Enhanced Remedial Alternatives Study for San Gabriel Valley Area 1 Superfund Site South El Monte Operable Unit (SEMOU) Los Angeles County, California

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LIST OF ACRONYMS AND ABBREVIATIONS

µg/L	Microgram(s) per liter
AOP	Advance oxidation process
ARAR	Applicable or relevant and appropriate requirement
bgs	Below ground surface
CBWA	Central Basin Water Association
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
COC	Contaminant of concern
DCA	Dichloroethane
DCE	Dichloroethene
DDW	Division of Drinking Water, California State Water Resources Control Board
DTSC	California Department of Toxic Substances Control
DWR	California Department of Water Resources
EA	EA Engineering, Science, and Technology, Inc.
EPA	U.S. Environmental Protection Agency
ERAS	Enhanced Remedial Alternatives Study
FEFLOW	Finite Element subsurface FLOW system software
FS	Feasibility Study
Gilbane	Gilbane Federal
gpm	Gallons per minute
GRA	General response action
GSWC	Golden State Water Company
GWETS	Groundwater extraction and treatment system
HHRA	Human health risk assessment
ISB	In situ bioremediation
LARWQCB	Los Angeles Regional Water Quality Control Board
lf	Linear feet
LGAC	Liquid-phase granular activated carbon
LTM	Long-term monitoring
MCL	Maximum contaminant level
MNA	Monitored natural attenuation

MP	City of Monterey Park
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NDMA	n-Nitrosodimethylamine
NL	Notification level
No.	Number
NPL	National Priorities List
O&M	Operation and maintenance
OMMP	Operations, monitoring, and maintenance plan
OSY	Operating safe yield
OU	Operable unit
PCE	Tetrachloroethene
PRB	Permeable reactive barrier
PRP	Potentially responsible party
RAO	Remedial action objective
RI	Remedial Investigation
ROD	Record of Decision
ROW	Right-of-way
SEMOU	South El Monte Operable Unit
SG-1	San Gabriel Well No. 1
SG-2	San Gabriel Well No. 2
SGVWC	San Gabriel Valley Water Company
state	State of California
TCE	Trichloroethene
TCP	1,2,3-Trichloropropane
UV	Ultraviolet
VGAC	Vapor-phase granular activated carbon
VOC	Volatile organic compound
Watermaster	Main San Gabriel Basin Watermaster
WNOU	Whittier Narrows Operable Unit
WQA	San Gabriel Basin Water Quality Authority
WRD	Water Replenishment District of Southern California

1. INTRODUCTION

The U.S. Environmental Protection Agency (EPA) authorized EA Engineering, Science, and Technology, Inc. (EA), under Response Action Contract Number EP-S9-14-01, Task Order 029-RIFS-094X, to prepare an Enhanced Remedial Alternatives Study (ERAS) for the San Gabriel Valley Area 1 Superfund Site, South El Monte Operable Unit (SEMOU) located in Los Angeles County, California (Figure 1-1). This ERAS meets the requirements of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, as amended, and the National Oil and Hazardous Substance Pollution Contingency Plan (NCP) (EPA 1990). The ERAS was prepared in accordance with *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (EPA 1988).

1.1 PURPOSE AND OVERVIEW

This ERAS presents the evaluation of remedial alternatives to address the regional groundwater contamination at the SEMOU. Additionally, the ERAS presents an evaluation of groundwater alternatives outside the boundary of the SEMOU, in the adjacent Whittier Narrows Operable Unit (WNOU) (Figure 1-2) because the SEMOU is the source of groundwater contamination in the hydraulically connected WNOU. The evaluation of these remedial alternates was performed using data collected through the end of 2018. Additional data that is collected post 2018 will be evaluated during the remedial design process.

EPA is the lead regulatory agency for the San Gabriel Valley Superfund sites. The State of California (or state) supports EPA through the California Department of Toxic Substances Control (DTSC) and Los Angeles Regional Water Quality Control Board (LARWQCB). EPA is addressing contamination in the deep regional groundwater aquifer zone, which is a source of drinking water. DTSC and LARWQCB are addressing sources of shallow contamination at the source facilities. EPA and the state will use the results of this ERAS to assess options for remedy enhancement and optimization.

1.2 REPORT ORGANIZATION

The sections of the ERAS report are:

- Section 1—Introduction. Summarizes background information, site and hydrogeologic setting, the nature and extent of contamination, and the risk assessment conducted during the Remedial Investigation (RI) process.

- Section 2—Remedial Action Objectives and ARARs. Describes the development of remedial action objectives (RAOs) and potential applicable or relevant and appropriate requirements (ARARs), and describes the basin adjudication that affects remedy selection.

- Section 3—Identification and Screening of Remedial Technologies. Identifies and describes a range of remedial technologies, process options, and general response actions (GRAs) that EPA can use to address contaminated groundwater and screens them based on overall effectiveness, implementability, and cost.

- Section 4—Remedial Alternatives Development. Develops remedial alternatives by combining remedial approaches, technologies, and process options that we retained in Section 3.

- Section 5—Detailed Analysis of Remedial Alternatives. Provides detailed analysis of remedial alternatives using the nine criteria listed in the NCP (EPA 1990) and a comparative evaluation of those alternatives with similar objectives.

- Section 6—References. Provides details for the citations provided throughout the report.

1.3 SEMOU/WNOU BACKGROUND

EPA added the San Gabriel Valley Superfund sites to the National Priorities List (NPL) on May 8, 1984. They are composed of four NPL sites (San Gabriel Valley Superfund Sites Area 1 through Area 4) and contain eight operable units OUs. An OU, as defined in the NCP, is a discrete action that comprises an incremental step toward comprehensively addressing site problems. Figure 1-2 shows the four NPL Sites and eight OUs that make up the San Gabriel Valley Superfund sites. EPA has been addressing regional volatile organic compound (VOC)-impacted groundwater contamination at the four San Gabriel Valley Superfund sites since the 1980s.

1.3.1 SEMOU/WNOU Description

The San Gabriel Valley encompasses a basin that serves as a primary drinking water source. The SEMOU is located in Area 1, in the south-central portion of the San Gabriel Basin (EPA 2000). The SEMOU includes multiple, separate, and commingled plumes that comprise a large area of groundwater contamination in eastern Los Angeles County.

The SEMOU is the sole source of contamination at the contiguous and hydraulically connected WNOU, which is located at the southern end of the SEMOU boundary. The VOCs tetrachloroethene (PCE) and trichloroethene (TCE) are the primary contaminants most frequently detected above drinking water standards in the SEMOU. Contamination from the SEMOU has migrated to the south into the WNOU shallow and intermediate aquifer zones, threatening drinking water sources in the Central Basin south of the San Gabriel Basin. The downgradient groundwater impacts have resulted in EPA taking action to control contaminant migration in the WNOU (EPA 1999). EPA designated the SEMOU to address regional groundwater contamination in the OU and to address groundwater migrating south toward the WNOU and west to the Alhambra OU3 (Area 3). EPA designated the WNOU specifically to address groundwater contamination flowing out of the San Gabriel Basin, through Whittier Narrows, into the Montebello Forebay portion of the Central Basin (EPA 2011).

1.3.2 SEMOU/WNOU Site History

In 1979, environmental monitoring activities in the City of Azusa revealed chlorinated VOCs in shallow groundwater. Subsequent data collection efforts by water purveyors determined that VOCs also impacted deeper production wells at multiple locations. This finding triggered additional investigations that revealed the presence of VOCs, notably PCE and TCE, throughout large areas of the San Gabriel basin (Gilbane Federal [Gilbane] 2019a). In the SEMOU, several drinking water wells impacted with VOCs at concentrations above drinking water standards led to EPA actions that included shutting down affected wells, blending affected well water with water from unaffected wells, and installing wellhead treatment systems to meet drinking water standards.

After conducting an interim RI and Feasibility Study (FS) (Geosystems 1998, 1999), EPA issued the SEMOU Interim Record of Decision (ROD) (EPA 2000) for the regional groundwater system selecting containment through extraction, treatment, and monitoring as the remedy. The SEMOU RAOs defined in the ROD require migration control for VOC concentrations that exceed state or federal drinking water standards. The RAOs for the SEMOU do not include numeric, chemical-specific objectives for the aquifer or a timeframe for restoration because the Interim ROD considers the actions to be an interim remedy that will contain contamination until EPA selects the final remedy.

Since the late 1980s, EPA has conducted field investigations and evaluated remedial actions in Whittier Narrows. In 1993, EPA implemented a monitoring-only Interim ROD (EPA 1993b), which included installation of several monitoring wells and routine quarterly monitoring of wells for VOCs. However, increasing contaminant concentrations suggested an imminent threat to groundwater resources in the Central Basin, and EPA subsequently prepared an Interim ROD amendment for additional remedial actions (EPA 1999). The WNOU Interim ROD Amendment for the regional groundwater system also selected containment through extraction, treatment, and monitoring as the remedy (EPA 1999). DTSC currently leads the operation and maintenance (O&M) of the WNOU interim remedy.

Because the SEMOU source areas are a source of the VOC contamination addressed by the interim remedies in both the SEMOU and WNOU, any evaluation of long-term cleanup alternatives must consider combined SEMOU and WNOU remedy pumping, groundwater flow, contaminant distribution, and cleanup technologies (Gilbane 2019a).

1.3.3 SEMOU Investigations

In the 1980s, EPA and LARWQCB identified Potentially Responsible Party (PRP) facilities that potentially contributed to the groundwater contamination discovered in the SEMOU. EPA and LARWQCB required PRP investigations to assess the lateral and vertical extent of VOCs in soil and/or groundwater. These investigations resulted in the remediation of contaminated soil at 29 facilities, installation of shallow monitoring wells at 62 facilities, and shallow groundwater remediation at 3 facilities (Gilbane 2019a).

In the mid-90s, a group known as the SEMOU Participants conducted an interim RI/FS to assess the extent of groundwater contamination in support of interim remedial actions and to evaluate the impact of the contamination on production wells. Concurrent with RI activities, EPA performed a baseline risk assessment to evaluate potential risk to human health (CH2M Hill 1997). The EPA used sampling data from 25 production wells, 1 EPA monitoring well, and 131 facility site assessment monitoring wells to identify at least 17 shallow aquifer “hot spots” where contaminants of concern (COCs) were present.

Site assessment activities at PRP facilities included vadose zone remediation and groundwater monitoring under EPA oversight until 2002. These activities continued under the direction of the state after 2002. In 2011, EPA began a supplemental groundwater RI to gather additional information. The supplemental RI included sampling existing shallow zone and intermediate zone monitoring wells and installing and sampling new shallow and intermediate zone monitoring wells. The objectives were to assess the horizontal and vertical extent of groundwater contamination in and downgradient of the SEMOU to support interim actions and to evaluate the impact of contamination from the SEMOU on the WNOU and on production wells in the western portion of the SEMOU.

EPA updated the baseline risk assessment using the data acquired at the SEMOU after the initial assessment. The results of the supplemental human health risk assessment (HHRA) identified six COCs (PCE, TCE, 1,2,3-trichloropropane [TCP], cis-1,2-dichloroethene [DCE], 1,1-DCE, and 1,1-dichloroethane [DCA]) and three emerging contaminants (perchlorate, 1,4-dioxane, and n-nitrosodimethylamine [NDMA]) for consideration at the SEMOU (Gilbane 2019a). This ERAS only considers treatment for these COCs and emerging contaminants as shown in Table 1-1.

During site modeling performed in 2018-2019, EPA identified 29 facilities (Figure 1-3) with recent soil vapor data available (between 2011 and 2017) for use in estimating residual VOC mass in the vadose zone (CH2M Hill 2020). The estimate of mass in the aquifer is based on PCE concentrations because it is the predominant and highest concentration contaminant in SEMOU groundwater. EPA’s contractor (Gilbane), with input from LARWQCB, DTSC, and CH2M Hill (also an EPA contractor), estimated the residual VOC mass in the vadose zone at each facility using soil vapor sampling results and groundwater elevation data. Gilbane assumed that the three phases (vapor, dissolved, and sorbed phases) of PCE in the vadose zone at each depth interval are in an equilibrium state and the total vadose zone mass is the sum of the three phases. One of the 29 facilities, Hytone Cleaners, makes up 70 percent of the total estimated volume of residual vadose zone mass (CH2M Hill 2020). Hytone Cleaners is located in the northeastern part of the SEMOU, far from most of the other sources and SEMOU contamination. Based on groundwater monitoring data, EPA believes that the Hytone contamination remains localized and has not commingled with the main SEMOU plumes located near the middle of the OU. DTSC is in the process of operating a soil vapor extraction system to remediate the vadose zone at Hytone Cleaners. A forthcoming SEMOU vapor intrusion RI report will present and evaluate the indoor air and soil gas data in the SEMOU (EA 2019).

Groundwater contamination resulted from the release of COCs at possibly hundreds of locations in the SEMOU. Large “hot spots” are not present, as contamination has dispersed through the regional aquifer over time. EPA is addressing contamination in the deep regional aquifer zone, which is a drinking water source. The State of California, through the DTSC, is addressing sources of shallow contamination at the source facilitiesand will continue to add facilities to investigate in the future. The San Gabriel Basin Water Quality Authority (WQA) is also leading investigations and cleanups. WQA is working with the LARWQCB to investigate 12 sites and an orphan 1,2-dioxane hot spot area at the Whitmore Street Groundwater Remediation Facility.

1.3.4 SEMOU/WNOU Interim Remedies

The WQA operates the interim remedy under a Cooperative Agreement with EPA. The WQA subcontracts with three water utilities to operate the remedy and implement the interim remedial actions in the SEMOU: Golden State Water Company (GSWC), San Gabriel Valley Water Company (SGVWC), and the City of Monterey Park (MP). DTSC subcontracts directly with the SGVWC to operate the interim remedial action at the WNOU. This section provides a description of the interim remedies implemented for the SEMOU and WNOU.

1.3.4.1 SEMOU Interim Remedy

In September 2000, EPA issued an Interim ROD describing the selected remedy for containing contaminants present in the regional aquifer (EPA 2000). An Explanation of Significant Differences incorporated perchlorate treatment as a necessary component of the interim remedy and evaluated the need for 1,4-dioxane treatment (EPA 2005). The Interim ROD states that the purpose of the interim remedial action is to control the migration of contamination and that future remedial actions may include additional industrial facilities identified as contamination sources. The RAOs, as stated in the Interim ROD, are:

- Prevent exposure of the public to contaminated groundwater
- Contain further migration of contaminated groundwater from more highly contaminated portions of the aquifer to less contaminated areas or depths
- Reduce the impact of continued contamination migration on downgradient water supply wells
- Protect future uses of less contaminated and uncontaminated groundwater.

The major components of the interim remedy are four separate groundwater pump-and-treat systems operated by three water purveyors: MP, GSWC, and SGVWC. The remedial systems include the following:

- Multiple water supply wells used as remedial extraction wells
  - EPA selected the extraction rates and well locations during the remedial design process
- Water treatment equipment capable of removing VOCs from contaminated groundwater
  - Treatment technologies are either liquid-phase granular activated carbon (LGAC) on its own or LGAC in combination with air stripping and vapor-phase granular activated carbon (VGAC)
- Disinfection steps because the treated water is destined for potable use; two of the facilities also include pH adjustment steps and have blending plans to address perchlorate and nitrate.
- Conveyance systems consisting of pipelines and booster pumps to transport contaminated groundwater from the extraction wells to the treatment plants, and to transport treated water from the plant to the water distribution systems of the three water purveyors
- Monitoring wells to help assess remedy performance.

The SEMOU includes Central and Western Containment areas. Figure 1-4 shows the remedy and non-remedy extraction wells, plus monitoring well locations. Table 1-2 presents information on the existing remedy extraction well completion intervals and flow rates.

EPA did not design the SEMOU interim remedy to capture shallow groundwater contamination migrating south into the adjacent WNOU. Instead, the WNOU interim remedy provides contaminant migration control within the shallow aquifer.

EPA plans to transfer the site to DTSC at the end of the 10-year long-term response action in May 2023.

1.3.4.2 WNOU Interim Remedy

In 1993, EPA issued an Interim ROD for the WNOU that required no immediate action to address groundwater contamination beyond recommendations for additional monitoring (EPA 1993b). However, increasing contaminant levels prompted EPA to issue an Interim ROD Amendment that required an active pump-and-treat system located just north of the Whittier Narrows Dam (EPA 1999). The COCs include chloroform, 1,1-DCE, 1,2-DCA, 1,4-dioxane, PCE, and TCE (EPA 1999). EPA designed the interim remedy to capture shallow and intermediate aquifer VOC contamination migrating south of the SEMOU (EPA 2005).

The RAO as stated in the Interim ROD Amendment is as follows:

> *"To the extent technically and economically feasible, EPA intends to control contaminant migration in Whittier Narrows so that impacts originating from industrial activities in the San Gabriel Basin will not cause production wells in Whittier Narrows and the Central Basin to exceed drinking water standards."*

Either EPA or the DTSC have operated the WNOU interim remedy since 2002. It captures impacted groundwater migrating southward from the SEMOU in the vicinity of the intersection of the Pomona Freeway (State Route 60) and Rosemead Boulevard. The interim remedy consists of seven extraction wells, conveyance piping, and a treatment system. The treatment system employs LGAC to remove the organic contaminants and includes disinfection with sodium hypochlorite for the portion of treated water destined for potable water use. Figure 1-5 presents the remedy extraction and monitoring well locations. Table 1-2 presents information on the existing remedy extraction well completion intervals and flow rates.

On May 17, 2013, the State of California (DTSC) assumed responsibility for O&M of the WNOU interim remedy. The State of California assigned DTSC as its agent, and contracted SGVWC to operate the treatment facility (Gilbane 2019a). In June 2017, DTSC submitted a State of California Proposition 1 Groundwater Grant Program Implementation Application to fund the design and construction of an additional pipeline and booster station to increase the extraction rates necessary for contaminant capture. This infrastructure project is currently in the design phase.

1.4 SITE SETTING

The San Gabriel Valley, and underlying basin, is approximately 25 miles east of the Pacific Ocean and encompasses an area of approximately 170 square miles (Figure 1-1). The SEMOU covers approximately 8 square miles in the south-central portion of the San Gabriel Valley and is bounded by the San Bernardino Freeway (Interstate 10) to the north, the Pomona Freeway (State Route 60) to the south, the San Gabriel River Freeway (Interstate 605) to the east, and San Gabriel Boulevard to the west (Figure 1-2). Most of the SEMOU is highly developed, except for land within the Whittier Narrows Flood Control Basin. The SEMOU includes the entire city of South El Monte and parts of the cities of El Monte and Rosemead. The zoning for a majority of the SEMOU area is for residential use, particularly the eastern and western portions of the OU. Industrial activities, primarily small to medium-sized businesses, are present across the central portion of the SEMOU (Gilbane 2019a).

The WNOU encompasses an area of approximately 4 square miles in the southern portion of the San Gabriel Valley. The WNOU is approximately bounded by the Pomona Freeway (State Route 60), the Whittier Narrows Dam, and Hacienda Hills (Figure 1-2). Whittier Narrows is a 1.5-mile gap in the low-lying hills and separates the San Gabriel Groundwater Basin from the downgradient Central Groundwater Basin. The WNOU includes the Whittier Narrows Recreation Area, which provides flood control and outdoor recreational use (URS 2019). The

WNOU also includes parts of the cities of Montebello, Whittier, Pico Rivera, South El Monte, and Industry. Residential, commercial, and light industrial land-uses surround the WNOU. Industrial areas are generally east of the core groundwater contaminants entering the WNOU (URS 2019).

1.5 HYDROGEOLOGIC SETTING

This section describes conditions that control groundwater movement and the distribution of contaminants in the San Gabriel Groundwater Basin, and more localized SEMOU and WNOU.

1.5.1 Regional Hydrogeology

The San Gabriel Valley overlies a Pliocene to Pleistocene age structural basin created by regional compressional forces that uplifted the San Gabriel Mountains (California Department of Water Resources [DWR] 1966, 2004). The basin is bounded to the north by the San Gabriel Mountains and to the southwest, south, and southeast by a crescent-shaped system of low hills. Whittier Narrows is a gap in the low-lying hills bounding the San Gabriel Valley to the south.

The San Gabriel Basin is composed of a coalesced sequence of alluvial deposits that host a groundwater reservoir recharged by runoff from the surrounding highlands and rainfall on the valley floor. As described in interim and Supplemental RI reports (Geosystems 1998; Gilbane 2019a), a sequence of fine-grained deposits in the western portion of the basin separates a shallow water-bearing zone (shallow zone) from a deeper water-bearing zone. EPA has divided the deeper water-bearing zone at the site into an “intermediate zone” and a “deep zone.” The deep zone extends to the bottom of alluvial sediments, which California DWR estimates to be 900 to 1,000 feet below ground surface (bgs) in the SEMOU and WNOU (California DWR 1966). Stetson Engineers, Inc. (a contractor for SGVWC) estimates that the total freshwater storage capacity within the regional aquifer system is 8.7 million acre-feet (Stetson Engineers, Inc. 2016).

Groundwater flows generally southward toward the Whittier Narrows, except in areas where well extraction influences the flow. Groundwater discharge occurs primarily through well extraction (80 percent) and Whittier Narrows outflow (20 percent). Groundwater discharging through Whittier Narrows enters the Central Basin (Figures 1-1 and 1-2).

The Rio Hondo and San Gabriel River systems route surface water through the San Gabriel Valley. Both river systems flow through the SEMOU and WNOU. Urbanization has resulted in significant areas of pavement and many miles of stream channel lining for flood control purposes, which reduce infiltration of water through streambeds to the underlying groundwater flow system (Stetson Engineers, Inc. 2016).

1.5.2 Local Hydrogeology

SEMOU and WNOU monitoring and extraction well installations have helped refine the current understanding of groundwater flow conditions and the extent of COCs in the regional aquifer system (Figures 1-4 and 1-5). Hydrogeologic cross-sections C-C' and F-F' oriented west-east and north-south, respectively, illustrate conditions through the SEMOU (Figures 1-6a and 1-6b). Figures 1-6c and 1-6d show cross-sections G-G' and H-H' oriented west-east and north-south, respectively, to further illustrate subsurface conditions through the WNOU (URS 2019). The hydrogeologic cross-sections display the well completion intervals, sediment type, groundwater levels, and PCE concentrations in groundwater.

Gilbane defined three water-bearing zones and a separating sequence to describe local hydrogeologic conditions (Gilbane 2019a):

- Shallow Zone. This zone extends from the water table, present at depths of about 35 to 75 feet bgs, to the top of the separating sequence, which is generally present from 60 to 130 feet bgs. The shallow zone is present under unconfined conditions with groundwater flow principally to the south and southwest toward Whittier Narrows. The state considers the zone to be a potential drinking water source.

- Separating Sequence. A series of fine-grained deposits that vary in thickness from 45 to 165 feet represent the sequence. The greatest sequence thickness is present in the northwest corner of the SEMOU. The sequence is thin in the southwest corner of the SEMOU and is not present within the entire WNOU.

- Intermediate Zone. This zone underlies the separating sequence and extends to a depth of about 500 to 600 feet bgs in the SEMOU and WNOU, respectively. The vertical extent of VOC impacts, as opposed to lithologic changes, defines the bottom of the intermediate zone. The intermediate zone is present under semi-confined to confined conditions. The state considers the zone to be a drinking water source.

- Deep Zone. This zone underlies the intermediate zone and extends to approximately 900 to 1,000 feet bgs and defines the estimated vertical extent of alluvial sediments in the SEMOU and WNOU.

Groundwater flow directions within the SEMOU vary and are dependent on proximity to extraction wells (Figure 1-7a), while flow within the WNOU is principally to the south-southwest (Figure 1-7b). Within the SEMOU, there is a groundwater divide from which flow moves westward toward remedy wells or southward toward Whittier Narrows. This divide, or hydraulic pressure boundary, is beneath contaminant source areas located in the central portion of the SEMOU (Gilbane 2019a). The flow divide location is transient in response to pumping stresses and recharge rates, and generally moves south toward the Pomona Freeway during drought conditions (CH2M Hill 2011). Localized pumping influences the vertical gradients between the various zones.

1.6 NATURE AND EXTENT OF GROUNDWATER CONTAMINATION

In addition to the two primary VOC contaminants, PCE and TCE, compliance groundwater monitoring has detected several, less extensive, emerging contaminants (perchlorate, 1,4-dioxane, NDMA, and TCP). Since discovery, groundwater contaminant levels for PCE have declined from concentrations in the 1,000s of micrograms per liter (µg/L) to current concentrations in the 10s to 100s of µg/L (Gilbane 2019b). Figures 1-8a through 1-8d depict the areas of contamination in the shallow and intermediate zones using the estimated PCE concentrations defined as initial conditions for the groundwater modeling performed in support of the ERAS (Appendix A, CH2M Hill 2021b).

The interim RI (Geosystems 1998), Supplemental RI (Gilbane 2019a), and remedial action compliance and performing monitoring reports (Gilbane 2019b, URS 2019) summarize the characterization of the nature and extent of groundwater contamination in the shallow and intermediate zones. The following subsections provide an overview of the current nature and extent of groundwater contamination in the SEMOU and WNOU with a focus on PCE concentrations because the overall distribution of this contaminant is widespread.

1.6.1 Shallow Zone Contaminant Distribution

The interim RI (Geosystems 1998) determined that the shallow zone contained most of the known sources of groundwater contamination. The interim RI detected VOC concentrations at several hundred times the federal and state drinking water standards extending from the SEMOU into the downgradient WNOU. TCE and cis-1,2-DCE concentrations are most frequently above maximum contaminant levels (MCLs), indicating more favorable conditions for active biological transformation of PCE and TCE, and/or potential contributions from TCE sources in the shallow zone (Gilbane 2019a).

Overall, VOC concentrations within the commingled plumes have decreased substantially since the interim RI in response to (1) source facility remediation that reduced contaminant loading to the shallow zone, (2) operation of groundwater extraction and treatment systems, and (3) natural processes such as advection and dispersion (Gilbane 2019a).

Figure 1-8a shows the shallow zone contaminant distribution used for groundwater model simulations conducted by CH2M Hill (2021b). The contaminant distribution is based on recent EPA and DTSC groundwater sampling events. Data from monitoring wells SEMW18 (northern plume), SEMW28 (eastern plume), SEMW22 (south central plume), and SEMW26 (a limited area) indicate that these wells define the areas with PCE concentrations more than 10 times the MCL. Historical PCE concentrations ranged up to 440 µg/L in the SEMOU (SEMW03) and up to 340 µg/L in the WNOU (EPAW415). Shallow zone contamination extends into the WNOU as defined by monitoring wells located immediately north and south of the Pomona Freeway (State Route 60).

1.6.2 Intermediate Zone Contaminant Distribution

In the intermediate zone, VOC concentrations were historically lower than in the shallow zone but still exceeded federal MCLs. Figures 1-8b through 1-8d show the intermediate zone contaminant distribution used for groundwater model simulations conducted by CH2M Hill (2021b). EPA and DTSC generated the interpreted PCE concentration contours for three depth intervals: the upper-intermediate zone (150-300 feet bgs), the middle-intermediate zone (300-450 feet bgs), and the lower-intermediate zone (450-600 feet bgs).

1.6.2.1 SEMOU

In the SEMOU, the capture zone established by remedy extraction wells limits migration of the VOC plume downgradient of the Western Containment Area. Other VOC compounds, such as TCE, are rarely present at concentrations above MCLs or are at concentrations less than MCLs, suggesting that the widespread nature of PCE is most likely due to the absence of conditions favorable to biological transformation (Gilbane 2019a).

The most widespread portions of the VOC plume above MCLs occur within the upper- and middle-intermediate zone (Figure 1-8b and 1-8c). However, the lateral extent of PCE in the middle-intermediate zone is considerably smaller than in the upper-intermediate zone. In 2016, only one well (SEMW07) completed in the lower-intermediate zone and located just east of the Western Containment Area had PCE concentrations above the MCL. Figure 1-8d depicts the distribution of contamination in the lower-immediate zone. Figures 1-6a and 1-6b depict the vertical distribution of PCE (as of 2016) on SEMOU west-east and north-south cross sections, respectively.

The maximum PCE concentrations continue to be present in the central portion of the SEMOU located east of the Rio Hondo. The group of remedy wells in the Central Containment Area contain these PCE concentrations, as evidenced by the high PCE levels in MP12, MP15, and the SGVWC Plant 8 extraction wells. Five wells monitor the northern to northwestern margin of the VOC plume. Monitoring well SEMW18C (in the upper intermediate aquifer) has detectable concentrations of PCE that are less than the MCL. Monitoring wells SEMW04 and SEMW08 tend to have PCE concentrations slightly above the MCL and approximately delineate the limits of the plume in the northwestern area. A change in flow direction, combined with decreasing VOC trends provides strong evidence that the boundary of the plume is just north of monitoring well SEMW08 (Gilbane 2019a).

Site investigations have fully characterized the lateral and vertical extent of emerging contaminants relative to MCLs and state notification levels (NLs). Concentrations of perchlorate, NDMA, nitrate, and hexavalent chromium were below the MCLs or NLs in 2016 at all monitoring locations screened within the upper, middle, and lower intermediate zones. Three wells in the upper intermediate aquifer had 1,4-dioxane concentrations above the NL of 1 µg/L, with the maximum occurring at well SEMW18C at a concentration of 2.8 µg/L. Finally, 1,2,3-TCP had two exceedances of the NL in 2016, the highest being at well SEMW09, where the 0.012 μg/L detection slightly exceeded the NL of 0.005 μg/L. However, some of the laboratory reporting limits for this compound are above the NL.

1.6.2.2 WNOU

Within the WNOU, there are no known sources of groundwater contamination or PRPs (URS 2019). PCE concentrations exceed federal and/or state MCLs for drinking water; while TCE, perchlorate, 1,4-dioxane, NDMA, and 1,2,3-TCP are also present in groundwater but at concentrations below MCLs or NLs.
PCE concentrations continue to be higher within the upper-intermediate and middle-intermediate zones present from 150 to 450 feet bgs (Figures 1-8b and 1-8c). In 2018, PCE concentrations ranged from non-detect to a maximum of 14 μg/L at monitoring well EPAW415 located in the northern portion of the WNOU. The historical upper-intermediate and middle-intermediate zone PCE concentrations ranged up to 300 μg/L and 170 μg/L, respectively at the same location (URS 2019). Historical lower-intermediate zone PCE concentrations ranged up to 18 μg/L (EPAMW1MP) in the WNOU. Using 2017 data, Figures 1-6c and 1-6d show the vertical distribution of PCE on west-east and north-south cross sections, respectively.

1.7 RISK EVALUATION

In 1997, EPA completed the SEMOU Preliminary Baseline Risk Assessment to estimate human health and environmental risks should EPA take no action to address documented contamination (CH2M Hill 1997). EPA used the baseline assessment and subsequent addendum to identify the contaminants and exposure pathways that they must address with the remedial action. The Supplemental RI (Gilbane 2019a) includes a supplemental HHRA to evaluate whether, after implementation of the interim remedy, the contaminated groundwater still poses a significant risk to human health if human receptors (e.g., local residents and workers) or ecological receptors (e.g., native wildlife) encounter untreated groundwater. Because federal and state drinking water regulations and local limitations on utilization of private drinking water wells make it extremely unlikely that either residential consumers or workers would drink the contaminated groundwater, this health risk evaluation is conservative. The following sections provide summaries of the risk assessments.

1.7.1 Human Health Risk Assessment

The supplemental HHRA indicated that arsenic, hexavalent chromium, PCE, TCE, and 1,4-dioxane were potential COCs for both the shallow and intermediate zones, although the highest concentrations of arsenic and hexavalent chromium are less than their respective federal and state MCLs. The excess lifetime cancer risk levels for both PCE and TCE in the shallow and intermediate zones exceed the 10^{-4} upper bound of the EPA risk management range. The noncarcinogenic hazards were also greater than 1 for PCE and TCE.

1,4-Dioxane present in the shallow aquifer poses a potential risk, but the risk is within EPA's risk-management range of 10^{-6} to 10^{-4}. Concentrations of 1,4-dioxane in the intermediate aquifer have a de minimis risk in that they are less than 10^{-6} and a hazard index of 1. The California State Resources Control Board Division of Drinking Water (DDW) NL for 1,4-dioxane was the point of comparison (California Environmental Protection Agency 2015).

Despite its low frequency of detection in the intermediate aquifer at concentrations above the DDW NL, EPA considers NDMA a COC because the potential carcinogenic risk to residents and workers is greater than 10^{-4}. However, EPA has concluded that NDMA is not site related. EPA previously detected NDMA at concentrations that exceeded the DDW NL, primarily in the WNOU, but has not detected elevated NDMA concentrations in years.

A separate HHRA assesses the risk from exposure to potential vapor intrusion within the SEMOU (EA 2019).

1.7.2 Ecological Evaluation

EPA conducted a risk evaluation during both the preliminary and supplemental RIs for groundwater to determine whether there are any potential ecological exposure pathways in the SEMOU. The majority of the land in the SEMOU is residential or commercial. Feral species and wild birds represent the native wildlife in the area. Native vegetation and wildlife exist in minor amounts within the Whittier Narrows Recreational Area, as extensive portions are concrete-lined channels. The EPA did not conduct ecological studies for the SEMOU RI (Geosystems 1998) or the Supplemental RI (Gilbane 2019a) because EPA listed the SEMOU as a groundwater Superfund site and there are no known exposure pathways for ecological receptors.

Except for the northeastern corner, most of the WNOU remains undeveloped and is a flood control and recreational area. The WNOU contains hiking trails, birding areas (with two endangered bird species), parks, lakes, and floodplain. Ecological information is available from studies performed by the U.S. Army Corps of Engineers in the Whittier Narrows Recreational Area (U.S. Army Corps of Engineers 1995).

EPA concluded that ecological receptor risk from groundwater contaminants within the SEMOU and WNOU is absent (EPA 2000) because there is no untreated discharge of contaminated groundwater at the SEMOU and, at the WNOU, very limited potential for groundwater to discharge to surface water. Although EPA detected VOC vapors in buildings within the SEMOU that might impact animal burrows, no burrowing birds or mammals occupy the SEMOU due to the lack of suitable habitats (EA 2019).

1.7.3 Risk Assessment Conclusions

The need for continued action by EPA and the state in the SEMOU and WNOU is based on the ongoing presence of contamination in groundwater at levels that exceed drinking water standards, the potential for this contamination to continue to migrate into groundwater areas that are presently clean or less contaminated, and the continuing use of groundwater in and around the SEMOU and WNOU as a source of drinking water.

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2. REMEDIAL ACTION OBJECTIVES AND ARARs

The NCP states that the goal of the remedy selection process is "to select remedies that are protective of human health and the environment, that maintain protection over time, and that minimize untreated waste" (40 Code of Federal Regulations [CFR] §300.430[a][1][I]). RAOs, described in the FS and ROD, are narrative statements that provide the foundation for development of the site-specific remedial strategy and take into consideration the COCs, exposure routes and receptors, and acceptable contaminant levels for each contaminated medium (EPA 1988, 2014). In addition, all remedies selected in the Superfund process must comply with (or the decision document must justify the waiver of) ARARs described in the Interim ROD (EPA 2000). Although this ERAS follows the EPA FS guidance and format to a large extent, its primary purpose is remedy optimization and improvement, not remedy selection. Therefore, it has some differences from the guidance. For instance, a typical FS only has one set of remedial goals and objectives, while this document has three sets that address the original remedy (status quo), optimized containment of the contamination, and restoration of the aquifer. It also does not include any ARARs. The remedy selected in the current ROD or in any subsequent decision documents, based on the ERAS or future evaluations, will include the RAOs and comply with ARARs.

This section describes the ERAS RAOs, GRAs, and general ARARs, and the current basin adjudication that affect remedy implementation.

2.1 REMEDIAL ACTION OBJECTIVES

The SEMOU Interim ROD describes a performance-based approach where the remedy meets RAOs using specific criteria for the selected remedy (EPA 2000). The intent of the Interim ROD was to allow for flexibility in implementation of the remedy while significantly reducing exposure to contaminated groundwater. The RAOs from the Interim ROD are as follows:

- Prevent exposure of the public to contaminated groundwater
- Contain further migration of contaminated groundwater from more highly contaminated portions of the aquifer to less contaminated areas or depths
- Reduce the impact of continued contamination migration on downgradient water supply wells
- Protect future uses of less contaminated and uncontaminated groundwater.

The WNOU Interim ROD has the following RAO:

- "To the extent technically and economically feasible, EPA intends to control contaminant migration in Whittier Narrows so that contamination originating from industrial activities in the San Gabriel Basin will not cause production wells in Whittier Narrows and the Central Basin to exceed drinking water standards."

The RAOs from the Interim RODs reflect EPA's regulatory goal of restoring usable groundwater to its beneficial uses wherever practicable, within a time frame that is reasonable; or, if restoration is impracticable, to prevent further migration of the plume, prevent exposure to the contaminated groundwater, and evaluate further risk reduction (40 CFR Section 300.430(a)(l)(iii)(F)).

The RAOs from the Interim RODs do not include numeric, chemical-specific objectives in the aquifer or a time frame for restoration because the remedy options focus on containment of contamination. Inclusion of the following additional RAOs, which focus on site restoration, are dependent on the final remedy selected.

- Restoration of SEMOU groundwater quality to appropriate beneficial use wherever practical within a reasonable timeframe.

- Restoration of WNOU groundwater quality to appropriate beneficial use wherever practical within a reasonable timeframe.

The ERAS considers multiple alternatives ranging from a no action alternative to expansion of the interim remedy to reach cleanup goals within an acceptable timeframe. If future performance evaluations determine that the remedy is unlikely to achieve the RAOs and ARAR-based cleanup levels, even after optimization, then it may be appropriate to modify the groundwater restoration RAOs and to explore whether EPA should consider a Technical Impracticability waiver (EPA 1993a).

The RAOs associated with any optimized remedies will include site restoration timeframes and may also include numeric, chemical-specific objectives. Section 5 discusses technical, financial, and administrative barriers to achieving drinking water standards for the SEMOU and WNOU.

2.2 GENERAL RESPONSE ACTIONS

GRAs are medium-specific actions likely to satisfy the RAOs (EPA 1988). The development of remedial alternatives begins with the identification of GRAs that can meet RAOs. Section 3 of this ERAS presents a screening of the GRAs identified for groundwater and Section 4 develops them into remedial alternatives. The bullets below list the GRAs and remedial technologies that are subcategories of the GRAs, as appropriate:

- No Further Action—As required by the NCP (NCP § 300.430 [e][6]), the selected remedial alternatives must include the No Further Action alternative as the baseline alternative against which EPA judges the effectiveness of all other remedial alternatives.

- Institutional Controls—These are non-engineered instruments, such as administrative and legal controls, that help minimize the potential for human exposure to contamination and protect the integrity of a remedy by limiting land or resource use. Institutional controls can be applicable in all stages of the remedial process to accomplish various remedial objectives.

- Monitoring—Long-term groundwater monitoring is an important component of a containment alternative. Additionally, groundwater monitoring can provide data to help determine effectiveness of the selected remedy.

- Containment—Groundwater extraction can prevent migration of the contaminant and eliminate exposure pathways to potential receptors through hydraulic control. This ERAS does not include source reduction or source control remedial actions because the state is addressing these issues.

- Ex situ Treatment Actions—These actions subject contaminants to processes that alter their state, transform them to innocuous forms, or immobilize them unless site- or contaminant-specific characteristics make it impracticable. This ERAS assesses existing and planned treatment systems to determine if they can meet objectives. Examples of ex situ treatment actions include:
  - Extracted Groundwater Treatment
  - Disposal of Treated or Untreated Waste Media (Wastewater and Residuals)
  - Treated Water Discharge or End Use Process Options.

- In situ Treatment Cleanup Actions—In situ treatment systems treat the contaminated medium in place; consequently, the need for aboveground waste management is minimal. Examples of in situ treatment processes for groundwater include:
  - Natural Attenuation
  - Chemical Processes
  - Biological Processes
  - Physical Processes.

EPA screened GRAs applicable to groundwater contamination based on the ability to meet remedial response objectives and applicability of the technology to site conditions (Section 3). EPA dismissed several technologies from further consideration based on these two criteria. Response actions involving extraction and treatment of contaminated groundwater require end use by a public water system or reinjection because EPA does not have pumping rights to support the remedy. EPA can implement GRAs using one or more remedial technologies.

2.3 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

As mentioned previously, remedies selected in the Superfund process must comply with (or the decision document must justify the waiver of) ARARs set forth in the FS and ROD. Although this ERAS follows the EPA FS guidance, its primary purpose is remedy optimization and improvement, not remedy selection. It also does not include any ARARs.

The remedy selected in the Interim ROD (EPA 2000) or in any subsequent decision documents, based on the ERAS or future evaluations, will include the RAOs and comply with ARARs. The primary ARARs will be chemical-specific *Federal Primary Drinking Water Standards (40 CFR Part 141) and California State Primary Drinking Water Standards*. Federal primary drinking water standards (MCLs under the Safe Drinking Water Act United States Code §§ 300, et seq.) protect the public from contaminants that may be in drinking water sources. California has promulgated drinking water standards for public drinking water sources under the California Safe Drinking Water Act.

2.4 BASIN ADJUDICATIONS

The WNOU and SEMOU are in the Main San Gabriel Basin while the Montebello Forebay, adjacent to and downgradient of Whittier Narrows, is in the Central Basin. The rights to pump groundwater from the San Gabriel Basin and the Central Basins are fully adjudicated (i.e., assigned to specified users in accordance with a court judgment). EPA does not have pumping rights in either basin, so any groundwater pumped in support of an EPA remedy must either make use of another parties' water rights or EPA needs to enter into a water production agreement with the Main San Gabriel Basin Watermaster (Watermaster) that authorizes pumping without rights.

These adjudications significantly impact both the pumping and end use options available to EPA when implementing groundwater remedies in the San Gabriel Basin.

There are three judgments that govern groundwater management in the Whittier Narrows/South El Monte vicinity.

2.4.1 San Gabriel Basin Judgment

A stipulated judgment by the Superior Court of Los Angeles County in 1973 (amended in 1989) adjudicated the water rights in the Main San Gabriel Basin. This adjudication assigned water rights to approximately 50 parties that each hold rights to greater than one percent of the natural safe yield of the basin (152,700-acre-feet per year, established in the judgment), and approximately 100 parties that each hold rights to less than 1 percent of the natural safe yield. Also, according to the judgment, only selected parties have the right to export groundwater out of the Main San Gabriel Basin. This is an important limitation for Whittier Narrows, which is located immediately adjacent to the Central Basin.

The judgment also establishes the duties of a Watermaster, which include annually determining an operating safe yield (OSY) for the basin, monitoring pumpers' compliance with the judgment, issuing permits for all new and increased pumping in the basin, and preparing an annual report that includes details of pumping activities in the basin. The Watermaster establishes the amount of groundwater that each water rights holder can pump in any year. The Watermaster adjusts it by prorating the pumper's prescriptive rights (percentage of natural safe yield) by the OSY. For fiscal year 2019-2020, the Watermaster approved 150,000 acre-feet as the OSY for the basin.

The state regulates purveyors as public water supply systems, who supply most of the groundwater pumped from the Main San Gabriel Basin to the public to use as drinking water. Annually, pumping typically equals or exceeds the OSY of the basin. When excess extraction occurs, the judgment has established provisions for assessing pumpers the cost of importing replacement water to replenish the excess amount that they extracted.

2.4.2 Long Beach Judgment

The Long Beach Judgment is the 1964 settlement of a lawsuit between parties in the Central and San Gabriel Basins. This judgment mandates that the San Gabriel Basin deliver an average of 98,415-acre-feet of useable water to the Central Basin each year. This water consists of: (1) surface flow that passes through Whittier Narrows, (2) subsurface (groundwater) flow through Whittier Narrows, and (3) a portion of the water exported (piped) from the San Gabriel Basin to the Central Basin.

Although the Long Beach Judgment specifies an average entitlement of 98,415-acre-feet per year, the court-appointed Watermaster calculates the actual entitlement yearly. The Watermaster tabulates the water discharged through Whittier Narrows. If the San Gabriel Basin delivers more than 98,415-acre-feet to the Central Basin in a year, then the Watermaster will credit San Gabriel Basin with the excess. Conversely, if San Gabriel Basin delivers less, they must make up the difference, either from past credits or, if that is not sufficient, through delivery of imported surface water as makeup water to the Central Basin.

2.4.3 Central Basin Judgment

In 1950, local authorities created the Central Basin Water Association (CBWA) to address overdraft and long-term decline of groundwater levels in the Central Basin. The CBWA developed a plan to provide supplemental water to major producers, limit groundwater extraction from the Central Basin, and create an exchange water pool to provide groundwater pumping rights for users lacking access to other supplemental water supplies.

After the formation of the CBWA, a lawsuit ensued that resulted in the 1962 Central Basin Judgment through which the Central Basin was fully adjudicated. Like the San Gabriel Basin Judgment, the Central Basin Judgment established the Central Basin Watermaster to administer the adjudication. The Water Replenishment District of Southern California (WRD) currently serves as the administrative body for the Central Basin Watermaster. The WRD assesses all producers of groundwater for replenishment water. The definition of replenishment water is: imported water purchased by WRD and artificially recharged within the basin.

In 1991, amendments to the Central Basin Judgment provided a replenishment assessment exemption for contaminated groundwater extracted for the strict purpose of remediation. This amendment does not include an upper limit to the quantity of water that may be exempt. However, any exemption is subject to WRD Board approval.

3. IDENTIFICATION AND SCREENING OF REMEDIAL TECHNOLOGIES

The ERAS considers a combination of remedial technologies, engineering controls, and institutional controls for development of remedial alternatives. Accordingly, this section identifies and screens the remedial technologies likely to satisfy RAOs. EPA screened the technologies and specific process options using the following criteria:

- Effectiveness—This criterion measures the ability of a technology to (1) reduce toxicity, mobility, or volume, (2) minimize residual risks, (3) afford long-term protection, (4) comply with ARARs, (5) minimize short-term impacts, and (6) achieve protectiveness in a limited duration. Technologies that offer significantly less effectiveness than other proposed technologies may be eliminated from the alternative development process. In addition, the ERAS may eliminate technologies that do not provide adequate protection of human health and the environment.

- Implementability—This criterion measures the technical feasibility and availability of a technology and the administrative feasibility of implementing it (e.g., obtaining permits for offsite activities, rights-of-way [ROW], or construction). The ERAS may eliminate technologies that are technically or administratively infeasible or that would require equipment, specialists, or facilities that are not available within a reasonable period.

- Cost—This criterion considers the relative costs for implementing a technology. Technologies that cost more to implement but offer no benefit in effectiveness or implementability over other technologies may be excluded from the alternative development process.

The following sections describe the remedial technologies and provide an analysis of their performance relative to the screening criteria. Table 3-1 presents a summary of the technology screening. This ERAS considers technologies retained during the screening process to develop remedial alternatives in Section 4.

3.1 NO ACTION

The NCP requires consideration of a No Action remedial alternative that serves as the baseline against which EPA judges the effectiveness of all other remedial alternatives (40 CFR §300.430 [e][6]). In this ERAS, EPA evaluated No Action and No Further Action. No Action means no active remediation or monitoring to meet the RAOs and the water purveyors continue to provide wellhead treatment. No Further Action means there is no additional action beyond continued operation of the current Interim ROD containment remedies in place for the SEMOU and WNOU.

No Action is not effective because EPA takes no actions to change the existing operation of the current containment remedies. All drinking water currently served by water utilities meets federal and state drinking water standards. Because federal and state drinking water regulations and local limitations on utilization of private drinking water wells make it extremely unlikely that either residential consumers or workers would drink the contaminated groundwater, the risk of exposure is low. However, the costs and the barriers to implement No Action are minimal. EPA included the No Action alternative for comparative purposes only.

EPA retained No Action for development of remedial alternatives.

3.2 HYDRAULIC CONTROL SCENARIOS AND TARGET AREAS

Hydraulic control is a remedial approach used to contain contaminated groundwater within a target area. Thereby reducing the mobility of chemicals, eliminating exposure pathways, and preventing further impacts to the groundwater resource. Areas targeted for hydraulic containment include portions of the shallow and intermediate aquifer zones contaminated with COCs above chemical-specific ARARs.

The following subsections define the Western and Central Containment Areas within the SEMOU, shallow zone contaminant areas within the SEMOU, and the WNOU.

3.2.1 SEMOU – Western Containment Area

The Western Containment Area is located primarily in the City of Rosemead between San Gabriel Boulevard and Walnut Grove Avenue (Figure 1-4). The area refers to the intermediate zone of contamination located downgradient (west) of MP12 in the vicinity of GSWC wells San Gabriel Well Number (No.) 1 (SG-1) and San Gabriel Well No. 2 (SG-2), Garvey1 and Garvey2, and Earle1; and additional MP wells (MP1, MP3, MP5, MP6, MP10, and Fern) (Figure 1-4). The intermediate zone is the primary target for remediation of contamination present from approximately 150 to 500 feet bgs.

3.2.2 SEMOU – Central Containment Area

Extraction wells MP12 and MP15 and SGVWC Plant 8 wells SGVWC8A through SGVWC8F and the area within 1,500 feet downgradient of these extraction wells create the Central Containment Area. Figure 1-4 shows the water purveyor remedy and non-remedy extraction wells, plus existing monitoring well locations. The intermediate zone is the primary target for remediation of contamination present from approximately 150 to 500 feet bgs.

3.2.3 SEMOU – Shallow Zone Contamination

Shallow zone contamination is located primarily in the City of South El Monte as defined by high contaminant concentrations (Figure 1-8a). These shallow zone areas are the target for remediation of contamination present from approximately 50 to 150 feet bgs.

3.2.4 WNOU

Groundwater contamination in the shallow and intermediate zones that has migrated from the SEMOU to the WNOU defines the WNOU target area (Figures 1-8a through 1-8d). Currently, there is no shallow zone contamination above federal MCLs in the WNOU.

3.3 GROUNDWATER EXTRACTION

Groundwater extraction is a common remediation technology used to address groundwater contaminant plumes. The technology involves pumping contaminated groundwater to the surface via a network of extraction wells. The extracted water then flows through conveyance piping to a treatment facility where treatment processes remove contaminants. After treatment, the facility distributes the treated water depending on the water's intended end use (e.g., the facility may reinject non-potable water to the aquifer and it may deliver potable water to local water purveyors). Various groundwater extraction designs could achieve different remedy objectives, such as hydraulic control or aquifer restoration.

The following subsections describe groundwater modeling (a prerequisite to implement groundwater extraction) and groundwater extraction with either hydraulic control or aquifer restoration as the remedy objective.

3.3.1 Groundwater Modeling

Numerical models of groundwater flow and contaminant transport can determine optimal placement and flow rates of extraction wells and, if needed, injection wells. Models incorporate hydrogeologic data (e.g., boring logs and pumping tests) and contaminant concentrations from the area of interest to simulate groundwater flow patterns and their effect on the movement of contaminants. The model can incorporate multiple combinations of wells and flow rates to simulate how flow and transport patterns change for each combination. EPA and the state can then select the optimal arrangements of wells and flow rates and use them as the basis for remedial alternative evaluation and design.

In 2006, EPA developed the original SEMOU numerical groundwater flow model using Finite Element subsurface FLOW system software (FEFLOW). EPA has updated and refined this model multiple times to evaluate pumping strategies for the interim remedy. The current version consists of 12 layers representing the shallow aquifer, transition zone, intermediate aquifer, and deep aquifer (CH2M Hill 2015). Using the model, the current minimum flow rate targets for the SEMOU and WNOU interim remedy are roughly 5,850 and 3,500 gallons per minute (gpm), respectively. Table 1-2 provides the target flow rates for individual wells.

As part of the ERAS, EPA initially used the 2015 model to evaluate the performance of different remedial alternatives under various pumping scenarios (Appendix A, CH2M Hill 2021a). Subsequently, EPA updated the model through 2019 and conducted additional remedial alternative simulations (Appendix A, CH2M Hill 2021b).

3.3.2 Groundwater Extraction – Hydraulic Control

Hydraulic control is an approach to groundwater extraction that aims to limit the migration of a contaminant plume. This method can contain an entire plume or only portions of it (e.g., the areas of highest concentration). The groundwater modeling step for hydraulic control focuses on finding a combination of wells and flow rates that effectively contain the plume (or portion of the plume).

Groundwater modeling conducted as part of the ERAS (Appendix A) suggests hydraulic control is an effective approach for containment of contaminated groundwater at the target areas. The approach is implementable, though obtaining access to install wells where needed can increase the difficulty of implementation, especially in developed areas.

The groundwater modeling scenarios that include hydraulic control as a primary objective for the SEMOU that the approach will require approximately zero to five new extraction wells (Table 3-2). This ERAS estimates that the costs to install the extraction wells will be moderate to high, but not prohibitively expensive.

EPA retained hydraulic control for development of remedial alternatives.

3.3.3 Groundwater Extraction – Restoration

Aquifer restoration is an approach to groundwater extraction that aims to remove contaminant mass from an aquifer to restore it to beneficial use. The groundwater modeling step for restoration focuses on finding an array of wells and flow rates that reduce contaminant concentrations to an acceptable level within a targeted timeframe. Groundwater extraction for the purpose of restoration generally requires higher flow rates and more wells than hydraulic control.

The groundwater modeling scenarios that include restoration as a primary objective for the SEMOU indicate that this method could restore the aquifer in about 35 to 70 years. EPA and the state could readily implement this approach, although obtaining access to install wells where needed can increase the difficulty of implementation, especially in developed areas.

The groundwater modeling scenarios that include restoration indicate that the approach will require approximately 11 to 13 new extraction wells (Table 3-2). Also, EPA and the state would have to install new pumps in up to four existing extraction wells (i.e., MP-12, MP-15, SGWVWC 8B, and SGWVWC 8C) to increase their flow rates. The costs to install the extraction wells is high, but not prohibitively expensive.

EPA retained restoration via groundwater extraction for development of remedial alternatives.

3.4 TREATMENT TECHNOLOGIES FOR EXTRACTED GROUNDWATER

Extracted groundwater requires treatment to reduce the concentrations of COCs to below levels specified by regulatory standards. The following sections evaluate technologies that are effective at treating VOCs and 1,4-dioxane in groundwater.

3.4.1 VOC Treatment

Two of the most common technologies to treat VOCs in groundwater are air stripping and adsorption.

3.4.1.1 Air Stripping

Air stripping removes VOCs from water by volatilizing them, thus transferring them from the liquid-phase to the gas-phase. The air stripper forces air upward through a treatment vessel while contaminated water flows downward. As air and water mix, VOCs transfer from the water to the air. The vessel typically contains chemically inert media to retard the flow of water, promote mixing, and increase the air-water contact time and contact area. The treated water flows out of the vessel to the next step in the treatment train. The air, now laden with VOCs, either flows to another process for further treatment or is directly discharged to the atmosphere, depending on its VOC concentrations and site-specific air discharge requirements. If the air requires treatment, the common technologies used to treat VOCs in the gas-phase are VGAC, catalytic oxidation, and thermal oxidation.

Air stripping is an effective remedial technology for the treatment of VOCs, is implementable, and is already a part of the SEMOU remedy. However, if the concentrations of VOCs are high in the contaminated water, the use of post-treatment technologies may be necessary to lower concentrations in the effluent air and water streams to acceptable levels. Air stripping may also require the use of pre-treatment processes (e.g., pH adjustment) to prevent precipitation of inorganic compounds in the vessel, which can plug the vessel and decrease its efficiency. If the air stripping does not require pre- or post-treatment technologies then costs are low; otherwise, costs are moderate.

EPA retained air stripping for development of remedial alternatives.

3.4.1.2 Adsorption

Adsorption is a treatment technology that transfers contaminants from the liquid phase (or gas phase) to the solid phase by sorbing the contaminants to the surface of treatment media. The treatment media is in a vessel and contaminated water flows into the vessel and through the media. The contaminants adsorb to the surface of the treatment media and clean water then flows out of the vessel. Once the adsorption capacity of the media is exhausted, it requires replacement or regeneration. Granular activated carbon is a common treatment media for organic compounds that are present at low concentrations.

Adsorption is the primary treatment technology for the interim remedies and is effectively removing VOCs from groundwater at the SEMOU and WNOU treatment facilities. The technology is implementable, though it may require pre-treatment processes (e.g., pH adjustment) to prevent precipitation of inorganic compounds, which can plug the media and decrease its adsorption capacity. DDW does not require pre-treatment processes for the interim remedies at the SEMOU and WNOU. The cost of the treatment media and the concentration of contaminants, which determines the usage rate of the media, drives adsorption costs. If the adsorption process does not require pre-treatment technologies, then costs are moderate; otherwise, costs are moderate to high.

EPA retained adsorption for development of remedial alternatives.

3.4.2 1,4-Dioxane Treatment

The treatment technologies available to remove 1,4-dioxane from water are few due to its low volatility and its hydrophilic nature. Advance Oxidation Processes (AOPs) are one of the established treatment technologies available to address 1,4-dioxane.

In the context of environmental remediation, AOPs typically fully or partially oxidize organic compounds that are not amenable to biological degradation or compounds that physical treatment technologies (e.g., air stripping and adsorption) cannot effectively remove.

AOPs generate the free radical hydroxyl, a strong oxidant, to degrade contaminants. The combination of ultraviolet (UV) light or ozone and another oxidant, like hydrogen peroxide, generates the hydroxyl radical. In a treatment system that employs UV light and hydrogen peroxide, the system injects hydrogen peroxide and mixes it into influent contaminated water, which then flows through a vessel containing UV lamps. The UV light and hydrogen peroxide form hydroxyl that then reacts and degrades organic compounds. The effluent water may contain by-products from the oxidation reaction that require removal. As a result, AOPs may require post-treatment processes (e.g., adsorption).

AOPs are an effective technology for the treatment of 1,4-dioxane and can also treat VOCs and most other organic compounds. They are implementable, but only moderately so because of design and safety issues. The design parameters for AOPs vary for different wastewaters and, thus, EPA and the state would have to conduct bench- or pilot-scale studies prior to implementation. The oxidants may require special safety precautions, relative to other technologies. The cost of the oxidants, contaminant concentrations (as they determine dosing rates), and energy requirements drive the costs associated with AOPs. If the AOP does not require post-treatment technologies then costs are moderate; otherwise, costs are moderate to high.

Though detected at the site, EPA does not consider 1,4-dioxane a COC. Therefore, EPA will not retain AOPs for development of remedial alternatives. If 1,4-dioxane becomes a COC, EPA will re-evaluate options and may select AOPs as a treatment technology for the contaminant. The

MP's treatment plant, a component of the existing SEMOU remedy, is in the process of a conversion to AOP with LGAC for treatment of VOCs and 1,4-dioxane.

3.4.3 Treatment Facility Siting Considerations

The location of extraction wells, the treated water's end use, and the land use at the site affects the siting of a treatment facility. Facilities are mostly located near their extraction wells and treated water discharge points to minimize the length of conveyance piping required and to minimize pressure losses. To reduce the disturbance of the local community from noise and the increase in vehicle traffic, EPA and the state will locate the facility away from residential areas. The ability to obtain access to property where EPA and the state would build the facility and location-specific ARARs, such as floodplain regulations, also influence the siting of a facility.

EPA will consider the recreational area near the intersection of Rosemead Boulevard and the Pomona Freeway 60 (Figure 1-2) for placement of a new treatment facility during the development of alternatives (Section 4). The area is outside the 100-year floodplain, as of early 2020 (Federal Emergency Management Agency 2008), centrally located relative to the SEMOU and WNOU, and owned by the government, which would facilitate the acquisition of access and permissions to build. The area is also approximately half a mile away from the nearest residential areas.

3.5 TREATED WATER END USE

This section describes options for the end use of treated groundwater.

3.5.1 Potable Water End Use

Usage of treated water as potable water requires the distribution of treated water to local water purveyors who then distribute the water to their consumers. The interim remedy provides potable water to three water purveyors: MP, SGVWC, and GSWC. In this ERAS, EPA considers the provision of water to those water purveyors and to two additional purveyors, the City of Whittier and Suburban, due to these purveyors' proximity to the WNOU and previous contractual relationships.

Treated water destined for potable water use requires extra treatment processes relative to non-potable water, such as disinfection (e.g., by chlorine addition) and redundant treatment (e.g., multiple treatment trains or "polishing" steps). The water purveyor commonly pays the portion of the costs associated with "typical" potable water production. These typical costs can include, disinfection, portions of the water quality monitoring requirements, and pumping needed to boost the water into the water purveyor's system.

EPA and the state will need to establish agreements with each water purveyor to determine the flow rates that each purveyor can accept, water quality requirements, needed infrastructure modifications, and water rights arrangements. EPA's current remedy includes potable water as an end use at the site, so this option is implementable. Nonetheless, increases in the volume of treated water may decrease implementability depending on the water purveyor's ability to receive additional water.

The cost to implement potable water use will be similar to non-potable water use. Potable water use requires extra treatment processes (e.g., disinfection) that non-potable water use does not require; however, the water purveyors typically pay the extra treatment costs. Further, in an adjudicated basin like San Gabriel Valley, non-potable water use options may still require extra treatment processes, resulting in a negligible cost difference between potable and non-potable water use options.

EPA will retain end use of treated water as a potable water source for development of remedial alternatives.

3.5.2 Non-potable Water End Use

Treatment systems may discharge treated water as non-potable water in a variety of ways, such as reinjection to the aquifer through injection wells and surface discharge to a nearby body of water. Reinjection into a potable aquifer is likely to have similar treatment requirements as potable water, except that they will not include disinfection. Note that potable water requires disinfection, but it is a cost born by purveyors and is not a part of the Superfund remedy. For potable end use, DDW will likely require a secondary polishing process, negating the cost and permitting savings from the purveyors' performing the disinfection. Thus, the treatment requirements for non-potable and potable water use at this site are equally stringent.

The following subsections describe and screen reinjection and surface discharge as non-potable water end use options.

3.5.2.1 Surface Water Discharge

Surface water discharge flows through conveyance piping from the treatment facility to a nearby body of water. Pumps at the facility and booster stations, if necessary, provide the pressure needed to move water from the facility to the discharge location. In the adjudicated San Gabriel Valley, the biggest factor affecting implementability of surface water discharge is water rights. In addition, the implementability of surface discharge depends on the distance between the treatment facility and the body of water, the body of water's ability to accept additional water, and on the ability to meet water quality discharge criteria (e.g., the criteria required by National Pollutant Discharge Elimination System permits).

Currently, the Whittier Narrows treatment plant discharges treated water to surface water. The plant discharges a portion of its treated water to Legg Lakes, located approximately 500 feet north of the plant. The maximum amount that the plant can discharge to Legg Lakes without additional financial considerations associated with water replenishment is 800 gpm. Given regulator concerns, the lakes may not be an implementable option for higher flows or treated water from new treatment facilities along Rosemead, even if the costs include the replenishment water. Therefore, surface discharge to Legg Lakes, for flow rates 800 gpm or less, is implementable, with treatment facilities located in the SEMOU along Rosemead Boulevard and the WNOU areas being the most amenable to this option due to their proximity to the lakes. The cost to implement surface water discharge, including replenishment costs, is only slightly lower than reinjection and potable water use.

EPA will retain surface discharge of treated water, as non-potable water, for development of remedial alternatives.

3.5.2.2 Reinjection

Reinjection of treated water involves the installation of injection wells and constructing conveyance piping between the wells and the treatment facility. EPA and the state would install vaults at the well heads to house sample ports, valves, and instrumentation (e.g., flowmeters). Pumps at the facility and booster stations, if necessary, provide the pressure needed to move water from the facility to the injection wells.

The implementability of reinjection depends on the ability to inject water without adversely affecting groundwater flow patterns and the ability to meet water quality discharge criteria (e.g., the criteria needed to meet State Water Resources Control Board Resolution No. 68-16).

Reinjection is implementable at the site; however, it requires developing a Water Production Agreement with the Watermaster. Groundwater modeling of multiple groundwater extraction and injection scenarios (Appendix A) indicates that reinjection of treated water in the WNOU or near the intersection of Pomona Freeway and Rosemead Boulevard will not adversely affect groundwater flow patterns. Further, EPA expects that the groundwater treatment technologies retained earlier in this section will meet the discharge criteria needed to reinject treated water.

The costs to implement reinjection are moderate, relative to surface discharge and potable water use. Repurposing existing extraction wells and piping that are no longer in use for reinjection can reduce the implementation cost.

EPA retained reinjection of treated water, as non-potable water, for development of remedial alternatives.

3.6 IN SITU GROUNDWATER TREATMENT

In situ groundwater treatment technologies treat contaminated media in-place, eliminating the need to extract groundwater to an above-ground treatment facility. They may be physical, chemical, or biological in nature. In situ technologies may be part of a remedy to reduce contaminant mass (i.e., treatment) or to prevent contaminants from spreading beyond affected areas (i.e., containment). In situ technologies can reduce contaminant mass in areas of high concentrations (e.g., source areas) and areas with a small volume of contaminated groundwater.

This section evaluates in situ groundwater treatment technologies that can treat VOCs and 1,4-dioxane in groundwater.

3.6.1 Chemical Processes

Chemical processes applicable to organic compounds include chemical oxidation and chemical reduction.

Chemical oxidation involves injection of oxidizing agents into the contaminated media, typically through a series of injection wells. The oxidizing agents react with and degrade organic contaminants. The reaction produces innocuous by-products, such as carbon dioxide and water, and potentially harmful by-products. Another type of chemical oxidation is a permeable reactive barrier (PRB) to intercept a groundwater plume or to treat a source area. Chemical reduction uses reducing reagents instead of oxidizing reagents and is similar to chemical oxidation.

Chemical oxidation is effective at decreasing concentrations of VOCs and 1,4-dioxane. The oxidizing reagents that can degrade the COCs include hydrogen peroxide, ozone, and persulfate. Chemical reduction is effective at decreasing concentrations of chlorinated solvents but is not effective at decreasing 1,4-dioxane concentrations. The reducing reagents effective for chlorinated solvents include zero-valent iron and ferrous iron. In situ chemical processes have limited implementability because the contaminant plumes at SEMOU and WNOU cover a large area. Large plumes require many injection wells or a long PRB to be effective. Further, the amount of reagent needed would be high. Due to the high number of wells, length of PRB, and quantity of reagents needed to address a large plume, the costs to implement this technology will be high.

EPA did not retain in situ chemical processes for development of remedial alternatives.

3.6.2 Biological Processes

The biological technology most applicable to organic compounds at the site is in situ bioremediation (ISB).

ISB involves the addition of chemicals, microorganisms, or both to contaminated groundwater through injection wells to create a favorable environment for microorganisms to multiply and, in the process, degrade contaminants. The effectiveness of bioremediation depends on the ability to maintain those favorable conditions, which includes the pH, temperature, oxidation or reduction conditions, and hydrology of the contaminated area.

ISB is an effective and proven technology for treating VOCs. There is evidence that 1,4-dioxane is amenable to ISB, but ISB is not an established technology for 1,4-dioxane.

Like in situ chemical oxidation, ISB has limited implementability at SEMOU and WNOU and is likely to have a high cost due to the large size of the contaminant plumes.

EPA did not retain in situ biological processes for development of remedial alternatives.

3.6.3 Physical Processes

Physical treatment technologies applicable to organic compounds include air sparging, in-well stripping, and thermal treatment.

Air sparging is an in situ remedial technology that reduces concentrations of volatile constituents by injecting contaminant-free air into the subsurface saturated zone, enabling a phase transfer of VOCs from a dissolved state to a vapor phase. The air then vents through the unsaturated zone via vapor extraction. Thermal processes can augment air sparging to increase the temperature of the media and enhance volatilization. The thermal processes include electrical heating, steam injection, and hot air injection.

In-well air stripping is a technology that injects air into a vertical well typically screened both at depth, in the saturated zone, and above the water table, in the vadose zone. A blower or air compressor via a drop pipe and diffuser typically injects air into the well below the water table, thereby aerating the water. The aerated water rises in the well and flows out of the system through the upper screen. The system draws contaminated water into the system at the lower screen. This process results in a "circulation" of treatment, whereby VOCs volatilize within the well above the water table. A soil vapor extraction system typically removes and treats the vapors. The partially treated groundwater circulates from the unsaturated zone back to the affected aquifer via percolation. Recirculation and repetition of the process sequentially reduces contaminant concentrations.

Physical treatment technologies are effective for VOCs. 1,4-Dioxane is not amenable to physical treatment due to its low Henry's law constant, although the industry is developing technologies that can increase its volatility and allow for removal via physical methods like vapor extraction.

Due to the large size of the plumes at the site, these physical technologies have limited implementability, and EPA expects them to have a high implementation cost. These technologies would require many extraction wells to be effective. Further, the technologies have a high energy demand relative to other in situ technologies, which contributes to their elevated implementation costs.

EPA did not retain in situ physical processes for development of remedial alternatives.

3.6.4 Monitored Natural Attenuation

Monitored natural attenuation (MNA) is a treatment approach that allows natural processes to achieve RAOs without enhancement or aggressive treatment. The "natural attenuation processes" that are at work in such a remediation approach include physical, chemical, or biological processes, that under favorable conditions, reduce the mass, toxicity, mobility, volume, or concentration of contaminants in the groundwater. The processes may include biodegradation (aerobic or anaerobic), dispersion, or dilution.

The natural processes monitored during MNA can be effective at reducing VOC concentrations, though the rate of degradation can be low. The chemical 1,4-dioxane is resistant to biodegradation and, thus, EPA expects that MNA processes will not be effective at reducing 1,4-dioxane concentrations.

Although low cost, MNA has limited effectiveness and implementability potential for the site.

EPA did not retain MNA for development of remedial alternatives.

3.7 RAW AND TREATED WATER CONVEYANCE

The development of alternatives section (Section 4) describes all combinations of groundwater extraction and treated water end use options that require the construction of conveyance piping to connect the extraction wells, treatment facilities, and discharge locations.

3.7.1 Conceptual Pipeline Alignments

Section 4 presents the conceptual pipeline alignments developed for each remedial alternative. Table 3-3 presents the estimated diameter and length of new piping required for each remedial alternative. The estimates assume a water flow velocity of 5 feet per second.

EPA expects that the alternatives will require between 16,600 and 64,300 linear feet (lf) of new piping (Table 3-3). The pipe diameters will range between approximately 4 and 20 inches, with most of the piping (≥70 percent) being less than or equal to 12 inches in diameter.

3.7.2 Pipeline Installation Considerations

EPA and the state will select pipeline routes that minimize construction costs, difficulty of construction, and impact on the local community. They will avoid construction near high-traffic roads and near essential services (e.g., hospitals and police stations), if possible. Routes that minimize the number of street crossings and depth of excavation are preferable.

The major obstacles the conceptual pipeline alignments may encounter are highway and water crossings (e.g., the Pomona Highway and Rio Hondo Channel). These obstacles will most likely require special construction methods to install the piping, such as jack and bore or directional drilling. EPA and the state may be able to install pipelines through bridges, provided the bridges can carry utilities and support the additional weight. These construction methods will increase the time to construct the pipelines and may require specialized workers and equipment. Therefore, pipeline installation that includes these obstacles will likely have high implementation costs relative to pipeline installation in unobstructed areas.

3.8 GROUNDWATER MONITORING PROGRAM

Groundwater monitoring is a required component for all the remedial alternatives except the No Action alternative. EPA requires monitoring to evaluate the effectiveness of remedies (e.g., to determine whether a remedy is containing a plume or whether contaminant concentrations are decreasing). Monitoring includes the collection of data at monitoring wells and the collection of data from third party sources for monitoring wells and extraction/injection wells that are not part of the site but may affect the remedy. The data collected typically include:

- Contaminant concentrations
- Water quality parameters (e.g., pH, conductivity, and oxidation-reduction potential)
- Groundwater elevation
- Extraction and injection flow rates
- Precipitation
- Groundwater recharge.

Monitoring activities occur at regular intervals, typically quarterly or annually depending on the remedy objectives, and continue until achievement of the remedial objectives.

The interim remedy for the SEMOU has a groundwater monitoring program. The *Final Sampling and Analysis Plan* (Innovative Technical Solutions, Inc. 2011) describes the program. Monitoring includes collection of groundwater elevations on a quarterly basis and semi-annual to annual sampling of monitoring wells to determine contaminant concentrations. Table 3-4a lists the monitoring wells that are part of the groundwater monitoring program.

The interim remedy for the WNOU also has a groundwater monitoring program. The *Performance Evaluation Report for 2018* (URS 2019) describes the program. Monitoring includes collection of groundwater levels and sampling of monitoring wells on an annual basis. Table 3-4b lists the monitoring wells that are part of the groundwater monitoring program.

EPA retained groundwater monitoring for development of remedial alternatives.

3.9 INSTITUTIONAL CONTROLS

The primary institutional controls considered under the ERAS include coordination with state and local agencies with jurisdiction over well drilling and groundwater use within the adjudicated San Gabriel Basin. The ongoing information exchange provided by these institutional controls protect public health by reducing the contaminant threat to production wells, eliminating the potential risk associated with drinking contaminated water, and preventing operation of wells that interfere with plume containment and restoration goals.

Agreements with the Watermaster can implement new restrictions on the installation of production wells and water use in areas within or in the vicinity of the delineated plumes, as needed. Institutional controls are effective for managing risk, relatively easy to implement, and of low cost.

Institutional controls are part of the remedial alternatives developed in Section 4.

3.10 GROUNDWATER MANAGEMENT PLAN

All remedial alternatives are subject to the existing controls on groundwater extraction and use already in effect in the San Gabriel and Central Basins. Well permit requirements, drinking water regulatory controls, and Watermaster authority to regulate and allocate water resources, ensure a degree of centralized control over the extraction, and use of SEMOU and WNOU groundwater. However, these existing controls may not be adequate to ensure that water rights holders operate their production wells in a manner that is compatible with the groundwater contamination containment goals of the interim remedial action and potential aquifer restoration goals under the final remedy.

Although impaired, groundwater in the SEMOU and WNOU remains an important source of drinking water. The DDW typically considers production wells incorporated into an EPA Superfund cleanup to be an extremely impaired source that requires special considerations prior to use as a drinking water supply (California Department of Public Health Policy 97-005). Further, Los Angeles County Department of Health Services requires a well permit prior to installing wells in the SEMOU or WNOU. The permit covers well construction specifications and location.

The extent of documented groundwater contamination potentially limits the ability of numerous water rights holders to fully exercise their water rights and creates a significant challenge for certain rights holders to operate their production wells in a manner that is compatible with the groundwater contamination containment and/or restoration goals considered within the ERAS. Consequently, implementation of a detailed Groundwater Management Plan may be necessary to ensure that the selected remedy is effective.

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4. REMEDIAL ALTERNATIVES DEVELOPMENT

The purpose of this section is to develop and evaluate remedial alternatives that will address the RAOs for the contaminated groundwater in the SEMOU and WNOU. The remedial alternatives include a combination of technologies and process options retained from the screening process (Section 3) to develop the remedial alternatives. This section presents the descriptions of the remedial alternatives. The remedial alternatives are conceptual in nature, but EPA developed them with enough detail to evaluate against the NCP criteria, develop cost estimates of plus 50 to minus 30 percent, and compare with other alternatives. Although this ERAS follows the EPA FS guidance and format to a large extent, its primary purpose is remedy optimization and improvement. EPA and DTSC will evaluate the results of the ERAS and potential funding sources for remedy optimization and seek input from stakeholders. Prior to implementation, EPA or DTSC will develop changes to the current remedy using the remedial design process, and specific methodologies and construction sequences may change based on additional information gathered as part of pre-design activities. Section 5 presents the evaluation of each alternative against the NCP criteria and a comparative evaluation of those alternatives that employ similar approaches. For example, EPA compares alternatives that focus on hydraulic control separately from alternatives that focus on aquifer restoration.

The ERAS describes a range of possible remedial approaches including goals for containment to limit migration with the interim remedies, system optimization, complete restoration of the aquifer to drinking water standards, and a hybrid that is a combination of containment and partial aquifer restoration. The remedial alternatives consider a range of financial, administrative, and logistical issues that EPA and the state must resolve to achieve these goals. The ERAS considers the following remedial alternatives:

- Alternative 1 – No Action (Purveyor Point-of-Use Treatment)
- Alternative 2 – No Further Action (SEMOU/WNOU Interim Remedies)
- Alternative 3 – Optimize Existing SEMOU/WNOU Interim Remedies
- Alternative 4 – SEMOU/WNOU Hydraulic Control plus Pumping to Enhance WNOU Cleanup
- Alternative 5 – SEMOU/WNOU Hydraulic Control Plus Pumping and Reinjection to Enhance WNOU Cleanup
- Alternative 6 – SEMOU/WNOU Enhanced Cleanup
- Alternative 7 – SEMOU/WNOU Enhanced and Accelerated Cleanup.

Table 4-1 provides a summary of the remedial alternatives including the identified remedy objectives and components for both OUs. The alternatives address target areas of contamination described in Section 3.2 and assume conservative groundwater extraction rates necessary to achieve the remedial goals as established through a model simulation process (Appendix A).

4.1 ALTERNATIVE 1: NO ACTION (PURVEYOR POINT-OF-USE TREATMENT)

EPA requires consideration of a "No Action" alternative for comparison to other remedial alternatives (EPA 1988). In this alternative, EPA and the state takes no remedial actions to control contaminant migration from or within the SEMOU, so there are no costs associated with this alternative. This alternative limits mitigation measures to natural attenuation of contaminants and the degree of hydraulic containment achieved by pumping of existing extraction wells.

4.2 ALTERNATIVE 2: NO FURTHER ACTION (SEMOU/WNOU INTERIM REMEDIES)

Alternative 2 assumes "No Further Action" beyond the continuation of the interim containment remedies implemented within the SEMOU and WNOU (EPA 1999, 2000). Remedial objectives include protection of human health and containment but not aquifer restoration. Recent modeling simulations suggest that operation of the interim remedies will extend well beyond a 30-year timeframe without achieving drinking water standards (Appendix A). The long timeframe is in part due to the large amount of contamination already present in the aquifer, declining contaminant mass removal efficiencies over time, and potential contaminant concentration rebound after pumping stops (Keely 1989; Cohen et al. 1997), as conceptually shown in Figure 4-1.

The following subsections describe groundwater extraction, treatment, end use, and monitoring components of Alternative 2. Table 4-2 provides the proposed flow rates and treatment plant capacities. Figure 4-2 shows components of the remedial alternative.

