THIRD QUARTER 2014
QUARTERLY OPERATIONS AND MONITORING REPORT
GROUNDWATER TREATMENT AND SOIL VAPOR EXTRACTION REMEDIATION SYSTEM
MODESTO GROUNDWATER SUPERFUND SITE
MODESTO, CA

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TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

TABLES

FIGURES

APPENDICES

LIST OF ACRONYMS AND ABBREVIATIONS

ALS	ALS Laboratory Group
ASTM	American Society for Testing and Materials
bgs	below ground surface
BOD	biochemical oxygen demand
City	City of Modesto
CPT	cone penetrometer test
DQO	data quality objective
EPA	United States Environmental Protection Agency
Eurofins	Eurofins Air Toxics, Inc.
FB	field blank
FD	field duplicate
ft/ft	foot per foot
GAC	granular-activated carbon
GEL	GEL Laboratories, LLC
gpm	gallons per minute
GWTS	groundwater treatment system
IX	ion exchange
LCS	laboratory control sample
LGAC	liquid-phase granular-activated carbon
MB	method blank
MCL	maximum contaminant level
MDL	method detection limit
msl	mean sea level
MS	matrix spike
MSD	matrix spike duplicate
Municipal Well	City of Modesto Municipal Water Supply Well
MWH	MWH Americas, Inc.
NS	normal sample
O&M	operation and maintenance
PARCC	precision, accuracy, representativeness, completeness, and comparability
PCE	tetrachloroethene
P&ID	process and instrumentation diagram
PQL	practical quantitation limit
QA	quality assurance
QC	quality control
RPD	relative percent difference

LIST OF ACRONYMS AND ABBREVIATIONS (Continued)

SAP	sampling and analysis plan
SM	standard method
SOP	standard operating procedure
SVE	soil vapor extraction
TB	trip blank
TDS	total dissolved solid
TSS	total suspended solid
URS	URS Group, Inc.
USACE	United States Army Corps of Engineers
Validata	Validata Chemical Services, Inc.
VGAC	vapor-phase granular-activated carbon
VOC	volatile organic compound
µg/L	micrograms per liter
3Q14	third quarter 2014

1.0 INTRODUCTION

This *Third Quarter 2014* (3Q14) *Quarterly Operation and Monitoring Report* for the Modesto Groundwater Superfund Site, in Modesto, California, covers the reporting period of July 1 through 30 September 2014, and describes the monitoring and sampling program, summarizes the performance of the systems, and provides results of routine system operations. The remainder of this section provides an overview of the site history and report organization. For ease of reading, all figures and tables are included at the end of the report.

1.1 Site History

The City of Modesto (City) is in Stanislaus County, California, and is approximately 80 miles southeast of Sacramento (Figure 1-1). The Modesto Groundwater Superfund Site is in a commercial area on McHenry Avenue, south of Orangeburg Avenue, behind Halford's Cleaners (941 McHenry Avenue).

In 1984, through routine sampling of water supply wells, the City discovered contamination in its Municipal Water Supply Well (Municipal Well) 11 (Figure 1-2) at the corner of Magnolia and Mensinger avenues. Laboratory analysis of the Municipal Well 11 sample collected in 1984 indicated tetra-chloroethene (PCE) in excess of the federal and state maximum contaminant level (MCL) of 5 micrograms per liter (μg/L). PCE is an industrial solvent commonly used in dry cleaning and was found to have originated at Halford's Cleaners, approximately 1,000 feet from Municipal Well 11.

Municipal Well 11 was taken out of service by the City in 1984 and reactivated in April 1987 when levels of PCE and other chlorinated solvents were not detected at concentrations above MCLs. In February 1989, Municipal Well 11 was again taken out of service after PCE concentrations exceeded the MCL a second time. The well remained out of service until May 1991 when the City installed a wellhead granular-activated carbon (GAC) treatment system. The GAC system reduced the PCE concentration to below the MCL before the water entered the public supply system. Municipal Well 11 was returned to service in June 1991 and operated until October 1995, when the City indefinitely deactivated the well because naturally occurring uranium was detected above the MCL of 20 picoCuries per liter.

The Modesto Groundwater Superfund Site was placed on the United States Environmental Protection Agency's (EPA's) National Priorities List on 31 March 1989. In December 1989, the EPA's Emergency Response Section collected soil and soil vapor samples in the vicinity of Halford's Cleaners. Fifteen monitoring wells were installed and were sampled from 1992 to 1998. Based on the data obtained, the EPA selected the technology for treatment and removal of the contamination. A soil vapor extraction (SVE) system and a groundwater treatment system (GWTS) were installed on 16 May 2000, and 12 June 2000, respectively, to remediate the source area and contain the groundwater contamination plume.

Results from a site investigation conducted in 2007 and from a soil vapor rebound test conducted from late November 2006 through January 2007 identified significant vapor mass at the northwestern corner of the Halford's Cleaners building and possibly extending underneath the building (see *Soil Vapor Extraction System Optimization and Enhancement Methods, Modesto Groundwater Superfund Site* [MWH Americas, Inc. (MWH), 2008] for summary results). Initial sub-slab vapor sampling in buildings at and near the source area in February 2008 confirmed that high concentrations of PCE in vapor (up to 20,000 parts per billion by volume) were present under the concrete slab foundation of the Halford's Cleaners building (MWH, 2010a). An SVE optimization plan was implemented in November 2008 by installing and extracting vapor from three SVE wells (SVE-02, SVE-03, and SVE-04). The new wells were installed within what is considered to be a source area. SVE-01 was taken offline and is monitored in the quarterly sampling program.

The groundwater monitoring well network was expanded in 2008, 2011, and 2013. In 2008, 16 additional groundwater monitoring wells were installed to evaluate the lateral and vertical extents of the groundwater plume. Subsection 2.3 of the *Quarterly Operations and Monitoring Report, Fourth Quarter 2008* (MWH, 2009) describes a dense non-aqueous-phase liquid investigation (none was discovered).

Nine additional wells (MW-21A through MW-29B) were installed in 2011 to help delineate the lateral and vertical extent of the PCE concentrations in groundwater that exceed the MCL. The letter report *Groundwater Monitoring Well Installations, Modesto Groundwater Superfund Site* (URS Group, Inc. [URS], 2011) describes these installations and includes well construction and boring logs.

URS installed eight additional groundwater monitoring wells (MW-30A through MW-35B) between June and August 2013 to define PCE concentrations in the A, B, and C zones. Nested wells MW-32B and MW-32C and well MW-35B were installed to serve as guard wells for Municipal Wells 6 and 7, respectively (URS, 2013a).

To address the PCE concentrations in groundwater that were migrating farther downgradient, a cone penetrometer test (CPT) investigation was conducted in 2011 to identify an optimal location for an additional interim extraction well (URS, 2012a). An additional CPT investigation was conducted in June 2012 to further define and delineate concentrations detected in the 2011 investigation (URS, 2012b). The area investigated included segments of Griswold Avenue, Hintze Avenue, and private properties adjacent to Griswold Avenue. PCE results from the HydroPunch sample locations indicated that a plume exceeding 1,000 µg/L was present in the A zone beneath Griswold Avenue from approximately Geer Court to 250 feet east of McHenry Avenue. A new extraction well (EW-02) was installed in the area of high PCE concentrations in groundwater, approximately 300 feet south of Halford's Cleaners and approximately 50 feet north of Griswold Avenue, and brought online in September 2012.

Beginning in July 2012, the operation and maintenance (O&M) responsibility of the groundwater treatment system for the site was transferred from the EPA to the California Department of Toxic Substances Control.

1.1.1 Other Nearby PCE Plumes

Two other PCE groundwater plumes, herein referred to as the Elwood's and McHenry Village plumes, have been identified within 1 mile of the Halford's Cleaners site. The Elwood's plume (south of the site) is the more significant because of its close proximity to the Halford's plume and the potential for commingling of the groundwater plumes. The source area of the Elwood's plume is approximately 2,100 feet (0.4 mile) south of Halford's Cleaners near the intersection of Morris and McHenry avenues. PCE has been detected at concentrations as high as 11,000 µg/L in samples from nine shallow monitoring wells at this location. The wells were originally installed to monitor a fuels release from a nearby 7-11 convenience store, which has subsequently closed with regard to fuels release cleanup. Elwood's Dry Cleaners was identified as a responsible party for PCE contamination discovered in groundwater samples from the fuels site. PCE was detected at one well at 8,100 µg/L in September 2005 and at 1,500 µg/L in March 2011 (Tetra Tech, 2011). In 2011, three wells were installed between the Halford's plume (Modesto Groundwater Superfund Site) and the Elwood's plume. The two A zone wells indicate that the Halford's plume is defined to the south in the A zone; however, concentrations at the B zone well exceeded the PCE MCL, indicating that there may be commingling of the Halford's and Elwood's plumes in the B zone.

The McHenry Village PCE plume is approximately 4,650 feet (0.9 mile) north of Halford's Cleaners, at the intersection of McHenry and Briggsmore avenues. PCE from the McHenry Village site has impacted nearby Municipal Well 21. PCE is being actively remediated at this site and has been monitored in groundwater since approximately 1998 in several monitoring wells, including more recently in seven deeper wells screened in the equivalent to the B zone hydrostratigraphic interval. Groundwater monitoring data from September 2008 showed that PCE was present at concentrations as high as 64 µg/L in the deepest monitoring wells screened approximately 120 feet below ground surface (bgs). Thus, the vertical extent of the McHenry Village plume was not defined. Water levels from shallow monitoring wells at other cleanup sites in the region confirm the overall southeastern flow direction observed in the A and B zones at Halford's Cleaners. As such, it appears unlikely that PCE from the McHenry Village plume is affecting areas of the aquifer impacted by the Halford's release 1 mile south (MWH, 2010b).

1.2 Report Organization

This report is organized as follows:

Section 1.0 provides a brief history of the Modesto Groundwater Superfund Site.

Section 2.0 describes the remedial systems.

Section 3.0 describes the sampling programs.

Section 4.0 provides performance evaluations for the GWTS, including a groundwater capture zone analysis.

Section 5.0 summarizes results and provides recommendations for the GWTS and SVE system O&M programs.

Section 6.0 provides an analytical data quality review.

Section 7.0 lists reference information for documents cited in this report.

Tables and figures are provided at the end of the report. The report is supported with the following appendices, which are provided on a compact disc at the end of the report:

Appendix A provides the treatment system process and instrumentation diagrams (P&IDs) for the GWTS and SVE system.

Appendix B provides laboratory analytical data tables.

Appendix C provides laboratory data validation reports.

Appendix D provides system uptime and shutdown tables.

Appendix E provides O&M process logs.

Appendix F provides operational history, including a brief discussion of the routine and non-routine O&M performed on the GWTS.

Appendix G provides historical data, as follows:

G-1 Well Construction Details
G-2 Groundwater Monitoring Well Table Elevations
G-3 Searchable Historical and Current Analytical Data
G-4 Historical PCE Concentration Trends in Groundwater Monitoring Wells
G-5 PCE Mass Removed by the Groundwater Treatment System

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2.0 DESCRIPTION OF REMEDIAL SYSTEM

The Modesto Groundwater Superfund Site GWTS and SVE systems are located behind Halford's Cleaners and between an auto repair shop and Season's Lodge (Figure 2-1). The SVE and GWTS process equipment is contained within two metal storage containers in a fenced and locked compound.

2.1 GWTS

The GWTS includes two operable extraction wells (EW-01R and EW-02, an equalization tank, particulate filters, an air stripper, two liquid-phase GAC (LGAC) vessels, one vapor-phase GAC (VGAC) vessel, and two ion exchange (IX) units, as well as piping and control systems. EW-02 was operating at approximately 46 gallons per minute (gpm) from September 2012 to July 2013 after it was installed to remove PCE mass that had migrated downgradient of EW-01R. However, PCE concentrations near EW-01R began increasing and exceeded PCE concentrations near EW-02 in 1Q13, likely because EW-01R was shutdown in 3Q12 when EW-02 was placed online. Therefore, EW-01R was returned to service on 22 July 2014 and has operated in conjunction with EW-02 to increase mass removal. EW-01R operated 22 July through 30 September 2014 and EW-02 operated during 3Q14. Appendix A includes GWTS P&ID diagrams.

Extracted groundwater is pumped from the equalization tank through the air stripper for primary treatment of PCE. The treated water is then pumped from the air stripper sump through the LGAC vessels to remove remaining PCE concentrations. The VGAC vessel treats the air stream from the air stripper. The IX units are installed in series after the LGAC vessels and treat a slip stream (portion) of the total system flow to remove low levels of naturally occurring uranium from the groundwater before discharge to the City's sewer collection system. The design flow rate of the system is 50 gpm.

The components of the GWTS, except the VGAC vessel, are contained in an 8.5- by 8.5- by 20-foot metal storage container. The VGAC vessel is next to the container within the fenced compound. A secondary containment unit is underneath the storage container. Any water draining into the secondary containment is manually pumped to the equalization tank to be treated before it is discharged to the sewer. Additional information about the GWTS is available in the *Groundwater Treatment System Operation and Maintenance Manual, Modesto Groundwater Superfund Site* (O&M Manual) (URS, 2013b), which details the operating equipment (manufacturers, models, standard settings, inspection frequency, troubleshooting, etc.).

The groundwater monitoring network consists of 48 wells throughout the site in residential and business communities (Figure 2-2). Table G-1 (Appendix G) includes well construction details.

2.2 SVE System

A rebound study was performed between January and December 2014,when the entire system was shut down. Additional details on the study results will be provided in the future SVE Rebound Report of Findings (the draft was submitted for United States Army Corps of Engineers [USACE]/EPA review on 31 March 2015).

The SVE system includes three extraction wells (SVE-02, SVE-03, and SVE-04), a blower, a condensate collection drum, air filters, silencers, one 2,000-pound VGAC vessel, conveyance piping, control systems, and an air conditioning unit. Figure 2-3 shows the locations of SVE wells, vapor monitoring wells, and conveyance piping configuration. Appendix A includes SVE system P&ID diagrams.

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3.0 SAMPLING AND MONITORING PROGRAM

Sampling and monitoring at the Modesto Groundwater Superfund Site is performed in accordance with the *Sampling and Analysis Plan for Long-Term Monitoring, Site Investigations, and Soil Vapor Extractions, Modesto Groundwater Superfund Site* (2013 SAP) (URS, 2013c). Table B-2 (Appendix B) includes sample locations and associated analytical test methods, phase (water, vapor, etc.), and date of sampling activity for the second quarter event.

The quarterly sampling program consists of two types of sampling: site sampling (groundwater and soil vapor) and system sampling. EPA manages both site sampling and SVE system sampling. The SVE system was shutdown 13 January 2014 to allow for a rebound evaluation of soil vapor concentrations following procedures in the *Soil Vapor Extraction Rebound Testing Work Plan, Modesto Groundwater Superfund Site Work Plan* (URS 2013d); therefore, soil vapor samples were collected during 3Q14 as part of the rebound study. The State of California manages the GWTS sampling program.

3.1 Site Sampling and Monitoring

Site sampling to monitor groundwater includes collecting groundwater samples from the network of 48 groundwater monitoring wells and 2 groundwater extraction wells for analysis by EPA Method E524.2. When the SVE system is operating, site sampling to monitor the vadose zone includes collecting vapor samples from the three SVE wells and nine vapor monitoring locations for analysis by EPA Method TO15. Subsection 3.1.1 describes sampling of groundwater wells during 3Q14.

The rebound study was initiated for the SVE system in January 2014. Prior to shutdown, baseline sampling was conducted on 6 and 7 January 2014, which included sampling of all SVE wells, soil vapor monitoring wells, sub-slab monitoring points and an influent to the VGAC vessel of the SVE system. During 3Q14, monthly sampling of selected indoor air, sub slab and MWs to monitor for potential concentration rebound was conducted on 23 and 24 July, 20 and 21 August, and 16 and 17 September 2014. Analytical results for the 3Q14 rebound samples will be provided in the future SVE Rebound Report of Findings (the draft was submitted for USACE/EPA review on 31 March 2015).

