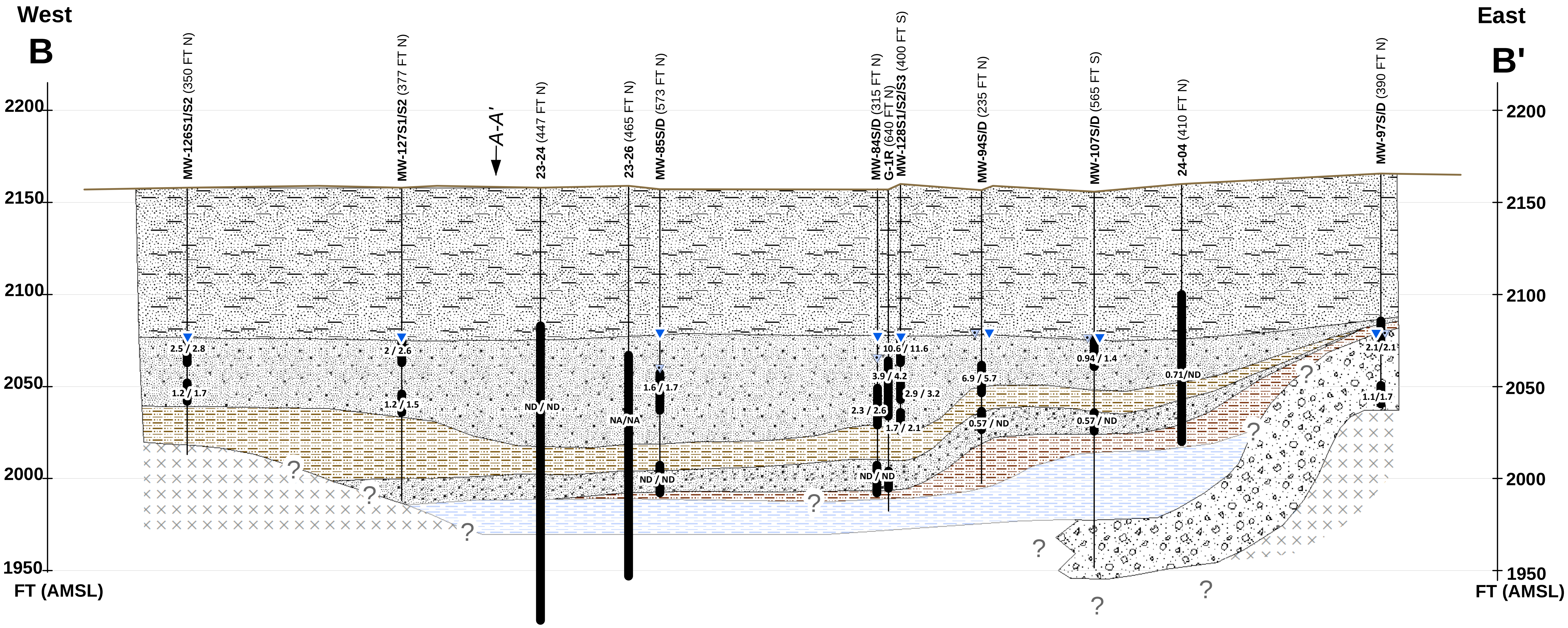
Hinkley, California

GEOLOGIC CROSS SECTION
A-A'
(Section B-B' from Technical Memorandum Update to Upper Aquifer Groundwater Investigation Activities, Stantec 2012)

FIGURE: 6

JOB NUMBER:	DRAWN BY:	CHECKED BY:	APPROVED BY:	DATE:
185702482	TF	BD	CM	02/17/12

Z:\PG&E\MXD_Files\January 2012\Background Study\Figure 7 (X-Section B) (2012-2-17)C size.mxd



Geologic Contacts

- ▨ Unsaturated Zone (UZ)
- ▨ Upper Aquifer Shallow Zone (A1)
- ▨ Upper Aquifer Confining Clay layer (UA CCL) "The Brown Clay"
- ▨ Upper Aquifer Lower Zone (A2)
- ▨ Upper Aquifer Deep Clay Layer (A2 DCU)
- ▨ Upper Aquifer / Lower Aquifer (LA CCL) "The Blue Clay"
- ▨ Lower Aquifer - Weathered Bedrock (LA WBR)
- ☒ Bedrock (BDRK)

10x Vertical Exaggeration

0 250 500 1,000 1,500 Feet

1 inch = 500 feet

Legend

—	Well / Borehole
▬	Screen Interval
—	Ground Surface
(10 FT S)	Projected Distance From Line of Cross Section
▼	Water Level A1 Zone Well (October 2011)
▽	Water Level A2 Zone Well (October 2011)
1.70 / 2.70	Cr6 / CrT Concentrations in micrograms per liter (µg/L) (4th Quarter 2011, or if 4th Quarter 2011 data unavailable then most recent)
NA/NA	Not Available. Well has either not been sampled or has been sampled but validated results are not yet available as of the date of this report.

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GEOLOGIC CROSS SECTIONS
B-B'
(Section G-G' from Technical Memorandum Update to Upper Aquifer Groundwater Investigation Activities, Stantec 2012)

FIGURE: 7

JOB NUMBER: 185702482
DRAWN BY: TF
CHECKED BY: BD
APPROVED BY: CM
DATE: 02/17/12

Z:\PG&E\MXD_Files\January 2012\Background Study\Figure 8 (GW flow in A1 Zone) (2012-2-17)C size.mxd

Wells by Well Type

- ● Groundwater Monitoring Well
- ⊕ Domestic Supply Well
- ◒ Agricultural Supply Well
- ⊡ Groundwater Extraction Well
- ⌖ Freshwater Injection Well
- ⊕ Soil Boring
- ⊞ Multi-Use, Test Well, Inactive Groundwater Extraction Well

▨ PGE Property Boundaries

● Upper Aquifer Chromium Investigation Monitoring Wells Installed Since December 2010 (MW-94 through MW-154)

⊕ Chromium Investigation Borings Advanced Since December 2010 (120-SB1, 120-SB2, D-B1, E-B1)

2102 ∿ Potentiometric Surface of Shallow Zone Elevation Contour (ft above MSL)

Note

Well labels shown in gray scale text are for reference only and were not used to contour the potentiometric surface illustrated on this figure.

Shallow Zone Chromium Plume (Fourth Quarter 2011)

Concentration of Hexavalent Chromium (ug/l)

∿ 50 ug/l

∿ 10 ug/l

∿ 3.1 ug/l

(Dashed Where Inferred)

Source: CH2MHill Fourth Quarter 2011 Groundwater Monitoring Report and Domestic Well Sampling Results, January 30, 2012

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FOR: Pacific Gas & Electric Groundwater Remediation Project Hinkley, California		POTENTIOMETRIC GROUNDWATER SURFACE FOR THE UPPER AQUIFER SHALLOW ZONE FOURTH QUARTER 2011		FIGURE: 8
JOB NUMBER: 185702482	DRAWN BY: TF	CHECKED BY: BD	APPROVED BY: CM	DATE: 02/17/12

Z:\PG&E\MXD_Files\January 2012\Background Study\Figure 9 (GW flow in A2 Zone) (2012-2-17)C size.mxd

Wells by Well Type

- ● Groundwater Monitoring Well
- ⊕ Domestic Supply Well
- ◒ Agricultural Supply Well
- ⊡ Groundwater Extraction Well
- ⯐ Freshwater Injection Well
- ✚ Soil Boring
- ⊞ Multi-Use, Test Well, Inactive Groundwater Extraction Well

▨ PGE Property Boundaries

● Upper Aquifer Chromium Investigation Monitoring Wells Installed Since December 2010 (MW-94 through MW-154)

✚ Chromium Investigation Borings Advanced Since December 2010 (120-SB1, 120-SB2, D-B1, E-B1)

2102 Potentiometric Surface of Deep Zone Elevation Contour (ft above MSL)

Note

Well labels shown in gray scale text are for reference only and were not used to contour the potentiometric surface illustrated on this figure.

Deep Zone Chromium Plume (Fourth Quarter 2011)

Concentration of Hexavalent Chromium (ug/l)

- 50 ug/l
- 10 ug/l
- 3.1 ug/l

Source: CH2MHill Fourth Quarter 2011 Groundwater Monitoring Report and Domestic Well Sampling Results, January 30, 2012

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POTENTIOMETRIC GROUNDWATER
SURFACE FOR THE UPPER AQUIFER
DEEP ZONE
FOURTH QUARTER 2011

FIGURE: 9

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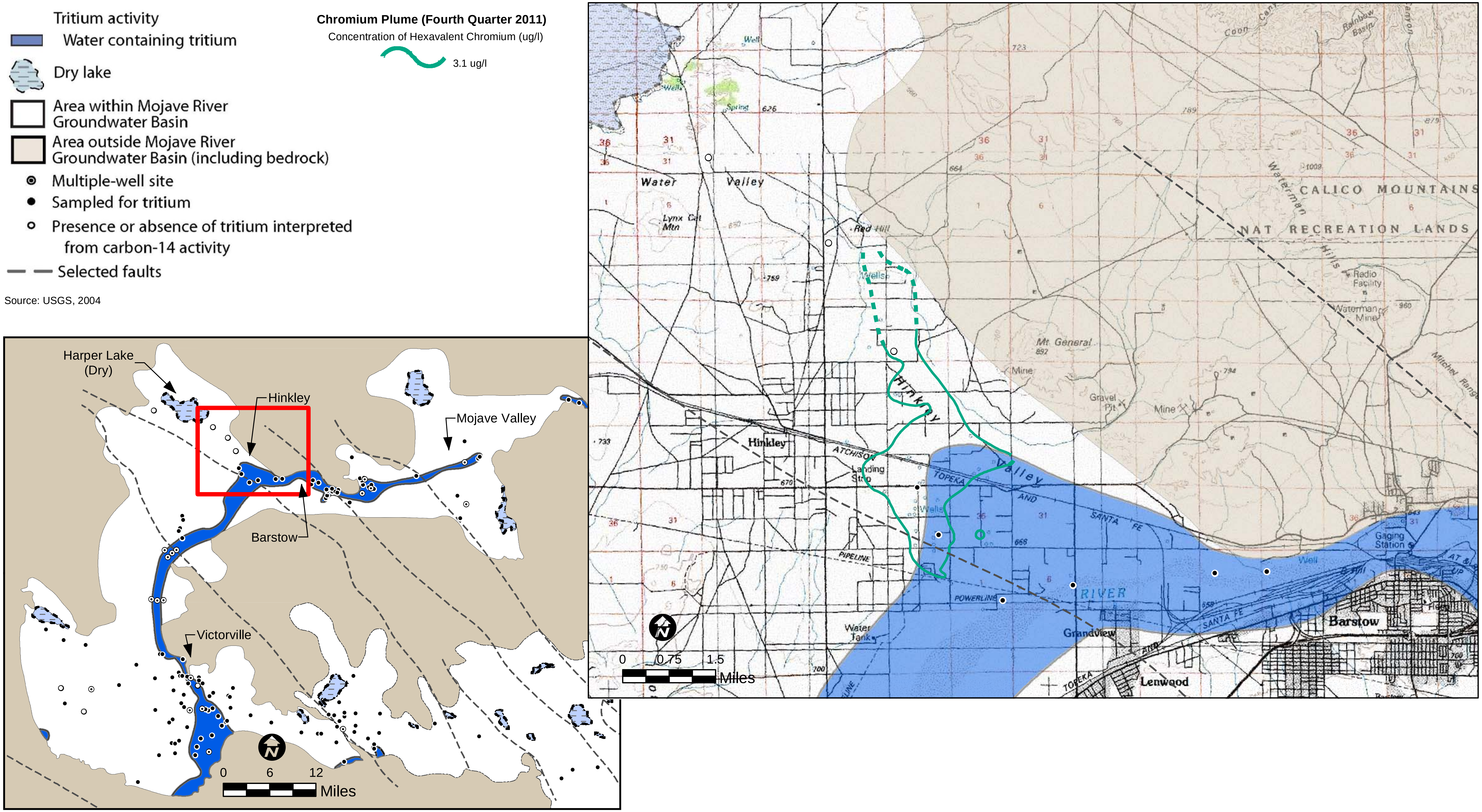

Source: USGS, 2004

![Stantec logo]

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TRITIUM IN GROUNDWATER

FIGURE: 10

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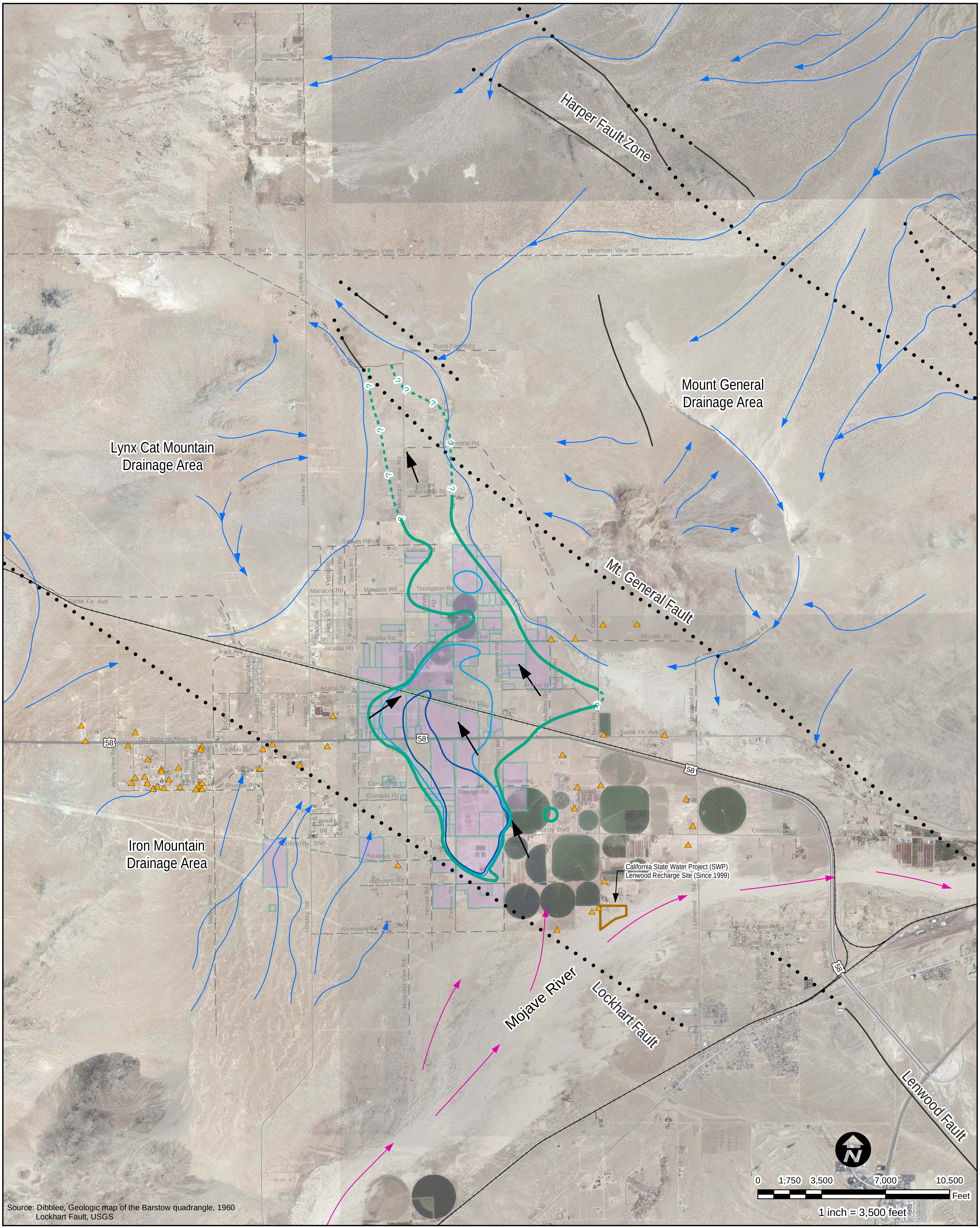
Z:\PG&E\MXD_Files\January 2012\Background Study\Figure 11 (GW recharge to Hinkley Valley) (2012-2-10)C size.mxd



Source: Dibblee, Geologic map of the Barstow quadrangle, 1960
Lockhart Fault, USGS

→	Generalized Upper Aquifer Groundwater Flow Direction
→	Simplified Surface Drainage in and Around the Hinkley Valley
→	Mojave River Flow and Recharge to Hinkley Valley
▲	Well from Prior Background Study
▨	PGE Property Boundaries
———	Geologic Fault
— — —	Dashed Where Indefinite
● ● ● ●	Dotted Where Concealed

Chromium Plume (Fourth Quarter 2011)

Concentration of Hexavalent Chromium (ug/l)

~	50 ug/l
~	10 ug/l
~	3.1 ug/l (Dashed Where Inferred)

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GROUNDWATER RECHARGE
TO THE HINKLEY VALLEY

FIGURE:
11

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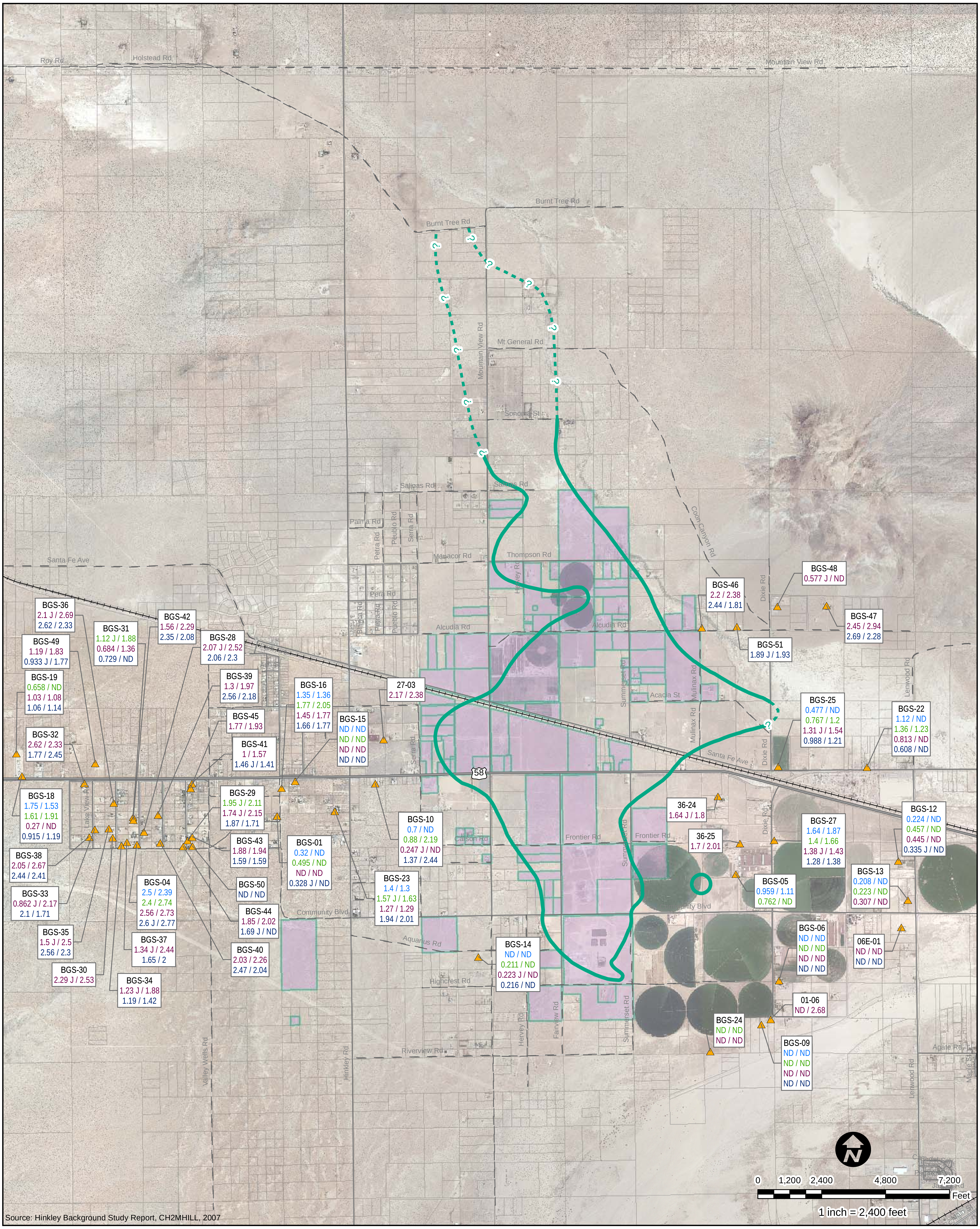
Z:\PG&E\MXD_Files\January 2012\Background Study\Figure 12 (Cr Results Prior) (2012-2-17)C size.mxd



Source: Hinkley Background Study Report, CH2MHILL, 2007

▲	Background Wells 1st through 4th Quarters, 2006
ND / ND	First Quarter Cr6 / CrT (ug/L)
ND / ND	Second Quarter Cr6 / CrT (ug/L)
ND / ND	Third Quarter Cr6 / CrT (ug/L)
ND / ND	Fourth Quarter Cr6 / CrT (ug/L)

▨ PGE Property Boundaries

Chromium Plume (Fourth Quarter 2011)

Concentration of Hexavalent Chromium (ug/l)

3.1 ug/l (Dashed Where Inferred)

Note

1) Cr6 / CrT - Hexavalent Chromium / Total Chromium
2) J - Indicates and Estimated Value
3) ND - Not Detected

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CHROMIUM RESULTS
FROM PRIOR BACKGROUND
STUDY

FIGURE:
12

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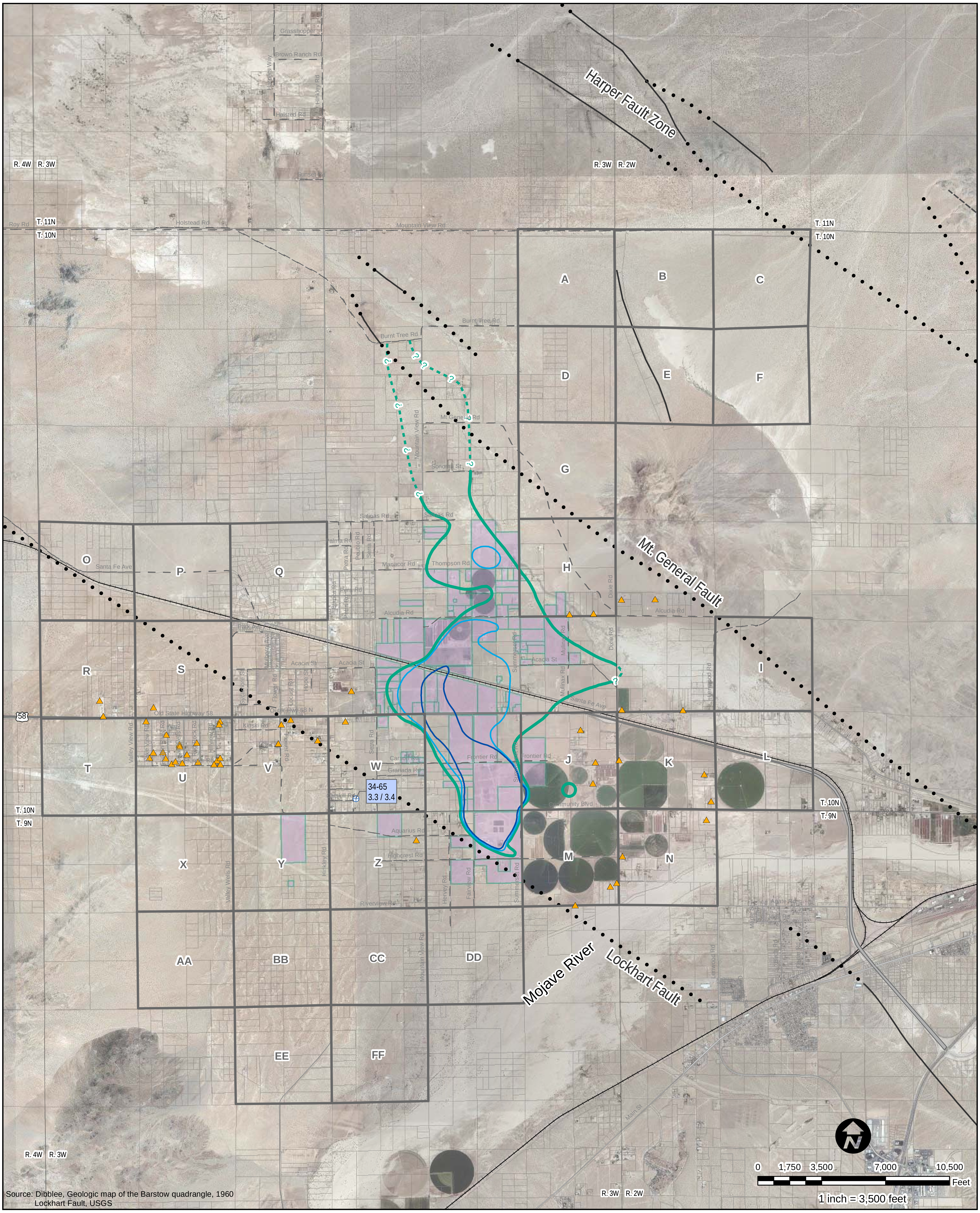
Z:\PG&E\MXD_Files\January 2012\Background Study\Figure 13 (Gridded Area for Short Screen) (2012-1-24)C size.mxd



Source: Dibblee, Geologic map of the Barstow quadrangle, 1960
Lockhart Fault, USGS

34-65 3.3 / 3.4	Domestic well outside the current chromium plume with recent Cr6 and CrT results above established background values
▲	Well from Previous Background Study
⊕	Domestic Supply Well
A	Sampling Grid
▨	PGE Property Boundaries

———	Geologic Fault
— — — ·	Dashed Where Indefinite
● ● ● ●	Dotted Where Concealed

Note

1) One groundwater monitoring well is proposed within each grid. The well will be located as close as reasonable possible to the center point of each grid, in consideration of property access as well as biological and cultural sensativities."