4.2.1 Groundwater Extraction

The groundwater extraction component of the interim remedy limits contaminant migration within the intermediate zone through hydraulic containment. Target extraction rates for the SEMOU and WNOU are 5,850 and 3,500 gpm, respectively. Combined, the target extraction rate is 9,350 gpm under the interim remedy. The following sections describe remedy extraction well operations within the SEMOU and WNOU.

4.2.1.1 SEMOU Extraction

The MP, GSWC, and the SGVWC would continue to operate the SEMOU remedy wells completed in the intermediate aquifer zone. The Central and Western Containment systems have target extraction rates of 4,850 and 1,000 gpm, respectively. Target flow rates for individual wells are as follows.

- City of Monterey Park. Extraction wells MP12 and MP15 are part of the Central Containment system with target extraction rates of 1,800 and 1,750 gpm, respectively. Extraction well MP5, with a target extraction rate of 130 gpm, is part of the Western Containment system.

- Golden State Water Company. Two extraction wells are located at the San Gabriel treatment plant, SG-1 and SG-2. These wells have a combined target extraction rate of 870 gpm. These wells are part of the Western Containment system.

- San Gabriel Valley Water Company. Five extraction wells (SGVWC8B, 8C, 8D, 8E, and 8F) are located at SGVWC Plant 8. However, only wells SGVWC8B, SGVWC8C, and SGVWC8D are part of the SEMOU interim remedy because wells SGVWC8E and SGVWC8F are open to deeper, uncontaminated portions of the aquifer (EPA 2013). SGVWC8C and SGVWC8D have a combined target extraction rate of 1,300 gpm and are part of the Central Containment system.

4.2.1.2 WNOU Extraction

The WNOU interim remedy captures groundwater contamination migrating southward from the SEMOU. The extraction well network consists of separate shallow and intermediate zone wells that focus on removal of contaminants near Whittier Narrows Dam (Figure 1-5). Extraction well details include:

- Shallow Zone. Extraction wells include EW4-3, EW4-4, EW4-8, and EW4-9. These wells have been offline since 2012, except for routine maintenance and groundwater sampling events due to reduced contaminant concentrations (URS 2019).

- Intermediate Zone. Extraction wells include EW4-5, EW4-6, and EW4-7 located north of the Whittier Narrows Dam. These wells are screened from approximately 160 to 390 feet bgs.

The target extraction rate from interim remedy wells completed in the intermediate zone is 3,500 gpm. At this target flow rate, near complete containment of the contaminant plume likely prevents migration of groundwater exceeding chemical-specific ARARs into the Central Basin and Whittier Narrows supply wells (URS 2019).

4.2.2 Groundwater Treatment

The interim remedy treatment systems will continue to operate under this alternative to protect human health and limit contaminant migration. Current treatment capacity within the SEMOU and WNOU is approximately 12,600 and 3,750 gpm, respectively. The sections below describe treatment system components within each OU.

4.2.2.1 SEMOU Treatment

Local water purveyors operate the existing groundwater treatment systems (i.e., MP, GSWC, and SGVWC). Figure 4-2 provides approximate locations for each treatment system. The treatment system components are as follows.

- City of Monterey Park. The Delta Plant, located on Delta Avenue in the City of Rosemead, treats extracted groundwater from extraction wells MP12 and MP15 using an air stripping and off-gas treatment process followed by a secondary treatment barrier of LGAC vessels. Chemical amendments control precipitation in the air stripper tower and provide final pH adjustment and disinfection (EPA 2013). The treatment system has a maximum capacity of 4,500 gpm. A separate LGAC treatment system operates at the well MP5 location with an estimated capacity of 1,600 gpm.

- Golden State Water Company. The San Gabriel Plant, located along South San Gabriel Boulevard in the City of Rosemead, treats extracted groundwater from extraction wells SG-1 and SG-2 using lead-lag pairs of LGAC vessels followed by a final disinfection step (EPA 2013). Requirements within the California DDW nitrate-blending plan limit SG-1 and SG-2 production to 1,200 and 300 gpm, respectively (EPA 2013). The San Gabriel Plant has a maximum treatment capacity of 1,500 gpm.

- San Gabriel Valley Water Company. SGVWC Plant 8 is located along the Rio Hondo Channel in the City of South El Monte. The plant consists of a 5,000-gpm air stripper with an off-gas treatment system approved by the South Coast Air Quality Management District. A LGAC treatment system, operating in a lead-lag configuration, serves as a secondary treatment barrier for water treated by the air stripper prior to final disinfection.

4.2.2.2 WNOU Treatment

The WNOU treatment plant, located along Durfee Avenue within the Whittier Narrows Recreation area, consists of a groundwater extraction and treatment system (GWETS) for contaminated groundwater. The GWETS consists of twenty pairs of LGAC vessels operated in lead-lag configurations that can separately treat shallow and intermediate zone groundwater to meet specific end use requirements (URS 2019). Each vessel pair can treat 750 gpm. Of the twenty pairs, only five are operational and the rest are off-line, resulting in a treatment capacity of 3,750 gpm.

In 2013, EPA transferred responsibility for the long-term O&M of the treatment plant to the state (DTSC). In turn, the state contracted with SGVWC for O&M support, including running the treatment system. In 2016, EPA completed improvements to the plant that include an upgraded chlorination system, a 400,000-gallon potable water reservoir, and a potable-water booster pump station, in order to restore potable end use options. Since 2016, these improvements have been in standby mode until DTSC constructs additional water blending infrastructure for potable water end-use (URS 2019).

4.2.3 Treated Water End Use

Potential end uses include delivery of potable water sources to local purveyors, reinjection for aquifer recharge, and discharge to surface waters. Under Alternative 2, the SEMOU and WNOU treatment systems will continue to provide most of the treated water to local water purveyors to supply potable water distribution systems. The sections below describe potential water end uses under this alternative.

4.2.3.1 Water Purveyor

This alternative assumes that SEMOU and WNOU treatment systems will continue to serve as baseline supply for the local-water purveyor system demands at an average flow rate of 8,550 gpm. Individual water purveyor use of the treated water source is as follows:

- City of Monterey Park. MP treatment plants in the SEMOU will deliver 3,680 gpm to the potable water distribution system.

- San Gabriel Valley Water Company. The SGVWC Plant 8 in the SEMOU will deliver 1,300 gpm to the potable water distribution system. The WNOU plant will deliver an additional 2,000 gpm to the SGVWC distribution system once the WNOU plant water-blending infrastructure is in place. The water-blending infrastructure, funded by the State of California Proposition 1 Groundwater Grant Program, will likely be operational in the year 2022 (URS 2019).

- Golden State Water Company. The GSWC treatment plant in the SEMOU will deliver 870 gpm to the potable water distribution system.

- City of Whittier. The WNOU treatment plant will deliver 700 gpm to the potable water distribution system through an existing intertie once the water-blending infrastructure is in place. A hydrologic and engineering assessment will be required to evaluate whether the City of Whittier's infrastructure can accept the treated water from the WNOU treatment plant.

4.2.3.2 Surface Water/Reinjection

This alternative assumes that the WNOU treatment plant will continue to discharge to Legg Lakes to recharge the aquifer at the target flow rate of 800 gpm once the water blending infrastructure at the WNOU plant is in place. This rate is based on an evaluation by Los Angeles County of the approximate volume of water it historically used to keep the lakes full.

4.2.4 Conveyance Systems

Conveyance systems transport raw water from remedy extraction wells to the treatment plants and finished water from the treatment plants to the designated end use connection points. The existing conveyance piping networks will continue to support the interim SEMOU and WNOU remedies included in this alternative.

4.2.4.1 SEMOU Systems

This alternative assumes that the treatment systems will continue to convey untreated water from the extraction wells to the water purveyors' (i.e., MP, SGVWC, and GSWC) existing SEMOU treatment plants and from the treatment plants to the distribution systems through existing conveyance systems. Continued operation of the SEMOU interim remedy does not require additional conveyance systems.

4.2.4.2 WNOU Systems

Multiple pipelines are in place to convey shallow and intermediate zone groundwater to the WNOU treatment plant, and to route the treated water to designated end-use recipients. The pipelines range in diameter from 8 to 24 inches (URS 2019). Pipelines leading to Legg Lakes situated immediately northwest of the WNOU treatment plant currently discharge treated water from the intermediate zone (Figure 4-2). The shallow zone system is not currently in use and remains idle under this alternative.

The ERAS assumes that the planned water-blending infrastructure will be in place when EPA and the state implements the alternative. The water-blending infrastructure will allow blending of treated water from existing facilities to achieve an acceptable total dissolved solid concentration for potable water distribution by the SGVWC. The DTSC is constructing the water-blending infrastructure as part of a state-funded grant, and for the purposes of this ERAS EPA assumes that the state will complete the system. Therefore, the ERAS does not incorporate the capital costs for the project in the remedial alternative evaluation provided in Section 5. The water-blending infrastructure will allow the WNOU plant to blend approximately 2,000 gpm and distribute it to SGVWC. Even with the blending infrastructure in place, this alternative will need an additional end use for 700 gpm to achieve the alternative's target extraction rate of 3,500 gpm.

For this alternative, EPA assumes that the City of Whittier will receive the final 700 gpm. The WNOU treatment plant connection to the City of Whittier requires minor piping modifications at the facility.

4.2.5 Groundwater Monitoring/Water Management Plan

EPA has installed an extensive groundwater monitoring well network to evaluate interim remedy performance for the SEMOU and WNOU (Figures 1-4 and 1-5). The monitoring network includes conventional single-completion wells, well clusters screened over multiple depth intervals, and multi-port wells (i.e., Westbay Monitoring Systems). This alternative assumes that the existing monitoring network will continue to support performance assessments and track conditions that could affect the remedy. Tables 3-4a and 3-4b summarize well identifications, completion intervals, and monitoring frequency.

EPA and the state will continue to evaluate remedy performance through monitoring of remedy extraction rates, hydraulic gradients, and chemical-specific ARARs in the SEMOU Central and Western Containment areas and the WNOU. Semi-annual groundwater monitoring events will provide the information needed to evaluate the overall effectiveness of containment systems and contaminant concentration trends. Groundwater model simulations will continue to support the evaluation of hydraulic control effectiveness.

EPA, WQA, and DDW will provide oversight for the remedial systems operated by the existing water purveyors. The water purveyors will operate each treatment plant in accordance with the standard procedures outlined in their respective Operations, Monitoring, and Maintenance Plans (OMMPs) to ensure compliance with DDW permit conditions (CH2M Hill 2013). EPA expects that the WQA (SEMOU) and DTSC (WNOU) will continue reporting on remedy performance in annual reports.

4.3 ALTERNATIVE 3: OPTIMIZE EXISTING SEMOU/WNOU INTERIM REMEDIES

This alternative considers optimization of existing containment remedies through adjustments to the groundwater extraction strategy. The remedial goals include protection of human health and limiting contaminant migration.

Figure 4-3 and Table 4-3 provide the location of the assumed remedy components and average flow rates, respectively. The following subsections describe groundwater extraction, treatment, end use, and monitoring components of Alternative 3.

4.3.1 Groundwater Extraction

This alternative builds on the interim remedy through improved targeting of intervals from which the existing interim remedies extract groundwater for hydraulic capture. Optimization will potentially lead to reduced target rates with the more efficient pumping; however, the ERAS evaluation does not include these reduced rates. Note also that this remedial alternative is not specifically targeting mass removal rates higher than those the interim remedies are already achieving.

The improved targeting of intervals may include changes to extraction locations and depths. The sections below describe examples of potential optimization efforts assumed for remedial alternative development.

4.3.1.1 SEMOU Optimization

The SEMOU contaminant concentrations are higher in the upper-intermediate zone than the middle- and lower-intermediate zones. As shown on Figure 1-6a, remedy extraction well MP12 has a long screen interval that extends significantly below the vertical extent of PCE contamination. As a representative optimization option, Alternative 3 considers modification of MP12 to enhance overall contaminant capture in the Central Containment area.

EPA and the state would seal portions of the MP12 screen interval to reduce the interval to approximately 200-500 feet bgs to optimize contaminant mass removal from the intermediate zone.

4.3.1.2 WNOU Optimization

Within the WNOU, PCE concentrations are highest within the upper-intermediate and middle-intermediate zones present from 150 to 450 feet bgs (Figures 1-8b and 1-8c). However, hydraulic capture is incomplete within the middle- and lower-intermediate zones because remedy extraction wells only extend to a depth of 390 feet bgs and may not be ideally located given the current and predicted future extent of deeper contamination. Groundwater quality data and model simulations suggest that optimized extraction would improve hydraulic containment of contamination within the lower-intermediate zone where contaminant concentrations are present above chemical-specific ARARs (Appendix A, CH2M Hill 2021b).

For the conceptual optimization effort under Alternative 3, EPA and the state will install one new intermediate zone extraction well in the general vicinity of existing extraction well EW4-3. The well contractor will screen the new well across the middle-intermediate zone and into the lower-intermediate zone from approximately 350 to 550 feet bgs to improve capture of contaminated groundwater. Pumping rate reductions at well EW4-5 and EW4-6 will balance groundwater extraction from the new well.

4.3.2 Groundwater Treatment

No change from the treatment systems described under Alternative 2.

4.3.3 Treated Water End Use

No change from the treated water end uses described under Alternative 2.

4.3.4 Conveyance Systems

No change in the conveyance systems described under Alternative 2.

4.3.5 Groundwater Monitoring/Water Management Plan

No change in groundwater monitoring or water management from that described under Alternative 2.

4.4 ALTERNATIVE 4: SEMOU/WNOU HYDRAULIC CONTROL PLUS PUMPING TO ENHANCE WNOU CLEANUP

This remedial alternative incorporates SEMOU/WNOU hydraulic control (Alternative 2) plus additional pumping in the SEMOU to accelerate WNOU cleanup. The remedial goals under this alternative are (1) protection of human health, (2) limiting contaminant migration, and (3) WNOU restoration.

Figure 4-4 and Table 4-4a provide the location of the remedy components and average flow rates, respectively. Table 4-4b includes the proposed infrastructure modifications, and the groundwater model simulations completed in support of the alternative are in Appendix A.

The following subsections describe groundwater extraction, treatment, end use, and monitoring components of Alternative 4.

4.4.1 Groundwater Extraction

Within the SEMOU, Alternative 4 assumes an increase in the target extraction rate from 5,850 gpm (Alternative 2) to 8,350 gpm. The additional 2,500 gpm of groundwater extraction would occur just north of the Pomona Freeway (Figure 4-4). This alternative assumes installation and groundwater extraction from one extraction well cluster (EXT1) completed in the shallow-, upper-intermediate-, and middle-intermediate zone; and two upper-intermediate zone extractions wells (EXT2 and EXT4). Table 3-2 provides the proposed target zones and flow rates for each new remedy well.

Within the WNOU, groundwater extraction would be the same as the current interim remedy targets described for Alternative 2, although the flow rates will decline over time as the extent of contamination in WNOU shrinks.

4.4.2 Groundwater Treatment

Alternative 4 assumes the interim remedy treatment systems will continue to treat the target flows as described under Alternative 2. Alternative 4 will route the additional 2,500-gpm requiring treatment to the following facilities:

- MP Delta Plant. An additional 1,000 gpm to the MP Delta Plant, increasing the treatment requirements to 4,550 gpm. MP is in the process of changing and upgrading the treatment system. For the purposes of the ERAS, EPA assumes that the upgrades will enable the system to handle the extra capacity required for this alternative.

- SGVWC Plant 8. An additional 750 gpm to the SGVWC Plant 8, increasing the treatment requirements to 2,050 gpm. The current treatment capacity is 5,000 gpm; therefore, the plant will not expand under this alternative.

- WNOU Plant. An additional 750 gpm to the GWETS, increasing the treatment requirements to 4,250 gpm. The current treatment capacity is 3,750 gpm; therefore, Alternative 4 will require expansion of the GWETS. Plant operators will increase the GWETS capacity by bringing on-line existing LGAC vessel pairs that are currently off-line. Alternative 4 also requires GWETS modifications to reroute treated water to the pipeline leading to extraction wells EW4-3 and EW4-4, which EPA and the state will convert to injection wells as part of this alternative.

4.4.3 Treated Water End Use

Under Alternative 4, the treated water end use consists of potable use by existing water purveyors and reinjection as described below.

4.4.3.1 Water Purveyor

Under Alternative 4, the assumed treated water flow rates for purveyor distribution are as follows:

- City of Monterey Park. MP treatment plants deliver 4,680 gpm to the MP distribution system. Represents a target base rate of 3,680 gpm (Alternative 2) plus 1,000 gpm. As part of this alternative, EPA assumes that MP would eliminate pumping from non-remedy wells in the SEMOU to offset the increased volume from the remedy.

- San Gabriel Valley Water Company. SGVWC Plant 8 delivers 1,650 and 400 gpm to the SGVWC and GSWC distribution systems, respectively. Represents a target base rate of 1,300 gpm (Alternative 2) plus 350 and 400 gpm to the SGVWC and GSWC distribution systems, respectively. As part of this alternative, EPA assumes that SGVWC and GSWC would eliminate pumping from non-remedy wells in the SEMOU to offset the increased volume from the remedy.

- Golden State Water Company. The GSWC plant will continue to deliver 870 gpm to the distribution system, as described under Alternative 2.

4.4.3.2 Surface Water/Reinjection

Alternative 4 assumes the WNOU plant will continue to discharge on average 800 gpm to supply Legg Lakes as in Alternative 2. This alternative will return an additional 750 gpm of treated water to the shallow zone through reinjection at inactive shallow extraction wells EW4-3 and EW4-4 (Figure 4-4). EPA and the state will retrofit these inactive extractions wells to accommodate reinjection to the shallow zone.

4.4.4 Conveyance Systems

Alternative 4 requires the construction of new conveyance systems in support of the remedy (Table 3-3 and Figure 4-4). The raw- and treated-water conveyance requirements are as follows:

- Raw Water Conveyance. New piping from the new extraction well locations to the WNOU plant, SGVWC Plant 8, and MP Delta Plant. Estimated new conveyance requirements are 8,800 lf of ≤6-inch diameter pipe and 21,200 lf of ≤12-inch diameter pipe.

- Treated Water Conveyance. EPA assumes that existing interties between SGVWC and GSWC will transfer the 400 gpm of treated water that the SGVWC Plant 8 will deliver to the GSWC distribution system. EPA also assumes the costs to activate, or upgrade, the interties will be negligible relative to the overall cost of this alternative and, thus, the cost estimate does not include those costs (Appendix B).

- Treated Water Conveyance. Rerouting of treated water at the WNOU GWETS to the converted existing shallow zone raw water conveyance line from wells EW4-3 and EW4-4 and reconfiguration of the EW4-3 and EW4-4 wellheads for injection. Assumes existing raw water piping can be repurposed for treated water conveyance.

The major obstacles the conveyance piping will encounter are:

- Crossing the Pomona Freeway near its intersection with Rosemead Boulevard
  - The freeway is approximately 300 feet wide (eight lanes)

- Crossing the Rio Hondo Channel, near its intersection with Garvey Avenue
  - The channel is approximately 500 feet wide
  - The channel is concrete-lined
  - The Garvey Avenue crossing consists of a four-lane road bridge.

The cost estimate (Appendix B) assumes the piping will be installed beneath these obstacles using the jack and bore construction method.

4.4.5 Groundwater Monitoring/Water Management Plan

With a few exceptions, the groundwater monitoring and management plans are similar to those described under Alternative 2. Groundwater monitoring will include annual data collection from the wells listed in Tables 3-4a and 3-4b, EPA and the state will evaluate remedy performance and continue to oversee operation of the remedial systems.

DDW will likely require updates to existing procedures outlined in treatment plant OMMPs to reflect the proposed modifications. The updated plans will include requirements for monitoring of influent quality from the new remedy wells completed in the shallow and intermediate zones. The updated OMMPs will also include plans for O&M of the new remedy wells and ancillary infrastructure.

The alternative assumes that EPA and the state can modify end-use agreements with existing water purveyors to include acceptance of the additional water volume under their existing San Gabriel Basin water rights. A reduction in non-remedy extraction well pumping will offset all source water obtained from remedy extraction wells to avoid the replenishment assessment fees that would likely be imposed by the Watermaster. Further, the alternative calls for the return of shallow zone water extractions to the same zone after treatment through reinjection; the ERAS assumes that these returns are covered by a water production agreement with the Watermaster that would exempt the production from replenishment assessment fees. Under these assumptions, the ERAS does not include costs of potential replenishment fees in the alternative analysis described in Section 5. Rather, water management costs only include permitting and permit compliance.

4.5 ALTERNATIVE 5: SEMOU/WNOU HYDRAULIC CONTROL PLUS PUMPING AND REINJECTION TO ENHANCE WNOU CLEANUP

Alternative 5 includes the interim remedy enhancements described under Alternative 4 plus increased reinjection of treated shallow zone water to potentially accelerate WNOU cleanup efforts. Like Alternative 4, the remedial goals are (1) protection of human health, (2) limiting contaminant migration, and (3) WNOU restoration.

Figure 4-5 and Table 4-5a provide the location of the remedy components and average flow rates, respectively. Table 4-5b includes the proposed infrastructure modifications, and the groundwater model simulations completed in support of the alternative are in Appendix A.

The following subsections describe groundwater extraction, treatment, end use, and monitoring components of Alternative 5.

4.5.1 Groundwater Extraction

Under Alternative 5, the SEMOU remedy pumping is the same as described for Alternative 4, i.e., groundwater extraction assumes interim remedy pumping (Alternative 2) plus an additional 2,500 gpm of remedy pumping just north of the Pomona Freeway (Figure 4-5). This requires installation of remedy wells at locations EXT1, EXT2, and EXT4 for groundwater extraction from the shallow zone (500 gpm), upper-intermediate zone (1,700 gpm), and middle-intermediate zone (300 gpm). Location EXT1 includes separate shallow zone and intermediate zone wells, while locations EXT2 and EXT4 consist of single wells for intermediate zone groundwater extraction. Table 3-2 provides the proposed target zones and flow rates for each new remedy well.

The WNOU groundwater extraction remains the same as described for Alternative 2, although the flow rates will decline over time as the extent of contamination in WNOU shrinks.

4.5.2 Groundwater Treatment

Within the SEMOU, the existing treatment plants would continue operate at the interim remedy target flow rate of 5,850 gpm. Therefore, this alternative does not include changes to treatment plant operations.

The WNOU treatment plant will increase from an approximate 3,500 to 6,000 gpm target flow rate under this alternative. Groundwater extracted from the new shallow zone well (500 gpm) would remain separated from the new and existing intermediate zone wells (5,500 gpm) through the treatment process. The WNOU treatment plant capacity is 3,750 gpm; therefore, this alternative requires a capacity expansion. Bringing on-line existing LGAC vessel pairs that are currently off-line will expand the capacity. This alternative assumes minor piping system modifications to connect the plant with the pipeline to the City of Whittier and to direct treated water to pipelines leading to reinjection wells.

4.5.3 Treated Water End Use

The treated water end use consists of potable use by existing and new water purveyors, surface discharge to Legg Lakes, and reinjection to the shallow zone (Table 4-5a). The following sections describe each of these end uses.

4.5.3.1 Water Purveyor

Treated water end use for the SEMOU water purveyors would be the same as described under Alternative 2. That is, existing water purveyors operating under the interim remedy (i.e., MP, SGVWC, and GSWC) would continue to deliver treated water at an average combined flow rate of 8,550 gpm (5,850 gpm in SEMOU and 2,700 gpm in WNOU).

Alternative 5 assumes that the City of Whittier end use would increase from an average flow rate of 700 gpm (Alternative 2) to 1,200 gpm through an existing intertie. A hydrologic and engineering assessment will be required to evaluate whether the City of Whittier's infrastructure can accept the treated water from the WNOU treatment plant.

4.5.3.2 Surface Water/Reinjection

Alternative 5 assumes continued routing of treated water to Legg Lakes for surface recharge at an average flow rate of 800 gpm.

Under this alternative, EPA and the state will convert shallow zone extraction wells EW4-3 and EW4-4 to injection wells through reconfiguration of the wellheads. The combined injection rate assumed for these shallow zone wells is 500 gpm.

Also, EPA and the state will install an upper-intermediate zone injection well (INJ3) south of the Pomona Freeway with an average injection rate of 1,500 gpm.

4.5.4 Conveyance Systems

Alternative 5 requires the use of existing and new conveyance systems in support of the remedy (Table 3-3 and Figure 4-5). The water intended for potable use is in a separate line than the water for non-potable use because the system treats the two types of water separately. New raw and treated conveyance system requirements are as follows:

- Shallow Zone Raw Water Conveyance. New raw water piping routed south from the extraction well EXT1 location along Rosemead Boulevard for connection with an existing unused raw water line near extraction well EW4-3. The estimated new conveyance requirements are 4,800 lf of ≤12-inch diameter pipe.

- Intermediate Zone Raw Water Conveyance. New raw water conveyance piping (one line) routed south from the extraction well EXT1 to the WNOU GWETS. Estimated new conveyance requirements are 1,600 lf of ≤12-inch diameter pipe and 7,800 lf of ≤20-inch diameter pipe.

- Treated Water Conveyance. This alternative requires reconfiguration of WNOU treatment plant yard piping to reroute treated water to the converted existing raw water conveyance to the EW4-3 and EW4-4 locations for reinjection (EPA assumes one of the existing raw water shallow pipelines can be repurposed for treated water conveyance). This alternative requires EPA and the state to route the new treated water conveyance from the well EW4-3 location along Rosemead Boulevard north to the new reinjection location INJ3; the estimated new conveyance requirements are 2,400 lf of ≤12-inch diameter pipe. This alternative also requires reconfiguration of the EW4-3 and EW4-4 wellheads for injection.

The major obstacle the conveyance piping will encounter is crossing the Pomona Freeway near its intersection with Rosemead Boulevard. The freeway is approximately 300 feet wide (eight lanes). The cost estimate (Appendix B) assumes the piping will be installed beneath the freeway using the jack and bore construction method.

4.5.5 Groundwater Monitoring/Water Management Plan

With a few exceptions, the groundwater monitoring and management plans are similar to those described under Alternative 2. Groundwater monitoring will include annual data collection from the wells listed in Tables 3-4a and 3-4b, EPA and the state will evaluate remedy performance and continue to oversee operation of the remedial systems.

DDW will likely require updates to existing procedures outlined in the WNOU treatment plant OMMPs to reflect the proposed modifications, including reinjection. The updated plan will include requirements for monitoring of influent quality from the new remedy wells completed in the shallow and intermediate zones. The updated OMMP will also need to include plans for O&M of the new remedy wells and ancillary infrastructure.

The alternative assumes that the state can modify the end-use agreement with the City of Whittier to include acceptance of the additional 500 gpm under their existing San Gabriel Basin water rights to avoid replenishment assessment fees.

This ERAS assumes that the remaining 2,000 gpm of new extraction from shallow and intermediate zone wells (that this alternative identifies for reinjection) is covered by a water production agreement with the Watermaster that would exempt the production from replenishment assessment fees. Under these assumptions, the ERAS does not include costs of potential replenishment fees in the alternatives analysis described in Section 5. Water management costs only include permitting and permit compliance. The alternative will require water management planning to ensure compliance with Watermaster requirements for groundwater extraction and end use.

4.6 ALTERNATIVE 6: SEMOU/WNOU ENHANCED CLEANUP

Alternative 6 assumes expansion of the interim remedy systems to affect cleanup of both OUs within an "enhanced" timeframe. In the context of this ERAS, an enhanced timeframe is considered to be 60 to 70 years from current conditions. The remedial goals are (1) protection of human health, (2) limiting contaminant migration, and (3) SEMOU and WNOU restoration.

Figure 4-6 and Table 4-6a provide the location of the remedy components and average flow rates, respectively. Table 4-6b includes the proposed infrastructure modifications, and the groundwater model simulations completed in support of the alternative are in Appendix A.

The following subsections describe groundwater extraction, treatment, end use, and monitoring components of Alternative 6.

4.6.1 Groundwater Extraction

This alternative assumes the SEMOU remedy pumping described under Alternative 2 plus an additional 5,500 gpm obtained from increased pumping from two existing SEMOU remedy wells completed in the intermediate zone, five new extraction wells completed in the upper-intermediate zone, and six new extraction wells completed in the shallow zone. Flow rate and pumping equipment requirements for the additional 5,500 gpm are on Table 3-2. Figure 4-6 shows the locations for the existing interim remedy (Alternative 2) plus the proposed remedy wells. The pumping strategy improves contaminant removal through greater pumping in the Western and Central Containment area and addresses high contaminant concentrations within the shallow and intermediates zones in the central portion of the SEMOU.

Within the WNOU, groundwater extraction would be the same as for Alternative 2, although the flow rates will decline over time as the extent of contamination in WNOU shrinks.

4.6.2 Groundwater Treatment

Within the SEMOU, interim remedy groundwater treatment systems would continue to operate at the Alternative 2 baseline flow rate of 5,850 gpm. Alternative 6 requires an additional 3,500 gpm of treatment at the following facilities:

- City of Monterey Park. Treatment requirements will increase from 3,680 to 4,780 gpm. MP is in the process of changing and upgrading the treatment system. For the purposes of the ERAS, EPA assumes that the upgrades will enable the system to handle the extra capacity required for this alternative.

- San Gabriel Valley Water Company. SGVWC Plant 8 treatment requirements increase from 1,300 to 1,950 gpm. Enough treatment capacity is available to handle the additional flow.

- Pomona Freeway Plant. Assumes the construction of a new treatment plant located near the northwest quadrant of the Pomona Freeway interchange with Rosemead Boulevard (Figure 4-6). Raw water sources include approximately 1,600 gpm from the shallow zone and 150 gpm from the intermediate zone. The plant will use two-stage LGAC systems to treat on average 1,750 gpm.

The WNOU treatment plant flow rates will increase from approximately 3,500 to 5,500 gpm. The current treatment capacity is 3,750 gpm; therefore, this alternative requires a capacity expansion. Bringing on-line existing LGAC vessel pairs that are currently off-line will expand treatment capacity. Other treatment plant modifications include completing an interconnection with the City of Whittier and minor piping modifications to get treated water into converted existing raw water conveyance lines.

4.6.3 Treated Water End Use

Under Alternative 6, the treated water end use consists of potable use by existing and new water purveyors, surface discharge to Legg Lakes, and reinjection (Table 4-6a). Total discharge will increase from approximately 9,350 to 14,850 gpm. The sections below describe each of these end uses.

4.6.3.1 Water Purveyor

Alternative 6 assumes the SEMOU and WNOU water purveyors will continue to deliver treated water from the remedy extraction wells. This ERAS assumes that the water purveyors will distribute approximately 11,550 gpm of treated water as follows:

- City of Monterey Park. Treated water end use will increase from 3,680 to 4,680 gpm. An increase of 1,000 gpm from the interim remedy targets assumed under Alternative 2.

- San Gabriel Valley Water Company. An increase in treated water use from 3,300 to 3,650 gpm (1,650 gpm in the SEMOU and 2,000 gpm in the WNOU). An increase of 350 gpm from the interim remedy targets assumed under Alternative 2.

- Golden State Water Company. An increase in treated water use from 870 to 1,270 gpm. An increase of 400 gpm from the interim remedy targets assumed under Alternative 2.

- City of Whittier. An increase in treated water use from 700 to 1,950 gpm through an existing intertie. An increase of 1,250 gpm from the interim remedy targets assumed under Alternative 2. A hydrologic and engineering assessment will be required to evaluate whether the City of Whittier's infrastructure can accept the treated water from the WNOU treatment plant.

4.6.3.2 Surface Water/Reinjection

Alternative 6 assumes the continued routing of treated water to Legg Lakes for surface recharge at an average flow rate of 800 gpm. Approximately 2,500 gpm of treated water will have a reinjection end use as follows:

- EPA and the state will repurpose shallow zone extraction wells EW4-3 and EW4-4 for groundwater injection through reconfiguration of the wellheads. This ERAS assumes a combined injection rate for these two wells of 750 gpm.

- EPA and the state will install an upper-intermediate zone injection well (INJ3) south of the Pomona Freeway with an estimated injection capacity of 1,750 gpm.

4.6.4 Conveyance Systems

Alternative 6 requires the use of existing and new conveyance systems for the remedy. Figure 4-6 shows the layout of the new conveyance system. The bullets below and Table 3-3 describe the conveyance piping requirements.

- Shallow Zone Raw Water Conveyance to New Treatment Plant near the Pomona Freeway

  — Six shallow extraction wells (i.e., EXT1, 3, 5, 7, 8, and 10) require an estimated 9,400 lf of ≤6-inch diameter pipe and 7,300 lf of ≤12-inch diameter pipe.

- Intermediate Zone Raw Water Conveyance to Multiple Treatment Plants

- Four extraction wells (i.e., EXT1, 2, 3, and 7) to the WNOU treatment plant require an estimated 6,000 lf of ≤6-inch diameter pipe and 5,000 lf of ≤12-inch diameter pipe.
- Extraction well EXT9 to the MP Delta Plant requires an estimated 1,600 lf of ≤12-inch diameter pipe.
- Extraction well EXT7 to SGVWC Plant 8 requires an estimated 2,400 lf of ≤6-inch diameter pipe and 100 lf of ≤12-inch diameter pipe.
- Extraction wells (i.e., EXT1, 2, 3, and 7) to the new SEMOU Plant (proposed) require an estimated 800 lf of ≤6-inch diameter pipe.
- Two existing extraction wells (i.e., MP15 and SGVWC8C) will have higher flow rates relative to the interim remedy and, thus, may require larger conveyance pipes to accommodate the increased flow. EPA assumes these extraction wells will require an estimated 100 lf of new ≤12-inch diameter pipe and 1,600 lf of new ≤20-inch diameter pipe to convey raw water to the MP Delta treatment plant and the SGVWC Plant 8.

- Treated Water Conveyance
  - SEMOU plant to intermediate zone injection well INJ3 requires an estimated 3,800 lf of ≤12-inch diameter pipe.
  - Conversion of raw water conveyance lines to wells EW4-3 and EW4-4 to treated water conveyance for reinjection assumes the use of the 3,200 lf of existing conveyance line. This conversion will require complete EW4-3/EW4-4 wellhead reconfiguration for injection.
  - EPA assumes that the SGVWC Plant 8 and MP Delta Plant will deliver 400 gpm of treated water to the GSWC distribution system, and that this water will flow through existing interties between the water purveyors. EPA also assumes the costs to activate, or upgrade, the interties will be negligible relative to the overall cost of this alternative. Therefore, the cost estimate does not include those costs (Appendix B).

The major obstacle the conveyance piping will encounter is crossing the Pomona Freeway near its intersection with Rosemead Boulevard. The freeway is approximately 300 feet wide (eight lanes). The cost estimate (Appendix B) assumes the piping will be installed beneath the freeway using the jack and bore construction method.

4.6.5 Groundwater Monitoring/Water Management Plan

The groundwater monitoring and management plans are like those described under Alternative 2. Groundwater monitoring will include annual data collection from the wells listed in Tables 3-4a and 3-4b, EPA and the state will evaluate remedy performance and continue to oversee operation of the remedial systems.

DDW will likely require updates to existing procedures outlined in treatment plant OMMPs for all existing treatment plants to reflect the proposed modifications. The updated plans will include requirements for monitoring of influent quality from the new remedy wells completed in the shallow and intermediate zones. The updated OMMPs will also need to include plans for O&M of the new remedy wells and ancillary infrastructure. The proposed new SEMOU treatment plant located near the Pomona Freeway will require extensive permitting and testing before the appropriate agencies approve it for operation.

The alternative assumes that EPA and the state can modify the existing end-use agreements with the four water purveyors (MP, City of Whittier, SGVWC, and GSWC) to include acceptance of additional treated water under their existing San Gabriel Basin water rights to avoid replenishment assessment fees.

This ERAS assumes that the 2,500 gpm of new extraction from shallow and intermediate zone wells (that this alternative identifies for reinjection) is covered by a water production agreement with the Watermaster that would exempt the production from replenishment assessment fees. Under these assumptions, the ERAS does not include costs for potential replenishment fees in the alternatives analysis described in Section 5. Water management costs only include permitting and permit compliance. This alternative will require water management planning to ensure compliance with Watermaster requirements for groundwater extraction and end use.

4.7 ALTERNATIVE 7: SEMOU/WNOU ENHANCED AND ACCELERATED CLEANUP

Alternative 7 includes expansion of the interim remedy systems to affect cleanup of both OUs within an “enhanced and accelerated” timeframe. In the context of the ERAS, EPA considers an enhanced and accelerated timeframe an additional 35 to 40 years from current conditions to achieve cleanup. The remedial goals are (1) protection of human health, (2) limiting contaminant migration, and (3) SEMOU and WNOU restoration.

Figure 4-7 and Table 4-7a provide the location of the remedy components and average flow rates, respectively. Table 4-7b includes the proposed infrastructure modifications, and the groundwater model simulations completed in support of the alternative are in Appendix A.

The following subsections describe groundwater extraction, treatment, end use, and monitoring components of Alternative 7.

4.7.1 Groundwater Extraction

The SEMOU remedy pumping is the same as described under Alternative 2 plus an additional 9,500 gpm. The additional groundwater extraction from the shallow and intermediate zone are 2,500 and 7,000 gpm, respectively. The new sources are the result of increased pumping from four existing SEMOU remedy wells completed in the intermediate zone, four new extraction wells completed in the upper-intermediate zone, two new extraction wells completed in middle-intermediate zone, and seven new extraction wells completed in the shallow zone.

Table 3-2 summarizes the individual well flow rates and pumping equipment requirements for the additional groundwater extraction. Figure 4-7 shows the locations for the existing interim remedy and new remedy wells proposed under this alternative.

The WNOU pumping is the same as described for Alternative 2, although the flow rates will decline over time as the extent of contamination in WNOU shrinks.

4.7.2 Groundwater Treatment

Within the SEMOU, interim remedy groundwater treatment systems continue to operate at the Alternative 2 baseline flow rate of 5,850 gpm. This ERAS assumes an additional 3,550 gpm of treatment capacity at the following facilities:

- City of Monterey Park. Treatment requirements increase from 3,680 to 4,880 gpm. MP is in the process of changing and upgrading the treatment system. For the purposes of the ERAS, EPA assumes that the upgrades will enable the system to handle the extra capacity required for this alternative.

- San Gabriel Valley Water Company. SGVWC Plant 8 treatment requirements increase from 1,300 to 1,900 gpm. Enough treatment capacity is available to handle the additional flow.

- Pomona Freeway Plant. Assumes the construction of a new treatment plant located near the northwest quadrant of the Pomona Freeway interchange with Rosemead Boulevard (Figure 4-7). Raw water sources include approximately 1,750 gpm from the shallow zone. The plant will use two-stage LGAC systems to treat on average 1,750 gpm.

The WNOU treatment plant flow rates increase from approximately 3,500 to 9,450 gpm, or an additional 5,950 gpm. The current treatment capacity is 3,750 gpm; therefore, this alternative requires expansion of the treatment capacity. Bringing on-line existing LGAC vessel pairs that are currently off-line will expand the capacity. Other treatment plant modifications include completing an interconnection with the City of Whittier and minor piping modifications to get treated water into converted existing raw water conveyance lines.

4.7.3 Treated Water End Use

Under Alternative 7, the treated water end use consists of potable use by existing and new water purveyors, surface discharge to Legg Lakes, and reinjection (Table 4-6a). Total discharge will increase from approximately 9,350 to 18,850 gpm.

4.7.3.1 Water Purveyor

Alternative 7 assumes the SEMOU and WNOU water purveyors will continue to deliver treated water from the expanded remedy extraction well network. EPA assumes the alternative distributes approximately 15,550 gpm of treated water as follows:

- City of Monterey Park. An increase in treated water use from 3,680 to 4,680 gpm. An increase of 1,000 gpm from the interim remedy targets assumed under Alternative 2.

- San Gabriel Valley Water Company. An increase in treated water use from 3,300 to 3,700 gpm (1,700 gpm in the SEMOU and 2,000 gpm in the WNOU). An increase of 400 gpm from the interim remedy targets assumed under Alternative 2.

- Golden State Water Company. An increase in treated water use from 870 to 1,270 gpm. An increase of 400 gpm from the interim remedy targets assumed under Alternative 2.

- City of Whittier. An increase from 700 to 2,200 gpm through an existing intertie. An increase of 1,500 gpm from the target rate assumed under Alternative 2. A hydrologic and engineering assessment will be required to evaluate whether the City of Whittier's infrastructure can accept the treated water from the WNOU treatment plant.

- Suburban Water System. Approximately 3,700 gpm of treated water delivery through a new connection at Suburban's Bartolo wellfield.

4.7.3.2 Surface Water/Reinjection

Alternative 7 assumes the continued routing of treated water to Legg Lakes for surface recharge at an average flow rate of 800 gpm. Approximately 2,500 gpm of treated water will have a reinjection end use as follows:

- EPA will repurpose shallow zone extraction wells EW4-3 and EW4-4 for reinjection through reconfiguration of the wellheads. This ERAS assumes a combined injection rate for these two wells of 750 gpm.

- EPA will install an upper intermediate zone well (INJ3) south of the Pomona Freeway with an estimated injection capacity of 1,750 gpm.

4.7.4 Conveyance Systems

Alternative 7 requires the use of existing and new conveyance systems for the remedy. Figure 4-7 shows the layout of the new conveyance system. The bullets below summarize the new conveyance piping requirements:

- Shallow Zone Raw Water Conveyance
    - Five shallow extraction wells (i.e., EXT5, 7, 8, 9, and 10) require an estimated 11,600 lf of ≤6-inch diameter pipe and 9,500 lf of ≤12-inch diameter pipe to deliver 1,750 gpm to the new SEMOU treatment plant located near the Pomona Freeway.
    - Two shallow extraction wells (i.e., EXT1 and 3) require an estimated 2,600 lf of ≤6-inch diameter pipe and 8,800 lf of ≤12-inch diameter pipe to convey 750 gpm of the extracted water to the WNOU treatment plant.
- Intermediate Zone Raw Water Conveyance to Multiple Treatment Plants
    - Six new extraction wells (i.e., EXT1, 2, 3, 4, 7, and 9) and existing remedy well SGVWC8B require an estimated 600 lf of ≤6-inch, 8,500 lf of ≤12-inch, and 10,200 lf of ≤20-inch diameter pipe to convey raw water to the WNOU treatment plant.
    - Extraction well cluster EXT7 requires an estimated 200 lf of ≤12-inch diameter pipe to convey raw water to the SGVWC Plant 8.
    - Extraction well EXT9 requires an estimated 1,600 lf of ≤12-inch and 100 lf of ≤20-inch diameter pipe to convey raw water to the MP Delta treatment plant.
    - Four existing extraction wells (i.e., MP12, MP15, SGVWC8B, and SGVWC8C) will have higher flow rates relative to the interim remedy and, thus, may require larger conveyance pipes to accommodate the increased flow. EPA assumes these extraction wells will require an estimated 1,800 lf of new ≤12-inch diameter pipe and 100 lf of new ≤20-inch diameter pipe to convey raw water to the MP Delta treatment plant and the SGVWC Plant 8.
- Treated Water Conveyance
    - EPA assumes that the SGVWC Plant 8 and MP Delta Plant will deliver the 400 gpm of treated water to the GSWC distribution system through existing interties between the water purveyors. EPA also assumes the costs to activate, or upgrade, the interties will be negligible relative to the overall cost of this alternative. Therefore, the cost estimate does not include those costs (Appendix B).

- SEMOU plant (proposed) to the intermediate zone injection well INJ3 requires an estimated 3,800 lf of ≤12-inch diameter pipe.

- WNOU treatment plant to City of Whittier interconnection requires minimal piping modification at the GWETS.

- WNOU treatment plant to the Suburban Bartolo wellfield requires an estimated 6,800 lf of ≤20-inch diameter piping, including crossing the San Gabriel River.

- Conversion of raw water conveyance lines to wells EW4-3 and EW4-4 to treated water conveyance for reinjection assumes use of 3,200 lf of existing conveyance line. Complete EW4-3/EW4-4 wellhead reconfiguration for injection.

The major obstacles the conveyance piping will encounter are:

- Crossing the Pomona Freeway near its intersection with Rosemead Boulevard
  - The freeway is approximately 300 feet wide (eight lanes)

- Crossing the San Gabriel River, southeast of Legg Lakes
  - The river is approximately 300 feet wide
  - The river is unlined

- Crossing the Rio Hondo Channel, near its intersection with Garvey Avenue
  - The channel is approximately 500 feet wide
  - The channel is concrete-lined
  - The Garvey Avenue crossing consists of a four-lane road bridge.

The cost estimate (Appendix B) assumes the piping will be installed beneath these obstacles using the jack and bore construction method.

4.7.5 Groundwater Monitoring/Water Management Plan

The groundwater monitoring and management plans are like those described under Alternative 2. Groundwater monitoring will include annual data collection from the wells listed in Tables 3-4a and 3-4b, EPA and the state will evaluate remedy performance and continue to oversee operation of the remedial systems.

DDW will likely require updates to existing procedures outlined in treatment plant OMMPs for all existing treatment plants to reflect the proposed modifications. The updated plans will include requirements for monitoring of influent quality from the new remedy wells completed in the shallow and intermediate zones. The updated OMMPs will also need to include plans for O&M of the new remedy wells and ancillary infrastructure. The proposed SEMOU treatment plant located near the Pomona Freeway will require extensive permitting and testing before agency approval for operation.

The alternative assumes that EPA and the state can modify existing end-use agreements with the four water purveyors (City of Monterey Park, City of Whittier, SGVWC and GSWC) to include acceptance of additional treated water under their existing San Gabriel Basin water rights to avoid replenishment assessment fees. This alternative will require a new agreement with similar provisions with Suburban Water Systems.

This ERAS assumes that the 2,500 gpm of new extraction from shallow and intermediate zone wells (that this alternative identifies for reinjection) is covered by a water production agreement with the Watermaster that would exempt the production from replenishment assessment fees. Under these assumptions, the ERAS does not include costs for potential replenishment fees in the alternatives analysis described in Section 5. Water management costs only include permitting and permit compliance.

This alternative will require water management planning to ensure compliance with Watermaster requirements for groundwater extraction and end use.

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5. DETAILED ANALYSIS OF REMEDIAL ALTERNATIVES

This section evaluates the remedial alternatives developed in Section 4, following protocols outlined in EPA's RI/FS guidance (EPA 1988). The detailed analysis consists of a two-step process. In the first step, EPA evaluated each alternative individually against the NCP criteria. In the second step, EPA performed a comparative analysis using the same criteria to identify key differences between alternatives. This section defines the evaluation criteria, presents detailed descriptions of the alternatives, and analyzes each alternative using the established evaluation criteria. Tables 5-1 and 5-2 present a summary of the detailed analysis and comparative evaluation, respectively. Appendix B provides the detailed cost estimates.

This ERAS does not provide a typical comparative analysis of the remedial alternatives due to different remedial goals for each of the three sets of alternatives evaluated (No Action, Containment, Restoration). However, within each of the three sets of alternatives, EPA evaluated the remedial alternatives against one another. Because each of the remedial alternatives are energy intensive, EPA did not evaluate green remediation metrics in this ERAS. During the remediation process, EPA and the state will make all efforts possible to employ green practices (e.g., procurement, performance monitoring).

5.1 DESCRIPTION OF EVALUATION CRITERIA

EPA evaluated the assembled alternatives based on the nine criteria required by 40 CFR §300.430(e) of the NCP. As stated in EPA guidance (EPA 1988), remedial actions must accomplish the following:

- Be protective of human health and the environment
- Attain ARARs (or provide grounds for invoking a waiver)
- Be cost effective
- Use permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable
- Evaluate the CERCLA preference for treatment that reduces toxicity, mobility, and volume as a principal element, or explain why it does not.

The bullets below list the nine criteria used to evaluate each alternative:

- Overall protection of human health and the environment
- Compliance with ARARs
- Long-term effectiveness and permanence
- Reduction in toxicity, mobility, or volume through treatment
- Short-term effectiveness

- Implementability
- Cost
- State acceptance
- Community acceptance.

The first two are the threshold criteria. The next five are balancing criteria. The final two criteria (state and community acceptance) are modifying criteria. The following sections discuss each of the nine NCP criteria.

5.1.1 Overall protection of human health and the environment

This criterion evaluates whether each alternative provides adequate protection of human health and the environment. The overall assessment of protection considers the alternative's long-term effectiveness, permanence, short-term effectiveness, and compliance with ARARs. The evaluation of protectiveness focuses on the reduction or elimination of site risks by the proposed remedial alternative. This criterion is a threshold criterion, and the selected remedial alternative must meet this criterion.

5.1.2 Compliance with ARARs

This criterion evaluates whether each alternative will meet all federal and state ARARs identified or whether there is justification for waiving one or more ARARs. This criterion is also a threshold criterion that the selected remedial alternative must meet.

5.1.3 Long-term effectiveness and permanence

This criterion evaluates alternatives in terms of risk that remains at the site after the remedy has met the RAO. The primary focus of this evaluation is the extent and effectiveness of controls used to manage the risk posed by treatment residuals or untreated wastes. Long-term effectiveness is one of the balancing criteria. The EPA considers the following factors in evaluating this criterion:

- Adequacy of remedial controls
- Reliability of remedial controls
- Magnitude of the residual risk.

5.1.4 Reduction of toxicity, mobility, or volume through treatment

This evaluation criterion evaluates the CERCLA statutory preference for treatment options that permanently and significantly reduce the toxicity, mobility, or volume of the contaminants. The preference is satisfied when treatment reduces the principal threats through the following:

- Destruction of toxic contaminants
- Reduction in contaminant mobility

- Reduction in the total mass of toxic contaminants
- Reduction in the total volume of contaminated media.

5.1.5 Short-term effectiveness

This evaluation criterion evaluates the effects of the alternative during the construction and implementation phase until the remedy meets the RAO. Under this criterion, EPA evaluates the alternatives for their effects on human health and the environment during implementation of the remedial action. The EPA considers the following factors in evaluating this criterion:

- Exposure of the community during implementation
- Exposure of workers during construction
- Environmental impacts
- Time to achieve RAOs.

5.1.6 Implementability

This criterion evaluates the technical and administrative feasibility of implementing an alternative and the availability of various services and materials that the remedy may require during its implementation. The EPA considers the following factors in evaluating this criterion:

- Ability to construct the technology
- Monitoring requirements
- Availability of equipment and specialists
- Ability to obtain approvals from regulatory agencies.

5.1.7 Cost

The evaluation of costs includes three principal components, capital cost, annual O&M costs, and present value. EPA calculated the cost for each alternative from estimates of capital and O&M costs. Capital costs consist of direct and indirect costs. Direct costs include the purchase of equipment, labor, and materials necessary to implement the alternative. Indirect costs include engineering, financial, and other services such as testing and monitoring. Annual O&M costs for each alternative include operating labor, maintenance materials and labor, auxiliary materials, and energy. The present worth of a project represents the principal amount of money, which if invested in the initial year of the remedy and disbursed as needed, would be enough to cover all costs associated with the remedial action.

The EPA expects a cost estimate for an alternatives analysis to fall within the range of 30 percent below to 50 percent above the actual project cost (i.e., accuracy of -30 percent and +50 percent) (U.S. Army Corps of Engineers and EPA 2000).

5.1.8 State and Community Acceptance

These two criteria evaluate the issues and concerns of the state and community regarding each remedial alternative. If EPA proposes a new remedy, they will evaluate these criteria in a ROD based on feedback from the state and community on the Proposed Plan and supporting technical documents.

5.2 ALTERNATIVE 1: NO ACTION (PURVEYOR POINT-OF-USE TREATMENT)

Overall protection of human health and the environment—Alternative 1 does not include actions to contain the contaminant plumes or to restore the aquifer. The alternative also does not implement a monitoring program to determine whether natural processes (e.g., dispersion and biodegradation) are reducing contaminant concentrations or whether the plume is stable.

Existing federal and state regulations prevent water purveyors from distributing water with COC concentrations above MCLs. The existence of these regulations, and state monitoring and reporting requirements that ensure enforcement of the regulations, ensure human receptors do not drink untreated drinking water and, thus, prevent unacceptable exposure to human health.

Alternative 1 is not a traditional no action alternative in that it includes treatment and provides potable water to residents. All drinking water currently served by water utilities meets federal and state drinking water standards. In that respect, it is protective of human health but is not protective of the environment, as it allows uncontrolled migration of contaminants and does not attempt to restore the aquifer.

Compliance with ARARs—Since EPA would implement no actions, there are no ARARs for the alternative to meet.

Long-term effectiveness—Alternative 1 does not implement actions to prevent migration of contaminated groundwater or to restore the aquifer. Contaminated groundwater may spread to less contaminated or uncontaminated portions of the aquifer and adversely affect future use of groundwater in those portions. However, enforcement of federal and state drinking water regulations and, if necessary, point-of-use treatment systems that water purveyors would install, will protect human receptors from exposure to contaminants.

Alternative 1 does not effectively address the RAOs pertaining to containment and aquifer restoration in the long-term. The alternative will likely meet the RAO pertaining to human exposure in the long-term.

Reduction of toxicity, mobility, or volume through treatment—Alternative 1 does not implement actions that would reduce the toxicity, mobility, or volume of contaminants through treatment. There may be a reduction of those characteristics due to natural attenuation processes, but the remedy does not implement a groundwater monitoring program that would verify whether natural attenuation is taking place.

Short-term effectiveness—Since EPA would implement no actions, this alternative does not pose short-term risks to the community, workers, or the environment.

Implementability—Since EPA would take no actions, this alternative is very implementable.

Cost—There are no costs associated with Alternative 1, assuming the following:

- Water purveyors will pay for point-of-use systems.

5.3 ALTERNATIVE 2: NO FURTHER ACTION – SEMOU/WNOU INTERIM REMEDIES

Overall protection of human health and the environment—Alternative 2 includes continued implementation of the interim remedies. The interim remedies include hydraulic containment of the contaminant plumes via groundwater extraction and implementation of a groundwater monitoring program to evaluate the effectiveness of the remedies. Water purveyors treat extracted groundwater to reduce COC concentrations to meet federal and state drinking water regulations. The existence of these regulations, and state monitoring and reporting requirements that ensure enforcement of the regulations, ensure human receptors do not drink untreated drinking water and, thus, prevent unacceptable exposure to human health.

Therefore, Alternative 2 is protective of human health and the environment.

Compliance with ARARs—The existing interim remedies meet ARARs and likely will continue to meet them.

Long-term effectiveness—Groundwater modeling suggests the interim containment remedies will require more than 30 years to reduce contaminant concentrations in groundwater below chemical-specific ARARs (Appendix A, CH2M Hill 2021b). However, the initial groundwater modeling simulations (Appendix A, CH2M Hill 2021a) indicate the interim remedies will take longer, more than 70 years, to reduce contaminant concentrations. Water purveyors treat the extracted groundwater; thus, human exposure to contaminants does not occur.

Although the recent groundwater modeling (Appendix A) does not show complete containment under Alternative 2, the interim remedies are currently achieving containment. Therefore, Alternative 2 effectively addresses RAOs pertaining to containment and human exposure in the long-term. However, this alternative requires that groundwater extraction operations continue for a long period of time.

Reduction of toxicity, mobility, or volume through treatment—Alternative 2 extracts and treats contaminated groundwater and, thus, provides reductions in toxicity and volume of contaminated water. The treatment process removes contaminants (VOCs) from the groundwater either via LGAC or by air stripping, followed by adsorption onto VGAC. The process eventually destroys the contaminants when the water purveyors dispose of or regenerate the carbon.

Containment of the contaminated groundwater effectively reduces its mobility.

Short-term effectiveness—Alternative 2 is a continuation of the existing interim remedies. The infrastructure (e.g., wells, piping, treatment facilities) required to implement this alternative is already in place. Therefore, this alternative is very effective in the short-term as it does not pose short-term risks to the community, workers, or the environment.

Implementability—Since Alternative 2 is a continuation of the existing interim remedies, the alternative is implementable. However, EPA and DTSC have encountered challenges with distribution of the treated water for a potable end use and permitting issues at the WNOU.

Cost—EPA estimates the capital costs to implement Alternative 2 to be $76,600. EPA estimates the present value of O&M and long-term monitoring (LTM) costs to be $52,700,000, assuming a discount rate of 7 percent and a period of 70 years. EPA selected a period of 70 years to compare the costs with the alternative with the longest O&M period, Alternative 6. Groundwater modeling suggests that Alternative 6 will require up to 70 years to restore the aquifer at the SEMOU. The total present value cost to implement the alternative is **$52,800,000**. The cost estimate makes the following key assumptions:

- The capital costs associated with this alternative only include finishing the interconnection between the WNOU treatment plant and the City of Whittier's drinking water distribution system.

- The O&M costs are based on the average costs to operate the interim remedy treatment facilities over the last 4 years. The estimate assumes those costs include all expenses associated with O&M activities at the site, including prime contractor overhead and profit. The estimate assumes those costs do not include LTM costs or periodic repair costs.

5.4 ALTERNATIVE 3: OPTIMIZE EXISTING SEMOU/WNOU INTERIM REMEDIES

Overall protection of human health and the environment—Alternative 3 is identical to Alternative 2 except it installs one new extraction well and modifies the screen interval of an existing extraction well to improve the efficiency of hydraulic containment.

Thus, Alternative 3 is protective of human health and the environment for the same reasons that Alternative 2 is protective.

Compliance with ARARs—The existing interim remedies meet ARARs. EPA expects That the changes Alternative 3 requires will meet location- and action-specific ARARs, such as waste disposal requirements.
Long-term effectiveness—The long-term effectiveness of Alternative 3 is essentially the same as that of Alternative 2.

Reduction of toxicity, mobility, or volume through treatment—Alternative 3 extracts and treats the same volume of contaminated groundwater as Alternative 2 and has the same RAOs. Therefore, this alternative provides reductions in toxicity, mobility, and volume that are similar to those described for Alternative 2.

Short-term effectiveness—The short-term risks to the local community due to the installation and modification of the extraction wells are minor increases in traffic, noise from the drilling rigs, minor dust production due to the movement of large equipment and handling of soil cuttings. Standard construction practices can mitigate those risks.

The short-term risks to workers are mainly associated with the use of a drilling rig. Use of standard drilling practices can mitigate those risks.

The short-term risks to the environment include the disposal of waste material, stormwater runoff from areas of construction, and pollution resulting from construction equipment (e.g., oil and fuel spills and exhaust emissions). Standard construction practices can mitigate those risks.

EPA expects that the installation of the new extraction well for Alternative 3 will take approximately 6 months to complete.

Due to minor scope of construction, which will have minimal effects to the local community, workers, and the environment, this alternative is effective in the short-term.

Implementability—Many extraction wells, similar to what EPA would install for Alternative 3, are already present at the site. Therefore, Alternative 3 is technically feasible as well as administratively feasible. The equipment, materials, and labor needed to install the extraction well are not out of the ordinary and, thus, are readily available.

Alternative 3 is implementable.

Cost—EPA estimates the capital costs to implement Alternative 3 to be $1,850,000. EPA estimates the present value of O&M and LTM costs to be $52,700,000, assuming a discount rate of 7 percent and a period of 70 years. EPA selected a period of 70 years to compare the costs with the alternative with the longest O&M period, Alternative 6. The total present value cost to implement the alternative is **$54,600,000**. The cost estimate makes the following key assumptions:

- EPA will install one new extraction well, EXT4-3-IZ.
- EPA will modify existing extraction well MP12 to reduce the length of its screen interval.
- EPA based the O&M costs on the average costs to operate the interim remedy treatment facilities over the last 4 years. The estimate assumes those costs include all expenses associated with O&M activities at the site, including prime contractor overhead and profit. The estimate assumes those costs do not include LTM costs or periodic repair costs.

5.5 ALTERNATIVE 4: SEMOU/WNOU HYDRAULIC CONTROL PLUS PUMPING TO ENHANCE WNOU CLEANUP

Overall protection of human health and the environment—Alternative 4 continues the interim remedies and implements additional extraction of groundwater in the SEMOU, just north of the Pomona Freeway (Figure 4-4). The interim remedies provide hydraulic control of the contaminant plumes within the SEMOU and WNOU and the additional extraction aids aquifer restoration in the WNOU. EPA conducts groundwater monitoring to verify the effectiveness of the remedies. Water purveyors treat extracted groundwater to reduce COC concentrations to meet federal and state drinking water regulations. The existence of these regulations, and state monitoring and reporting requirements that ensure enforcement of the regulations, ensure human receptors do not drink untreated drinking water and, thus, prevent unacceptable exposure to human health.

Therefore, Alternative 4 is protective of human health and the environment.

Compliance with ARARs—The existing components of the interim remedies meet ARARs and will likely continue to meet them. EPA expects that the new components of Alternative 4 (e.g., conveyance piping, expansion of treatment capacity at the WNOU treatment plant, and extraction wells) will meet location- and action-specific ARARs.

Long-term effectiveness—Alternative 4 extracts a greater amount of contaminated groundwater than Alternatives 2 and 3 to restore the aquifer in the WNOU and contain the contaminant plumes in the SEMOU and WNOU. EPA expects that Alternative 4 will restore the aquifer in the WNOU within approximately 30 years or less, which effectively prevents human exposure there. Contaminated water would remain in the SEMOU for a period greater than 70 years (Appendix A, CH2M Hill 2021a), but the remedy would effectively contain the contamination. Water purveyors will continue to treat extracted groundwater, thus, preventing human exposure to contaminants.

Alternative 4 effectively addresses RAOs pertaining to containment, human exposure, and aquifer restoration (WNOU only) in the long-term. However, this alternative requires that groundwater extraction operations continue in the SEMOU for a long period of time (more than 70 years).

Reduction of toxicity, mobility, or volume through treatment—Alternative 4 extracts and treats contaminated groundwater and, thus, provides reductions in toxicity, mobility, and volume of contaminated water. The treatment process removes contaminants (VOCs) from the groundwater either via LGAC or by air stripping, followed by adsorption onto VGAC. The process eventually destroys the contaminants when the water purveyors dispose of or regenerate the carbon.

Short-term effectiveness—Alternative 4 requires the installation of a substantial amount of conveyance piping and new extraction wells. The conveyance piping must cross the Pomona Freeway, near its intersection with Rosemead Boulevard, and the Rio Hondo Channel, near its intersection with Garvey Avenue.

The short-term risks to the local community include increases in traffic, especially due to construction of conveyance pipe installed in ROWs adjacent to roads. Noise and dust generated by drilling and excavation of trenches for piping will also contribute to short-term risks. The implementation of a traffic control plan when installing piping will help mitigate traffic congestion, though some congestion may be inevitable. Standard construction practices can reduce the impact of dust and noise on the local community.

The short-term risks to workers include hazards related to drilling, working near roads during pipeline installation, overhead hazards such as movement of heavy items (e.g., carbon vessels and large-diameter pipe) via crane or similar equipment, and the hazards of working near excavations that exceed 5 feet (e.g., engulfment). Standard construction practices can mitigate those risks.

The short-term risks to the environment include the disposal of waste material, stormwater runoff from areas of construction, and pollution resulting from construction equipment (e.g., oil and fuel spills and exhaust emissions). Standard construction practices can mitigate those risks.

EPA estimates that Alternative 4 will require 12 months to construct.

Due to the substantial construction component, which will impact the local community, workers, and environment for approximately 1 year, this alternative has moderate effectiveness in the short term.

Implementability—Alternative 4 requires construction that is common of drinking water pipelines, water supply wells, and water/wastewater treatment facilities. From a technical standpoint, the components of Alternative 4 are routine and standard to construct and operate. The methods required for construction (e.g., drilling, jacking and boring, and excavation to depths up to approximately 10 feet) do require some specialized skills and equipment, but none that are difficult to acquire. The technologies (e.g., groundwater extraction and treatment via air stripping and activated carbon adsorption) are reliable and effective at removing VOC contamination from groundwater.

The implementation of a groundwater monitoring program will allow for the collection of data necessary to assess whether the alternative is effective. Groundwater modeling based on the collected data can help assess whether the alternative will continue to be effective. The main obstacles to implementation are administrative. EPA must acquire property or access agreements to install wells and pipelines. Placement of these items on public land, to the extent possible, will minimize access issues. The nearby Whittier Narrows Recreational Area and existing treatment plants will likely provide enough space to stage construction materials and equipment.

EPA must make agreements with entities that have water rights (e.g., local water purveyors) to allow for groundwater extraction. There are existing agreements in place with multiple water purveyors as part of the interim containment remedies. EPA assumes that they can modify these agreements to accommodate the increase in groundwater extraction required by this alternative.

The permits needed for construction should not be difficult to obtain.

Alternative 4 is moderately implementable due to its sizable administrative obstacles (e.g., property acquisition, permitting, and water rights agreements).

Cost—EPA estimates the capital costs to implement Alternative 4 to be $16,700,000. EPA estimates the present value of O&M and LTM costs to be $58,400,000, assuming a discount rate of 7 percent and a period of 70 years for groundwater extraction in the SEMOU and a period of 30 years for extraction in and near the WNOU. The periods are different for the OUs because the groundwater modeling suggests this alternative will clean up the WNOU contamination sooner than the SEMOU contamination (Appendix A). The total present value cost to implement the alternative is **$75,100,000**. The cost estimate makes the following key assumptions:

- The SGVWC Plant 8 can connect to the GSWC pipe network by expansion of an existing intertie, and the costs to expand the intertie, if needed, are negligible relative to the overall cost of this alternative.

- EPA can obtain access agreements to install extraction wells where indicated on Figure 4-4. The estimate does not include costs to acquire property or access.

- The O&M costs are based on the average costs to operate the interim remedy treatment facilities over the last 4 years. The estimate assumes those costs include all expenses associated with O&M activities at the site, including prime contractor overhead and profit. The estimate assumes those costs do not include LTM costs or periodic repair costs.

- The O&M and LTM costs do not include maintenance costs associated with reinjection of treated water. Those costs may apply to the O&M/LTM period but are minor relative to the overall O&M/LTM costs of this alternative.

5.6 ALTERNATIVE 5: SEMOU/WNOU HYDRAULIC CONTROL PLUS PUMPING AND REINJECTION TO ENHANCE WNOU CLEANUP

Overall protection of human health and the environment—Alternative 5 is identical to Alternative 4 except the additional groundwater the remedy extracts is reinjected near WNOU, rather than distributed to water purveyors.

Alternative 5 addresses the same goals as Alternative 4 and, therefore, it is also protective of human health and the environment.

Compliance with ARARs—EPA expects that Alternative 5, like Alternative 4, will comply with ARARs.

Long-term effectiveness—Alternative 5, like Alternative 4, is effective in the long-term but requires that groundwater extraction operations continue in the SEMOU for a long period of time.

Reduction of toxicity, mobility, or volume through treatment—Alternative 5 extracts and treats the same volume of contaminated groundwater as Alternative 4. Therefore, this alternative provides reductions in toxicity, mobility, and volume that are like those described for Alternative 4.

Short-term effectiveness—The short-term effectiveness of Alternative 5 is like that of Alternative 4 (moderately effective). However, the length of conveyance piping needed for Alternative 5 is at least 50 percent less than Alternative 4, Alternative 5 does not require installation of piping across the Rio Hondo Channel, and, as a result, Alternative 5 will take a shorter period of time to construct.

Implementability—The implementability of Alternative 5 is like that of Alternative 4 (moderately implementable) with a shorter construction time and smaller construction footprint.

Cost—EPA estimates the capital costs to implement Alternative 5 to be $15,400,000. EPA estimates the present value of O&M and LTM costs to be $58,400,000, assuming a discount rate of 7 percent and a period of 70 years for groundwater extraction in the SEMOU and a period of 30 years for extraction in and near the WNOU. The periods are different for the OUs because the groundwater modeling suggests this alternative will clean up the WNOU contamination sooner than at the SEMOU contamination (Appendix A). The total present value cost to implement the alternative is **$73,800,000**. The cost estimate makes the following key assumptions:

- EPA can obtain access agreements to install extraction wells where indicated on Figure 4-5. The estimate does not include costs to acquire property or access.

- The O&M costs are based on the average costs to operate the interim remedy treatment facilities over the last 4 years. The estimate assumes those costs include all expenses associated with O&M activities at the site, including prime contractor overhead and profit. The estimate assumes those costs do not include LTM costs or periodic repair costs.

- The O&M and LTM costs do not include maintenance costs associated with reinjection of treated water. Those costs may apply to the O&M/LTM period but are minor relative to the overall O&M/LTM costs of this alternative.

5.7 ALTERNATIVE 6: SEMOU/WNOU ENHANCED CLEANUP

Overall protection of human health and the environment—Alternative 6 continues the interim remedies and implements additional extraction of groundwater in the SEMOU. The additional extraction is substantial and would restore the aquifer in both the SEMOU and the WNOU. EPA would conduct groundwater monitoring to verify the effectiveness of the remedy. Water purveyors treat extracted groundwater to reduce COC concentrations to meet federal and state drinking water regulations. The existence of these regulations, and state monitoring and reporting requirements that ensure enforcement of the regulations, ensure human receptors do not drink untreated drinking water and, thus, prevent unacceptable exposure to human health.

Therefore, Alternative 6 is protective of human health and the environment.

Compliance with ARARs—The existing components of the interim remedies meet ARARs and will likely continue to meet them. EPA expects that the new components of Alternative 6 (e.g., conveyance piping, construction of a new treatment plant, and extraction wells) will meet location- and action-specific ARARs, which include, for instance, effluent air discharge requirements.

Long-term effectiveness—EPA developed Alternative 6 to eventually restore the aquifer in both OUs, which effectively eliminates potential human exposure. Groundwater modeling suggests the alternative will achieve aquifer restoration within a period of approximately 60 to 70 years (Appendix A, CH2M Hill 2021a).

Alternative 6 effectively addresses RAOs pertaining to containment, human exposure, and aquifer restoration in the long-term.

Reduction of toxicity, mobility, or volume through treatment—Alternative 6 includes extraction and treatment of large volumes of contaminated groundwater, which significantly reduces its volume and mobility. The treatment process removes contaminants (VOCs) from the groundwater either via LGAC or by air stripping, followed by adsorption onto VGAC. The process eventually destroys the contaminants when the water purveyors dispose of or regenerate the carbon.

Short-term effectiveness—Alternative 6 requires the installation of a substantial amount of conveyance piping, new extraction wells, expansion of treatment capacity at the WNOU treatment plant, and construction of a new treatment plant. The conveyance piping must cross the Pomona Freeway near its intersection with Rosemead Boulevard.

The short-term risks to the local community, workers, and the environment are essentially the same as those described for Alternative 4. However, the scope of construction is significantly larger for Alternative 6. Alternative 6 requires approximately 12 new extraction and injection wells and 38,000 feet of new conveyance piping. Further, Alternative 6 requires the construction of a new treatment plant. The estimated construction time for Alternative 6 is 1.7 years.

Due to the large scope of construction, Alternative 6 has substantial short-term impacts to the local community, workers, and the environment.

Implementability—Alternative 6 will have the same implementability obstacles as Alternative 4. However, Alternative 6 requires the construction of a new treatment plant, a larger quantity of conveyance piping (38,000 feet), and the installation of more extraction and injection wells (12). Therefore, Alternative 6 is low to moderately implementable.

The new treatment plant will require acquisition of property or access agreements. This study assumes that EPA will construct the plant on government-owned land in the Whittier Narrows Recreation Area (Figure 4-6). The land has open-spaces that are large enough to accommodate the footprint of the plant (approximately 1 acre). The land use is currently recreational, with several baseball and soccer fields in proximity to the proposed location. Therefore, the design of the new plant should consider aesthetics and noise production, which will most likely require input from local stakeholders (e.g., Los Angeles County and the city of South El Monte).

Cost—EPA estimates the capital costs to implement Alternative 6 to be $34,400,000. EPA estimates the present value of O&M and LTM costs to be $69,000,000, assuming a discount rate of 7 percent and a period of 70 years for groundwater extraction in the SEMOU and a period of 30 years for extraction in and near the WNOU. Groundwater modeling suggests this alternative will clean up SEMOU contamination after 60 to 70 years and WNOU contamination after approximately 30 years (Appendix A, CH2M Hill, 2021a). The total present value cost to implement the alternative is **$103,000,000**. The cost estimate makes the following key assumptions:

- The SGVWC Plant 8 can connect to the GSWC pipe network by expansion of an existing intertie, and the costs to expand the intertie, if needed, are negligible relative to the overall cost of this alternative.

- The MP Delta treatment plant distribution line can connect to the GSWC pipe network by expansion of an existing intertie, and the costs to expand the intertie, if needed, are negligible relative to the overall cost of this alternative.

- EPA can obtain access agreements to install extraction and injection wells where indicated on Figure 4-6. The estimate does not include costs to acquire property or access.

- The estimate does not include land acquisition costs for the proposed treatment plant in SEMOU.

- Three-phase power for the proposed treatment plant can extend from the existing WNOU treatment plant or from a location that is a similar distance away from the proposed location for the new treatment plant. EPA considers this a conservative estimate that they may refine during the design phase if they identify a closer location.

- The proposed treatment plant will consist of the following treatment processes: bag filters, two-stage liquid-phase carbon adsorption, and pH adjustment.

- The O&M costs are based on the average costs to operate the interim remedy treatment facilities over the last 4 years. The estimate assumes those costs include all expenses associated with O&M activities at the site, including prime contractor overhead and profit. The estimate assumes those costs do not include LTM costs or periodic repair costs.

- The O&M and LTM costs do not include maintenance costs associated with reinjection of treated water. Those costs may apply to the O&M/LTM period but are minor relative to the overall O&M/LTM costs of this alternative.

5.8 ALTERNATIVE 7: SEMOU/WNOU ENHANCED AND ACCELERATED CLEANUP

Overall protection of human health and the environment—Alternative 7 is identical to Alternative 6 except the volume of groundwater extracted is much greater to reduce the time required to restore the aquifer.

Therefore, Alternative 7 is protective of human health and the environment.

Compliance with ARARs—EPA expects Alternative 7, like Alternative 6, to comply with ARARs.

Long-term effectiveness—Alternative 7 achieves the same objectives as Alternative 6. Therefore, Alternative 7 effectively addresses RAOs pertaining to containment, human exposure, and aquifer restoration in the long-term. Based on groundwater modeling results (Appendix A, CH2M Hill 2021a), Alternative 7 would achieve those objectives within approximately 40 years.

Reduction of toxicity, mobility, or volume through treatment—Alternative 7 will have approximately the same reductions as Alternative 6 except they are likely to occur faster.

Short-term effectiveness—Alternative 7 requires the installation of a substantial amount of conveyance piping, new extraction wells, expansion of the treatment capacity at the WNOU treatment plant, and construction of a new treatment plant. The conveyance piping must cross the Pomona Freeway, near its intersection with Rosemead Boulevard, and the Rio Hondo Channel, near its intersection with Garvey Avenue, and the San Gabriel River in Whittier Narrows.

The scope of construction for Alternative 7 is similar to Alternative 6. However, Alternative 7 requires approximately 70% more new conveyance piping and the piping for Alternative 7 must cross the San Gabriel River and the Rio Hondo Channel. The short-term risks for Alternative 7 are essentially the same as Alternative 6 but will affect a larger area of construction and will be in-place for a longer period of time due to the longer construction time (approximately 2.5 years).

Implementability—The implementability of Alternative 7 is similar to that of Alternative 6 (low to moderately implementable) with a longer construction time and larger construction footprint.

Cost—EPA estimates the capital costs to implement Alternative 7 to be $51,000,000. EPA estimates the present value of O&M and LTM costs to be $80,100,000, assuming a discount rate of 7 percent and a period of 40 years for groundwater extraction in the SEMOU and a period of 30 years for extraction in and near the WNOU. Groundwater modeling suggests this alternative will clean up SEMOU contamination after approximately 40 years and WNOU contamination after approximately 30 years (Appendix A, CH2M Hill 2021a). The total present value cost to implement the alternative is **$131,000,000**. The cost estimate makes the following key assumptions:

- The SGVWC Plant 8 can connect to the GSWC pipe network by expansion of an existing intertie, and the costs to expand the intertie, if needed, are negligible relative to the overall cost of this alternative.
- The MP Delta treatment plant distribution line can connect to the GSWC pipe network by expansion of an existing intertie, and the costs to expand the intertie, if needed, are negligible relative to the overall cost of this alternative.
- The WNOU treatment plant can connect to the Suburban pipe network by installing conveyance as shown on Figure 4-7.
- EPA will obtain access agreements to install extraction and injection wells where indicated on Figure 4-7. The estimate does not include costs to acquire property or access.
- The estimate does not include land acquisition costs for the proposed treatment plant in SEMOU.

- Three-phase power for the proposed treatment plant can extend from the existing WNOU treatment plant, or from a location that is a similar distance away from the proposed location for the new treatment plant. EPA considers this a conservative estimate that they may refine during the design phase if they identify a closer location.

- The proposed treatment plant will consist of the following treatment processes: bag filters, two-stage liquid-phase carbon adsorption, and pH adjustment.

- The O&M costs are based on the average costs to operate the interim remedy treatment facilities over the last 4 years. The estimate assumes those costs include all expenses associated with O&M activities at the site, including prime contractor overhead and profit. The estimate assumes those costs do not include LTM costs or periodic repair costs.

- The O&M and LTM costs do not include maintenance costs associated with reinjection of treated water. Those costs may apply to the O&M/LTM period but are minor relative to the overall O&M/LTM costs of this alternative.

5.9 CONSIDERATIONS FOR COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES

This section compares remedial alternatives with similar objectives based on the seven criteria. EPA broke down the alternatives into three groups based on their objectives: containment alternatives (Alternatives 2 and 3), containment and aquifer restoration alternatives (Alternatives 4 and 5), and aquifer restoration alternatives (Alternatives 6 and 7). Table 5-2 provides a summary of the comparison. EPA excluded Alternative 1 from the comparison presented in this section due to its lack of a remedial objective, but Table 5-2 includes its ranking relative to the other alternatives.

5.9.1 Containment Remedial Alternatives

Alternatives 2 and 3 provide hydraulic containment of the contaminant plumes. This section describes the strengths and weakness of the two alternatives relative to one another with respect to the threshold and primary balancing criterion.