3.1.1 Groundwater Sampling and Monitoring

USACE personnel, Sacramento District measured depths to groundwater on 22 and 23 September 2014, and collected groundwater samples between 22 and 24 September 2014. Depth-to-groundwater measurements and groundwater samples were collected from 48 groundwater monitoring wells to evaluate changes in the depth to water and the influence of groundwater extraction on the PCE plume, and to estimate the extent of contamination, horizontal flow directions, and plume capture (the portion of a groundwater plume that is expected to flow into an extraction well assuming it continues operating consistently for a period of time).

Groundwater elevations are also used to evaluate potential vertical groundwater flow directions and to develop groundwater elevation contour maps. Groundwater elevations calculated from water levels measured with an electronic water level meter at A, B, and C zone wells during 3Q14 were contoured using the Natural Neighbor function in ArcGIS 10 and adjusted using professional hydrogeologic judgment.

Groundwater samples were collected starting with the least contaminated groundwater monitoring well and continuing in order to the most contaminated groundwater monitoring well; the order of sampling is established using previous quarterly analytical results. Groundwater samples were collected using passive diffusion bags. Samples from operating extraction wells (EW-02 and EW-01R) were collected from sample port number 1 (SP-01) at the GWTS influent line and analyzed for volatile organic compounds (VOCs) using EPA Method E524.2.

The 2010 *Sampling and Analysis Plan, Modesto Groundwater Superfund Site* (2010 SAP) describes sampling procedures (URS, 2010). Water purged from the groundwater monitoring wells during sampling was transferred through a bag filter into the GWTS equalization tank.

3.2 System Sampling and Monitoring

Sampling and monitoring of the GWTS system at the Modesto Groundwater Superfund Site were performed in accordance with the City of Modesto 2013 Groundwater Discharge Permit GW0098 (City of Modesto, 2013), and the 2010 SAP (URS, 2010). Generally, two categories of samples are collected from the remedial systems: compliance monitoring and performance monitoring. Compliance monitoring samples are collected to satisfy regulatory requirements; performance monitoring samples are collected to assess the contaminant removal processes of the remedial systems.

3.2.1 Groundwater System Sampling and Monitoring

Compliance monitoring samples for the GWTS are collected monthly and quarterly from the system influent and effluent as the system is operating. System effluent samples are analyzed monthly for VOCs (Method E524.2), total dissolved solids (TDS) (Standard Method [SM] 2540C), total suspended solids (TSS) (Method SM2540D), biochemical oxygen demand (BOD) (Method SM5210B), quarterly for total uranium (Method American Society for Testing and Materials [ASTM] D5174), and annually for bioassay. Performance samples are collected monthly to monitor and assess the performance and efficiency of the air stripper, LGAC, IX media, and VGAC. The GWTS VOC performance monitoring samples (analyzed by Method E524.2) are collected from the carbon influent, carbon mid-bed, and carbon effluent. The GWTS uranium performance monitoring samples are collected from the post carbon/pre-IX, IX mid-bed, and IX effluent and analyzed using Method ASTM D5174. The vapor (airstripper off-gas) performance samples are collected at the VGAC influent and effluent (stack) and analyzed using Method TO15. Figures 1-1 and 1-2 in Appendix A illustrate the sampling port locations for the GWTS. Appendix B presents analytical data tables for the 3Q14 sampling event.

4.0 PERFORMANCE EVALUATION

Subsections 4.1 and 4.2 discuss site and system performance evaluations, respectively, based on current and historical analytical results. The site performance evaluation estimates the current extent of contamination and the hydraulic gradients affecting plume migration directions. System sampling helps evaluate the remedial progress of the GWTS and SVE system.

Section 6.0 provides a summary of the quality assurance (QA) and quality control (QC) results for the samples collected during 3Q14. Appendix B provides a complete set of validated analytical data for groundwater collected during the 3Q14 reporting period. Table B-2 summarizes the sample results from monitoring wells. Table B-3 summarizes results for the groundwater treatment system, including EW-02 and EW-01R (listed as GWTS-INF). Appendix C includes the laboratory data validation reports for this reporting period's analytical data.

4.1 Site Performance

Subsection 4.1 provides 3Q14 results of the groundwater sampling events. Figures 4-1, 4-2, and 4-3 show the stratigraphic conceptual model in the northwest to southeast, west to east, and southwest to northeast directions, respectively.

Subsection 4.1.2 presents an analysis of vertical groundwater gradients, and Subsection 4.1.3 provides the capture zone analyses from EW-01R and EW-02.

4.1.1 Groundwater Monitoring and Sampling Results

Groundwater elevations decreased in all monitoring wells between 2Q14 and 3Q14. Based on water levels measured between 22 and 23 September 2014, groundwater elevations ranged from 41.92 feet mean sea level (msl) at MW-16A to 47.45 feet msl at MW-31A in the A zone. Groundwater elevations ranged from 41.55 feet msl at MW-33B to 46.13 feet msl at MW-30B in the B zone, and 33.85 feet msl at MW-04C to 37.59 feet msl at MW-17C in the C zone. Between 2Q14 and 3Q14, groundwater elevations decreased an average of 3.08 feet in A zone wells, decreased an average of 4.14 feet in B zone wells, and decreased an average of 9.77 feet in C zone wells. The magnitude of these quarter to quarter changes in groundwater elevation are greater for 2Q14 to 3Q14 than in previous quarters and may indicate the City of Modesto's increased reliance on groundwater (i.e., increased pumping) because of the reduced volume of available surface water due to the statewide drought. Groundwater elevations are expected to decline as the drought continues into its fourth consecutive year. Appendix G presents historical and current water level measurements and analytical data.

Figure 4-4 shows groundwater elevations trends at nine selected A zone wells. The wells were selected to provide representative groundwater elevation behavior across the A zone plume. As shown in Figure 4-4, groundwater elevations decreased in all nine wells between 1.19 feet at MW-31A and 3.69 feet at MW-20A between 2Q14 and 3Q14 and are at the lowest levels in this group of wells since 2010 or since their first measurement.

Figures 4-5, 4-6, and 4-7 show potentiometric surface data, groundwater flow directions, and PCE concentration data for the A, B, and C zones, respectively. Hydraulic gradients indicated by the potentiometric contours indicate that groundwater in the A and B zones flows southeast across the site. In the vicinity of EW-02 and EW-01R, A zone groundwater flows toward the hydraulic depression created by the operation of these wells (Figure 4-5). Section 2.1 discusses the restart of EW-01R.

The average hydraulic gradient parallel to the direction of regional groundwater flow in the A zone was approximately 0.002 foot per foot (ft/ft), or approximately 10.1 feet per mile, to the southeast in 3Q14 (Figure 4-5). The approximate B zone gradient was also 0.002 ft/ft, or approximately 10.1 feet per mile, to the southeast in 3Q14 (Figure 4-6). Groundwater in the C zone was flowing northeast with a horizontal gradient of approximately 0.0033 ft/ft, or 17.6 feet per mile in 3Q14 (Figure 4-7).

In general, the gradient direction in the C zone has been observed to be more westerly during the third quarters (either southwest or south-southwest) and more easterly during the fourth and first quarters (southeast or south-southeast). The groundwater flow direction in 3Q14 was to the northeast, which is atypical, but may indicate increased pumping at Municipal Well 12, which is located approximately 750 feet east of Halford's Cleaners, respectively, and thus may explain the shift in the groundwater flow direction in the C zone. As discussed in previous groundwater reports for the site, the gradients in this deeper zone are strongly influenced by regional supply well pumping that increases during the spring and summer months (MWH, 2010a). Pumping histories from January 2000 through August 2009 for City supply wells surrounding the site are compiled in Appendix B of the *Groundwater Remediation Optimization Methods*, *Modesto Groundwater Superfund Sites* (MWH, 2010b).

To evaluate the potential hydraulic influence on the extents of PCE plumes from the operation of Municipal Wells 6 and 7, URS installed transducers in six A zone, five B zone, and three C zone monitoring wells between 28 June and 7 December 2011. Evaluation of the data collected using the transducers indicated that municipal well pumping has a greater effect on C zone water levels than on A or B zone levels, and pumping at these municipal wells increases the prevailing downward gradient between the A zone and B zone and between the B zone and the C zone. Increases in the downward gradient can result in downward migration of PCE beneath portions of the site.

The southern portion of the plume most likely would be influenced throughout the calendar year by pumping at Municipal Wells 6 and 7 located southeast and southwest, respectively, of the southern boundary of the plume (Figures 4-6 and 4-7). Municipal Well 12 may have had a stronger hydraulic influence in 3Q14, causing the northeastern flow direction in 3Q14. Additional details on this evaluation are provided in the *Interpretation of Local Groundwater Level Changes and Influences from City of Modesto Municipal Water Supply Wells Nos. 6 and 7 Technical Memorandum* (URS, 2012c). Further evidence that municipal well pumping is influencing plume migration is that PCE concentrations exceeding the MCL were reported in samples collected at MW-16C in 1Q13 through 3Q13 and again in 2Q14 and 3Q14 after having results less than the MCL from 4Q08 to 4Q12. Increased PCE concentrations in the C zone are consistent with increased pumping from municipal wells with screens or perforations in the C zone or deeper during summer months. Subsection 4.1.1.1 provides details of the PCE reported in the C zone.

4.1.1.1 PCE

In 3Q14, PCE was detected at concentrations exceeding the 5 µg/L MCL at EW-01R and EW-02 and at 23 monitoring wells. PCE concentrations are shown on Figures 4-5, 4-6, and 4-7 for the A, B, and C zones, respectively, and as composite plumes on Figure 4-8. The distribution of PCE concentrations greater than 5 µg/L in groundwater is illustrated with isoconcentration contour lines (lines of equal concentration). The distribution of PCE concentrations is also illustrated on generalized geologic cross-sections that dissect the site along northwest to southeast (Figure 4-9) and west to east (Figure 4-10) lines. Table B-2 (Appendix B) includes current quarterly groundwater monitoring well analytical results. Figures G-4(a) through G-4(av) (Appendix G-4) show PCE time series plots for monitoring wells MW-01A through MW35B.

A Zone

As depicted on Figure 4-5, the PCE MCL plume is approximately 1,750 feet long, parallel to the primary hydraulic gradient direction, and approximately 2,175 feet wide in the east-west, cross-gradient direction. The northwest-southeast axis of the A zone plume parallels the primary gradient direction.

In 3Q14, the PCE plume is defined in most areas except in the southwest direction near MW-31A. PCE at MW-31A, approximately 865 feet southwest of MW-23A, exceeded the MCL for the third consecutive time since the well was installed in 3Q13. PCE concentrations have fluctuated seasonally at MW-13A from just above to below the MCL, resulting in the PCE plume being undefined during quarters when the PCE results were greater than the MCL. In 3Q14, the PCE result at MW-13A (1.6 µg/L) was less than the MCL.

EW01R was restarted in July. Wells were sampled 2 months later in September 2014. PCE concentrations at MW-3A, MW-4A, and MW-8A, have decreased since EW-01R was restarted. These wells are located approximately 30, 150, and 100 feet, respectively, from EW-01R. The PCE concentration decreased from 420 µg/L in 2Q14 to 150 µg/L in 3Q14 at MW-3A; from 300 µg/L in 2Q14 to 140 µg/L in 3Q14 at MW-4A; and from 31 µg/L in 2Q14 to less than the reporting limit in 3Q14 at MW-8A. These wells will continue to be monitored to evaluate the effectiveness of EW-01R. Section 4.1.3 discusses plume capture by EW-01R, when operating, and EW-02.

PCE was detected historically in Municipal Wells 14 and 8, approximately 2,375 feet (0.45 mile) west and 5,320 feet (1.0 mile) west-southwest, respectively, of Halford's Cleaners. Municipal Wells 8 and 14 have been offline since 2007 and 2006, respectively (MWH, 2010b); however, the plume may have been drawn toward Municipal Wells 8 or 14 before they were shut down. Municipal Well 17, more than 3,500 feet northwest of the monitoring wells, has remained in consistent operation and may have some hydraulic influence on the plume because it has a 40-foot-long screened interval approximately 25 feet lower than the screened zones of MW-13A, MW-14A, MW-23A, MW-30A, and MW-31A and had an open borehole from 204 to 232 feet bgs at the time of construction. There are no wells positioned to provide data that would indicate whether the hydraulic influence of pumping at Municipal Well 17 is affecting the PCE plume. However, the well location is hydraulically opposite from the predominant gradient direction and the distance between it and behavior of water levels in the monitoring wells near the plume makes it unlikely that its hydraulic influence is measurable in the Halford's plume area. Municipal Wells 6 and 7, alternatively, are closer to the plume than Municipal Wells 14 and 17 and are still operating. The *Interpretation of Local Groundwater Level Changes and Influences from City of Modesto Municipal Water Supply Wells Nos. 6 and 7 Technical Memorandum* (URS, 2012c) reports that water levels at some A zone monitoring wells had slight responses when Municipal Wells 6 and 7 were operating. Municipal Well 6 is screened in the A and B zones and, though Municipal Well 7 is screened below the A zone (in the B zone), pumping at Municipal Wells 6 and 7 may be affecting the migration of the A zone plume.

A sewer line running beneath Griswold Avenue just north of MW-23A could contribute to the PCE detections at MW-23A. Discharges from Halford's Cleaners to the sewer line have been identified as a source of contamination to the subsurface. Sewer lines south of the former Elks Club and west of Halford's Cleaners were sampled during August 1985 (MWH, 2010b). A PCE concentration of 1,040 parts per million was reported in a sewer sediment sample collected at the manhole where the north-south sewer line intersects with an east-west sewer line beneath Griswold Avenue. It is possible that PCE flowed down-sewer to that intersection and leaked from the sewer along Griswold Avenue resulting in the high concentrations exceeding 1,000 µg/L in HydroPunch samples collected along the east-west sewer line with an axis that is nearly perpendicular to the southeast hydraulic gradient of the A zone (Figure 4-10). Westerly flow and releases along the Griswold Avenue sewer line may account for the

PCE concentrations of between 5 and 50 µg/L reported at the wells in the west portion of the A zone plume such as MW-23A. The sewer line extends to Enslen Avenue, south on Enslen Avenue, then west on Coldwell Avenue (Figure 4-5).

B Zone

Figure 4-6 depicts the B zone PCE plume and potentiometric surface contours. In 3Q14, PCE was detected above the MCL at 11 of the 18 B zone wells. The plume is approximately 2,400 feet long parallel to the predominant gradient direction (northwest/southeast) and has a width of approximately 2,700 feet.

Data from the B zone wells indicate that the hydraulic axis of the plume trends northwest to southeast. The B zone plume shape likely has been hydraulically influenced by pumping at municipal wells. The *Interpretation of Local Groundwater Level Changes and Influences from City of Modesto Municipal Water Supply Wells Nos. 6 and 7 Technical Memorandum* (URS, 2012c) indicates that water levels at most B zone monitoring wells had slight responses when Municipal Wells 6 and 7 were operating. The maximum observed water level changes were -0.24 and -0.19 foot at MW-09B and MW-17B, respectively, when pumping at Municipal Well 6 was evaluated and -0.19 and -0.32 foot at MW-16B and MW-19B, respectively, when pumping at Municipal Well 7 was evaluated. Municipal Well 6 is screened in the A and B zones and Municipal Well 7 is screened in B zone; therefore, pumping at Municipal Wells 6 and 7 may be hydraulically influencing the B zone plume.

Prior to 3Q13, the PCE plume in the B zone was undefined in the northern, western, and southeastern directions. In 3Q13, MW-30B and MW-34B were installed to define the plume in the northern and western directions, respectively, and MW-32B and MW-33B were installed to define the plume in the southeast direction. The PCE concentrations at MW-30B, MW-32B, and MW-33B were less than the MCL or not detected in 3Q14; therefore, the plume is defined in the northwestern and southeastern directions. The PCE plume was currently defined west of MW-34B because the 3Q14 PCE concentration at MW-34B was less than the MCL for the first time since its construction.