Chromium Plume (Fourth Quarter 2011)

Concentration of Hexavalent Chromium (ug/l)

∼	50 ug/l
∼	10 ug/l
∼	3.1 ug/l (Dashed Where Inferred)

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PROPOSED BACKGROUND
INVESTIGATION SAMPLING AREAS

FIGURE: 13

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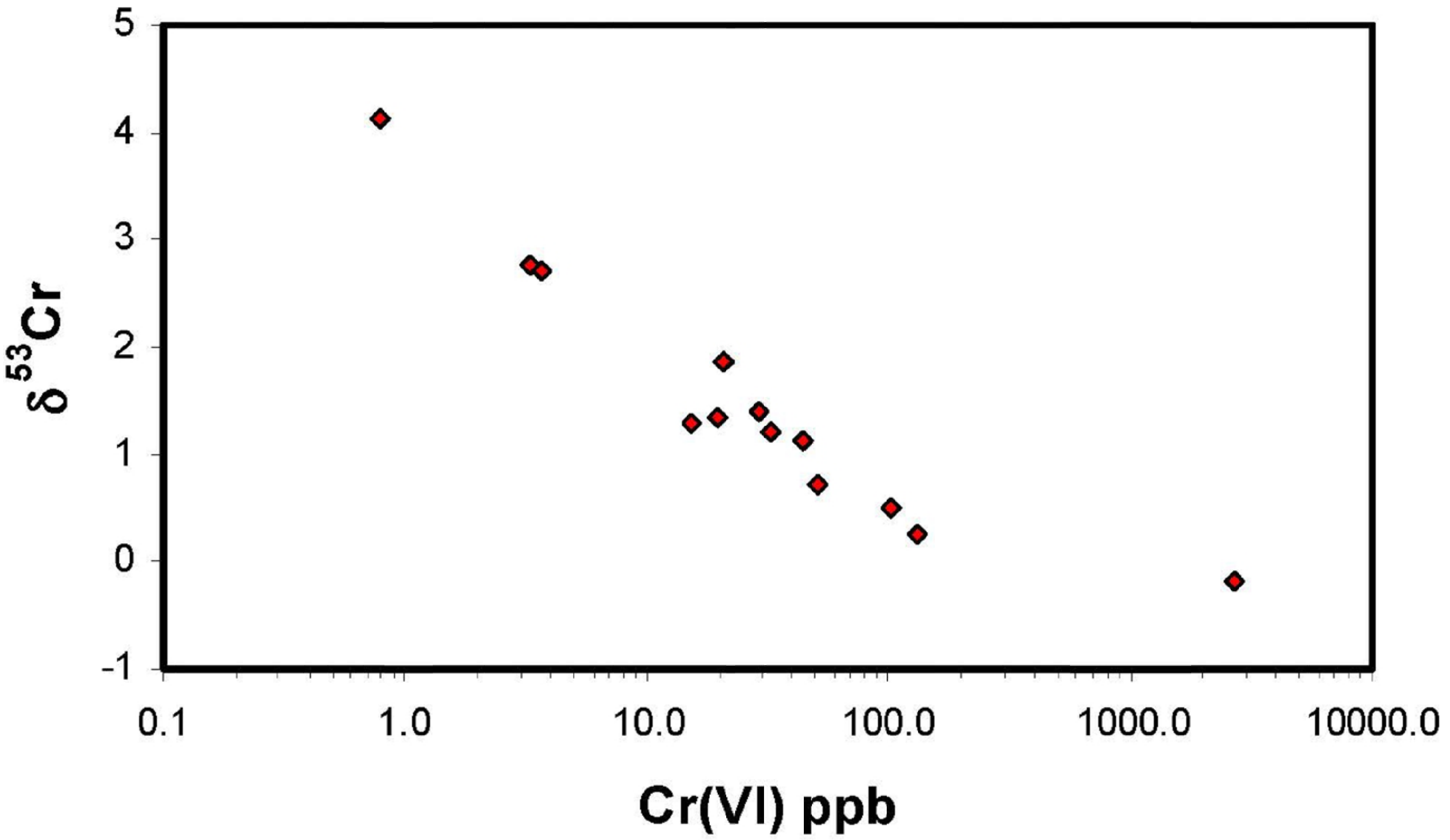
Z:\PG&E\MXD_Files\January 2012\Background Study\Figure 14 (Cr Isotope Prior) (2012-2-17)8x11.mxd



Source: Hinkley Background Study Report, CH2MHILL, 2007

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CHROMIUM ISOTOPE DATA FROM PRIOR BACKGROUND STUDY

FIGURE: 14

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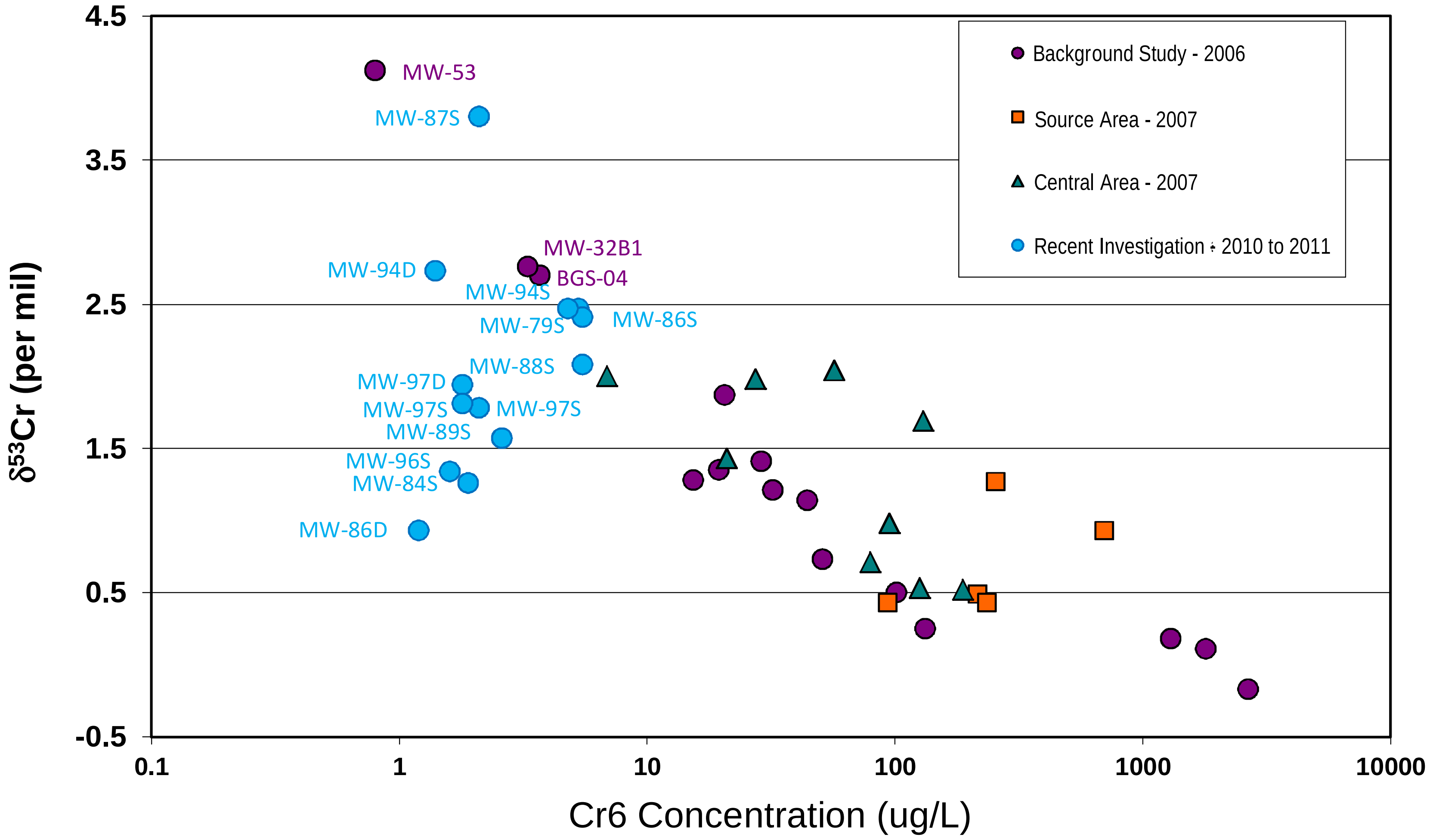
Z:\PG&E\MXD_Files\January 2012\Background Study\Figure 15 (Cr Isotope Recent) (2012-2-17)8x11.mxd



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CHROMIUM ISOTOPE DATA

FIGURE:
15

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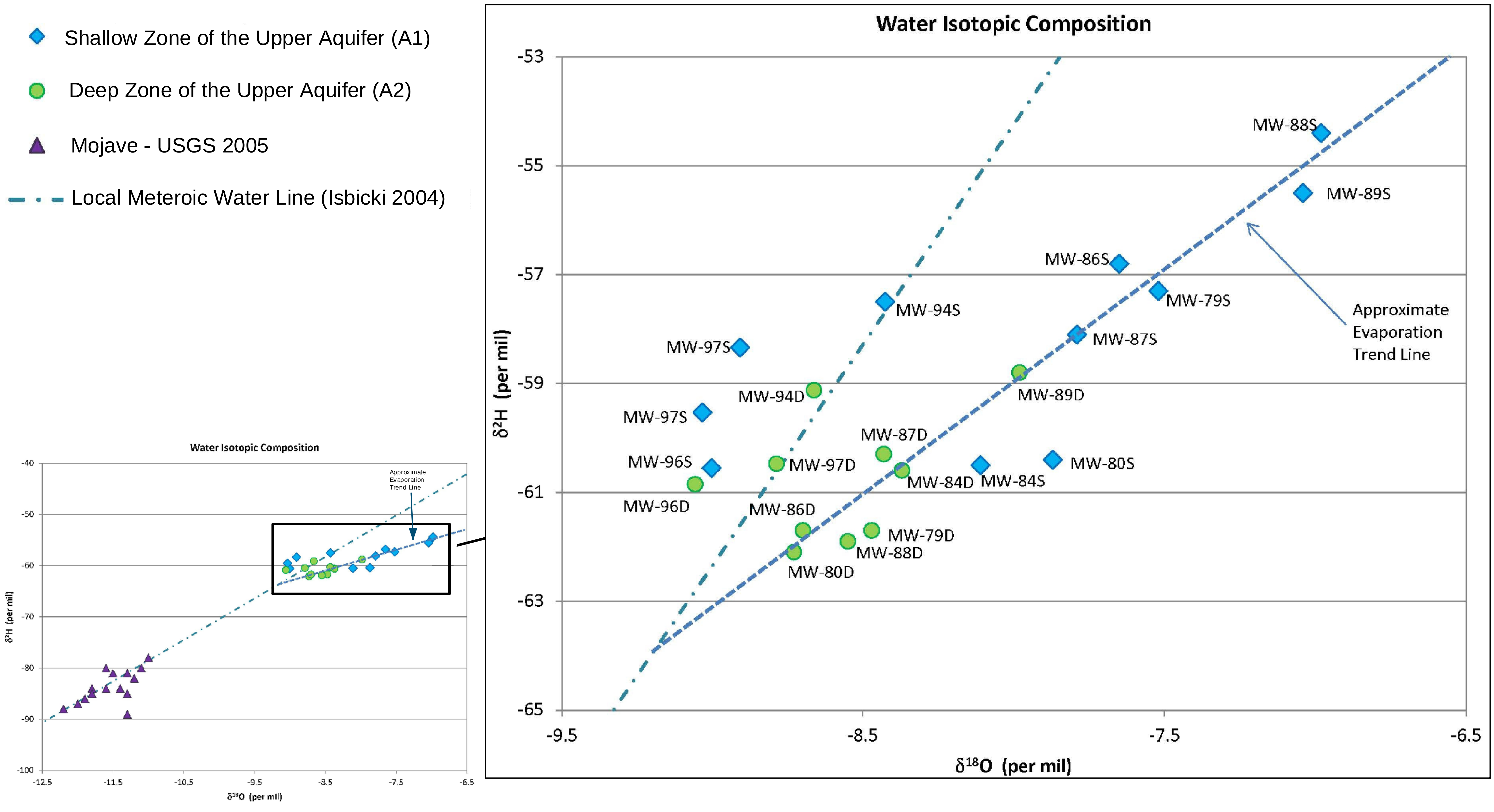
Z:\PG&E\MXD_Files\January 2012\Background Study\Figure 16 (O and H Isotope) (2012-2-17)11X17.mxd



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OXYGEN AND HYDROGEN ISOTOPE DATA FROM MOST RECENT EVALUATIONS

FIGURE:
16

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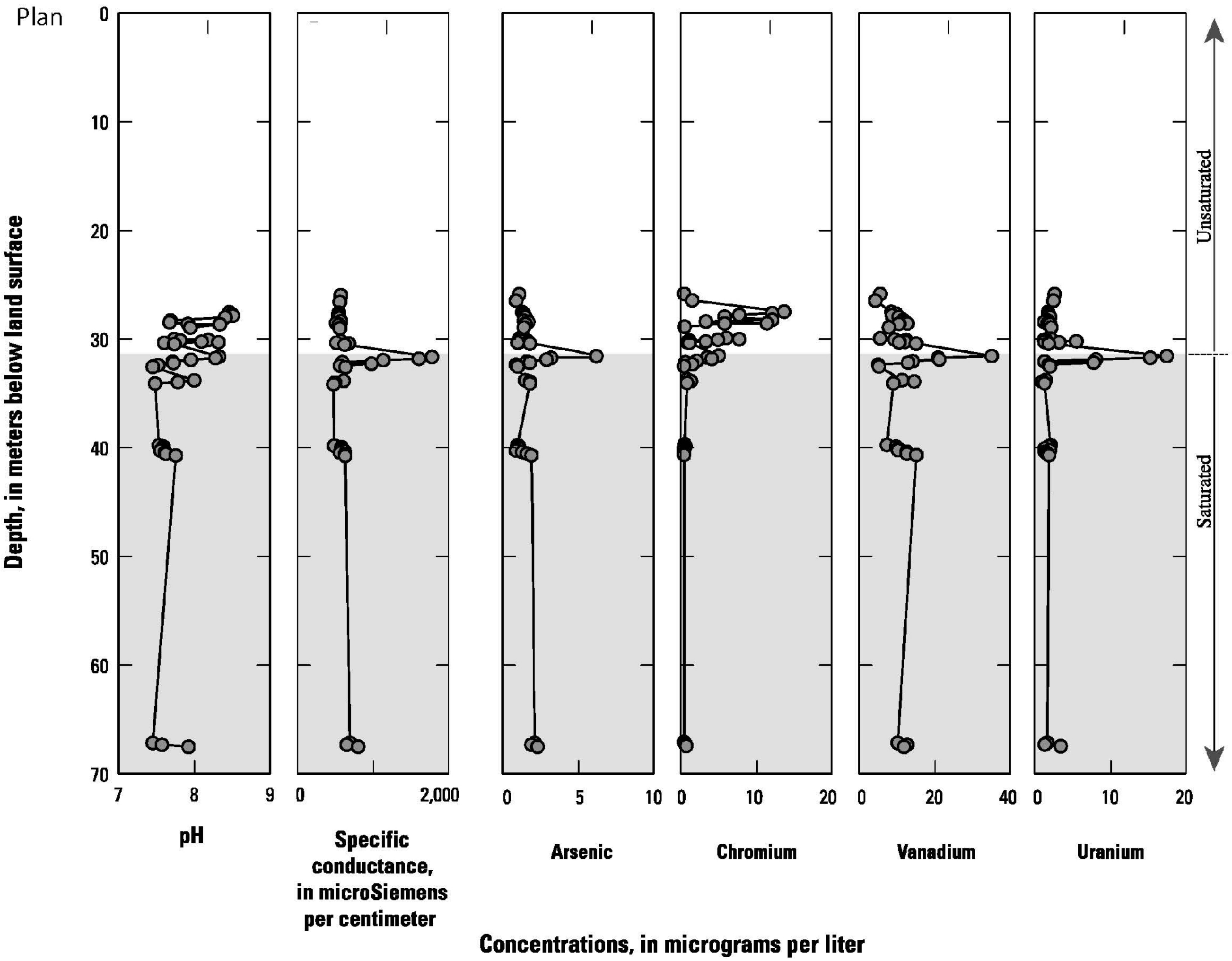
Z:\PG&E\MXD_Files\January 2012\Background Study\Figure 17 (Profile of GW data) (2012-2-17)8x11.mxd



Notes:
1. Figure taken from: J.A. Izbiki et al., Applied Geochemistry 23 (2008) 1325-1352.
2. Data collected from core material from Sheep Creek fan upgradient from El Mirage, western Mojave Desert, southern California.

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PROFILE OF GROUNDWATER DATA FROM IZBICKI

FIGURE: 17

JOB NUMBER: 185702482
DRAWN BY: TF
CHECKED BY: BD
APPROVED BY: CM
DATE: 02/17/12

APPENDIX A

Work Plan for Evaluation of Background
Chromium in the Groundwater of the Upper Aquifer in the Hinkley Valley
Pacific Gas and Electric Company
Stantec PN# 185702482
February 22, 2012

Appendix A - Peer Reviewer Comments and Response to Comments for Groundwater Background Study Report (CH2MHILL, February 2007)

Reviewers
James A. Jacobs, PG, CHG, Chief Hydrologist, **Clearwater Group**, Richmond, CA
Yorman Ruban, PhD, Professor Civil and Environmental Engineering, **UC Berkeley**, Berkeley, CA
Stuart J.Nagourney, Adjunct Professor of Chemistry, **The College of New Jersey**, NJ

Item No.	Comment	Peer	Location (Page)	Category	PG&E Responses
1	The uneven distribution of measurement locations (sampling wells) could lead to bias when using the data for predictions unless analysis is applied to take this into account. There are known techniques to handle the clustering effect. It does not appear that declustering was applied to the data.	UC Berkeley	Spatial Sampling UCB Page 1	Spatial Distribution	PG&E agrees. Additional data analysis could be conducted to evaluate the potential effect of clustering. However, in our view, such efforts would best be applied to data that are more representative of the physical system (i.e., depth discrete data collected in a more even manner in the Hinkley Valley [comments in rows 2 and 3]).
2	PG&E proposed to expand the well network (area being sampled) to compensate for the lack of discrete-depth samples (page 1-4). This approach cannot work unless the concentration field is stationary and statistically isotropic, which cannot be the case.	UC Berkeley	Spatial Sampling UCB Page 2 (Additional comment 1)	Discrete-depth sampling	PG&E agrees that the depth discrete sampling was not adequately conducted in the original study, and potentially biased results. This issue warrants additional investigation.
3	Table 3-1 indicates that several wells are screened over the upper (floodplain) and lower (regional) aquifer. ... This could lead to ambiguity as to what the concentration averages actually represent (i.e. which geologic unit?). Furthermore, it could also lead to bias ... The ambiguity could be removed to a large degree through appropriate modeling, but to my understanding this has not been done.	UC Berkeley	Spatial Sampling UCB Page 2 (Additional comment 2)	Discrete-depth sampling	PG&E agrees that the depth discrete sampling was not adequately conducted in the original study and potentially biased results. This issue warrants additional investigation.
4	Spatial averages are of little predictive value in the case of non-stationary variables such as the concentration. The population sample mixes measurements taken upstream (potentially low values) and downstream (potentially larger values) of the compression area. There also appears to be a trend of the concentrations increasing from east to west. All this could lead to biases. A physically-based analysis could take the trends in the concentration into account and provide better predictions.	UC Berkeley	Spatial Sampling UCB Page 2 (Additional comment 3)	Spatial Distribution	Sampling locations for the background study were selected outside of the known potential compressor station plume. As a result, the concern regarding the mixing of data collected "upstream" and "downstream" of the compressor station does not apply. While the recommendation to use a physically-based model has technical merit in concept, such analysis at this scale is not practical. Current models do not have the capability to incorporate a stochastic physical model with a transient description of groundwater flow and geochemical processes that naturally contribute hexavalent chromium to groundwater. It is recognized that the statistics applied were an approximation, but they were consistent with industry practices for background determination and the methods presented in the work plan.
5	To address the bias of a temporally unbalanced data set (due to expansion of the well network, same amount of data not available for all wells), the average value of Cr 6 and Cr T concentrations from each well were used in the statistical analysis. Each well is represented by one arithmetic mean result instead of by the actual number of samples taken at that well. I find this approach lacking in several respects, and I would recommend against it. My reasons are as follows. Averaging is known to alter the statistical nature of the variables being averaged. The primary effect is reducing variability. The consequence of that is that the averaged variables provide a "smoother" version of reality, and as a result the high and low values are averaged out. The elimination of high values of the concentration from consideration is obviously of concern in the context of this study because it would lead to biased estimates.	UC Berkeley	Temporal Sampling UCB Page 2-3	Statistics Averaging and Use of Physically Based Model	The reviewer indicates that temporal averaging may have biased the background numbers low. PG&E concurs that temporal averaging of data is not the most statistically accurate method to address the uneven temporal data sets that resulted from sampling access issues during the study. However, by "smoothing" out the dataset, the method that was used resulted in a lower (i.e., more conservative) estimate of background. Temporal averaging is not proposed in the next study.
6	The normal distribution is a favorite model selection in applications because of its simplicity:... In order to test whether or not a normal model is acceptable, the background study elected to use the formalism of hypothesis testing. The underlying theory is documented in many textbooks. The approach is to state a null hypothesis (in this case, that the concentrations are normally distributed) and then to apply a test that would indicate whether this assumption could be rejected or not. A fundamental tenet of hypothesis testing is that the test can only determine whether there's enough evidence to reject the null hypothesis. Hypothesis testing does not provide conclusive evidence that the null hypothesis is the right one. It can only determine whether or not there's enough evidence to reject it. Based on this, the statement made in Appendix I that "the probabilities (p-values) from the Shapiro-Wilk test (W test) provide evidence about whether the background total and hexavalent chromium concentrations are normally or log-normally' distributed" is very doubtful. The test does not provide such evidence, its power is only to state whether there's enough evidence to reject the assumption of normality. Not having enough evidence to reject the null hypothesis (normality) does not mean that the normal model is the best one. ... There is evidence for asymmetry in Table 6.1 where differences between the mean and median of the distribution are shown to exist: in normal distributions these values should be equal (or at least very close to each other). Hence, there are indications against the assumption of normality. ... The question is whether the assumption of normality is the safe assumption and should it be used as the null hypothesis. In my opinion it is not a safe assumption because it could underestimate the probabilities of high concentrations. For example, a lognormal distribution has a longer "tail" and it assigns higher probabilities to the high concentrations, and so it could possibly be a safer assumption. This option and perhaps others need to be considered.	UC Berkeley	Statistical Normality UCB Page 3 (paragraph 1,2), Page 4 (paragraph 5)	Statistics Normality Model	In several paragraphs, the reviewer questions the use of hypothesis testing and selection of the normal model, indicating that the normal model may have been accepted even though it does not necessarily completely describe the data set. The reviewer indicates that acceptance and the use of the normal model based on hypothesis testing may have biased the background number low. PG&E agrees that biasing the data low is not ideal and should be improved upon.

Item No.	Comment	Peer	Location (Page)	Category	PG&E Responses
7	The quality of the sample population is obviously of primary consideration. Shapiro and Wilk (1965) assume that their samples are identically distributed. Section 2.2 in the Shapiro-Wilk paper states that "The objective is to derive a test for the hypothesis that this is a sample from a normal distribution with unknown mean 11 and unknown variance 62." As discussed in Section 2, the sample population includes measured concentrations and averaged measured concentrations. Because averaging alters the statistical nature of the underlying distribution, the population sample appears to be inappropriate for this kind of test because differences in temporal averaging procedures (e.g., averaging over 2, or 3 or 4 measurements) will lead to different statistical distributions for the various samples within the population sample, in a violation of the requirements of the test. The consequences of such violation need to be analyzed, but in principle, inferences from such a hybrid sample population are not suitable for determining the nature of the underlying distribution.	UC Berkeley	Statistical Normality UCB Page 4 (paragraph 4)	Statistics	PG&E agrees. As discussed in response to the comment on item 5, the need to average individual well concentrations overtime was an unfortunate consequence of having uneven temporal data for individual sampling locations due to difficulties accessing wells in the sampling program. This issue could be addressed through additional investigation work.
8	The Background Study does not assume correlation between the concentration measurements (ie, the measurements are assumed to be spatially-uncorrelated). This assumption, although not unreasonable for measurements with large distances in between, is not justified theoretically, and is particularly challenging for measurements at close proximity. It needs to be supported with evidence (could not be found in Study). There is concern that the test is inconsistent with the underlying physics.	UC Berkeley	Statistical Normality UCB Page 5 (paragraph 2)	Statistics	Additional geostatistical evaluation of the data (see response to comment in item 1 [declustering evaluation]) may be warranted to confirm the Study assumption of sample independence. It is important to note that, although the background wells appear relatively close together on the figures, minimum distance between the wells was typically on the order of 100s or 1000s of feet. These distances, and the relatively slow rate of groundwater movement, tend to support the assumption of sample independence. Additional investigation would confirm or refute this assumption.
9	The test of normality addresses the question of whether or not the population sample could be described as normally-distributed. It does not address the question of whether or not the normal model inferred from the population sample is a good model for prediction of regional or local averages of the concentration and its confidence intervals. The outcome of the Shapiro-Wilk test is questionable.	UC Berkeley	Statistical Normality UCB Page 5 (paragraphs 3 and 4)	Statistics	PG&E is open to a more rigorous statistical evaluation of the data generated for the background study, and welcomes specific input regarding suggested additional evaluations of this type. However, in our view, such efforts would best be applied to data that are more representative of the physical system (i.e., depth discrete data [comments 2 and 3]).
10	Very little information is provided regarding model calibration (Appx B; Section B.1.4) and is not enough to confirm the adequacy of the calibration effort. 1. The model was calibrated based on groundwater levels only. (a) Water levels alone cannot be used for calibrating the spatial distribution of the hydraulic conductivity because there is no unique relationship between water levels and conductivity. Without sound calibration of the hydraulic conductivity and field porosity, the groundwater model cannot be used to predict velocities and concentrations. (b) No information is provided on the quality of the match between measured head and model-based predictions. Even small errors in the predicted heads could lead to large errors in the head gradients, velocities, and concentrations. (c) Without reliable estimates for the hydraulic conductivity, the reliability of the water budget analysis cannot be established.	UC Berkeley	Quality of GW Modeling UCB Page 5 (Paragraph 1)	GW Modeling	The groundwater model referenced in the Groundwater Background Study Report was deemed to be sufficiently calibrated for the purposes used in the report, although it is acknowledged that sufficient documentation was not provided. Calibration efforts included comparison of observed and calculated groundwater elevations, relationships between predicted and observed heads across various portions of the aquifer (gradients across the plume), and sensitivity analysis for hydraulic parameters. The residual mean error for the model was less that 1 foot, the root mean squared error about 5 feet, and the scaled root mean squared error less than 0.04 feet.
11	No attempt is reported to test the model against the concentration data (useful strategy to establish the credibility of the model). Methods for using concentration data are available.	UC Berkeley	Quality of GW Modeling UCB Page 5 (Paragraph 2)	GW Modeling	Simulated contaminant transport was not evaluated at the time of the Background Study. Due to the size and history of the site, an accurate simulation is not possible.
12	No attempt to model spatial variability of the hydrologic parameters is reported. Assuming the hydraulic conductivity to be uniform within each of the hydrostratigraphic units would neglect the possible consequences of channeling effects (fast flow channels would lead to faster downstream migration of chemicals). More work is needed in order to align the model calibration efforts with modern concepts. Uncertainty quantification (UQ) should be an important part of the study. No UQ that meets acceptable norms was carried out.	UC Berkeley	Quality of GW Modeling UCB Page 6 (Paragraph 1)	GW Modeling	The hydraulic conductivity was not assumed to be uniform within each stratigraphic unit as the reviewer implies in this comment. Each layer has several different hydraulic conductivity zones that were developed and varied based on calibration efforts.

Item No.	Comment	Peer	Location (Page)	Category	PG&E Responses
13	The first point I would like to make is that, regardless of whether or not the Shapiro-Wilk test is applicable or not, there is a need to evaluate the predictive capabilities of the normal model, and that is a different issue altogether. In other words, even if one accepts that the population sample is normal (see Section 3 for discussion on the difficulties with this), this does not constitute a confirmation that the normal model could actually be used for predicting (at best) anything but the statistics of that population sample, until the predictive capability itself is tested. The main reason for that is the issue of ergodicity. For spatial averages to be representative, the population sample must be ergodic (see Rubin, 2003). That means that the population sample must cover all the possible states of the sampled system, and in the right proportions. If this condition is met, then the population sample would be sufficient for making inferences about spatial averages. For stationary problems, satisfying the condition of ergodicity requires extensive spatial sampling. How large the sampled domain needs to be? This can only be established through physically-based modeling of the aquifer, including modeling of the spatial variability of the hydraulic conductivity and the flow and transport fields related to the spatial variability model. The added complication here is that the concentration field is non-stationary. This could be compensated through physically- based stochastic modeling strategies (Rubin, 2003). Another strategy to evaluate the model's predictive capability is through cross-validation (Rubin, 2003).	UC Berkeley	General Comments UCB Page 6 (paragraph 1)	Statistics Ergodicity, Physically based model	While the recommendation to use a physically-based model has technical merit in concept, such analysis at this scale is not practical. Current models do not have the capability to incorporate a stochastic physical model with a transient description of groundwater flow and geochemical processes that naturally contribute hexavalent chromium to groundwater. It is recognized that the statistics applied were an approximation, but they were consistent with industry practices for background determination and the methods presented in the work plan.
14	Another issue to consider is the no-detect concentrations. Figures 5-4 and 5-5 and associated discussion indicate that locations where the concentrations were measured below the detect limits were assigned values equal to half the detection limit. This is speculative. It may be a good speculation, but it is still a speculation, nonetheless. The speculation is in considering and analyzing the concentration from the perspective of a spatially-uncorrelated variable rather than a spatially-correlated variable. The point is that if one adopts the spatial correlation perspective, the no-detects could be interpreted in different ways. For example, one could also speculate that the no-detects could be indications of fast-flow channels with very high concentrations further downstream (Wilson and Rubin, 2002), or that the wells with no-detects were placed in low- conductivity areas with by-pass flow nearby. At times one must resort to speculations when it comes to groundwater applications, but there is a need to establish their likelihood. What is needed here is to substantiate this speculation by evaluating it using a physically-based flow and transport model. Another important point is that including speculative values in the population sample used to test normality is not warranted. Without accounting for the uncertainty around this speculation, one cannot assign any confidence intervals to any prediction that is based on a population sample that includes these values. This adds further doubts to the value of the normality test (see Section 3 for additional discussion).	UC Berkeley	General Comments UCB Page 6, Section 5 (paragraph 2) and Page 7 (paragraph 1)	Statistics	As the reviewer notes, there are multiple options for treatment of non-detect values for statistical analyses. In the background study, the non-detect values were treated as half the reporting limit, consistent with the work plan. This treatment may have biased the background number high or low. As noted above in response to the comment in item 4, the application of a physically based model, as the reviewer suggests, to this issue is not feasible.
15	Uncertainty quantification (UQ) is the idea that all sources of uncertainty must be accounted for when making predications. Modeling the model (normal and alternative) uncertainty and the parameters associated with the model is needed. In the Background Study, once a decision was made to accept the normal model, it was viewed as a certain model and that does not model realistically the uncertainty.	UC Berkeley	General Comments UCB Page 7 (paragraph 2)	Statistics	PG&E is open to a more rigorous statistical evaluation of the data generated for the background study, and welcomes specific input regarding suggested additional evaluations of this type. However, in our view, such efforts would best be applied to data that are more representative of the physical system (i.e., depth discrete data [comments 2 and 3]).
16	The Hinkley Valley in the Background Study area can be divided into 5 main areas: Core Area, South Upgradient Area, East Cross Gradient Area, West Cross Gradient Area, and North Downgradient Area (see Clearwater Figure 1). Of the 48 background study wells, 4 wells are screened only in the Upper Aquifer. The remaining background study wells (well screens over both the Upper and Lower Aquifer or no information available as to the screened zone) provide a mixed well concentration for CrT and Cr6 and do not accurately reflect the conditions of the specific aquifer zone.	Clearwater Group	Spatial Sampling CWG Pages 7 and 8	Sampling Program: Vertical Distribution	PG&E agrees that sampling of mixed aquifer wells introduced bias into the data set, and recommends additional investigation to correct this bias.
17	Of the 5 areas (shown in Figure 1), the South Upgradient Area is the most likely to provide natural or background levels of CrT and Cr6. Samples from the Mojave River, although more than one mile from the PG&E facilities, may show less anthropogenic influences for background samples of CrT and Cr6 for the region.	Clearwater Group	Spatial Sampling CWG Page 9 (paragraph 1)	Sampling Program: Spatial Distribution	The background number should reflect chromium concentrations in the area that are occurring outside of the inputs from PG&E's discharges of hexavalent chromium-bearing water to unlined ponds at the compressor station. As such, anthropogenic influences from sources other than the compressor station, e.g. agriculture, should not be discounted in the background study.

