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STATE OF CALIFORNIA

STATE WATER RESOURCES CONTROL BOARD

IN THE MATTER OF LAHONTAN REGIONAL WATER QUALITY CONTROL BOARD CLEANUP AND ABATEMENT ORDER NO. R6V-2008-0002-A4	No. REQUEST FOR IMMEDIATE AND EMERGENCY STAY; PETITION FOR REVIEW AND MEMORANDUM OF POINTS AND AUTHORITIES IN SUPPORT THEREOF

This *Request for Immediate and Emergency Stay; Petition for Review and Memorandum of Points and Authorities in Support Thereof* is respectfully submitted to the California State Water Resources Control Board ("State Board") on behalf of Pacific Gas and Electric Company ("PG&E" or "Petitioner") pursuant to Water Code Sections 13320(a) and 13321, and California Code of Regulations ("CCR") Title 23, Section 2050 et seq., for review of Cleanup and Abatement Order No. R6V-2008-0002-A4 ("CAO") with respect to the Hinkley Compressor Station located at 35863 Fairview Road (APN 048S-112-52) in Hinkley, California (the "Facility"). A copy of the CAO is attached as Attachment 1.

The California Regional Water Quality Control Board, Lahonton Region ("Lahonton Board") issued two prior draft versions of the CAO and invited comments from interested parties. PG&E appreciates the opportunity to comment on those prior draft versions and the changes that were made by the Lahontan Board Executive Officer and staff as a result of comments from interested parties. Nevertheless, the final CAO, issued on January 8, 2013, still contains issues that require State Board review. The Lahontan Board issued the CAO which, without setting out any scientific or factual justification, specifies detailed requirements that PG&E must follow to comply with the CAO including directing PG&E to ignore all data more than three years old, to draw plume boundary lines that connect data points from monitoring wells that are 2,600 feet apart, and to use domestic well data to draw plume boundaries. In addition, the CAO (again, without setting out any scientific or factual justification requires PG&E to sample domestic wells in a broad, undefined area, to perform an undefined statistical analysis of water sample results from each domestic well to determine if the chromium concentrations are trending higher, and then to install monitoring wells at the locations of domestic wells showing increasing trends even in areas with chromium concentrations below background levels. These CAO requirements exceed the Lahontan Board's authority because:

- They are unsupported by factual or scientific findings in the CAO
- They improperly specify the means to comply
- They preclude the use of professional judgment resulting in faulty scientific

conclusions

- They improperly require investigation in areas where naturally occurring chromium concentrations occur that have not been linked to PG&E's discharge
- They improperly require investigation and monitoring in areas where chromium concentrations are below background levels legally established by Lahontan Board order (Lahontan Board Order No. R6V-2008-0002A)
- They improperly require investigation based upon a background value that has been questioned by the Lahontan Board and third parties and is in the process of being updated, and
- They will result in plume maps that are artificially expanded.

As a result, PG&E is seeking State Board review of the requirements of the CAO.

PG&E does not object to installing additional monitoring wells in Hinkley and, in fact, in February 2012 PG&E proposed a new background study that would include dozens of new monitoring wells throughout the Hinkley area. On July 9, 2012, PG&E also proposed the installation of 12 new groundwater assessment monitoring wells. However, as outlined briefly above and in more detail below, the CAO goes well beyond merely requiring the installation of monitoring wells. For example, the CAO requires the drawing of plume boundaries based only on well concentration data and not considering additional relevant technical data or professional judgment such as groundwater flow and geochemical data. The CAO also ignores the need to further define natural background chromium levels in Hinkley as well as PG&E's recent reports demonstrating that groundwater in the Hinkley area upgradient of the chromium plume contains chromium at levels up to at least 8 ppb that are not related to PG&E's discharge.

In 2007, PG&E performed a background study of the chromium concentrations naturally found in groundwater in the Hinkley area. The scope of the 2007 Background Chromium Study was limited to a portion of the southern Hinkley groundwater basin. Using long screened wells, the study calculated upper tolerance limit concentrations of hexavalent chromium and total chromium in the study area of 3.1 ppb and 3.2 ppb, respectively. These values were adopted by the Lahontan Board in Order No. R6V-2008-0002A.[1]

However, based on new data and additional information, the Lahontan Board and others have questioned the original background values set by the Board. PG&E concurred with the peer review comments on the original study and in response PG&E submitted a new background study work plan in February 2012. PG&E's proposed new background study would include peer review and input from state and federal scientific agencies as well as the Hinkley community technical expert and others. According to the work plan, the new background study would be much broader than the original study and would require the installation of numerous new monitoring wells strategically placed throughout the Hinkley area, expanding beyond the original study area as well as reviewing multiple lines of evidence pertaining to chromium sources, such as groundwater flow direction and geochemistry. PG&E's new background study work plan has been reviewed by experts at the United States Geologic Survey (USGS), the community's technical expert, and Lahontan Board staff. The new background study will take approximately eighteen months to complete once the work plan is approved by the Lahontan Board.

PG&E also recently conducted investigations in the western portion of the Hinkley area in order to gather additional information regarding water quality and hydrogeology in this area, including the impact of the Lockhart fault. On January 14, 2013, PG&E submitted a report on the western area investigation of Hinkley (CH2M HILL and Stantec, 2013). A excerpt of the report is attached as Attachment 2. The report described an extensive effort to assess groundwater flow and chromium levels in western area groundwater and provided multiple lines of evidence demonstrating that chromium in the western area did not come from PG&E's activities. In fact, the western area investigation identified a well with a groundwater level nearly 50 feet higher than the plume area and more than 1 mile west of PG&E's plume – on the up-gradient side of the Lockhart Fault - containing 8 ppb hexavalent chromium that could not have come from PG&E's activities. This report calls into further question the original hexavalent chromium background

[1] As a result, at present, because of the Lahontan Board order setting background values, the Board should not require remediation or investigation of groundwater containing chromium at concentrations below these established background levels.

value of 3.1 ppb. However, the CAO rests squarely on the 3.1 ppb value and requires plume delineation within and beyond the original area studied to establish the 3.1 ppb level with no geographic limits to the investigation requirements. It is not appropriate to apply the 3.1 ppb level to areas outside the original 2007 study area, particularly where studies by others and new data collected by PG&E have proven that non-PG&E chromium exists at higher levels outside of this study area.[2]

The CAO would require unprecedented monitoring efforts based on the prior background study that the Lahontan Board has repeatedly questioned. A more sound scientific approach would be to move forward with the new background study prior to requiring this extensive new monitoring. In addition, PG&E believes that the newly ordered monitoring and delineation activities are unnecessary because PG&E has offered both interim replacement water (bottled water service) and whole house replacement water to every resident within one mile of the current chromium plume boundary.[3] PG&E believes that the scientific, technical and legal challenges associated with the CAO require its stay and revocation.

PG&E is committed to the best science, engineering and remedial design for the Hinkley Groundwater Remediation Program. We have welcomed and incorporated Lahontan Board and third-party review and recommendations into our programs and practices. We understand that the Lahontan Board will be issuing a cleanup and abatement order sometime in late 2013 or early 2014 that will include the final cleanup standards for hexavalent chromium and remediation timeframes based on the alternatives analyzed in the EIR. PG&E does not believe the CAO will

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[2] Naturally occurring hexavalent chromium concentrations in groundwater have been detected as high as 8 ppb in areas upgradient of the plume to the west. See "*Conceptual Site Model for Groundwater Flow and the Occurrence of Chromium in Groundwater of the Western Area*", dated January 14 (CH2M Hill and Stantec, 2013). Additionally, naturally occurring hexavalent chromium concentrations have been detected at varying levels in areas outside the original Hinkley background study area. See studies cited in Dennis Maslonkowski Declaration (Attachment 2).

[3] The independent technical expert hired by the Hinkley Community Advisory Committee (referred to as the "IRP Manager"), also questioned the need for the CAO when commenting on the draft CAO: "However, the IRP Manager is uncertain, at time of writing, and to the extent of his own internal data review, if this apparent desire for increased accuracy is warranted or needed, in light of plume delineation, plume management, and ongoing whole house water supply actions underway in parallel actions within the project. In short, the IRP Manager does not understand what is driving the present need for the draft CAO; given that the plume management, replacement water supply and remedy assessment tasks currently underway would appear to be well served, from an environmental engineering perspective, by the accuracy inherent in the present plume delineation practices."

result in any scientifically valid data that could either affect the final remedial design or be used to better understand the levels of naturally occurring hexavalent chromium in Hinkley. Given this setting and the fact that the CAO is not supported by California law, PG&E believes that the CAO should be vacated. Therefore, Petitioner requests an immediate and emergency stay so that a full review of the issues raised by the CAO may occur.

1. Name and Address of Petitioner

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2. Specific Action or Inaction for Which This Petition for Review is Sought

Petitioner requests review of the actions of the Lahontan Regional Board in connection with the issuance of the CAO, entitled "Amended Cleanup and Abatement Order No. R6V-2008-0002-A4 (WDID No. 6B369107001) Requiring Pacific Gas and Electric Company to Clean Up and Abate Waste Discharges of Total and Hexavalent Chromium to the Groundwaters of the

Mojave Hydrologic Unit," dated January 8, 2012.

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REQUEST FOR IMMEDIATE and EMERGENCY STAY

Pursuant to Water Code section 13321 and Title 23, CCR section 2053, Petitioner requests an immediate and emergency stay of the CAO.

Under section 2053 of the State Board's regulations (CCR, tit. 23, § 2053), a stay of the effect of an order shall be granted if petitioner shows: (i) There will be substantial harm to the Petitioner or to the public interest if a stay is not granted; (ii) There will be no substantial harm to other interested persons and to the public interest if a stay is granted; and (iii) There are substantial questions of fact or law regarding the disputed action.

Pursuant to 23 CCR 2053, "a petition for stay shall be supported by a declaration under penalty of perjury of a person or persons having knowledge of the facts alleged." As such, this Request for Immediate and Emergency Stay is accompanied by the following declarations that are attached as follows:

- DECLARATION OF DENNIS MASLONKOWSKI, a California Professional Geologist, Certified Hydrogeologist, and Certified Engineering Geologist employed as a Senior Technical Consultant at CH2MHill, Attachment 3
- DECLARATION OF LARRY HILSCHER a Statistician in the Environmental Services Group at CH2MHill, Attachment 4

THERE WILL BE SUBSTANTIAL HARM TO THE PETITIONER OR TO THE PUBLIC INTEREST IF A STAY IS NOT GRANTED

If the CAO is not stayed, Petitioner will suffer substantial harm because compliance with the CAO's mandates are inconsistent with state law, specify compliance in ways that exclude relevant data and professional judgment resulting in unsupported science and incorrect conclusions, and that require investigations where there is no link to PG&E's discharge. Specifically, (1) the CAO orders PG&E to ignore all data collected more than three years ago, without providing any scientific or factual justification for such a limitation; (2) the CAO requires PG&E to draw plume maps that connect monitoring wells that are 2,600 feet apart again without scientific or factual justification; and (3) the CAO requires domestic well monitoring in an area far outside the Hinkley area for which there is no link to PG&E's discharge and the area is well beyond the area studied by the original background study.

a. The CAO Prohibition on Using Data More Than Three Years Old Is Scientifically Unsupported and Would Result in Incomplete and Improper Conclusions

Contrary to sound scientific principles and generally accepted practice, the CAO prohibits the use of all data that is more than three years old without providing any technical or other support or justification for that prohibition. The CAO states: "If PG&E believes that chromium data in groundwater is not related to its historic chromium discharges and should not be drawn in the plume boundary, it must use data collected within the past three years to make its argument." (CAO at 8.) No Finding or other language in the CAO explains why it is appropriate to exclude all data more than three years old. As a result, the CAO exceeds the Lahontan Board's legal authority and would be an abuse of discretion per Code of Civ. Proc., § 1094.5, subd. (b); Wat. Code, §§ 13320, subd. (a) & 13330. "Abuse of discretion is established if the respondent has not proceeded in the manner required by law, the order or decision is not supported by the findings, or the findings are not supported by the evidence." (Code of Civ. Proc., § 1094.5, subd. (b).) A regional board's actions must have strong support in the evidence and be further supported by findings which bridge the logical gap between the evidence and action. (Topanga Assn. for a Scenic Community v. County of Los Angeles (1974) 11 Cal.3d 506, 514.) Because the CAO prohibition on using data more than three years old is not supported by any evidence or findings in the CAO, it is beyond the Lahontan Board's authority.

Similarly, this CAO prohibition on using data more than three years old is an example of the CAO exceeding the Lahontan Board's authority by setting very specific means for compliance, in this instance specifying what data can or cannot be used in making an argument to the Lahontan Board. The Lahontan Board exceeds its statutory authority when it specifies the means for PG&E to comply with CAO provisions, including plume delineation provisions and prohibitions on the use of valid data. (See Wat. Code, § 13360.)

> No waste discharge requirement or other order of a regional board . . . shall specify the design, location, type of construction, or particular manner in which compliance may be had with that requirement, order, or decree, and the person so ordered shall be permitted to comply with the order in any lawful manner.

(Wat. Code, § 13360, subd. (a).)

The limitation on the Lahonton Board's authority to direct the method of compliance under Section 13360 has been described, by analogy, as follows: "That is to say, the Water Board may identify the disease and command that it be cured but not dictate the cure." (Tahoe-Sierra Pres. Council v. State Water Res. Control Bd. (1989) 210 Cal.App.3d 1421, 1438.) In this case, the CAO does exactly what Water Code section 13360 forbids: specify the location and manner of monitoring and plume depiction through which PG&E "must achieve" plume definition, including prohibiting the use of valid data to interpret plume location. (CAO at 8; see also Wat. Code, § 13360, subd. (a).)

In addition, excluding all data more than three years old would prevent the review of long term groundwater water level data and water quality trends not only for chromium, but also for other water quality parameters. (Declaration of Dennis Maslonkowski ("Maslonkowski Dec." at 2). This data is critical to provide context for more recent data observations. (Maslonkowsi Dec. at 2.) For example, if a well previously contained chromium above 3.1 ppb more than three years ago, that fact would be critical in understanding the significance of data collected within the last three years from the same well.

In addition, the geological logs from many of the wells on the site (which form the basis for the geologic understanding of the area) as well as the aquifer tests and other sources of hyrogeological information collected by PG&E, USGS, Mojave Water Agency, and other agencies were often collected more than three years ago. (Maslonkowski Dec. at 2.) If this data is excluded, a significant source of knowledge pertaining to the hydrogeologic setting of the site would be lost. And, without an understanding of the hydrogeologic setting of the site, any discussion of, or conclusions regarding, groundwater would be incomplete and very likely incorrect. (Maslonkowski Dec. at 2.)

The CAO prohibition on using any data more than three years old has already been invoked by the Lahontan Board. In a January 31, 2013, letter denying PG&E's request for an extension of time to allow for additional technical review and input from the community and interested technical experts as to the Fourth Quarter chromium testing results, the Lahontan Board indicated that PG&E could provide an argument with its submittal of the data, provided that PG&E complied with the CAO prohibition on using any data more than three years old. (Jan. 31, 2013 Letter at 2.)[4] As a result, PG&E is not allowed to refer to chromium concentrations found in wells more than three years ago in the very area under discussion. This unsupported limitation will result in incomplete and very likely incorrect conclusions regarding chromium concentrations in the area under discussion. (Maslonkowski Dec. at 2.) Absent relief from the State Board through a stay of the CAO, PG&E will be subject to these unnecessary limitations. The resulting incomplete or incorrect conclusions will cause undue concern to the public that can't be easily remedied later, even if the prohibition is removed.

b. The CAO Requirement to Draw Plume Boundaries Connecting Data Points from Monitoring Wells that are 2,600 feet apart Is Not Supported By Science or Facts in the CAO and Would Artificially Expand the Size of the Plume Depiction

In 2011, the Lahontan Board issued an order requiring PG&E to draw the chromium plume boundary linking monitoring wells within 2,000 feet of each other with concentrations over 3.1 ppb hexavalent chromium or 3.2 ppb total chromium. The CAO arbitrarily expands this definition by increasing the distance between connected wells from 2,000 to 2,600 feet: "[p]lume

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[4] The Lahontan Board's January 31, 2013 letter states PG&E may submit its alternative interpretation regarding the western plume boundary "pursuant to Order C.2.h. of CAO R6V-2009-0002-A4", [sic] which in turn states, "[i]f PG&E believes that chromium data in groundwater is not related to its historic chromium discharges and should not be drawn in the plume boundary, it must use data collected within the past three years to make its argument." (Jan. 31, 2013 Letter at p. 2 and CAO at 8.)

boundary lines must be drawn to connect any monitoring well located within *one-half mile (2,600 ft)* of any other monitoring well having chromium concentrations of 3.1 ppb Cr(VI) or 3.2 ppb Cr(T) or greater." (CAO at 8, emphasis added.) The CAO does not include any technical basis or other support for this arbitrary expansion.

As outlined above, California law requires that a CAO requirement be supported by evidence and by findings in the CAO. Here, the CAO requirement to connect data points from monitoring wells 2,600 feet apart is not supported by any direct empirical evidence nor is it supported by any findings in the CAO.[5] As a result, the requirement is an abuse of discretion.

The requirement to connect wells 2,600 feet apart is also another example of the CAO exceeding the Lahontan Board's authority by setting very specific means to achieve and depict plume definition, in this instance prescribing the exact distance between wells that must be connected to form plume boundaries. The CAO does exactly what Water Code section 13360 forbids: specify the location and manner of monitoring and plume depiction through which PG&E "must achieve" plume definition. (CAO at 8; see also Wat. Code, § 13360, subd. (a).)

The arbitrary and inflexible requirement to draw plume boundaries connecting data points from all wells that are within 2,600 feet also precludes the use of other relevant data or professional judgment based on site specific circumstances. (Maslonkowski Dec. at 1.) For example, a documented fault exists in the Hinkley area that limits the movement of groundwater (and hence, the chromium plume) across the fault. (Maslonkowski Dec. at 1-2.) Yet, the CAO would not allow the use of this fact or any technical judgment regarding whether wells on opposite sides of the fault should be connected by a plume boundary line. As a result, the CAO

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[5] The only findings that discuss potential plume movement, Findings 8 & 12, do not contain any discussion or evidence pertaining to a requirement to connect data points from monitoring wells that are 2,600 feet apart. Moreover, Finding 8 which states that the plume is undefined to the east, north, and west relies on the unsupported assumption that any chromium in these areas is plume related. That assumption is contrary to data collected not just by PG&E, but also by regulatory agencies and others documenting naturally occurring chromium in Hinkley area groundwater and nearby locations. (Maslonkowski Dec. at 4-5.) In addition, PG&E recently submitted a report on its investigation of the western Hinkley area that demonstrated that chromium in wells in the western area at levels as high as 8 ppb did not come from PG&E. (Maslonkowski Dec. at 5.) Similarly, Finding 12 states that the chromium plume could have traveled 7.32 miles based on a simple groundwater velocity calculation. However, the finding ignores the fact that Hinkley valley groundwater was heavily pumped for agricultural purposes for many years. (Maslonkowski Dec. at 5-6.) The velocity calculations do not consider any agricultural pumping and, therefore, do not provide a reasonable or accurate assessment. (Maslonkowski Dec. at 6.)

would result in incomplete, incorrect, or artificially expanded plume boundary depictions. An artificially expanded plume boundary depiction would cause increased public concern without a factual basis. Such concern would not be easily changed or remedied, even if the underlying requirement was later removed and a smaller plume depiction was created to replace the artificially expanded version.

c. The CAO Contains No Geographic Limit on the Required New Monitoring and Plume Delineation Requirements Thereby Requiring Unlimited Investigation based upon a Background Value that has been Repeatedly Questioned for the South Hinkley Valley and was Never Intended for Use Outside this Valley; and, the CAO Contains Undefined and Vague Terms That Make Compliance Impossible

Ordering provision I.A.1. of the CAO requires PG&E to sample "domestic wells in target areas of the northern-most plume area at the Hinkley Gap, the eastern boundary area near Dixie Road, and any other areas outside of the currently identified primary contiguous plume boundary that may show anomalous or otherwise unexplained concentrations of chromium in domestic wells." (CAO at 6.) The requirement to sample wells in "any other areas outside of the currently identified primary contiguous plume boundary that may show anomalous or otherwise unexplained concentrations of chromium in domestic wells" contains no geographic limitations. On its face, this language could require PG&E to sample wells (and install new monitoring wells based on the sampling results) all the way to Barstow (several miles to the east of Hinkley). As a result, the CAO is overbroad on its face and requires modification. In addition, the CAO inappropriately applies the 3.1 ppb background level developed in 2007 based on a limited study area in the southern Hinkley groundwater basin to locations well-outside of the original study area. It is not scientifically appropriate to apply a background study value from one area to another location. (Maslonkowski Dec. at 2-3.)

This provision also demonstrates the undefined and ambiguous terms used in the CAO that make compliance impossible. For example, the CAO does not define the term "anomalous or otherwise unexplained concentrations of chromium in domestic wells." Chromium is found naturally in groundwater throughout the state, including in the Hinkley area. (Maslonkowski Dec. at 4-5.) Therefore, the presence of chromium in domestic wells is neither anomalous nor otherwise unexplained. Even if that were not the case, the CAO does not provide enough guidance to determine what is meant by "anomalous or unexplained concentrations of chromium." Similarly, the CAO uses undefined terms such as "Hinkley Gap" and "target areas." It is impossible to meaningfully comply with the CAO without more clarity.

Finally, this is an example of the CAO exceeding the Lahontan Board's authority by ordering PG&E to investigate areas that are not linked to PG&E's discharge. State Water Resources Control Board Resolution No. 92-49 authorizes regional boards to require investigation and cleanup and abatement for any location "affected by the discharge or threatened discharge." (Resolution No. 92-49, section II.A.3.) This presupposes that the investigation and cleanup and abatement are linked to that discharger's activities. Yet, the CAO does not link the required monitoring activities to PG&E's discharge. This lack of nexus between the hexavalent chromium levels and any activity by PG&E undermines the CAO. An administrative agency's findings must be sufficient to allow parties to determine the basis for the agency's action. (Topanga Assn. for a Scenic Community v. County of Los Angeles (1974) 11 Cal.3d 506, 514.) The findings must form an analytic bridge between the evidence and the agency's conclusion. (Id. at p. 515.) Yet, at this time, the Lahontan Board's CAO lacks findings linking PG&E's discharge to the required monitoring that could extend well outside the Hinkley area.

INTERESTED PERSONS AND THE PUBLIC INTEREST WILL NOT BE SUBSTANTIALLY HARMED IF A STAY IS GRANTED

Interested persons and the public interest will not be placed at risk if a stay is granted because all properties within one mile of the current chromium plume are already eligible to receive bottled water from PG&E and all properties within one mile of the current chromium plume that have any detectable level of chromium in their well water are eligible to receive whole house replacement water from PG&E.

<u>SUBSTANTIAL QUESTIONS OF LAW AND FACT EXIST REGARDING THE DISPUTED ACTION</u>

As explained in the Memorandum of Points and Authorities in Section 7 below and hereby incorporated by reference, there are substantial questions of both law and fact regarding the Lahontan Regional Board's adoption of the CAO.

FOR ALL THE FOREGOING REASONS, Petitioner respectfully requests that the State Board grant an immediate and emergency stay of the effect of Order No. R6V-2008-0002A4 until such time as final action is taken on this Petition.

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3. <u>Date the Regional Board Acted or Failed to Act</u>

The date of the Lahontan Regional Board's action is January 8, 2013, the date the CAO was signed by the Executive Office of the Lahontan Regional Board.

4. <u>Statement of Reasons the Action is Inappropriate or Improper</u>

The issuance of the CAO was beyond the authority of the Lahontan Regional Board, inappropriate, improper, or not supported by the record, for the following reasons:

(a) The CAO Prohibition on Using Data More Than Three Years Old Is Scientifically Unsupported in the CAO and Would Result in Incomplete and Improper Conclusions;

(b) The CAO Requirement to Draw Plume Boundaries Connecting Data Points from Monitoring Wells that are 2,600 feet apart Is Not Supported By Science or Facts and Would Artificially Expand the Size of the Plume Depiction;

(c) The CAO Contains No Geographic Limit on the Required New Monitoring and Plume Delineation Requirements Thereby Requiring Unlimited

Investigation based upon a Background Value that has been Repeatedly Questioned for the South Hinkley Valley and was Never Intended for Use Outside this Valley and the CAO Contains Undefined and Vague Terms That Make Compliance Impossible;

(d) The CAO Improperly Requires New Monitoring Wells Based on Chromium Concentration Trends Even When Chromium Concentrations are Below Background Levels; and,

(e) The CAO's Directive to Delineate the Plume using Domestic Well Data Would Result in An Artificially Expanded Plume without a Scientific or Factual Basis.

5. <u>The Manner in Which Petitioner is Aggrieved</u>

Petitioner is aggrieved by the Lahontan Regional Board's issuance of a CAO that is inconsistent with State law and that would require scientifically and factually unsupported sampling and statistical analysis of domestic wells followed by the installation of monitoring wells in areas not linked to PG&E's chromium discharges and that would specify the means for compliance such that years of data must be ignored and professional judgment is excluded.

6. <u>Petitioner's Requested Action by the State Board</u>

Petitioner respectfully requests that the State Board: (1) immediately stay the effect and enforcement of the CAO; and (2) vacate the CAO.

Additionally, Petitioner requests that the State Board determine the lawfulness of the Lahontan Regional Board's order prohibiting PG&E from using all data collected more than three years ago in ongoing work at the site.

Additionally, Petitioner requests that the State Board determine the lawfulness of the Lahontan Board's order specifying that PG&E must connect data points from monitoring wells that are 2,600 feet apart.

7. **<u>Memorandum of Points and Authorities</u>**

a. The CAO Prohibition on Using Data More Than Three Years Old Is Scientifically Unsupported in the CAO and Would Result in Incomplete and Improper Conclusions

As outlined above in Petitioner's request for an immediate and emergency stay and fully incorporated herein by reference, the CAO prohibition on using data more than three years old is scientifically unsupported in the CAO and would result in incomplete and improper conclusions. Because this provision is not supported by any evidence or findings in the CAO, it is beyond the Lahontan Board's authority. Similarly, this requirement is another example of the CAO exceeding the Lahontan Board's authority by setting very specific means for compliance, in this instance specifying what data can or cannot be used in making an argument to the Lahontan Board. This prohibition on using valid data would exclude data that is critical to understanding the site setting and the significance of current data.

b. The CAO Requirement to Draw Plume Boundaries Connecting Data Points from Monitoring Wells that are 2,600 feet apart Is Not Supported in the CAO By Science or Facts and Would Artificially Expand the Size of the Plume Depiction

As outlined above in Petitioner's request for an immediate and emergency stay and fully incorporated herein by reference, the CAO requirement to draw plume boundaries connecting data points from monitoring wells that are 2, 600 feet apart is not supported by science or facts and would artificially expand the size of the plume depiction while precluding the use of relevant data and professional judgment based on site specific circumstances. As a result, this CAO requirement would be an abuse of discretion by the Lahontan Board and is an example of the CAO exceeding the Lahontan Board's authority by setting very specific means to achieve and depict plume definition, in this instance prescribing the exact distance between wells that must be connected to form plume boundaries.

c. The CAO Contains No Geographic Limit on the Required New Monitoring and Plume Delineation Requirements Thereby Requiring Unlimited Investigation based upon a Background Value that has been Repeatedly Questioned for the South Hinkley Valley and was Never Intended for Use Outside this Valley and the CAO Contains Undefined and Vague Terms That Make Compliance Impossible

As outlined above in Petitioner's request for an immediate and emergency stay and fully incorporated herein by reference, the CAO contains no geographic limit on the required new monitoring and plume delineation requirements that, therefore, could extend for many miles into numerous locations that are not linked to PG&E's discharge. The CAO investigation and plume delineation requirements are based on the background values for the south Hinkley valley from the original background study. As a result, the CAO requires investigation and plume delineation using background values for the south Hinkley valley in areas well outside the south Hinkley valley. This is scientifically and technically unjustified and inappropriate. Moreover, the CAO contains numerous undefined and ambiguous terms that make compliance impossible.

d. The CAO Improperly Requires New Monitoring Wells Based on Chromium Concentration Trends Even When Chromium Concentrations are Below Background Levels

Ordering provision 1.A.1. of the CAO requires PG&E to perform a statistical analysis of domestic wells to determine "positive or negative changes in groundwater chromium concentrations over the six month period beginning March 2013." (CAO at 6.) This requirement goes on to state: "The general vicinity of domestic wells exhibiting an increasing trend in chromium concentrations will be targeted for follow-up installation of a shallow groundwater monitoring well." (CAO at 6.) Ordering provision 1.C. states that an October 30, 2013 report must report on the statistical test results "and recommended locations for the installation of additional monitoring wells within a quarter mile of any domestic well(s)." (CAO at 7.) These ordering provisions are vague and leave many key terms undefined. Specifically, "increasing trend" is undefined. Would an increase from 0.2 ppb Cr6 to 0.3 ppb Cr6 represent a "positive or negative change in groundwater chromium concentrations" such that installation of a new monitoring well is required? The CAO does not provide definitions or specificity to allow this question to be considered with all pertinent information.

More troubling is the language found in Finding 14 relating to the statistical trend requirement. Finding 14 states that domestic well monitoring "must be conducted to determine if there is an increasing trend of chromium concentrations before concentrations have the potential to rise above background levels. ... The Statistical trend will be used to establish potential risk to human health of the residents of the area and determine where additional monitoring wells are needed to further define the plume." (CAO at 4.). Finding 14 further requires that "data from the domestic well sampling must then be evaluated using a statistical test such as the Mann-Kendall to determine if there is an increasing trend in any of these domestic wells over this period." (CAO at 4.) This language requires new monitoring wells based on any "increasing trend" no matter how small and no matter whether or how far the chromium levels are below background. There is no rational basis for these requirements in the CAO.

Statistician Larry Hilscher reviewed the CAO statistical analysis and monitoring well requirements and concluded that the statistical trending analysis does not provide a reasonable basis for requiring new monitoring wells. First, the typical significance level (0.05) of the available statistical tests means that there will be a 5% false positive rate. In other words, even if the data were randomly chosen, approximately one in twenty wells would be expected to show a statistical increasing trend in the sample data when no such trend was actually taking place in the well. (Declaration of Larry Hilscher ("Hilscher Dec.") at 1-2.) However, the CAO would require a new monitoring well based on the faulty trending conclusion.

Perhaps more importantly, a statistical trend test by itself (without considering all of the relevant data and exercising professional judgment) is a very poor trigger for requiring monitoring wells. This is particularly true when no lower limit chromium concentration is specified for the required magnitude of the increasing trend and the chromium levels are below levels identified as natural background by Lahontan Board order. (Hilscher Dec. at 2.) The statistical trend test by itself does not provide any indication whether the chromium concentrations or any increasing chromium trend in a well are related to PG&E. For example, a small increase in chromium concentrations, particularly at levels identified as below natural background by Lahontan Board order (such as from 0.1 ppb to 0.2 ppb over six months), does not demonstrate the arrival from any particular source of chromium. (Hilscher Dec. at 2.) There is simply no rational justification to solely use conclusions from a trend test as the basis for requiring new monitoring wells.[6] (Maslonkowski Dec. at 7-8.)

Finally, the CAO exceeds the Lahontan Board's authority by ordering PG&E to investigate areas where chromium levels are below levels identified as natural background by Lahontan Board order. Water Code section 13304 requires cleanup of all waste discharged and restoration of affected water to background conditions. (Resolution No. 92-49, finding 4.) "[U]nder no circumstances shall these provisions be interpreted to require cleanup and abatement which achieves water quality conditions that are better than background conditions[.]" (Resolution No. 92-49, section III.F.1.) Regional boards shall "ensure that dischargers are required to clean up and abate the effects of discharges in a manner that promotes attainment of either background water quality, or the best water quality which is reasonable if background levels of water quality cannot be restored[.]" (Resolution No. 92-49, section III.G.) Yet, the CAO would require that PG&E investigate areas that contain chromium levels below levels identified as natural background by Lahontan Board order. As outlined above, there are no findings in the CAO linking PG&E's discharge to chromium in wells at concentrations below those identified as background by Lahontan Board order.

e. The CAO's Directive to Delineate the Plume using Domestic Well Data Would Result in An Artificially Expanded Plume without a Scientific or Factual Basis

The CAO would require PG&E to draw the chromium plume boundary around domestic

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[6] Finding 14 also attempts to link the statistical trending analysis to potential risk to human health. However, there is no connection between statistical trend analysis and human health risk. There is no scientific support for the concept that an increasing chromium trend in a well at levels below background represents a risk to human health. The two issues are simply not related and the CAO should not attempt to link these unrelated issues.

wells that are above 3.1 ppb of hexavalent chromium or 3.2 ppb of total chromium, if PG&E is unable to access nearby property to install monitoring wells within six months. (CAO at 8.) This requirement is not supported scientifically or factually in the CAO and it would artificially expand the depiction of the plume.

The Lahontan Board has correctly required PG&E to utilize monitoring wells to provide appropriate and representative groundwater data as the basis for establishing plume boundaries based on their careful design and installation. The proposed requirement to use data from domestic wells ignores the significant differences that may exist between data from domestic wells and monitoring wells and the less reliable domestic well testing results. For example, monitoring wells typically have short (10-15 feet) well screens, pvc casings with factory milled slots and carefully selected filter pack, non-stainless steel pumps and other materials, and known installation details and history. However, domestic wells often have long well screens (100 feet or more), steel casings with handmade slots created in the field and sometimes no filter pack, stainless steel pumps and materials that can contribute hexavalent chromium to water samples, and unknown installation history and details. (Maslonkowski Dec. at 6-7.) These significant differences in purpose and construction make comparison of the testing results between monitoring and domestic wells inappropriate and not technically sound. (Maslonkowski Dec. at 6-7.) In some cases, such depictions could be contrary to the groundwater flow direction, resulting in serious errors in the understanding of site conditions. (Maslonkowski Dec. at 6-7.)

In addition, the CAO's directive to depict the plume in areas where property is inaccessible would result in an artificial expansion of the plume boundary. For example, while PG&E is diligently seeking federal and state permits to install monitoring wells within endangered species habitat, PG&E is legally prohibited, until the permits are received, from destroying habitat such as may occur during well installation. Similarly, there is no basis for ordering PG&E to assume that the plume has expanded to areas where residents have refused to grant access to install a monitoring well.

Basing the plume boundary on these arbitrary and artificial requirements also ignores important factors such as technical judgment, site-specific conditions, and groundwater flow. Plume delineation using such a method would be technically unsound. (Maslonkowski Dec. at 6-7.)

Finally, the requirement to draw the plume around domestic wells with chromium concentrations above 3.1 ppb would drastically expand the apparent size of the plume by including multiple areas where monitoring and domestic wells are either non-detect for chromium or contain chromium levels below background levels. (Maslonkowski Dec. at 6-7.) There is no scientific or legal basis for this requirement.

8. A COPY OF THIS PETITION HAS BEEN SENT TO THE LAHONTAN REGIONAL BOARD

In accordance with title 23, section 2050(a)(8) of the CCR, the Petitioner mailed a true and correct copy of this petition by First Class mail on February 7, 2013, to the Lahontan Regional Board at the following address:

Patty Kouyoumdjian, Executive Officer
Regional Water Quality Control Board Lahontan Region
2501 Lake Tahoe Boulevard
South Lake Tahoe, CA 96150-7704

9. ISSUES RAISED IN THE PETITION WERE PRESENTED TO THE LAHONTAN REGIONAL BOARD BEFORE IT ACTED

Petitioner raised many of the issues discussed within this Petition with the Lahontan Regional Board in comment letters on prior drafts of the CAO, including a comment letter addressed to Lauri Kemper on August 9, 2012 in response to the Draft Amended CAO No. R6V-2008-0002A4. It was not possible for Petitioner to previously comment on several new issues raised for the first time in new provisions in the final CAO.

DATED: February 7, 2013

J. DREW PAGE
LAW OFFICES OF J. DREW PAGE

By: [signature]
DREW PAGE
Attorneys for Petitioner
PACIFIC GAS AND ELECTRIC COMPANY

DATED: February 7, 2013

TRACY J. EGOSCUE
EGOSCUE LAW GROUP

BY: [signature]
TRACY J. EGOSCUE
Attorneys for Petitioner
PACIFIC GAS AND ELECTRIC COMPANY

ATTACHMENT 1:

COPY OF CAO No. R6V-2008-0002-A4

January 8, 2013

Kirk Howard, Vice President
Gas Transmissions and Distribution
Pacific Gas and Electric Company
77 Beale Street, Mailcode B275
San Francisco, CA 94105

CLEANUP AND ABATEMENT ORDER NO. R6V-2008-0002-A4

I am issuing this Cleanup and Abatement Order (CAO) to require Pacific Gas and Electric Company (PG&E) to fully define the chromium plume in the Hinkley area, especially the targeted northern-most area at the Hinkley Gap and the Eastern area at Dixie Road. It is important that we have a clear and up-to-date understanding of the chromium plume boundaries. This critical information will guide us as we clean up groundwater pollution from the PG&E compressor station and will ensure protection of public health in the community.

Some key milestones in the CAO include:

- February 22, 2013 – Sampling and Analysis Workplan
- March 15, 2013 - Domestic well sampling begins
- October 30, 2013 - Report on domestic well sampling and plume definition efforts

This CAO requires PG&E to monitor and statistically evaluate hexavalent chromium concentrations in domestic water supply wells in areas outside the southern contiguous plume boundary. This CAO orders monthly domestic well sampling to determine if there is an increasing trend of chromium in groundwater before the concentrations have risen above background levels. Where an increasing trend is identified, additional monitoring wells are required to be installed. Further, this CAO requires PG&E to install additional monitoring wells in order to delineate the full lateral and vertical extent of chromium in groundwater, including locations where chromium has been detected in domestic wells above the maximum background levels. This CAO is based on sound scientific principles and is protective of public health.

Upon completion of the February 22, 2013 workplan, I would like to hold a public meeting in March to discuss the actions proposed in the draft workplan and to answer questions from the Hinkley community.

In this CAO I have not allowed for eastward plume expansion as was originally proposed in the draft CAO released for public comment. I believe it is not necessary at this time because cleanup activities can continue without it. Until we have had an opportunity to review additional information compiled on the fate and transport of remediation by-products, allowing for plume expansion would be premature.

Also, the draft CAO required PG&E to provide bottled water and include the owner of domestic well 34-65 in the Whole House Replacement Water Program. This provision is no longer needed since the property owner has reportedly opted into the property purchase program. Therefore, this requirement was removed.

This CAO does not rescind requirements in prior CAOs.

As always, I am available to answer any questions regarding this CAO and can be reached at (530) 542-5412; or you can also contact Lauri Kemper, Assistant Executive Officer, at (530) 542-5436.

Patty Z. Kouyoumdjian

Patty Z. Kouyoumdjian
Executive Officer

Enclosure: CAO R6V-2008-0002-A4

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
LAHONTAN REGION

AMENDED CLEANUP AND ABATEMENT ORDER
NO. R6V-2008-0002-A4

WDID NO. 6B369107001

REQUIRING PACIFIC GAS AND ELECTRIC COMPANY
TO CLEAN UP AND ABATE WASTE DISCHARGES
OF TOTAL AND HEXAVALENT CHROMIUM TO THE
GROUNDWATERS OF THE MOJAVE HYDROLOGIC UNIT

San Bernardino County

The California Regional Water Quality Control Board, Lahontan Region (Water Board), finds:

Discharger

1. The Pacific Gas and Electric Company owns and operates the Hinkley Compressor Station (hereafter the "Facility"), located at 35863 Falrview Road, Hinkley in San Bernardino County. For the purposes of this Order, the Pacific Gas and Electric Company is referred to as the "Discharger."

Regulatory History

2. On August 6, 2008, the Water Board issued Cleanup and Abatement Order (CAO) No. R6V-2008-0002 to the Discharger to clean up and abate the effects of waste discharges and threatened discharges containing total chromium (Cr[T]) and hexavalent chromium (Cr[VI]) to waters of the state. The CAO required the Discharger to take additional corrective actions to contain chromium migrating with groundwater, to continue to implement groundwater remediation in the source area and central plume area, and to develop and implement a final cleanup strategy. The CAO also modified the monitoring and reporting program for permitted projects.

3. Paragraph 3 of the Order provisions of the CAO required the Discharger to contain the total and hexavalent chromium plumes to locations where hexavalent chromium was below the interim background level of 4 parts per billion (ppb) and the total chromium was below 50 ppb.

    a. The Discharger was required to achieve containment of the hexavalent chromium plume in the groundwater by December 31, 2008, using the Discharger's *Boundary Control Monitoring Program and Updated Site-Wide Groundwater Monitoring Program* (submitted July 2, 2008 and prepared by Secor International) as described in Finding 16 in the CAO.

b. The Discharger was required to achieve containment of the total chromium plume in the groundwater by December 31, 2008, also based on the *Boundary Control Monitoring Program and Updated Site-Wide Groundwater Monitoring Program* as described in Finding 16 in the CAO.

4. Paragraph 4 of the Order provisions of the CAO required the Discharger to continue implementing full-scale in-situ corrective actions in the source area and central area of the chromium plume, or an alternate but equally effective method, to remediate the elevated chromium concentrations in groundwater.

5. The CAO required the Discharger to clean up and abate the chromium plume to background levels and set an interim amount of 4 ppb. Amended Order No. R6V-2008-0002A1 (Amended Order No. 1), effective November 12, 2008, adopted average and maximum background levels for hexavalent chromium of 1.2 ppb and 3.1 ppb, respectively. The adopted average and maximum background levels in Amendment Order No. 1 for total chromium are 1.5 ppb and 3.2 ppb, respectively. These background levels were adopted for the purposes of establishing background water quality conditions to be used later to consider cleanup strategies and to support future decisions regarding cleanup levels. For plume containment, the level remained at 4 ppb for both total and hexavalent chromium.

6. Amended Order No. R6V-2008-0002A3 (Amended Order No. 3), effective March 14, 2012, revised Paragraph 3 described above in Finding No. 3 by requiring the Discharger to contain the total and hexavalent chromium plumes of 3.1 ppb and 3.2 ppb, respectively, to locations south of Thompson Road. In addition, it required that the Discharger take all practicable actions to extract the total and hexavalent chromium plumes north of Thompson Road where concentrations exceeded 10 ppb.

7. On April 9, 2008, the Water Board adopted General Waste Discharge Requirements (Board Order No. R6V-2008-0014) for the Hinkley chromium contamination to facilitate groundwater remediation. Board Order No. R6V-2008-0014 allows the discharge of various products to facilitate cleanup of groundwater contamination in the area from the Compressor Station in the south to almost Thompson Road in the north. To be authorized to initiate discharge, the Discharger must submit a Notice of Intent describing the proposed remedial project and discharges to land and/or groundwater. Following a public comment period, the Executive Officer was authorized to issue a Notice of Applicability (NOA) to allow the discharge or discharges and prescribed an appropriate monitoring and reporting program.

Undefined Chromium Plume in Upper Aquifer

8. Pursuant to Orders from the Water Board, the Discharger has undertaken multiple investigations for defining the chromium plume in the upper aquifer to background levels. The document *Third Quarter 2012 Groundwater Monitoring Report and Domestic Well Sampling Results* describes the results of groundwater and domestic

well sampling during July to September 2012. Figure 3-1 in the report shows the extent of chromium in groundwater at concentrations exceeding background levels as being greater than 5 miles in length and about 2 miles in width. The quarterly report also shows that the chromium plume continues to be undefined to the east and north of the core plume area. The report also shows an area to the west of the core plume area, near the intersection of Hinkley Road and Community Boulevard, with concentrations above background that is separate from the core plume area. Further investigations are needed to fully define the lateral and vertical extent of all portions of the chromium plume and assess groundwater flow in the upper aquifer to evaluate threats to beneficial uses and to plan future corrective actions.

9. On July 9, 2012, the Discharger submitted a workplan to install additional wells for chromium plume definition. The workplan, prepared by Stantec, proposed installing wells at eight locations in the northern plume area by the Hinkley Gap. Monitoring well pairs and triplets are being proposed to monitor for the evidence of chromium. The proposed well locations, however, are not adequate to fully define the chromium plume boundaries. While the workplan does not state reasoning for large gaps in sampling locations, the Discharger has stated in the past its inability to gain access to certain private property. A revised workplan is being requested by this Order.

10. An August 20, 2012 Technical Memorandum by the Discharger cites groundwater investigation activities during the first six months of 2012. The Memorandum contains a map showing that the Discharger was unable to gain access to private property for installing additional monitoring wells at five of the eight locations proposed in the July 9, 2012 workplan. Furthermore, the map shows that the Discharger was also not able to gain access to an additional six private properties, as proposed in the September 1, 2011 Groundwater Investigation Report. These latter well locations are needed to define the northern chromium plume along the western and eastern boundaries, while the former well locations were proposed to define the northern plume extent.

11. Subsequent data submitted by the Discharger on September 18, 2012 shows that chromium in domestic wells exceeds the maximum background levels along Hinkley Road, 1.6 miles north of monitoring well MW-130S1 in the Harper Dry Lake Valley (also called Water Valley). Groundwater samples contained 4.0 ppb Cr(VI) and 3.8 ppb Cr(T) in the domestic well at 41717 American Way. Additionally, water samples from the domestic well at 42584 Hinkley Road contained 4.6 ppb Cr(VI) and 4.3 ppb Cr(T). These detections confirmed chromium results taken by private owners and submitted to the Water Board. Monitoring wells are necessary along the distance from well MW-130S1 to the latter residence to define the chromium plume in the Harper Dry Lake Valley, which is hydraulically downgradient of groundwater in the Hinkley Valley.