MW-35B was installed as a guard well for Municipal Well 7. The 3Q14 PCE concentration at MW-35B (9.2 µg/L) exceeded the MCL for the fourth consecutive quarter indicating that the 5 µg/L PCE plume has migrated cross-gradient to within 350 feet of Municipal Well 7 because of its hydraulic influence when pumping. In 3Q14, the plume was undefined west of MW-35B.

The northern portion of the 5 µg/L PCE plume has been undefined since 1Q12. PCE concentrations at MW-09B have exceeded MCLs but have been decreasing since 1Q12. The 3Q14 PCE concentration at MW-09B was 6.9 µg/L.

C Zone

Figure 4-7 shows groundwater elevation contours and PCE concentration data for the C zone. In 3Q14, PCE was detected at concentrations less than the MCL at all C zone wells except for MW-04C (9.3 µg/L) and MW-16C (21 µg/L). The PCE concentration at MW-4C was greater than the MCL in 3Q14 for the first time since 3Q13. In 3Q14, the plume was undefined north of MW-4C. PCE concentrations at MW-16C have been fluctuating above and below the MCL since 1Q13 (Appendix G-4v). Well MW-32C screened in the C zone was installed between MW-16C and Municipal Well 6 to define the downgradient extent of concentrations exceeding the MCL and to serve as a guard well for Municipal Well 6. PCE has not exceeded the reporting limit in any groundwater samples collected from MW-32C.

No other PCE detections exceeding the MCL were reported in samples from C zone wells in 3Q14.

4.1.1.2 Other VOCs

Other than PCE, no VOCs exceeded MCLs in 3Q14. Other VOCs have been reported at site wells in previous quarters. However, Halford's Cleaners is unlikely to be the source of these other VOCs in groundwater (unless they are PCE degradation products) because these other VOCs have not been detected at MW-01A, MW-05A, or MW-08A—the wells nearest to Halford's Cleaners. For that reason, no further speculation about the sources of VOCs other than PCE and its degradation products is provided, as this report is an evaluation of the contamination from Halford's Cleaners.

4.1.2 Analysis of Vertical Groundwater Gradients

Vertical gradients were calculated using 3Q14 data at one well pair with screens in the A zone, nine well pairs with screens in the A or B zones, and six well pairs with screens in the B or C zones. Table 4-1 summarizes the vertical gradients for each well pair. For comparison, Table 4-1 also lists vertical gradients calculated for 1Q14 and 2Q14. Figures 4-9 and 4-10 also depict the direction of vertical gradients between well pairs along cross-sectional planes.

There was a downward gradient within the A zone between MW-21A/MW-22A. One of the nine A zone-B zone well pairs indicated an upward gradient (MW-21A/MW-25B). The remaining eight A zone-B zone well pairs indicated a downward gradient. All six B zone-C zone well pairs indicated a downward gradient.

Well pairs MW-16A/MW-16B, MW-16B/MW-16C, and MW-32B/MW-32C all indicate downward gradients from both the A to the B zone and the B to the C zone. These downward gradients likely are caused by the hydraulic influence of pumping at Municipal Well 6, which, in turn, contributes to the increase in PCE concentrations at the B and C zone wells discussed in Subsection 4.1.1.1.

4.1.3 Extraction Wells Capture Zone Analyses

Figures 4-9 and 4-11 show estimated groundwater plume capture from extraction wells EW-01R and EW-02. EW-01R operated from 22 July to 30 September at a rate of approximately 23 gpm. EW-02 operated at a rate of approximately 25 gpm through the full quarter. These rates were selected to ensure that the combined flow rate would not exceed the maximum flow rate (50 gpm) allowed in the City of Modesto 2013 Groundwater Discharge Permit GW0098 (City of Modesto, 2013).

Two lines of evidence (groundwater elevation contours developed with 3Q14 data and particle tracks developed with the site's groundwater model, MODFLOW) were used to estimate the extent of capture presented on Figure 4-9 and projected onto Figure 4-11. A model simulation predicting 3Q14 particle tracks EW-01R was performed for the first time since the well was shutdown in 3Q12.

Figure 4-11 shows the estimated capture zone as a curved line consisting of the estimated stagnation points near EW-01R and EW-02. The extent of capture in the A zone estimated with the model's simulation of EW-01R and EW-02 pumping at 23 and 25 gpm, respectively, as the sweep of groundwater flow lines toward the wells based on reverse particle tracking (i.e., particles released at the well and modeled backward to determine their starting points). Though the flow rate of EW-02 was reduced from approximately 48 to 25 gpm to accommodate extraction at EW-01R in 3Q14, the interpreted extent of 3Q14 capture was similar to the extent of capture interpreted in previous quarters when the well operated at full capacity.

The downgradient extent of capture of EW-01R is interpreted to extend to MW-4A. The downgradient extent of capture of EW-02 is interpreted to extend to the location of MW-10A.

Figure 4-9 shows the estimated vertical extent of capture by EW-01R and EW-02. The downgradient extent of capture depicted in profile view is based on both the empirical and modeled lines of evidence. The vertical capture zone extent below the screens of EW-01R and EW-02 is an estimate based on water level data, modeling, and vertical gradients. Vertical gradients calculated using 3Q14 groundwater elevation data from wells near EW-02 (MW 04A/MW 04B) were upward from the B to the A zone. Therefore, the estimated capture zone has been drawn deeper below the bottom of the screened interval of EW-01R and EW-02.

4.2 System Performance

System compliance and performance samples were collected to evaluate the effectiveness of the remedial systems. Water, vapor, and media samples were collected according to requirements in the SAP (URS, 2010) and the City of Modesto 2013 Groundwater Discharge Permit GW0098 (City of Modesto, 2013). Treatment system effluent samples collected during the reporting period for vapor emissions and sewer discharge were below maximum allowable discharge limits.

4.2.1 GWTS Results

During 3Q14, the GWTS operated for approximately 2,184 hours (out of 2,208 hours possible during the quarter), an uptime of approximately 99 percent. Tables D-1 through D-3 (Appendix D) present GWTS shutdown summaries for July, August, and September, respectively.

The GWTS treated a total of approximately 6.1 million gallons of water and removed approximately 6.8 pounds of PCE during this reporting period. From August 2001 through 3Q14, the system has treated approximately 245 million gallons of water and has removed approximately 652 pounds of PCE. Figure 4-12 is a graph illustrating the cumulative PCE mass removed by the GWTS since it began operation in August 2001.

During the 3Q14 reporting period, the GWTS pumped and treated groundwater from EW-02 (entire quarter) and EW-01R (22 July through 30 September 2014). The influent PCE concentrations were 170, 110, and 110 µg/L during July, August, and September, respectively. Samples were also analyzed for uranium. Table B-3 (Appendix B) provides a summary of treatment system analytical results for 3Q14; Table 4-2 summarizes PCE results for 3Q14.

5.0 RECOMMENDATIONS

This section provides a summary of observations and recommendations for the GWTS and SVE system.

5.1 GWTS – Summary Observations and Recommendations

The PCE MCL plume is only partially captured in the A zone (Figures 4-5, 4-9, and 4-11), though the extent of capture has improved since EW-02 was brought online in September 2012. EW-01R was restarted in 3Q14 and operated at 23 gpm to improve capture near MW-3A. These rates were selected to ensure that the combined flow rate would not exceed the maximum flow rate (50 gpm) allowed in the City of Modesto 2013 Groundwater Discharge Permit GW0098 (City of Modesto, 2013).

Based on 3Q14 data, the known extent of the plume is approximately 1,750 feet long, parallel to the primary gradient direction. Data from MW-31A indicate that the plume is approximately 2,175 feet wide in the east-west, cross-gradient direction (Figure 4-5). In the B zone, the plume is approximately 2,400 feet long, parallel to the primary gradient direction (northwest/southeast), and an estimated 2,700 feet wide in the B zone based on data obtained from MW-34B (Figure 4-6). PCE concentrations at two C zone wells exceeded the MCL in 3Q14 (Figure 4-7).

Data collected in 3Q14 indicate that the PCE plume was not fully defined in the A zone. Concentrations at MW-31A and MW-13A have fluctuated above and below the MCL from quarter to quarter (Figures G-4[q] and G-4[aq] [Appendix G]). The PCE concentration at MW-31A exceeded the MCL, whereas the PCE concentration was less than the MCL at MW-13A in 3Q14. Additional analytical data are necessary to determine if groundwater at MW-31A will exhibit fluctuations similar to those historically exhibited at MW-13A. An additional well screened in the A zone may be needed west-southwest of MW-31A to define A zone concentrations in this direction.

PCE concentrations at MW-03A and MW-04A decreased in 3Q14, which is attributed to the operation of EW-01R. Well EW-01R returned to service and operated in conjunction with EW-02 in 3Q14, with the intent of reducing PCE concentrations in groundwater at MW-03A. EW-01R operated for 3 months between its startup (22 July) and sample dates (24 September) and the PCE concentration at MW-03A decreased from 420 µg/L in 2Q14 to 150 µg/L in 3Q14.

The interpreted extent of capture from pumping both EW-02 and EW-01R was similar to the extent of capture in previous quarters when only EW-02 was online. The downgradient extent of capture of EW-01R is interpreted to extend to location of MW-4A. The downgradient extent of capture of EW-02 is interpreted to extend to the location of MW-10A.

The plume exceeding the MCL in the B zone is undefined in the north (near MW-09B) and southwest (near MW-35B) directions. MW-34B was installed to delineate the western plume extent; however, the PCE result at this well has exceeded the MCL every quarter since its installation in 3Q13 except 3Q14, indicating that the plume may not be defined west of MW-34B in the future. Therefore, wells screened in the B zone may be needed west and southwest of MW-34B and north of MW-09B to define B zone concentrations in these directions. In addition, Municipal Well 7 should be sampled for PCE to determine if the plume present at MW-35B has reached it.

The downward gradients from the A zone to the B zone, from the B zone to the C zone, and increased concentrations at MW-16C are likely influenced by pumping at Municipal Well 6. Groundwater at well pair MW-32B and MW-32C has the potential for downward flow that would result in plume migration from the B zone to the C zone. Therefore, decreasing the flow rates at Municipal Wells 6 and 7 should be considered to reduce the potential for affecting PCE plume migration, and PCE concentrations should continue to be monitored at Municipal Wells 6 and 7 (URS, 2012c). Decreasing the flow rates at Municipal Well 12, if operating, should also be considered to lessen the effect on the groundwater flow direction in the C zone.

Additional monitoring wells may also be needed to determine the potential for commingling of the Halford's and Elwood's plumes. Additionally, groundwater extraction wells may be needed to prevent migration of a commingled plume toward water supply wells. In 3Q14, the greatest threat of PCE impacting a municipal well was in the area southwest of MW-35B, where the plume appears to be migrating toward Municipal Well 7. Increased extraction and other remediation alternatives (i.e., in situ treatment) are being evaluated in the draft feasibility study (URS, pending).

5.2 SVE – Summary Observations and Recommendations

SVE system shutdown, rebound monitoring, and monitoring of indoor air concentrations was implemented beginning January 2014 in accordance with the *Soil Vapor Extraction Rebound Testing Work Plan, Modesto Groundwater Superfund Site Work Plan* (URS, 2013d). Results of the rebound study will be reported at the completion of the study in the SVE Rebound Study Report of Findings (the draft was submitted for USACE/EPA review on 31 March 2015).

6.0 QUALITY CONTROL SUMMARY REPORT

6.1 Introduction

This section summarizes QA/QC results for samples collected and data generated during the period of July through September 2014 (3Q14) at the Modesto Groundwater Superfund Site. Sampling activity protocols are provided in the 2010 SAP (URS, 2010) and 2013 SAP (URS, 2013c). Based on the data review, all data collected during this period are of known and acceptable quality in relation to the data quality objectives (DQOs) of this project. All data are considered usable as qualified for the intended purposes.

Between 10 July and 24 September 2014, field samples, field duplicates (FDs), and field QC samples were collected for groundwater and air samples. Water samples were collected from the GWTS and existing monitoring wells. Air samples were collected from the GWTS and SVE system rebound study. Table B-1 (Appendix B) lists contaminants of concern at the Modesto Groundwater Superfund Site. Analyses performed include the following:

Site and system sampling and monitoring analyses:

ALS Laboratory Group (ALS) (formerly Columbia Analytical Services)

- TDS by SM2540C: 3 normal samples (NS)
- TSS by SM2540D: 3 NS
- BOD by SM5210B: 3 NS
- VOCs in water by EPA Method E524.2: 13 NS, 2 FD, 3 trip blanks (TBs), 1 field blank (FB) and 3 matrix spike/matrix spike duplicates (MS/MSDs)

Eurofins/Air Toxics, Inc. (Eurofins)

- VOCs in air by EPA Method TO15: 6 NS

EPA Region 9 Laboratory

- VOCs in water by EPA Method E524.2: 48 NS, 4 FDs, 4 TBs, 1 FB, and 3 MS/MSDs

GEL Laboratories, LLC (GEL)

- Total uranium by ASTM D5174: 10 NS, and 3 MS/laboratory duplicates

Table B-2 (Long-Term Monitoring) and Table B-3 (GWTS) (Appendix B) summarize these sample results.

Analytical chemistry services are provided by the ALS in Kelso, Washington; Eurofins in Folsom, California; EPA Region 9 laboratory in Richmond, California; and GEL in Charleston, South Carolina. All laboratories are certified by the California Department of Health Services through the Environmental Laboratory Accreditation Program to perform hazardous waste analyses.

All EPA Region 9 analytical results were validated by Validata Chemical Services, Inc. (Validata) in Duluth, Georgia, using the criteria established in the SAP, analytical methods, and EPA Region 9 laboratory standard operating procedures (SOPs), as well as the National Functional Guidelines for Superfund Organic Methods Data Review (EPA, 2008). The sample results validated by Validata were validated electronically. The URS project chemist reviewed all remaining data using criteria established in analytical methods and the laboratories SOPs. Appendix C provides data validation reports and qualified data tables. Several data validation flags were used in the validation process. The definitions of these qualifier flags are below:

U Indicates the compound or analyte was considered not detected due to external contamination.

UJ Indicates the compound or analyte was analyzed for but not detected at or above the stated limit. The sample detection limit is an estimated value.

J Indicates the analyte was positively identified; the associated numerical value is an approximate concentration of the analyte in the sample.

R QC indicates that the result is not usable. The presence or absence of the compound or analyte cannot be verified or the reported result is compromised as to be unusable.

6.2 DQOs

DQOs are qualitative and quantitative statements that specify the quality of the data required to meet the goals of site investigations and support decisions made in remedial response activities. Data quality was assessed in terms of its precision, accuracy, representativeness, completeness, and comparability (PARCC). These criteria are briefly defined in the following subsections. The results of the field and laboratory QC checks are evaluated against the DQOs, and the quality of the data is assessed according to PARCC parameters. QC sample results that fall outside of these criteria serve to signal the production of unacceptable or biased data that could result in the implementation of corrective action or the qualification of data.

6.2.1 Precision

Precision is a measurement of mutual agreement among individual measurements of the same property, usually under prescribed conditions. Data evaluated to assess precision consist of results from the analysis of FD pairs and MS/MSD samples. The precision measurement is established using the relative percent difference (RPD) between the duplicate sample results, and is expressed as:

$$RPD = \frac{\lfloor X_1 - X_2 \rfloor}{\left[\left(X_1 + X_2 / 2\right)\right]} \times 100$$

Where:

X_1 and X_2 represent the individual concentrations of the target analyte in the two replicate analyses.