Item No.	Comment	Peer	Location (Page)	Category	PG&E Responses
18	Since the Upper Aquifer is likely to contain the majority of the CrT and Cr6, collecting samples where the well screens are unknown provides little useful information. The agricultural wells with unknown screen depths are likely to have been screened in both aquifer zones. Data from wells that are screened in more than one aquifer or having unknown screen depths should not be used in studies to establish background concentrations of CrT and Cr6. Installation of new monitoring wells with proper screens in specific and isolated aquifer zones is the best way to get accurate data on groundwater concentrations of CrT and Cr6.	Clearwater Group	Spatial Sampling CWG Page 9 (paragraph 3)	Sampling Program: Vertical Distribution	PG&E agrees that sampling of mixed aquifer wells likely introduced bias into the data set, and recommends additional investigation to correct this bias.
19	The natural Cr6 and CrT levels will be difficult to assess since the entire area has had intense agricultural pumping from both Upper and Lower Aquifers for up to eight decades. Artificial recharge has also been occurring in certain locations, affecting the natural background conditions of CrT and Cr6. The background study for both CrT and Cr6 in the current form is inadequate and inaccurate.	Clearwater Group	Spatial Sampling CWG Page 9 (paragraph 4)	Sampling Program: Spatial Distribution	PG&E agrees that potential anthropogenic impacts that are not related to compressor station discharges of Cr6 should be considered/addressed in further background studies. It is important to note that any non-PG&E impacts that historic land use may have had on Cr6 and CrT concentrations in groundwater in the Hinkley Valley should be considered part of the background condition of the groundwater.
20	There are only three wells from the West Cross Gradient area and one well from the Southern Upgradient Area that are known to be screened specifically in the Upper Aquifer. One to three wells in specific aquifer zones do not provide enough information to evaluate background concentrations or even current concentrations. From my field experience and given the size of the Hinkley area, a minimum of 20 to 40 properly constructed groundwater monitoring wells (designed to sample only one aquifer zone) should provide the minimal number of groundwater sampling locations for a scientifically reasonable background study. Detailed statistical evaluation of geochemical data coming from a majority of wells with unknown screen intervals or of screens covering commingled aquifers does not provide much scientific value.	Clearwater Group	Temporal Sampling CWG Page 10 (paragraph 1)	Sampling Program: Vertical Distribution	PG&E agrees that sampling of mixed aquifer wells introduced bias into the data set, and recommends additional investigation to correct this bias. The sampling program suggested by the reviewer was considered in the development of a work plan for additional investigation.
21	It was noted that 14 background study wells were sampled for 4 quarters. Various additional wells were added to the study. Statistical analyses should be run on the data from the original 14 wells. Statistics from one dataset cannot be combined with statistics from another dataset. These two datasets should be reported separately.	Clearwater Group	Temporal Sampling CWG Page 10 (paragraph 2)	Statistics	PG&E is open to a more rigorous statistical evaluation of the data generated for the background study, and welcomes specific input regarding suggested additional evaluations of this type. However, in our view, such efforts would best be applied to data that are more representative of the physical system (i.e., depth discrete data [comments 2 and 3]).
22	With regard to the assumption of statistical normality, aquifer-specific information and detailed statistics from wells screened in specific aquifers is required to put the laboratory analytical data into a geologic perspective. Properly performed statistics on inaccurate geochemical data are not valid.	Clearwater Group	Statistical Normality CWG Page 10 (paragraph 3)	Statistics	PG&E agrees. Additional investigation is appropriate.
23	The chosen set of 'background' wells are not located adequately upgradient and outside the range of influence of actively pumping (historically or currently) extraction wells (which could be drawing the Cr6 plume in an upgradient direction) to be representative of background conditions. Virtually all of the chosen wells are located in a cross gradient position from the main plume with poorly defined cross gradient CrT and Cr6 plume boundaries. Well data should reflect specific aquifer zones, not mixed zones. Given the eight decades of intense agricultural pumping, it is possible that with preferred flow pathways (high permeability zones due to lithologic characteristics or geologic faults (Lockhart) or other potential conduits), some of the CrT and Cr6 from the Core Area may have migrated over the past decades toward the east or west into the East Cross Gradient Area or the West Cross Gradient Area, respectively.	Clearwater Group	Quality of GW Modeling CWG Page 11 (comment a)	Sampling Program: Spatial Distribution	An analysis of historical pumping was performed in an attempt to locate background study well locations outside the historic plume migration pathway. Background study wells were located outside of areas that were known or predicted to be influenced by the plume. PG&E recognizes that there is uncertainty in this analysis, and that additional work is required to establish background concentrations for the Hinkley Valley.
24	Groundwater flow and transport modeling are needed to evaluate the role of actively pumping of current wells in the migration of the plume. Range of influence of individual pumping or injection wells should be mapped and modeled.	Clearwater Group	Quality of GW Modeling CWG Page 11 (comment b)	GW Modeling	As discussed in Section B2 of Appendix B on Groundwater Modeling, recent historic pumping was incorporated into the modeling effort, based on data collected by the Watermaster since the adjudication of the basin.
25	Correlation between land irrigation of CrT and Cr6 impacted groundwater at the Land Treatment Units and the presence of chromium in the underlying soil and groundwater needs more focused investigation. The mechanism of remediation of spraying Cr6 onto the soil and the conversion of the oxidized Cr6 into the reduced Cr3 and ultimately into chromium hydroxide using soil as a treatment media are not well documented or verified. Peroxide and acids may clean the drip or irrigation lines, but may also help to mobilize and carry the CrT and Cr6 deeper into the subsurface environment if the acids or peroxide are spilled onto the soil.	Clearwater Group	Quality of GW Modeling CWG Page 11 (comment c)	Remediation	Since the initiation of operation of the Desert View Dairy Land Treatment Unit in 2004, chromium data have been collected annually from 5 foot deep lysimeters . These data demonstrate the consistent and complete treatment of Cr6 in the root zone of the soil. The reviewer was likely unaware of this information, because it was outside the scope of the documents provided for the background study review.

Item No.	Comment	Peer	Location (Page)	Category	PG&E Responses
26	There has been none, and there is currently no hydraulic control over the groundwater basin, so the plume will continue to migrate. The Cr6 plume is expanding both laterally to the north, as well as vertically, as evidenced by plume maps from 2001 to current consultant studies.	Clearwater Group	Quality of GW Modeling CWG Page 11 (comment d)	Remediation	In 2011, additional studies were conducted to delineate the Cr6 plume to the north, and in the Lower Aquifer near monitor well MW-23C. The investigations revealed additional areas where elevated concentrations of Cr6 are present in groundwater beyond what was previously understood. Groundwater extraction and treatment were greatly increased through the operation of three new agricultural units in 2011, which improved hydraulic capture of the plume. As additional areas of elevated Cr6 have been discovered, plans for expansion of the groundwater extraction and treatment have been proposed to the Water Board.
27	There may be historic patterns of Cr6 migration which have left residue available for future recapture and migration.	Clearwater Group	Quality of GW Modeling CWG Page 11 (comment e)	Remediation	See responses to comment 19 on potential historical anthropogenic influences, and comment 25 on the lack of residual Cr6 from historic land treatment unit application of Cr6-bearing groundwater.
28	A detailed site conceptual model of the CrT and Cr6 initial release(s), migration in the subsurface soils and aquifers, extraction at Land Treatment Units, and application of this untreated CrT and Cr6 impacted water onto the land surface should be developed. The lack of above-ground treatment of CrT and Cr6, in which the extracted groundwater is removed from the aquifers at the Land Treatment Units and dripped or (historically) sprayed onto surface soils, is potentially creating another CrT and Cr6 release, albeit, at lower CrT and Cr6 concentrations. The concepts of groundwater extraction of CrT and Cr6 impacted groundwater and the reapplication of this water onto the land without treatment has not been well proven or well documented as a method to immobilize CrT and Cr6. Documentation should be provided showing the soil in these areas where untreated CrT and Cr6 impacted groundwater is being released onto the land surface is a safe and effective remediation method for CrT and Cr6 in groundwater. The documentation should also evaluate the potential for hyperaccumulation or uptake of CrT and Cr6 in plants or deposition and concentration of CrT and Cr6 in the shallow soil.	Clearwater Group	Quality of GW Modeling CWG Page 12 (comment f; first paragraph)	Remediation	Since the initiation of operation of the Desert View Dairy Land Treatment Unit in 2004, chromium data have been collected annually from 5 foot deep lysimeters. These data demonstrate the consistent and complete treatment of Cr6 within the root zone of the soil. The reviewer was likely unaware of this information, because it was outside the scope of the documents provided for the background study review.
29	Large changes in climate and rain patterns could occur in the future, creating higher risks of remobilization of the CrT and Cr6 in the shallow soil near the groundwater drip or spray systems at the Land Treatment Units. Sources at the PG&E Compressor Station must be mapped and plotted in relationship to the release and the current location of the contaminants in both the shallow soils as well as the Upper Aquifer and the Lower Aquifer.	Clearwater Group	Quality of GW Modeling CWG Page 12 (comment f; 2nd paragraph)	Remediation	The main factor influencing the potential remobilization of Cr3 that is formed through treatment in the Land Treatment Unit is re-oxidation by manganese oxides. The extent of oxidation is not expected to be significant, based on site geochemical conditions. Changes in climate and rain patterns would not affect this potential mechanism for remobilization. Soil sources at the compressor station have previously been investigated and remediated.
30	Samples from agricultural or domestic wells which cross the Upper Aquifer and Lower Aquifer have little value in defining CrT or Cr6 background concentrations based on aquifer or geologic units. Correlating the flows from the two different aquifer zones, one unconfined and the other confined, is not an appropriate or satisfactory method for determining background levels of CrT and Cr6. Mixing within the wells that were screened over two aquifers is likely to occur by diffusion, and possibly by other mechanisms. If filter packs are part of the well construction, then additional groundwater flow pathways exist for mixing of two originally separated groundwater aquifers. Using decades old domestic and agricultural wells which were readily available but designed for water production is not appropriate for background studies of CrT or Cr6 which are associated with two vertically discrete aquifer units.	Clearwater Group	Quality of GW Modeling CWG Page 12 (comment g)	Sampling Program: Vertical Distribution	PG&E agrees that sampling of mixed aquifer wells introduced bias into the data set, and recommends additional investigation to correct this bias. The sampling program suggested by the reviewer was considered in the development of a work plan for additional investigation.
31	Wells inside the radius of influence (ROI) of wells extracting contaminated groundwater cannot be identified as background wells. A background well should not lie within the zone of influence of a pumping well, or within the influence of the wells in the Hinkley Compressor station or Land Treatment Unit extraction systems. In addition, the wells to be used as background wells should have screens in one of the aquifer zones, but not both.	Clearwater Group	Additional Comments - Background Well Selection CWG Page 13 (comment 4a)	Groundwater Modeling	It was not the intention of the background study to include monitoring wells within the radius of influence of wells extracting contaminated groundwater. Future investigation activities would also be designed to place monitoring wells outside of the ROI of such extraction wells.
32	All groundwater extraction volumes and their ROIs should be mapped. The plume/gradient map should be evaluated with the ROI information. The Lockhart Fault and other faults in the Hinkley, California area may affect groundwater migration or influence preferred groundwater flow pathways. These elements should be evaluated in future hydrogeologic studies.	Clearwater Group	Additional Comments - Effects of GW Extraction CWG Page 13 (comment 4b)	Groundwater Modeling	Providing ROI for extraction and injection wells requires defining the time frame over which the influence is evaluated. Since pumping rates and extraction configurations are constantly changing, this is not a simple or straightforward analysis. However, we agree that there may be merit to this approach moving forward.

Item No.	Comment	Peer	Location (Page)	Category	PG&E Responses
33	All water applications from the Land Treatment Units should be mapped with detail on duration in time and volume of water of the applications. The deposition of wind-borne contaminants is discounted since there is low rainfall, yet Cr6 in dust can be an important exposure pathway if concentrations of Cr6 are high. In areas where CrT and Cr6 are high in the shallow soil, plant hyperaccumulation of CrT and Cr6 and the potential of livestock accumulation of chromium from ingesting impacted plants or impacted soil should be verified and documented with laboratory analysis.	Clearwater Group	Additional Comments - Influence of LTUs CWG Page 14 (comment 4c)	Remediation	As discussed above, the treatment of Cr6 by the Land Treatment Units is well documented and, therefore, there is no need for a detailed tracking Cr6 applied to the LTUs as part of the conceptual site model development. In addition, Cr6 within the LTU is applied sub-surface, limiting the chance for airborne exposure to Cr6. Within the soil, the Cr6 is documented to be converted to Cr3, alleviating the reviewer's concern over airborne Cr6 in dust.
34	All injection wells and their ROI should be mapped for the whole basin.	Clearwater Group	Additional Comments - GW Recharge CWG Page 14 (comment 4d)	Groundwater Modeling	Providing ROI for extraction and injection wells requires defining the time frame over which the influence is evaluated. Since pumping rates and extraction configurations are constantly changing, this is not a simple or straightforward analysis. However, PG&E agrees that there may be merit to this approach moving forward.
35	Heavy groundwater extraction since the 1930's supports the concept that the CrT and Cr6 plume has migrated cross gradient through preferred flow pathways. Major geochemical changes in the Hinkley Valley caused by large water movements, including extraction, are likely to have occurred over the past several decades, altering background levels of CrT and Cr6.	Clearwater Group	Additional Comments - Influence of Historic GW Extraction CWG Page 14 (comment 4e)	Groundwater Modeling	As discussed in the response to the comment on line 23, historical pumping estimates were incorporated into the groundwater modeling effort that supported the sampling location selection. For future work, additional assumptions could be applied to aid in placement of monitoring wells. Changes in Cr6 and CrT concentrations that have occurred due to regional agricultural pumping are a part of background conditions. The effects of these activities should not be removed from the background determination.
36	A scientific site conceptual model of the release, migration, extraction, and reapplication of the impacted waters onto soil should be carefully and methodically performed. If needed, additional geologic cross sections should be prepared. To help establish well construction details and depths of screened intervals, well condition and other downhole information should be documented using a video camera and geophysical logging tools. This will help to establish whether the wells are acting as vertical conduits. All migration pathways should be mapped.	Clearwater Group	Additional Comments - Site Conceptual Modeling CWG Page 14 (comment 4f)	Remediation	Much of this work has already been completed. As mentioned above, reapplication of impacted waters for agricultural irrigation is not a significant migration pathway.
37	The discrete depth sampling dataset is not sufficient. New monitoring wells should be constructed solely for the purpose of groundwater sampling. It is recommend that 20 to 40 new groundwater monitoring wells be constructed to current California standards in the Upper Aquifer and Lower Aquifer. The wells should be constructed so only one aquifer is screened for each well.	Clearwater Group	Additional Comments - Discrete Sampling CWG Page 14 (comment 4g)	Sampling Program: Vertical Distribution	PG&E agrees that sampling mixed aquifer wells introduced bias into the data set, and recommends additional investigation to correct this bias. The sampling program suggested by the reviewer was considered in the development of a work plan for additional investigation.
38	The extraction of groundwater containing CrT and Cr6 and application of this impacted water on to the land surface without above-ground treatment should be rigorously evaluated and scientifically justified and documented. The concern is whether the CrT and Cr6 are really being cleaned up, or whether the CrT and Cr6 are being smeared in the shallow subsurface and ultimately being allowed to impact deeper soil horizons and groundwater resources. Groundwater resources in the area are heavily used for agricultural and domestic water supplies. Any additional impact from CrT and Cr6 on soil and groundwater resources should be examined, tested, and documented in a careful and systematic manner. The drip lines for the Land Treatment Units are being cleaned with hydrogen peroxide and acid. These chemicals, if in contact with heavy metals, including CrT and Cr6, might allow for more impacts in the shallow soils by increasing heavy metal solubility and enhancing mobilization of CrT and Cr6 in the shallow soils.	Clearwater Group	Additional Comments - LTUs/Remediation CWG Page 14 (Task II)	Remediation	Since the initiation of operations of the Desert View Dairy Land Treatment Unit in 2004, chromium data has been collected annually from 5 foot deep lysimeters. These data demonstrate the consistent and complete treatment of Cr6 within the root zone of the soil. The re-oxidation of chromium will be limited, as concurred upon in a review of the Hinkley Feasibility Study by the DTSC, and is not expected to be affected by changes in climate. Data collected to date do not indicate any overall impact of the application of hydrogen peroxide and acid on chromium treatment.
39	The scientific approach to this study is seriously flawed if wells used in the study do not have proper screens in one discrete aquifer zone. If the mixed-aquifer wells are used for the overall concentration maps for CrT and Cr6, the maps will be in error and likely to underestimate the CrT and Cr6 concentrations (most of water derived from cleaner Lower Aquifer). The wells currently in the background study were not designed for high-quality geochemical sampling. Applying detailed statistics to laboratory sample data from domestic and agricultural wells with mixed aquifer water does not provide accurate results and likely underestimates the CrT and Cr6 concentrations. Although it might be economically attractive to use existing and available domestic and agricultural wells, the study does not meet the scientific objectives of trying to determine background concentrations of CrT and Cr6. The use of statistical methods on the chemical data as well as averaging laboratory concentrations of CrT and Cr6 from these wells does not provide accurate or correct results for background information.	Clearwater Group	Additional Comments - Well selection CWG Page 14 and 15 (Task III)	Vertical Distribution	PG&E agrees that sampling mixed aquifer wells introduced bias into the data set, and recommends additional investigation to correct this bias. The sampling program suggested by the reviewer was considered in the development of a work plan for additional investigation.

Item No.	Comment	Peer	Location (Page)	Category	PG&E Responses
40	Natural background levels of CrT and Cr6 for specific aquifers in the Hinkley, California, area can be determined with a significant drilling program of new wells with well screens limited to one aquifer zone in upgradient areas unaffected by historical pumping. It is possible that undisturbed hydrogeologic areas in the Hinkley, California, area do not exist due to the excessive groundwater pumping in the area. Samples upgradient toward the Mojave River may provide the best chance at finding what might be considered background CrT and Cr6 concentrations.	Clearwater Group	Recommendations CWG Page 16	Spatial Distribution	PG&E agrees that sampling mixed aquifer wells introduced bias into the data set, and recommends additional investigation to correct this bias. The sampling program suggested by the reviewer was considered in the development of a work plan for additional investigation.
41	Background levels are important to establish, but are very different from remediation goals or drinking water standards. Groundwater background levels, best available technology remediation levels, and the various drinking water standards and other exposure and toxicity concentrations must be integrated to develop an appropriate and realistic remediation or cleanup goals for the site. After ten years of assessment and monitoring, remediation has been limited and the CrT and Cr6 plume is expanding northward in the Upper Aquifer and there has been recent vertical migration into the Lower Aquifer.	Clearwater Group	Recommendations CWG Page 16	Remediation	PG&E is working towards gaining complete capture of the Cr6 plume delineated in 2011, including the Lower Aquifer, as documented in plans proposed to the Water Board.
42	Create a scientifically valid site conceptual model of the release, migration, extraction, and reapplication to land of the groundwater containing CrT and Cr6.	Clearwater Group	Recommendations (a) Site Conceptual Model CWG Page 16	Remediation	see response to comment on item 36.
43	Map all the surface areas where groundwater containing chromium has been historically discharged to the land surface for irrigation purposes at the Land Treatment Units. Identify what levels (concentrations) of CrT and Cr(IV) are in the shallow soil and the groundwater (besides the 5 foot lysimeters). Evaluate and verify the Land Treatment Unit extraction and water application process to document that CrT and Cr6 are being properly immobilized.	Clearwater Group	Recommendations (b) LTUs CWG Page 17	Remediation	Since the initiation of operations of the Desert View Dairy Land Treatment Unit in 2004, chromium data have been collected annually from 5 foot deep lysimeters. These data demonstrate the stable treatment of Cr6 within the root zone of the soil.
44	Map the radius of influence of pumping wells located within the Hinkley Valley and the extracted waters discharge areas.	Clearwater Group	Recommendations (c) Pumping Influence CWG Page 17	Groundwater Modeling	As part of the groundwater modeling effort to support the background study workplan, historical pumping in the area was evaluated and calibrated with known pumping data available from the Watermaster since the adjudication of the basin.
45	Construct and install 20 to 40 new monitoring wells in accordance with current California well standards that are screened in one aquifer so that the CrT and Cr6 aquifer contamination can be directly measured. A representative number of wells should be installed upgradient and outside the range of influence of historic or current pumping.	Clearwater Group	Recommendations (d) Aquifer-Specific Data CWG Page 17	Sampling Program: Vertical Distribution	PG&E agrees that additional investigation work is warranted, and looks forward to working with the Water Board and third party scientific peer reviewers to develop a plan for additional work.
46	Gain hydraulic control on the chromium plume in the Upper Aquifer which appears to be expanding northward. Gain hydraulic control of the Lower Aquifer which appears to be impacted from vertical movement of the CrT- and Cr6-containing groundwater sourced from the Upper Aquifer. The vertical migration and spreading of the chromium plume are a concern and should be addressed.	Clearwater Group	Recommendations (e) Plume Control CWG Page 17	Remediation	PG&E is working towards gaining complete capture of the Cr6 plume delineated in 2011, including the Lower Aquifer, as documented in plans proposed to the Water Board.
47	Identify background concentrations for CrT and Cr6 in the area, and develop remediation goals.	Clearwater Group	Recommendations (f) CWG Page 17	Remediation	PG&E agrees.
48	Initiate more aggressive hydraulic control and remediation to contain and shrink the currently expanding CrT and Cr6 groundwater plume in both the Upper Aquifer and Lower Aquifer.	Clearwater Group	Recommendations (g) CWG Page 17	Remediation	PG&E is working towards gaining complete capture of the Cr6 plume delineated in 2011, including the Lower Aquifer, as documented in plans proposed to the Water Board.
49	The sampling design is questionable. Since the purpose of the study was to define the extent of the plume (not identify the primary source), more sampling should have occurred in the direction that the plume was believed to be directed toward rather than nearer to the known source. The sampling that did take place provides much more data than was required from sampling sites that were closest to the source, which biases the data summaries higher. This could seriously impact any conclusions upon this data set regarding the extent and migration of the plume.	College of New Jersey	Spatial Sampling CNJ Page 1 (Response 1)	Sampling Program: Spatial Distribution	PG&E asserts that all areas should be considered in an additional investigation. The changing geologic environment and anthropogenic influences other than discharge of Cr6 by PG&E may influence background concentrations, and are important considerations that must be considered in the analysis.
50	The approach used in this study relative to the temporal trends appears to be reasonable. The use of an arithmetic mean to express the average concentrations of both total and hexavalent chromium is appropriate.	College of New Jersey	Temporal Sampling CNJ Page 1 (Response 2)	Statistics	Comment noted.
51	The spatial sampling design that was used in this study is questionable (as stated in Response 1).	College of New Jersey	Quality of GW Modeling CNJ Page 1 (Response 4)	Spatial Distribution	PG&E agrees that the sampling network could be improved, and looks forward to working with the Water Board and third party scientific peer reviewers to develop a plan for additional work.

Item No.	Comment	Peer	Location (Page)	Category	PG&E Responses
52	EMAX and Truesdale Laboratories (the two analytical laboratories involved with the Study) were asked what calibration ranges were used for Methods 6010B, 6020A and 7199. EMAX's responses were satisfactory. It is unclear from Truesdale's response if the low level calibration ranges for Methods 6010B and 6020A were used for the analyses in this study.	College of New Jersey	Additional Comments Quality of Analytical Data CNJ Pages 1 and 2 issue 1	Lab Chemistry	See responses on Laboratory Chemistry in Appendix C.
53	EMAX and Truesdale Laboratories were asked what the value of the CRQL Check Standard (CRI) and the method control limits were for Method 6020A. EMAX's response was satisfactory. Truesdale admitted in their response that they failed to perform this quality assurance as required by the method during the time that data for this study were obtained.	College of New Jersey	Additional Comments Quality of Analytical Data CNJ Pages 1 and 2 issue 2	Lab Chemistry	See responses on Laboratory Chemistry in Appendix C.
54	EMAX and Truesdale Laboratories were asked if Reporting Limit (RL) check samples were analyzed for Methods 7199 and 6010B and if so, what were the control limits and what were the actual recoveries. Information on the RLs for Method 6020A were provided by EMAX, but no information was supplied for Method 7199 or on how these limits were derived. Truesdale admitted in their response that they failed to analyze a RL check sample during the time tat data for this study were obtained.	College of New Jersey	Additional Comments Quality of Analytical Data CNJ Pages 1 and 2 issue 3	Lab Chemistry	See responses on Laboratory Chemistry in Appendix C.
55	EMAX and Truesdale Laboratories were asked how the RLs were established for Methods 6010B, 60220A and 7199 and what is the relationship between the Method Detection Limit (MDL) and RL for each method. Information on the RLs for Method 6020A were provided by EMAX, but no information was supplied for Method 7199 or on how these limits were derived. Truesdale's response of varying criteria for a quantitative relationship between the MDL and RL is too vague to be acceptable.	College of New Jersey	Additional Comments Quality of Analytical Data CNJ Page 2 issue 4	Lab Chemistry	See responses on Laboratory Chemistry in Appendix C.
56	EMAX and Truesdale Laboratories were asked what SRM was used for QC for 7199 as per Section 5.4 as this data was apparently not reported. EMAX's response was satisfactory. Truesdale's use of a mid-range check sample is NOT acceptable as a QC material as per the criteria for quality control specified in Method 7199. This would make the data for this study for Cr6 questionable.	College of New Jersey	Additional Comments Quality of Analytical Data CNJ Page 2 issue 5	Lab Chemistry	See responses on Laboratory Chemistry in Appendix C.
57	EMAX and Truesdale Laboratories were asked why the spiking levels for both CRT and Cr6 analyses MUCH higher than the expected sample concentrations for all analytical methods. EMAX's response was not satisfactory. The laboratory should have chose the concentration level of matrix spikes for both CrT and Cr6 closer to the actual sample levels (usually a multiple of 3-5 the expected value is applied). The choice of much higher spiking levels means that the calculated recoveries have little value in assessing the quality of the actual sample concentrations and the impact to those results from possible matrix interferences. Truesdale's response was not satisfactory for the exact same reason.	College of New Jersey	Additional Comments Quality of Analytical Data CNJ Page 2 issue 6	Lab Chemistry	See responses on Laboratory Chemistry in Appendix C.
58	No criteria were provided from either laboratory as to the criteria for data assigned U or J flags.	College of New Jersey	Additional Comments Quality of Analytical Data CNJ Page 3 issue 1	Lab Chemistry	See responses on Laboratory Chemistry in Appendix C.
59	Based upon experience with examining data for the analysis for Cr6 in water samples and soil extracts, this data set showed that an unusually high percentage of samples failed the quality control criteria for the Continuing Calibration Verification (CCV). An explanation for this anomaly should be provided so as to show that the conclusions drawn from these data have not been compromised.	College of New Jersey	Additional Comments Quality of Analytical Data CNJ Page 3 issue 2	Lab Chemistry	See responses on Laboratory Chemistry in Appendix C.
60	How were samples chosen for matrix spiking (was this procedure randomized so as to not bias the results)?	College of New Jersey	Additional Comments Quality of Analytical Data CNJ Page 3 issue 3	Lab Chemistry	See responses on Laboratory Chemistry in Appendix C.
61	The workplan (Item #2 of Additional Materials) specifies the use of Method 6010 for the analysis of CrT; Method 6020A was used instead. This may impact the ability to quantify for CrT at low concentration levels since the RL for Method 6020A is much lower than that for Method 6010.	College of New Jersey	Additional Comments Quality of Analytical Data CNJ Page 3 issue 4	Lab Chemistry	See responses on Laboratory Chemistry in Appendix C.
62	Some data for Cr6 in this study was reported by the USEPA determinative method 218.6, other data was reported by Method 7196A and still other data was reported by Method 7199. These methods all have different sensitivities and different capabilities to report Cr6 without analytical interferences. Why were different methods used to measure Cr6?	College of New Jersey	Additional Comments Quality of Analytical Data CNJ Page 3 issue 5	Lab Chemistry	See responses on Laboratory Chemistry in Appendix C.
63	The rationale for using median vs. mean for data summaries was never provided.	College of New Jersey	Additional Comments Quality of Analytical Data CNJ Page 3 issue 6	Statistics	Per USEPA guidance, the 95% upper threshold limit was based on the mean and standard deviation of the data set.
64	The authors of the report chose to use a method from the UnitedStates Geological Survey (USGS) to attempt to define specific Cr species present in samples, any specie interconversion (either oxidation of Cr3 to Cr6 or reduction of Cr6 to Cr3). This method is not certified by any State or national laboratory accreditation authority. Information that was supplied suggests that this USGS method has only been applied to speciation of As. USEPA Method 6800, Elemental and Speciated Isotope Dilution Mass Spectrometry allows the identification individual Cr species, the extent of any specie interconversion, and can correct final results for up to 80% conversion. USEPA Method 6800 is certified by State and national laboratory accreditation authorities. Why was Method 6800 not used for this application?	College of New Jersey	Additional Comments Quality of Analytical Data CNJ Page 3 issue 7	Lab Chemistry	See responses on Laboratory Chemistry in Appendix C.

