

**CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
LAHONTAN REGION**

**MEETING OF NOVEMBER 12-13, 2014
BARSTOW**

ITEM: 8

SUBJECT: **WORKSHOP - CLEANUP AND ABATEMENT ORDER
DISCUSSION, PACIFIC GAS & ELECTRIC COMPANY'S
(PG&E) HINKLEY COMPRESSOR STATION, SAN
BERNARDINO COUNTY**

CHRONOLOGY:

August 2008	Cleanup and Abatement Order (CAO) No. R6V-2008-0002 directed PG&E, among other things, to develop and implement a final cleanup strategy for chromium in groundwater.
July 2013	Resolution certifying an Environmental Impact Report (EIR) analyzing five cleanup strategy alternatives.
March 2014	Adoption of Board Order No. R6V-2014-0023, Waste Discharge Requirements (WDRs) for Agricultural Treatment Units.
September 2014	Workshop at Water Board meeting to discuss PG&E's remedial timeframe estimates and CAO elements.

BACKGROUND: This is the second of two workshops to discuss potential requirements of an upcoming CAO which will be issued to PG&E in 2015 for historical releases of hexavalent chromium from the Hinkley Compressor Station. At the first workshop held during the September 2014 Water Board meeting, the types of requirements that would be contained in the CAO and estimates of cleanup timeframes were discussed. This workshop will focus on: 1) monitoring programs, and 2) plume containment/capture requirements.

DISCUSSION: **1. Monitoring Programs**
Current Requirements
Prior Water Board orders require groundwater monitoring in Hinkley for several purposes: 1) delineating the chromium plume at several key concentrations, 2) tracking plume containment and remediation

effectiveness, and 3) determining domestic well water quality. Monitoring to meet these objectives is contained in various CAOs, investigative orders and Waste Discharge Requirements (i.e., the March 2014 WDRs for Agricultural Treatment Units [ATUs] and the 2008 General WDRs that regulate in-situ remedial operations).

Under current requirements, most domestic and monitoring wells are sampled four times per year (quarterly). Twice yearly (semi-annual) sampling is allowed for certain monitoring wells, such as upgradient wells or those not used to define the plume boundary.

PG&E's Preliminary Sampling Program

PG&E has developed a preliminary proposed sampling program which reduces sampling frequencies and locations based on certain criteria, such as chromium concentrations, data trends, location of wells, or monitoring objectives. This preliminary program will be described by PG&E staff during the workshop. See Enclosure 1 for Water Board staff's summary of existing monitoring requirements and PG&E's preliminary proposed changes. Enclosure 2 contains PG&E staff's description of and rationale for the requested monitoring program changes.

Summary of PG&E's Preliminary Changes to Existing Monitoring Programs

1. Monitoring wells for plume delineation near active remediation areas:
 - Quarterly sampling of wells adjacent to the plume at different depths
 - Semi-annual or annual sampling of wells in the plume interior, to track remediation effectiveness
 - No sampling of wells that are not used for plume delineation, and have a general stable trend below 3.1 parts per billion hexavalent chromium
2. Monitoring wells away from active remediation areas (e.g., areas north of Salinas Road, Hinkley Gap, North Hinkley Valley):
 - Mostly semi-annual sampling at one key depth, rather than quarterly sampling at all depths
 - Quarterly sampling at one depth where concentrations are more variable
3. Domestic well sampling for chromium required in the ATU WDRs:
 - Quarterly sampling where ATU operations could change groundwater flow near a domestic well

- Quarterly sampling if domestic well Cr6 concentrations are 3.1 parts per billion or greater
 - Semi-annual sampling if domestic well is below 3.1 parts per billion Cr6, within 1 mile of ATUs
 - No sampling in neighborhood near Hinkley School, instead use sentry monitoring wells to verify no plume movement toward neighborhood
4. Domestic well sampling not required by ATU WDRs (northern area):
- Northern area domestic wells sampled annually if Cr6 concentrations since late 2013 are greater than 3.1 parts per billion, or within 2,000 feet of monitoring well with past Cr6 greater than 10 parts per billion.
 - No sampling for other northern area domestic wells

Community Outreach

In September 2014, Water Board staff attended a technical exchange meeting in Hinkley to discuss, in part, PG&E's monitoring program changes. The meeting was attended by the members of the Community Advisory Committee, the Independent Review Panel (IRP) manager, and staff of PG&E. The IPR manager provided comments on the information discussed at the meeting (see Enclosure 3).

Key Questions/Issues

1. Is it appropriate to reduce sampling (frequency and/or locations) in monitoring wells based on the criteria proposed by PG&E? Are there additional criteria that should be considered?
2. Should domestic well sampling required by the ATU WDRs be reduced as proposed at this time?
3. Are the sentry wells proposed adequate to protect domestic wells in the Hinkley downtown neighborhood?
4. Is the sampling approach for the northern area adequate to detect Cr increases to protect domestic wells and detect plume migration?

2. Plume Capture/Containment and Remediation Effectiveness.

One key measure of remediation effectiveness is plume capture, where the chromium plume is not migrating with groundwater but is contained within specific boundaries. This is being achieved primarily through groundwater extraction and application to ATUs (the freshwater injection system in the western portion of the plume also provides hydraulic containment). As effective remediation continues, groundwater monitoring should show that the plume area is becoming smaller, and an associated adjustment to the

plume capture boundary line is needed as the extraction locations are moved to account for the smaller plume size. This adaptive management approach is needed, but is lacking in current CAO requirements. See Enclosure 4, CAO R6V-2008-002A3 for current plume capture requirements and metrics.

Key Issues

1. Crafting adaptable plume capture requirements in the new CAO to allow for modifications as remediation continues and the plume contracts inward.
2. Including a contingency plan requirement if chromium concentrations "rebound" as extraction well pumping is shifted in response to plume contraction.

3. Workshop

The workshop will consist of two parts. In the first part, Water Board staff will provide of brief overview of the workshop and purposes for monitoring. The second part will be a presentation by PG&E. PG&E staff will first provide follow-up information on questions raised at the September Board meeting on the remedial timeframe assessment and groundwater modeling. PG&E will then describe its groundwater monitoring proposal and capture metrics. Following a question and answer period, Water Board staff may summarize input and discuss next steps.

RECOMMENDATION:

This is an informational item only; however, the Water Board may provide direction to staff.

ENCLOSURES:

Enclosure	Item	Bates Number
1	Water Board staff's summary of existing monitoring requirements and PG&E's preliminary proposed changes	8-7
2	PG&E staff's briefing on requests for changes to existing monitoring Programs <ul style="list-style-type: none"> • Note: Oversized Figures 1 – 6 can be viewed online at http://www.waterboards.ca.gov/lahontan/board_info/agenda/2014_schedule.shtml, or in person at the Water Board's Victorville and South Lake Tahoe offices. Hardcopies are provided for Lahontan Water Board members. 	8-11
3	IRP Manager comments on technical exchange meeting, baseline and proposed groundwater sampling program	8-25
4	CAO R6V-2008-0002A3 with plume capture metrics	8-31
5	Water Board staff presentation	8-47
6	PG&E staff presentations: <ul style="list-style-type: none"> • Responses to questions from September Board meeting • Preliminary monitoring program overview 	8-53

ENCLOSURE 1

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Enclosure 1: Summary of Existing Monitoring Requirements and PG&E's Suggested Changes

Monitoring Objective	Monitoring Area	Parameters	Existing Monitoring Frequency	PG&E's Preliminary Monitoring Plan
Monitoring Well (MW) Sampling				
<ul style="list-style-type: none"> Plume delineation Remediation effectiveness 	MWs near active remediation (IRZs, ATUs, freshwater injection area), generally south of Thompson Road	Cr, TDS, N, As, Mn, Fe, total organic carbon	Quarterly to semi-annually	For MWs to define plume, continue quarterly at reduced locations. Annual or semi-annual for MWs in plume core interior at reduced locations. No sampling for MWs not adjacent to plume. For MWs for ATU remediation effectiveness, no change
<ul style="list-style-type: none"> Plume delineation 	MWs away from active remediation (north of Salinas Road)	Cr	Quarterly at multi-depth wells	Semi-annual sampling at one key depth
<ul style="list-style-type: none"> Plume containment/ hydraulic capture 	Thompson Road area. Specific MW pairs/triplets in shallow & deep zone of upper aquifer	Water levels	Continuous in – well sampling, reported monthly	Flexible locations to adapt to plume geometry changes
Domestic Well (DW) Sampling				
Domestic well sampling (Replacement water)	DWs within 1 mile downgradient/crossgradient of Cr plume and within 2,000' upgradient of Cr plume	Cr	Quarterly	Northern area DWs (away from active remediation) sampled annually if > 3.1 ppb Cr6 since late 2013, or within 2,000' of MW with >10 ppb Cr6. No other northern DW sampling proposed
Domestic well baseline (EIR "pre-remedial")				
<ul style="list-style-type: none"> Chromium 	DWs within 0.5 mile downgradient/ crossgradient of new ATU	Cr	Quarterly for 1 year	No change

Monitoring Objective	Monitoring Area	Parameters	Existing Monitoring Frequency	PG&E's Preliminary Monitoring Plan
<ul style="list-style-type: none"> Remediation byproducts 	DWs within 1 mile downgradient/ crossgradient of new ATU	Various combinations of TDS, N, U, Mn, As, Fe	Quarterly for 1 year	No change
<ul style="list-style-type: none"> Groundwater drawdown 	DWs within 0.5 mile of existing or proposed groundwater extraction wells	Water levels	Quarterly for 1 year	Use nearby MWs where DW access is unavailable
Domestic well protection (During remediation)				
<ul style="list-style-type: none"> Chromium 	DWs within 1 mile downgradient/crossgradient of Cr plume	Cr	Quarterly	Quarterly for DWs where modeling shows remediation could affect groundwater flow near DW, or if > than 3.1 ppb Cr6. Semi-annual if within 1 mile of Cr plume and < 3.1 ppb. Sentry MWs for neighborhood north of Hinkley School
<ul style="list-style-type: none"> Remediation byproducts 	DWs within 0.5 mile downgradient/crossgradient of ATU	TDS, N, U (Mn, As, Fe if near IRZ)	Semi-annual	No change
<ul style="list-style-type: none"> Groundwater drawdown 	DWs within 0.25 mile of any groundwater extraction point	Water levels	Semi-annual	Use MWs within 0.25 miles of DW (between extraction point and DW)

Acronyms/Symbols: As: arsenic; ATU: Agricultural Treatment Unit; CAO: Cleanup and Abatement Order; Cr: chromium (total and hexavalent); DW: domestic well (includes household and agricultural supply wells); EIR: Environmental Impact Report; Fe: iron; IRZ: in-situ remediation zone; Mn: manganese; MW: monitoring well; N: nitrate; ppb: parts per billion; U: uranium (includes other radionuclides: gross alpha and beta); WDRs: Waste Discharge Requirements; >: greater than; <: less than

ENCLOSURE 2

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Briefing Paper for Lahontan Water Board
Developing a Consolidated Monitoring and Reporting Program
2015 CAO for PG&E Hinkley Groundwater Remediation

Pacific Gas and Electric Company (PG&E) has prepared this Briefing Paper for the Lahontan Regional Water Quality Control Board (Water Board) regarding future monitoring at the Hinkley Groundwater Remediation site. Accompanying this Briefing Paper are the following figures:

- Figure 1. Preliminary Groundwater Monitoring Program- Upper and Lower Aquifer
- Figure 2. Wells Not Included in the Preliminary Monitoring Program for Remediation and Chromium Monitoring Surrounding the Contiguous Plume- Shallow Zone of the Upper Aquifer
- Figure 3. Wells Not Included in the Preliminary Monitoring Program for Remediation and Chromium Monitoring Surrounding the Contiguous Plume - Deep Zone of the Upper Aquifer
- Figure 4. Data Trends for Preliminary Monitoring Program for Chromium Monitoring in the North Area- Shallow Zone of the Upper Aquifer
- Figure 5. Preliminary Domestic Well Sampling Program
- Figure 6. Data Trends for Preliminary Domestic Well Sampling Program

Background

The Water Board is expected to adopt a Cleanup and Abatement Order (CAO) in 2015 for the PG&E Hinkley site. The new CAO will mandate comprehensive groundwater remediation after multiple years of board-ordered investigations, remedial measures to contain and treat the plume, and extensive site monitoring and sampling. Among its provisions, the CAO will contain requirements for a Monitoring and Reporting Program (MRP). In response to an earlier PG&E proposal to modify the monitoring and sampling program in one area, Lahontan Water Board staff requested that PG&E take a holistic look at monitoring and sampling in the project area and propose a project-wide approach.

PG&E assembled an interdisciplinary team of experts from its consultants (CH2M Hill, Arcadis, Stantec) to develop a project-wide perspective on the MRP that will accompany the 2015 CAO. PG&E has been in discussions with Water Board staff, Technical Working Group (TWG), the Independent Review Panel (IRP) Manager, and the US Geological Survey (USGS) regarding these potential changes to the MRP.

Quarterly monitoring is currently performed in 670 monitoring wells pursuant to 34 Water Board orders and letters for monitoring and reporting dating to 2006. Over 400 domestic wells have been sampled since 2011. Tens of thousands of samples have been collected for investigations, chromium plume monitoring, and remedial evaluations throughout the project area, and long-term monitoring results from these hundreds of wells allow assessment of trends over time throughout the project area. These results provide a robust basis for determining where future monitoring is needed as the investigation phase comes to a close and efforts move, with the 2015 CAO, to remediation of the plume.

The preliminary MRP would include the following changes.

- Consolidate reporting of all groundwater monitoring and reporting into one comprehensive quarterly report, including the monitoring required separately to verify and evaluate groundwater remedy performance (see remedy performance requirements below)
- Consolidate all monitoring well sampling requirements for chromium monitoring into one cohesive site-wide plan, reduce redundant monitoring, and sunset the requirements in older Board orders and letters
- Redesign the monitoring well network for the contiguous plume
- Redesign the monitoring well network in the North Area (north of Salinas Road)
- Update domestic wells to be sampled
- Update hydraulic containment metric to allow adaptive changes as remediation progresses

What ongoing sampling is not included in the new MRP?

The Water Board is contracting with the USGS to determine chromium background in the project area away from the contiguous plume. The USGS will be deploying state-of-the-art geochemical and hydrogeologic methods to determine if chromium in outlying parts of the project area is related to the PG&E compressor station or is naturally occurring. Consequently, we do not think it is appropriate or necessary for the MRP to have the same objective of determining site background.

Remedy performance requirements are being adopted separately for the In-situ Reactive Zones (IRZs) and Agricultural Treatment Units (ATUs), and hydraulic containment metric.

- ATU requirements are specified in Waste Discharge Requirements (WDRs) (R6V-2014-0023)
- IRZ monitoring requirements are specified in the 2/19/14 Water Board letter

Reporting on remedy performance is proposed to be consolidated into the 2015 MRP so that future reports provide a cohesive and unified view of the site each quarter, rather than the multiple quarterly reports currently required.

The balance of this briefing summarizes the scientific and technical basis used in this preliminary re-design of the monitoring program to be incorporated into an MRP to accompany adoption of the 2015 CAO, consisting of the groundwater monitoring and domestic well sampling programs.

Groundwater Monitoring Program

Figure 1 presents a preliminary groundwater monitoring program for the 2015 CAO for monitoring in the area around the contiguous plume and in the area north of Salinas Road.

Re-Designed Monitoring Network for Contiguous Plume

In this area of the site, extensive groundwater monitoring is conducted under current orders to evaluate the remediation performance. The objective of additional sampling is to monitor the contiguous

chromium plume in the vicinity of the currently planned remedial activities. The consulting team has designed a robust monitoring network to define and monitor the plume at different depths within the impacted aquifers. In selecting wells, the team considered:

- Well locations needed to contour chromium (3.1/3.2 parts per billion [ppb], 10 ppb and higher)
- Groundwater gradients and flow directions
- Chromium 6 concentrations in each well over time, evaluated using the same statistical methods that USGS is deploying in its trend analysis
- The comprehensive groundwater remedy will be operating in this area.
- Chromium in the area of the contiguous plume is within the upper aquifer and lower aquifer.

In the preliminary re-designed monitoring network for the 2015 CAO, wells around the contiguous plume would be sampled quarterly in a network that is suitably dense to facilitate contouring chromium and detect changes in concentrations. Wells would not be included that are upgradient or far from the plume and have been generally stable, particularly those with chromium 6 concentrations below 3.1 ppb. Figure 2 and Figure 3 illustrate past chromium 6 test results over time for monitoring wells that would not continue in the 2015 MRP.

Re-Designed Monitoring Network for North Area

The North Area is generally north of Salinas Road, and somewhat different than the area of the contiguous plume in that chromium are substantially lower than in the remediation area and generally stable over time. In designing the monitoring network that would be needed for the 2015 CAO, we considered the following.

- Well locations needed to contour chromium (3.1/3.2 ppb, 10 ppb and higher)
- Groundwater gradients and flow directions
- Chromium 6 concentrations in each well over time, evaluated using the same statistical methods that USGS is deploying in its trend analysis (see Figure 4)
- Each monitoring well location is actually a cluster of wells, usually with two or three wells completed at multiple depths for detailed vertical mapping of chromium concentrations within the shallow zone of the upper aquifer. Over the years, results at all locations confirmed that one depth interval generally has the highest chromium concentration and can serve as an indicator well for these locations.

As demonstrated in Figure 4, chromium 6 concentration trends in the North Area are generally stable. A few wells have chromium 6 concentrations that vary more, but the concentrations are not increasing. In the preliminary re-designed monitoring network for the 2015 CAO, semi-annual sampling would be performed in the North Area for the majority of monitoring wells based on the general stability of concentration trends, and those monitoring wells with varying concentrations would be sampled quarterly. After reviewing the concentration trends on Figure 4 for all well depths in a given well cluster, one well from each well cluster was selected as the best indicator well for chromium distribution in this area.

Domestic Well Sampling Program

Multiple years of sampling have conclusively shown that all current domestic supply wells in the Hinkley project area are consistently below the newly adopted maximum contaminant level (MCL) of 10 ppb for chromium. The vast majority (>95%) of these domestic wells also are consistently below the current background level of 3.1 ppb for chromium 6. Through various Water Board orders, PG&E is currently required to sample over 200 domestic wells quarterly, though the number that are in use and accessible to PG&E varies over time, and many are not in day-to-day use. In developing an approach to the domestic well sampling program to accompany the 2015 CAO, the following regulatory context and scientific and technical concepts were considered.

- July 2014 adoption of the MCL of 10 ppb for chromium 6
- Current background level of 3.1 ppb chromium 6 continues to be used while the USGS Background Study is being completed
- Each domestic well's chromium 6 concentration over time
- Each domestic well's location relative to monitoring wells having higher chromium concentrations
- The April 2014 WDRs for the Agricultural Treatment Units (ATUs) contain the Environmental Impact Report (EIR) requirements to monitor domestic wells within the ATU mitigation sampling area shown on Figure 5 to detect increases in chromium concentrations caused by remediation. These monitoring requirements were reviewed in light of the above.

The output of this analysis regarding chromium monitoring of domestic wells to accompany the 2015 CAO is shown on Figure 5 and described below.

Within ATU Mitigation Sampling Area

The 2014 WDRs for the ATUs contain the initial EIR requirements to sample quarterly all domestic wells within the area shown on Figure 5, but also provided that the requirements may be modified based on chromium concentration trends and other factors. The chromium 6 concentration trends for most wells inside the ATU mitigation sampling area are shown on Figure 6. The proposed changes to be incorporated into the 2015 CAO domestic well program are:

- Sample wells quarterly where new ATUs may cause changes in groundwater flow (area based on modeling is shown with orange outline on Figures 5 and 6), as per the intent of EIR mitigation.
- Sample wells quarterly within ATU mitigation sampling area outside of the area affected by remediation (i.e. outside the orange outline on Figures 5 and 6) if above 3.1 ppb chromium 6, otherwise semi-annually.
- Provide assurance to residents in the high density neighborhood via quarterly sampling of targeted sentry wells located between the neighborhood and the plume. Sampling of these sentry wells, rather than domestic wells, will minimize disturbance to residents in the high density neighborhood. Sentry wells are shown in green on Figure 5.

Outside the ATU Mitigation Sampling Area

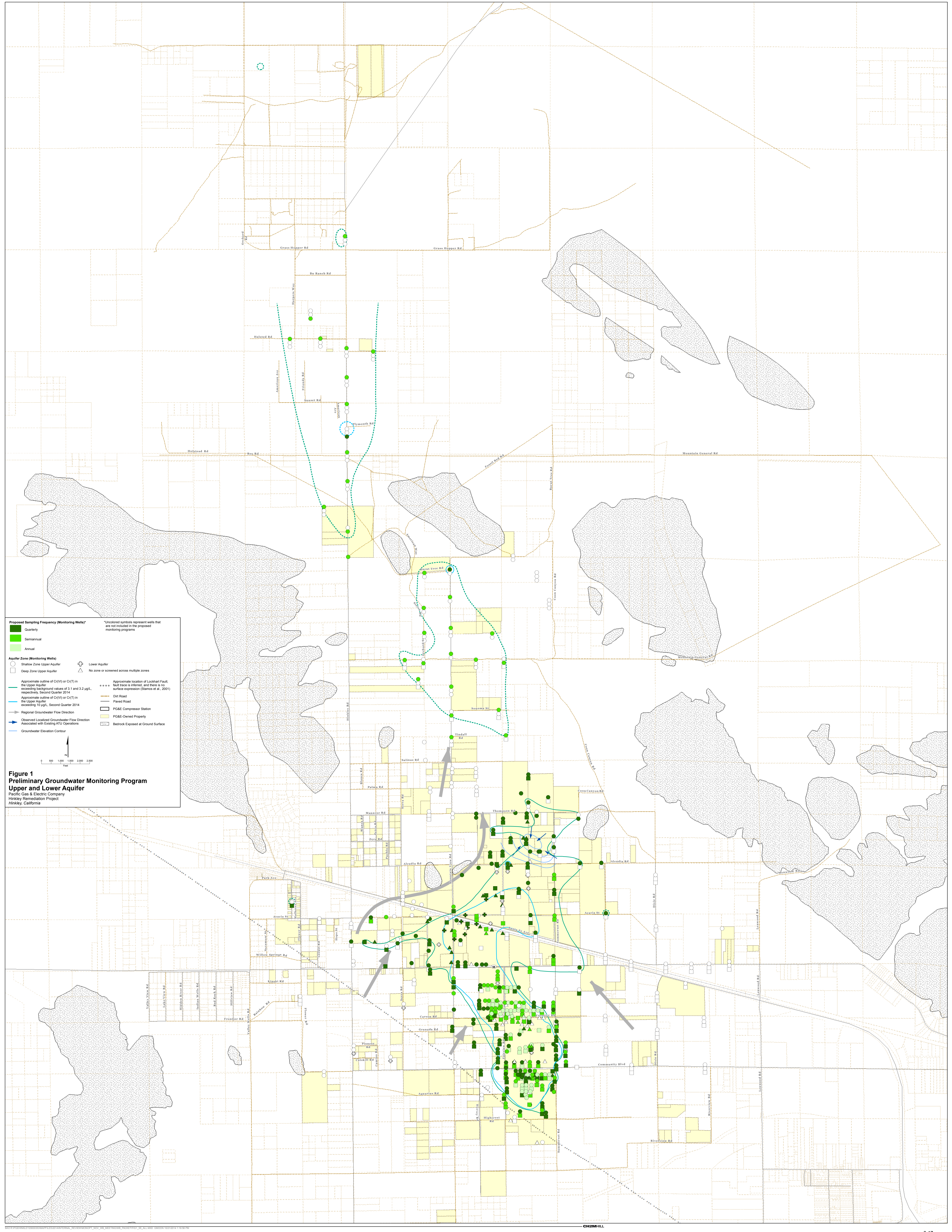
The domestic wells in the preliminary sampling plan outside the ATU mitigation sampling area are shown on the Figure 5. Because concentrations are all substantially below the MCL for chromium 6 of 10 ppb, chromium 6 concentration trends show stability over time, and the area is far outside of the effects of the remediation activities, annual monitoring of these domestic wells is specified in the preliminary plan. Domestic wells would continue to be sampled as follows:

- Sample wells annually with chromium 6 concentrations above 3.1 ppb since third quarter 2013
- Sample wells annually if within 2,000 feet of monitoring wells with past chromium 6 concentrations above 10 ppb (even if domestic well has not been above 3.1 ppb).