6.2.2 Accuracy

Accuracy is defined as the proximity of the mean of a set of results to the true value. Accuracy is assessed through the evaluation of initial and continuing calibration data, as well as laboratory control sample

(LCS) recoveries, surrogate standard recoveries, and MS recoveries, which are expressed as a percent recovery according to the following equation:

$$\text{percent recovery} = \frac{(\text{spiked sample conc.} - \text{sample conc.})}{\text{known conc. of spike}} \times 100$$

6.2.3 Representativeness

Representativeness is defined as the degree to which sample data accurately and precisely represent the characteristics of the site, parameter variations at a sampling point, or environmental conditions. Representativeness, in terms of sample integrity for this investigation, was qualitatively evaluated based on the analysis of TBs, FBs, and method blank (MB) samples. In addition, sample collection and handling methods and the cooler receipt forms were reviewed to confirm that samples were received under proper storage conditions.

6.2.4 Completeness

Two types of completeness have been evaluated for this project. Analytical completeness is the number of unqualified results related to the total number of results reported, expressed as a percentage. The analytical completeness goal is 90 percent. Technical completeness is the number of valid results related to the total number of results reported, expressed as a percentage. The technical completeness goal for this project is 95 percent.

6.2.5 Comparability

Data comparability is achieved by using standard analytical methods and reporting limits, and by using standard units of measurements, as specified in the methods. Comparability is a qualitative parameter.

6.3 Quality Control Results

The following subsections summarize the data review process and results in terms of PARCC criteria, as defined in the 2010 SAP (URS, 2010) and 2013 SAP (URS, 2013c). Appendix C provides qualified data based on this review process.

6.3.1 Precision and Accuracy

Precision and accuracy were evaluated based on the results of QC samples collected by the field team and QC samples that originated in the laboratory. The calculated RPD for MS/MSDs and FD pairs provided information on the precision of sampling and analytical procedures. MS/MSD analyses were associated with all samples for this sampling event. All data were reviewed for accuracy based on the surrogate spike, MS/MSD, and LCS percent recoveries**.** The criteria used for the evaluation are provided in the Quality Assurance Project Plan found in the 2010 SAP (URS, 2010) and 2013 SAP (URS, 2013c). Appendix C provides data validation findings. Tables B-2 and B-3 (Appendix B) provide FD results.

6.3.2 Representativeness

Representativeness was evaluated through the analysis of FB, TB, and MB samples. Additionally, sample collection and handling methods and the cooler receipt forms were reviewed. All sample bottles were received in good condition and the chain-of-custody documents agreed with the sample labels.

TBs are required to accompany each cooler of aqueous samples sent to the laboratory for analysis of VOCs. One TB accompanied each cooler for each of the sampling dates. Tables B-2 and B-3 (Appendix B) list TB detections.

FBs are used to determine if potential sample contamination has occurred during the sample collection process. FBs are analyzed using the same analytical procedures as the associated samples. Tables B-2 and B-3 (Appendix B) provides FB detections.

MBs are processed through the same analytical procedures as the associated samples. MBs are analyzed with each batch of samples to provide information on contamination originating in the analytical process. MB detections are indicated in the data validation report provided in Appendix C.

6.3.3 Completeness

Completeness of data was evaluated by assuring that all analytical requests were met, samples were received in proper condition, and all analyses were performed within the appropriate holding times. Overall analytical completeness met the project goal of 90 percent. Details are provided in the data validation report in Appendix C. The overall technical completeness for this data set exceeded the project goal of 95 percent. Refer to Appendix C for a breakdown of completeness by method.

6.3.4 Comparability

Comparability was evaluated for this sampling event by analyzing all samples according to the specified EPA analytical methods, which use standard units of measurement. Necessary sample dilutions, due to the presence of elevated target compound concentrations, did not affect data usability and comparability. Results for some analytes are reported below the practical quantitation limit (PQL) but above the method detection limit (MDL). The “J” flag has been applied to results reported between the MDL and the PQL.

6.4 Summary of Data Reliability

Based on this evaluation, all data collected during this period are of known and acceptable quality in relation to the DQOs of this project. All data are considered usable as qualified for the intended purposes.

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TABLES

Table 4-1. Vertical Gradients, Third Quarter 2014

Well No.	Monitoring Zone	Groundwater Elevation (feet msl)	3Q14 Vertical Gradient	2Q14 Vertical Gradient	1Q14 Vertical Gradient
MW-21A	A	42.10			
MW-22A	A	42.24	-0.0035	-0.0065	0.0045
MW-04A	A	44.10			
MW-04B	B	43.55	-0.0083	0.0118	0.0139
MW-08A	A	45.17			
MW-09B	B	43.89	-0.0172	-0.003	0.0065
MW-10A	A	44.16			
MW-10B	B	43.46	-0.0084	0.0021	0.0033
MW-16A	A	41.92			
MW-16B	B	41.88	-0.0008	-0.0004	-0.0004
MW-17A	A	43.69			
MW-17B	B	43.12	-0.011	-0.0004	0.0017
MW-19A	A	42.87			
MW-19B	B	41.77	-0.0238	-0.0112	-0.01
MW-20A	A	43.13			
MW-20B	B	42.37	-0.01	-0.0014	-0.0012
MW-21A	A	42.10			
MW-25B	B	42.92	0.0149	0.0058	0.0005
MW-30A	A	47.24			
MW-30B	B	46.13	-0.0198	-0.0032	0.0011
MW-04B	B	43.55			
MW-04C	C	33.85	-0.117	-0.0124	0.0006
MW-10B	B	43.46			
MW-10C	C	36.48	-0.1045	-0.018	-0.0033
MW-16B	B	41.88			
MW-16C	C	35.75	-0.0631	-0.0131	-0.0022
MW-17B	B	43.12			
MW-17C	C	37.59	-0.0594	-0.0162	-0.0054
MW-20B	B	42.37			
MW-20C	C	35.79	-0.0903	-0.0145	0.003
MW-32B	B	41.83			
MW-32C	C	36.82	-0.0619	-0.0114	-0.0036

msl = mean sea level
3Q14 = third quarter 2014

positive gradient = upward
negative gradient = downward

Table 4-2. GWTS PCE Sample Results: Third Quarter 2014

Sample Port	Location	Sample Date	pH	PCE (µg/L)
SP-01	GWTS Influent	7/10/2014	7.41	170
		8/7/2014	7.34	110
		9/4/2014	7.19	110
SP-03	LGAC Influent	7/10/2014	8.45	4.6 (4.6)
		8/7/2014	8.42	2.1
		9/4/2014	8.54	2.5
SP-04	LGAC Mid Bed	7/10/2014	8.33	0.89
		8/7/2014	8.25	1.2 (1.2)
		9/4/2014	8.42	1.7
SP-05	LGAC Effluent[a]	7/10/2014	8.27	<0.50
SP-07	GWTS Effluent	7/10/2014	8.05	<0.50
		8/7/2014	8.05	<0.50
		9/4/2014	8.19	0.50 J

[a] Also is the ion exchange resin influent.

J = estimated concentration
GWTS = groundwater treatment system
LGAC = liquid-phase granular-activated carbon
PCE = tetrachloroethene
SP = sample port
µg/L = micrograms per liter
< = less than
( ) = field duplicate result

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FIGURES

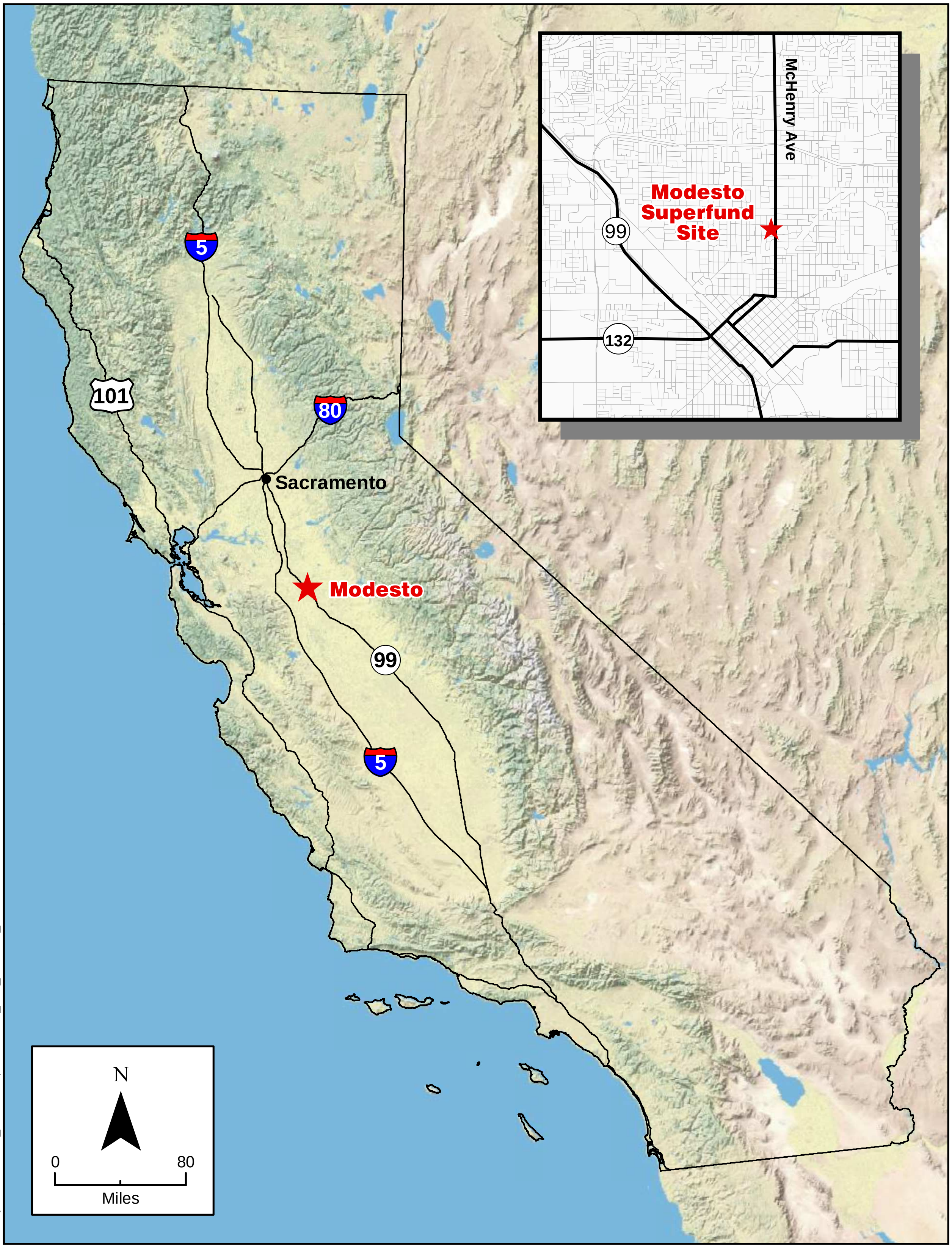

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Figure 1-1. Site Location, Modesto Groundwater Superfund Site, Modesto, California

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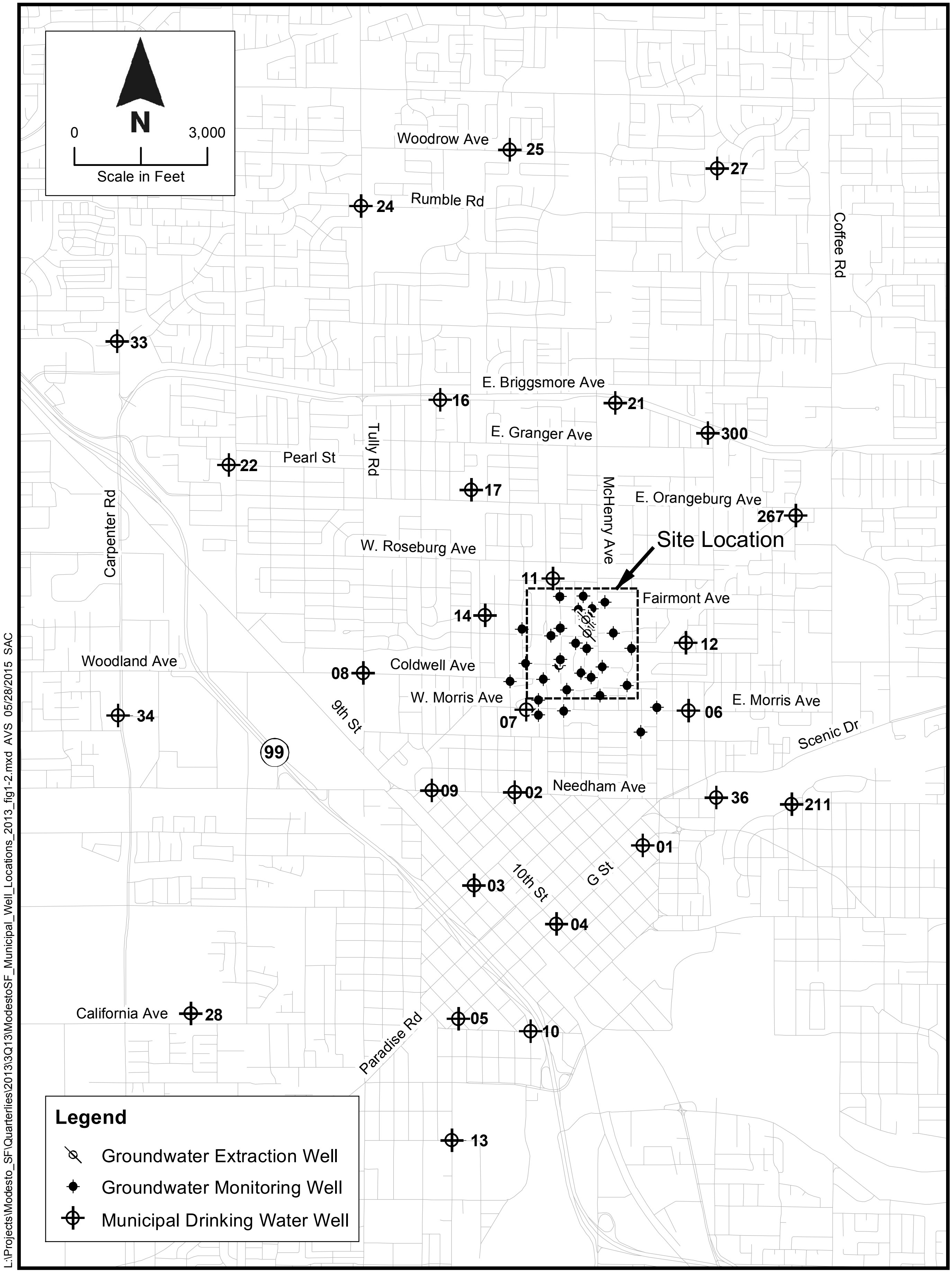