APPENDIX B

Work Plan for Evaluation of Background
Chromium in the Groundwater of the Upper Aquifer in the Hinkley Valley
Pacific Gas and Electric Company
Stantec PN# 185702482
February 22, 2012

Appendix B
Installation, Development, and Sampling of Monitoring Wells

Section 3 of this Work Plan includes proposed installation, development, and sampling of short screened monitoring wells. The following presents proposed methods for the installation and development of new wells, and for the sampling of new and existing wells.

SOIL BORING ADVANCEMENT AND LOGGING

Well permits will be obtained from San Bernardino County prior to the start of drilling activities. The following describes the standard methods to be used during installation of the upper aquifer monitoring wells.

Boreholes for the new monitoring wells will be advanced using hollow-stem auger methods. Core sampling will be completed using eight-inch outside-diameter (OD) augers and single 2.5-inch diameter schedule 80 polyvinyl chloride (PVC) wells will be installed in this sized borehole. The borehole will be reamed to 10-inch OD for the installation of four-inch diameter single completion schedule 40 PVC wells and 2.5-inch diameter schedule 80 PVC nested wells, as appropriate. All soil cuttings generated during these activities will be transported to the approved Ranch Land Treatment Unit (Ranch AU) for management.

All encountered soils will be logged according to the Unified Soil Classification System (USCS) by a qualified PG&E representative under the direct supervision of a California Professional Geologist (PG). Unsaturated zone soils (grade to approximately 70 feet below ground surface, or ft-bgs) will be logged from auger cuttings at a minimum of every five feet. Continuous split-spoon or split-core barrel sampling will be performed from first encountered water to the total depth of the boring. Borings will be advanced to a maximum depth based on the occurrence of the confining clay layer separating the upper and lower aquifers (*i.e.,* the LA CCL or “blue clay”) or bedrock, whichever is encountered first.

MONITORING WELL CONSTRUCTION

Monitoring wells installed at the water table will be completed with 4-inch diameter schedule 40 PVC and will not be nested with deeper wells. All wells completed below the water table surface will be constructed using 2.5-inch-diameter schedule 80 (PVC) as single or nested wells depending on local lithology. The following describes the installation of the single completion and nested wells.

Single Completion Wells

Single completion monitoring wells will be installed by placing the PVC well materials in the borehole and placing filter pack sand, hydrated bentonite, and cement/grout slurry in the annular space. All wells screens will be constructed with 0.020-inch machine slotted perforations and #2/12 filter sands. Wells near the water table will be completed using 15 feet of screen and those completed below the water table will have 10-feet of screen. The filter pack sand will be placed in the well annulus from the bottom of the boring (*i.e.,* bottom of the well screen) to approximately two feet above the top of the well screen. Hydrated bentonite will be placed above the filter sand and continue into the unsaturated zone to a level of at least 20 feet above the water table surface. Wells will be backfilled to the ground surface using cement grout slurry and completed at surface grade with a flush-mounted Christy well box and bolted steel cover.

Nested Dual Completion Wells

Both screen sections in a nested pair will be completed with 10-feet of 0.020-inch machine slotted perforations and #2/12 filter sands. The deeper well casing will first be placed in the borehole and the filter pack sand and bentonite will be used as annulus as described above for the single completion wells. Hydrated bentonite will be placed in the borehole to within two feet of the depth of the bottom of the shallow well. Approximately two feet of additional filter pack sand will be placed in the borehole, and then the shallow well casing will be set on the top of the sand. Filter pack sand will be placed to approximately two feet above the top of the slotted screen and hydrated bentonite will be placed above the filter sand continuing into the unsaturated zone to a level of at least 20 feet above the water table surface. The remaining annular space will be backfilled to the ground surface using cement grout slurry and completed at surface grade with a flush-mounted Christy well box and bolted steel cover.

WELL DEVELOPMENT, SAMPLING, ANALYSIS, AND SURVEYING

The following discusses the development, sampling and laboratory analysis, and surveying for the new monitoring wells.

Well Development

Each of the new monitoring wells will be developed using mechanical surging, and bailing and/or pumping. A minimum of ten casing volumes of water will be removed from each well during development, unless the well goes dry and does not recharge at a rate that would facilitate the removal of ten casing volumes. At these locations, bailing and pumping will be conducted when feasible, within the confines of the well recharge rate. In some cases, more than ten casings volumes of water may be removed in an effort to reduce turbidity. Each well will be developed twice prior to sampling to optimize well development and achieve the lowest turbidity feasible prior to sampling..

Water generated during development will be transferred directly into a trailer-mounted holding tank. The water will then be transferred to the Central *In Situ* Reactive Zone (IRZ), where it will be placed in a permanent holding tank for ethanol amendment and injection.

New Well Sampling and Laboratory Analysis

A minimum of 72 hours after the second development, each of the new monitoring well will be sampled by qualified PG&E representatives. Wells will be sampled according to the approved low-flow sampling procedures detailed in Appendix A of the *Second Semiannual Monitoring Report—Year 2006, Hinkley Compressor Station, Hinkley, California* (CH2MILL, February 28, 2007), or in accordance with the three-volume purge methods detailed in the *Purging and Sampling of Monitoring Wells with Temporary*

Submersible Pumps / Stabilized Drawdown Method, Standard Operating Procedure SOP-A2 (CH2MHILL, January 10, 2012). Both methodologies are summarized below.

- Wells will be sampled using either an air bladder pump or a portable electric submersible pump with dedicated tubing. The pump/tubing inlet will be set near the center point of the well screen;
- Wells purged and sampled using the low-flow, minimal-drawdown method, will follow U.S. Environmental Protection Agency (US EPA) guidelines (US EPA, 1996);
- Wells purged and sampled using three-volume purge method will be purged until a minimum of three well casing volumes have been removed;
- A Horiba model U-22 field water quality meter will be used to measure pH, electrical conductivity, temperature, dissolved oxygen, and redox potential of the purge water. Each well will be purged until these parameters stabilized;
- Prior to sampling, the static water level will be measured; and,
- Samples will be filtered in the field to remove fine sediment, prior to placement in the sample bottles.

Samples will be delivered to an independent, state-certified laboratory under appropriate chain-of-custody procedures and analyzed for both Cr6 using EPA Method 218.6 and CrT using US EPA Method 6010B.

Sampling Existing Long Screen Wells

The prior background study (CH2MHILL, 2007) included the sampling of previously existing domestic or agricultural long screen production wells. PG&E currently samples numerous domestic wells in the Hinkley Valley on a regular basis. The scope of work presented in this Work Plan may include the sampling of select long screen domestic or agricultural wells to compare to the new short screen well data. Sampling methods for the long screen wells are described in the *Purging and Sampling of Active Domestic Wells with Dedicated Pumps, Standard Operating Procedure for PG&E Hinkley Groundwater Monitoring Program (SOP-A6)*. Water Board concurrence with these methods was provided to PG&E in a letter dated February 10, 2012. The sampling methods and Water Board concurrence letter are included as Attachment B-1.

SURVEYING

Each of the new monitoring wells will be surveyed to a common datum to record elevation above mean sea level.

California Regional Water Quality Control Board
Lahontan Region

Matthew Rodriquez
Secretary for
Environmental Protection

2501 Lake Tahoe Boulevard, South Lake Tahoe, California 96150
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Edmund G. Brown Jr.
Governor

February 10, 2012

To Interested Persons,

This letter discusses procedures for domestic well sampling in Hinkley related to chromium contamination in groundwater.

Background

At the December 8, 2011 meeting held at the Hinkley Elementary School, members of the public voiced concern about sampling procedures being employed by the Pacific Gas and Electric Company (PG&E) for domestic wells. Water Board staff promised to look into PG&E's sampling procedures and compare it to those that are considered standard for the industry and follow up with a response.

PG&E's Well Sampling Procedures

PG&E is under orders by the California Regional Water Quality Control Board, Lahontan Region, (Water Board), to conduct a domestic well sampling program within one mile of the chromium plume boundary. As part of that program, PG&E's consultant, CH2MHill, developed a Standard Operating Procedures (SOP) (Enclosure 1) for purging and sampling domestic and community wells.

The SOP states that domestic wells with active pumps "can be sampled directly without satisfying extensive purging criteria after water contained in the pump and associated tubing/ plumbing has been purged." Wells are generally purged for approximately 5 minutes. However, final purge time and volume will depend on the specific well system and the dedicated pump flow rate. For wells installed with a sampling port before a holding tank, a water sample is collected directly from this location.

Comparing PG&E SOP with Other SOPs

Water Board staff researched guidelines and standards within government agencies and professional organizations for appropriate purging and sampling of domestic wells. In California, the Department of Water Resources' (DWR) Well Standards provide minimum requirements for the construction, maintenance (including sampling), and destruction of private water wells to prevent pollution to groundwater. DWR's Well Standards are used by laboratories when collecting samples of private wells and are enforced by local governments, such as county health departments.

For chemical sampling of domestic wells, Section 15, Appendix D of the Well Standards (Enclosure 2) describes minimum requirements for the collection of water samples:

> "The sample should be collected after the well has been pumped long enough to remove standing water and development and disinfectant chemicals, and to ensure that water from the producing formation(s) has entered the well..."

The above-referenced Well Standard is not specific in the length of time for purging domestic wells before sampling but does state that it is the formation (aquifer materials outside the well) and not standing water within the well that is sampled.

Well Standards are used as a framework by other state agencies in developing standard procedures for private well sampling. One example is the SOP prepared by the California Department of Pesticide Regulation (Enclosure 3). The SOP states the purpose for purging is to eliminate standing water from a well and allow the system to be recharged with fresh water from the aquifer. Purging time is based on the minutes the pump runs. For sampling before a storage or pressure tank, the SOP advises to purge the well casing by opening enough faucets to force the pump to run for a minimum of 10 minutes. After which, water should flow through a sampling port for at least 20 seconds to clear potential debris before collecting a sample. If a pump is already running, the time the well has been running may be applied to the required purging time.

Water Board staff also researched standard procedures or guidance for private well purging and sampling from the U.S. EPA and water well associations. Our findings determined that purging of water wells for approximately five minutes is reasonable for the collection of water samples for chemical analyses. However, final purge time and volume was dependent on knowledge of the specific well system and the pump flow rate for the well being sampled.

Conclusion

Water Board staff finds that PG&E's SOP for purging and sampling of domestic wells in Hinkley is consistent with DWR's Well Standards and guidance issued by other agencies and professional associations. Purging of wells for approximately five minutes as a general rule of thumb appears reasonable, especially when well designs and pump specifics are unknown. Yet, where the well design and well volume and pump rate are known, purging needs to be modified to ensure that standing water is removed prior to sampling. For instance, purging time may be reduced for a well having a short screen length or having a pump with a large flow rate. All such relevant factors should be taken into consideration by PG&E when the purge volume and time is being implemented during sampling of Hinkley domestic wells.

If you have any questions concerning PG&E's well sampling program, you may contact its Community Center in Hinkley at (760) 253-7888 or toll free at 1-855-816-9722.

Should you have questions concerning this letter, please contact Lisa Dernbach of the Water Board at (530) 542-5424 or at ldernbach@waterboards.ca.gov.

Lauri Kemper

LAURI KEMPER
ASSISTANT EXECUTIVE OFFICER

Enclosures:
1. PG&E's Well Sampling Standard Operating Procedures
2. California Water Well Standards, Section 15, Appendix D
3. California Department of Pesticide Regulations Well Sampling SOP

CC: PG&E Hinkley Technical Mailing List and Lyris List

LSD/adw/T: Dernbach/PG&E Hinkley/PG&E domestic well sampling letter 1-12
Send to file: WDID (VVL) 6B369107001

ENCLOSURE 1

SOP-A6

Purging and Sampling of Active Domestic Wells with Dedicated Pumps Standard Operating Procedure for PG&E Hinkley Groundwater Monitoring Program

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This standard operating procedure (SOP) describes the procedures and equipment to be used for groundwater sampling of active domestic wells that are equipped with dedicated and functional well pumps at the PG&E Hinkley site.

Samples for water quality measurement and laboratory analysis are collected directly from existing or installed sampling ports at the well head/discharge piping. Samples should not be collected from holding tanks.

The active domestic wells are typically larger in diameter and usually have long perforated/screen intervals. Therefore, the purging and sampling procedures for these wells are different from the procedures used for sampling conventional groundwater monitoring wells. Wells that are actively pumping on a regular basis (e.g., domestic wells) can be sampled directly without satisfying extensive purging criteria after water contained in the pump and associated tubing/plumbing has been purged.

REQUIRED DOCUMENTS

- Event-specific "planned sampling and analysis table" (PST).
- Applicable project work plan or monitoring plan, and related Hinkley SOPs as needed.
- Hinkley Program Health and Safety Plan (HSP).
- Well construction and depth to water information, if available.
- Previous purge and sampling log sheets, if available.
- Well Survey Form
- Blank purge and sampling log sheets and field logbook.

PREPARATION AND SETUP

1) Review event-specific PST or event-specific field instructions, HSP, previous sampling logs, and initiate field logbook for sampling activity.
2) Field-check and setup sampling equipment: water level (WL) meter, water quality (WQ) meters, flow-through cell, field filter, purge water container, health and safety equipment, etc. Inspect and calibrate field equipment prior to use according to SOP-A11, *Calibration of Field Instruments*.
3) Inventory sample bottles, review required analyses, confirm the lab courier schedule, and prepare groundwater sampling log.
4) Conduct a well survey. Confirm and note the operation status (e.g., active) of the domestic well from wellhead meter (if present) or well owner information. When possible, inspect and/or confirm the condition of the well, well's pump, wellhead and associated piping.

5) Confirm the presence/absence of a sampling port (a.k.a. spigot), pressure relief valve, holding tank, and backflow valve in the tank. Determine whether a well retrofit is needed for the installation of a sampling port before the holding tank. Consult with the well owner before modifying the well and pump system and request his/her consent. If needed, install a sampling port as close as possible to the wellhead. The most common procedure for this retrofit is to remove the pressure relief valve from the wellhead or pipe and install a small pipe extension with a sampling port and re-install the pressure relief valve at the end of the pipe extension.

6) If a backflow valve is missing at the holding tank or does not work properly to prevent water from running back into the sampling port and well during sampling, the holding tank will be emptied before purging and sampling begins.

7) If the domestic well has been inactive for more than 24 hours, a water level measurement can be taken. Measure initial static WL according to SOP-A9, *Water Level Measurements*. Record WL value on sampling log.

PURGING AND SAMPLING PROCEDURES -ACTIVE DOMESTIC WELLS

8) Install a flow-through cell to the sampling port and record a set of water quality parameters (pH, conductivity, temperature, turbidity, dissolved oxygen, temperature, and ORP). If it is not possible to connect the flow-through cell, a clean 5-gallon bucket may be used by filling the bucket with purge water and inserting the instrument probes directly into the bucket. If the bucket is used, turbulence in the bucket should be minimized and only pH, conductivity, ORP, and temperature need to be recorded. Record units and time for all measurements collected. Record on the sampling log if any parameter readings are anomalous or unstable due to instrument problems.

9) Purge the well for approximately five minutes to ensure that water contained in the pump and associated tubing/plumbing has been purged. The final purged volume and purge time will depend on the specific well system and the dedicated pump flow rate.

10) Samples will be collected directly from the sampling port. A single set of field parameters should be recorded (collecting stabilized field parameters is not required). Record observations on sample appearance, clarity, and odors.

9) Collect samples for analyses according to the PST and/or event-specific field instructions. Sample containers are to be filled by transferring water directly from the sampling port to the appropriate sample container. If the PST calls for filtered and/or preserved samples, refer to SOP-A7, *Sample Field Filtration and Preservation for Metals*.

10) Complete the field sampling log, including description of samples collected, final WL, and purge volume of discharge or purge. If the pump is equipped with a flow meter, record the flow rate as well. Close and secure the well including access gates or fences.

INVESTIGATION-DERIVED WASTE MANAGEMENT

Different types of potentially-contaminated investigation-derived waste (IDW) will be generated during groundwater sampling efforts. These may include:

- Used personal protective equipment (PPE).
- Disposable sampling equipment.
- Decontamination fluids.
- Purged groundwater and excess groundwater collected for sample container filling.

Used PPE and disposable equipment will be placed in a municipal refuse dumpster. These wastes are not considered hazardous and can be sent to a municipal landfill. Any PPE and disposable equipment that is to be disposed of that could still be reused will be rendered inoperable before disposal in the refuse dumpster.

Regarding disposal of wastewater (decontamination water, and purge and excess groundwater), all wastewater generated during sampling of active domestic wells will be discharged directly to the ground at the well site.

ENCLOSURE 2

Water Well Standards

CHAPTER II. STANDARDS

Section 15. Water Quality Sampling.[Note 18]

The requirements to be followed with respect to water quality sampling are:

A. *Community Water Supply Wells and Certain Industrial Wells.* The water from all community water supply wells and industrial wells which provide water for use in food processing shall be sampled immediately following development and disinfection, and appropriate analysis made. Rules and regulations governing the constituents to be tested, type of testing, etc, for community water supply systems are contained in Chapter 15, "Domestic Water Quality and Monitoring", of Title 22, California Administrative Code. Water analysis shall be performed by a laboratory certified by the California Department of Health Services. A copy of the laboratory analysis shall be forwarded to the California Department of Health Services or to the local health department. Approval of the enforcing agency must be obtained before the well is put into use.

   Except where there is free discharge from the pump (that is, there is no direct connection to the water delivery system such as to a sump), a sample tap (see Figure 7) shall be provided on the discharge line so that water representative of the water in the well may be drawn for laboratory analysis. The tap shall be located so as to prevent back siphonage to the pump discharge when the pump is shut off (e.g., on the system side of the check valve).

B. *Other Types of Wells.* To determine the quality of water produced by a new well it should be sampled immediately following construction and development. Appropriate analyses shall be made based upon the intended uses of the water.

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Water Well Standards

APPENDIX D

COLLECTION OF WATER QUALITY SAMPLES

Water from all new wells should be sampled in order to determine the quality of the water that is being produced. The type of analysis that will be made is dependent on the expected use of the water. For example, individual domestic wells should be sampled for determination of bacterial quality and chemical quality. The water from agricultural wells is generally examined only for the presence of specific chemicals unless there is the likelihood that there will be incidental domestic use of the water, in which case the bacterial quality ought to be determined too.

Recommendations regarding the types of analyses to be performed for the various uses of water will be found in numerous references on water quality and groundwater; however, it is best to consult with local agencies such as county farm advisors, health departments or water service agencies (irrigation or water districts). Sampling of community water supply wells is covered by requirements of the California Department of Health Services. Note 28

Bacterial Sampling

For individual domestic wells, technical advice regarding the collection of bacteriological samples may be obtained from the local health departments or from the laboratories that will examine the sample. If no technical assistance is available, the following procedure will suffice: A sterile sample bottle, preferably one provided by the laboratory, must be used. It is extremely important that nothing except the water to be analyzed come in contact with the inside of the bottle or the cap; the water must not be allowed to flow over an object or over the hands and into the bottle while it is being filled. If the water is collected from a sample tap, turn on the tap and allow the water to flow for 2 or 3 minutes before collecting the sample. Note 29 Do not rinse the sample bottle. The sample should be delivered to the laboratory as soon as possible and in no case more than 30 hours after its collection. During delivery, the sample should be kept as cool as possible (but not frozen).

Chemical Sampling

Generally, a routine mineral analyses (determination of the concentrations of the common minerals such as calcium, sodium, chloride, sulfate, etc.) plus analyses for selected minor elements will suffice, particularly where there is no prior knowledge of the chemical quality of the water in the area where the well is located. Where quality conditions in the surrounding area are known, a more selective analysis may be made. For specified uses it may also be desirable to make analysis for concentrations of certain constituents (such as iron and manganese in the case of domestic water or boron in irrigation water). Organic chemicals are not routinely determined. Information or advice on chemical quality conditions may be obtained from local agencies such as the county farm advisors, health departments, etc.

The sample should be collected after the well has been pumped long enough to remove standing water and development and disinfectant chemicals, and to ensure that water from the producing formation(s) has entered the well. The water sample should be collected in a chemically clean container, preferably one obtained from the laboratory that will perform the analysis. The container should be rinsed several times with the water to be sampled prior to collecting the sample. The laboratory performing the analysis should issue instructions regarding the quantity of sample required and whether or not preservatives are needed. However, one-half gallon (1.9 litres) is usually sufficient for a routine mineral analysis; one gallon (3.8 litres) when analyses for minor elements (i.e., iron, manganese, etc.) is also required. Sample quantities for organic chemicals vary according to the type of analysis, and range from very small amounts up to several gallons (litres). In addition, where organic chemicals are to be determined, special sampling procedures and equipment may be required. This is particularly true for volatile organic compounds.

In all cases the temperature of the water should be determined immediately upon collection of the sample.

Appendix C **Table of Contents** **Appendix E**

ENCLOSURE 3

1.0 INTRODUCTION

1.1 Purpose

This SOP provides instructions for obtaining permission, purging and collecting a water sample from a well, and then how to preserve the sample. With a two-person crew, staff may divide the tasks by one person conducting sampling (section 3.3) and the other conducting the documentation (section 3.11).

1.2 Definitions

1.2.1 **Purging-**eliminates standing water from a well and allows the system to be recharged with fresh water from the aquifer.

2.0 MATERIALS

2.1 A copy of this and other appropriate SOP's and the study protocol

2.2 Phone numbers for your supervisor, other teams, and the Department of Pesticide Regulation (DPR) Business Services Office (BSO)

2.3 DPR permission form to sample well (Appendix 1) in English and Spanish

2.4 DPR ground water brochures ("Your Water–Our Commitment to Safety") in English and Spanish

2.5 Plastic bag (18 in by 24 in) for ground cover

2.6 Plastic bag (6 in by 12 in) to cover electrical points

2.7 Replacement (Schrader®) snifter valves

2.8 Replacement snifter valve core stems

2.9 Alligator valve caps (Gator®)

2.10 Snifter valve core stem remover

2.11 Snifter valve sampling tube

2.12 Locking pliers to secure Teflon® tube to snifter valve while sampling if unable to use the alligator valve caps

2.13 5/16 and 7/16 box end wrenches for replacing snifter valve if needed

2.14 Teflon® tape

2.15 Sample containers (refer to section 4.3)

2.16 De-ionized or distilled water for field blanks and equipment rinses (refer to section 3.7)

2.17 Polystyrene foam holders for one-liter sample bottles (6-packs) or appropriate packing for other size containers

2.18 1 half-pint Mason jar

2.19 pH meter or pH litmus paper

2.20 Preservative, if necessary (refer to section 4.4)

2.21 Ice chests

2.22 Ice materials (refer to section 4.4.3)

2.23 Chain of Custody form (Appendix 5)

2.24 Department of Water Resources (DWR) form 429 (Appendix 4)

2.25 Well information form (Appendix 2)

2.26 Digital camera

2.27 Global Positioning System (GPS) unit

2.28 Water level meter

2.29 Measuring wheel

2.30 Rangefinder

2.31 Extra sample bottles

2.32 Latex gloves (in sizes appropriate for sampling crew)

2.33 Duct tape and/or rubber bands to secure plastic bag around points box

2.34 Tool box which has check list for above items attached

2.35 Garden hose

2.36 Bucket

3.0 PROCEDURES

3.1 Obtain Permission to Sample Well

You must obtain the well owner's permission to collect samples before beginning any part of the sampling procedure, including evaluating the suitability of the well.

3.4 Purging Procedures

Purging is required prior to collecting any samples. Purging time is based on the minutes the pump runs. If the pump cycles on and off during the purging process be sure to keep track of the total time the pump is running. If the well is already running when the crew arrives at the well, the time the well has been running may be applied to the required purging time. To speed up the process of purging make sure the well tank is emptying as fast as the pump can fill it. Do this by opening enough faucets around the house and monitoring the pressure gauge on the storage tank. If the output is equal to the inflow, the gauge will hold at a steady level below the pump's shutoff pressure.

3.4.1 **Sampling prior to the tank:** Purge the well casing by opening enough faucets to force the well pump to run for a minimum of 10 minutes.

3.4.2 **Sampling after the tank:** Drain three tank volumes prior to sampling. Purging time must be calculated based on tank volume and outflow rate. Check to make sure the owner will permit such water use before flushing the tank. For larger storage tanks, it is preferable to locate a different well in the area or arrange to return at a later date when the well is scheduled to run for an extended period. If the well has already been running long enough to have drained the three tank volumes (i.e., running an irrigation system for several hours), it is possible to collect the sample after the tank without purging. Always note that the sample was obtained after the tank on the Well Information form and other relevant information regarding pump run-time and tank purging.

3.5 Preparing a Snifter Valve Sample Port for Sample Collection

3.5.1 After the purging cycle, turn faucets off and turn off the power at the circuit box or switch box. A final method to shut off a well is by interrupting the points in the point's box. Staff should not attempt this procedure until an experienced staff member has trained them.

3.5.2 Before removing or replacing the snifter valve, cover the electrical point box (Figure 2) with a plastic bag and secure with duct tape to avoid getting water in the points and short-circuiting the system (Figure 9).

APPENDIX C

Work Plan for Evaluation of Background
Chromium in the Groundwater of the Upper Aquifer in the Hinkley Valley
Pacific Gas and Electric Company
Stantec PN# 185702482
February 22, 2012

Pacific Gas and Electric Company

Kevin M. Sullivan
Hinkley Remediation
Project Manager
Shared Services Dept

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January 20, 2012

Ms. Lauri Kemper, Assistant Executive Officer
Ms. Lisa Dernbach, Senior Engineering Geologist
California Regional Water Quality Control Board, Lahontan Region
2501 Lake Tahoe Boulevard
South Lake Tahoe, California 96150

Subject: Investigative Order No. R6V-2011-0105, Request For Information On Laboraotry Quality Control Data For 2007 Background Study Report, Pacific Gas And Electric Company, Hinkley Compressor Station, San Bernadino County

Dear Ms. Kemper and Ms. Dernbach:

Pacific Gas and Electric Company (PG&E) respectfully submits the enclosed Technical Memoradum, which presents the response to Investigative Order No. R6V-2011-0105, issued by the Regional Water Quality Control Board, Lahontan Region (Water Board) on December 29, 2011. This Order requested responses to nine specific comments related to laboratory quality control data for Hinkley Groundwater Background Study Report (CH2M Hill, 2007) and requested submittal of the raw analytical data, which is provided on a compact disc (CD). In addition, the Technical Memoradum presents responses to comments provided by Dr. Stuart Nagourney in the Peer Review received by the Water Board on October 14, 2011.

Please contact me if you have questions regarding the information provided in the enclosed Technical Memorandum.

Sincerely,

Kevin Sullivan
Hinkley Remediation Project Manager

Attachments:

Technical Memorandum – Response to Investigative Order No. R6V-2011-0105 and Peer Review Comments on Laboratory Quality Control Data for 2007 Groundwater Background Study Report, Hinkley Remediation Project

Compact Disc (CD) – Hexavalent Chromium Analytical Data, Truesdail Laboratories, Inc. and EMAX Laboratories, Hinkley Groundwater Background Study (CH2M HILL, 2007)

Response to Investigative Order No. R6V-2011-0105 and Peer Review Comments on Laboratory Quality Control Data for 2007 Groundwater Background Study Report, Hinkley Remediation Project

PREPARED FOR:	Pacific Gas and Electric Company
COPY TO:	Eliana Makhlouf Shawn Duffy
PREPARED BY:	CH2M HILL
DATE:	January 19, 2012
PROJECT NUMBER:	432629

This technical memorandum presents the response to Investigative Order No. R6V-2011-0105 issued by the California Regional Water Quality Control Board, Lahontan Region (Water Board) (Water Board, 2011), which requested information on laboratory quality control data for the Groundwater Background Study Report (CH2M HILL, 2007), prepared on behalf of Pacific Gas and Electric Company (PG&E) for the Hinkley Remediation Project. In addition, this memorandum presents responses to comments provided by Dr. Nagourney in the Peer Review received by the Water Board on October 14, 2011.

The responses to questions one through nine in Investigative Order R6V-2011-0105 are provided below.

1) **Comment:** For the continuing calibration verification (CCV) failures for EPA Method SW 7199, discuss what percentage out of range were the CCV recoveries.

   Response: During the first Groundwater Background Study sampling event, (January/February 2006) all Method SW 7199 sample analyses were performed by Truesdail Laboratories, Inc. (TLI) and the CCV recoveries for all analyses were within the method criteria of 90 – 110% recovery.

   For the three subsequent sampling events, all Method SW7199 sample analyses were performed by EMAX Laboratory (EMAX). Of the 129 sample analyses performed by EMAX, 31 (26 samples and 5 field duplicates) or 24 percent had one or more of the bracketing CCVs with recoveries that were outside the method criteria. CCV recoveries for the out of control sample analyses ranged from a low of 72 percent to a high of 123 percent with 19 results biased low and 12 biased high. In accordance with the PG&E program Quality Assurance Project Plan (QAPP) (CH2M HILL, 2008) that cites USEPA National Functional Guidelines for Inorganic Data Review (2002), the range of the out of control CCV recoveries was not significant enough to warrant data rejection, but did require data qualification by applying “J/UJ” flags to out of control results. Therefore, the results were determined to be of sufficient quality to be used for purposes of the Groundwater Background Study.

2) **Comment:** Provide raw data, calibration curves, CCVs, and quality control (QC) samples, from hexavalent chromium analysis.

   Response: All analytical data for hexavalent chromium are provided on the enclosed CD. The data are organized by sample delivery groups (SDGs) provided to CH2M HILL by the laboratories. There are 17 SDGs from EMAX and four SDGs from TLI. The table below identifies each SDG number associated with hexavalent chromium analysis associated with the Groundwater Background Study.