Overall protection of human health and the environment—Both alternatives provide adequate protection of human health and the environment by containing contaminated groundwater and preventing migration from more highly contaminated areas to less contaminated areas. Groundwater extraction provides hydraulic containment of the contaminant plumes. Treating the extracted groundwater to meet chemical-specific ARARs prior to its delivery to consumers or discharge to Legg Lakes addresses the unacceptable exposure to human receptors.

Alternative 3 is identical to Alternative 2 except it requires the installation or modification of extraction wells to improve the efficiency of hydraulic containment and contaminant mass removal. With existing institutional controls in effect, there should be no increase in long-term potential for human exposure under either alternative.

Compliance with ARARs—Alternatives 2 and 3 are both configured to meet ARARs. This includes ARARs related to protection of the drinking water supply, treatment of extracted groundwater, and discharge of the treated water (either to water purveyors or Legg Lakes). Alternative 3 improvements are also likely to meet location- and action-specific ARARs, such as those pertaining to well construction and waste disposal.

Long-term effectiveness—Groundwater modeling suggests the interim containment remedies will require more than 70 years to reduce contaminant concentrations in groundwater to below chemical-specific ARARs. Alternatives 2 and 3 effectively addresses RAOs pertaining to containment and human exposure in the long-term. However, both alternatives require that groundwater extraction operations continue for a very long time. Thus, both alternatives have only fair performance against the criterion.

Reduction of toxicity, mobility, or volume through treatment—Alternatives 2 and 3 satisfy the statutory preference for treatment. These alternatives reduce the volume and mobility of contamination by inhibiting further contaminant migration. The treatment technologies include either air stripping with off-gas controls or liquid-phase carbon adsorption, which irreversibly reduce the toxicity and volume of contaminants in the extracted groundwater and result in an effluent stream that meets drinking water standards.

Alternative 3 extracts and treats the same volume of contaminated groundwater as Alternative 2 and has the same RAOs. However, with improved hydraulic containment and contaminant mass removal, Alternative 3 has a fair performance rating against the criterion. Alternative 2 has a poor performance rating against the criterion.

Short-term effectiveness—Alternative 2 is a continuation of the existing interim remedies. The infrastructure (e.g., wells, piping, treatment facilities) required to implement this alternative is already in place. Therefore, EPA considers this alternative very effective in the short-term as it does not pose short-term risks to the community, workers, or the environment. EPA considers alternative 2 to have excellent performance against the criterion.

In comparison, Alternative 3 has short-term risks due to new well installation and well modifications that will result in temporary increases in traffic, noise from the drilling rigs, and minor dust production due to the movement of large equipment and handling of soil cuttings. Short-term risks to workers are mainly associated with drilling rig operation while short-term risks to the environment are related to the disposal of waste material that may be hazardous (e.g., soil cuttings and drilling fluids). The estimated time to construct is 6 months. EPA considers Alternative 3 to have good performance against the criterion.

Implementability—Since Alternative 2 is a continuation of the existing interim remedies, the implementability obstacles (i.e., technical feasibility, administrative feasibility, and availability of services and materials) do not apply. Therefore, EPA considers this alternative very implementable with excellent performance against the criterion.

Many extraction and injection wells similar to what Alternative 3 needs are already present at the site. Therefore, Alternative 3 is technically feasible as well as administratively feasible. The equipment, materials, and labor needed to install the extraction wells are not out of the ordinary and, thus, are readily available. EPA considers Alternative 3 implementable with good performance against the criterion.

Cost—Alternative 2 has lower capital costs ($76,600) than Alternative 3 ($1,850,000). The difference in capital costs is due to the need in Alternative 3 to optimize the interim containment remedies by installing or modifying extraction wells whereas Alternative 2 does not include optimization. Both alternatives have the same O&M and LTM costs (present worth; $38,900,000), assuming a discount rate of 7 percent and a period of 70 years for both.

5.9.2 Containment (SEMOU only) and Aquifer Restoration (WNOU only) Remedial Alternatives

Alternatives 4 and 5 provide hydraulic containment of the contaminant plumes and aquifer restoration within the WNOU. This section describes the strengths and weakness of the two alternatives relative to one another with respect to the threshold and primary balancing criteria.

Overall protection of human health and the environment—Alternatives 4 and 5 both satisfy RAOs and reduce risks to human health and the environment by containing contaminated groundwater, preventing migration from more highly contaminated areas to less contaminated areas, and providing aquifer restoration within the WNOU.

Alternative 4 continues the interim remedies and implements additional extraction of groundwater near the WNOU. The interim remedies provide hydraulic control of the contaminant plumes within the SEMOU and the additional extraction aids aquifer restoration in the WNOU. Treating the extracted groundwater to meet chemical-specific ARARs prior to its delivery to consumers or discharge to Legg Lakes addresses the unacceptable exposure to human receptors. Therefore, Alternative 4 is protective of human health and the environment.

Alternative 5 is identical to Alternative 4 except the additional groundwater that the remedy extracts is reinjected near WNOU rather than distributed to water purveyors. Alternative 5 addresses the same goals as Alternative 4 and, therefore, it is also protective of human health and the environment.

Compliance with ARARs—The existing components of the interim remedies meet ARARs and will likely continue to meet them. EPA expects that the new components of Alternative 4 (e.g., conveyance piping, expansion of treatment capacity at an existing treatment facility, and extraction wells) will meet location- and action-specific ARARs, which include well construction requirements, Occupational Safety and Health Administration construction safety regulations, and stormwater discharge requirements. EPA expects that Alternative 5, like Alternative 4, will also comply with ARARs.

Long-term effectiveness—Alternatives 4 and 5 extract a greater amount of contaminated groundwater than the containment only alternatives to restore the aquifer in the WNOU. Contaminated water would remain in the SEMOU for greater than 70 years, but the remedy would effectively contain the contamination. The remedy would clean up contaminated water in the WNOU after a period of approximately 30 years. Water purveyors would continue to treat extracted groundwater, thus, preventing human exposure to contaminants.

Alternatives 4 and 5 effectively address RAOs pertaining to containment, human exposure, and aquifer restoration (WNOU only) in the long-term. However, these alternatives require groundwater extraction and treatment operations to continue in the SEMOU for a very long time. EPA rated both alternatives as having fair performance against the criterion.

Reduction of toxicity, mobility, or volume through treatment—Alternatives 4 and 5 extract and treat contaminated groundwater and, thus, provide reductions in toxicity, mobility, and volume of contaminated water. Activated carbon adsorbs the contaminants (VOCs), which the treatment process eventually destroy. The objectives of these alternatives are containment at the SEMOU and aquifer restoration at the WNOU. Therefore, the focus of these alternatives in the SEMOU will be reduction of mobility while the focus at the WNOU will be reduction of toxicity, mobility, and volume.

Alternative 5 extracts and treats the same volume of contaminated groundwater as Alternative 4 and has the same RAOs. Therefore, this alternative provides reductions in toxicity, mobility, and volume that are similar to those described for Alternative 4. EPA rated both alternatives as having fair performance against the criterion.

Short-term effectiveness—Alternatives 4 and 5 require the installation of a substantial amount of conveyance piping and new extraction wells. However, the length of conveyance piping needed for Alternative 5 is at least 50 percent less than Alternative 4. Further, Alternative 5 does not require installation of piping across the Rio Hondo Channel. Under both alternatives, conveyance piping must cross the Pomona Freeway near its intersection with Rosemead Boulevard. The estimated time to construct ranges from 10 months (Alternative 5) to 12 months (Alternative 4).

The short-term risks to the local community include increases in traffic, especially due to construction of conveyance pipe, which will likely traverse ROWs adjacent to roads. Noise and dust generated by drilling and excavation of trenches for piping will also contribute to short-term risks. The implementation of a traffic control plan when installing piping will help mitigate traffic congestion, though some congestion may be inevitable.

The short-term risks to workers include hazards related to drilling, working near roads during pipeline installation, overhead hazards such as movement of heavy items (e.g., carbon vessels and large-diameter pipe) via crane or similar equipment, and the hazards of working near excavations that exceed 5 feet (e.g., engulfment).

The short-term risks to the environment include the disposal of waste material that may be hazardous (e.g., soil cuttings and drilling fluids), stormwater runoff from areas of construction, and pollution resulting from construction equipment (e.g., oil and fuel spills and exhaust emissions). Standard construction practices such as disposal of waste in accordance with federal and state regulations (e.g., Resource Conservation and Recovery Act), implementation of a stormwater pollution prevention plan, and implementation of spill controls (e.g., containment berms) can mitigate those risks.

EPA rated Alternatives 4 and 5 as having fair and good performance against the criterion, respectively.

Implementability—Alternatives 4 and 5 are moderately implementable. However, Alternative 5 is likely to have a shorter construction timeline, smaller construction footprint, and less administrative burden.

Alternatives 4 and 5 require construction that is common of drinking water pipelines, water supply wells, and water/wastewater treatment facilities. From a technical standpoint, the components are routine and standard to construct and operate. The methods required for construction (e.g., drilling, jacking and boring, and excavation to depths up to approximately 10 feet) do require some specialized skills and equipment, but none that are difficult to acquire. The technologies (e.g., groundwater extraction and treatment via air stripping and activated carbon adsorption) are reliable and effective at removing VOC contamination from groundwater.

The implementation of a groundwater monitoring program will allow for the collection of data necessary to assess whether the alternatives are effective. Groundwater modeling based on the collected data can help assess whether the alternatives will continue to be effective.

The main obstacles to implementation are administrative. EPA will need to acquire property or access agreements to install wells and pipelines and to setup a staging area during construction. Placement of these items on public land, to the extent possible, will minimize access issues. The nearby Whittier Narrows Recreational Area and existing treatment plants will likely provide enough space to stage construction materials and equipment.

EPA will make agreements with entities that have water rights (e.g., local water purveyors) to allow for groundwater extraction. There are existing agreements in place with multiple water purveyors as part of the interim containment remedies. EPA assumes that they can modify these agreements to accommodate the increase in groundwater extraction required by Alternatives 4 and 5.

EPA expects that the permits needed for construction are not difficult to obtain. Therefore, EPA considers Alternative 5 more implementable than Alternative 4. EPA rates Alternatives 4 and 5 as having fair and good performance against the criterion, respectively.

Cost—EPA estimates the capital costs for Alternative 5 ($15,400,000) are similar to the costs needed for Alternative 4 ($16,700,000). Both alternatives have the same O&M and LTM costs (present worth; $46,100,000), assuming a discount rate of 7 percent and a period of 70 years for both.

5.9.3 Aquifer Restoration Remedial Alternatives

Alternatives 6 and 7 provide hydraulic containment of the contaminant plumes and aquifer restoration within both OUs. This section describes the strengths and weakness of the two alternatives relative to one another with respect to the threshold and primary balancing criteria.

Overall protection of human health and the environment—Alternatives 6 and 7 continue the interim remedies and implement additional extraction of groundwater in the SEMOU. The additional extraction is substantial, relative to other containment and restoration alternatives, and would restore the aquifer in both the SEMOU and the WNOU. EPA will conduct groundwater monitoring to verify the effectiveness of the remedies. Treating the extracted groundwater to meet chemical-specific ARARs prior to its delivery to consumers, discharge to Legg Lakes, or reinjection to the aquifer addresses the unacceptable exposure to human receptors. Therefore, EPA considers both alternatives protective of human health and the environment.

Compliance with ARARs—The existing components of the interim remedies meet ARARs and will likely continue to meet them. EPA expects that the new components of Alternatives 6 and 7 (e.g., conveyance piping, construction of a new treatment plant, and extraction wells) will meet location- and action-specific ARARs, which include well construction requirements, Occupational Safety and Health Administration construction safety regulations, effluent air discharge permits, and stormwater discharge requirements.

Long-term effectiveness—Alternatives 6 and 7 effectively addresses RAOs pertaining to containment, human exposure, and aquifer restoration in the long-term. However, based on groundwater modeling results (Appendix A, CH2M Hill 2021a), Alternative 7 would achieve those objectives within approximately 40 years, a shorter timeframe than Alternative 6. EPA rates Alternatives 6 and 7 as having good and excellent performance against the criterion, respectively.

Reduction of toxicity, mobility, or volume through treatment—The objective of both Alternatives 6 and 7 is aquifer restoration in the SEMOU and WNOU via groundwater extraction and treatment. Therefore, these alternatives will, eventually, reduce the toxicity of contaminated groundwater to a level that meets chemical-specific ARARs. Doing so would reduce the volume and mobility of contaminated water. During treatment, the contaminants (VOCs) adsorb onto activated carbon and are eventually destroyed when the carbon is disposed of or regenerated.

The alternatives have the same reductions, but they are expected to occur faster under Alternative 7. EPA rates Alternatives 6 and 7 as having good and excellent performance against the criterion, respectively.

Short-term effectiveness—Alternatives 6 and 7 require installation of a substantial amount of conveyance piping, several complicated pipeline crossings, new extraction and injection wells, expansion of treatment capacity at the WNOU treatment plant, and construction of a new treatment plant. The short-term risks for both alternatives are essentially the same but Alternative 7 will affect a larger area and require more time to construct.

The short-term risks to the local community include increases in traffic, especially due to construction of conveyance pipe, which will likely traverse ROWs adjacent to roads. Noise and dust generated by drilling and excavation of trenches for piping will also contribute to short-term risks. The implementation of a traffic control plan when installing piping will help mitigate traffic congestion, though some congestion may be inevitable.

The short-term risks to workers include hazards related to drilling, working near roads during pipeline installation, overhead hazards such as movement of heavy items (e.g., carbon vessels and large-diameter pipe) via crane or similar equipment, and the hazards of working near excavations that exceed 5 feet (e.g., engulfment). Standard construction practices can mitigate those risks.

The short-term risks to the environment include the disposal of waste material that may be hazardous (e.g., soil cuttings and drilling fluids), stormwater runoff from areas of construction, and pollution resulting from construction equipment (e.g., oil and fuel spills and exhaust emissions). Standard construction practices can mitigate those risks.

EPA rates Alternatives 6 and 7 as having fair and poor performance against the criterion, respectively, as a direct result of the scale of construction.

Implementability—Alternatives 6 and 7 require construction of a new treatment plant, a large quantity of conveyance piping, multiple facility and structure crossings, and the installation of multiple extraction and injection wells. From a technical standpoint, the components are routine and standard to construct and operate. The methods required for construction (e.g., drilling, jacking and boring, and excavation to depths up to approximately 10 feet) do require some specialized skills and equipment, but none that are difficult to acquire. The technologies (e.g., groundwater extraction and treatment via either air stripping and vapor-phase carbon adsorption or liquid-phase carbon adsorption) are reliable and effective at removing VOC contamination from groundwater.

The implementation of a groundwater monitoring program will allow for the collection of data necessary to assess whether the alternative is effective. Groundwater modeling based on the collected data can help assess whether the alternative will continue to be effective.

The main obstacles to implementation are administrative. EPA must acquire property or access agreements to install wells and pipelines and to setup a staging area during construction. Placement of these items on public land, to the extent possible, will minimize access issues. The nearby Whittier Narrows Recreational Area and existing treatment plants will likely provide enough space to stage construction materials and equipment. The new treatment plant will require acquisition of property or access agreements to accommodate the footprint of the plant (approximately ¾ acre).

EPA must make agreements with entities that have water rights (e.g., local water purveyors) to allow for groundwater extraction. There are existing agreements in place with multiple water purveyors as part of the interim containment remedies. EPA assumes that they can modify these agreements to accommodate the increase in groundwater extraction required by these alternatives.

EPA expects that the permits needed for construction are not difficult to obtain.

Alternative 7 is likely to have a greater administrative burden than Alternative 6. Therefore, it is less implementable than Alternative 6. EPA rates Alternatives 6 and 7 as having fair and poor performance against the criterion, respectively as a direct result of the scale of construction.

Cost—EPA estimates the capital costs for Alternative 6 ($34,400,000) are approximately 70 percent of the costs needed for Alternative 7 ($51,000,000). The O&M and LTM costs (present worth) for Alternative 6 ($56,800,000) are also lower than those for Alternative 7 ($68,100,000), assuming a discount rate of 7 percent for both and periods of 70 and 40 years, respectively.

Alternative 7 has higher capital costs than Alternative 6 primarily because it requires the installation of a larger quantity of conveyance pipe and extraction wells, the conveyance piping has to cross the Rio Hondo Channel, it includes construction of an interconnection between the WNOU treatment plant and the Suburban drinking water piping network, and because construction of its components is expected to require more time (approximately 2.5 years) than construction of the components for Alternative 6 (1.7 years).

Alternative 7 has higher O&M and LTM costs than Alternative 6 because, despite its shorter operation time, it requires treatment of a higher volume of contaminated groundwater (approximately 30,000 acre-feet per year) than Alternative 6 (24,000 acre-feet per year).

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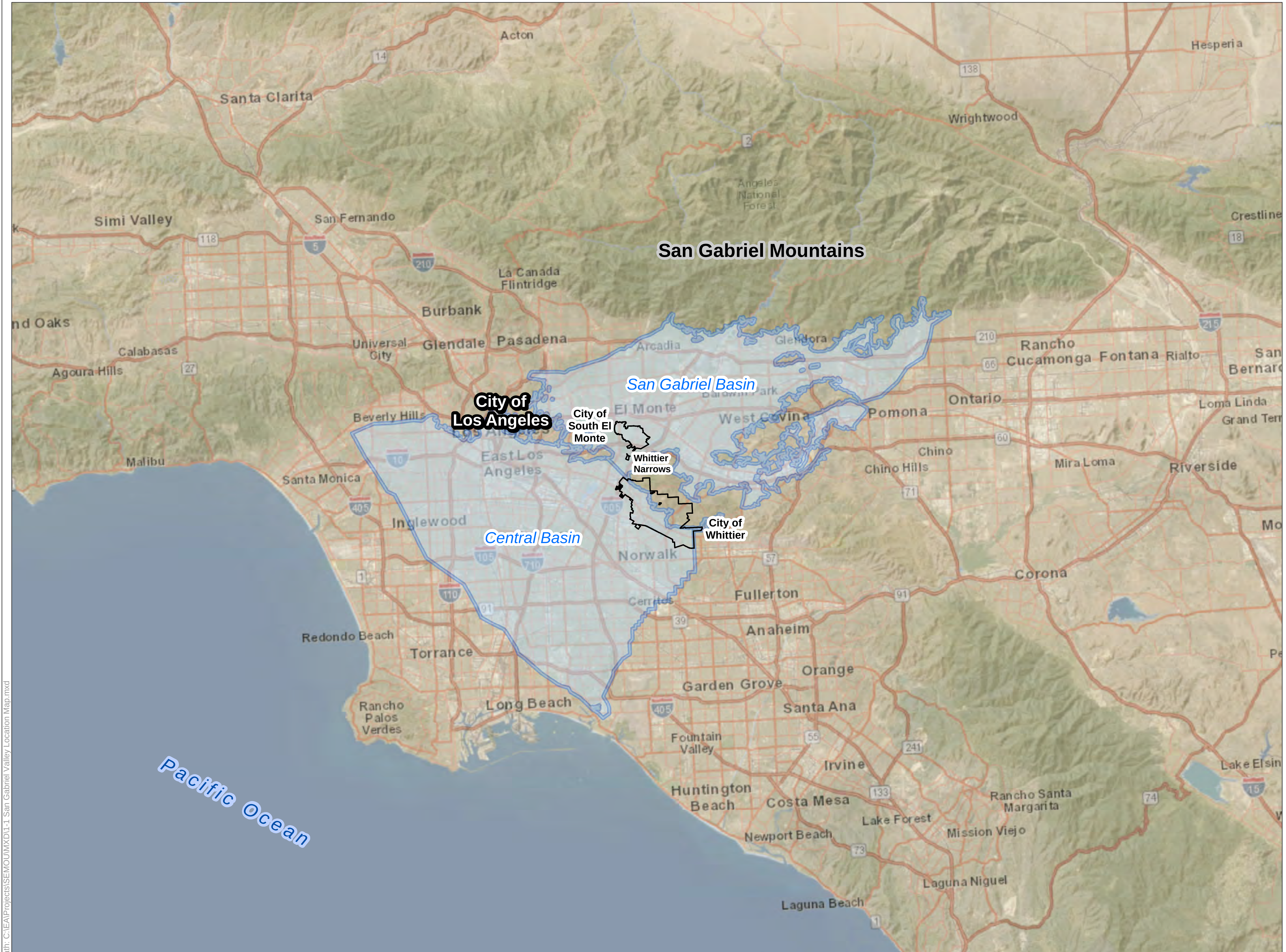
Figures



Legend

City Limits

Groundwater Basin

0 3 6 12

Miles

Data Sources: Esri 2006, 2017; Groundwater Basins provided by California Natural Resources Agency, 2020

Enhanced Remedial Alternatives Study
South El Monte Operable Unit
Los Angeles County, California
San Gabriel Valley Area 1 Superfund Site

Figure 1-1
San Gabriel Valley Location Map

Path: C:\EA\Projects\SEMOU\MXD\1-1 San Gabriel Valley Location Map.mxd

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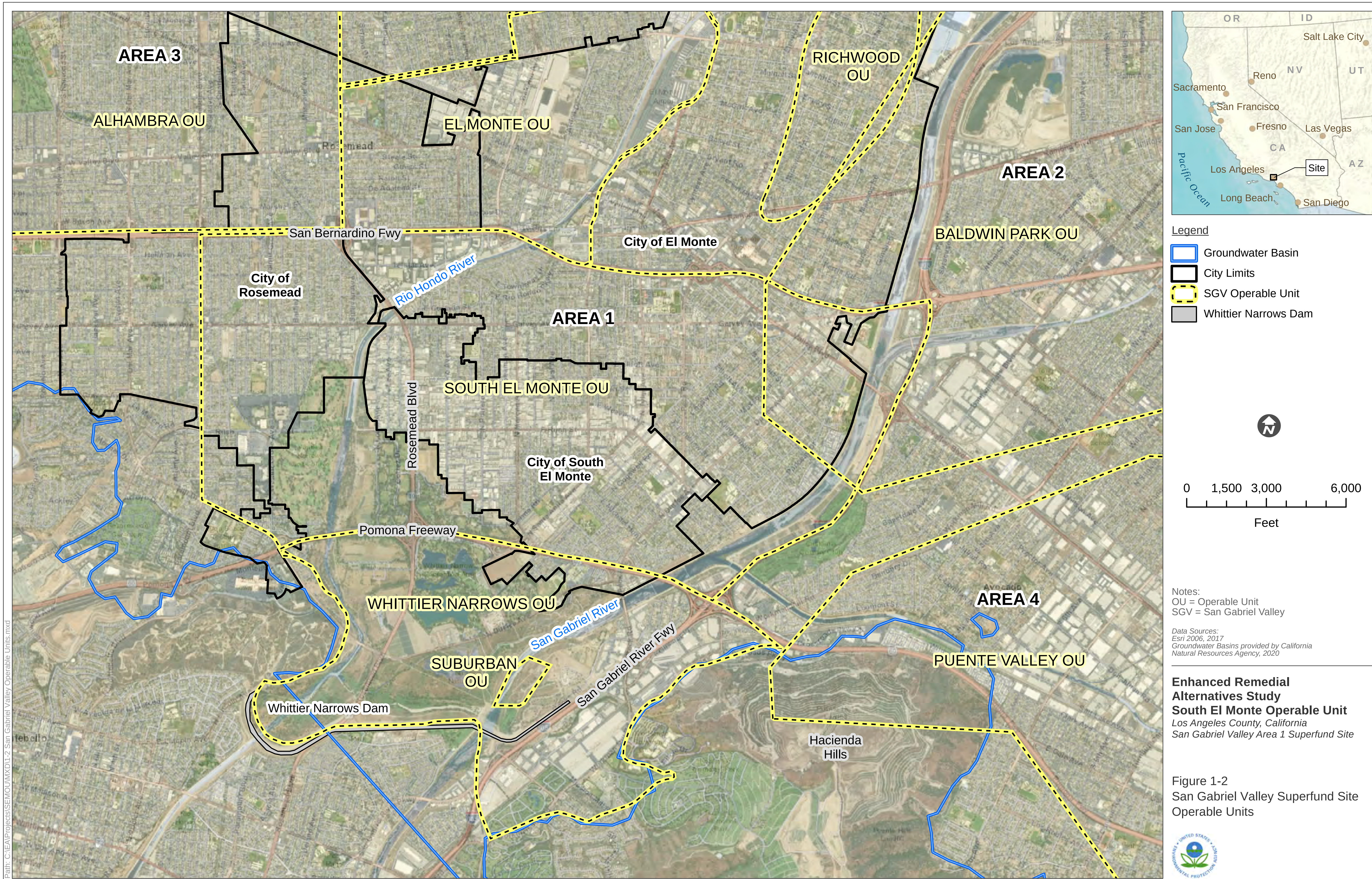

Enhanced Remedial Alternatives Study
South El Monte Operable Unit
Los Angeles County, California
San Gabriel Valley Area 1 Superfund Site

Figure 1-2
San Gabriel Valley Superfund Site Operable Units

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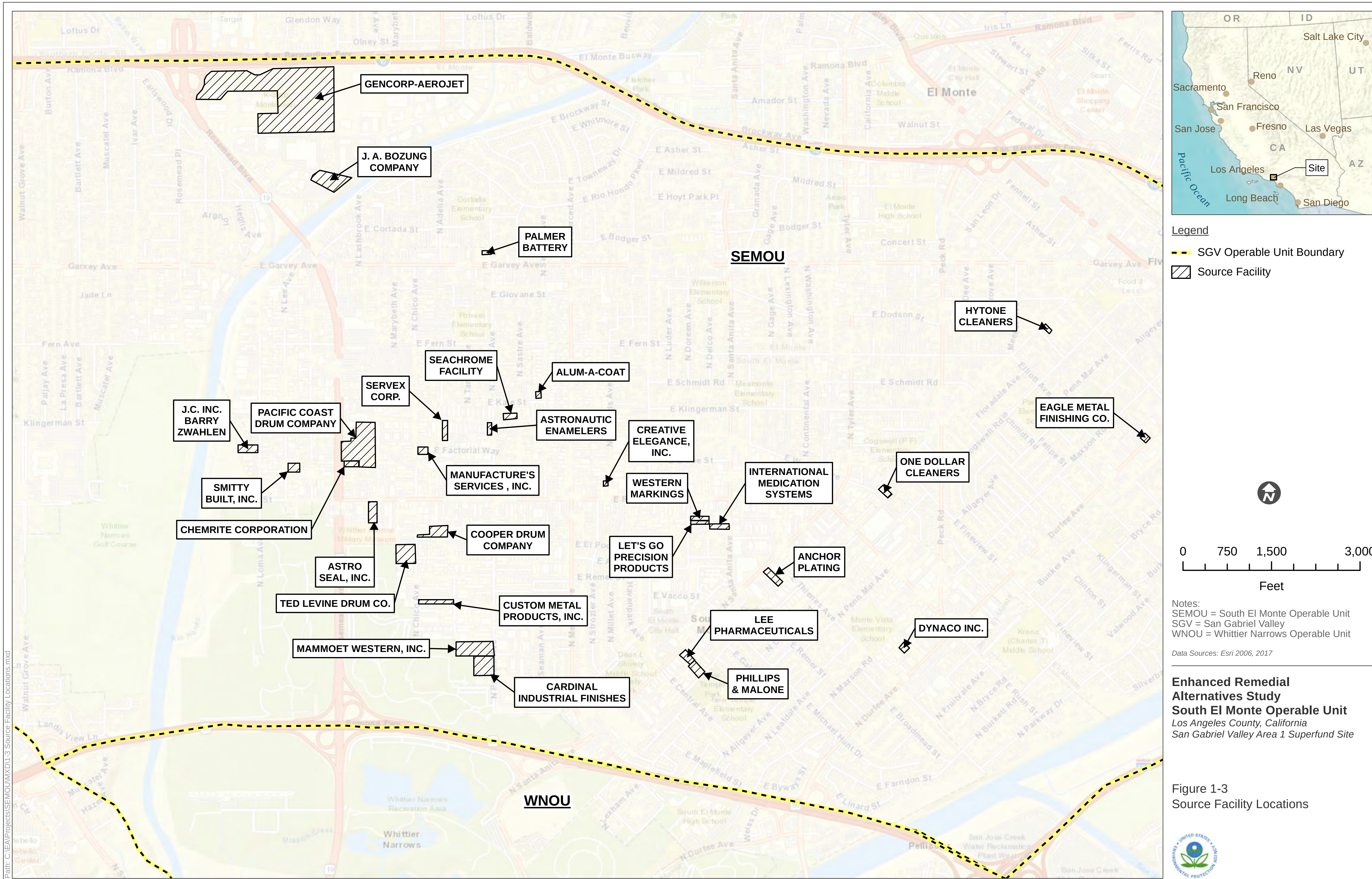

Figure 1-3
Source Facility Locations

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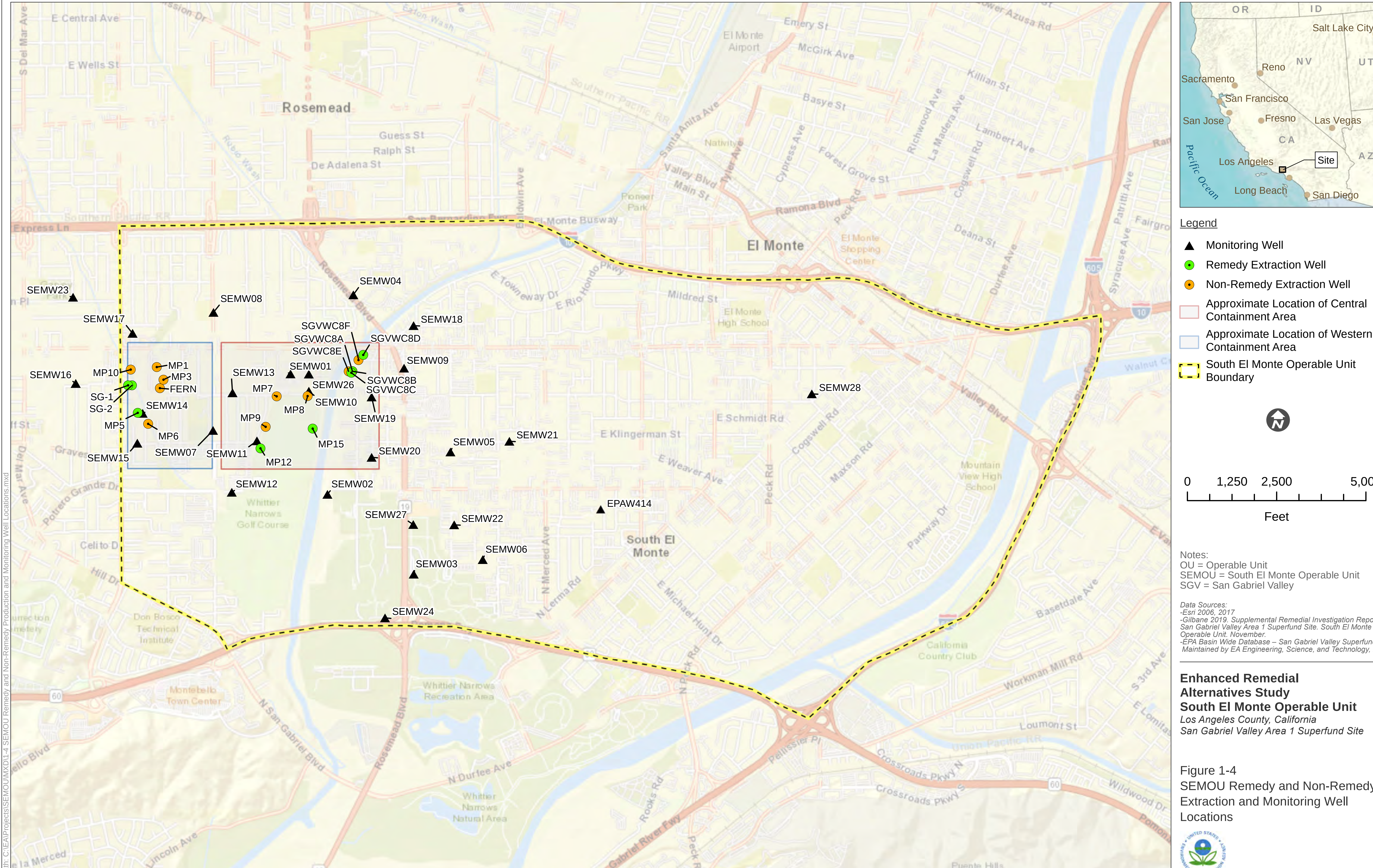


Legend

- ▲ Monitoring Well
- Remedy Extraction Well
- Non-Remedy Extraction Well
- Approximate Location of Central Containment Area
- Approximate Location of Western Containment Area
- South El Monte Operable Unit Boundary

0 1,250 2,500 5,000

Feet

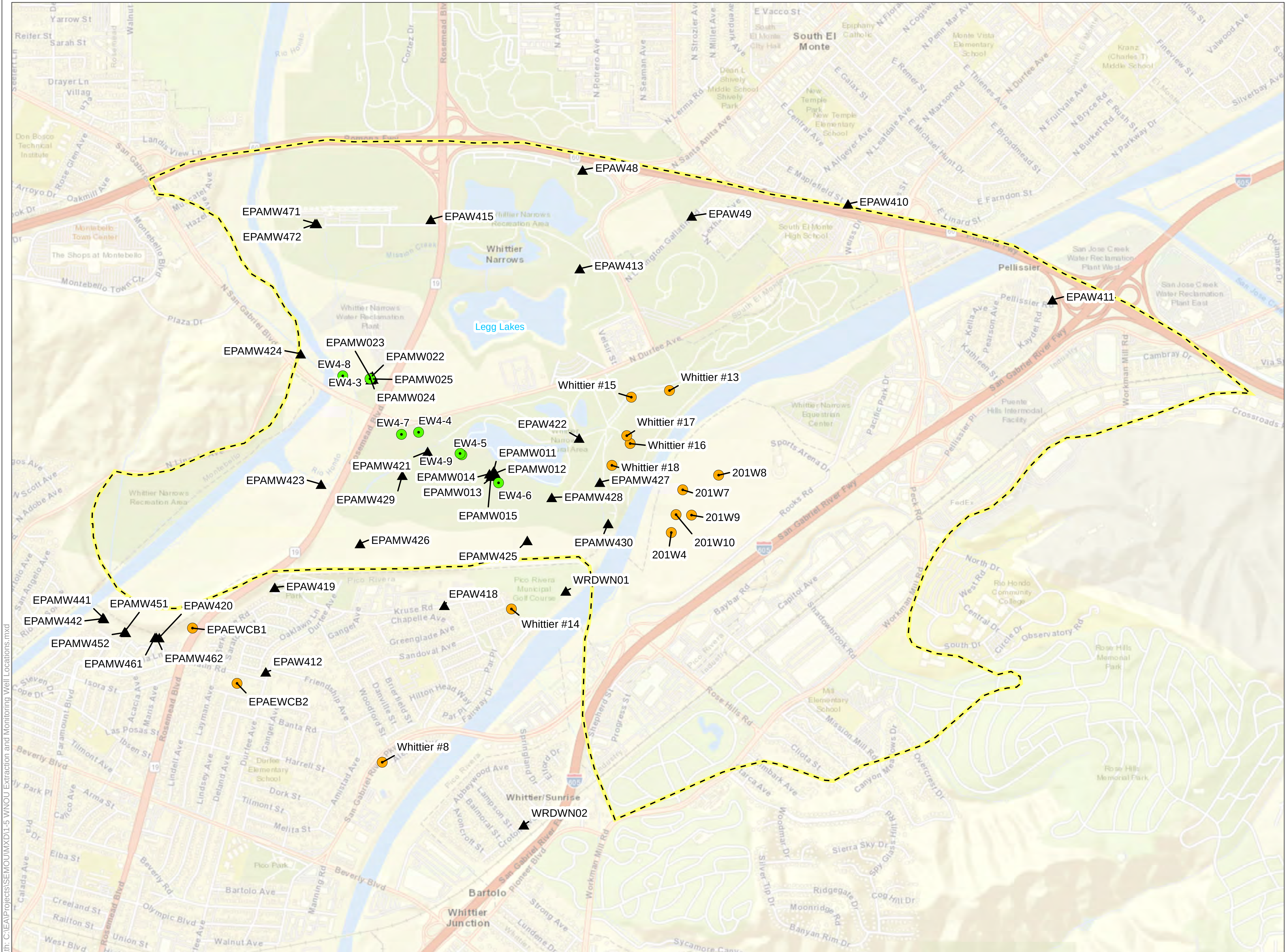
Notes:
OU = Operable Unit
SEMOU = South El Monte Operable Unit
SGV = San Gabriel Valley

Data Sources:
-Esri 2006, 2017
-Gilbane 2019. Supplemental Remedial Investigation Report. San Gabriel Valley Area 1 Superfund Site. South El Monte Operable Unit. November.
-EPA Basin Wide Database – San Gabriel Valley Superfund Site. Maintained by EA Engineering, Science, and Technology, Inc.

Enhanced Remedial Alternatives Study
South El Monte Operable Unit
Los Angeles County, California
San Gabriel Valley Area 1 Superfund Site

Figure 1-4
SEMOU Remedy and Non-Remedy Extraction and Monitoring Well Locations

Path: C:\EA\Projects\SEMOU\MXD\1-4 SEMOU Remedy and Non-Remedy Production and Monitoring Well Locations.mxd



Legend

- ▲ Monitoring Well
- Remedy Extraction Well
- Non-Remedy Extraction Wells
- Whittier Narrows Operable Unit Boundary

0 750 1,500 3,000

Feet

Notes:
OU = Operable Unit
SGV = San Gabriel Valley
WNOU = Whittier Narrows Operable Unit

Data Sources:
-Esri 2006, 2017
-URS. 2019. Performance Evaluation Report for 2018. San Gabriel Valley Area 1 Superfund Site. Whittier Narrows Operable Unit. September.
-EPA Basin Wide Database – San Gabriel Valley Superfund Site. Maintained by EA Engineering, Science, and Technology, Inc.

Enhanced Remedial Alternatives Study
South El Monte Operable Unit
Los Angeles County, California
San Gabriel Valley Area 1 Superfund Site

Figure 1-5
WNOU Extraction and Monitoring Well Locations

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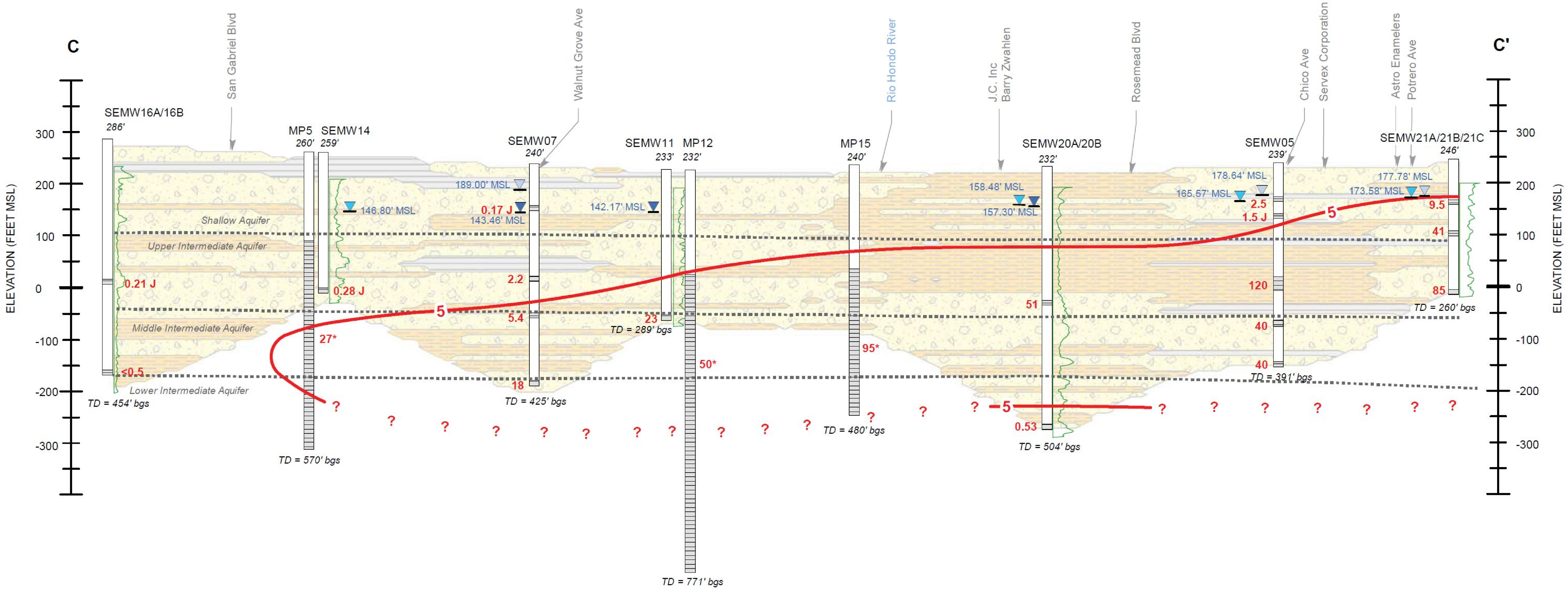


Well graded sand and gravelly sand with moderate amounts of fine sand and silt.

Poorly graded sand, silty sand to sandy silt

Silt to silty clay and silty clay mixtures

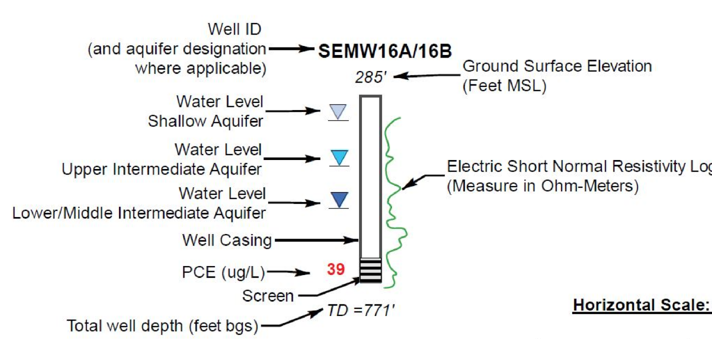
Approximate extent of VOC plume (>MCL), May/June 2016 intermediate aquifer

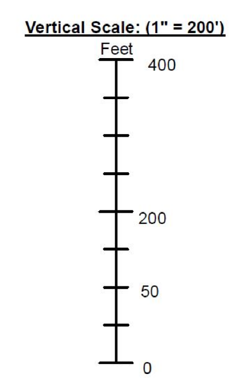
Aquifer delineation (estimated)

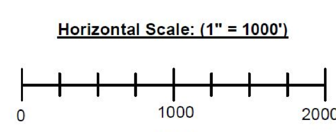
Notes:

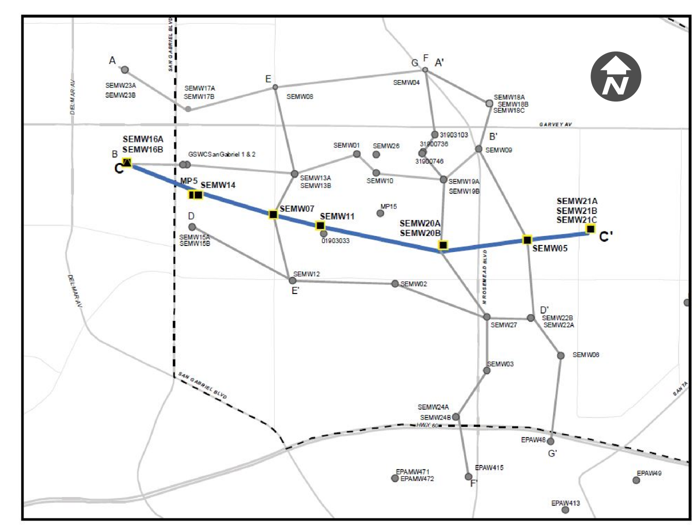
- Cross-section depicts materials of comparable permeability and hydraulic conductivity
- All contacts are generalized and approximate
- msl = mean sea level
- bgs = below ground surface
- PCE = tetrachloroethene
- J = estimated value
- VOC = volatile organic compounds
- MCL = maximum contaminant level

26* = *Actual depth of PCE is unknown due to the long screen interval.









Notes:
Figure graphics and data obtained from Figure 3-4 of the Supplemental Remedial Investigation Report (Gilbane 2019a).
SEMOU = South El Monte Operable Unit

Data Sources:
Esri 2006, 2017
Gilbane 2019a. Supplemental Remedial Investigation Report. San Gabriel Valley Area 1 Superfund Site. South El Monte Operable Unit. November.

Enhanced Remedial Alternatives Study
South El Monte Operable Unit
Los Angeles County, California
San Gabriel Valley Area 1 Superfund Site

Figure 1-6a
SEMOU Hydrogeologic Cross-Section, C-C'

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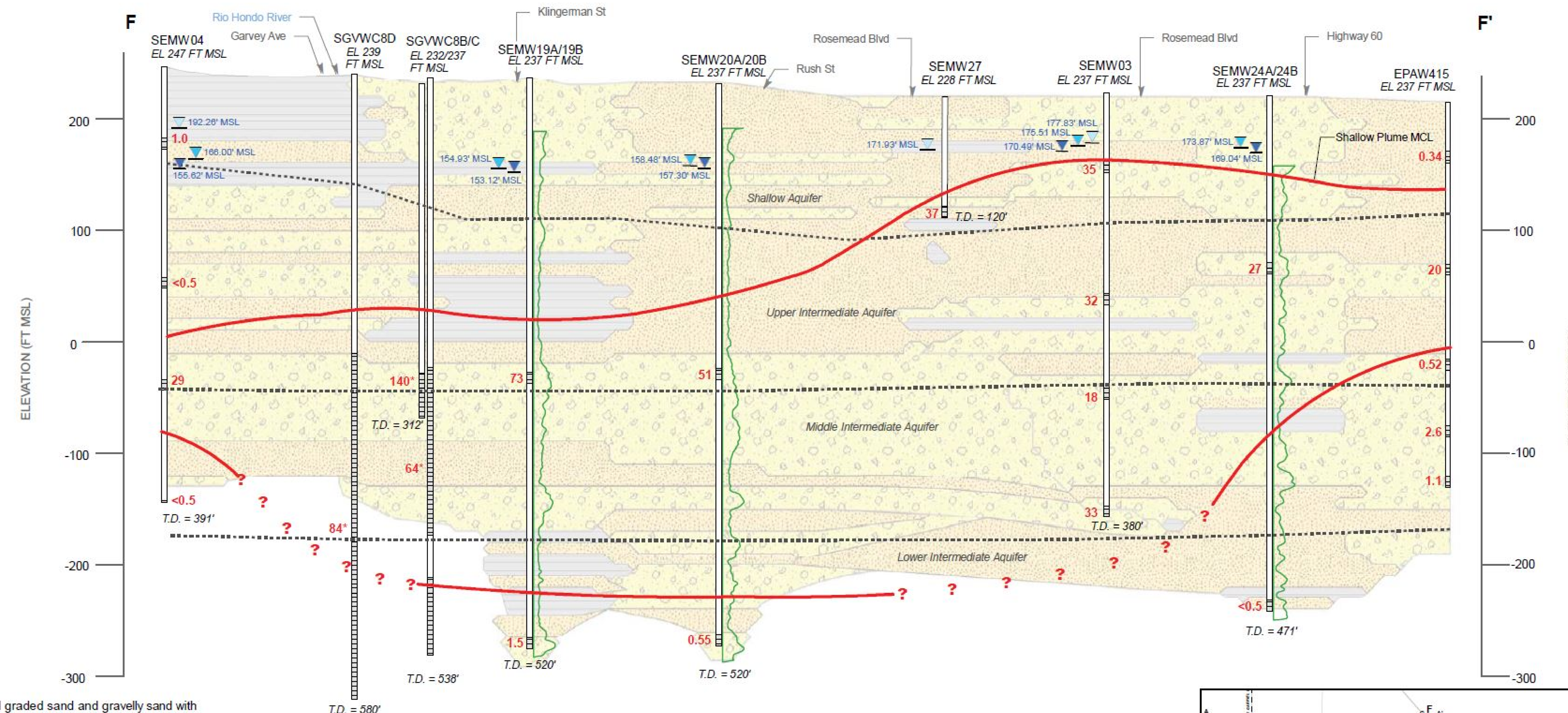


Well graded sand and gravelly sand with moderate amounts of fine sand and silt.

Poorly graded sand, silty sand to sandy silt

Silt to silty clay and silty clay mixtures

Approximate extent of VOC plume (>MCL), May/June 2016 intermediate aquifer

Aquifer delineation (estimated)

Notes:

- Cross-section depicts materials of comparable permeability and hydraulic conductivity
- All contacts are generalized and approximate
- msl = mean sea level
- bgs = below ground surface
- PCE = tetrachloroethene
- J = estimated value
- VOC = volatile organic compounds
- MCL = maximum contaminant level

Well ID (and aquifer designation where applicable) → SEMW04

Ground Surface Elevation (Feet MSL) → 247'

Water Level Shallow Aquifer

Water Level Upper Intermediate Aquifer

Water Level Lower/Middle Intermediate Aquifer

Electric Short Normal Resistivity Log (Measure in Ohm-Meters)

Well Casing

Screen

PCE (ug/L) → 19J

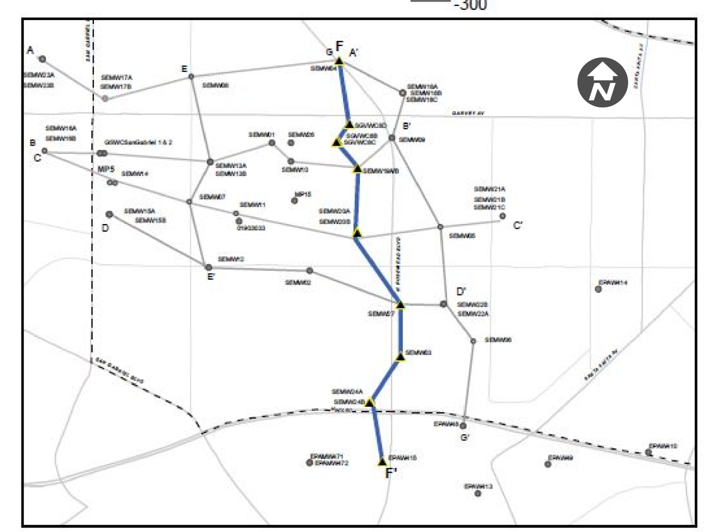
Total well depth (feet bgs) → TD = 391'

98* = *Actual depth of PCE is unknown due to the long screen interval.

Vertical Scale: 1" = 100'

Horizontal Scale: (1" = 1000')

0 1000 2000 Feet



Notes:
Figure graphics and data obtained from Figure 3-7 of the Supplemental Remedial Investigation Report (Gilbane 2019a).
SEMOU = South El Monte Operable Unit

Data Sources:
Esri 2006, 2017
Gilbane 2019a. Supplemental Remedial Investigation Report. San Gabriel Valley Area 1 Superfund Site. South El Monte Operable Unit. November.

Enhanced Remedial Alternatives Study
South El Monte Operable Unit
Los Angeles County, California
San Gabriel Valley Area 1 Superfund Site

Figure 1-6b
SEMOU Hydrogeologic Cross-Section, F-F'

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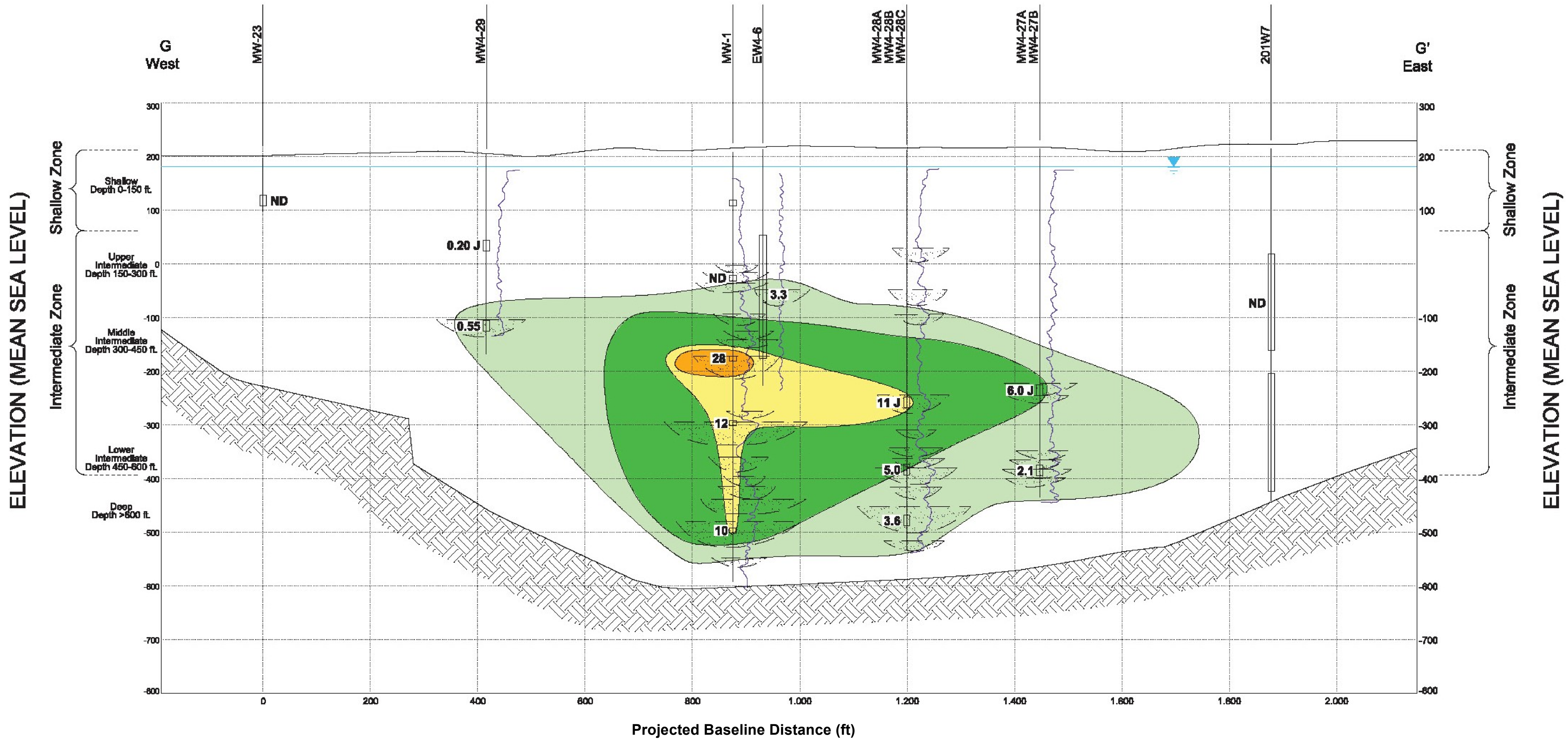

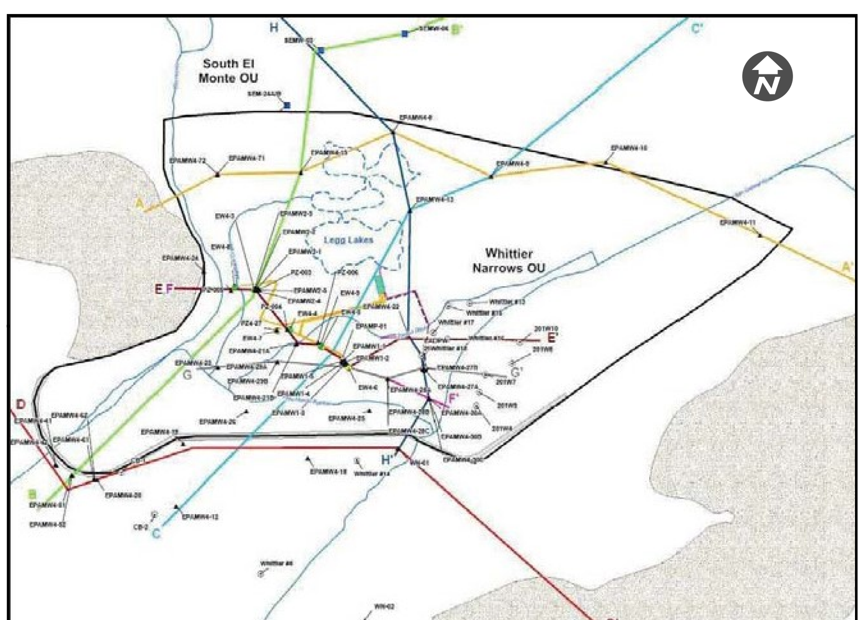

EXPLANATION

HYDROSTRATIGRAPHIC UNITS

Predominantly Sand with Silt and Clay

Predominantly Gravel and Sand

GEOLOGICAL UNITS

Tp — Pico Unit

Depth intervals are approximate; actual elevations vary throughout Whittier Narrows.

Geologic interpretation of selected coarse units across or near well screen zones. Interpretation based on the DTSC braided channel deposit model using historical Short Normal Resistivity logs for identification.

Short (16") Normal Resistivity Geophysical Log

MW4-71 — Well ID

5 — Screen Interval with PCE Concentration in Groundwater (µg/L)

J — Estimated value detected less than the laboratory reporting limit

Approximate Water Table

ND — Not Detected

NS — Not Sampled

PCE — Tetrachloroethene (Maximum Concentrations Posted)

PCE Contamination Ranging from 0.5 to 5 µg/L

PCE Contamination Ranging from 5 to 10 µg/L

PCE Contamination Ranging from 10 to 25 µg/L

PCE Contamination Ranging from 25 to 50 µg/L

PCE Contamination Ranging from 50 to 100 µg/L

PCE Contamination Above 100 µg/L

Notes:
PCE data collected in 2017.
Concentration contour dashed where inferred.

0 200 400 — H: 1"=400'
0 100 200 — V: 1"=200'

Notes:
Figure graphics and data obtained from Figure 18 of the 2018 Performance Evaluation Report (URS 2019)
WNOU = Whittier Narrows Operable Unit

Data Sources:
Esri 2006, 2017
URS. 2019. Performance Evaluation Report for 2018 San Gabriel Valley Area 1 Superfund Site, Whittier Narrows Operable Unit. Prepared for Department of Toxic Substance Control. September 2019.

Enhanced Remedial Alternatives Study
South El Monte Operable Unit
Los Angeles County, California
San Gabriel Valley Area 1 Superfund Site

Figure 1-6c
WNOU Hydrogeologic Cross-Section, G-G'

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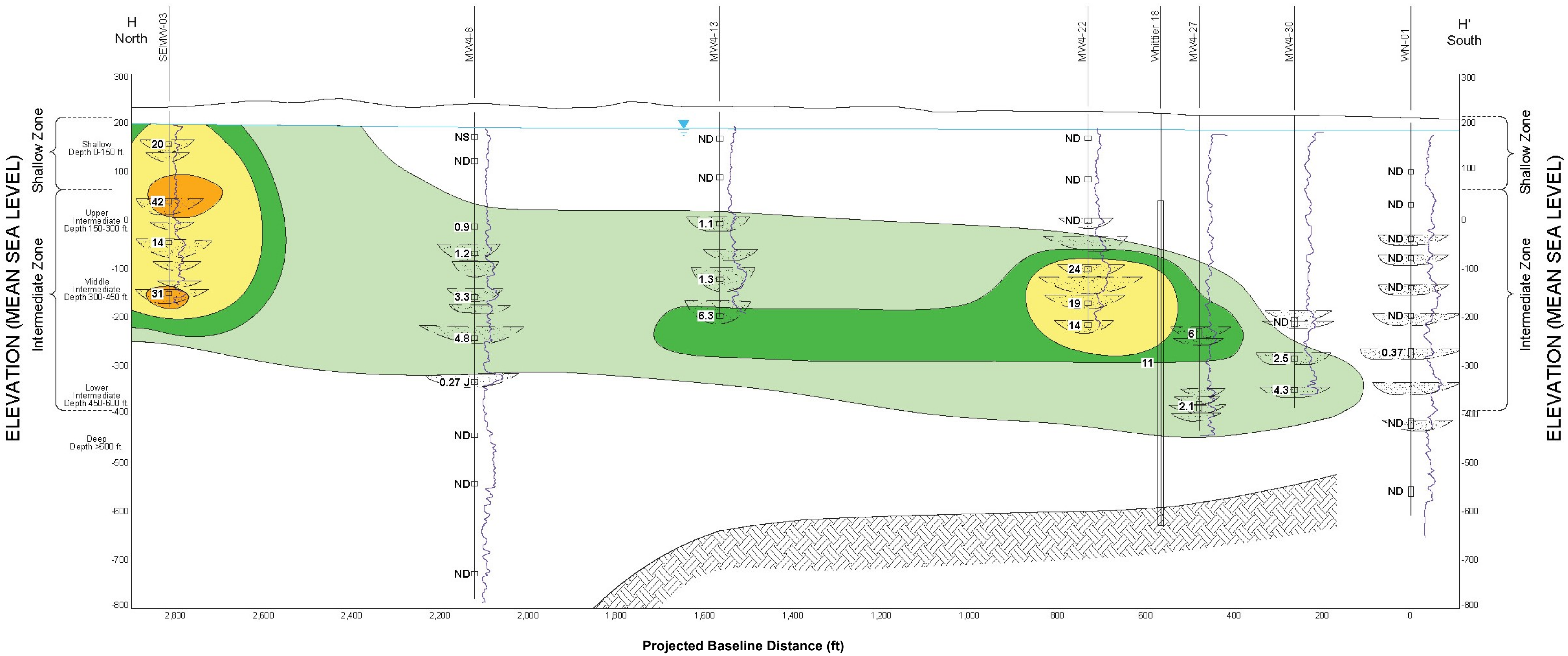

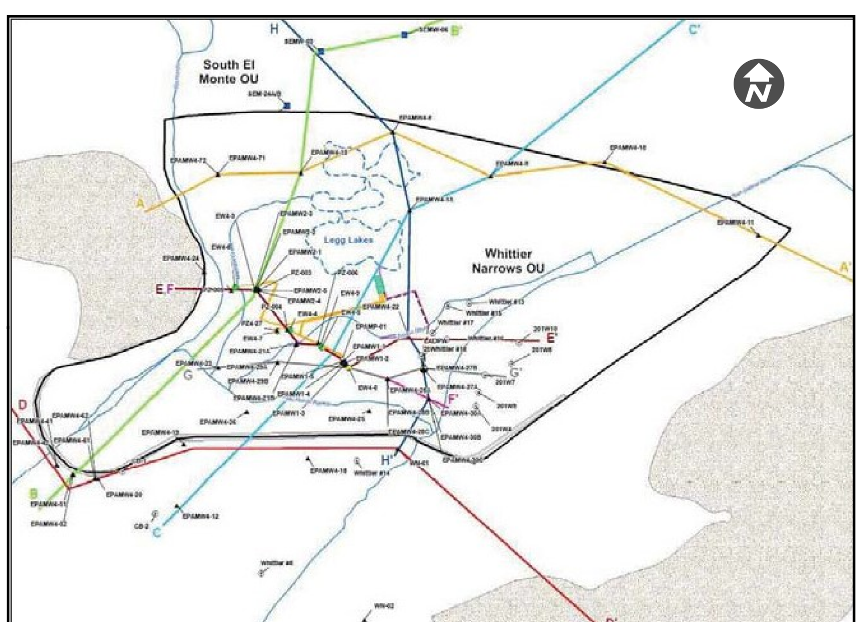

EXPLANATION

HYDROSTRATIGRAPHIC UNITS

- Predominantly Sand with Silt and Clay
- Predominantly Gravel and Sand

GEOLOGICAL UNITS

- Tp Pico Unit

Depth intervals are approximate; actual elevations vary throughout Whittier Narrows.

Geologic interpretation of selected coarse units across or near well screen zones. Interpretation based on the DTSC braided channel deposit model using historical Short Normal Resistivity logs for identification.

- Short (16") Normal Resistivity Geophysical Log
- MW4-71 Well ID
- 5 Screen Interval with PCE Concentration in Groundwater (µg/L)
- J Estimated value detected less than the laboratory reporting limit
- Approximate Water Table
- **ND** Not Detected
- **NS** Not Sampled
- PCE Tetrachloroethene (Maximum Concentrations Posted)

- PCE Contamination Ranging from 0.5 to 5 µg/L
- PCE Contamination Ranging from 5 to 10 µg/L
- PCE Contamination Ranging from 10 to 25 µg/L
- PCE Contamination Ranging from 25 to 50 µg/L
- PCE Contamination Ranging from 50 to 100 µg/L
- PCE Contamination Above 100 µg/L

Notes:
PCE data collected in 2017.
Concentration contour dashed where inferred.

0 110 220 H: 1"=220'
0 100 200 V: 1"=200'

Notes:
Figure graphics and data obtained from Figure 19 of the 2018 Performance Evaluation Report (URS 2019)
WNOU = Whittier Narrows Operable Unit

Data Sources:
Esri 2006, 2017
URS. 2019. Performance Evaluation Report for 2018 San Gabriel Valley Area 1 Superfund Site, Whittier Narrows Operable Unit. Prepared for Department of Toxic Substance Control. September 2019.

Enhanced Remedial Alternatives Study
South El Monte Operable Unit
Los Angeles County, California
San Gabriel Valley Area 1 Superfund Site

Figure 1-6d
WNOU Hydrogeologic Cross-Section, H-H'

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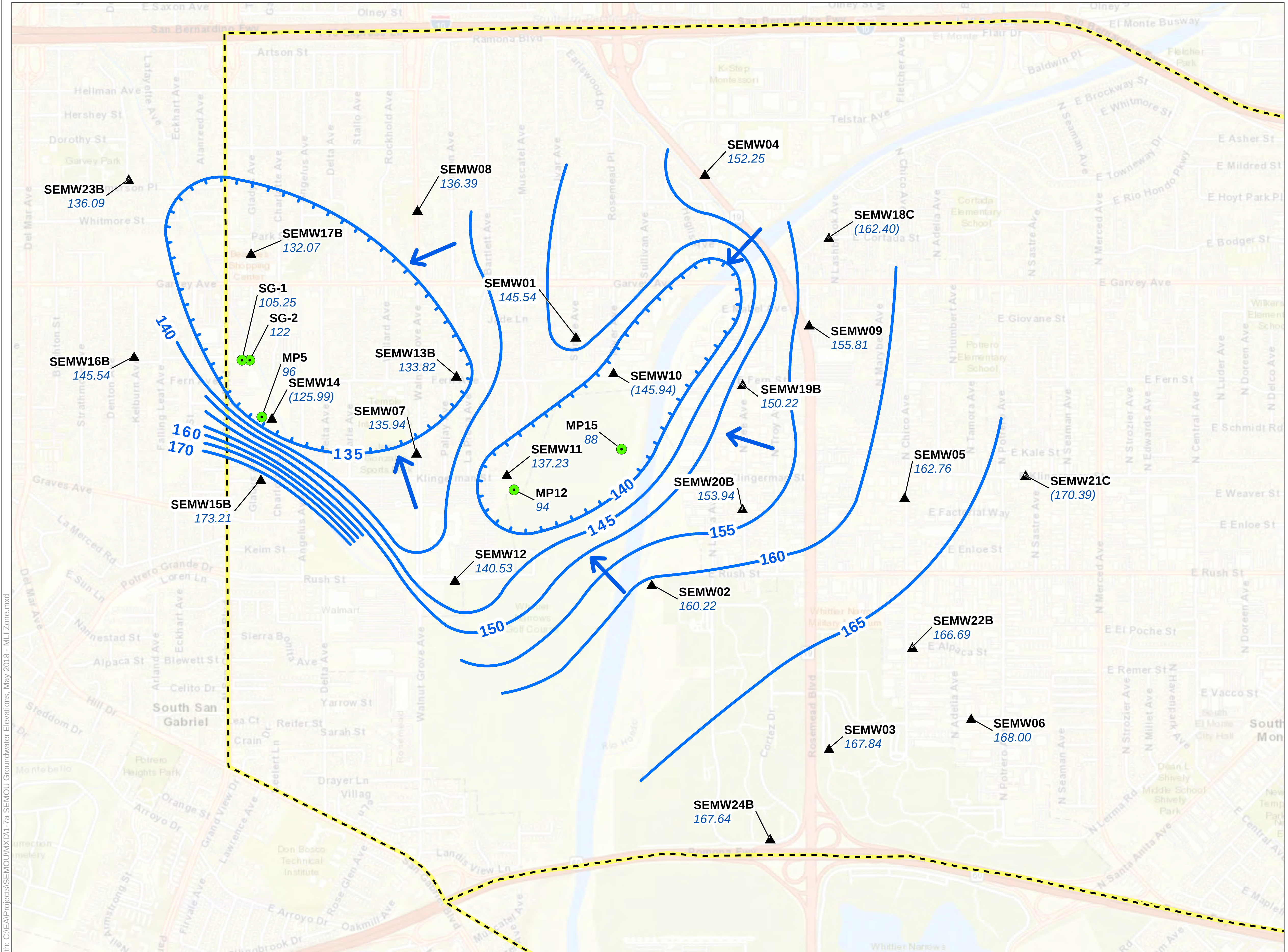

Legend

- Remedy Extraction Well
- Monitoring Well
- Groundwater Elevation Contour
- Groundwater Elevation Sink
- SGV Operable Unit Boundary
- Direction of Groundwater Flow

0 500 1,000 2,000

Feet

Notes:
Groundwater elevation is reported in feet above mean sea level.
The groundwater elevation data and contours shown were obtained from Figure 3-12 (Gilbane 2019b).
Values in parenthesis not used for contouring.
SEMOU = South El Monte Operable Unit
SGV = San Gabriel Valley

Data Sources:
Esri 2006, 2017
Gilbane 2019b. Remedial Action 2018 Compliance Monitoring Report. San Gabriel Valley Area 1 Superfund Site. South El Monte Operable Unit. March.

Enhanced Remedial Alternatives Study
South El Monte Operable Unit
Los Angeles County, California
San Gabriel Valley Area 1 Superfund Site

Figure 1-7a
SEMOU Groundwater Elevations
Middle-Lower Intermediate Aquifer
May 2018

Path: C:\EA\Projects\SEMOU\MXD\1-7a SEMOU Groundwater Elevations, May 2018 - MLI Zone.mxd

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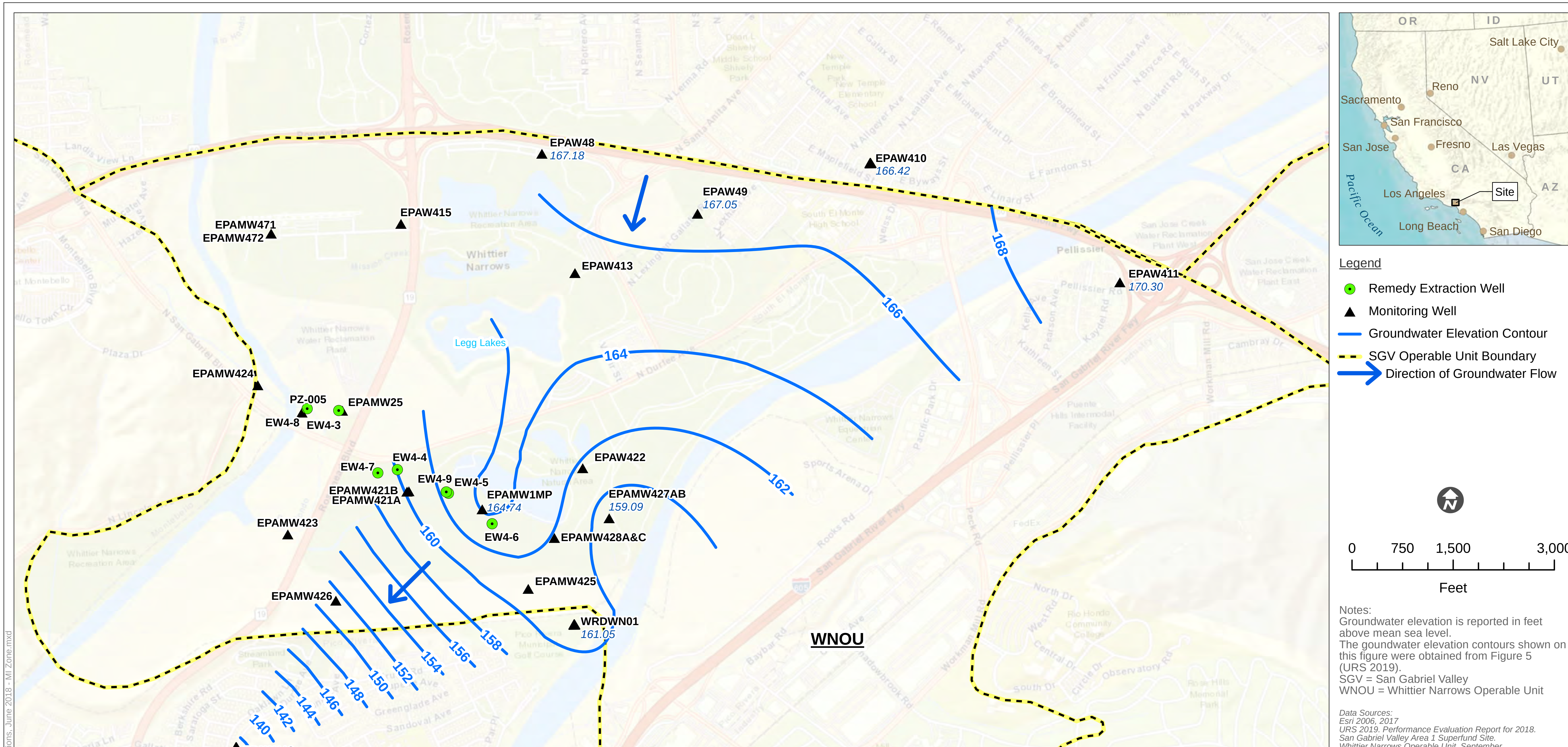

Notes:
Groundwater elevation is reported in feet above mean sea level.
The goundwater elevation contours shown on this figure were obtained from Figure 5 (URS 2019).
SGV = San Gabriel Valley
WNOU = Whittier Narrows Operable Unit

Data Sources:
Esri 2006, 2017
URS 2019. Performance Evaluation Report for 2018. San Gabriel Valley Area 1 Superfund Site. Whittier Narrows Operable Unit. September.

Enhanced Remedial Alternatives Study
South El Monte Operable Unit
Los Angeles County, California
San Gabriel Valley Area 1 Superfund Site

Figure 1-7b
WNOU Groundwater Elevations
Middle-Intermediate Aquifer
June 2018

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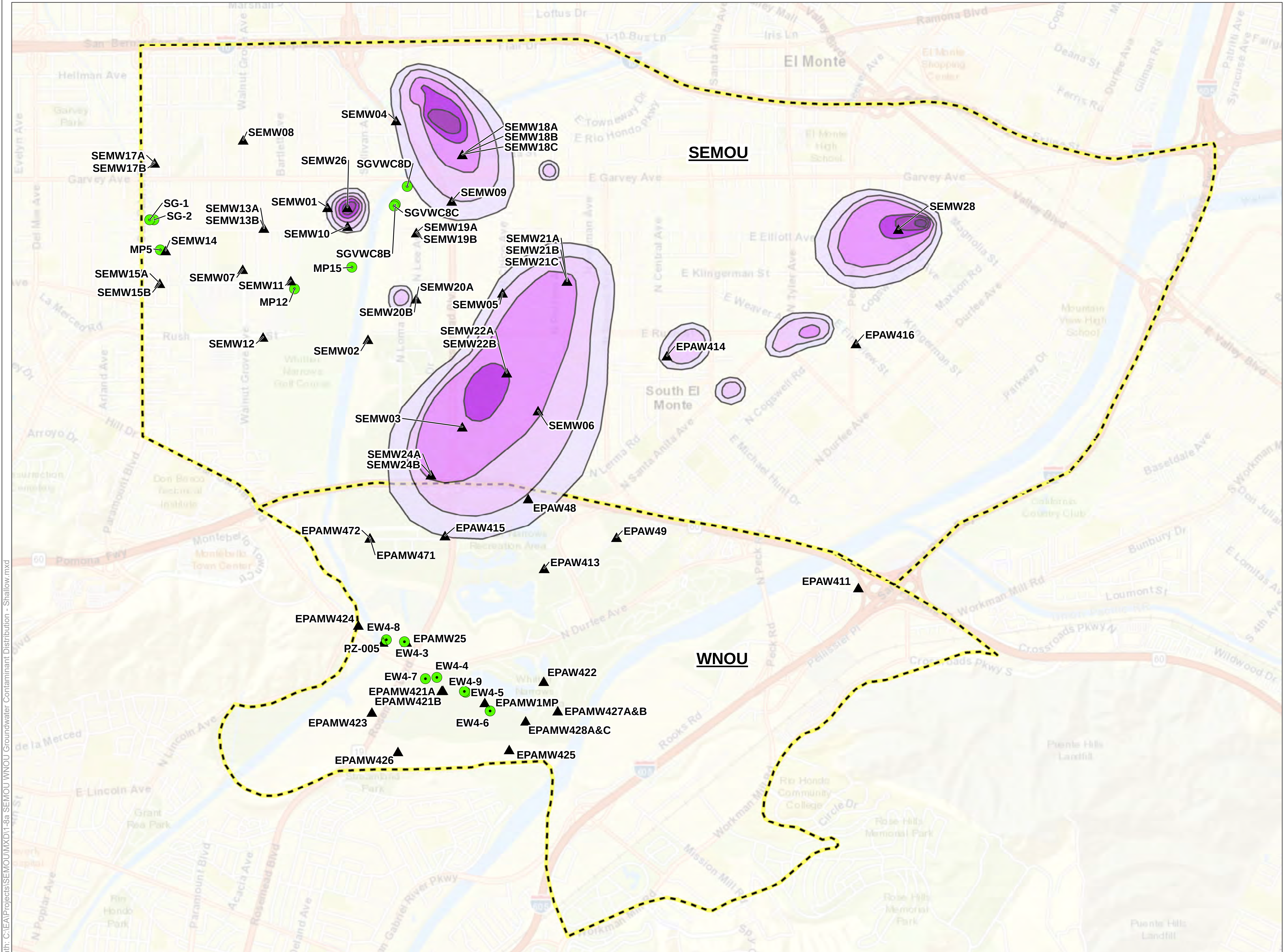


Legend

- Remedy Extraction Well
- Monitoring Well
- SGV Operable Unit Boundary
- PCE greater than 0.5 µg/L
- PCE greater than 5 µg/L (the Federal MCL)
- PCE greater than 10 µg/L
- PCE greater than 50 µg/L
- PCE greater than 100 µg/L
- PCE greater than 1,000 µg/L

0 1,250 2,500 5,000

Feet

Notes:
The areas of contamination shown were developed by CH2M Hill for use as the starting VOC concentrations for the site flow and transport simulations (CH2M Hill 2021b).