Figure 1-2. Municipal Well Locations, Modesto Groundwater Superfund Site

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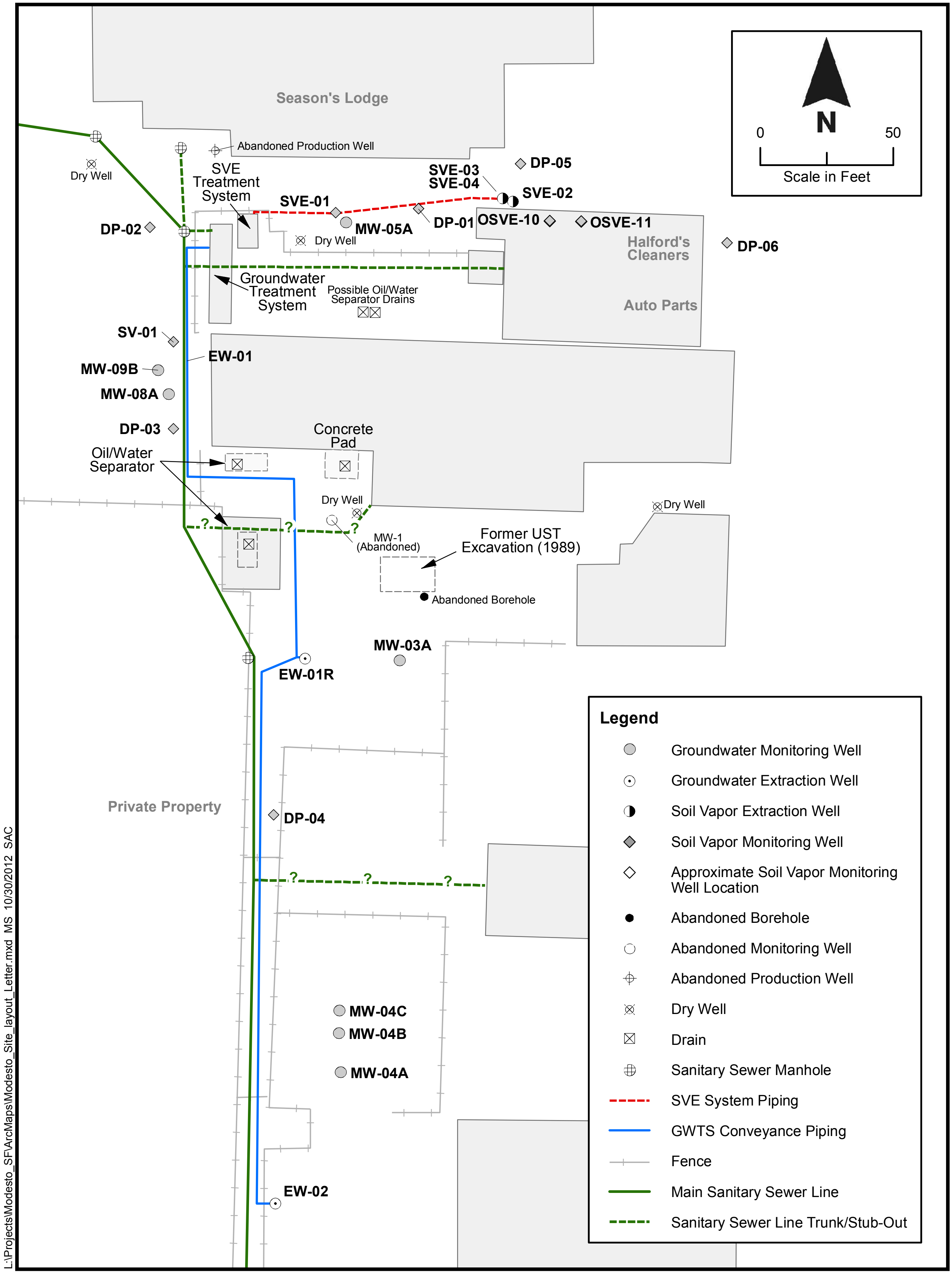

Figure 2-1. Site Layout
Modesto Groundwater Superfund Site

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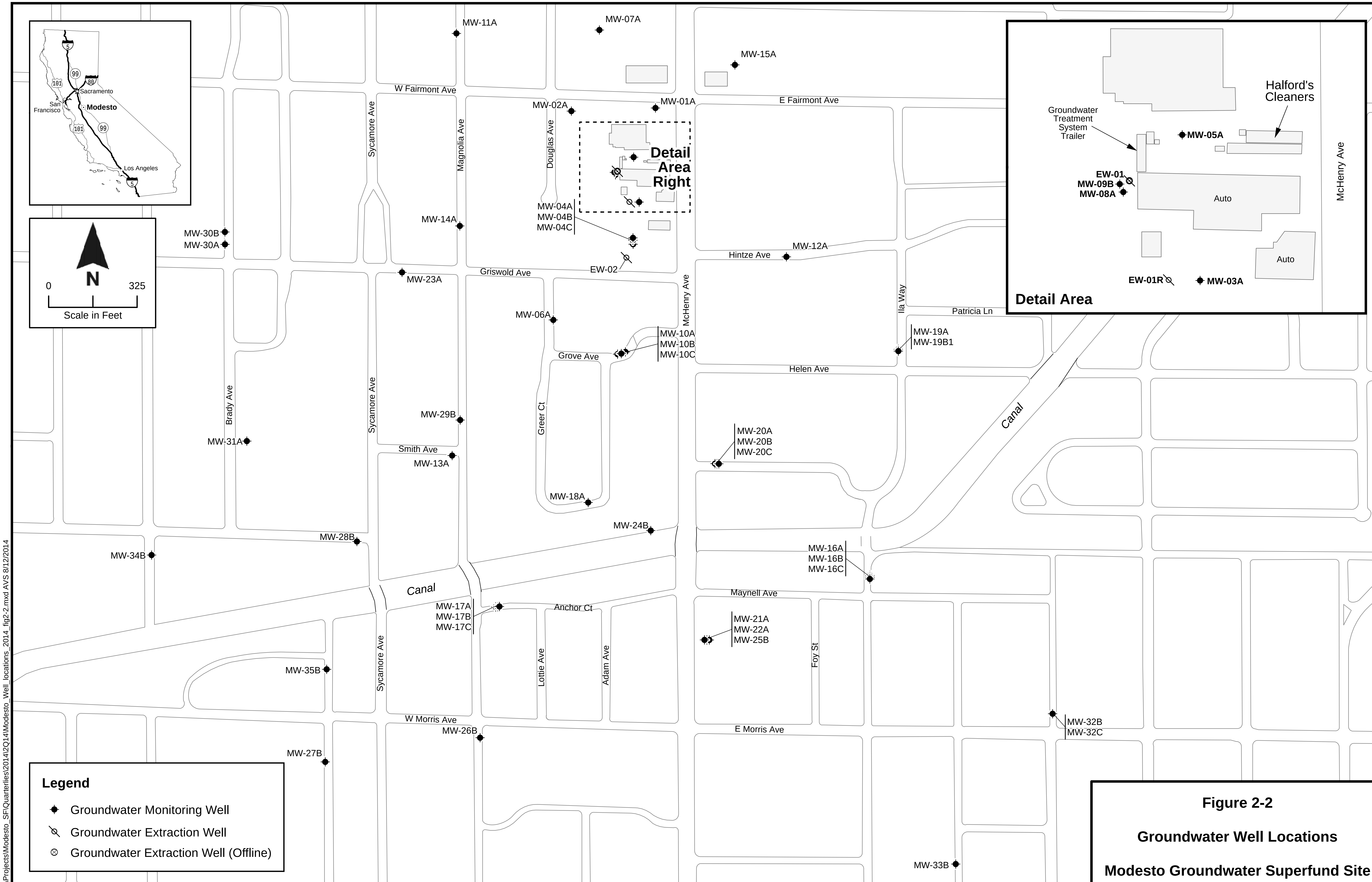

Figure 2-2

Groundwater Well Locations

Modesto Groundwater Superfund Site

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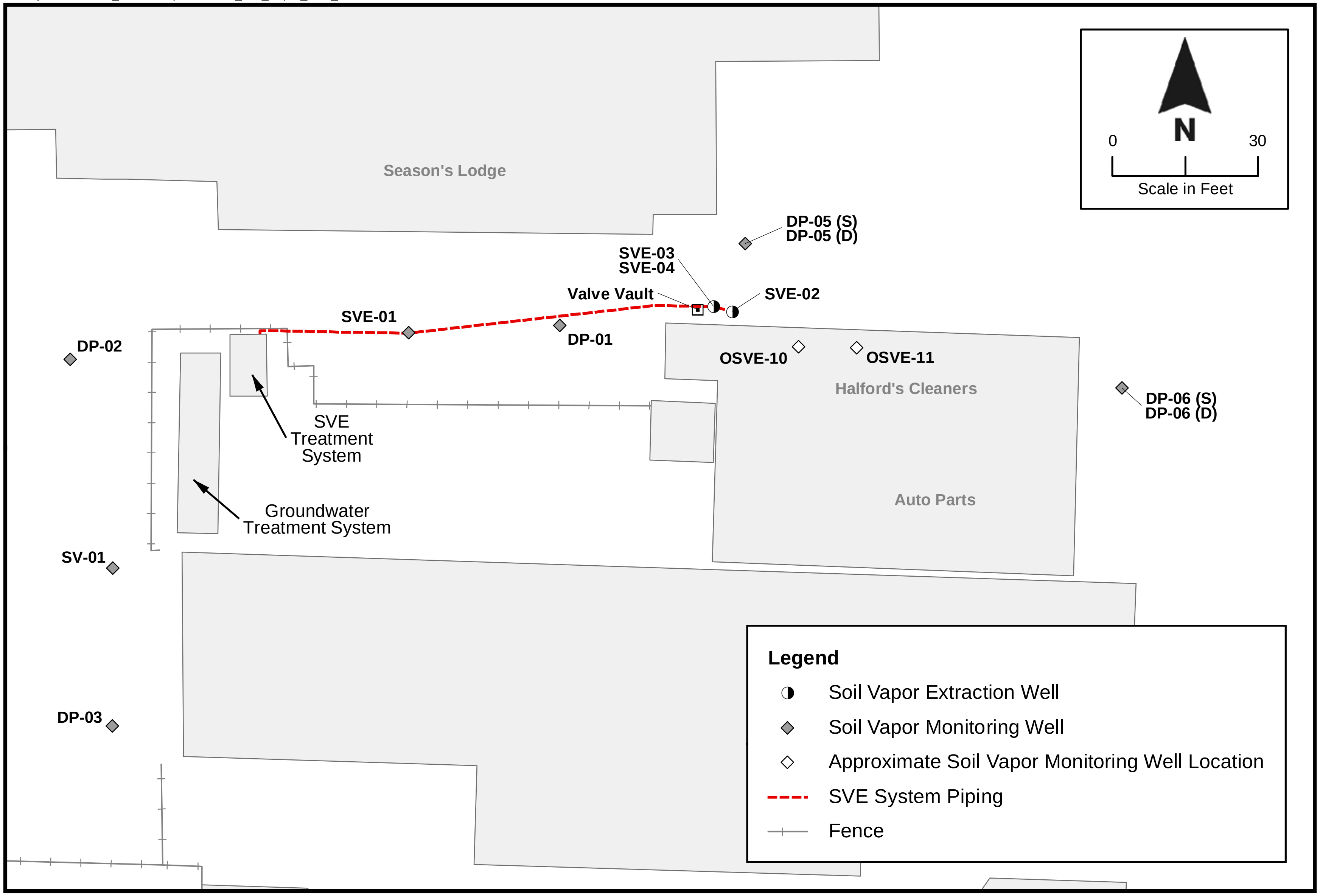

Figure 2-3. Soil Vapor Well Locations, Halford's Cleaners Area, Modesto Groundwater Superfund Site

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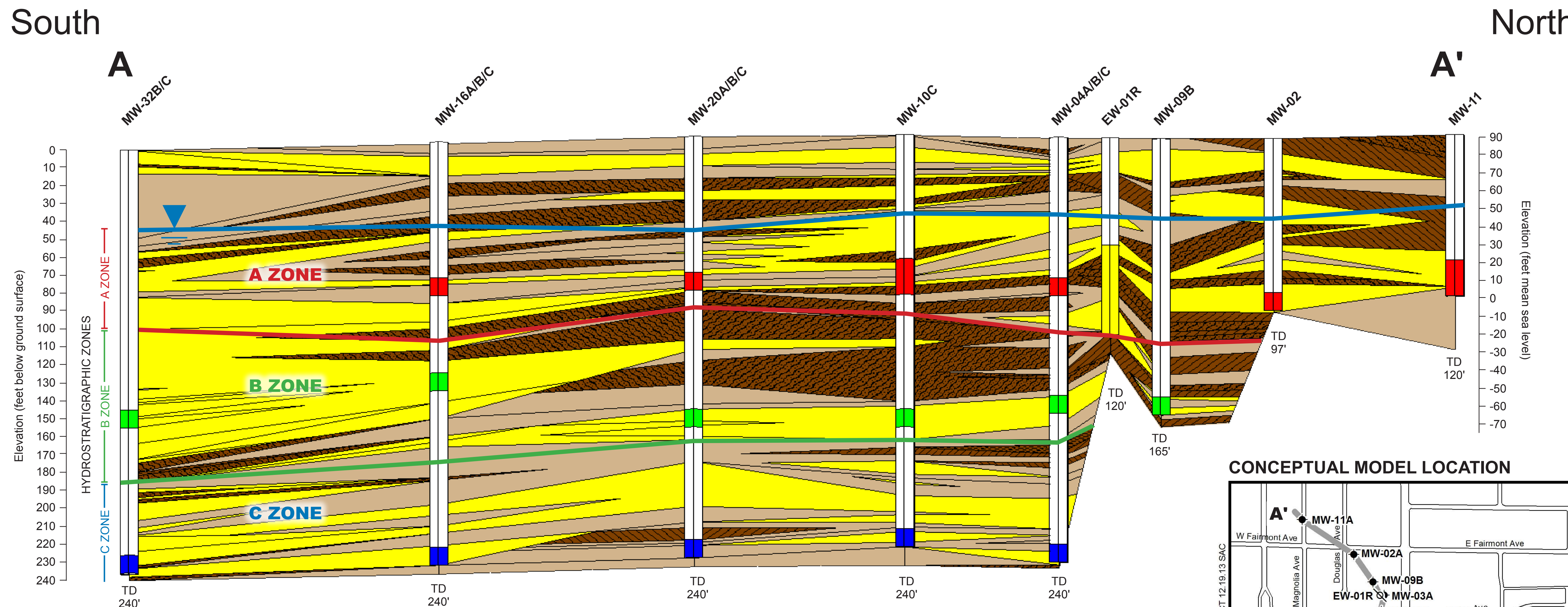
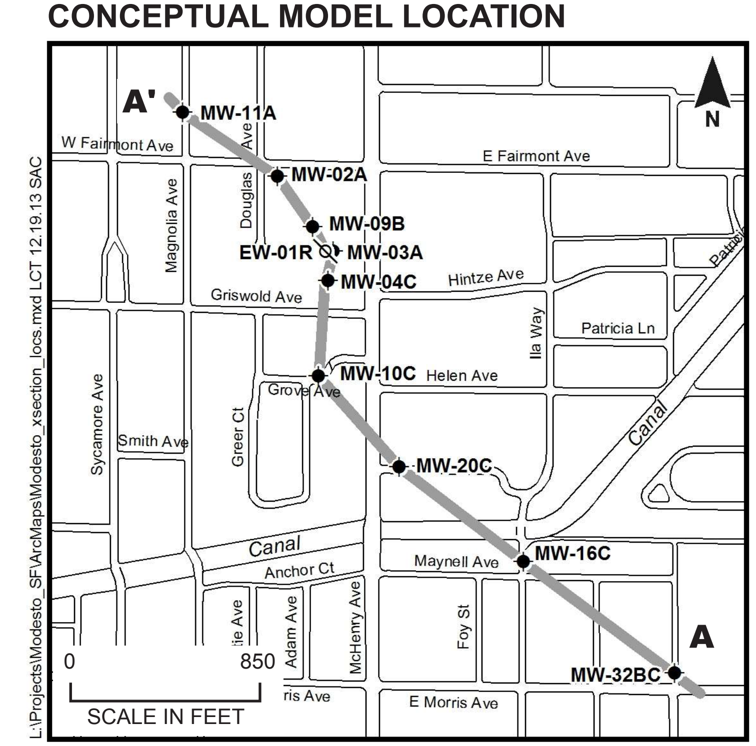


0 300
HORIZONTAL SCALE IN FEET
Vertical Exaggeration = 5X

CONCEPTUAL MODEL LOCATION



LEGEND

- Gravel, Gravelly Sand, Sand, Sand to Silty Sand
- Silty Sand to Silt
- Clayey Silt to Silty Clay

Approximate Water Table Surface (A Zone)

MW-20A/B/C
Groundwater Monitoring Well
- A Zone Screen
- B Zone Screen
- C Zone Screen