EMAX SDG Numbers	TLI SDG Numbers
06D180, 06D191, 06D205, 06D215, 06G152, 06G165, 06G182, 06G200, 06I248, 06I262, 06I280, 06J236, 06J257, 06J279, 06K142, 06K156, 06K180	951265, 951327, 951368, 951421

3) **Comment:** Provide information on matrix spike amounts and recoveries for hexavalent chromium.

Response: The spike concentration at TLI for hexavalent chromium was 1.0 microgram per liter (µg/L). There were four SDGs of data with three different site specific matrix spike samples in three of the four SDGs. The SDG without the site specific matrix spike has a matrix spike completed on a non-site sample. The recoveries were all in control with 98, 94, and 106 percent recovery. The acceptance limits used by the laboratory were 90 – 110 percent. The concentration of the matrix spike was five times the reporting level and applicable to the majority of sample concentrations determined over the study.

The spike concentration at EMAX Laboratory for hexavalent chromium was 1.0 µg/L. There were 17 SDGs of data with 18 different site specific matrix spike samples in 15 of the 17 SDGs. The SDG without the site specific matrix spike has a matrix spike completed on a non-site sample. The recoveries were predominantly in control ranging from 76 to 115 percent recovery. The acceptance limits used by the laboratory were 85 – 115 percent. Two of the 18 matrix spikes were out of control with a low bias but still provide data that met project data quality objectives for evaluating background hexavalent chromium concentrations. The concentration of the matrix spike was five times the reporting level and applicable to the majority of sample concentrations determined over the study.

4) **Comment:** A description of how samples were chosen for matrix spiking.

Response: The matrix spikes were randomly selected by the laboratory as part of the analytical batch control requirements.

5) **Comment:** Provide evidence that Mid-Range Calibration Check Standards (MRCCSs) were prepared from a second source standard. Provide National Institute of Standards Traceability (NIST) documentation for MRCCSs.

Response: MRCCSs were prepared from a different lot number source from the initial calibration stock at TLI as well as at EMAX Laboratory as shown in files provided on the attached CD. This same standards traceability documentation is also available in each of the SDGs provided in response to Question Number 2.

6) **Comment:** Verify which calibration curve was used for EPA Method 6010B (was the standard or low level calibration curve used?). Provide documentation showing calibration curve.

Response: Method 6010B was not used by either lab for the Hinkley Groundwater Background Study rather Method 6020 was used for total chromium analysis as explained in the response to Question Number 9.

7) **Comment:** Provide valid California Environmental Laboratory Accreditation Program (ELAP) certificates for each lab for total and hexavalent chromium analysis for the calendar year 2006.

Response: Both TLI and EMAX were ELAP certified in 2006. Copies of the certifications for 2006 are provided in Attachment A.

8) **Comment:** Discuss why EPA Method 6800 was not used for chromium species identification.

   Response: The Hinkley Background Study was conducted from January to November 2006 and therefore pre-dated the promulgation of Method 6800, which was posted in February 2007.

9) **Comment:** Discuss why EPA method 6020A was used instead of Method 6010 for total chromium.

   Response: USEPA method 6020A achieves a lower level of detection for total chromium than that of EPA Method 6010B and therefore was used for the project.

Attachment B to this technical memorandum provides additional responses to comments provided by Dr. Nagourney regarding the quality control procedures used by the laboratory for chromium analysis. In summary, based on a review of the laboratory methods and data obtained for the study, the quality of the laboratory analysis performed for the study was appropriate and met all of the requirements of the USEPA methods employed. The issues raised by the reviewer can be explained by 1) the incomplete answers provided to the reviewer by the laboratories, 2) expectations of the reviewer for quality control measures that were slightly different or beyond the requirements of the USEPA methods, or 3) a misunderstanding on the part of the reviewer about which methods were applied to the data set. As summarized in Attachment B, the data yielded through these analyses are deemed of high quality and the use of these data for the purposes of the background study was appropriate. A detailed response to comments on the laboratory chemistry comments is provided in Attachment B.

References

CH2M Hill. 2007. *Groundwater Background Study Report, Hinkley Compressor Station, Hinkley, California.* February.

__________. 2008. *PG&E Program Quality Assurance Project Plan.* December.

United States Environmental Protection Agency (USEPA). 2002. *USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Superfund Data Review*. July.

Regional Water Quality Control Board, Lahontan Region (Water Board), 2011. *Investigative Order R6V-2011-0105, Request for Information on Laboratory Quality Control Data for 2007 Groundwater Background Study Report, Pacific Gas and Electric Company (PG&E), Hinkley Compressor Station, San Bernardino County*. December.

Attachments

Attachment A	California ELAP Certificates for Truesdail Laboratories, Inc. and EMAX Laboratories
Attachment B	Response to Comments on Laboratory Chemistry and Quality Control Data
Compact Disc (CD)	Hexavalent Chromium Analytical Data, Truesdail Laboratories, Inc. and EMAX Laboratories, Hinkley Groundwater Background Study (CH2M HILL, 2007)

Attachment A
California ELAP Certificates – Truesdail Laboratories, Inc. and EMAX Laboratories

California
Department of
Health Services

STATE OF CALIFORNIA
DEPARTMENT OF HEALTH SERVICES
ENVIRONMENTAL LABORATORY ACCREDITATION PROGRAM

ENVIRONMENTAL LABORATORY CERTIFICATION

Is hereby granted to

TRUESDAIL LABORATORIES, INC.

14201 FRANKLIN AVENUE

TUSTIN, CA 92780

Scope of certification is limited to the
"Accredited Fields of Testing"
which accompanies this Certificate.

Continued certification status depends on successful completion of site visit, proficiency testing studies, and payment of applicable fees.

This Certificate is granted in accordance with provisions of Section 100825, et seq. of the Health and Safety Code.

Certificate No: **1237**
Expiration Date: **07/31/2006**
Effective Date: **07/01/2004**

Berkeley, California
subject to forfeiture or revocation.

George C. Kulasingam, Ph.D.
Program Chief
Environmental Laboratory Accreditation Program

California Department of Health Services

State of California—Health and Human Services Agency
Department of Health Services

ARNOLD SCHWARZENEGGER
Governor

July 1, 2004

Certificate No.: **1237**

NORMAN E. HESTER, Ph.D
TRUESDAIL LABORATORIES, INC.
14201 FRANKLIN AVENUE
TUSTIN, CA 92780

Dear NORMAN E. HESTER, Ph.D:

This is to advise you that the laboratory named above continues to be certified as an environmental testing laboratory pursuant to the provisions of the California Environmental Laboratory Improvement Act (Health and Safety Code (HSC), Division 101, Part 1, Chapter 4, Section 100825, et seq.). Certification for all currently certified Fields of Testing that the laboratory has applied for renewal shall remain in effect until **07/31/2006** unless revoked.

Please note that the renewal application for certification is subject to an on-site visit, and continued use of the certificate is contingent upon:

- **successful completion of the site visit;**
- **acceptable performance in the required performance evaluation (PE) studies;**
- **timely payment of all fees, including an annual fee due before July 31, 2005;**
- **compliance with Environmental Laboratory Accreditation Program (ELAP) statutes (HSC, Section 100825, et seq.) and Regulations (California Code of Regulations (CCR),Title 22, Division 4, Chapter 19).**

An updated "Approved Fields of Testing" will be issued to the laboratory upon completion of the renewal process. The application for the next renewal must be received 90 days before the expiration of this certificate to remain in force according to the CCR, Section 64801 through 64827.

Please note that the laboratory is required to notify ELAP of any major changes in the laboratory such as the transfer of ownership, change of laboratory director, change in location, or structural alterations which may affect adversely the quality of analyses (HSC, Section 100845(b)(d)). Please include the above certificate number in all your correspondence to ELAP.

If you have any questions, please contact ELAP at (510) 540-2800.

Sincerely,

George C. Kulasingam

George C. Kulasingam, Ph.D.
Program Chief
Environmental Laboratory Accreditation Program

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SEP 02 2004

DHS-ELAP 1625 Shattuck Ave Room #101, Berkeley, CA 94709-1611
phone (510) 540-2800, fax (510)849-5106
Internet Address: www.dhs.ca.gov/elap

CALIFORNIA DEPARTMENT OF HEALTH SERVICES
ENVIRONMENTAL LABORATORY ACCREDITATION PROGRAM
List of Approved Fields of Testing and Analytes

TRUESDAIL LABORATORIES, INC.
14201 FRANKLIN AVENUE
TUSTIN, CA

PHONE No. (714) 730-6239
COUNTY ORANGE

Certificate No. 1237

---

01 Microbiology of Drinking Water and Wastewater

01.01A	Total and Fecal Coliform in Drinking Water by Multiple Tube Fermentation
01.02A	Total and Fecal Coliform in Drinking Water by Membrane Filtration
01.03	Total Coliform and E. coli in Drinking Water by Chromogenic/Fluorogenic Substrate
01.04A	Total and Fecal Coliform in Drinking Water by Clark's Presence/Absence
01.05	Heterotrophic Plate Count
01.06	Total Coliform in Wastewater by Multiple Tube Fermentation
01.07	Fecal Coliform in Wastewater by Multiple Tube Fermentation
01.08	Total Coliform in Wastewater by Membrane Filtration
01.09	Fecal Coliform in Wastewater by Membrane Filtration
01.10	Fecal Streptococci or Enterococci by Multiple Tube Fermentation
01.12	Total Coliform in Source Water by Multiple Tube Fermentation
01.13	Fecal Coliform in Source Water by Multiple Tube Fermentation
01.14	Total Coliform in Source Water by Membrane Filtration
01.16	Total Coliform in Source Water by Chromogenic/Fluorogenic Substrate

02 Inorganic Chemistry and Physical Properties of Drinking Water

02.01	Alkalinity
02.02	Calcium
02.03	Chloride
02.04	Corrosivity
02.05	Fluoride
02.06	Hardness
02.07	Magnesium
02.08	MBAS
02.09	Nitrate
02.10	Nitrite
02.11	Sodium
02.12	Sulfate
02.13A	Total Dissolved Solids
02.13B	Conductivity
02.16	Phosphate, ortho
02.17	Silica
02.18	Cyanide
02.19	Potassium
02.24	Perchlorate
02.31	UV 254

03 Analysis of Toxic Chemical Elements in Drinking Water

03.01	Arsenic
03.02	Barium
03.03	Cadmium
03.04	Chromium, total
03.05	Copper
03.06	Iron
03.07	Lead

03.08	Manganese
03.09	Mercury
03.10	Selenium
03.11	Silver
03.12	Zinc
03.13	Aluminum
03.15	Antimony
03.16	Beryllium
03.17	Nickel
03.18	Thallium
03.19	Chromium (VI)

04 Organic Chemistry of Drinking Water by GC/MS

04.02	EPA Method 524.2
04.03C	EPA Method 525.2 Polynuclear Aromatic Hydrocarbons
04.03D	EPA Method 525.2 Adipates
04.03E	EPA Method 525.2 Phthalates
04.08	EPA Method 525.2 PAH/Adipates/Phthalates only

05 Organic Chemistry of Drinking Water (excluding GC/MS)

05.04	EPA Method 502.2
05.06	EPA Method 504.1 EDB, DBCP
05.07	EPA Method 505
05.09	EPA Method 507 N,P Pesticides
05.10A	EPA Method 508
05.10B	EPA Method 508.1
05.11	EPA Method 508A PCBs Quantitation
05.13-1	EPA Method 515.1 Chlorophenoxy Herbicides
05.20A-1	EPA Method 551 Chlorinated Hydrocarbons
05.21A	EPA Method 552.1 Dalapon
05.26-1	EPA Method 552.2 Haloacetic Acids
05.26-2	Standard Methods 6251B Haloacetic Acids

06 Radiochemistry

06.01	Gross Alpha and Beta Radiation in Drinking Water EPA Method 900.0
06.02	Total Radium EPA Method 903.0
06.03	Radium 226 EPA Method 903.1 SM 7500 Ra-B
06.04	Uranium EPA Method 908.0
06.05	Radon 222 EPA Method 913.0
06.09	Tritium EPA Method 906.0 SM 7500^{3}H - B
06.10	Gross Alpha by Co-precipitation SM 7110C

09 Physical Properties Testing of Hazardous Waste

09.01	Ignitability by Flashpoint Determination
09.02	Corrosivity - pH Determination
09.03	Corrosivity - towards steel
09.04	Reactivity

10 Inorganic Chemistry and Toxic Chemical Elements of Hazardous Waste

10.01	Antimony
10.02	Arsenic
10.03	Barium

10.04	Beryllium
10.05	Cadmium
10.06	Chromium, total
10.07	Cobalt
10.08	Copper
10.09	Lead
10.10	Mercury
10.11	Molybdenum
10.12	Nickel
10.13	Selenium
10.14	Silver
10.15	Thallium
10.16	Vanadium
10.17	Zinc
10.18	Chromium (VI)
10.19	Cyanide
10.20	Fluoride
10.21	Sulfide

11 Extraction Tests of Hazardous Waste

11.01	California Waste Extraction Test (WET)
11.02	Extraction Procedure Toxicity
11.03	Toxicity Characteristic Leaching Procedure (TCLP) All Classes

12 Organic Chemistry of Hazardous Waste by GC/MS

12.01	EPA Method 8240B Volatile Compounds
12.02	EPA Method 8250A Semi-volatile compounds
12.03A	EPA Method 8270C Extractable Organics
12.06A	EPA Method 8260B Volatile Compounds

13 Organic Chemistry of Hazardous Waste (excluding GC/MS)

13.01	EPA Method 8010B Halogenated Volatiles
13.02A	EPA Method 8015B
13.03	EPA Method 8020A Aromatic Volatiles
13.05A	EPA Method 8041
13.06C	EPA Method 8061A
13.10A	EPA Method 8120A Chlorinated Hydrocarbons
13.10B	EPA Method 8121 Chlorinated Hydrocarbons
13.11B	EPA Method 8141A
13.12A	EPA Method 8150B Chlorinated Herbicides
13.12C	EPA Method 8151A Chlorinated Herbicides
13.13	EPA Method 8310 Polynuclear Aromatic Hydrocarbons
13.14B	EPA Method 8318
13.15	Total Petroleum Hydrocarbons - Gasoline (LUFT)
13.16	Total Petroleum Hydrocarbons - Diesel (LUFT)
13.17	EPA Method 418.1 TRPH - Screening by IR
13.18	EPA Method 8011 EDB and DBCP
13.19A	EPA Method 8021B Halogenated Volatiles only
13.19B	EPA Method 8021B Aromatic Volatiles only
13.19C	EPA Method 8021B BTEX and MTBE only
13.24A	EPA Method 8080A PCBs only
13.24C	EPA Method 8082 PCBs only

13.25A	EPA Method 8080A Organochlorine Pesticides only
13.25C	EPA Method 8081A Organochlorine Pesticides only
13.26	EPA Method 8031 Acrylonitrile
13.27A	EPA Method 8032A
13.29A	EPA Method 8315A

14 Bulk Asbestos Analysis

14.01	Bulk Asbestos, 1% or greater concentrations (Title 22, CCR, 66261.24(a)(2)(A))

16 Wastewater Inorganic Chemistry, Nutrients and Demand

16.01	Acidity
16.02	Alkalinity
16.03	Ammonia
16.04	Biochemical Oxygen Demand
16.05	Boron
16.06	Bromide
16.07	Calcium
16.09	Chemical Oxygen Demand
16.10	Chloride
16.11	Chlorine Residual, total
16.12	Cyanide
16.13	Cyanide amenable to Chlorination
16.14	Fluoride
16.15	Hardness
16.16	Kjeldahl Nitrogen
16.17	Magnesium
16.18	Nitrate
16.19	Nitrite
16.20	Oil and Grease
16.21	Organic Carbon
16.22	Oxygen, Dissolved
16.23	pH
16.24	Phenols
16.25	Phosphate, ortho
16.26	Phosphorus, total
16.27	Potassium
16.28	Residue, Total
16.29	Residue, Filterable (Total Dissolved Solids)
16.30	Residue, Nonfilterable (Total Suspended Solids)
16.31	Residue, Settleable (Settleable Solids)
16.32	Residue, Volatile
16.33	Silica
16.34	Sodium
16.35	Specific Conductance
16.36	Sulfate
16.37	Sulfide (includes total & soluble)
16.38	Sulfite
16.39	Surfactants (MBAS)
16.40	Tannin and Lignin
16.41	Turbidity
16.44	Total Recoverable Petroleum Hydrocarbons by IR
16.45	Total Organic Halides

17 Toxic Chemical Elements in Wastewater

17.01 Aluminum
17.02 Antimony
17.03 Arsenic
17.04 Barium
17.05 Beryllium
17.06 Cadmium
17.07 Chromium (VI)
17.08 Chromium, total
17.09 Cobalt
17.10 Copper
17.11 Gold
17.12 Iridium
17.13 Iron
17.14 Lead
17.15 Manganese
17.16 Mercury
17.17 Molybdenum
17.18 Nickel
17.20 Palladium
17.21 Platinum
17.24 Selenium
17.25 Silver
17.27 Thallium
17.28 Tin
17.29 Titanium
17.30 Vanadium
17.31 Zinc

18 Organic Chemistry of Wastewater by GC/MS

18.01 EPA Method 624
18.02 EPA Method 625

19 Organic Chemistry of Wastewater (excluding GC/MS)

19.01 EPA Method 601
19.02 EPA Method 602
19.03 EPA Method 603 Acrolein, Acrylonitrile
19.04 EPA Method 604
19.05 EPA Method 605 Benzidine
19.06 EPA Method 606 Phthalate Esters
19.07 EPA Method 607 Nitrosamines
19.08 EPA Method 608
19.09 EPA Method 609 Nitroaromatics and Cyclic Ketones
19.10 EPA Method 610
19.11 EPA Method 611 Haloethers
19.14 EPA Method 612 Chlorinated Hydrocarbons

CALIFORNIA DEPARTMENT OF HEALTH SERVICES
ENVIRONMENTAL LABORATORY ACCREDITATION PROGRAM
Accredited Fields of Testing

TRUESDAIL LABORATORIES, INC.
14201 FRANKLIN AVENUE
TUSTIN, CA 92780

Lab Phone (714) 730-6239

Certificate No: I-1237

Field of Testing: 04 - Organic Chemistry of Drinking Water by GC/MS

04.02	355	1,2,3-Trichloropropane	CDHS SRL PT/GCMS

As of 12/02/2002 , this list supersedes all previous lists for this certificate number.
Customers: Please verify the current accreditation standing with the State.

STATE OF CALIFORNIA
DEPARTMENT OF HEALTH SERVICES
ENVIRONMENTAL LABORATORY ACCREDITATION PROGRAM

NELAP - RECOGNIZED

ACCREDITATION

Is hereby granted to

EMAX LABORATORIES, INC.

1835 WEST 205th STREET
TORRANCE, CA 90501

Scope of accreditation is limited to the
"NELAP Fields of Accreditation"
which accompanies this Certificate.

Continued accredited status depends on successful
ongoing participation in the program.

This Certificate is granted in accordance with provisions of
Section 100825, et seq. of the Health and Safety Code.

Certificate No.: **02116CA**

Expiration Date: **08/31/2006**

Effective Date: **08/31/2005**

Richmond, California
subject to forfeiture or revocation

George C. Kulasingam, Ph.D.
Program Chief
Environmental Laboratory Accreditation Program

CALIFORNIA DEPARTMENT OF HEALTH SERVICES

ENVIRONMENTAL LABORATORY ACCREDITATION PROGRAM - NELAP RECOGNIZED

Fields of Accreditation

EMAX LABORATORIES, INC. **Lab Phone** (310) 618-8889

1835 WEST 205th STREET
TORRANCE, CA 90501

Certificate No: 02116CA **Renew Date: 08/31/2006**

102 - Inorganic Chemistry of Drinking Water

102.030	001	EPA 300.0	Bromide
102.030	002	EPA 300.0	Chlorate
102.030	003	EPA 300.0	Chloride
102.030	005	EPA 300.0	Fluoride
102.030	006	EPA 300.0	Nitrate
102.030	007	EPA 300.0	Nitrite
102.030	008	EPA 300.0	Phosphate, Ortho
102.030	010	EPA 300.0	Sulfate
102.040	004	EPA 300.1	Bromate
102.045	001	EPA 314.0	Perchlorate
102.100	001	SM2320B	Alkalinity
102.120	001	SM2340B	Hardness
102.121	001	SM2340C	Hardness
102.130	001	SM2510B	Conductivity
102.140	001	SM2540C	Total Dissolved Solids
102.145	001	EPA 160.1	Total Dissolved Solids
102.150	001	SM4110B	Chloride
102.150	002	SM4110B	Fluoride
102.150	003	SM4110B	Nitrate
102.150	004	SM4110B	Nitrite
102.150	005	SM4110B	Phosphate, Ortho
102.150	006	SM4110B	Sulfate
102.200	001	SM4500-F C	Fluoride
102.260	001	SM5310B	Total Organic Carbon
102.261	001	SM5310B	DOC
102.270	001	SM5540C	Surfactants
102.520	001	EPA 200.7	Calcium
102.520	002	EPA 200.7	Magnesium
102.520	003	EPA 200.7	Potassium
102.520	004	EPA 200.7	Silica
102.520	005	EPA 200.7	Sodium

103 - Toxic Chemical Elements of Drinking Water

103.130	001	EPA 200.7	Aluminum
103.130	002	EPA 200.7	Arsenic
103.130	003	EPA 200.7	Barium
103.130	004	EPA 200.7	Beryllium
103.130	005	EPA 200.7	Cadmium
103.130	007	EPA 200.7	Chromium
103.130	008	EPA 200.7	Copper

103.130	009	EPA 200.7	Iron
103.130	011	EPA 200.7	Manganese
103.130	012	EPA 200.7	Nickel
103.130	015	EPA 200.7	Silver
103.130	017	EPA 200.7	Zinc
103.140	001	EPA 200.8	Aluminum
103.140	002	EPA 200.8	Antimony
103.140	003	EPA 200.8	Arsenic
103.140	004	EPA 200.8	Barium
103.140	005	EPA 200.8	Beryllium
103.140	006	EPA 200.8	Cadmium
103.140	007	EPA 200.8	Chromium
103.140	008	EPA 200.8	Copper
103.140	009	EPA 200.8	Lead
103.140	010	EPA 200.8	Manganese
103.140	011	EPA 200.8	Mercury
103.140	012	EPA 200.8	Nickel
103.140	013	EPA 200.8	Selenium
103.140	014	EPA 200.8	Silver
103.140	015	EPA 200.8	Thallium
103.140	016	EPA 200.8	Zinc
103.161	001	EPA 245.2	Mercury
103.310	001	EPA 218.6	Chromium (VI)

104 - Volatile Organic Chemistry of Drinking Water

104.030	001	EPA 504.1	1,2-Dibromoethane
104.030	002	EPA 504.1	1,2-Dibromo-3-chloropropane
104.040	001	EPA 524.2	Benzene
104.040	002	EPA 524.2	Bromobenzene
104.040	003	EPA 524.2	Bromochloromethane
104.040	006	EPA 524.2	Bromomethane
104.040	007	EPA 524.2	n-Butylbenzene
104.040	008	EPA 524.2	sec-Butylbenzene
104.040	009	EPA 524.2	tert-Butylbenzene
104.040	010	EPA 524.2	Carbon Tetrachloride
104.040	011	EPA 524.2	Chlorobenzene
104.040	012	EPA 524.2	Chloroethane
104.040	014	EPA 524.2	Chloromethane
104.040	015	EPA 524.2	2-Chlorotoluene
104.040	016	EPA 524.2	4-Chlorotoluene
104.040	018	EPA 524.2	Dibromomethane
104.040	019	EPA 524.2	1,3-Dichlorobenzene
104.040	020	EPA 524.2	1,2-Dichlorobenzene
104.040	021	EPA 524.2	1,4-Dichlorobenzene
104.040	022	EPA 524.2	Dichlorodifluoromethane
104.040	023	EPA 524.2	1,1-Dichloroethane
104.040	024	EPA 524.2	1,2-Dichloroethane
104.040	025	EPA 524.2	1,1-Dichloroethene
104.040	026	EPA 524.2	cis-1,2-Dichloroethene

104.040	027	EPA 524.2	trans-1,2-Dichloroethene
104.040	028	EPA 524.2	Dichloromethane
104.040	029	EPA 524.2	1,2-Dichloropropane
104.040	030	EPA 524.2	1,3-Dichloropropane
104.040	031	EPA 524.2	2,2-Dichloropropane
104.040	032	EPA 524.2	1,1-Dichloropropene
104.040	033	EPA 524.2	cis-1,3-Dichloropropene
104.040	034	EPA 524.2	trans-1,3-Dichloropropene
104.040	035	EPA 524.2	Ethylbenzene
104.040	036	EPA 524.2	Hexachlorobutadiene
104.040	037	EPA 524.2	Isopropylbenzene
104.040	038	EPA 524.2	4-Isopropyltoluene
104.040	039	EPA 524.2	Naphthalene
104.040	040	EPA 524.2	Nitrobenzene
104.040	041	EPA 524.2	N-propylbenzene
104.040	042	EPA 524.2	Styrene
104.040	043	EPA 524.2	1,1,1,2-Tetrachloroethane
104.040	044	EPA 524.2	1,1,2,2-Tetrachloroethane
104.040	045	EPA 524.2	Tetrachloroethene
104.040	046	EPA 524.2	Toluene
104.040	047	EPA 524.2	1,2,3-Trichlorobenzene
104.040	048	EPA 524.2	1,2,4-Trichlorobenzene
104.040	049	EPA 524.2	1,1,1-Trichloroethane
104.040	050	EPA 524.2	1,1,2-Trichloroethane
104.040	051	EPA 524.2	Trichloroethene
104.040	052	EPA 524.2	Trichlorofluoromethane
104.040	053	EPA 524.2	1,2,3-Trichloropropane
104.040	054	EPA 524.2	1,2,4-Trimethylbenzene
104.040	055	EPA 524.2	1,3,5-Trimethylbenzene
104.040	056	EPA 524.2	Vinyl Chloride
104.040	057	EPA 524.2	Xylenes, Total
104.045	001	EPA 524.2	Bromodichloromethane
104.045	002	EPA 524.2	Bromoform
104.045	003	EPA 524.2	Chloroform
104.045	004	EPA 524.2	Dibromochloromethane
104.045	005	EPA 524.2	Trihalomethanes
104.050	002	EPA 524.2	Methyl tert-butyl Ether (MTBE)
104.050	004	EPA 524.2	tert-Amyl Methyl Ether (TAME)
104.050	005	EPA 524.2	Ethyl tert-butyl Ether (ETBE)
104.050	006	EPA 524.2	Trichlorotrifluoroethane
108 - Inorganic Chemistry of Wastewater			
108.016	001	EPA 110.2	Color
108.020	001	EPA 120.1	Conductivity
108.030	001	EPA 130.1	Hardness
108.040	001	EPA 130.2	Hardness
108.050	001	EPA 150.1	pH
108.060	001	EPA 160.1	Residue, Filterable
108.070	001	EPA 160.2	Residue, Non-filterable

108.080	001	EPA 160.3	Residue, Total
108.090	001	EPA 160.4	Residue, Volatile
108.100	001	EPA 160.5	Residue, Settleable
108.110	001	EPA 180.1	Turbidity
108.112	001	EPA 200.7	Boron
108.112	002	EPA 200.7	Calcium
108.112	004	EPA 200.7	Magnesium
108.112	005	EPA 200.7	Potassium
108.112	006	EPA 200.7	Silica
108.112	007	EPA 200.7	Sodium
108.120	001	EPA 300.0	Bromide
108.120	002	EPA 300.0	Chloride
108.120	003	EPA 300.0	Fluoride
108.120	004	EPA 300.0	Nitrate
108.120	005	EPA 300.0	Nitrite
108.120	006	EPA 300.0	Nitrate-nitrite, Total
108.120	007	EPA 300.0	Phosphate, Ortho
108.120	008	EPA 300.0	Sulfate
108.130	001	EPA 305.1	Acidity
108.140	001	EPA 310.1	Alkalinity
108.172	001	EPA 330.3	Chlorine Residual, Total
108.180	001	EPA 335.1	Cyanide, amenable
108.181	001	EPA 335.2	Cyanide, Total
108.191	001	EPA 340.2	Fluoride
108.201	001	EPA 350.2	Ammonia
108.212	001	EPA 351.3	Kjeldahl Nitrogen
108.234	001	EPA 353.3	Nitrate-nitrite, Total
108.235	001	EPA 353.3	Nitrate calc.
108.262	001	EPA 365.2	Phosphate, Ortho
108.263	001	EPA 365.2	Phosphorus, Total
108.270	001	EPA 370.1	Dissolved Silica
108.290	001	EPA 376.1	Sulfide
108.291	001	EPA 376.2	Sulfide
108.300	001	EPA 377.1	Sulfite
108.310	001	EPA 405.1	Biochemical Oxygen Demand
108.323	001	EPA 410.4	Chemical Oxygen Demand
108.330	001	EPA 413.1	Oil and Grease
108.340	001	EPA 415.1	Total Organic Carbon
108.350	001	EPA 418.1	Total Recoverable Petroleum Hydrocarbons
108.360	001	EPA 420.1	Phenols, Total
108.370	001	EPA 425.1	Surfactants
108.380	001	EPA 1664	Oil and Grease
108.390	001	SM2130B	Turbidity
108.400	001	SM2310B	Acidity
108.410	001	SM2320B	Alkalinity
108.420	001	SM2340B	Hardness (calc.)
108.421	001	SM2340C	Hardness
108.430	001	SM2510B	Conductivity