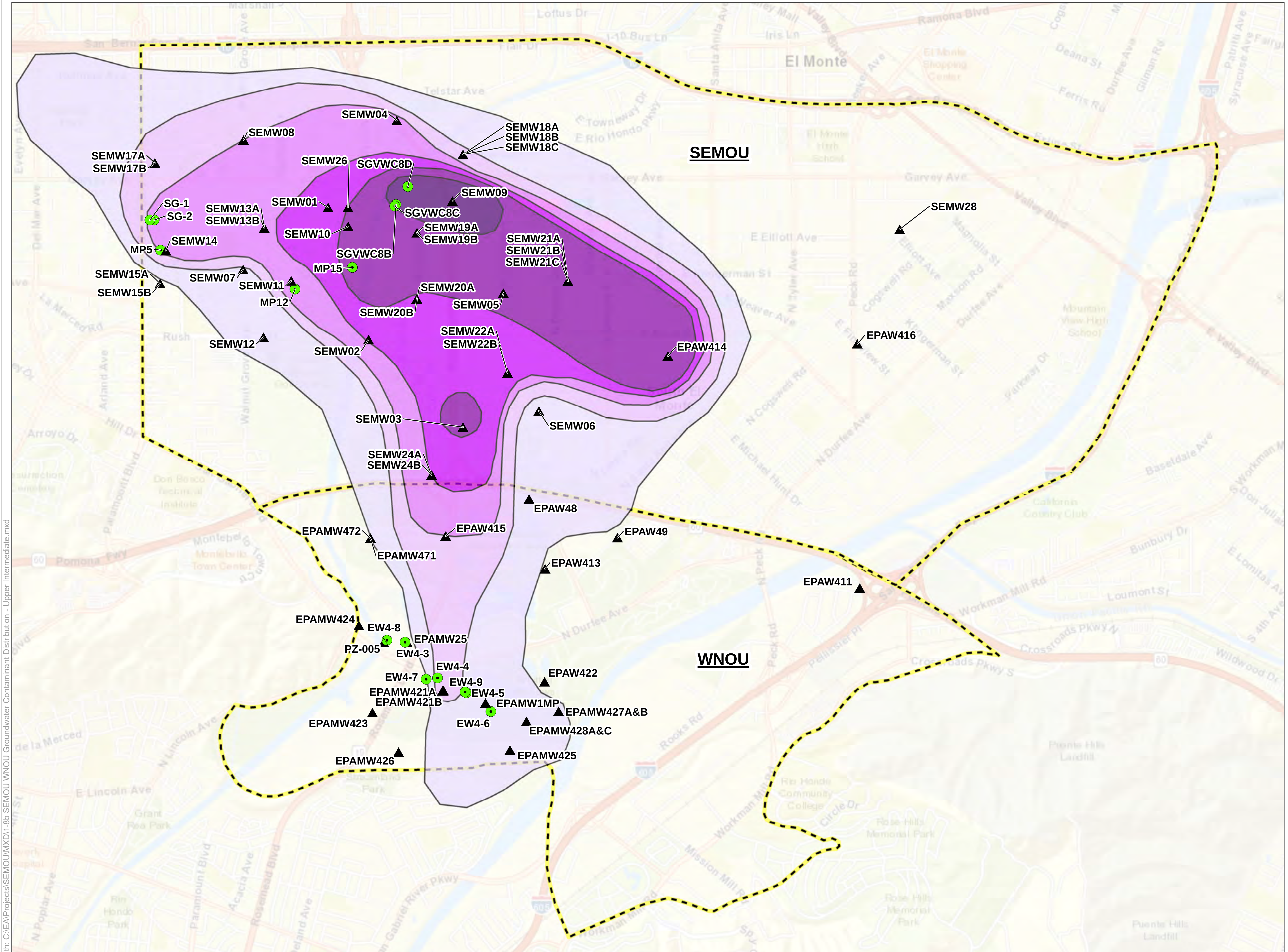
MCL = Maximum Contaminant Level
PCE = tetrachloroethylene
SEMOU = South El Monte Operable Unit
SGV = San Gabriel Valley
VOC = Volatile Organic Compound
WNOU = Whittier Narrows Operable Unit
µg/L = microgram(s) per liter

Data Sources:
-Esri 2006, 2017

Enhanced Remedial Alternatives Study
South El Monte Operable Unit
Los Angeles County, California
San Gabriel Valley Area 1 Superfund Site

Figure 1-8a
SEMOU and WNOU Extent of Groundwater Contamination - Shallow Zone Aquifer

Path: C:\EA\Projects\SEMOU\MXD\1-8a SEMOU WNOU Groundwater Contaminant Distribution - Shallow.mxd



Legend

- Remedy Extraction Well
- Monitoring Well
- SGV Operable Unit Boundary
- PCE greater than 0.5 µg/L
- PCE greater than 5 µg/L (the Federal MCL)
- PCE greater than 10 µg/L
- PCE greater than 25 µg/L
- PCE greater than 50 µg/L
- PCE greater than 100 µg/L

0 1,250 2,500 5,000

Feet

Notes:
The areas of contamination shown were developed by CH2M Hill for use as the starting VOC concentrations for the site flow and transport simulations (CH2M Hill 2021b).

MCL = Maximum Contaminant Level
PCE = tetrachloroethylene
SEMOU = South El Monte Operable Unit
SGV = San Gabriel Valley
VOC = Volatile Organic Compound
WNOU = Whittier Narrows Operable Unit
µg/L = microgram(s) per liter

Data Sources:
-Esri 2006, 2017

Enhanced Remedial Alternatives Study
South El Monte Operable Unit
Los Angeles County, California
San Gabriel Valley Area 1 Superfund Site

Figure 1-8b
SEMOU and WNOU Extent of Groundwater Contamination - Upper Intermediate Zone Aquifer

Path: C:\EA\Projects\SEMOU\MXD\1-8b SEMOU WNOU Groundwater Contaminant Distribution - Upper Intermediate.mxd

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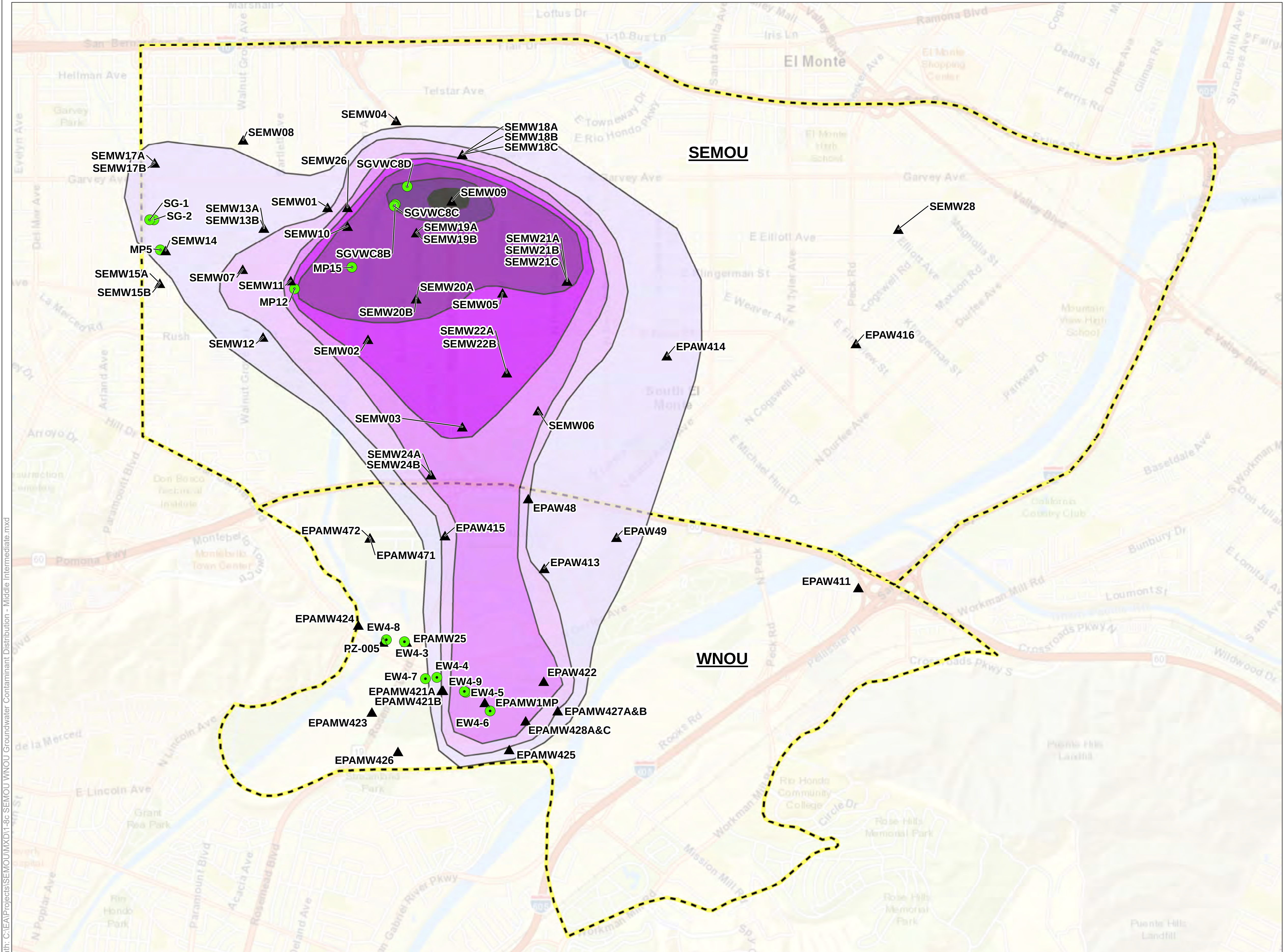

Legend

- Remedy Extraction Well
- Monitoring Well
- SGV Operable Unit Boundary
- PCE greater than 0.5 µg/L
- PCE greater than 5 µg/L (the Federal MCL)
- PCE greater than 10 µg/L
- PCE greater than 25 µg/L
- PCE greater than 50 µg/L
- PCE greater than 100 µg/L
- PCE greater than 200 µg/L

0 1,250 2,500 5,000
Feet

Notes:
The areas of contamination shown were developed by CH2M Hill for use as the starting VOC concentrations for the site flow and transport simulations (CH2M Hill 2021b).

MCL = Maximum Contaminant Level
PCE = tetrachloroethylene
SEMOU = South El Monte Operable Unit
SGV = San Gabriel Valley
VOC = Volatile Organic Compound
WNOU = Whittier Narrows Operable Unit
µg/L = microgram(s) per liter

Data Sources:
-Esri 2006, 2017

Enhanced Remedial Alternatives Study
South El Monte Operable Unit
Los Angeles County, California
San Gabriel Valley Area 1 Superfund Site

Figure 1-8c
SEMOU and WNOU Extent of Groundwater Contamination - Middle Intermediate Zone Aquifer

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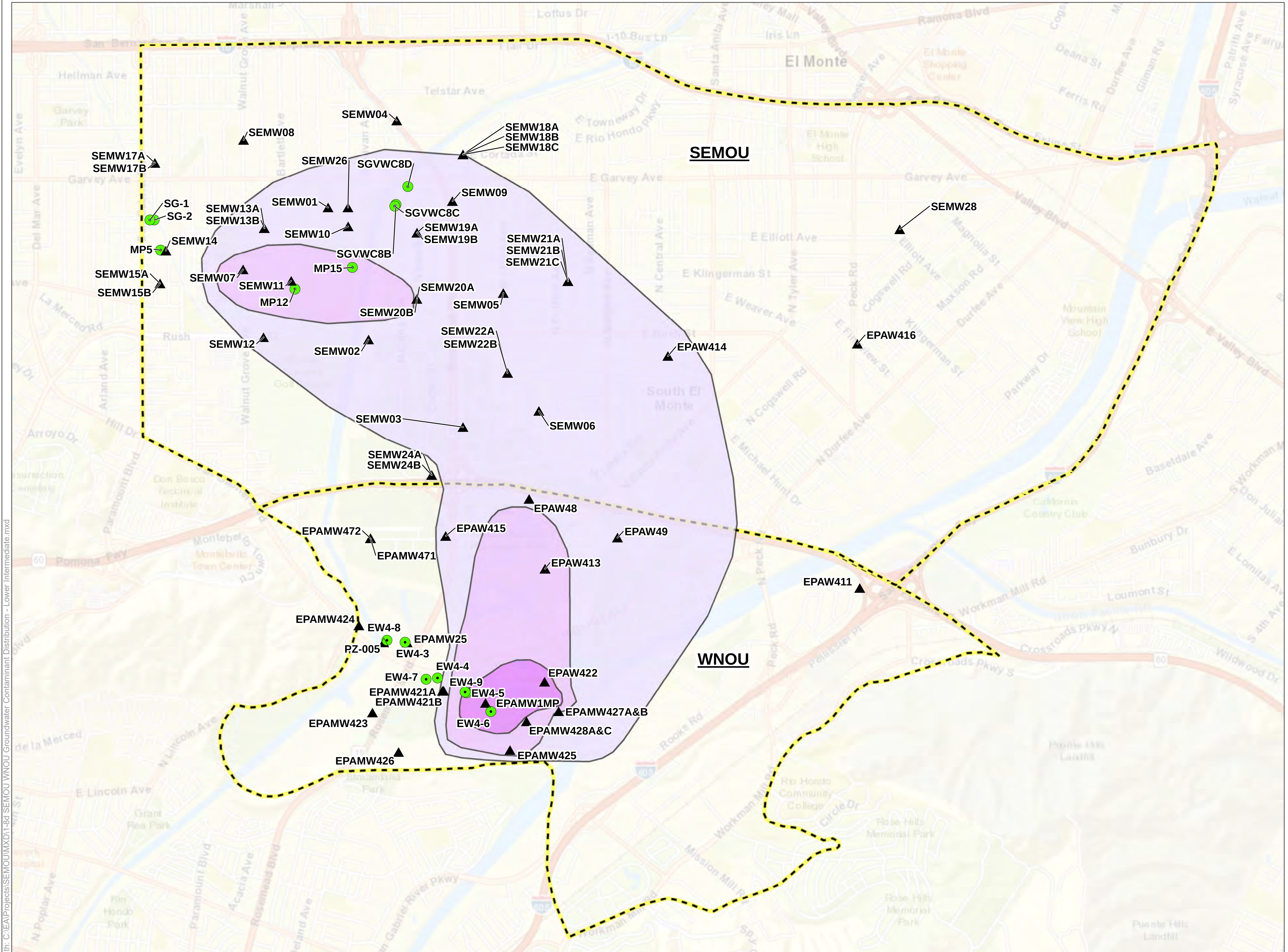

OR ID NV UT CA AZ Salt Lake City Reno Sacramento San Francisco San Jose Fresno Las Vegas Los Angeles Site Long Beach San Diego Pacific Ocean

Legend

- Remedy Extraction Well
- Monitoring Well
- SGV Operable Unit Boundary
- PCE greater than 0.5 µg/L
- PCE greater than 5 µg/L (the Federal MCL)
- PCE greater than 10 µg/L

0 1,250 2,500 5,000
Feet

Notes:
The areas of contamination shown were developed by CH2M Hill for use as the starting VOC concentrations for the site flow and transport simulations (CH2M Hill 2021b).

MCL = Maximum Contaminant Level
PCE = tetrachloroethylene
SEMOU = South El Monte Operable Unit
SGV = San Gabriel Valley
VOC = Volatile Organic Compound
WNOU = Whittier Narrows Operable Unit
µg/L = microgram(s) per liter

Data Sources:
-Esri 2006, 2017

Enhanced Remedial Alternatives Study
South El Monte Operable Unit
Los Angeles County, California
San Gabriel Valley Area 1 Superfund Site

Figure 1-8d
SEMOU and WNOU Extent of Groundwater Contamination - Lower Intermediate Zone Aquifer

Path: C:\EA\Projects\SEMOU\MXD\1-8d SEMOU WNOU Groundwater Contaminant Distribution - Lower Intermediate.mxd

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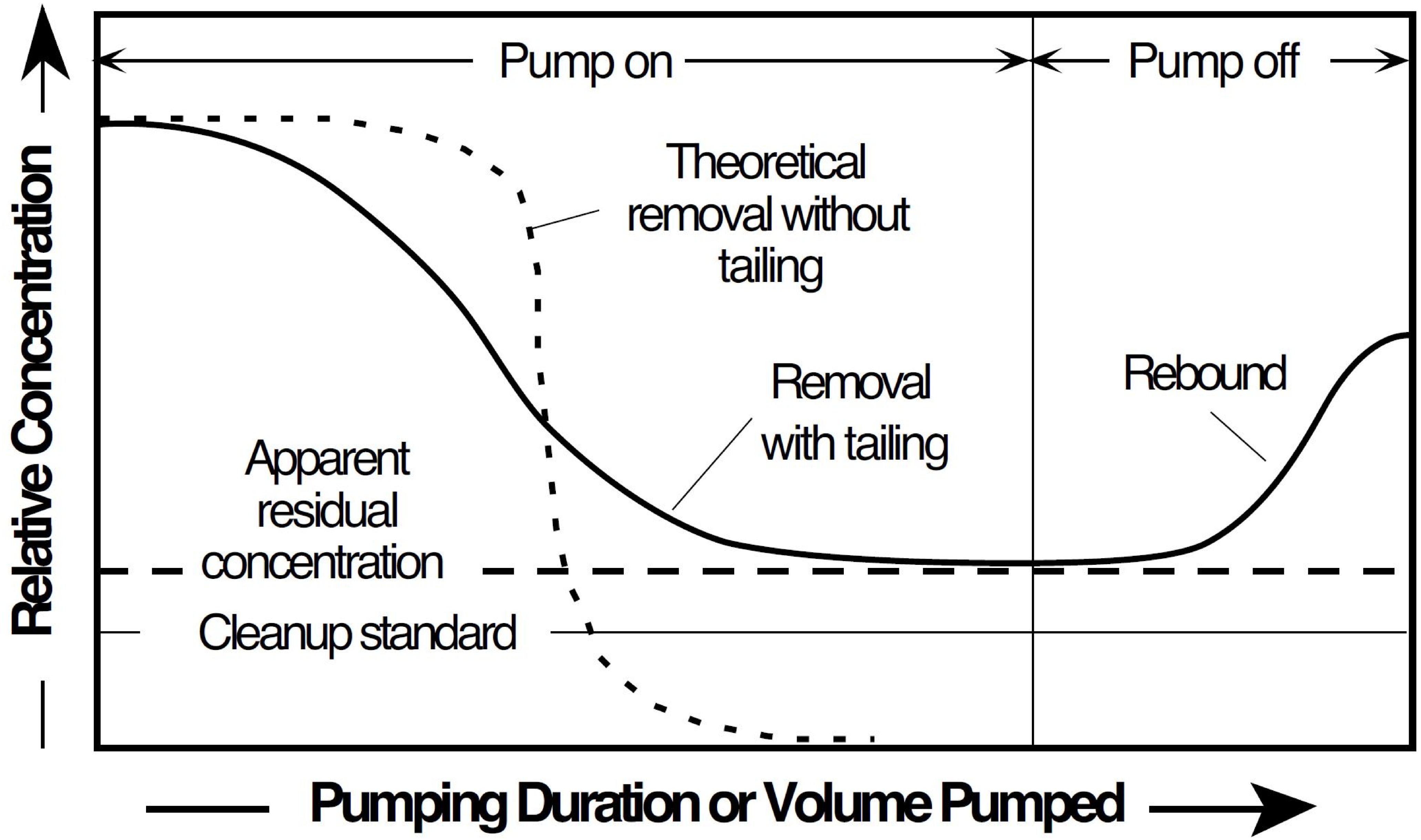

Data Sources:
Esri 2006, 2017
EPA. 1997. Ground Water Issue - Design Guidelines for Conventional Pump-and-Treat Systems. September.

Enhanced Remedial Alternatives Study
South El Monte Operable Unit
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Figure 4-1
Relative Contaminant Concentration Versus Duration of Groundwater Extraction

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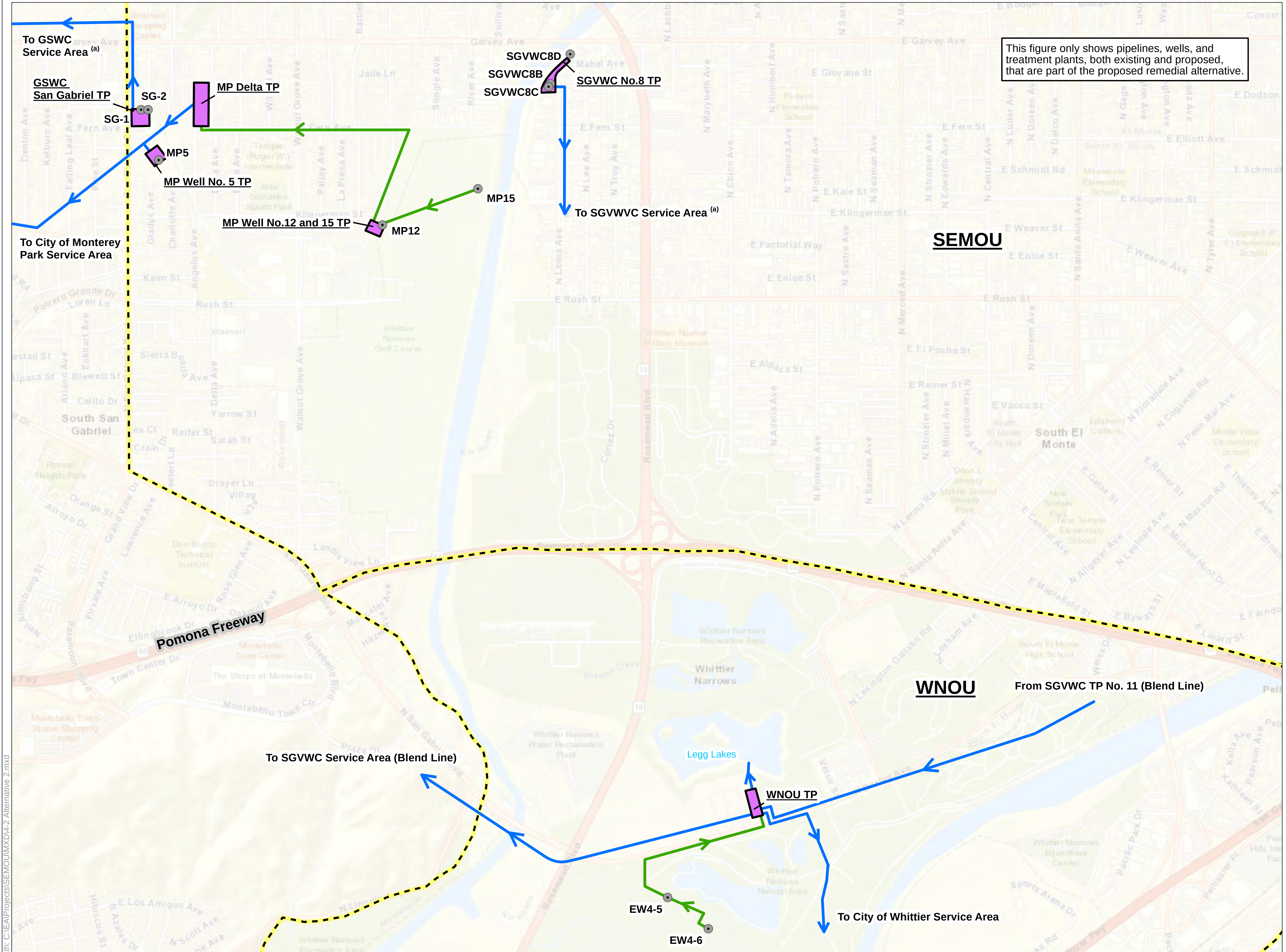

Legend
- Existing Extraction Well
- Existing Intermediate Raw Water Line
- Existing Treated Water Line
- San Gabriel Valley OU Boundary
- Groundwater Treatment Facility

0 750 1,500 3,000
Feet

Notes:
(a) - The layout of this pipeline was assumed for the purposes of the Enhanced Remedial Alternative Study.
Arrows indicate direction of pipe flow.
GSWC = Golden State Water Company
MP = City of Monterey Park
SEMOU = South El Monte Operable Unit
SG = San Gabriel
SGVWC = San Gabriel Valley Water Company
TP = Treatment Plant
WNOU = Whittier Narrows Operable Unit

Data Sources: Esri 2006, 2017

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South El Monte Operable Unit
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Figure 4-2 - Alternative 2
No Further Action SEMOU/WNOU Interim Remedies

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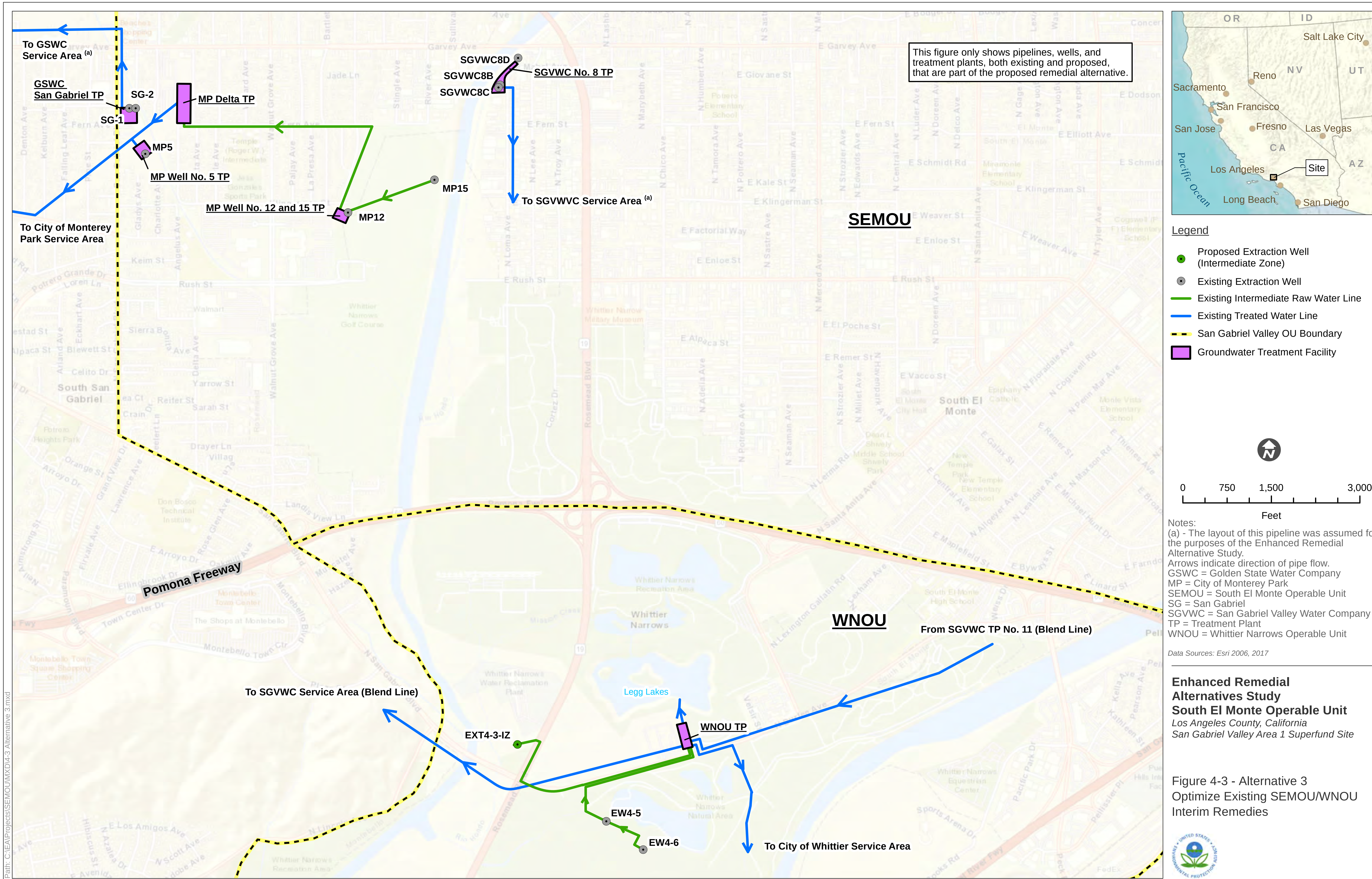

Enhanced Remedial Alternatives Study
South El Monte Operable Unit
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Figure 4-3 - Alternative 3
Optimize Existing SEMOU/WNOU Interim Remedies

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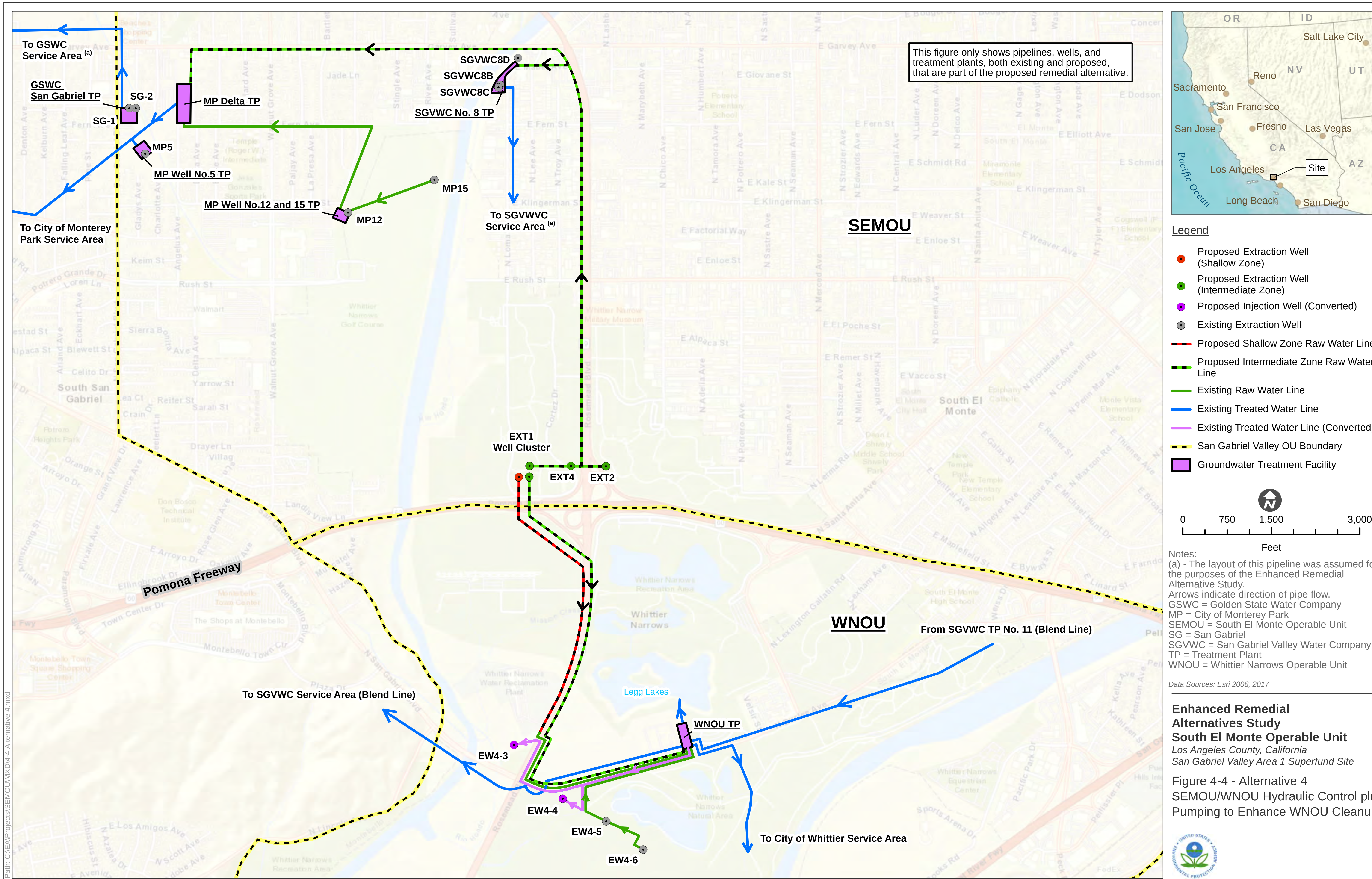
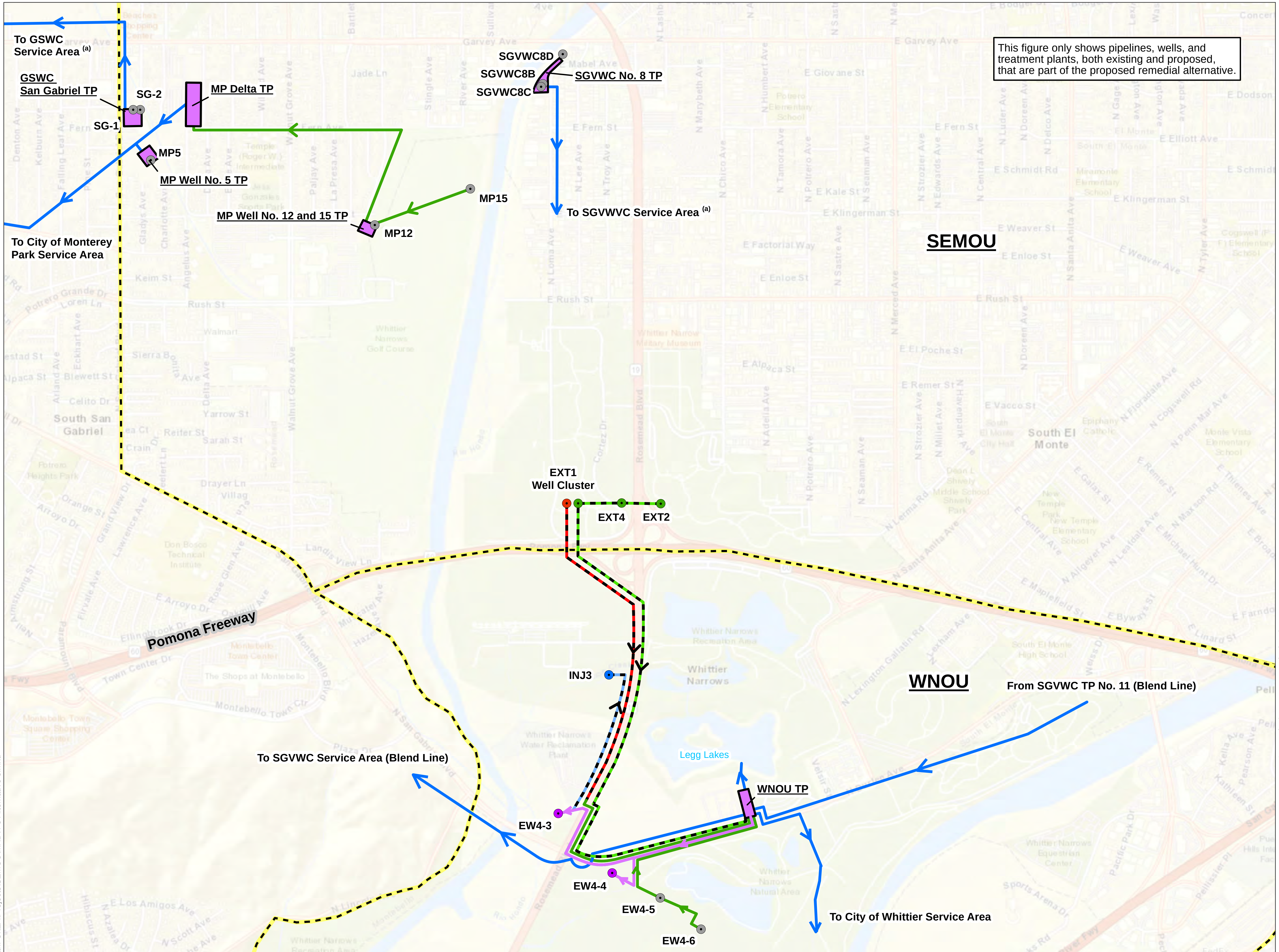


Figure 4-4 - Alternative 4
SEMOU/WNOU Hydraulic Control plus Pumping to Enhance WNOU Cleanup



Legend

- Proposed Extraction Well (Shallow Zone)
- Proposed Extraction Well (Intermediate Zone)
- Proposed Injection Well
- Proposed Injection Well (Converted)
- Existing Extraction Well
- Proposed Treated Water Line
- Proposed Shallow Zone Raw Water Line
- Proposed Intermediate Zone Raw Water Line
- Existing Raw Water Line
- Existing Treated Water Line
- Existing Treated Water Line (Converted)
- San Gabriel Valley OU Boundary
- Groundwater Treatment Facility

0 750 1,500 3,000
Feet

Notes:
(a) - The layout of this pipeline was assumed for the purposes of the Enhanced Remedial Alternative Study.
Arrows indicate direction of pipe flow.
GSWC = Golden State Water Company
MP = City of Monterey Park
SEMOU = South El Monte Operable Unit
SG = San Gabriel
SGVWC = San Gabriel Valley Water Company
TP = Treatment Plant
WNOU = Whittier Narrows Operable Unit

Data Sources: Esri 2006, 2017

Enhanced Remedial Alternatives Study
South El Monte Operable Unit
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Figure 4-5 - Alternative 5
SEMOU/WNOU Hydraulic Control plus Pumping and Reinjection to Enhance WNOU Cleanup

Path: C:\EA\Projects\SEMOU\MXD\4-5 Alternative 5.mxd

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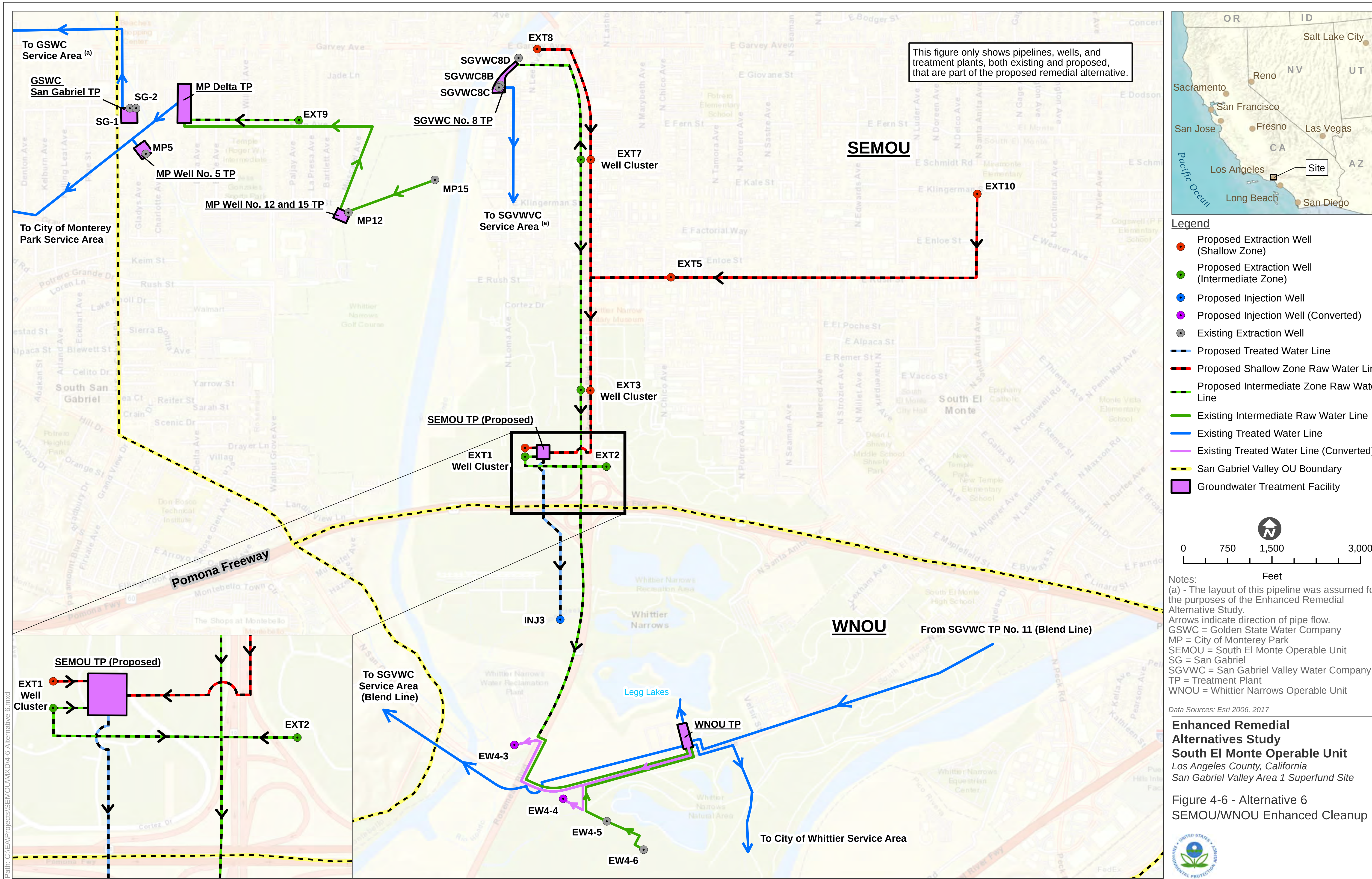
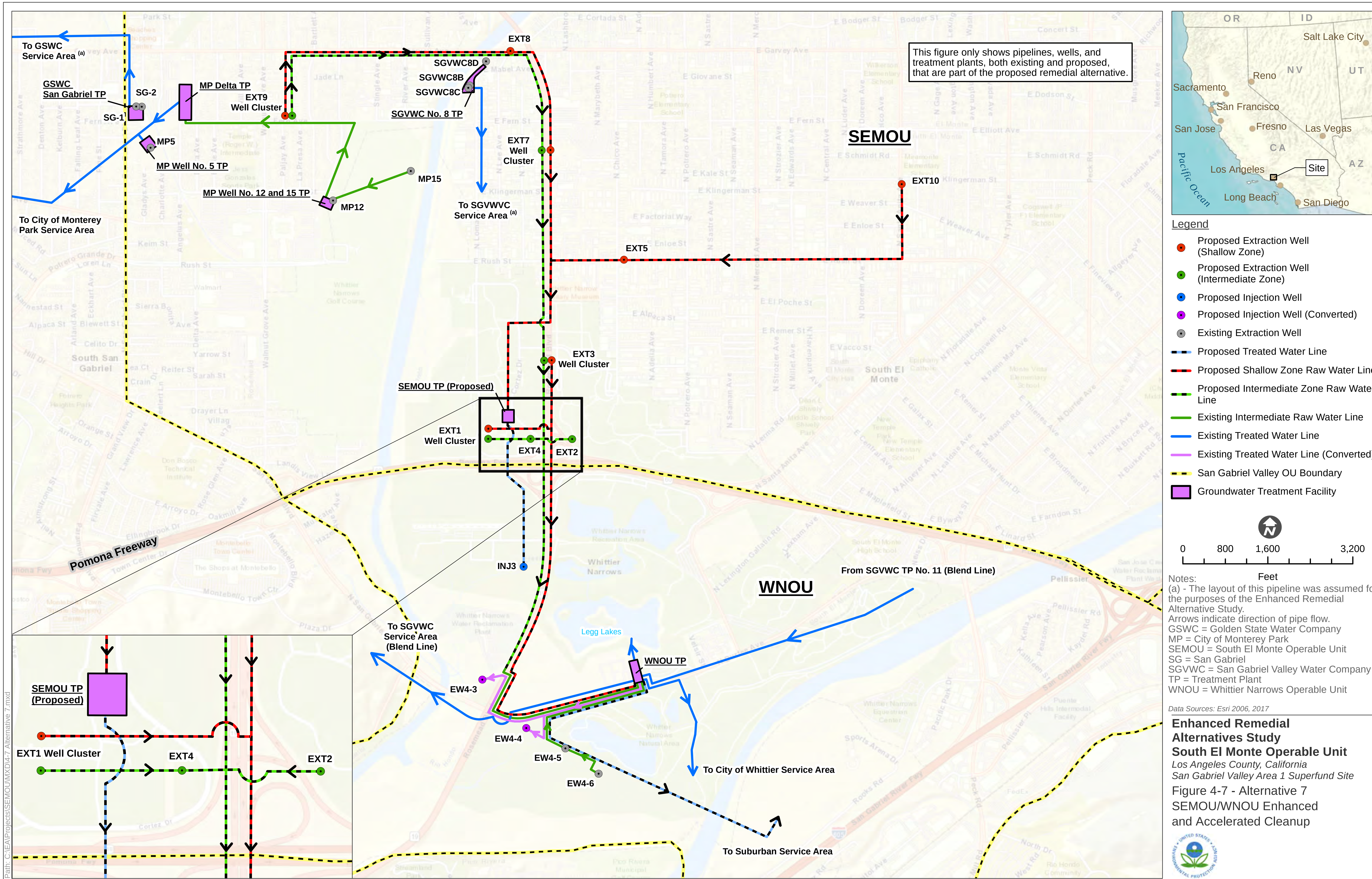


Figure 4-6 - Alternative 6
SEMOU/WNOU Enhanced Cleanup



Enhanced Remedial Alternatives Study
South El Monte Operable Unit
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Figure 4-7 - Alternative 7
SEMOU/WNOU Enhanced and Accelerated Cleanup

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Tables

TABLE 1-1
CONTAMINANTS OF CONCERN AND EMERGING CONTAMINANTS IN GROUNDWATER

Chemical Name [(a)]	Chemical Abstracts Service Number	Maximum Contaminant Levels (µg/L)		California Drinking Water Notification Level [(d)(e)] (µg/L)
		Federal [(b)]	California [(c)]	
Contaminants of Concern				
Tetrachloroethene	127-18-4	5	5	--
Trichloroethene	79-01-6	5	5	--
1,2,3-Trichloropropane	95-18-4	--	0.005	--
cis-1,2 Dichloroethene	156-59-2	70	6	--
1,1-dichloroethene	75-35-4	7	6	--
1,1-dichloroethane	75-34-3	--	5	--
Emerging Contaminants				
Perchlorate	14797-73-0	--	6	--
1,4-Dioxane	123-91-1	--	--	1
n-Nitrosodimethylamine	62-75-9	--	--	0.01

Notes:
(a) Gilbane Federal. 2019. *Supplemental Remedial Investigation Report, South El Monte Operable Unit San Gabriel Valley Area 1 Superfund Site, San Gabriel Basin, Los Angeles County, California* . EPA Contract No. EP-S9-08-03, Task Order 0047. November.
(b) 40 Code of Federal Regulations § 141.61 and 141.62. Accessed on February 24, 2021.
(c) Title 22 California Code of Regulations § 64431 and 64444. Accessed on February 24, 2021.
(d) California Water Boards, State Water Resources Control Board. 2020. *Drinking Water Notification Levels and Response Levels: An Overview* . Division of Drinking Water. February 6, 2020.
(e) For chemicals that lack maximum contaminant levels, the state of California has specified notification levels that are health-based advisory levels for drinking water use.

Acronyms:
-- = Not applicable.
µg/L = Micrograms per liter.
EPA = U.S. Environmental Protection Agency.

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TABLE 1-2
EXISTING REMEDY EXTRACTION WELLS

Well ID	Aquifer Designation	Screened Interval (feet bgs)	Minimum Target Flow Rate (gpm)	Average Flow Rate [a] (gpm)
South El Monte Operable Unit [b]				
MP5	IZ	170-570	130	325
MP12	IZ, DZ	201-771	1,800	1,799
MP15	IZ	205-210 245-325 350-360 390-425	1,750	1,561
SGVWC8B	IZ	260-300	0	5
SGVWC8C	IZ	234-410 458-518	650	804
SGVWC8D	IZ	250-560	650	1,013
SG-1	IZ	190-218 307-319 357-411	870	694
SG-2	IZ	209-216 252-259 269-272 354-393		237
Whittier Narrows Operable Unit [c]				
EW4-3	SZ	50 – 110	0	0
EW4-4	SZ	60 – 120	0	0
EW4-8	SZ	54 – 104	0	0
EW4-9	SZ	50 – 120	0	0
EW4-5	UIZ	160 – 390	1,500	22
EW4-6	UIZ	160 – 390	2,000	2,043
EW4-7	UIZ	160 – 350	0	2

Notes:

(a) This column presents the average flow rate from July 2017 to June 2018 for the South El Monte wells and the average flow rate in 2018 for the Whittier Narrows wells.

(b) EA obtained the information for the South El Monte Operable Unit from the following sources:
San Gabriel Basin Water Quality Authority. 2018. *Annual Performance Report (July 1, 2017 thru June 30, 2018)*. Superfund Support Agency Cooperative Agreement (V-99T29201). South El Monte Operable Unit. July.

EPA San Gabriel Valley Basin Wide Database – San Gabriel Valley Superfund Site. Maintained by EA.

(c) EA obtained the information for the Whittier Narrows Operable Unit from the following source:
URS. 2019. *Performance Evaluation Report for 2018*. San Gabriel Valley Area 1. Superfund Site. Whittier Narrows Operable Unit. September.

TABLE 1-2
EXISTING REMEDY EXTRACTION WELLS

Well ID	Aquifer Designation	Screened Interval (feet bgs)	Minimum Target Flow Rate (gpm)	Average Flow Rate [(a)] (gpm)

Aquifer Designations
SZ = Shallow zone.
IZ = Intermediate zone.
DZ = Deep zone.

Acronyms:
bgs = Below ground surface.
EA = EA Engineering, Science, and Technology, Inc.
EPA = U.S. Environmental Protection Agency.
gpm = Gallons per minute.
ID = Identification.

TABLE 3-1
TECHNOLOGY SCREENING: GROUNDWATER

General Response Action	Technology	Process Option	Effectiveness [a]	Implementability [a]	Cost [a]	Status
No Action	NA	NA	Not effective	Implementable	Low	**Retained**
Monitoring	NA	Groundwater Monitoring	NA	Implementable	Low	**Retained**
Institutional Controls	NA	NA	Effective	Implementable	Low	**Retained**
Containment	Groundwater Extraction	Hydraulic Control	Effective	Implementable	Moderate	**Retained**
Removal	Groundwater Extraction	Aquifer Restoration	Limited Effectiveness	Implementable	High	**Retained**
Treatment (Ex Situ)	Physical	Air Stripping	Effective (VOCs) Not effective (1,4-D)	Implementable	Low	**Retained**
		Adsorption	Effective (VOCs) Not effective (1,4-D)	Implementable	Low	**Retained**
	Chemical	Advanced Oxidation Processes	Effective	Limited Implementability	Moderate	**Retained**
Treatment (In Situ)	Physical	Air Sparging	Effective (VOCs) Not effective (1,4-D)	Limited Implementability	High	Not Retained
		In-Well Air Stripping	Effective (VOCs) Not effective (1,4-D)	Limited Implementability	High	Not Retained
	Chemical	Chemical Oxidation	Effective	Limited Implementability	High	Not Retained
		Chemical Reduction	Effective (Chlorinated Solvents), Not effective (1,4-D)	Limited Implementability	High	Not Retained

TABLE 3-1
TECHNOLOGY SCREENING: GROUNDWATER

General Response Action	Technology	Process Option	Effectiveness [(a)]	Implementability [(a)]	Cost [(a)]	Status
Treatment (In Situ)	Biological	Bioremediation	Effective (VOCs) Not effective (1,4-D)	Limited Implementability	High	Not Retained
	Physical/ Chemical/ Biological	Monitored Natural Attenuation	Limited Effectiveness	Limited Implementability	Low	Not Retained
Disposal	Potable Water	Provide to Water Purveyors	Effective	Implementable	Moderate	**Retained**
	Non-Potable Water	Surface Discharge	Effective	Implementable	Low to Moderate	**Retained**
		Injection	Effective	Implementable	Moderate	**Retained**

Notes:
(a) EA assigned the criteria one of the following ratings:

Effectiveness	Implementability	Cost
- Effective	- Implementable	- High
- Limited Effectiveness	- Limited Implementability	- Moderate
- Not Effective	- Not Implementable	- Low

Acronyms:
1,4-D = 1,4-Dioxane.
NA = Not applicable.
VOC = Volatile organic compound.

TABLE 3-2
SUMMARY OF FLOW RATES AND PUMP SIZING FOR PROPOSED AND EXISTING EXTRACTION WELLS WITH INCREASES IN FLOW RATES

Extraction Well Identification	Target Aquifer Zone	Flow Rate (gpm)	Estimated TDH (ft of water)	Assumed Pump Specifications for Cost Estimate [(a)]
Alternative 4 - SEMOU/WNOU Hydraulic Control plus Pumping to Enhance WNOU Cleanup				
EXT1	Shallow Zone	500	210	B
EXT1	Upper Intermediate Zone	650	240	B
EXT2	Upper Intermediate Zone	500	240	B
EXT4	Upper Intermediate Zone	600	230	B
EXT1	Middle Intermediate Zone	250	280	A
Alternative 5 - SEMOU/WNOU Hydraulic Control plus Pumping and Reinjection to Enhance WNOU Cleanup				
EXT1	Shallow Zone	500	210	B
EXT1	Upper Intermediate Zone	600	190	B
EXT2	Upper Intermediate Zone	500	190	B
EXT4	Upper Intermediate Zone	600	180	B
EXT1	Middle Intermediate Zone	300	200	A
Alternative 6 - SEMOU/WNOU Enhanced Cleanup				
EXT1	Shallow Zone	200	140	A
EXT3	Shallow Zone	400	140	A
EXT5	Shallow Zone	350	170	A
EXT7	Shallow Zone	200	180	A
EXT8	Shallow Zone	250	210	A
EXT10	Shallow Zone	200	270	A
EXT1	Upper Intermediate Zone	1,100	190	C
EXT2	Upper Intermediate Zone	200	190	A
EXT3	Upper Intermediate Zone	300	200	A
EXT7	Upper Intermediate Zone	700	310	B
EXT9	Upper Intermediate Zone	600	150	B
MP15 [(b)]	Intermediate Zone	630	140	B
SGVWC8C [(b)]	Intermediate Zone	1,150	130	C

TABLE 3-2
SUMMARY OF FLOW RATES AND PUMP SIZING FOR PROPOSED AND EXISTING EXTRACTION WELLS WITH INCREASES IN FLOW RATES

Extraction Well Identification	Target Aquifer Zone	Flow Rate (gpm)	Estimated TDH (ft of water)	Assumed Pump Specifications for Cost Estimate [a]
Alternative 7 - SEMOU/WNOU Enhanced and Accelerated Cleanup				
EXT1	Shallow Zone	350	220	A
EXT3	Shallow Zone	400	230	A
EXT1	Upper Intermediate Zone	1,000	180	C
EXT2	Upper Intermediate Zone	400	180	A
EXT3	Upper Intermediate Zone	500	180	B
EXT4	Upper Intermediate Zone	400	170	A
EXT7	Upper Intermediate Zone/ Middle Intermediate Zone	1,200	210	C
EXT9	Upper Intermediate Zone/ Middle Intermediate Zone	1,100	270	C
EXT5	Shallow Zone	400	160	A
EXT7	Shallow Zone	550	170	B
EXT8	Shallow Zone	200	190	A
EXT9	Shallow Zone	300	270	A
EXT10	Shallow Zone	300	260	A
MP12 [b]	Intermediate Zone	2,300	130	D
MP15 [b]	Intermediate Zone	830	150	C
SGVWC8B [b]	Intermediate Zone	600	130	B
SGVWC8C [b]	Intermediate Zone	1,250	130	C

Notes:
(a) Pump Specifications:
- A - 400 gpm at 225 TDH.
- B - 800 gpm at 240 TDH.
- C - 1,100 gpm at 300 TDH.
- D - 2,500 gpm at 150 TDH.

(b) These are existing extraction wells that will need a new pump to increase their flow rate.

Acronyms:
ft = Feet.
gpm = Gallons per minute.
SEMOU = South El Monte Operable Unit.
TDH = Total dynamic head.
WNOU = Whittier Narrows Operable Unit.

TABLE 3-3
ESTIMATED LENGTHS OF PROPOSED CONVEYANCE PIPING AND PIPE DIAMETERS

Pipe Network Identification	Estimated Length of Conveyance Pipe (LF)		
	D ≤ 6 inches [(a)]	12 ≥ D > 6 inches [(a)]	20 ≥ D > 12 inches [(a)]
Alternative 4 - SEMOU/WNOU Hydraulic Control plus Pumping to Enhance WNOU Cleanup			
Shallow Zone EWs to WNOU Treatment Plant	0	4,800	0
Intermediate Zone EWs to WNOU Treatment Plant	8,800	0	0
Intermediate Zone EWs to MP Delta and SGVWC Plant 8	0	16,400	0
Totals =	**8,800**	**21,200**	**0**
Alternative 5 - SEMOU/WNOU Hydraulic Control plus Pumping and Reinjection to Enhance WNOU Cleanup			
Shallow Zone EWs to WNOU Treatment Plant	0	4,800	0
Intermediate Zone EWs to WNOU Treatment Plant	0	1,600	7,800
WNOU Treatment Plant to IWs	0	2,400	0
Totals =	**0**	**8,800**	**7,800**
Alternative 6 - SEMOU/WNOU Enhanced Cleanup			
Shallow Zone EWs to SEMOU Treatment Plant (proposed)	9,400	7,300	0
Intermediate Zone EWs to WNOU Treatment Plant	6,000	5,000	0
Intermediate Zone EWs to SEMOU Plant (proposed)	800	0	0
Intermediate Zone EWs to SGVWC Plant 8	2,400	100	0
Intermediate Zone EWs to MP Delta Treatment Plant	0	1,600	1,600
SEMOU Treatment Plant (proposed) to IWs	0	3,800	0
Totals =	**18,600**	**17,800**	**1,600**
Alternative 7 - SEMOU/WNOU Enhanced and Accelerated Cleanup			
Shallow Zone EWs to SEMOU Treatment Plant (proposed)	11,600	9,500	0
Shallow Zone EWs to WNOU Treatment Plant	2,600	8,800	0
Intermediate Zone EWs to WNOU Treatment Plant	600	8,500	10,200
Intermediate Zone EWs to SGVWC Plant 8	0	200	0
Intermediate Zone EWs to MP Delta Treatment Plant	0	1,600	100
Interconnect between WNOU Treatment Plant and Suburban	0	0	6,800
SEMOU Treatment Plant (proposed) to IWs	0	3,800	0
Totals =	**14,800**	**32,400**	**17,100**

TABLE 3-3
ESTIMATED LENGTHS OF PROPOSED CONVEYANCE PIPING AND PIPE DIAMETERS

Pipe Network Identification	Estimated Length of Conveyance Pipe (LF)		
	$D \leq 6$ inches [a]	$12 \geq D > 6$ inches [a]	$20 \geq D > 12$ inches [a]

Notes:
(a) EPA estimated the pipe diameters based on the proposed flow rates (Table 3-2) and assuming a flow velocity of 5 feet per second.

Acronyms:
D = Pipe diameter.
EW = Groundwater extraction well.
GSWC = Golden State Water Company.
IW = Injection well.
LF = Linear feet.
MP = City of Monterey Park.
SEMOU = South El Monte Operable Unit.
SGVWC = San Gabriel Valley Water Company.
WNOU = Whittier Narrows Operable Unit.

TABLE 3-4a
SOUTH EL MONTE OPERABLE UNIT
GROUNDWATER MONITORING WELL NETWORK

Well ID	Aquifer Designation	Screened Interval (feet bgs)	Monitoring Frequency
SEMW01_04	SZ	45-53	--
SEMW01_03	UIZ	166-176	Annual
SEMW01_02	UIZ	238-248	Semi-annual
SEMW01_01	MIZ	330-340	Annual
SEMW02_04	SZ	38-48	--
SEMW02_03	SZ	112-122	Annual
SEMW02_02	UIZ	248-258	Semi-annual
SEMW02_01	MIZ	344-354	Semi-annual
SEMW03_04	SZ	62-72	--
SEMW03_03	UIZ	180-190	Semi-annual
SEMW03_02	MIZ	265-275	Annual
SEMW03_01	MIZ	371-380	Annual
SEMW04_04	SZ	64-74	--
SEMW04_03	UIZ	189-198	Annual
SEMW04_02	UIZ	281-290	Semi-annual
SEMW04_01	MIZ	389-398	Annual
SEMW05_05	SZ	65-74	--
SEMW05_04	SZ	98-107	--
SEMW05_03	UIZ	209-218	Semi-annual
SEMW05_02	MIZ	299-309	Annual
SEMW05_01	MIZ	381-391	Annual
SEMW06_04	SZ	58-67	--
SEMW06_03	SZ	120-129	--
SEMW06_02	UIZ	270-280	Annual
SEMW06_01	MIZ	357-366	Annual
SEMW07_04	SZ	80-90	--
SEMW07_03	UIZ	215-225	Semi-annual
SEMW07_02	MIZ	285-295	Annual
SEMW07_01	LIZ	415-425	Semi-annual
SEMW08_05	SZ	100-110	--
SEMW08_04	UIZ	230-240	Semi-annual
SEMW08_03	UIZ	305-315	Semi-annual
SEMW08_02	MIZ	375-385	Annual
SEMW08_01	LIZ	445-455	Annual
SEMW09	UIZ/MIZ	260-310	Semi-annual
SEMW10	UIZ	250-260	Annual
SEMW11	MIZ	280-290	Annual
SEMW12	MIZ	370-380	Semi-annual
SEMW13A	UIZ	240-250	Semi-annual
SEMW13B	MIZ	390-400	Semi-annual
SEMW14	UIZ	260-270	Semi-annual
SEMW15A	UIZ	224-234	Semi-annual

TABLE 3-4a
SOUTH EL MONTE OPERABLE UNIT
GROUNDWATER MONITORING WELL NETWORK

Well ID	Aquifer Designation	Screened Interval (feet bgs)	Monitoring Frequency
SEMW15B	MIZ	434-444	Semi-annual
SEMW16A	UIZ	270-280	Semi-annual
SEMW16B	MIZ	444-454	Semi-annual
SEMW17A	UIZ	220-230	Semi-annual
SEMW17B	MIZ	330-340	Semi-annual
SEMW18A	SZ	86-96	--
SEMW18B	SZ	144-154	--
SEMW18C	UIZ	240-250	--
SEMW19A	UIZ	264-274	--
SEMW19B	LIZ	502-512	--
SEMW20A	UIZ	256-266	--
SEMW20B	LIZ	494-504	--
SEMW21A	SZ	78-88	--
SEMW21B	SZ	138-148	--
SEMW21C	UIZ	250-260	--
SEMW22A	UIZ	252-262	--
SEMW22B	LIZ	486-496	--
SEMW23A	UIZ	214-224	--
SEMW23B	MIZ	366-376	--
SEMW24A	UIZ	150-160	--
SEMW24B	LIZ	452-462	--
SEMW26	SZ	75-85	--
SEMW27	SZ	110-120	--
SEMW28	SZ	75-85	--
EPAW414_01	LIZ	440-450	Annual
EPAW414_02	MIZ	365-375	Annual
EPAW414_03	UIZ	270-280	Annual
EPAW414_04	UIZ	175-185	Annual
EPAW414_05	SZ	100-110	--
EPAW414_06	SZ	50-60	--

Notes:
EA obtained the information presented on this table from Table 2-1 of the *Supplemental Remedial Investigation Report* (Gilbane 2019a) and Table 4-3 of the *Final Sampling and Analysis Plan* (Innovative Technical Solutions, Inc. 2011).

Aquifer Designations
SZ = Shallow zone.
UIZ = Upper intermediate zone.
MIZ = Middle intermediate zone.
LIZ = Lower intermediate zone.

TABLE 3-4a
SOUTH EL MONTE OPERABLE UNIT
GROUNDWATER MONITORING WELL NETWORK

Well ID	Aquifer Designation	Screened Interval (feet bgs)	Monitoring Frequency

Acronyms:
-- = Not available.
bgs = Below ground surface.
ID = Identification.

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TABLE 3-4b
WHITTIER NARROWS OPERABLE UNIT
GROUNDWATER MONITORING WELL NETWORK

Station ID	Well ID	Aquifer Designation	Screened Interval (feet bgs)	Monitoring Frequency
EPAMW011	MW1-1	DZ	700-710	Annual
EPAMW012	MW1-2	LIZ	500-510	Annual
EPAMW013	MW1-3	IZ	380-390	Annual
EPAMW014	MW1-4	UIZ	230-240	Annual
EPAMW015	MW1-5	SZ	90-100	Annual
EPAMW022	MW2-2	IZ	430-450	Annual
EPAMW023	MW2-3	IZ	316-336	Annual
EPAMW024	MW2-4	UIZ	202-222	Annual
EPAMW025	MW2-5	SZ	68-88	Annual
EPAMW441	MW4-41	UIZ	285-295	Annual
EPAMW442	MW4-42	UIZ	225-235	Annual
EPAMW451	MW4-51	UIZ	270-280	Annual
EPAMW452	MW4-52	UIZ	200-210	Annual
EPAMW461	MW4-61	UIZ	251-261	Annual
EPAMW462	MW4-62	UIZ	140-150	Annual
EPAMW471	MW4-71	UIZ	210-220	Annual
EPAMW472	MW4-72	SZ	82-92	Annual
EPAW48_01	MW4-8 (Zone 1)	DZ	945-955	Annual
EPAW48_02	MW4-8 (Zone 2)	DZ	760-770	Annual
EPAW48_03	MW4-8 (Zone 3)	DZ	660-670	Annual
EPAW48_04	MW4-8 (Zone 4)	LIZ	550-560	Annual
EPAW48_05	MW4-8 (Zone 5)	LIZ	460-470	Annual
EPAW48_06	MW4-8 (Zone 6)	IZ	375-385	Annual
EPAW48_07	MW4-8 (Zone 7)	UIZ	285-295	Annual
EPAW48_08	MW4-8 (Zone 8)	UIZ	230-240	Annual
EPAW48_09	MW4-8 (Zone 9)	SZ	95-105	Annual
EPAW48_10	MW4-8 (Zone 10)	SZ	45-55	Annual
EPAW49_01	MW4-9 (Zone 1)	DZ	955-965	Annual
EPAW49_02	MW4-9 (Zone 2)	DZ	900-910	Annual
EPAW49_03	MW4-9 (Zone 3)	DZ	750-760	Annual
EPAW49_04	MW4-9 (Zone 4)	DZ	650-660	Annual
EPAW49_05	MW4-9 (Zone 5)	LIZ	515-525	Annual
EPAW49_06	MW4-9 (Zone 6)	IZ	350-360	Annual
EPAW49_07	MW4-9 (Zone 7)	UIZ	295-305	Annual
EPAW49_08	MW4-9 (Zone 8)	UIZ	230-240	Annual
EPAW49_09	MW4-9 (Zone 9)	SZ	100-110	Annual
EPAW49_10	MW4-9 (Zone 10)	SZ	40-50	Annual
EPAW410_01	MW4-10 (Zone 1)	DZ	810-820	Annual
EPAW410_02	MW4-10 (Zone 2)	DZ	675-685	Annual
EPAW410_03	MW4-10 (Zone 3)	LIZ	595-605	Annual
EPAW410_04	MW4-10 (Zone 4)	LIZ	470-480	Annual
EPAW410_05	MW4-10 (Zone 5)	IZ	320-330	Annual

TABLE 3-4b
WHITTIER NARROWS OPERABLE UNIT
GROUNDWATER MONITORING WELL NETWORK

Station ID	Well ID	Aquifer Designation	Screened Interval (feet bgs)	Monitoring Frequency
EPAW410_06	MW4-10 (Zone 6)	UIZ	220-230	Annual
EPAW410_07	MW4-10 (Zone 7)	SZ	130-140	Annual
EPAW410_08	MW4-10 (Zone 8)	SZ	65-75	Annual
EPAW410_09	MW4-10 (Zone 9)	SZ	35-45	Annual
EPAW411_01	MW4-11 (Zone 1)	LIZ	545-555	Annual
EPAW411_02	MW4-11 (Zone 2)	LIZ	490-500	Annual
EPAW411_03	MW4-11 (Zone 3)	IZ	400-410	Annual
EPAW411_04	MW4-11 (Zone 4)	IZ	305-315	Annual
EPAW411_05	MW4-11 (Zone 5)	UIZ	225-235	Annual
EPAW411_06	MW4-11 (Zone 6)	SZ	120-130	Annual
EPAW411_07	MW4-11 (Zone 7)	SZ	60-70	Annual
EPAW412_01	MW4-12 (Zone 1)	LIZ	490-500	Annual
EPAW412_02	MW4-12 (Zone 2)	IZ	315-325	Annual
EPAW412_03	MW4-12 (Zone 3)	UIZ	225-235	Annual
EPAW412_04	MW4-12 (Zone 4)	SZ	120-130	Annual
EPAW412_05	MW4-12 (Zone 5)	SZ	45-55	Annual
EPAW413_01	MW4-13 (Zone 1)	IZ	415-425	Annual
EPAW413_02	MW4-13 (Zone 2)	IZ	340-350	Annual
EPAW413_03	MW4-13 (Zone 3)	UIZ	225-235	Annual
EPAW413_04	MW4-13 (Zone 4)	SZ	130-140	Annual
EPAW413_05	MW4-13 (Zone 5)	SZ	50-60	Annual
EPAW415_01	MW4-15 (Zone 1)	IZ	335-345	Annual
EPAW415_02	MW4-15 (Zone 2)	UIZ	290-300	Annual
EPAW415_03	MW4-15 (Zone 3)	UIZ	230-240	Annual
EPAW415_04	MW4-15 (Zone 4)	UIZ	145-155	Annual
EPAW415_05	MW4-15 (Zone 5)	SZ	45-55	Annual
EPAW418_01	MW4-18 (Zone 1)	UIZ	280-290	Annual
EPAW418_02	MW4-18 (Zone 2)	UIZ	230-240	Annual
EPAW418_03	MW4-18 (Zone 3)	UIZ	160-170	Annual
EPAW418_04	MW4-18 (Zone 4)	SZ	95-105	Annual
EPAW419_01	MW4-19 (Zone 1)	UIZ	295-305	Annual
EPAW419_02	MW4-19 (Zone 2)	UIZ	230-240	Annual
EPAW419_03	MW4-19 (Zone 3)	UIZ	160-170	Annual
EPAW419_04	MW4-19 (Zone 4)	SZ	100-110	Annual
EPAW419_05	MW4-19 (Zone 5)	SZ	40-50	Annual
EPAW420_01	MW4-20 (Zone 1)	IZ	350-360	Annual
EPAW420_02	MW4-20 (Zone 2)	SZ	70-80	Annual
EPAMW421A	MW4-21A	UIZ	266-286	Annual

TABLE 3-4b
WHITTIER NARROWS OPERABLE UNIT
GROUNDWATER MONITORING WELL NETWORK

Station ID	Well ID	Aquifer Designation	Screened Interval (feet bgs)	Monitoring Frequency
EPAMW421B	MW4-21B	SZ	70-90	Annual
EPAW422_01	MW4-22 (Zone 1)	IZ	430-440	Annual
EPAW422_02	MW4-22 (Zone 2)	IZ	385-395	Annual
EPAW422_03	MW4-22 (Zone 3)	IZ	315-325	Annual
EPAW422_04	MW4-22 (Zone 4)	UIZ	215-225	Annual
EPAW422_05	MW4-22 (Zone 5)	SZ	130-140	Annual
EPAW422_06	MW4-22 (Zone 6)	SZ	45-55	Annual
EPAMW423	MW4-23	SZ	70-90	Annual
EPAMW424	MW4-24	SZ	24-45	Annual
EPAMW425	MW4-25	SZ	25-50	Annual
EPAMW426	MW4-26	SZ	27-52	Annual
EPAMW427A	MW4-27A	IZ	440-460	Annual
EPAMW427B	MW4-27B	LIZ	590-610	Annual
EPAMW428A	MW4-28A	LIZ	460-480	Annual
EPAMW428B	MW4-28B	LIZ	585-605	Annual
EPAMW428C	MW4-28C	DZ	680-690	Annual
EPAMW429A	MW4-29A	UIZ	160-180	Annual
EPAMW429B	MW4-29B	IZ	310-330	Annual
EPAMW430A	MW4-30A	IZ	415-435	Annual
EPAMW430B	MW4-30B	LIZ	495-505	Annual
EPAMW430C	MW4-30C	LIZ	560-570	Annual
WRDWN01_01	WN-01 (Zone 1)	DZ	749-769	Annual
WRDWN01_02	WN-01 (Zone 2)	DZ	609-629	Annual
WRDWN01_03	WN-01 (Zone 3)	LIZ	463-483	Annual
WRDWN01_04	WN-01 (Zone 4)	IZ	392-402	Annual
WRDWN01_05	WN-01 (Zone 5)	IZ	334-344	Annual
WRDWN01_06	WN-01 (Zone 6)	UIZ	273-283	Annual
WRDWN01_07	WN-01 (Zone 7)	UIZ	233-243	Annual
WRDWN01_08	WN-01 (Zone 8)	UIZ	163-173	Annual
WRDWN01_09	WN-01 (Zone 9)	SZ	95-105	Annual
WRDWN02_01	WN-02 (Zone 1)	DZ	659-679	Annual
WRDWN02_02	WN-02 (Zone 2)	LIZ	579-599	Annual
WRDWN02_03	WN-02 (Zone 3)	LIZ	469-489	Annual
WRDWN02_04	WN-02 (Zone 4)	IZ	418-428	Annual
WRDWN02_05	WN-02 (Zone 5)	IZ	329-339	Annual
WRDWN02_06	WN-02 (Zone 6)	UIZ	263-273	Annual
WRDWN02_07	WN-02 (Zone 7)	UIZ	213-233	Annual

TABLE 3-4b
WHITTIER NARROWS OPERABLE UNIT
GROUNDWATER MONITORING WELL NETWORK

Station ID	Well ID	Aquifer Designation	Screened Interval (feet bgs)	Monitoring Frequency
WRDWN02_08	WN-02 (Zone 8)	UIZ	136-146	Annual
WRDWN02_09	WN-02 (Zone 9)	SZ	91-101	Annual
SEMW03_01	MW-3 (Zone 1)	IZ	371-380	Annual
SEMW03_02	MW-3 (Zone 2)	UIZ	265-275	Annual
SEMW03_03	MW-3 (Zone 3)	UIZ	180-190	Annual
SEMW03_04	MW-3 (Zone 4)	SZ	62-72	Annual
SEMW06_02	MW-6 (Zone 2)	UIZ	270-280	Annual
SEMW06_04	MW-6 (Zone 4)	SZ	58-67	Annual

Notes:
EA obtained the information presented on this table from Section 3 and Tables 1 and 2 of the *Performance Evaluation Report for 2018* (URS 2019).

Aquifer Designations
SZ = Shallow zone.
UIZ = Upper intermediate zone.
IZ = Intermediate zone.
LIZ = Lower intermediate zone.
DZ = Deep zone.

Acronyms:
bgs = Below ground surface.
ID = Identification.

TABLE 4-1
REMEDIAL ALTERNATIVES

Alternatives		Remedy Objectives	Remedy Components		
			SEMOU	WNOU	Treated Water End Use
1	No Action Purveyor Point-of-Use Treatment	- Prevent exposure	- Water purveyors provide wellhead treatment, as necessary	- Water purveyors provide wellhead treatment, as necessary	NA
2	No Further Action SEMOU/WNOU Interim Remedies	- Prevent exposure - Containment	- Hydraulic Control	- Hydraulic Control	- Potable Water - Surface Discharge
3	Optimize Existing SEMOU/WNOU Interim Remedies				
4	SEMOU/WNOU Hydraulic Control Plus Pumping to Enhance WNOU Cleanup	- Prevent exposure - Containment (SEMOU only) - Aquifer Restoration (WNOU only)	- Hydraulic Control	- Hydraulic Control - Aquifer Restoration	- Potable Water - Injection - Surface Discharge
5	SEMOU / WNOU Hydraulic Control Plus Pumping and Reinjection to Enhance WNOU Cleanup				
6	SEMOU/WNOU Enhanced Cleanup	- Prevent exposure - Containment - Aquifer Restoration	- Hydraulic Control - Aquifer Restoration	- Hydraulic Control - Aquifer Restoration	- Potable Water - Injection - Surface Discharge
7	SEMOU/WNOU Enhanced and Accelerated Cleanup				

Acronyms:
NA = Not applicable.
POU = Point of use.
SEMOU = South El Monte Operable Unit.
WNOU = Whittier Narrows Operable Unit.

TABLE 4-2
REMEDIAL ALTERNATIVE 2 - NO FURTHER ACTION (SEMOU/WNOU INTERIM REMEDIES)
CURRENT AND PROPOSED FLOW RATES AND TREATMENT CAPACITY

Treatment System		Groundwater Extraction: Shallow Zone [a]	Groundwater Extraction: Intermediate Zone [a]	Treatment: Raw Water Influent	Treatment: Treatment Capacity	Treated Water End Use: Water Purveyors [a]: MP	Water Purveyors [a]: SGVWC	Water Purveyors [a]: GSWC	Water Purveyors [a]: City of Whittier	Water Purveyors [a]: Suburban	Surface Discharge [a]: Legg Lakes	Injection [a]: WNOU (EW4-3 and EW4-4)	Injection [a]: Near Hwy 60 (INJ 3)	Total Discharge
MP	Delta Plant	-- --	3,550 --	**3,550**	**4,500**	3,680 --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	**3,680**
	Well No. 5 Plant	-- --	130 --	**130**	**1,600**									
SGVWC Plant 8		-- --	1,300 --	**1,300**	**5,000**	-- --	1,300 --	-- --	-- --	-- --	-- --	-- --	-- --	**1,300**
GSWC Plant		-- --	870 --	**870**	**1,500**	-- --	-- --	870 --	-- --	-- --	-- --	-- --	-- --	**870**
SEMOU Plant (proposed)		-- --	-- --	**0**	**NA**	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	**0**
WNOU Plant		-- --	3,500 --	**3,500**	**3,750**	-- --	2,000 --	-- --	700 --	-- --	800 --	-- --	-- --	**3,500**
			Total =	**9,350**									**Total =**	**9,350**

Notes:
The numerical values presented on this table are flow rates in units of gallons per minute.
This alternative requires minimal infrastructure improvements. Therefore, a table describing proposed infrastructure modifications was not prepared for this alternative.
(a) **Gray Text: Target flow rates for the interim containment remedies.**
Black Text: Increase in flow rates proposed as part of this remedial alternative.