EW-01R
Groundwater Extraction Well
- B Zone Screen

URS

Figure 4-1
Stratigraphic Conceptual Model A-A'
Modesto Groundwater Superfund Site

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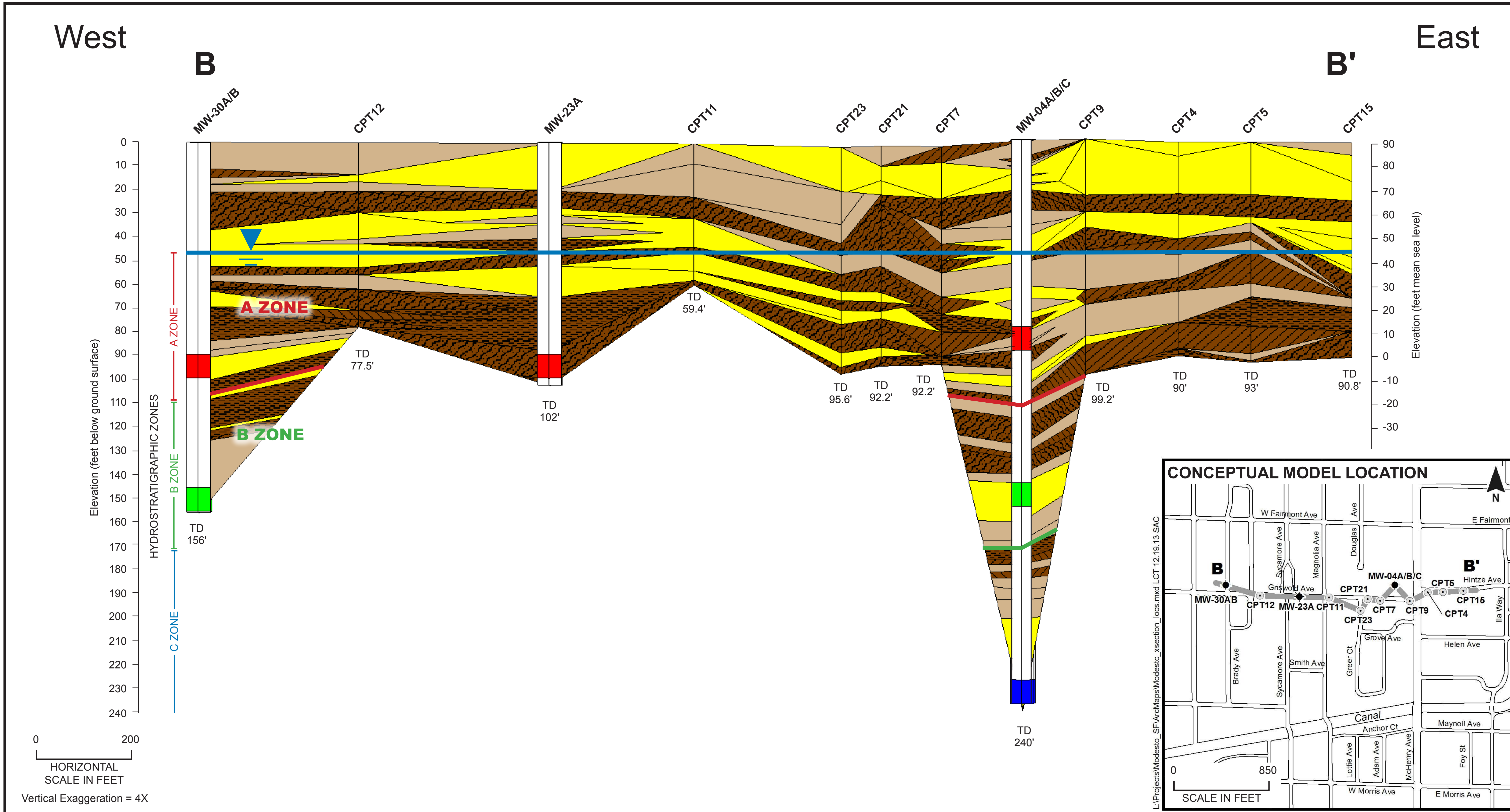

LEGEND

- Gravel, Gravelly Sand, Sand, Sand to Silty Sand
- Silty Sand to Silt
- Clayey Silt to Silty Clay

Approximate Water Table Surface (A Zone)

MW-04A/B/C Groundwater Monitoring Well

- A Zone Screen
- B Zone Screen
- C Zone Screen

URS

Figure 4-2
Stratigraphic Conceptual Model B-B'
Modesto Groundwater Superfund Site

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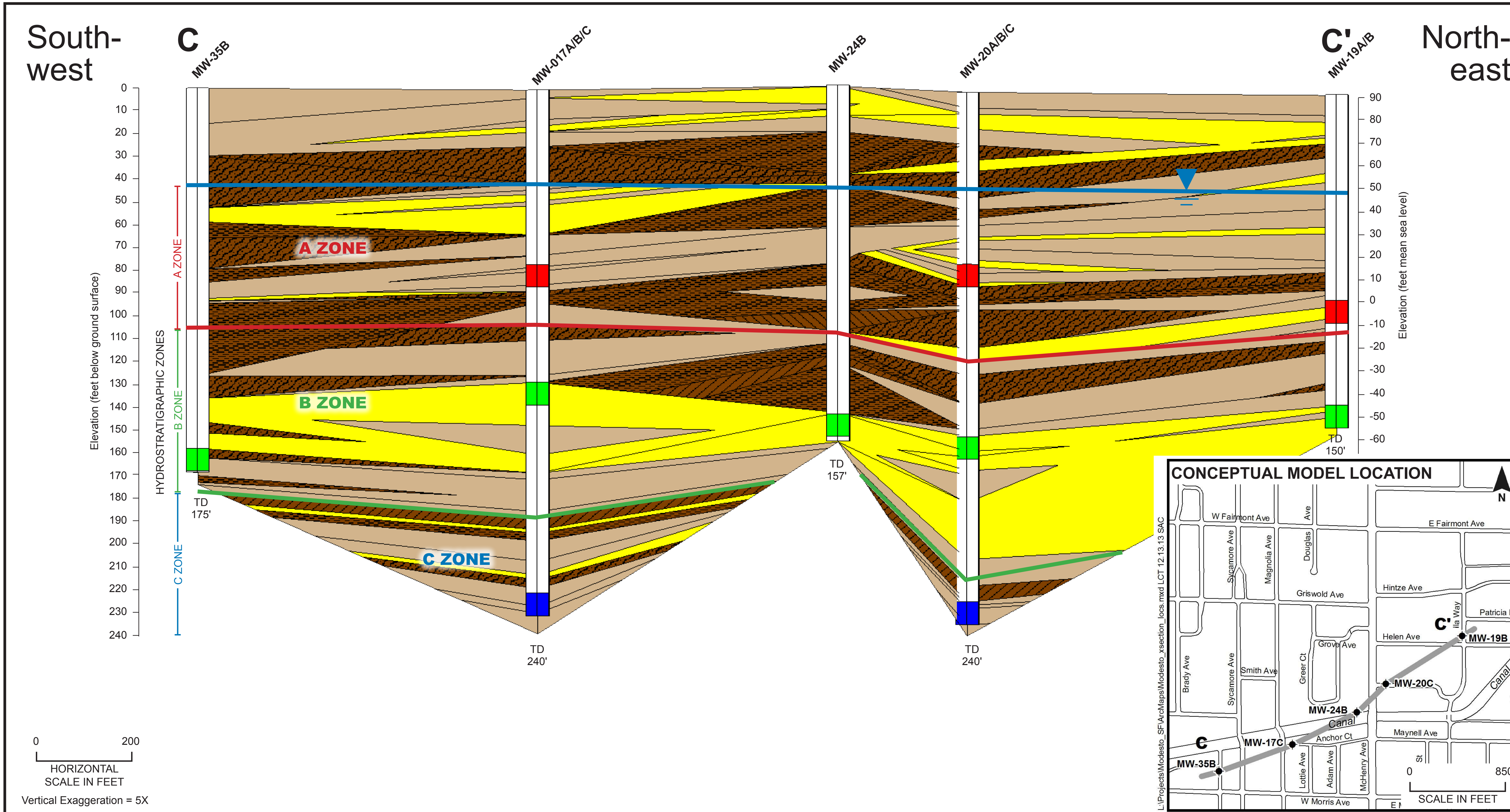

LEGEND

Gravel, Gravelly Sand, Sand, Sand to Silty Sand

Silty Sand to Silt

Clayey Silt to Silty Clay

Approximate Water Table Surface (A Zone)

MW-17A/B/C

Groundwater Monitoring Well

A Zone Screen

B Zone Screen

C Zone Screen

URS

Figure 4-3
Stratigraphic Conceptual Model C-C'
Modesto Groundwater Superfund Site

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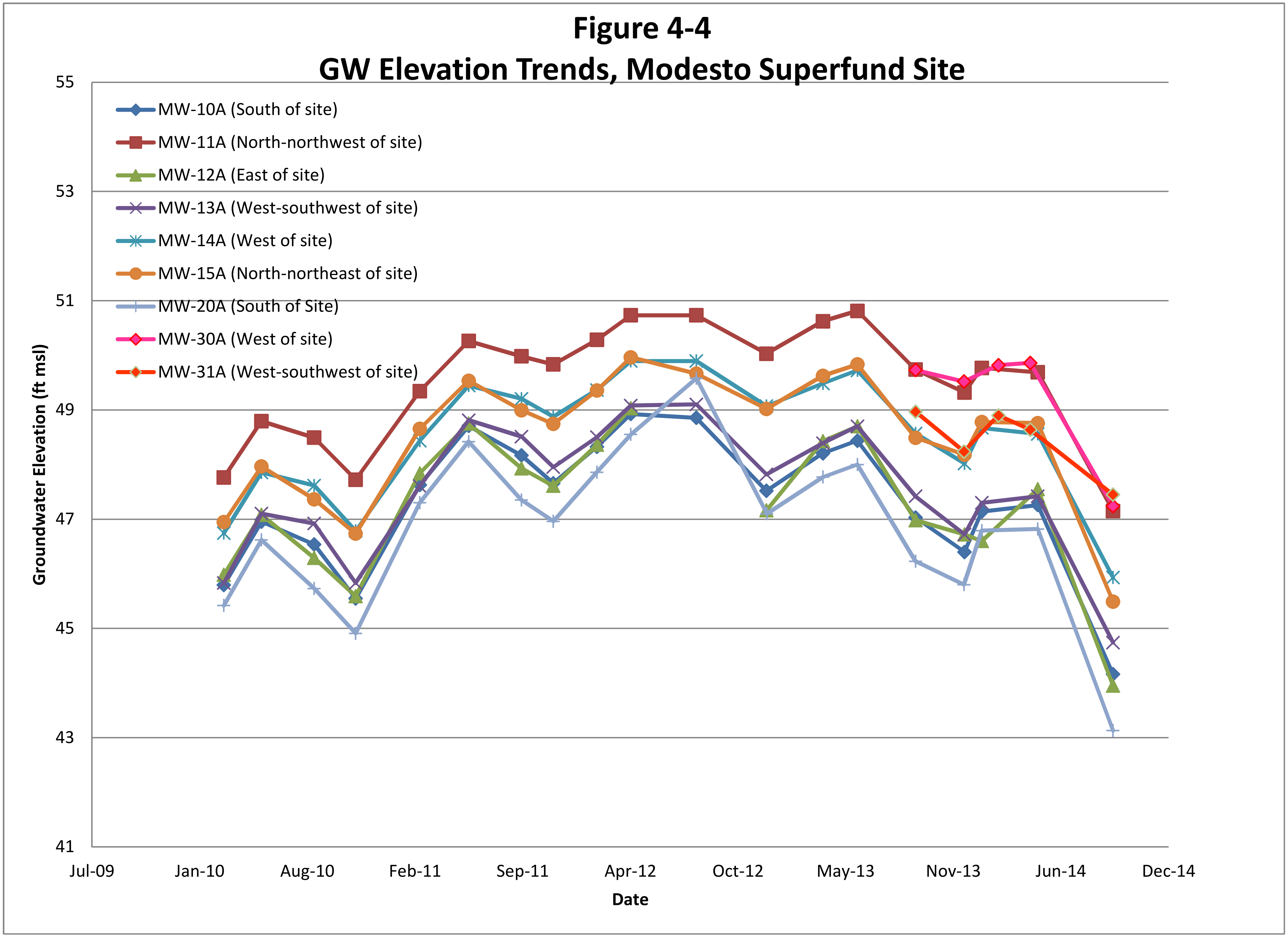

Figure 4-4
GW Elevation Trends, Modesto Superfund Site
MW-10A (South of site)
MW-11A (North-northwest of site)
MW-12A (East of site)
MW-13A (West-southwest of site)
MW-14A (West of site)
MW-15A (North-northeast of site)
MW-20A (South of Site)
MW-30A (West of site)
MW-31A (West-southwest of site)
Groundwater Elevation (ft msl)
55
53
51
49
47
45
43
41
Jul-09
Jan-10
Aug-10
Feb-11
Sep-11
Apr-12
Oct-12
May-13
Nov-13
Jun-14
Dec-14
Date

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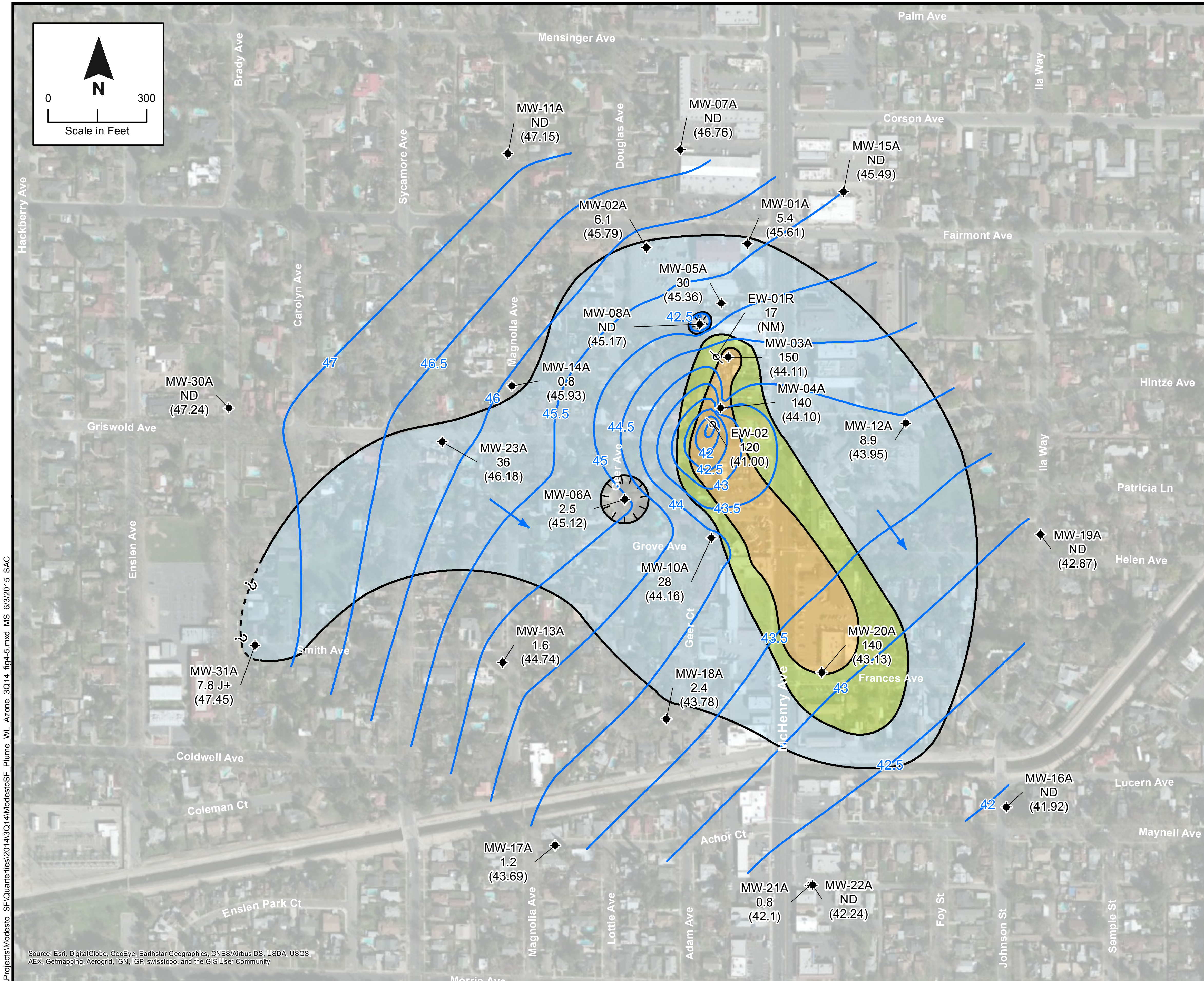