12. The flow of groundwater through the Hinkley Valley and to Harper Dry Lake Valley is well documented in U.S. Geological Survey (USGS) and Mojave Water Agency reports. For instance, according to a 2001 USGS report by Stamos et al titled "Simulation of Ground-Water Flow in the Mojave River Basin, California," the Hinkley Valley consists of highly transmissive aquifer conditions for groundwater movement. A significant drop in groundwater elevation from 2,200 feet above mean sea level (MSL) at the Mojave River to approximately 2,050 feet above MSL at the Harper Dry Lake influences the groundwater movement through the Hinkley Valley. The direction of groundwater movement is from the Mojave River through the Hinkley Valley and to the Harper Dry Lake Valley. The Discharger's September 2012 Feasibility Study lists a groundwater flow velocity of 1-4 feet per day (ft/day). Using a conservative average of 2 ft/day, the length of the chromium plume can be calculated since the time of the initial 1952 discharge as (assuming time between current time and discharge is 60 years, minus 7 years for the waste to percolate to groundwater):

    (2 ft/day x 365 days/year x 53 years) / 5280 ft/mile = 7.32 miles of potential plume migration of the leading edge of the plume.

    When one considers the distance from the point of release (the Hinkley Compressor Station) to the Hinkley Gap is approximately 6 miles and the groundwater flow velocity, it is reasonable to assume that chromium concentrations detected near the Hinkley Gap may be related to the release from the Hinkley Compressor Station. Such plume migration threatens approximately 12 domestic wells along the flow path in the Harper Dry Lake Valley.

13. This Order amends CAO No. R6V-2008-0002 to require the Discharger to fully define the lateral and vertical extent of the chromium plume in the upper aquifer where it is still unknown. The Order includes requirements for chromium plume mapping and potentiometric maps showing groundwater flow direction, velocity, and gradient in monitoring reports.

14. To fully define the plume, especially in the targeted northern-most area at the Hinkley Gap and the eastern area at Dixie Road, this Order requires the Discharger to prepare a workplan to sample domestic wells in these areas once a month for a period of at least 6 months beginning in **March 2013** to determine the levels of total and hexavalent chromium. This monitoring must be conducted to determine if there is an increasing trend of chromium concentrations before concentrations have the potential to rise above background levels. The data from the domestic well sampling must then be evaluated using a statistical test, such as the Mann-Kendall test, to determine if there is an increasing trend in any of these domestic wells over this period. The statistical trends will be used to establish potential risk to public health of residents in the area, and determine where additional monitoring wells are needed to further define the plume. If a domestic well displays an increasing trend, then a monitoring well must be installed within a quarter mile from that domestic well. The

Discharger must submit a report summarizing these data and a workplan for subsequent monitoring well installation by **October 30, 2013**.

CEQA

15. This enforcement action is being taken by this regulatory agency to enforce the provisions of the Water Code and, as such, is exempt from the provisions of the California Environmental Quality Act (CEQA) (Public Resources Code section 21000 et seq.) in accordance with California Code of Regulations, title 14, section 15321. The implementation of this CAO Amendment is an action to assure the restoration of the environment and meets the criteria set forth in section 15321. In addition, this action is exempt from the provisions of the CEQA, in accordance with the California Code of Regulations, title 14, section 15301 because there is negligible or no expansion of the existing monitor well pairs and triplets and infrastructure that will be used to implement this Order. In addition, the additional monitoring wells required to be installed by this Order are exempt from CEQA in accordance with the California Code of Regulations, title 14, section 15303, which allows the construction or conversion of small structures, such as monitoring wells. No exception to these exemptions apply, as this Order does not allow take of any endangered species without a permit from the applicable federal or state agency.

Effect of Prior Orders

16. This Order amends CAO No. R6V-2008-0002. All findings in prior Orders of the Water Board not directly superseded by findings in this Order remain in effect. This Order shall not be construed to preclude enforcement against the Discharger for failure to comply with any requirement in any other Order issued by the Water Board.

IT IS HEREBY ORDERED that, pursuant to the Water Code sections 13267 and 13304, the Discharger shall clean up and abate the effects of the discharge and threatened discharge of chromium to waters of the state, and shall comply with the provisions of this Order:

I. Chromium Plume Definition in the Upper Aquifer

The Discharger must define the extent of total and hexavalent chromium in the upper aquifer within the targeted areas of the Hinkley Valley shown on the chromium plume maps in the *Third Quarter 2012 Groundwater Monitoring Report and Domestic Well Sampling Results*, the figure showing proposed well locations in the July 9, 2012 Monitoring Well Installation Workplan, and to locations in the Harper Dry Lake Valley where chromium has been detected in domestic wells above the maximum background levels.

A. **By February 22, 2013**, the Discharger must submit a workplan proposing:

1. A sampling and analysis plan to immediately sample domestic wells in target areas of the northern-most plume area at the Hinkley Gap, the eastern boundary area near Dixie Road, and any other areas outside of the currently identified primary contiguous plume boundary that may show anomalous or otherwise unexplained concentrations of chromium in domestic wells. The workplan must include a statistically based trend analysis methodology to determine positive or negative changes in groundwater chromium concentrations over the six month period, beginning March 2013. The general vicinity of domestic wells exhibiting an increasing trend in chromium concentrations will be targeted for follow-up installation of a shallow groundwater monitoring well.

2. Groundwater monitoring well sampling locations in the upper aquifer in the following areas that will allow for the definition of the vertical and lateral extent of the chromium plume to at least maximum background concentrations of 3.1 ppb Cr(VI) and 3.2 ppb Cr(T) and to verify groundwater flow.

   a. Proposed monitoring well locations shall not exceed one-quarter mile distance from other monitoring wells in accessible areas.
   b. Eastern boundary: east of wells MW-115 and MW-145 on Dixie Road.
   c. Northern boundary: north of wells MW-154 and MW-130 to at least domestic well 21N-04 on Hinkley Road in the Harper Dry Lake Valley; west of Mountain View Road (north of Salinas Road); and east of Fairview Road extension (north of Sonoma Road).

   The proposed sampling locations must be previously scoped to assure a reasonable probability of success in gaining access and likelihood of well installation or temporary groundwater sampling, such as within previously disturbed areas, such as right of ways. The workplan shall identify all properties owned by the Discharger, and discuss and mark on the map areas where previous attempts to gain access to private properties and desert tortoise habitat have been unsuccessful. Nothing in this Order authorizes the take of a federal or state listed endangered species.

B. **By March 15, 2013**, the Discharger must begin sampling domestic wells in the northern-most plume area at the Hinkley Gap and the eastern boundary area near Dixie Road monthly for a period of not less than 6 months for total and hexavalent chromium concentrations. These data will be used to establish potential risk to residents that rely on the domestic water supply. The Discharger must provide well owners with analytical data as soon as they are available following each sampling event.

C. **By October 30, 2013,** the Discharger must submit a report of domestic well monitoring conducted in accordance with the sampling and analysis plan required in section I.A.1 of this Order. The report must include all analytical data, appropriate maps, statistical test results, and recommended locations for the installation of additional monitoring wells within a quarter mile of any domestic well(s).

The report must also define the full lateral and vertical extent of chromium in groundwater, based on the monitoring information gathered pursuant to section I.A.2 of this Order, for total and hexavalent chromium to at least the maximum background levels of 3.1 ppb and 3.2 ppb, respectively, and determines the direction of groundwater flow. The report must contain the following additional information:

1. **Maps:**
   a. Extent of total and hexavalent chromium in groundwater in the upper aquifer:
      i. A map showing the maximum plume boundary throughout the uppermost saturated zone.
      ii. A separate map showing the plume boundary in the lowermost saturated zone.
   b. Extent of total and hexavalent chromium in groundwater in the lower aquifer using a map showing the maximum plume boundary.
   c. Potentiometric map showing the groundwater flow directions, estimated flow velocity, and calculated gradients, along the length of the mapped chromium plume and beyond where water table data exist.

2. **Map Content**:
   a. Text font size on maps shall be 9 points or greater.
   b. Street names must be shown in black color to be easily legible.
   c. Location of all active supply wells used for remedial actions and the compressor station operations.
   d. Approximate location of the Lockhart Fault.
   e. Chromium boundary lines on plume maps must reflect the reported data for the maximum concentration in monitoring wells and extraction wells at all locations. Monitoring wells showing 3.1 ppb Cr(VI) or 3.2 ppb Cr(T) must have plume lines drawn through the monitoring well.
   f. Plume boundary lines must show monitoring and extraction well concentration contours representing the maximum extent of the

following: 1,000 ppb Cr(VI) or Cr(T), 50 ppb Cr(T), 10 ppb Cr(VI) or Cr(T), 3.1 ppb Cr(VI) or 3.2 ppb Cr(T). Plume boundary lines must be drawn to connect any monitoring well located within one-half mile (2,600 ft) of any other monitoring well having chromium concentrations of 3.1 ppb Cr(VI) or 3.2 ppb Cr(T) or greater. The dashed line representing the inferred chromium boundary of 3.1 ppb Cr(VI) or 3.2 ppb Cr(T) shall be a dark color so as to stand out.

i. Where access to private property or endangered species habitat has not been granted for six months or more, the chromium plume boundary shall be drawn around any domestic well containing chromium concentrations exceeding 3.1 ppb Cr(VI) or 3.2 ppb Cr(T) for at least two consecutive quarters and within one-half mile distance of the prior quarter's plume boundary. The map shall denote concentration isocontour lines with a hash mark to indicate uncertainty in these areas.

g. Domestic wells having chromium concentrations exceeding maximum background levels and which recently become inactive can be removed from maps only if a monitoring well exists and is monitored within one-quarter mile distance of that domestic well.
h. If PG&E believes that chromium data in groundwater is not related to its historic chromium discharges and should not be drawn in the plume boundary, it must use data collected within the past three years to make its argument.

3. **Report Content:**
   a. Description of methods and actions for installing wells.
   b. Laboratory results:
      i. Sample results showing a difference of 25% or greater between Cr(VI) and Cr(T) concentrations shall be re-tested and the ensuing results described.
   c. Interpretation of chromium plume boundary.
   d. If the chromium plume boundary is undefined in certain areas (sampling locations are more than one-quarter mile distance), propose additional sampling locations and implementation schedule.
   e. Include boring logs and well designs.
   f. Geologic cross sections across the northern plume extent (from Salinas Road and north).
   g. Discussion of calculated groundwater flow direction and velocity.

4. **Plume Map Submittals:**
   a. Chromium plume maps must be submitted to the Water Board in digitized form (such as a pdf document) within **one** working day of the report due date. At least one of the submitted maps shall be printable on 81/2 in by 11 inch paper.

5. **Geotracker Submittals:**
   a. Report must be uploaded to the State Water Resources Control Board's Geotracker database, within **one** working day of the report due date.

II. Groundwater Monitoring Reports

Beginning with the third quarter 2013 quarterly groundwater monitoring report for site-wide and domestic well monitoring, due by **October 30, 2013,** and every quarter (three months) thereafter, the Discharger must include applicable information for maps and reports as described above in Paragraphs C.1., C.2., and C.3. Chromium plume maps and Geotracker submittals shall be implemented according to the due dates described in Paragraphs C.4. and C.5.

III. Laboratory Analysis

Testing for total chromium analyses must be done using US EPA Methods 6010B or 6020A to a reporting limit of 1 ppb. Testing for hexavalent chromium must be conducted in accordance with US EPA Method SW 218.6 with a reporting limit of 0.1 ppb. All future analyses of water samples must utilize the most recent testing methods with the lowest available reporting limits. The laboratory used must be certified by the California Environmental Laboratory Accreditation Program (ELAP).

IV. Liability for Oversight Costs Incurred by the Water Board

The Discharger shall be liable, pursuant to Water Code section 13304, to the Water Board for all reasonable costs incurred by the Water Board to investigate unauthorized discharges of waste, or to oversee cleanup of such waste, abatement of the effects thereof, or other remedial action, pursuant to this Order. The Discharger shall reimburse the Water Board for all reasonable costs associated with site investigation, oversight, and cleanup to include the cost of split sample collection and analyses. Failure to pay any invoice for the Water Board's investigation and oversight costs within the time stated in the invoice (or within thirty days after the date of invoice, if the invoice does not set forth a due date) shall be considered a violation of this Order. If the Property is enrolled in a State Water Board-managed reimbursement program, reimbursement shall be made pursuant to this Order and according to the procedures established in that program.

V. Certifications for all Plans and Reports

All technical and monitoring plans and reports required in conjunction with this Order are required pursuant to Water Code section 13267 and shall include a statement by the Discharger, or an authorized representative of the Discharger, certifying (under penalty of perjury in conformance with the laws of the State of California) that the workplan and/or report is true, complete, and accurate. Hydrogeologic reports and plans shall be prepared or directly supervised by, and signed and stamped by a Professional Geologist or Civil Engineer registered in California. It is expected that all interpretations and conclusions of data in these documents be truthful, supported with evidence, with no attempts to mislead by false statements, exaggerations, deceptive presentation, or failure to include essential information.

VIII. No Limitation of Water Board Authority

This Order in no way limits the authority of this Water Board to institute additional enforcement actions or to require additional investigation and cleanup of the site consistent with the Water Code. This Order may be revised by the Executive Officer or Water Board representative as additional information becomes available.

IX. Enforcement Options

Failure to comply with the terms or conditions of this Order will result in additional enforcement action that may include the imposition of administrative civil liability pursuant to Water Code sections 13268 and 13350 or referral to the Attorney General of the State of California for such legal action as she may deem appropriate.

X. Right to Petition

Any person aggrieved by this action of the Lahontan Water Board may petition the State Water Resources Control Board (State Water Board) to review the action in accordance with Water Code section 13320 and California Code of Regulations, title 23, section 2050 and following. The State Water Board must receive the petition by 5:00 p.m., 30 days after the date of this Order, except that if the thirtieth day following the date of this Order falls on a Saturday, Sunday, or state holiday, the petition must be received by the State Water Board by 5:00 p.m. on the next business day. Copies of the law and regulations applicable to filing petitions may be found on the Internet at: http://www.waterboards.ca.gov/public_notices/petitions/water_quality or will be provided upon request.

Patty Z. Kouyoumdjian (signature) — January 8, 2013

Patty Z. Kouyoumdjian
Executive Officer

Date

ATTACHMENT 2:

WESTERN STUDY REPORT EXCERPT

FULL REPORT AVAILABE ON GEOTRACKER

(http://geotracker.waterboards.ca.gov/esi/uploads/geo_report/6010085344/SL0607111288.PDF)

Pacific Gas and Electric Company

Kevin Sullivan
Hinkley Remediation Project Manager
Shared Services

3401 Crow Canyon Road
San Ramon, CA 94583
(925) 415-2615 (office)
kmsu@pge.com

January 14, 2013

Lauri Kemper
Lisa Dernbach
Planning and Toxics Division
California Regional Water Quality Control Board
Lahontan Region
2501 Lake Tahoe Boulevard
South Lake Tahoe, California 96150

Subject: Conceptual Site Model for Groundwater Flow and the Occurrence of Chromium in Groundwater of the Western Area, Pacific Gas and Electric Company, Hinkley Compressor Station, Hinkley, California

Dear Ms. Kemper and Ms. Dernbach:

Enclosed is Pacific Gas and Electric Company's (PG&E's) report titled *Conceptual Site Model for Groundwater Flow and the Occurrence of Chromium in Groundwater of the Western Area, Pacific Gas and Electric Company, Hinkley Compressor Station, Hinkley, California*. This report presents the chromium data collected from the newly installed monitoring wells in this area. In addition, this report presents the results of an evaluation of historical and recent groundwater level data, historical agricultural land use information (through a review of aerial photographs), and geochemical data.

Based on the water quality and water level data from the newly installed monitoring wells and historical information from the investigation areas (water levels and aerial photographs), it is evident that the chromium detected in the monitoring and domestic wells to the southwest, west and northwest of the Hinkley Compressor Station is naturally occurring and not associated with PG&E's chromium plume. First and foremost, the current and historical water level data contained in USGS, DWR and university reports confirm that groundwater levels in this area have been, and continue to be, substantially higher (up to 50 feet) compared with water levels within the chromium plume; the Lockhart Fault likely plays an important role in maintaining higher water levels in this area. Aerial photographs confirm that neither substantial agricultural nor domestic groundwater pumping was ever conducted in the area to the west of the chromium plume that would have lowered these groundwater levels. Second, chromium data from newly installed upper aquifer monitoring wells on the southwest (upgradient) side of the fault indicate chromium levels up to 8.0 micrograms per liter (µg/L) at locations that are, and historically have been, upgradient of the chromium plume. A reasonable hypothesis is that the local geologic conditions in this area are conducive to naturally occurring chromium above the established background levels. PG&E intends to conduct further studies in this area to understand why the naturally occurring chromium levels are elevated compared with other areas that have been investigated to date.

In February 2012, PG&E submitted the *Work Plan for Evaluation of Background Chromium in the Groundwater of the Upper Aquifer in the Hinkley Valley* (February 2012 Background Study Work Plan) to the California Regional Water Quality Control Board, Lahontan Region Water Board) for a study to evaluate background levels by installing and sampling additional monitoring wells throughout the Hinkley Valley; the results presented herein are in part the beginnings of this important evaluation. The presence of naturally occurring chromium in the investigation area monitoring wells considerably above the currently established background levels (3.1 µg/L for hexavalent chromium and 3.2 µg/L for total chromium) suggests similar conditions likely occur in other areas where PG&E is currently conducting investigations. We look forward to discussions with the Water Board, the United States Geological Survey, and the Community Advisory Committee Independent Review Panel Manager on January 16, 2013, to discuss the February 2012 Background Study Work Plan and their recent comments. We plan to submit a Revised Background Study Work Plan shortly thereafter, and we look forward to further implementation of the study during 2013 to continue our understanding of naturally occurring chromium.

Sincerely,

Kevin Sullivan
Hinkley Remediation Project Manager, Shared Services

Enclosure

Report

Conceptual Site Model for Groundwater Flow and the Occurrence of Chromium in Groundwater of the Western Area Pacific Gas and Electric Company Hinkley Compressor Station, Hinkley, California

Prepared for

California Regional Water Quality Control Board, Lahontan Region

On behalf of

Pacific Gas and Electric Company

January 14, 2013

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Conceptual Site Model for Groundwater Flow and the Occurrence of Chromium in Groundwater of the Western Area

Pacific Gas and Electric Company, Hinkley Compressor Station, Hinkley, California

Prepared for

California Regional Water Quality Control Board,
Lahontan Region

on behalf of

Pacific Gas and Electric Company

January 14, 2013

This report was prepared under the supervision of
California Professional Geologists

PROFESSIONAL GEOLOGIST
ISAAC ARABY WOOD
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STATE OF CALIFORNIA

Isaac A. Wood, P.G., CH2M HILL

January 14, 2013
Date

REGISTERED GEOLOGIST
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STATE OF CALIFORNIA

Chris R. Maxwell, P.G., Stantec

January 14, 2013
Date

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Acronyms and Abbreviations

95 UTL	95 percent upper tolerance limit
δ	delta
δD	delta deuterium
δ16O	delta oxygen-16
δ18O	delta oxygen-18
μg/L	micrograms per liter
AU	Agricultural Unit
Amended CAO	Amended Cleanup and Abatement Order No. R6V-2011-0005A2
Background Study	*Groundwater Background Study Report, Hinkley Compressor Station, Hinkley, California*
bgs	below ground surface
CAO	Cleanup and Abatement Order
Cr (III)	trivalent chromium
Cr(T)	total chromium
Cr(VI)	hexavalent chromium
DO	dissolved oxygen
DVD	Desert View Dairy
DVD LTU	Desert View Dairy Land Treatment Unit
DWR	California Department of Water Resources
FS Report	*Replacement Water Feasibility Study Report, Hinkley Compressor Station, Hinkley California*
LTU	Land Treatment Unit
MCL	maximum contaminant level
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
mil	parts per thousand
MSL	mean sea level
NWFI	Northwest Freshwater Injection
ORP	oxidation reduction potential
PG&E	Pacific Gas and Electric Company
ppt	parts per thousand
Preliminary Report	*Preliminary Reporting of Geology and Hydrology for Investigations in the Western Area*
redox	reduction-oxidation

SWRCB	State Water Resources Control Board
TDS	total dissolved solids
USGS	United States Geological Survey
VSMOW	Vienna Standard Mean Ocean Water
Water Board	California Regional Water Quality Control Board, Lahontan Region
WWRW	whole house replacement water

Executive Summary

On November 19, 2012, the Pacific Gas and Electric Company (PG&E) submitted to the California Regional Water Quality Control Board, Lahontan Region (Water Board) the *Preliminary Reporting of Geology and Hydrology for Investigations in the Western Area* (Preliminary Report; Stantec, 2012c). The Preliminary Report presented the geologic and hydrologic data collected from the newly installed wells without chromium data because these data were not available at the time of submittal; however, this report presents the chromium data collected from newly installed Western Area wells. In addition, this report also presents and evaluates the following: historical land use information (through a review of aerial photographs) to estimate areas where extensive groundwater withdrawals have occurred over time; historical and recent groundwater level data; and new geochemical data for the Western Area.

Following are the key findings of this evaluation:

- Current and historical groundwater levels to the west of PG&E's chromium plum are—and have historically been—substantially higher (up to 50 feet) compared with water levels in the plume areas. Studies published by others and discussed herein, including the California Department of Water Resources (DWR) and the United States Geological Survey (USGS), strongly support this conclusion. Aerial photographs presented herein confirm that neither substantial agricultural nor domestic groundwater pumping that could have lowered groundwater levels occurred in the areas to the west of the plume. Groundwater flow is currently—and historically (since at least 1950) has been—from southwest to northeast in this area. Chromium associated with the PG&E plume could not feasibly have moved to area of the newly installed monitoring wells.
- Chromium, both hexavalent (Cr[VI]) and total dissolved (Cr[T]), is present in the newly installed western area upper aquifer monitoring wells at levels considerably higher than the established background levels of 3.1 micrograms per liter (µg/L) and 3.2 µg/L, respectively. CrVI was detected up to 8.0 µg/L in a newly installed monitoring well (MW-163S) located more than 1 mile west of PG&E's plume. The current and historical water-level information confirm that the chromium at MW-163S, and several other newly installed monitoring wells to the west, is not associated with the plume but, rather, is naturally occurring.
- Geochemical data presented herein suggest groundwater conditions to the west of PG&E's chromium plume differs from conditions in the plume areas. Well MW-163S is located immediately adjacent to a bedrock outcrop of dioritic gneiss that appears to contain abundant mafic minerals that could be associated with naturally occurring chromium levels. In February 2012, PG&E submitted to the Water Board the *Work Plan for Evaluation of Background Chromium in the Groundwater of the Upper Aquifer in the Hinkley Valley* (February 2012 Background Study Work Plan; Stantec, 2012b). The information presented herein confirms that naturally occurring chromium is present in groundwater of the Hinkley Valley considerably higher than the established background levels.

In summary, the information presented herein confirms that chromium is present in groundwater to the west of the PG&E plume at naturally occurring concentrations considerably higher than the established background levels. Domestic wells in this area with chromium above the established background levels have not been affected by the plume but, rather, represent the natural conditions. Natural conditions that are conducive to naturally occurring chromium as observed in this Western Area are likely present in other areas of the Hinkley Valley. The natural chromium conditions should be fully evaluated through implementation of the Revised Background Study.

SECTION 1

Introduction and Background Information

This report was prepared in response to the detection of hexavalent chromium (Cr[VI]) and total chromium (Cr[T]) in Western Area monitoring and domestic wells at concentrations exceeding the established maximum background concentrations of 3.1 and 3.2 micrograms per liter (µg/L), respectively, as reported in the *Groundwater Background Study Report, Hinkley Compressor Station, Hinkley, California* (Background Study; CH2M HILL, 2007). This report presents the chromium data collected from newly installed monitoring wells (Table 1) in the Western Area, defined herein as the area west of the Pacific Gas and Electric Company (PG&E) groundwater chromium plume associated with PG&E's Hinkley Compressor Station (CH2M HILL, 2012). In addition, this report presents an evaluation of historical and recent groundwater level data, historical agricultural land use information (through a review of aerial photographs), and geochemical data. Figure 1 shows the location of Western Area wells, the Hinkley Compressor Station, and other site features.

1.1 Introduction

On May 8, 2012, PG&E submitted to the California Regional Water Quality Control Board, Lahontan Region (Water Board) the *Work Plan for Installation of Upper Aquifer Monitoring Wells to the west of Mountain View Road* (Stantec, 2012a). Following were the three primary objectives of the proposed work scope:

- Evaluate groundwater gradients in the Western Area, particularly in the vicinity of the Lockhart Fault.
- Collect groundwater samples for laboratory analyses for Cr(VI) and Cr(T).
- Initiate the installation of wells to be used to support the *Work Plan for Evaluation of Background Chromium in the Groundwater of the Upper Aquifer in the Hinkley Valley* (February 2012 Background Study Work Plan; Stantec, 2012b).

With verbal concurrence from the Water Board, the scope of work proposed in the work plan was initiated in August 2012, and monitoring well installation, groundwater sampling, and laboratory analysis of chromium samples has been completed. On November 19, 2012, PG&E submitted to the Water Board the *Preliminary Reporting of Geology and Hydrology for Investigations in the Western Area* (Preliminary Report; Stantec, 2012c), which presented the geologic and hydrologic data collected from the newly installed wells; the chromium data was not yet available when the report was submitted.

1.2 Report Organization

This report presents available recent and historical geologic, hydrogeologic, and geochemical data as a comprehensive conceptual site model for groundwater flow and chromium occurrence in the Western Area. This report is organized as follows:

- **Section 1, Introduction and Background Information,** states the goals of the report and summarizes relevant previous investigations of the Western Area.
- **Section 2, Hydrogeologic Features and Current Conditions,** describes the aquifers and local-scale hydrostratigraphic units, summarizes results of research by others of the influence of the Lockhart Fault on groundwater movement, and presents recent data used to compute current hydraulic gradients and groundwater flow directions in the Western Area.
- **Section 3, Historical Hydrogeologic Conditions,** evaluates hydrogeologic conditions in the Western Area from the time the Hinkley Compressor Station became operational to present and interprets them based on review of available historical groundwater level data from several sources, information regarding past groundwater withdrawals in the Hinkley basin, and groundwater modeling conducted by the United States Geological Survey (USGS).

- **Section 4, Distribution of Chromium and Geochemical Conditions,** presents recent chromium concentration data and interprets other geochemical parameter data to identify potential source areas for chromium detected in groundwater in the Western Area.
- **Section 5, Summary of Conceptual Site Model for Groundwater Flow and Chromium Occurrence in Western Area,** summarizes the key points of the evaluation of current and historical hydrogeologic conditions, current distribution of chromium, and other relevant geochemical data into a conceptual site model for the distribution of chromium in the Western Area.
- **Section 6, Works Cited,** provides data sources and references to other sources of information used to prepare this report.

1.3 Relevant Prior Investigations of the Western Area

Four previous hydrogeologic evaluations conducted in the Western Area provided information that influenced the Western Area investigation (Stantec, 2012c) and conceptual site model development. These previous evaluations are summarized below.

1.3.1 Study of Background Chromium in the Hinkley Valley

On February 28, 2007, PG&E submitted the Background Study (CH2M HILL, 2007), which concluded that the 95 percent upper tolerance limit (95 UTL) concentrations for Cr(VI) and Cr(T) concentrations in the Hinkley Valley are 3.09 and 3.23 µg/L, respectively. As a result of the Background Study, the Water Board established background levels of 3.1 µg/L for Cr(VI) and 3.2 µg/L for Cr(T) for subsequent multiple investigation and evaluation efforts conducted by PG&E since 2007. In 2011, the Water Board submitted the Background Study for independent peer review. In summary, the peer reviewers expressed concerns regarding the methods of the Background Study and suggested that the established Cr(VI) and Cr(T) background values may not be representative of the entire area or Upper versus Lower aquifers in the Hinkley basin.

In February 2012, PG&E submitted to the Water Board the February 2012 Background Study Work Plan (Stantec, 2012b). One of the methods proposed for determining background chromium concentrations in the Hinkley Valley included installing and sampling Upper Aquifer monitoring wells at approximately 32 locations on a gridded pattern. Six of the nine locations where drilling was conducted during the Western Area investigation are located in areas identified for well construction in the February 2012 Background Study Work Plan (Stantec, 2012b).

1.3.2 Domestic Well 34-65

On June 28, 2011, PG&E submitted to the Water Board a technical memorandum that evaluated hydrogeologic and hydraulic gradient (groundwater flow) data between domestic well 34-65 (Figure 1) and PG&E's Hinkley Compressor Station (CH2M HILL, 2011a). This memorandum was submitted at the request of the Water Board to investigate chromium concentrations in domestic well 34-65 above the established background concentrations. At the request of the Water Board (July 28, 2011), a revised technical memorandum was submitted to the Water Board on September 2, 2011 (CH2M HILL, 2011b). The revised memorandum summarized groundwater modeling results for the Hinkley Valley from the USGS (Stamos et al., 2001) and presented additional groundwater elevation data. The findings of the revised technical memorandum recognized that historical and recent groundwater flow direction is from the southwest to the northeast and that chromium detected In well 34-65 is naturally occurring.

1.3.3 Evaluation of Lower Aquifer Conditions in the Western Area

On April 9, 2012, a *Replacement Water Feasibility Study Report, Hinkley Compressor Station, Hinkley California* (FS Report) was submitted to the Water Board by PG&E (ARCADIS, 2012a). The FS Report provided an evaluation of whole house replacement water (WWRW) options for residences with domestic and private supply wells with chromium concentrations above established background concentrations near the chromium plume. In response to verbal comments from Water Board, a revised FS Report was submitted to the Water Board on June 6, 2012 (ARCADIS, 2012b), and on June 7, 2012, the Water Board issued Amended Cleanup and Abatement Order No. R6V-2011-0005A2 (Amended CAO) approving the revised FS Report. One of the six WWRW alternatives presented involved drilling of a new water supply well into the Lower Aquifer for qualifying residents (Alternative 5). A portion of the Western Area was identified by the Water Board that could meet the criteria for domestic Lower Aquifer water supply. PG&E installed and sampled three Lower Aquifer monitoring wells (MW-158C, MW-159C, and MW-160C) in the Western Area to assess the geology and groundwater quality. The Preliminary Report presented the geologic information collected from these well borings. The groundwater quality data for these wells is presented in *Third Quarter 2012 Groundwater Monitoring Report and Domestic Well Sampling Results* (CH2M HILL, 2012).

1.3.4 Preliminary Reporting of Geology and Hydrology

On November 19, 2012, PG&E submitted the *Preliminary Reporting of Geology and Hydrology for Investigations in the Western Area* (Stantec, 2012c). The Preliminary Report presented the groundwater level and geologic information collected from newly installed monitoring wells (19 Upper Aquifer wells and 3 Lower Aquifer wells). Groundwater level data for other nearby monitoring wells were also included. The data presented in the Preliminary Report confirmed that the current groundwater flow direction in the Western Area is from the southwest to the northeast. Further, the groundwater levels measured in the newly installed wells were considerably higher (by up to 50 feet) than groundwater levels measured at monitoring wells located at the western limits of the Hinkley Compressor Station chromium plume.

SECTION 2

Hydrogeologic Features and Current Conditions

This section summarizes key hydrogeologic features and conditions that influence the occurrence and movement of groundwater in the Western Area. Figure 2 shows a generalized cross-sectional block diagram of the Western Area groundwater levels and flow direction and key conceptual site model features.

2.1 Hydrostratigraphic Units

Hydrostratigraphic units found in the Western Area include the Upper Aquifer, blue clay (Lower Aquifer confining clay layer), and the Lower Aquifer.

2.1.1 Upper Aquifer

The lithology of the Upper Aquifer (shallow and deep zones) is highly variable due to the layers being deposited in a fluvial and alluvial environment. Grain size can vary from coarse- to fine-grained over short distances laterally and vertically. These geological conditions complicate the transport and distribution of chromium in groundwater. The Upper Aquifer in the Western Area consists of unconsolidated coarse-grained (primarily medium- to coarse-grained sand) and fine-grained (primarily silt) sediments. The coarse-grained sediments contain varying degrees of fine sand, silt, and clay, with minor amounts of gravel in some locations. The fine-grained sediments contain varying amounts of fine sand and clay, which results in heterogeneous and locally complex hydrogeologic conditions. The origin of the sediments is generally fluvial in nature (California Department of Water Resources [DWR], 1983); some geologic facies exhibit lateral connectivity, while others are highly discontinuous over short distances. The Upper Aquifer thins toward the bedrock outcrops in Western Area (Figure 5, geologic cross-section A-A'). Figure 5 illustrates in cross-sectional view the Upper Aquifer in relation to the other hydrostratigraphic units in the Western Area.

2.1.2 Blue Clay

The base of the Upper Aquifer is defined across much of the site by a blue clay aquitard; the origin of these sediments is likely a shallow playa lake (DWR, 1983). Where present, the depth to the aquitard is variable across the central and eastern Hinkley Valley, generally ranging from about 140 feet below ground surface (bgs) at the shallowest locations to the west, to 170 feet bgs at the deepest locations to the east. Newly constructed Lower Aquifer wells (MW-158C, MW-159C, and MW-160C) illustrated on Figure 5 geologic cross-sections B-B' and D-D' show that the blue clay thins to the west and is absent (i.e., pinches out) in the far western areas of the site. Recent boring logs (MW-158C, MW-159C, and MW-160C) in the Western Area show the blue clay varies in thickness from 5 to 25 feet and occurs approximately 115 to 130 feet bgs (Stantec, 2012c).

2.1.3 Lower Aquifer

The Lower Aquifer consists of sediments between the base of the blue clay and the top of the consolidated bedrock. In borings where the Lower Aquifer was encountered by PG&E, the sediments appear to be composed of weathered bedrock and colluvium (i.e., eroded and redeposited bedrock detritus). The thickness of the weathered rock is variable, generally ranging from a few feet to upwards of 20 feet. The Lower Aquifer consisting of unconsolidated sediments and/or weathered bedrock below the blue clay is shown on Figure 5 geologic cross-sections. Recent boring logs in the Western Area wells show the following:

- **MW-158C** –Alluvium of the Lower Aquifer, consisting of gravelly sand with clay, clayey sand, and sand, was encountered from 137 to 143 feet bgs. Weathered bedrock was encountered from 143 to 149 feet bgs below the alluvium of the Lower Aquifer.
- **MW-159C** –Weathered bedrock was encountered from 127 to 162 feet bgs and included fine-grained, sandy clay and clayey sand layers.
- **MW-160C** –Weathered bedrock was encountered from 157 to 190 feet bgs.

2.2 Bedrock

The Lower Aquifer consists of weathered bedrock, and bedrock is also present at ground surface in portions of the Western Area. Figure 3 shows bedrock outcrops mapped by Dibblee (2008) in and near the Western Area. These outcrops consist of diorite and metamorphic rocks (gneiss, marble, and quartzite). Figure 1 shows that Iron Mountain is located further west of these bedrock outcrops and comprises primarily metamorphic rocks, including schist, marble, quartz-biotite, and metavolcanic rocks (Boettcher, 1990).

Bedrock is likely heterogeneous (Boettcher, 1990), and although groundwater might flow through bedrock in fractures and thin weathered zones, there is no evidence that it does so in sufficient quantity for bedrock to be considered an aquifer. Figure 4 shows locations for Western Area geologic cross-sections A-A' to F-F', and the cross-sections themselves are depicted in Figure 5 (Stantec, 2012c).

2.3 Influence of the Lockhart Fault

The Lockhart Fault is a right-lateral strike slip fault (Amoroso and Miller, 2012). The projection of the Lockhart Fault as illustrated on figures in the Amoroso and Miller report is drawn as reported by the USGS and is shown to be concealed beneath alluvium in the Western Area; no obvious surface expression of the fault was observed. The location of the Lockhart Fault where a surface expression is not visible in the Hinkley Valley is inferred from fault features observed in bedrock outcrops further to the northwest and southeast of the Hinkley Valley. As discussed in the Preliminary Report (Stantec, 2012c), the bedrock surface topography suggests the presence of a structural trough that may coincide with the fault's location.

Historical groundwater elevation data in the Hinkley Valley suggest the presence of a partial barrier to groundwater flow along the Lockhart Fault's inferred projection. The following provides quotations from the reports by DWR, USGS, and the California State University-Fullerton regarding the hydrogeologic effects of the fault:

> *"The Lockhart fault impedes the movement of ground water in the Harper Basin and in older alluvium within Hinkley Valley in the Middle Mojave Basin. Although the paucity of water wells in the Harper Basin precludes quantitative estimates of this impediment, the generally higher level of the water table southwest of the fault suggests the fault impedes ground water flow...Although there is no surface trace of the Lockhart fault in Hinkley Valley, the extension of the trace from Harper Basin coincides with the southwest flank of a deep pumping hole in Hinkley Valley. The steep gradient of that flank indicates an effective impediment to ground water flow."* (DWR, 1967)

> *"Although there is no surface trace of the Lockhart fault in the Hinkley area, the extension of its trace from Harper Basin coincides with the southwest flank of a pumping depression in the Hinkley area. The steep gradient of that flank indicates an impediment to groundwater flow. Because the Lockhart fault does not extend to the land surface in the Hinkley area, some water moves through the alluvial fill over the top of the fault. Groundwater level data for 1978 indicate that, on the southwest side of the fault, higher water levels occur, with a drop of about 50 feet across the Lockhart fault...The 1978 water level contours show thot southwest of the Lockhart fault, groundwater movement is still northeasterly."* (DWR, 1983)

> *"'The Lockhart Fault cuts through the northern part of Iron Mountain and extends south of Harper Lake through Hinkley Valley and into the unconsolidated rocks south of the Mojave River in the Centro subarea. This fault appears to impede the movement of ground water in the regionol and the floodplain aquifers although there is no evidence of this effect in the floodplain aquifer along the river (Gregory C. Lines, U.S Geological Survey, oral communication., 1996).' No surface water was noted along the Mojave River that could be attributed to hydrologic influence of a fault barrier."* (Stamos et al., 2001)

> *"The Lockhart fault zone is documented to impede and affect groundwater flow (DWR, 1967). This northwest-southeast trending fault extends northwest from the southwest flank of the Fry Mountains 70 mi (113 km) to the northwest of Harper Lake Basin. Although the lack of water wells in Harper Lake Basin precludes quantitative estimates of this impediment, the higher water table level southwest of the fault suggests the fault impedes groundwater flow."* (California State University-Fullerton, 2007)

In summary, each report concluded that the Lockhart Fault is present beneath the buried alluvial materials in the Hinkley Valley and likely impedes groundwater flow. Current groundwater elevations (Figures 6 and 7) indicate that groundwater flows from the southwest to the northeast across the Lockhart Fault. Section 3 discusses groundwater flow conditions during the past several decades.

2.4 Current Hydrogeologic Conditions

Current hydrogeologic conditions consisting of horizontal and vertical gradients measured in October and November 2012 (Fourth Quarter) are presented in the following subsections.

2.4.1 Horizontal Gradients

Current hydrogeologic conditions are defined by measured groundwater elevation data collected during Fourth Quarter 2012. The depth to groundwater in the Upper Aquifer, as measured in the monitoring wells installed by PG&E throughout the Hinkley Valley, ranges from approximately 65 to 100 feet bgs. The saturated Upper Aquifer thickness ranges from approximately 15 feet where bedrock is relatively shallow in the Western Area to upwards of 100 feet thick where the top of the blue clay is relatively deep (170 to 180 feet bgs) in the central and eastern Hinkley Valley.

Groundwater in the Upper Aquifer of the central and eastern portion of the Hinkley Valley generally flows in a north-northwesterly direction from the Hinkley Compressor Station site 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. 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 4 feet per day (Haley and Aldrich, 2010 and 2011)

Groundwater elevations, including newly constructed Western Area wells, were measured site-wide during October and November 2012. As shown on Figure 6, the horizontal hydraulic gradients estimated from the groundwater level data show groundwater flow in the shallow zone of the Upper Aquifer is generally northeasterly in the Western Area. A notable exception to this pattern occurs near the Northwest Freshwater Injection (NWFI) Area, where groundwater levels are relatively high compared to the surrounding area and outward radial flow occurs from the injection wells. East of the Western Area, the hydraulic gradient generally shifts north toward groundwater extraction wells on the Desert View Dairy (DVD) and former Gorman properties.

Figure 7 shows groundwater flow directions and gradients in the deep zone of the Upper Aquifer. The hydraulic gradients in the deep zone are very similar to those in the shallow zone. Mounding along the NWFI area is less noticeable possibly due to fewer monitoring points, and the cones of depression around groundwater extraction wells are more pronounced.

2.4.2 Vertical Gradients

Vertical hydraulic gradients listed in Table 2 for the Western Area were computed from November 2012 groundwater level data in order to help understand groundwater movement in the area (Figure 8). Wells appended with "S" or "D" are completed in the Upper Aquifer, and wells appended with "C" are completed in the Lower Aquifer. Vertical hydraulic gradients do not appear to be consistent across the Western Area, either within the Upper Aquifer (between "S" and "D" wells) or between the Upper and Lower Aquifer (between "S" or "D" and "C" wells).

Well nests MW-158, MW-159, and MW-160 all have completions above and below the blue clay. Vertical hydraulic gradients across the blue clay at MW-158 and MW-160 are upward, with the magnitude of gradient much larger at MW-158 located downgradient (northeast) of the Lockhart Fault. At MW-159, on the upgradient (southwest) side of the mapped fault, the vertical hydraulic gradient is downward across the blue clay.

Within the Upper Aquifer, downward vertical gradients are more prevalent toward the north and within the plume boundary near Highway 58 and Santa Fe Avenue. The downward vertical gradients are likely the result of remediation pumping (which generally occurs in the lower zone of the Upper Aquifer) or freshwater injection (which primarily occurs over the upper portion of the Upper Aquifer). Near the compressor station and along the west side of the fault, gradients are upward.

SECTION 3

Historical Hydrogeologic Conditions

This section presents information relating to historical hydrogeologic conditions in the Hinkley Valley, from the early 1950s through 2009. The data presented include a detailed evaluation of aerial photographs to estimate the extent of agricultural activities in the Western Area portion of the Hinkley Valley, groundwater gradient analysis for wells with historical water level data, and estimates of historical hydraulic gradients and groundwater flow directions from previously published reports.

3.1 Aerial Photography and Historical Groundwater Pumping

Historically, the primary use of groundwater in the Hinkley Valley has been irrigated agriculture, with substantially smaller quantities used for industrial and domestic purposes. No significant surface water sources have been available; therefore, groundwater withdrawals in the Hinkley area are directly proportional to irrigated acreage, which can be estimated from aerial photographs. Most of the irrigated land in the Western Area and central part of the Hinkley Valley (north from the Hinkley Compressor Station) has been supplied with groundwater withdrawn from water supply wells located on or adjacent to each field and commonly applied to the fields via either furrow irrigation (more common in the 1950s and 1960s) or by using an agricultural pivot centered about an irrigation well. Therefore, analyzing historical irrigation acreage provides valuable insight into long-term groundwater gradient trends in place of having complete water level records. As a result, although groundwater pumping rates have not always been reported by water users in the Hinkley Valley, annual groundwater withdrawals can be approximated and computed based on irrigated acreage that is visible on aerial photographs.

Appendix A-1 provides aerial photographs for years 1952, 1954, 1958, 1965, 1968, 1970, 1971, 1984, 1989, 1994, and 2002. These photographs were evaluated to estimate the extent of agricultural land use in the Western Area, and they show agricultural land use predominantly occurring in the central and eastern portions of the Hinkley Valley, with very limited agricultural land use occurring in the Western Area.

In 2004, PG&E submitted the *Work Plan—Revised Background Chromium Study at the PG&E Compressor Station, Hinkley, California* (CH2M HILL, 2004). Appendix B, Figure B-3, from this work plan shows estimated groundwater pumping in the Hinkley Valley over this time period (1950s to early 2000s), based on a review of historical aerial photographs depicting land use (i.e., land in agricultural production was assumed to have active groundwater pumping); this figure is included as Figure 9 of this report. As shown on Figure 9, most pumping from this time period occurred In the central and eastern portion of the Hinkley Valley.

In 2001, the USGS published the *Simulation of Ground-Water Flow in the Mojave River Basin, California* (Stamos et al., 2001), which presented the results of model simulations for the Mojave River groundwater basins, including the Western Area of the Hinkley Valley, and included assumptions with regards to historical and current uses of groundwater. Figure 10 illustrates USGS assumptions regarding groundwater withdrawals in 1931, 1951, 1971, and 1994. As shown on Figure 10, the USGS concluded that very little groundwater pumping has historically occurred in the Western Area compared with the central and eastern parts of the Hinkley Valley.

3.2 Published Studies Including Hinkley Valley Data

The published historical data presented in this section indicate that Upper Aquifer groundwater flow has consistently been from the southwest towards the northeast in the Western Area, which is comparable with the current groundwater flow conditions presented in Section 2.4 of this report. The following subsections summarize groundwater data by DWR, the USGS, and other researchers, and data that indicate the historical groundwater levels in the central parts of the Hinkley Valley were substantially lower than those in the Western Area, particularly southwest of the Lockhart Fault, during the time periods of substantial pumping in the Hinkley Valley (1950s to 1990s).

3.2.1 California Department of Water Resources (1967)

The California DWR studied the Mojave River groundwater basins and published the results in the Mojave River *Groundwater Basins Investigation, Bulletin 84* (DWR Bulletin 84; DWR, 1967). Groundwater flow near the Western Area determined from 1964 groundwater level is illustrated on Figure 11 of this report. As shown on Figure 11, the groundwater flow in the Hinkley Valley in 1964 was characterized by a hydraulic depression near the central portion of the valley as a result of the agricultural pumping. The hydraulic depression included the areas of the current Desert View Dairy Land Treatment Unit (DVD LTU) and Agricultural Units (AUs), but it does not extend westward across the inferred trace of the Lockhart Fault into the Western Area. Groundwater flow in the Western Area in 1964 is depicted as flowing from the southwest to northeast towards the hydraulic depression. The difference in groundwater elevation from the Western Area to the depression is approximately 60 feet (2,140 to 2,080 feet above mean sea level [MSL]).