PG&E would not continue sampling wells with chromium 6 concentrations consistently under 3.1 ppb and further than 2,000 feet from a monitoring well above 10 ppb chromium 6.

Approximately 90 domestic wells would be sampled at different frequencies of quarterly, semiannual, or annual as outlined above. We will work with the Water Board and program participants to plan for any anticipated changes to the domestic well sampling program. Any eventual changes to this program will be communicated with adequate notice to the community and program participants.

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Proposed Sampling Frequency (Monitoring Wells)

- Quarterly
- Semiannual
- Annual

Aquifer Zone (Monitoring Wells)

- Shallow Zone Upper Aquifer
- Deep Zone Upper Aquifer
- Lower Aquifer
- No zone or screened across multiple zones

Approximate outline of Cr(VI) or Cr(T) in the Upper Aquifer exceeding background values of 3.1 and 3.2 µg/L, respectively, Second Quarter 2014

Approximate outline of Cr(VI) or Cr(T) in the Upper Aquifer exceeding 10 µg/L, Second Quarter 2014

Regional Groundwater Flow Direction

Observed Localized Groundwater Flow Direction Associated with Existing ATU Operations

Groundwater Elevation Contour

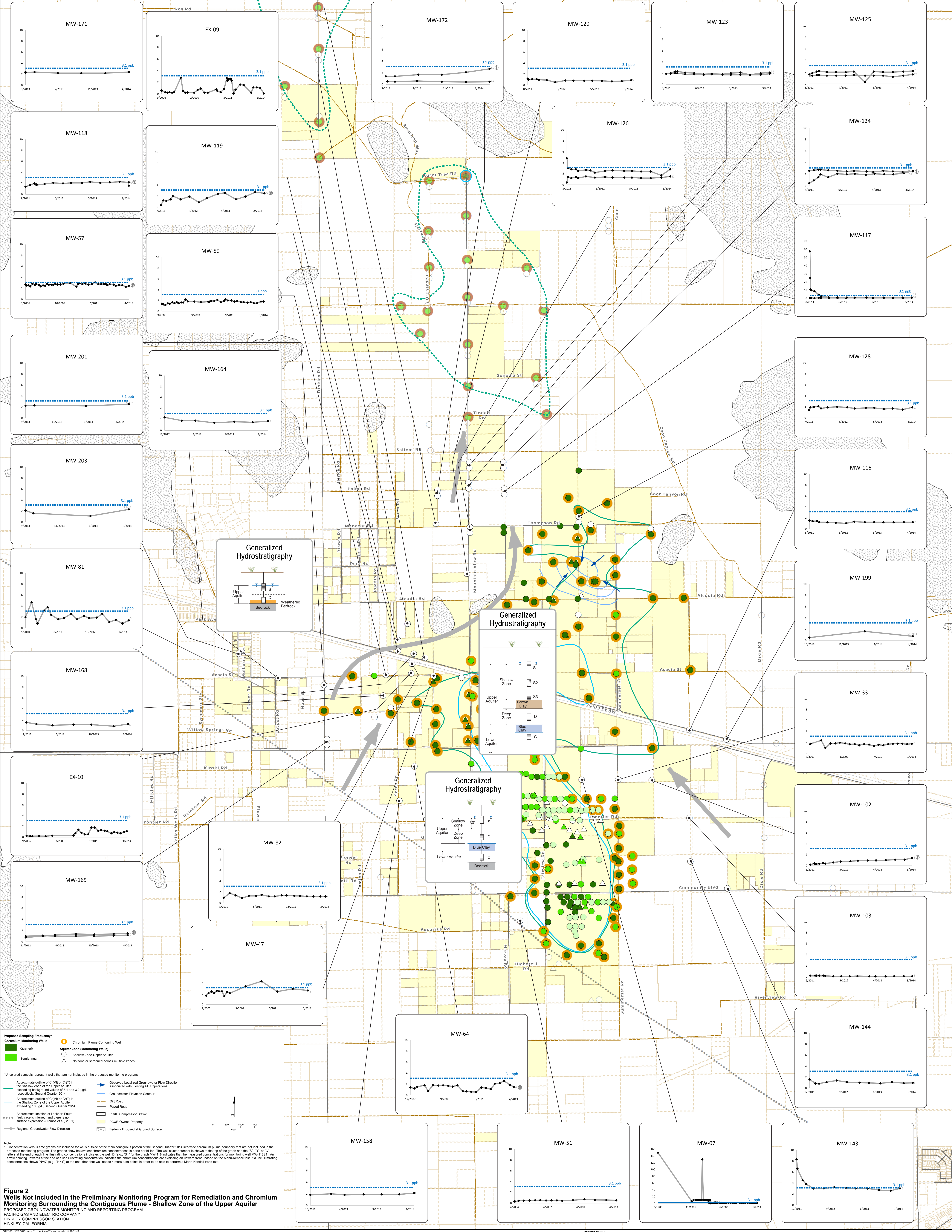
Uncolored symbols represent wells that are not included in the proposed monitoring programs

Approximate location of Lockhart Fault: fault trace is inferred, and there is no surface expression (Stamos et al., 2001)

- Dirt Road
- Paved Road
- PG&E Compressor Station
- PG&E-Owned Property
- Bedrock Exposed at Ground Surface

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

Figure 1
Preliminary Groundwater Monitoring Program
Upper and Lower Aquifer
 Pacific Gas & Electric Company
 Hinkley Remediation Project
 Hinkley, California



Proposed Sampling Frequency*

- Chromium Monitoring Wells
 - Quarterly
 - Semiannual
- Chromium Plume Contouring Well
- Aquifer Zone (Monitoring Wells)
 - Shallow Zone Upper Aquifer
 - No zone or screened across multiple zones

*Uncolored symbols represent wells that are not included in the proposed monitoring program.

Approximate outline of Cr(VI) or Cr(III) in the Shallow Zone of the Upper Aquifer exceeding background values of 3.1 and 3.2 µg/L, respectively, Second Quarter 2014.

Approximate outline of Cr(VI) or Cr(III) in the Shallow Zone of the Upper Aquifer exceeding 10 µg/L, Second Quarter 2014.

Approximate location of Lockhart Fault, fault trace is inferred, and there is no surface expression (Stamos et al., 2001).

Regional Groundwater Flow Direction

- PG&E Compressor Station
- PG&E-Owned Property
- Bedrock Exposed at Ground Surface

Observed Localized Groundwater Flow Direction

- Associated with Existing ATU Operations
- Groundwater Elevation Contour
- Dirt Road
- Paved Road

Figure 2
Wells Not Included in the Preliminary Monitoring Program for Remediation and Chromium Monitoring Surrounding the Contiguous Plume - Shallow Zone of the Upper Aquifer

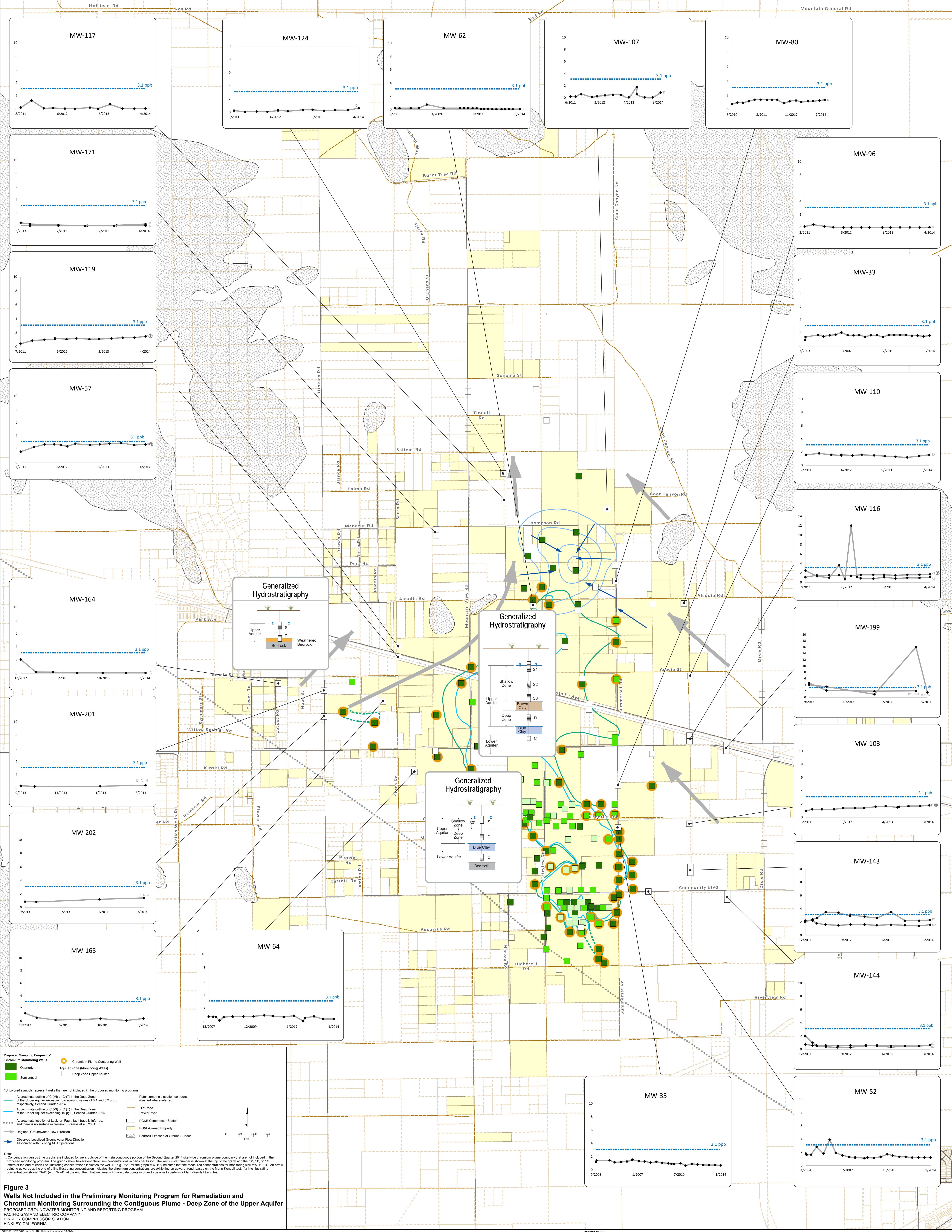
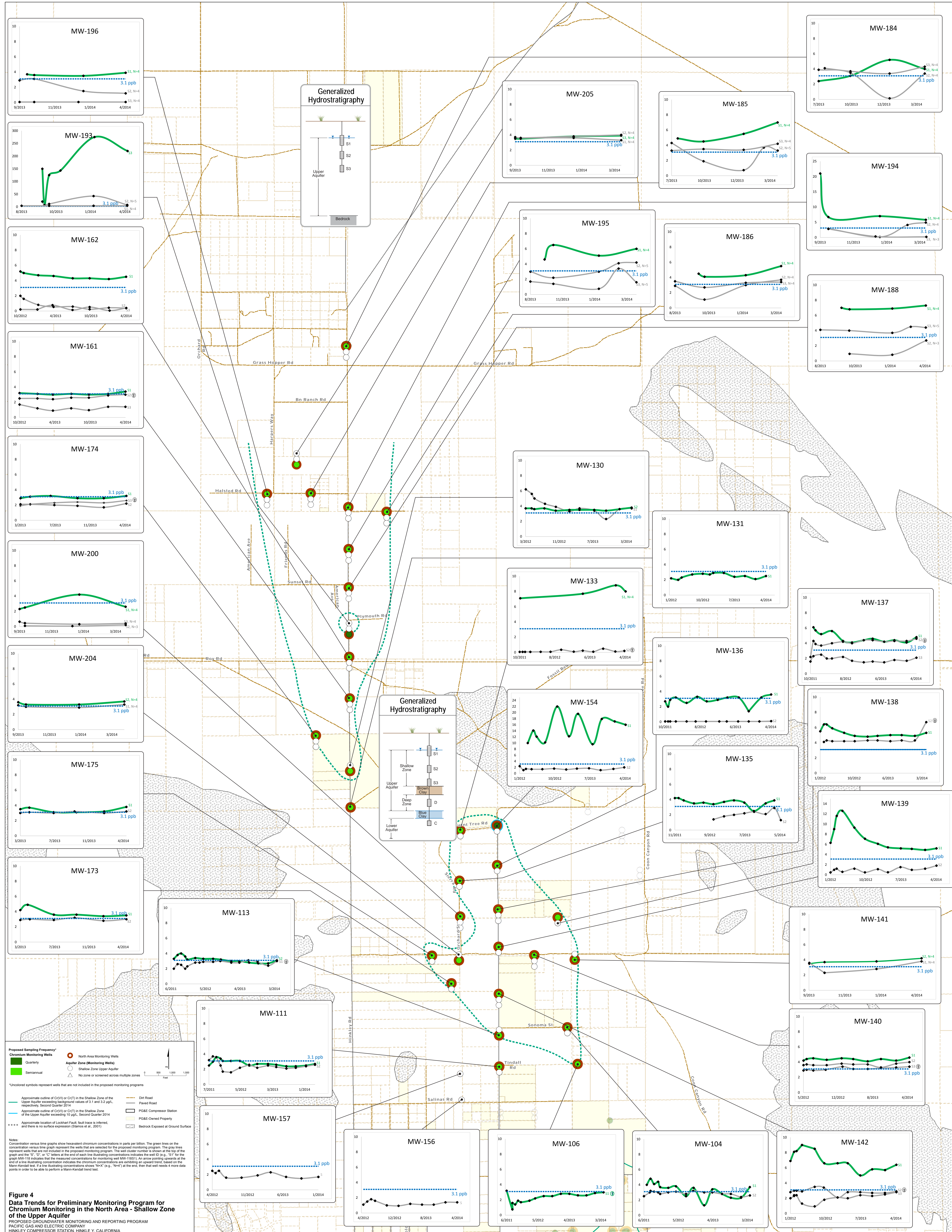


Figure 3
Wells Not Included in the Preliminary Monitoring Program for Remediation and Chromium Monitoring Surrounding the Contiguous Plume - Deep Zone of the Upper Aquifer
 PROPOSED GROUNDWATER MONITORING AND REPORTING PROGRAM
 PACIFIC GAS AND ELECTRIC COMPANY
 HINKLEY COMPRESSOR STATION
 HINKLEY, CALIFORNIA



Proposed Sampling Frequency*
 Chromium Monitoring Wells
 Quarterly
 Semiannual

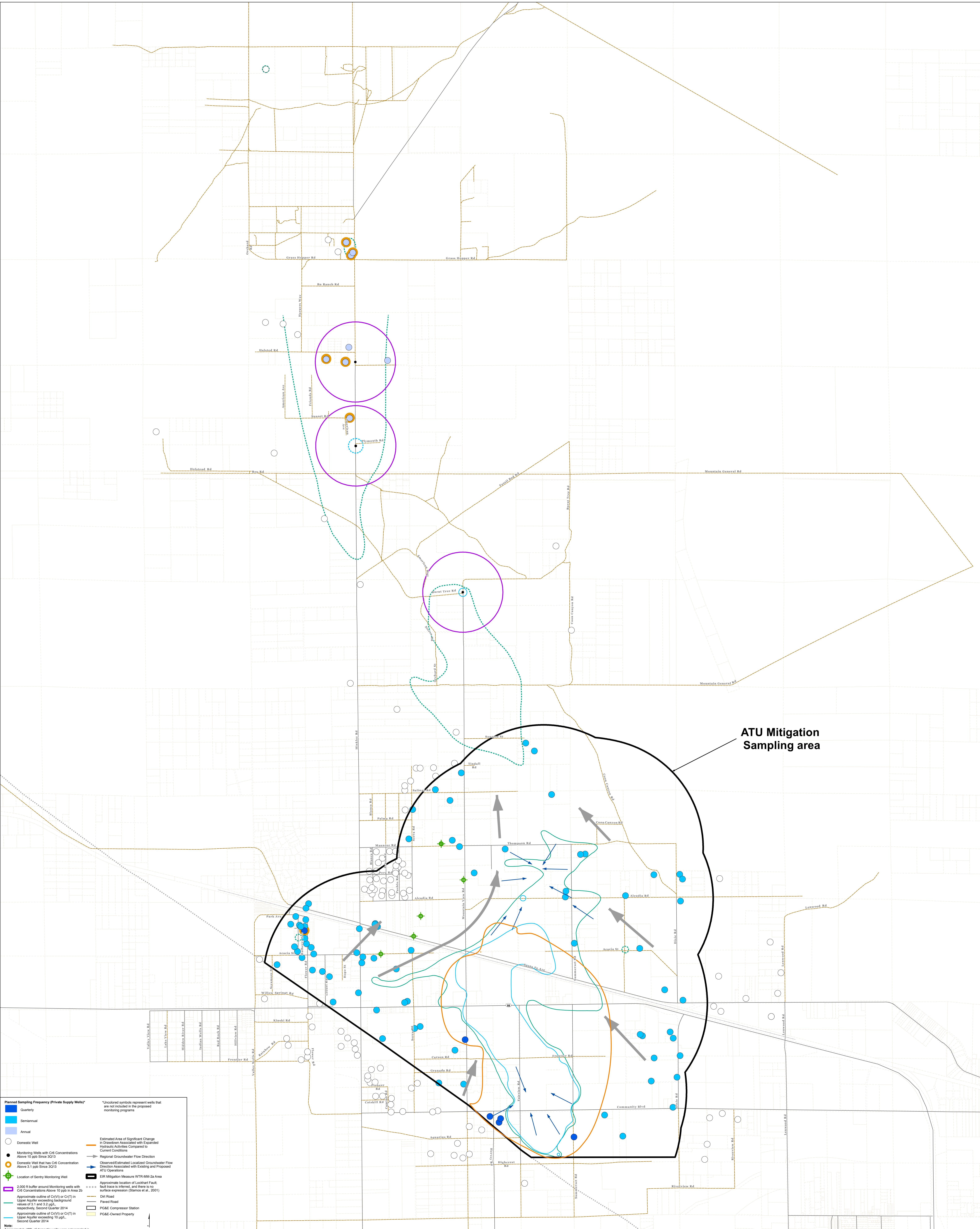
Legend:
 North Area Monitoring Wells
 Aquifer Zone (Monitoring Wells)
 Shallow Zone Upper Aquifer
 No zone or screened across multiple zones

*Unlocated symbols represent wells that are not included in the proposed monitoring programs

Approximate outline of Cr(VI) or Cr(III) in the Shallow Zone of the Upper Aquifer exceeding background values of 3.1 and 3.2 µg/L, respectively, Second Quarter 2014
 Approximate outline of Cr(VI) or Cr(III) in the Shallow Zone of the Upper Aquifer exceeding 10 µg/L, Second Quarter 2014
 Approximate location of Lockhart Fault; fault trace is inferred, and there is no surface expression (Stamos et al., 2001)

Notes:
 Concentration versus time graphs show measured chromium concentrations in parts per billion. The green lines on the concentration versus time graph represent the wells that are selected for the proposed monitoring program. The gray lines represent wells that are not included in the proposed monitoring program. The well cluster number is shown at the top of the graph and the "S", "D", or "C" letters at the end of each line illustrating concentrations indicates the well ID (e.g., "S1" for the graph MW-193 indicates that the measured concentrations for monitoring well MW-193S1). An arrow pointing upwards at the end of a line illustrating concentration indicates the chromium concentrations are exhibiting an upward trend, based on the Mann-Kendall test. If a line illustrating concentrations shows "N/A" (e.g., "N=4") at the end, then that well needs 4 more data points in order to be able to perform a Mann-Kendall trend test.

Figure 4
Data Trends for Preliminary Monitoring Program for Chromium Monitoring in the North Area - Shallow Zone of the Upper Aquifer
 PROPOSED GROUNDWATER MONITORING AND REPORTING PROGRAM
 PACIFIC GAS AND ELECTRIC COMPANY
 HINKLEY COMPRESSOR STATION, HINKLEY, CALIFORNIA



ATU Mitigation Sampling area

Planned Sampling Frequency (Private Supply Wells)

- Quarterly
- Semiannual
- Annual

Monitoring Wells with C66 Concentrations

- Above 10 ppb Since 3Q13
- Domestic Well that has C66 Concentration Above 3.1 ppb Since 3Q13
- Location of Sentry Monitoring Well

Estimated Area of Significant Change in Drawdown Associated with Expanded Hydraulic Activities Compared to Current Conditions

- Observed/Estimated Localized Groundwater Flow Direction Associated with Existing and Proposed ATU Operations
- ER Mitigation Measure VTR-AMA-2a Area
- Approximate location of Lockhart Fault; 2,000 ft buffer around Monitoring wells with C66 Concentrations Above 10 ppb in Area 2a
- Approximate outline of Cr(VI) or Cr(T) in Upper Aquifer exceeding background values of 3.1 and 3.2 µg/L, respectively, Second Quarter 2014
- Approximate outline of Cr(VI) or Cr(T) in Upper Aquifer exceeding 10 µg/L, Second Quarter 2014

Other Symbols and Features:

- Domestic Well
- PO&E Compressor Station
- PO&E-Owned Property
- Dirt Road
- Paved Road
- Regional Groundwater Flow Direction
- Observed/Estimated Localized Groundwater Flow Direction Associated with Existing and Proposed ATU Operations
- Approximate location of Lockhart Fault; fault trace is inferred, and there is no surface expression (Sims et al., 2001)

Note: Approximately 40% of domestic wells were not sampled in Second Quarter 2014, due to well inoperability, vacancy, owner refusal, etc.