108.440	001	SM2540B	Residue, Total
108.441	001	SM2540C	Residue, Filterable
108.442	001	SM2540D	Residue, Non-filterable
108.443	001	SM2540F	Residue, Settleable
108.480	001	SM4500-F C	Fluoride
108.490	001	SM4500-H+ B	pH
108.590	001	SM5210B	Biochemical Oxygen Demand
108.602	001	SM5220D	Chemical Oxygen Demand
108.610	001	SM5310B	Total Organic Carbon
108.630	001	SM5520B	Oil and Grease

109 - Toxic Chemical Elements of Wastewater

109.010	001	EPA 200.7	Aluminum
109.010	002	EPA 200.7	Antimony
109.010	003	EPA 200.7	Arsenic
109.010	004	EPA 200.7	Barium
109.010	005	EPA 200.7	Beryllium
109.010	007	EPA 200.7	Cadmium
109.010	009	EPA 200.7	Chromium
109.010	010	EPA 200.7	Cobalt
109.010	011	EPA 200.7	Copper
109.010	012	EPA 200.7	Iron
109.010	013	EPA 200.7	Lead
109.010	015	EPA 200.7	Manganese
109.010	016	EPA 200.7	Molybdenum
109.010	017	EPA 200.7	Nickel
109.010	019	EPA 200.7	Selenium
109.010	021	EPA 200.7	Silver
109.010	023	EPA 200.7	Thallium
109.010	024	EPA 200.7	Tin
109.010	025	EPA 200.7	Titanium
109.010	026	EPA 200.7	Vanadium
109.010	027	EPA 200.7	Zinc
109.020	001	EPA 200.8	Aluminum
109.020	002	EPA 200.8	Antimony
109.020	003	EPA 200.8	Arsenic
109.020	004	EPA 200.8	Barium
109.020	005	EPA 200.8	Beryllium
109.020	006	EPA 200.8	Cadmium
109.020	007	EPA 200.8	Chromium
109.020	008	EPA 200.8	Cobalt
109.020	010	EPA 200.8	Lead
109.020	011	EPA 200.8	Manganese
109.020	012	EPA 200.8	Molybdenum
109.020	013	EPA 200.8	Nickel
109.020	014	EPA 200.8	Selenium
109.020	015	EPA 200.8	Silver
109.020	016	EPA 200.8	Thallium
109.020	017	EPA 200.8	Vanadium

109.020	018	EPA 200.8	Zinc
109.104	001	EPA 218.6	Chromium (VI)
110 - Volatile Organic Chemistry of Wastewater			
110.040	001	EPA 624	Benzene
110.040	002	EPA 624	Bromodichloromethane
110.040	003	EPA 624	Bromoform
110.040	004	EPA 624	Bromomethane
110.040	005	EPA 624	Carbon Tetrachloride
110.040	006	EPA 624	Chlorobenzene
110.040	007	EPA 624	Chloroethane
110.040	008	EPA 624	2-Chloroethyl Vinyl Ether
110.040	009	EPA 624	Chloroform
110.040	010	EPA 624	Chloromethane
110.040	011	EPA 624	Dibromochloromethane
110.040	012	EPA 624	1,2-Dichlorobenzene
110.040	013	EPA 624	1,3-Dichlorobenzene
110.040	014	EPA 624	1,4-Dichlorobenzene
110.040	015	EPA 624	1,1-Dichloroethane
110.040	016	EPA 624	1,2-Dichloroethane
110.040	017	EPA 624	1,1-Dichloroethene
110.040	018	EPA 624	trans-1,2-Dichloroethene
110.040	019	EPA 624	1,2-Dichloropropane
110.040	020	EPA 624	cis-1,3-Dichloropropene
110.040	021	EPA 624	trans-1,3-Dichloropropene
110.040	022	EPA 624	Ethylbenzene
110.040	023	EPA 624	Methylene Chloride
110.040	024	EPA 624	1,1,2,2-Tetrachloroethane
110.040	025	EPA 624	Tetrachloroethene
110.040	026	EPA 624	Toluene
110.040	027	EPA 624	1,1,1-Trichloroethane
110.040	028	EPA 624	1,1,2-Trichloroethane
110.040	029	EPA 624	Trichloroethene
110.040	030	EPA 624	Trichlorofluoromethane
110.040	031	EPA 624	Vinyl Chloride
110.040	042	EPA 624	Oxygenates
111 - Semi-volatile Organic Chemistry of Wastewater			
111.100	001	EPA 625	Acenaphthene
111.100	002	EPA 625	Acenaphthylene
111.100	003	EPA 625	Anthracene
111.100	004	EPA 625	Benzidine
111.100	005	EPA 625	Benz(a)anthracene
111.100	006	EPA 625	Benzo(b)fluoranthene
111.100	007	EPA 625	Benzo(k)fluoranthene
111.100	008	EPA 625	Benzo(g,h,i)perylene
111.100	009	EPA 625	Benzo(a)pyrene
111.100	010	EPA 625	Benzyl Butyl Phthalate
111.100	011	EPA 625	Bis(2-chloroethoxy)methane
111.100	012	EPA 625	Bis(2-chloroethyl) Ether

111.100	013	EPA 625	Bis(2-chloroisopropyl) Ether
111.100	014	EPA 625	Di(2-ethylhexyl) Phthalate
111.100	015	EPA 625	4-Bromophenyl Phenyl Ether
111.100	016	EPA 625	4-Chloro-3-methylphenol
111.100	017	EPA 625	2-Chloronaphthalene
111.100	018	EPA 625	2-Chlorophenol
111.100	019	EPA 625	4-Chlorophenyl Phenyl Ether
111.100	020	EPA 625	Chrysene
111.100	021	EPA 625	Dibenz(a,h)anthracene
111.100	022	EPA 625	1,2-Dichlorobenzene
111.100	023	EPA 625	1,3-Dichlorobenzene
111.100	024	EPA 625	1,4-Dichlorobenzene
111.100	025	EPA 625	3,3'-Dichlorobenzidine
111.100	026	EPA 625	2,4-Dichlorophenol
111.100	027	EPA 625	Diethyl Phthalate
111.100	028	EPA 625	2,4-Dimethylphenol
111.100	029	EPA 625	Dimethyl Phthalate
111.100	030	EPA 625	Di-n-butyl phthalate
111.100	031	EPA 625	Di-n-octyl phthalate
111.100	032	EPA 625	2,4-Dinitrophenol
111.100	033	EPA 625	2,4-Dinitrotoluene
111.100	034	EPA 625	2,6-Dinitrotoluene
111.100	035	EPA 625	Fluoranthene
111.100	036	EPA 625	Fluorene
111.100	037	EPA 625	Hexachlorobenzene
111.100	038	EPA 625	Hexachlorobutadiene
111.100	039	EPA 625	Hexachlorocyclopentadiene
111.100	040	EPA 625	Hexachloroethane
111.100	041	EPA 625	Indeno(1,2,3-c,d)pyrene
111.100	042	EPA 625	Isophorone
111.100	043	EPA 625	2-Methyl-4,6-dinitrophenol
111.100	044	EPA 625	Naphthalene
111.100	045	EPA 625	Nitrobenzene
111.100	046	EPA 625	2-Nitrophenol
111.100	047	EPA 625	4-Nitrophenol
111.100	048	EPA 625	N-nitrosodimethylamine
111.100	049	EPA 625	N-nitrosodi-n-propylamine
111.100	050	EPA 625	N-nitrosodiphenylamine
111.100	051	EPA 625	Pentachlorophenol
111.100	052	EPA 625	Phenanthrene
111.100	053	EPA 625	Phenol
111.100	054	EPA 625	Pyrene
111.100	055	EPA 625	1,2,4-Trichlorobenzene
111.100	056	EPA 625	2,4,6-Trichlorophenol
111.170	001	EPA 608	Aldrin
111.170	002	EPA 608	a-BHC
111.170	003	EPA 608	b-BHC
111.170	004	EPA 608	d-BHC

111.170	005	EPA 608	g-BHC (Lindane)
111.170	006	EPA 608	Chlordane
111.170	007	EPA 608	4,4'-DDD
111.170	008	EPA 608	4,4'-DDE
111.170	009	EPA 608	4,4'-DDT
111.170	010	EPA 608	Dieldrin
111.170	011	EPA 608	Endosulfan I
111.170	012	EPA 608	Endosulfan II
111.170	013	EPA 608	Endosulfan Sulfate
111.170	014	EPA 608	Endrin
111.170	015	EPA 608	Endrin Aldehyde
111.170	016	EPA 608	Heptachlor
111.170	017	EPA 608	Heptachlor Epoxide
111.170	018	EPA 608	Toxaphene
111.170	019	EPA 608	PCB-1016
111.170	020	EPA 608	PCB-1221
111.170	021	EPA 608	PCB-1232
111.170	022	EPA 608	PCB-1242
111.170	023	EPA 608	PCB-1248
111.170	024	EPA 608	PCB-1254
111.170	025	EPA 608	PCB-1260
111.170	031	EPA 608	PCBs

114 - Inorganic Chemistry of Hazardous Waste

114.010	001	EPA 6010B	Antimony
114.010	002	EPA 6010B	Arsenic
114.010	003	EPA 6010B	Barium
114.010	004	EPA 6010B	Beryllium
114.010	005	EPA 6010B	Cadmium
114.010	006	EPA 6010B	Chromium
114.010	007	EPA 6010B	Cobalt
114.010	008	EPA 6010B	Copper
114.010	009	EPA 6010B	Lead
114.010	010	EPA 6010B	Molybdenum
114.010	011	EPA 6010B	Nickel
114.010	012	EPA 6010B	Selenium
114.010	013	EPA 6010B	Silver
114.010	014	EPA 6010B	Thallium
114.010	015	EPA 6010B	Vanadium
114.010	016	EPA 6010B	Zinc
114.020	001	EPA 6020	Antimony
114.020	002	EPA 6020	Arsenic
114.020	003	EPA 6020	Barium
114.020	004	EPA 6020	Beryllium
114.020	005	EPA 6020	Cadmium
114.020	006	EPA 6020	Chromium
114.020	007	EPA 6020	Cobalt
114.020	008	EPA 6020	Copper
114.020	009	EPA 6020	Lead

114.020	010	EPA 6020	Molybdenum
114.020	011	EPA 6020	Nickel
114.020	012	EPA 6020	Selenium
114.020	013	EPA 6020	Silver
114.020	014	EPA 6020	Thallium
114.020	015	EPA 6020	Vanadium
114.020	016	EPA 6020	Zinc
114.031	001	EPA 7041	Antimony
114.040	001	EPA 7060A	Arsenic
114.081	001	EPA 7131A	Cadmium
114.091	001	EPA 7191	Chromium
114.103	001	EPA 7196A	Chromium (VI)
114.106	001	EPA 7199	Chromium (VI)
114.121	001	EPA 7211	Copper
114.131	001	EPA 7421	Lead
114.140	001	EPA 7470A	Mercury
114.141	001	EPA 7471A	Mercury
114.170	001	EPA 7740	Selenium
114.181	001	EPA 7761	Silver
114.191	001	EPA 7841	Thallium
114.222	001	EPA 9014	Cyanide
114.230	001	EPA 9034	Sulfides, Total
114.240	001	EPA 9040	pH
114.241	001	EPA 9045	pH
114.250	001	EPA 9056	Fluoride
115 - Extraction Test of Hazardous Waste			
115.020	001	EPA 1311	Toxicity Characteristic Leaching Procedure (TCLP)
115.030	001	CCR Chapter11, Article 5, Appendix II	Waste Extraction Test (WET)
115.040	001	EPA 1312	Synthetic Precipitation Leaching Procedure (SPLP)
116 - Volatile Organic Chemistry of Hazardous Waste			
116.010	001	EPA 8011	1,2-Dibromoethane
116.010	002	EPA 8011	Dibromochloropropane
116.020	011	EPA 8015B	Ethylene Glycol
116.030	001	EPA 8015B	Gasoline-range Organics
116.040	002	EPA 8021B	Benzene
116.040	039	EPA 8021B	Ethylbenzene
116.040	041	EPA 8021B	Methyl tert-butyl Ether (MTBE)
116.040	047	EPA 8021B	Toluene
116.040	056	EPA 8021B	Xylenes, Total
116.080	001	EPA 8260B	Acetone
116.080	002	EPA 8260B	Acetonitrile
116.080	003	EPA 8260B	Acrolein
116.080	004	EPA 8260B	Acrylonitrile
116.080	005	EPA 8260B	Allyl Alcohol
116.080	006	EPA 8260B	Allyl Chloride
116.080	007	EPA 8260B	Benzene
116.080	009	EPA 8260B	Bromoacetone
116.080	010	EPA 8260B	Bromochloromethane

116.080	011	EPA 8260B	Bromodichloromethane
116.080	012	EPA 8260B	Bromoform
116.080	013	EPA 8260B	Bromomethane
116.080	014	EPA 8260B	n-Butyl Alcohol
116.080	015	EPA 8260B	Carbon Disulfide
116.080	016	EPA 8260B	Carbon Tetrachloride
116.080	018	EPA 8260B	Chlorobenzene
116.080	019	EPA 8260B	Chloroethane
116.080	020	EPA 8260B	2-Chloroethyl Vinyl Ether
116.080	021	EPA 8260B	Chloroform
116.080	022	EPA 8260B	Chloromethane
116.080	023	EPA 8260B	Chloroprene
116.080	024	EPA 8260B	3-Chloropropionitrile
116.080	025	EPA 8260B	Crotonaldehyde
116.080	026	EPA 8260B	Dibromochloromethane
116.080	027	EPA 8260B	Dibromochloropropane
116.080	028	EPA 8260B	1,2-Dibromoethane
116.080	030	EPA 8260B	Dibromomethane
116.080	031	EPA 8260B	1,2-Dichlorobenzene
116.080	032	EPA 8260B	1,3-Dichlorobenzene
116.080	033	EPA 8260B	1,4-Dichlorobenzene
116.080	034	EPA 8260B	cis-1,4-Dichloro-2-butene
116.080	035	EPA 8260B	trans-1,4-Dichloro-2-butene
116.080	036	EPA 8260B	Dichlorodifluoromethane
116.080	037	EPA 8260B	1,1-Dichloroethane
116.080	038	EPA 8260B	1,2-Dichloroethane
116.080	039	EPA 8260B	1,1-Dichloroethene
116.080	040	EPA 8260B	trans-1,2-Dichloroethene
116.080	041	EPA 8260B	cis-1,2-Dichloroethene
116.080	042	EPA 8260B	1,2-Dichloropropane
116.080	043	EPA 8260B	1,3-Dichloropropane
116.080	044	EPA 8260B	2,2-Dichloropropane
116.080	045	EPA 8260B	1,1-Dichloropropene
116.080	046	EPA 8260B	cis-1,3-Dichloropropene
116.080	047	EPA 8260B	trans-1,3-Dichloropropene
116.080	048	EPA 8260B	1,3-Dichloro-2-propanol
116.080	049	EPA 8260B	1,2,3,4-Diepoxybutane
116.080	050	EPA 8260B	1,4-Dioxane
116.080	053	EPA 8260B	Ethylbenzene
116.080	055	EPA 8260B	Ethyl Methacrylate
116.080	056	EPA 8260B	Hexachlorobutadiene
116.080	058	EPA 8260B	2-Hexanone (MBK)
116.080	059	EPA 8260B	Iodomethane
116.080	060	EPA 8260B	Isobutyl Alcohol
116.080	061	EPA 8260B	Malononitrile
116.080	062	EPA 8260B	Methacrylonitrile
116.080	064	EPA 8260B	Methyl tert-butyl Ether (MTBE)
116.080	065	EPA 8260B	Methylene Chloride

116.080	066	EPA 8260B	Methyl Ethyl Ketone
116.080	067	EPA 8260B	Methyl Methacrylate
116.080	068	EPA 8260B	4-Methyl-2-pentanone (MIBK)
116.080	069	EPA 8260B	Naphthalene
116.080	070	EPA 8260B	Nitrobenzene
116.080	072	EPA 8260B	N-nitrosodi-n-butylamine
116.080	074	EPA 8260B	Pentachloroethane
116.080	075	EPA 8260B	Pentafluorobenzene
116.080	076	EPA 8260B	2-Picoline
116.080	078	EPA 8260B	Propionitrile
116.080	079	EPA 8260B	N-propylamine
116.080	080	EPA 8260B	Pyridine
116.080	081	EPA 8260B	1,1,1,2-Tetrachloroethane
116.080	082	EPA 8260B	1,1,2,2-Tetrachloroethane
116.080	083	EPA 8260B	Tetrachloroethene
116.080	084	EPA 8260B	Toluene
116.080	086	EPA 8260B	1,2,3-Trichlorobenzene
116.080	087	EPA 8260B	1,2,4-Trichlorobenzene
116.080	088	EPA 8260B	1,1,1-Trichloroethane
116.080	089	EPA 8260B	1,1,2-Trichloroethane
116.080	090	EPA 8260B	Trichloroethene
116.080	091	EPA 8260B	Trichlorofluoromethane
116.080	092	EPA 8260B	1,2,3-Trichloropropane
116.080	093	EPA 8260B	Vinyl Acetate
116.080	094	EPA 8260B	Vinyl Chloride
116.080	095	EPA 8260B	Xylenes, Total
116.080	096	EPA 8260B	tert-Amyl Methyl Ether (TAME)
116.080	097	EPA 8260B	tert-Butyl Alcohol (TBA)
116.080	098	EPA 8260B	Ethyl tert-butyl Ether (ETBE)
116.080	099	EPA 8260B	Bromobenzene
116.080	100	EPA 8260B	n-Butylbenzene
116.080	101	EPA 8260B	sec-Butylbenzene
116.080	102	EPA 8260B	tert-Butylbenzene
116.080	103	EPA 8260B	2-Chlorotoluene
116.080	104	EPA 8260B	4-Chlorotoluene
116.080	105	EPA 8260B	Isopropylbenzene
116.080	106	EPA 8260B	N-propylbenzene
116.080	107	EPA 8260B	Styrene
116.080	108	EPA 8260B	1,2,4-Trimethylbenzene
116.080	109	EPA 8260B	1,3,5-Trimethylbenzene
116.100	001	LUFT GC/MS	Total Petroleum Hydrocarbons - Gasoline
116.100	002	LUFT GC/MS	Benzene
116.100	003	LUFT GC/MS	Toluene
116.100	004	LUFT GC/MS	Xylenes
116.100	005	LUFT GC/MS	Methyl tert-butyl Ether (MTBE)
116.110	001	LUFT	Total Petroleum Hydrocarbons - Gasoline

117 - Semi-volatile Organic Chemistry of Hazardous Waste

117.010	001	EPA 8015B	Diesel-range Total Petroleum Hydrocarbons

117.015	001	LUFT GC/MS	Diesel-range Total Petroleum Hydrocarbons
117.016	001	LUFT	Diesel-range Total Petroleum Hydrocarbons
117.017	001	EPA 418.1	TRPH Screening
117.110	001	EPA 8270C	Acenaphthene
117.110	002	EPA 8270C	Acenaphthylene
117.110	003	EPA 8270C	Acetophenone
117.110	004	EPA 8270C	2-Acetylaminofluorene
117.110	005	EPA 8270C	1-Acetyl-2-thiourea
117.110	006	EPA 8270C	4-Aminobiphenyl
117.110	007	EPA 8270C	Aniline
117.110	008	EPA 8270C	Anthracene
117.110	010	EPA 8270C	Benzidine
117.110	011	EPA 8270C	Benz(a)anthracene
117.110	012	EPA 8270C	Benzo(b)fluoranthene
117.110	013	EPA 8270C	Benzo(k)fluoranthene
117.110	014	EPA 8270C	Benzo(g,h,i)perylene
117.110	015	EPA 8270C	Benzo(a)pyrene
117.110	016	EPA 8270C	Benzoic Acid
117.110	018	EPA 8270C	Benzyl Alcohol
117.110	019	EPA 8270C	Benzyl Butyl Phthalate
117.110	020	EPA 8270C	Bis(2-chloroethoxy)methane
117.110	021	EPA 8270C	Bis(2-chloroethyl) Ether
117.110	022	EPA 8270C	Bis(2-chloroisopropyl) Ether
117.110	023	EPA 8270C	Di(2-ethylhexyl) Phthalate
117.110	024	EPA 8270C	4-Bromophenyl Phenyl Ether
117.110	025	EPA 8270C	Carbazole
117.110	026	EPA 8270C	4-Chloroaniline
117.110	027	EPA 8270C	4-Chloro-3-methylphenol
117.110	029	EPA 8270C	2-Chloronaphthalene
117.110	030	EPA 8270C	2-Chlorophenol
117.110	031	EPA 8270C	4-Chlorophenyl Phenyl Ether
117.110	032	EPA 8270C	Chrysene
117.110	033	EPA 8270C	2-Cyclohexyl-4,6-dinitrophenol
117.110	034	EPA 8270C	2,4-Diaminotoluene
117.110	036	EPA 8270C	Dibenz(a,h)anthracene
117.110	037	EPA 8270C	Dibenzofuran
117.110	038	EPA 8270C	Dibenzo(a,e)pyrene
117.110	039	EPA 8270C	1,2-Dichlorobenzene
117.110	040	EPA 8270C	1,3-Dichlorobenzene
117.110	041	EPA 8270C	1,4-Dichlorobenzene
117.110	042	EPA 8270C	3,3'-Dichlorobenzidine
117.110	043	EPA 8270C	2,4-Dichlorophenol
117.110	044	EPA 8270C	2,6-Dichlorophenol
117.110	045	EPA 8270C	Diethyl Phthalate
117.110	050	EPA 8270C	p-Dimethylaminoazobenzene
117.110	051	EPA 8270C	7,12-Dimethylbenz(a)anthracene
117.110	052	EPA 8270C	a,a-Dimethylphenethylamine
117.110	053	EPA 8270C	2,4-Dimethylphenol

117.110	054	EPA 8270C	Dimethyl Phthalate
117.110	055	EPA 8270C	Di-n-butyl phthalate
117.110	056	EPA 8270C	Di-n-octyl phthalate
117.110	060	EPA 8270C	2,4-Dinitrophenol
117.110	061	EPA 8270C	2,4-Dinitrotoluene
117.110	062	EPA 8270C	2,6-Dinitrotoluene
117.110	063	EPA 8270C	Diphenylamine
117.110	064	EPA 8270C	1,2-Diphenylhydrazine
117.110	066	EPA 8270C	Ethyl Methanesulfonate
117.110	067	EPA 8270C	Fluoranthene
117.110	068	EPA 8270C	Fluorene
117.110	069	EPA 8270C	Hexachlorobenzene
117.110	070	EPA 8270C	Hexachlorobutadiene
117.110	071	EPA 8270C	Hexachlorocyclopentadiene
117.110	072	EPA 8270C	Hexachloroethane
117.110	073	EPA 8270C	Hexachlorophene
117.110	074	EPA 8270C	Hexachloropropene
117.110	075	EPA 8270C	Indeno(1,2,3-c,d)pyrene
117.110	076	EPA 8270C	Isophorone
117.110	077	EPA 8270C	Isosafrole
117.110	078	EPA 8270C	Maleic Anhydride
117.110	079	EPA 8270C	3-Methylcholanthrene
117.110	080	EPA 8270C	2-Methyl-4,6-dinitrophenol
117.110	082	EPA 8270C	Methyl Methanesulfonate
117.110	083	EPA 8270C	2-Methylnaphthalene
117.110	084	EPA 8270C	2-Methylphenol
117.110	085	EPA 8270C	3-Methylphenol
117.110	086	EPA 8270C	4-Methylphenol
117.110	087	EPA 8270C	Naphthalene
117.110	088	EPA 8270C	1,4-Naphthoquinone
117.110	089	EPA 8270C	1-Naphthylamine
117.110	090	EPA 8270C	2-Naphthylamine
117.110	092	EPA 8270C	2-Nitroaniline
117.110	093	EPA 8270C	3-Nitroaniline
117.110	094	EPA 8270C	4-Nitroaniline
117.110	095	EPA 8270C	Nitrobenzene
117.110	096	EPA 8270C	2-Nitrophenol
117.110	097	EPA 8270C	4-Nitrophenol
117.110	098	EPA 8270C	N-nitrosodi-n-butylamine
117.110	099	EPA 8270C	N-nitrosodiethylamine
117.110	100	EPA 8270C	N-nitrosodimethylamine
117.110	101	EPA 8270C	N-nitrosodi-n-propylamine
117.110	102	EPA 8270C	N-nitrosodiphenylamine
117.110	103	EPA 8270C	N-nitrosomethylethylamine
117.110	104	EPA 8270C	N-nitrosomorpholine
117.110	105	EPA 8270C	N-nitrosopiperidine
117.110	106	EPA 8270C	N-nitrosopyrrolidine
117.110	107	EPA 8270C	5-Nitro-o-toluidine

117.110	108	EPA 8270C	Pentachlorobenzene
117.110	109	EPA 8270C	Pentachloronitrobenzene
117.110	110	EPA 8270C	Pentachlorophenol
117.110	111	EPA 8270C	Phenacetin
117.110	112	EPA 8270C	Phenanthrene
117.110	113	EPA 8270C	Phenol
117.110	116	EPA 8270C	2-Picoline
117.110	119	EPA 8270C	Pyrene
117.110	120	EPA 8270C	Pyridine
117.110	122	EPA 8270C	Safrole
117.110	124	EPA 8270C	1,2,4,5-Tetrachlorobenzene
117.110	125	EPA 8270C	2,3,4,6-Tetrachlorophenol
117.110	128	EPA 8270C	o-Toluidine
117.110	129	EPA 8270C	1,2,4-Trichlorobenzene
117.110	130	EPA 8270C	2,4,5-Trichlorophenol
117.110	131	EPA 8270C	2,4,6-Trichlorophenol
117.110	132	EPA 8270C	1,3,5-Trinitrobenzene
117.111	025	EPA 8270C	Dimethoate
117.111	026	EPA 8270C	Dinoseb
117.111	036	EPA 8270C	Famphur
117.111	039	EPA 8270C	Isodrin
117.111	040	EPA 8270C	Kepone
117.111	054	EPA 8270C	Parathion Ethyl
117.111	055	EPA 8270C	Parathion Methyl
117.111	056	EPA 8270C	Phorate
117.111	058	EPA 8270C	Sulfotepp
117.111	061	EPA 8270C	O,O,O-triethyl Phosphorothioate
117.140	001	EPA 8310	Acenaphthene
117.140	002	EPA 8310	Acenaphthylene
117.140	003	EPA 8310	Anthracene
117.140	004	EPA 8310	Benz(a)anthracene
117.140	005	EPA 8310	Benzo(a)pyrene
117.140	006	EPA 8310	Benzo(b)fluoranthene
117.140	007	EPA 8310	Benzo(k)fluoranthene
117.140	008	EPA 8310	Benzo(g,h,i)perylene
117.140	009	EPA 8310	Chrysene
117.140	010	EPA 8310	Dibenz(a,h)anthracene
117.140	011	EPA 8310	Fluoranthene
117.140	012	EPA 8310	Fluorene
117.140	013	EPA 8310	Indeno(1,2,3-c,d)pyrene
117.140	014	EPA 8310	Naphthalene
117.140	015	EPA 8310	Phenanthrene
117.140	016	EPA 8310	Pyrene
117.170	001	EPA 8330	4-Amino-2,6-dinitrotoluene
117.170	002	EPA 8330	2-Amino-4,6-dinitrotoluene
117.170	003	EPA 8330	1,3-Dinitrobenzene
117.170	004	EPA 8330	2,4-Dinitrotoluene
117.170	005	EPA 8330	2,6-Dinitrotoluene

117.170	006	EPA 8330	Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)
117.170	007	EPA 8330	Methyl-2,4,6-trinitrophenylnitramine
117.170	008	EPA 8330	Nitrobenzene
117.170	009	EPA 8330	2-Nitrotoluene
117.170	010	EPA 8330	3-Nitrotoluene
117.170	011	EPA 8330	4-Nitrotoluene
117.170	012	EPA 8330	Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine
117.170	013	EPA 8330	1,3,5-Trinitrobenzene
117.170	014	EPA 8330	2,4,6-Trinitrotoluene
117.190	001	EPA 8332	Nitroglycerine
117.210	001	EPA 8081A	Aldrin
117.210	002	EPA 8081A	a-BHC
117.210	003	EPA 8081A	b-BHC
117.210	004	EPA 8081A	d-BHC
117.210	005	EPA 8081A	g-BHC (Lindane)
117.210	007	EPA 8081A	a-Chlordane
117.210	008	EPA 8081A	g-Chlordane
117.210	009	EPA 8081A	Chlordane (tech.)
117.210	010	EPA 8081A	Chlorobenzilate
117.210	011	EPA 8081A	Chloroneb
117.210	012	EPA 8081A	Chlorothalonil
117.210	013	EPA 8081A	4,4'-DDD
117.210	014	EPA 8081A	4,4'-DDE
117.210	015	EPA 8081A	4,4'-DDT
117.210	016	EPA 8081A	Diallate
117.210	020	EPA 8081A	Dieldrin
117.210	021	EPA 8081A	Endosulfan I
117.210	022	EPA 8081A	Endosulfan II
117.210	023	EPA 8081A	Endosulfan Sulfate
117.210	024	EPA 8081A	Endrin
117.210	025	EPA 8081A	Endrin Aldehyde
117.210	026	EPA 8081A	Endrin Ketone
117.210	027	EPA 8081A	Heptachlor
117.210	028	EPA 8081A	Heptachlor Epoxide
117.210	029	EPA 8081A	Hexachlorobenzene
117.210	033	EPA 8081A	Methoxychlor
117.210	039	EPA 8081A	Toxaphene
117.220	001	EPA 8082	PCB-1016
117.220	002	EPA 8082	PCB-1221
117.220	003	EPA 8082	PCB-1232
117.220	004	EPA 8082	PCB-1242
117.220	005	EPA 8082	PCB-1248
117.220	006	EPA 8082	PCB-1254
117.220	007	EPA 8082	PCB-1260
117.220	008	EPA 8082	2-Chlorobiphenyl
117.220	009	EPA 8082	2,3-Dichlorobiphenyl
117.220	010	EPA 8082	2,2',5-Trichlorobiphenyl
117.220	011	EPA 8082	2,4',5-Trichlorobiphenyl