3.2.2 California Department of Water Resources (1983)

In June 1983 the California DWR published the *Hydrogeology and Groundwater Quality in the Lower Mojave River Area, San Bernardino County* (DWR, 1983). The report was completed under an interagency agreement with the State Water Resources Control Board (SWRCB), with the following stated purpose:

> *"...to develop information on geohydrology and groundwater quality in the Lower Mojave River Area...to be used in evaluating the potential impact of dairy and other wastes on the location of water resources and in setting waste discharge requirements."*

Figure 11 shows that, in 1978, groundwater elevations were developed for a similar geographic area as shown in the DWR Bulletin 84 (DWR, 1967). Figure 11 shows the groundwater depression in the central portion of the Hinkley Valley was more pronounced when compared with 1964. In contrast, the groundwater elevations depicted in the Western Area appear to be mostly unchanged over this time period. The result is a more pronounced southwest to northeast gradient from the Western Area to the central portion of the Hinkley Valley, with an estimated 100-foot difference in groundwater elevation (2,150 feet in the Western Area when compared with 2,050 feet in the central portion of the hydraulic depression).

3.2.3 United States Geologic Survey (2001)

In 2001, the USGS published *Simulation of Ground-Water Flow in the Mojave River Basin, California* (Stamos et al., 2001). Appendix A-2 contains the figures illustrating simulated drawdown from the USGS model from 1935 to 1999 at 5-year intervals using the Hinkley area as base map. The simulations include the USGS groundwater-pumping assumptions presented on Figure 9. Figure 5 in Appendix A-2 shows that simulated changes (i.e., decline) in groundwater levels in the Hinkley Valley exhibit a pronounced difference on either side of the Lockhart Fault by 1955, which continues through 1999 (Figure 14 in Appendix A-2). Declines are more substantial in the central portion of the Hinkley Valley compared to the Western Area. The simulations are consistent with the DWR groundwater level measurements from 1964 and 1978 (Figure 11).

The differences observed between modeled drawdown in the Western Area and the central portion of the Hinkley Valley is attributed to both the hydraulic effects of the fault and the locations of groundwater pumping wells, which were primarily in the central portion of the Hinkley Valley. The USGS model simulation results (provided in Appendix A-2) indicate that the hydraulic gradient between the Western Area and the central portion of the Hinkley Valley has consistently been from southwest to northeast, became more pronounced (i.e., steep) starting in the early 1950s, and continued through the 1990s as water levels in the central portion of the valley declined more than in the Western Area (Stamos et al., 2001).

3.2.4 Mojave Water Agency and California State University-Fullerton (2007)

In 2007, the California State University-Fullerton prepared, on behalf of the Mojave Water Agency, the *Harper Lake Basin, San Bernardino County, California Hydrogeologic Report* with the following stated purpose: "to provide an overview of previously published data and new data on the geography, climate, geology, hydrology, hydrogeology, and groundwater chemistry of the Harper Lake Basin." The Executive Summary of the report stated the following: "Groundwater recharge comes primarily from underflow from the middle Mojave River Valley basin through a small alluvial divide near Red Hill. Flow through the Red Hill gap is approximately 1,000 acre feet per year."

Because the primary purpose of the study was focused on the Harper Lake area, the data evaluation and presentation for the Hinkley Valley is approached differently than the DWR reports discussed above. Data evaluation is separated into four areas: Mojave River, Center, Southwest, and Northeast. The inferred trace of the Lockhart Fault separates the Southwest and Center Areas in the northern portion of the 2007 report study area. The Mojave River Area includes wells on both sides of the fault; the Western Area and the chromium plume area are both categorized as being in the Mojave River Area.

Figure 12 illustrates the study area for the 2007 report and key physiographic features, including the Mojave River and the Lockhart Fault. Figure 12 shows most of the wells in the Center and Mojave River Areas exhibit substantial changes in water levels over the illustrated time period, particularly starting in the late 1940s and early 1950s. These changes are consistent with areas of observed pumping shown in aerial photographs contained in Appendix A-1 and the hydraulic depression observed in the central portion of the Hinkley Valley by the DWR shown on Figure 11.

Groundwater level changes observed in the Southwest Area as shown on Figure 12 do not appear to coincide with those observed in the Center and Mojave River Areas. Groundwater levels in Southwest Area wells appear to be relatively consistent including the period of 1950 to 1990 when dramatic groundwater level declines were observed in the Center and Mojave River Areas. These observations are consistent with those of the DWR and the USGS, in that groundwater levels to the southwest of the Lockhart Fault were not substantially influenced by the large-scale pumping that occurred in other parts of the Harper Lake basin.

The absence of substantial groundwater level changes in Southwest Area wells does not by itself characterize the Western Area conditions. However, these data do support a conclusion that groundwater levels on the southwest side of the Lockhart Fault have not exhibited the same dramatic changes as those on the northeast side of the fault, and that groundwater flow has consistently been from the southwest to the northeast across the Lockhart Fault towards the current chromium plume area. The fault has played a key role in maintaining relatively high Upper Aquifer groundwater levels in the Western Area during periods of historical agricultural pumping in the central portion of the Hinkley Valley. Historical and current data indicate groundwater levels have been higher on the southwest side of the fault compared to the chromium plume area prior to, during, and after the chromium was released at site.

3.3 Historical Groundwater Elevation Evaluations

Historical groundwater elevation data are available from the USGS (http://nwis.waterdata.usgs.gov/nwis/gwlevels) as well as from PG&E's database of groundwater-level measurements. These data were evaluated to assess historical Western Area groundwater conditions. Figure 13A through 13F show of a series of maps showing the quantity of available groundwater level data in the Hinkley Valley, by decade, starting in the 1950s. Unfortunately, no wells have a record of data spanning the entire time period of interest, from the time the Hinkley Compressor Station began operation in 1952 to present. There is a large gap in data collection in the 1970s and 1980s.

3.3.1 Historical Hydrographs

Available data for selected wells that illustrate groundwater level changes in the Hinkley Valley were evaluated for trends. Figure 13G shows the locations of these selected wells. Hydrographs of historical groundwater elevation data in the Western Area (Figure 13G) are shown on Figure 14; for comparison, hydrographs for wells in the central and eastern parts of the Hinkley Valley are shown on Figure 15. Despite the data gaps, the available data show a much more rapid decline in groundwater elevations in the central and eastern portions of the Hinkley Valley during the 1950s and 1960s than in the Western Area during the same time period. Drawdown in the eastern valley was particularly severe during the 1950s and 1960s, as indicated by the rapid drawdown in the late

1950s and subsequent recovery in the 1980s at well 010N003W26R001S (Figure 17). This level of drawdown and/or recovery is not observed in any well in the Western Area.

Although the number of wells with sufficient data with which to generate informative hydrographs during the 1950s is limited, a comprehensive set of groundwater level measurements from late 1958 and early 1959 is available; these data are posted and contoured on Figure 16. Based on these contours, groundwater flow directions are interpreted to be generally from the southwest towards the northeast in the Western Area, with a large cone of depression in the center of the Hinkley Valley. The Western Area flow directions are very similar to those depicted in Figures 6 and 7.

3.3.2 Well Triplet Gradient and Flow Direction Calculations

Available data from the 1990s to the early 2000s along the western margin of the chromium plume associated with the Hinkley Compressor Station were evaluated in detail using four sets of well triplets to compute flow direction and hydraulic gradient; the data are presented in Figures 17 through 20. While well screen information for all of the wells used in the analysis is not known, typical construction of older wells is either with a shallow screen (upper aquifer) or a long screen (Upper and Lower aquifers). Wells 02-02 (Upper Aquifer), 02-04 (Upper Aquifer), and 03-01A (unknown screen) are all located on the southwest side of the Lockhart Fault, and the computed gradient for data in this area ranges from 0.005 to about 0.002, with flow directions consistently to the northeast (Figure 17). A second triplet that used well 35-05 (Upper Aquifer) on the northeast side of the mapped fault) instead of well 02-04 results in a steeper hydraulic gradient (between 0.003 and 0.004), with direction generally north (Figure 18). A third triplet, shifted east of the second triplet and using wells 35-26 (cross screened) and 35-06 (unknown screen), results in north-to-northeast flow directions, with even steeper gradients (Figure 19). The fourth triplet is further north and uses wells 35-05, 34-06 (cross screened), and 35-06 (to the north of the previous three triplets) and results in a gradient not quite as steep and a flow direction that is northerly (Figure 20).

It is acknowledged that this analysis is qualified as approximate by the lack of uniformity or knowledge of screen interval and by data limitations (the time period only covers a portion of the historical period of interest). However, similar to results of the aerial photograph analysis and interpretations of other investigators regarding historical hydraulic gradients, the triplet analysis indicates a consistent northward-to-northeastward gradient in the Western Area with the available data. It should be noted that the data available for triplet analysis are limited to a small set of wells, albeit in an important part of the Western Area. Calculating hydraulic gradients using this approach typically cannot provide the level of detail provided by groundwater level contour maps developed from a larger number of monitoring wells.

3.3.3 Historical Thickness of Upper Aquifer in Western Area

Figure 21 illustrates geologic cross-section F-F′ from the Preliminary Report (Stantec, 2012c), and illustrates the potentiometric surface from the November 2012 measurements. The base of the Upper Aquifer (the top of the blue clay) reaches an elevation of approximately 2,100 feet above MSL approximately 1,000 feet west of the inferred transect of the Lockhart Fault, and it continues to rise in elevation further to the west and northwest. The groundwater hydrographs for the eastern area shown on Figure 15, illustrated by the DWR (Figure 11), and others suggest historical water levels to the northeast of the Lockhart Fault were equal to, or less than, 2,100 feet above MSL during the time periods of substantial pumping in the Hinkley Valley (1960s to 1990s). These data further support a conclusion that Upper Aquifer groundwater flow has consistently been from southwest to northeast in the Western Area. Westward groundwater flow would require Upper Aquifer groundwater levels to historically have been at an elevation that would not be feasible given the elevation of the blue clay (i.e., the Upper Aquifer would be dry or very thin at such elevations).

3.3.4 Recent Potentiometric Maps

Selected potentiometric maps presented in Groundwater Monitoring Program reports (CH2M HILL 2003, 2006, 2009a, and 2009b) are provided in Appendix A-3. These maps, while limited in available data for the Western Area, show that groundwater flow has been consistently from the north-northwest to north-northeast in recent years. Where data are available southwest of the compressor station, flow directions from the southwest towards the northeast are consistent to those presented on Figures 6 and 7 using 2012 data for newly constructed Western Area monitoring wells.

3.4 Historical Data Summary

The historical data presented in this section indicate that Upper Aquifer groundwater flow has consistently been from the southwest towards the northeast in the Western Area, comparable to the current groundwater flow conditions presented in Section 2.4 of this report. The groundwater data by PG&E, DWR, USGS, and other researchers that has been summarized in the preceding sections indicate that historical groundwater levels in the central and eastern parts of the Hinkley Valley were substantially lower than those in the Western Area, particularly southwest of the Lockhart Fault, during the time periods of substantial pumping in the Hinkley Valley (1950s to 1990s).

Historical aerial photograph analysis suggests that agricultural activity has been significantly limited in the Western Area since 1950 relative to the rest of the Hinkley Valley. Hydraulic gradient analysis using well triplets indicates that the hydraulic gradients were consistently northeastward during the 1990s, when the USGS collected an extensive data set from several wells near the Lockhart Fault. Further, historical westward groundwater flow would have required Upper Aquifer groundwater levels to have been at an elevation that would not be feasible given the elevation of the blue clay, because the currently thin Upper Aquifer in the Western Area would be dry or very thin at such groundwater elevations.

SECTION 4

Distribution of Chromium and Geochemical Conditions

This section summarizes the conditions and processes by which naturally occurring chromium can be dissolved in groundwater of the Western Area and presents the current chromium distribution for this area, including monitoring results for newly constructed monitoring wells. Additionally, this section presents geochemical and stable isotope data that show differences in groundwater characteristics in the Western Area compared to the central part of the Hinkley Valley north of the Hinkley Compressor Station.

4.1 Natural Occurrence of Chromium in Groundwater in the Hinkley Valley

Naturally occurring Cr(VI) is ubiquitous in groundwater systems throughout the Mojave Desert and globally with naturally occurring concentrations sometimes exceeding 50 µg/L in alluvial aquifers in the western Mojave Desert (Izbiki, 2008a, b) and elsewhere in central and southern Arizona (Robertson, 1975 and 1991), and western New Mexico (Robertson, 1991). Throughout the Mojave Desert, chromium occurs naturally in rocks and alluvium at concentrations up to over 1,000 parts per million. 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 naturally occurring chromium in rocks and alluvium with chromium concentrations in groundwater. The results of the USGS investigations are summarized as follows:

- The highest chromium concentrations are generally found in basaltic, ultramafic, and mafic rocks and alluvium containing the mineral chromite. Naturally occurring Cr(VI) concentrations in groundwater of the Mojave Desert above the maximum contaminant level (MCL) of 50 µg/L have been reported in alluvium eroded from these rocks.
- Moderate chromium concentrations are generally found in less mafic, plutonic, metamorphic, and volcanic rocks. Naturally occurring Cr(VI) concentrations up to 36.6 µg/L in groundwater have been reported under these conditions in the Mojave Desert (Ball and Izbicki, 2004; Nishikawa et al, 2004).
- The lowest chromium concentrations are generally associated with highly weathered fluvial deposits such as those found near the Mojave River.

Where trivalent chromium (Cr[III])-containing minerals are present, the ability of manganese dioxides, common in desert environments, to oxidize Cr(III) to Cr(VI) is well established (Bartlett and James, 1979; Eary and Rai, 1987; Fendorf and Zasoski, 1992). In the presence of manganese oxides, chromium-containing mafic minerals can produce Cr(VI) in unsaturated zone pore water and groundwater. Manganese is also associated with the mafic minerals, and the weathered surfaces of rocks and minerals typically contain secondary manganese oxide mineral coatings. Oxidation of Cr(III) to Cr(VI) can occur when pore water or groundwater is in contact with these solids under oxic conditions. A slight amount of Cr(III) is dissolved and becomes oxidized on the surface of the manganese oxides, creating Cr(VI), while manganese is reduced and partially dissolves. As oxidation of Cr(III) proceeds over time, dissolution occurs at the mafic mineral surface and Cr(VI) may be concentrated in the surrounding groundwater.

The alluvium eroded from the diorite and metamorphic rock outcrops near recently constructed wells in the Western Area (Figures 22A, 22B, and 22C) typically contain varying ranges of mafic minerals, such as olivine, pyroxene, amphibole, and biotite. These mafic minerals may contain Cr(III) at concentrations up to 100 milligrams per kilogram (mg/kg) (Independent Environmental Technical Evaluation Group, 2004). The alluvial sediments eroded from the diorite and metamorphic rocks are expected to have higher Cr(III) content than the Mojave River fluvial deposits common within, east and south of the PG&E plume area. Therefore, oxidation of Cr(III) on the surfaces of these minerals to form Cr(VI), which is soluble in groundwater, is more likely in the

Western Area than the southern central and eastern areas of the Hinkley Valley where sediments naturally have lower Cr(III) content.

4.2 Chromium Distribution in Western Area

Table 3 lists 2012 chromium results for groundwater samples obtained from Western Area monitoring wells. Table 3 also includes 2011 and 2012 chromium data for Western Area domestic wells where Cr(VI) or Cr(T) has been reported above the established background levels of 3.1 and 3.2 µg/L, respectively. Chromium results from 2011 were included in Table 3 for domestic wells if chromium concentrations exceeded background levels in 2011 but have not exceeded background levels during 2012 sampling events. Figures 22A, 22B, and 22C show chromium concentrations for the shallow and deep zones of the Upper Aquifer and the Lower Aquifer, respectively. Chromium results shown on Figures 22A, 22B, and 22C include the most recent chromium results for 2012 at monitoring wells and the most recent hexavalent chromium results above 3.1 µg/L in 2011 or 2012 for domestic wells.

In the Western Area of the Upper Aquifer, Cr(VI) concentrations are highest on the southwest side of the Lockhart Fault as shown on Figure 22A for shallow zone monitoring wells MW-159S (6.0 µg/L) and MW-163S (8.0 µg/L), and MW-160D (4.0 µg/L), and on Figure 22B for deep zone Upper Aquifer monitoring well MW-159D (4.2 µg/L). In the Lower Aquifer monitoring wells, Cr(VI) concentrations were not detected above reporting limits on either side of the Lockhart Fault (Figure 22C).

Domestic wells are generally screened across multiple aquifers as shown in cross-sections in Figure 5. For these domestic wells, the source of chromium is most likely from the Upper Aquifer based on the available monitoring well data.

4.3 Geochemical Conditions and Stable Isotopes

The geochemical conditions in the Western Area are different from those in the central and eastern portions of the Hinkley Valley due to different recharge sources, geologic conditions, agricultural influences, and the presence of older groundwater. Most groundwater in the central and eastern portions of the Hinkley Valley, including the PG&E plume area, has been significantly affected by current and historical agricultural operations. The following subsections discuss these differences.

4.3.1 Redox Conditions

Aerobic conditions are generally necessary for Cr(VI) to persist at appreciable levels in groundwater systems. As a result, understanding the reduction-oxidation (redox) conditions present is critical to evaluating horizontal and vertical Cr(VI) distribution. Dissolved oxygen (DO), oxidation reduction potential (ORP), dissolved manganese, and dissolved arsenic have been applied as redox indicator parameters for this evaluation. Table 4 lists DO, ORP, dissolved manganese, and dissolved arsenic data for newly constructed Western Area monitoring wells and other selected wells (well locations are shown on Figure 23). The following convention was generally used for designation of aerobic or anaerobic conditions:

- Aerobic conditions are generally indicated by DO greater than 1 milligrams per liter (mg/L) and ORP greater than -50 millivolts (mV).
- Anaerobic conditions are generally indicated by DO less than 1 mg/L and ORP less than -50 mV.
- Aerobic and/or anaerobic conditions were further assessed by the relative levels of dissolved manganese and/or arsenic present.

Upper Aquifer wells in the Western Area with the shallowest well screens are "S"-designated monitoring wells MW-150 through MW-169, except for MW-160D (which is a shallow zone well) generally have the highest Cr(VI) concentrations (see Section 3.2), exhibit aerobic conditions, and have low concentrations of dissolved manganese and arsenic, as expected in an aerobic environment. Both aerobic and anaerobic conditions are evident in deeper-screened Upper Aquifer monitoring wells in the Western Area ("D"-designated monitoring wells MW-150 through

MW-169, except for MW-160D (which is a shallow zone well). Only one deeper screened well (MW-159D) exhibited Cr(VI) concentrations above 3.1 µg/L during Fourth Quarter (October through December 2012) sampling. Concentrations of dissolved manganese and arsenic were higher in deep zone wells compared to shallow zone wells, and ORP was as low as -217.3 mV (MW-167D).

Generally anaerobic conditions are present in groundwater at the three Lower Aquifer wells constructed in the Western Area (MW-158C, MW-159C, and MW-160C). Cr(VI) concentrations at these three wells are very low (less than 0.26 µg/L), while dissolved arsenic concentrations are above 10 µg/L at all three of these Lower Aquifer wells.

4.3.2 Nitrate and Total Dissolved Solids

Figure 23 presents total dissolved solids (TDS), nitrate, and deuterium stable isotope data for selected monitoring wells in the Western Area and in the central part of the Hinkley Valley known to be impacted by chromium associated with the PG&E Hinkley Compressor Station (data shown in Table 4). As shown on Figure 23, the TDS concentrations in the wells of the central Hinkley Valley are generally twice the levels reported for monitoring locations southwest of the Lockhart Fault, with the highest levels reported for shallow zone water table wells. Nitrate concentrations in the central Hinkley Valley are also consistently greater than wells in the central Hinkley Valley, with the highest levels reported for shallow zone water table wells. At newly constructed water table monitoring wells MW-159S and MW-163S, where the highest Cr(VI) concentrations were reported, the nitrate concentrations are just over 1 mg/L, whereas nitrate concentrations over 7 mg/L are prevalent upgradient of and within the PG&E plume area. There is also a localized area of elevated TDS and nitrate in the area west of Serra Road and north of Santa Fe Avenue; this is likely related to former cattle pen and diary operations in this area.

These data indicate that groundwater in the southwestern area has been considerably less affected, or perhaps unaffected, by historical and more recent agricultural operations as compared to groundwater in the central part of the Hinkley Valley. Because agricultural operations have been ongoing in the central Hinkley Valley since the 1950s (when Compressor Station wastewater was first discharged), it is reasonable to expect that groundwater affected by PG&E chromium would also have TDS and nitrate levels comparable with the levels observed throughout the central Hinkley Valley at present. However, the low TDS and nitrate levels in the monitoring locations southwest of the Lockhart Fault are not comparable; therefore, as the groundwater flow data in Section 3 indicated, it is improbable that Cr(VI) released during historical PG&E operations has migrated cross-gradient to monitoring locations southwest of the Lockhart Fault. These findings are also supported by a review of historical aerial photographs of the Western Area compared with the PG&E plume area and east of the PG&E plume area presented in Section 3.4.1 and Appendix A-1, which show limited agricultural land use in the Western Area during the period of interest.

4.3.3 Stable Isotopes of Oxygen and Deuterium

Most of the world's precipitation originates from the evaporation of seawater, and the ratio of concentrations of oxygen-18 to oxygen-16 (δ18O) and of deuterium (hydrogen-2) to hydrogen-1 (δD), both relative to ocean water standards, for precipitation throughout the world is linearly correlated and distributed along a line known as the global meteoric water line (Craig, 1961), shown on Figure 24. The δ18O and δD values for groundwater samples relative to the global meteoric water line provide evidence of the source of the water and fractionation processes that have affected the water's stable-isotope values. This information about the source and evaporative history can be used to evaluate the water's movement between aquifers. Because groundwater moves slowly, isotopic data typically preserve a record of groundwater recharge and movement under predevelopment conditions. This is especially useful in areas where traditional hydrologic data (such as water levels) have been altered by pumping, by changes in recharge and discharge, or as a result of human activities (Izbiki and Michel, 2004). δ18O and δD abundances are expressed as ratios in delta (δ) notation as a per mil (parts per thousand [ppt]) difference relative to the standard Vienna Standard Mean Ocean Water (VSMOW). By convention, the ratio of VSMOW is 0 per mil.

Figure 24 presents a plot of δ18O and δD data for the wells shown on Figure 23. The points that plot to the upper right in this plot (solid brown dots) are considered to have a heavier isotopic signature (that is, they are enriched in the heavier isotopes, oxygen-18 and deuterium), while the points that plot to the lower left (blue dots) are considered lighter in isotopic signature. Review of Figure 24 indicates that the lighter isotopic signatures occur most commonly at wells upgradient of the PG&E compressor station (BW-01S/D) and at wells in the Western Area, whereas the heaviest isotopic signatures are found in wells in the central part of the Hinkley Valley north of the Hinkley Compressor Station.

The heavier isotopic signature is interpreted to result from preferential enrichment as partially evaporated agricultural water that has percolated back down to the groundwater table, has been recaptured by pumping wells, and subsequently reapplied to crops. This cycle likely began in the 1950s when intensive agriculture in the Hinkley Valley began and was supported by high groundwater withdrawal rates. This process appears to have resulted in a unique "heavy" isotopic signature in the central Hinkley Valley compared to the Western Area.

The δD data for selected wells in the central part of the Hinkley Valley (upgradient and downgradient of the Hinkley Compressor Station) and in the Western Area (Figure 23) are color-coded to illustrate differences in these areas. δD values of less than 60 ppt are shown with blue symbols, whereas δD values greater than 60 ppt are shown with brown symbols. It is evident from this map that there are distinct isotopic differences between the central and Western Area wells.

The Western Area wells have a notably "lighter" isotopic signature than do wells in the central Hinkley Valley that contain chromium associated with the Hinkley Compressor Station. Because the PG&E Cr(VI) was released at the same time that intensive agricultural operations were ongoing, the isotopic data (along with TDS, nitrate, and groundwater flow data) suggest that the source of groundwater in the Western Area is different than the source of groundwater in the central Hinkley Valley.

SECTION 5

Summary of Conceptual Site Model for Groundwater Flow and Chromium Occurrence in Western Area

This section summarizes the key points discussed in the prior sections of this report (current and historical hydrogeologic conditions, current distribution of chromium, and other relevant geochemical data) and describes a conceptual site model for groundwater flow and distribution of chromium in the Western Area. The goal of the conceptual site model is to provide a succinct, but comprehensive, hydrogeologic construct that describes the current understanding of the Western Area.

The Western Area conceptual site model was developed from the following:

- Previous research and reporting by the DWR and USGS on regional hydrogeologic conditions, influence of the Lockhart Fault on groundwater flow in the Hinkley Valley, and on occurrence and geochemistry of chromium in the Mojave Desert
- Recent groundwater level data obtained from existing domestic and monitoring wells and from new monitoring wells installed by PG&E at several locations in the Western Area during 2012
- Available historical groundwater level data reported by the USGS, DWR, and other sources
- Interpretation of historical aerial photographs (to estimate historical pumping rates based on acreage of irrigated agriculture at different times in the Hinkley Valley)
- Recent groundwater quality data (specifically for chromium and geochemical indicator parameters) from existing and new monitoring wells

Following is a summary of the key results of the evaluation presented In previous sections of this report, focusing on the primary conclusions that make up the conceptual site model. Because this is a summary of information presented in other sections of this report, references to original sources of information are not included below for the sake of brevity and readability; information sources for each point below are provided in previous sections of this report:

- Hydrostratigraphic units specific to the Western Area include Upper Aquifer, blue clay (Lower Aquifer confining clay layer), and Lower Aquifer/bedrock unit. The bedrock in the Western Area consists of diorite, gneiss, marble, quartzite, schist, and metavolcanic rocks. The Upper and Lower Aquifers are the principal water-bearing hydrostratigraphic units in the Western Area. The alluvium eroded from bedrock in the Western Area may contain varying ranges of mafic minerals such as olivine, pyroxene, amphibole, and biotite. These mafic minerals may contain Cr(III) at concentrations up to 100 mg/kg.
- The Hinkley Valley has historically been pumped extensively, primarily for agricultural use. Information published by DWR and USGS indicate groundwater flow in the Western Area historically has consistently been from the southwest to the northeast; this is consistent with the data collected from the newly installed monitoring wells.
- Groundwater pumping and aquifer drawdown has historically been greatest in the central portion of the Hinkley Valley; the Western Area has not been substantially pumped either under historical or current conditions. During periods when the central portion of the Hinkley Valley was extensively pumped for agricultural use (primarily 1950s to 1990s), the historical information suggests the Lockhart Fault provided a buffer against the substantial hydraulic influence of this pumping in the area southwest of the fault. The result of extensive pumping in the central portion of the Hinkley Valley was an apparent steepening of the hydraulic gradient from southwest to northeast in the Western Area.
- Historical data and model simulations by the DWR and the USGS indicate groundwater would have flowed from southwest to northeast in the Western Area since chromium was released at the compressor station in

the early 1950s. DWR data suggest the difference in groundwater levels were substantially higher in the Western Area when compared with the central portion of the Hinkley Valley during periods of agricultural pumping. Under current conditions, the difference in groundwater level between the chromium plume area and MW-163S (where Cr(VI) was detected at 8.0 µg/L) is nearly 50 feet.

- The alluvial sediments eroded from the diorite and metamorphic rocks in the Western Area comprise the Upper and Lower Aquifers and are expected to have higher Cr(III) content than the Mojave River fluvial deposits common within, east of, and south of the PG&E plume area. Therefore, oxidation of Cr(III) on the surfaces of these minerals to form Cr(VI) (which is soluble in groundwater) is more likely in the Western Area than the central and southern areas of the Hinkley Valley where sediments naturally have lower Cr(III) content.
- Chromium is present in Upper Aquifer monitoring wells, and many domestic wells in the Western Area above the established background limits, including well 34-65. These wells are located downgradient of MW-163S, where Cr(VI) was detected at 8.0 µg/L. The highest concentrations of chromium in the Western Area are typically detected at monitoring wells screened across the water table. Chromium was not present above the established background limits in the three Lower Aquifer monitoring wells installed and sampled by PG&E in the Western Area and were at or only slightly above non-detect levels.
- Geochemical data indicate that the Western Area generally has a distinct geochemical signature from the central Hinkley Valley near and downgradient of the Compressor Station. The key difference between these two areas is that historical and current agricultural operations have significantly affected groundwater in the mapped PG&E plume area versus the Western Area where naturally occurring chromium is present.

The above conclusions drawn from review of historical information and recent data support a conceptual site model for groundwater flow and chromium distribution in the Western Area consisting of the following principal features:

- Chromium occurs naturally in minerals present in the bedrock and the eroded alluvial deposits that comprise groundwater-bearing hydrostratigraphic units in the Western Area. Oxidation of Cr(III) to Cr(VI) and subsequent dissolution of Cr(VI) in groundwater produces detectable concentrations of Cr(VI) in the Western Area of the Hinkley Valley and other locations in the Mojave Desert where geochemical conditions are suitable.
- Available data from the Western Area indicate that the highest chromium concentrations in the Upper Aquifer occur at well MW-163S, located approximately 0.25 mile from an outcrop of metamorphic rock at the southwest margin of the Regional Aquifer system in the Hinkley Valley. Chromium concentrations show a spatially decreasing trend at wells located downgradient (north to northeast) from MW-163S (and the metamorphic outcrop) along the expected flow path for groundwater in the Western Area.
- Consistent with previous investigations, the current direction of the hydraulic gradient and groundwater flow is from the southwest towards the northeast in the Western Area. Hydraulic gradients in the Western Area since 1952 (when the Hinkley Compressor Station became operational) have strongly favored northeastward flow of groundwater and transport of Cr(VI). Migration of dissolved Cr(VI) in the opposite direction, from the Hinkley Compressor Station southwestward to wells located a substantial distance (more than 1 mile) away, would have been highly improbable, based on evaluation of available data and results of previous research by others.
- Groundwater southwest of the Lockhart Fault in the Western Area is geochemically and isotopically distinct from groundwater in the central Hinkley Valley area, including the area of the Hinkley Compressor Station. The most plausible explanation for these differences, particularly in consideration of current and historical groundwater flow directions, is that most groundwater in the Western Area has traveled a different flow path (from southwest to northeast) and been chemically influenced by different processes than groundwater in the central Hinkley Valley.

SECTION 6
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Tables

Table 1
Well Details and Groundwater Elevations - November 2012
Pacific Gas and Electric Company - Hinkley Chromium Remediation Project
Hinkley, California

Well ID	Well Installation Date	Depth to Top of Perforated Interval (ft. BGS)	Depth to Bottom of Perforated Interval (ft. BGS)	Screened Interval Length (ft.)	Depth to Groundwater	Well Reference Elevation (ft. MSL)	Groundwater Elevation (ft. MSL)
MW-158S	9/20/2012	100	115	15	103.04	2202.943	2099.90
MW-158C	7/25/2012	138	148	10	97.44	2203.073	2105.63
MW-159S	9/17/2012	90	105	15	92.05	2224.409	2132.36
MW-159D	9/18/2012	109.8	119.8	10	90.78	2224.153	2133.37
MW-159C	8/7/2012	130	160	30	94.60	2223.542	2128.94
MW-160S	9/26/2012	95	110	15	109.70	2230.55	2120.85
MW-160D	9/27/2012	120	130	10	97.80	2230.141	2132.34
MW-160C	9/5/2012	159	189	30	95.69	2230.021	2134.33
MW-163S	10/3/2012	80	95	15	85.40	2234.757	2149.36
MW-163D	10/2/2012	101	111	10	85.43	2234.42	2148.99
MW-164S	10/2/2012	75	90	15	80.68	2174.912	2094.23
MW-164D	10/1/2012	98	108	10	84.27	2175.01	2090.74
MW-165S	10/15/2012	97	112	15	97.00	2192.488	2095.49
MW-165D	10/11/2012	116	126	10	96.90	2192.429	2095.53
MW-167S1	10/29/2012	96	111	15	87.28	*2212.43*	*2125.15*
MW-167S2	10/30/2012	119	129	10	87.50	*2212.43*	*2124.93*
MW-167D	10/22/2012	158	168	10	87.07	*2212.43*	*2125.36*
MW-168S	11/6/2012	92.8	107.8	15	86.43	*2176.18*	*2089.75*
MW-168D	11/5/2012	129.5	139.5	10	88.35	*2176.18*	*2087.83*
MW-169S1	11/8/2012	88	103	15	86.01	*2181.37*	*2095.36*
MW-169S2	11/12/2012	109	119	10	NM	*2181.37*	--
MW-169D	11/7/2012	140	150	10	89.49	*2181.37*	*2091.88*

BGS = below ground surface
ft. = feet
MSL = mean sea level
NS = not surveyed
NM = not measured
Well Reference Elevations shown in *italics are estimated based on available topographic data*. These wells had not been surveyed as of the report date.

TABLE 2
Vertical Gradients for Selected Monitoring Wells
Conceptual Site Model for Groundwater Flow and the Occurrence of Chromium in Groundwater of the Western Area
Pacific Gas and Electric Company Hinkley Compressor Station, Hinkley, CA

Shallow Well Screen Interval (feet bgs)	Deep Well Screen Interval (feet bgs)	Date	Shallow Well Elevation (feet MSL)	Deep Well Elevation (feet MSL)	Water Level Elevation Difference (feet)	Vertical Distance between Screens [1] (feet)	Vertical Hydraulic Gradient (feet/foot)	Direction
MW-14S 82-97	**MW-14A** 100-110	7-Nov-2012	2092.352	2091.28	**-1.07**	15.5	-0.069	downward
MW-14S 82-97	**MW-14B** 132-142	5-Nov-2012	2092.352	2090.08	**-2.27**	47.5	-0.048	downward
MW-14S 82-97	**MW-14C** 190-200	5-Nov-2012	2092.352	2097.79	**5.44**	105.5	0.052	upward
MW-22A1 69-89	**MW-22A2** 90-100	5-Nov-2012	2084.42	2083.32	**-1.10**	16.0	-0.069	downward
MW-22A1 69-89	**MW-22B** 115-125	5-Nov-2012	2084.42	2082.14	**-2.28**	41.0	-0.056	downward
MW-24A1 76-96	**MW-24B** 144-154	5-Nov-2012	2088.14	2084.23	**-3.91**	63.0	-0.062	downward
MW-24A1 76-96	**MW-24A2** 114-124	5-Nov-2012	2088.14	2085.89	**-2.25**	33.0	-0.068	downward
MW-28A 82.9-92.9	**MW-28B** 96.8-106.8	11-Oct-2012	2085.44	2085.33	**-0.11**	13.9	-0.0079	downward
MW-28A 82.9-92.9	**MW-28C** 131-136	11-Oct-2012	2085.44	2085.053	**-0.39**	45.6	-0.0085	downward
MW-33A 98.2-108.2	**MW-33B** 137.4-147.4	5-Nov-2012	2101.52	2092.97	**-8.55**	39.2	-0.22	downward
MW-38A 94.4-104.4	**MW-38B** 115.7-125.7	5-Nov-2012	2090.38	2090.45	**0.07**	21.3	0.0033	upward
MW-42B1 107.8-117.8	**MW-42B2** 119.4-129.4	17-Oct-2012	2082.84	2082.88	**0.04**	11.6	0.0034	upward
MW-45A 94.8-104.8	**MW-45B** 110.3-120.3	4-Oct-2012	2089.03	2088.833	**-0.20**	15.5	-0.013	downward
MW-47A 82-92	**MW-47** 93.3-103.3	3-Dec-2012	2087.7	2087.01	**-0.69**	11.3	-0.061	downward
MW-57 89-99	**MW-57D** 104-114	2-Oct-2012	2085.612	2088.544	**2.93**	15.0	0.20	upward
MW-73S 95-110	**MW-73D** 120-135	11-Dec-2012	2112.535	2112.617	**0.08**	25.0	0.0033	upward
MW-76S 95-110	**MW-76D** 120-130	9-Oct-2012	2090.646	2091.564	**0.92**	22.5	0.041	upward
MW-101S 79-89	**MW-101D** 99-109	5-Nov-2012	2085.616	2085.635	**0.02**	20.0	0.0010	upward
MW-108S 83-98	**MW-108D** 108-118	9-Oct-2012	2086.623	2086.328	**-0.30**	22.5	-0.013	downward

TABLE 2

Vertical Gradients for Selected Monitoring Wells

Conceptual Site Model for Groundwater Flow and the Occurrence of Chromium in Groundwater of the Western Area

Pacific Gas and Electric Company Hinkley Compressor Station, Hinkley, CA

Shallow Well Screen Interval (feet bgs)	Deep Well Screen Interval (feet bgs)	Date	Shallow Well Elevation (feet MSL)	Deep Well Elevation (feet MSL)	Water Level Elevation Difference (feet)	Vertical Distance between Screens [1] (feet)	Vertical Hydraulic Gradient (feet/foot)	Direction
MW-119S 75-90	**MW-119D** 110-120	10-Oct-2012	2087.301	2088.075	**0.77**	32.5	0.024	upward
MW-121S 86-101	**MW-121D** 109-119	12-Dec-2012	2094.5	2091.795	**-2.70**	20.5	-0.13	downward
MW-122S 85-100	**MW-122D** 117-127	5-Nov-2012	2095.674	2094.31	**-1.36**	29.5	-0.046	downward
MW-147S 84-99	**MW-147D** 110-120	5-Nov-2012	2092.038	2091.177	**-0.86**	23.5	-0.037	downward
MW-150S1 97-112	**MW-150S2** 124-134	5-Nov-2012 (S1) 12-Dec-2012 (S2)	2124.92	2135.03	**10.11**	24.5	0.41	upward
MW-155S 113-128	**MW-155D** 142-152	12-Dec-2012	2098.628	2110.126	**11.50**	26.5	0.43	upward
MW-158S 100-115	**MW-158C** 138-148	11-Dec-2012	2099.823	2106.333	**6.51**	35.5	0.18	upward
MW-159S 90-105	**MW-159C** 130-160	4-Dec-2012	2132.309	2129.512	**-2.80**	47.5	-0.059	downward
MW-159S 90-105	**MW-159D** 109.8-119.8	4-Dec-2012	2132.309	2132.923	**0.61**	17.3	0.035	upward
MW-160D 120-130	**MW-160C** 159-189	11-Dec-2012	2132.241	2134.571	**2.33**	49	0.048	upward
MW-164S 75-90	**MW-164D** 98-108	05-Dec-2012 (S) 04-Dec-2012 (D)	2094.292	2085.514	**-8.78**	20.5	-0.43	downward
MW-165S 97-112	**MW-165D** 116-126	11-Dec-2012	2095.538	2095.569	**0.03**	16.5	0.0019	upward
MW-167S1 96-111	**MW-167D** 158-168	3-Dec-2012	2122.4	2122.06	**-0.34**	59.5	-0.0057	downward
MW-167S1 96-111	**MW-167S2** 119-129	3-Dec-2012	2122.4	2121.6	**-0.80**	20.5	-0.039	downward
MW-168S 92.8-107.8	**MW-168D** 129.5-139.5	5-Dec-2012	2093.26	2091.68	**-1.58**	34.2	-0.046	downward
MW-169S1 88-103	**MW-169D** 140-150	5-Dec-2012	2094.24	2091.76	**-2.48**	49.5	-0.050	downward
MW-169S1 88-103	**MW-169S2** 109-119	5-Dec-2012	2094.24	2094.14	**-0.10**	18.5	-0.0054	downward
PZ-01A 88.5-103.5	**PZ-01B** 132-142	11-Dec-2012	2094.657	2091.83	**-2.83**	41.0	-0.069	downward
SA-MW-16S 80-105	**SA-MW-16D** 120-140	7-Nov-2012	2117.004	2123.705	**6.70**	37.5	0.18	upward

TABLE 2

Vertical Gradients for Selected Monitoring Wells

Conceptual Site Model for Groundwater Flow and the Occurrence of Chromium in Groundwater of the Western Area

Pacific Gas and Electric Company Hinkley Compressor Station, Hinkley, CA

Shallow Well Screen Interval (feet bgs)	Deep Well Screen Interval (feet bgs)	Date	Shallow Well Elevation (feet MSL)	Deep Well Elevation (feet MSL)	Water Level Elevation Difference (feet)	Vertical Distance between Screens [1] (feet)	Vertical Hydraulic Gradient (feet/foot)	Direction
SA-MW-17S 80-105	**SA-MW-17D** 120-140	7-Nov-2012	2115.337	2116.617	**1.28**	37.5	0.034	upward
SA-MW-26S 85-100	**SA-MW-26D** 116-126	15-Oct-2012	2119.794	2124.069	**4.28**	28.5	0.15	upward
SC-MW-11S 80-95	**SC-MW-11D** 120-145	6-Nov-2012	2109.661	2112.276	**2.61**	45.0	0.058	upward
SC-MW-12S 80-100	**SC-MW-12D** 120-145	6-Nov-2012	2107.669	2112.18	**4.51**	42.5	0.11	upward
SC-MW-13S 90-105	**SC-MW-13D** 120-140	6-Nov-2012	2105.337	2111.42	**6.08**	32.5	0.19	upward

NOTES:

[1] Vertical distance between well screens represents the distance between screen midpoints.

bgs = below ground surface

MSL = Mean Sea Level

TABLE 3

Chromium Data for Western Area Monitoring and Domestic Wells

Conceptual Site Model for Groundwater Flow and the Occurrence of Chromium in Groundwater of the Western Area

Pacific Gas and Electric Company Hinkley Compressor Station, Hinkley, California

Well ID	Aquifer	Sample Date	Sample Type	Chromium, Hexavalent (µg/L)	Chromium, Dissolved (µg/L)
Monitoring Wells					
DW-02	Shallow Zone Upper Aquifer	12-Jan-12		0.78	1.0
		10-Apr-12		0.89	1.4
		23-Jul-12		0.86	1.0
		17-Oct-12		0.93	ND (1.0)
MW-118S	Shallow Zone Upper Aquifer	31-Jan-12		1.9	2.1
		24-Apr-12		2.1	2.2
		25-Jul-12		2.0	2.4
		10-Oct-12		2.1	2.2
MW-119D	Deep Zone Upper Aquifer	31-Jan-12		1.0	1.2
		24-Apr-12		1.2	1.7
		24-Apr-12	FD	1.1	1.4
		25-Jul-12		1.1	1.4
		10-Oct-12		1.2	1.4
MW-119S	Shallow Zone Upper Aquifer	31-Jan-12		1.4	1.6
		24-Apr-12		1.9	2.3
		25-Jul-12		0.85	1.1
		10-Oct-12		1.6	1.8
MW-121D	Deep Zone Upper Aquifer	31-Jan-12		2.2	2.8
		26-Apr-12		2.5	3.2
		27-Jun-12		2.9	2.9
		10-Jul-12		2.9	3.1
		08-Oct-12		2.9	3.9
		08-Oct-12	FD	2.9	3.7
		07-Dec-12		3.1	3.3
MW-121S	Shallow Zone Upper Aquifer	01-Feb-12		1.6	1.5
		27-Apr-12		1.5	2.2
		11-Jul-12		1.4	1.5
		10-Oct-12		1.9	2.3
MW-122D	Deep Zone Upper Aquifer	30-Jan-12		ND (0.06)	ND (1.0)
		30-Jan-12	FD	0.064J	ND (1.0)
		23-Apr-12		ND (0.06)	ND (1.0)
		16-Jul-12		0.063	ND (1.0)
		08-Oct-12		ND (0.06)	ND (1.0)
MW-122S	Shallow Zone Upper Aquifer	31-Jan-12		0.56	ND (1.0)
		27-Apr-12		0.53	ND (1.0)
MW-147D	Deep Zone Upper Aquifer	26-Jan-12		1.2	2.5
		26-Jan-12	FD	1.2	2.1
		23-Feb-12		1.2	1.6
		25-Apr-12		1.3	1.7
		26-Jul-12		1.2	1.4
		12-Oct-12		1.2	2.3
MW-147S	Shallow Zone Upper Aquifer	26-Jan-12		2.4	4.5
		23-Feb-12		2.0	2.4
		25-Apr-12		2.1	2.3
		26-Jul-12		1.8	1.9

TABLE 3

Chromium Data for Western Area Monitoring and Domestic Wells

Conceptual Site Model for Groundwater Flow and the Occurrence of Chromium in Groundwater of the Western Area

Pacific Gas and Electric Company Hinkley Compressor Station, Hinkley, California

Well ID	Aquifer	Sample Date	Sample Type	Chromium, Hexavalent (µg/L)	Chromium, Dissolved (µg/L)
Monitoring Wells					
MW-147S	Shallow Zone Upper Aquifer	12-Oct-12		2.3	2.4
MW-148S	Shallow Zone Upper Aquifer	26-Jan-12		1.9	2.2
		23-Feb-12		1.8	2.4
		25-Apr-12		1.9	2.1
		26-Jul-12		1.8	1.9
		16-Oct-12		1.7	1.7
MW-149S	Shallow Zone Upper Aquifer	31-Jan-12		1.5	1.4
		24-Feb-12		1.3	1.6
		24-Feb-12	FD	1.3	1.5
		15-Mar-12		1.4	2.1
		25-Apr-12		1.5	1.9
		19-Jul-12		1.4	1.7
		16-Oct-12		1.4	1.6
MW-150S1	Shallow Zone Upper Aquifer	31-Jan-12		0.61	1.2
		23-Feb-12		0.53	1.7
		15-Mar-12		0.58	1.2
		25-Apr-12		0.63	1.5
		19-Jul-12		0.58	ND (1.0)
		16-Oct-12		0.58	ND (1.0)
MW-150S2	Deep Zone Upper Aquifer	23-Feb-12		ND (0.06)	ND (1.0)
		15-Mar-12		ND (0.06)	ND (1.0)
		25-Apr-12		ND (0.06)	ND (1.0)
		13-Jul-12		ND (0.06)	ND (1.0)
		03-Oct-12		ND (0.06)	ND (1.0)
MW-153S	Shallow Zone Upper Aquifer	14-Mar-12		4.8	4.9
		24-Apr-12		5.6	5.7
		16-May-12		5.5	6.7
		18-Jul-12		2.2	2.5
		18-Jul-12	FD	2.2	2.3
		16-Oct-12		3.2	3.6
MW-155D	Deep Zone Upper Aquifer	29-Mar-12		ND (0.06)	ND (1.0)
		26-Apr-12		ND (0.06)	ND (1.0)
		15-May-12		ND (0.06)	ND (1.0)
		15-May-12	FD	ND (0.06)	ND (1.0)
		13-Jul-12		ND (0.06)	ND (1.0)
		03-Oct-12		ND (0.06)	ND (1.0)
MW-155S	Shallow Zone Upper Aquifer	29-Mar-12		0.29	ND (1.0)
		26-Apr-12		0.38	ND (1.0)
		15-May-12		0.46	ND (1.0)
		13-Jul-12		0.42	ND (1.0)
		03-Oct-12		0.46	ND (1.0)
MW-158C	Lower Aquifer	22-Aug-12		0.26	ND (1.0)
		04-Sep-12		0.1	ND (1.0)
		26-Dec-12		ND (0.2)	ND (1.0)
MW-158S	Shallow Zone Upper Aquifer	17-Oct-12		1.8	1.9