Scale: 0 to 2000 Feet

Figure 5
Preliminary Domestic Well Sampling Program
 Pacific Gas & Electric Company
 Hinkley Remediation Project
 Hinkley, California

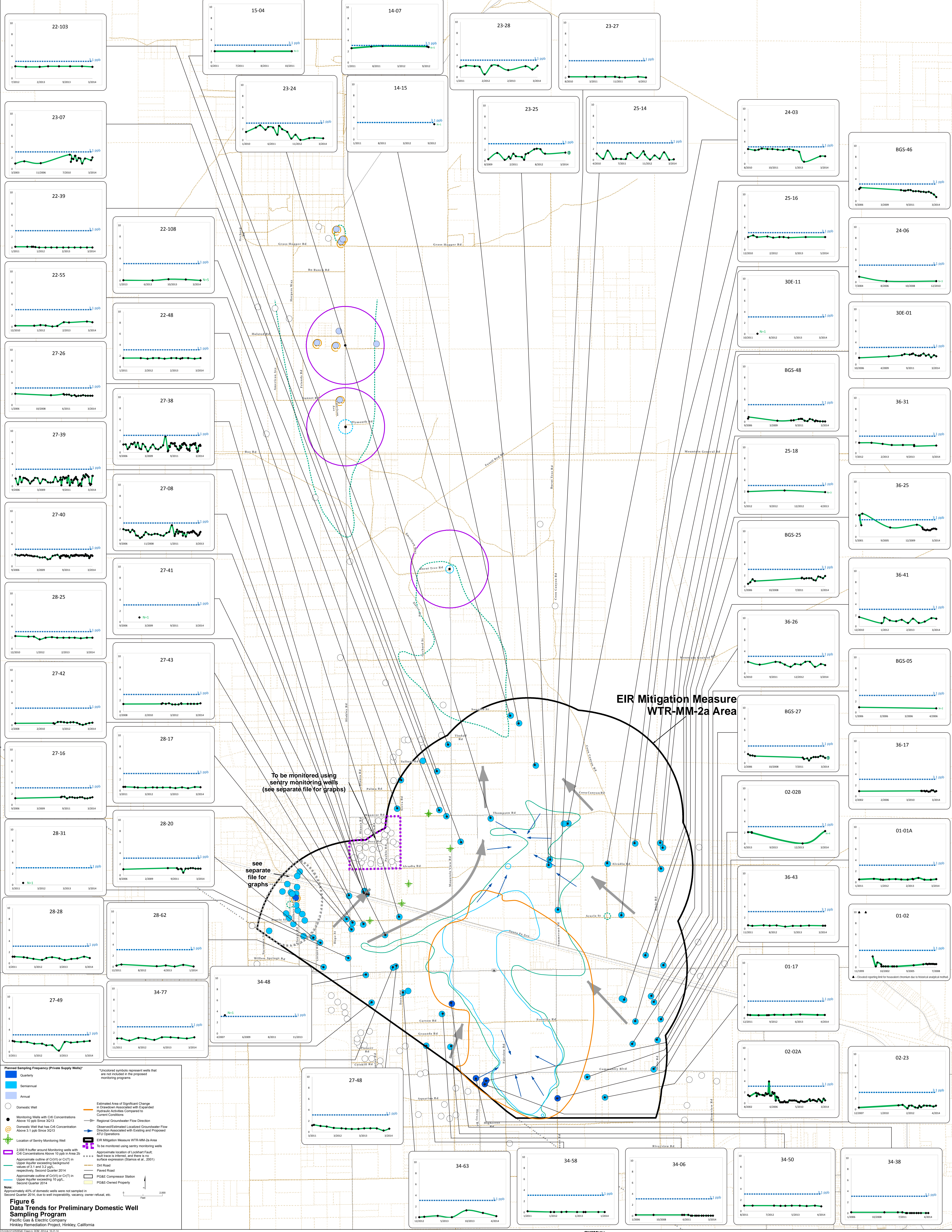


Figure 6
Data Trends for Preliminary Domestic Well Sampling Program
 Pacific Gas & Electric Company
 Hinkley Remediation Project, Hinkley, California

**EIR Mitigation Measure
 WTR-MM-2a Area**

To be monitored using
 sentry monitoring wells
 (see separate file for graphs)

see
 separate
 file for
 graphs

ENCLOSURE 3

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October 20, 2014

Anne Holden, PG
Lisa Dernbach, PG, CHG, CEG
Lauri Kemper, PE
California Regional Water Quality Control Board, Lahontan Region
2501 Lake Tahoe Boulevard
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RE: Follow-up, Reflective/Work-in-Progress Comments from the IRP Manager Regarding the Technical Exchange Meeting describing (1) The Residential Groundwater Quality Baseline for the Planned ATUs Expansion Program and, (2) The Proposed Groundwater Sampling Program for the Pending New Cleanup and Abatement Order (CAO).

Dear Anne, Lisa and Lauri:

The IRP Manager and CAC Members thank the Lahontan Regional Water Quality Control Board (Water Board) for convening a Technical Exchange Meeting (TEM) with PG&E held on September 25, 2014 at the Hinkley Community Senior Center. The main topics were the definition of the existing residential groundwater quality baseline and how it could be future-affected by the new and existing Agricultural Treatment Units (ATUs) and, the scope of PG&E's proposed groundwater sampling program for the new Cleanup and Abatement Order (CAO) planned for release by the Water Board next year.

1. Residential Water Quality Baseline for ATUs

PG&E presented different alternatives to calculate the groundwater quality in the project area for the ATUs. Statistical analysis such as the Mann-Kendall, 95 Percent Upper Tolerance Limit (UTL) Test, and other statistical methods were presented. It is our opinion that this is a good start to a discussion that is much needed, however, further discussions are certainly required to select the best statistical method to calculate the groundwater baseline conditions; and equally importantly, attempt to bring the CAC, and to a less detailed extent, the Community at large, along with the computational approach. The IRP Manager's Team has considerable experience in the use of statistical methods to evaluate vast quantities of groundwater data gained from work at major projects in Southern California, and can make this knowledge and experience available to the Hinkley "work team."

The CAC has informed the IRP Manager that they are willing to assist the baseline process by contacting community members and/or residents who, to date, have not allowed PG&E to sample their domestic wells to determine baseline conditions and stress the possible importance of data collected from their wells for the program. At the above meeting, CAC members requested that PG&E provide a list with the names of community members and/or residents who have not yet allowed PG&E to sampling their domestic well for the baseline conditions.

2. Proposed Monitoring Program for the Final CAO

PG&E presented a preliminary monitoring program for the new CAO that is scheduled to be released by the Water Board in 2015. **Figure 1** shows the proposed scope of future groundwater monitoring program. PG&E provided a comprehensive explanation on the proposed new sampling program, which is constructed around two main, general, building blocks, namely:

- Reduced frequency of sampling is justified at monitoring wells with no statistical significant Cr6 concentration trends.
- Sampling only one monitoring well at each multi-level, monitoring well location with the highest Cr6 concentration.

The IRP Manager is presently taking time to understand the logic of PG&E's proposal and plans to explain PG&E's proposed monitoring program to the CAC in the weeks ahead. A component of our CAC discussions will be an attempt to place what PG&E is suggesting into perspective versus other major Southern California groundwater monitoring programs. Namely, that it is not uncommon for the scope and frequency of a groundwater monitoring program to be "reviewed and right-sized," as the plume(s) become(s) defined, and best science shows that human health is being protected.

As we have suggested in other components of the Hinkley groundwater program, the IRP Manager proposes that a decision tree should be developed, and suitably modified as time progresses, for the proposed monitoring program. Decision tree criteria could, for example, include the conditions to (further) decrease sampling at monitoring and domestic wells (stable Cr6 trends) along with statistical criteria to increase sampling (increasing Cr6 trends).

We hope, in our IRP Manager role, to help facilitate the pathway to a right-sized monitoring program which all parties can believe is technically adequate to (a) measure the progress of the remedy, and (b) continue to insure the protectiveness of human health. PG&E discussed during the TEM that they will be submitting a proposed groundwater sampling plan to the Water Board and the

IRP Manager plans to discuss and review the proposed groundwater sampling plan with all the key stakeholders once the plan is issued.

Should you have any questions or comments, please feel free to contact either of the undersigned via email or phone as provided below:

Dr. Raudel Sanchez: rsanchez@projectnavigator.com, 714-388-1821

Dr. Ian A. Webster: iwebster@projectnavigator.com, 714-863-0483

Sincerely yours,



Raudel Sanchez, Ph.D.
Project Manager



Ian A. Webster, Sc.D.
Hinkley IRP Manager

Attachments

Figure 1: Proposed Scope of Future GW Monitoring Program

CC:

CAC Members

Kevin Sullivan, PG&E

David Harnish, PG&E

Iain Baker, PG&E

Margaret Gentile, Arcadis

FIGURE 1

Proposed Scope of Future GW Monitoring Program

IRP Manager is Initiating a Review of the Proposed Modifications and How to Describe Such Changes to the CAC & Hinkley Community



ENCLOSURE 4

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**CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
LAHONTAN REGION**

**AMENDED CLEANUP AND ABATEMENT ORDER
NO. R6V-2008-0002A3**

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:

1. The Pacific Gas and Electric Company owns and operates the Hinkley Compressor Station (hereafter the "Facility"), located at 35863 Fairview Road, Hinkley in San Bernardino County. For the purposes of this Order, the Pacific Gas and Electric Company is referred to as the "Discharger."
2. The purpose of this Amendment is to address the hydraulic containment of chromium-affected groundwater south of Thompson Road in Hinkley, California, and actions to reduce plume migration in the area generally north of Thompson Road.
3. On August 6, 2008, the Water Board issued Cleanup and Abatement Order No. R6V-2008-0002 (combined with its amendments, hereafter referred to as the "CAO" or "CAO R6V-2008-0002") to the Discharger to clean up and abate the effects of waste discharges and threatened discharges containing hexavalent chromium and total chromium to waters of the State. The CAO required the Discharger to develop and implement a comprehensive cleanup strategy to clean up and abate the chromium plume to background levels and set an interim maximum background level of 4 parts per billion (ppb).
4. The CAO also required the Discharger to take immediate additional corrective actions to contain chromium migrating with groundwater and to continue to implement groundwater remediation in the source area and central plume area. The CAO also modified the monitoring and reporting program for permitted projects.
5. Order Paragraph 3 of the CAO required the Discharger to contain the hexavalent and total chromium plumes to locations where hexavalent chromium was below the interim background level of 4 ppb and the total chromium was below 50 ppb.

- a. The Discharger was required to achieve containment of the hexavalent chromium plume in the ground water 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 Order.
 - b. The Discharger was required to achieve containment of the total chromium plume in the ground water 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 Order.
6. Amendment Order No. R6V-2008-0002A1, 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 the Amendment Order 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, considering cleanup strategies and supporting future decisions regarding cleanup levels. For plume containment, the level remained at 4 ppb for both hexavalent chromium and total chromium.
7. Amendment Order No. R6V-2008-0002A2, effective April 7, 2009, allowed lateral migration of the 4 ppb hexavalent chromium plume boundary east of the South Central Remediation In-situ Area from discharges to groundwater extracted and piped from cleanup actions in the northwest plume area. Lateral plume expansion of 1,000 feet was allowed as long as it could be shown that the chromium would be captured by the existing groundwater extraction system in the downgradient flow direction.
8. In its First Quarterly 2009 Evaluation Monitoring Report, the Discharger reported that hexavalent chromium control limits were exceeded in Monitoring Well 62-A beginning in November 2008. The results were verified in February and March, 2009. The report was submitted April 29, 2009. Subsequent quarterly reports indicated that Monitoring Well 62-A continued to exceed hexavalent chromium control limits (with the exception of one quarter) through the Fourth Quarterly 2011 Groundwater Monitoring Report, submitted January 30, 2012. Data reported by the Discharger indicates that Monitoring Wells 72S and 79S have also exceeded hexavalent chromium concentrations, greater than 4 ppb. Since 2009, the migrating chromium plume in groundwater has affected domestic and agricultural wells at concentrations exceeding the maximum background concentration for hexavalent chromium of 3.1 ppb or total chromium of 3.2 ppb. Affected wells are located east of Summerset Road, and north of Thompson Road to Mount General Road.
9. On March 14, 2012, the Water Board adopted Settlement Agreement and Stipulation for Entry of Order; Order No. R6V-2012-0013 at its public meeting after receiving comments from the public. The Settlement Agreement addresses the period of

violation of CAO R6V-2008-0002 for plume migration from January 1, 2009 to December 31, 2011. As part of Order No. R6V-2012-0013, the Water Board agreed to amend CAO R6V-2008-0002 to replace CAO Paragraph 3 with the requirements presented in this Amendment to CAO R6V-2008-0002 addressing chromium plume migration.

10. In the interim period prior to Water Board certification of an environmental impact report and adoption of waste discharge requirements to achieve comprehensive cleanup, modified corrective actions by the Discharger from those listed in CAO R6V-2008-0002 are necessary to achieve containment north of Highway 58, at the Desert View Dairy and north to Thompson Road, and north of Thompson Road to Salinas Road. The Discharger will take actions reasonably available and permissible to reduce chromium levels in the impacted areas during this interim period. Chromium impacts to groundwater may be subject to cleanup additional investigative and cleanup requirements set by the Water Board.
11. This enforcement action is being taken by this regulatory agency to enforce the provisions of the California Water Code, and as such is exempt from the provisions of the California Environmental Quality Act (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 is exempt from the provisions of the California Environmental Quality Act, and in accordance with the California Code of Regulations, title 14, sections 15301 and 15303. The existing monitor well pairs and triplets and infrastructure are subject to section 15301 because there is negligible or no expansion of their existing uses. The extraction well to be installed north of Thompson Road is a new, small structure subject to section 15303.

IT IS HEREBY ORDERED that, pursuant to the Water Code section 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:

- A. Cleanup and Abatement Order No. R6V-2008-0002 is amended for the purposes of evaluating plume containment and complying with Requirement No. 3 of Cleanup and Abatement Order No. R6V-2008-0002 by replacing Requirement No. 3 with the following.

3. Plume Containment

Hydraulic Containment of Chromium-Affected Groundwater South of Thompson Road: As part of its effort to prevent further migration of chromium-affected groundwater, the Discharger shall achieve and maintain hydraulic capture within the targeted areas shown on Figures 1 and 2 in Attachment A (incorporated herein by reference) by completing the following.

- 3.1 Discharger shall operate and maintain the groundwater extraction system that exists as of January 15, 2012, or its functional equivalent, such that hydraulic containment is maintained within the areas indicated on Figures 1 and 2 in Attachment A on a year-round basis. Separate Areas of Hydraulic Containment are established for the shallow zone of the Upper Aquifer and the deep zone of the Upper Aquifer. The Water Board will determine hydraulic containment compliance by comparing hydraulic gradients or groundwater flow direction vectors calculated from groundwater elevation data from select well pairs and triplets and piezometers with control limits, as outlined in Attachment B of this Order (incorporated herein).
- 3.2 Water levels shall be monitored on a monthly basis, year-round. For this evaluation, the Discharger shall collect continual pressure transducer data by the end of the month (e.g., January 31) and a data evaluation shall be submitted by the Discharger by the 15th of the subsequent month (e.g., February 15). If the evaluation demonstrates that the average monthly water level data from any of the well pair or triplet metrics provided in Attachment B is not met, the Discharger shall:
 - a. Verify the water levels manually within five days of the evaluation, and in any case no later than the 20th of the month when the data evaluation is submitted.
 - b. If the manual measurements confirm that there is no longer an inward gradient, the Discharger will adjust operations within five days in the field using existing infrastructure (i.e., adjust individual well pumping rates).
 - c. With the Water Board staff's written approval, the Discharger may demonstrate plume capture using alternative metrics (e.g., well pairs or triplets) to verify inward plume capture.
- 3.3 The Water Board may find the Discharger out of compliance with this Order if either of the following occurs:
 - a. The third consecutive month of data (e.g., January, February and March) for the same well pair or triplet indicates that the capture metrics are still not met, or
 - b. If for any 3 out of 12 months during the course of one year (e.g., July 2012 through July 2013), a specific well pair or triplet does not meet capture metrics.
- 3.4 Should either condition 3.3.a. or 3.3.b. occur, then by the 15th of the following month, the Discharger shall submit a contingency plan to re-establish capture

in addition to the existing infrastructure. The Water Board staff will review the contingency plan and either accept it or request modifications in writing.

Actions to Reduce Plume Migration in Area Generally North of Thompson Road:

The Discharger shall take reasonable and practicable corrective actions to reduce hexavalent chromium concentrations in groundwater and to reduce plume migration in areas north of Thompson Road (as illustrated by Attachment C incorporated herein by reference) by taking the following interim actions prior to the approval of the final remedy proposed by Discharger:

- 3.6 Starting the summer of 2012, the Discharger shall conduct groundwater extraction during the summer months of June 1 through September 30 in at least one location to maximize extraction and chromium removal. Failure to implement this action will constitute a violation of this Order.
- 3.7 By July 1, 2012, the Discharger shall review existing extraction and well sampling data and evaluate the need for additional extraction within the area depicted by Attachment C. If additional extraction is deemed necessary, the Discharger shall evaluate extraction methods and propose additional actions and a schedule to implement further chromium removal north of Thompson Road in the area depicted on Attachment B. The Discharger shall include the most effective actions reasonably feasible. The Discharger shall then implement these additional actions according to the schedule, subject to obtaining all required permits from regulatory agencies including approvals required by the California Environmental Quality Act and state and federal Endangered Species Acts, which approvals the Discharger shall diligently seek. In the event of any delay, the Discharger shall notify the Water Board staff in writing and seek a modification of the schedule. Failure to implement this action will constitute a violation of this Order.
- 3.8 The Discharger shall dispose of extracted groundwater containing chromium concentrations in a manner approved by Water Board staff.
- 3.9 In the event the Discharger determines that the new remedial components required by paragraphs 3.1-3.5 are interfering with the Discharger's ability to maintain inward gradients as required by paragraphs 3.1-3.5, the Discharger shall notify Water Board staff within five days of that determination and provide written evidence supporting the Discharger's determination. After notifying the Water Board, the Discharger may suspend the remedial requirements required by paragraphs 3.1-3.5 for no longer than is necessary to develop alternative pumping regimes above and/or below Thompson Road that will maintain internal hydraulic capture south of Thompson Road while maximizing chromium removal north of Thompson Road. The Discharger shall consult Water Board staff as necessary and seek written approval before taking any actions inconsistent with paragraphs 3.1-3.9 of this Order.

Any modifications to this order amending CAO No. R6V-2008-0002 are only effective upon the written approval of the Executive Officer or Assistant Executive Officer. 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 California Water Code section 13350 or referral to the Attorney General of the State of California for such legal action as she may deem appropriate.

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.

I, Harold J. Singer, Executive Officer and Board Advisor, do hereby certify that the foregoing is a full, true and correct copy of an Order adopted by the California Regional Water Quality Control Board, Lahontan Region, on March 14, 2012.



HAROLD J. SINGER
EXECUTIVE OFFICER

Attachments:

- A. Hydraulic Capture Zones, Figures 1 and 2
- B. Hydraulic Zone Capture Metrics
- C. Area for Extraction and Treatment of Hexavalent Chromium in Ground Water
North of Thompson Road

ATTACHMENT A
HYDRAULIC CAPTURE ZONES
FIGURES 1 AND 2

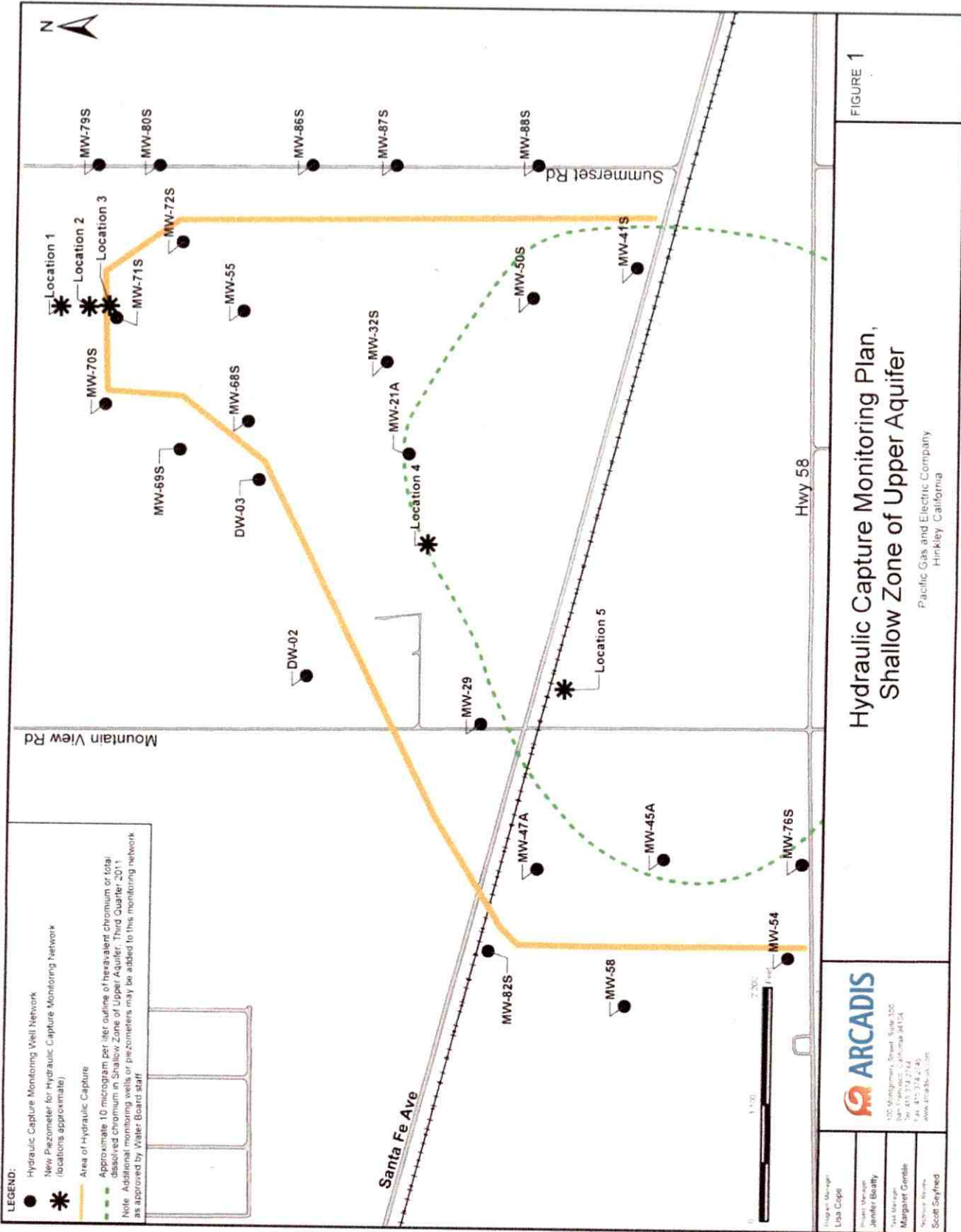


FIGURE 1

Hydraulic Capture Monitoring Plan, Shallow Zone of Upper Aquifer

Pacific Gas and Electric Company
Hinkley, California

LEGEND:

- Hydraulic Capture Monitoring Well Network
- New Piezometer for Hydraulic Capture Monitoring Network (locations approximate)
- * Area of Hydraulic Capture
- Approximate 10 microgram per liter outline of hexavalent chromium or total dissolved chromium in Shallow Zone of Upper Aquifer, Third Quarter, 2011
- Note: Additional monitoring wells or piezometers may be added to this monitoring network as approved by Water Board Staff