Acronyms:
-- = Flow rate equals zero gallons per minute.
GSWC = Golden State Water Company.
IZ = Intermediate zone.
MP = City of Monterey Park.
NA = Not applicable.
SEMOU = South El Monte Operable Unit.
SGVWC = San Gabriel Valley Water Company.
SZ = Shallow zone.
WNOU = Whittier Narrows Operable Unit.

TABLE 4-3
REMEDIAL ALTERNATIVE 3 - OPTIMIZE EXISTING SEMOU/WNOU INTERIM REMEDIES
CURRENT AND PROPOSED FLOW RATES AND TREATMENT CAPACITY

Treatment System		Groundwater Extraction		Treatment		Treated Water End Use								
						Water Purveyors [a]					Surface Discharge [a]	Injection [a]		
		Shallow Zone [a]	Intermediate Zone [a]	Raw Water Influent	Treatment Capacity	MP	SGVWC	GSWC	City of Whittier	Suburban	Legg Lakes	WNOU (EW4-3 and EW4-4)	Near Hwy 60 (INJ 3)	Total Discharge
MP	Delta Plant	-- --	3,550 --	**3,550**	**4,500**	3,680 --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	**3,680**
	Well No. 5 Plant	-- --	130 --	**130**	**1,600**									
SGVWC Plant 8		-- --	1,300 --	**1,300**	**5,000**	-- --	1,300 --	-- --	-- --	-- --	-- --	-- --	-- --	**1,300**
GSWC Plant		-- --	870 --	**870**	**1,500**	-- --	-- --	870 --	-- --	-- --	-- --	-- --	-- --	**870**
SEMOU Plant (proposed)		-- --	-- --	**0**	**NA**	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	**0**
WNOU Plant		-- --	3,500 --	**3,500**	**3,750**	-- --	2,000 --	-- --	700 --	-- --	800 --	-- --	-- --	**3,500**
			Total =	**9,350**									**Total =**	**9,350**

Notes:
The numerical values presented on this table are flow rates in units of gallons per minute.
This alternative requires minimal infrastructure improvements. Therefore, a table describing proposed infrastructure modifications was not prepared for this alternative
(a) **Gray Text: Target flow rates for the interim containment remedies.**
Black Text: Increase in flow rates proposed as part of this remedial alternative.

Acronyms:
-- = Flow rate equals zero gallons per minute.
GSWC = Golden State Water Company.
IZ = Intermediate zone.
MP = City of Monterey Park.
NA = Not applicable.
SEMOU = South El Monte Operable Unit.
SGVWC = San Gabriel Valley Water Company.
SZ = Shallow zone.
WNOU = Whittier Narrows Operable Unit.

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TABLE 4-4a
REMEDIAL ALTERNATIVE 4 - SEMOU/WNOU HYDRAULIC CONTROL PLUS PUMPING TO ENHANCE WNOU CLEANUP
CURRENT AND PROPOSED FLOW RATES AND TREATMENT CAPACITY

		Groundwater Extraction		Treatment		Treated Water End Use								
						Water Purveyors (a)					Surface Discharge (a)	Injection (a)		
Treatment System		Shallow Zone (a)	Intermediate Zone (a)	Raw Water Influent	Treatment Capacity	MP	SGVWC	GSWC	City of Whittier	Suburban	Legg Lakes	WNOU (EW4-3 and EW4-4)	Near Hwy 60 (INJ 3)	Total Discharge
MP	Delta Plant	-- --	3,550 1,000	**4,550**	**4,550 (b)**	3,680 1,000	-- --	-- --	-- --	-- --	-- --	-- --	-- --	**4,680**
	Well No. 5 Plant	-- --	130 --	**130**	**1,600**									
SGVWC Plant 8		-- --	1,300 750	**2,050**	**5,000**	-- --	1,300 350	-- 400	-- --	-- --	-- --	-- --	-- --	**2,050**
GSWC Plant		-- --	870 --	**870**	**1,500**	-- --	-- --	870 --	-- --	-- --	-- --	-- --	-- --	**870**
SEMOU Plant (proposed)		-- --	-- --	**0**	**NA**	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	**0**
WNOU Plant		-- 500	3,500 250	**4,250**	**3,750**	-- --	2,000 --	-- --	700 --	-- --	800 --	-- 750	-- --	**4,250**
			Total =	**11,850**									**Total =**	**11,850**

Notes:
The numerical values presented on this table are flow rates in units of gallons per minute.
(a) Gray Text: **Target flow rates for the interim containment remedies.**
Black Text: Increase in flow rates proposed as part of this remedial alternative.
Orange Highlighted Cells: Extraction flow rate exceeds the plant's flow capacity.
(b) The City of Monterey Park is in the process of changing and upgrading the treatment system, which currently has a capacity of 4,500 gpm. For the purposes of the ERAS, EPA assumes that the upgrades will enable the system to handle the extra capacity required for this alternative.

Acronyms:
-- = Flow rate equals zero gallons per minute.
GSWC = Golden State Water Company.
IZ = Intermediate zone.
MP = City of Monterey Park.
NA = Not applicable.
SEMOU = South El Monte Operable Unit.
SGVWC = San Gabriel Valley Water Company.
SZ = Shallow zone.
WNOU = Whittier Narrows Operable Unit.

TABLE 4-4b
REMEDIAL ALTERNATIVE 4 - SEMOU/WNOU HYDRAULIC CONTROL PLUS PUMPING TO ENHANCE WNOU CLEANUP
PROPOSED INFRASTRUCTURE MODIFICATIONS

	Groundwater Extraction				Treatment	Treated Water End Use			
	Shallow Zone Extraction Well Network		Intermediate Zone Extraction Well Network			Water Purveyor Connections		Injection Well Network	
Treatment System [a]	Number of Wells	Conveyance Piping (LF)	Number of Wells	Conveyance Piping (LF)	Proposed Modifications	Description	Conveyance Piping (LF)	Number of Wells	Conveyance Piping (LF)
MP Delta	-	-	3 [b]	16,400 [b]	-	-	-	-	-
SGVWC Plant 8	-	-	-	-	-	-	-	-	-
SEMOU Plant (proposed)	-	-	-	-	-	-	-	-	-
WNOU Plant	1	4,800	1	8,800	-Minor modifications needed to complete the existing connection to the City of Whittier. -To accommodate additional flow, plant capacity will be expanded by bringing existing vessels on-line.	-	-	2 [c]	3,200 [c]

Notes:
(a) The Golden State Water Company and City of Monterey Park Well No. 5 treatment facilities were omitted because they do not require infrastructure modifications.
(b) The wells and piping will also connect to SGVWC Plant 8. The flow from the piping will split between the two treatment facilities.
(c) The wells and piping are existing infrastructure that EPA will repurpose for groundwater injection.

Acronyms:
gpm = Gallons per minute.
IZ = Intermediate zone.
LF = Linear feet.
MP = City of Monterey Park.
NA = Not applicable.
SEMOU = South El Monte Operable Unit.
SGVWC = San Gabriel Valley Water Company.
SZ = Shallow zone.
WNOU = Whittier Narrows Operable Unit.

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TABLE 4-5a
REMEDIAL ALTERNATIVE 5 - SEMOU/WNOU HYDRAULIC CONTROL PLUS PUMPING AND REINJECTION TO ENHANCE WNOU CLEANUP
CURRENT AND PROPOSED FLOW RATES AND TREATMENT CAPACITY

Treatment System		Groundwater Extraction		Treatment		Treated Water End Use								
						Water Purveyors [a]					Surface Discharge [a]	Injection [a]		
		Shallow Zone [a]	Intermediate Zone [a]	Raw Water Influent	Treatment Capacity	MP	SGVWC	GSWC	City of Whittier	Suburban	Legg Lakes	WNOU (EW4-3 and EW4-4)	Near Hwy 60 (INJ 3)	Total Discharge
MP	Delta Plant	-- --	3,550 --	**3,550**	**4,500**	3,680 --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	**3,680**
	Well No. 5 Plant	-- --	130 --	**130**	**1,600**									
SGVWC Plant 8		-- --	1,300 --	**1,300**	**5,000**	-- --	1,300 --	-- --	-- --	-- --	-- --	-- --	-- --	**1,300**
GSWC Plant		-- --	870 --	**870**	**1,500**	-- --	-- --	870 --	-- --	-- --	-- --	-- --	-- --	**870**
SEMOU Plant (proposed)		-- --	-- --	**0**	**NA**	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	**0**
WNOU Plant		-- 500	3,500 2,000	**6,000**	**3,750**	-- --	2,000 --	-- --	700 500	-- --	800 --	-- 500	-- 1,500	**6,000**
			Total =	**11,850**									**Total =**	**11,850**

Note:
The numerical values presented on this table are flow rates in units of gallons per minute.
(a) **Gray Text: Target flow rates for the interim containment remedies.**
Black Text: Increase in flow rates proposed as part of this remedial alternative.
Orange Highlighted Cells: Extraction flow rate exceeds the plant's flow capacity.

Acronyms:
-- = Flow rate equals zero gallons per minute.
GSWC = Golden State Water Company.
IZ = Intermediate zone.
MP = City of Monterey Park.
NA = Not applicable.
SEMOU = South El Monte Operable Unit.
SGVWC = San Gabriel Valley Water Company.
SZ = Shallow zone.
WNOU = Whittier Narrows Operable Unit.

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TABLE 4-5b
REMEDIAL ALTERNATIVE 5 - SEMOU/WNOU HYDRAULIC CONTROL PLUS PUMPING AND REINJECTION TO ENHANCE WNOU CLEANUP
PROPOSED INFRASTRUCTURE MODIFICATIONS

	Groundwater Extraction				Treatment	Treated Water End Use			
	Shallow Zone Extraction Well Network		Intermediate Zone Extraction Well Network			Water Purveyor Connections		Injection Well Network	
Treatment System [(a)]	Number of Wells	Conveyance Piping (LF)	Number of Wells	Conveyance Piping (LF)	Proposed Modifications	Description	Conveyance Piping (LF)	Number of Wells	Conveyance Piping (LF)
MP Delta	-	-	-	-	-	-	-	-	-
SGVWC Plant 8	-	-	-	-	-	-	-	-	-
SEMOU Plant (proposed)	-	-	-	-	-	-	-	-	-
WNOU Plant	1	4,800	4	9,400	-Minor modifications needed to complete the existing connection to the City of Whittier. -To accommodate additional flow, plant capacity will be expanded by bringing existing vessels on-line.	-	-	3 [(b)]	5,600 [(b)]

Notes:
(a) The Golden State Water Company and City of Monterey Park Well No. 5 treatment facilities were omitted because they do not require infrastructure modifications.
(b) Two of the wells and 3,200 LF of the piping are existing infrastructure that EPA will repurpose for groundwater injection.

Acronyms:
gpm = Gallons per minute.
IZ = Intermediate zone.
LF = Linear feet.
MP = City of Monterey Park.
NA = Not applicable.
SEMOU = South El Monte Operable Unit.
SGVWC = San Gabriel Valley Water Company.
SZ = Shallow zone.
WNOU = Whittier Narrows Operable Unit.

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TABLE 4-6a
REMEDIAL ALTERNATIVE 6 - SEMOU/WNOU ENHANCED CLEANUP
CURRENT AND PROPOSED FLOW RATES AND TREATMENT CAPACITY

Treatment System		Groundwater Extraction		Treatment		Treated Water End Use								
						Water Purveyors [a]					Surface Discharge [a]	Injection [a]		
		Shallow Zone [a]	Intermediate Zone [a]	Raw Water Influent	Treatment Capacity	MP	SGVWC	GSWC	City of Whittier	Suburban	Legg Lakes	WNOU (EW4-3 and EW4-4)	Near Hwy 60 (INJ 3)	Total Discharge
MP	Delta Plant	-- --	3,550 1,100	**4,650**	**4,650 [b]**	3,680 1,000	-- --	-- 100	-- --	-- --	-- --	-- --	-- --	**4,780**
MP	Well No. 5 Plant	-- --	130 --	**130**	**1,600**									
SGVWC, Plant No. 8		-- --	1,300 650	**1,950**	**5,000**	-- --	1,300 350	-- 300	-- --	-- --	-- --	-- --	-- --	**1,950**
GSWC Plant		-- --	870 --	**870**	**1,500**	-- --	-- --	870 --	-- --	-- --	-- --	-- --	-- --	**870**
SEMOU Plant (proposed)		-- 1,600	-- 150	**1,750**	**NA**	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- 1,750	**1,750**
WNOU Plant		-- --	3,500 2,000	**5,500**	**3,750**	-- --	2,000 --	-- --	700 1,250	-- --	800 --	-- 750	-- --	**5,500**
			Total =	**14,850**									**Total =**	**14,850**

Notes:

The numerical values presented on this table are flow rates in units of gallons per minute.

(a) **Gray Text: Target flow rates for the interim containment remedies.**

Black Text: Increase in flow rates proposed as part of this remedial alternative.

Orange Highlighted Cells: Extraction flow rate exceeds the plant's flow capacity.

(b) The City of Monterey Park is in the process of changing and upgrading the treatment system, which currently has a capacity of 4,500 gpm. For the purposes of the ERAS, EPA assumes that the upgrades will enable the system to handle the extra capacity required for this alternative.

Acronyms:

-- = Flow rate equals zero gallons per minute.
GSWC = Golden State Water Company.
IZ = Intermediate zone.
MP = City of Monterey Park.
NA = Not applicable.
SEMOU = South El Monte Operable Unit.
SGVWC = San Gabriel Valley Water Company.
SZ = Shallow zone.
WNOU = Whittier Narrows Operable Unit.

TABLE 4-6b
REMEDIAL ALTERNATIVE 6 - SEMOU/WNOU ENHANCED CLEANUP
PROPOSED INFRASTRUCTURE MODIFICATIONS

Treatment System [a]	Groundwater Extraction				Treatment	Treated Water End Use			
	Shallow Zone Extraction Well Network		Intermediate Zone Extraction Well Network			Water Purveyor Connections		Injection Well Network	
	Number of Wells	Conveyance Piping (LF)	Number of Wells	Conveyance Piping (LF)	Proposed Modifications	Description	Conveyance Piping (LF)	Number of Wells	Conveyance Piping (LF)
MP Delta	-	-	1	3,200	Larger pump will be installed in existing extraction well MP15.	-	-	-	-
SGVWC Plant 8	-	-	1	2,500	Larger pump will be installed in existing extraction well 8C.	-	-	-	-
SEMOU Plant (proposed)	6	16,700	1	800	-	-	-	1	3,800
WNOU Plant	-	-	2 [b]	11,000	-Minor modifications needed to complete the existing connection to the City of Whittier. -To accommodate additional flow, plant capacity will be expanded by bringing existing vessels on-line.	-	-	2 [b]	3,200 [b]

Notes:
(a) The Golden State Water Company and City of Monterey Park Well No. 5 treatment facilities were omitted because they do not require infrastructure modifications.
(b) Extraction wells EXT1 and EXT7 would contribute water to multiple treatment plants (Figure 4-6). To avoid double-counting the wells on this table, EXT1 was assigned to the SEMOU Plant (proposed) and EXT7 was assigned to SGVWC Plant 8, even though they would also supply water to the WNOU Plant.
(c) The wells and piping are existing infrastructure that EPA will repurpose for groundwater injection.

Acronyms:
gpm = Gallons per minute.
IZ = Intermediate zone.
LF = Linear feet.
MP = City of Monterey Park.
NA = Not applicable.
SEMOU = South El Monte Operable Unit.
SGVWC = San Gabriel Valley Water Company.
SZ = Shallow zone.
WNOU = Whittier Narrows Operable Unit.

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TABLE 4-7a
REMEDIAL ALTERNATIVE 7 - SEMOU/WNOU ENHANCED AND ACCELERATED CLEANUP
CURRENT AND PROPOSED FLOW RATES AND TREATMENT CAPACITY

Treatment System		Groundwater Extraction		Treatment		Treated Water End Use								
						Water Purveyors [a]					Surface Discharge [a]	Injection [a]		
		Shallow Zone [a]	Intermediate Zone [a]	Raw Water Influent	Treatment Capacity	MP	SGVWC	GSWC	City of Whittier	Suburban	Legg Lakes	WNOU (EW4-3 and EW4-4)	Near Hwy 60 (INJ 3)	Total Discharge
MP	Delta Plant	-- --	3,550 1,200	**4,750**	**4,750 [b]**	3,680 1,000	-- --	-- 200	-- --	-- --	-- --	-- --	-- --	**4,880**
	Well No. 5 Plant	-- --	130 --	**130**	**1,600**									
SGVWC Plant 8		-- --	1,300 600	**1,900**	**5,000**	-- --	1,300 400	-- 200	-- --	-- --	-- --	-- --	-- --	**1,900**
GSWC Plant		-- --	870 --	**870**	**1,500**	-- --	-- --	870 --	-- --	-- --	-- --	-- --	-- --	**870**
SEMOU Plant (proposed)		-- 1,750	-- --	**1,750**	**NA**	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- 1,750	**1,750**
WNOU Plant		-- 750	3,500 5,200	**9,450**	**3,750**	-- --	2,000 --	-- --	700 1,500	-- 3,700	800 --	-- 750	-- --	**9,450**
			Total =	**18,850**									**Total =**	**18,850**

Notes:
The numerical values presented on this table are flow rates in units of gallons per minute.
(a) **Gray Text: Target flow rates for the interim containment remedies.**
Black Text: Increase in flow rates proposed as part of this remedial alternative.
Orange Highlighted Cells: Extraction flow rate exceeds the plant's flow capacity.
(b) The City of Monterey Park is in the process of changing and upgrading the treatment system, which currently has a capacity of 4,500 gpm. For the purposes of the ERAS, EPA assumes that the upgrades will enable the system to handle the extra capacity required for this alternative.

Acronyms:
-- = Flow rate equals zero gallons per minute.
GSWC = Golden State Water Company.
IZ = Intermediate zone.
MP = City of Monterey Park.
NA = Not applicable.
SEMOU = South El Monte Operable Unit.
SGVWC = San Gabriel Valley Water Company.
SZ = Shallow zone.
WNOU = Whittier Narrows Operable Unit.

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TABLE 4-7b
REMEDIAL ALTERNATIVE 7 - SEMOU/WNOU ENHANCED AND ACCELERATED CLEANUP
PROPOSED INFRASTRUCTURE MODIFICATIONS

	Groundwater Extraction				Treatment	Treated Water End Use			
	Shallow Zone Extraction Well Network		Intermediate Zone Extraction Well Network			Water Purveyor Connections		Injection Well Network	
Treatment System [(a)]	Number of Wells	Conveyance Piping (LF)	Number of Wells	Conveyance Piping (LF)	Proposed Modifications	Description	Conveyance Piping (LF)	Number of Wells	Conveyance Piping (LF)
MP Delta	-	-	-	1,700	Larger pumps will be installed in existing extraction wells MP12 and 15.	-	-	-	-
SGVWC Plant 8	-	-	-	200	Larger pump will be installed in existing extraction well 8B.	-	-	-	-
SEMOU Plant (proposed)	5	21,100	-	-	-	-	-	1	3,800
WNOU Plant	2	11,400	6	19,300	-Minor modifications needed to complete the existing connection to the City of Whittier. -To accommodate additional flow, plant capacity will be expanded by bringing existing vessels on-line.	Interconnection to Suburban will be constructed.	6,800	2 [(b)]	3,200 [(b)]

Notes:
(a) The Golden State Water Company and City of Monterey Park Well No. 5 treatment facilities were omitted because they do not require infrastructure modifications.
(b) The wells and piping are existing infrastructure that EPA will repurpose for groundwater injection.

Acronyms:
gpm = Gallons per minute.
IZ = Intermediate zone.
LF = Linear feet.
MP = City of Monterey Park.
NA = Not applicable.
SEMOU = South El Monte Operable Unit.
SGVWC = San Gabriel Valley Water Company.
SZ = Shallow zone.
WNOU = Whittier Narrows Operable Unit.

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TABLE 5-1
DETAILED ANALYSIS SUMMARY

		CONTAINMENT REMEDIES		CONTAINMENT (SEMOU) AND AQUIFER RESTORATION (WNOU) REMEDIES		AQUIFER RESTORATION REMEDIES	
Criteria [(a)]	**Alternative 1:** No Action Purveyor Point-of-Use Treatment	**Alternative 2:** No Further Action SEMOU/WNOU Interim Remedies	**Alternative 3:** Optimize Existing SEMOU/WNOU Interim Remedies	**Alternative 4:** SEMOU/WNOU Hydraulic Control Plus Pumping to Enhance WNOU Cleanup	**Alternative 5:** SEMOU/WNOU Hydraulic Control Plus Pumping and Reinjection to Enhance WNOU Cleanup	**Alternative 6:** SEMOU/WNOU Enhanced Cleanup	**Alternative 7:** SEMOU/WNOU Enhanced and Accelerated Cleanup
(1) Overall Protection of Human Health and the Environment	**No**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
	EPA implements no actions to contain the contaminant plumes or restore the aquifer.	Alternatives provide hydraulic containment of contaminants and reduce concentrations of contaminants in extracted groundwater to acceptable levels.		Alternatives provide hydraulic containment of contaminants in the SEMOU, aid aquifer restoration in the WNOU, and reduce concentrations of contaminants in extracted groundwater to acceptable levels.		Alternatives extract contaminated groundwater to aid aquifer restoration in both the SEMOU and the WNOU and they reduce concentrations of contaminants in extracted groundwater to acceptable levels.	
(2) Compliance with ARARs	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
	EPA implements no actions; therefore, there are no ARARs to be met.	EPA expects the alternatives to comply with MCLs and all other ARARs (e.g., well construction requirements).		EPA expects the alternatives to comply with MCLs and all other ARARs (e.g., OSHA construction safety regulations and stormwater discharge permits).		EPA expects the alternatives to comply with MCLs and all other ARARs (e.g., OSHA construction safety regulations and stormwater discharge permits).	
(3) Long-Term Effectiveness and Permanence	★	★★	★★	★★	★★	★★★	★★★★
	EPA expects the alternative to achieve the RAOs pertaining to human exposure. However, the alternative does not effectively address RAOs pertaining to containment and aquifer restoration in the long-term.	The alternatives address RAOs pertaining to containment and human exposure in the long-term. However, these alternatives require groundwater extraction operations for a long period of time (> 70 years).		The alternatives address RAOs pertaining to containment, human exposure, and aquifer restoration (WNOU only) in the long-term. However, these alternatives require groundwater extraction operations for a long period of time (> 70 years) in the SEMOU.		The alternatives address RAOs pertaining to human exposure and aquifer restoration in the long-term. EPA expects Alternative 6 to restore the aquifer in approximately 70 years. EPA expects Alternative 7 to restore the aquifer in approximately 40 years.	
(4) Reduction of Toxicity, Mobility, or Volume through Treatment	★	★	★★	★★	★★	★★★	★★★★
	EPA will take no actions to treat the contaminants.	Hydraulic containment of contaminated groundwater effectively reduces its mobility. Treatment via either air stripping/vapor-phase carbon adsorption or liquid-phase carbon adsorption reduces toxicity and volume of contaminated groundwater, though reductions are not the goal of a containment remedy.		Hydraulic containment of contaminated groundwater effectively reduces its mobility. Treatment via either air stripping/vapor-phase carbon adsorption or liquid-phase carbon adsorption reduces toxicity and volume of contaminated groundwater.		Extraction and treatment of contaminated groundwater to restore the aquifer reduces the toxicity, mobility, and volume of contaminated water. Treatment via either air stripping/vapor-phase carbon adsorption or liquid-phase carbon adsorption.	

TABLE 5-1
DETAILED ANALYSIS SUMMARY

Criteria [a]	Alternative 1: No Action Purveyor Point-of-Use Treatment	CONTAINMENT REMEDIES		CONTAINMENT (SEMOU) AND AQUIFER RESTORATION (WNOU) REMEDIES		AQUIFER RESTORATION REMEDIES	
		Alternative 2: No Further Action SEMOU/WNOU Interim Remedies	**Alternative 3:** Optimize Existing SEMOU/WNOU Interim Remedies	**Alternative 4:** SEMOU/WNOU Hydraulic Control Plus Pumping to Enhance WNOU Cleanup	**Alternative 5:** SEMOU/WNOU Hydraulic Control Plus Pumping and Reinjection to Enhance WNOU Cleanup	**Alternative 6:** SEMOU/WNOU Enhanced Cleanup	**Alternative 7:** SEMOU/WNOU Enhanced and Accelerated Cleanup
(5) Short-Term Effectiveness	★★★★	★★★★	★★★	★★	★★★	★★	★
	EPA will take no actions; therefore, no short-term risks are posed to the community, workers, or the environment.	The infrastructure needed to implement this alternative is already in place. Therefore, no short-term risks are posed to the community, workers, or the environment.	Minor construction, to shorten the screen interval on an existing extraction well and to install one new extraction well, will pose minimal short-term risks.	Alternatives requires installation of a substantial amount of conveyance piping and new extraction wells. The conveyance piping will need to cross the Pomona Highway and, for Alternative 4 only, will also cross the Rio Hondo Channel. Short-term risks include increases in traffic, noise and dust, construction safety hazards, and potential for environmental contamination due to waste disposal, stormwater runoff, and operation of heavy equipment.		The short-term risks are the same as those described for Alternatives 4 and 5. However, Alternatives 6 and 7 require the construction of a new treatment plant and the installation of a larger amount of conveyance piping and new extraction wells. Alternative 7 also requires the installation of piping that will cross the San Gabriel River to complete an interconnection between the WNOU treatment plant and Suburban.	
(6) Implementability	★★★★	★★★★	★★★	★★	★★★	★★	★
	Very implementable since no actions are taken.	EPA has already overcome the main implementability obstacles (e.g., land acquisition and permits).	EPA expects the implementability obstacles to be minimal due to the small scope of the work and the fact that many extraction wells are already present at the site.	The construction required is typical of drinking water pipelines, water supply wells, and water treatment facilities. The technologies (e.g., groundwater extraction and treatment via either air stripping/vapor-phase carbon adsorption or liquid-phase carbon adsorption) are reliable and effective at removing VOCs from groundwater. The main obstacles to implementation are administrative (e.g., property acquisition, permitting, water rights agreements).		Alternatives 6 and 7 will have the same implementability obstacles as Alternatives 4 and 5. However, Alternatives 6 and 7 will require the construction of a new treatment plant and installation of more extraction wells and conveyance piping. The new treatment plant will require acquisition of property, most likely within the Whittier Narrows Recreational Area. The location of the plant in the recreational area would provide plenty of space for the facility but will require the consideration of its effects on visitors to the area (e.g., aesthetics and noise).	
(7) Cost [b] (Present Value, $)	$ -	$ 52,800,000	$ 54,600,000	$ 75,100,000	$ 73,800,000	$ 103,000,000	$ 131,000,000

Notes:

(a) EPA assigned the alternatives one of the following ratings for each criteria, except the overall protection of human health and the environment, compliance with ARARs, and cost criteria:

★★★★ = Excellent performance against the criterion.
★★★ = Good performance against the criterion.
★★ = Fair performance against the criterion.
★ = Poor performance against the criterion.

(b) The expected accuracy of the cost estimate is -30/+50 percent. EPA calculated the present value costs using a 7 percent discount rate.

Acronyms:
ARAR = Applicable or Relevant and Appropriate Requirement.
EPA = U.S. Environmental Protection Agency.
MCL = Maximum contaminant level.
O&M = Operation and maintenance.
OSHA = Occupational Safety and Health Administration.
RAO = Remedial action objective.
SEMOU = South El Monte Operable Unit.
VOC = Volatile organic compound.
WNOU = Whittier Narrows Operable Unit.

TABLE 5-2
COMPARATIVE EVALUATION SUMMARY

	Alternatives	Threshold Criteria: Overall protection of human health and the environment	Threshold Criteria: Compliance with ARARs	Balancing Criteria [a]: Long-term effectiveness and permanence	Reduction in toxicity, mobility, or volume through treatment	Short-term effectiveness	Construction Time (years)	Implementability	**Total Cost [b] (present worth) =**	Capital cost +	Lifetime O&M and LTM cost (present value)	O&M and LTM Timeframe (years)
1	No Action Purveyor Point-of-Use Treatment	No	Yes	★	★	★★★★	Not Applicable	★★★★	$ -	$ -	$ -	Not Applicable
CONTAINMENT REMEDIES												
2	No Further Action SEMOU/WNOU Interim Remedies	Yes	Yes	★★	★	★★★★	0.1	★★★★	$ 52,800,000	$ 76,600	$ 52,700,000	70
3	Optimize Existing SEMOU/WNOU Interim Remedies	Yes	Yes	★★	★★	★★★	0.5	★★★	$ 54,600,000	$ 1,850,000	$ 52,700,000	70
CONTAINMENT (SEMOU ONLY) AND AQUIFER RESTORATION (WNOU ONLY) REMEDIES												
4	SEMOU/WNOU Hydraulic Control Plus Pumping to Enhance WNOU Cleanup	Yes	Yes	★★	★★	★★	1	★★	$ 75,100,000	$ 16,700,000	$ 58,400,000	70
5	SEMOU / WNOU Hydraulic Control Plus Pumping and Reinjection to Enhance WNOU Cleanup	Yes	Yes	★★	★★	★★★	0.9	★★★	$ 73,800,000	$ 15,400,000	$ 58,400,000	70
AQUIFER RESTORATION REMEDIES												
6	SEMOU/WNOU Enhanced Cleanup	Yes	Yes	★★★	★★★	★★	1.7	★★	$ 103,000,000	$ 34,400,000	$ 69,000,000	70
7	SEMOU/WNOU Enhanced and Accelerated Cleanup	Yes	Yes	★★★★	★★★★	★	2.5	★	$ 131,000,000	$ 51,000,000	$ 80,100,000	40

NOTE:
(a) EPA assigned the alternatives one of the following ratings for each balancing criteria, except cost:
★★★★ = Excellent performance against the criterion.
★★★ = Good performance against the criterion.
★★ = Fair performance against the criterion.
★ = Poor performance against the criterion.
(b) The expected accuracy of a Feasibility Study cost estimate is -30/+50 percent. EPA calculated present value costs using a 7 percent discount rate.

Acronyms:
ARAR = Applicable or Relevant and Appropriate Requirement.
LTM = Long-term monitoring.
O&M = Operation and maintenance.

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Appendix A

Groundwater Modeling

A1. CH2M Hill 2021a, Enhanced Remedial Alternative Study Simulations

A2. CH2M Hill 2021b, Discharge Options Study: Model Update and Revised Enhanced Remedial Alternatives Study Simulations

Enhanced Remedial Alternative Study Simulations, South El Monte and Whittier Narrows Operable Units, San Gabriel Valley Superfund Site, Los Angeles County, California

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DATE: March 11, 2021

PROJECT NUMBER 388672CH.DE.01

Introduction

CH2M (now a subsidiary of Jacobs), on behalf of the EPA, conducted groundwater flow and contaminant transport modeling in the hydraulically connected South El Monte Operable Unit (SEMOU) and Whittier Narrows Operable Unit (WNOU) of the San Gabriel Valley (SGV) Superfund Site, in Los Angeles County, California, as part of ongoing oversight of the SEMOU remedy.

EPA tasked CH2M with conducting this modeling to evaluate migration of volatile organic compound (VOC) contamination in the shallow and intermediate zones, while accounting for ongoing remedy operations and continued loading of VOC contamination into the aquifer from residual vadose zone sources within the SEMOU. The model results support an enhanced remedial alternatives study (ERAS), which EPA will use to evaluate a range of remedial options for addressing VOC contamination in SEMOU and WNOU groundwater. EPA coordinated closely with the California Department of Toxic Substances Control (DTSC) and the Regional Water Quality Control Board – Los Angeles District (RWQCB) throughout the modeling effort.

CH2M conducted the transport modeling for the SEMOU/WNOU ERAS in three phases, using tetrachloroethylene (PCE) as the representative VOC contaminant. CH2M conducted Phase 1 transport simulations to evaluate the approximate potential cleanup time for SEMOU and WNOU groundwater, assuming ongoing loading from residual vadose zone sources and continued operation of the interim SEMOU and WNOU remedies.

CH2M conducted Phase 2 transport simulations to assess more closely mass loading from the residual SEMOU vadose zone sources and evaluate how facility-specific vadose zone cleanup could potentially impact long-term groundwater cleanup in the two operable units (OUs). Phase 1 and 2 transport simulation results are included in an April 22, 2020, technical memorandum (TM) titled, Groundwater Flow and Contaminant Transport Modeling, South El Monte and Whittier Narrows Operable Units, San Gabriel Valley Superfund Site, Los Angeles County, California (CH2M, 2020). The April 2020 TM includes background information on the SEMOU/WNOU model, development of the contaminant transport model, and the residual mass estimates associated with the SEMOU vadose zone sources.

The Phase 1 and 2 transport modeling results provide the basis for the third phase of transport modeling, where CH2M conducted predictive simulations to evaluate five of the ERAS remedial alternatives. This TM documents the results of the third phase transport modeling. The TM is organized into the following sections:

- Description of the Contaminant Transport Model. Briefly describes the numerical model used to conduct the alternative simulations.
- ERAS Remedial Alternative Simulations. Describes the predictive simulations CH2M conducted to evaluate aquifer clean up in the SEMOU/WNOU under five of the ERAS remedial alternatives.
- Discussion. Briefly summarizes the ERAS remedial alternative simulation results.

1.0 Description of the Contaminant Transport Model

1.1 Transport Model Development for the Phase 1 and Phase 2 Simulations

CH2M developed the transport model by modifying the 2015 FEFLOW flow model for the SEMOU/WNOU area (CH2M, 2015). FEFLOW is a sophisticated modeling software that solves the governing groundwater flow and contaminant transport equations using a multidimensional, finite, element method (Diersch, Hans-Jörg G, 2014). CH2M documented the predictive contaminant transport model development details in the 2020 TM, which describes the Phase 1 and Phase 2 transport modeling activities (CH2M, 2020). Following is a summary of the Phase 2 contaminant transport model:

- The model domain consists of a triangular model mesh covering the entire San Gabriel Groundwater Basin (SGB) with refined elements in the SEMOU/WNOU area. The model boundaries align with the physical boundaries of the SGB. Boundary types include:
  - A specified flux boundary representing minor inflow into SGB from the adjacent Raymond Basin
  - A specified head boundary simulating outflow from the SGB into the Central Basin through Whittier Narrows
  - A specified head boundary simulating mountain-front recharge at the base of the San Gabriel Mountains
  - No-flow boundaries coinciding with the contact between alluvial deposits and bedrock outcrops
- CH2M has conceptualized the hydrostratigraphy of SGB in the SEMOU/WNOU area into three aquifer units, representing general vertical horizons:
  - Shallow Zone – This zone covers the depth interval from the water table to approximately 150 feet below ground surface (bgs).
  - Intermediate Zone – This zone represents the depth interval from approximately 150 to 600 feet bgs, inclusive of the fine-grained separating sequence in the SEMOU. To allow for a more refined evaluation of the Intermediate Zone, CH2M further divided it into the Upper Intermediate Zone (representing the approximate depth interval from 150 to 300 feet bgs), the Middle Intermediate Zone (representing the approximate depth interval from 300 to 450 feet bgs), and Lower Intermediate Zone (representing the approximate depth interval from 450 to 600 feet bgs).
  - Deep Zone – This zone covers the depth interval below 600 feet bgs.
- The FEFLOW model is composed of 12 layers that represent the conceptual units described above, with layers 1 and 2 representing the Shallow Zone, layers 3 and 4 representing the separating sequence, layers 5 to 8 representing the Intermediate Zone, and layers 9 to 12 representing the Deep Zone.
- Major aquifer stresses consist of groundwater inflow and outflow components. Model inflow includes recharge from precipitation, irrigation return flow, unlined sections of the Rio Hondo and San Gabriel River channels, Legg Lakes, and spreading basins. Model outflow includes pumping from

municipal production wells and remedy extraction wells and groundwater flow out of the SGB into the Central Basin.

- CH2M employed a 30-year simulation period for the predictive simulations of future contaminant transport, The inflow and outflow components for the conceptual 30-year future period are represented by a water budget compiled from historical data. For the inflow (recharge) components, CH2M used the estimated values for the 15-year period from 1999 through 2004. CH2M repeated the values from this 15-year period once to create the 30-year dataset needed for the simulations. For the production well pumping, CH2M used the pumping records from the 5-year period from 2009 to 2014 (representing the last 5 years of the FEFLOW model period); the team repeated these values 6 times to produce the assumed pumping distribution for the 30-year predictive simulation. CH2M assumed that the existing SEMOU and WNOU remedy wells would pump continuously at their target rates, as follows:
  - SEMOU – 5,850 gallons per minute (gpm) from Monterey Park Wells 5, 12, and 15 (3,680 gpm); San Gabriel Valley Water Company Wells 8C and 8D (1,300 gpm); and Golden State Water Company Wells San Gabriel 1 and San Gabriel 2 wells (870 gpm).
  - WNOU – 3,500 gpm from EW4-5 (2,500 gpm) and EW4-6 (1,000 gpm).
- The transport model incorporates transport processes, including advection, hydrodynamic dispersion, and sorption. Degradation of PCE during transport is not included.
- CH2M assigned key transport model parameter values, including: a) effective porosity at 0.12 for Shallow Zone model layers 1 and 2 and 0.25 for all other model layers; b) longitudinal dispersivity of 50 meters and transverse dispersivity of 0.5 meter throughout the model; and c) a retardation factor for PCE transport of 1.2 for Shallow Zone model layers 1 and 2 and 1.8 for the other model layers.
- CH2M based the initial PCE distribution in the predictive transport model on the interpreted depth-specific 2013 PCE contamination contours for the Shallow Zone, Upper Intermediate Zone, Middle Intermediate Zone, and Lower Intermediate Zone. CH2M digitized the mapped PCE concentration contours and assigned the associated contaminant mass to the corresponding model layers: Shallow Zone contamination to model slices 1 and 2, Upper Intermediate Zone contamination to slices 4 and 5, Middle Intermediate Zone contamination to slices 6 and 7, and Lower Intermediate Zone contamination to slice 8.
- To assess the potential impacts of ongoing PCE migration from the vadose zone below the 29 identified source zone facilities, CH2M conducted unsaturated vadose zone flow and transport modeling using Hydrus-1D to estimate mass loading mechanisms. Using the Hydrus-1D modeled PCE leakage concentrations, CH2M evaluated three different approaches to representing the PCE source term in the FEFLOW transport model and concluded that use of fixed nodal sources was the best method for representing mass loading from the vadose zone into the aquifer.
- CH2M evaluated the potential impact of future facility-specific vadose zone cleanup by assuming that mass flux concentrations reduced by 90 percent after the first 10 years of the simulation. The model results suggest that vadose cleanup efforts will have a limited impact on the simulated cleanup times and future PCE distribution in the aquifer. CH2M attributes this limited impact to the relatively small amount of residual mass estimated to be remaining in the vadose zone (about 418 kilograms) compared with the large mass already present in the aquifer (approximately 20,000 kilograms between the dissolved and sorbed phases).

1.2 Refinement of Transport Model in Phase 3 Simulation

Prior to initiating the Phase 3 modeling to evaluate selected ERAS remedial alternatives, CH2M, in coordination with EPA and DTSC, further refined the transport model developed for Phases 1 and 2, as follows:

- CH2M further refined model representation of the Intermediate Zone by evenly dividing model layers 5 (Upper Intermediate), 6 (Middle Intermediate), and 7 (Lower Intermediate) into two layers each.
- CH2M refined the vertical pumping distribution from WNOU remedy wells and production wells that had screens spanning multiple model layers. CH2M identified and changed the active pumping wells into multiple-layer pumping (MLP) wells. Previously, the model assigned a pre-defined vertical pumping allocation based on the relative transmissivity distribution among the different model layers. MLP wells represent vertical conduits with specified radii and well screen tops and bottoms. For MLP wells, the vertical allocation of pumping is dynamically assigned by the model throughout the simulation, accounting for both transmissivity and simulated hydraulic head distributions. CH2M converted the following pumping wells into MLP wells:
  - WNOU remedy wells EW4-5, EW4-6, and EW4-7
  - Suburban Water Systems production wells 201W7, 201W8, 201W9, and 201W10
  - The City of Whittier production wells W8, W13, W14, W15, W16, W17, and W18
  - Central Basin production wells CB-1 and CB-2
  - Rose Hills Memorial Park Association wells Rose Hill 01, Rose Hill 03, and Rose Hill 04

  CH2M had previously converted the active SEMOU remedy wells and production wells to MLP wells (CH2M, 2015).
- CH2M removed the additional recharge that had been applied along a section of Mission Creek to account for overflows to Mission Creek from Legg Lakes. The reduction was based on the assumption that future discharges from the WNOU remedy to Legg Lakes will be lower; therefore, overflow from Legg Lakes into Mission Creek will be lower.

2.0 Simulations of ERAS Remedial Alternative

For the Phase 3 transport modeling, CH2M simulated future contaminant transport conditions under five of the ERAS remedial alternatives. Except for the model refinements described in Section 1.2, the set up of the Phase 3 transport model remained largely the same as the Phase 2 transport model, including the same representation of inflow and outflow components, transport parameters, and initial PCE distribution. CH2M used fixed mass nodal sources to represent the continued loading from residual vadose zone PCE sources in the SEMOU. For the simulations of all five remedial alternatives, CH2M assumed future facility-specific vadose zone cleanup will reduce the PCE mass migrating into groundwater by 90 percent after the first 10 years of the simulation.

The five ERAS remedial alternatives we simulated are:

- Alternative No. 2: No Further Action, assumes continued operation of the interim SEMOU and WNOU remedies.
- Alternative No. 4: Alternative No.2 (Interim SEMOU and WNOU remedies), along with expanded pumping at the southern end of the SEMOU to enhance WNOU cleanup.
- Alternative No. 5: Alternative No. 4, plus reinjection to further enhance WNOU cleanup.

- Alternative No. 6: Alternative 2, plus expanded pumping in the SEMOU to target an enhanced cleanup timeframe of less than 70 years.
- Alternative No. 7: Alternative 2, plus expanded pumping in the SEMOU to target an enhanced and accelerated cleanup timeframe of less than 40 years.

Table 1[1] provides details on the assumed remedy well pumping rates for each remedial alternative. Table 1 also summarizes changes to existing SEMOU and WNOU production well pumping in association with remedial alternative end use assumptions.

3.0 Discussion

Figures 1a to 1d[2] through Figures 5-2a to 5-2d show the simulated PCE concentration contours for the shallow, upper intermediate, middle intermediate, and lower intermediate zones at the end of the simulations for Alternatives 2, 4, 5, 6, and 7.

At the end of 30 years in all the simulation results, a relatively large contaminant plume remains in the Shallow Zone and Upper Intermediate Zone to the east/northeast of the main area of contamination in the SEMOU. This eastern plume is the result of mass loading from the former Hytone Cleaners facility, where DTSC is currently implementing site-specific cleanup actions. Considering DTSC's efforts, the simulations likely overestimate the extent of contamination originating from the Hytone facility.

3.1 Alternative 2

The results of the predictive contaminant transport simulations show the following predicted results at the end of the 30-year simulation:

- In the Shallow Zone, a broad area of contamination remains, exceeding the maximum contaminant level across much of the SEMOU (Figure 1a). The Shallow Zone contamination also migrates further into the WNOU, but does not reach the WNOU remedy wells.
- The model predicts that the Upper Intermediate Zone contamination is contained by remedy well pumping in the WNOU and the western portion of the SEMOU (Figure 1b).
- As shown in Figures 1c and 1d, the model predicts that the contamination in the middle and lower intermediate zones will migrate beyond the WNOU remedy wells and into the Central Basin. This predicted lack of containment occurs in the western WNOU. This is different than current conditions, where it appears that some deeper contamination could potentially move beyond the WNOU extraction wells at the eastern end of the wellfield.

3.2 Alternative 4

The results of the predictive contaminant transport simulations show the following predicted results at the end of the 30-year simulation:

- For the Shallow Zone, Alternative 4 results are like the Alternative 2 results, except that the new pumping in the SEMOU near the 60 Freeway effectively limits future migration into the WNOU Shallow Zone (Figure 2a).
- As illustrated in Figures 2b through 2d, the model results show some residual contamination in the WNOU in all three Intermediate Zone depth intervals. However, the new southern SEMOU pumping

[1] Table provided at the end of this TM, behind the "Table" divider.

[2] All figures appear at the end of this TM, behind the "Figures" divider.

appears to effectively limit migration of new contamination into WNOU. The residual WNOU contamination has a small footprint and does not reach the WNOU remedy wells.

3.3 Alternative 5

The results of the 30-year predictive contaminant transport simulations for Alternative 5 (Figures 3a through 3d) are very similar to the results shown for Alternative 4 (Figures 2a through 2d). After 30 years, the additional injection of treated water on the upgradient side of the WNOU under Alternative 5 results in slightly less Intermediate Zone contamination remaining in WNOU, compared to Alternative 4.

3.4 Alternative 6

CH2M has included two sets of predictive contaminant transport simulation results for Alternative 6. The results, presented in Figures 4-1a through 4-1d, show the predicted contamination after 30 years to allow for direct comparison to Alternatives 2, 4, and 5. The simulation results provided in Figures 4-2a through 4-2d show the simulated contaminant distribution after 60 years. The second set of results shows the extent of contamination remaining near the end of the target cleanup time of 60 to 70 years under this alternative. The 30-year results demonstrate the significant progress towards cleanup provided by the 5,500 gpm of additional remedy pumping incorporated into Alternative 6. Figures 4-2a through 4-2d show that after 60 years almost no contamination remains above 10 micrograms per liter and the footprint of the remaining contamination between 5 and 10 micrograms per liter is limited. For these simulations, the remedy pumping rate at each extraction well location remains fixed throughout the simulation period. Considering the significant reduction in the lateral and vertical distribution of contamination over time, Alternative 6 could very likely lead to the full cleanup of the SEMOU/WNOU area if the pumping rates were optimized over time. For example, pumping from wells in areas that clean up over time could be reduced or eliminated, and the pumping could be shifted to locations where contamination remains.

3.5 Alternative 7

As with Alternative 6, CH2M has included two sets of predictive contaminant transport simulation results for Alternative 7. The simulation results presented in Figures 5-1a through 5-1d show the predicted contamination after 30 years to allow for direct comparison to Alternatives 2, 4, 5, and 6. The simulation results shown in Figures 5-2a through 5-2d show the simulated contaminant distribution after 40 years. The 40-year results show the extent of contamination remaining at the end of the Alternative 7 target cleanup time.

The 30-year results demonstrate the additional progress toward cleanup provided by the 9,000 gpm of additional remedy pumping incorporated into Alternative 7, compared to the 5,500 gpm of new pumping included in Alternative 6. The additional progress after 30 years is most apparent in the Intermediate Zone (Figures 5-1b through 5-1d). Figures 5-2a through 5-2d show that almost no Intermediate Zone contamination remaining after 40 years under Alternative 7 (except the Hytone-related plume in the Upper Intermediate Zone). Although the simulation results predict that there will still be non-Hytone Shallow Zone contamination remaining after 40 years (Figure 5-2a), the limited amount of contamination left in the Intermediate Zone indicates that more pumping could be shifted from the Intermediate Zone up to the Shallow Zone over time. With periodic refinement of the pumping distribution over time, cleanup of the SEMOU/WNOU area very likely could be completed within 40 years under Alternative 7.

4.0 References

CH2M. 2011. Whittier Narrows OU Groundwater Flow Model Update and Contaminant Transport Simulations. Technical Memorandum prepared for U.S. Environmental Protection Agency (EPA), Region 9. July.

CH2M. 2015. Modeling Evaluation of the SEMOU Interim Remedy Target Pumping Rates. Technical Memorandum prepared for U.S. Environmental Protection Agency (EPA), Region 9. July.

CH2M. 2020. Groundwater Flow and Contaminant Transport Modeling, South El Monte and Whittier Narrows Operable Units, San Gabriel Valley Superfund Site, Los Angeles County, California. Technical Memorandum prepared for U.S. Environmental Protection Agency (EPA), Region 9. April.

Diersch, Hans-Jörg G. 2014. FEFLOW – finite element modeling of Flow, Mass and Heat Transport in Porous and Fractured Media. Springer, Berlin Heidelberg, XXXV.

Table

Table 1. Summary of Assumed Pumping Rates for Selected ERAS Remedial Alternatives

Alt. #	Alternative Description	Remedy Pumping: SEMOU	Remedy Pumping: WNOU	End Use
2	No Further Action (continue interim containment remedies)	5,850 gpm: MP (central)- 3,550 gpm (MP12-1,800; MP15-1,750) SGVWC 8C/8D- 1,300 gpm GSWC SG1/SG2- 870 gpm MP (western)- MP5- 130 gpm	3,500 gpm: EW4-6- 1,000 gpm EW4-5- 2,500 gpm	SEMOU- no change WNOU- 2,000 gpm to SGVWC, 700 gpm to Whittier, 800 gpm to Legg Lakes
4	Interim or optimized containment remedies plus expanded SEMOU pumping to enhance WNOU cleanup	Alt 2 Plus 2,500 gpm: Ext 1- 500 gpm SZ; 600 gpm UIZ; 300 gpm MIZ Ext 2- 500 gpm UIZ Ext 4- 600 gpm UIZ	Same as Alt 2	1,000 gpm to MP (Turn off MP1, MP3, MP10, Fern) 400 gpm to GSWC (Turn off Garvey #3) 350 gpm to SGVWC (Turn off G4, 8F) 750 gpm to injection at WNOU EW4-3/EW4-4
5	Alternative 4 plus reinjection to further enhance WNOU cleanup	Same as Alt 4	Same as Alt 2	500 gpm to Whittier (Shut. Whittier 15) 1,500 gpm injection in UIZ near 60 Freeway 500 injection to EW4-3/EW4-4
6	WNOU and SEMOU Enhanced Cleanup	Alt 2 Plus 5,500 gpm: Ext 1- 200 gpm SZ; 1,100 gpm UIZ Ext 2- 200 gpm UIZ Ext 3- 400 gpm SZ; 300 gpm UIZ Ext 5- 350 gpm SZ Ext 7- 200 gpm SZ; 700 gpm UIZ Ext 8- 250 gpm SZ Ext 9- 600 gpm UIZ Ext 10- 200 gpm SZ MP-15- 500 gpm more from IZ SGVWC 8C- 500 gpm more from IZ	2,800 gpm: EW4-6- 2,100 gpm EW4-5- 700 gpm	3,000 gpm to purveyors: 1,000 gpm to MP (Turn off MP1, MP3, MP10, Fern) 400 gpm to GSWC (Turn off Garvey #3) 350 gpm to SGVWC (Turn off G4, 8F) 1,250 gpm to Whittier (Reduce Well 15) 2,500 gpm injection: 1,750 injection in UIZ near 60 Freeway 750 gpm to injection at WNOU EW4-3/EW4-4
7	WNOU and SEMOU Enhanced and Accelerated Cleanup	Alt 2 Plus 9,500 gpm: Ext 1- 500 gpm SZ; 1,300 gpm UIZ; 500 gpm MIZ Ext 2- 500 gpm UIZ Ext 3- 600 gpm SZ; 500 gpm UIZ; 300 gpm MIZ Ext 5- 350 gpm SZ Ext 7- 200 gpm SZ; 700 gpm UIZ; 400 gpm MIZ Ext 8- 250 gpm SZ Ext 9- 400 gpm SZ; 800 gpm UIZ; 300 gpm MIZ Ext 10- 200 gpm SZ MP-12- 700 gpm more from IZ MP-15- 500 gpm more from IZ SGVWC 8C- 500 gpm more from IZ	Same as Alt 6	7,000 gpm to purveyors: 1,000 gpm to MP (Turn off MP1, MP3, MP10, Fern) 400 gpm to GSWC (Turn off Garvey #3) 350 gpm to SGVWC (Turn off G4, 8F) 1,492 gpm to Whittier (Turn off Well 15) 3,758 to Suburban (Turn off 201W7 and 201W10; reduce 201W9 by 435 gpm) 2,500 gpm injection: 1,750 injection in UIZ near 60 Freeway 750 gpm to injection at WNOU EW4-3/EW4-4

Notes:
gpm = gallon per minute
GSWC = Golden State Water Company
IZ = Intermediate Zone
MIZ = Middle Intermediate Zone
MP = Monterey Park
SEMOU = South El Monte Operable Unit
SGVWC = San Gabriel Valley Water Company
SZ = Shallow Zone
UIZ = Upper Intermediate Zone
WNOU = Whittier Narrows Operable Unit

Figures

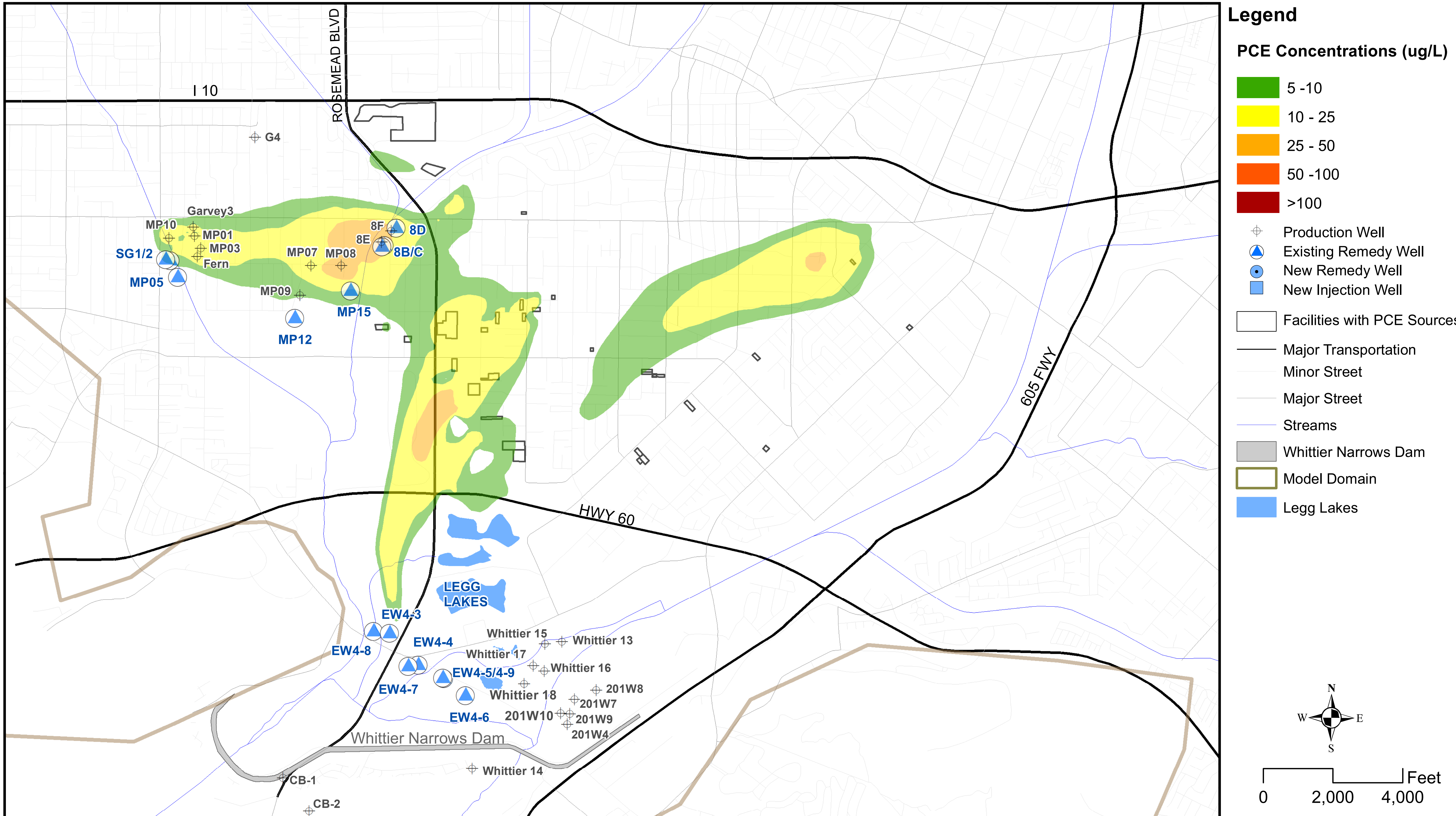

FIGURE 1a
Alternative 2
Simulated PCE Concentrations, Year 30
Shallow Zone (Slice 1)
South El Monte/Whittier Narrows OUs
San Gabriel Valley Superfund Sites
Los Angeles County, California

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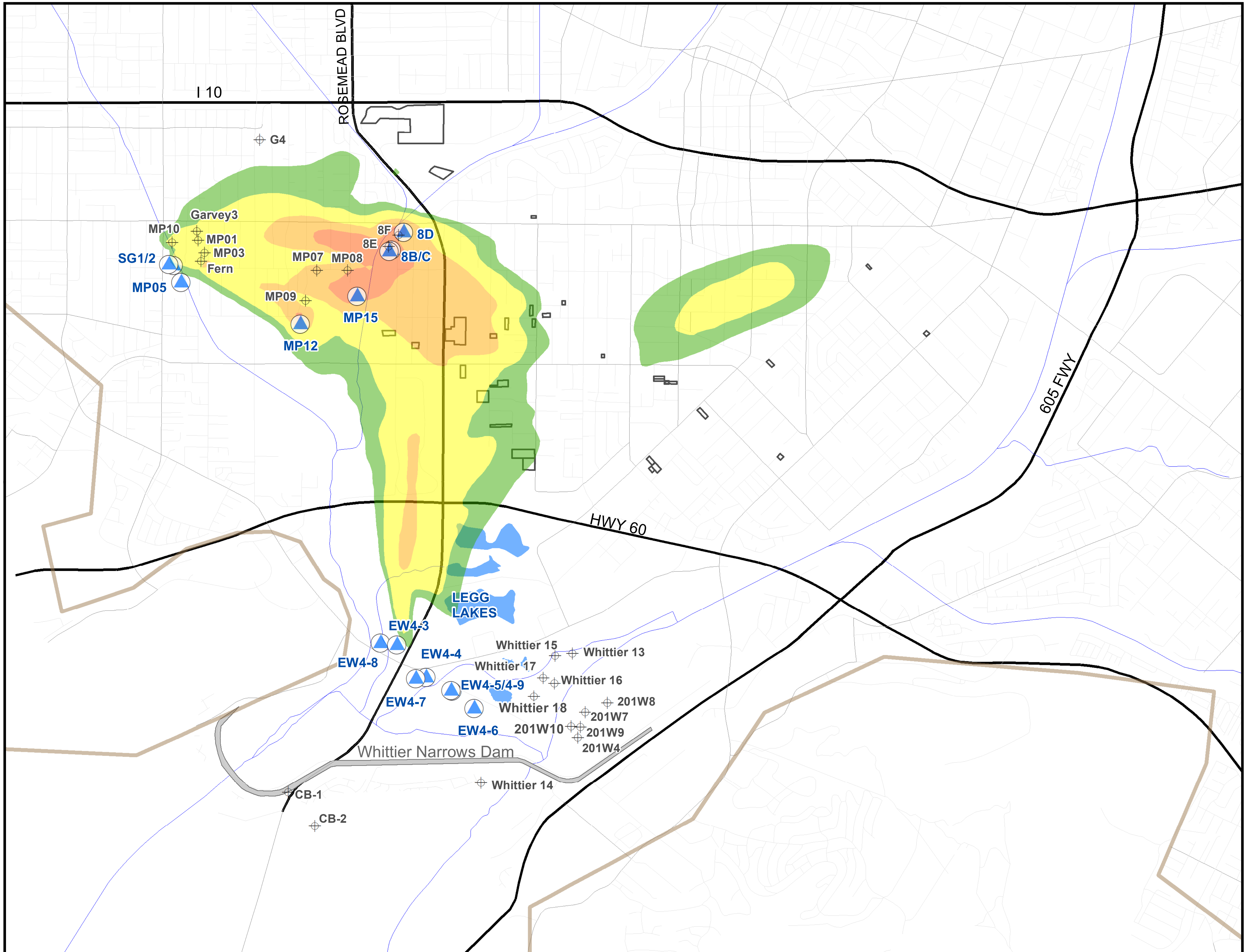

Legend

PCE Concentrations (ug/L)

- 5 -10
- 10 - 25
- 25 - 50
- 50 -100
- >100
- Production Well
- Existing Remedy Well
- New Remedy Well
- New Injection Well
- Facilities with PCE Sources
- Major Transportation
- Minor Street
- Major Street
- Streams
- Whittier Narrows Dam
- Model Domain
- Legg Lakes

FIGURE 1b
Alternative 2
Simulated PCE Concentrations, Year 30
Upper Intermediate Zone (Slice 4)
South El Monte/Whittier Narrows OUs
San Gabriel Valley Superfund Sites
Los Angeles County, California

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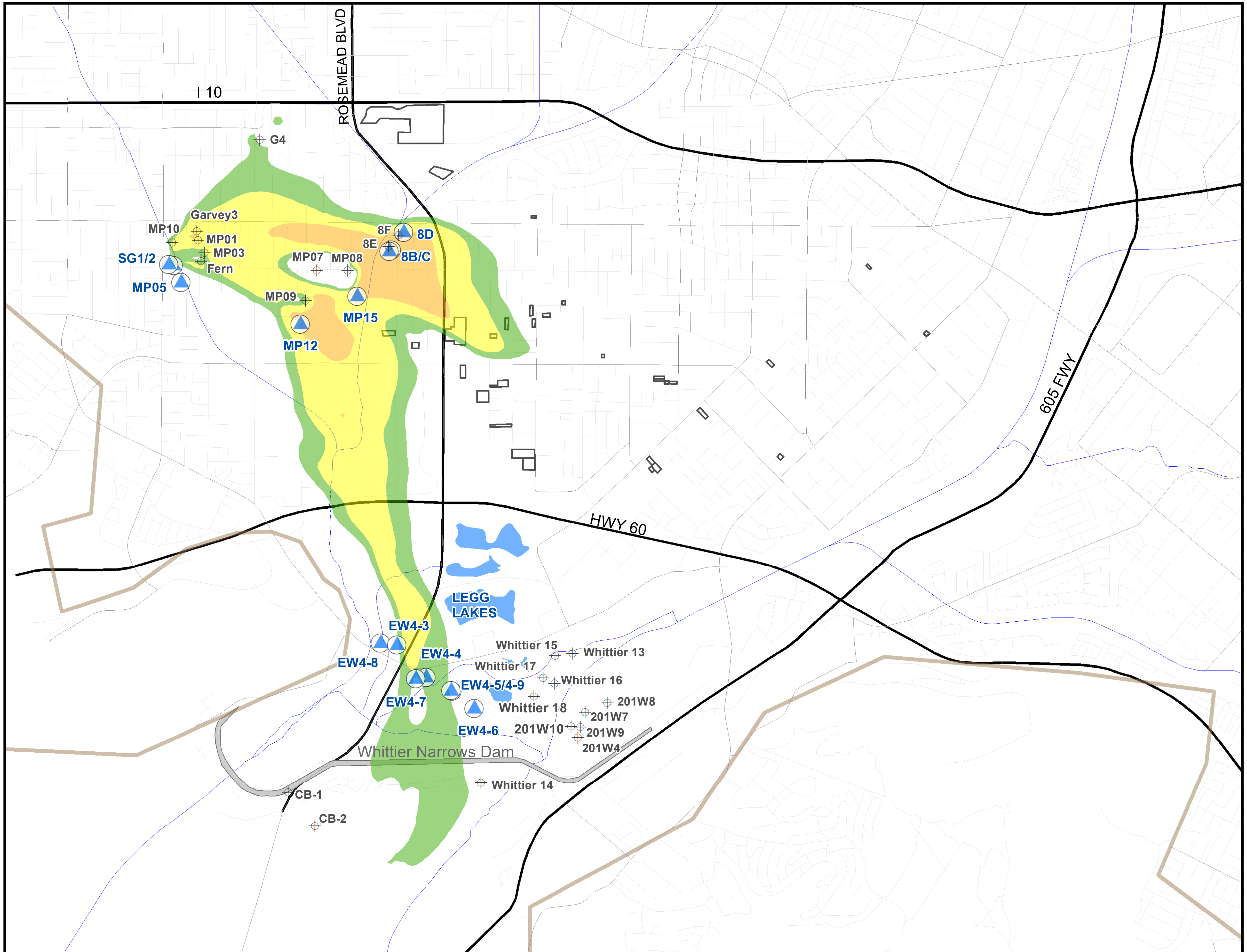

Legend

PCE Concentrations (ug/L)

- 5 -10
- 10 - 25
- 25 - 50
- 50 -100
- >100
- Production Well
- Existing Remedy Well
- New Remedy Well
- New Injection Well
- Facilities with PCE Sources
- Major Transportation
- Minor Street
- Major Street
- Streams
- Whittier Narrows Dam
- Model Domain
- Legg Lakes

N W E S

0 2,000 4,000 Feet

FIGURE 1c
Alternative 2
Simulated PCE Concentrations, Year 30
Middle Intermediate Zone (Slice 7)
South El Monte/Whittier Narrows OUs
San Gabriel Valley Superfund Sites
Los Angeles County, California

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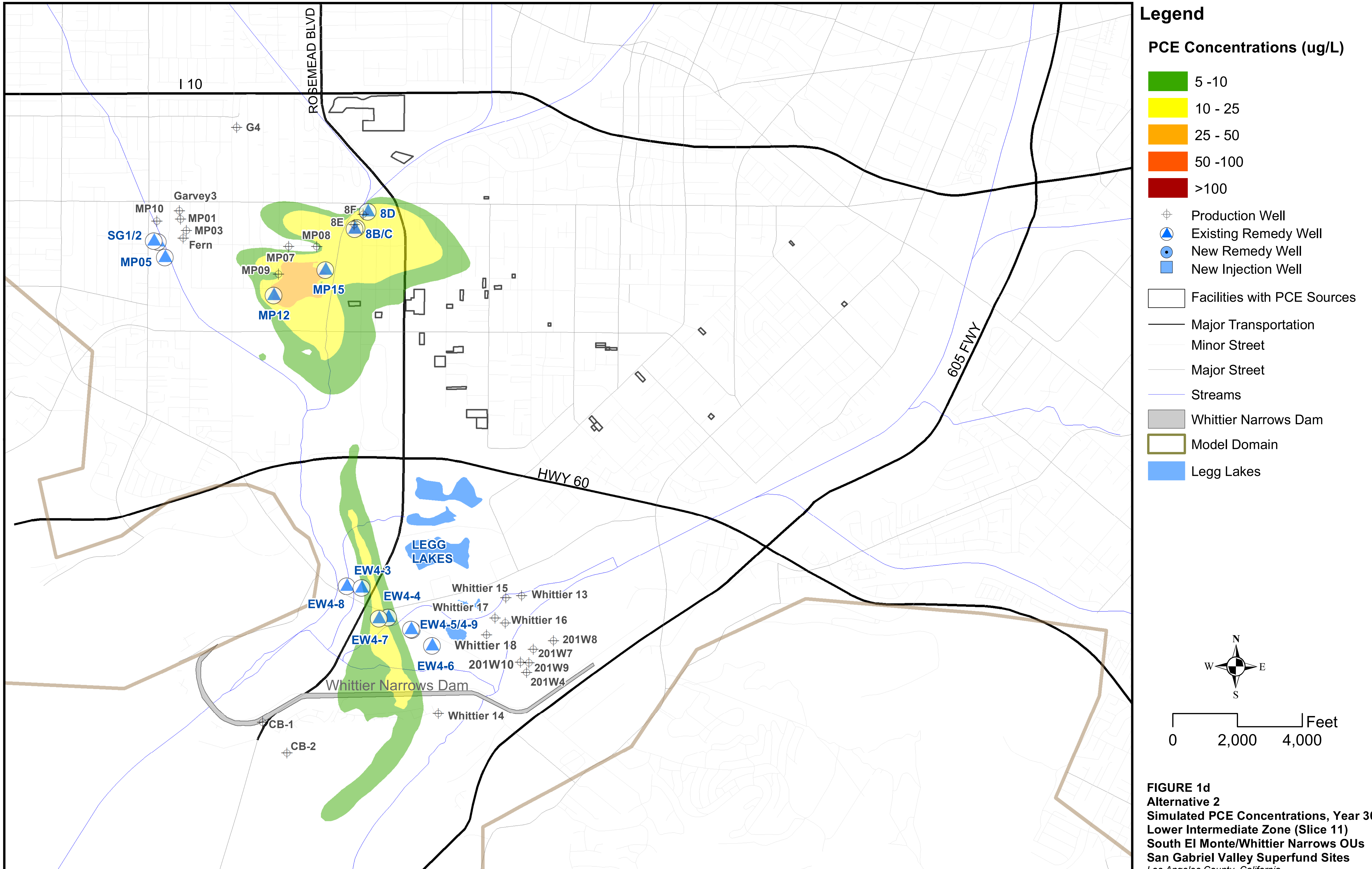

FIGURE 1d
Alternative 2
Simulated PCE Concentrations, Year 30
Lower Intermediate Zone (Slice 11)
South El Monte/Whittier Narrows OUs
San Gabriel Valley Superfund Sites
Los Angeles County, California

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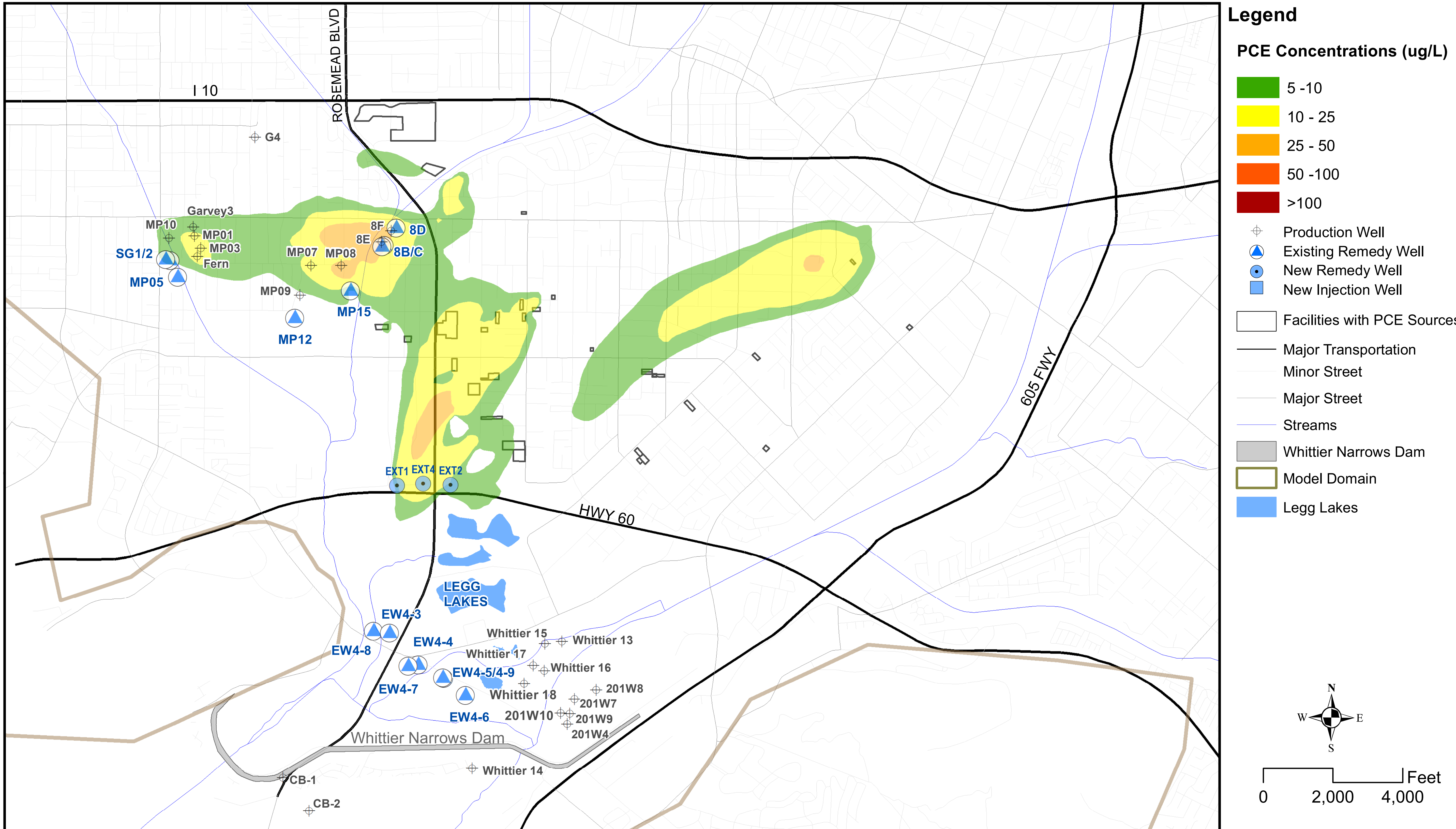

FIGURE 2a
Alternative 4
Simulated PCE Concentrations, Year 30
Shallow Zone (Slice 1)
South El Monte/Whittier Narrows OUs
San Gabriel Valley Superfund Sites
Los Angeles County, California

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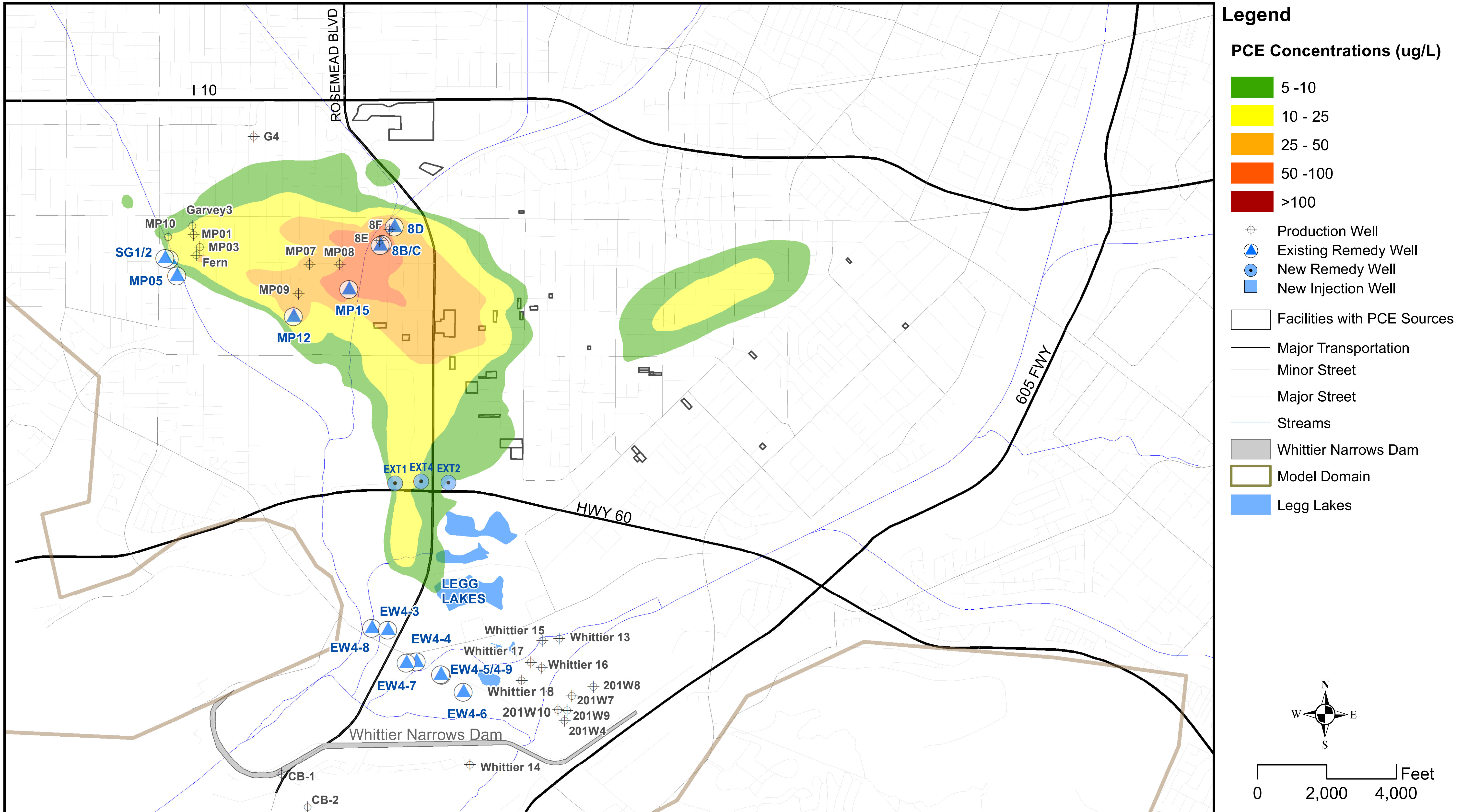
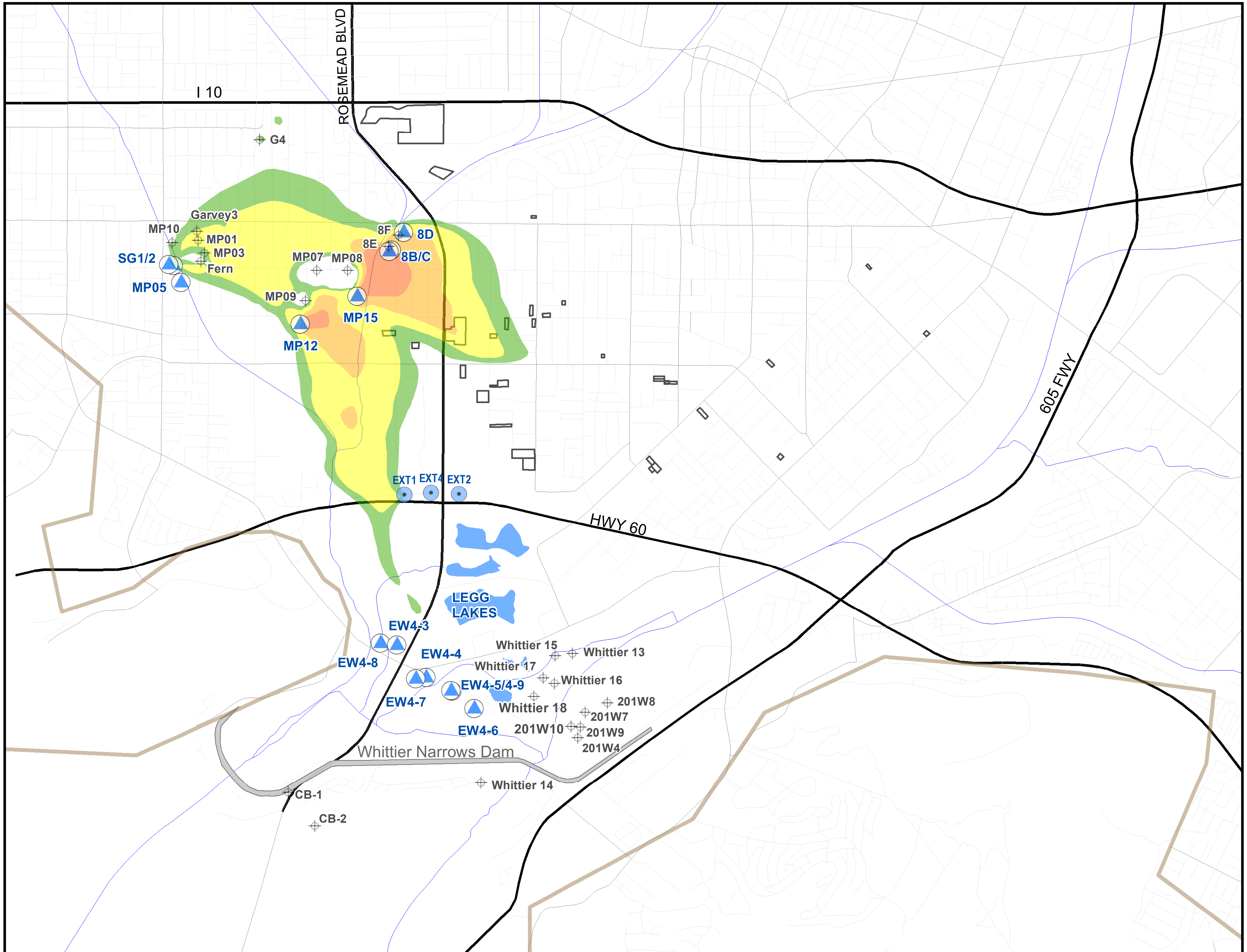