TABLE 3

Chromium Data for Western Area Monitoring and Domestic Wells

Conceptual Site Model for Groundwater Flow and the Occurrence of Chromium in Groundwater of the Western Area

Pacific Gas and Electric Company Hinkley Compressor Station, Hinkley, California

Well ID	Aquifer	Sample Date	Sample Type	Chromium, Hexavalent (µg/L)	Chromium, Dissolved (µg/L)
Monitoring Wells					
MW-159C	Lower Aquifer	22-Aug-12		0.12	ND (1.0)
		04-Sep-12		0.14	ND (1.0)
		18-Oct-12		ND (0.06)	ND (1.0)
MW-159D	Deep Zone Upper Aquifer	18-Oct-12		4.2	4.2
MW-159S	Shallow Zone Upper Aquifer	18-Oct-12		6.0	6.1
MW-160C	Lower Aquifer	14-Sep-12		ND (0.06)	ND (1.0)
		18-Oct-12		ND (0.06)	ND (1.0)
MW-160D	Deep Zone Upper Aquifer	18-Oct-12		4.0	4.1
MW-163D	Deep Zone Upper Aquifer	03-Dec-12		ND (0.06)	ND (1.0)
MW-163S	Shallow Zone Upper Aquifer	08-Nov-12		8.0	8.7
MW-164D	Deep Zone Upper Aquifer	05-Dec-12		2.1	3.0
MW-164S	Shallow Zone Upper Aquifer	08-Nov-12		2.4	2.4
MW-165D	Deep Zone Upper Aquifer	08-Nov-12		0.99	1.1
MW-165S	Shallow Zone Upper Aquifer	08-Nov-12		0.77	ND (1.0)
MW-167D	Deep Zone Upper Aquifer	03-Dec-12		ND (0.06)	ND (1.0)
MW-167S1	Shallow Zone Upper Aquifer	03-Dec-12		0.5	ND (1.0)
MW-167S2	Shallow Zone Upper Aquifer	03-Dec-12		ND (0.06)	ND (1.0)
MW-168D	Deep Zone Upper Aquifer	05-Dec-12		1.2	1.4
MW-168S	Shallow Zone Upper Aquifer	05-Dec-12		1.5	1.8
MW-169D	Deep Zone Upper Aquifer	05-Dec-12		0.086	ND (1.0)
MW-169S1	Shallow Zone Upper Aquifer	05-Dec-12		1.4	2.7
		26-Dec-12		1.2	3.5
MW-169S2	Shallow Zone Upper Aquifer	05-Dec-12		3.4	3.7
MW-29	Shallow Zone Upper Aquifer	12-Jan-12		2.2	4.0
		09-Apr-12		1.5	2.1
		23-Jul-12		1.1	1.7
		23-Jul-12	FD	1.0	1.7
		17-Oct-12		1.6	1.4
MW-37	Shallow Zone Upper Aquifer	31-Jan-12		1.0	1.3
		19-Jul-12		0.73	1.2
MW-38A	Shallow Zone Upper Aquifer	31-Jan-12		4.4	4.9
		17-Apr-12		6.2	6.3
		19-Jul-12		2.2	2.5
		04-Oct-12		2.0	2.0
MW-38B	Deep Zone Upper Aquifer	31-Jan-12		19.8	21.2
		19-Jul-12		22.1	20.7
MW-44A	Shallow Zone Upper Aquifer	01-Feb-12		1.8	2.2
MW-44B	Deep Zone Upper Aquifer	01-Feb-12		3.1	3.0
MW-47	Upper Aquifer	27-Jan-12		2.1	3.0
		27-Jan-12	FD	2.1	2.4
		17-Apr-12		3.4	3.9

TABLE 3

Chromium Data for Western Area Monitoring and Domestic Wells

Conceptual Site Model for Groundwater Flow and the Occurrence of Chromium In Groundwater of the Western Area

Pacific Gas and Electric Company Hinkley Compressor Station, Hinkley, California

Well ID	Aquifer	Sample Date	Sample Type	Chromium, Hexavalent (µg/L)	Chromium, Dissolved (µg/L)
Monitoring Wells					
MW-47	Upper Aquifer	20-Jul-12		2.8	2.7
		05-Oct-12		2.4	2.6
MW-47A	Shallow Zone Upper Aquifer	20-Jul-12		2.9	2.9
MW-48	Shallow Zone Upper Aquifer	27-Jan-12		1.3	1.6
		23-Jul-12		1.3	1.7
MW-51	Shallow Zone Upper Aquifer	23-Aug-12		0.6	ND (1.0)
MW-53	Shallow Zone Upper Aquifer	01-Feb-12		0.92	ND (1.0)
		01-Feb-12	FD	0.91	ND (1.0)
		31-Jul-12		0.87	1.1
MW-54	Shallow Zone Upper Aquifer	01-Feb-12		0.86	ND (1.0)
		17-Apr-12		0.89	1.4
		31-Jul-12		0.8	1.2
		03-Oct-12		0.81	1.3
MW-57	Shallow Zone Upper Aquifer	02-Feb-12		2.8	2.8
		17-Apr-12		2.8	3.3
		13-Jun-12		2.8	3.0
		30-Jul-12		2.6	3.0
		02-Oct-12		2.8	2.8
MW-57D	Deep Zone Upper Aquifer	02-Feb-12		2.7	2.6
		17-Apr-12		2.7	3.4
		13-Jun-12		2.6	2.7
		30-Jul-12		2.4	3.0
		02-Oct-12		2.8	2.9
MW-58	Shallow Zone Upper Aquifer	02-Feb-12		0.58	ND (1.0)
		17-Apr-12		0.55	ND (1.0)
		23-Jul-12		0.54	ND (1.0)
		01-Oct-12		0.67	ND (1.0)
MW-59	Shallow Zone Upper Aquifer	02-Feb-12		1.8	1.6
		17-Apr-12		1.9	2.4
		23-Jul-12		1.7	1.8
		08-Oct-12		1.7	1.7
		08-Oct-12	FD	1.7	1.9
MW-61	Shallow Zone Upper Aquifer	02-Feb-12		0.29	ND (1.0)
		18-Apr-12		0.57	ND (1.0)
		23-Jul-12		0.18	ND (1.0)
		23-Jul-12	FD	0.32	ND (1.0)
		09-Oct-12		0.084	ND (1.0)
MW-64A	Shallow Zone Upper Aquifer	02-Feb-12		1.1	1.5
		02-Feb-12	FD	1.1	ND (1.0)
		18-Apr-12		2.1	2.6
		19-Jul-12		2.2	2.6
		08-Oct-12		2.6	2.6
MW-64B	Deep Zone Upper Aquifer	02-Feb-12		0.92	ND (1.0)
		19-Jul-12		0.14	3.4

TABLE 3

Chromium Data for Western Area Monitoring and Domestic Wells

Conceptual Site Model for Groundwater Flow and the Occurrence of Chromium in Groundwater of the Western Area

Pacific Gas and Electric Company Hinkley Compressor Station, Hinkley, California

Well ID	Aquifer	Sample Date	Sample Type	Chromium, Hexavalent (µg/L)	Chromium, Dissolved (µg/L)
Monitoring Wells					
MW-64B	Deep Zone Upper Aquifer	23-Aug-12		0.61	ND (1.0)
MW-66A	Shallow Zone Upper Aquifer	06-Feb-12		3.2	3.4
		18-Apr-12		2.9	3.2
		23-Jul-12		2.8	2.9
		02-Oct-12		3.1	3.0
		02-Oct-12	FD	2.9	3.2
MW-67A	Shallow Zone Upper Aquifer	06-Feb-12		0.8	1.2
		18-Apr-12		0.68	1.4
		11-Jul-12		0.69	1.1
		08-Oct-12		0.82	ND (1.0)
MW-67B	Deep Zone Upper Aquifer	06-Feb-12		0.68	ND (1.0)
		11-Jul-12		0.61	1.6
MW-73D	Deep Zone Upper Aquifer	30-Jan-12		0.78	1.8
		12-Apr-12		0.84	1.0
		23-Jul-12		0.77	1.0
		09-Oct-12		0.8	ND (1.0)
MW-73S	Shallow Zone Upper Aquifer	30-Jan-12		0.99	3.6J
		12-Apr-12		1.0	1.3
		23-Jul-12		0.89	1.3
		09-Oct-12		0.9	1.1
MW-74D	Shallow Zone Upper Aquifer	30-Jan-12		4.4	4.7
		12-Apr-12		6.3	6.6
		23-Jul-12		4.6	4.8
		09-Oct-12		1.9	2.2
		09-Oct-12	FD	1.9	2.2
MW-75D	Deep Zone Upper Aquifer	30-Jan-12		0.62	3.5J
		12-Apr-12		1.0	1.3
		31-Jul-12		1.1	1.2
		09-Oct-12		0.62	ND (1.0)
MW-76D	Deep Zone Upper Aquifer	06-Feb-12		0.72	1.3
		12-Apr-12		0.77	ND (1.0)
		20-Jul-12		0.67	ND (1.0)
		20-Jul-12	FD	0.71	ND (1.0)
		09-Oct-12		0.69	1.0
MW-76S	Shallow Zone Upper Aquifer	06-Feb-12		3.0	3.2
		12-Apr-12		3.1	3.4
		20-Jul-12		3.0	3.0
		09-Oct-12		2.6	2.4
MW-77D	Deep Zone Upper Aquifer	03-Feb-12		0.84	1.2
		12-Apr-12		1.0	1.2
		23-Jul-12		0.93	1.3
		09-Oct-12		1.0	1.1
MW-77S	Shallow Zone Upper Aquifer	03-Feb-12		0.84	1.2
		03-Feb-12	FD	0.86	1.1
		12-Apr-12		0.9	1.1

TABLE 3

Chromium Data for Western Area Monitoring and Domestic Wells

Conceptual Site Model for Groundwater Flow and the Occurrence of Chromium in Groundwater of the Western Area

Pacific Gas and Electric Company Hinkley Compressor Station, Hinkley, California

Well ID	Aquifer	Sample Date	Sample Type	Chromium, Hexavalent (µg/L)	Chromium, Dissolved (µg/L)
Monitoring Wells					
MW-77S	Shallow Zone Upper Aquifer	23-Jul-12		0.78	1.2
		09-Oct-12		0.89	ND (1.0)
MW-78D	Deep Zone Upper Aquifer	03-Feb-12		1.7	2.2
		16-Apr-12		1.6	1.8
		16-Apr-12	FD	1.6	1.8
		31-Jul-12		1.6	1.8
		08-Oct-12		1.7	2.5
MW-78S	Shallow Zone Upper Aquifer	03-Feb-12		0.91	1.1
		16-Apr-12		0.88	1.1
		31-Jul-12		0.75	1.1
		08-Oct-12		0.91	1.0
MW-81S	Shallow Zone Upper Aquifer	03-Feb-12		2.6	2.9
		26-Apr-12		1.6	2.3
		31-Jul-12		2.2	2.3
		10-Oct-12		1.8	2.1
MW-82S	Shallow Zone Upper Aquifer	03-Feb-12		1.2	1.6
		26-Apr-12		1.2	1.5
		31-Jul-12		1.4	1.6
		05-Oct-12		1.4	1.6
		05-Oct-12	FD	1.4	1.5
Domestic Supply Wells*					
28-08	Unknown	02-Dec-11		2.5	3.5
		20-Jan-12		2.0	2.0
		11-Apr-12		2.5	2.0
		11-Apr-12	FD	2.5	2.0
		10-Jul-12		2.3	1.8
28-37	Unknown	14-Jul-11		3.0	2.5
		16-Dec-11		3.4	2.9
		18-Jan-12		2.9	2.8
		18-Jan-12	FD	2.9	2.7
		23-Apr-12		2.9	2.7
28-38	Unknown	13-Jul-11		3.1	2.8
		11-Nov-11		3.1	3.3
		23-Jan-12		3.0	2.9
		10-Sep-12		3.2	3.0
33-11	Upper & Lower Aquifer	15-Dec-11		4.6	5.0
		15-Dec-11	FD	4.6	5.1
		19-Jan-12		3.6	4.8
		03-May-12		4.0	5.0
		16-Jul-12		5.0	5.1
33-23	Unknown	04-May-12		0.25	ND (1.0)
		10-Jul-12		0.074	5.0
		24-Jul-12		0.73	ND (1.0)
34-16	Unknown	12-Jan-12		5.4	5.1
		30-Jan-12		3.8	4.7

TABLE 3

Chromium Data for Western Area Monitoring and Domestic Wells

Conceptual Site Model for Groundwater Flow and the Occurrence of Chromium in Groundwater of the Western Area

Pacific Gas and Electric Company Hinkley Compressor Station, Hinkley, California

Well ID	Aquifer	Sample Date	Sample Type	Chromium, Hexavalent (µg/L)	Chromium, Dissolved (µg/L)
Domestic Supply Wells*					
34-16	Unknown	05-Apr-12		5.4	5.7
		12-Jul-12		5.5	5.6
34-20	Upper & Lower Aquifer	21-Dec-11		1.3	1.2
		20-Jan-12		0.5	ND (1.0)
		05-Apr-12		1.8	1.7
		12-Jul-12		2.5	2.5
34-25	Upper & Lower Aquifer	27-Apr-12		6.5	6.3
		12-Jul-12		6.7	6.9
34-45	Upper & Lower Aquifer	01-Dec-11		3.0	3.3
		01-Dec-11	FD	2.9	3.0
		19-Jan-12		2.6	2.6
		02-May-12		2.7	2.5
		12-Jul-12		2.6	2.6
34-65	Upper & Lower Aquifer	18-May-11		3.3	3.5
		31-May-11		3.4	3.4
		07-Jul-11		3.4	3.2
		11-Nov-11		3.3	3.4
		18-Jan-12		2.7	2.6
		05-Apr-12		3.3	3.1
		05-Apr-12	FD	3.3	3.0
		13-Jul-12		3.2	3.2
		13-Jul-12	FD	3.1	3.2

Note:

* Some domestic wells were not sampled in 2012 so data set for domestic wells includes 2011 data.

µg/L micrograms per liter
FD Results shown are for a duplicate groundwater sample taken on this date
ND (x.x) Not detected at the reporting limit shown

Data Qualifiers:
J Analyte was present in the sample but the laboratory reported concentration is qualified as estimated by data validation because one or more quality control criteria were not met.

TABLE 4

Chromium and Geochemical Indicator Parameter Data for Western Area and Selected Other Monitoring Wells

Conceptual Site Model for Groundwater Flow and the Occurrence of Chromium in Groundwater of the Western Area

Pacific Gas and Electric Company Hinkley Compressor Station, Hinkley, California

Location	Date	Sample Type	Chromium, dissolved	Chromium, Hexavalent	Total dissolved solids (TDS)	Nitrate (as nitrogen)	Manganese, dissolved	Arsenic, dissolved	pH	Dissolved oxygen	Oxidation reduction potential	Deuterium	Oxygen 18
			µg/L	µg/L	mg/L	mg/L	mg/L	µg/L		mg/L	mV	0/00	0/00
BW-01D	04/06/12		2.5	2.1	---	---	---	---	7.52	9.68	23.7	---	---
	04/30/12		2.4	2.2	406	5.19	---	---	7.28	7.18	131.0	-60.5	-8.4
	07/23/12		1.7	1.5	---	---	---	---	7.41	8.13	87.2	---	---
	10/15/12		1.6	1.5	---	---	---	---	7.44	7.90	93.9	---	---
BW-01S	04/06/12		1.3	0.88	---	---	---	---	7.43	5.38	106.0	---	---
	04/30/12		ND (1.0)	0.82	484	7.58	---	---	6.87	7.61	146.0	-60.5	-8.2
	07/23/12		ND (1.0)	0.61	---	---	---	---	7.31	9.75	106.7	---	---
	10/15/12		ND (1.0)	0.65	---	---	---	---	7.42	8.80	118.1	---	---
MW-108D	02/02/12		46.8	45.0	---	---	---	---	6.93	5.59	118.5	---	---
	04/13/12		40.8	40.2	1,130	12.6	---	---	6.98	5.90	123.6	-57.9	-7.8
	07/25/12		37.2	40.5	---	---	---	---	6.80	6.30	89.4	---	---
	07/25/12	FD	37.6	40.4	---	---	---	---	---	---	---	---	---
	10/09/12		42.6	45.0	---	13.0	0.0025	0.98	7.08	5.12	25.4	---	---
	10/09/12	FD	43.8	44.7	---	12.5	0.0026	0.93	---	---	---	---	---
MW-108S	02/02/12		31.2	29.2	---	---	---	---	6.84	5.83	128.3	---	---
	04/13/12		35.7	33.6	1,150	14.2	---	---	7.05	6.89	76.5	-58.1	-7.8
	07/25/12		35.2	35.3	---	---	---	---	6.96	5.40	75.5	---	---
	10/09/12		38.0	39.2	---	14.8	0.0037	0.88	7.11	5.35	44.1	---	---
MW-121D	01/31/12		2.8	2.2	---	---	---	---	7.30	1.15	25.1	---	---
	04/26/12		3.2	2.5	418	7.61	---	---	7.54	2.30	61.9	-62.4	-8.7
	06/27/12		2.9	2.9	---	---	---	---	7.01	2.03	12.0	---	---
	07/10/12		3.1	2.9	---	---	---	---	6.92	1.02	1.0	---	---
	10/08/12		3.9	2.9	---	7.10	0.00075	3.0	7.38	2.11	57.8	---	---
	10/08/12	FD	3.7	2.9	---	7.00	0.00089	3.0	---	---	---	---	---
	12/07/12		3.3	3.1	---	---	---	---	7.46	2.25	42.6	---	---
MW-14A	02/01/12		15.9	13.5	1,030	---	---	---	7.13	5.27	13.2	---	---
	02/01/12	FD	14.8	13.6	1,040	---	---	---	---	---	---	---	---
	04/13/12		11.6	11.6	1,020	8.02	ND (0.01)	ND (1.0)	6.96	3.36	82.4	-57.3	-7.7
	07/26/12		---	---	---	---	---	---	7.15	5.20	15.2	---	---
	07/27/12		9.2	9.5	1,100	6.10	0.0024	0.68	---	---	---	---	---

TABLE 4

Chromium and Geochemical Indicator Parameter Data for Western Area and Selected Other Monitoring Wells

Conceptual Site Model for Groundwater Flow and the Occurrence of Chromium in Groundwater of the Western Area

Pacific Gas and Electric Company Hinkley Compressor Station, Hinkley, California

Location	Date	Sample Type	Chromium, dissolved	Chromium, Hexavalent	Total dissolved solids (TDS)	Nitrate (as nitrogen)	Manganese, dissolved	Arsenic, dissolved	pH	Dissolved oxygen	Oxidation reduction potential	Deuterium	Oxygen 18
			µg/L	µg/L	mg/L	mg/L	mg/L	µg/L		mg/L	mV	0/00	0/00
MW-14A	11/07/12		7.9	8.5	---	5.00	ND (0.0005)	0.65	7.18	3.78	92.9	---	---
MW-14S	02/01/12		31.5	30.0	1,300	13.5	---	---	7.04	7.12	48.5	---	---
	04/13/12		30.9	31.4	1,220	12.6	ND (0.01)	ND (1.0)	7.01	7.39	118.3	-58.7	-8.0
	07/27/12		30.0	31.0	1,300	11.0	0.00083	0.61	7.01	9.64	-53.1	---	---
	11/07/12		30.0	32.0	1,300	12.0	ND (0.0005)	0.6	7.20	8.25	56.0	---	---
MW-150S1	01/31/12		1.2	0.61	270	ND (0.50)	---	---	7.21	6.90	184.1	---	---
	02/23/12		1.7	0.53	275	ND (0.50)	---	---	7.24	6.89	125.1	---	---
	03/15/12		1.2	0.58	259	ND (0.50)	---	---	7.90	6.94	55.1	---	---
	04/25/12		1.5	0.63	268	ND (0.50)	---	---	7.32	6.80	113.4	-62.8	-8.7
	07/19/12		ND (1.0)	0.58	---	---	---	---	7.82	6.92	157.9	---	---
	10/16/12		ND (1.0)	0.58	---	ND (0.50)	ND (0.0005)	1.5	7.88	7.58	142.0	---	---
MW-153S	03/14/12		4.9	4.8	556	5.81	---	---	7.65	5.20	67.5	---	---
	04/24/12		5.7	5.6	562	6.37	---	2.3	7.75	5.88	44.2	-63.0	-8.8
	05/16/12		6.7	5.5	598	6.29	---	---	7.39	4.58	41.5	---	---
	07/18/12		2.5	2.2	---	---	---	---	7.17	2.85	70.8	---	---
	07/18/12	FD	2.3	2.2	---	---	---	---	---	---	---	---	---
	10/16/12		3.6	3.2	---	11.5	0.0019	2.4	7.56	3.30	38.1	---	---
MW-155D	03/29/12		ND (1.0)	ND (0.06)	312	ND (0.50)	---	---	7.41	0.57	-95.0	---	---
	04/26/12		ND (1.0)	ND (0.06)	290	ND (0.50)	---	---	7.24	0.87	35.3	---	---
	05/15/12		ND (1.0)	ND (0.06)	280	ND (0.50)	---	---	7.21	0.31	-98.7	---	---
	05/15/12	FD	ND (1.0)	ND (0.06)	283	ND (0.50)	---	---	---	---	---	---	---
	07/13/12		ND (1.0)	ND (0.06)	310	---	---	---	7.15	0.66	-10.9	---	---
	10/03/12		ND (1.0)	ND (0.06)	---	ND (0.05)	0.35	4.2	7.15	0.06	-72.8	-62.9	-8.8
MW-155S	03/29/12		ND (1.0)	0.29	509	3.88	---	---	7.55	3.66	-13.5	---	---
	04/26/12		ND (1.0)	0.38	492	5.27	---	---	7.25	4.61	108.9	---	---
	05/15/12		ND (1.0)	0.46	515	4.62	---	---	7.29	4.11	40.6	---	---
	07/13/12		ND (1.0)	0.42	480	---	---	---	7.30	6.68	82.0	---	---
	10/03/12		ND (1.0)	0.46	---	2.90	0.002	2.5	7.31	3.67	101.1	-61.9	-8.5
MW-158C	08/22/12		ND (1.0)	0.26	310	0.088	0.0099	41.0	8.50	0.20	.7	---	---

TABLE 4

Chromium and Geochemical Indicator Parameter Data for Western Area and Selected Other Monitoring Wells

Conceptual Site Model for Groundwater Flow and the Occurrence of Chromium in Groundwater of the Western Area

Pacific Gas and Electric Company Hinkley Compressor Station, Hinkley, California

Location	Date	Sample Type	Chromium, dissolved	Chromium, Hexavalent	Total dissolved solids (TDS)	Nitrate (as nitrogen)	Manganese, dissolved	Arsenic, dissolved	pH	Dissolved oxygen	Oxidation reduction potential	Deuterium	Oxygen 18
			µg/L	µg/L	mg/L	mg/L	mg/L	µg/L		mg/L	mV	0/00	0/00
MW-158C	09/04/12		ND (1.0)	0.1	---	---	---	---	7.78	2.84	207.1	---	---
	12/06/12		---	---	---	---	---	---	8.17	0.69	57.3	-63.0	-8.6
	12/26/12		ND (1.0)	ND (0.2)	264	ND (0.50)	---	---	8.25	0.77	-109.4	---	---
MW-158S	10/17/12		1.9	1.8	365	ND (0.50)	0.00071	4.5	7.36	5.70	64.9	---	---
	12/06/12		---	---	---	---	---	---	7.63	5.12	104.2	-64.6	-8.7
MW-159C	08/22/12		ND (1.0)	0.12	320	0.09	0.039	11.0	8.10	3.35	-56.1	---	---
	09/04/12		ND (1.0)	0.14	---	---	---	---	7.88	1.29	64.2	---	---
	10/18/12		ND (1.0)	ND (0.06)	340	ND (0.50)	---	---	7.86	0.39	-59.3	---	---
	12/04/12		---	---	---	---	---	---	7.98	0.49	-33.6	-62.8	-8.6
MW-159D	10/18/12		4.2	4.2	329	ND (0.50)	0.021	2.2	7.49	3.52	48.6	---	---
	12/04/12		---	---	---	---	---	---	7.56	3.44	53.7	-64.5	-8.7
MW-159S	10/18/12		6.1	6.0	457	1.09	0.014	1.3	7.18	5.59	-33.1	---	---
	12/04/12		---	---	---	---	---	---	7.36	5.63	-49.5	-63.2	-8.5
MW-160C	09/14/12		ND (1.0)	ND (0.06)	350	0.15	0.017	13.0	7.90	1.36	85.1	---	---
	10/18/12		ND (1.0)	ND (0.06)	321	ND (0.50)	---	---	7.93	0.16	-67.1	---	---
MW-160D	10/18/12		4.1	4.0	318	2.65	---	---	7.35	0.92	-2.6	---	---
MW-163D	12/03/12		ND (1.0)	ND (0.06)	562	ND (0.50)	0.32	11.2	7.42	0.79	-112.1	-63.6	-8.5
MW-163S	11/08/12		8.7	8.0	304	1.26	---	---	7.67	4.26	-26.5	---	---
	12/06/12		---	---	---	---	0.0087	2.5	7.90	4.08	50.9	-61.2	-8.2
MW-164D	12/04/12		---	---	---	---	---	---	8.05	3.04	-60.1	---	---
	12/05/12		3.0	2.1	384	ND (0.50)	0.0079	21.4	---	---	---	-64.8	-8.9
MW-164S	11/08/12		2.4	2.4	1,940	6.16	---	---	7.20	4.75	68.9	---	---
	12/05/12		---	---	---	---	0.0079	3.8	7.32	3.98	41.9	-63.1	-8.4
MW-165D	11/08/12		1.1	0.99	413	1.41	---	---	7.65	3.70	81.2	---	---
MW-165S	11/08/12		ND (1.0)	0.77	426	ND (0.50)	---	---	7.57	2.95	72.0	---	---
MW-167D	12/03/12		ND (1.0)	ND (0.06)	360	ND (0.50)	0.139	7.4	8.02	0.24	-217.3	---	---
MW-167S1	12/03/12		ND (1.0)	0.5	1,430	4.42	0.0669	4.7	7.19	1.08	-58.6	---	---
MW-167S2	12/03/12		ND (1.0)	ND (0.06)	369	ND (0.50)	0.0276	8.3	7.83	0.29	-228.3	---	---

TABLE 4

Chromium and Geochemical Indicator Parameter Data for Western Area and Selected Other Monitoring Wells

Conceptual Site Model for Groundwater Flow and the Occurrence of Chromium in Groundwater of the Western Area

Pacific Gas and Electric Company Hinkley Compressor Station, Hinkley, California

Location	Date	Sample Type	Chromium, dissolved	Chromium, Hexavalent	Total dissolved solids (TDS)	Nitrate (as nitrogen)	Manganese, dissolved	Arsenic, dissolved	pH	Dissolved oxygen	Oxidation reduction potential	Deuterium	Oxygen 18
			µg/L	µg/L	mg/L	mg/L	mg/L	µg/L		mg/L	mV	0/00	0/00
MW-168D	12/05/12		1.4	1.2	280	ND (0.50)	---	---	7.89	1.48	-52.0	---	---
MW-168S	12/05/12		1.8	1.5	1,170	63.2	---	---	7.04	1.07	25.1	---	---
MW-169D	12/05/12		ND (1.0)	0.086	319	ND (0.50)	---	---	7.90	0.47	-164.1	---	---
MW-169S1	12/05/12		2.7	1.4	2,070	124	---	---	6.60	2.43	45.2	---	---
	12/26/12		3.5	1.2	2,170	125	---	---	6.41	2.48	25.2	---	---
MW-169S2	12/05/12		3.7	3.4	381	6.16	---	---	7.64	3.27	-6.1	---	---
MW-86S	01/17/12		5.0	4.8	1,390	16.0	---	---	6.73	4.82	42.6	---	---
	04/10/12		5.9	5.1	1,300	15.8	---	---	7.06	3.85	131.1	---	---
	04/10/12	FD	5.3	5.1	1,360	15.8	---	---	---	---	---	---	---
	07/20/12		5.3	4.8	1,350	15.3	---	---	6.84	6.18	53.7	---	---
	10/18/12		4.8	4.5	1,390	16.1	---	---	7.16	5.79	57.6	---	---
	10/18/12	FD	4.7	4.6	1,370	15.1	---	---	---	---	---	---	---
MW-87S	01/17/12		3.4	2.7	1,220	11.2	---	---	7.41	2.62	49.5	---	---
	04/10/12		3.0	2.7	1,090	11.0	---	---	7.61	2.90	66.8	---	---
	07/24/12		2.6	2.3	1,160	10.2	---	---	7.54	2.81	65.1	---	---
	10/18/12		3.1	3.2	1,340	13.0	---	---	7.48	2.69	40.8	---	---
MW-88S	01/18/12		6.1	5.4	1,310	15.4	---	---	6.95	4.48	69.8	---	---
	04/10/12		5.9	5.3	1,240	15.3	---	---	7.14	4.93	33.4	---	---
	07/24/12		5.2	4.4	1,250	15.0	---	---	6.83	5.42	20.7	---	---
	07/24/12	FD	5.3	4.4	1,240	15.4	---	---	---	---	---	---	---
	10/12/12		5.0	4.9	1,270	16.2	---	---	6.92	5.70	119.7	---	---
SA-MW-05D	02/08/12		3,900	4,300	---	5.90	ND (0.0005)	1.3	7.36	5.14	87.8	---	---
	04/24/12		3,880	4,200	640	7.27	0.0011	1.4	7.34	6.51	82.1	-53.9	-7.2
	08/07/12		2,800	2,800	---	6.00	0.09	1.0	7.19	4.76	-31.7	---	---
	10/19/12		3,200	3,100	---	5.00	0.0016	1.2	7.23	3.64	77.6	---	---

TABLE 4

Chromium and Geochemical Indicator Parameter Data for Western Area and Selected Other Monitoring Wells

Conceptual Site Model for Groundwater Flow and the Occurrence of Chromium in Groundwater of the Western Area

Pacific Gas and Electric Company Hinkley Compressor Station, Hinkley, California

Notes:

0/00	differences from global standards in ppt
µg/L	micrograms per liter
mg/L	milligrams per liter
mV	millivolts

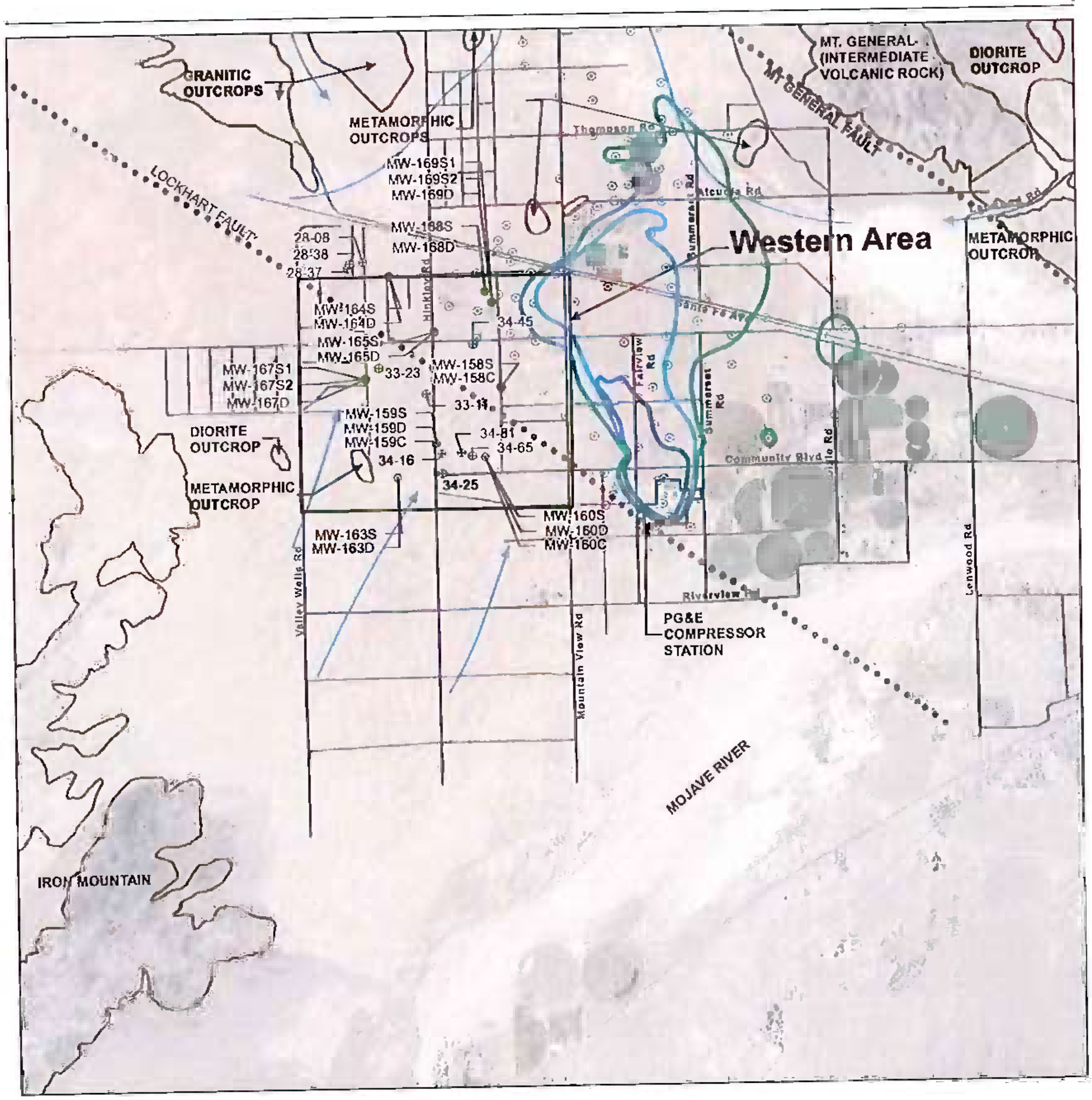
Sample Types:

FD field duplicate, unless otherwise indicated all samples are primary samples

Results Flags:

---	Analyte not sampled
FQ	Dissolved oxygen measurement is outside of the expected range and may not be indicative of in situ conditions due to instrument malfunction.
J	concentration or reporting limit estimated by laboratory or data validation
ND	not detected at shown reporting limit.

Figures



LEGEND

- Domestic Wells with recent (2011-2012) chromium detections above 3.1 micrograms per liter
- Existing Groundwater Monitoring Well
- New Groundwater Monitoring Wells
- Approximate outline of Cr(VI) or Cr(T) in Upper Aquifer exceeding values of 3.1 and 3.2 μg/L, respectively, Third Quarter 2012
- Approximate 10 μg/L outline of Cr(VI) or Cr(T) concentrations in Upper Aquifer, Third Quarter 2012
- Approximate 50 μg/L outline of Cr(VI) or Cr(T) concentrations in Upper Aquifer, Third Quarter 2012
- Simplified surface drainage in and around Hinkley Valley
- Approximate Surface Trace of Lockhart Fault (Stamos et al., 2001)
- Bedrock outcrops primarily consist of metamorphic, granite, or diorite rocks unless otherwise noted.

N

0 2,000 4,000
Feet

FIGURE 1
SITE LOCATION MAP
CONCEPTUAL SITE MODEL FOR GROUNDWATER FLOW AND THE OCCURRENCE OF CHROMIUM IN GROUNDWATER OF THE WESTERN AREA
PACIFIC GAS AND ELECTRIC COMPANY
HINKLEY COMPRESSOR STATION
HINKLEY, CALIFORNIA

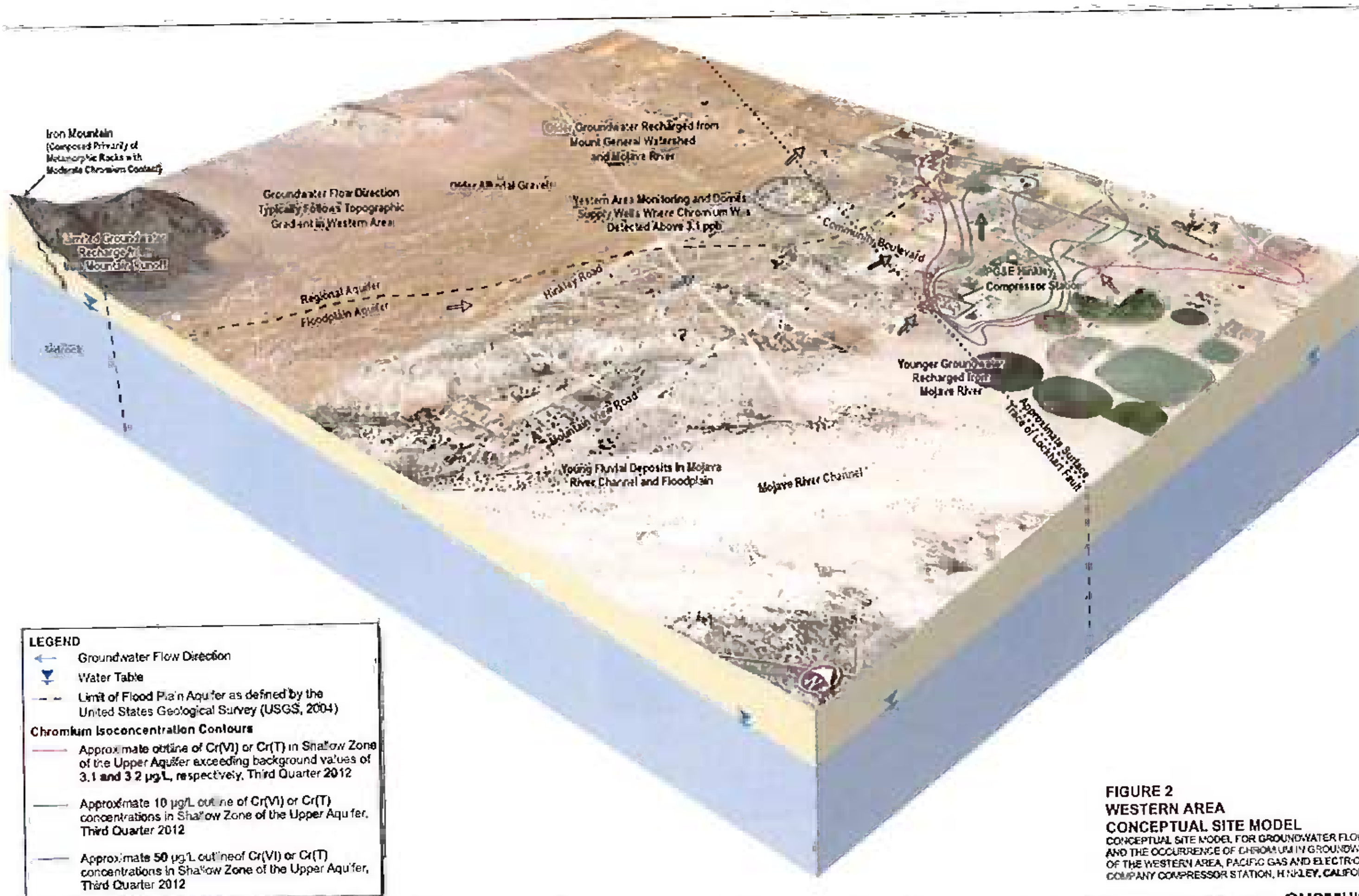


FIGURE 2
WESTERN AREA
CONCEPTUAL SITE MODEL
CONCEPTUAL SITE MODEL FOR GROUNDWATER FLOW AND THE OCCURRENCE OF CHROMIUM IN GROUNDWATER OF THE WESTERN AREA, PACIFIC GAS AND ELECTRIC COMPANY COMPRESSOR STATION, HINKLEY, CALIFORNIA

CH2MHILL

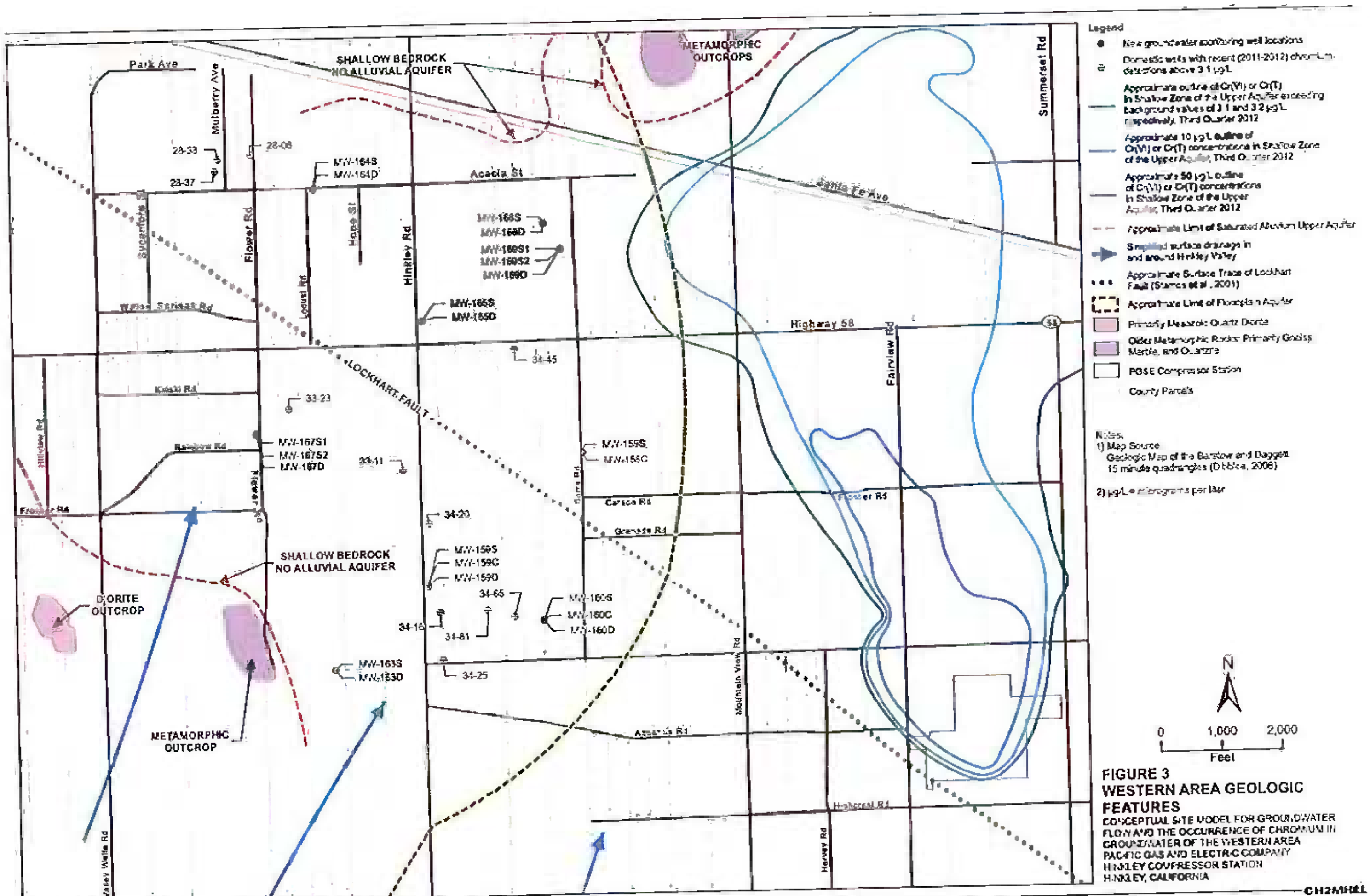
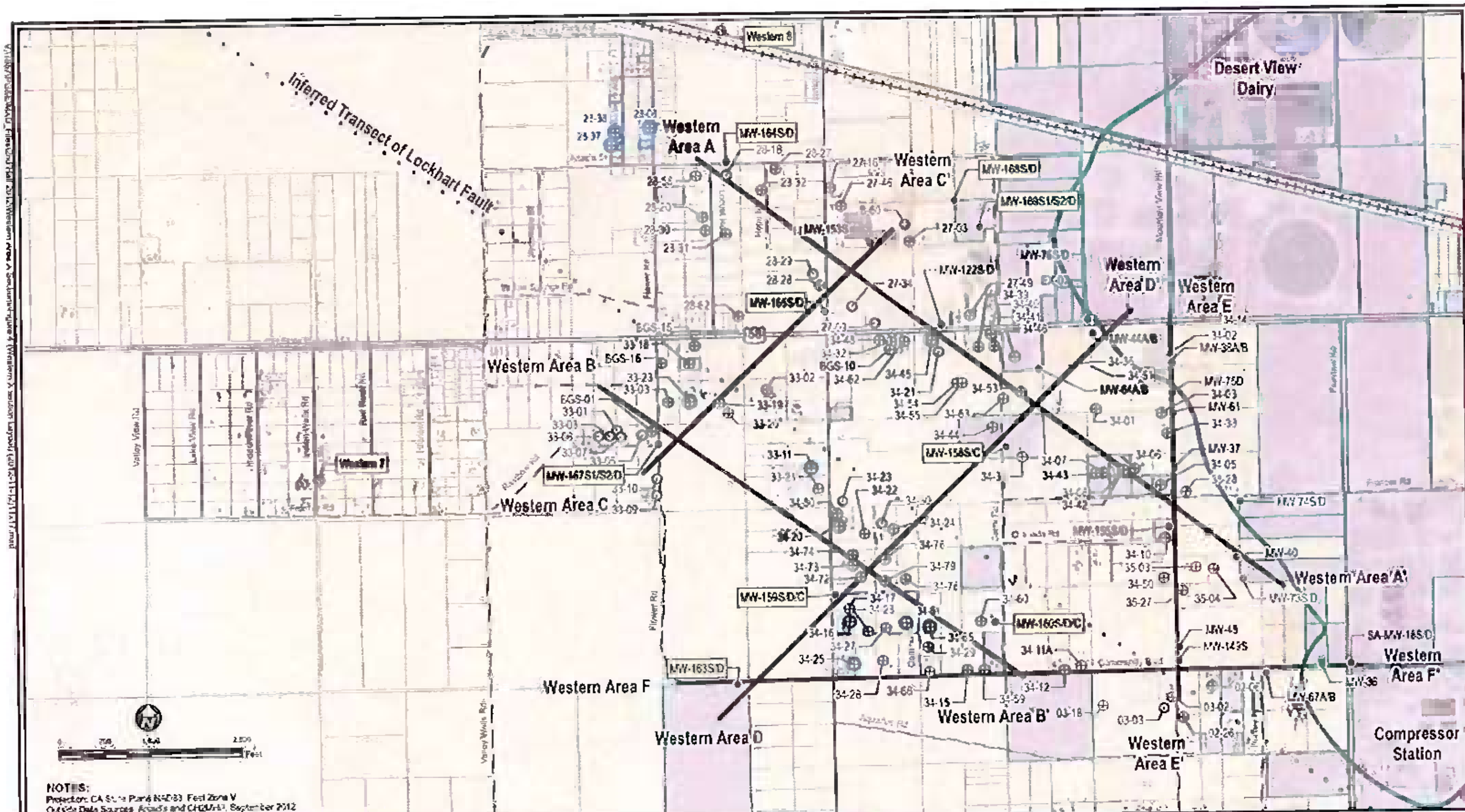