Figure 4-5
Groundwater Potentiometric Surface and PCE in A Zone Groundwater
Third Quarter 2014
Modesto Groundwater Superfund Site

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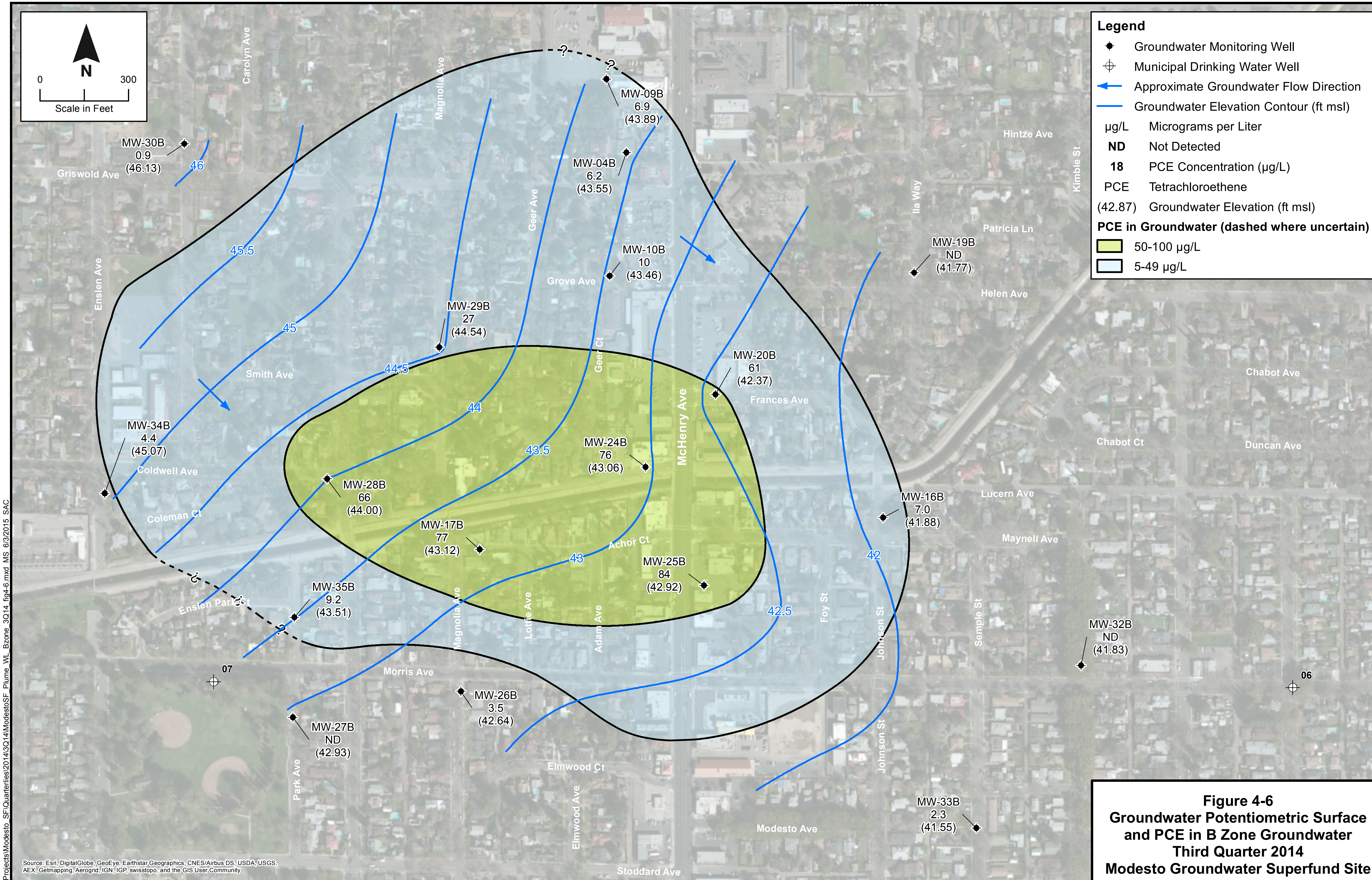

Figure 4-6
Groundwater Potentiometric Surface and PCE in B Zone Groundwater
Third Quarter 2014
Modesto Groundwater Superfund Site

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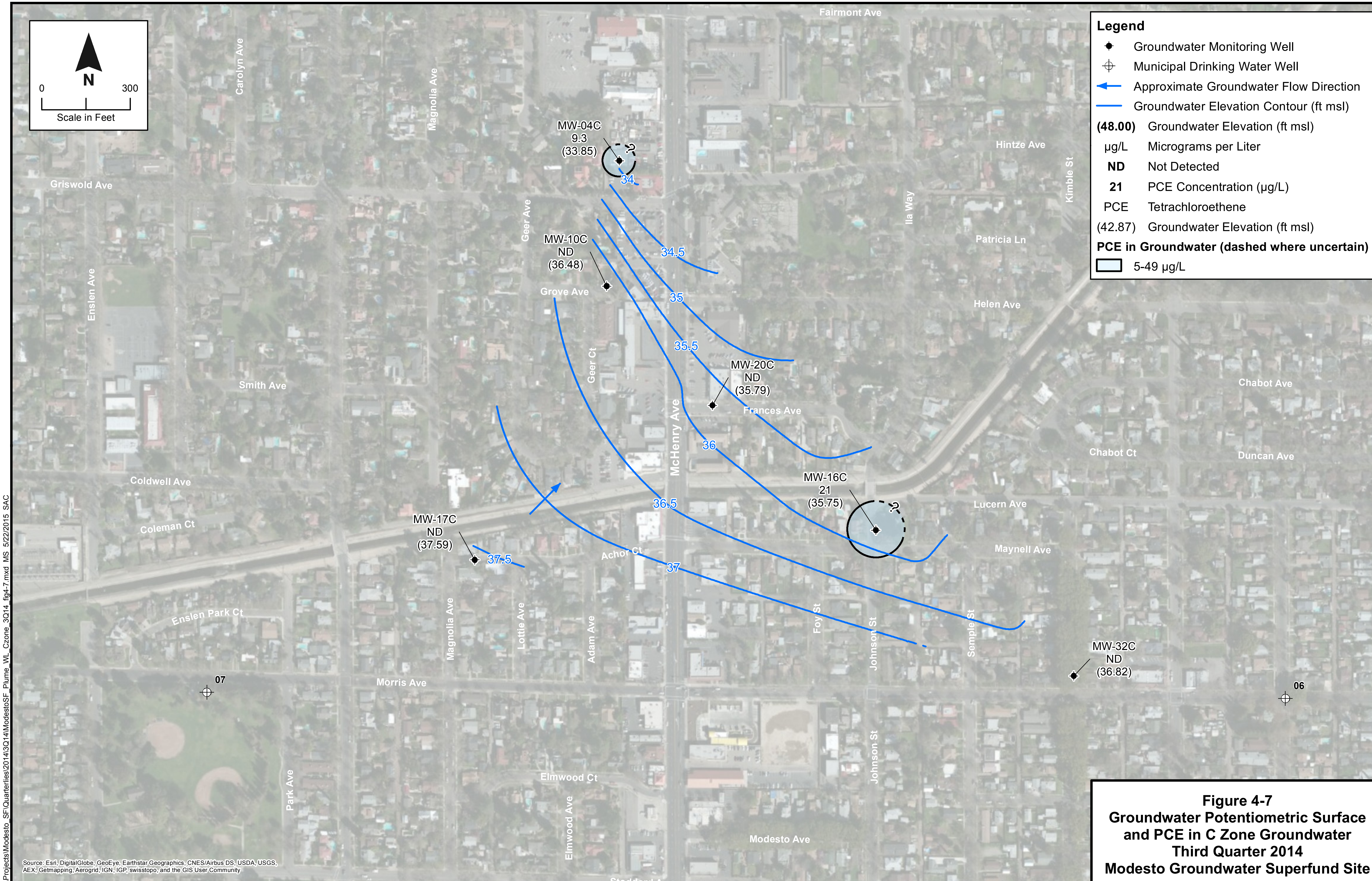

Figure 4-7
Groundwater Potentiometric Surface and PCE in C Zone Groundwater
Third Quarter 2014
Modesto Groundwater Superfund Site

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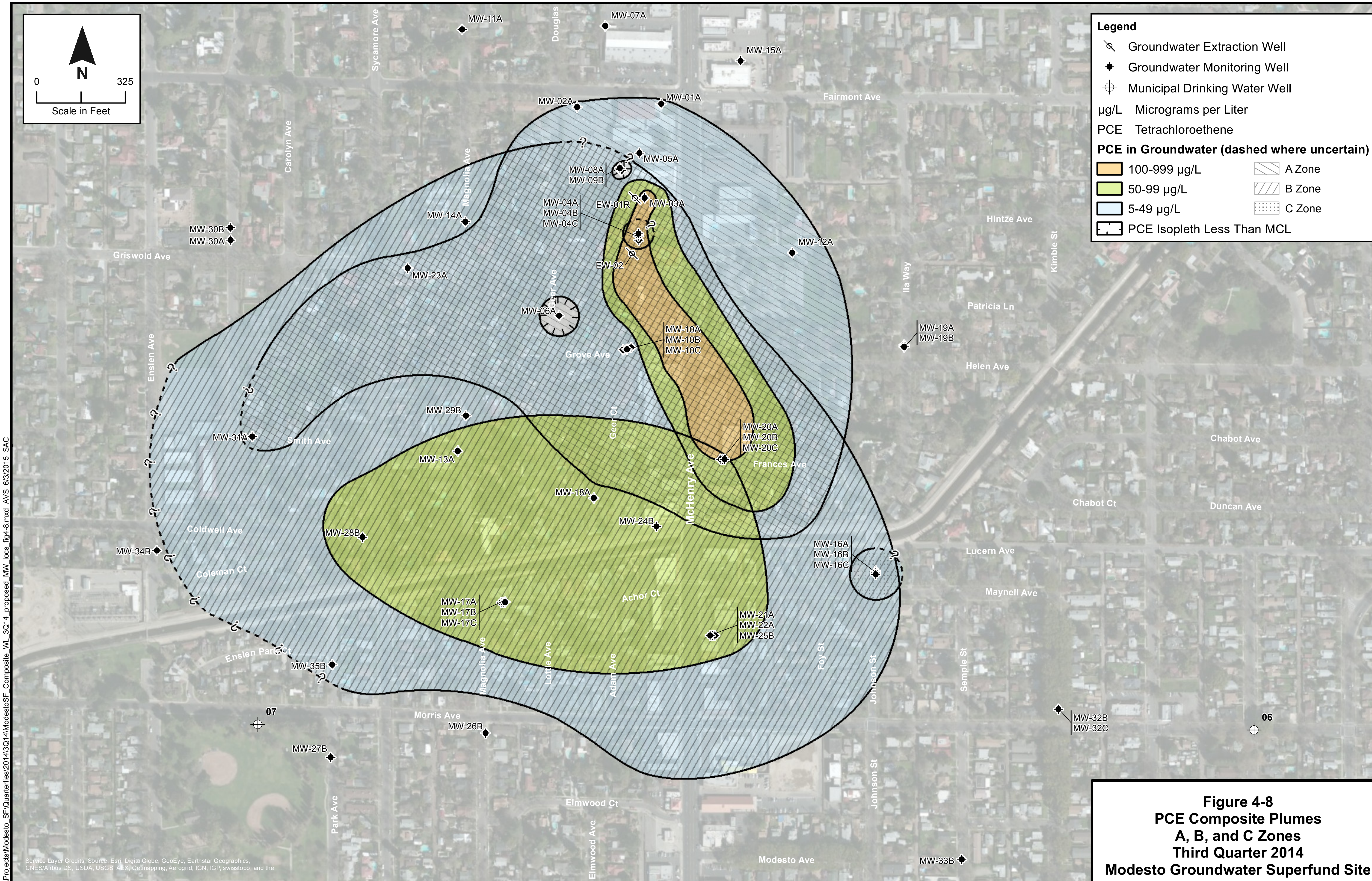

Figure 4-8
PCE Composite Plumes
A, B, and C Zones
Third Quarter 2014
Modesto Groundwater Superfund Site

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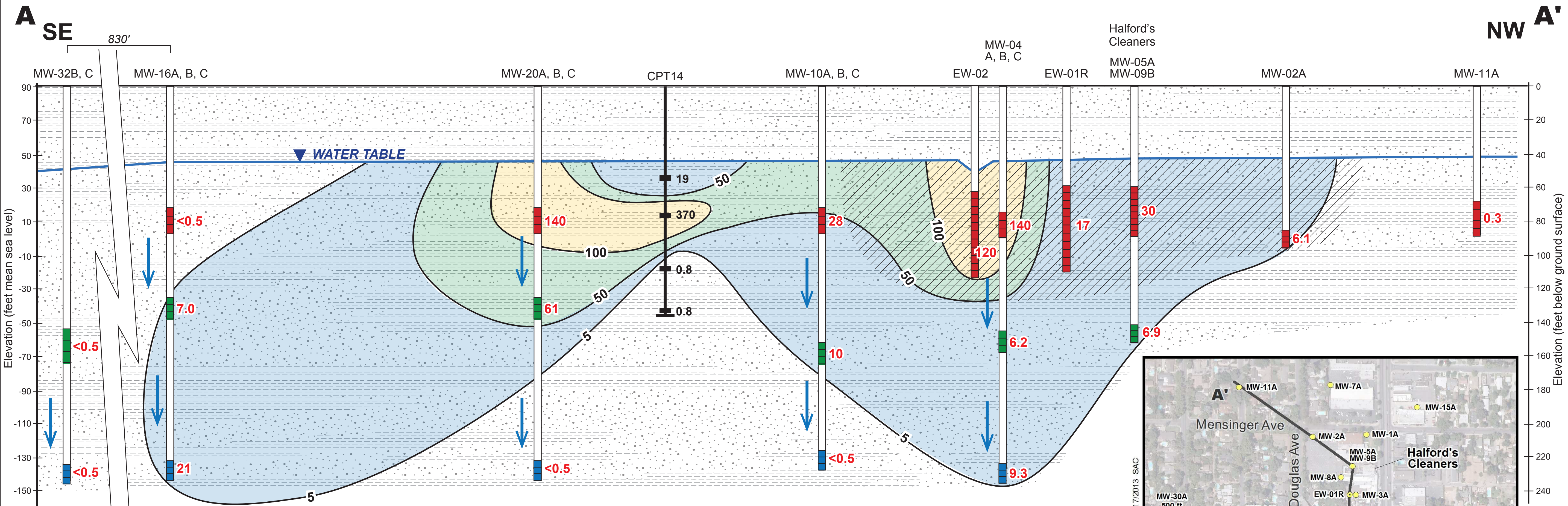