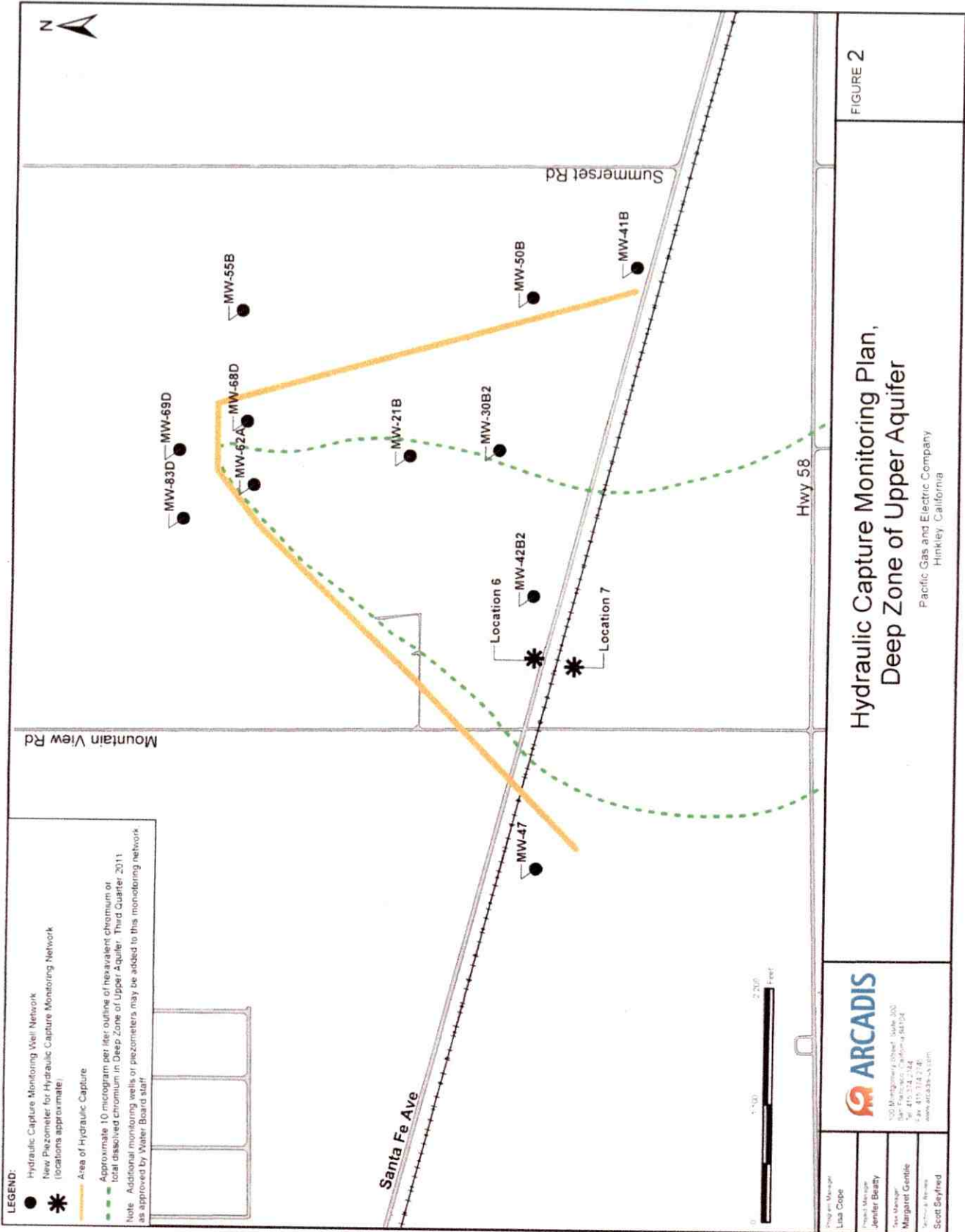
100 Montgomery Street, Suite 1000
San Francisco, California 94104
Tel: 415.774.2744
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Project Manager:
Lisa Coppe

Project Manager:
Jennifer Beatty

Field Manager:
Margaret Conable

Technical Reviewer:
Scott Seyfried



ATTACHMENT B
HYDRAULIC ZONE CAPTURE METRICS

APPENDIX A

Hydraulic capture shall be demonstrated through analysis of potentiometric surfaces in the A1 and A2 layers of the upper aquifer measured at least monthly. Hydraulic capture shall be demonstrated using those monitoring wells or piezometers identified in Table A-1 or other wells as accepted by Water Board staff. For well pairs, the inner well must have a potentiometric surface lower than the outer well. For well triplets, the vector described by the potentiometric surfaces at the three wells must show a gradient directed inward of the capture boundary line shown on Figures A-1 or A-2, for the A1 and A2 depth layers, respectively.

Table A-1 Hydraulic Capture Monitoring Plan

Depth Interval	Well Pairs		Well Triplets
A1 Layer	Outer Well	Inner Well	
	MW-86S	MW-55S	
	MW-80S	MW-72S	
	DW-03	MW-68S	
	MW-79S	MW-71S	
	New wells ^{1,2}	MW-71S	
			MW-88S, -87S, -32S
			MW-70S, -69S, -71S ²
			DW-02, MW-29, -21A or new piezometer ³ near MW-31
			MW-58, -45A and -47A
	MW-82S	new piezometer ³ near EX-29/-30	
			MW-54, -76S and -45A
			MW-50S, -88S and -41S
A2 Layer	Outer Well	Inner Well	
	MW-41B	MW-30B2	
	MW-83D	MW-62A	
	MW-69D	MW-62A ²	
	MW-50B	MW-21B	
	MW-47	MW-42B2 or new piezometer ³ near EX-29/-30 or EX-26	
			MW-69D, MW55B, MW-68D ²

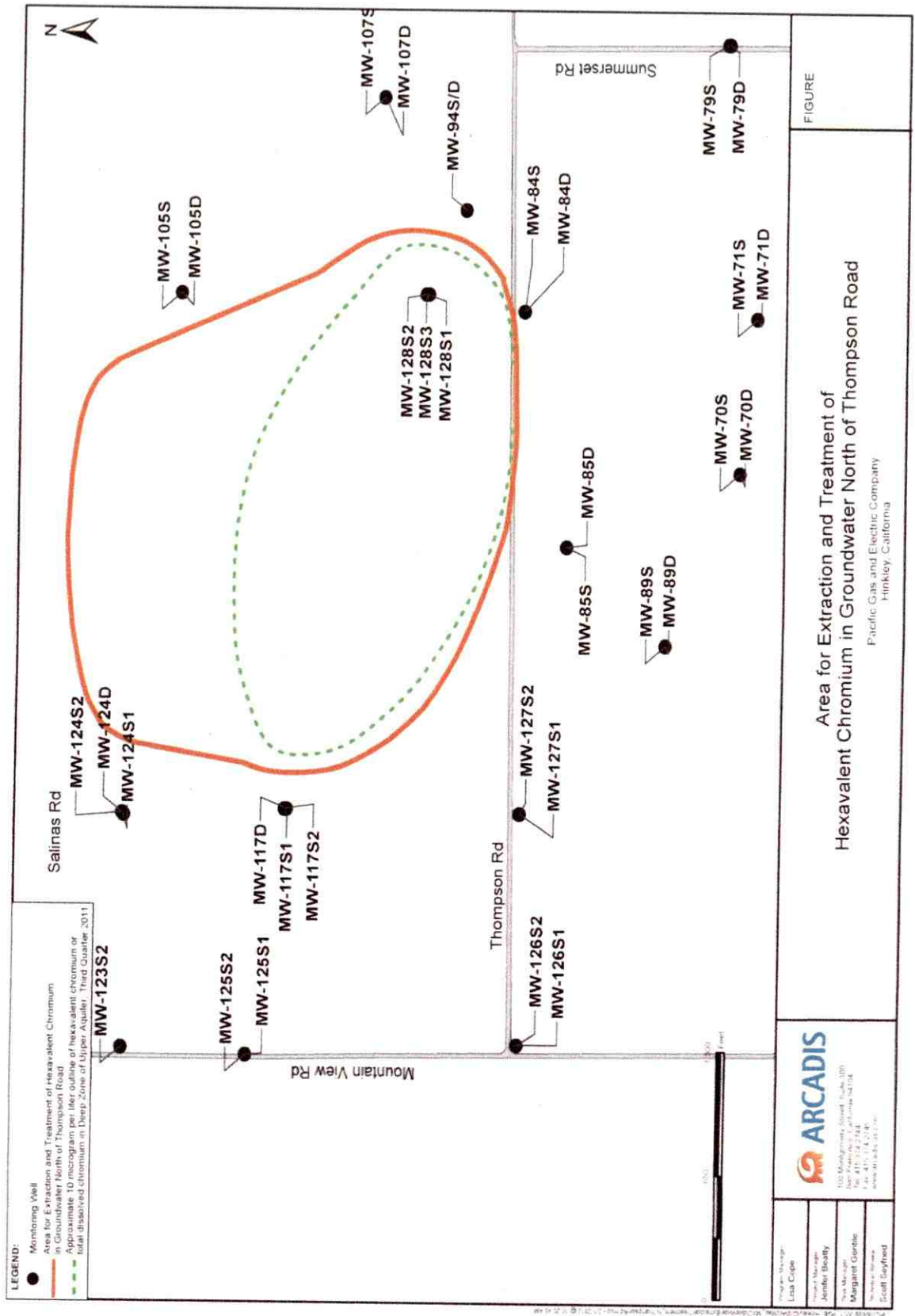
¹“New Wells” indicates one or more piezometers in a row north of 71S. There is technical uncertainty as to the exact location of the down gradient capture line. Therefore only one of the piezometers will need to indicate an inward gradient. This piezometer must be outboard of the containment line.”

² It is understood that seasonal groundwater extraction to the north of this well pair/triplet may temporarily expand capture to the north. As a result, it is acceptable that an inward gradient or vector at these points may not be demonstrated during extraction from the A1 interval north of G2R, and/or from the A2 interval north of Alcudia Road. Expanding capture to the north will continue to meet the minimal plume capture requirement.

³ If the new piezometer cannot be installed due to access limitations pursuant to Endangered Species Act, then PG&E will develop an alternative location.

ATTACHMENT C

AREA FOR EXTRACTION AND TREATMENT OF HEXAVALENT
CHROMIUM IN GROUND WATER NORTH OF THOMPSON ROAD



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ENCLOSURE 5

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ITEM 8: CLEANUP AND ABATEMENT ORDER WORKSHOP

Monitoring Programs and Plume Containment
Requirements

Lauri Kemper, Assistant Executive Officer
November 12, 2014
Barstow, CA



Order of Presentations

Water Board staff:

- Overview of monitoring purposes

PG&E staff presentations:

- Follow-up on Remedial Timeframe Assessment questions from September 2014 Board Meeting
- Monitoring Program Revision and Plume Containment Requirements

All:

- Questions and Discussion

Water Board staff:

- Item Summary

Purposes of Groundwater Monitoring in Hinkley

- 1) Delineating chromium plume at several key concentrations
- 2) Tracking plume containment and remediation effectiveness
- 3) Determining domestic well water quality

Monitoring is contained in various CAOs, investigative orders and Waste Discharge Requirements

- March 2014 WDRs for Agricultural Treatment Units
- 2008 General WDRs that regulate in-situ remedial operations
- CAO will require monitoring programs to track progress toward remediation goals and to verify that domestic well chromium levels remain below the hexavalent chromium MCL.
- Monitoring in existing WDRs will not be repeated in the CAO

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ENCLOSURE 6

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Follow-up – Remedial Timeframe Modeling Questions

November 12, 2014

Lahontan RWQCB Meeting, Barstow, CA



Follow-up on Remedial Timeframe Modeling

- Questions from last meeting:

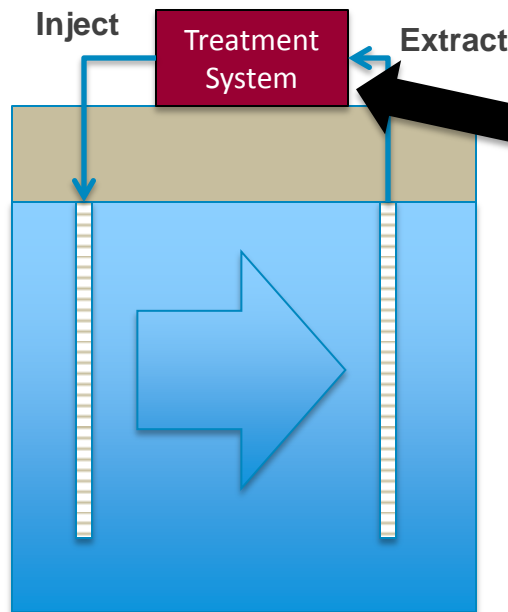
Q: How would the use of a bioreactor affect the modeling results?

Q: Could a bioreactor be used to treat hotspots?



Modeling Different Treatment Technologies

- The FS and EIR have evaluated several alternatives with aboveground treatment options (e.g. Alternatives 2, 5, 4C-5) in which water was extracted, treated, and re-injected
- The type of aboveground treatment does not affect modeling results, unless the subsurface components (like injection or extraction wells) are different

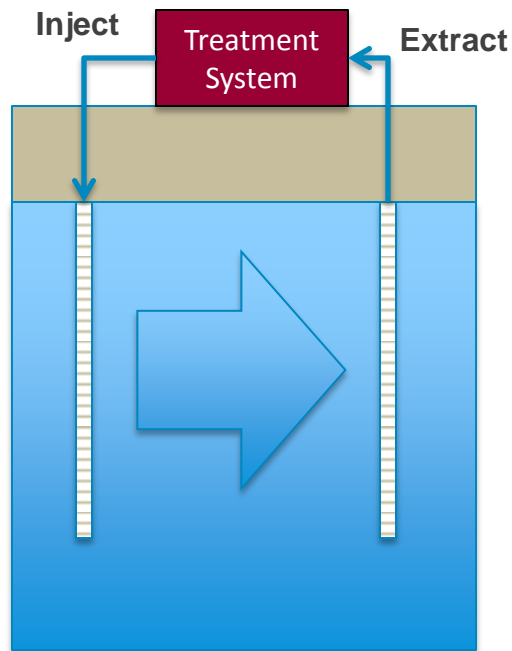


- Reduction/Coagulation/Filtration
- Ion Exchange
- Bioreactor

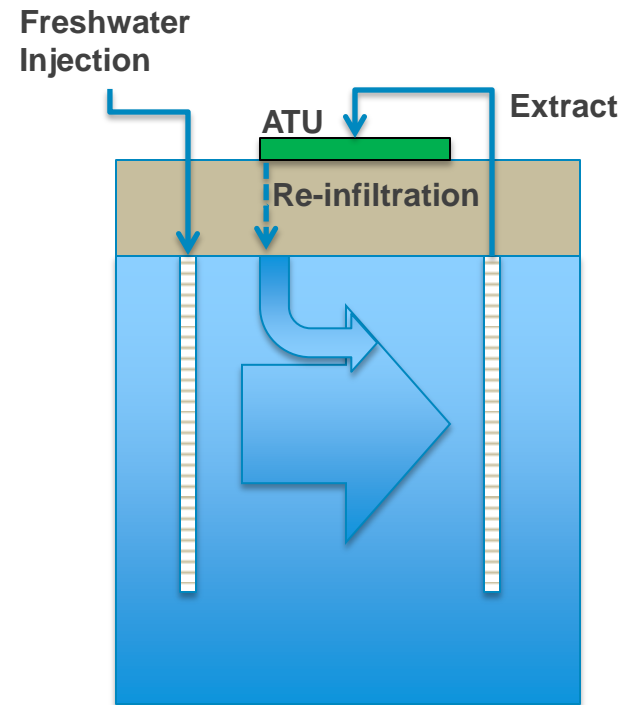


ATUs are also a form of aboveground treatment

- Effects underground are similar to current remedy operations
- Timeframes are driven by location and operation of injection and extraction wells (and to a lesser extent, re-infiltration), rather than aboveground components



Aboveground Treatment

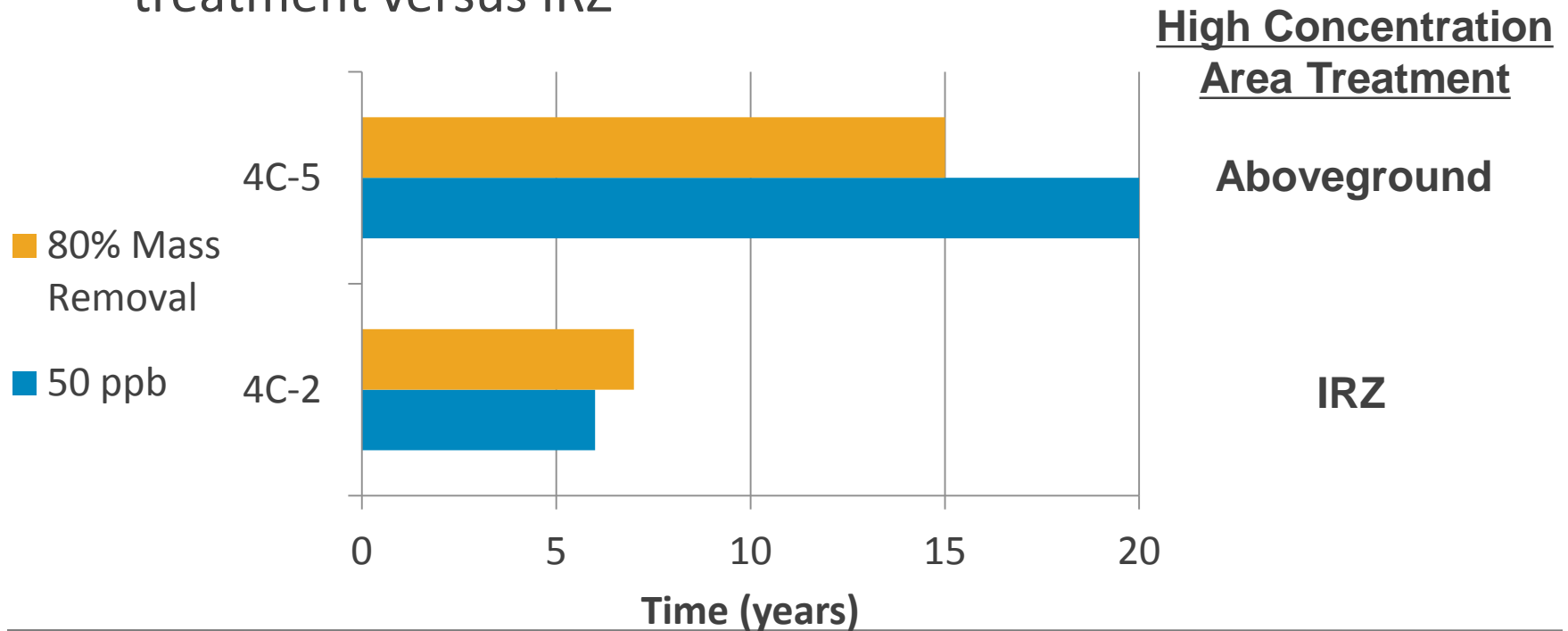


Current Remedial Operations



Follow-up on Remedial Timeframe Modeling

- *Could a bioreactor be used to treat hotspots?*
Not effectively. Feasibility Study results indicate slower treatment of high concentration areas with aboveground treatment versus IRZ





Questions on differences in model predicted times among layers

- Questions from last meeting:

Q: How is initial Cr(VI) mass distributed in model layers?

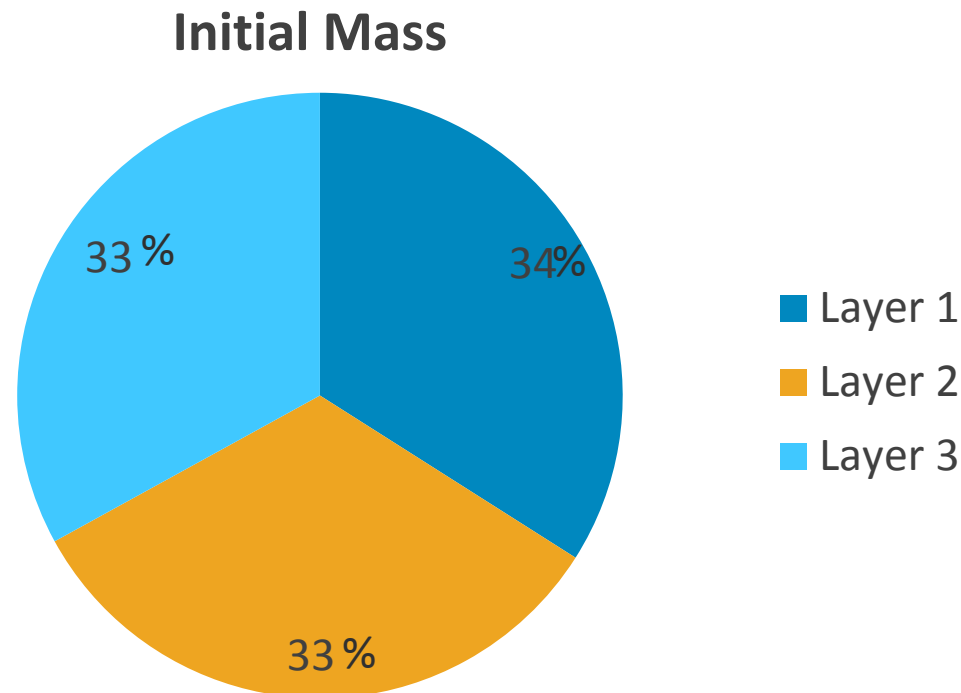
Q: Why is the deep layer predicted to be cleaned up more slowly?



Follow-up on Remedial Timeframe Modeling

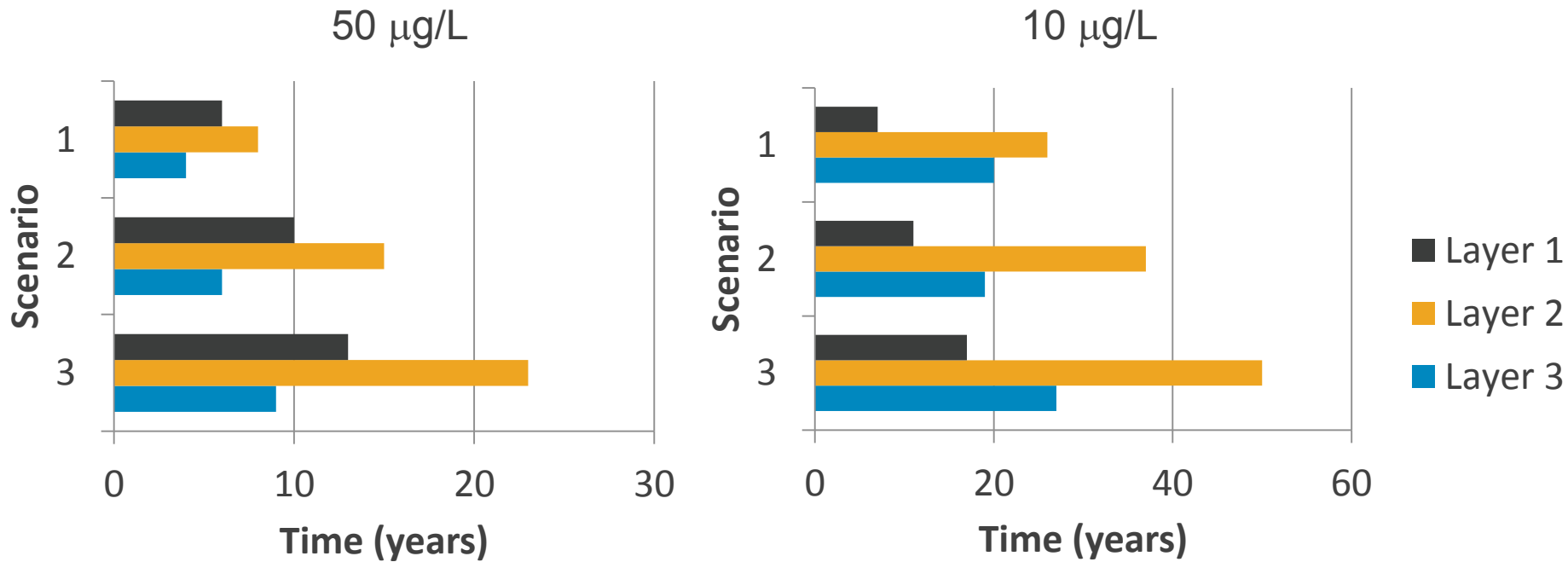
Q: How is initial Cr(VI) mass distributed in model layers?