FIGURE 3
WESTERN AREA GEOLOGIC FEATURES
CONCEPTUAL SITE MODEL FOR GROUNDWATER FLOW AND THE OCCURRENCE OF CHROMIUM IN GROUNDWATER OF THE WESTERN AREA
PACIFIC GAS AND ELECTRIC COMPANY
HINKLEY COMPRESSOR STATION
HINKLEY, CALIFORNIA



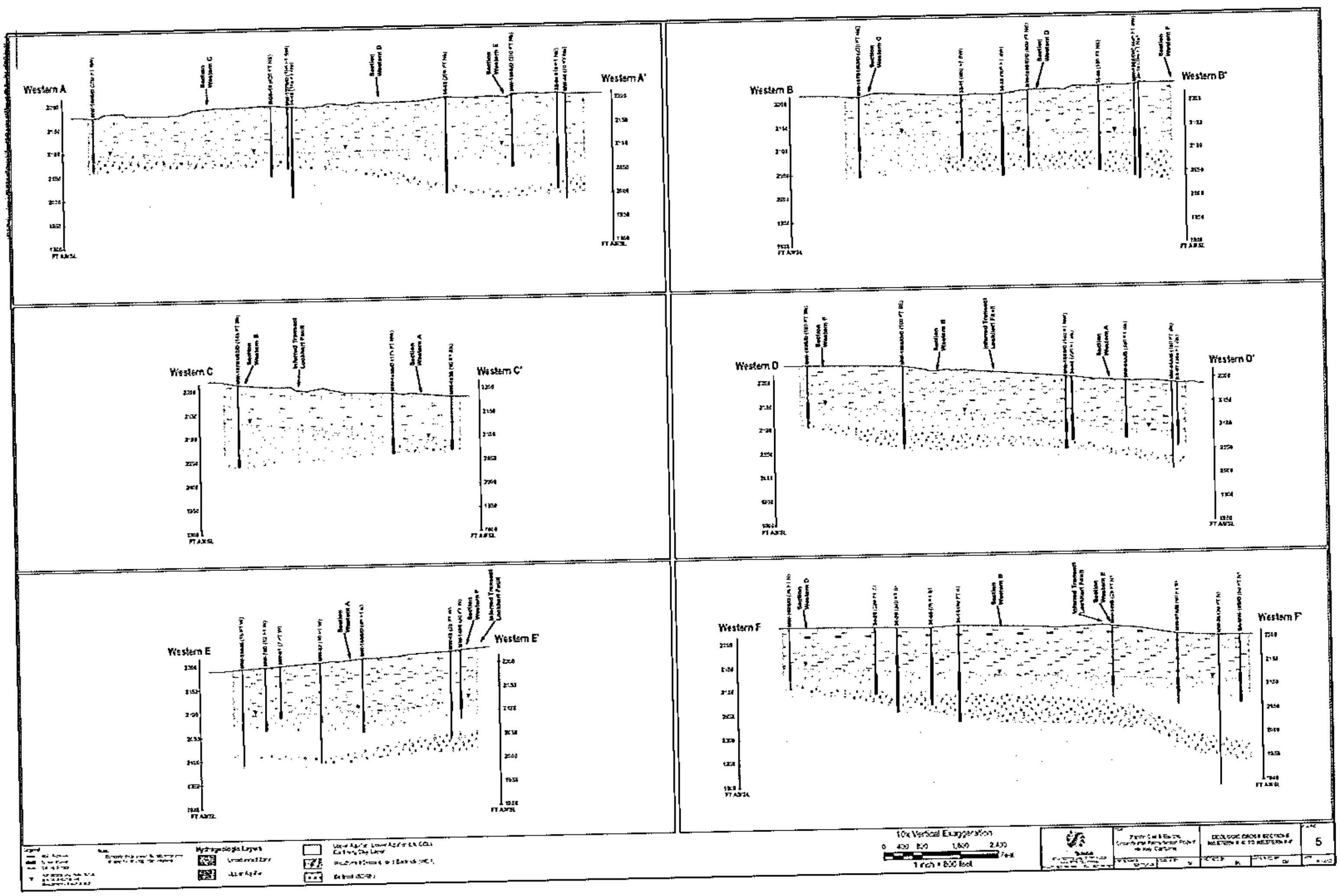
Wells by Well Type
- Monitoring Well
- Domestic Supply Well
- Soil Boring
- PGE Property Boundaries

Chromium Plume (Third Quarter 2012)
Concentration of Hexavalent Chromium (ug/l)
3.1 ug/l
Geologic Fault
Dashed Where Indefinite
Dotted Where Concealed

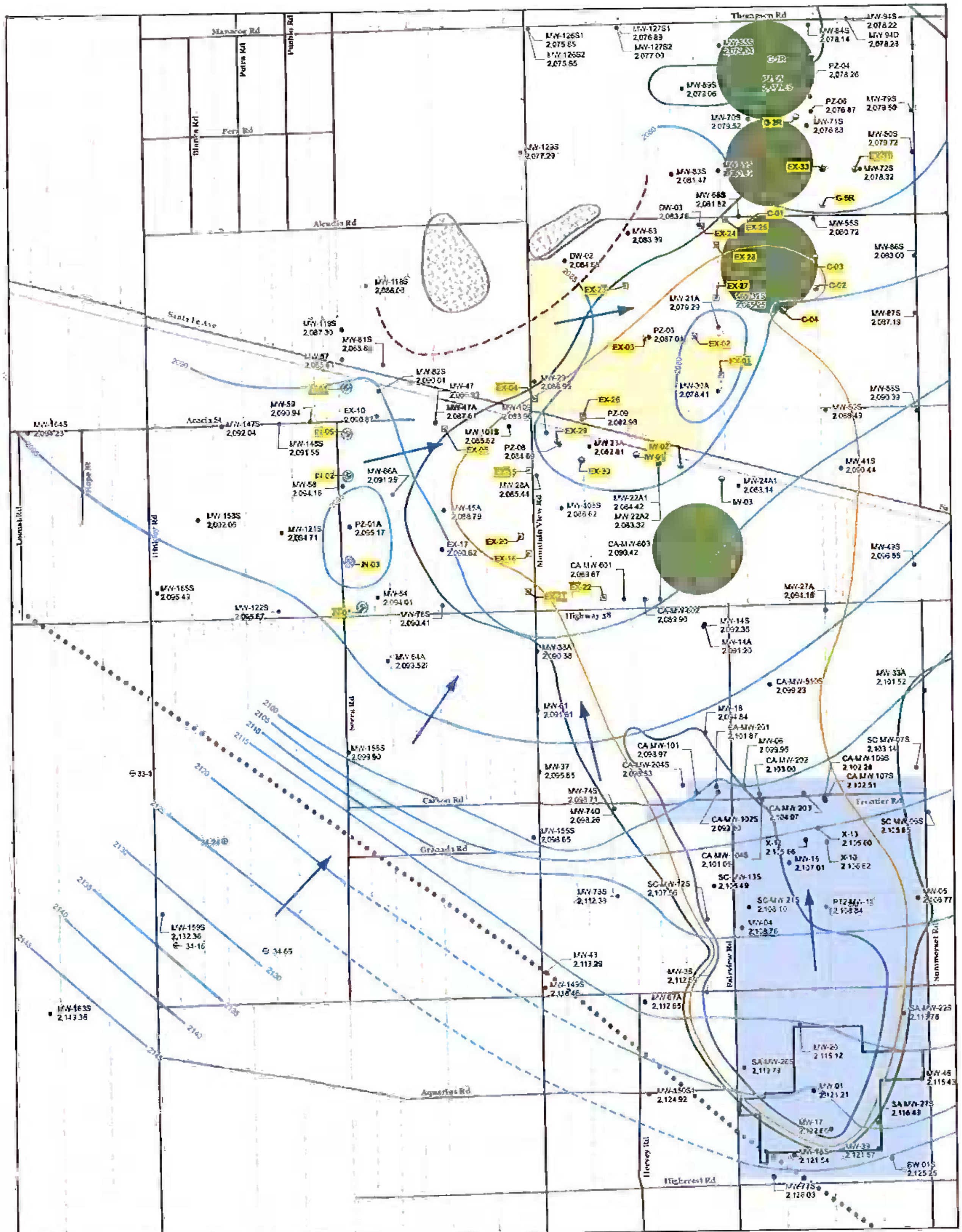
Note:
34-65 Domestic Wells with Recent (2011-2012) CrS/CrT results > 3.1 ppb
MW-153S/D Locations completed during this Investigation

Stantec
57 LAFAYETTE CIRCLE, 2ND FLOOR
LAFAYETTE, CALIFORNIA

FOR:			FIGURE:
Pacific Gas & Electric Groundwater Remediation Project Hinkley, California	SITE LAYOUT AND LINES OF GEOLOGIC SECTION		4
JOB NUMBER: 185702536	DRAWN BY: TF	CHECKED BY: BO	APPROVED BY: CM
DATE: 10/12/12			



Western A
Western A'
Western B
Western B'
Western C
Western C'
Western D
Western D'
Western E
Western E'
Western F
Western F'
10x Vertical Exaggeration
0 400 800 1,600 2,400 Feet
1 inch = 800 feet
5



LEGEND

- • Monitoring Well
- Domestic Supply Well
- Agricultural Supply Well (active wells highlighted yellow)
- Groundwater Extraction Well (active wells highlighted yellow)
- Freshwater Injection Well (active wells highlighted yellow)
- Approximate outline of Cr(VI) or Cr(T) in Shallow Zone of the Upper Aquifer exceeding background values of 3.1 and 3.2 µg/L, respectively, Third Quarter 2012
- Approximate 10 µg/L outline of Cr(VI) or Cr(T) concentrations in Shallow Zone of the Upper Aquifer, Third Quarter 2012
- Approximate 50 µg/L outline of Cr(VI) or Cr(T) concentrations in Shallow Zone of the Upper Aquifer, Third Quarter 2012
- Potentiometric Elevation Contours, Dashed Where Inferred (feet above mean sea level, 5 ft contour interval)
- General Groundwater Flow Direction
- Approximate Limit of Saturated Alluvium in Shallow Zone of Upper Aquifer
- Active Agricultural Units
- In Situ Reactive Zone
- DVD LTU Irrigation Fields
- PG&E Compressor Station
- County Parcels
- Bedrock Exposed at Ground Surface
- • • • Approximate Surface Trace of Lockhart Fault (Stamos et al., 2001)

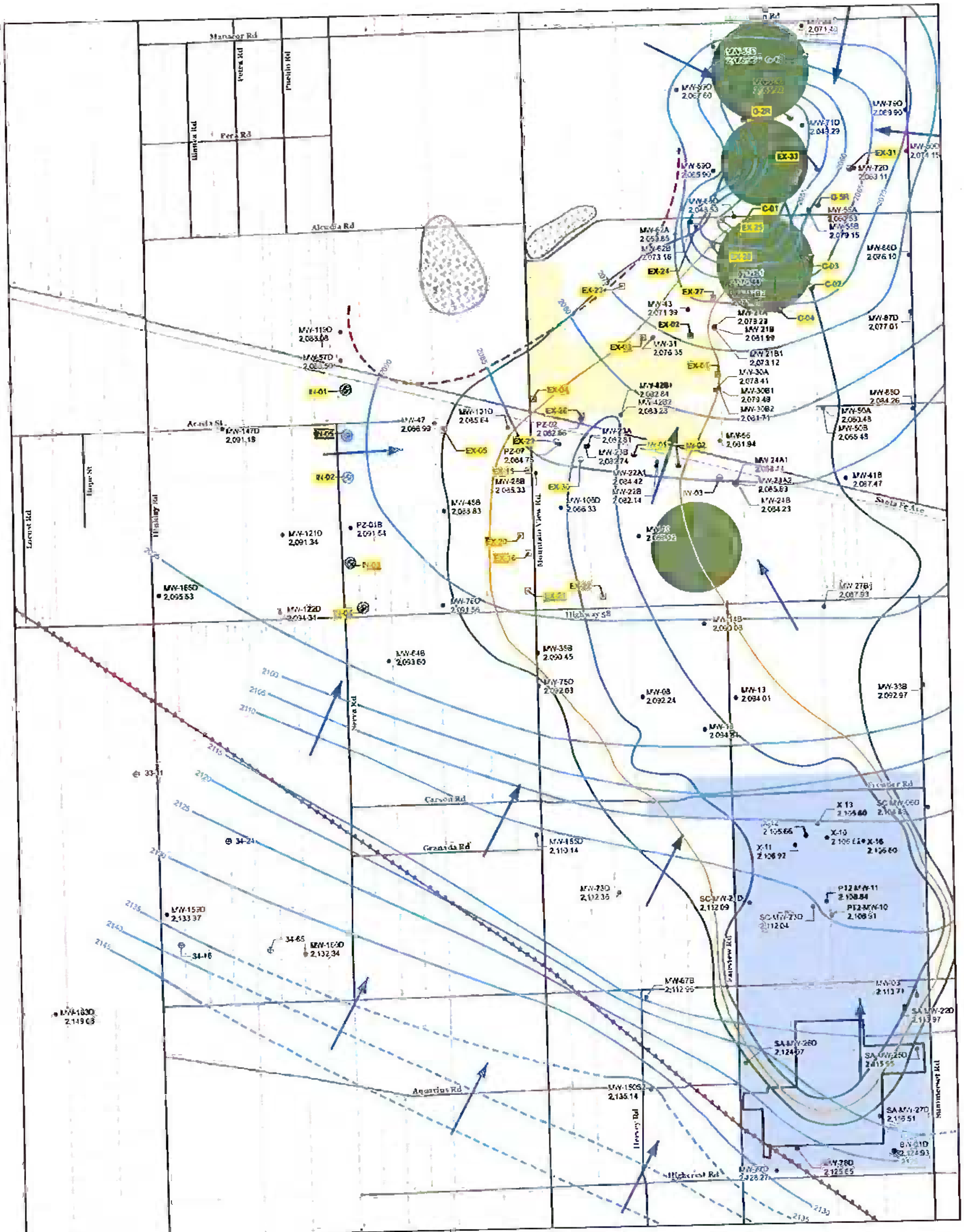
Note: Groundwater elevations calculated using manual water level measurements collected in October and November 2012

N

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

FIGURE 6
GROUNDWATER ELEVATIONS IN SHALLOW ZONE OF UPPER AQUIFER, FOURTH QUARTER 2012
CONCEPTUAL SITE MODEL FOR GROUNDWATER FLOW AND THE OCCURRENCE OF CHROMIUM IN GROUNDWATER OF THE WESTERN AREA
PACIFIC GAS AND ELECTRIC COMPANY
HINKLEY COMPRESSOR STATION
HINKLEY, CALIFORNIA

CH2MHILL



LEGEND

- Monitoring Well
- Domestic Supply Well
- Agricultural Supply Well (active wells highlighted yellow)
- Groundwater Extraction Well (active wells highlighted yellow)
- Freshwater Injection Well (active wells highlighted yellow)
- Lockhart_Fault
- Approximate outline of Cr(VI) or Cr(T) in Deep Zone of the Upper Aquifer exceeding background values of 3.1 and 3.2 µg/L, respectively, Third Quarter 2012
- Approximate 10 µg/L outline of Cr(VI) or Cr(T) concentrations in Deep Zone of the Upper Aquifer, Third Quarter 2012
- Approximate 50 µg/L outline of Cr(VI) or Cr(T) concentrations in Deep Zone of the Upper Aquifer, Third Quarter 2012
- Potentiometric Elevation Contours, Dashed Where Inferred (feet above mean sea level, 5 ft contour interval)
- General Groundwater Flow Direction
- Approximate Limit of Saturated Alluvium, In Deep Zone Upper Aquifer
- Active Agricultural Units
- In Situ Reactive Zone
- DVD LTU Irrigation Fields
- PG&E Compressor Station
- County Parcels
- Bedrock Exposed at Ground Surface
- Approximate Surface Trace of Lockhart Fault (Stamos et al., 2001)

Note: Groundwater elevations calculated using manual water level measurements collected in October and November 2012

N

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

FIGURE 7
GROUNDWATER ELEVATIONS IN DEEP ZONE OF UPPER AQUIFER, FOURTH QUARTER 2012
CONCEPTUAL SITE MODEL FOR GROUNDWATER FLOW AND THE OCCURRENCE OF CHROMIUM IN GROUNDWATER OF THE WESTERN AREA
PACIFIC GAS AND ELECTRIC COMPANY
HINKLEY COMPRESSOR STATION
HINKLEY, CALIFORNIA

CH2MHILL

BAO \\...\2012\HYDRO SUPPORT\WESTERN AREA REPORT\FIG7_...MXD ...1/.../2013 5:14:20 PM

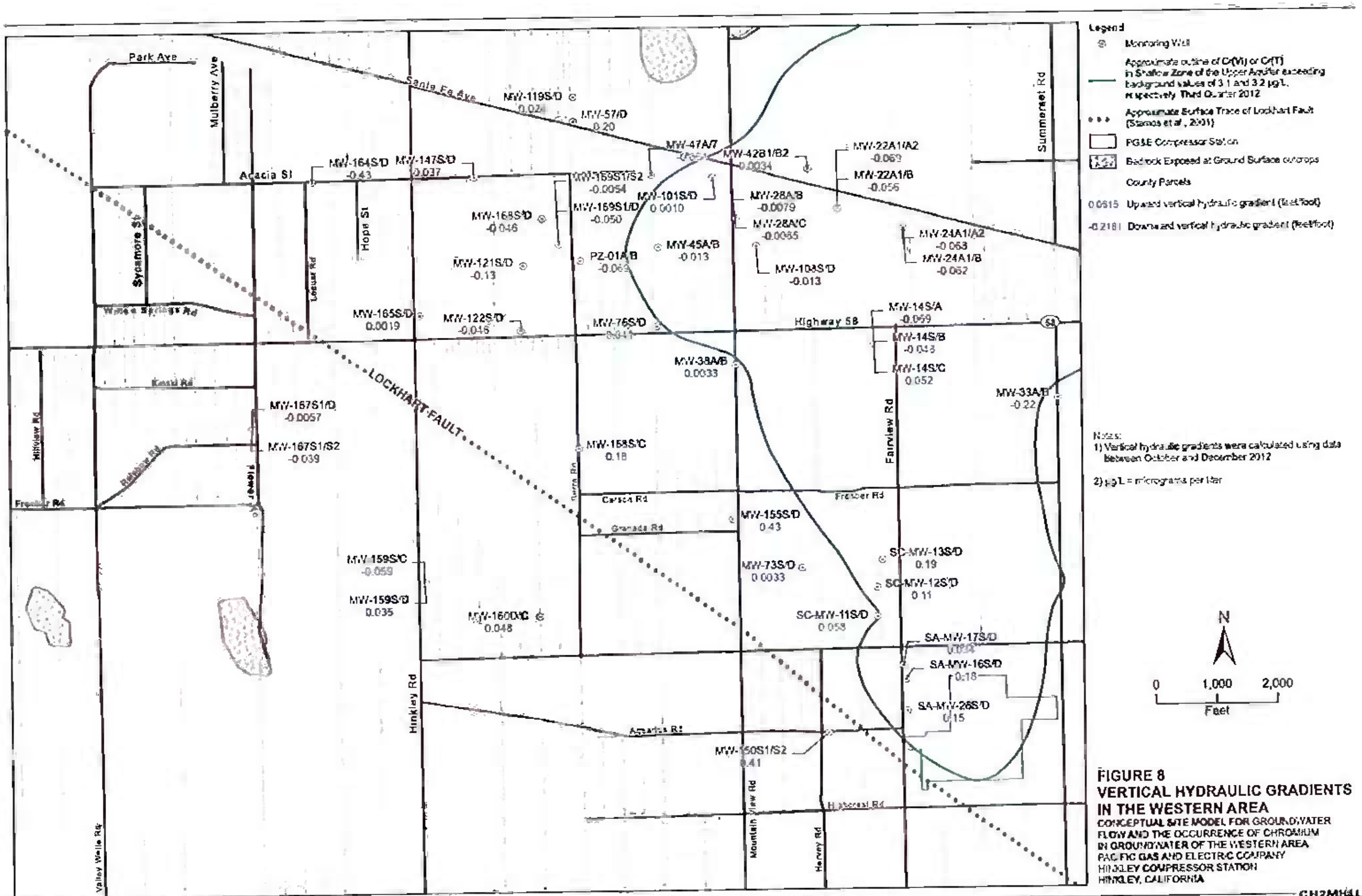
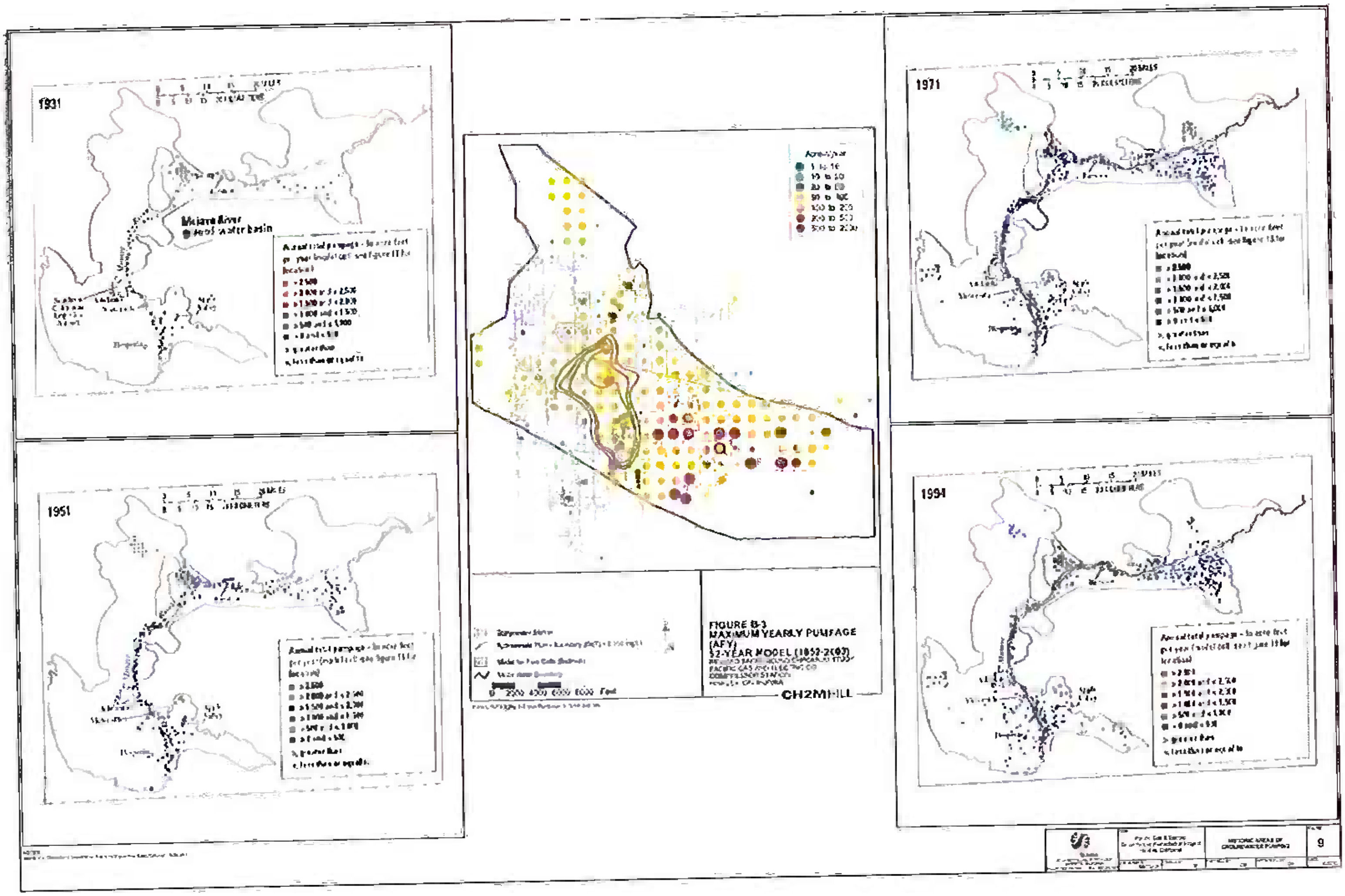
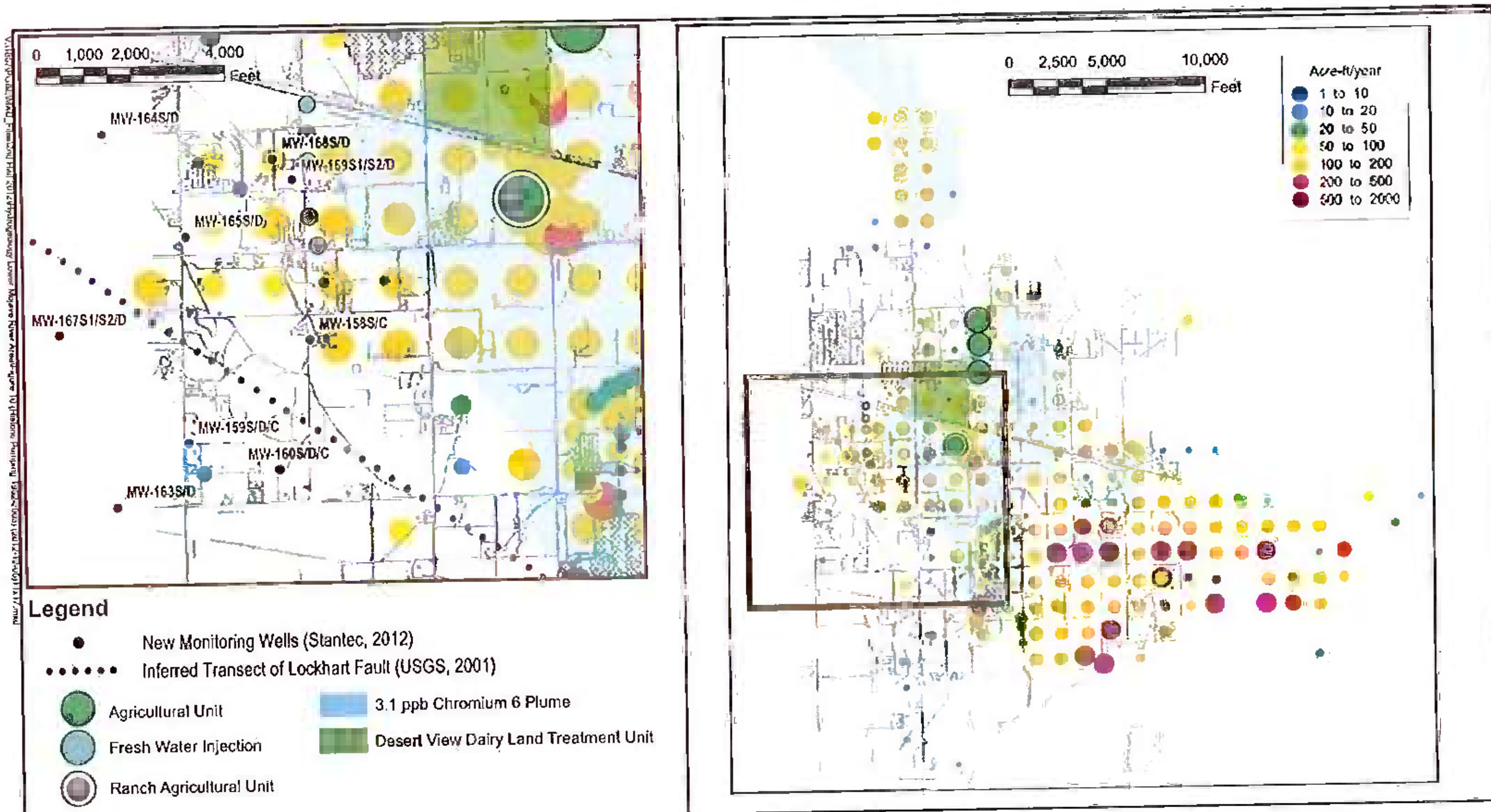


FIGURE 8
VERTICAL HYDRAULIC GRADIENTS IN THE WESTERN AREA
CONCEPTUAL SITE MODEL FOR GROUNDWATER FLOW AND THE OCCURRENCE OF CHROMIUM IN GROUNDWATER OF THE WESTERN AREA
PACIFIC GAS AND ELECTRIC COMPANY
HINKLEY COMPRESSOR STATION
HINKLEY, CALIFORNIA


1931
1951
1971
1994
Mojave River
FIGURE B-3
MAXIMUM YEARLY PUMPAGE
(AFY)
CH2MHILL
9

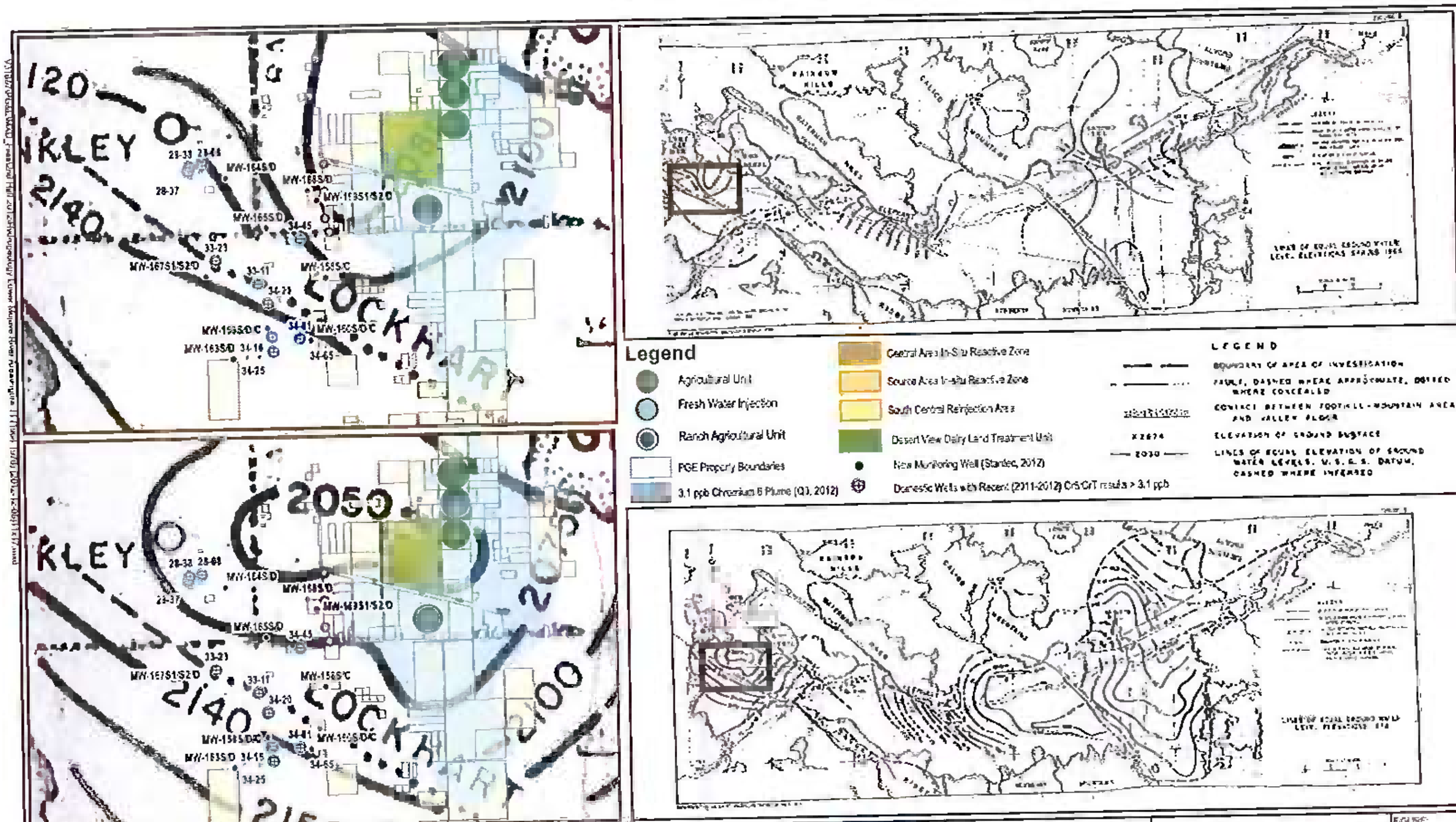


Legend

- New Monitoring Wells (Stantec, 2012)
- Inferred Transect of Lockhart Fault (USGS, 2001)
- Agricultural Unit
- Fresh Water Injection
- Ranch Agricultural Unit
- 3.1 ppb Chromium 6 Plume
- Desert View Dairy Land Treatment Unit

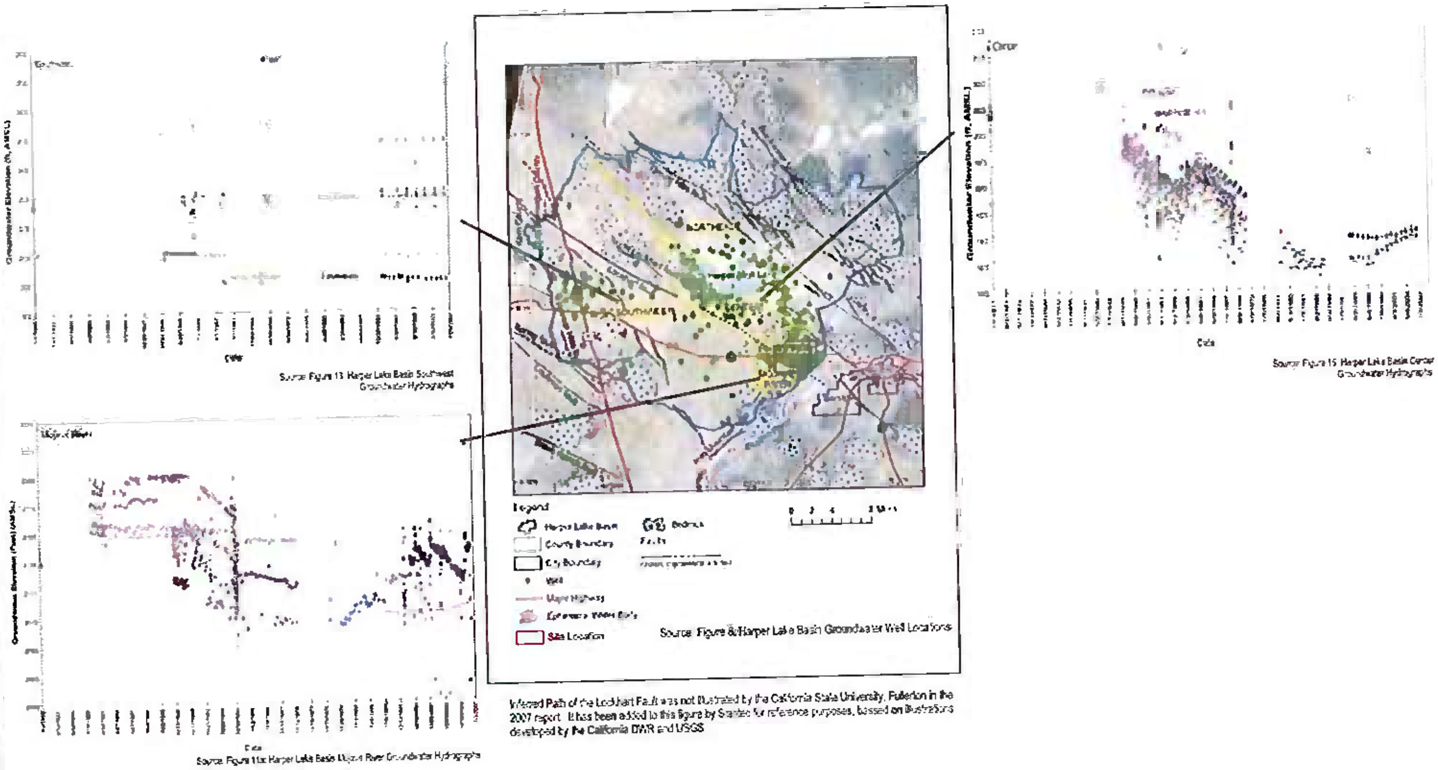
Source:
"Revised Background Chromium Study at the PG&E Compressor Station, Hinkley, California", PG&E, September 2004

Stantec 57 LAFAYETTE CIRCLE, 2ND FLOOR LAFAYETTE, CALIFORNIA PHONE: (925) 299-9300 FAX: (925) 299-9302	FOR: Pacific Gas & Electric Groundwater Remediation Project Hinkley, California		HISTORIC AREAS OF GROUNDWATER PUMPING IN THE HINKLEY VALLEY (1952 TO 2001) REVISED BACKGROUND STUDY WORK PLAN - (CH2M HILL, 2001)	FIGURE: 10
	JOB NUMBER: 185702424	DRAWN BY: TF	CHECKED BY: CM / APPROVED BY: CM	DATE: 12/06/12



Source:
State of California. Department of Water Resources, Southern District.
"Hydrogeology and Groundwater Quality in the Lower Mojave River Area, San Bernardino County, June 1983."