117.220	012	EPA 8082	2,2',3,5'-Tetrachlorobiphenyl
117.220	013	EPA 8082	2,2',5,5'-Tetrachlorobiphenyl
117.220	014	EPA 8082	2,3',4,4'-Tetrachlorobiphenyl
117.220	015	EPA 8082	2,2',3,4,5'-Pentachlorobiphenyl
117.220	016	EPA 8082	2,2',4,5,5'-Pentachlorobiphenyl
117.220	017	EPA 8082	2,3,3',4',6-Pentachlorobiphenyl
117.220	018	EPA 8082	2,2',3,4,4',5'-Hexachlorobiphenyl
117.220	019	EPA 8082	2,2',3,4,5,5'-Hexachlorobiphenyl
117.220	020	EPA 8082	2,2',3,5,5',6-Hexachlorobiphenyl
117.220	021	EPA 8082	2,2',4,4',5,5'-Hexachlorobiphenyl
117.220	022	EPA 8082	2,2',3,3',4,4',5-Heptachlorobiphenyl
117.220	023	EPA 8082	2,2',3,4,4',5,5'-Heptachlorobiphenyl
117.220	024	EPA 8082	2,2',3,4,4',5',6-Heptachlorobiphenyl
117.220	025	EPA 8082	2,2',3,4',5,5',6-Heptachlorobiphenyl
117.220	026	EPA 8082	2,2',3,3',4,4',5,5',6-Nonachlorobiphenyl
117.240	001	EPA 8141A	Atrazine
117.240	002	EPA 8141A	Azinphos Methyl
117.240	004	EPA 8141A	Chlorfenvinphos
117.240	005	EPA 8141A	Chlorpyrifos
117.240	006	EPA 8141A	Chlorpyrifos Methyl
117.240	007	EPA 8141A	Demeton-O
117.240	008	EPA 8141A	Demeton-S
117.240	009	EPA 8141A	Diazinon
117.240	010	EPA 8141A	Dimethoate
117.240	012	EPA 8141A	EPN
117.240	013	EPA 8141A	Ethion
117.240	014	EPA 8141A	Famphur
117.240	015	EPA 8141A	Malathion
117.240	016	EPA 8141A	Mevinphos
117.240	017	EPA 8141A	Naled
117.240	018	EPA 8141A	Parathion Ethyl
117.240	019	EPA 8141A	Parathion Methyl
117.240	020	EPA 8141A	Phorate
117.240	022	EPA 8141A	Ronnel
117.240	024	EPA 8141A	Sulfotepp
117.240	026	EPA 8141A	Thionazin
117.250	001	EPA 8151A	2,4-D
117.250	002	EPA 8151A	2,4-DB
117.250	003	EPA 8151A	2,4,5-T
117.250	004	EPA 8151A	2,4,5-TP
117.250	006	EPA 8151A	Dalapon
117.250	007	EPA 8151A	Dichlorprop
117.250	008	EPA 8151A	Dinoseb
117.250	009	EPA 8151A	MCPA
117.250	010	EPA 8151A	MCPP
117.250	011	EPA 8151A	4-Nitrophenol
117.250	012	EPA 8151A	Pentachlorophenol
117.250	013	EPA 8151A	Picloram

117.250	014	EPA 8151A	Dicamba
117.250	015	EPA 8151A	3,5-Dichlorobenzoic Acid
117.250	016	EPA 8151A	Acifluorfen
117.250	017	EPA 8151A	Bentazon
117.250	018	EPA 8151A	Chloramben
117.250	019	EPA 8151A	DCPA

120 - Physical Properties of Hazardous Waste

120.010	001	EPA 1010	Ignitability
120.040	001	Section 7.3 SW-846	Reactive Cyanide
120.050	001	Section 7.3 SW-846	Reactive Sulfide
120.070	001	EPA 9040B	Corrosivity - pH Determination
120.080	001	EPA 9045C	Corrosivity - pH Determination

STATE OF CALIFORNIA
DEPARTMENT OF HEALTH SERVICES
ENVIRONMENTAL LABORATORY ACCREDITATION PROGRAM

NELAP - RECOGNIZED

ACCREDITATION

Is hereby granted to

EMAX LABORATORIES, INC.

1835 WEST 205th STREET
TORRANCE, CA 90501

Scope of accreditation is limited to the
"NELAP Fields of Accreditation"
which accompanies this Certificate.

Continued accredited status depends on successful
ongoing participation in the program.

This Certificate is granted in accordance with provisions of
Section 100825, et seq. of the Health and Safety Code.

Certificate No.: **02116CA**
Expiration Date: **08/31/2007**
Effective Date: **08/31/2006**

Richmond, California
subject to forfeiture or revocation

George C. Kulasingam, Ph.D.
Program Chief
Environmental Laboratory Accreditation Program

CALIFORNIA DEPARTMENT OF HEALTH SERVICES

ENVIRONMENTAL LABORATORY ACCREDITATION PROGRAM - NELAP RECOGNIZED

Fields of Accreditation

EMAX LABORATORIES, INC. **Lab Phone** (310) 618-8889

1835 WEST 205th STREET
TORRANCE, CA 90501

Certificate No: 02116CA **Renew Date: 08/31/2007**

102 - Inorganic Chemistry of Drinking Water

102.030	001	EPA 300.0	Bromide
102.030	002	EPA 300.0	Chlorate
102.030	003	EPA 300.0	Chloride
102.030	005	EPA 300.0	Fluoride
102.030	006	EPA 300.0	Nitrate
102.030	007	EPA 300.0	Nitrite
102.030	008	EPA 300.0	Phosphate, Ortho
102.030	010	EPA 300.0	Sulfate
102.040	004	EPA 300.1	Bromate
102.045	001	EPA 314.0	Perchlorate
102.100	001	SM2320B	Alkalinity
102.120	001	SM2340B	Hardness
102.121	001	SM2340C	Hardness
102.130	001	SM2510B	Conductivity
102.140	001	SM2540C	Total Dissolved Solids
102.145	001	EPA 160.1	Total Dissolved Solids
102.150	001	SM4110B	Chloride
102.150	002	SM4110B	Fluoride
102.150	003	SM4110B	Nitrate
102.150	004	SM4110B	Nitrite
102.150	005	SM4110B	Phosphate, Ortho
102.150	006	SM4110B	Sulfate
102.200	001	SM4500-F C	Fluoride
102.260	001	SM5310B	Total Organic Carbon
102.261	001	SM5310B	DOC
102.270	001	SM5540C	Surfactants
102.520	001	EPA 200.7	Calcium
102.520	002	EPA 200.7	Magnesium
102.520	003	EPA 200.7	Potassium
102.520	004	EPA 200.7	Silica
102.520	005	EPA 200.7	Sodium

103 - Toxic Chemical Elements of Drinking Water

103.130	001	EPA 200.7	Aluminum

103.130	003	EPA 200.7	Barium
103.130	004	EPA 200.7	Beryllium
103.130	005	EPA 200.7	Cadmium
103.130	007	EPA 200.7	Chromium
103.130	008	EPA 200.7	Copper
103.130	009	EPA 200.7	Iron
103.130	011	EPA 200.7	Manganese
103.130	012	EPA 200.7	Nickel
103.130	015	EPA 200.7	Silver
103.130	017	EPA 200.7	Zinc
103.140	001	EPA 200.8	Aluminum
103.140	002	EPA 200.8	Antimony
103.140	003	EPA 200.8	Arsenic
103.140	004	EPA 200.8	Barium
103.140	005	EPA 200.8	Beryllium
103.140	006	EPA 200.8	Cadmium
103.140	007	EPA 200.8	Chromium
103.140	008	EPA 200.8	Copper
103.140	009	EPA 200.8	Lead
103.140	010	EPA 200.8	Manganese
103.140	011	EPA 200.8	Mercury
103.140	012	EPA 200.8	Nickel
103.140	013	EPA 200.8	Selenium
103.140	014	EPA 200.8	Silver
103.140	015	EPA 200.8	Thallium
103.140	016	EPA 200.8	Zinc
103.161	001	EPA 245.2	Mercury

104 - Volatile Organic Chemistry of Drinking Water

104.030	001	EPA 504.1	1,2-Dibromoethane
104.030	002	EPA 504.1	1,2-Dibromo-3-chloropropane
104.040	000	EPA 524.2	Volatile Organic Compounds
104.040	001	EPA 524.2	Benzene
104.040	002	EPA 524.2	Bromobenzene
104.040	003	EPA 524.2	Bromochloromethane
104.040	006	EPA 524.2	Bromomethane
104.040	007	EPA 524.2	n-Butylbenzene
104.040	008	EPA 524.2	sec-Butylbenzene
104.040	009	EPA 524.2	tert-Butylbenzene
104.040	010	EPA 524.2	Carbon Tetrachloride
104.040	011	EPA 524.2	Chlorobenzene
104.040	012	EPA 524.2	Chloroethane

104.040	014	EPA 524.2	Chloromethane
104.040	015	EPA 524.2	2-Chlorotoluene
104.040	016	EPA 524.2	4-Chlorotoluene
104.040	018	EPA 524.2	Dibromomethane
104.040	019	EPA 524.2	1,3-Dichlorobenzene
104.040	020	EPA 524.2	1,2-Dichlorobenzene
104.040	021	EPA 524.2	1,4-Dichlorobenzene
104.040	022	EPA 524.2	Dichlorodifluoromethane
104.040	023	EPA 524.2	1,1-Dichloroethane
104.040	024	EPA 524.2	1,2-Dichloroethane
104.040	025	EPA 524.2	1,1-Dichloroethene
104.040	026	EPA 524.2	cis-1,2-Dichloroethene
104.040	027	EPA 524.2	trans-1,2-Dichloroethene
104.040	028	EPA 524.2	Dichloromethane
104.040	029	EPA 524.2	1,2-Dichloropropane
104.040	030	EPA 524.2	1,3-Dichloropropane
104.040	031	EPA 524.2	2,2-Dichloropropane
104.040	032	EPA 524.2	1,1-Dichloropropene
104.040	033	EPA 524.2	cis-1,3-Dichloropropene
104.040	034	EPA 524.2	trans-1,3-Dichloropropene
104.040	035	EPA 524.2	Ethylbenzene
104.040	036	EPA 524.2	Hexachlorobutadiene
104.040	037	EPA 524.2	Isopropylbenzene
104.040	038	EPA 524.2	4-Isopropyltoluene
104.040	039	EPA 524.2	Naphthalene
104.040	040	EPA 524.2	Nitrobenzene
104.040	041	EPA 524.2	N-propylbenzene
104.040	042	EPA 524.2	Styrene
104.040	043	EPA 524.2	1,1,1,2-Tetrachloroethane
104.040	044	EPA 524.2	1,1,2,2-Tetrachloroethane
104.040	045	EPA 524.2	Tetrachloroethene
104.040	046	EPA 524.2	Toluene
104.040	047	EPA 524.2	1,2,3-Trichlorobenzene
104.040	048	EPA 524.2	1,2,4-Trichlorobenzene
104.040	049	EPA 524.2	1,1,1-Trichloroethane
104.040	050	EPA 524.2	1,1,2-Trichloroethane
104.040	051	EPA 524.2	Trichloroethene
104.040	052	EPA 524.2	Trichlorofluoromethane
104.040	053	EPA 524.2	1,2,3-Trichloropropane
104.040	054	EPA 524.2	1,2,4-Trimethylbenzene
104.040	055	EPA 524.2	1,3,5-Trimethylbenzene

104.040	056	EPA 524.2	Vinyl Chloride
104.040	057	EPA 524.2	Xylenes, Total
104.045	001	EPA 524.2	Bromodichloromethane
104.045	002	EPA 524.2	Bromoform
104.045	003	EPA 524.2	Chloroform
104.045	004	EPA 524.2	Dibromochloromethane
104.045	005	EPA 524.2	Trihalomethanes
104.050	002	EPA 524.2	Methyl tert-butyl Ether (MTBE)
104.050	004	EPA 524.2	tert-Amyl Methyl Ether (TAME)
104.050	005	EPA 524.2	Ethyl tert-butyl Ether (ETBE)
104.050	006	EPA 524.2	Trichlorotrifluoroethane

108 - Inorganic Chemistry of Wastewater

108.016	001	EPA 110.2	Color
108.020	001	EPA 120.1	Conductivity
108.030	001	EPA 130.1	Hardness
108.040	001	EPA 130.2	Hardness
108.050	001	EPA 150.1	pH
108.060	001	EPA 160.1	Residue, Filterable
108.070	001	EPA 160.2	Residue, Non-filterable
108.080	001	EPA 160.3	Residue, Total
108.090	001	EPA 160.4	Residue, Volatile
108.100	001	EPA 160.5	Residue, Settleable
108.110	001	EPA 180.1	Turbidity
108.112	001	EPA 200.7	Boron
108.112	002	EPA 200.7	Calcium
108.112	004	EPA 200.7	Magnesium
108.112	005	EPA 200.7	Potassium
108.112	006	EPA 200.7	Silica
108.112	007	EPA 200.7	Sodium
108.120	001	EPA 300.0	Bromide
108.120	002	EPA 300.0	Chloride
108.120	003	EPA 300.0	Fluoride
108.120	004	EPA 300.0	Nitrate
108.120	005	EPA 300.0	Nitrite
108.120	006	EPA 300.0	Nitrate-nitrite, Total
108.120	007	EPA 300.0	Phosphate, Ortho
108.120	008	EPA 300.0	Sulfate
108.130	001	EPA 305.1	Acidity
108.140	001	EPA 310.1	Alkalinity
108.172	001	EPA 330.3	Chlorine Residual, Total
108.181	001	EPA 335.2	Cyanide, Total

108.191	001	EPA 340.2	Fluoride
108.201	001	EPA 350.2	Ammonia
108.212	001	EPA 351.3	Kjeldahl Nitrogen
108.234	001	EPA 353.3	Nitrate-nitrite, Total
108.235	001	EPA 353.3	Nitrate calc.
108.262	001	EPA 365.2	Phosphate, Ortho
108.263	001	EPA 365.2	Phosphorus, Total
108.270	001	EPA 370.1	Dissolved Silica
108.290	001	EPA 376.1	Sulfide
108.291	001	EPA 376.2	Sulfide
108.300	001	EPA 377.1	Sulfite
108.310	001	EPA 405.1	Biochemical Oxygen Demand
108.323	001	EPA 410.4	Chemical Oxygen Demand
108.330	001	EPA 413.1	Oil and Grease
108.340	001	EPA 415.1	Total Organic Carbon
108.350	001	EPA 418.1	Total Recoverable Petroleum Hydrocarbons
108.360	001	EPA 420.1	Phenols, Total
108.370	001	EPA 425.1	Surfactants
108.380	001	EPA 1664	Oil and Grease
108.390	001	SM2130B	Turbidity
108.400	001	SM2310B	Acidity
108.410	001	SM2320B	Alkalinity
108.420	001	SM2340B	Hardness (calc.)
108.421	001	SM2340C	Hardness
108.430	001	SM2510B	Conductivity
108.440	001	SM2540B	Residue, Total
108.441	001	SM2540C	Residue, Filterable
108.442	001	SM2540D	Residue, Non-filterable
108.443	001	SM2540F	Residue, Settleable
108.480	001	SM4500-F C	Fluoride
108.490	001	SM4500-H+ B	pH
108.590	001	SM5210B	Biochemical Oxygen Demand
108.602	001	SM5220D	Chemical Oxygen Demand
108.610	001	SM5310B	Total Organic Carbon
108.630	001	SM5520B	Oil and Grease

109 - Toxic Chemical Elements of Wastewater

109.010	001	EPA 200.7	Aluminum
109.010	002	EPA 200.7	Antimony
109.010	003	EPA 200.7	Arsenic
109.010	004	EPA 200.7	Barium
109.010	005	EPA 200.7	Beryllium

109.010	007	EPA 200.7	Cadmium
109.010	009	EPA 200.7	Chromium
109.010	010	EPA 200.7	Cobalt
109.010	011	EPA 200.7	Copper
109.010	012	EPA 200.7	Iron
109.010	013	EPA 200.7	Lead
109.010	015	EPA 200.7	Manganese
109.010	016	EPA 200.7	Molybdenum
109.010	017	EPA 200.7	Nickel
109.010	019	EPA 200.7	Selenium
109.010	021	EPA 200.7	Silver
109.010	023	EPA 200.7	Thallium
109.010	024	EPA 200.7	Tin
109.010	025	EPA 200.7	Titanium
109.010	026	EPA 200.7	Vanadium
109.010	027	EPA 200.7	Zinc
109.020	001	EPA 200.8	Aluminum
109.020	002	EPA 200.8	Antimony
109.020	003	EPA 200.8	Arsenic
109.020	004	EPA 200.8	Barium
109.020	005	EPA 200.8	Beryllium
109.020	006	EPA 200.8	Cadmium
109.020	007	EPA 200.8	Chromium
109.020	008	EPA 200.8	Cobalt
109.020	009	EPA 200.8	Copper
109.020	010	EPA 200.8	Lead
109.020	011	EPA 200.8	Manganese
109.020	012	EPA 200.8	Molybdenum
109.020	013	EPA 200.8	Nickel
109.020	014	EPA 200.8	Selenium
109.020	015	EPA 200.8	Silver
109.020	016	EPA 200.8	Thallium
109.020	017	EPA 200.8	Vanadium
109.020	018	EPA 200.8	Zinc
109.104	001	EPA 218.6	Chromium (VI)

110 - Volatile Organic Chemistry of Wastewater

110.040	001	EPA 624	Benzene
110.040	002	EPA 624	Bromodichloromethane
110.040	003	EPA 624	Bromoform
110.040	004	EPA 624	Bromomethane
110.040	005	EPA 624	Carbon Tetrachloride

110.040	006	EPA 624	Chlorobenzene
110.040	007	EPA 624	Chloroethane
110.040	008	EPA 624	2-Chloroethyl Vinyl Ether
110.040	009	EPA 624	Chloroform
110.040	010	EPA 624	Chloromethane
110.040	011	EPA 624	Dibromochloromethane
110.040	012	EPA 624	1,2-Dichlorobenzene
110.040	013	EPA 624	1,3-Dichlorobenzene
110.040	014	EPA 624	1,4-Dichlorobenzene
110.040	015	EPA 624	1,1-Dichloroethane
110.040	016	EPA 624	1,2-Dichloroethane
110.040	017	EPA 624	1,1-Dichloroethene
110.040	018	EPA 624	trans-1,2-Dichloroethene
110.040	019	EPA 624	1,2-Dichloropropane
110.040	020	EPA 624	cis-1,3-Dichloropropene
110.040	021	EPA 624	trans-1,3-Dichloropropene
110.040	022	EPA 624	Ethylbenzene
110.040	023	EPA 624	Methylene Chloride
110.040	024	EPA 624	1,1,2,2-Tetrachloroethane
110.040	025	EPA 624	Tetrachloroethene
110.040	026	EPA 624	Toluene
110.040	027	EPA 624	1,1,1-Trichloroethane
110.040	028	EPA 624	1,1,2-Trichloroethane
110.040	029	EPA 624	Trichloroethene
110.040	030	EPA 624	Trichlorofluoromethane
110.040	031	EPA 624	Vinyl Chloride
110.040	042	EPA 624	Oxygenates

111 - Semi-volatile Organic Chemistry of Wastewater

111.100	001	EPA 625	Acenaphthene
111.100	002	EPA 625	Acenaphthylene
111.100	003	EPA 625	Anthracene
111.100	004	EPA 625	Benzidine
111.100	005	EPA 625	Benz(a)anthracene
111.100	006	EPA 625	Benzo(b)fluoranthene
111.100	007	EPA 625	Benzo(k)fluoranthene
111.100	008	EPA 625	Benzo(g,h,i)perylene
111.100	009	EPA 625	Benzo(a)pyrene
111.100	010	EPA 625	Benzyl Butyl Phthalate
111.100	011	EPA 625	Bis(2-chloroethoxy)methane
111.100	012	EPA 625	Bis(2-chloroethyl) Ether
111.100	013	EPA 625	Bis(2-chloroisopropyl) Ether

111.100	014	EPA 625	Di(2-ethylhexyl) Phthalate
111.100	015	EPA 625	4-Bromophenyl Phenyl Ether
111.100	016	EPA 625	4-Chloro-3-methylphenol
111.100	017	EPA 625	2-Chloronaphthalene
111.100	018	EPA 625	2-Chlorophenol
111.100	019	EPA 625	4-Chlorophenyl Phenyl Ether
111.100	020	EPA 625	Chrysene
111.100	021	EPA 625	Dibenz(a,h)anthracene
111.100	022	EPA 625	1,2-Dichlorobenzene
111.100	023	EPA 625	1,3-Dichlorobenzene
111.100	024	EPA 625	1,4-Dichlorobenzene
111.100	025	EPA 625	3,3'-Dichlorobenzidine
111.100	026	EPA 625	2,4-Dichlorophenol
111.100	027	EPA 625	Diethyl Phthalate
111.100	028	EPA 625	2,4-Dimethylphenol
111.100	029	EPA 625	Dimethyl Phthalate
111.100	030	EPA 625	Di-n-butyl phthalate
111.100	031	EPA 625	Di-n-octyl phthalate
111.100	032	EPA 625	2,4-Dinitrophenol
111.100	033	EPA 625	2,4-Dinitrotoluene
111.100	034	EPA 625	2,6-Dinitrotoluene
111.100	035	EPA 625	Fluoranthene
111.100	036	EPA 625	Fluorene
111.100	037	EPA 625	Hexachlorobenzene
111.100	038	EPA 625	Hexachlorobutadiene
111.100	039	EPA 625	Hexachlorocyclopentadiene
111.100	040	EPA 625	Hexachloroethane
111.100	041	EPA 625	Indeno(1,2,3-c,d)pyrene
111.100	042	EPA 625	Isophorone
111.100	043	EPA 625	2-Methyl-4,6-dinitrophenol
111.100	044	EPA 625	Naphthalene
111.100	045	EPA 625	Nitrobenzene
111.100	046	EPA 625	2-Nitrophenol
111.100	047	EPA 625	4-Nitrophenol
111.100	048	EPA 625	N-nitrosodimethylamine
111.100	049	EPA 625	N-nitrosodi-n-propylamine
111.100	050	EPA 625	N-nitrosodiphenylamine
111.100	051	EPA 625	Pentachlorophenol
111.100	052	EPA 625	Phenanthrene
111.100	053	EPA 625	Phenol
111.100	054	EPA 625	Pyrene

111.100	055	EPA 625	1,2,4-Trichlorobenzene
111.100	056	EPA 625	2,4,6-Trichlorophenol
111.170	001	EPA 608	Aldrin
111.170	002	EPA 608	a-BHC
111.170	003	EPA 608	b-BHC
111.170	004	EPA 608	d-BHC
111.170	005	EPA 608	g-BHC (Lindane)
111.170	006	EPA 608	Chlordane
111.170	007	EPA 608	4,4'-DDD
111.170	008	EPA 608	4,4'-DDE
111.170	009	EPA 608	4,4'-DDT
111.170	010	EPA 608	Dieldrin
111.170	011	EPA 608	Endosulfan I
111.170	012	EPA 608	Endosulfan II
111.170	013	EPA 608	Endosulfan Sulfate
111.170	014	EPA 608	Endrin
111.170	015	EPA 608	Endrin Aldehyde
111.170	016	EPA 608	Heptachlor
111.170	017	EPA 608	Heptachlor Epoxide
111.170	018	EPA 608	Toxaphene
111.170	019	EPA 608	PCB-1016
111.170	020	EPA 608	PCB-1221
111.170	021	EPA 608	PCB-1232
111.170	022	EPA 608	PCB-1242
111.170	023	EPA 608	PCB-1248
111.170	024	EPA 608	PCB-1254
111.170	025	EPA 608	PCB-1260
111.170	031	EPA 608	PCBs

114 - Inorganic Chemistry of Hazardous Waste

114.010	001	EPA 6010B	Antimony
114.010	002	EPA 6010B	Arsenic
114.010	003	EPA 6010B	Barium
114.010	004	EPA 6010B	Beryllium
114.010	005	EPA 6010B	Cadmium
114.010	006	EPA 6010B	Chromium
114.010	007	EPA 6010B	Cobalt
114.010	008	EPA 6010B	Copper
114.010	009	EPA 6010B	Lead
114.010	010	EPA 6010B	Molybdenum
114.010	011	EPA 6010B	Nickel
114.010	012	EPA 6010B	Selenium

114.010	013	EPA 6010B	Silver
114.010	014	EPA 6010B	Thallium
114.010	015	EPA 6010B	Vanadium
114.010	016	EPA 6010B	Zinc
114.020	001	EPA 6020	Antimony
114.020	002	EPA 6020	Arsenic
114.020	003	EPA 6020	Barium
114.020	004	EPA 6020	Beryllium
114.020	005	EPA 6020	Cadmium
114.020	006	EPA 6020	Chromium
114.020	007	EPA 6020	Cobalt
114.020	008	EPA 6020	Copper
114.020	009	EPA 6020	Lead
114.020	010	EPA 6020	Molybdenum
114.020	011	EPA 6020	Nickel
114.020	012	EPA 6020	Selenium
114.020	013	EPA 6020	Silver
114.020	014	EPA 6020	Thallium
114.020	015	EPA 6020	Vanadium
114.020	016	EPA 6020	Zinc
114.103	001	EPA 7196A	Chromium (VI)
114.106	001	EPA 7199	Chromium (VI)
114.140	001	EPA 7470A	Mercury
114.141	001	EPA 7471A	Mercury
114.222	001	EPA 9014	Cyanide
114.230	001	EPA 9034	Sulfides, Total
114.240	001	EPA 9040B	Corrosivity - pH Determination
114.241	001	EPA 9045C	Corrosivity - pH Determination
114.250	001	EPA 9056	Fluoride

115 - Extraction Test of Hazardous Waste

115.020	001	EPA 1311	Toxicity Characteristic Leaching Procedure (TCLP)
115.030	001	CCR Chapter11, Article 5, Appendix II	Waste Extraction Test (WET)
115.040	001	EPA 1312	Synthetic Precipitation Leaching Procedure (SPLP)

116 - Volatile Organic Chemistry of Hazardous Waste

116.010	001	EPA 8011	1,2-Dibromoethane
116.010	002	EPA 8011	Dibromochloropropane
116.020	011	EPA 8015B	Ethylene Glycol
116.030	001	EPA 8015B	Gasoline-range Organics
116.040	002	EPA 8021B	Benzene
116.040	039	EPA 8021B	Ethylbenzene
116.040	041	EPA 8021B	Methyl tert-butyl Ether (MTBE)

116.040	047	EPA 8021B	Toluene
116.040	056	EPA 8021B	Xylenes, Total
116.080	001	EPA 8260B	Acetone
116.080	002	EPA 8260B	Acetonitrile
116.080	003	EPA 8260B	Acrolein
116.080	004	EPA 8260B	Acrylonitrile
116.080	005	EPA 8260B	Allyl Alcohol
116.080	006	EPA 8260B	Allyl Chloride
116.080	007	EPA 8260B	Benzene
116.080	009	EPA 8260B	Bromoacetone
116.080	010	EPA 8260B	Bromochloromethane
116.080	011	EPA 8260B	Bromodichloromethane
116.080	012	EPA 8260B	Bromoform
116.080	013	EPA 8260B	Bromomethane
116.080	014	EPA 8260B	n-Butyl Alcohol
116.080	015	EPA 8260B	Carbon Disulfide
116.080	016	EPA 8260B	Carbon Tetrachloride
116.080	018	EPA 8260B	Chlorobenzene
116.080	019	EPA 8260B	Chloroethane
116.080	020	EPA 8260B	2-Chloroethyl Vinyl Ether
116.080	021	EPA 8260B	Chloroform
116.080	022	EPA 8260B	Chloromethane
116.080	023	EPA 8260B	Chloroprene
116.080	024	EPA 8260B	3-Chloropropionitrile
116.080	025	EPA 8260B	Crotonaldehyde
116.080	026	EPA 8260B	Dibromochloromethane
116.080	027	EPA 8260B	Dibromochloropropane
116.080	028	EPA 8260B	1,2-Dibromoethane
116.080	030	EPA 8260B	Dibromomethane
116.080	031	EPA 8260B	1,2-Dichlorobenzene
116.080	032	EPA 8260B	1,3-Dichlorobenzene
116.080	033	EPA 8260B	1,4-Dichlorobenzene
116.080	034	EPA 8260B	cis-1,4-Dichloro-2-butene
116.080	035	EPA 8260B	trans-1,4-Dichloro-2-butene
116.080	036	EPA 8260B	Dichlorodifluoromethane
116.080	037	EPA 8260B	1,1-Dichloroethane
116.080	038	EPA 8260B	1,2-Dichloroethane
116.080	039	EPA 8260B	1,1-Dichloroethene
116.080	040	EPA 8260B	trans-1,2-Dichloroethene
116.080	041	EPA 8260B	cis-1,2-Dichloroethene
116.080	042	EPA 8260B	1,2-Dichloropropane