A: Initial Cr(VI) mass is distributed evenly among layers





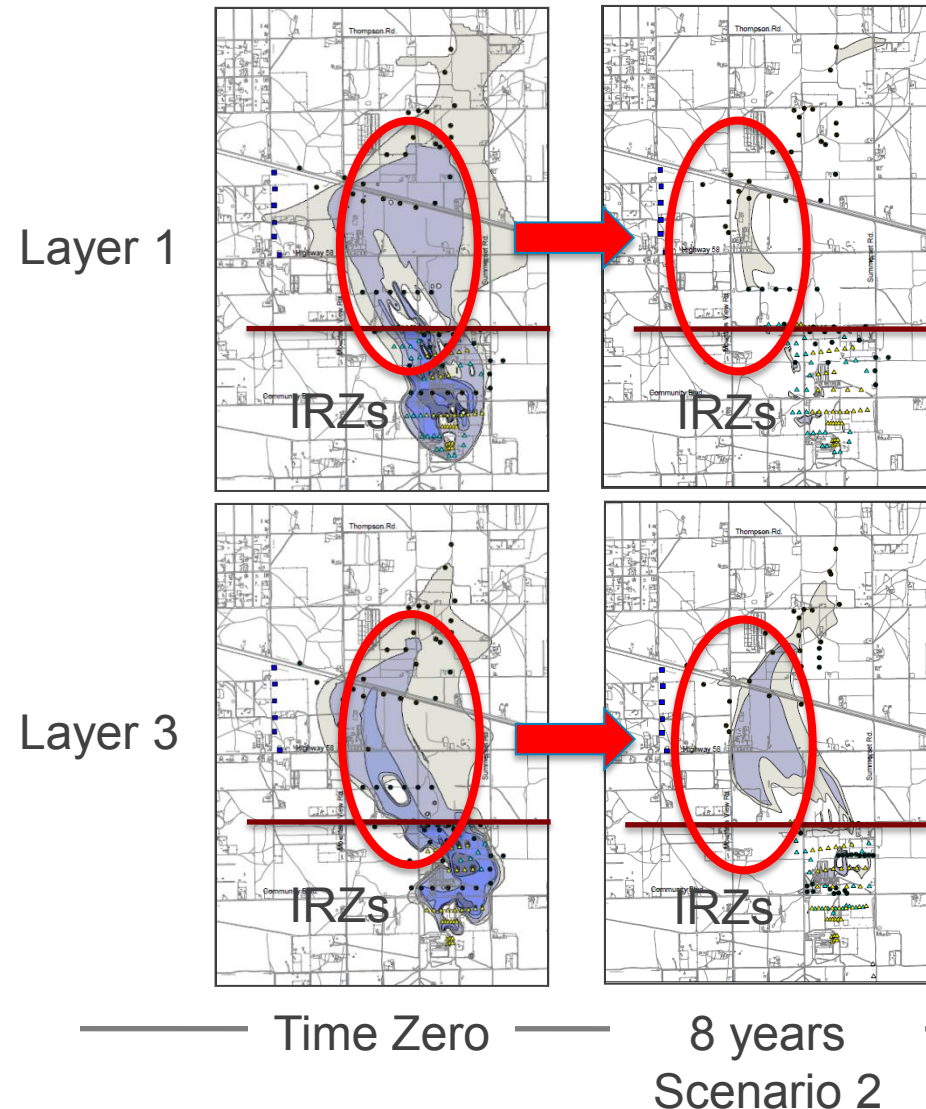
Why is the deep layer predicted to be cleaned up more slowly?



- Due to differences in spatial mass distribution, remedial history and hydrogeology among layers, layers behave differently among metrics:
 - Layer 3 (deepest) is fastest for 50 ppb metric
 - Layer 1 (shallow) is fastest 10 ppb metric



Why is deep layer 10 ppb predicted to be cleaned up more slowly?



Red circled area (North of the IRZs) is the rate limiting area:

- There is more initial mass north of the IRZ in deep (Layer 3) than in shallow (Layer 1)
- Shallow (Layer 1) northern IRZ treatment began earlier, in late 2007,
 - Deep Layer 3 began in late 2012
- Shallow (Layer 1) also cleans up a bit faster due to effects of ATU reinfiltration



Monitoring and Reporting Plan Development for 2015 CAO

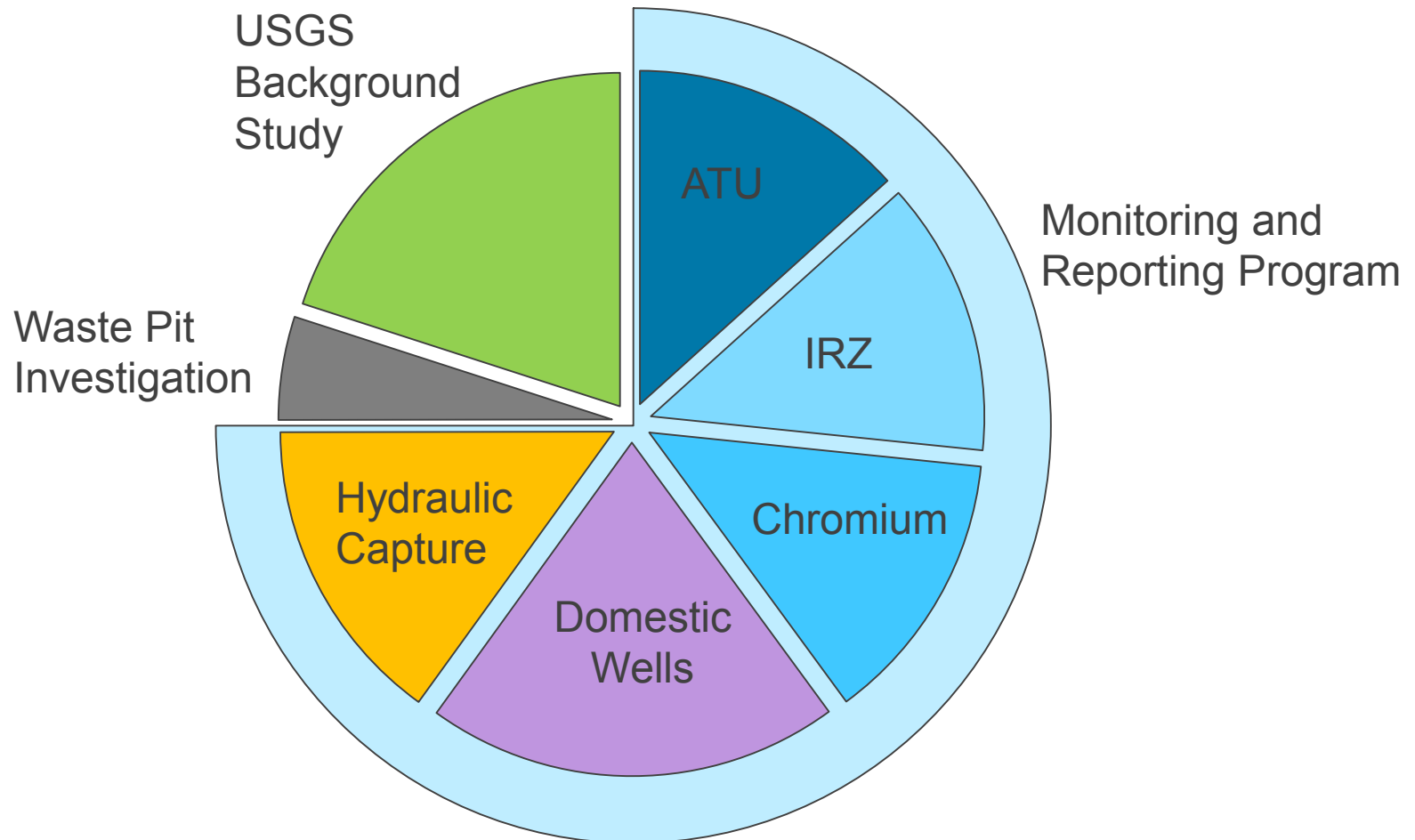
November 12, 2014

Lahontan RWQCB Meeting, Barstow, CA



Introduction

Monitoring Programs





Introduction

Extensive Existing Data

- 670 current monitoring wells (337 for investigation)
 - 16,970 historical results
- Over 400 domestic wells sampled with 4,770 results
- **All** currently sampled domestic wells are below MCL = 10 ppb for chromium 6, and 95% below the current background level of 3.1 ppb



Introduction

Hinkley Site is in Transition

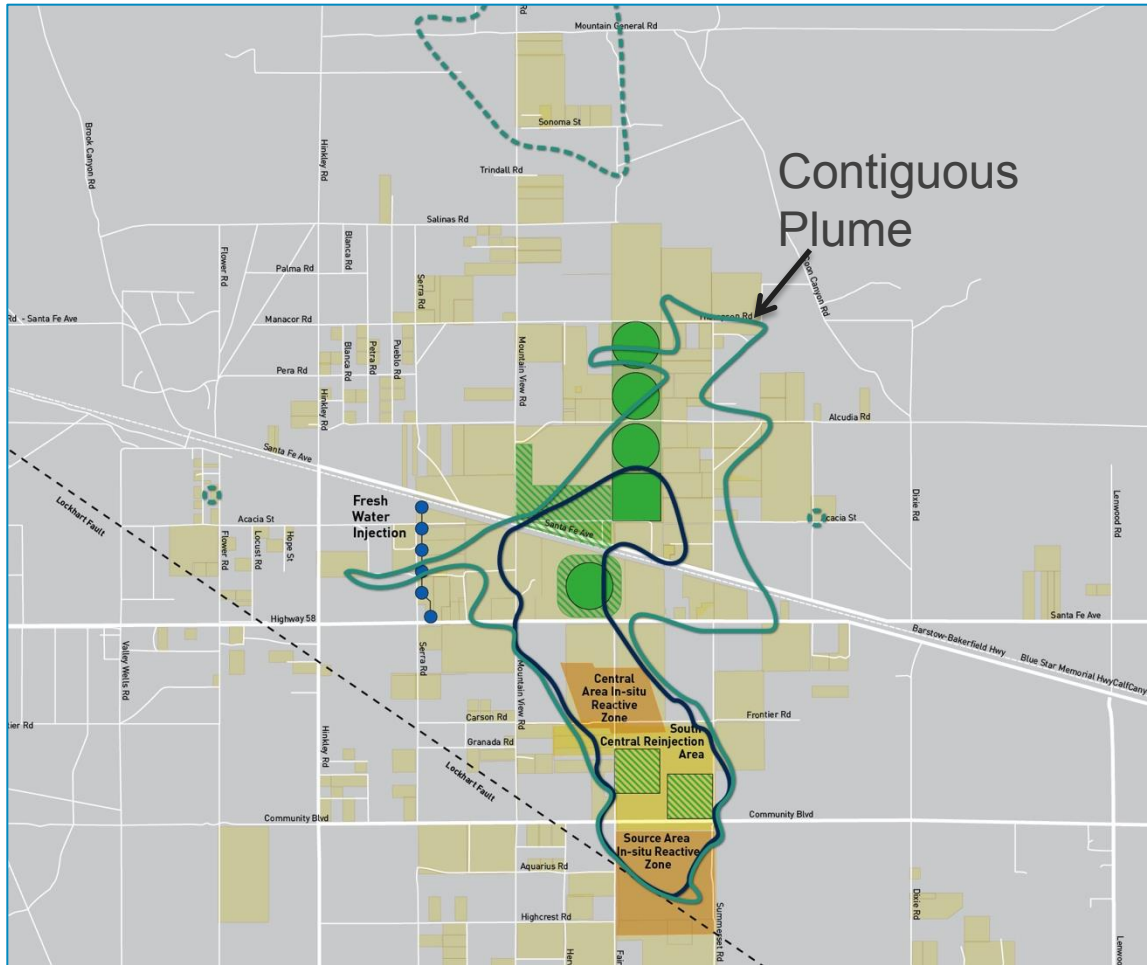
- Investigation is transitioning to background study
- Focus on comprehensive groundwater remediation
- 34 Orders/letters currently specify monitoring/reporting