FIGURE 2b
Alternative 4
Simulated PCE Concentrations, Year 30
Upper Intermediate Zone (Slice 4)
South El Monte/Whittier Narrows OUs
San Gabriel Valley Superfund Sites
Los Angeles County, California



Legend

PCE Concentrations (ug/L)

- 5 -10
- 10 - 25
- 25 - 50
- 50 -100
- >100

- Production Well
- Existing Remedy Well
- New Remedy Well
- New Injection Well
- Facilities with PCE Sources
- Major Transportation
- Minor Street
- Major Street
- Streams
- Whittier Narrows Dam
- Model Domain
- Legg Lakes

N W E S

0 2,000 4,000 Feet

FIGURE 2c
Alternative 4
Simulated PCE Concentrations, Year 30
Middle Intermediate Zone (Slice 7)
South El Monte/Whittier Narrows OUs
San Gabriel Valley Superfund Sites
Los Angeles County, California

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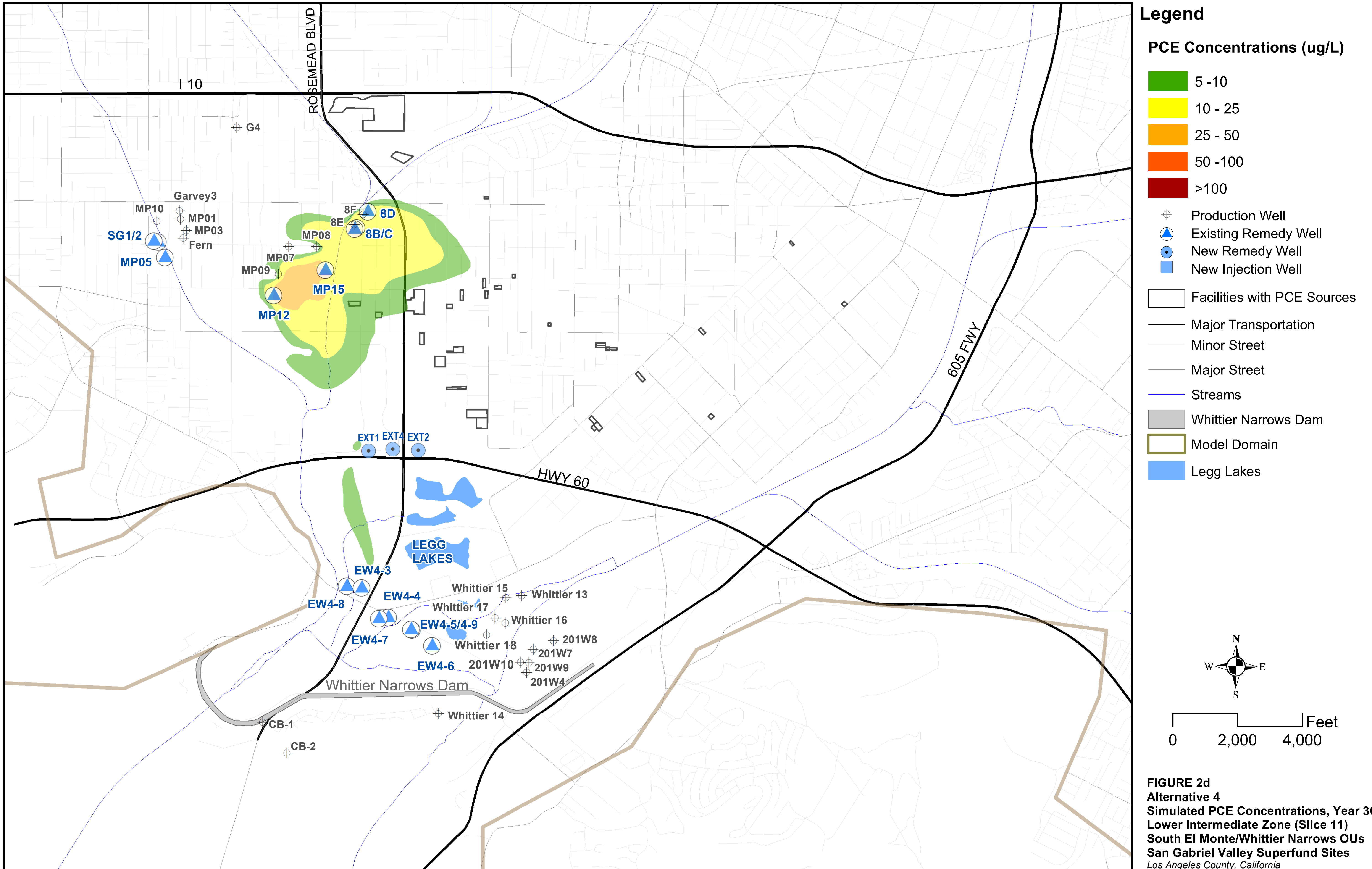

FIGURE 2d
Alternative 4
Simulated PCE Concentrations, Year 30
Lower Intermediate Zone (Slice 11)
South El Monte/Whittier Narrows OUs
San Gabriel Valley Superfund Sites
Los Angeles County, California

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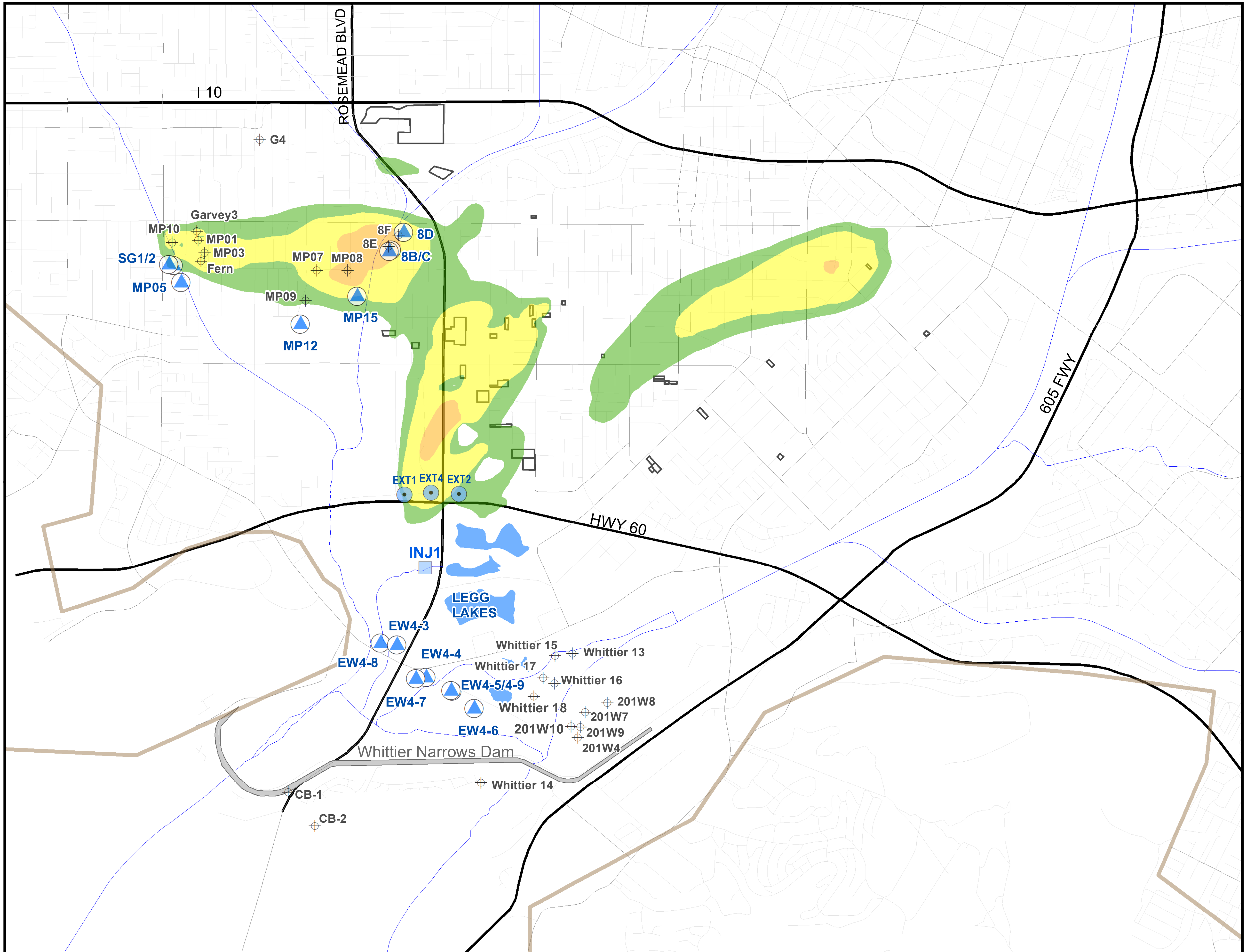

Legend

PCE Concentrations (ug/L)

- 5 -10
- 10 - 25
- 25 - 50
- 50 -100
- >100
- Production Well
- Existing Remedy Well
- New Remedy Well
- New Injection Well
- Facilities with PCE Sources
- Major Transportation
- Minor Street
- Major Street
- Streams
- Whittier Narrows Dam
- Model Domain
- Legg Lakes

N W E S

0 2,000 4,000 Feet

FIGURE 3a
Alternative 5
Simulated PCE Concentrations, Year 30
Shallow Zone (Slice 1)
South El Monte/Whittier Narrows OUs
San Gabriel Valley Superfund Sites
Los Angeles County, California

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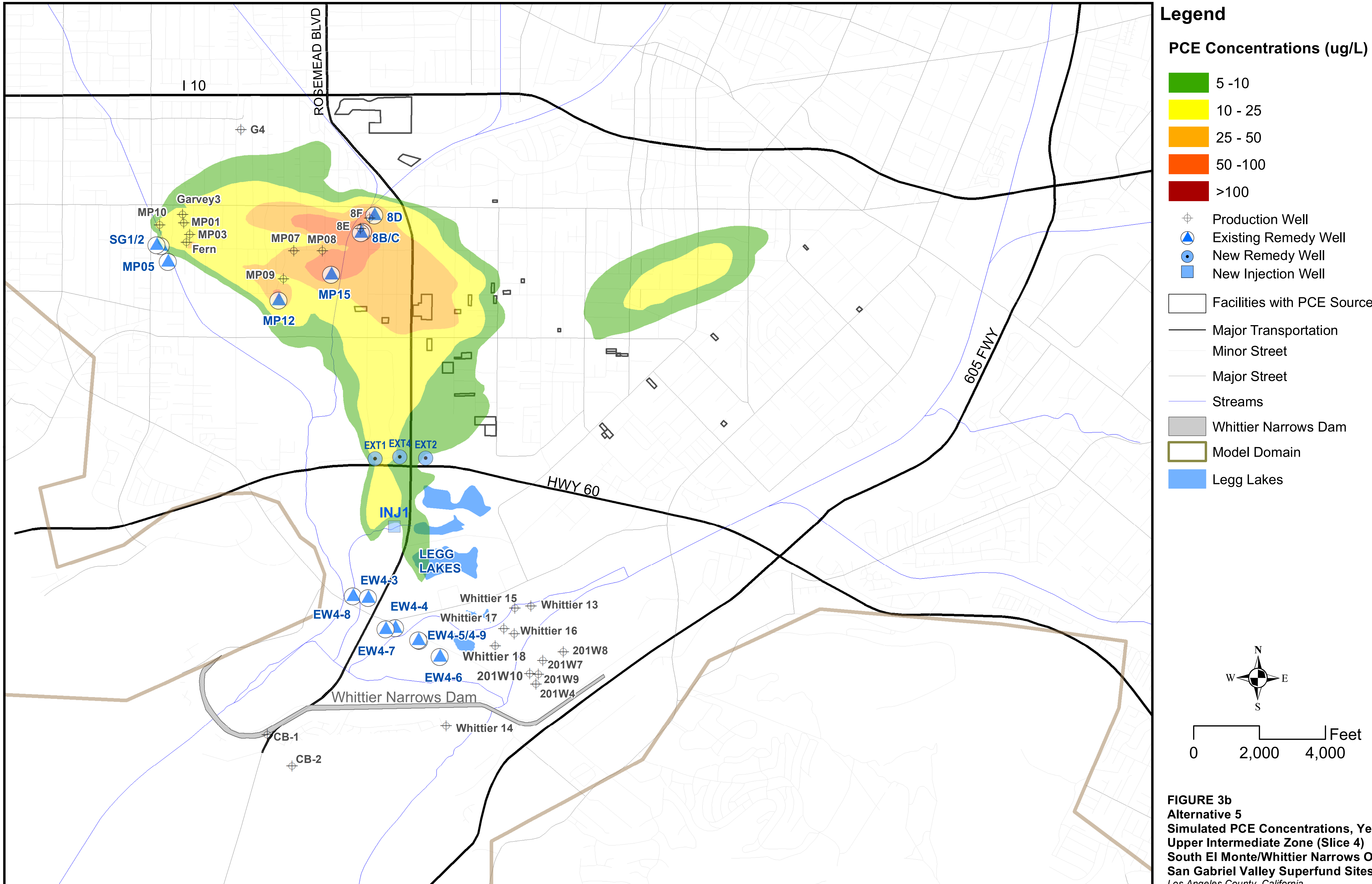

FIGURE 3b
Alternative 5
Simulated PCE Concentrations, Year 30
Upper Intermediate Zone (Slice 4)
South El Monte/Whittier Narrows OUs
San Gabriel Valley Superfund Sites
Los Angeles County, California

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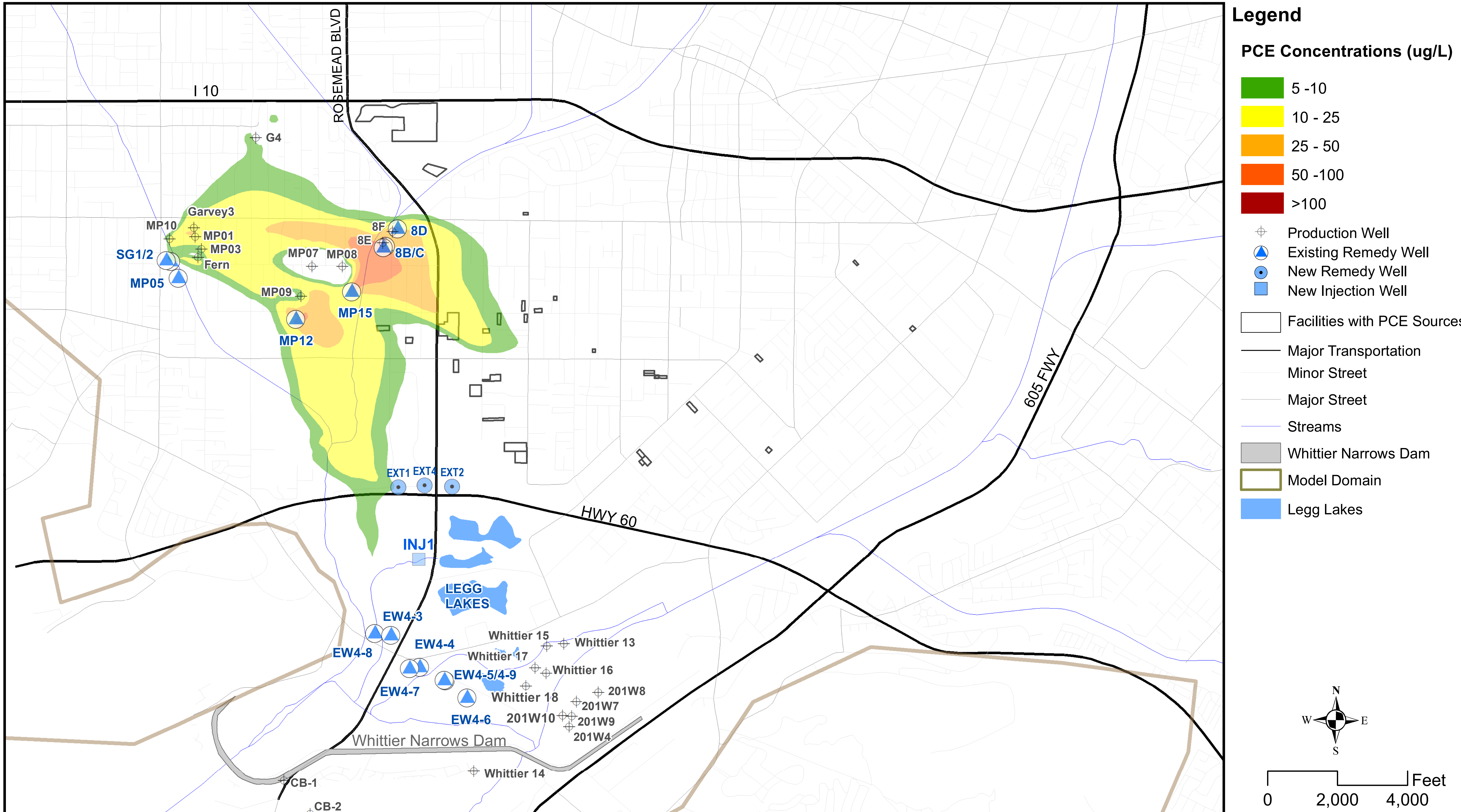

FIGURE 3c
Alternative 5
Simulated PCE Concentrations, Year 30
Middle Intermediate Zone (Slice 7)
South El Monte/Whittier Narrows OUs
San Gabriel Valley Superfund Sites
Los Angeles County, California

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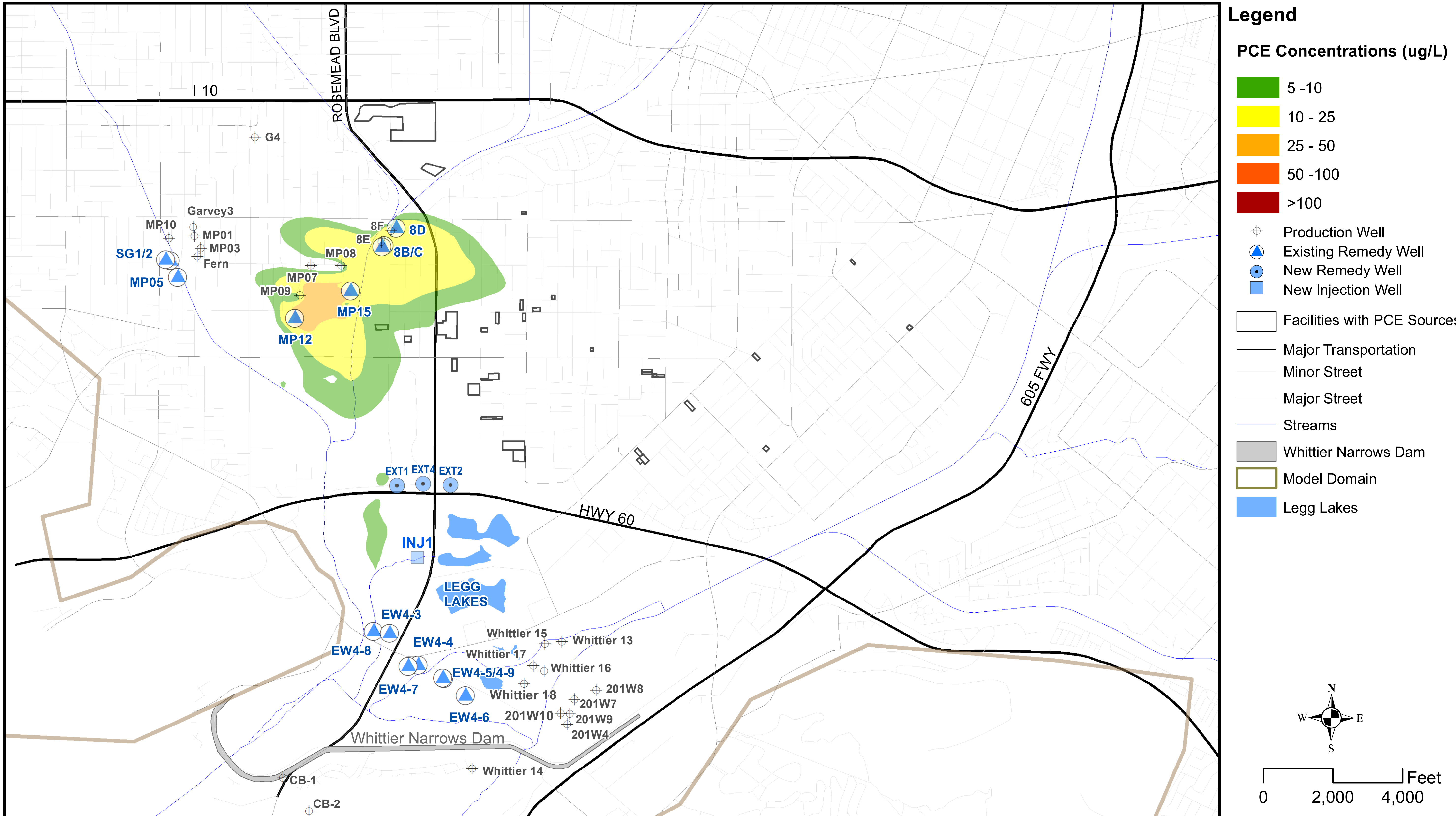

FIGURE 3d
Alternative 5
Simulated PCE Concentrations, Year 30
Lower Intermediate Zone (Slice 11)
South El Monte/Whittier Narrows OUs
San Gabriel Valley Superfund Sites
Los Angeles County, California

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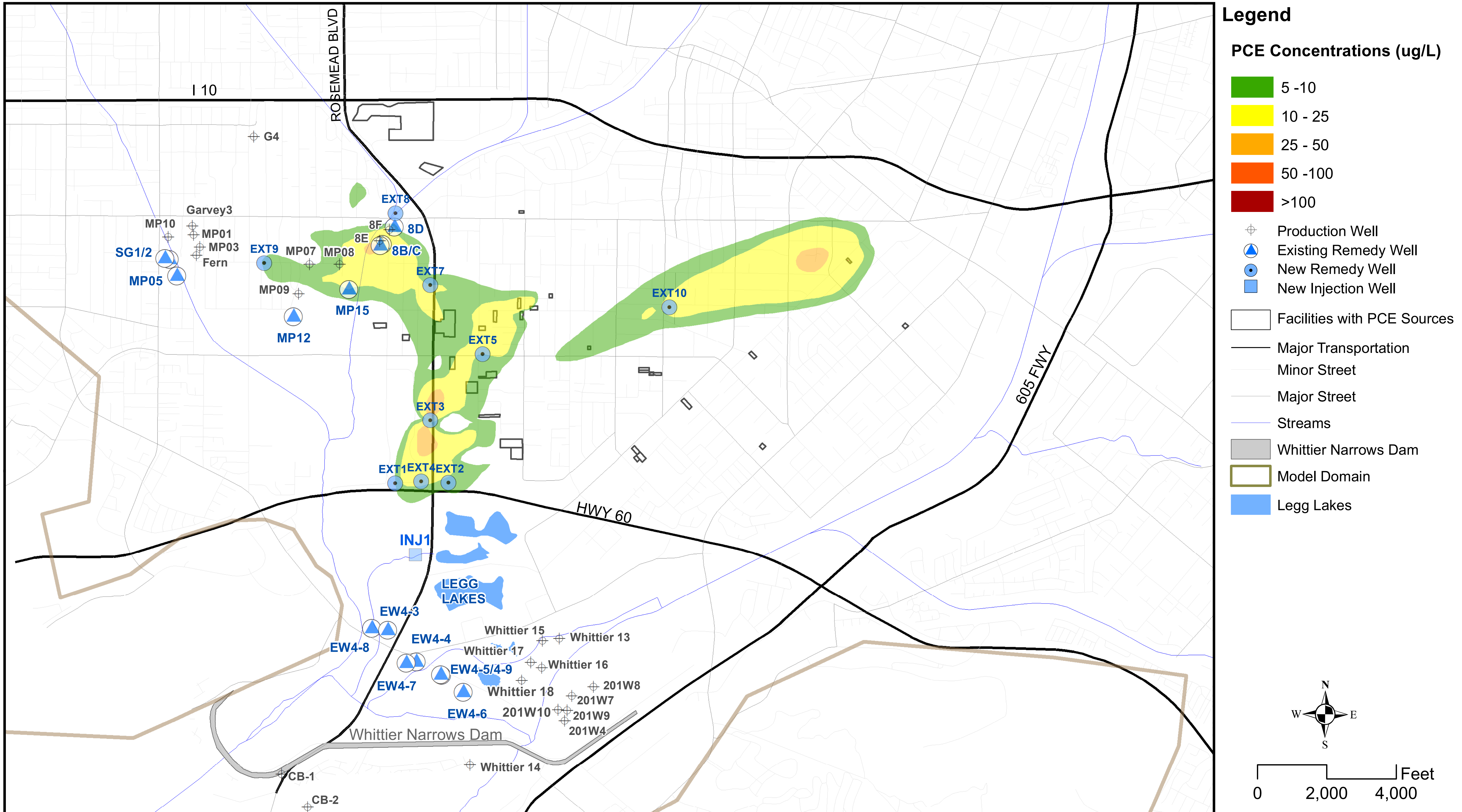

FIGURE 4-1a
Alternative 6
Simulated PCE Concentrations, Year 30
Shallow Zone (Slice 1)
South El Monte/Whittier Narrows OUs
San Gabriel Valley Superfund Sites
Los Angeles County, California

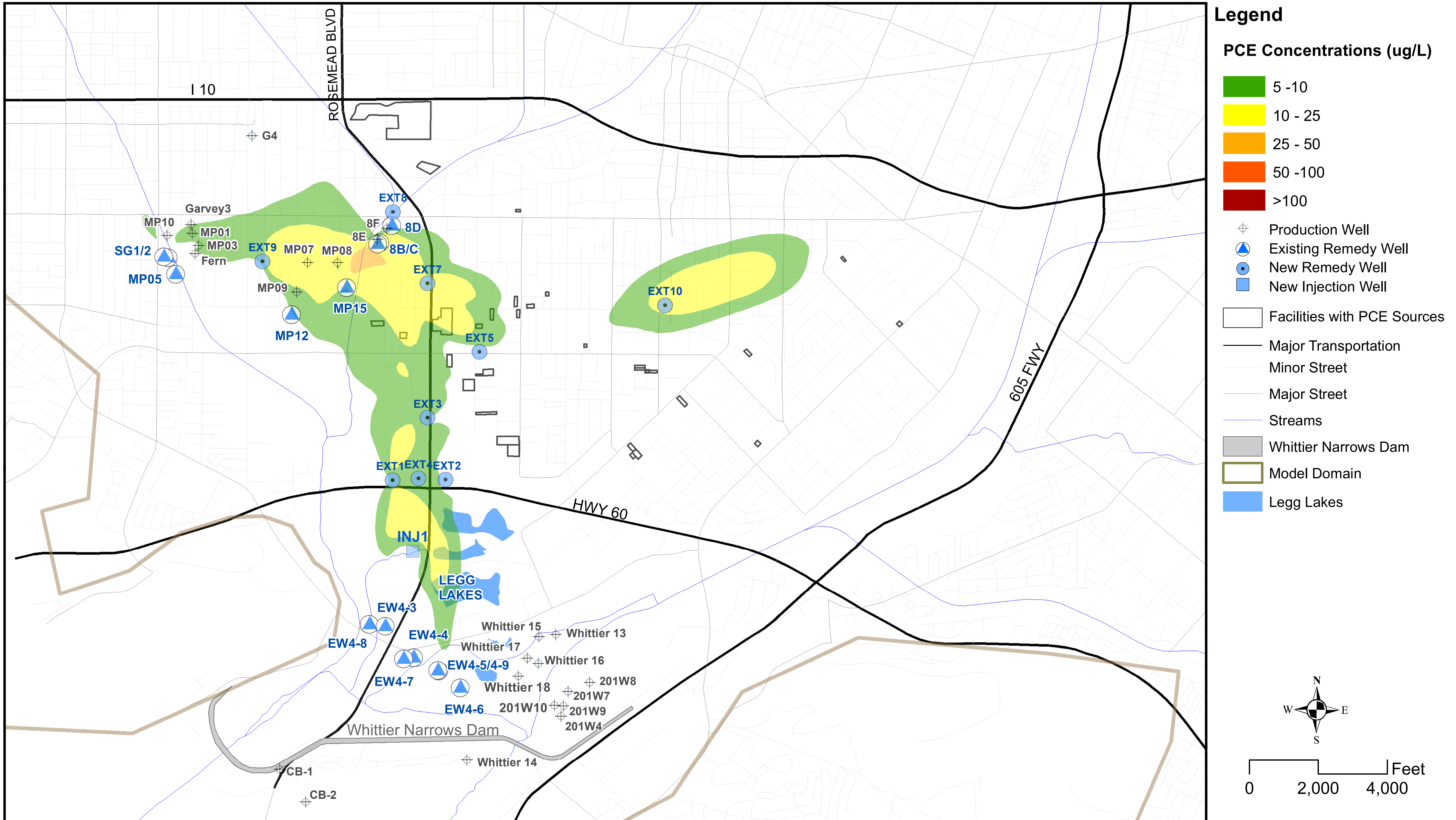

FIGURE 4-1b
Alternative 6
Simulated PCE Concentrations, Year 30
Upper Intermediate Zone (Slice 4)
South El Monte/Whittier Narrows OUs
San Gabriel Valley Superfund Sites
Los Angeles County, California

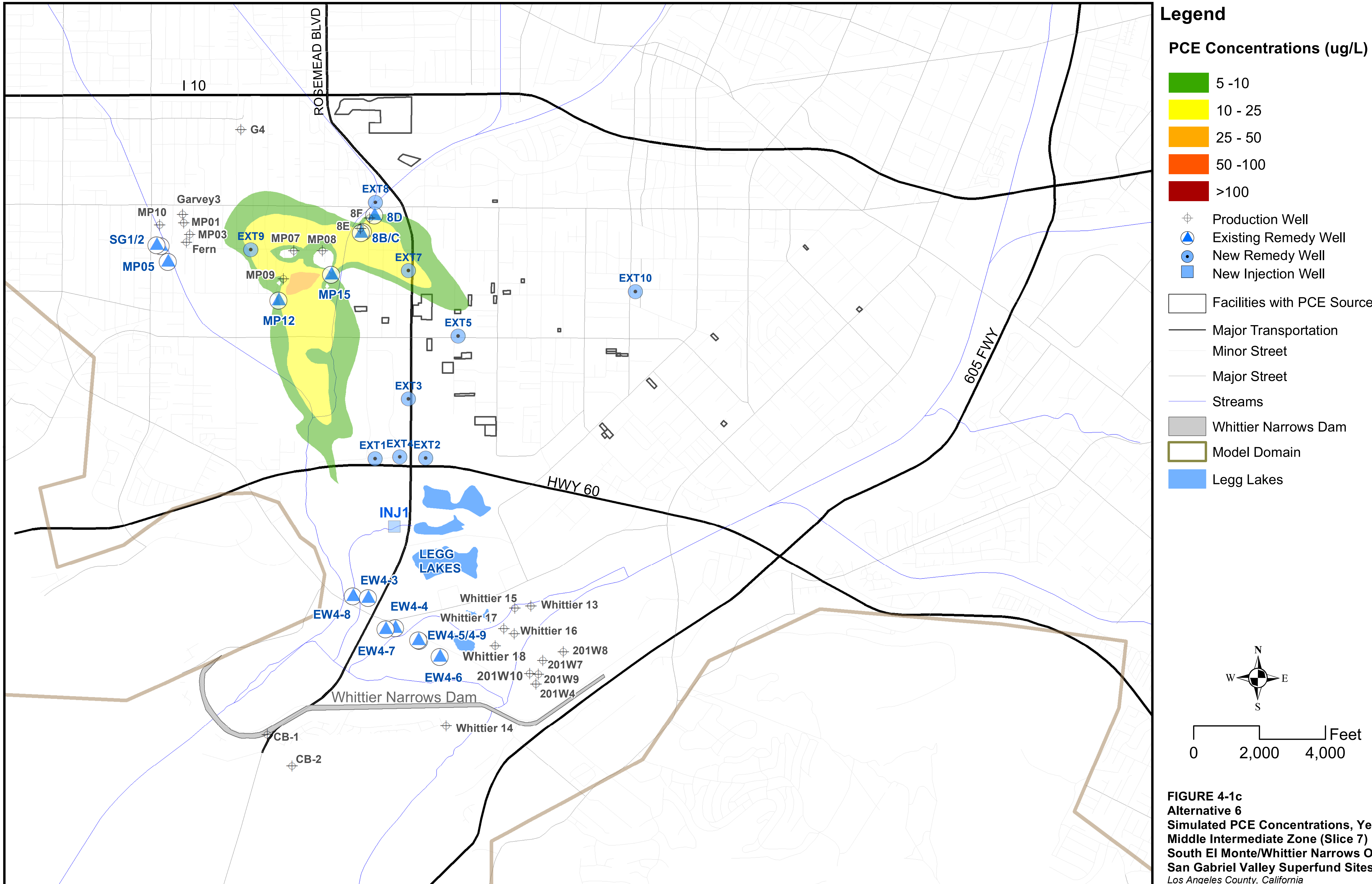

FIGURE 4-1c
Alternative 6
Simulated PCE Concentrations, Year 30
Middle Intermediate Zone (Slice 7)
South El Monte/Whittier Narrows OUs
San Gabriel Valley Superfund Sites
Los Angeles County, California

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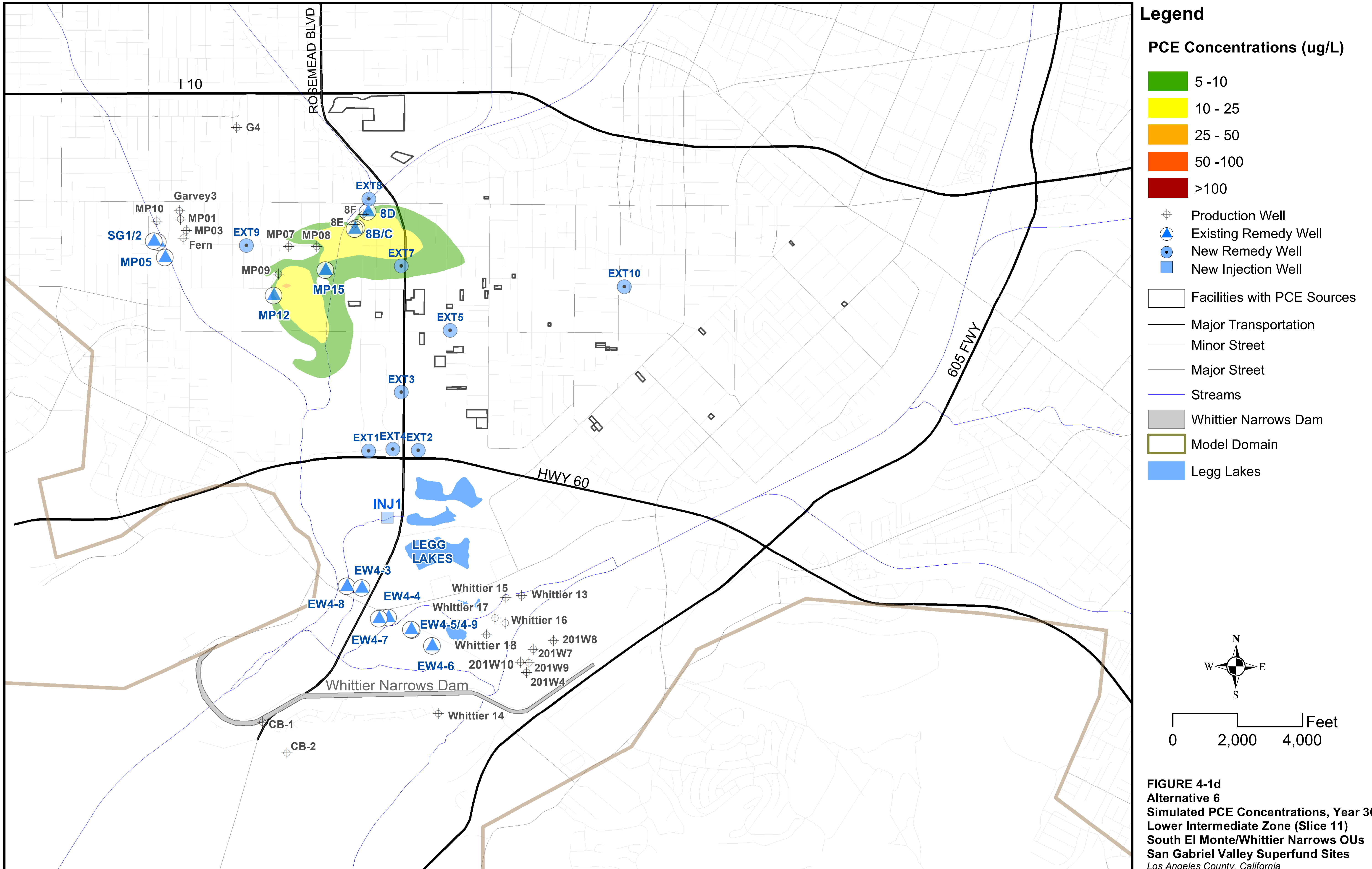

FIGURE 4-1d
Alternative 6
Simulated PCE Concentrations, Year 30
Lower Intermediate Zone (Slice 11)
South El Monte/Whittier Narrows OUs
San Gabriel Valley Superfund Sites
Los Angeles County, California

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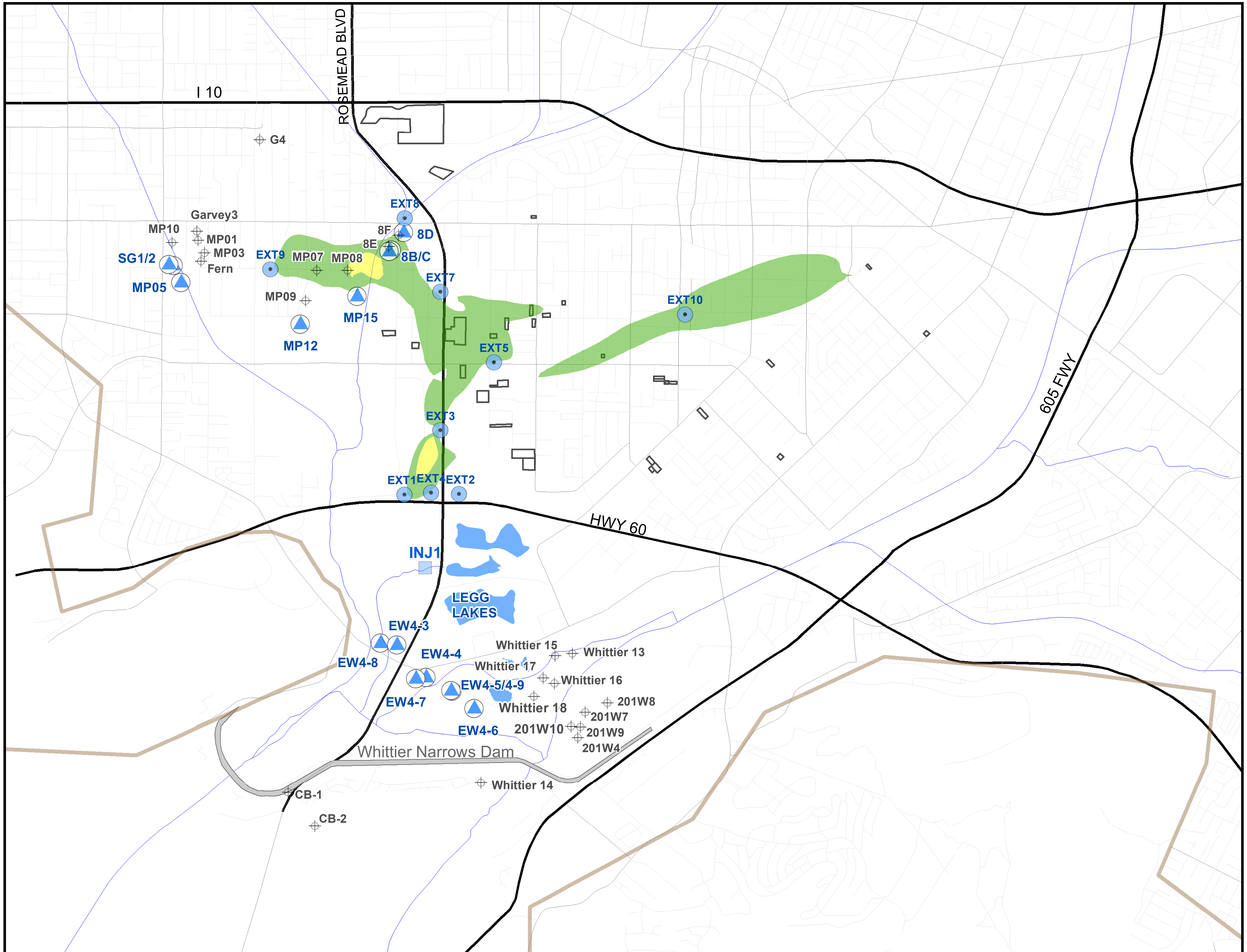

Legend

PCE Concentrations (ug/L)

- 5 -10
- 10 - 25
- 25 - 50
- 50 -100
- >100
- Production Well
- Existing Remedy Well
- New Remedy Well
- New Injection Well
- Facilities with PCE Sources
- Major Transportation
- Minor Street
- Major Street
- Streams
- Whittier Narrows Dam
- Model Domain
- Legg Lakes

FIGURE 4-2a
Alternative 6
Simulated PCE Concentrations, Year 60
Shallow Zone (Slice 1)
South El Monte/Whittier Narrows OUs
San Gabriel Valley Superfund Sites
Los Angeles County, California

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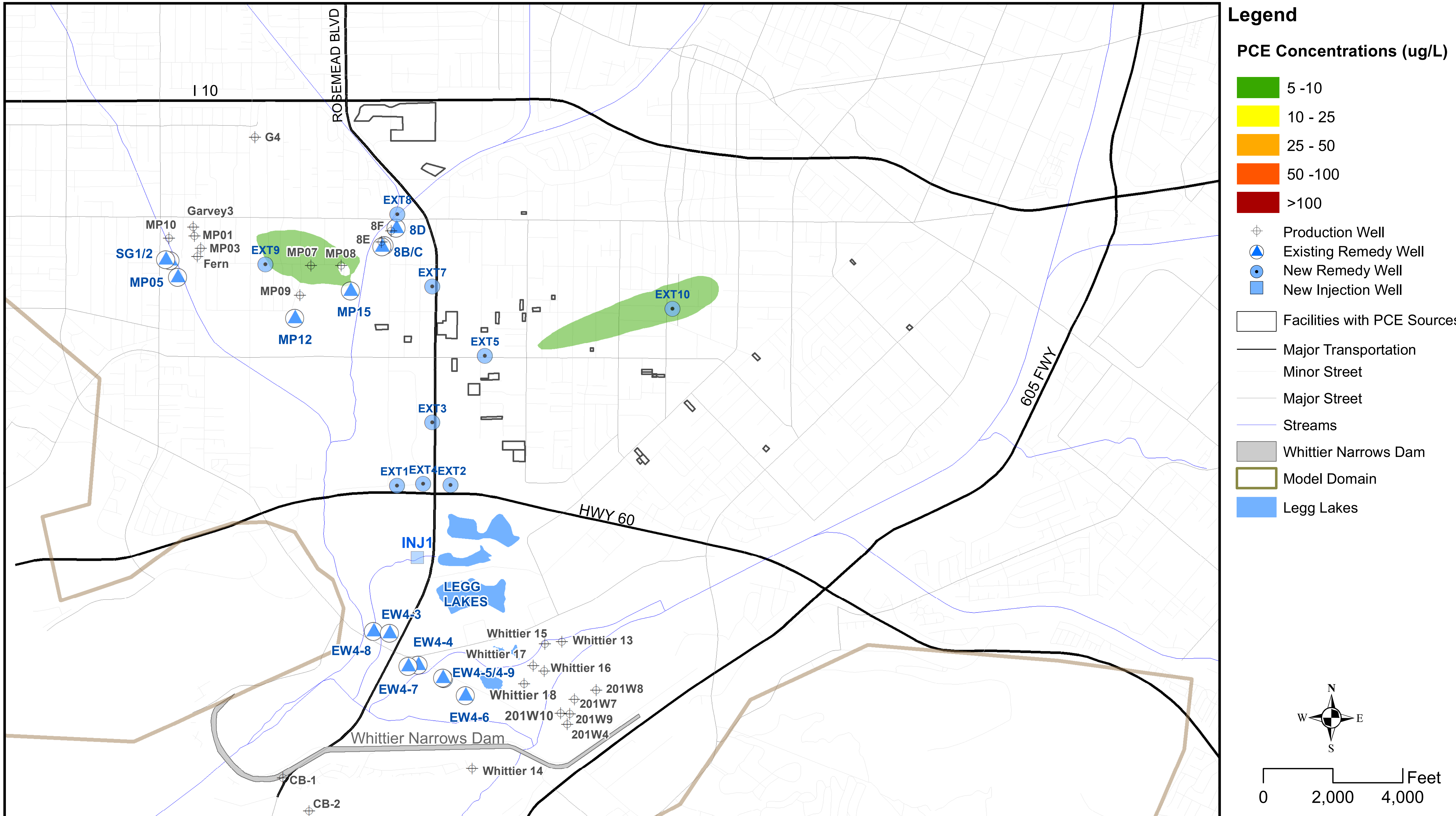

FIGURE 4-2b
Alternative 6
Simulated PCE Concentrations, Year 60
Upper Intermediate Zone (Slice 4)
South El Monte/Whittier Narrows OUs
San Gabriel Valley Superfund Sites
Los Angeles County, California

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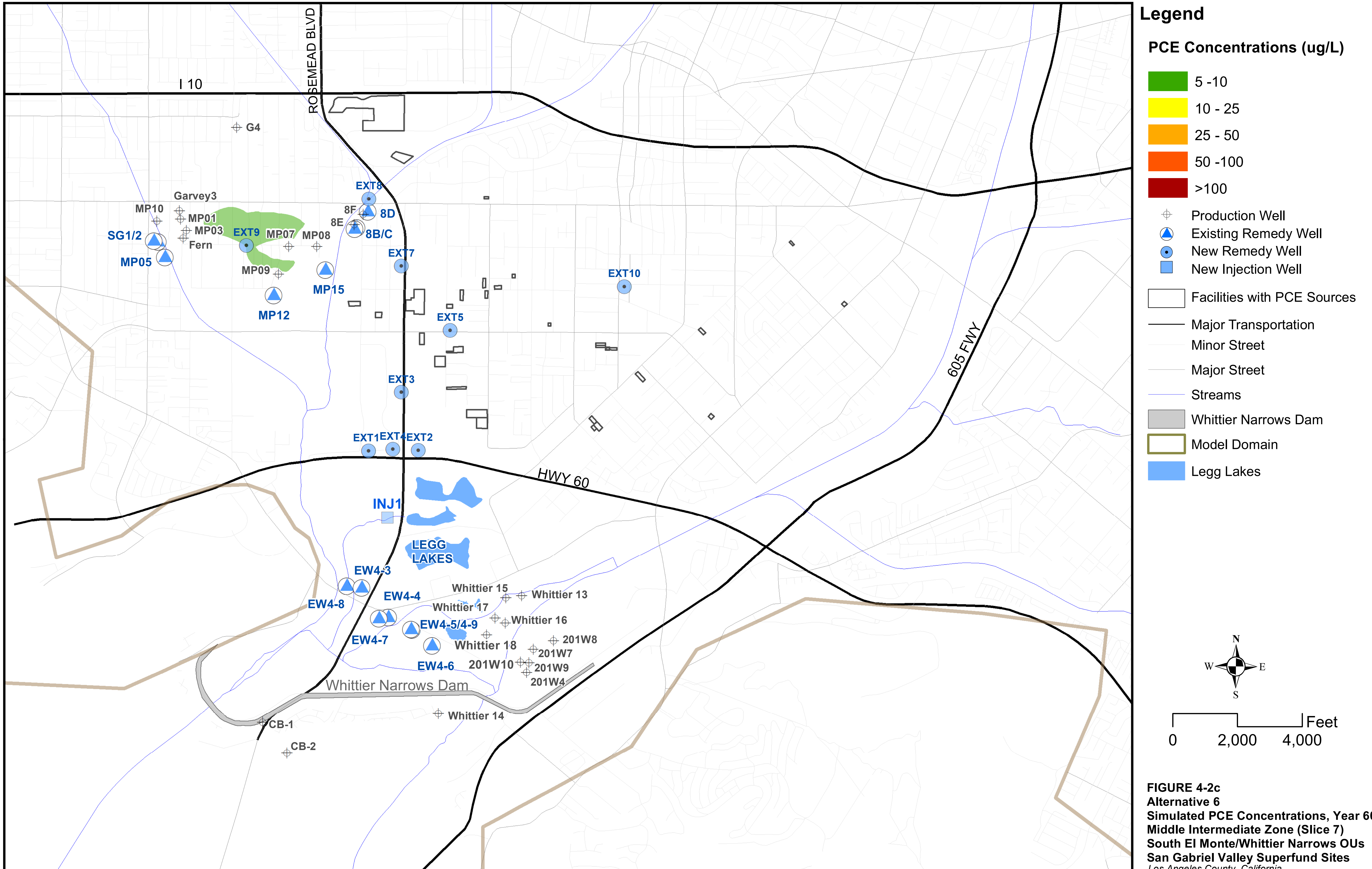

FIGURE 4-2c
Alternative 6
Simulated PCE Concentrations, Year 60
Middle Intermediate Zone (Slice 7)
South El Monte/Whittier Narrows OUs
San Gabriel Valley Superfund Sites
Los Angeles County, California

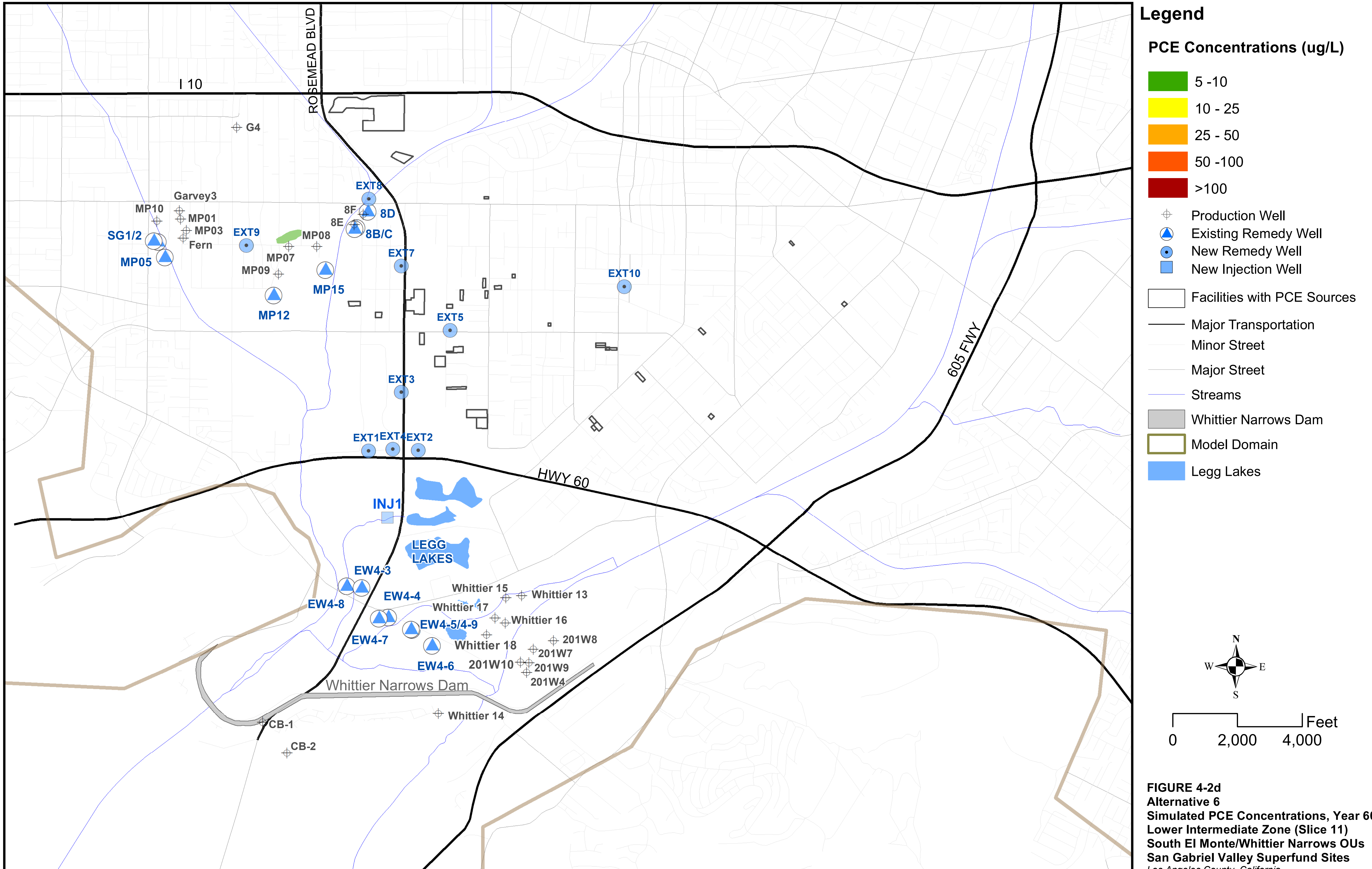

FIGURE 4-2d
Alternative 6
Simulated PCE Concentrations, Year 60
Lower Intermediate Zone (Slice 11)
South El Monte/Whittier Narrows OUs
San Gabriel Valley Superfund Sites
Los Angeles County, California

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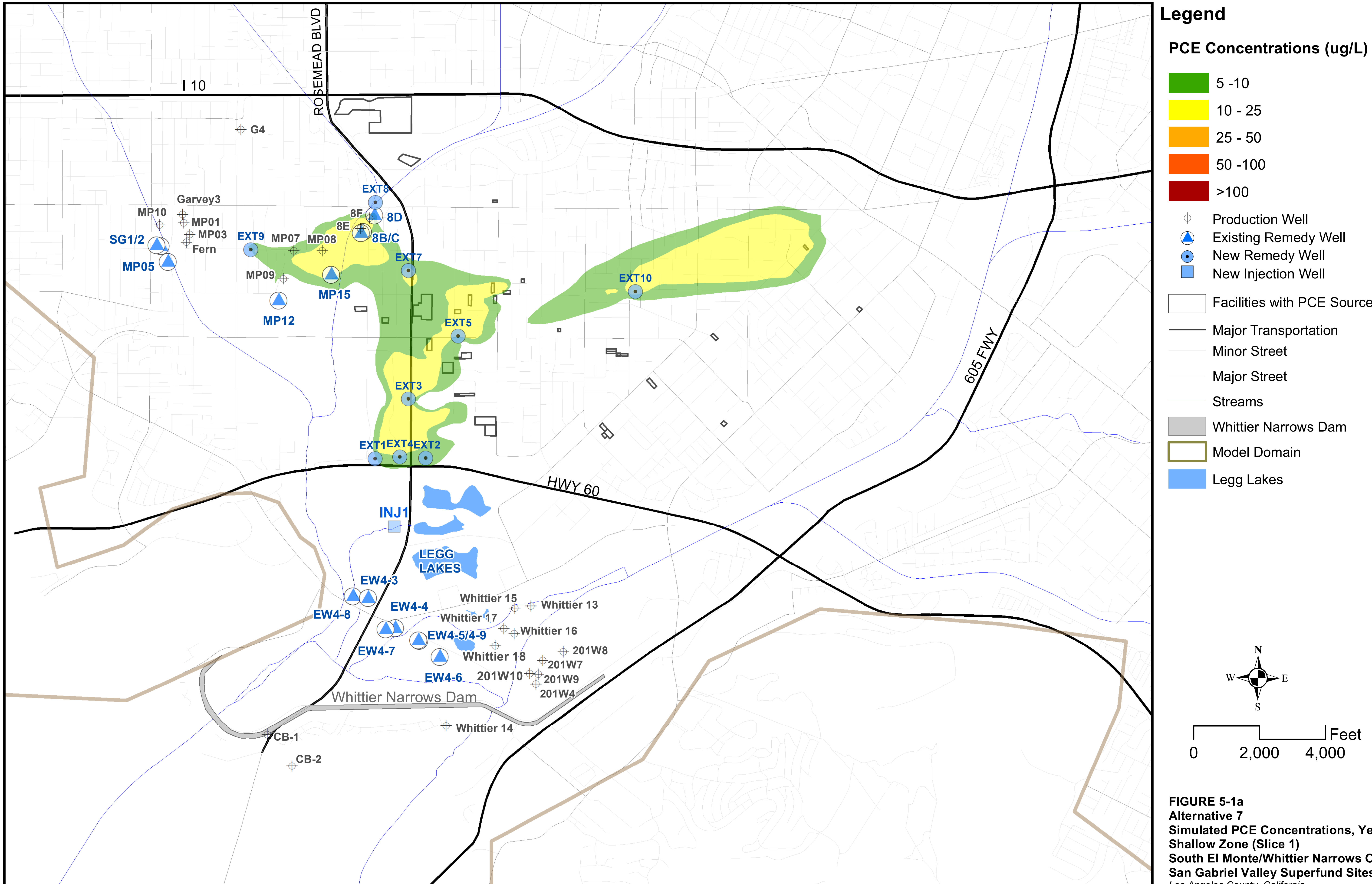

FIGURE 5-1a
Alternative 7
Simulated PCE Concentrations, Year 30
Shallow Zone (Slice 1)
South El Monte/Whittier Narrows OUs
San Gabriel Valley Superfund Sites
Los Angeles County, California

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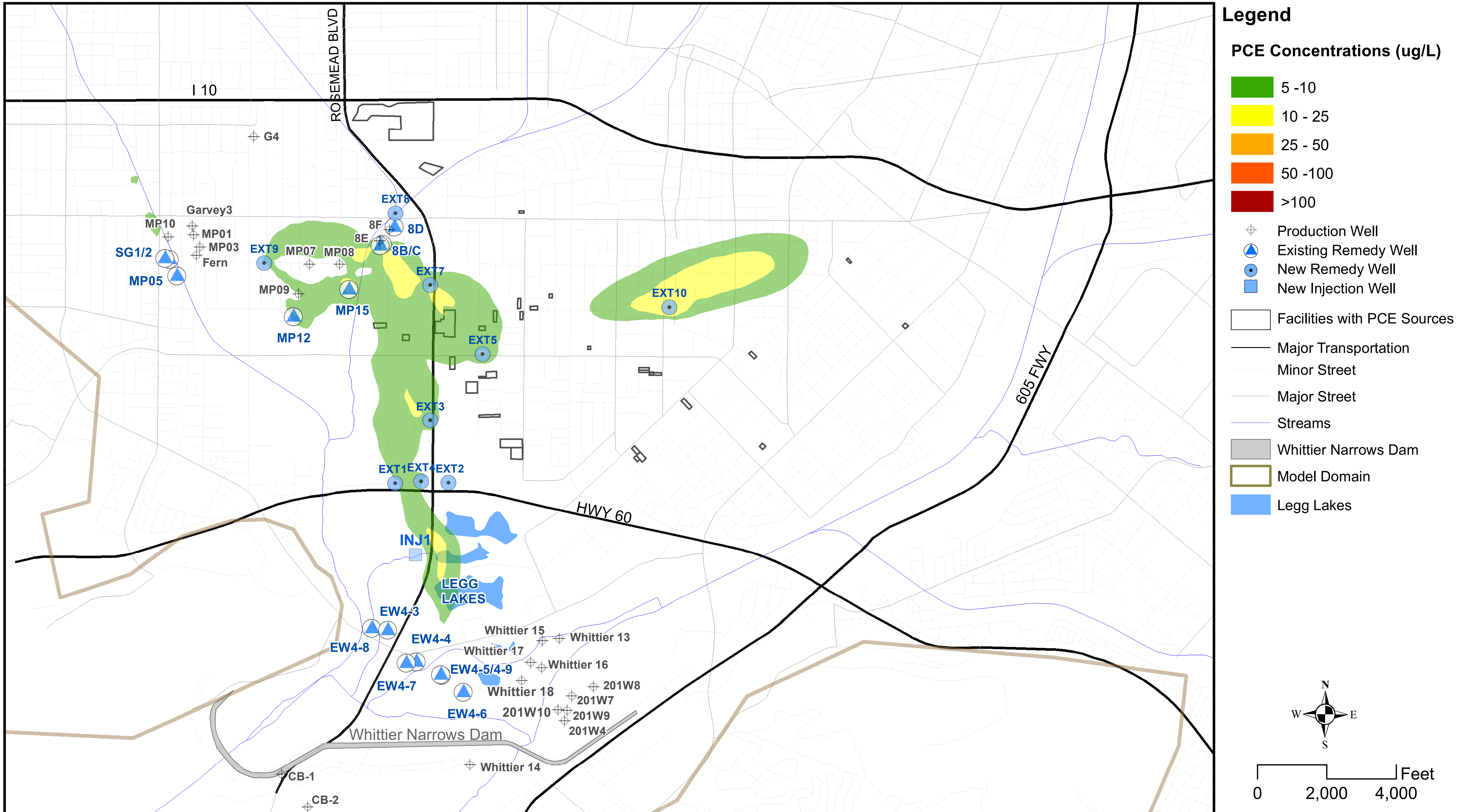

FIGURE 5-1b
Alternative 7
Simulated PCE Concentrations, Year 30
Upper Intermediate Zone (Slice 4)
South El Monte/Whittier Narrows OUs
San Gabriel Valley Superfund Sites
Los Angeles County, California

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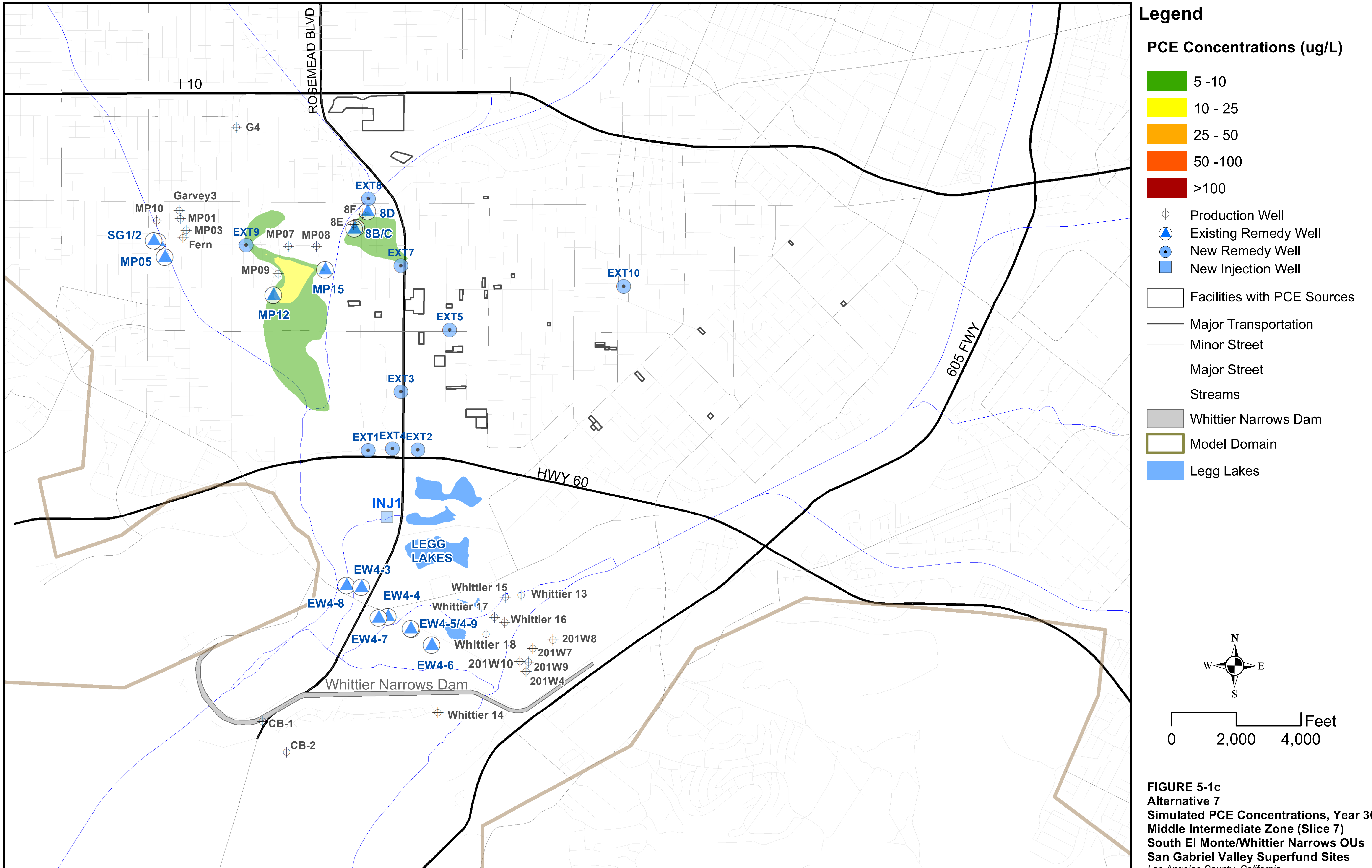

FIGURE 5-1c
Alternative 7
Simulated PCE Concentrations, Year 30
Middle Intermediate Zone (Slice 7)
South El Monte/Whittier Narrows OUs
San Gabriel Valley Superfund Sites
Los Angeles County, California

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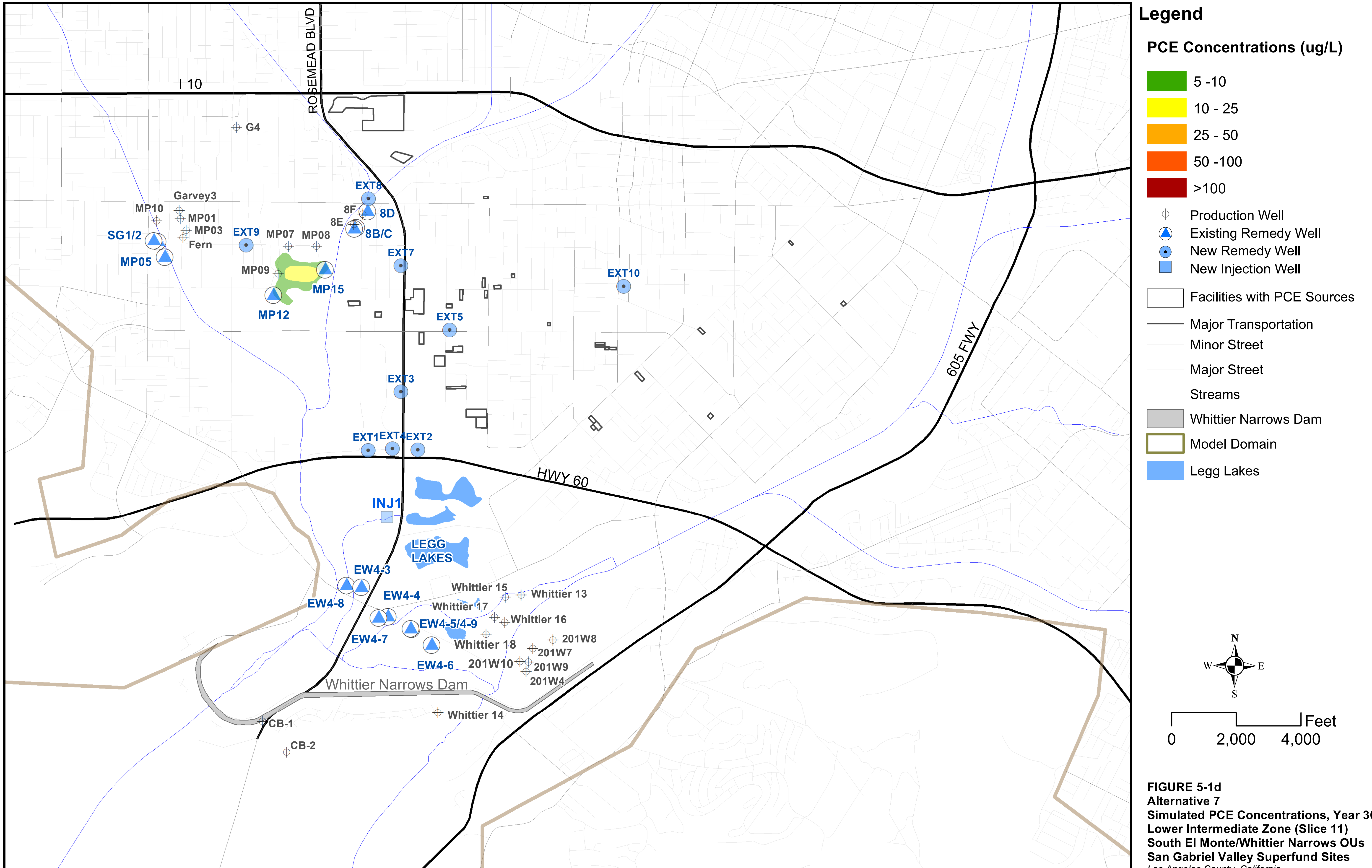

FIGURE 5-1d
Alternative 7
Simulated PCE Concentrations, Year 30
Lower Intermediate Zone (Slice 11)
South El Monte/Whittier Narrows OUs
San Gabriel Valley Superfund Sites
Los Angeles County, California

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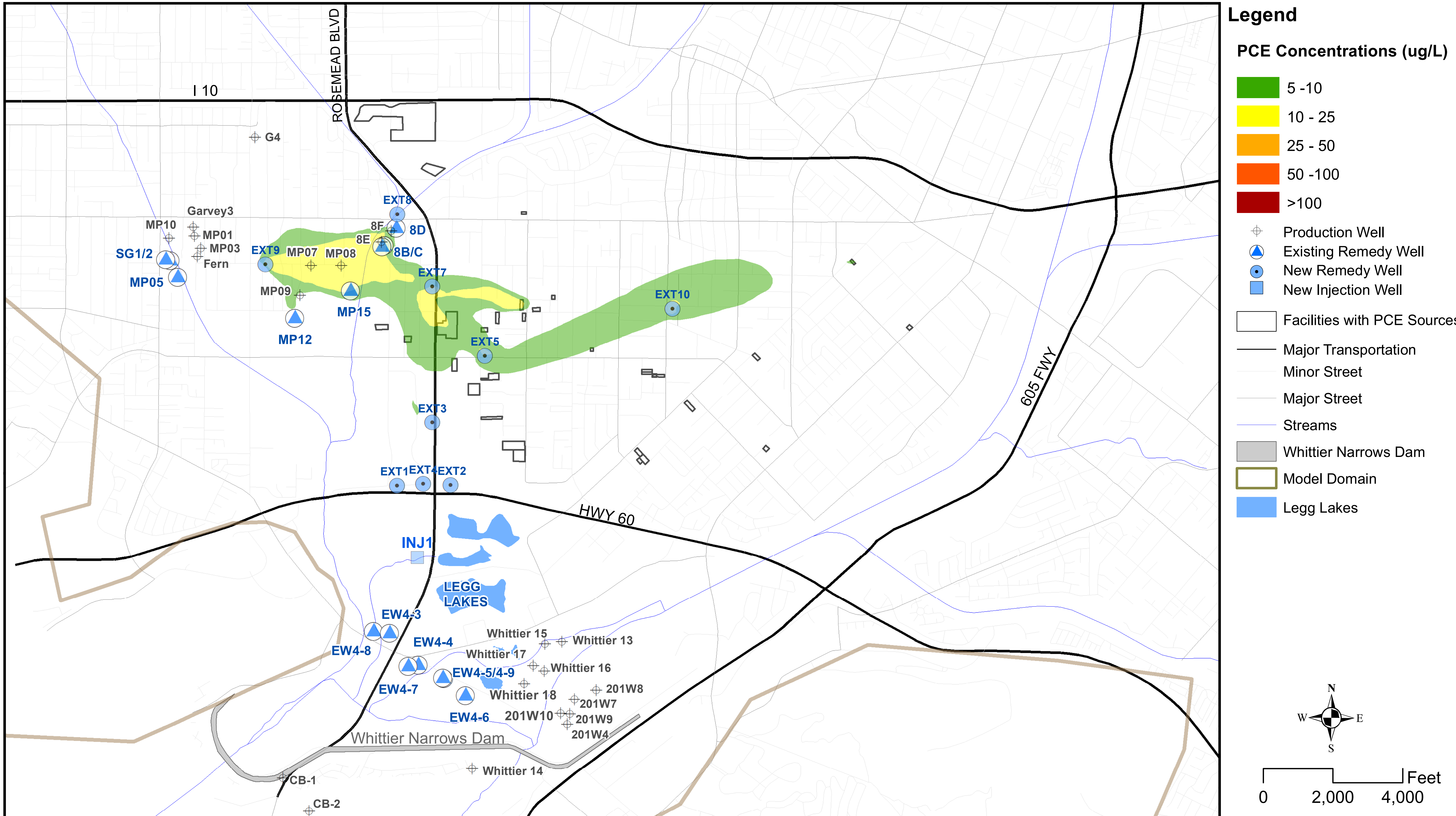

FIGURE 5-2a
Alternative 7
Simulated PCE Concentrations, Year 40
Shallow Zone (Slice 1)
South El Monte/Whittier Narrows OUs
San Gabriel Valley Superfund Sites
Los Angeles County, California

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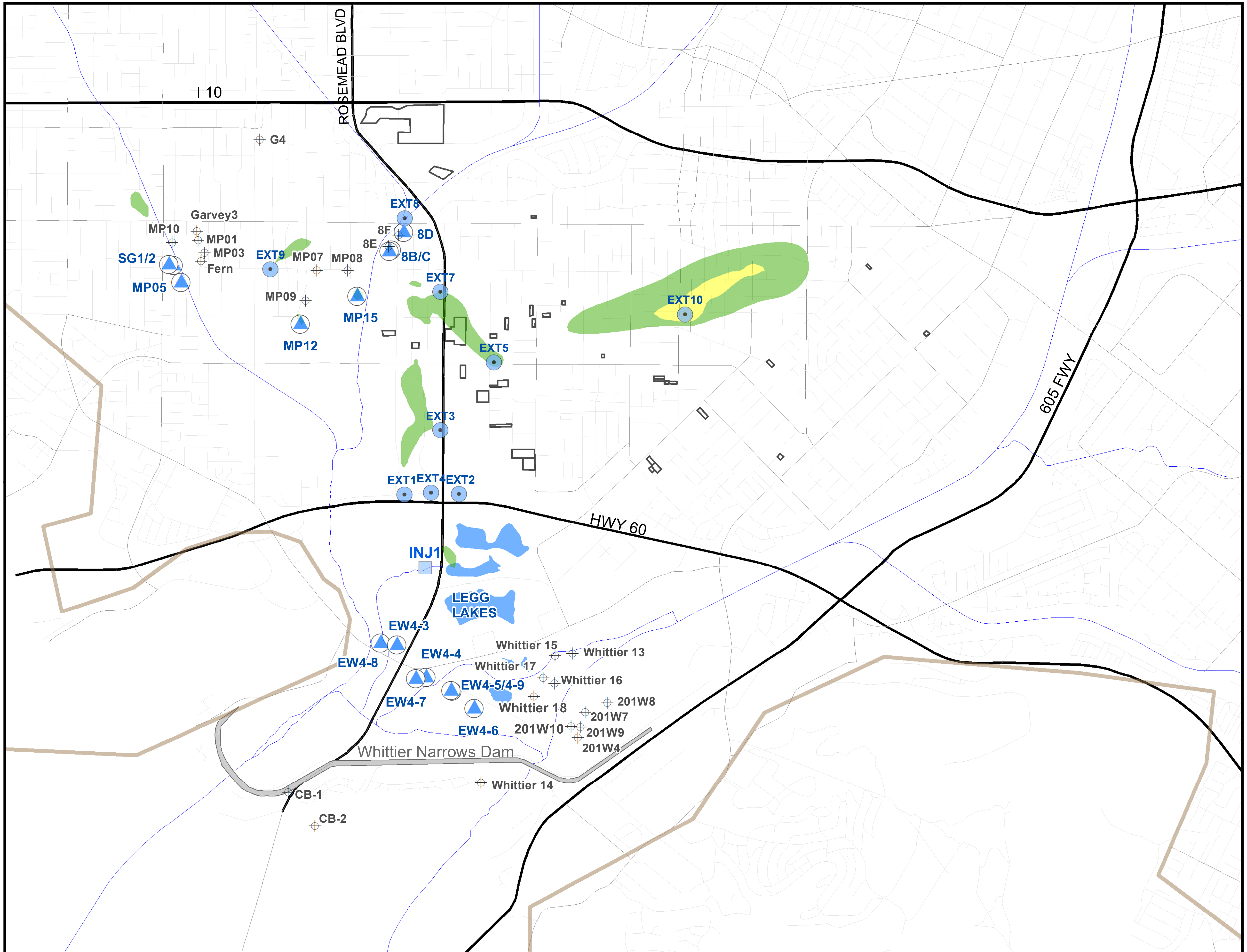

Legend

PCE Concentrations (ug/L)

- 5 -10
- 10 - 25
- 25 - 50
- 50 -100
- >100
- Production Well
- Existing Remedy Well
- New Remedy Well
- New Injection Well
- Facilities with PCE Sources
- Major Transportation
- Minor Street
- Major Street
- Streams
- Whittier Narrows Dam
- Model Domain
- Legg Lakes

N
W E
S

Feet
0 2,000 4,000

FIGURE 5-2b
Alternative 7
Simulated PCE Concentrations, Year 40
Upper Intermediate Zone (Slice 4)
South El Monte/Whittier Narrows OUs
San Gabriel Valley Superfund Sites
Los Angeles County, California

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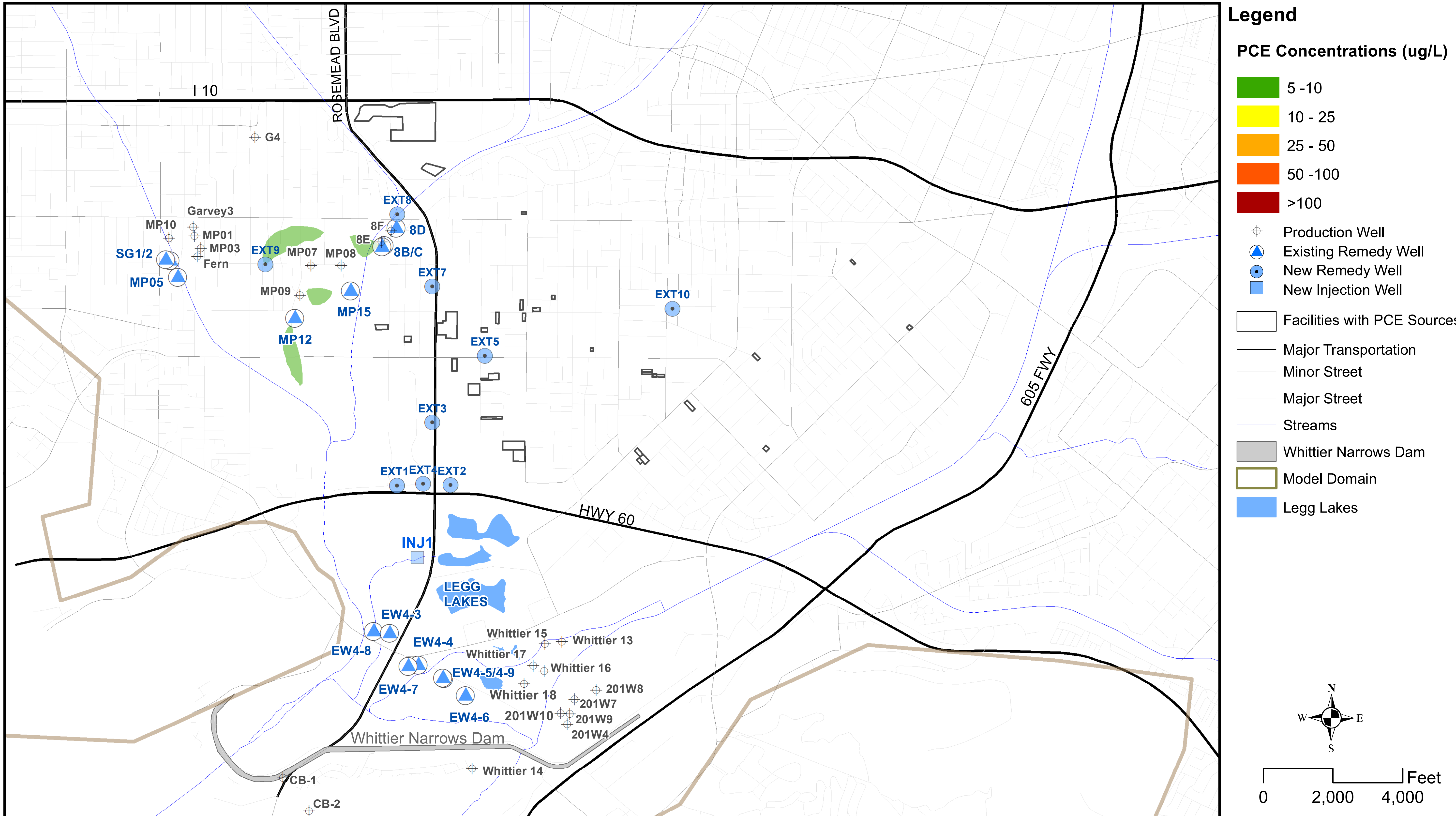

FIGURE 5-2c
Alternative 7
Simulated PCE Concentrations, Year 40
Middle Intermediate Zone (Slice 7)
South El Monte/Whittier Narrows OUs
San Gabriel Valley Superfund Sites
Los Angeles County, California

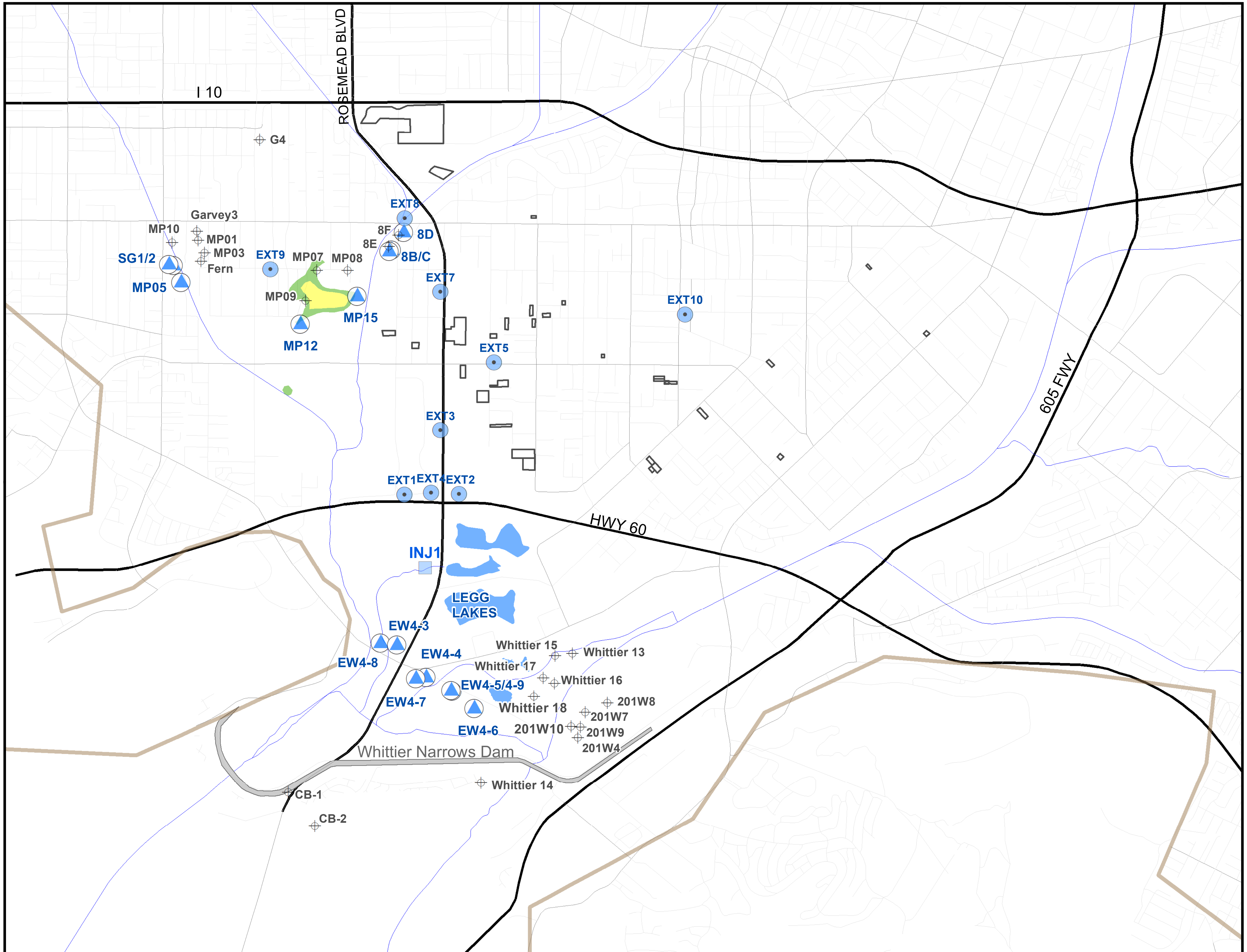

FIGURE 5-2d
Alternative 7
Simulated PCE Concentrations, Year 40
Lower Intermediate Zone (Slice 11)
South El Monte/Whittier Narrows OUs
San Gabriel Valley Superfund Sites
Los Angeles County, California

Whittier Narrows Operable Unit Discharge Options Study: Model Update and Revised Enhanced Remedial Alternatives Study Simulations, San Gabriel Valley Superfund Site Area 1

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Introduction

CH2M (now a subsidiary of Jacobs), on behalf of the EPA, conducted a discharge options study (DOS) at the Whittier Narrows Operable Unit (WNOU) of the San Gabriel Valley (SGV) Area 1 Superfund Site, in Los Angeles County, California. In support of the DOS, CH2M completed groundwater flow and contaminant transport modeling to evaluate treated water end-use scenarios. Because the adjacent, hydraulically connected South El Monte Operable Unit (SEMOU) serves as the source of the WNOU contamination, we included the SEMOU in the DOS modeling effort. This technical memorandum (TM) is the final deliverable of the DOS.