116.080	043	EPA 8260B	1,3-Dichloropropane
116.080	044	EPA 8260B	2,2-Dichloropropane
116.080	045	EPA 8260B	1,1-Dichloropropene
116.080	046	EPA 8260B	cis-1,3-Dichloropropene
116.080	047	EPA 8260B	trans-1,3-Dichloropropene
116.080	048	EPA 8260B	1,3-Dichloro-2-propanol
116.080	049	EPA 8260B	1,2,3,4-Diepoxybutane
116.080	050	EPA 8260B	1,4-Dioxane
116.080	053	EPA 8260B	Ethylbenzene
116.080	055	EPA 8260B	Ethyl Methacrylate
116.080	056	EPA 8260B	Hexachlorobutadiene
116.080	058	EPA 8260B	2-Hexanone (MBK)
116.080	059	EPA 8260B	Iodomethane
116.080	060	EPA 8260B	Isobutyl Alcohol
116.080	061	EPA 8260B	Malononitrile
116.080	062	EPA 8260B	Methacrylonitrile
116.080	064	EPA 8260B	Methyl tert-butyl Ether (MTBE)
116.080	065	EPA 8260B	Methylene Chloride
116.080	066	EPA 8260B	Methyl Ethyl Ketone
116.080	067	EPA 8260B	Methyl Methacrylate
116.080	068	EPA 8260B	4-Methyl-2-pentanone (MIBK)
116.080	069	EPA 8260B	Naphthalene
116.080	070	EPA 8260B	Nitrobenzene
116.080	072	EPA 8260B	N-nitrosodi-n-butylamine
116.080	074	EPA 8260B	Pentachloroethane
116.080	075	EPA 8260B	Pentafluorobenzene
116.080	076	EPA 8260B	2-Picoline
116.080	078	EPA 8260B	Propionitrile
116.080	079	EPA 8260B	N-propylamine
116.080	080	EPA 8260B	Pyridine
116.080	081	EPA 8260B	1,1,1,2-Tetrachloroethane
116.080	082	EPA 8260B	1,1,2,2-Tetrachloroethane
116.080	083	EPA 8260B	Tetrachloroethene
116.080	084	EPA 8260B	Toluene
116.080	086	EPA 8260B	1,2,3-Trichlorobenzene
116.080	087	EPA 8260B	1,2,4-Trichlorobenzene
116.080	088	EPA 8260B	1,1,1-Trichloroethane
116.080	089	EPA 8260B	1,1,2-Trichloroethane
116.080	090	EPA 8260B	Trichloroethene
116.080	091	EPA 8260B	Trichlorofluoromethane
116.080	092	EPA 8260B	1,2,3-Trichloropropane

116.080	093	EPA 8260B	Vinyl Acetate
116.080	094	EPA 8260B	Vinyl Chloride
116.080	095	EPA 8260B	Xylenes, Total
116.080	096	EPA 8260B	tert-Amyl Methyl Ether (TAME)
116.080	097	EPA 8260B	tert-Butyl Alcohol (TBA)
116.080	098	EPA 8260B	Ethyl tert-butyl Ether (ETBE)
116.080	099	EPA 8260B	Bromobenzene
116.080	100	EPA 8260B	n-Butylbenzene
116.080	101	EPA 8260B	sec-Butylbenzene
116.080	102	EPA 8260B	tert-Butylbenzene
116.080	103	EPA 8260B	2-Chlorotoluene
116.080	104	EPA 8260B	4-Chlorotoluene
116.080	105	EPA 8260B	Isopropylbenzene
116.080	106	EPA 8260B	N-propylbenzene
116.080	107	EPA 8260B	Styrene
116.080	108	EPA 8260B	1,2,4-Trimethylbenzene
116.080	109	EPA 8260B	1,3,5-Trimethylbenzene

117 - Semi-volatile Organic Chemistry of Hazardous Waste

117.010	001	EPA 8015B	Diesel-range Total Petroleum Hydrocarbons
117.015	001	LUFT GC/MS	Diesel-range Total Petroleum Hydrocarbons
117.016	001	LUFT	Diesel-range Total Petroleum Hydrocarbons
117.017	001	EPA 418.1	TRPH Screening
117.110	001	EPA 8270C	Acenaphthene
117.110	002	EPA 8270C	Acenaphthylene
117.110	003	EPA 8270C	Acetophenone
117.110	004	EPA 8270C	2-Acetylaminofluorene
117.110	005	EPA 8270C	1-Acetyl-2-thiourea
117.110	006	EPA 8270C	4-Aminobiphenyl
117.110	007	EPA 8270C	Aniline
117.110	008	EPA 8270C	Anthracene
117.110	010	EPA 8270C	Benzidine
117.110	011	EPA 8270C	Benz(a)anthracene
117.110	012	EPA 8270C	Benzo(b)fluoranthene
117.110	013	EPA 8270C	Benzo(k)fluoranthene
117.110	014	EPA 8270C	Benzo(g,h,i)perylene
117.110	015	EPA 8270C	Benzo(a)pyrene
117.110	016	EPA 8270C	Benzoic Acid
117.110	017	EPA 8270C	p-Benzoquinone
117.110	018	EPA 8270C	Benzyl Alcohol
117.110	019	EPA 8270C	Benzyl Butyl Phthalate
117.110	020	EPA 8270C	Bis(2-chloroethoxy)methane

117.110	021	EPA 8270C	Bis(2-chloroethyl) Ether
117.110	022	EPA 8270C	Bis(2-chloroisopropyl) Ether
117.110	023	EPA 8270C	Di(2-ethylhexyl) Phthalate
117.110	024	EPA 8270C	4-Bromophenyl Phenyl Ether
117.110	025	EPA 8270C	Carbazole
117.110	026	EPA 8270C	4-Chloroaniline
117.110	027	EPA 8270C	4-Chloro-3-methylphenol
117.110	029	EPA 8270C	2-Chloronaphthalene
117.110	030	EPA 8270C	2-Chlorophenol
117.110	031	EPA 8270C	4-Chlorophenyl Phenyl Ether
117.110	032	EPA 8270C	Chrysene
117.110	033	EPA 8270C	2-Cyclohexyl-4,6-dinitrophenol
117.110	034	EPA 8270C	2,4-Diaminotoluene
117.110	036	EPA 8270C	Dibenz(a,h)anthracene
117.110	037	EPA 8270C	Dibenzofuran
117.110	038	EPA 8270C	Dibenzo(a,e)pyrene
117.110	039	EPA 8270C	1,2-Dichlorobenzene
117.110	040	EPA 8270C	1,3-Dichlorobenzene
117.110	041	EPA 8270C	1,4-Dichlorobenzene
117.110	042	EPA 8270C	3,3'-Dichlorobenzidine
117.110	043	EPA 8270C	2,4-Dichlorophenol
117.110	044	EPA 8270C	2,6-Dichlorophenol
117.110	045	EPA 8270C	Diethyl Phthalate
117.110	050	EPA 8270C	p-Dimethylaminoazobenzene
117.110	051	EPA 8270C	7,12-Dimethylbenz(a)anthracene
117.110	052	EPA 8270C	a,a-Dimethylphenethylamine
117.110	053	EPA 8270C	2,4-Dimethylphenol
117.110	054	EPA 8270C	Dimethyl Phthalate
117.110	055	EPA 8270C	Di-n-butyl phthalate
117.110	056	EPA 8270C	Di-n-octyl phthalate
117.110	060	EPA 8270C	2,4-Dinitrophenol
117.110	061	EPA 8270C	2,4-Dinitrotoluene
117.110	062	EPA 8270C	2,6-Dinitrotoluene
117.110	063	EPA 8270C	Diphenylamine
117.110	064	EPA 8270C	1,2-Diphenylhydrazine
117.110	066	EPA 8270C	Ethyl Methanesulfonate
117.110	067	EPA 8270C	Fluoranthene
117.110	068	EPA 8270C	Fluorene
117.110	069	EPA 8270C	Hexachlorobenzene
117.110	070	EPA 8270C	Hexachlorobutadiene
117.110	071	EPA 8270C	Hexachlorocyclopentadiene

117.110	072	EPA 8270C	Hexachloroethane
117.110	073	EPA 8270C	Hexachlorophene
117.110	074	EPA 8270C	Hexachloropropene
117.110	075	EPA 8270C	Indeno(1,2,3-c,d)pyrene
117.110	076	EPA 8270C	Isophorone
117.110	077	EPA 8270C	Isosafrole
117.110	078	EPA 8270C	Maleic Anhydride
117.110	079	EPA 8270C	3-Methylcholanthrene
117.110	080	EPA 8270C	2-Methyl-4,6-dinitrophenol
117.110	082	EPA 8270C	Methyl Methanesulfonate
117.110	083	EPA 8270C	2-Methylnaphthalene
117.110	084	EPA 8270C	2-Methylphenol
117.110	085	EPA 8270C	3-Methylphenol
117.110	086	EPA 8270C	4-Methylphenol
117.110	087	EPA 8270C	Naphthalene
117.110	088	EPA 8270C	1,4-Naphthoquinone
117.110	089	EPA 8270C	1-Naphthylamine
117.110	090	EPA 8270C	2-Naphthylamine
117.110	091	EPA 8270C	Nicotine
117.110	092	EPA 8270C	2-Nitroaniline
117.110	093	EPA 8270C	3-Nitroaniline
117.110	094	EPA 8270C	4-Nitroaniline
117.110	095	EPA 8270C	Nitrobenzene
117.110	096	EPA 8270C	2-Nitrophenol
117.110	097	EPA 8270C	4-Nitrophenol
117.110	098	EPA 8270C	N-nitrosodi-n-butylamine
117.110	099	EPA 8270C	N-nitrosodiethylamine
117.110	100	EPA 8270C	N-nitrosodimethylamine
117.110	101	EPA 8270C	N-nitrosodi-n-propylamine
117.110	102	EPA 8270C	N-nitrosodiphenylamine
117.110	103	EPA 8270C	N-nitrosomethylethylamine
117.110	104	EPA 8270C	N-nitrosomorpholine
117.110	105	EPA 8270C	N-nitrosopiperidine
117.110	106	EPA 8270C	N-nitrosopyrrolidine
117.110	107	EPA 8270C	5-Nitro-o-toluidine
117.110	108	EPA 8270C	Pentachlorobenzene
117.110	109	EPA 8270C	Pentachloronitrobenzene
117.110	110	EPA 8270C	Pentachlorophenol
117.110	111	EPA 8270C	Phenacetin
117.110	112	EPA 8270C	Phenanthrene
117.110	113	EPA 8270C	Phenol

117.110	116	EPA 8270C	2-Picoline
117.110	119	EPA 8270C	Pyrene
117.110	120	EPA 8270C	Pyridine
117.110	122	EPA 8270C	Safrole
117.110	124	EPA 8270C	1,2,4,5-Tetrachlorobenzene
117.110	125	EPA 8270C	2,3,4,6-Tetrachlorophenol
117.110	128	EPA 8270C	o-Toluidine
117.110	129	EPA 8270C	1,2,4-Trichlorobenzene
117.110	130	EPA 8270C	2,4,5-Trichlorophenol
117.110	131	EPA 8270C	2,4,6-Trichlorophenol
117.110	132	EPA 8270C	1,3,5-Trinitrobenzene
117.111	025	EPA 8270C	Dimethoate
117.111	026	EPA 8270C	Dinoseb
117.111	036	EPA 8270C	Famphur
117.111	039	EPA 8270C	Isodrin
117.111	040	EPA 8270C	Kepone
117.111	054	EPA 8270C	Parathion Ethyl
117.111	055	EPA 8270C	Parathion Methyl
117.111	056	EPA 8270C	Phorate
117.111	058	EPA 8270C	Sulfotepp
117.111	061	EPA 8270C	O,O,O-triethyl Phosphorothioate
117.140	001	EPA 8310	Acenaphthene
117.140	002	EPA 8310	Acenaphthylene
117.140	003	EPA 8310	Anthracene
117.140	004	EPA 8310	Benz(a)anthracene
117.140	005	EPA 8310	Benzo(a)pyrene
117.140	006	EPA 8310	Benzo(b)fluoranthene
117.140	007	EPA 8310	Benzo(k)fluoranthene
117.140	008	EPA 8310	Benzo(g,h,i)perylene
117.140	009	EPA 8310	Chrysene
117.140	010	EPA 8310	Dibenz(a,h)anthracene
117.140	011	EPA 8310	Fluoranthene
117.140	012	EPA 8310	Fluorene
117.140	013	EPA 8310	Indeno(1,2,3-c,d)pyrene
117.140	014	EPA 8310	Naphthalene
117.140	015	EPA 8310	Phenanthrene
117.140	016	EPA 8310	Pyrene
117.170	001	EPA 8330	4-Amino-2,6-dinitrotoluene
117.170	002	EPA 8330	2-Amino-4,6-dinitrotoluene
117.170	003	EPA 8330	1,3-Dinitrobenzene
117.170	004	EPA 8330	2,4-Dinitrotoluene

117.170	005	EPA 8330	2,6-Dinitrotoluene
117.170	006	EPA 8330	Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)
117.170	007	EPA 8330	Methyl-2,4,6-trinitrophenylnitramine
117.170	008	EPA 8330	Nitrobenzene
117.170	009	EPA 8330	2-Nitrotoluene
117.170	010	EPA 8330	3-Nitrotoluene
117.170	011	EPA 8330	4-Nitrotoluene
117.170	012	EPA 8330	Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine
117.170	013	EPA 8330	1,3,5-Trinitrobenzene
117.170	014	EPA 8330	2,4,6-Trinitrotoluene
117.190	001	EPA 8332	Nitroglycerine
117.210	001	EPA 8081A	Aldrin
117.210	002	EPA 8081A	a-BHC
117.210	003	EPA 8081A	b-BHC
117.210	004	EPA 8081A	d-BHC
117.210	005	EPA 8081A	g-BHC (Lindane)
117.210	007	EPA 8081A	a-Chlordane
117.210	008	EPA 8081A	g-Chlordane
117.210	009	EPA 8081A	Chlordane (tech.)
117.210	010	EPA 8081A	Chlorobenzilate
117.210	011	EPA 8081A	Chloroneb
117.210	012	EPA 8081A	Chlorothalonil
117.210	013	EPA 8081A	4,4'-DDD
117.210	014	EPA 8081A	4,4'-DDE
117.210	015	EPA 8081A	4,4'-DDT
117.210	016	EPA 8081A	Diallate
117.210	020	EPA 8081A	Dieldrin
117.210	021	EPA 8081A	Endosulfan I
117.210	022	EPA 8081A	Endosulfan II
117.210	023	EPA 8081A	Endosulfan Sulfate
117.210	024	EPA 8081A	Endrin
117.210	025	EPA 8081A	Endrin Aldehyde
117.210	026	EPA 8081A	Endrin Ketone
117.210	027	EPA 8081A	Heptachlor
117.210	028	EPA 8081A	Heptachlor Epoxide
117.210	029	EPA 8081A	Hexachlorobenzene
117.210	033	EPA 8081A	Methoxychlor
117.210	039	EPA 8081A	Toxaphene
117.220	001	EPA 8082	PCB-1016
117.220	002	EPA 8082	PCB-1221
117.220	003	EPA 8082	PCB-1232

117.220	004	EPA 8082	PCB-1242
117.220	005	EPA 8082	PCB-1248
117.220	006	EPA 8082	PCB-1254
117.220	007	EPA 8082	PCB-1260
117.220	008	EPA 8082	2-Chlorobiphenyl
117.220	009	EPA 8082	2,3-Dichlorobiphenyl
117.220	010	EPA 8082	2,2',5-Trichlorobiphenyl
117.220	011	EPA 8082	2,4',5-Trichlorobiphenyl
117.220	012	EPA 8082	2,2',3,5'-Tetrachlorobiphenyl
117.220	013	EPA 8082	2,2',5,5'-Tetrachlorobiphenyl
117.220	014	EPA 8082	2,3',4,4'-Tetrachlorobiphenyl
117.220	015	EPA 8082	2,2',3,4,5'-Pentachlorobiphenyl
117.220	016	EPA 8082	2,2',4,5,5'-Pentachlorobiphenyl
117.220	017	EPA 8082	2,3,3',4',6-Pentachlorobiphenyl
117.220	018	EPA 8082	2,2',3,4,4',5'-Hexachlorobiphenyl
117.220	019	EPA 8082	2,2',3,4,5,5'-Hexachlorobiphenyl
117.220	020	EPA 8082	2,2',3,5,5',6-Hexachlorobiphenyl
117.220	021	EPA 8082	2,2',4,4',5,5'-Hexachlorobiphenyl
117.220	022	EPA 8082	2,2',3,3',4,4',5-Heptachlorobiphenyl
117.220	023	EPA 8082	2,2',3,4,4',5,5'-Heptachlorobiphenyl
117.220	024	EPA 8082	2,2',3,4,4',5',6-Heptachlorobiphenyl
117.220	025	EPA 8082	2,2',3,4',5,5',6-Heptachlorobiphenyl
117.220	026	EPA 8082	2,2',3,3',4,4',5,5',6-Nonachlorobiphenyl
117.240	001	EPA 8141A	Atrazine
117.240	002	EPA 8141A	Azinphos Methyl
117.240	004	EPA 8141A	Chlorfenvinphos
117.240	005	EPA 8141A	Chlorpyrifos
117.240	006	EPA 8141A	Chlorpyrifos Methyl
117.240	007	EPA 8141A	Demeton-O
117.240	008	EPA 8141A	Demeton-S
117.240	009	EPA 8141A	Diazinon
117.240	010	EPA 8141A	Dimethoate
117.240	012	EPA 8141A	EPN
117.240	013	EPA 8141A	Ethion
117.240	014	EPA 8141A	Famphur
117.240	015	EPA 8141A	Malathion
117.240	016	EPA 8141A	Mevinphos
117.240	017	EPA 8141A	Naled
117.240	018	EPA 8141A	Parathion Ethyl
117.240	019	EPA 8141A	Parathion Methyl
117.240	020	EPA 8141A	Phorate

117.240	022	EPA 8141A	Ronnel
117.240	024	EPA 8141A	Sulfotepp
117.240	026	EPA 8141A	Thionazin
117.250	001	EPA 8151A	2,4-D
117.250	002	EPA 8151A	2,4-DB
117.250	003	EPA 8151A	2,4,5-T
117.250	004	EPA 8151A	2,4,5-TP
117.250	006	EPA 8151A	Dalapon
117.250	007	EPA 8151A	Dichlorprop
117.250	008	EPA 8151A	Dinoseb
117.250	009	EPA 8151A	MCPA
117.250	010	EPA 8151A	MCPP
117.250	011	EPA 8151A	4-Nitrophenol
117.250	012	EPA 8151A	Pentachlorophenol
117.250	013	EPA 8151A	Picloram
117.250	014	EPA 8151A	Dicamba
117.250	015	EPA 8151A	3,5-Dichlorobenzoic Acid
117.250	016	EPA 8151A	Acifluorfen
117.250	017	EPA 8151A	Bentazon
117.250	018	EPA 8151A	Chloramben
117.250	019	EPA 8151A	DCPA

120 - Physical Properties of Hazardous Waste

120.010	001	EPA 1010	Ignitability
120.040	001	Section 7.3 SW-846	Reactive Cyanide
120.050	001	Section 7.3 SW-846	Reactive Sulfide
120.070	001	EPA 9040B	Corrosivity - pH Determination
120.080	001	EPA 9045C	Corrosivity - pH Determination

Attachment B
Responses to Comments on Laboratory Chemistry and Quality Control Data

Attachment B: Responses to Comments on Laboratory Chemistry and Quality Control Data

CH2M HILL has reviewed the Peer Review comments on the Hinkley Groundwater Background Study (CH2M HILL, 2007) related to laboratory methods and quality control data prepared by Dr. Stuart Nagourney of the College of New Jersey on behalf of the Regional Water Quality Control Board, Lahontan Region (Water Board), dated October 14, 2011. Based on this review, the quality of the laboratory analyses was determined to be appropriate and to meet all of the requirements of the USEPA methods employed.

Detailed Response to Comments

The issues raised by Dr. Nagourney fall into three general categories: method calibration, establishment of reporting limits (RLs) and method detection limits (MDLs), and quality control (QC) check procedures. Dr. Nagourney posed six questions to the Truesdail Laboratories, Inc. (TLI) and EMAX Laboratories (EMAX). Based on the responses to these questions, Dr. Nagourney provided additional questions and comments regarding QC procedures, including questions on method calibration, RLs, and MDLs. Presented below are responses to each of the additional questions and comments provided by Dr. Nagourney.

1) What calibration ranges were used for Methods 6010B, 6020A and 7199?

   Comment on information provided by TLI: It is unclear from the response if the low level calibration ranges cited in the response for Methods 6010B and 6020A were used for the analyses in this study. If not, the data for this study for total chromium (Cr(T)) would be questionable.

   Response:

   - Method 6010B was not used by either lab for the Hinkley Groundwater Background Study.
   - For Method 6020A, the laboratories used the following calibration ranges:
     - TLI used 0.2 micrograms per liter (µg/L) to an upper range of 100, 200 or 500 µg/L.
     - EMAX used 10 µg/L to an upper range of 100 µg/L.
   - For Method 7199, the laboratories used the following calibration ranges:
     - TLI used a calibration range of 0.2 to 50 µg/L. As noted here, TLI did use a low concentration standard, 0.2 µg/L, for the low end of the calibration range.
     - EMAX used 0.2 µg/L to an upper range of 5.0 µg/L.

2) For Method 6020A, what was the value of the Contract Required Quantitation Limit Check Standard (CRI) and the method control limits?

   Comment on information provided by TLI: TLI admitted in their response that they failed to perform this quality assurance as required by the method during the time that data for this study were obtained.

   Response:

   - CRI is not a required criterion of 6020A, and as such the failure of TLI to perform this check did not compromise the quality of the data obtained.

- Regarding method control limits, the PG&E Program Quality Assurance Project Plan (QAPP) (CH2M HILL, 2008) requires the following:
    - Laboratory Control Sample (LCS) of 85 – 115% (method requires 80 – 120%). An LCS is a reagent water blank fortified with the compound(s) of interest that is processed through the entire method process just like a sample.
    - Matrix Spike/Matrix Spike Duplicate (MS/MSD) of 75 – 125%
    - The relative percent difference (RPD) or precision between the MS and MSD or sample and sample duplicate 20%RPD
    - Post spike and serial dilution are also required per the method requirements.

3) Were reporting limit (RL) check samples analyzed for Methods 7199 and 6010B? If so what are the control limits and what were the actual recoveries?

Comment on information provided by TLI: TLI admitted in their response that they failed to analyze a RL check sample during the time that data for this study were obtained.

Response:

- 6010B was not used for the Hinkley Groundwater Background Study.
- RL checks are not required by either method, and as such the failure of TLI to perform this check did not compromise the quality of the data obtained.

4) How were RLs established for Methods 6010B, 6020A and 7199? What is the relationship between the method detection limit (MDL) & RL for each method?

Comment on information provided by TLI: TLI's response of varying criteria for a quantitative relationship between the MDL and RL is too vague to be acceptable.

Response:

- MDL studies are performed annually and are required to meet the 40 CFR Part 136B criteria.
- The California Environmental Laboratory Accreditation Program (ELAP) states the RL must be defensible, be greater than the MDL, and will be specified by the end user of the data.
- The RL is defined by the CDPH as the concentration at which an analyte can be detected in a sample and its concentration can be reported with a reasonable degree of accuracy and precision. The CDPH defined reasonable as ± 20% accuracy and 20% RSD for replicate determinations. The acceptable ranges depend somewhat on the analytical methodology used. The CDPH states that for samples that do not pose a particular matrix problem, the RL is typically about three to five times higher than the MDL.
- The RLs used by the labs for the Hinkley Groundwater Background Study were derived from reporting limits specified in the June 29, 2001 Cleanup and Abatement Order (CAO) (Water Board, 2001), also specified in the QAPP (subsequent Waste Discharge Requirements [WDRs] such as R6V-2004-0034 actually specified a higher RL of 1 µg/L for Cr(VI) and 5 µg/L Cr(T)).
- In accordance with the project QAPP, an RL level low standard is used in the calibration curve.
- No data are reported below the RL. (Non-detects are reported at the RL.)

5) What standard reference material (SRM) was used for QC for 7199 as per Section 5.4? This data was apparently not reported.

   Comment on information provided by TLI: The use of a mid-range check sample is not acceptable as a QC material as per the criteria for quality control specified in Method 7199. This would make the data for this study for Cr(VI) questionable.

   Response:

   - Section 5.4 of the method requires a QCS (quality control sample) defined as "a mid-range standard, prepared from an independent commercial source" (i.e., a secondary source, separate from the initial calibration standards) be used to verify the instruments performance. It does not require Standard Reference Material (SRM), only a standard from a secondary source as defined by the QCS. The procedures used were in keeping with the method and the data obtained is therefore not questionable.
     - TLI uses a second source material for both their LCS and the second source mid-range calibration check standard.
     - EMAX uses a second source for their LCSs.
   - Both laboratories report LCS data in the lab reports.

6) Why were the spiking levels for both Cr(T) and Cr(VI) analyses much higher than the expected sample concentrations for all analytical methods?

   Comment on information provided by EMAX and TLI: This response was not satisfactory. The laboratory should have chosen the concentration level of matrix spikes for both Cr(T) and Cr(VI) to closer to the actual sample levels (usually a multiple of 3-5 the expected value is applied). The choice of much higher spiking levels means that the calculated recoveries have little value in assessing the quality of the actual sample concentrations and the impact to those results from possible matrix interferences.

   Response:

   - Method 6020A specifics – "MS/MSD samples should be spiked at the same level, and with the same spiking material, as the corresponding laboratory control sample that is at the project-specific action level or, when lacking project-specific action levels, at approximately mid-point of the linear dynamic range." No project specific action level was specified for the background study; therefore, the labs followed the spiking levels specified by the method.
   - Both laboratories used 1.0 µg/L as the spike concentration for Method 7199. The concentration of the matrix spike was five times the reporting level and applicable to the majority of sample concentrations determined over the study.

In addition to the initial six questions, Dr. Nagourney noted six additional concerns with analytical data in comments. The following are the concerns and the responses to those concerns.

1. **Comment:** No criteria were provided from either laboratory as to the criteria for data assigned "U" or "J" flags.

   Response: Laboratory analytical data was reviewed by CH2M HILL's project chemists to assess data quality and to identify deviations from analytical requirements. The flags provided in the Groundwater Background Study were assigned by the project chemists and the criteria associated to a specific result/flag are listed in Appendix F (Data Requiring Validation Flags).

2. **Comment**: "unusually high percentage of samples failed the quality control criteria for the Continuing Calibration Verification (CCV)."

   Response: During the first Hinkley Background Study sampling event, (January/February 2006) all Method SW 7199 sample analyses were performed by TLI and the CCV recoveries for all analyses were within the method criteria of 90 – 110% recovery. For the three subsequent sampling events, all Method SW7199 sample analyses were performed by EMAX Laboratory (EMAX). Of the 129 sample analyses performed by EMAX, 31 (26 samples, 5 field duplicates) or 24 percent had one or more of the bracketing CCVs with recoveries that were outside the method criteria. CCV recoveries for the out of control sample analyses ranged from a low of 72 percent to a high of 123 percent with 19 results biased low and 12 biased high. In accordance with the PG&E program Quality Assurance Program Plan (QAPP) (CH2M HILL, 2008) that cites USEPA National Functional Guidelines for Inorganic Data Review (2002), the range of the out of control CCV recoveries was not significant enough to warrant data rejection, but did require data qualification by applying "J/UJ" flags to out of control results. Therefore, the results were determined to be of sufficient quality to be used for purposes of the background study.

3. **Comment:** How were samples chosen for matrix spiking (was this procedure randomized so as to not bias the results?)

   Response: The matrix spikes were randomly selected by the laboratory.

4. **Comment:** The work plan specifies the use of method 6010 for the analysis of Cr(T); Method 6020A was used instead. This may impact the ability to quantify for Cr(T) at low concentration levels since the RL for Method 6020A is much lower than that for Method 6010.

   Response: Both methods use an Inductively Coupled Plasma (ICP) however Method 6020A pairs that with a mass spectrometer (measuring mass weight) which allows for lower concentration reporting for most metals. Method SW6020A met the RL objectives for the project.

5. **Comment**: Some data for Cr(VI) in this study were reported by USEPA determinative method 218.6, other data was reported by Method 7196A and still other data was reported by Method 7199. These methods all have different sensitivities and different capabilities to report Cr(VI) without analytical interferences. Why were different methods used to measure Cr(VI)?

Response: Only Method 7199 was used during the Hinkley Groundwater Background Study to analyze and report standard Cr(VI) results. There is no reference in the background study to either Method 218.6 or 7196.

6. **Comment**: The authors of the report chose to use a method from the USGS to attempt to define specific Cr species present in samples. This method is not certified by the State or NELAP. Information that was supplied suggests that this USGS method has only been applied to speciation of arsenic. USEPA Method 6800, Elemental and Speciated Isotope Dilution Mass Spectrometry allows the identification of individual Cr species… USEPA Method 6800 is certified by State and NELAP. Why was Method 6800 not used for this application?

   Response: Method 6800 was posted in February 2007, and the Hinkley Groundwater Background Study samples were collected quarterly from January 2006 to November 2006 and the report was submitted to the Water Board in Feb 2007 and therefore pre-date promulgation of Method 6800.