New Monitoring and Reporting Program for 2015 CAO
under preliminary development

- Holistic re-design
- Consolidated, adaptable requirements
- Unify reporting



Monitoring Programs

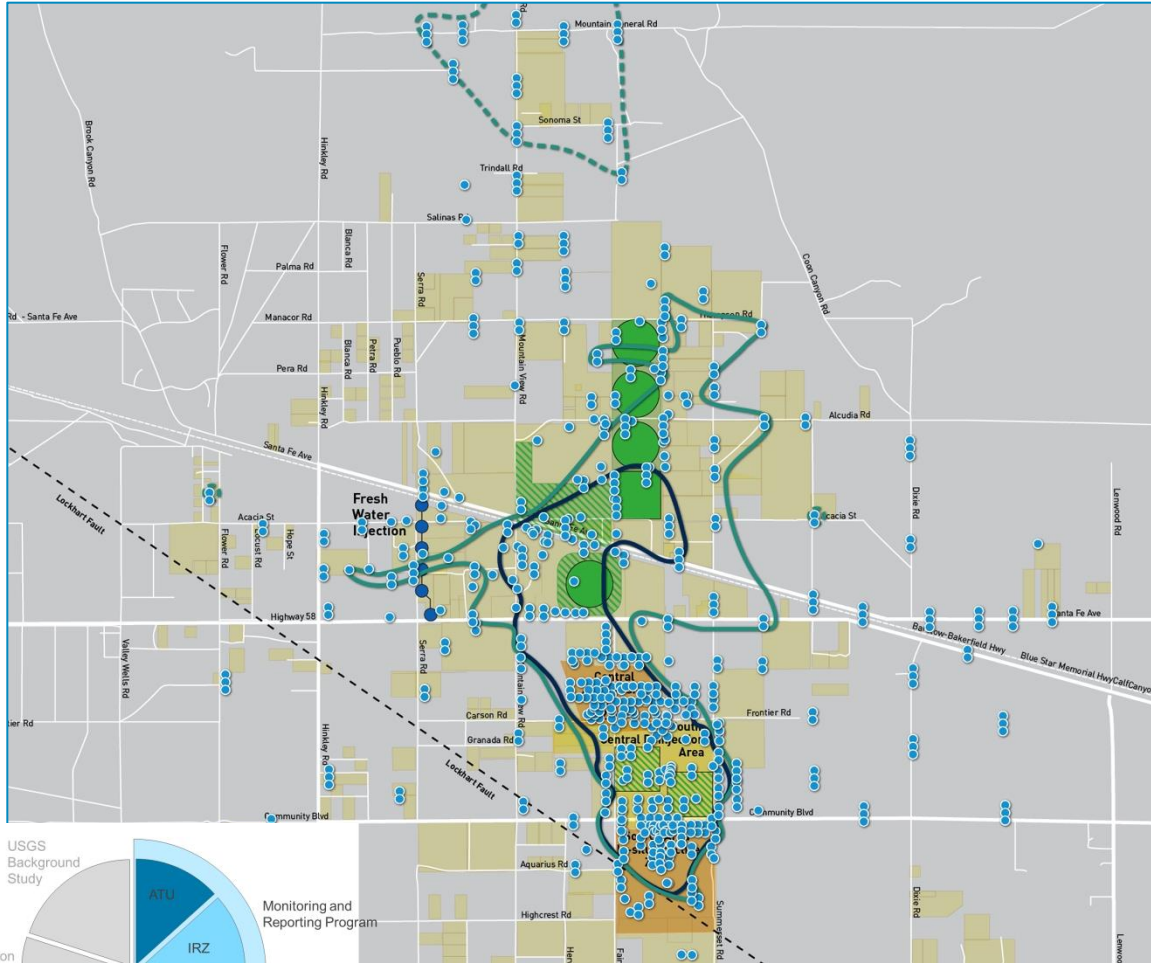


— 3.1 ppb Plume

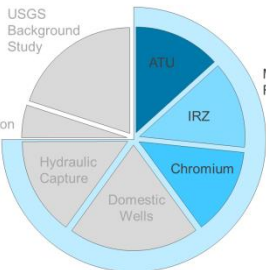
— 10ppb Plume



Monitoring Programs



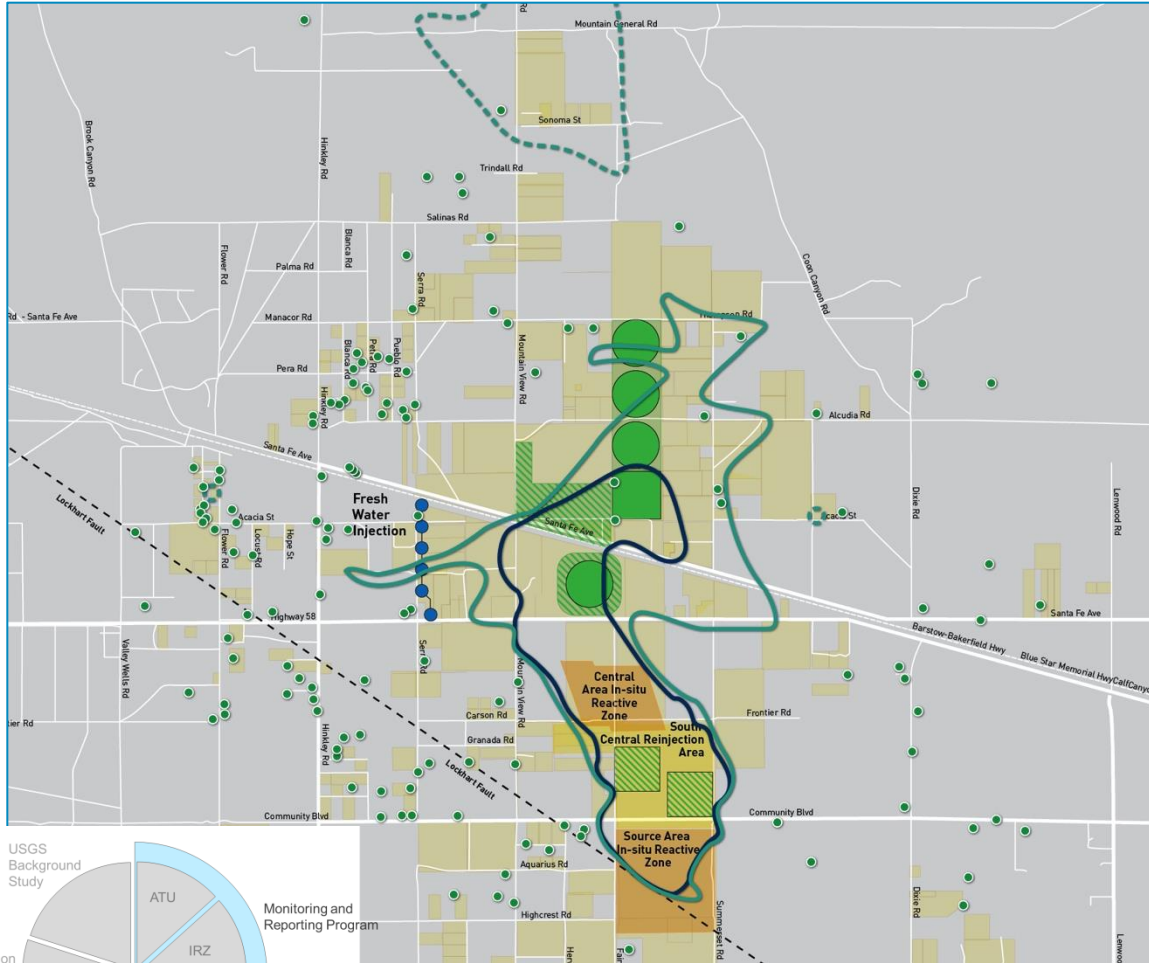
● Groundwater Monitoring Wells



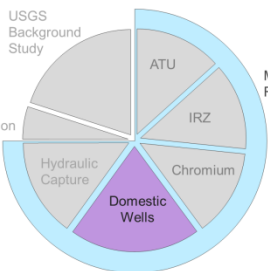
Monitoring and Reporting Program



Monitoring Programs

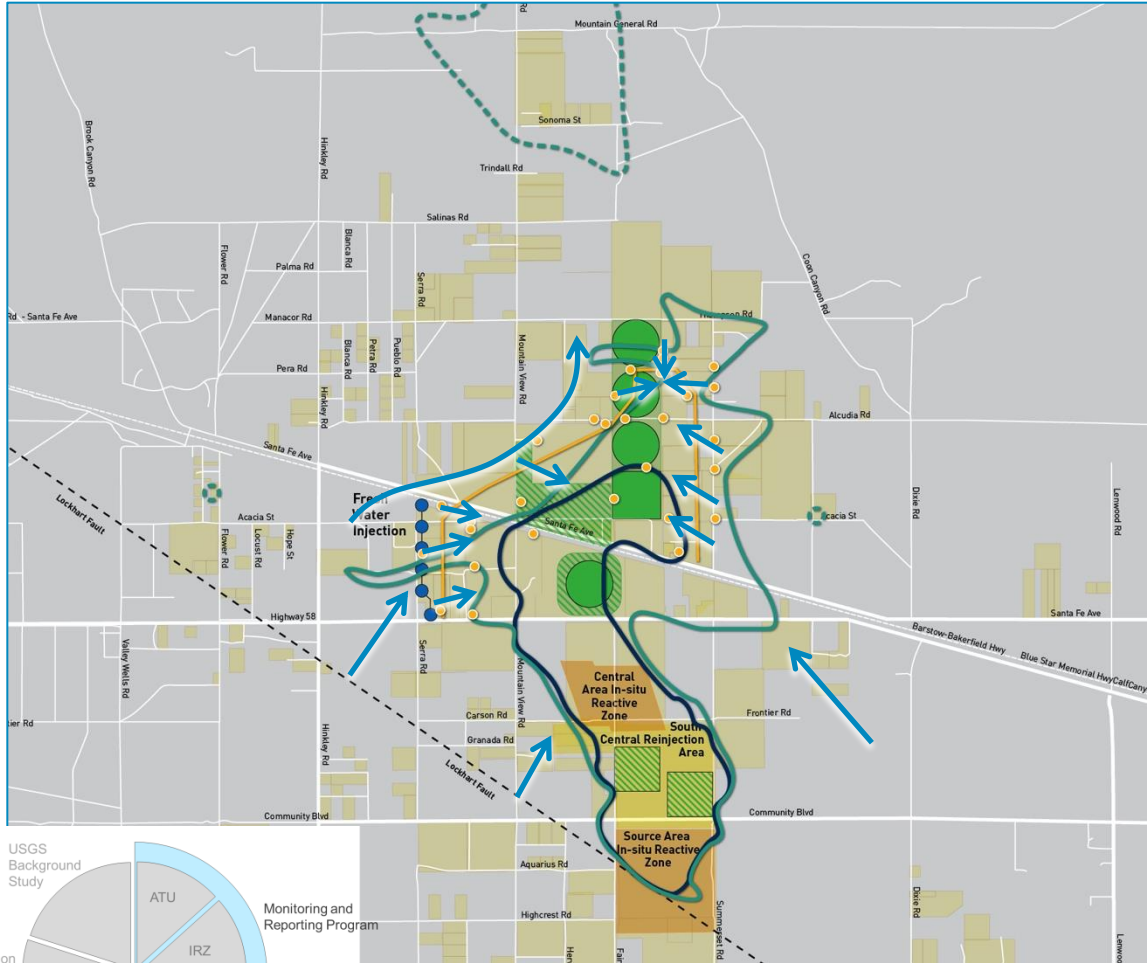


● Domestic Wells

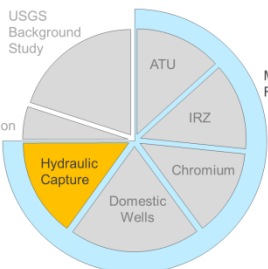




Monitoring Programs



- Hydraulic Capture Monitoring Area
- Groundwater Flow
- WL Wells

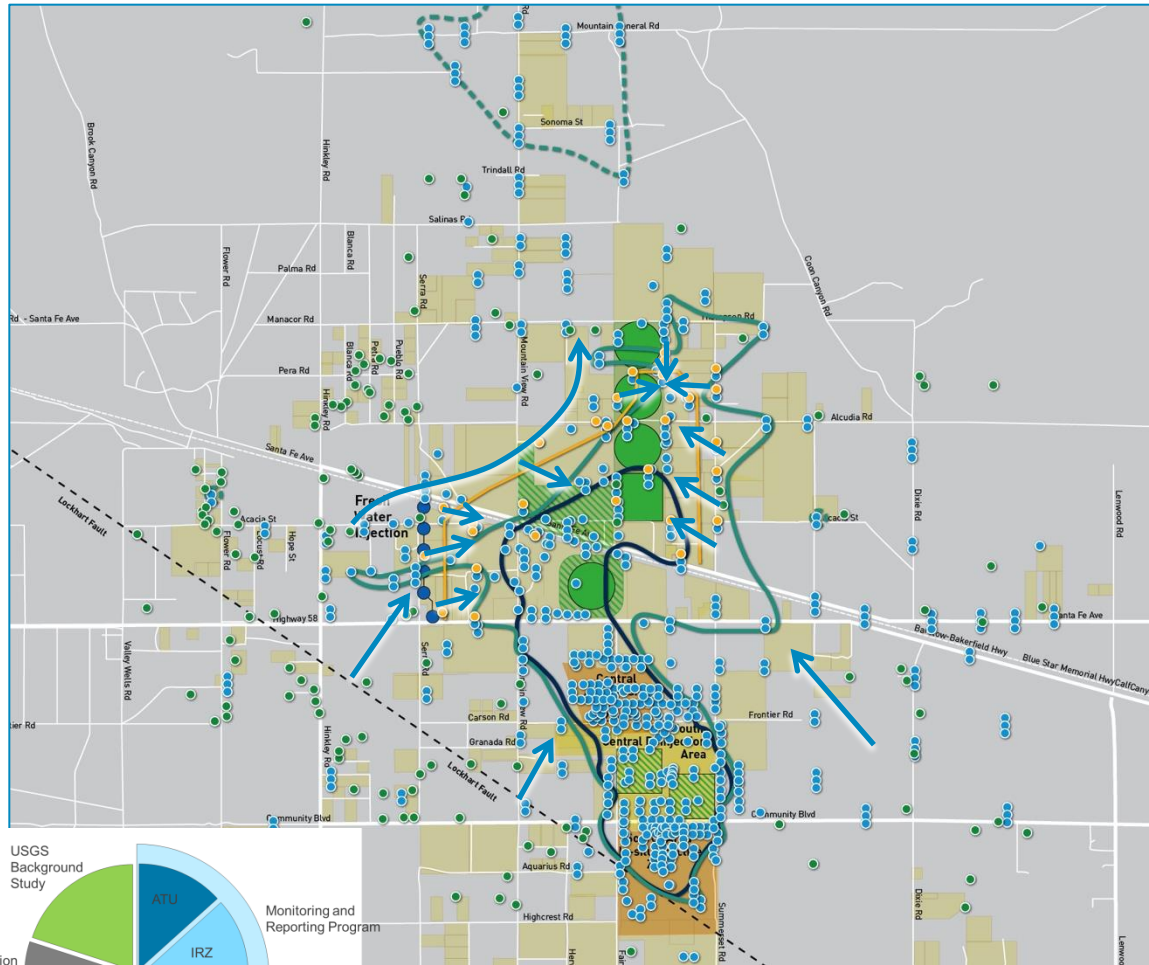


USGS Background Study

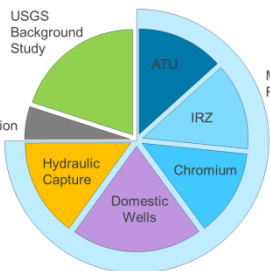
Monitoring and Reporting Program



Several Layers of Monitoring Work Together for Comprehensive Program



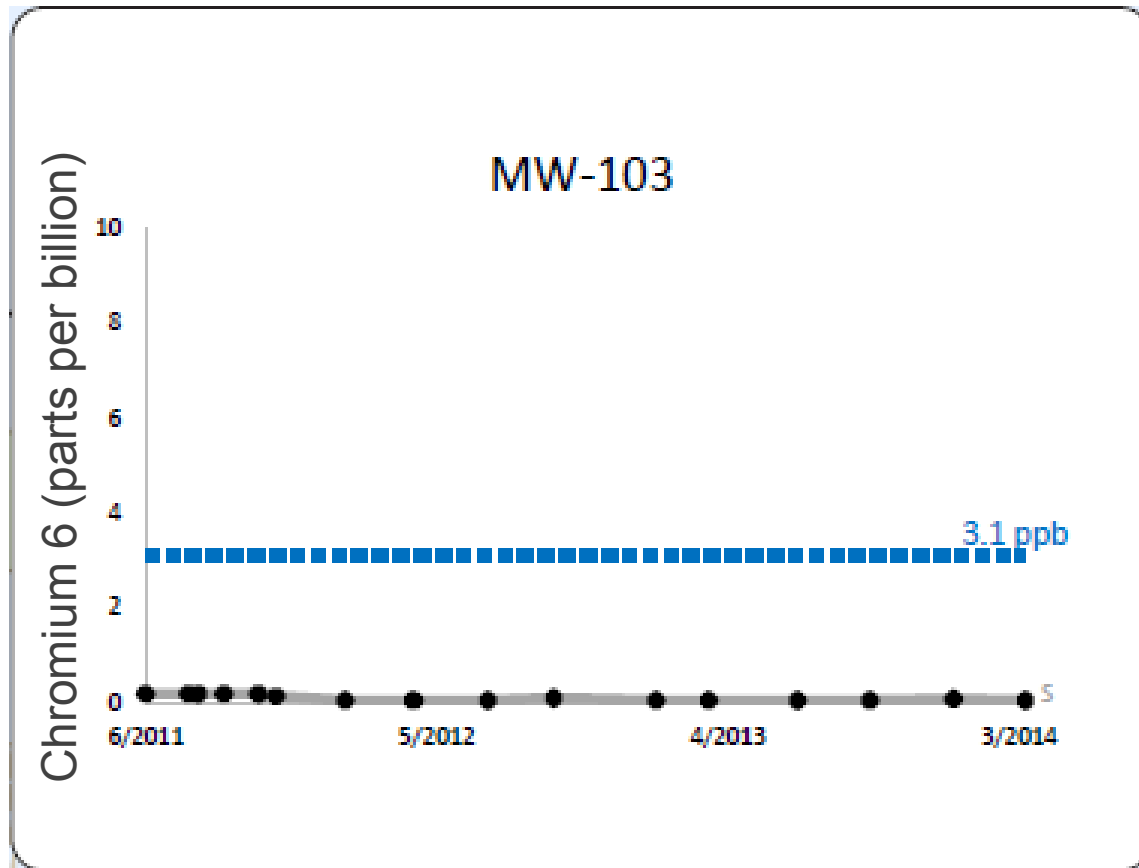
- 3.1 ppb Plume
- 10ppb Plume
- Groundwater Monitoring Wells
- Domestic Wells
- Hydraulic Capture Monitoring Area
- ← Groundwater Flow
- WL Wells





Data Analysis in Support of Preliminary Program

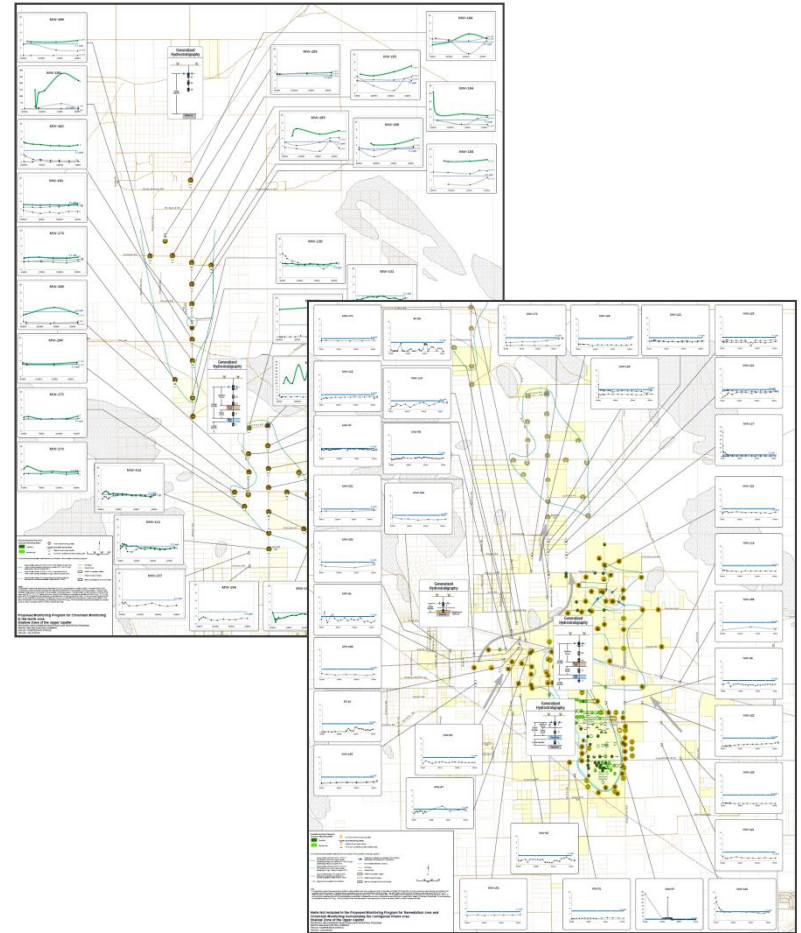
- Compiled historic data sets





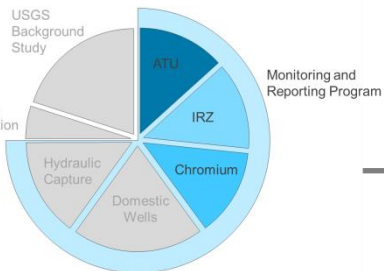
Existing Dataset Provides Information for Program Development

- 16,970 monitoring well results
- 4,770 domestic well results
- Site hydrogeology
- Extent of contiguous plume
- Where chromium 6 is low and stable
- Areas to watch
- Areas for background study





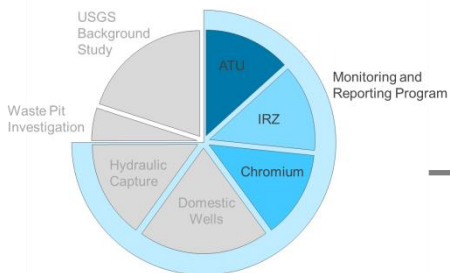
PRELIMINARY PLAN ATU, IRZ AND CHROMIUM GROUNDWATER MONITORING





Groundwater Monitoring Objectives

- Verify and evaluate remedy performance
- Monitor the main contiguous plume boundary
- Monitor chromium in northern area

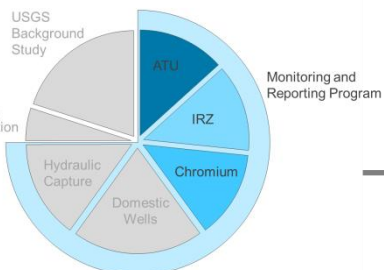
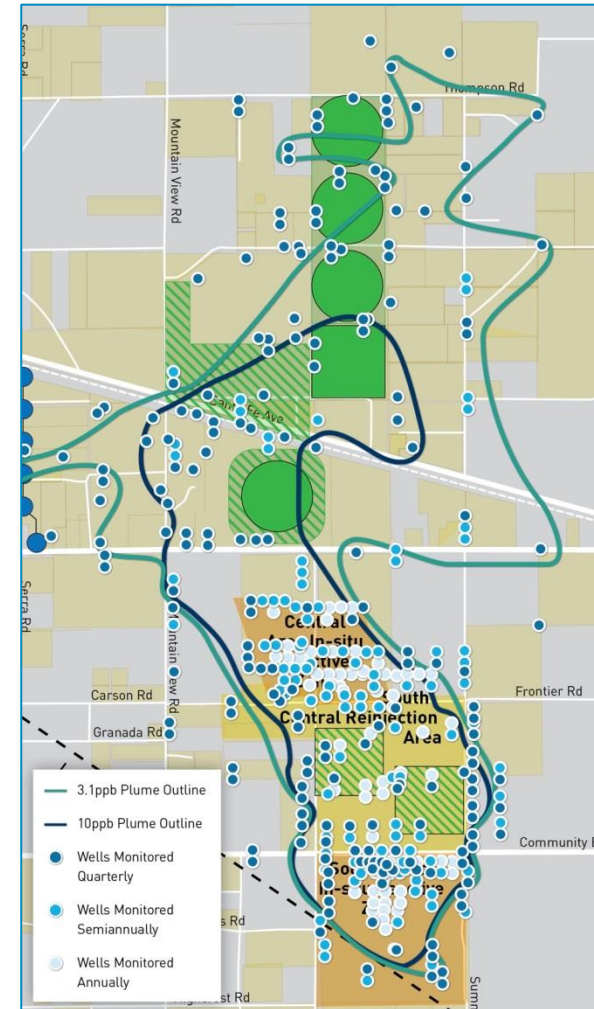




Verify and Evaluate Remediation Performance

Related Programs in Effect:

- Agricultural Treatment Units
 - 2014 Waste Discharge Requirements and Notice of Applicability
- In Situ Reactive Zones
 - In various Orders and letters
 - Water Board proposed revision in letter dated 2/19/14, pending adoption





Chromium Monitoring

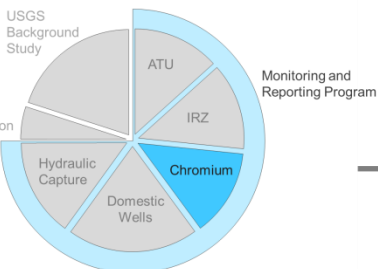
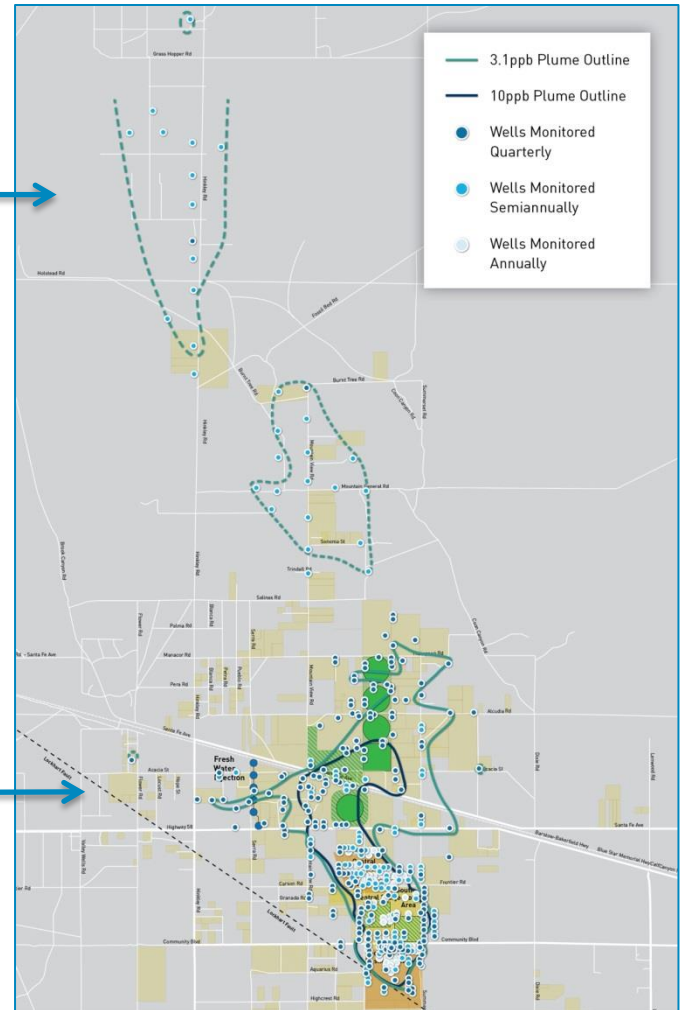
Monitor chromium in northern area

Semi-Annual/Quarterly Sampling at key depth within aquifer unit

Monitor the contiguous plume quarterly

Near active remediation

Locations to bound plume in each aquifer unit

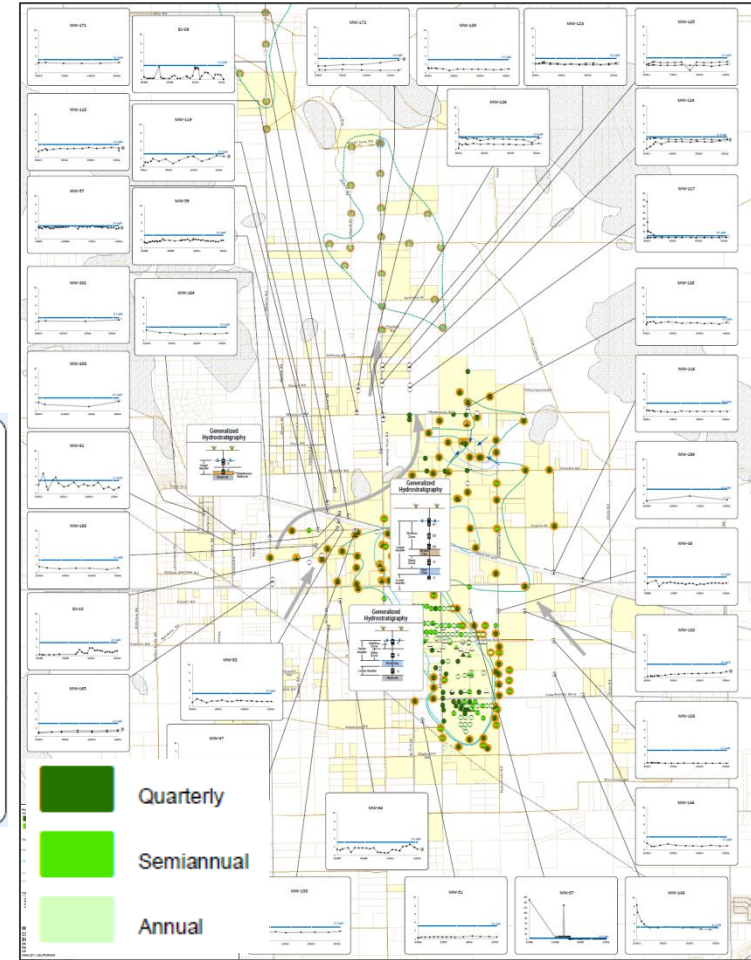
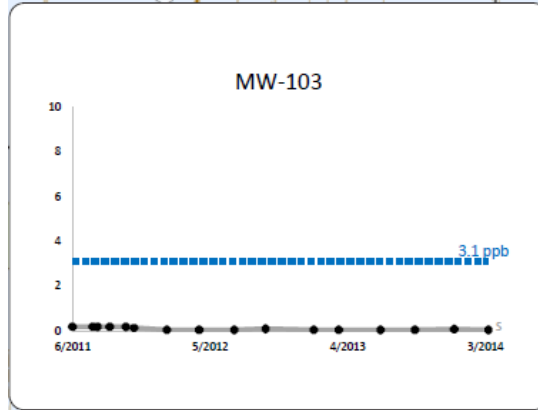
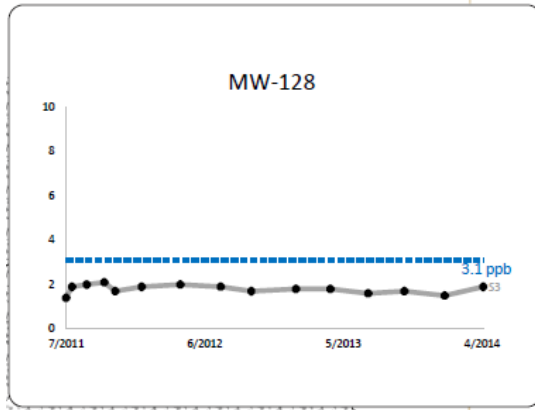




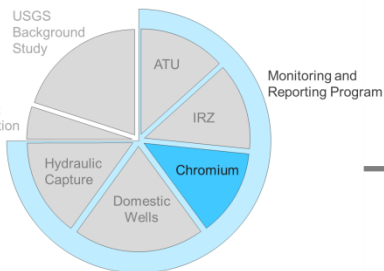
Chromium Monitoring around the Contiguous Plume

Rationale for locations:
Focused on wells for plume
contouring, including downgradient

Example Data Sets



See full-sized Figures 2 and 3

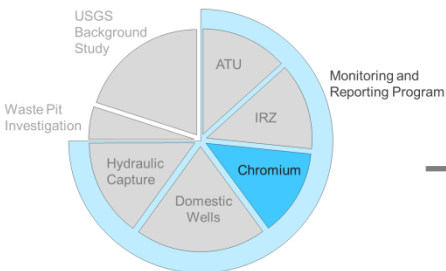




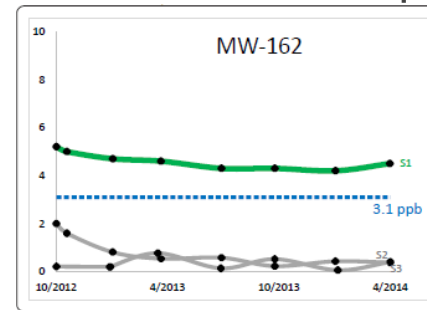
Chromium Monitoring North Area

Rationale for locations and frequency:

- Generally stable trends
- Chromium 6 present in only one aquifer unit
- Sample most informative interval within unit

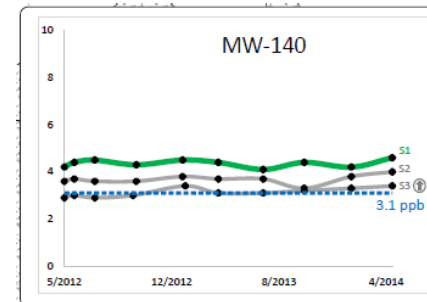


Example Data Sets-
Multiple intervals per location within same aquifer layer



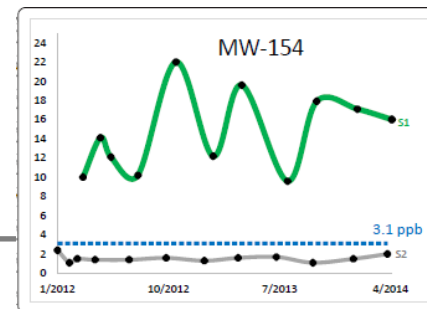
Interval for Semi-Annual

No Sampling



Interval for Semi-Annual

No Sampling

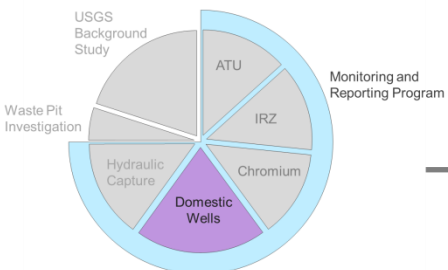


Interval for Quarterly

No Sampling



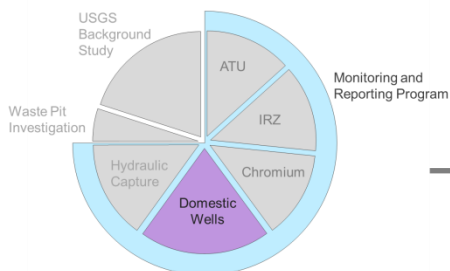
PRELIMINARY PLAN DOMESTIC WELL MONITORING FOR CHROMIUM





Domestic Well Program

- Program initiated in 2011 to respond to resident's concerns
- After several years of data, we know now that:
 - **ALL** currently sampled domestic wells below MCL = 10 ppb for chromium 6, and >95% below the current background level of 3.1 ppb
- Update program to monitor wells
 - Potentially influenced by remediation activities
 - With chromium 6 concentrations greater than 3.1 ppb or near elevated concentrations north of remedial area

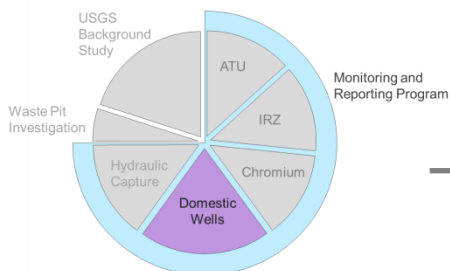




Other Monitoring Provides Layers of Protectiveness

MRP has three lines of monitoring to detect changes before a domestic well would see it:

- IRZ and ATU detailed monitoring programs
- Hydraulic capture – prescribed and detailed monitoring of cleanup area containment
- Chromium 6 testing surrounding cleanup for plume definition. Groundwater gradient monitoring.