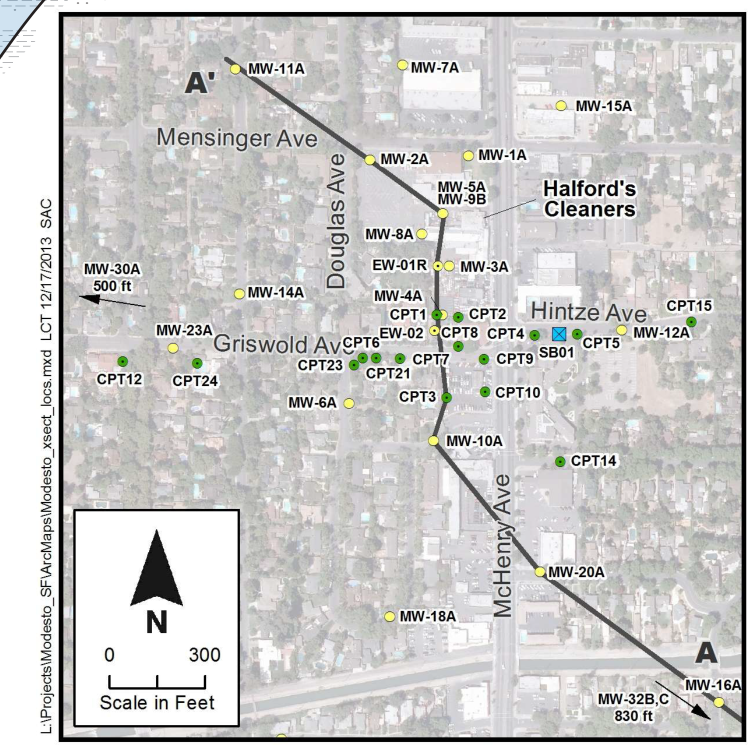

Legend

µ/L	Micrograms per Liter
5.2 ■	Hydropunch Groundwater Sample PCE Concentration (µg/L) (May/June 2011)
2.1	PCE Concentration (µg/L)
↑	Direction of Vertical Gradient
(red)	A Zone Screen
(green)	B Zone Screen
(blue)	C Zone Screen
(blue line)	Water Table Surface
(dotted)	Sand and Silty Sand
(dashed)	Cemented Very Fine Grained Sand, Silt, or Clay
(hatched)	EW-02 Interpreted Capture Zone

PCE Concentration

(blue)	5.0-49 µg/L
(green)	50-99 µg/L
(yellow)	100-999 µg/L

0 200
SCALE IN FEET

URS

Figure 4-9
Cross-Section A-A'
Extraction Well EW-02
Estimated Capture Zone
Third Quarter 2014
Modesto Groundwater Superfund Site

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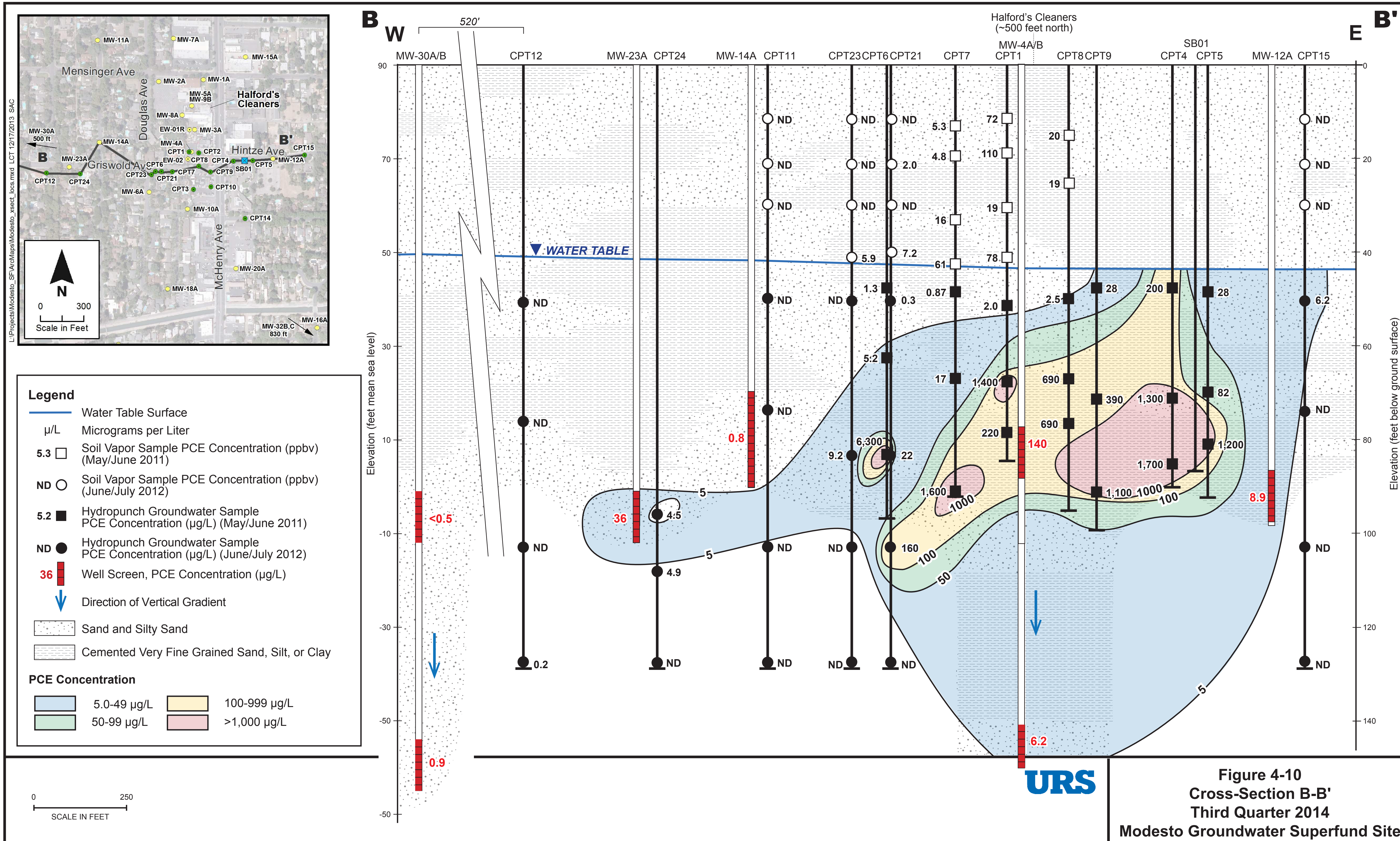

Figure 4-10
Cross-Section B-B'
Third Quarter 2014
Modesto Groundwater Superfund Site

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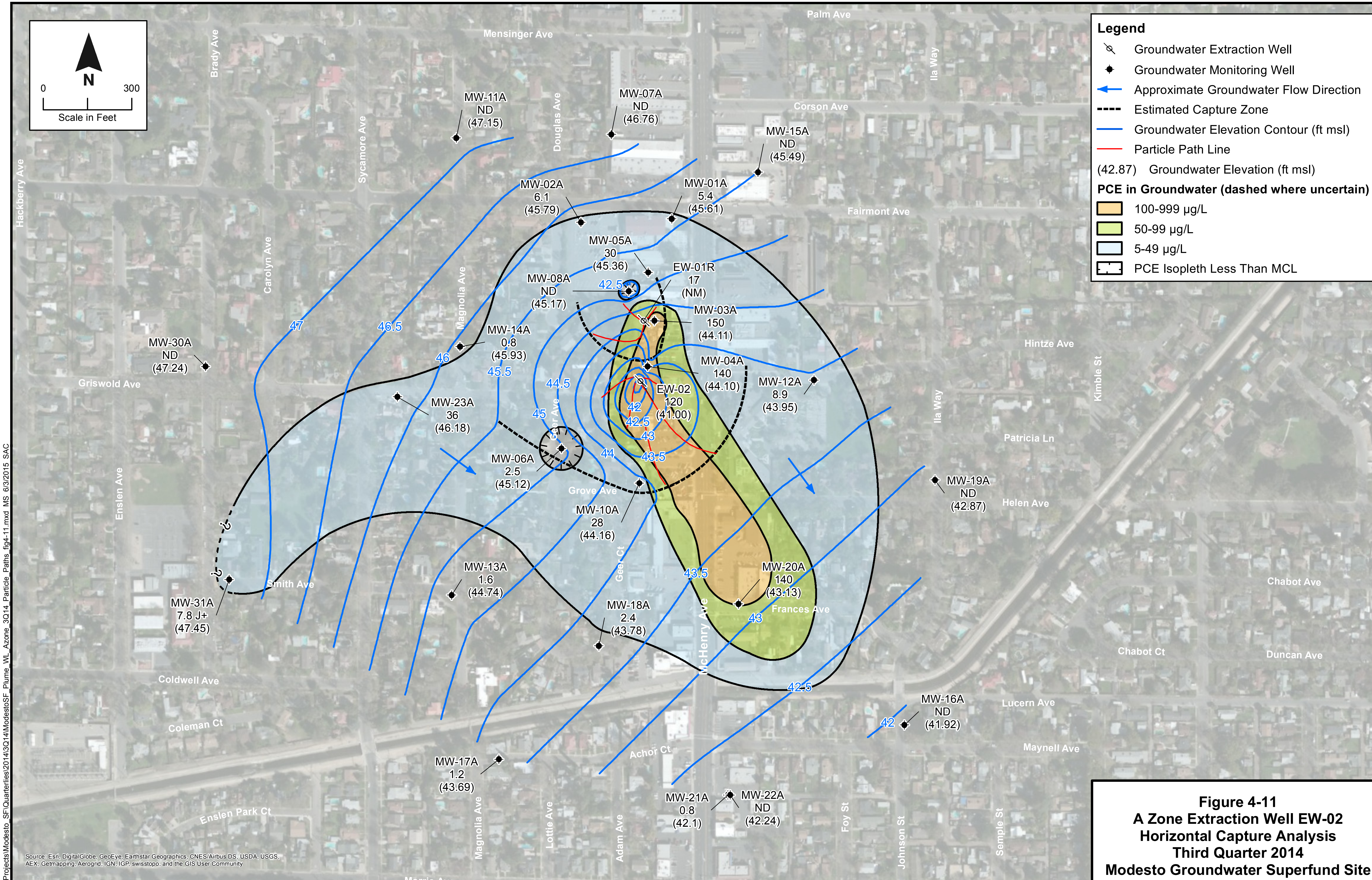

Figure 4-11
A Zone Extraction Well EW-02
Horizontal Capture Analysis
Third Quarter 2014
Modesto Groundwater Superfund Site

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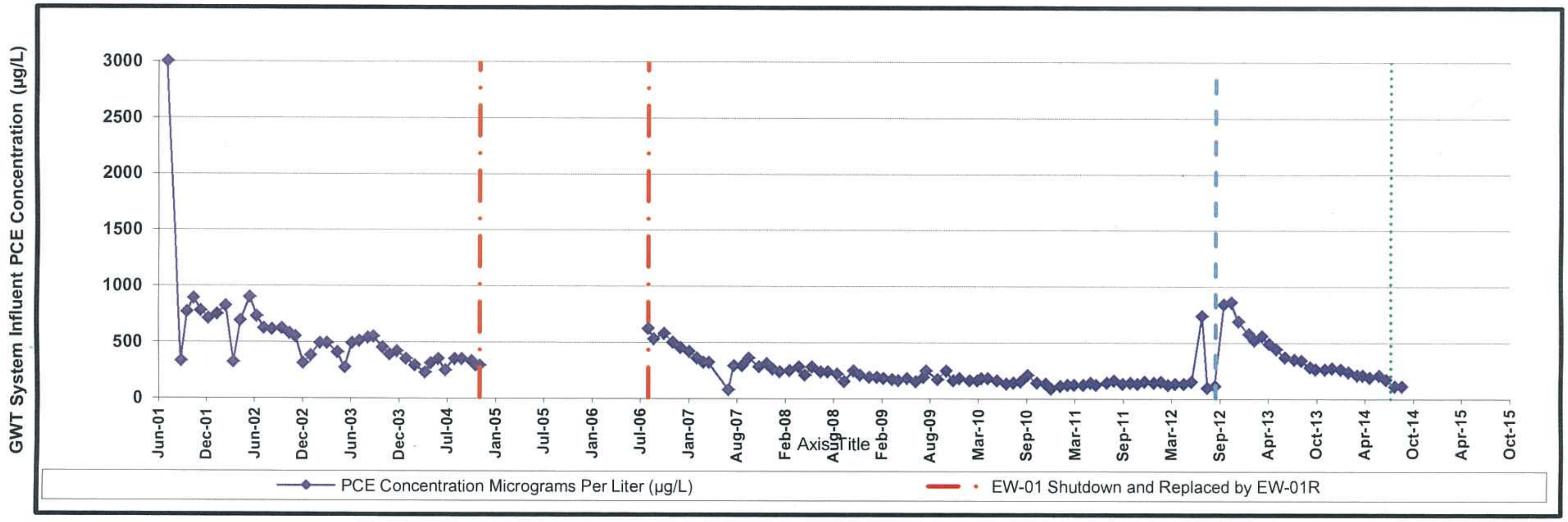
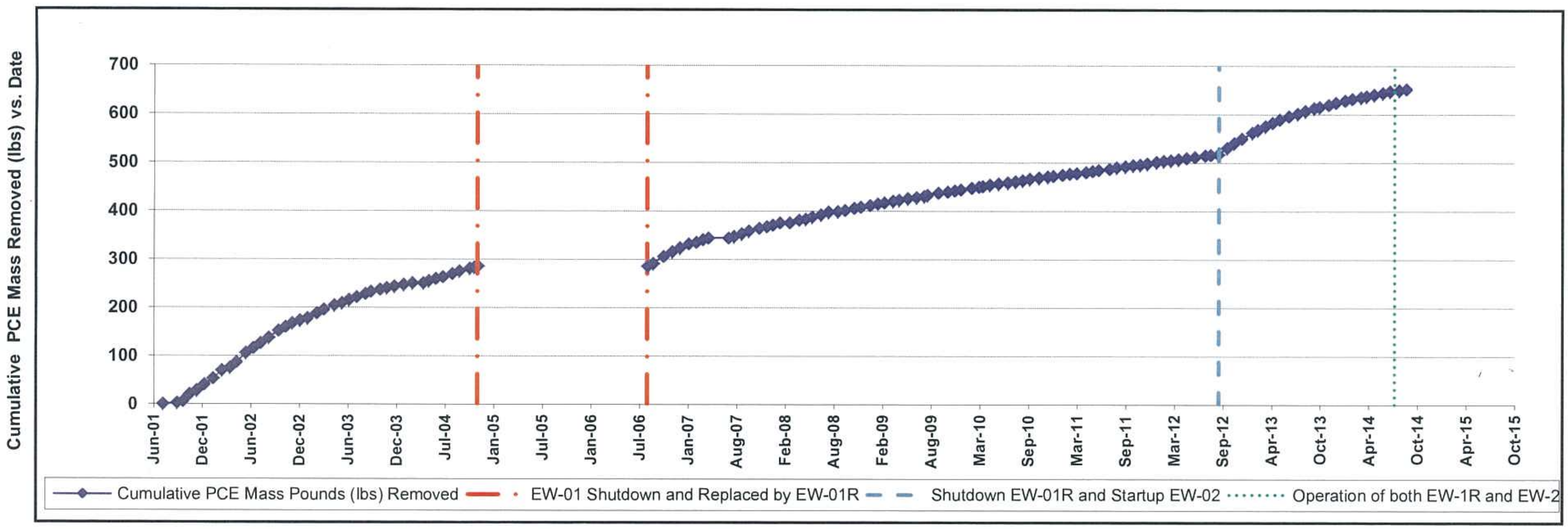
Figure 4-12
Cumulative PCE Mass Removed by the Groundwater Treatment System
Modesto Groundwater Superfund Site





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