EPA tasked CH2M with conducting this modeling to evaluate future migration of volatile organic compound (VOC) contamination in the shallow and intermediate zones, accounting for ongoing interim remedy operations and continued loading of VOC contamination into the aquifer from residual vadose zone sources located in the SEMOU. CH2M's model results support EPA's evaluation of discharge (i.e., end use) options for the WNOU that are a component of EPA's concurrent Enhanced Remedial Alternatives Study (ERAS) for the SEMOU and WNOU. EPA is using the ERAS to evaluate a range of remedial options for addressing the remaining VOC contamination in SEMOU and WNOU groundwater. EPA coordinated closely with the California Department of Toxic Substances Control (DTSC) and the Regional Water Quality Control Board – Los Angeles District (RWQCB) throughout the modeling effort.

Using tetrachloroethylene (PCE) as the representative VOC contaminant, CH2M conducted the transport modeling supporting the DOS and ERAS in four phases. CH2M conducted Phase 1 transport simulations to evaluate approximately how long it may take to clean up the aquifer in the SEMOU and WNOU area assuming continuous operation of the interim SEMOU and WNOU remedies and ongoing migration of contamination into the aquifer from residual sources in the SEMOU. CH2M conducted Phase 2 transport simulation to further assess various approaches for loading mass from the residual SEMOU vadose zone sources into the aquifer and to evaluate how facility-specific vadose zone cleanup could potentially impact long-term groundwater cleanup in the two operable units. Results of the Phase 1 and Phase 2 contaminant transport simulations are presented in a TM titled *Groundwater Flow and Contaminant Transport Modeling, South El Monte and Whittier Narrows Operable Units, San Gabriel Valley Superfund Site, Los Angeles County, California,* dated April 22, 2020 (CH2M, 2020).

In Phase 3 modeling, CH2M completed predictive contaminant transport simulations for five of the ERAS remedial alternatives (Alternatives 2, 4, 5, 6, and 7) to evaluate cleanup progress in the SEMOU/WNOU under a range of pumping and end use options. The results are documented in a TM titled *Draft*

Enhanced Remedial Alternative Study Simulations, South El Monte and Whittier Narrows Operable Units, San Gabriel Valley Superfund Site, Los Angeles County, California dated March 11, 2021 (CH2M, 2021).

CH2M conducted the Phase 1 through 3 transport simulations using the version of EPA's regional-scale FEFLOW model for the San Gabriel Basin (SGB) that we updated in 2015 (CH2M, 2015). The 2015 model simulates groundwater flow conditions in the SGB from October 1977 through March 2014.

Based on agreement between EPA and DTSC, the lead agency for the WNOU since 2013 when EPA completed 10 years of long-term remedial action, CH2M conducted the following Phase 4 groundwater flow and contaminant transport modeling activities:

- Updated the regional-scale SGB groundwater flow model to incorporate more recent pumping and recharge data.
- Developed a local-scale flow and transport model of the SEMOU/WNOU area with a much finer model mesh to simulate contaminant migration more accurately.
- Completed new simulations of the ERAS remedial alternatives using the local-scale model.

This TM contains the following sections:

- Updated SGB Regional Flow Model. Briefly describes the model update and the calibration results for the updated model.
- Local-scale SEMOU/WNOU Model Development. Describes the development of the local-scale SEMOU/WNOU model.
- Partial Calibration of the Local-Scale Contaminant Transport Model. Describes the approach and results of a limited calibration effort for the local-scale transport model.
- Predictive Contaminant Transport Simulations of the ERAS Remedial Alternatives Using the Local-scale Model. Describes the approach for simulating contaminant transport in the SEMOU/WNOU areas under the different ERAS remedial alternatives.
- ERAS Remedial Alternatives Simulation Results. Discusses the simulation results for each remedial alternative.
- Summary. Summarizes the DOS/ERAS Phase 4 modeling effort.

1.0 Updated San Gabriel Basin Regional Flow Model

1.1 Model Updates

CH2M updated the 2015 SGB regional FEFLOW model to extend the simulation period through June 2019. Consistent with previous model updates, we did not change the model domain and boundary conditions from the previous version of the model. CH2M also did not change the methods used to represent the major recharge and discharge components, including recharge from precipitation and return flow, rivers, lakes, and spreading basins and discharge through pumping. Additionally, we retained the refinements made to the 2015 SGB regional model during the previous transport simulation, including (CH2M, 2020):

- Evenly dividing model layers 5, 6 and 7, representing the Upper, Middle, and Lower Intermediate Zones, respectively, into two layers each.
- Converting active WNOU remedy wells and production wells to multiple-layer pumping (MLP).

CH2M adjusted our approach for estimating the volume of recharge along the upper section of Mission Creek to consistently assume that 75 percent of the water overflowing into Mission Creek from Legg Lakes recharges groundwater. We assumed that:

- Prior to starting operation of the WNOU remedy in 1999, no excess discharge to Mission Creek occurred; therefore, we did not apply recharge in the model.
- Between December 1999 and February 2002, only EW4-3 was in operation and all treated water discharged to Mission Creek.
- Between February 2002 and October 2004, the WNOU remedy was not in operation and no excess discharge to Mission Creek occurred, so no recharge is applied.
- Between October 2004 and April 2013, all the treated water from WNOU shallow extraction wells discharged to the Legg Lakes with overflow to the Mission Creek. For modeling purposes, we assumed that only discharge exceeding 800 gallons per minute (gpm) overflows to Mission Creek. Routine extraction from WNOU shallow extraction wells ceased in April 2013.
- Starting in October 2012, EPA or DTSC discharged a portion of the WNOU intermediate zone treated water to Legg Lakes. Between May 2013 and June 2019, EPA or DTSC discharged all the treated intermediate zone water to Legg Lakes. As with the prior shallow discharges, we assumed any Legg Lakes discharge above 800 gpm overflows to Mission Creek

CH2M obtained the pumping data for the extended model period through July 2019 from the San Gabriel Basin Watermaster and the Central Basin Watermaster. We obtained the data necessary to estimate recharge volumes (river and spreading basin recharge totals and precipitation records) from the Los Angeles County Department of Public Works.

The updated regional SGB model has fifteen model layers, with layers 1 and 2 representing the shallow zone, layers 3 and 4 the transition zone, layers 5 to 10 the intermediate zone, and layers 11 to 15 the deep zone. The model domain (Figure 1a) covers an area of approximately 170 square miles which is discretized into 162,504 nodes and 301,440 triangular elements with an average element diameter of approximately 178 meters.

1.2 Model Calibration

CH2M calibrated the updated regional SGB model for the period between October 1977 and June 2019 using monthly time steps. We retained the calibration wells from previous model updates (CH2M, 2015) for the current model calibration. Additionally, CH2M added eight well clusters located in the vicinity of the WNOU remedy wells, EPAW418 to EPAW422 and EPAW427 to EPAW429, to the calibration data set, resulting in a calibration dataset totaling 164 wells. Among the 164 calibration wells, 157 are monitoring wells located within or near the SEMOU/WNOU. The remaining seven wells are regional calibration wells located further away from the SEMOU/WNOU area. Figure 1a shows the distribution of the calibration wells within the model domain.

The modeling team achieved model calibration by slightly adjusting the horizontal and vertical hydraulic conductivities in a few areas. The team assessed the quality of the model calibration by visual inspection of scatter plots comparing simulated and observed hydraulic heads for each aquifer zone (Figure 2), and hydrographs comparing the simulated and observed hydraulic heads for each monitoring well (Figure 3 [note that Figure 3 is 38 pages]). In general, both the scatter plots and hydrographs show good matches between the simulated and observed hydraulic heads.

Table 1 summarizes the calibration statistics to quantitively assess the quality of model calibration. CH2M calculated calibration statistics for mean error (ME), root mean squared (RMS) error, percent RMS (%RMS) which is RMS normalized to the observed range of water head fluctuation during the calibration period, and r-squared (ranging between 0 and 1) measuring the model's capability to explain the variances in the observed hydraulic heads. Our calibration goal was to minimize ME, RMS error, and the percent RMS, and maximize the r-squared. The team did not calculate calibration statistics for the regional calibration wells because these are production wells with screens spanning over multiple model layers; therefore, there is not a direct comparison between modeled and observed water levels. Except for a few wells, the calibration statistics indicate an acceptable calibration.

2.0 Local-scale South El Monte and Whittier Narrows Operable Units Model Development

CH2M created a local-scale groundwater flow model focusing on the SEMOU/WNOU areas (Figure 1b) with a refined, finer model grid, than the regional SGB model, to improve the ability of the transport model to simulate contaminant migration. The smaller model elements of the local model provide more stable transport simulations. Additionally, the team divided layers 3 and 12 of the regional SGB model into two layers each to further reduce numerical instability, resulting in a 17-layer model. The domain of the local model covers an area of approximately 20 square miles, which is discretized into 599,058 nodes and 1,127,372 triangular elements with an average element diameter of approximately 58 meters.

The local-scale model handles the recharge and discharge inputs and outputs in the same manner as the corresponding flow components in the regional SGB model. The boundary of the local-scale model is a no-flow boundary where the aquifer meets the bedrock outcrops, primarily along the eastern and western sides of the WNOU. The remainder of the local-scale model boundary is a specified head boundary where the specified head values are simulated heads generated by the regional SGB model.

Figures 4a to 4e compare the simulated groundwater elevation contours between the local-scale and the regional SGB models for model layers 1, 4, 7, 11, and 16, representing respectively, the water table, upper intermediate zone, middle intermediate zone, lower intermediate zone, and the base of the aquifer. The simulated contours generated by the local model approximately match those generated by the regional SGB model.

Figure 5 presents hydrographs of simulated heads from the local-scale model versus observed heads for the newly added calibration wells in the WNOU area. The simulated heads from the local-scale model generally match the observed heads. In addition, the simulated hydrographs from the local-scale model (Figure 5) are nearly identical to the simulated hydrographs produced by the regional SGB model (Figure 3).

3.0 Partial Calibration of the Local-Scale Contaminant Transport Model

CH2M ran a simulation to evaluate the capability of the transport model developed using the local-scale SEMOU/WNOU flow model to simulate PCE migration in the SEMOU and WNOU areas between 2013 and 2019. The 2020 modeling report (CH2M, 2020) describes development of the 2013 SEMOU/WNOU area PCE distribution included in the simulation as a starting condition The local-scale model simulated migration of the 2013 PCE contamination for 6 years, culminating in a simulated PCE distribution in June 2019 at the end of the model period. We compared these simulated 2019 PCE conditions to the estimated 2019 PCE distribution presented on Figures 6a to 6d. Figures 6a through 6d present interpreted 2019 PCE concentration contours for the shallow and intermediate zones in the following approximate depth intervals:

- Shallow Zone – representing the depth interval from the water table to approximately 150 feet below ground surface (bgs)
- Upper Intermediate Zone – representing the depth interval from 150 to 300 feet bgs
- Middle Intermediate Zone – representing the depth interval from 300 to 450 feet bgs
- Lower Intermediate Zone – representing the depth interval from 450 to 600 feet bgs

CH2M developed the 2019 intermediate zone PCE contamination maps (Figures 6b through 6d) using 2018 contamination maps for the SEMOU (developed by EPA) and WNOU (developed by DTSC), merging these maps where they overlap near the SEMOU/WNOU boundary and reviewing 2019 monitoring results, where available, to make sure PCE concentrations had not changed. CH2M developed the 2019 shallow zone PCE map (Figure 6a) by starting with the 2013 shallow zone map and reviewing more recent 2017 to 2019 shallow zone monitoring results to adjust the contours as necessary. Sources of more recent shallow zone PCE data include:

- Limited shallow well results from EPA monitoring in the SEMOU
- Shallow well results from DTSC monitoring in the WNOU (nearly all of which are non-detect)
- Monitoring results from DTSC in the vicinity of the former Hytone Cleaners facility in the northeast SEMOU
- Monitoring results from WQA in northern SEMOU, near the former JA Bozung and Aerojet facilities

CH2M developed the local-scale SEMOU/WNOU transport model for the partial calibration effort by incorporating transport processes including hydrodynamic dispersion and sorption, in addition to advection, into the local-scale groundwater flow model. The following bullets briefly summarize the local-scale model partial calibration run assumptions:

- CH2M used a 6-year simulation period from June 2013 to June 2019, basing the starting conditions on the simulated June 2013 head distribution produced by the calibrated regional SGB flow model.
- CH2M based the starting contaminant distribution on the 2013 PCE maps (CH2M, 2020).
- CH2M incorporated mass loading to the aquifer at the 29 SEMOU facilities that EPA identified as ongoing sources of PCE contamination. The team treated these facilities as fixed mass nodal source boundaries as described in last year's modeling report. (CH2M, 2020)
- The team kept the transport parameters largely the same as the values incorporated into the previous transport simulations (CH2M, 2020). This includes:
  - Effective porosity of 0.12 for the shallow zone layers and 0.25 for the other model layers
  - Retardation factor of 1.2 for the shallow zone model layers and 1.9 for the other model layers
  - Longitudinal dispersivity of 50 meters for all model layers
- The team reduced the transverse dispersivity to 0.2 meter (compared to the prior value of 0.5 meter) to improve the transport simulation results, particularly in the shallow zone.

Figures 7a to 7d present the simulated local-scale model PCE contamination contours plumes for June 2019 in comparison to the estimated 2019 PCE contours described above. The simulated contours are mostly consistent with the mapped contours.

4.0 Predictive Contaminant Transport Simulations of the Enhanced Remedial Alternatives Study Remedial Alternatives Using the Local-scale Model

For this Phase 4 transport modeling, CH2M used the local-scale model to simulate future contaminant transport conditions under six of the ERAS remedial alternatives. The primary difference between the local-scale model and the regional SGB model is the refined, finer model grid with more closely spaced nodes and smaller elements. The setup of the local-scale model in support of the Phase 4 transport modeling is very similar to the prior Phase 3 transport modeling of the ERAS remedial alternatives (described in CH2M, 2021), including representation of inflow and outflow components and transport parameters. The following bullets briefly describe the specific Phase 4 model setup:

- Future hydrologic conditions. CH2M developed a conceptual 30-year groundwater budget by cycling the historical hydrologic data (both inflows and outflows) from the last 10 years of the model, June 2009 to June 2019, three times. For each remedial alternative simulation, we first ran a companion regional SGB groundwater flow model simulation using the specific remedial alternative pumping and end use assumption to produce the simulated heads needed as boundary conditions for the local-scale transport model.
- Initial hydraulic head distribution. The team used the simulated head distribution from the calibrated groundwater flow model for June 30, 2009 to represent the initial groundwater flow condition.
- Initial contaminant distribution. CH2M digitized the estimated 2019 PCE concentration contours (Figures 6a to 6d) for each vertical interval to generate a contaminant distribution. CH2M then assigned the PCE concentration grids to the local-scale contaminant transport model as initial starting mass conditions.
- Representation of continuing sources of contamination. CH2M used fixed mass nodal source boundaries to represent the continuing PCE sources in the vadose zone with mass loading rates based on the values estimated through the Hydrus-1D modeling (CH2M, 2020). In the Phase 3 simulations we reduced the amount of PCE migrating into groundwater by 90 percent after 10 years of the simulation (i.e., in 2023) to address conceptual vadose zone cleanup at the residual sources. The Phase 4 simulations start in 2019, 6 years later than the Phase 3 simulations. To be consistent with our prior assumptions, we reduced PCE loading at the residual sources by 90 percent 4 years into the Phase 4 simulations.
- Transport parameter values. CH2M used the transport parameter values developed for the partial calibration version of the transport model (see Section 3.0).

CH2M simulated all six active ERAS remedial alternatives (Table 2) using the local-scale SEMOU/WNOU model, including re-evaluating the five ERAS remedial alternatives previously evaluated using the regional SGB model in Phase 3 (CH2M, 2021). The six ERAS remedial alternatives are:

- Alternative 2. No Further Action, includes continued operation of the interim SEMOU and WNOU remedies.
- Alternative 3. Alternative 2 with optimization to improve the effectiveness of remedy pumping at the same total extraction rate.
- Alternative 4. Alternative 2 (Interim SEMOU and WNOU remedies) with expanded pumping at the southern end of the SEMOU to enhance WNOU cleanup.
- Alternative 5. Alternative 4 plus reinjection to further enhance WNOU cleanup.

- Alternative 6. Alternative 2 plus expanded pumping in the SEMOU to enhance SEMOU/WNOU cleanup in a timeframe of less than 70 years.
- Alternative 7. Alternative 2 plus expanded pumping in the SEMOU to enhance and accelerate SEMOU/WNOU cleanup in a timeframe of less than 40 years.

5.0 Enhanced Remedial Alternatives Study Remedial Alternatives Simulation Results

For each remedial alternative, we modified the local-scale flow model to incorporate the pumping and end use changes specific to that alternative, then simulated 30 years of contaminant migration with the alternative-specific operations in place.

Figures 8a to 8d through Figures 13a to 13d show the simulated PCE concentration contours for the shallow, upper intermediate, middle intermediate, and lower intermediate zones, after 30 years of operation under Alternatives 2, 3, 4, 5, 6, and 7, respectively.

In all the simulation results, at the end of 30 years, there is a small contaminant plume remaining in the shallow zone and a slightly larger plume in the upper intermediate zone to the east/northeast of the main area of contamination in the SEMOU. This eastern plume is the result of mass loading from the former Hytone Cleaners facility, where DTSC is currently implementing facility-specific cleanup actions. Considering DTSC's recent efforts, it is likely that these simulations overestimate the extent of contamination originating from the Hytone facility.

CH2M based the locations and rates of new pumping incorporated into ERAS Alternatives 4 through 7 on earlier Phase 2 contaminant transport modeling results conducted using the regional SGB model. The Phase 4 simulation results described below indicate the configuration of new pumping in Alternatives 4 through 7 could be refined in future assessments.

5.1 Alternative 2

The results of the predictive contaminant transport simulations show the following at the end of the 30-year simulation (Figures 8a through 8d):

- In the shallow zone, the only contamination remaining above the maximum contaminant level (MCL) is a small plume near the Hytone facility (Figure 8a). The model predicts that the rest of the shallow zone will have cleaned up. This represents a fairly significant change from the Phase 3 simulation results (CH2M, 2021) using the regional SGB model.
- In the upper intermediate zone, a broad area of contamination exceeding the MCL remains across the middle of the SEMOU (Figure 8b). The size of this area gets smaller in the middle (Figure 8c) and lower (Figure 8d) intermediate zone.
- For the upper intermediate zone, only a small area of contamination remains in the upgradient portion of the WNOU (Figure 8b).
- As shown on Figures 8c and 8d, the model predicts that small, narrow plumes in the middle and lower intermediate zones will migrate a short distance beyond the WNOU remedy wells. This predicted future lack of containment occurs in the western WNOU. This is different than current conditions where there is an area of deeper contamination that is not contained that extends beyond the eastern end of the WNOU well field.
- The simulation results indicate that the WNOU remedy pumping rate could be reduced after 30 years (or sooner) while still providing containment.

5.2 Alternative 3

For this simulation, the only change the team made to optimize Alternative 2 was to shift 1,000 gpm of WNOU pumping from EW4-5 and EW4-6 to a new intermediate zone extraction location in the western portion of the WNOU adjacent to existing shallow extraction well EW4-3. Our intent was to show that the intermediate zone contamination in the WNOU could be contained by pumping at the current target rate of 3,500 gpm. The results of the predictive contaminant transport simulations show the following at the end of the 30-year simulation (Figures 9a through 9d):

- Because we only made a small change in the pumping distribution in the downgradient portion of the WNOU, the simulation results for Alternative 3 look nearly the same as the Alternative 2 results.
- Figures 9c and 9d show that the shift in WNOU pumping results in full containment of the intermediate zone contamination in the western portion of the WNOU.
- As with Alternative 2, the simulation results indicate that the WNOU remedy pumping target rate could be reduced after 30 years (or sooner), while still providing containment.

5.3 Alternative 4

The results of the predictive contaminant transport simulations show the following at the end of the 30-year simulation (Figures 10a through 10d):

- For the shallow zone, the Alternative 4, 30-year simulation results are the same as the Alternative 2 results, with just a small residual plume near the Hytone facility (Figure 10a). Alternative 4 includes 500 gpm of new pumping from the shallow zone near the 60 Freeway (Table 2). The additional 500 gpm do not significantly enhance shallow-zone cleanup times and could potentially be removed from the Alternative 4 pumping scheme.
- The intermediate zone model results (Figures 10b through 10d) show that the new southern SEMOU pumping effectively eliminates migration of contamination into WNOU. There is no residual contamination in the WNOU in any of the three intermediate zone depth intervals. The simulation results indicate that DTSC could eliminate WNOU remedy pumping within 30 years and likely reduce it much sooner.

5.4 Alternative 5

The results of the 30-year predictive contaminant transport simulations for Alternative 5 (Figures 11a through 11d) are nearly the same as Alternative 4 results. Alternatives 4 and 5 use the same pumping scenario, with the only change between the alternatives being the additional reinjection added into the upgradient end of the WNOU in Alternative 5. If there are any benefits to WNOU cleanup from the additional reinjection, they would show up earlier in the simulation period and would not be apparent in the 30-year maps (Figures 11a through 11d) because the model predicts that the WNOU will be cleaned up in advance of 30 years.

5.5 Alternative 6

The results of the 30-year predictive contaminant transport simulations are presented on Figures 12a through 12d. These results demonstrate the significant progress towards intermediate zone cleanup provided by the 5,500 gpm of additional remedy pumping incorporated into Alternative 6 compared to Alternative 2 (Figures 8b through 8d) and the 3,000 gpm of additional pumping compared to Alternative 4 (Figures 10b through 10d). However, 1,600 gpm of the additional pumping in Alternative 6 would occur in shallow zone wells (Table 2). Given that the local-scale transport model predicts the shallow zone will clean up in less than 30 years without additional pumping (see Figure 8a for the Alternative 2 shallow zone results), there appears to be limited benefit to pumping an additional

1,600 gpm from the shallow zone. If we were to assign most of this 1,600 gpm to the intermediate zone, the 30-year results (Figures 12b through 12d) would show additional cleanup progress.

In the Phase 3 simulations (CH2M, 2021), we ran a longer 60-year simulation of Alternative 6 to demonstrate how close Alternative 6 would be to achieving full cleanup in this time frame. The target for Alternative 6 is cleanup in less than 70 years. We anticipate that a 60-year simulation of Alternative 6 using the local-scale transport model described in this TM would show nearly complete cleanup. However, before running this longer simulation, the team should adjust the starting Alternative 6 pumping configuration to include less shallow zone pumping and to focus more of the intermediate zone pumping in those areas shown on Figures 12b through 12d to have residual contamination.

5.6 Alternative 7

The simulation results presented on Figures 13a through 13d show the predicted contamination after 30 years of Alternative 7 operation. These results illustrate the additional progress towards intermediate zone cleanup provided by the 9,500 gpm of additional pumping incorporated into Alternative 7 compared to Alternative 2 (Figures 8b through 8d) and the 4,000 gpm of additional pumping compared to Alternative 6 (Figures 12b through 12d). For Alternative 7, 2,500 gpm of the new pumping is from the shallow zone (Table 2). As described for Alternative 6, there is likely limited benefit to shallow zone cleanup times with this much additional pumping from the shallow zone. Although the additional pumping under Alternative 7 (Figures 13b through 13d) provides considerable reduction in the residual intermediate zone contamination after 30 years compared to Alternative 2 (Figures 8b through 8d), this is not the case in comparison to Alternative 6 (Figures 12b through 12d).

For the Phase 3 simulations (CH2M, 2021), CH2M ran a 40-year simulation of Alternative 7 to illustrate the predicted progress towards full cleanup within 40 years under Alternative 7. We anticipate that using the local-scale transport model could show complete cleanup within 40 years under Alternative 7, if we adjusted the starting Alternative 7 pumping configuration to include less shallow zone pumping and to focus more of the intermediate zone pumping in those areas shown on Figures 13b through 13d to have residual contamination.

6.0 Summary

CH2M completed groundwater flow and contaminant transport modeling to evaluate treated water end use scenarios in support of the WNOU DOS. CH2M's model results also support EPA's evaluation of discharge (i.e., end use) options for the WNOU that are a component of the ERAS for the SEMOU and WNOU. This TM is the final deliverable of the WNOU DOS.

For this modeling effort, CH2M updated the 2015 version of EPA's regional SGB groundwater flow model to extend the simulation period through June 2019 to incorporate more recent hydraulic data (pumping and recharge). The modeling team made slight adjustments to hydraulic parameters in a few focused areas to improve the calibration of the updated regional SGB model.

Starting from the updated regional SGB model, CH2M developed a local-scale model focused on the SEMOU and WNOU to simulate contaminant transport more accurately in these areas. The team slightly refined the transport parameters through a partial calibration effort using the local-scale transport model to simulate changes in the contaminant distribution between 2013 and 2019.

Our conclusions from using the local-scale model for 30-year predictive contaminant transport simulations include the following:

- The model predicts that the shallow zone will be cleaned up to below the MCL in less than 30 years, except for a small residual plume at the Hytone facility, even under Alternative 2. Alternative 2 is a continuation of the current interim SEMOU/WNOU remedies with no new pumping in the shallow zone.

- For the intermediate zone, the model predicts that under Alternative 2 (current interim remedies), a large area of contamination will remain in central SEMOU after 30 years and there will be a small amount of migration beyond the WNOU extraction wells. The results also predict that the contaminant plume migrating through the WNOU after 30 years is relatively small, indicating that DTSC can likely reduce WNOU target pumping rates in the future.
- The Alternative 3 simulation results indicate that optimizing the WNOU remedy with a new well (or wells) while maintaining the current total target rate of 3,500 gpm could provide full containment.
- CH2M based the locations and rates of new pumping incorporated into ERAS Alternatives 4 through 7 on earlier Phase 2 contaminant transport modeling results conducted using the regional SGB model. The Phase 4 simulation results described in this TM indicate that the configuration of new pumping in Alternatives 4 through 7 could be refined in future assessments, with less pumping assigned to the shallow zone and more of the intermediate zone contamination focused in the central portion of the SEMOU.
- Alternatives 4 and 5 successfully accelerate WNOU cleanup. With further refinement of the pumping configuration, a pumping rate lower than the 2,500 gpm incorporated into these alternatives would likely achieve the goal of accelerated WNOU cleanup.
- Alternatives 6 and 7 are configured to clean up the SEMOU and WNOU in less than 70 and 40 years, respectively. Although these Phase 4, 30-year simulation results do not clearly demonstrate that those targets would be met, the Phase 3 results (CH2M, 2021) did infer that the alternatives would meet the cleanup targets. Overall, the Phase 4 simulation results demonstrate improved cleanup over the next 30 years compared to Phase 3 leading the team to conclude that Alternatives 6 and 7 would likely meet the target cleanup time frames using a reconfigured pumping distribution and, potentially lower total pumping rates.
- For these simulations, the remedy pumping rate at each remedy well location remains fixed throughout the 30-year simulation. Refining the simulated pumping rates periodically over this 30-year simulation period is likely to result in enhanced cleanup, considering the significant reduction in the lateral and vertical distribution of contamination observed over the 30-year simulations. For example, pumping from wells in areas that clean up over time could be reduced or eliminated, saving money, and the pumping shifted to locations where contamination remains, resulting in faster cleanup.

7.0 References

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Tables

Table 1. Summary Statistics of Model Calibration						
Aquifer Zone	Station_ID	Layer	ME (ft)[1]	RMS (ft)[3]	% RMS[4]	RSQ[5]
Shallow Zone	EMW207_05	1	-10.2	20.3	11.9%	0.86
	EPAMP01_09	1	5.5	7.3	4.3%	0.76
	EPAW410_08	1	1.8	5.4	3.2%	0.96
	EPAW410_09	1	2.0	8.0	4.7%	0.85
	EPAW412_05	1	1.5	4.4	2.6%	0.84
	EPAW413_05	1	1.6	5.9	3.4%	0.86
	EPAW414_05	1	1.3	6.4	3.8%	0.91
	EPAW414_06	1	0.8	8.6	5.0%	0.77
	EPAW415_05	1	4.3	6.8	4.0%	0.83
	EPAW416_04	1	-0.1	5.6	3.3%	0.89
	EPAW417_05	1	0.9	2.6	1.5%	0.93
	EPAW419_05	1	1.2	9.4	5.5%	0.29
	EPAW422_06	1	-3.2	9.1	5.3%	0.58
	SEMW01_04	1	-2.8	5.0	2.9%	0.87
	SEMW02_04	1	-12.6	20.0	11.7%	0.16
	SEMW03_04	1	0.6	7.5	4.4%	0.85
	SEMW04_04	1	-0.1	3.9	2.3%	0.91
	SEMW05_04	1	1.1	6.7	3.9%	0.91
	SEMW05_05	1	0.1	6.6	3.9%	0.92
	SEMW06_04	1	1.8	8.1	4.8%	0.83
	SEMW07_04	1	-6.0	8.4	4.9%	0.79
	SEMW18A	1	-1.1	3.4	2.0%	0.89
	SEMW21A	1	-2.5	3.8	2.2%	0.93
	SEMW28	1	-2.6	3.5	2.0%	0.85
	EPAW418_04	2	0.3	7.6	4.5%	0.61
	EPAW420_02	2	0.2	9.4	5.5%	0.18
	EPAW421B	2	-0.9	7.6	4.5%	0.64
	EMW205_04	3	-3.8	5.3	3.1%	0.96
	EMW206_03	3	1.4	3.1	1.8%	0.96
	EMW208_04	3	-0.4	4.3	2.5%	0.99
	EPAMP01_08	3	2.2	5.0	2.9%	0.78
	EPAW410_07	3	2.5	6.4	3.8%	0.97
	EPAW412_04	3	2.7	5.1	3.0%	0.85
	EPAW413_04	3	0.0	5.5	3.2%	0.91
	EPAW414_04	3	0.6	4.5	2.6%	0.94
	EPAW416_03	3	-3.3	9.8	5.7%	0.82
	EPAW417_04	3	3.9	7.3	4.3%	0.97
	EPAW419_04	3	3.7	7.0	4.1%	0.74
	EPAW422_05	3	-7.0	10.6	6.2%	0.71
	SEMW02_03	3	-3.6	8.5	5.0%	0.91
	SEMW06_03	3	-0.6	7.0	4.1%	0.90
	SEMW08_05	3	-1.5	2.6	1.5%	0.97
	SEMW18B	3	-5.5	5.8	3.4%	0.96
	SEMW21B	3	-2.8	4.0	2.3%	0.92
	SEMW26	3	-8.4	8.7	5.1%	0.99

Table 1. Summary Statistics of Model Calibration						
Aquifer Zone	Station_ID	Layer	ME (ft)[1]	RMS (ft)[3]	% RMS[4]	RSQ[5]
Transition Zone	SEMW27	3	-4.9	6.2	3.7%	0.87
	EMW205_03	4	-9.2	10.0	5.9%	0.98
	EMW207_03	4	0.9	4.8	2.8%	0.98
	EPAMP01_07	4	-1.0	4.9	2.9%	0.77
	EPAW413_03	4	-0.8	5.8	3.4%	0.88
	EPAW414_03	4	3.6	6.3	3.7%	0.93
	EPAW415_04	4	0.0	6.0	3.5%	0.84
	EPAW416_02	4	-0.1	3.5	2.1%	0.98
	EPAW417_03	4	1.5	4.2	2.5%	0.94
	EPAW418_03	4	2.2	5.9	3.5%	0.79
	EPAW419_03	4	9.8	11.5	6.8%	0.76
	EPAW422_04	4	-9.3	12.2	7.2%	0.71
	EPAW429A	4	-8.8	9.8	5.7%	0.71
	SEMW01_03	4	-6.9	9.1	5.4%	0.86
	SEMW03_03	4	-4.1	8.2	4.8%	0.88
	SEMW04_03	4	-6.8	8.7	5.1%	0.88
	SEMW05_03	4	-5.1	7.7	4.5%	0.92
	SEMW15A	4	-17.2	17.8	10.5%	0.79
	SEMW17A	4	-3.7	4.8	2.8%	0.89
	SEMW21C	4	-9.7	9.8	5.8%	0.98
	SEMW23A	4	-0.6	2.0	1.1%	0.91
	EMERP8_03	5	3.7	6.0	3.5%	0.97
	EMW205_02	5	-0.6	3.3	1.9%	0.96
	EMW206_01	5	1.3	4.2	2.4%	0.91
	EMW206_02	5	2.8	4.5	2.6%	0.93
	EMW207_02	5	3.0	6.5	3.8%	0.94
	EMW208_03	5	4.3	6.8	4.0%	0.97
	EPAMP01_06	5	-1.2	4.7	2.8%	0.79
	EPAW410_05	5	3.2	6.2	3.7%	0.91
	EPAW410_06	5	1.2	11.3	6.6%	0.55
	EPAW413_02	5	-2.1	6.1	3.6%	0.92
	EPAW414_02	5	3.1	5.8	3.4%	0.93
	EPAW415_03	5	-0.5	6.0	3.5%	0.88
	EPAW416_01	5	7.2	8.8	5.2%	0.92
	EPAW417_02	5	1.3	4.4	2.6%	0.91
	EPAW418_02	5	1.6	5.7	3.3%	0.80
	EPAW419_02	5	3.8	6.5	3.8%	0.81
	EPAW421A	5	-6.2	10.0	5.9%	0.61
	SEMW01_01	5	-0.6	6.9	4.0%	0.79
	SEMW01_02	5	-0.6	6.7	4.0%	0.80
	SEMW02_01	5	-4.1	8.9	5.2%	0.84
	SEMW02_02	5	0.9	6.1	3.6%	0.91
	SEMW03_02	5	-4.1	8.1	4.8%	0.87
	SEMW04_02	5	-0.6	6.9	4.1%	0.83
	SEMW05_01	5	-0.3	7.7	4.5%	0.86

Table 1. Summary Statistics of Model Calibration

Aquifer Zone	Station_ID	Layer	ME (ft)[1]	RMS (ft)[3]	% RMS[4]	RSQ[5]
Intermediate Zone	SEMW05_02	5	0.1	6.4	3.8%	0.91
	SEMW06_01	5	-4.0	7.8	4.6%	0.91
	SEMW06_02	5	-2.6	8.1	4.8%	0.84
	SEMW07_02	5	-0.7	5.1	3.0%	0.88
	SEMW07_03	5	0.4	6.3	3.7%	0.82
	SEMW08_03	5	-1.0	8.1	4.8%	0.61
	SEMW08_04	5	1.3	6.0	3.6%	0.81
	SEMW09	5	-5.6	6.2	3.7%	0.95
	SEMW10	5	-1.6	3.8	2.3%	0.90
	SEMW11	5	3.0	4.2	2.4%	0.93
	SEMW13A	5	-1.8	3.4	2.0%	0.92
	SEMW14	5	4.3	12.2	7.1%	0.37
	SEMW16A	5	4.5	5.7	3.4%	0.86
	SEMW17B	5	6.5	8.1	4.8%	0.75
	SEMW18C	5	-10.3	10.6	6.2%	0.91
	SEMW19A	5	-4.0	5.3	3.1%	0.83
	SEMW20A	5	-1.2	2.9	1.7%	0.89
	SEMW22A	5	-5.1	5.6	3.3%	0.93
	EPAW418_01	6	2.0	6.1	3.6%	0.81
	EPAW422_03	6	-7.1	11.0	6.5%	0.55
	EPAW429B	6	-14.4	14.9	8.8%	0.71
	EMERP8_01	7	2.1	7.9	4.7%	0.93
	EMERP8_02	7	4.8	6.7	3.9%	0.97
	EMW205_01	7	0.9	4.6	2.7%	0.93
	EMW207_01	7	1.5	6.8	4.0%	0.93
	EMW208_02	7	1.2	6.6	3.9%	0.93
	EPAMP01_05	7	-1.4	5.0	3.0%	0.77
	EPAW412_03	7	-2.1	4.9	2.9%	0.85
	EPAW413_01	7	-5.4	8.2	4.8%	0.88
	EPAW414_01	7	1.7	5.3	3.1%	0.97
	EPAW415_01	7	1.4	6.0	3.5%	0.88
	EPAW415_02	7	-1.3	6.0	3.5%	0.95
	EPAW417_01	7	4.5	13.6	8.0%	0.48
	SEMW03_01	7	-4.1	8.1	4.8%	0.88
	SEMW04_01	7	-2.8	7.1	4.2%	0.85
	SEMW12	7	6.7	7.4	4.4%	0.91
	SEMW13B	7	7.9	8.6	5.0%	0.86
	SEMW23B	7	1.9	3.6	2.1%	0.77
	SEMW24A	7	-2.1	16.6	9.7%	0.33
	EPAW422_02	8	-9.0	11.9	7.0%	0.72
	EPAMP01_03	9	3.5	14.4	8.4%	0.27
	EPAMP01_04	9	0.0	3.8	2.2%	0.82
	EPAW410_04	9	2.9	6.5	3.8%	0.96
	EPAW422_01	9	-8.5	11.7	6.9%	0.69
	EPAW427A	9	-14.3	14.7	8.6%	0.87

Table 1. Summary Statistics of Model Calibration

Aquifer Zone	Station_ID	Layer	ME (ft)[1]	RMS (ft)[3]	% RMS[4]	RSQ[5]
	SEMW07_01	9	11.5	14.7	8.6%	0.58
	SEMW08_01	9	8.8	11.8	6.9%	0.70
	SEMW08_02	9	8.7	11.6	6.8%	0.66
	SEMW15B	9	-32.2	32.4	19.0%	0.94
	SEMW16B	9	-4.3	6.2	3.6%	0.79
	SEMW19B	9	0.5	3.6	2.1%	0.83
	SEMW20B	9	0.9	2.8	1.6%	0.90
	SEMW22B	9	-5.3	6.0	3.5%	0.89
	SEMW24B	9	-4.2	18.3	10.7%	0.36
	EPAW428A	10	-15.4	15.8	9.3%	0.89
Deep Zone	EPAMP01_01	11	5.5	6.4	3.7%	0.77
	EPAMP01_02	11	5.2	6.2	3.6%	0.78
	EPAW410_01	11	-2.2	4.8	2.8%	0.95
	EPAW410_02	11	4.5	7.7	4.5%	0.95
	EPAW410_03	11	4.4	7.4	4.4%	0.95
	EPAW427B	11	-8.4	9.6	5.6%	0.83
	EPAW428B	11	-11.3	12.3	7.2%	0.80
	EPAW412_02	12	1.8	4.6	2.7%	0.83
	EPAW428C	12	-11.2	12.3	7.2%	0.80
	EPAW419_01	13	4.0	6.7	3.9%	0.81
	EPAW420_01	13	-2.2	7.7	4.5%	0.48
	EPAW412_01	14	3.1	6.3	3.7%	0.78
	Mean		-1.1	7.6	4.4%	0.83
	Max		11.5	32.4	19.0%	0.99
	Min		-32.2	2.0	1.1%	0.16

Note:

1. Mean Error

3. Root-Mean-Square error

3. Root-Mean-Square error normalized to the observed water level fluctuations of 170.21 ft.

4. r^2, serves as an indicator of goodness of fit for each calibration well.

Table 2 Summary of ERAS Remedial Alternatives

Alt. #	Alternative Description	Remedy Pumping		End Use
		SEMOU	WNOU	
2	No Further Action (continue interim containment remedies)	5,850 gpm: MP (Central)- 3,550 gpm (MP12-1,800; MP15-1,750) SGVWC 8C/8D- 1,300 gpm GSWC SG1/SG2- 870 gpm MP (Western)- MP5- 130 gpm	3,500 gpm: EW4-6- 1,000 gpm EW4-5- 2,500 gpm	SEMOU- no change WNOU- 2,000 gpm to SGVWC, 800 gpm to Legg Lakes (no reductions for SGVWC Prop. 1)
3	Optimize Existing SEMOU/WNOU Interim Remedies	Same as Alternative 2	3,500 gpm: EW4-6- 500 gpm EW4-5- 2,000 gpm EXT 0 - 1,000 gpm IZ	Same as Alternative 2
4	SEMOU/WNOU Hydraulic Control Plus Pumping to Enhance WNOU Cleanup	Alt 2 Plus 2,500 gpm: Ext 1- 500 gpm SZ; 600 gpm UIZ; 300 gpm MIZ Ext 2- 500 gpm UIZ Ext 4- 600 gpm UIZ	2,800 gpm: EW4-6- 2,100 gpm EW4-5- 700 gpm	1,000 gpm to MP (Shut. MP1, MP3, MP10, Fern) 400 gpm to GSWC (Shut. Garvey #3) 350 gpm to SGVWC (Shut. G4, 8F) 750 gpm to injection at WNOU EW4-3/EW4-4
5	SEMOU/WNOU Hydraulic Control Plus Pumping and Reinjection to Enhance WNOU Cleanup	Same as Alt 4	Same as Alt 4	500 gpm to Whittier (Shut. Whittier 15) 1,500 gpm injection in UIZ near 60 Fwy 500 injection to EW4-3/EW4-4
6	WNOU and SEMOU Enhanced Cleanup	Alt 2 Plus 5,500 gpm: Ext 1- 200 gpm SZ; 1,100 gpm UIZ Ext 2- 200 gpm UIZ Ext 3- 400 gpm SZ; 300 gpm UIZ Ext 5- 350 gpm SZ Ext 7- 200 gpm SZ; 700 gpm UIZ Ext 8- 250 gpm SZ Ext 9- 600 gpm UIZ Ext 10- 200 gpm SZ MP-15- 500 gpm more from IZ 8C- 500 gpm more from IZ	Same as Alt 4	3,000 gpm to purveyors: 1,000 gpm to MP (Shut. MP1, MP3, MP10, Fern) 400 gpm to GSWC (Shut. Garvey #3) 350 gpm to SGVWC (Shut. G4, 8F) 1,250 gpm to Whittier (Red. Well 15) 2,500 gpm injection: 1,750 injection in UIZ near 60 Fwy 750 gpm to injection at WNOU EW4-3/EW4-4
7	WNOU and SEMOU Enhanced and Accelerated Cleanup	Alt 2 Plus 9,500 gpm: Ext 1- 500 gpm SZ; 1,300 gpm UIZ; 500 gpm MIZ Ext 2- 500 gpm UIZ Ext 3- 600 gpm SZ; 500 gpm UIZ; 300 gpm MIZ Ext 5- 350 gpm SZ Ext 7- 200 gpm SZ; 700 gpm UIZ; 400 gpm MIZ Ext 8- 250 gpm SZ Ext 9- 400 gpm SZ; 800 gpm UIZ; 300 gpm MIZ Ext 10- 200 gpm SZ MP-12- 700 gpm more from IZ MP-15- 500 gpm more from IZ 8C- 500 gpm more from IZ	Same as Alt 4	7,000 gpm to purveyors: 1,000 gpm to MP (Shut. MP1, MP3, MP10, Fern) 400 gpm to GSWC (Shut. Garvey #3) 350 gpm to SGVWC (Shut. G4, 8F) 1,492 gpm to Whittier (Shut Well 15) 3,758 to Suburban (Shut. 201W7 and 201W10; red. 201W9 by 435 gpm) 2,500 gpm injection: 1,750 injection in UIZ near 60 Fwy 750 gpm to injection at WNOU EW4-3/EW4-4

Notes:
gpm = gallon per minute
GSWC = Golden State Water Company
IZ = Intermediate Zone
MIZ = Middle Intermediate Zone
MP = Monterey Park
SEMOU = South El Monte Operable Unit
SGVWC = San Gabriel Valley Water Company
SZ = Shallow Zone
UIZ = Upper Intermediate Zone
WNOU = Whittier Narrows Operable Unit

Figures

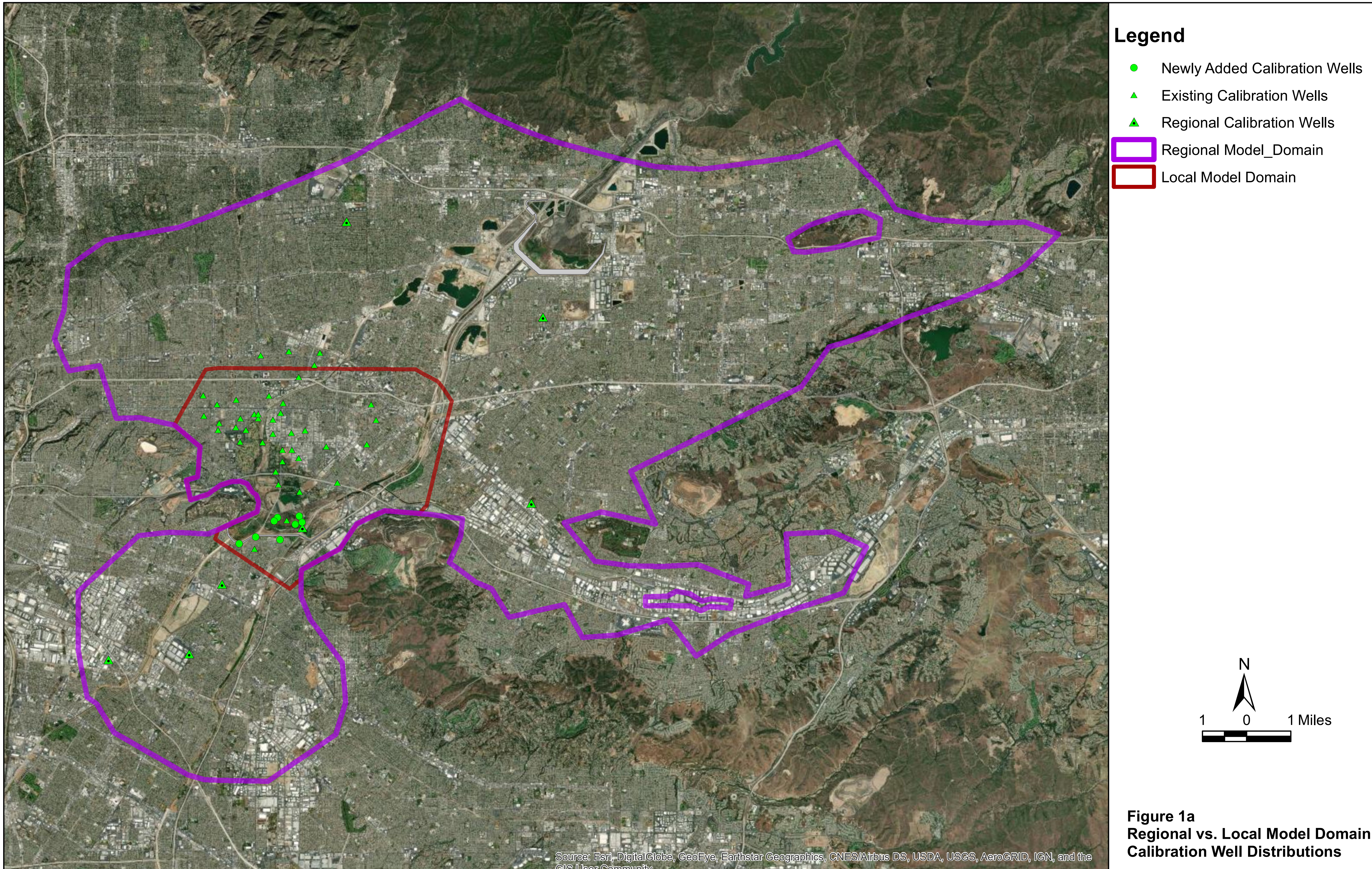

Figure 1a
Regional vs. Local Model Domain Calibration Well Distributions

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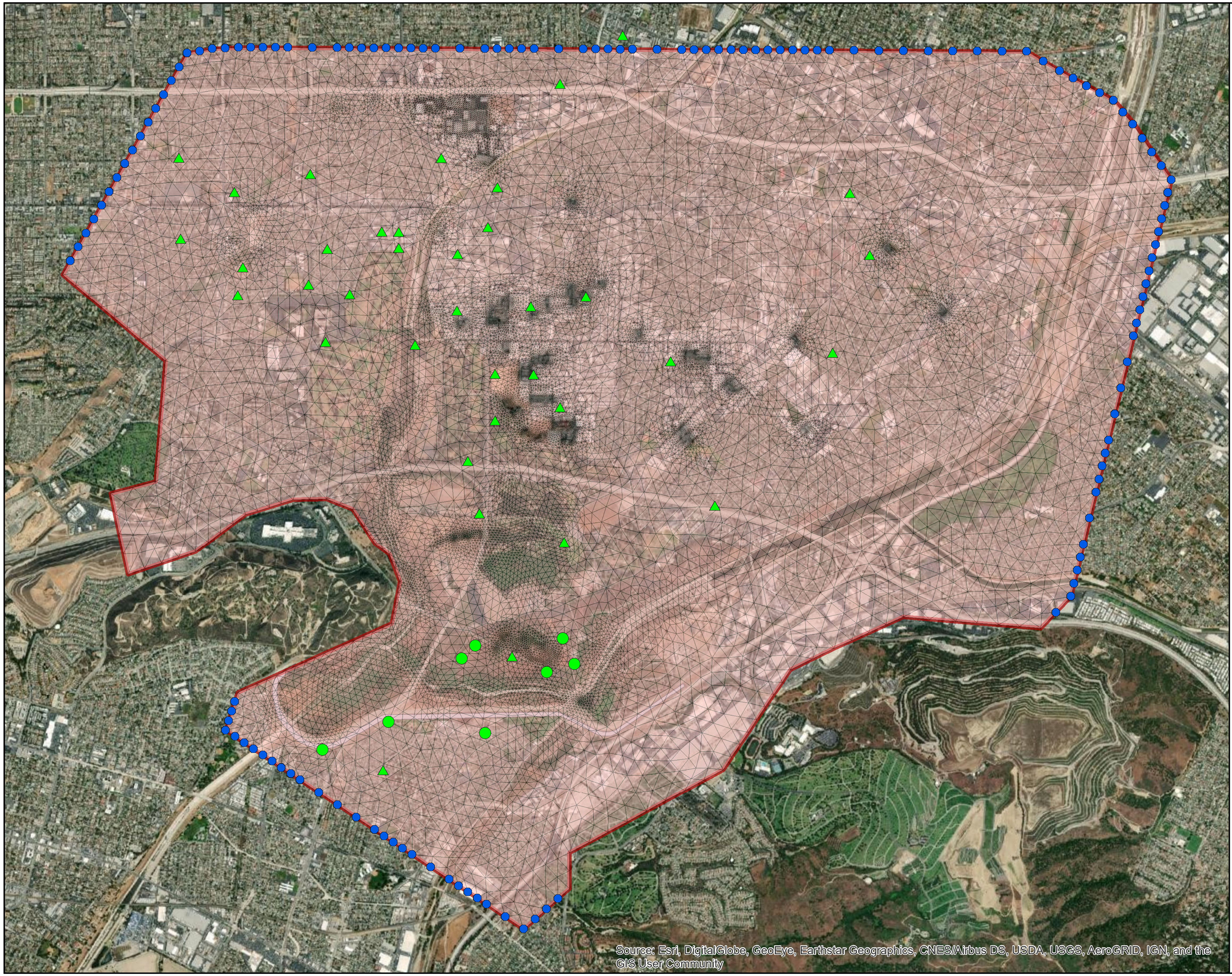

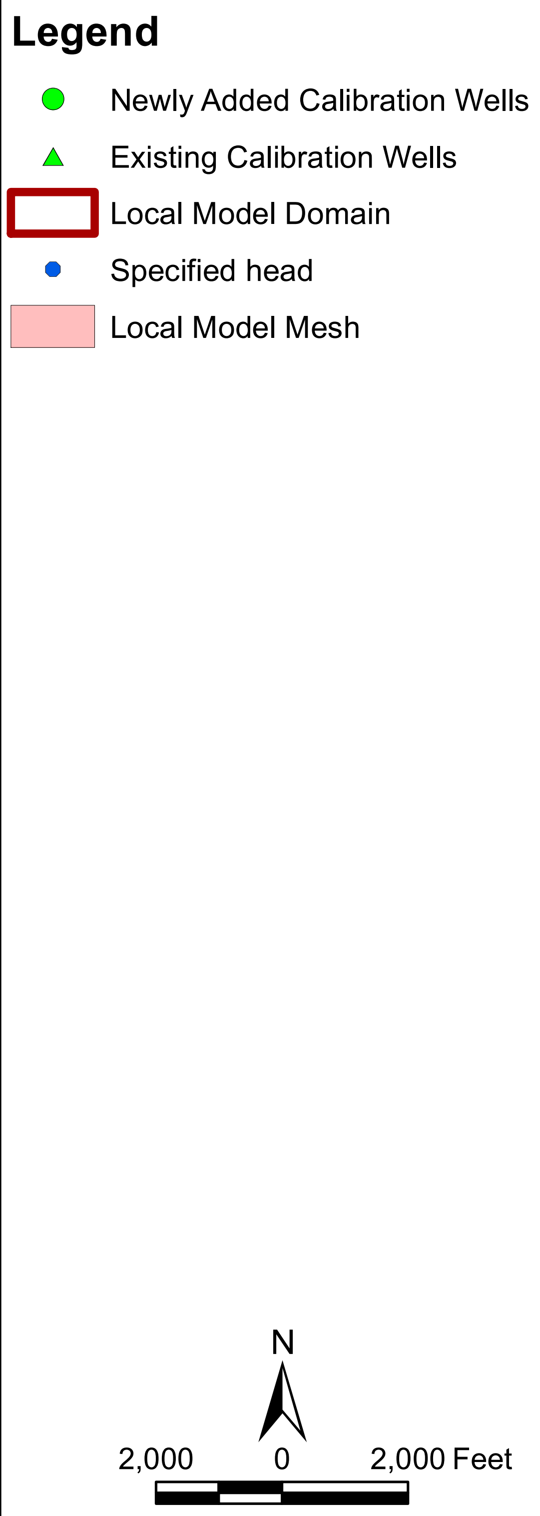

Figure 1b
Local Model Mesh
Calibration Well Distributions

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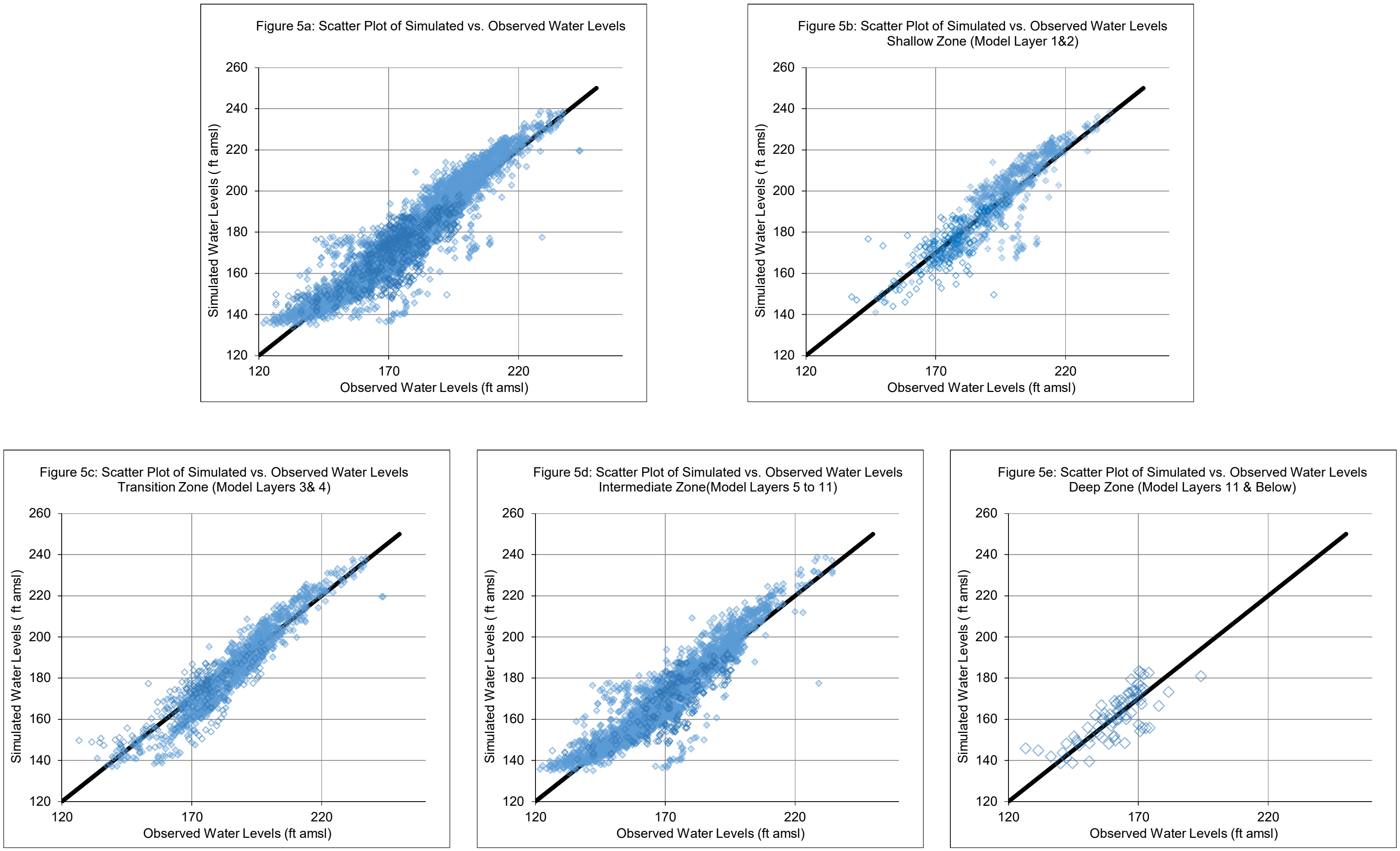


Figure 2 Scatter Plots of Simualted vs. Observed Heads Per Aquifer Zone

Figure 3 Measured vs. Simulated Hydrographs, Updated Regional SGB Model (Page 1/38)

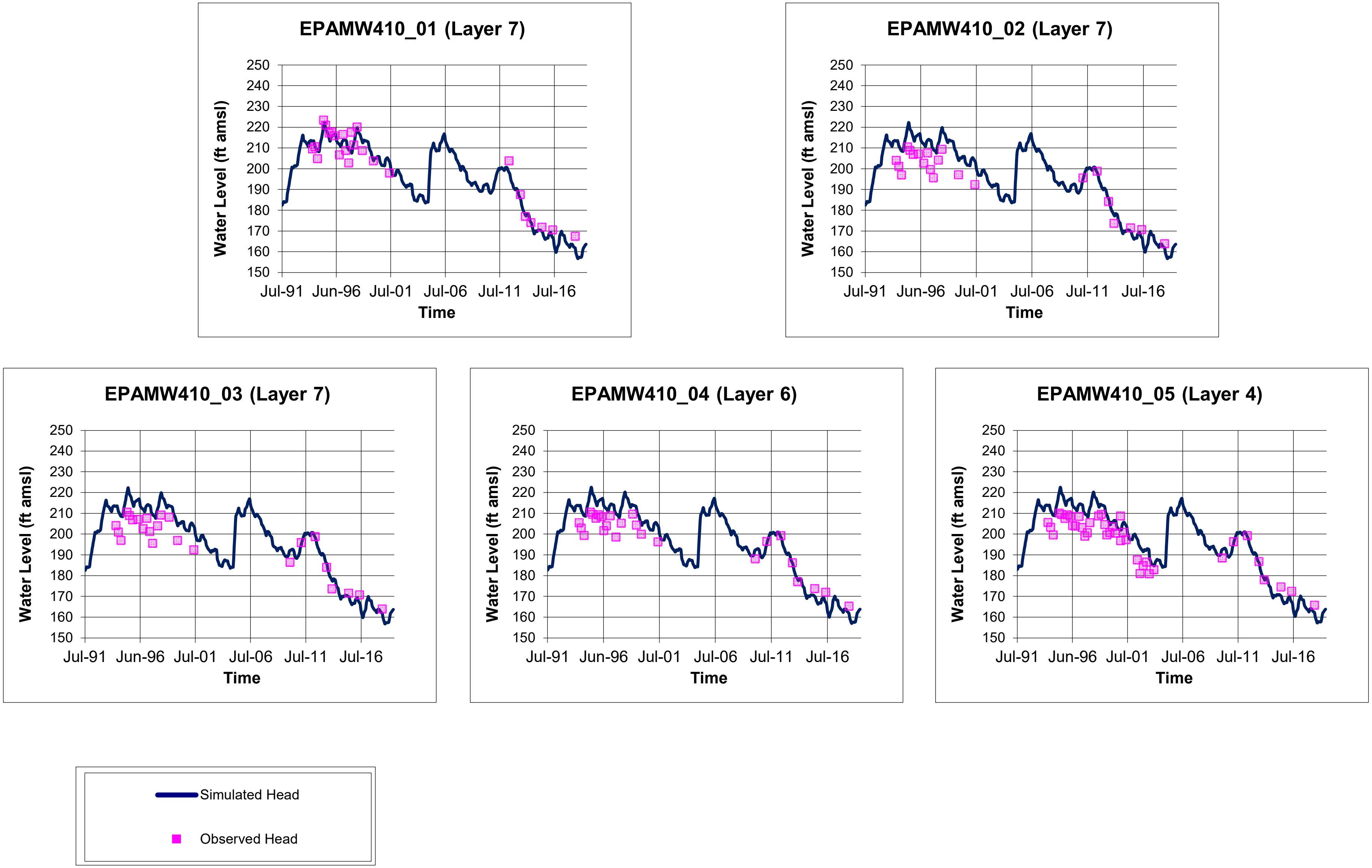
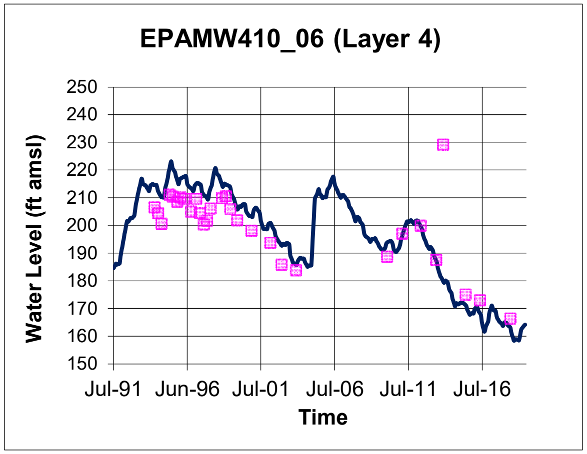
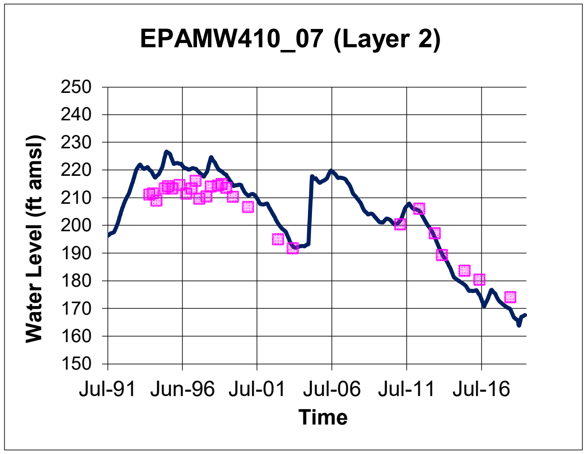
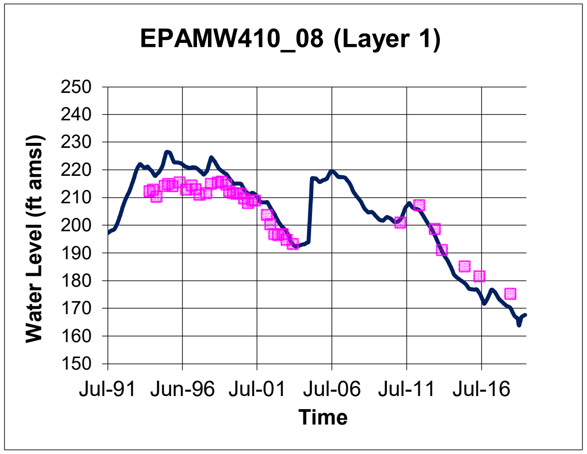
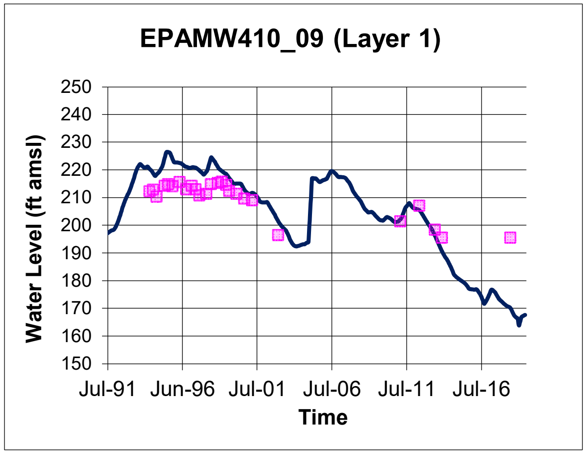


Figure 3 Measured vs. Simulated Hydrographs, Updated Regional SGB Model (Page 2/38)









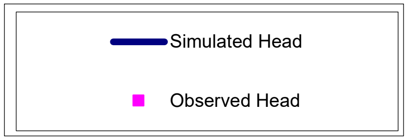


Figure 3 Measured vs. Simulated Hydrographs, Updated Regional SGB Model (Page 3/38)