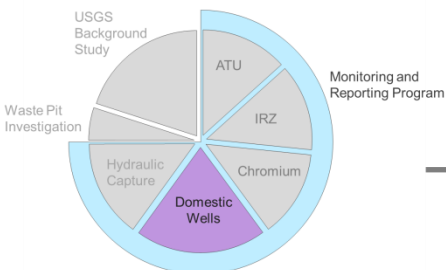
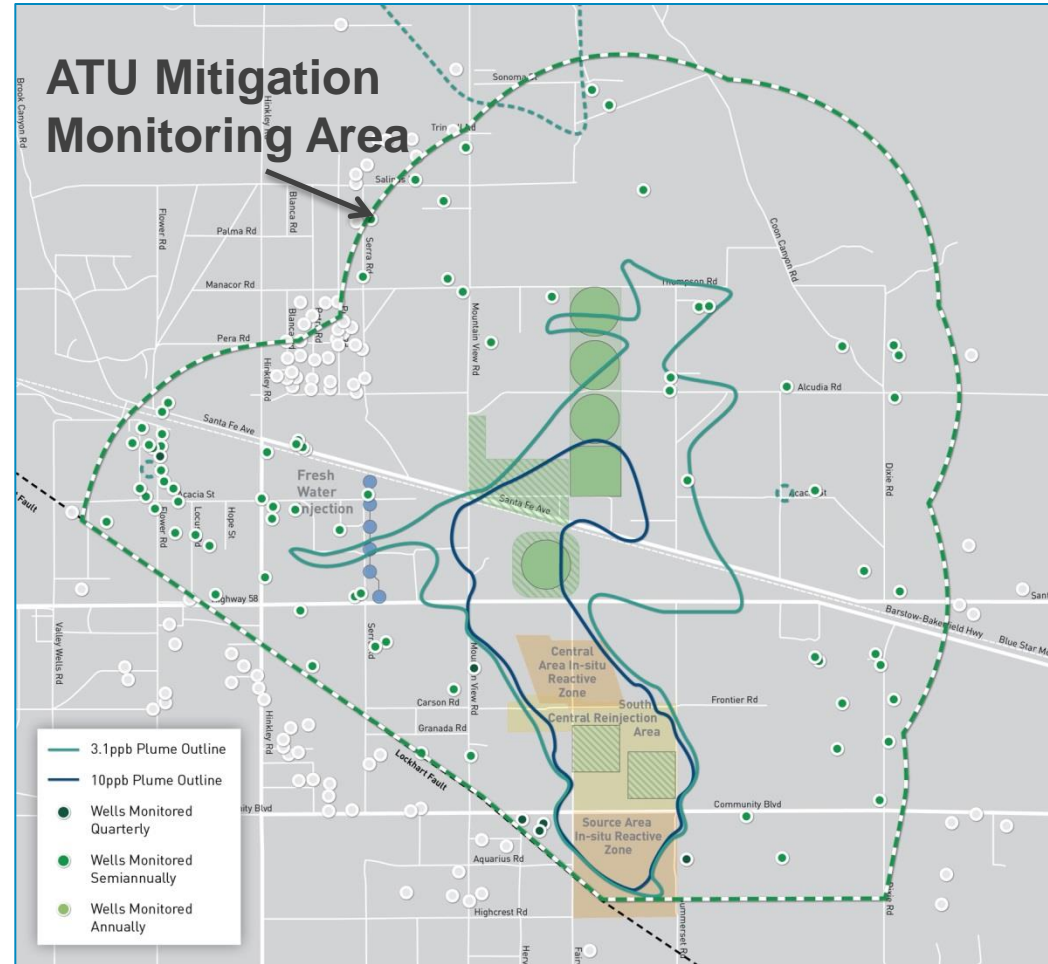




Domestic Well Program under EIR/ ATU WDRs

EIR Monitoring Objective-

- Detect changes in chromium 6 due to remediation
- Changes not anticipated to occur

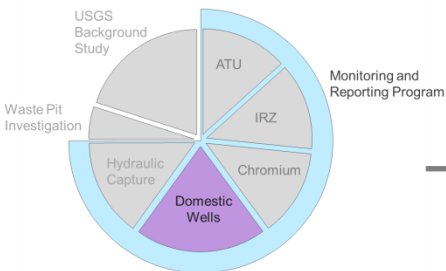
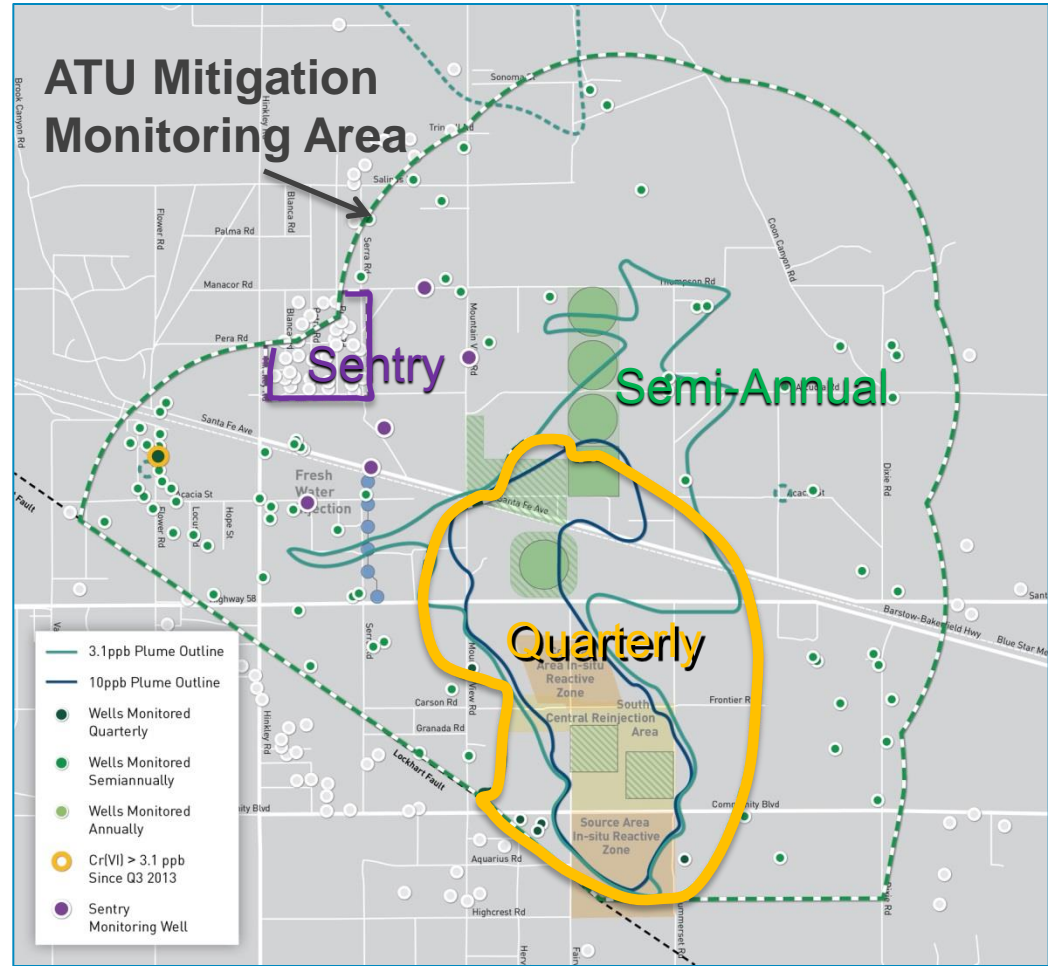




Domestic Well Program within ATU Mitigation Monitoring Area

Preliminary Program

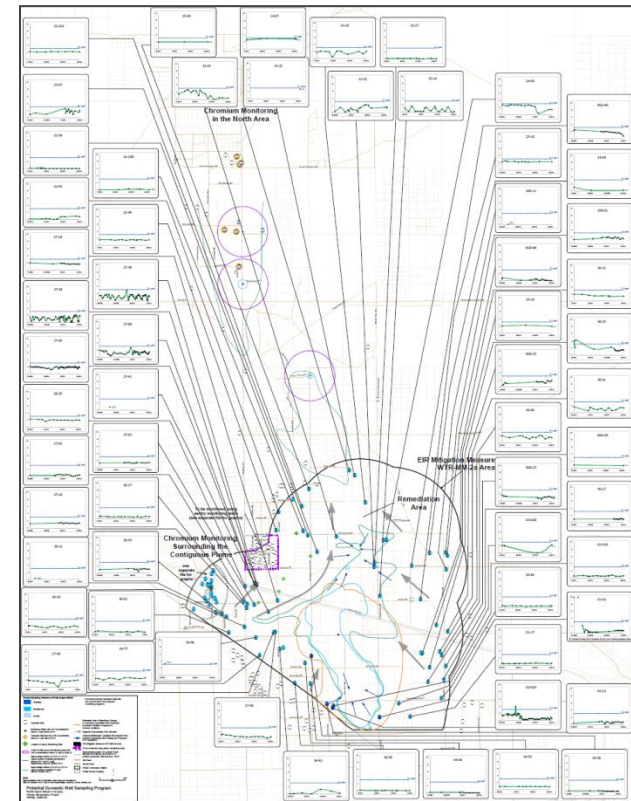
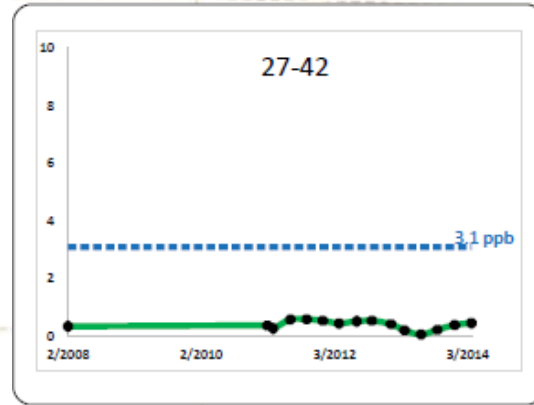
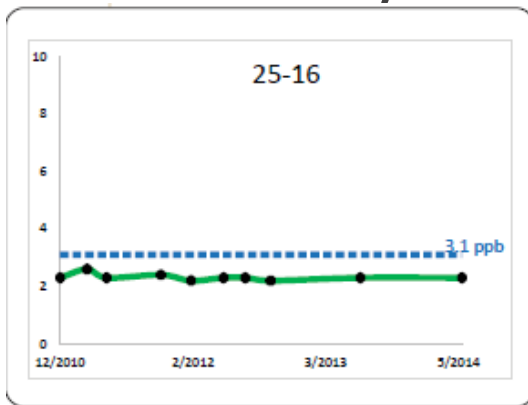
- Quarterly sampling where remediation changes may occur
- Otherwise
 - Quarterly for >3.1 ppb
 - Semi-annual < 3.1 ppb
 - Sentry monitoring wells for high density neighborhood



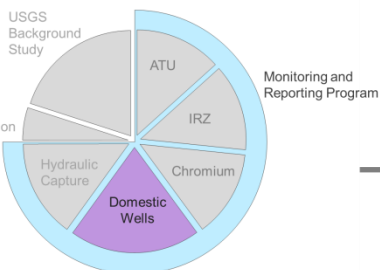


Domestic Well Program within ATU Mitigation Sampling Area

- Wells for semi-annual or sentry wells:
 - Will not be affected by remediation
 - Yield chromium 6 < 3.1 ppb
 - Generally stable



See full-sized Figure 6

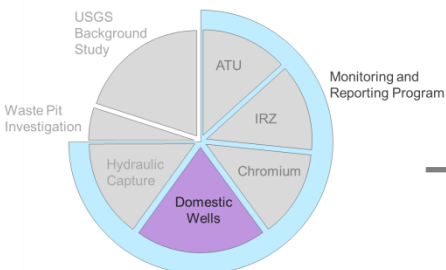




Domestic Well Program within Northern Area

Preliminary Program

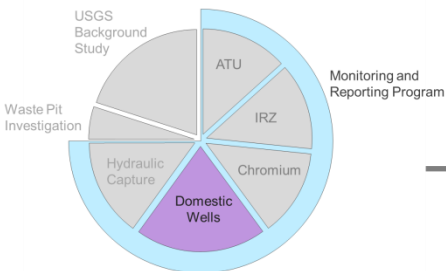
- Annual sampling for:
 - Wells with chromium 6 above 3.1 ppb
 - Wells within 2,000 feet of a monitoring well with chromium 6 above 10 ppb





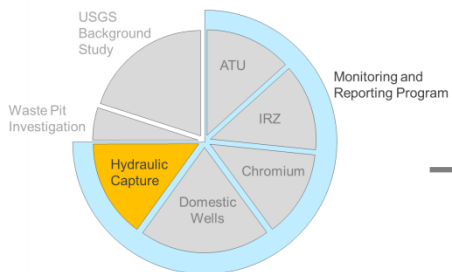
Domestic Well Program within Upgradient and Crossgradient Areas

- These areas clearly not affected by chromium 6 from the compressor station
- Aligns with earlier technical determinations by the Water Board



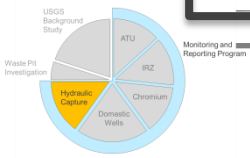
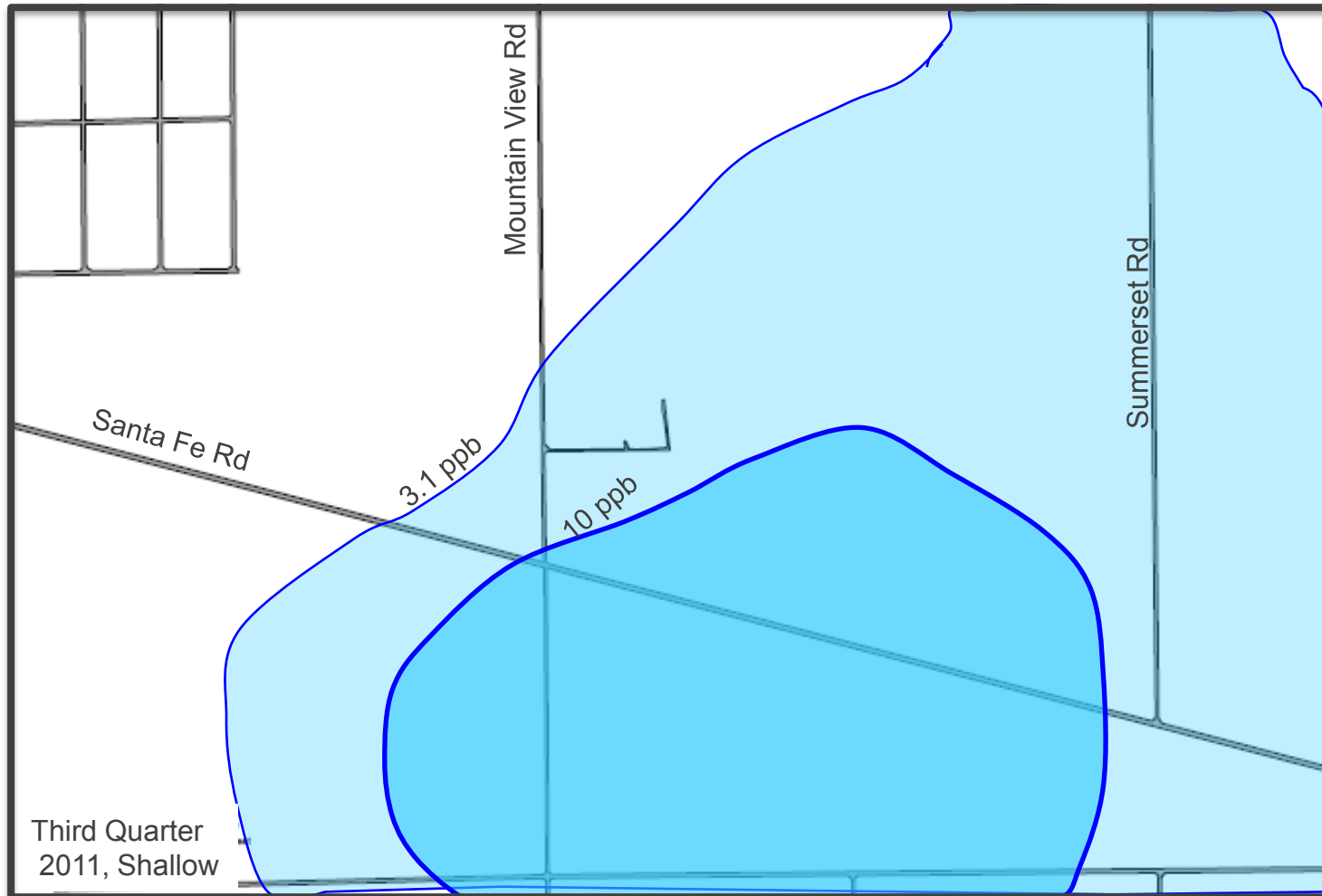


HYDRAULIC CAPTURE MONITORING



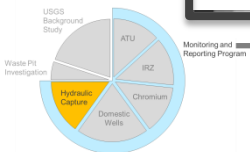
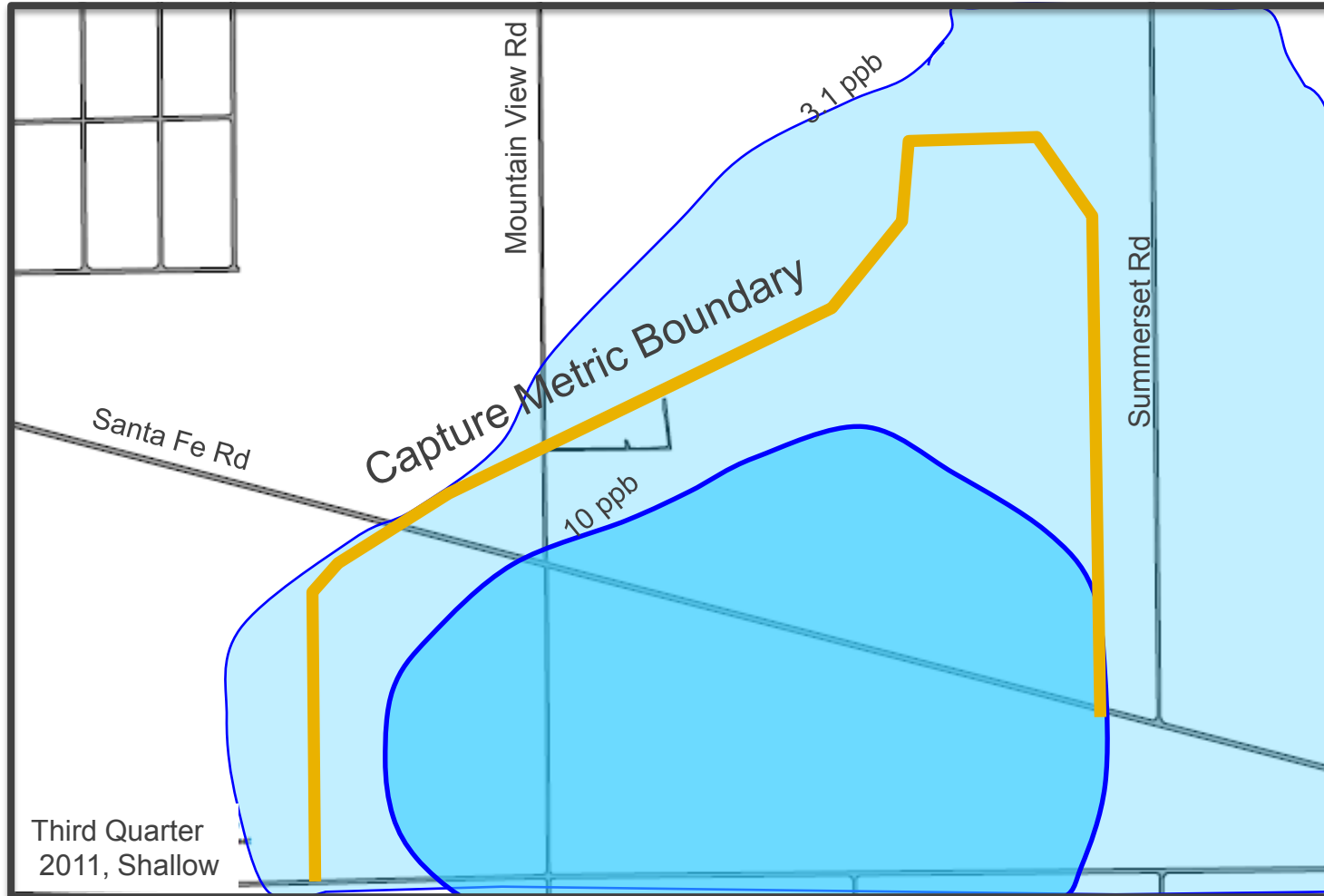