Stantec 57 LAFAYETTE CIRCLE, 2ND FLOOR LAFAYETTE, CALIFORNIA PHONE: (925) 299-9300 FAX: (925) 299-9302	FOR: Pacific Gas & Electric Groundwater Remediation Project Hinkley, California		GROUNDWATER FLOW IN THE WESTERN AREA - 1964 AND 1978 AS REPORTED BY THE CALIFORNIA DEPARTMENT OF WATER RESOURCES	FIGURE: 11
	JOB NUMBER: 185702424	DRAWN BY: TF	CHECKED BY: CM	APPROVED BY: CM	DATE: 12/03/12



Source: Figure 13: Harper Lake Basin Southwest Groundwater Hydrographs

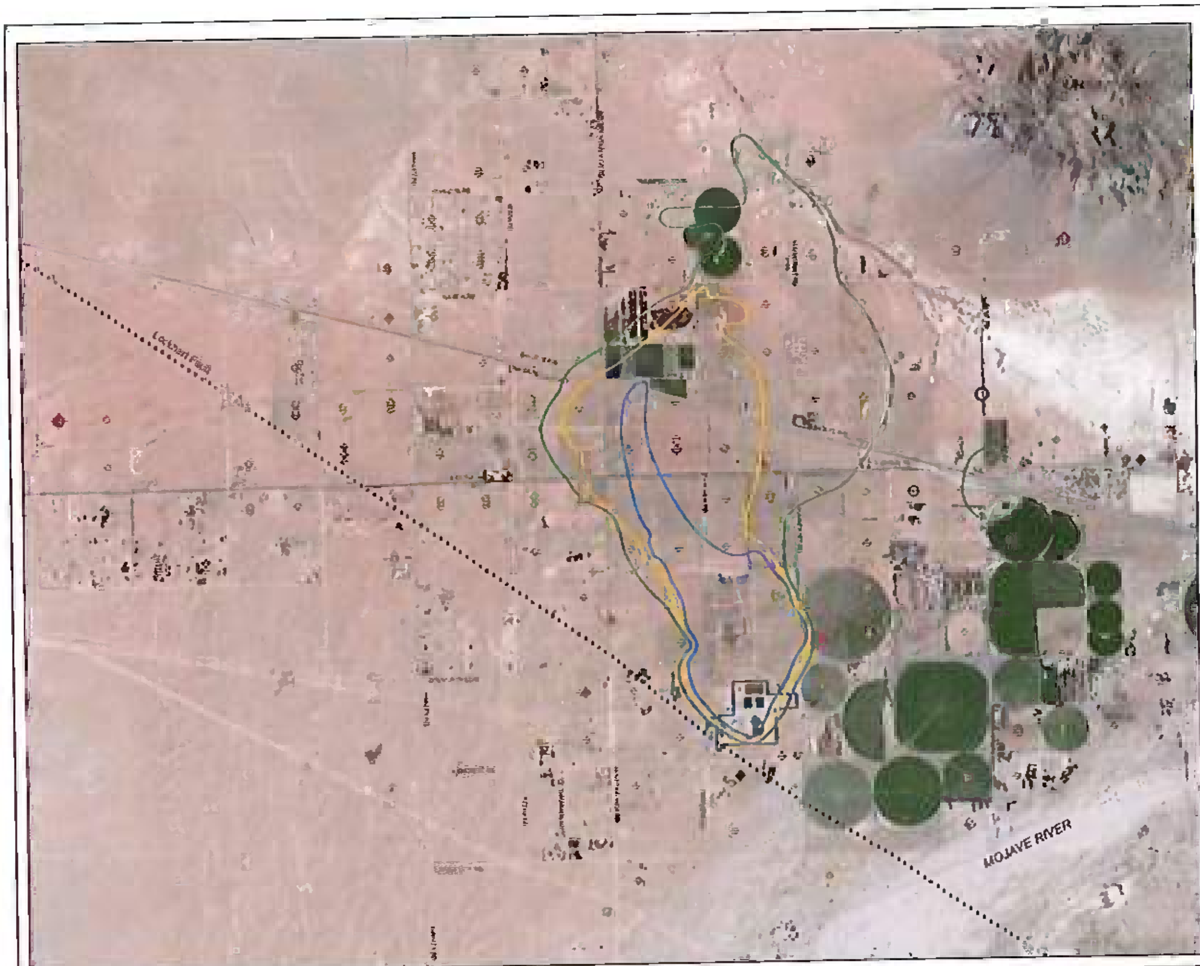
Source: Figure 15: Harper Lake Basin Center Groundwater Hydrographs

Source: Figure 8: Harper Lake Basin Groundwater Well Locations

Source: Figure 11a: Harper Lake Basin Mojave River Groundwater Hydrographs

Inferred Path of the Lockhart Fault was not illustrated by the California State University, Fullerton in the 2007 report. It has been added to this figure by Stantec for reference purposes, based on illustrations developed by the California DWR and USGS

12



Legend

- Approximate Surface Trace of Lockhart Fault (Stamos et al., 2001)
- Approximate 50 µg/L outline of Cr(VI) or CR(T) concentrations in the Shallow Zone of the Upper Aquifer, Third Quarter, 2012
- Approximate 10 µg/L outline of Cr(VI) or CR(T) concentrations in the Shallow Zone of the Upper Aquifer, Third Quarter, 2012
- Approximate outline of Cr(VI) or CR(T) in Shallow Zone of the Upper Aquifer exceeding background values of 3.1 and 3.2 µg/L, Respectively. Third Quarter, 2012
- PG&E Compressor Station

Number of Data Points at Each Well

- 1
- 2 - 10
- 11 - 20
- 21 - 50
- 51 - 100
- 100 - 250

Note:
µg/L = micrograms per liter

0 2,000 4,000
Feet
N

FIGURE 13A
GROUNDWATER ELEVATION DATA, 1950'S

CONCEPTUAL SITE MODEL FOR GROUNDWATER FLOW AND THE OCCURRENCE OF CHROMIUM IN GROUNDWATER OF THE WESTERN PACIFIC GAS AND ELECTRIC COMPANY HINKLEY COMPRESSOR STATION
HINKLEY, CALIFORNIA

CH2MHILL

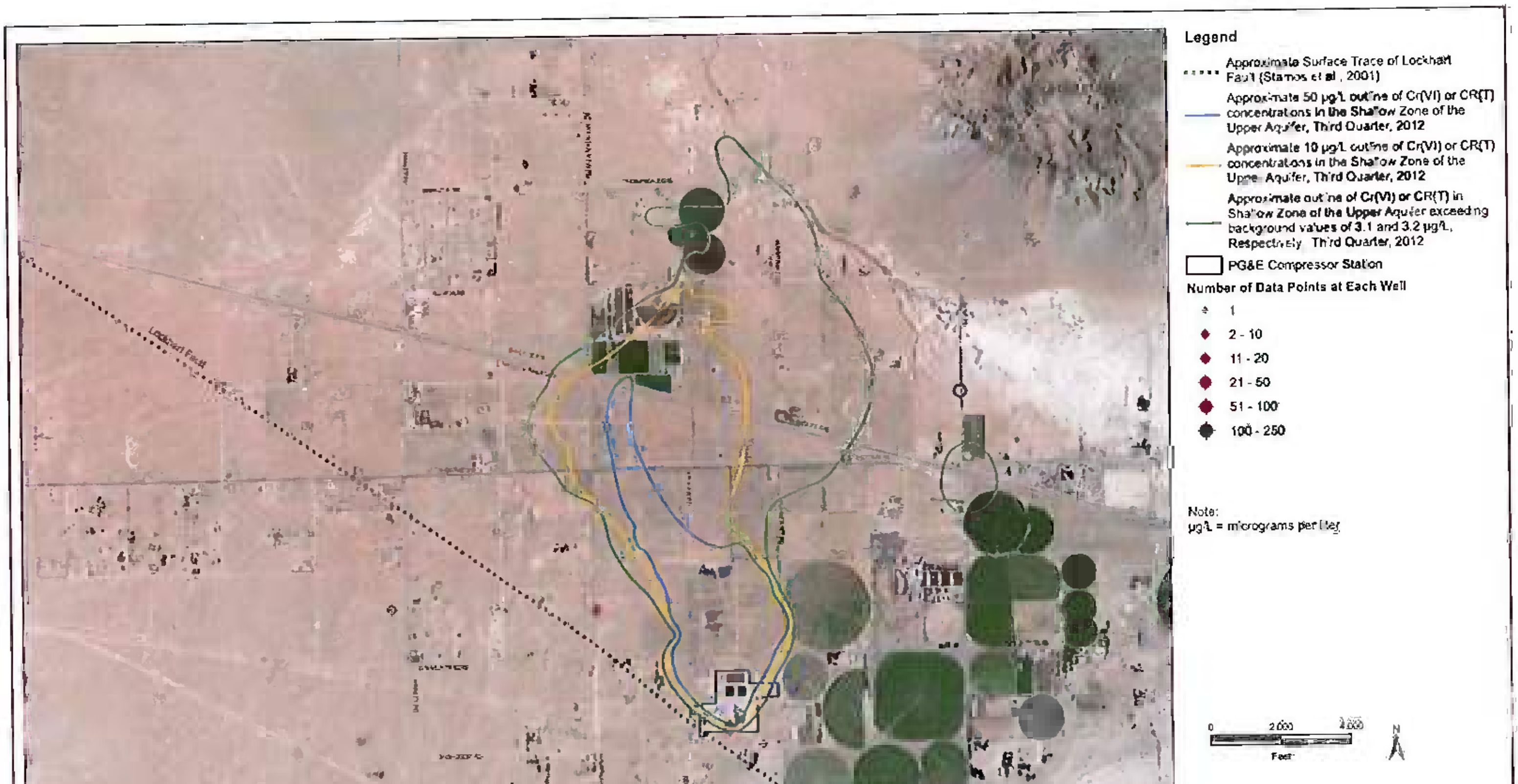


FIGURE 13B
GROUNDWATER ELEVATION DATA, 1960'S

CONCEPTUAL SITE MODEL FOR GROUNDWATER FLOW AND THE OCCURRENCE OF CHROMIUM IN GROUNDWATER OF THE WESTERN PACIFIC GAS AND ELECTRIC COMPANY HINKLEY COMPRESSOR STATION HINKLEY, CALIFORNIA

CH2MHILL

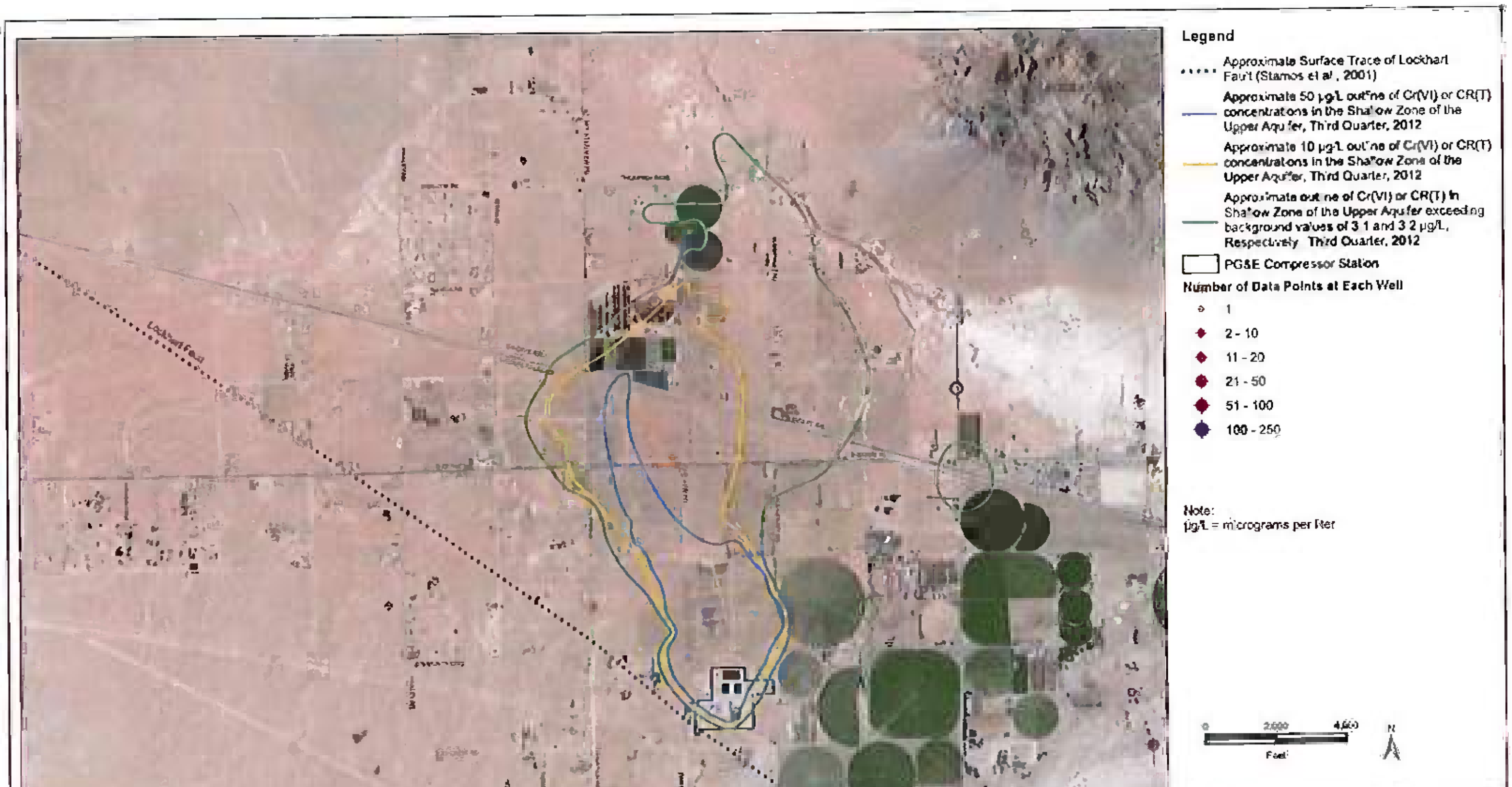


FIGURE 13C
GROUNDWATER ELEVATION DATA, 1970'S

CONCEPTUAL SITE MODEL FOR GROUNDWATER FLOW AND THE OCCURRENCE OF CHROMIUM IN GROUNDWATER OF THE WESTERN PACIFIC GAS AND ELECTRIC COMPANY HINKLEY COMPRESSOR STATION HINKLEY, CALIFORNIA

CH2MHILL

Legend

Approximate Surface Trace of Lockhart Fault (Stamos et al., 2001)

Approximate 50 μg/L outline of Cr(VI) or CR(T) concentrations in the Shallow Zone of the Upper Aquifer, Third Quarter, 2012

Approximate 10 μg/L outline of Cr(VI) or CR(T) concentrations in the Shallow Zone of the Upper Aquifer, Third Quarter, 2012

Approximate outline of Cr(VI) or CR(T) in Shallow Zone of the Upper Aquifer exceeding background values of 3.1 and 3.2 μg/L, Respectively, Third Quarter, 2012

PG&E Compressor Station

Number of Data Points at Each Well

- 1
- 2 - 10
- 11 - 20
- 21 - 50
- 51 - 100
- 100 - 250

Note:
μg/L = micrograms per liter

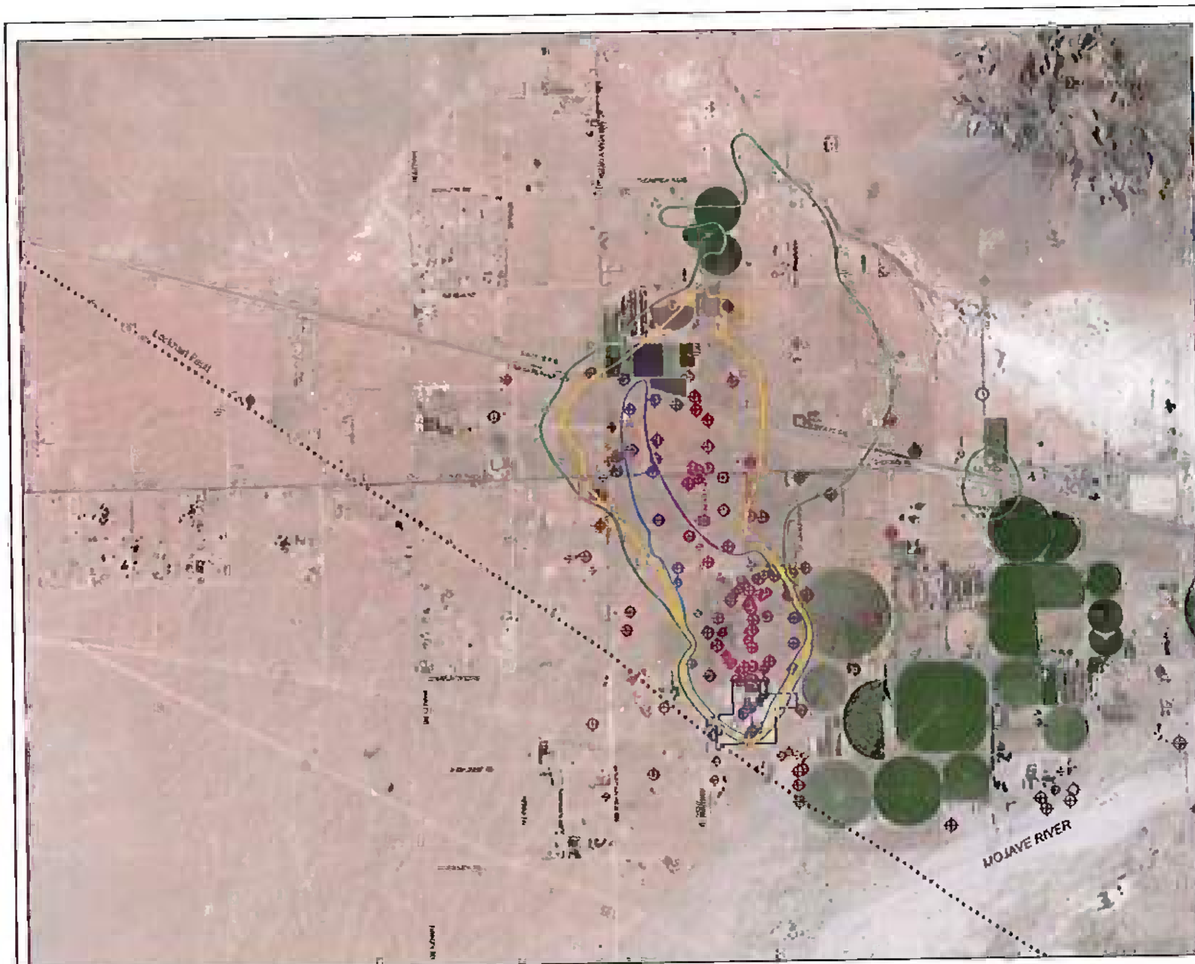
0 2,000 4,000
Feet

N

FIGURE 13D
GROUNDWATER ELEVATION DATA, 1980'S

CONCEPTUAL SITE MODEL FOR GROUNDWATER FLOW AND THE OCCURRENCE OF CHROMIUM IN GROUNDWATER OF THE WESTERN PACIFIC GAS AND ELECTRIC COMPANY HINKLEY COMPRESSOR STATION HINKLEY, CALIFORNIA

CH2MHILL



Legend

- Approximate Surface Trace of Lockhart Fault (Stamos et al., 2001)
- Approximate 50 µg/L outline of Cr(VI) or CR(T) concentrations in the Shallow Zone of the Upper Aquifer, Third Quarter, 2012
- Approximate 10 µg/L outline of Cr(VI) or CR(T) concentrations in the Shallow Zone of the Upper Aquifer, Third Quarter, 2012
- Approximate outline of Cr(VI) or CR(T) in Shallow Zone of the Upper Aquifer exceeding background values of 3.1 and 3.2 µg/L, Respectively. Third Quarter, 2012
- PG&E Compressor Station

Number of Data Points at Each Well

- 1
- 2 - 10
- 11 - 20
- 21 - 50
- 51 - 100
- 100 - 250

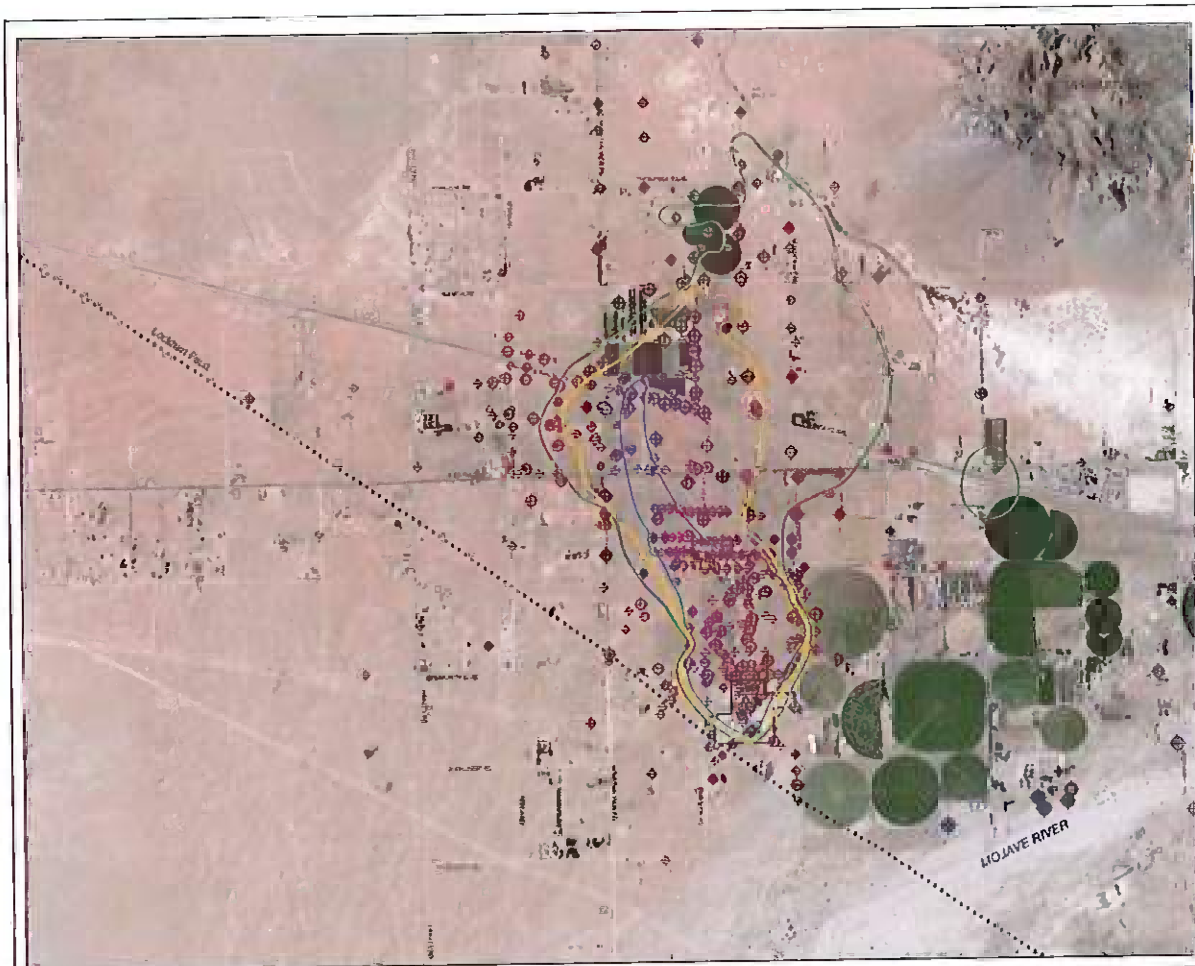
Note:
µg/L = micrograms per liter

0 2,000 4,000
Feet
N

FIGURE 13E
GROUNDWATER ELEVATION DATA, 1990'S

CONCEPTUAL SITE MODEL FOR GROUNDWATER FLOW AND THE OCCURRENCE OF CHROMIUM IN GROUNDWATER OF THE WESTERN PACIFIC GAS AND ELECTRIC COMPANY HINKLEY COMPRESSOR STATION HINKLEY, CALIFORNIA

CH2MHILL



Legend

- Approximate Surface Trace of Lockhart Fault (Stamos et al , 2001)
- Approximate 50 µg/L outline of Cr(VI) or CR(T) concentrations in the Shallow Zone of the Upper Aquifer, Third Quarter, 2012
- Approximate 10 µg/L outline of Cr(VI) or CR(T) concentrations in the Shallow Zone of the Upper Aquifer, Third Quarter, 2012
- Approximate outline of Cr(VI) or CR(T) in Shallow Zone of the Upper Aquifer exceeding background values of 3.1 and 3.2 µg/L, Respectively Third Quarter, 2012
- PG&E Compressor Station

Number of Data Points at Each Well

- 1
- 2 - 10
- 11 - 20
- 21 - 50
- 51 - 100
- 100 - 250

Note:
µg/L = micrograms per liter

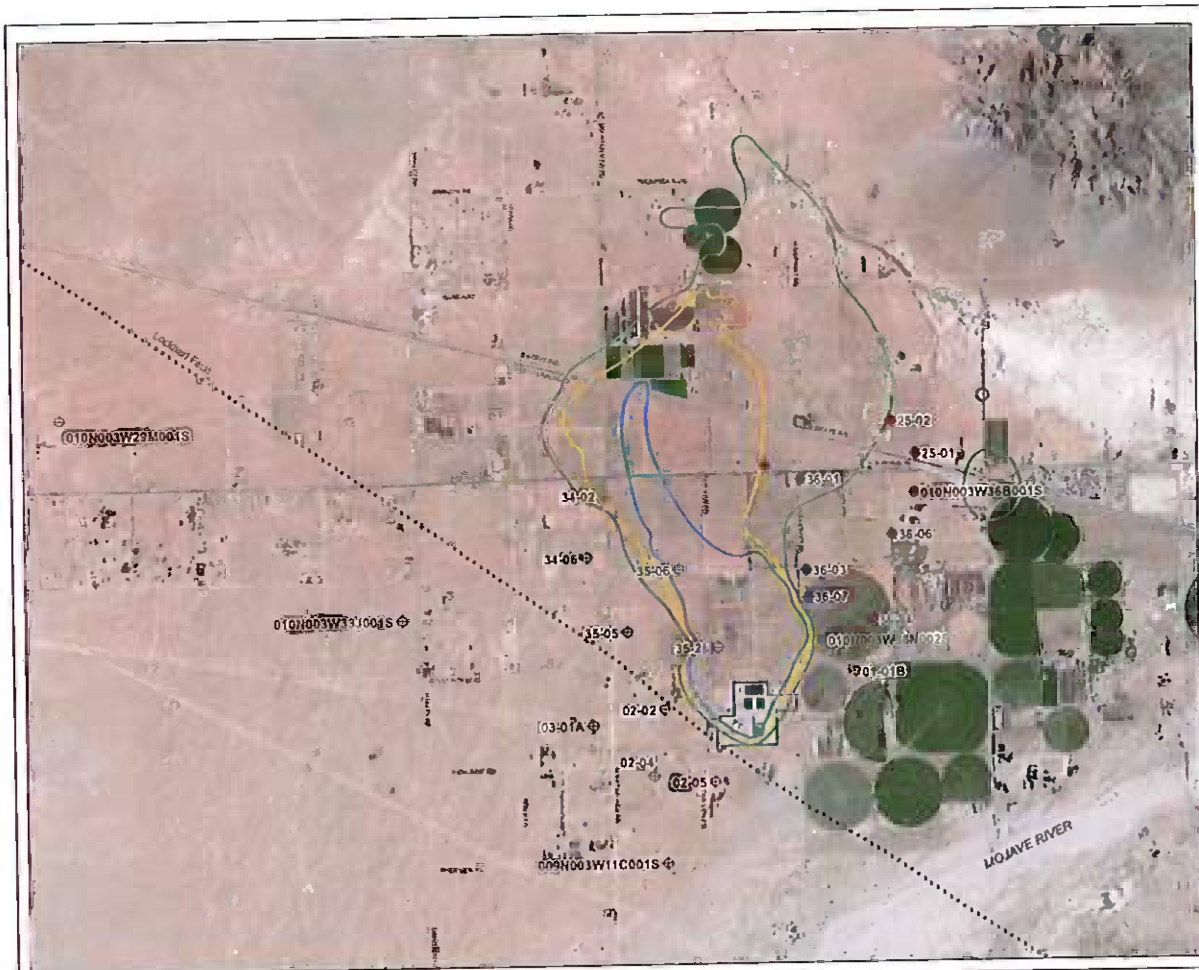
0 2,000 4,000
Feet

N

FIGURE 13F
GROUNDWATER ELEVATION DATA, 2000 THROUGH 2012

CONCEPTUAL SITE MODEL FOR GROUNDWATER FLOW AND THE OCCURRENCE OF CHROMIUM IN GROUNDWATER OF THE WESTERN PACIFIC GAS AND ELECTRIC COMPANY HINKLEY COMPRESSOR STATION HINKLEY, CALIFORNIA

CH2MHILL



Legend

- Western Area Wells
- Eastern Area Wells
- Approximate Surface Trace of Lockhart Fault (Stamos et al., 2001)
- Approximate 50 µg/L outline of Cr(VI) or CR(T) concentrations in the Shallow Zone of the Upper Aquifer, Third Quarter, 2012
- Approximate 10 µg/L outline of Cr(VI) or CR(T) concentrations in the Shallow Zone of the Upper Aquifer, Third Quarter, 2012
- Approximate outline of Cr(VI) or CR(T) in Shallow Zone of the Upper Aquifer exceeding background values of 3.1 and 3.2 µg/L, Respectively. Third Quarter, 2012
- PG&E Compressor Station

Note:
µg/L = micrograms per liter

FIGURE 13G
HYDROGRAPH WELLS

CONCEPTUAL SITE MODEL FOR GROUNDWATER FLOW AND THE OCCURRENCE OF CHROMIUM IN GROUNDWATER OF THE WESTERN PACIFIC GAS AND ELECTRIC COMPANY HINKLEY COMPRESSOR STATION HINKLEY, CALIFORNIA

CH2MHILL

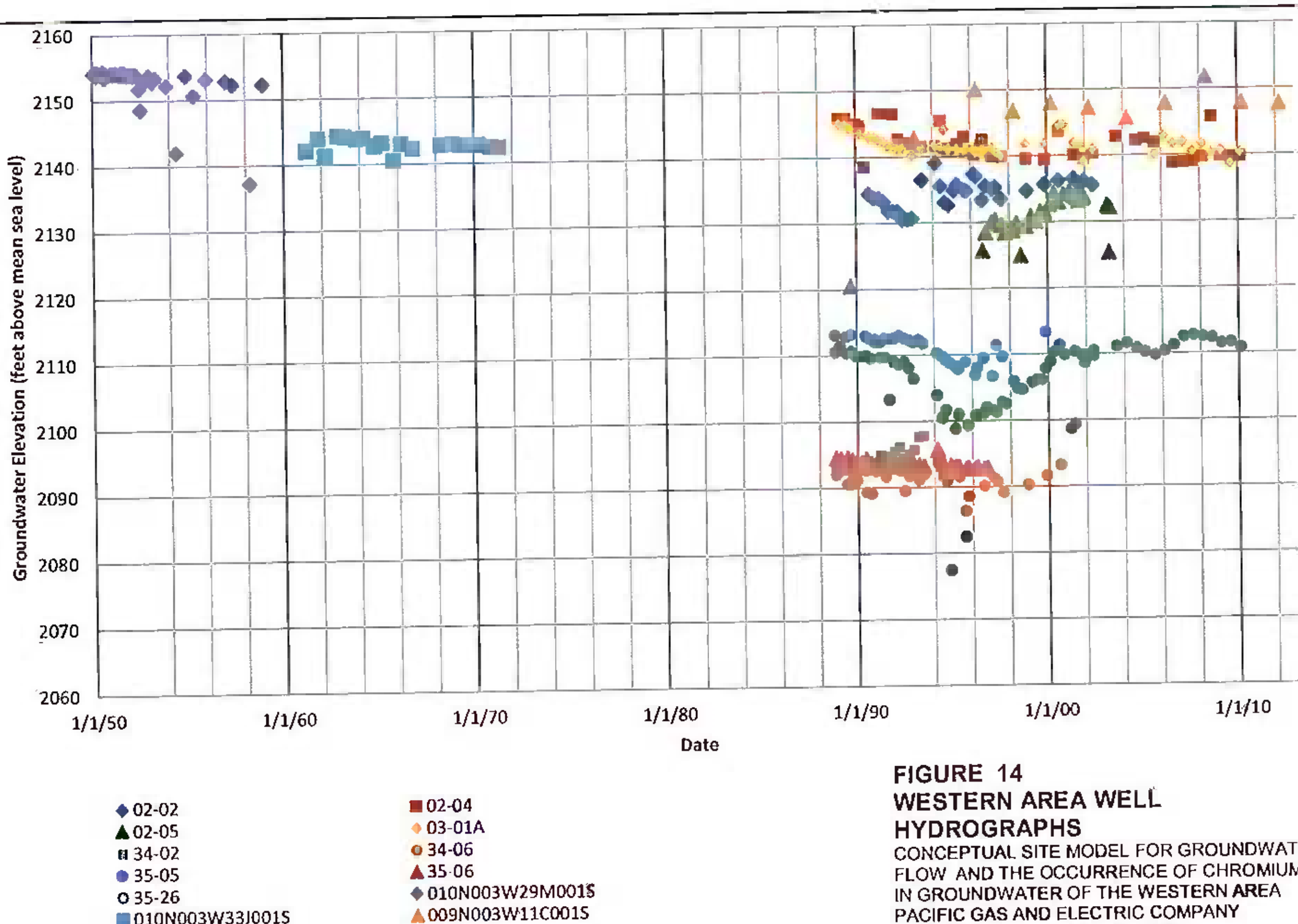


FIGURE 14
WESTERN AREA WELL HYDROGRAPHS
CONCEPTUAL SITE MODEL FOR GROUNDWATER FLOW AND THE OCCURRENCE OF CHROMIUM IN GROUNDWATER OF THE WESTERN AREA
PACIFIC GAS AND ELECTRIC COMPANY
HINKLEY COMPRESSOR STATION
HINKLEY, CALIFORNIA

CH2MHILL

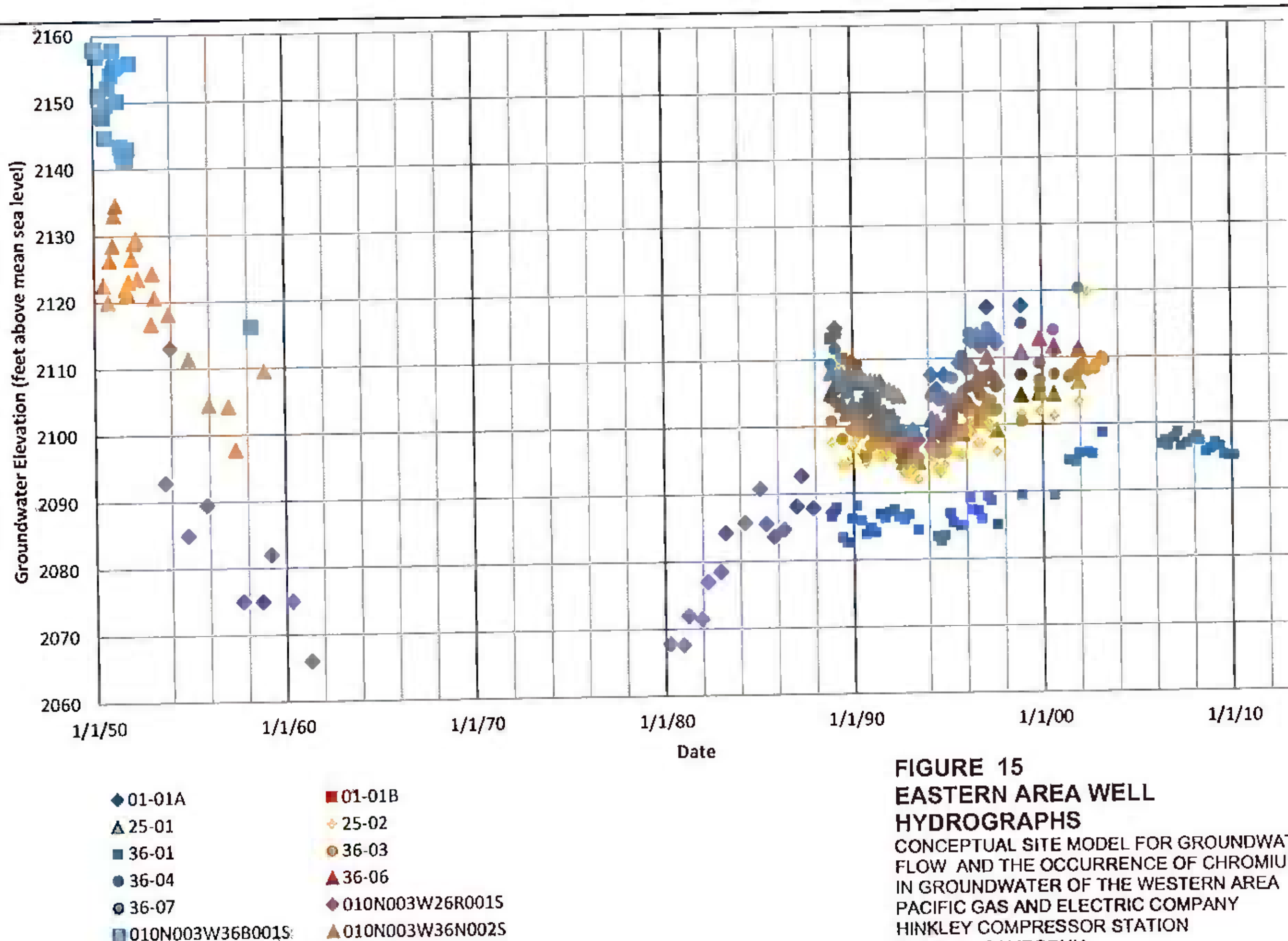
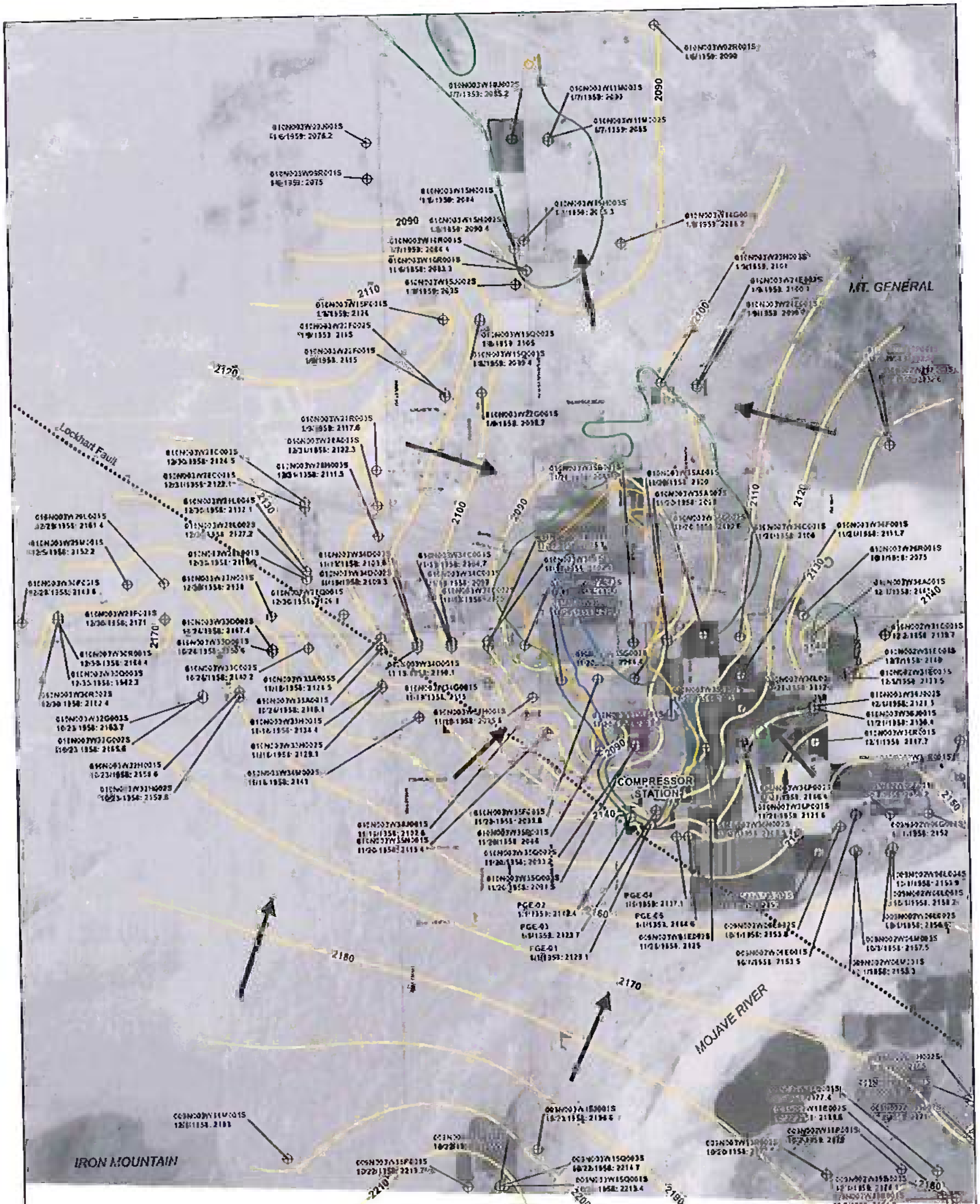


FIGURE 15
EASTERN AREA WELL HYDROGRAPHS
CONCEPTUAL SITE MODEL FOR GROUNDWATER FLOW AND THE OCCURRENCE OF CHROMIUM IN GROUNDWATER OF THE WESTERN AREA
PACIFIC GAS AND ELECTRIC COMPANY
HINKLEY COMPRESSOR STATION
HINKLEY, CALIFORNIA

CH2MHILL



Legend

- Reported Groundwater Elevation Measuring Point
- Approximate 50 µg/L outline of Cr(VI) or CR(T) concentrations in the Shallow Zone of the Upper Aquifer, Third Quarter, 2012
- Approximate 10 µg/L outline of Cr(VI) or CR(T) concentrations in the Shallow Zone of the Upper Aquifer, Third Quarter, 2012
- Approximate outline of Cr(VI) or CR(T) in Shallow Zone of the Upper Aquifer exceeding background values of 3.1 and 3.2 µg/L, Respectively, Third Quarter, 2012
- Potentiometric Elevation Contours (feet above mean sea level, 10 ft contour interval)
- Approximate Surface Trace of Lockhart Fault (Stamos et al., 2001)
- General Groundwater Flow Direction

Notes:

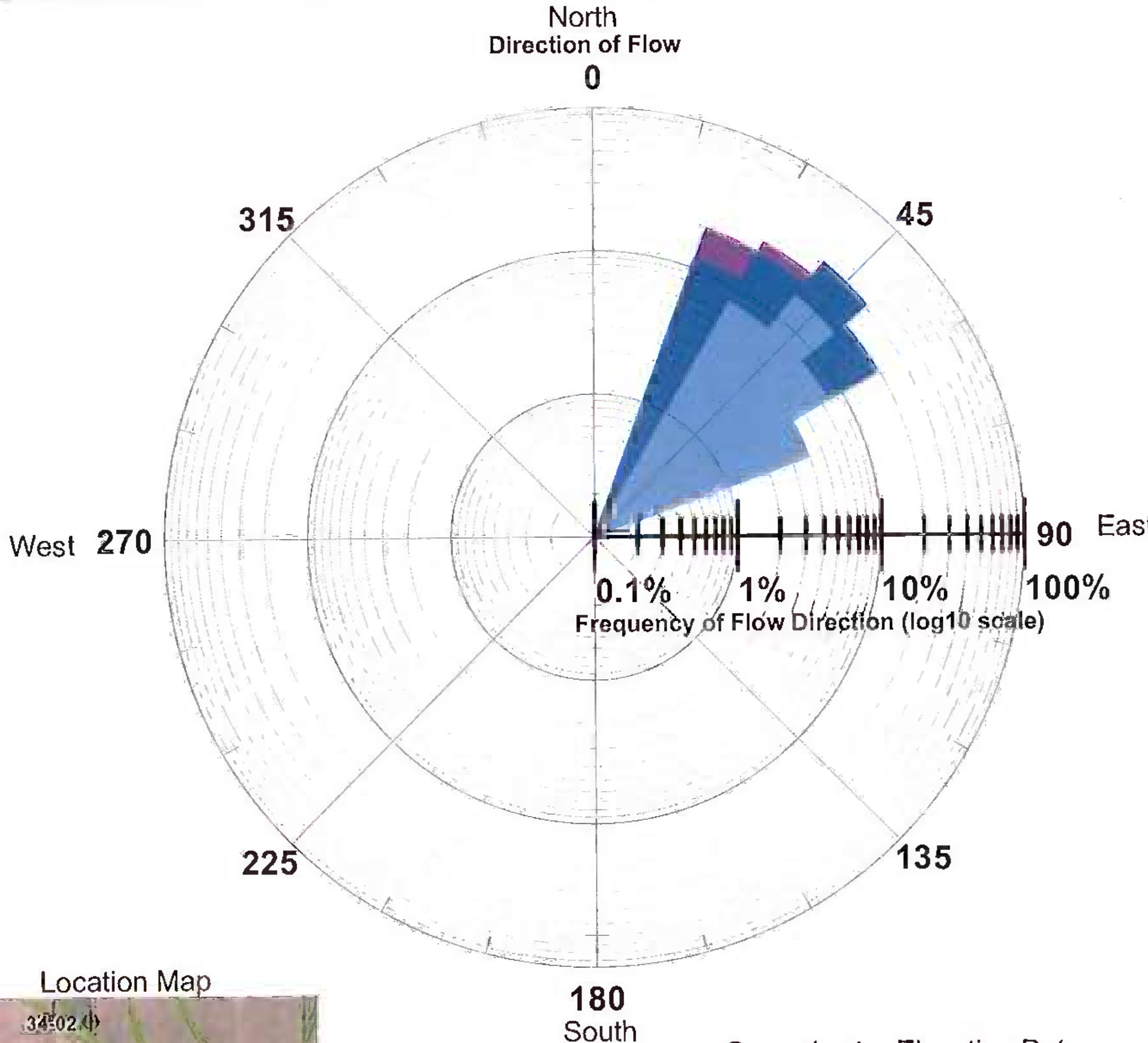
1. Locations of wells are approximate and some were reported to the nearest 1/16th tract. As such, contours are approximate.
2. Groundwater elevation data are from the United States Geological Survey (USGS, 2004) and USGS Water Resources of CA website http://waterdata.usgs.gov/ca/nwis/nwis
3. Data posted are from 10/1/1958 through 1/9/1959.
4. Background photo is from 1968 and is provided soley for reference. An aerial photograph from 1958-1959 is not available.
5. µg/L = micrograms per liter.

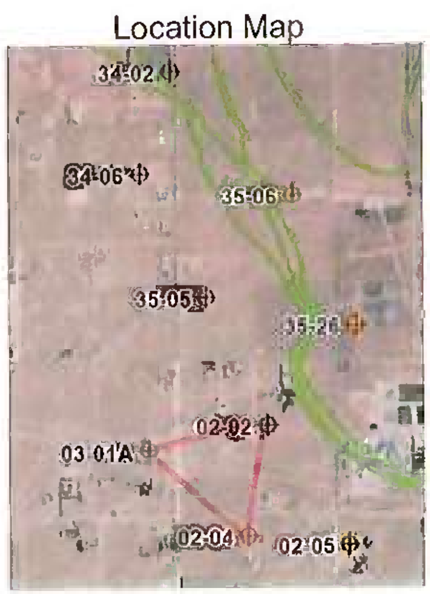
N 0 2,000 4,000 Feet

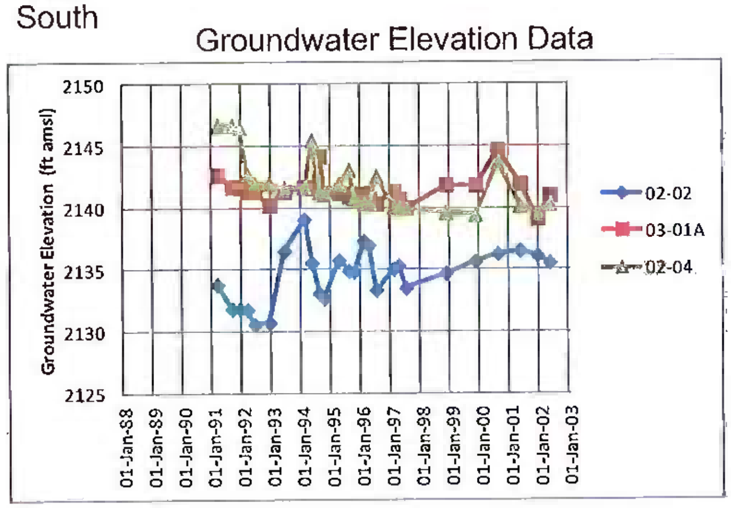
FIGURE 16
GROUNDWATER ELEVATION CONTOURS IN UPPER AND LOWER AQUIFERS, WINTER 1958-1959

CONCEPTUAL SITE MODEL FOR GROUNDWATER FLOW AND THE OCCURRENCE OF CHROMIUM IN GROUNDWATER OF THE WESTERN AREA
PACIFIC GAS AND ELECTRIC COMPANY
HINKLEY COMPRESSOR STATION
HINKLEY, CALIFORNIA

CH2MHILL







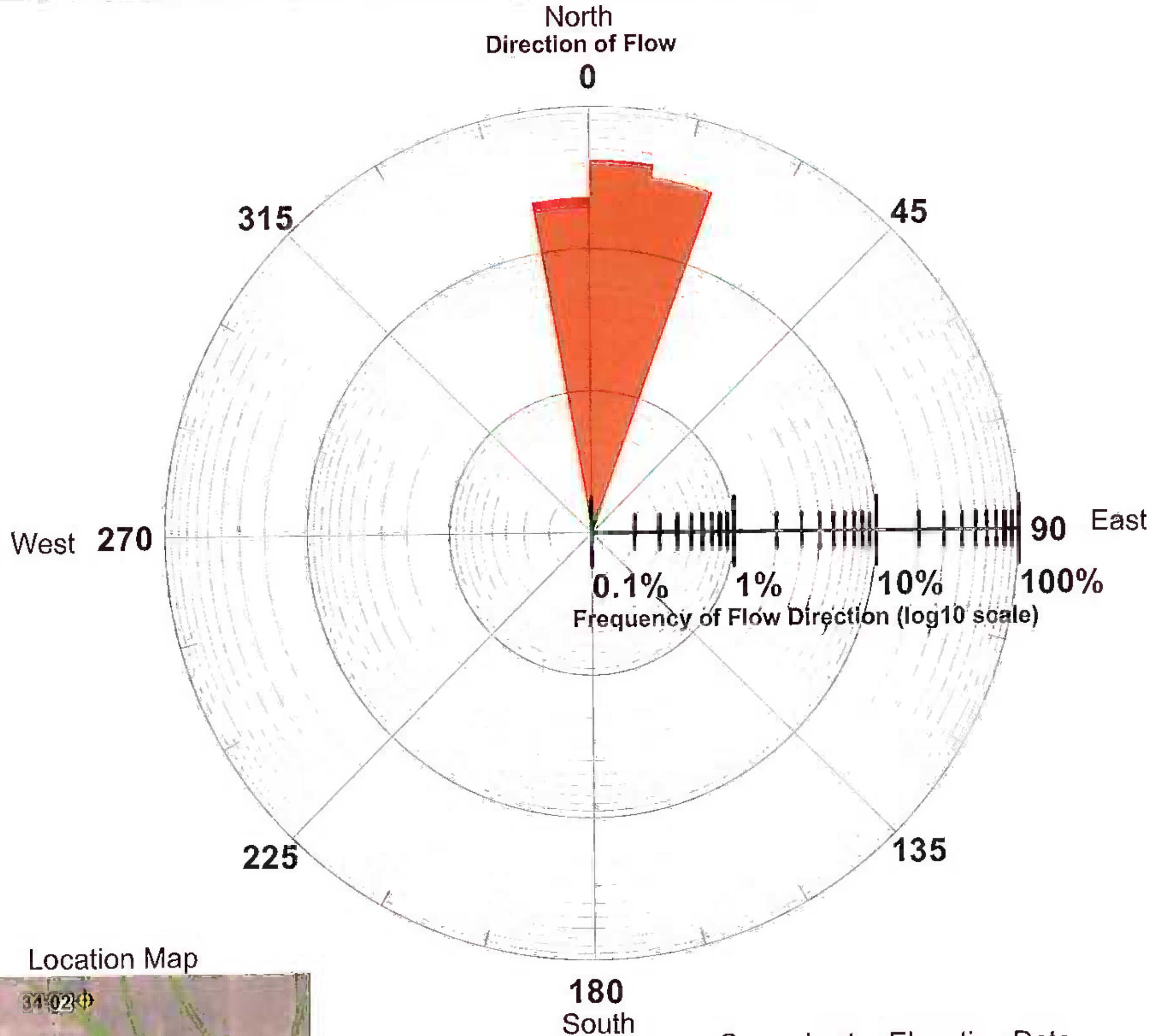
Hydraulic Gradient

- <=0.001
- >0.001 - 0.002
- >0.002 - 0.003
- >0.003 - 0.004
- >0.004

Notes:
1. Flow directions and gradients are from 25 synoptic measurements from 3/1991 to 5/2002.
2. Directional data are binned into 10 degree increments.
3. Location of the well triad is shown in the inset map.