Hydraulic Capture Monitoring



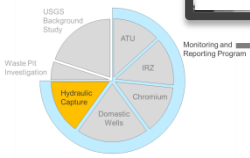
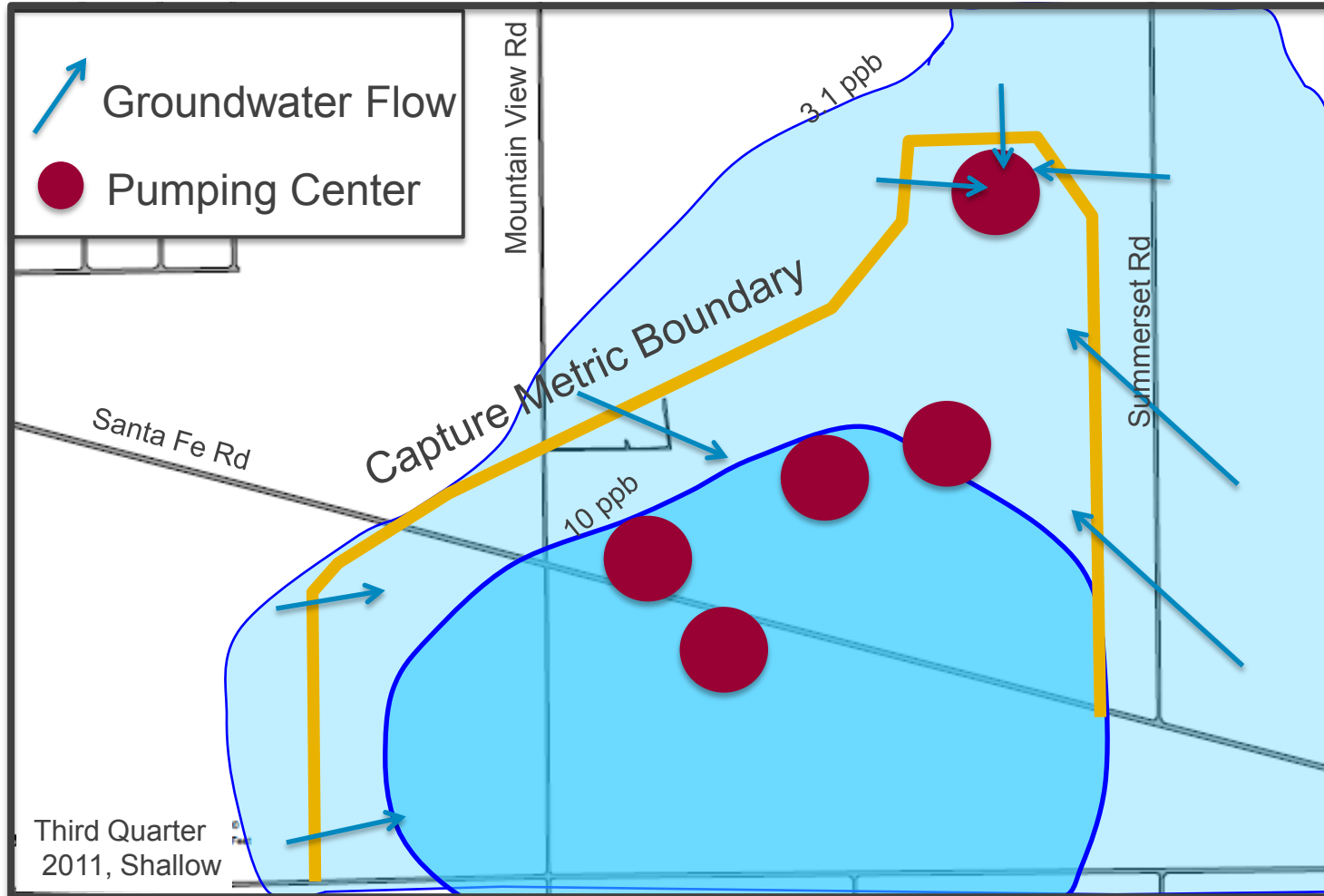


Capture Metric Boundary Established in 2011



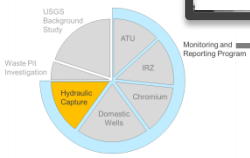
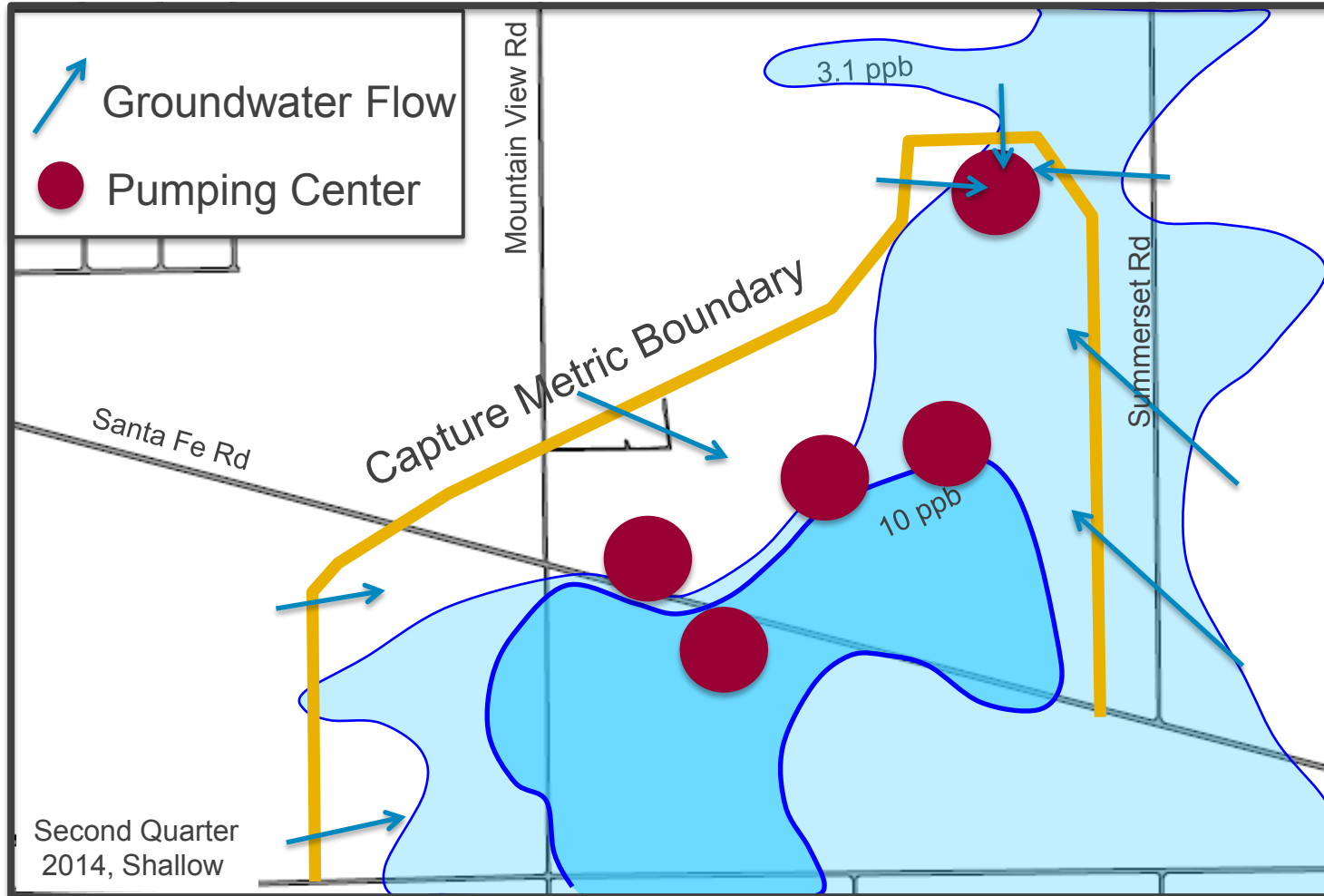


Pumping Centers Operated to Meet 2011 Boundary



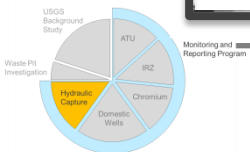
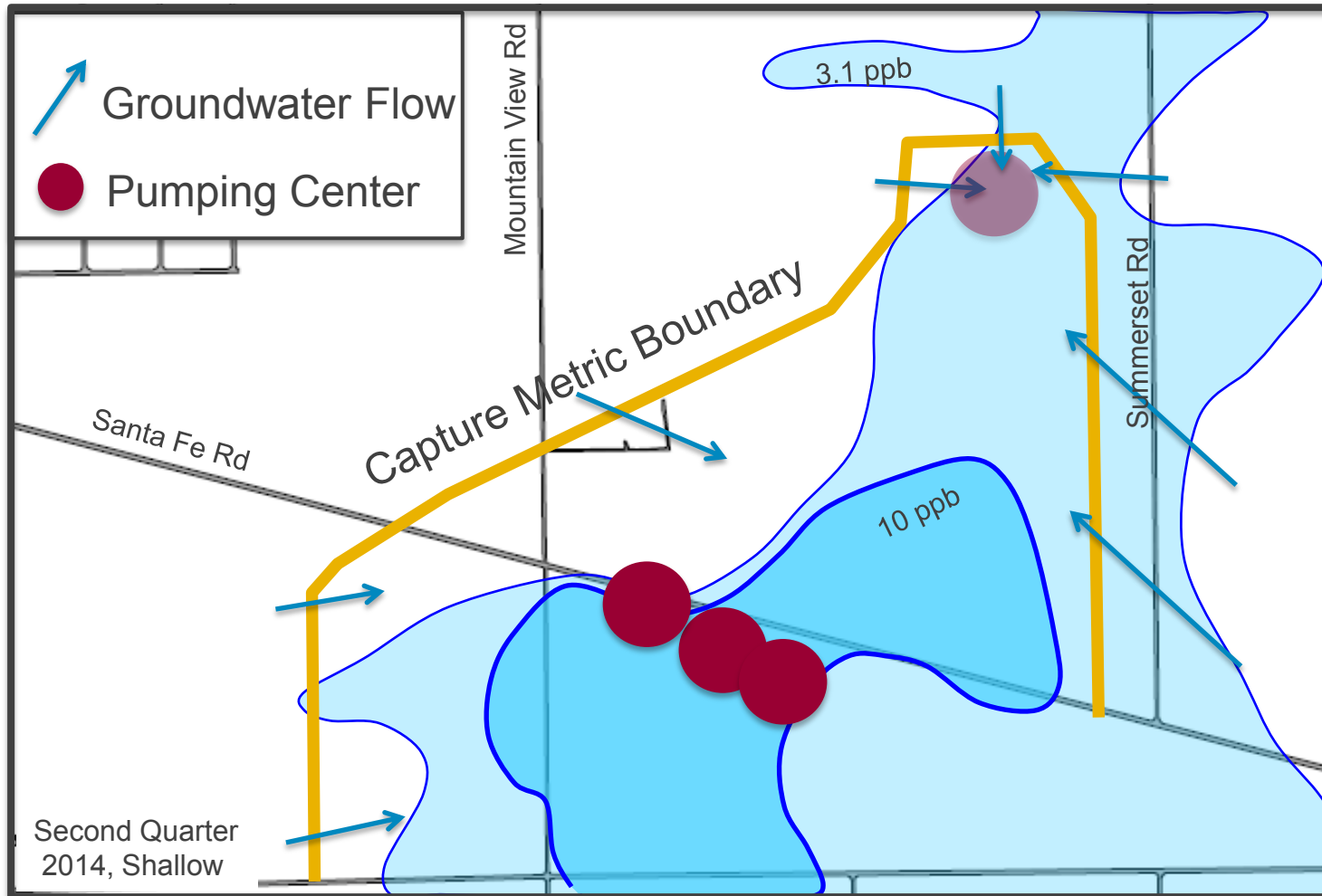


Clean-up Has Progressed Since 2011



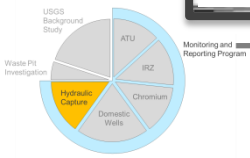
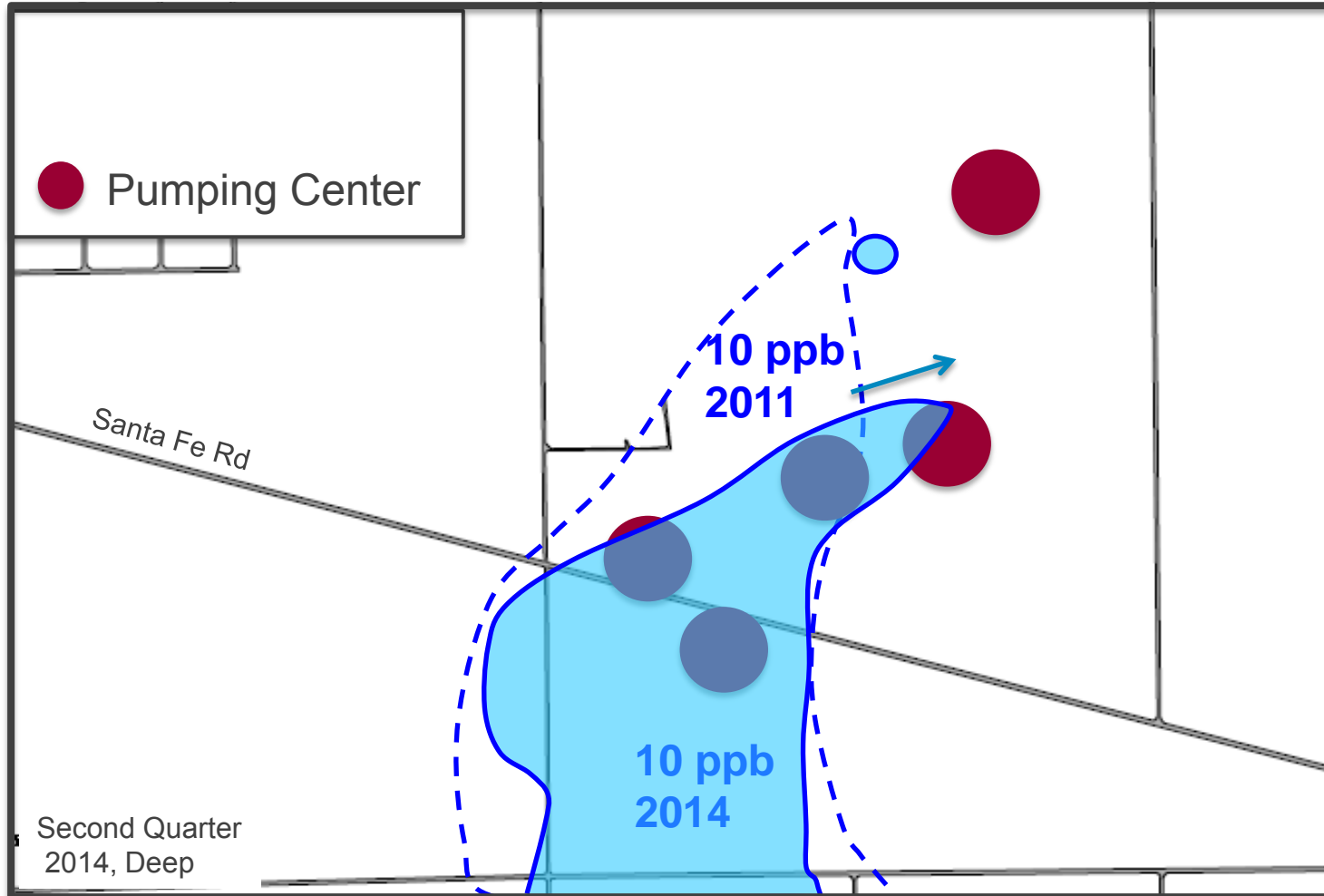


Time to optimize remedial pumping to target mass





Current extraction locations “pulling” deep plume east

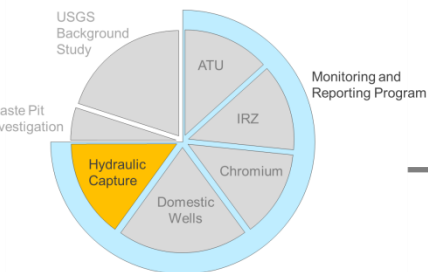




Hydraulic Capture Monitoring

- Recommendation for CAO hydraulic capture requirements:

Create a flexible requirement that allows for optimization of remedial pumping over time.



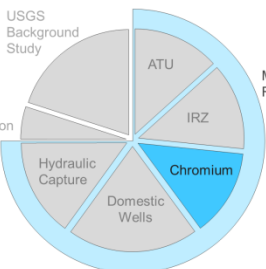
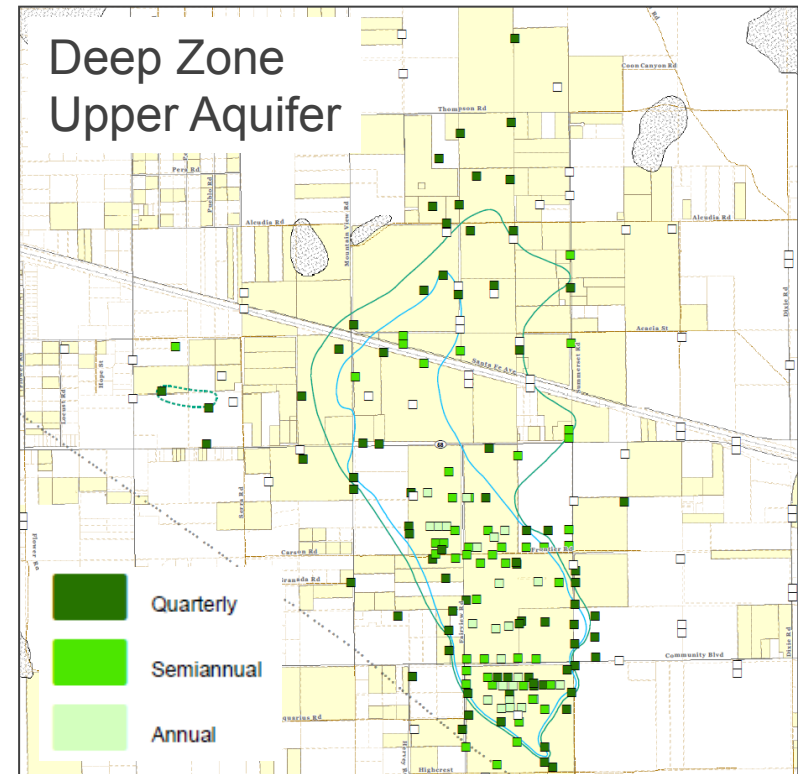
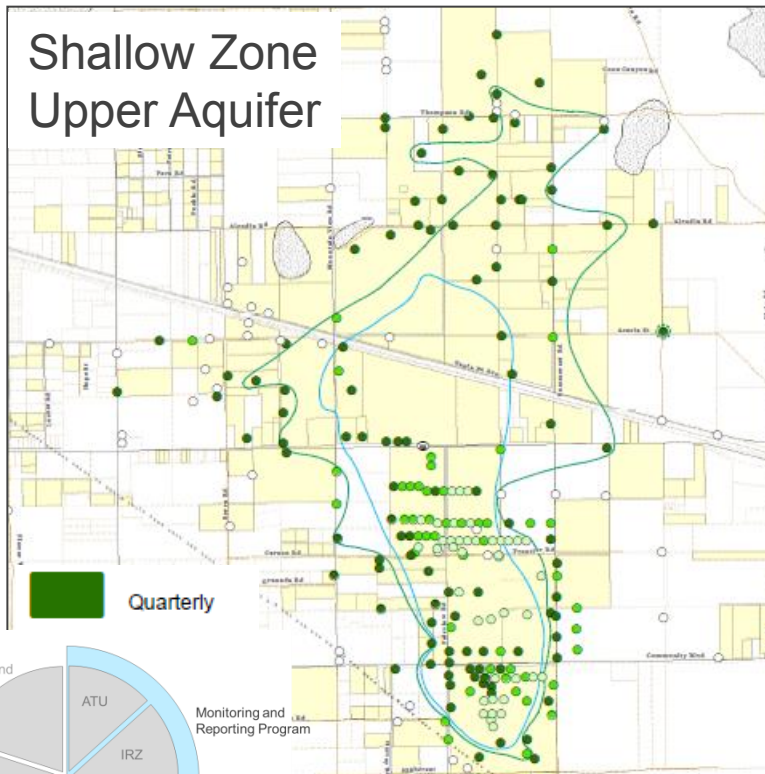


ADDITIONAL INFORMATION



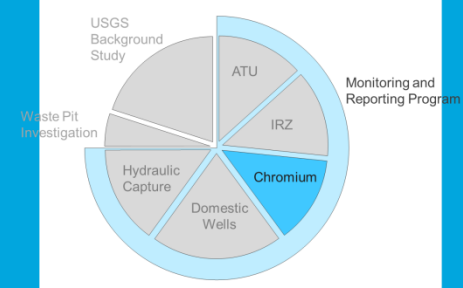
Chromium Monitoring around the Contiguous Plume

Rationale for locations: bound chromium 6 plume in each aquifer unit





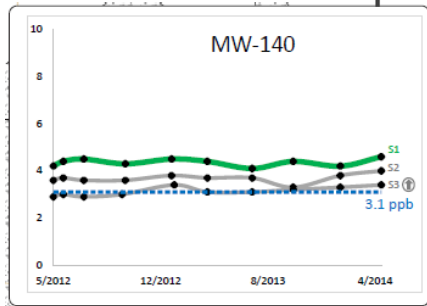
Chromium Monitoring North Area



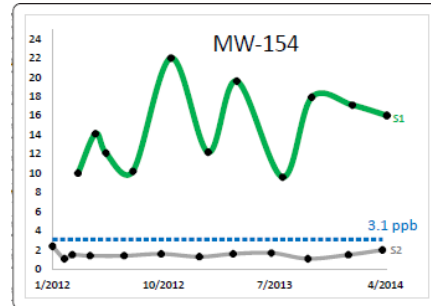
Rationale for semi-annual/quarterly sampling:

- Not under active remediation
- Chromium 6 concentrations generally stable
- Semi-annual sampling generally, quarterly if dynamic

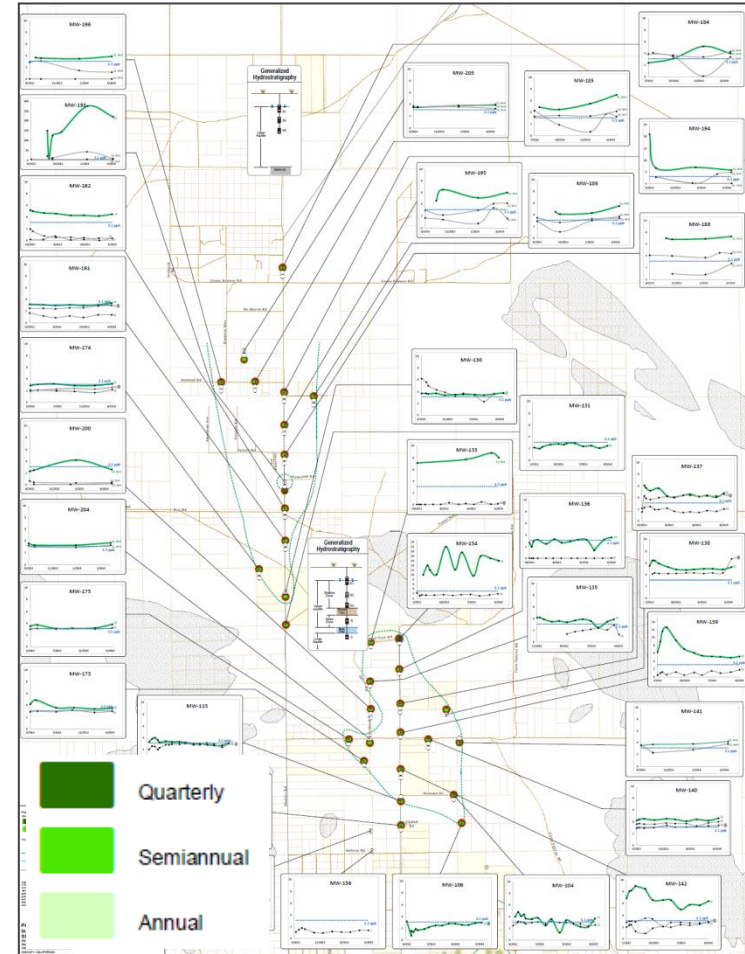
Example Data Sets



Semi-annual



Quarterly



See full-sized Figure 4