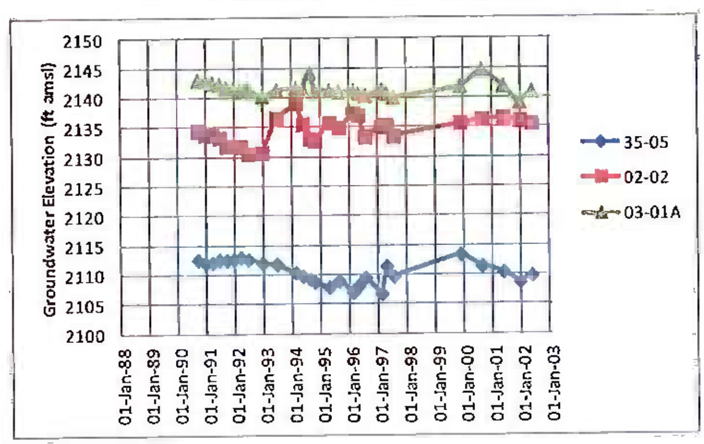
FIGURE 17
GROUNDWATER FLOW DIRECTIONS AND HYDRAULIC GRADIENTS FOR 02-04, 02-02 AND 03-01A
CONCEPTUAL SITE MODEL FOR GROUNDWATER FLOW AND THE OCCURRENCE OF CHROMIUM IN GROUNDWATER OF THE WESTERN AREA
PACIFIC GAS AND ELECTRIC COMPANY
HINKLEY COMPRESSOR STATION
HINKLEY, CALIFORNIA

CH2MHILL



Location Map

Groundwater Elevation Data



Hydraulic Gradient

- <=0.001
- >0.001 - 0.002
- >0.002 - 0.003
- >0.003 - 0.004
- >0.004

Notes:
1. Flow directions and gradients are from 27 synoptic measurements from 9/1990 to 9/2002.
2. Directional data are binned into 10 degree increments.
3. Location of the well triad and groundwater elevation data are in the insets.

FIGURE 18
GROUNDWATER FLOW DIRECTIONS AND HYDRAULIC GRADIENTS FOR 35-05, 02-02 AND 03-01A

CONCEPTUAL SITE MODEL FOR GROUNDWATER FLOW AND THE OCCURRENCE OF CHROMIUM IN GROUNDWATER OF THE WESTERN AREA
PACIFIC GAS AND ELECTRIC COMPANY
HINKLEY COMPRESSOR STATION
HINKLEY, CALIFORNIA

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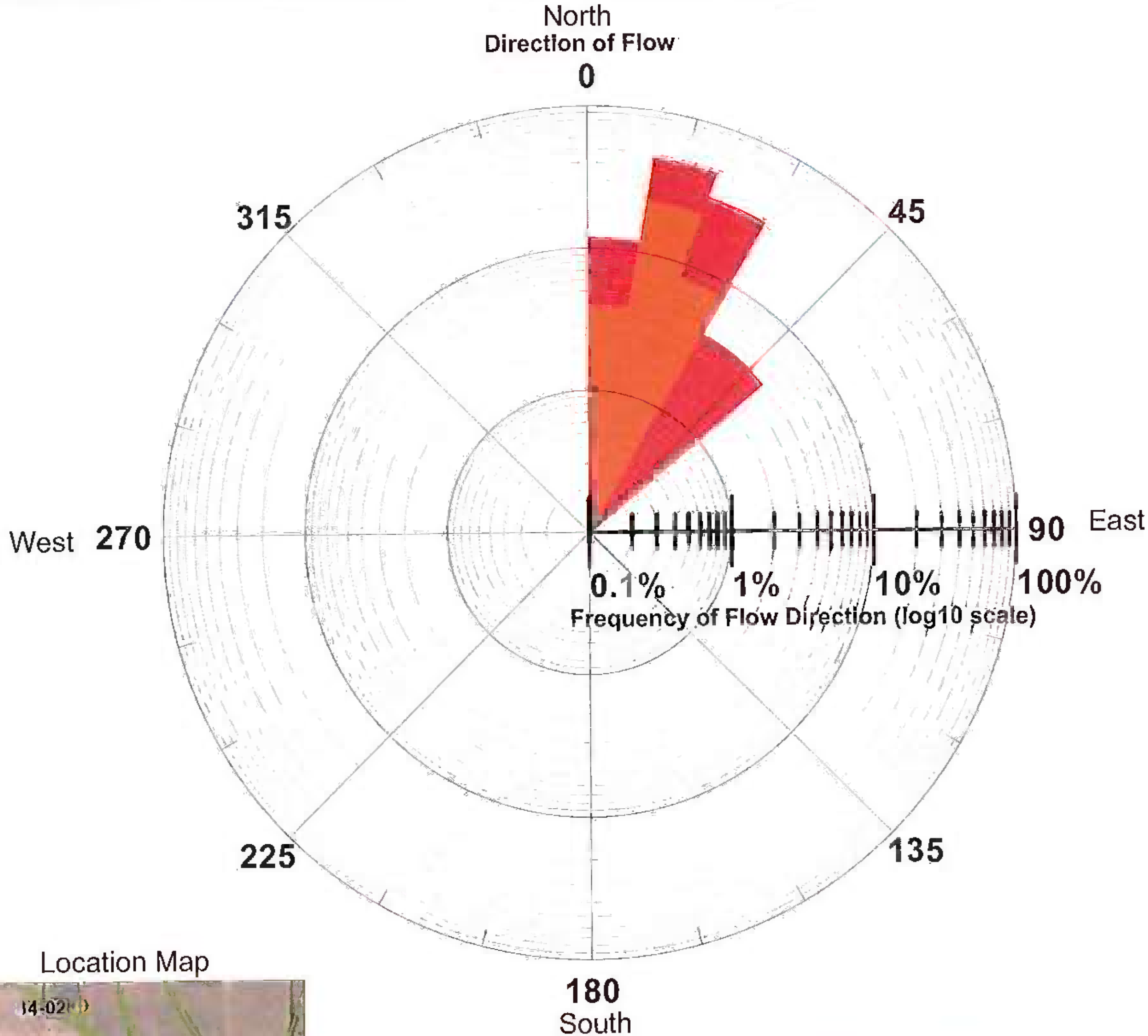
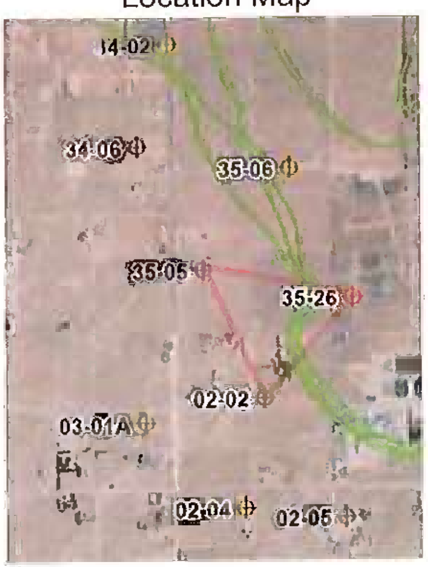
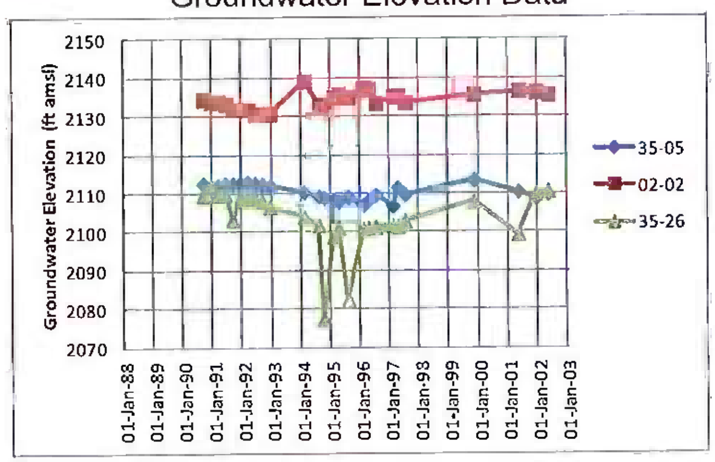


Location Map



Groundwater Elevation Data



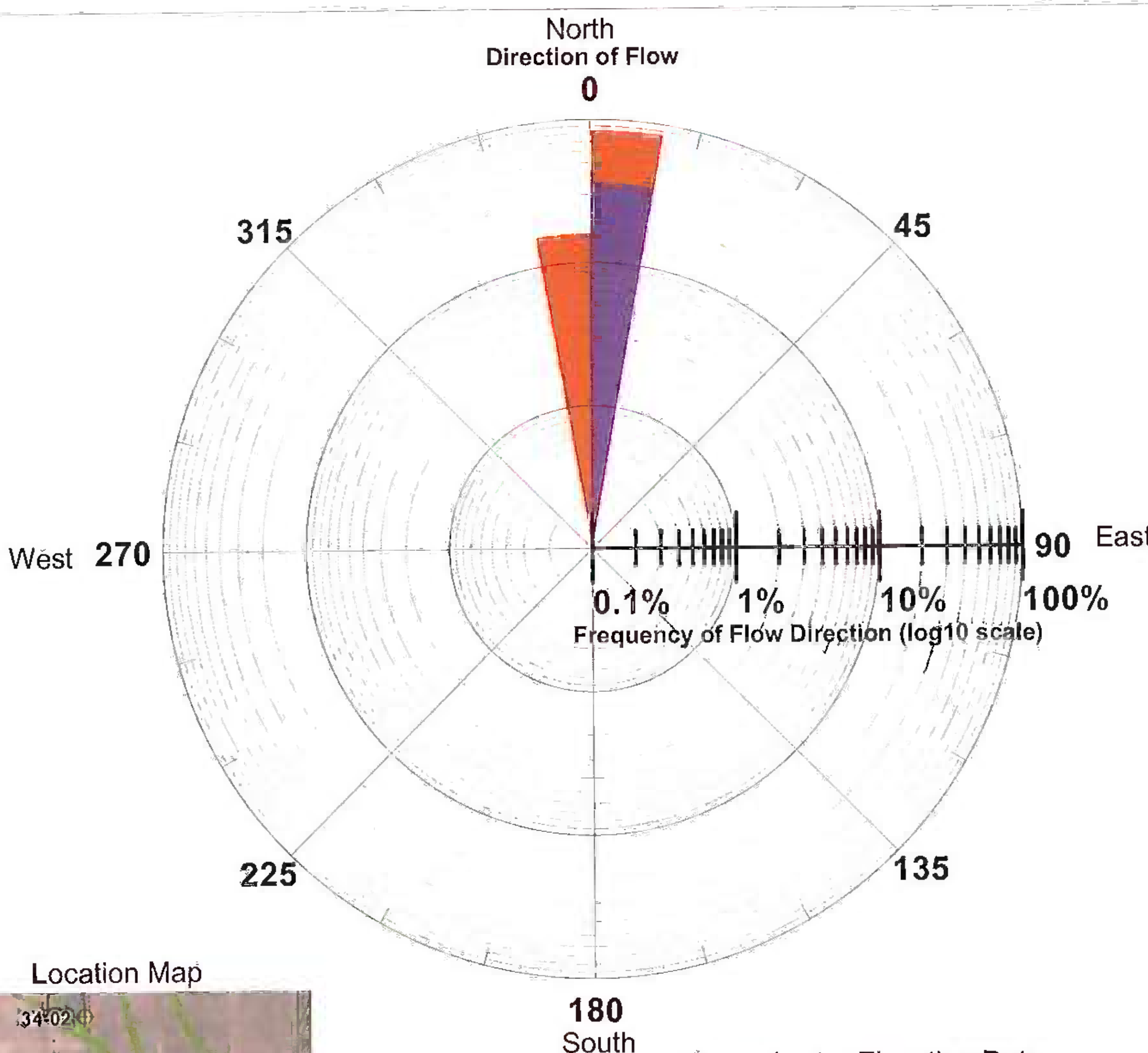
Hydraulic Gradient

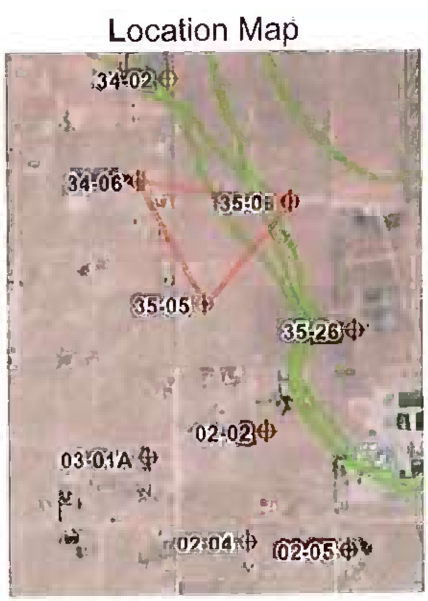
- **<=0.001**
- **>0.001 - 0.002**
- **>0.002 - 0.003**
- **>0.003 - 0.004**
- **>0.004**

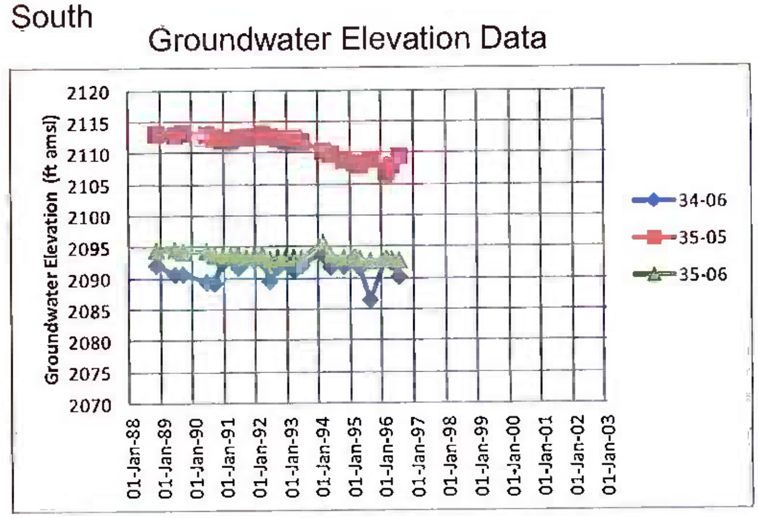
Notes:
1. Flow directions and gradients are from 27 synoptic measurements from 9/1990 to 9/2002.
2. Directional data are binned into 10 degree increments.
3. Location of the well triad and groundwater elevation data are in the insets.

FIGURE 19
GROUNDWATER FLOW DIRECTIONS AND HYDRAULIC GRADIENTS FOR 35-05, 02-02 AND 35-26
CONCEPTUAL SITE MODEL FOR GROUNDWATER FLOW AND THE OCCURRENCE OF CHROMIUM IN GROUNDWATER OF THE WESTERN AREA
PACIFIC GAS AND ELECTRIC COMPANY
HINKLEY COMPRESSOR STATION
HINKLEY, CALIFORNIA

CH2MHILL







Hydraulic Gradient

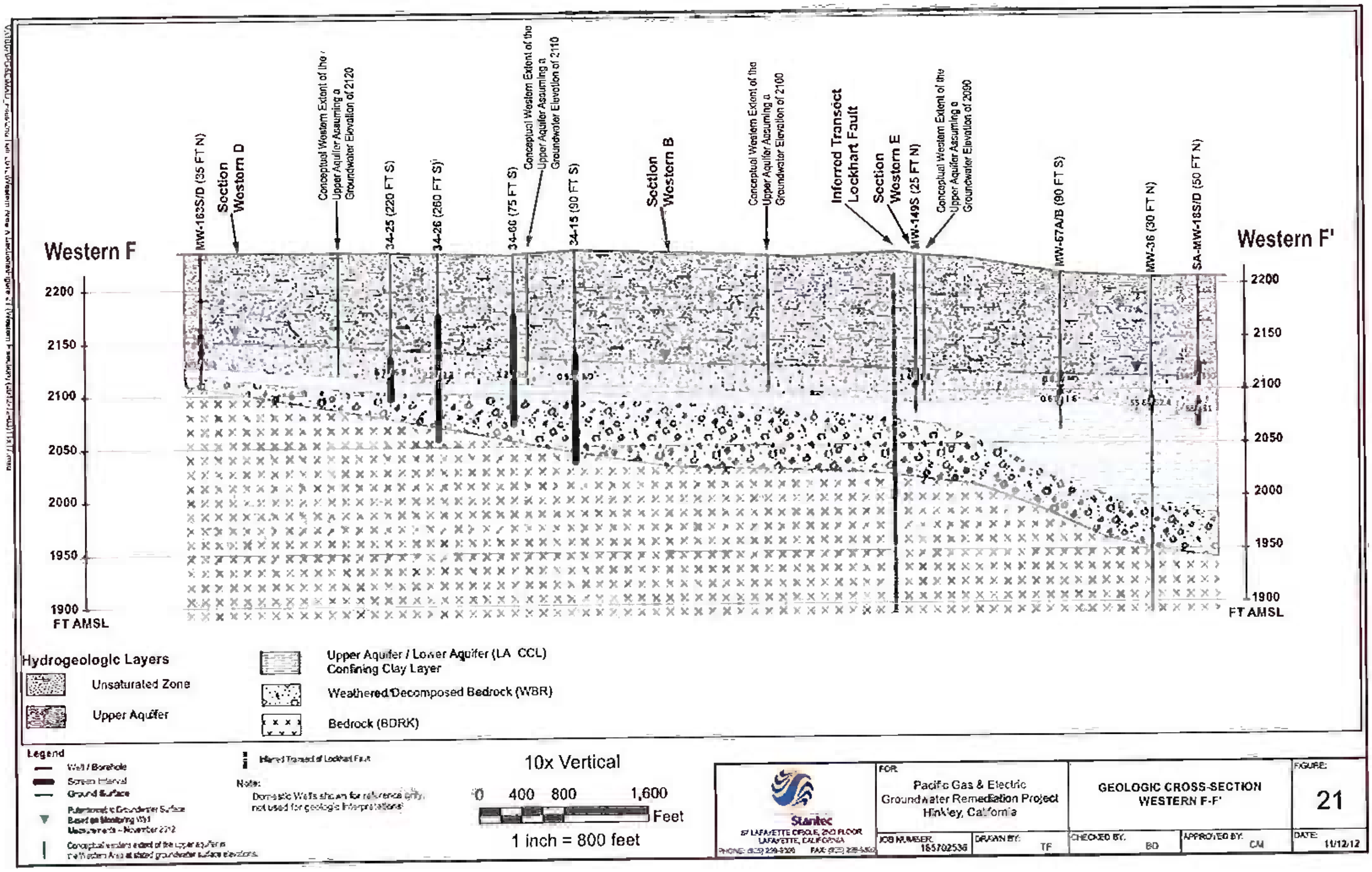
- <=0.001
- >0.001 - 0.002
- >0.002 - 0.003
- >0.003 - 0.004
- >0.004

Notes:
1. Flow directions and gradients are from 25 synoptic measurements from 11/1988 to 7/1996.
2. Directional data are binned into 10 degree increments.
3. Location of the well triad is shown in the inset map.

FIGURE 20
GROUNDWATER FLOW DIRECTIONS AND HYDRAULIC GRADIENTS FOR WELLS 35-05, 34-06 AND 35-06

CONCEPTUAL SITE MODEL FOR GROUNDWATER FLOW AND THE OCCURRENCE OF CHROMIUM IN GROUNDWATER OF THE WESTERN AREA
PACIFIC GAS AND ELECTRIC COMPANY
HINKLEY COMPRESSOR STATION
HINKLEY, CALIFORNIA

CH2MHILL



Western F
Western F'
MW-163S/D (35 FT N)
Section Western D
Conceptual Western Extent of the Upper Aquifer Assuming a Groundwater Elevation of 2120
34-25 (220 FT S)
34-26 (260 FT S)
34-66 (75 FT S)
Conceptual Western Extent of the Upper Aquifer Assuming a Groundwater Elevation of 2110
34-15 (90 FT S)
Section Western B
Conceptual Western Extent of the Upper Aquifer Assuming a Groundwater Elevation of 2100
Inferred Transect Lockhart Fault
Section Western E
MW-149S (25 FT N)
Conceptual Western Extent of the Upper Aquifer Assuming a Groundwater Elevation of 2090
MW-67A/B (90 FT S)
MW-36 (30 FT N)
SA-MW-18S/D (50 FT N)
2200
2150
2100
2050
2000
1950
1900
FT AMSL
Hydrogeologic Layers
Unsaturated Zone
Upper Aquifer
Upper Aquifer / Lower Aquifer (LA CCL) Confining Clay Layer
Weathered/Decomposed Bedrock (WBR)
Bedrock (BDRK)
Legend
Well / Borehole
Screen Interval
Ground Surface
Potentiometric Groundwater Surface Based on Monitoring Well Measurements – November 2012
Conceptual western extent of the upper aquifer in the Western Area at stated groundwater surface elevations.
Inferred Transect of Lockhart Fault
Note:
Domestic Wells shown for reference only, not used for geologic interpretations.
10x Vertical
0 400 800 1,600
Feet
1 inch = 800 feet
Stantec
57 LAFAYETTE CIRCLE, 2ND FLOOR
LAFAYETTE, CALIFORNIA
FOR:
Pacific Gas & Electric
Groundwater Remediation Project
Hinkley, California
GEOLOGIC CROSS-SECTION
WESTERN F-F'
FIGURE:
21
JOB NUMBER: 185702536
DRAWN BY: TF
CHECKED BY: BO
APPROVED BY: CM
DATE: 11/12/12

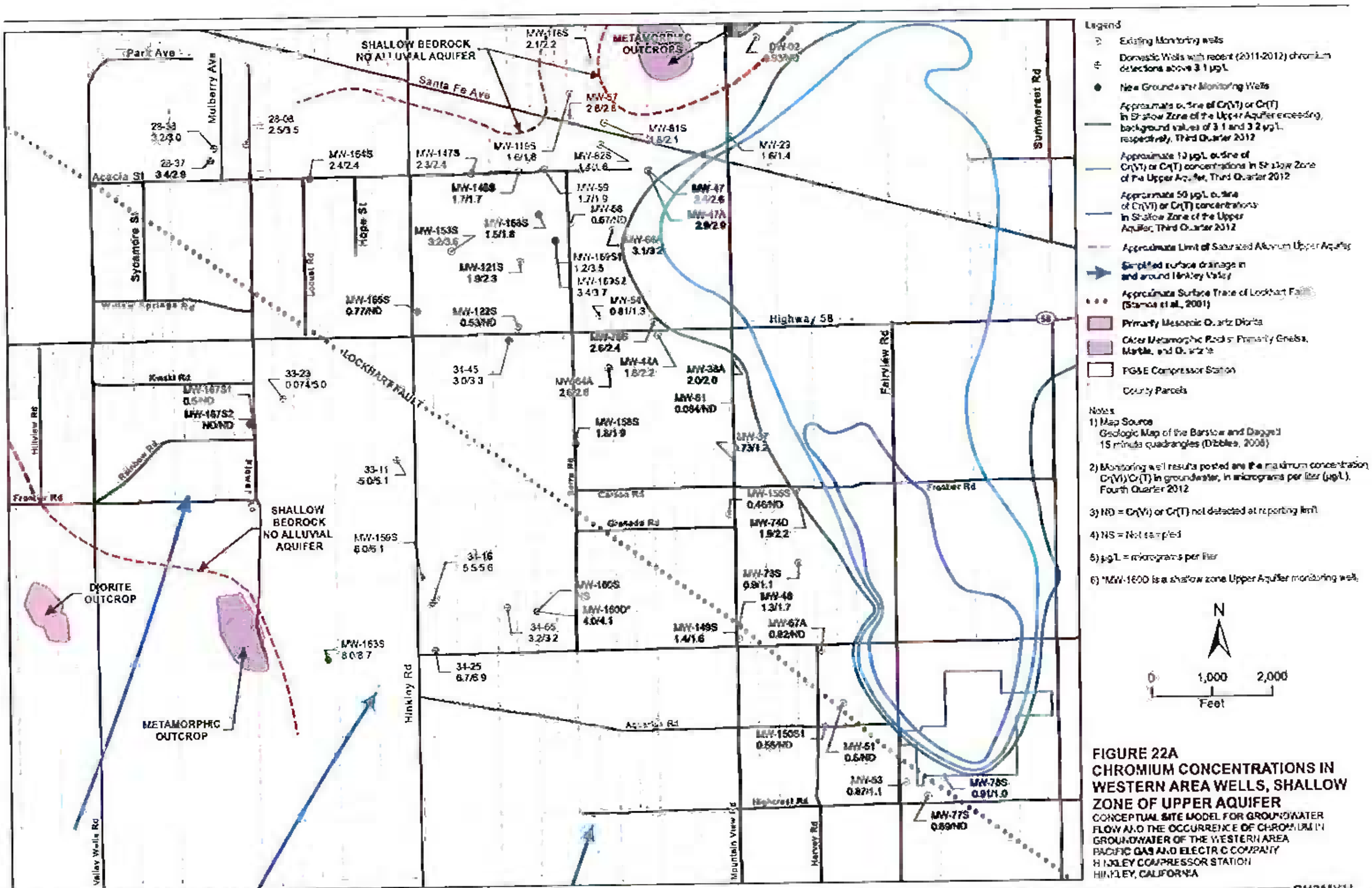


FIGURE 22A
CHROMIUM CONCENTRATIONS IN WESTERN AREA WELLS, SHALLOW ZONE OF UPPER AQUIFER
CONCEPTUAL SITE MODEL FOR GROUNDWATER FLOW AND THE OCCURRENCE OF CHROMIUM IN GROUNDWATER OF THE WESTERN AREA
PACIFIC GAS AND ELECTRIC COMPANY
HINKLEY COMPRESSOR STATION
HINKLEY, CALIFORNIA

CH2MHILL

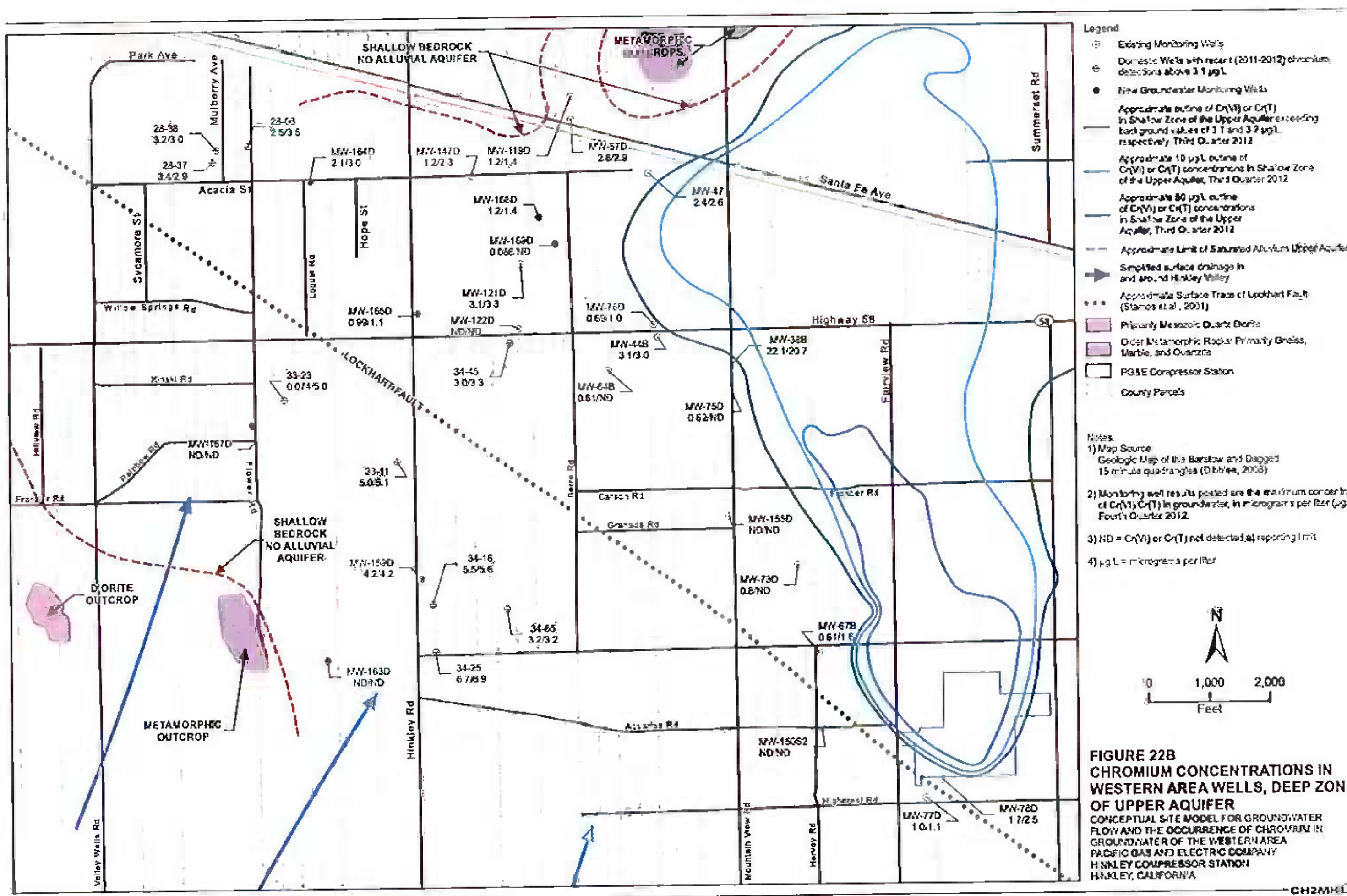


FIGURE 22B
CHROMIUM CONCENTRATIONS IN WESTERN AREA WELLS, DEEP ZONE OF UPPER AQUIFER
CONCEPTUAL SITE MODEL FOR GROUNDWATER FLOW AND THE OCCURRENCE OF CHROMIUM IN GROUNDWATER OF THE WESTERN AREA
PACIFIC GAS AND ELECTRIC COMPANY
HINKLEY COMPRESSOR STATION
HINKLEY, CALIFORNIA

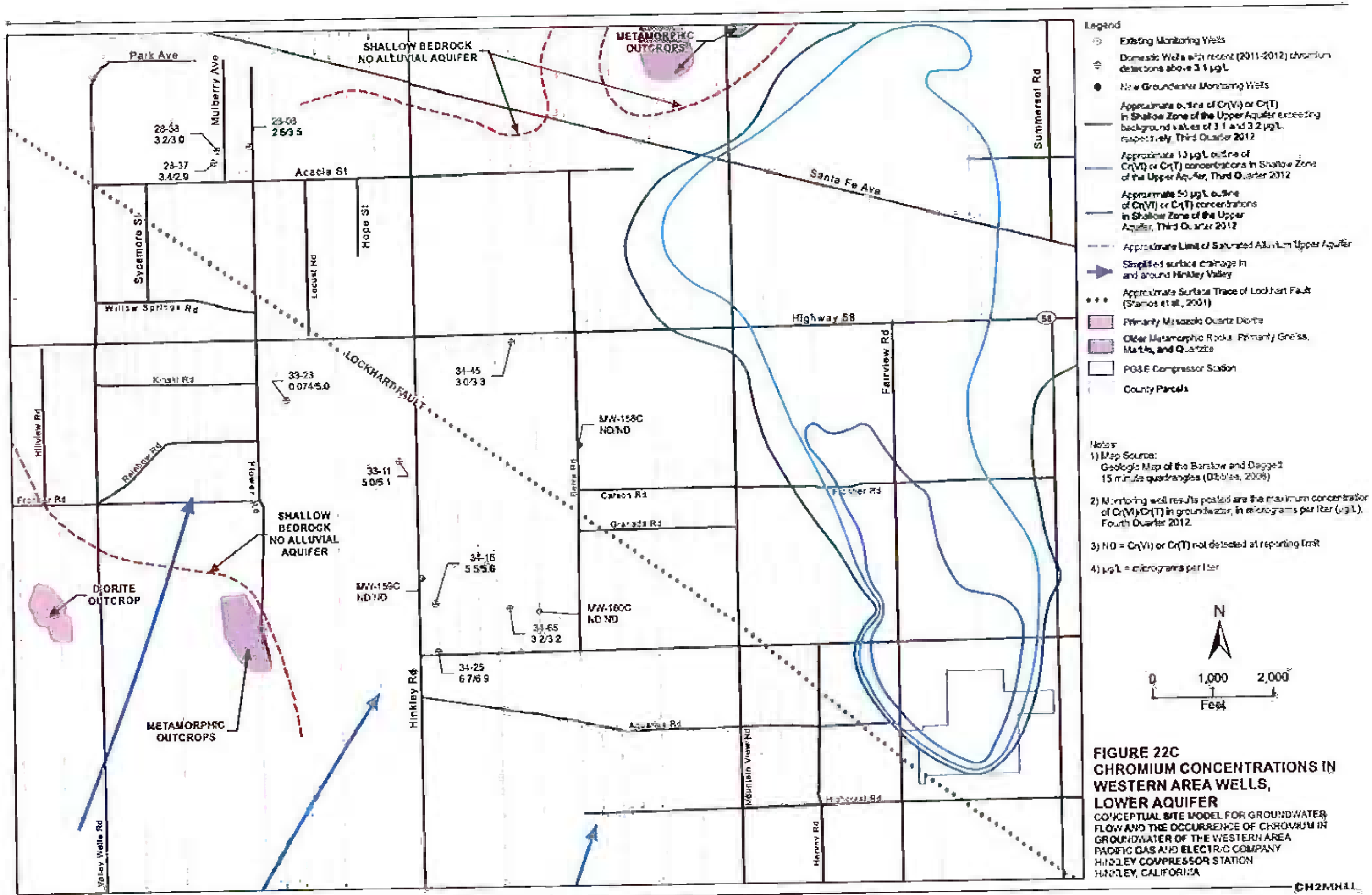


FIGURE 22C
CHROMIUM CONCENTRATIONS IN WESTERN AREA WELLS, LOWER AQUIFER
CONCEPTUAL SITE MODEL FOR GROUNDWATER FLOW AND THE OCCURRENCE OF CHROMIUM IN GROUNDWATER OF THE WESTERN AREA
PACIFIC GAS AND ELECTRIC COMPANY
HINKLEY COMPRESSOR STATION
HINKLEY, CALIFORNIA

CH2MHILL

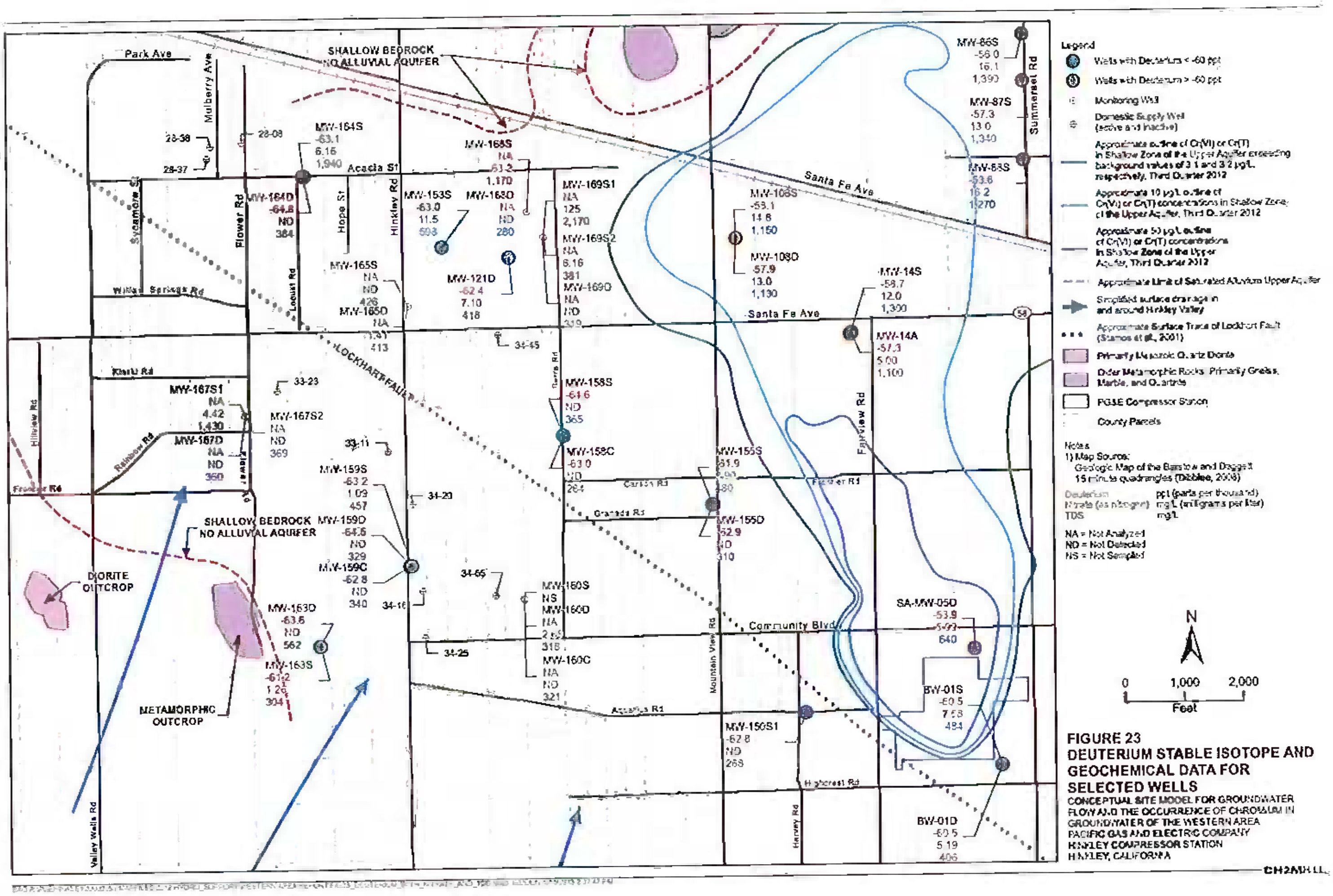
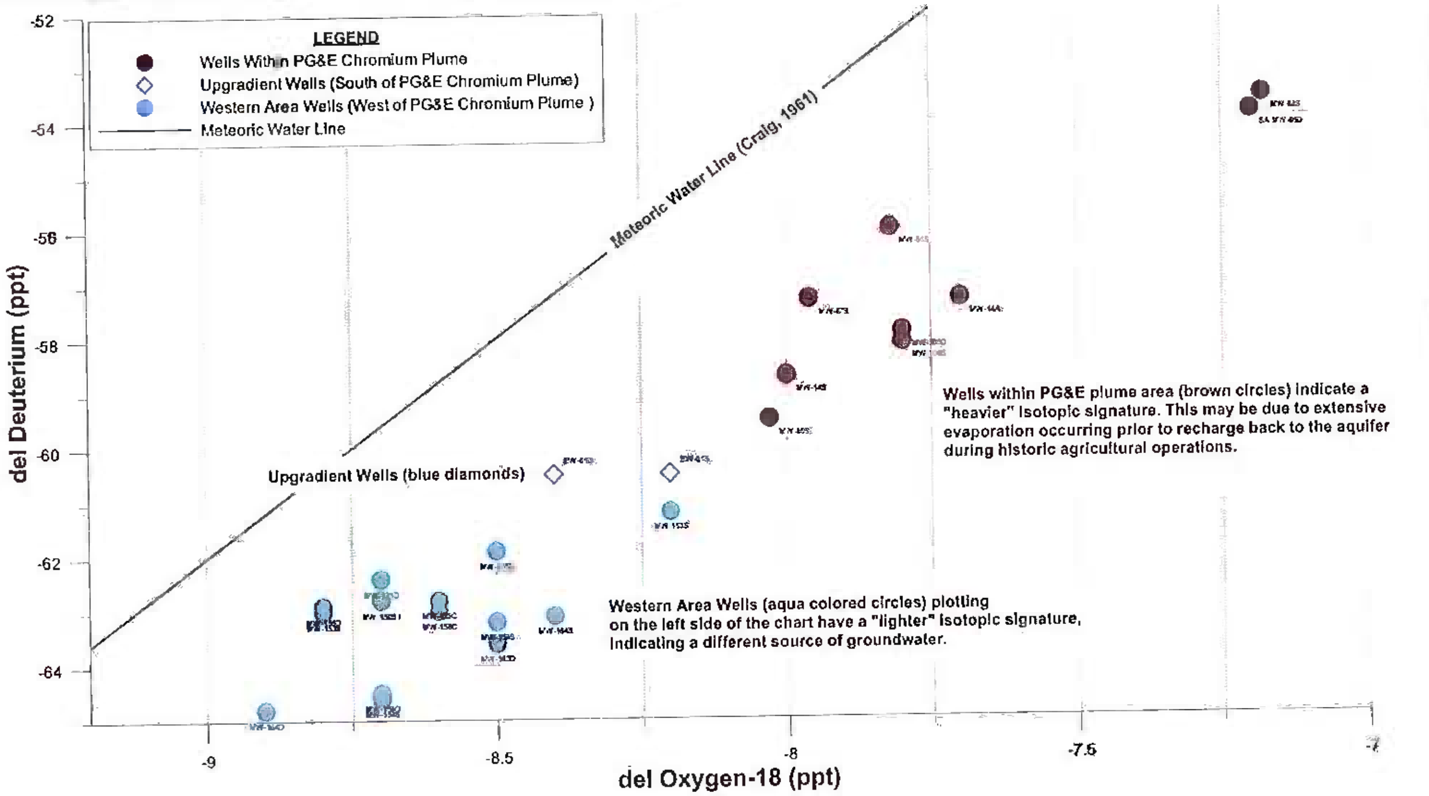


FIGURE 23
DEUTERIUM STABLE ISOTOPE AND GEOCHEMICAL DATA FOR SELECTED WELLS
CONCEPTUAL SITE MODEL FOR GROUNDWATER FLOW AND THE OCCURRENCE OF CHROMIUM IN GROUNDWATER OF THE WESTERN AREA
PACIFIC GAS AND ELECTRIC COMPANY
HINKLEY COMPRESSOR STATION
HINKLEY, CALIFORNIA



Note: ppt = parts per thousand

FIGURE 24
STABLE ISOTOPES OF OXYGEN AND DEUTERIUM
CONCEPTUAL SITE MODEL FOR GROUNDWATER FLOW AND
THE OCCURRENCE OF CHROMIUM IN GROUNDWATER OF THE WESTERN AREA
PACIFIC GAS AND ELECTRIC COMPANY HINKLEY COMPRESSOR STATION
HINKLEY, CALIFORNIA

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<u>ATTACHMENT 3</u>:

DECLARATION

(*DENNIS MASLONKOWSKI*)

DECLARATION OF DENNIS MASLONKOWSKI

I, Dennis Maslonkowski, declare:

I am employed by CH2M HILL Inc., as a Senior Technical Consultant. I am licensed by the State of California as a Professional Geologist, Certified Hydrogeologist, and Certified Engineering Geologist. My resume is attached to this Declaration as Exhibit A. Pacific Gas and Electric Company has engaged CH2M HILL to assist PG&E in connection with issues surrounding the chromium plume in Hinkley, California. I have worked on issues related to the chromium plume from May 2001 through July 2006, and again since August 2012. I was asked to provide my professional opinions related to technical issues including the use of hydrogeologic data in the interpretation and drawing of plume maps, the appropriateness of using domestic well data for plume delineation, the extent of naturally occurring chromium in the Hinkley Valley, and the statistical analysis of groundwater monitoring data.

My opinions are that:

a) The arbitrary and inflexible requirement to draw plume boundaries by connecting all wells that are within 2,600 feet precludes the use of professional judgment based on circumstances in the field. CAO ordering provision I.C.2.f requires that plume boundaries must be drawn to connect any monitoring well located within one-half mile (2,600 feet) of any other monitoring well having chromium concentrations of 3.1 ppb of hexavalent chromium or 3.2 ppb of total chromium. This requirement, based solely upon a criterion of distance, constrains the interpretation of the extent of the chromium plume boundary by limiting or excluding a more technically sound interpretation based upon site empirical data (such as geological and geochemical data, groundwater gradients, and chromium concentration trends) and professional judgment. For example, the report, "*Conceptual Site Model for Groundwater Flow and the*

Occurrence of Chromium in the Western Area" (CH2M Hill and Stantec, 2013) provides compelling information supporting the argument that the groundwater southwest of the Lockhart Fault that contains chromium is geochemically distinct from groundwater in the central Hinkley Valley area and should not arbitrarily be considered to be associated or connected to the chromium plume just based upon distance and proximity to the chromium plume.

b) Excluding hydrogeologic data more than three years old may result in an incomplete understanding of the nature and extent of the chromium plume and incorrect interpretation of the hydrogeologic site conceptual model. CAO ordering provision I.C.2.h stipulates that only data collected within the past three years can be used to support an argument that groundwater is not related to PG&E's plume. Following this requirement could prevent the use of appropriate, validated and representative hydrogeologic data including long-term groundwater water level data, aquifer test results, long-term water quality trend data (for both chromium and other water quality parameters), geologic logs from previously constructed wells, and prior data presented in technical reports prepared by the USGS, Mojave Water Agency and others. This older data is critical to providing a historic understanding of the extent of the plume and provides context for more recent data observations. A thorough interpretation of the plume extent and adequate understanding of the hydrogeologic conceptual site model would be lacking or incomplete without this older data. There is a high likelihood of erroneous technical conclusions when all data more than three years old is excluded from consideration.

c) It is not scientifically appropriate to apply a background study value from one area to another location. CAO ordering provision I.A.1 requires sampling of domestic wells in "*other areas outside of the currently identified primary contiguous plume boundary that may show anomalous or otherwise unexplained concentrations of chromium in domestic wells*". This is a very broad requirement suggesting that domestic wells may be sampled in areas with a high probability of having naturally-occurring chromium in groundwater beyond the area within the Hinkley Valley previously used to establish a background chromium value. However, the CAO would require PG&E to apply those original background study values to areas outside the Hinkley area that were not part of the original background study area. This technical inconsistency could result in the presumption that chromium concentrations detected in a domestic well above the 3.1 ppb hexavalent chromium value are related to the plume, when in fact the chromium could be from a natural source of chromium.

In September 2004, PG&E submitted the "*Work Plan – Revised Chromium Background Study at the PG&E Compressor Station, Hinkley, California*" (CH2M Hill, 2004). The 2004 Work Plan defined the areas where background groundwater samples would be collected, which were entirely within the southern area of the Hinkley valley. It is not technically appropriate to apply a background value calculated for one area (e.g. the southern area of the Hinkley valley) to groundwater samples collected from other areas that were not even part of the original study (e.g. the north area of the Hinkley valley, Water Valley, and the areas east of Lenwood Road (part of the Mojave River Floodplain). The northern area of the Hinkley valley and Water Valley are down-gradient of the southern area of the Hinkley valley. At least a portion of the groundwater in these valleys is likely not associated with recent groundwater flowing from the south. There are several lines of evidence indicating groundwater currently in the n area of the Hinkley valley basin (particularly north of Sonoma and Salinas Roads) and Water Valley is not associated with recharge from the south that would have occurred after 1952 when the chromium release occurred at the Compressor Station. These lines of evidence include the absence of tritium in groundwater samples collected to the north and the very low concentrations of total dissolved solids (TDS) and nitrate in northern groundwater samples compared to the very high TDS and nitrate in groundwater in the vicinity of Thompson Road. The existing groundwater gradients in the northern area of the Hinkley valley indicate groundwater velocity is very slow. Under current conditions, groundwater flow from the south near Thompson Road to the north near Red Hill is likely more than 50 years and potentially more than 70 years old.

d) Chromium is found naturally occurring in groundwater throughout the State of California, including in the Hinkley area. Naturally-occurring hexavalent chromium has been reported to be present in groundwater systems in the Mojave Desert and globally with naturally-occurring concentrations sometimes exceeding 50 micrograms per liter (µg/L) in alluvial aquifers in the western Mojave Desert (Ball et al., 2004; Izbicki et al., 2008). Within the Centro subarea of the Mojave groundwater basin, the Mojave River floodplain aquifer provides much of the groundwater recharge for the Hinkley Valley. This aquifer is used extensively by others for water supply, including municipal systems for communities upstream of Hinkley. As documented in the "*Work Plan for Evaluation of Background Chromium in the Groundwater of the Upper Aquifer in the Hinkley Valley*" (Stantec, 2012), municipal water systems upstream of Hinkley have sampled their respective water supplies for hexavalent chromium including the cities of Hesperia, Apple Valley, Victorville, and Adelanto. Hexavalent chromium is present in these water systems at concentrations as high as 6.3 μg/L in the Apple Valley South system (Golden State Water Company, 2010) and 16.1 μg/L in Hesperia (City of Hesperia Water District, 2010). As documented in the Western Report, chromium is also present in groundwater immediately up-gradient of the PG&E Compressor Station, on the west side of the Lockhart Fault. Hexavalent chromium was detected in monitoring wells installed by PG&E at concentrations up to 8.0 μg/L at locations up to one (1) mile to the west. The groundwater on the up-gradient side of the Lockhart Fault containing hexavalent chromium flows to the northeast, towards the area of PG&E's chromium plume (CH2M HILL and Stantec, 2013).

e) The historic pumping from the 1950's to 1990's and current agricultural pumping have limited the potential for groundwater flow and chromium plume migration to the North. Since the 1950's, groundwater in the southern area of the Hinkley valley basin has been pumped extensively for agriculture. As documented through aerial photographs provided in the "*Conceptual Site Model for Groundwater Flow and the Occurrence of Chromium in the Western Area*" (CH2M HILL and Stantec, 2013), extensive agricultural operations have existed continuously in the southern area of the Hinkley valley since the 1950s, particularly in the area of the Desert View Dairy (DVD) and immediately north and south of the DVD (similar to the locations where PG&E currently farms at Agricultural Units – AUs).

A substantial decline in groundwater levels occurred in the southern area of the Hinkley valley basin between the 1950's and the 1980's. As discussed in the Western

Report, these conditions have been documented by numerous authors including the California Department of Water Resources (DWR, 1967 and 1983) and the United States Geological Survey (Stamos, 2001). As shown in the DWR reports, a significant hydraulic depression developed in the southern area of the Hinkley valley basin with the lowest groundwater levels reportedly in the vicinity of the DVD. The hydraulic depression can be interpreted to suggest the complete capture of groundwater within the southern area of the Hinkley valley basins. During this time period there was little to no movement of groundwater to the north.

As shown on the aerial photographs provided in the Western Report, the current farming conducted by PG&E in the vicinity of the DVD is not inconsistent with the acreage farmed by others since the 1950's. As documented in the monthly reports presented to the Water Board, the current pumping conducted by PG&E is providing nearly complete capture of upper aquifer groundwater (A1 and A2 zones) near Thompson Road.

Finding 12 in the CAO states that the chromium plume could have traveled 7.32 miles based on a simple groundwater velocity calculation. However, the Finding ignores the fact that Hinkley valley groundwater was heavily pumped for agricultural purposes for many years. The velocity calculations do not consider any historic agricultural pumping and pumping depressions created by this pumping; therefore, do not provide a reasonable or accurate assessment.

f) Significant differences can exist between data obtained from domestic wells and monitoring wells. For example, monitoring wells typically have short (10-15 feet) well screens, polyvinyl chloride (PVC) casings with factory milled slots and carefully selected filter pack, non-stainless steel pumps and other materials, and known installation details and history. However, domestic wells often have long well screens (100 feet or more), steel casings with handmade slots created in the field and sometimes no filter pack, stainless steel pumps and materials that can contribute hexavalent chromium to water samples, and unknown installation history and details. These significant differences in purpose and construction make the comparison of the testing results between monitoring and domestic wells inappropriate and not technically sound. In some cases, water level data obtained from a domestic well could result in the interpretation of a groundwater gradient contrary to the actual groundwater flow direction, resulting in serious errors in the understanding of site conditions. Basing plume boundaries on arbitrary and artificial requirements such as the requirement to include domestic well data and/or to exclude all data more than three years old, ignores important factors such as technical judgment, site-specific conditions, and groundwater flow. Plume delineation using such methods would be technically unsound. The requirement to draw the plume around domestic wells with chromium concentrations above 3.1 ppb would drastically expand the apparent size of the plume by including multiple areas where monitoring and domestic wells are either non-detect for chromium or contain chromium levels below background levels.

g) Statistical trend tests, if used solely by themselves, without the consideration of all relevant and representative hydrogeologic data, are a very poor trigger for requiring monitoring wells. This is particularly true when no lower limit chromium concentration is specified for the required magnitude of the increasing trend and the chromium levels are below levels identified as natural background by the Lahontan Board order. The statistical tests by themselves do not provide any indication whether the chromium concentrations or any increasing chromium trend observed in the well sample data are related to PG&E's plume. For example, a small increase in chromium concentrations, particularly at levels identified as below natural background by Lahontan Board order (such as from 0.1 ppb to 0.2 ppb over six months), does not demonstrate the arrival from any particular source of chromium. There is simply no rational justification for using such a trending analysis, by itself, as the sole basis for requiring new monitoring wells.

I declare under penalty of perjury under the laws of the State of California that the foregoing is true and correct and that this Declaration was executed on February 7, 2013, at Oakland, California.

Dennis P Maslonkowski

Dennis P. Maslonkowski

References

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<u>**ATTACHMENT 4**</u>:

DECLARATION

(*DECLARATION OF LARRY HILSCHER*)

DECLARATION OF LARRY HILSCHER

I, Larry Hilscher, declare:

I am employed by CH2M HILL Inc., as a Statistician in the Environmental Services group. I am a degreed statistician with an M.S. degree in Statistics from the University of Texas at Austin which was preceded by an M.S. degree in Chemistry from Texas A&M University in College Station. My resume is attached to this Declaration as Exhibit A. Pacific Gas and Electric Company has engaged CH2M HILL to assist PG&E in connection with issues surrounding the chromium plume in Hinkley, California (CA). I was asked to provide my professional opinions related to statistical data evaluation issues.

My opinions are that:

The CAO requirement for new well installation when an increasing trend is identified does not ensure strong linkage with background exceedances. The CAO stipulates that a statistical test, such as the Mann-Kendall test, be used to determine if there is an increasing trend and that where an increasing trend is identified, additional monitoring wells are required to be installed. The Mann Kendall trend test is often used to provide information on temporal concentration patterns in groundwater wells and to support interpretations of other statistical tests such as confidence, tolerance, and prediction intervals. It is not typical to see a trend test used as a trigger for substantial resource expenditures.

One contributing reason for this is the likely false positive rate associated with this test. A typical significance level of 0.05 is used with the Mann Kendall test. This level results in a likely false positive rate of 5% for conclusions of increasing trends if there is actually no trend existing in the target population, that is, the true overall groundwater conditions for the wells being evaluated. Thus, if one begins with random data, which represents a population absent of true trends, one has the expectation of 5% significant increasing conclusions. An expectation of 5% does not mean that exactly five percent will occur each time (there could be more or less), but it does offer the most likely outcome.

Further, the conclusion of a significant increasing temporal trend stems from an increasing pattern in the sample data, but it neither addresses the magnitude of the concentration increase nor the potential timetable for an exceedance of an applicable concentration threshold. For that reason, it is surprising that a significantly increasing trend alone would be grounds for well installation. The statistical trend test by itself does not provide any indication whether the chromium concentrations or any increasing chromium trend in a well are related to PG&E or any other specific source. For example, a small increase in chromium concentrations, particularly at levels identified as below natural background (such as from 0.1 ppb to 0.2 ppb over six months), does not demonstrate the arrival from any particular source of chromium. A statistical trend test by itself when the chromium levels are below levels identified as natural background (without considering all of the relevant data and exercising professional judgment) could be a poor predictor of locations that might eventually exceed background and would therefore be a very poor trigger for requiring monitoring wells.

I declare under penalty of perjury under the laws of the State of California that the foregoing is true and correct and that this Declaration was executed on February 7, 2013, at Austin, Texas.

Larry Hilscher

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Attorneys for Petitioner
PACIFIC GAS AND ELECTRIC COMPANY

STATE OF CALIFORNIA

STATE WATER RESOURCES CONTROL BOARD

IN THE MATTER OF LAHONTAN REGIONAL WATER QUALITY CONTROL BOARD CLEANUP AND ABATEMENT ORDER NO. R6V-2008-0002-A4	No. REQUEST FOR SUPPLEMENTAL EVIDENCE

This *Request for Supplemental Evidence* pursuant to California Code of Regulations, Title 23, § 2050.6 is made regarding a previously filed and currently pending *Emergency Stay;*

Petition for Review; and Memorandum of Points and Authorities in Support Thereof ("Petition and Request for Stay") in the above entitled matter and is respectfully submitted to the California State Water Resources Control Board ("State Board") on behalf of Pacific Gas and Electric Company ("PG&E" or "Petitioner").

On March 26, 2013 and subsequent to PG&E filing the pending Petition and Request for Stay, the Lahontan Regional Water Quality Control Board ("Regional Board") issued Comments on the Workplan for Manganese Investigation (Investigative Order No. R6V-2012-0060) ("Manganese Investigative Order") and New Investigative Order No. R6V-2013-0026 ("New Manganese Investigative Order") with respect to the Hinkley Compressor Station located at 35863 Fairview Road (APN 048S-112-52) in Hinkley, California (the "Facility"). A copy of the New Manganese Investigative Order is attached as Attachment 1.

1. <u>The Request for Supplemental Evidence is Being Made As Soon as it Became Available</u>

This New Manganese Order was not available when the original Petition was filed, and PG&E is submitting this request as soon as possible.

2. <u>Detailed Statement of the Nature of the Evidence</u>

In filing the Petition and Request for Stay, PG&E challenged the Water Board's practice of specifying detailed requirements for reporting technical information and data as well as arbitrary plume depiction requirements pertaining to plume monitoring. Because the New Manganese Investigative Order continues both of these practices, PG&E is asking the State Water Resources Control Board to add the New Manganese Investigative Order to the Administrative Record. This supplemental evidence in the form of a subsequent Regional Board order is offered as evidence of a repeated action that is challenged by the pending Petition and Request for Stay.

The Regional Board issued an initial Manganese Investigative Order on December 21, 2012 requiring PG&E to submit a workplan to further define the location of naturally occurring manganese that is mobilized in groundwater as a result of PG&E's in situ groundwater remediation project in Hinkley (known as the In-situ Reactive Zone (IRZ)). PG&E submitted the required workplan ("Workplan") in a timely manner. In response to the Workplan, on March 26, 2013, the Regional Board acknowledged that PG&E fully complied with the requirements of the Manganese Investigative Order, but issued the New Manganese Investigative Order commenting on and approving the Workplan and requiring significant modifications. The New Manganese Investigative Order required that PG&E create new manganese plume maps based on arbitrary requirements and without scientific or factual justification that would artificially expand the plume depictions.

PG&E asks that the New Manganese Investigative Order be added to the record on review of Cleanup and Abatement Order No. R6V-2008-0002-A4 because it indicates a pattern of regulating PG&E remediation related activities that are in contravention of the California Water Code. The reporting requirements in the New Manganese Investigative Order detail PG&E's reporting of technical and scientific information in such a manner as to effectively remove professional judgment and analysis. Specifically, contour lines are directed to be drawn around all points with 390 ppb of manganese or greater within 500 feet if there are no data points with lesser concentrations. PG&E does not object to reporting information that is supported by evidence and technical information, however the New Manganese Investigative Order goes beyond this by directing plume delineation based upon the absence of data. The New Manganese Investigative Order contains no scientific or factual justification for these requirements. As outlined in PG&E's pending petition, the previously challenged order follows the same unsupported practices. Therefore, PG&E requests that the New Manganese Investigative Order be added to the record for PG&E's pending petition. PG&E believes that the New Investigative Order demonstrates the need for State Board action on PG&E's pending petition and request for an immediate stay.

3. <u>A Copy of this Request has Been Sent to the Lahontan Regional Board</u>

PG&E mailed a true and correct copy of this Request for Supplemental Evidence by electronic mail and overnight mail on April 26, 2013 to the Lahontan Regional Board at the following addresses:

Patty Kouyoumdjian, Executive Officer
Regional Water Quality Control Board Lahontan Region
2501 Lake Tahoe Boulevard
South Lake Tahoe, CA 96150-7704

Kim Niemeyer
Counsel for the Lahontan Regional Board
State Water Resources Control Board
Office of Chief Counsel
P.O. Box 100
Sacramento, CA 95812-0100

Dated: April 26, 2013

J. DREW PAGE
LAW OFFICES OF J. DREW PAGE

By: for J. Drew Page
DREW PAGE
Attorneys for Petitioner
PACIFIC GAS AND ELECTRIC COMPANY

Dated: April 26, 2013

TRACY J. EGOSCUE
EGOSCUE LAW GROUP

By:
TRACY J. EGOSCUE
Attorneys for Petitioner
PACIFIC GAS AND ELECTRIC COMPANY

ATTACHMENT 1

COMMENTS ON WORKPLAN FOR MANGANESE INVESTIGATION, PG&E COMPRESSOR STATION, HINKLEY, SAN BERNARDINO COUNTY (INVESTIGATIVE ORDER NO. R6V-2012-0060) AND NEW INVESTIGATIVE ORDER NO. R6V-2013-0026

March 26, 2013

Sheryl Bilbrey
Pacific Gas and Electric Company
3401 Crow Canyon Road
San Ramon, CA 94583

COMMENTS ON WORKPLAN FOR MANGANESE INVESTIGATION, PG&E COMPRESSOR STATION, HINKLEY, SAN BERNARDINO COUNTY (INVESTIGATIVE ORDER NO. R6V-2012-0060) AND NEW INVESTIGATIVE ORDER NO. R6V-2013-0026

Lahontan Water Board (Water Board) staff has reviewed the document "Byproduct Plume Monitoring in IRZ Areas" for the PG&E Compressor Station in Hinkley. The Workplan, prepared by Arcadis, was prepared in response to Investigative Order No. R6V-2012-0060 requiring additional byproduct plume delineation in the upper aquifer. The Workplan proposes two sampling and monitoring well installation layouts and recommends the one proposing the fewer monitoring wells. The Workplan also proposes a tracer test in the Source Area IRZ to begin four months after Water Board approval of the Workplan. Investigation results will be presented in a technical report upon completion of the tasks. Water Board staff accepts the Workplan with the following modifications in response to discussions with PG&E and the Hinkley public.

This letter acknowledges PG&E's full compliance with the requirements of Investigative Order No. R6V-2012-0060.

Water Board staff has the following comments, direction, and modifications concerning the Workplan. This letter also contains a new Investigative Order requiring PG&E to submit additional technical information and modified Byproduct Investigative Reports.

Monitoring Well Layout

1. The first proposed sampling and monitoring well installation layout is accepted for Areas 3 (southwest) and 5 (east).
2. The first proposed sampling and monitoring well installation layout is modified as described:
    a. Area 1 (north) – Install two monitoring well pairs that are outside the capture influence and either between or south of extraction wells EX-21

and EX-22. If neither situation is possible, install just one monitoring well pair between EX-21 and EX-22.

b. Area 2 (west) – Install proposed monitoring well pairs E1 and F1 to close the gap in this area.
c. Area 4 (south) – Install monitoring wells in the deep zone of the upper aquifer to compliment shallow zone wells MW-17 and MW-39. These additional monitoring wells should be able to detect if a southern-migrating byproduct plume or tracer is being acted upon by ten water supply wells used for the Compressor Station and remediation purposes.

3. Monitoring wells installed in the deep zone of the upper aquifer shall have a screen length of no more than 15 feet.

Tracer Test 1

The Workplan proposes to conduct a tracer test in the southernmost injection wells on the Compressor Station property to evaluate byproduct migration. Water Board staff concurs with the proposed tracer test to evaluate the potential threat of byproducts to domestic wells located west of the facility property. The following comments are provided to either clarify the tracer test monitoring program or to specifically identify or clarify tasks not mentioned in the Workplan.

1. Tracer testing in the Source Area IRZ shall be consistent with past tracer tests conducted in terms of volume or mass injected in October 2007.
2. The detection limit for tracers in groundwater shall be set at less than 10 ppb (<10 ppb).
3. If rehabilitation of wells SA-RW-11 and SA-RW-12 does not achieve the past injection capacity of at least 10 gpm, tracer injections shall be moved north to the row of wells containing SA-RW-5, SA-RW-6, and SA-RW-7.
4. Add the following southern monitoring wells to evaluate potential tracer migration southward towards water supply wells: MW-39, MW-78S/D, and the two new deep zone monitoring wells in Area 4.
5. Should monitoring detect tracer in any of the proposed northern monitoring wells (SA-SM-08, SA-SM-04, or SA-SM-11), monitoring shall be stepped out to the next row of monitoring wells to the north. If tracer is detected in the next row containing well SA-RW-05S/D, monitoring shall continue to be stepped out northward.
6. Should monitoring detect tracer along the western facility boundary in new well pairs H or G or in well SA-MW-26S/D, monitoring shall be stepped out to the west to domestic well 02-02A.
7. If tracer is detected in either SA-MW-26S/D or SA-MW-16S/D, monitoring shall continue to be stepped out northward and westward.
8. Should tracer be detected in SA-SM-28S/D, monitoring shall continue to be stepped out northward and westward.
9. Should tracer be detected in any of these western monitoring well pairs, SA-MW-28S/D, MW-67, SC-MW-11S/D, or SC-MW-12S/D, monitoring shall be stepped out to the west to include domestic wells 35-03 and 35-04.

Tracer Test 2

Water Board staff request a second tracer test be implemented in the western area of the SCRIA to evaluate bulging of byproducts that potentially threaten domestic wells on Mountain View Road. The second tracer test should be implemented on the west end of injection wells containing SC-IW-32 since there are no existing monitoring wells located to the west to detect potential bulging. This test can began following installation on proposed monitoring wells E and F in proposed Area 2. If tracer is detected in either proposed monitoring well pair E1 or F1, step out monitoring to the north and west directions.

Tracer Test Monitoring

The Workplan states that following implementation of the tracer injections, sampling will be conducted on a quarterly basis. Water Board staff believes this sampling frequency is not frequent enough or consistent with prior tracer tests.

The Water Board is requiring that PG&E comply with the following monitoring program for both tracer tests:

A. Maintain a log of the date, volume and concentration of the tracers (fluorescein and/or eosine) injected to groundwater. Record the volume of distilled water injected for dilution of initial injected concentration, if used. Calculate the diluted concentration of tracers following distilled water injection. Southern tracer test should be started by July 5, 2013. Northern tracer test should begin by July 26, 2013.

B. During tracer testing, maintain a log recording the date, time, monitoring or extraction well location, and measured tracer concentration from field probes or note color observation.

C. Collect monthly groundwater samples for the first three months after tracer injection to groundwater. Sample collection can be reduced to a quarterly frequency (once every three months).

D. Collect groundwater samples from monitoring wells for laboratory confirmation of fluorescein and eosine. The reporting limit for each constituent shall be 8 ppb for eosine and 2 ppb for fluorescein.

E. Following injection of tracers, concentrations will be monitored in the first row of downgradient monitoring wells. If tracers are detected, additional downgradient and cross-gradient monitoring wells must be sampled in the subsequent sampling event until the non-detect boundary line is defined. Where detected, tracers must continue to be monitored in subsequent sampling events, until the concentrations decline below 10 micrograms per liter for at least two consecutive quarterly sampling events.

Reporting

1. The minimum font size on figures and tables shall be 9 points.
2. Future site conceptual models shall not depict the Lockhart Fault as being on the ground surface since it is not an active fault with known surface features[1]. Dashed lines can be used with an explanation that the fault trace is inferred.
3. All references to manganese data in text or on figures must be shown in tables.
4. Future geologic cross-sections must be consistent in data depicted. For instance, if a well containing detected manganese concentration is shown in the cross section, then all wells within that same distance of the cross section line shall be depicted.
5. Maps showing domestic well locations must also show well numbers.
6. Show the location of domestic wells west of the Compressor Station and north of Aquarius Road when showing tracer injection and monitoring well locations.
7. Provide a description of the capture influence of extraction wells EX-21 and EX-22 and rationale for location of monitoring well pair(s) installed in Area 1.
8. Maps showing contour lines around manganese data points in all IRZ areas shall combine downgradient points of 390 ppb manganese or greater within 500 feet if there are no data points in between having lesser concentrations.
9. Tri-linear diagrams be included to compare the water quality data within the IRZ project and outside the IRZ project near residences having high concentrations of manganese in well water.

Byproduct Sampling in Monitoring Wells

The Workplan makes no mention that byproducts are being analyzed in existing monitoring well samples as required in Investigative Order R6V-2012-0060. However, in discussions between PG&E and Water Board staff, it was implied that such sampling and analyses are in fact occurring. Therefore, in the technical reports required below, describe the status and findings from byproduct analyses in the monitoring wells listed in the Investigative Order.

Schedule

The schedule proposed in the Workplan lists two months to install monitoring wells and lists implementing the tracer tests at four months following Water Board approval.

Water Board staff believe that the proposed schedule can be tightened up by conducting some tasks concurrently. For instance, monitoring well installation on the Compressor Station property can be implemented immediately after biological clearance is given in that area rather than wait until all off-site biological clearance is completed. In addition, the southern tracer test can be implemented (by July 5) following installation and development of monitoring wells to be located at the Compressor

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[1] *2001, Statmos et al., USGS, Simulation of Ground-Water Flow in the Mojave River Basin, California*

Station in Areas 3, 4, and 5, rather than wait for monitoring wells to be installed at further locations in Areas 1 and 2. Implementing these actions concurrently will reduce the schedule by about four weeks, allowing for the start of the tracer in three months after approval rather than 4 months.

Directives

Pursuant to section 13267 of the California Water Code, PG&E is directed to submit the following Byproduct Investigative technical reports:

1. **By August 10, 2013**, submit a letter report describing the status of byproduct investigation as modified by this Order, including reporting monitoring well installation dates and the dates tracer injections occurred. The letter report shall describe all byproduct investigation activities conducted to date and list planned activities for the next three months.

2. **By November 20, 2013,** submit a technical report describing investigation tasks and water results for the byproduct investigation. The report must include well designs and boring logs for all new monitoring wells. The report must also include laboratory results of byproducts in water samples collected from all upper aquifer monitoring well locations and applicable domestic wells. Present byproduct results on a map and in a cross section showing contour lines. The report shall describe the status of tracer tests and show the extent of tracer detections as contour lines on a map. Tracer information shall continue to be submitted in quarterly IRZ monitoring reports.

3. Beginning with the fourth quarter 2013 monitoring report for in-situ remediation activities, **due by January 15, 2014**, submit tracer information in quarterly reports. Information shall include sampling results, a discussion of on-going tracer monitoring, and a map showing location of detected tracers at or exceeding 10 ppb. Calculate the estimated movement of tracer compounds in groundwater at each tracer test location. Describe whether step-out monitoring locations will be added to the sampling program to continue to evaluate tracer movement in groundwater.

Enforcement

Technical reports required by this Investigative Order are necessary to investigate the water quality in the Hinkley basin during PG&E's ongoing cleanup of chromium pursuant to Cleanup and Abatement Order R6V-2008-0002 and amendments, based on Water Board's findings that:

- PG&E performs IRZ chromium remediation in the Hinkley basin,
- IRZ chromium remediation necessarily changes the groundwater chemistry and produces byproducts of metals (primarily arsenic and manganese) that dissolve into the groundwater,

- These metals byproducts may persist, temporally and spatially, in groundwater beyond expectations and unintentionally impair water quality in domestic wells,
- Technical reports are required to evaluate this potential threat to water quality.

The need for this investigation outweighs the burden on PG&E to produce the information for defining the manganese plume in groundwater will assist in evaluating potential threats to public health.

Pursuant to section 13268 of the Water Code, a violation of Water Code Section 13267 requirement may subject you to civil liability of up to $1,000 per day for each day in which the violation occurs.

If you have any questions concerning this matter, please contact Lisa Dernbach at (530) 542-5424 or ldernbach@waterboards.ca.gov.

Lauri Kemper

LAURI KEMPER, P.E.
ASSISTANT EXECUTIVE OFFICER

cc: PG&E Technical Mailing List

LSD/adw/T: PG&E Mn workplan comm and 13267 order 3-13 (ld)
Send to file: WDID 6B369107001 (VVL)

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February 28, 2013

Patty Kouyoumdjian
Executive Officer
California Regional Water Quality Control Board
Lahontan Region
2501 Lake Tahoe Boulevard
South Lake Tahoe, CA 96150

Re: Hinkley Groundwater Remediation Project: Clarifying Comments from the Independent Review Panel (IRP) Manager Regarding PG&E's Petition (dated 2/7/13) of the Chromium-6 Further Plume Definition Cleanup and Abatement Order (CAO) No.R6V-2008-0002-A4 (dated 1/8/13).

Keywords: Water Board's Cr6 Plume Definition Order of January 8, 2013; PG&E's Petition of Same; Petition's Quotation of IRP Manager's Opinions at Footnote 3; Explanation of Why Quotation Applies to Draft CAO and Not Current CAO.

Dear Executive Officer Kouyoumdjian:

The Independent Review Panel (IRP) Manager has reviewed Pacific Gas and Electric Company's (PG&E) request for immediate and emergency stay to petition "the Petition" for review of Cleanup and Abatement Order (CAO) No.R6V-2008-0002-A4 "the Order" issued by the Water Board (WB) on January 8, 2013. PG&E submitted the Petition to the WB on February 7, 2013. The main reason of this letter, submitted at the request of the Community Advisory Committee (CAC), is not to provide detailed comments[1] on the Petition, but to elaborate and clarify on a reference made by PG&E in their Petition regarding the IRP Manager's professional opinion on a certain issue pertaining to Cr-6 plume definition.

Specifically, on page 5, lines 10 to 13 of the Petition, PG&E stated the following:

"In addition, PG&E believes that the newly ordered monitoring and delineation activities are unnecessary because PG&E has offered both interim replacement (bottled water service) and whole house replacement water to every resident within one mile of the current chromium plume boundary.[3]"

The following is then stated in Footnote 3, page 5:

[1] Detailed comments will be submitted separately, henceforth.

"The independent technical expert hired by the Hinkley Community Advisory Committee (referred to as the "IRP Manager"), also questioned the need for the CAO when commenting on the draft CAO: "However, the IRP Manager is uncertain, at the time of writing, and to the extent of his own internal data review, if this apparent desire for increased accuracy is warranted or needed, in light of plume delineation, plume management, and ongoing whole house water supply actions underway in parallel actions within the project. In short, the IRP Manager does not understand what is driving the present need for the draft CAO; given that the plume management, replacement water supply and remedy assessment tasks currently underway would appear to be well served, from an environmental engineering perspective, by the accuracy inherent in the present plume delineation practices."

The IRP Manager's opinions regarding the CAO were submitted after review of the Draft CAO[2] of July, 2012 and not the Final CAO of January, 2013…which PG&E is now petitioning. The IRP Manager's comments in the August 10, 2012 letter were offered in the context of the multiple ongoing programs ongoing at the time the draft CAO was issued, and an evaluation of the practical implementability of the Draft CAO, leading the IRP Manager to determine that the draft CAO was seemingly infeasible to respond to, given its requirement to possibly install scores of monitoring wells in a very short time period.

The IRP Manager was also questioning the extent of work required for further plume delineation, at the appropriate confidence level, in accordance to the requirements from the Draft CAO. As stated in the IRP Manager's comments letter[3]: *"The IRP Manager agrees with the need for appropriate plume delineation but not at the expense of PG&E and the Water Board becoming distracted from work of greater importance. Quite frankly, the IRP Manager is concerned about the dilution of project management and field staff time, as they turn to focus on the requirements of the draft CAO."*

It is still the IRP Manager's belief that improved delineation of the plume needs to occur to decide upon the final remedy, but at an appropriate degree of accuracy and confidence consistent with the final remedies which have been proposed in the Final Remedy Feasibility Study[4]. The new vehicle for Cr6 plume definition is the Water Board's CAO of January 8, 2013, which has been petitioned by PG&E, and will be further commented on by the CAC and IRP Manager.

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[3] IRP Manager Letter to the Water Board, *Re: Comments from the Hinkley Groundwater Site Independent Review Panel (IRP) Manager on behalf of the Community Advisory Committee (CAC) Regarding the Draft Amended Cleanup and Abatement Order (CAO) No.R6v-2008-0002A4 Issued for Public Comment on July 25, 2012*. August 10, 2012.

[4] Final Remedy Feasibility Study, Addendum No.3, Prepared by Haley & Aldrich, Inc., for PG&E, September 15, 2011.

To clarify, Footnote 3 in the Petition was taken out of context and refers to the IRP Manager's comments on the draft CAO, and not the current final CAO.

Should you have any questions or comments please feel free to contact me at 714-388-1800 or by email at iwebster@projectnavigator.com.

Respectfully Submitted,

Ian A. Webster, Sc.D.

IRP Manager,

Hinkley Groundwater Remediation Project

Attachment:

IRP Manager Letter Regarding Draft CAO Submitted August 10, 2012

cc:

Hinkley Community Advisory Committee

California State Water Resources Control Board Members

PROJECT NAVIGATOR, LTD.®

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August 10, 2012

Ms. Lauri Kemper
California Regional Water Quality Control Board
Lahontan Region
2501 Lake Tahoe Boulevard
South Lake Tahoe, CA 96150

Re: Comments from the Hinkley Groundwater Site Independent Review Panel (IRP) Manager on behalf of the Community Advisory Committee (CAC) Regarding the Draft Amended Cleanup and Abatement (CAO) No. R6V-2008-0002A4 Issued for Public Comment on July 25, 2012.

Summary & Overview: ***The draft proposed CAO, first, permits Pacific Gas and Electric (PG&E) the use of additional "hydraulic plume volume" for the purposes of improved overall plume hydraulic control, and second, requires that PG&E perform more activities (employing domestic well data and newly installed monitoring well data) to improve the program's understanding of the definition of the chromium plume in the upper aquifer.***

On the first topic, the CAC is always concerned about allowances which permit plume expansion. However, in this specific case, after reviewing the expansion allowance in the broader context of the general improved hydraulic controls the action delivers elsewhere within the plume, the IRP Manager is comfortable with the new flexibility provided by this draft CAO.

Regarding the second topic of the proposed use of domestic wells for further plume characterization; the CAC is typically in favor of efforts which improve the definition of the chromium plume, however, we are also very much mindful of a project management need to optimize the degree to which the plume needs to be defined, bearing in mind the uses to which the plume definition information will be applied. This "best-use-of-effort-thinking" is especially true at the present time. For example, irrespective of possible changes in the plume shape which could arise from the draft CAO's requirements, the shape changes may be no more than academic, by comparison to the large acreage that will soon be serviced by the Whole House Replacement Water (WHRW) Program, which decouples residents from the plume, no matter how its shape could be reasonably modified under the draft CAO.

The IRP Manager is concerned that, while the draft CAO further plume program may seem valuable in concept, in reality, it could simply distract

the program from far more important initiatives, such as installing the WHRW Systems, completing the EIR, starting up additional in-situ treatment systems, finalizing the remedy feasibility study and initiating the 2-year long comprehensive background study.

The IRP Manager is recommending that, given the effort which the new CAO will entail, that before the draft CAO is finalized, Order visioning/planning technical exchange meetings take place. The IRP Manager recommends that these discussions should include GIS-driven reviews of the confidence and limitations on the present data to determine if the new draft CAO's plume definition demands are valuable, or as mentioned earlier, academic.

Dear Lauri:

The Hinkley Community Advisory Committee (CAC) and the Independent Review Panel (IRP) Manager have reviewed the Draft Amended Cleanup and Abatement Order (CAO) Number R6V-2008-0002A4, which was released for public comment on July 25, 2012.

The draft CAO addresses two issues which are important to the Hinkley Community. The draft CAO proposes to amend two previous cleanup and abatement orders[1] (**Attachments A and B**). The two main items that the draft CAO proposes to amend (or forward-manage) from the previous two orders are the following:

1. Allows for the additional lateral migration of the 3.1 ppb (previous 4.0 ppb) hexavalent chromium on the eastern plume boundary to spread no more than 2,000 ft (previous 1,000 ft) for the purposes of implementation of cleanup actions to contain chromium expansion on the downgradient boundary in the northwest direction.

2. Requires the submission of a Work Plan proposing sampling locations in the upper aquifer to allow the definition of the hexavalent chromium plume in the southern, eastern and northern plume boundaries. Along with the required

[1] The Draft CAO amends CAO No.R6V-2008-0002 and CAO No.R6V-2008-0002A2. CAO No.R6V-2008-0002 required Pacific Gas & Electric (PG&E) to define the hexavalent chromium plume in the upper aquifer in the Hinkley Valley. A Water Board letter dated September 29, 2011 addressed to PG&E outlines the requirements for contouring the affected area pursuant to CAO No.6V-2008-0002A2. CAO No.R6V-2008-0002A2 allowed the lateral migration of the 4.0 ppb hexavalent chromium plume boundary east of the South Central Reinjection Area (SCRIA) from discharges to groundwater piped from extraction wells in the northwest plume area. CAO No.R6V-2008-0002A2 allowed lateral plume expansion of 1,000 feet as long as PG&E showed that the hexavalent chromium would by captured by the existing groundwater extraction system.

Work Plan the draft CAO also describes proposed revised requirements[2] for contouring the hexavalent chromium plume. The proposed revisions to the contouring include the following:

a. Where access to private property or endangered species habitat has not been granted for six months or more, the chromium plume boundary is proposed to be drawn around any domestic well containing chromium concentrations exceeding 3.1 ppb hexavalent chromium or 3.2 ppb total chromium for at least two consecutive quarters and within one-half mile distance of the prior quarter's plume boundary.

b. Where plume monitoring wells are unable to replicate chromium concentrations in nearby domestic wells within 0.5ppb Cr6, the chromium plume boundary shall be drawn around any domestic well having concentrations exceeding 3.1 ppb hexavalent chromium or 3.2 ppb total chromium for at least two consecutive quarters, and within one-mile distance of the monitoring.

In general comment, first, the CAC and IRP Manager would like to acknowledge the Water Board's commitment, made at the June 28, 2012 TEM in Barstow with PG&E and the CAC, allowing the CAC and Community the ability to comment on draft Cleanup and Abatement Orders.

Second, the CAC also wishes to restate comments made over the past six months by Mr. Jon Quass in the role of CAC Co-Chair. Jon has stated that it is the CAC's general opinion that progress on the overall clean up of the Hinkley groundwater plume is best achieved via cooperative, open technical dialog leading to safely implemented field operations and monitoring...in contrast to management by an "Order-driven approach." The latter appears to be less efficient, leading to nonproductive efforts, which are not in the Community's best interests.

The IRP Manager's comments on the draft CAO are as follows:

1. With respect to Item 1 (above), the IRP Manager is in general agreement of permitting the expansion of the chromium plume boundary on the east side in the vicinity of Acacia Street from the currently permitted 1,000 ft to a new distance of 2,000 ft, as long as per the draft Order's requirements at Section II.A., PG&E can demonstrate that the area's chromium is being subsequently captured by the downgradient extraction system. One of the CAC's overall goals is to advocate for faster cleanup of the aquifer. In the IRP Manager's opinion, the new proposed

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[2] Current Hexavalent Chromium Map Contouring is in accordance with Water Board Letter, "*Re: Investigation Order R6V-2011-0079 Quarterly Groundwater Monitoring Reports, PG&E Compressor Station, Hinkley, San Bernardino,*" September 29, 2011.

allowance of 2,000 ft is consistent with this goal, in that, simply, more water can be pumped for plume management prior to selection of the final remedy.

2. With respect to plume investigation in the upper aquifer, and the draft CAO's requirement to employ domestic well data in the delineation of the plume boundaries, the IRP Manager offers the following perspectives and comments:

The CAC understands that to decide upon a final remedy, the Hinkley chromium plume needs to be defined to an *appropriate* degree of accuracy. The new draft CAO *implies* that the present Cr6 plume is not defined with sufficient accuracy to work the immediate path-forward remedial activities, and proposes to improve the delineation accuracy via the use of domestic wells and further new monitoring wells. Per the draft CAO, these wells are to be proposed and installed via a new Work Plan. However, the IRP Manager is uncertain, at time of writing, and to the extent of his own internal data review, if this apparent desire for increased accuracy is warranted or needed, in light of plume delineation, plume management, and ongoing whole house water supply actions underway in parallel actions within the project. In short, the IRP Manager does not understand what is driving the present need for the draft CAO; given that the plume management, replacement water supply and remedy assessment tasks currently underway would appear to be well served, from an environmental engineering perspective, by the accuracy inherent in the present plume delineation practices.

The IRP Manager is therefore recommending that before the draft CAO is finalized more time is allowed to examine and understand the implications of the draft CAO, and its benefit to the entire remediation program. The IRP Manager recommends that "draft Order visioning, scoping and value-added discussions" take place between the Water Board, PG&E, CAC representatives and the IRP Manager.

More specifically, topics which validate the need for further, discussion, understanding and consideration before the draft Order is issued are:

1. The IRP Manager agrees with the need for *appropriate plume delineation* but not at the expense of PG&E and the Water Board becoming distracted from work of greater importance. Quite frankly, the IRP Manager is concerned about the dilution of project management and field staff time, as they turn to focus on the requirements of the new CAO.

2. Further effort in field plume definition should only be commenced after a rigorous desk top evaluation[3] of plume contouring confidence has been

[3] The IRP Manager recommends that GIS techniques are employed.

performed. The IRP Manager recommends that the following issues are considered in this evaluation:

a. *Appropriate* plume definition accuracy should be the goal so that the final remedy conceptual design can be expeditiously formulated. The questions the IRP Manager cannot evaluate, or answer at this moment, are "what is the appropriate degree of plume definition accuracy?" and "what is the appropriate scope of a plume definition effort?" It maybe that a possible positive action for all, triggered by the issuance of this draft CAO, is a constructive, longer term dialog between the parties discussing plume definition, and the associated accuracy required at any particular stage to advance the project.[4]

b. The Whole House Replacement Water Systems[5] will soon be operational for Community members whose properties would be located within the potentially expanded-contoured bounds of the plume resulting from the draft CAO's required use of domestic wells at Ordered Section I.A. Given the possibility of this scenario, which should be verified using mapping techniques, further plume investigation efforts as described in the draft CAO, contribute little value to the process of developing the overall Hinkley groundwater solution.

3. As history has shown from the first background study in 2007, the use of domestic wells with poorly known construction details[6], to collect upper aquifer Cr6 impacts data, is a questionable decision.

4. The IRP Manager requests further clarification as to how the Water Board determined the 0.5ppb "delta value" that is referenced in draft CAO Section I. The CAC and the IRP Manager are unclear as to how the 0.5ppb metric was determined, and especially how its use during plume contouring work

[4] The CAC and the IRP Manager understand that plume definition accuracy is required to advance on work on future parts of the project including the Remedy Feasibility and Design Phases. We also understand that the plume needs to be defined accurately enough to insure that Community members are not affected by any possible health effects. Such activities, and thereby the appropriate degree of plume definition accuracy, given the stage of the project, appear to be progressing satisfactorily under the present work and management systems. (What concerns the IRP Manager (and this is a pure professional judgment call) is that ever increasing attempts for plume accuracy become very much akin to counting the number of angels dancing on the head of a pin. With the need to drive the project to a remedy phase foremost in the CAC's minds, the IRP Manager is not really too concerned if there are 980 angels or 1,020 angels on the proverbial pinhead, when he knows that an answer of 1,000 +/- 2% is an accurate enough answer, given the problem.)

[5] As required by CAO No.R6V-2011-0005A2

[6] That is materials and methods of construction, well's present structural integrity, and screen location and length.

would translate to improved protectiveness for Community members, when they will soon be sitting behind the "protection" of a Whole House Water Treatment System[7] in areas where the 0.5ppb criterion would possibly be applied.

5. At time of writing, the CAC and IRP Manager have just received the 2nd Q, 2012 plume monitoring data, with its derived plume contours. (see **Attachment C**.) The 3.1ppb Cr6 plume contour, in a significant (positive) change from the 1st Q, 2012 maps, has now been drawn showing an apparent Cr6 "plume break" in the vicinity of Thompson Road. If verified by future data, the IRP Manager believes this "break" is consistent with what one would see as a result of the water table gradient reversal actions undertaken by PG&E in response to a March, 2012 CAO[8], resulting from the February 2012 Settlement Agreement[9]. The IRP Manager recommends that the apparent success of this event is taken into consideration when now Ordering PG&E to further delineate the northern plume boundary.

The CAC and IRP Manager have a long-term interest in seeing that the analytical science associated with Cr6 isotope speciation improved and applied to the Hinkley project. The CAC has previously documented its opinions on this subject in a letter[10] to the Water Board and discussed at Water Board Public Meetings[11]. The topic of Cr6 speciation (natural Vs man-made Cr6) was initially Ordered by the Water Board in connection with an earlier version of the Replacement Water CAO[12]. This CAO has recently been amended[13] to "suspend" the need for speciation. The CAC continues to believe that "Cr6 isotope speciation" is an important technical issue for the Hinkley groundwater clean up program, and recommends, as previously documented, that Cr6 speciation science should continue to be reviewed for its applicability to Hinkley groundwater cleanup.

Given the seeming short fuse on this draft Order, the CAC and IRP Manager look forward to immediately discussing these topics with the Water Board and PG&E,. Please feel free to contact the IRP Manager at 714-863-0483.

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[7] Or new deeper well, as appropriate.
[8] CAO No.R6V-2008-0002A3.
[9] California Regional Water Quality Control Board, Lahontan Region. *Settlement Agreement and Stipulation for Entry Order Board Order No. R6V-2012-0013*, February 1, 2012
[10] Letter to Mr. Harold J. Singer previous Executive Officer of Lahontan Regional Water Quality Control Board Dated April 20, 2012 prepared by the CAC *Regarding Lahontan Water Board's Consideration of Amendment of Order No.6V-2011-0005A1(Order) Issued to Pacific Gas and Electric Company (PG&E), as Described in Your "Comments Request by April 23, 2012" Letter of March 22, 2012.*
[11] For further information regarding the June 13-14, 2012 Lahontan Water Board Meeting can be found at http://www.waterboards.ca.gov/rwqcb6/water_issues/projects/pge/index.shtml
[12] CAO No.R6V-2011-0005A1
[13] CAO No.R6V-2011-0005A2

Sincerely yours,

Ian A. Webster

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Hinkley Project, Independant Review Panel (IRP) Manager
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iwebster@projectnavigator.com

CC:
CAC Members
Jason Keadjian

Attachments

Attachment A:	Amended Cleanup and Abatement Order NO.R6V-2008-0002A4
Attachment B:	Water Board Letter Dated September 29, 2011 Re: Investigation Order R6V-2011-0079 Quarterly Groundwater Monitoring Reports, PG&E Compressor Station, Hinkley, San Bernardino
Attachment C:	2nd Quarter, 2012 Chromium Plume Map, PG&E, August 2012.