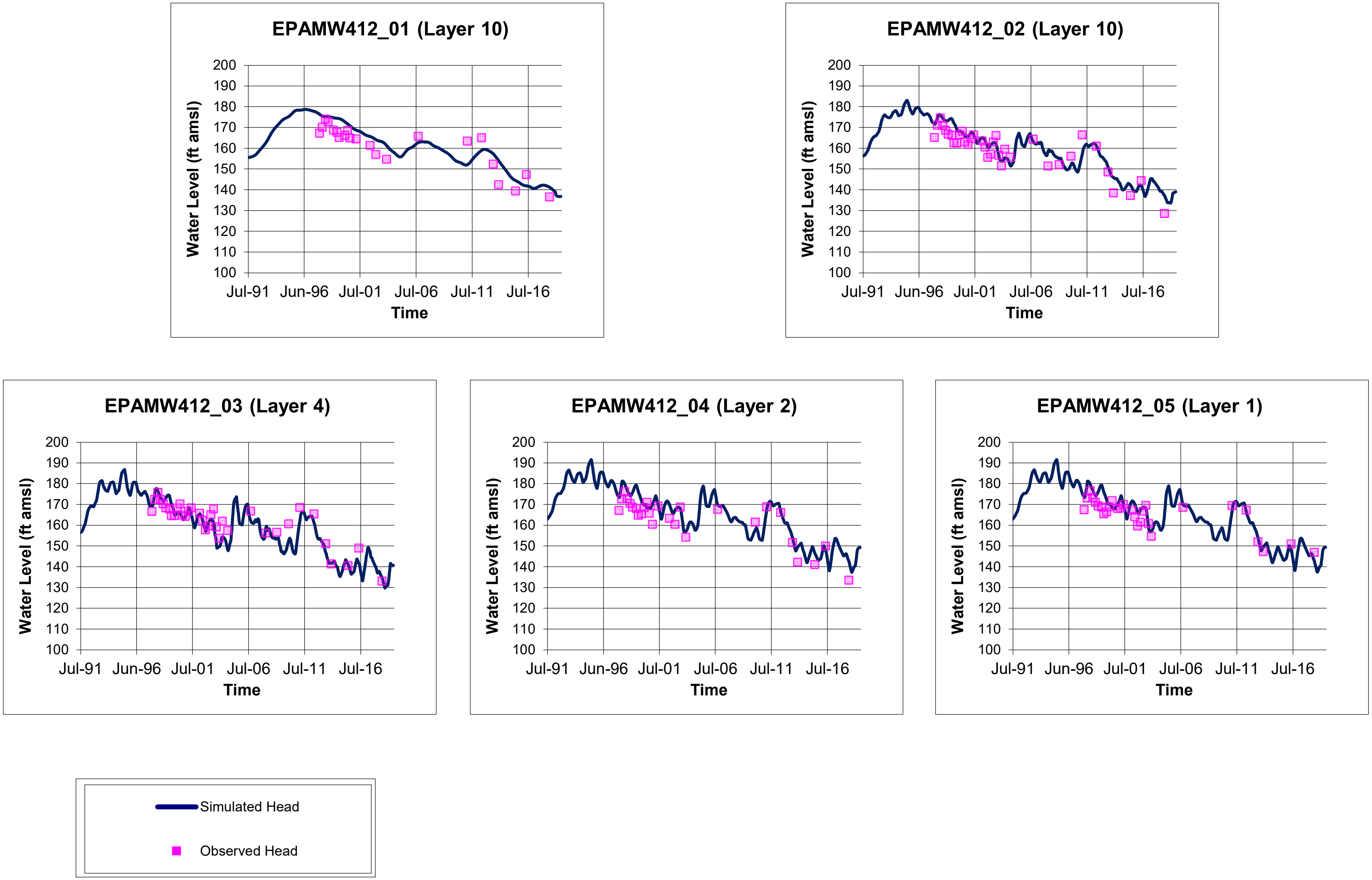
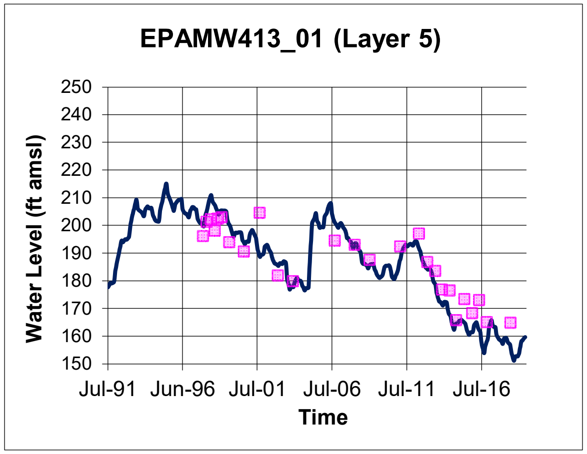
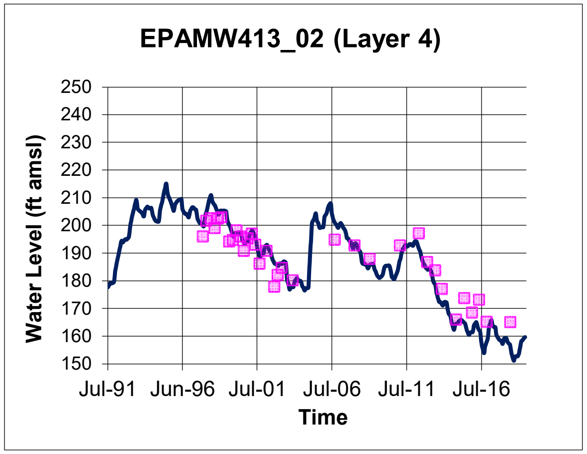
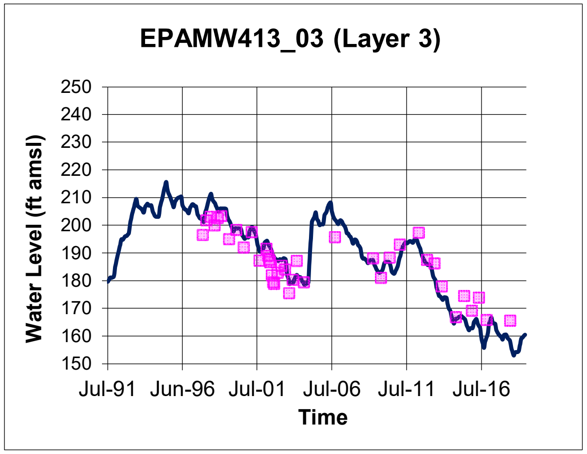
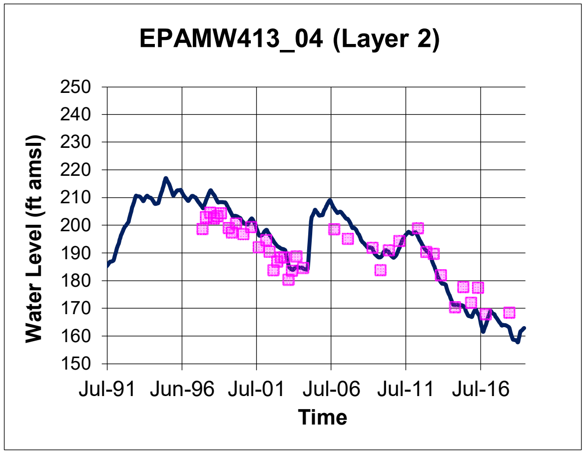


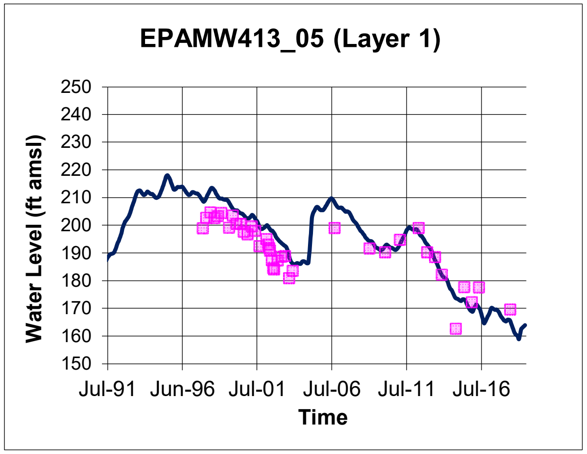
Figure 3 Measured vs. Simulated Hydrographs, Updated Regional SGB Model (Page 4/38)











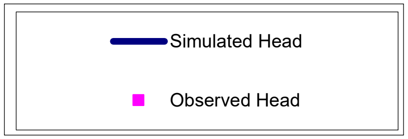


Figure 3 Measured vs. Simulated Hydrographs, Updated Regional SGB Model (Page 5/38)

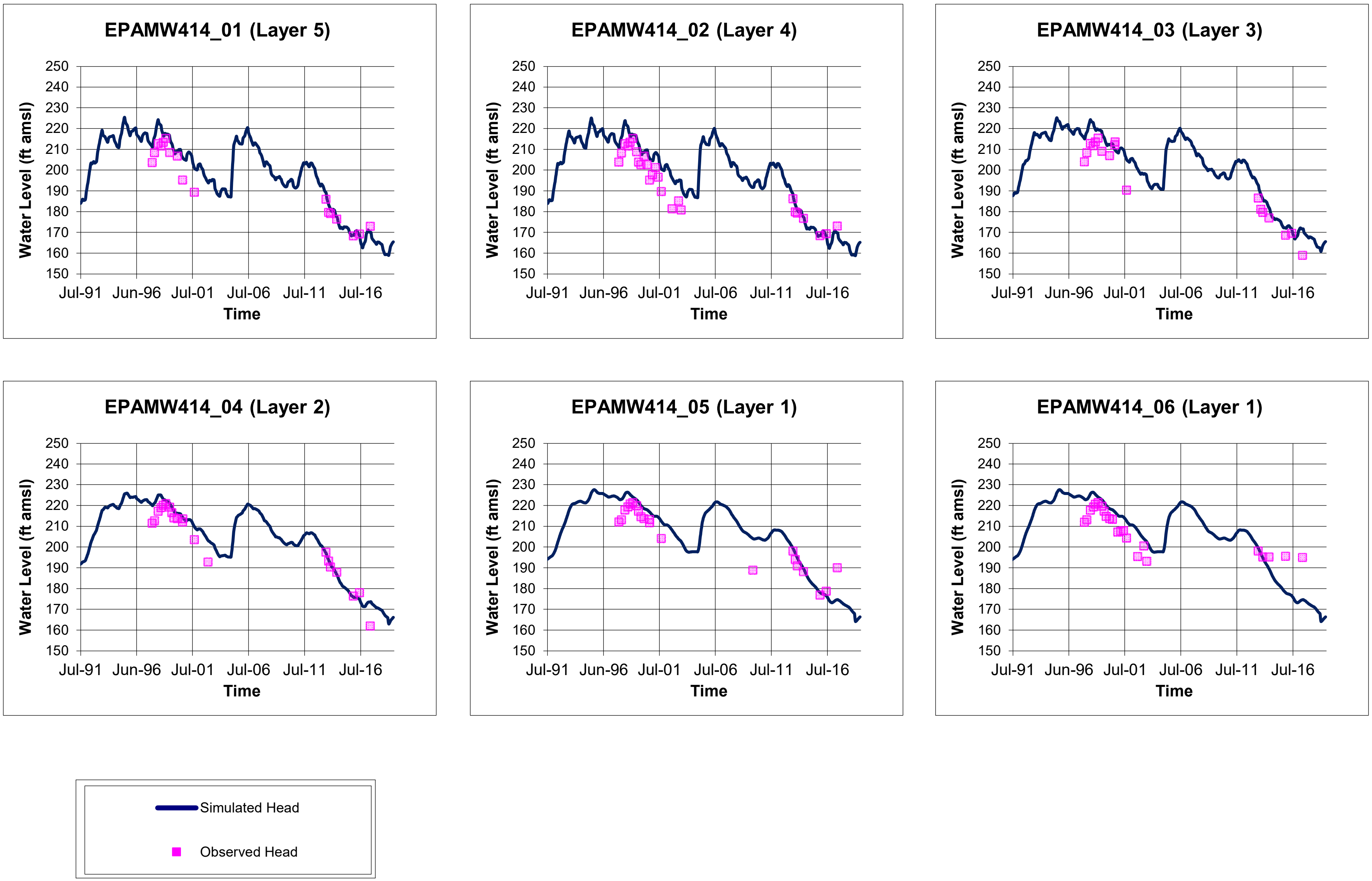


Figure 3 Measured vs. Simulated Hydrographs, Updated Regional SGB Model (Page 6/38)

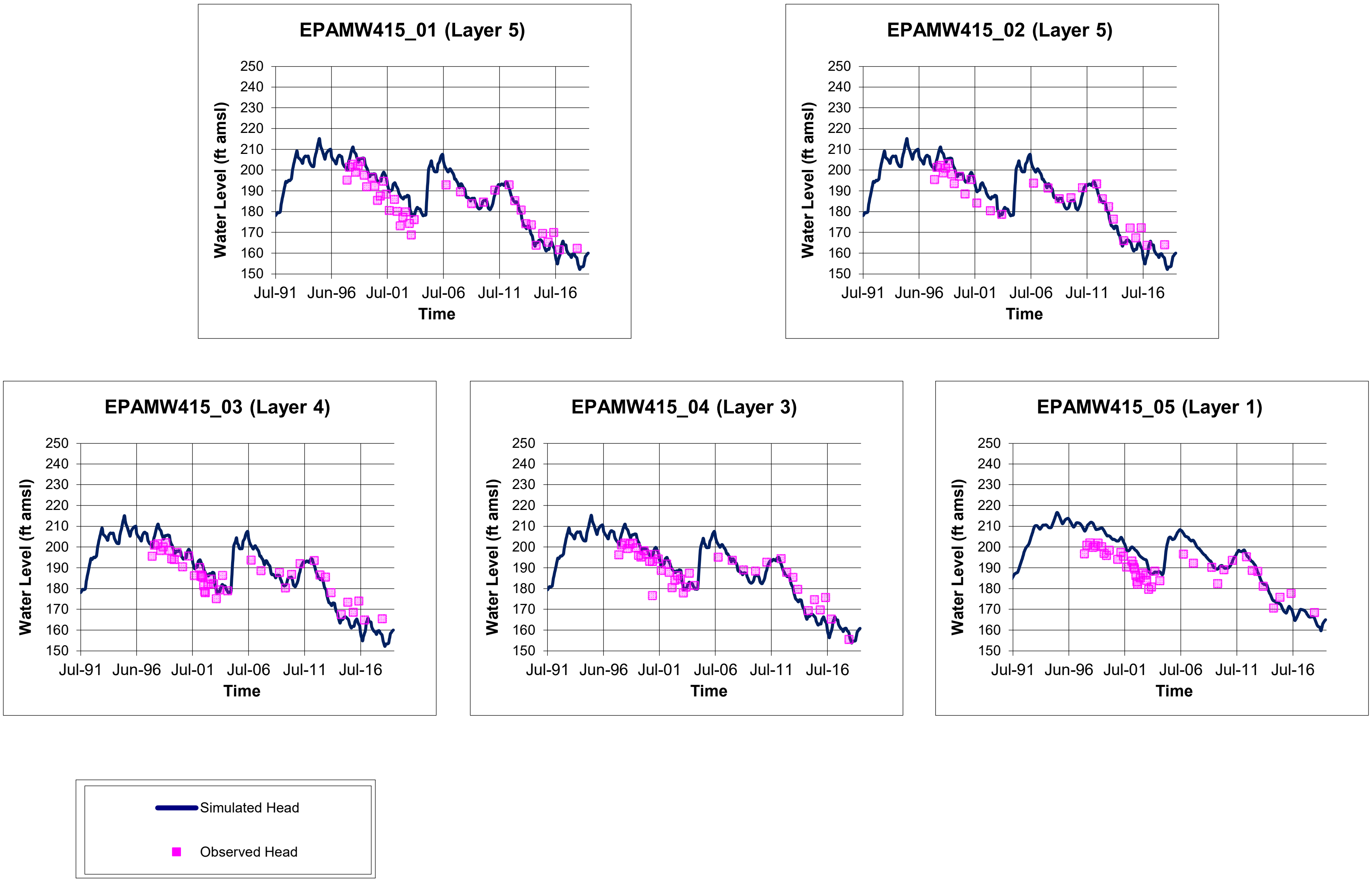
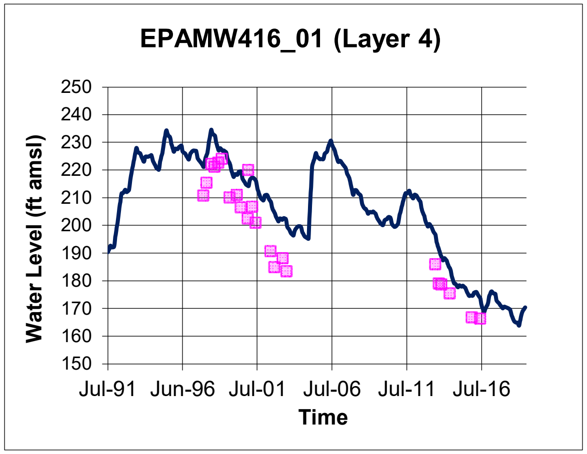
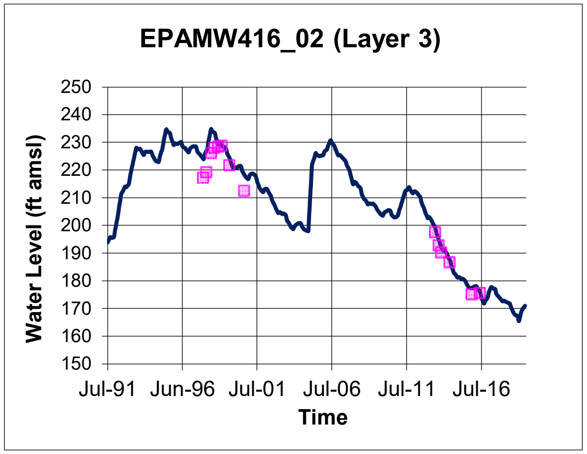
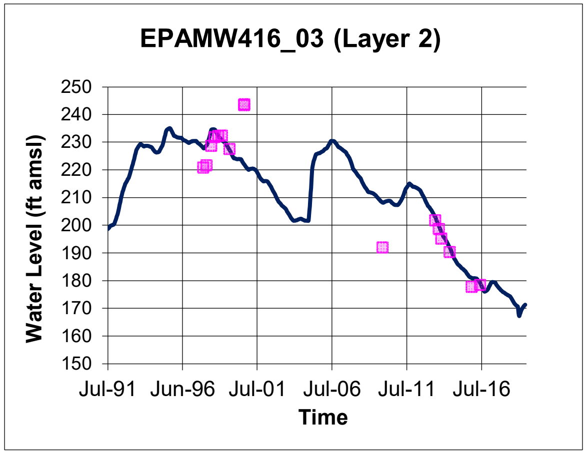
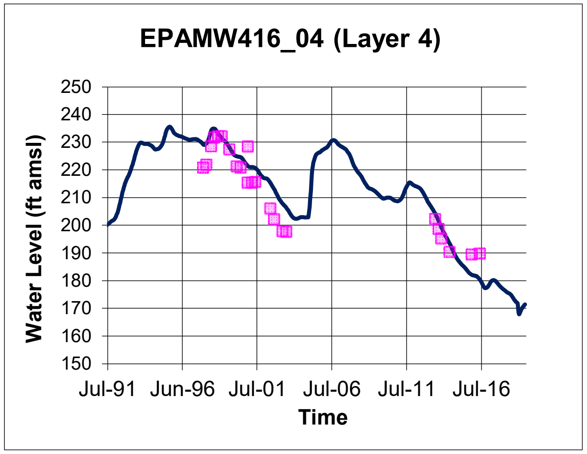


Figure 3 Measured vs. Simulated Hydrographs, Updated Regional SGB Model (Page 7/38)









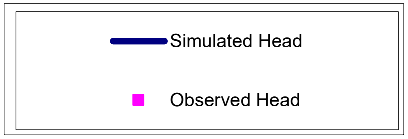
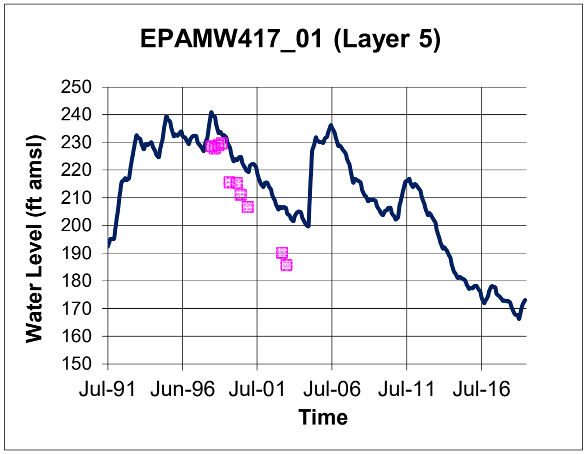
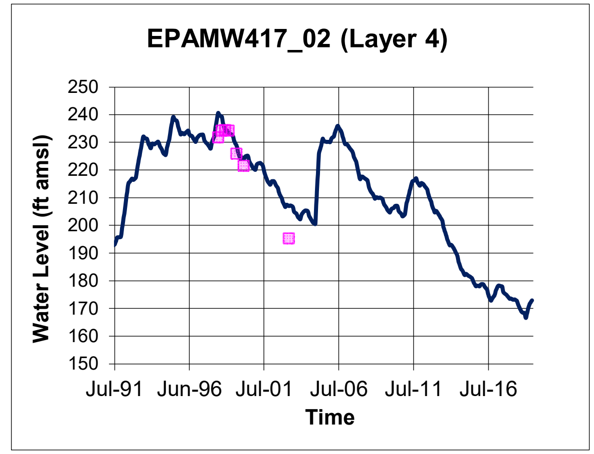
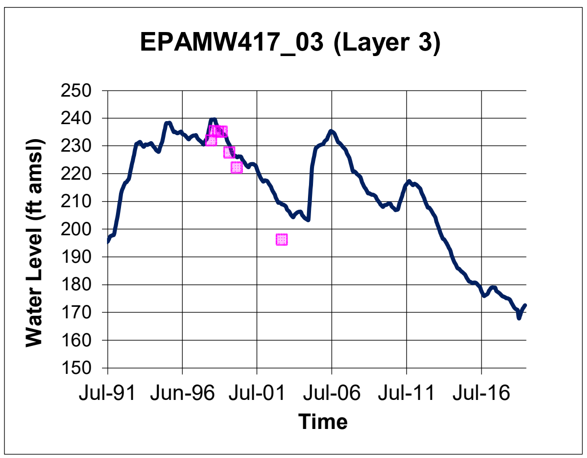
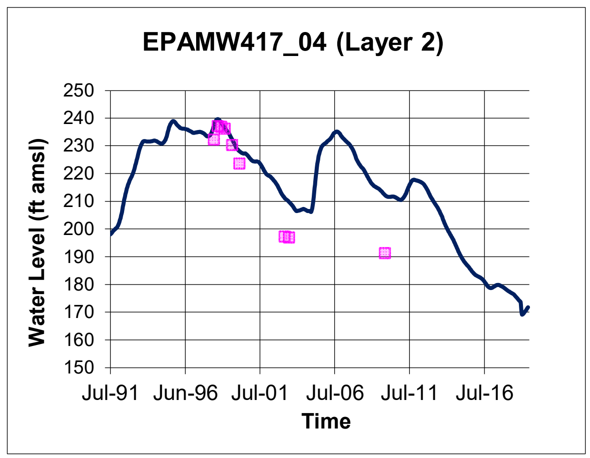


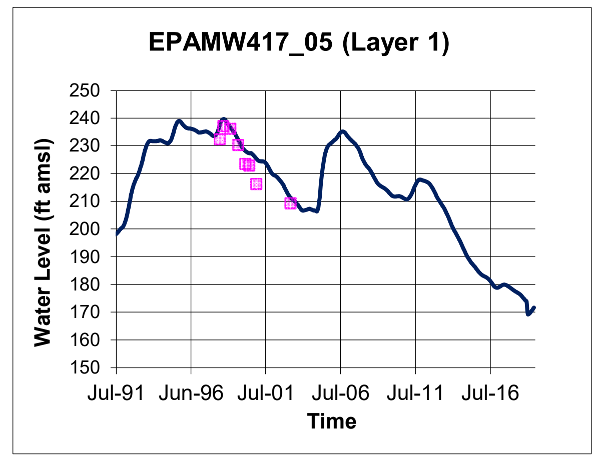
Figure 3 Measured vs. Simulated Hydrographs, Updated Regional SGB Model (Page 8/38)











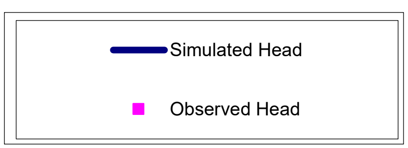


Figure 3 Measured vs. Simulated Hydrographs, Updated Regional SGB Model (Page 9/38)

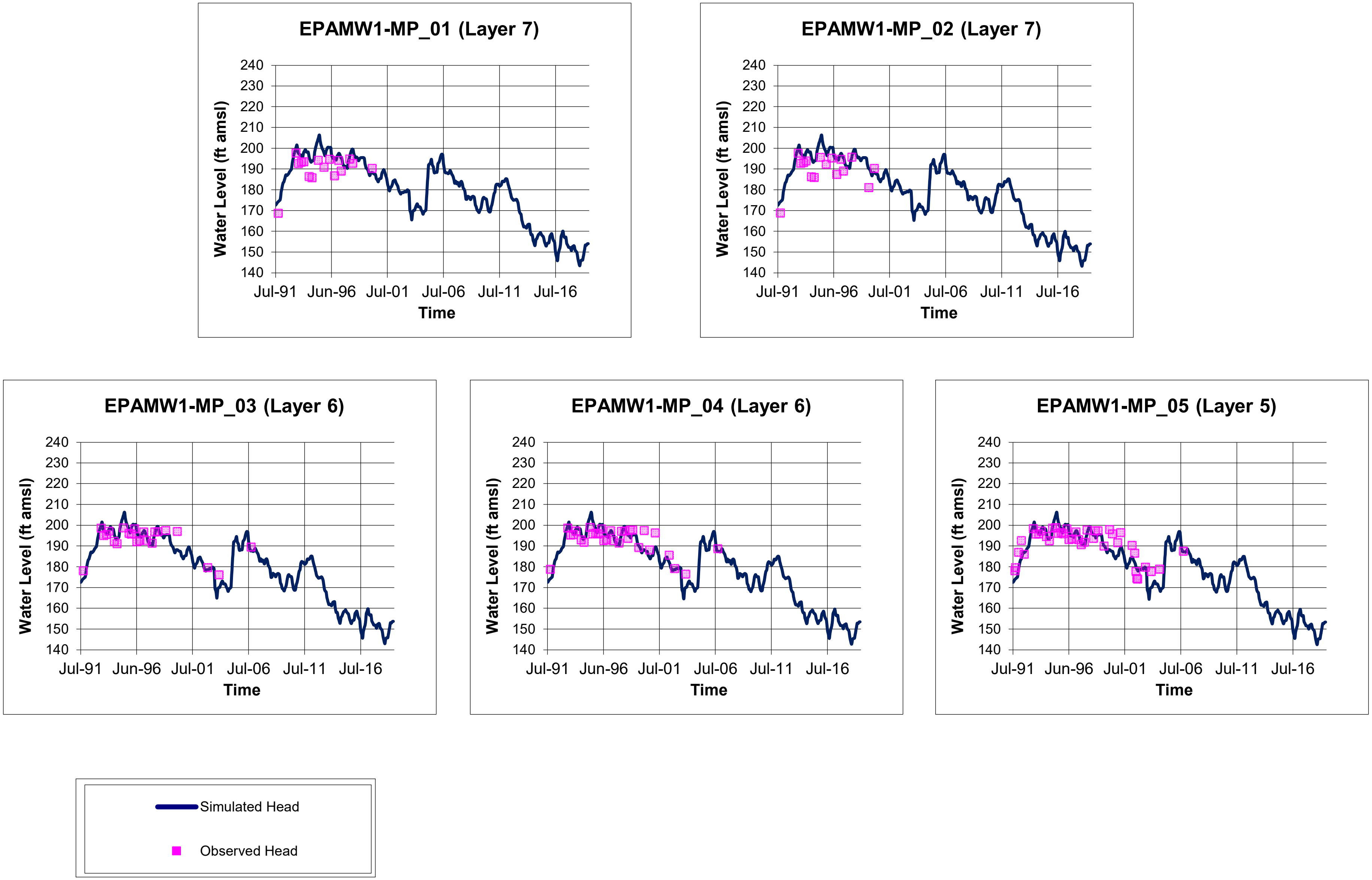


Figure 3 Measured vs. Simulated Hydrographs, Updated Regional SGB Model (Page 10/38)

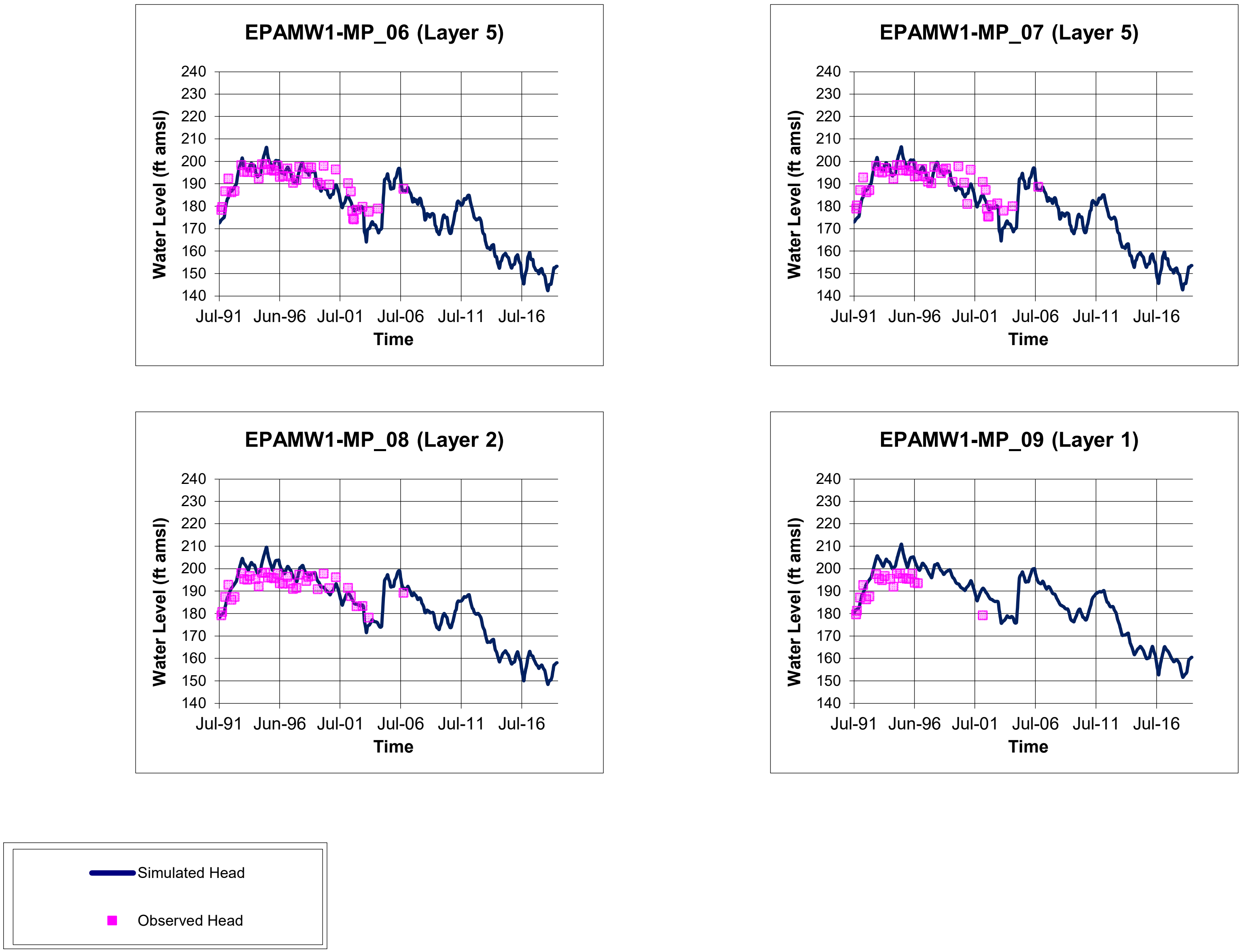
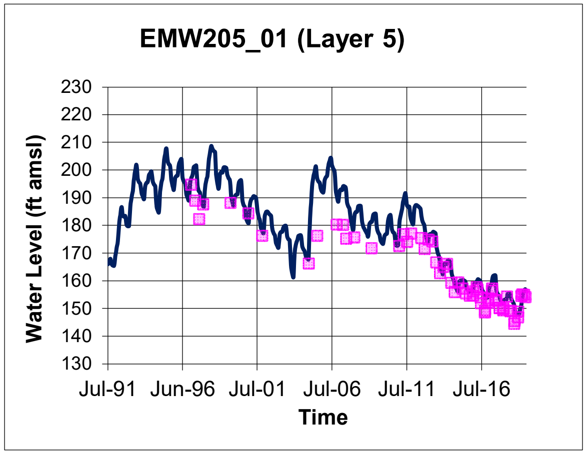
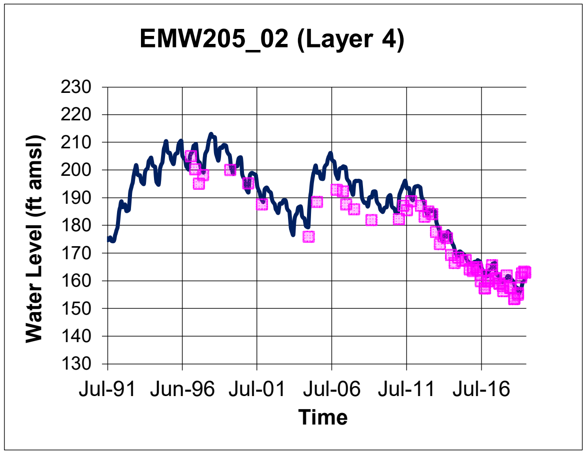
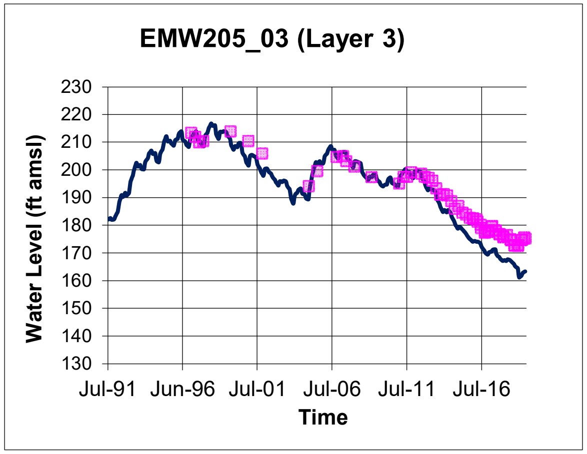
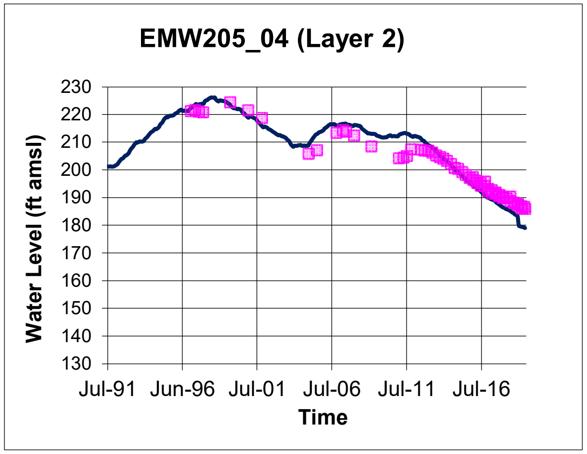


Figure 3 Measured vs. Simulated Hydrographs, Updated Regional SGB Model (Page 11/38)





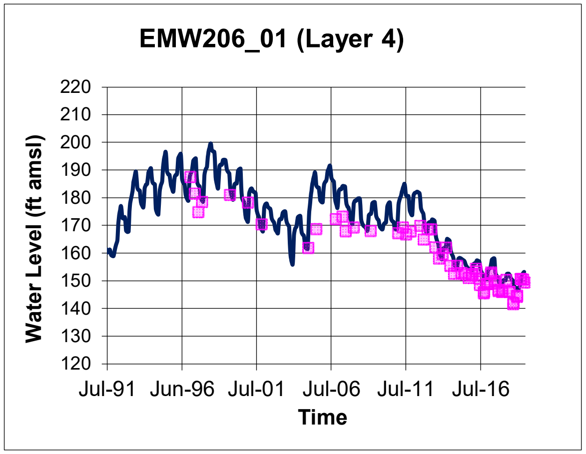


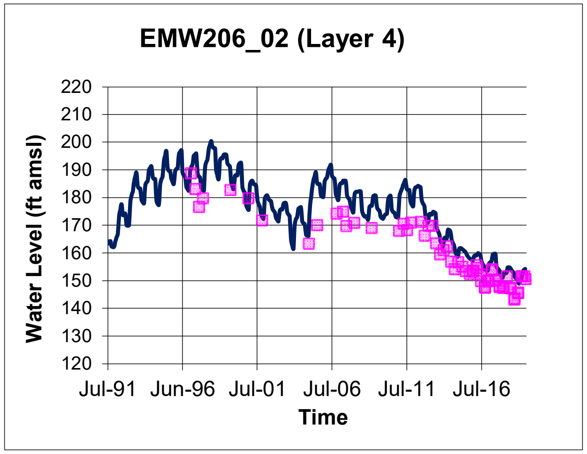


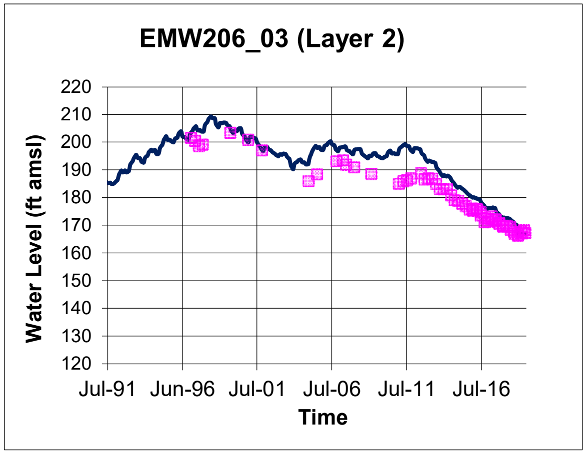
Simulated Head

Observed Head

Figure 3 Measured vs. Simulated Hydrographs, Updated Regional SGB Model (Page 12/38)







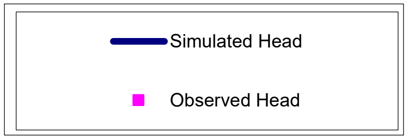


Figure 3 Measured vs. Simulated Hydrographs, Updated Regional SGB Model (Page 13/38)

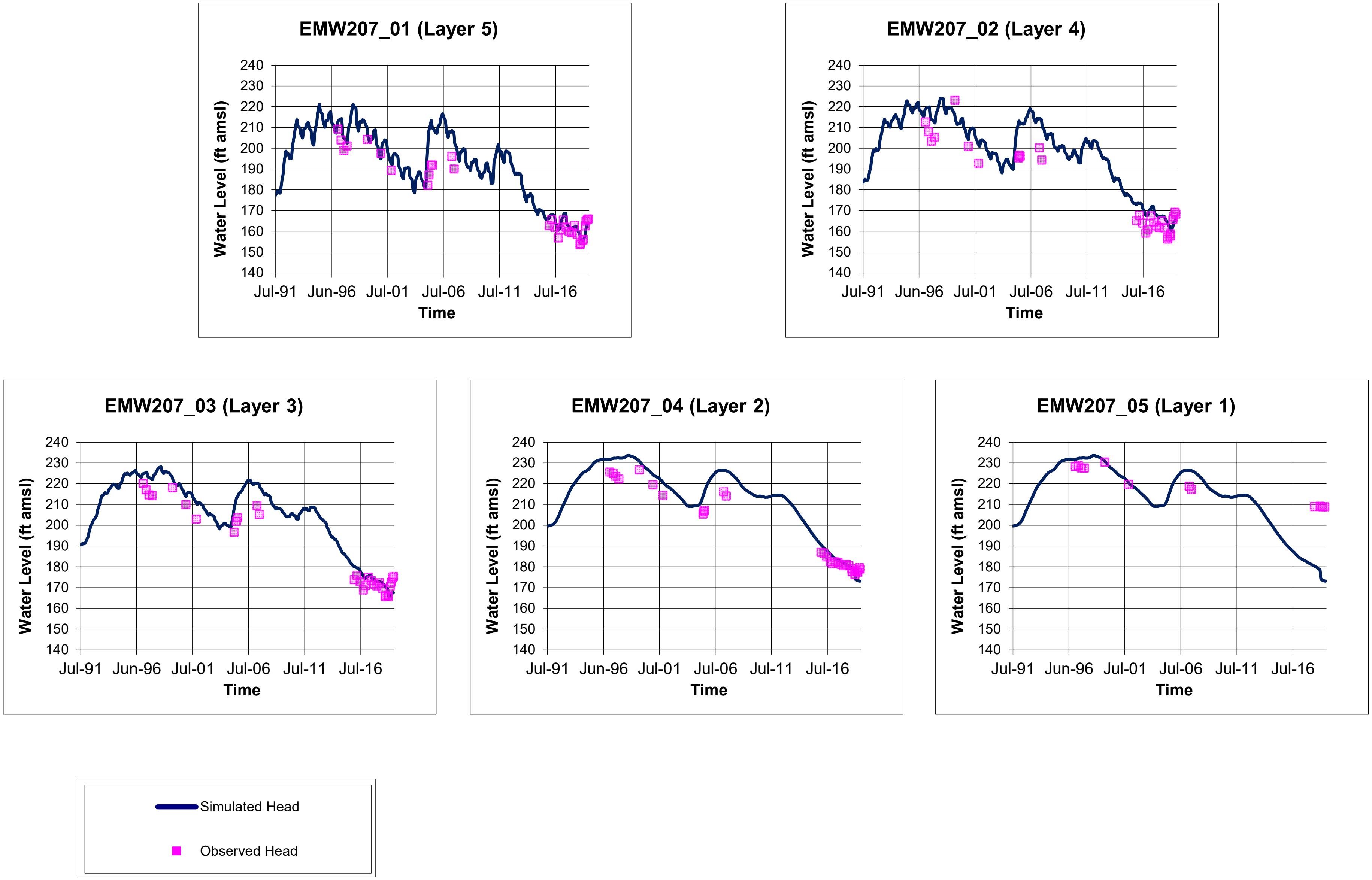
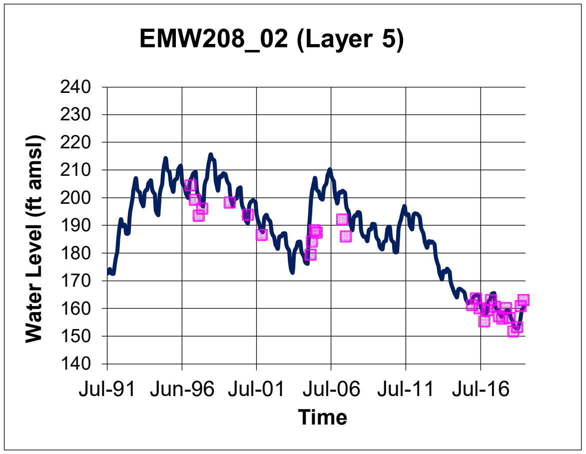
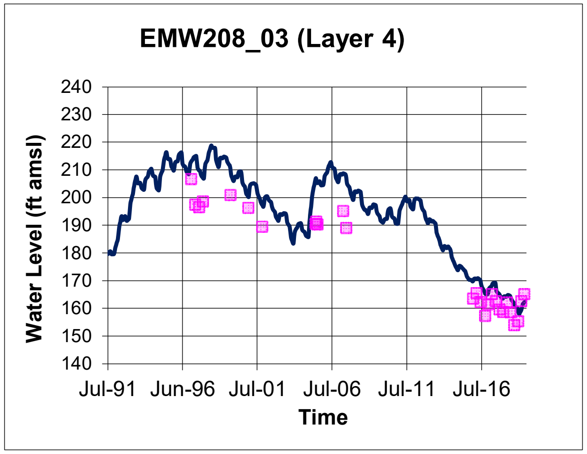
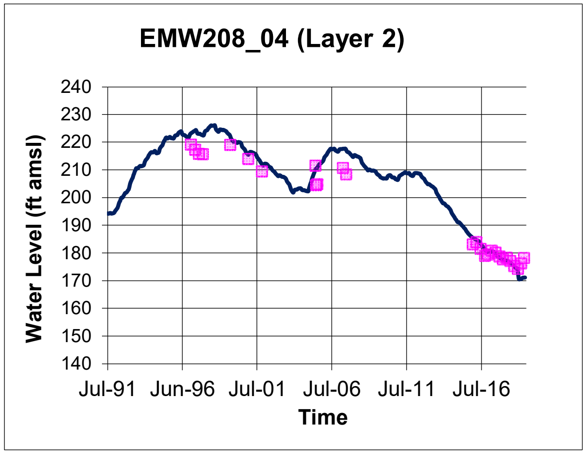


Figure 3 Measured vs. Simulated Hydrographs, Updated Regional SGB Model (Page 14/38)







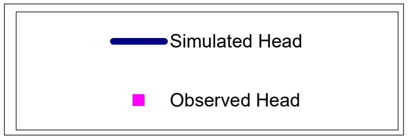
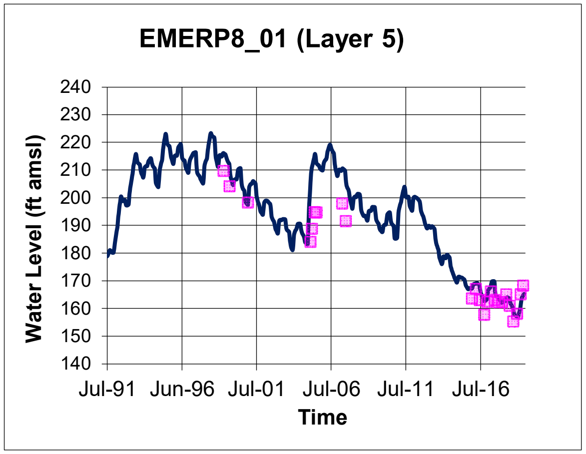
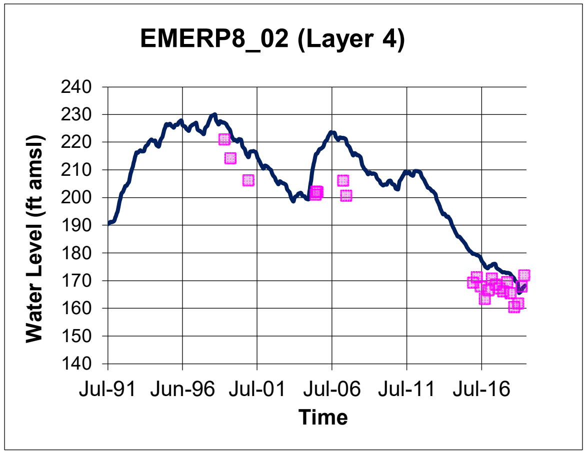
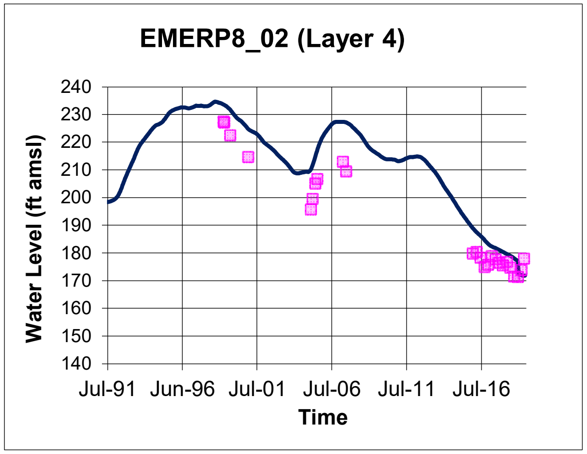


Figure 3 Measured vs. Simulated Hydrographs, Updated Regional SGB Model (Page 15/38)







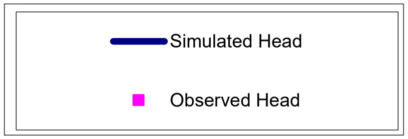
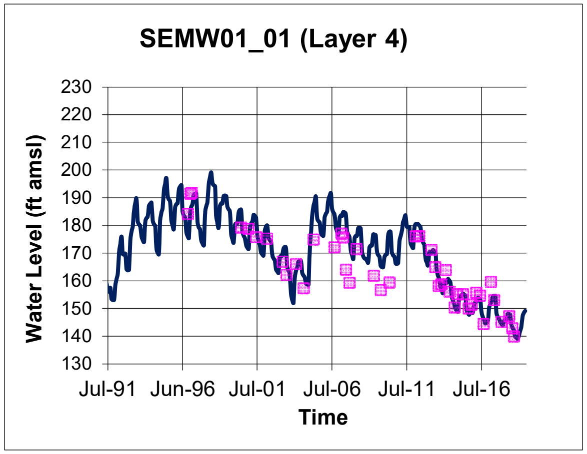
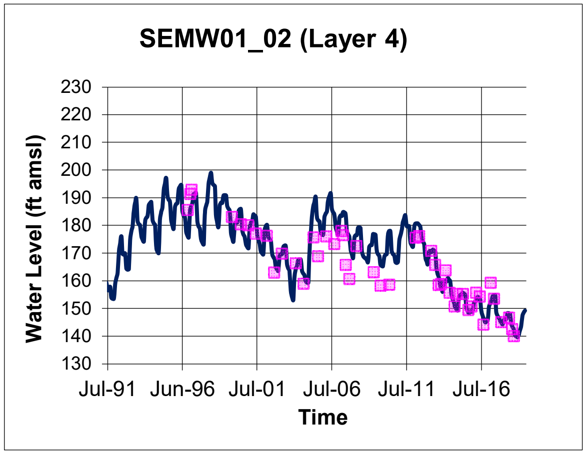
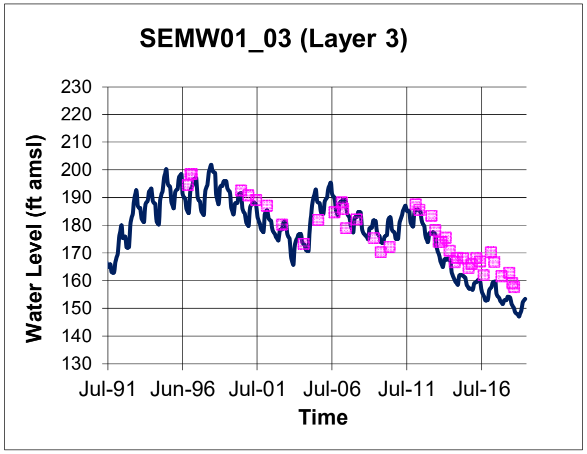
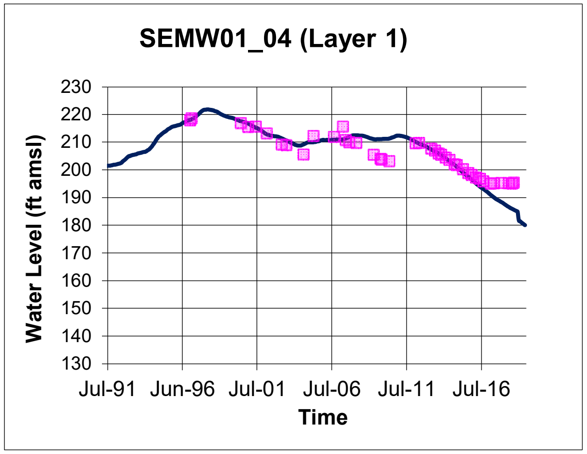


Figure 3 Measured vs. Simulated Hydrographs, Updated Regional SGB Model (Page 16/38)









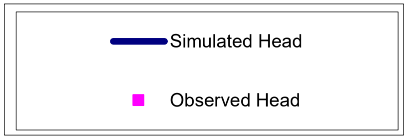
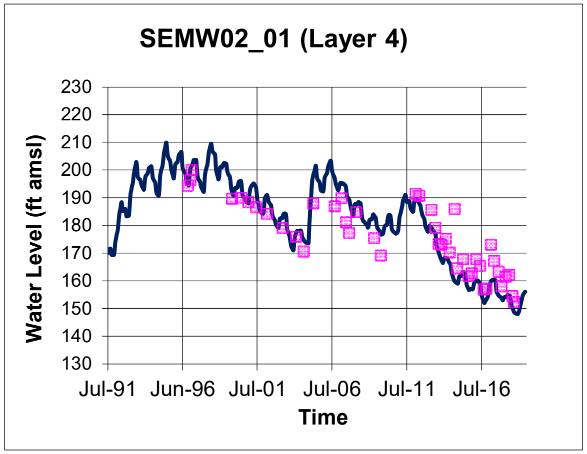
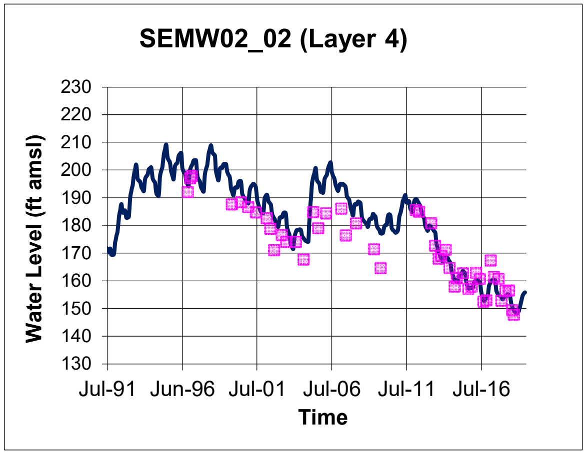
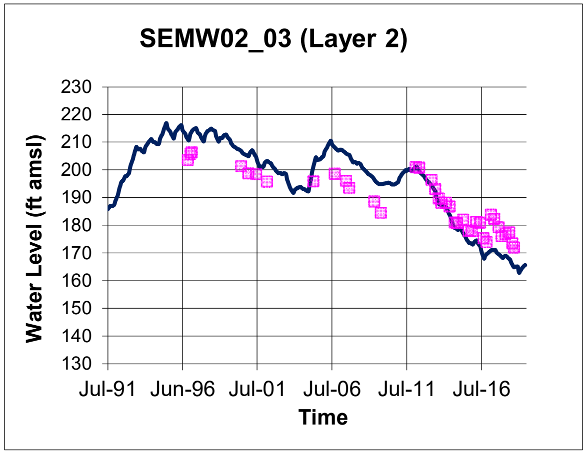
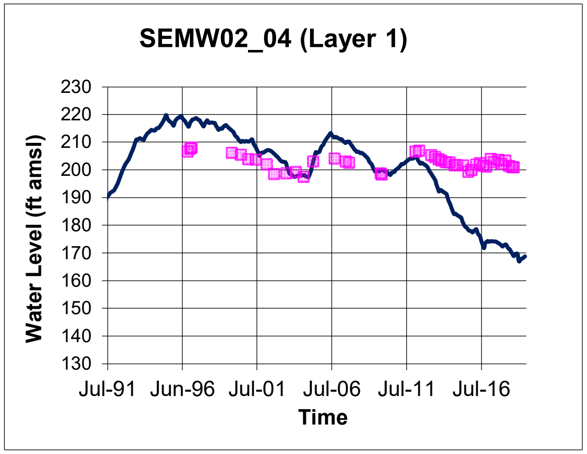


Figure 3 Measured vs. Simulated Hydrographs, Updated Regional SGB Model (Page 17/38)









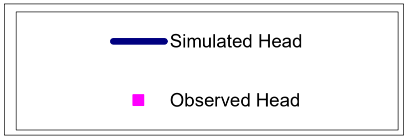
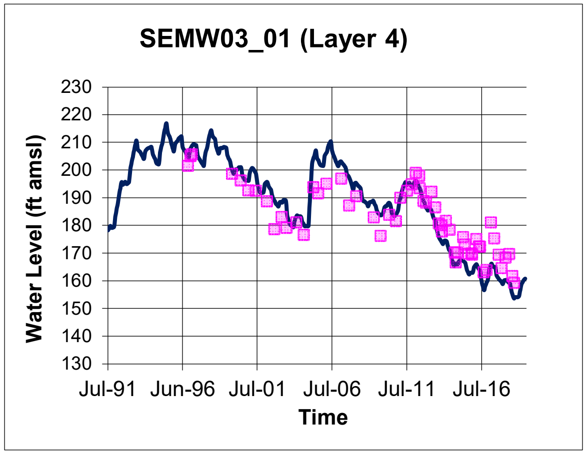
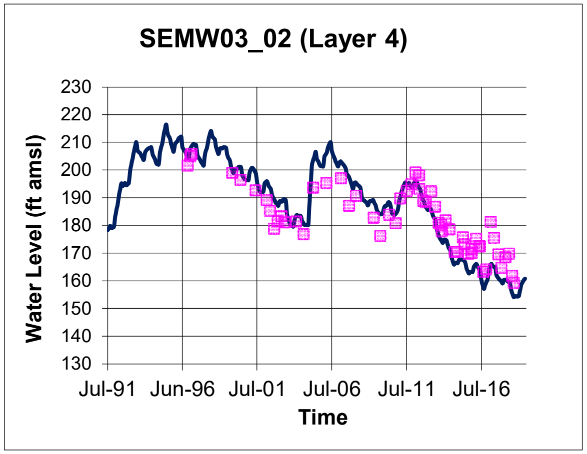
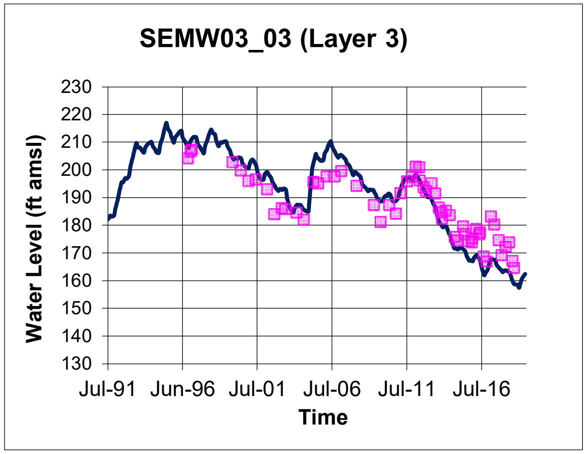
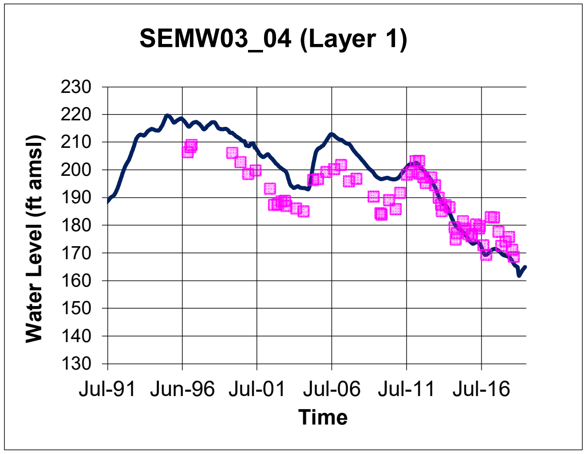


Figure 3 Measured vs. Simulated Hydrographs, Updated Regional SGB Model (Page 18/38)









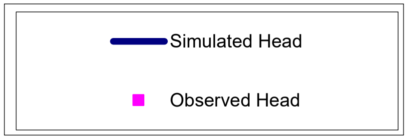
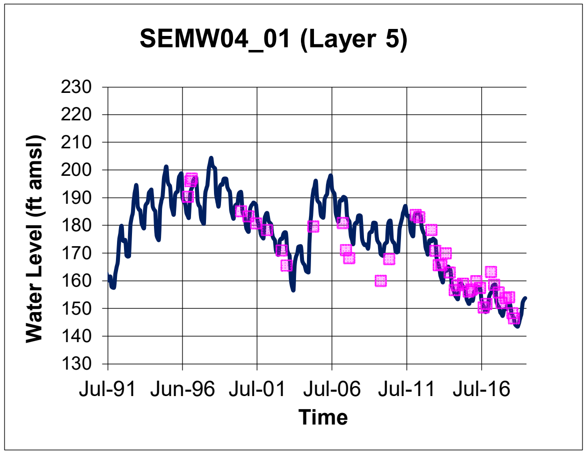
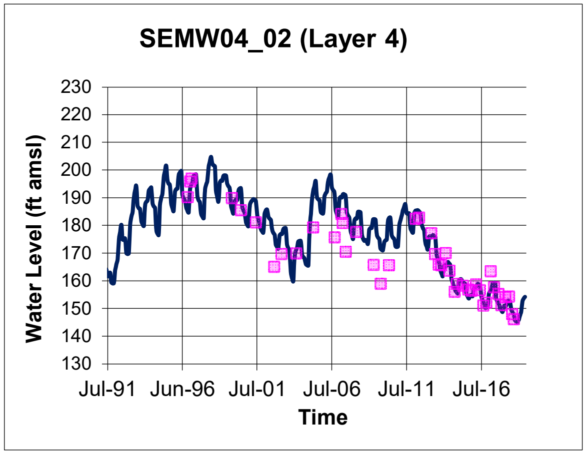
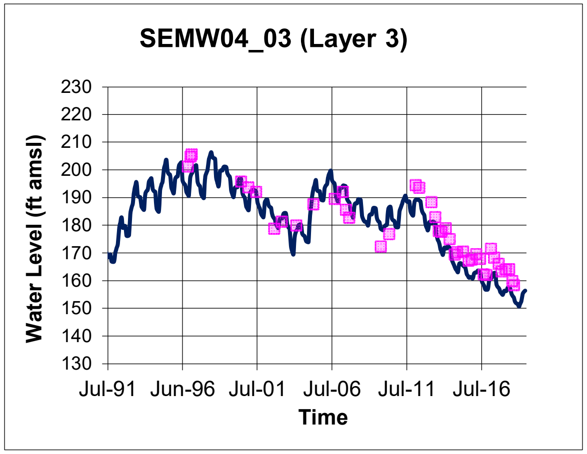
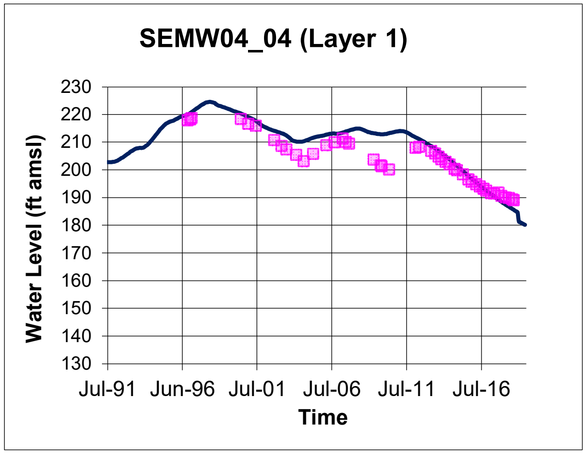


Figure 3 Measured vs. Simulated Hydrographs, Updated Regional SGB Model (Page 19/38)









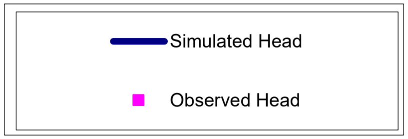


Figure 3 Measured vs. Simulated Hydrographs, Updated Regional SGB Model (Page 20/38)

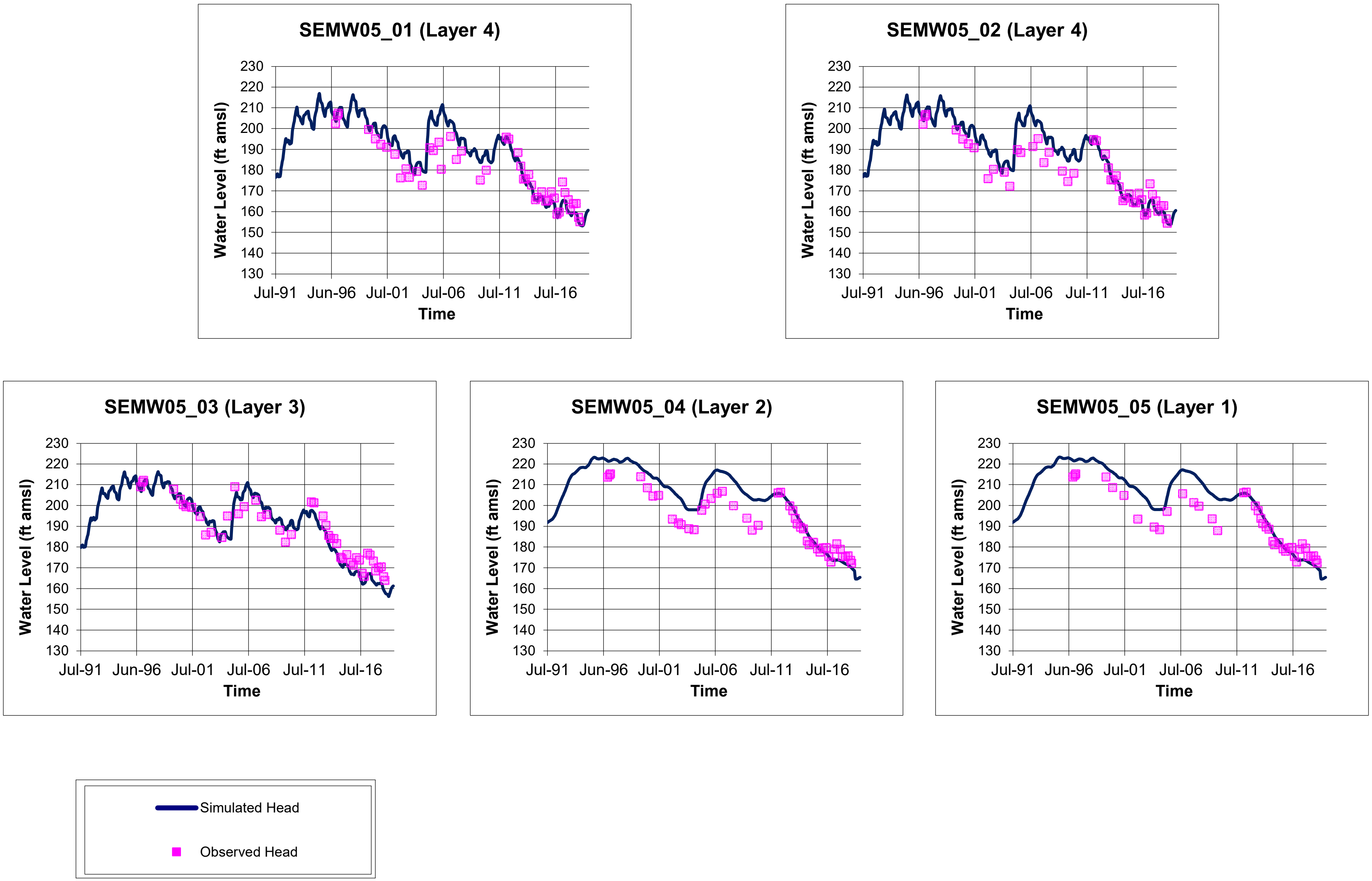
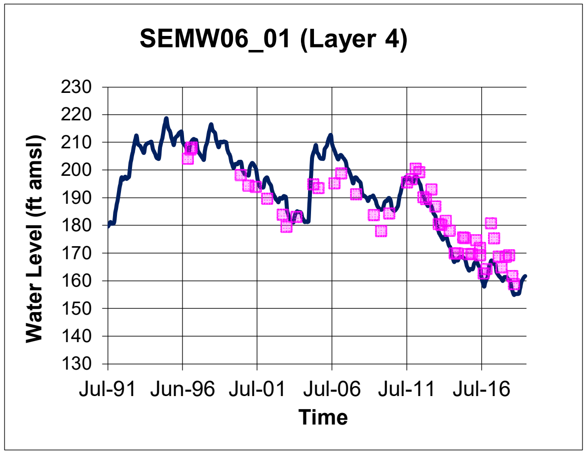
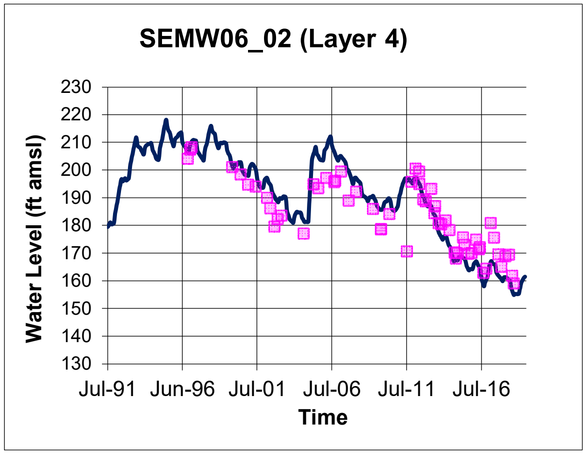
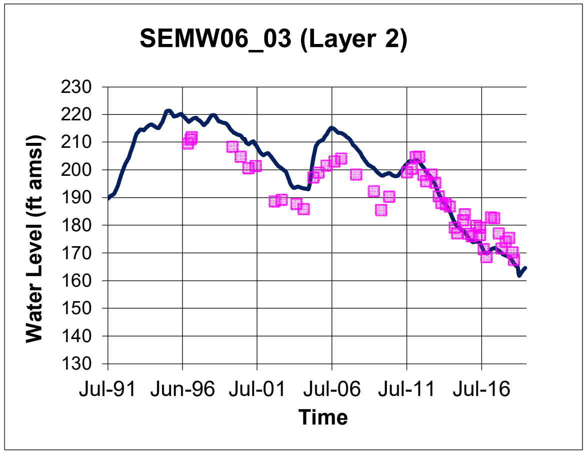
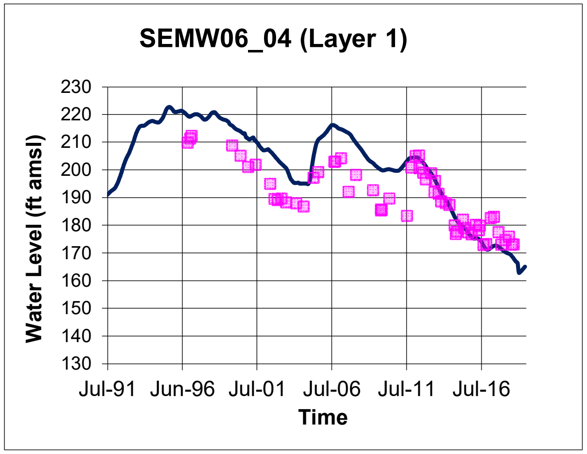


Figure 3 Measured vs. Simulated Hydrographs, Updated Regional SGB Model (Page 21/38)









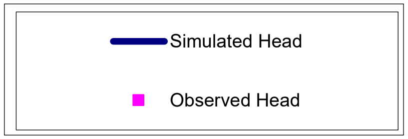
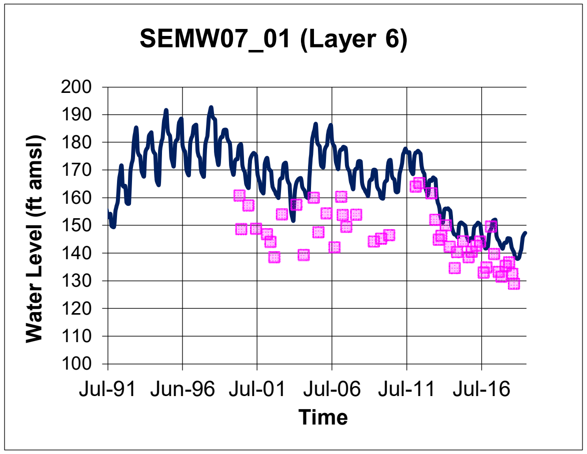
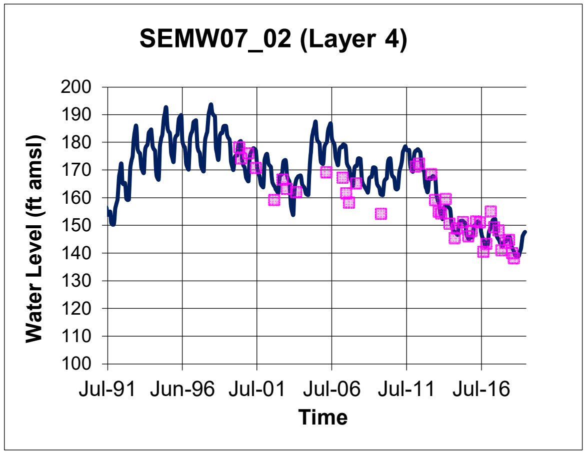
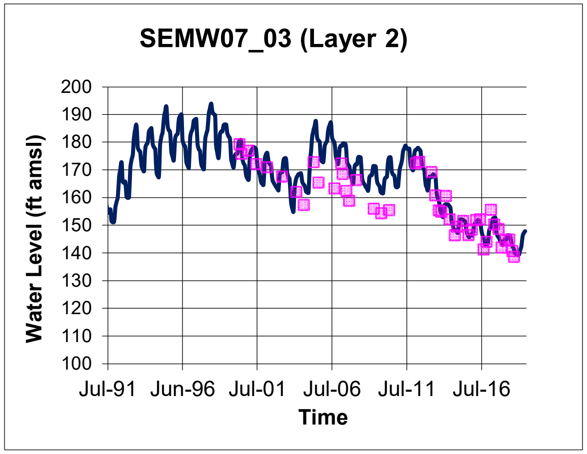
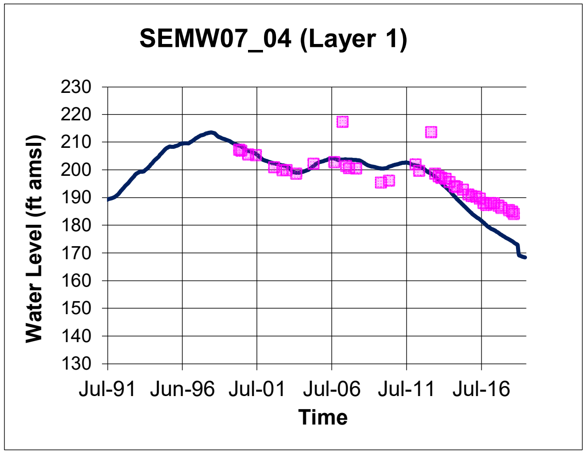


Figure 3 Measured vs. Simulated Hydrographs, Updated Regional SGB Model (Page 22/38)









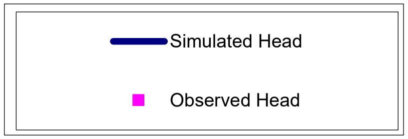
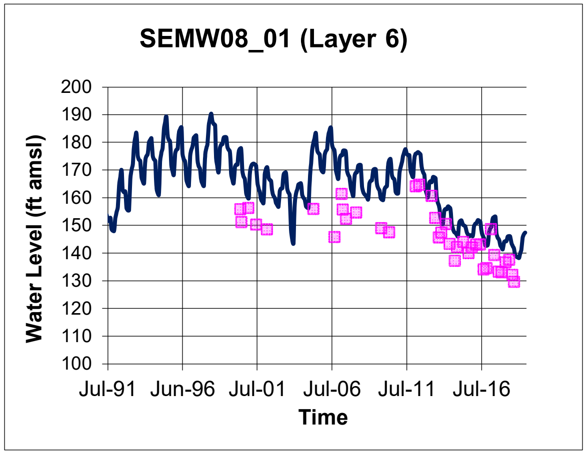
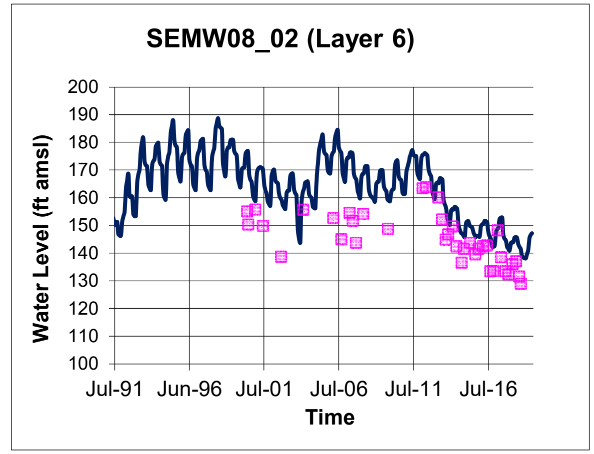
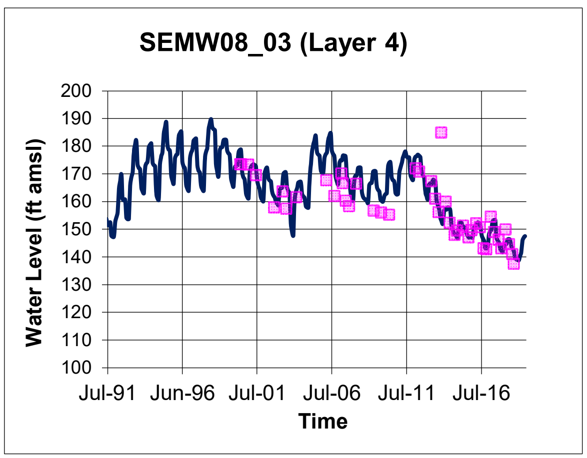
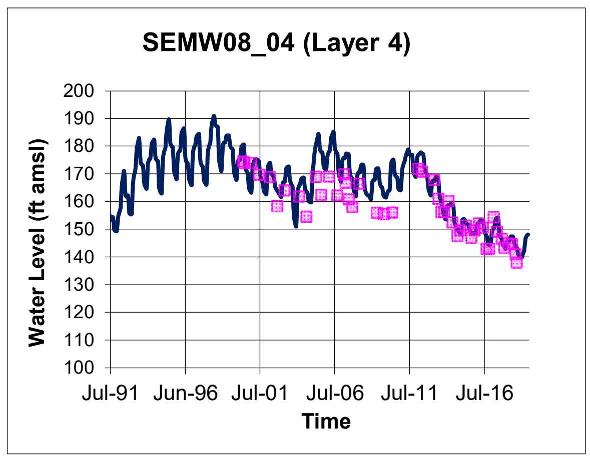


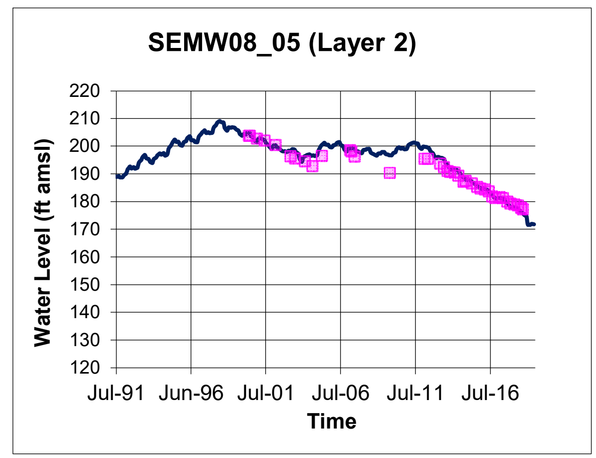
Figure 3 Measured vs. Simulated Hydrographs, Updated Regional SGB Model (Page 23/38)











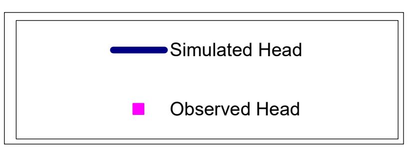
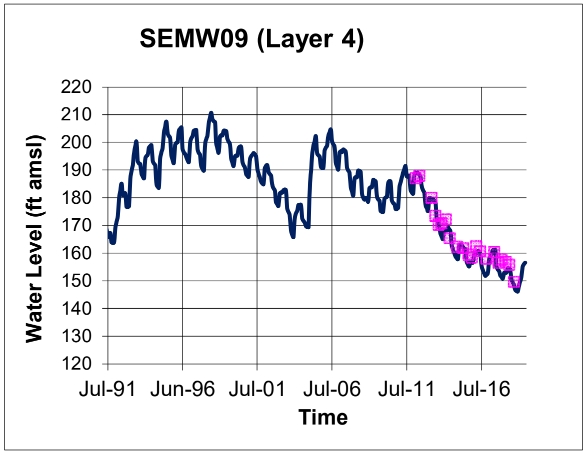
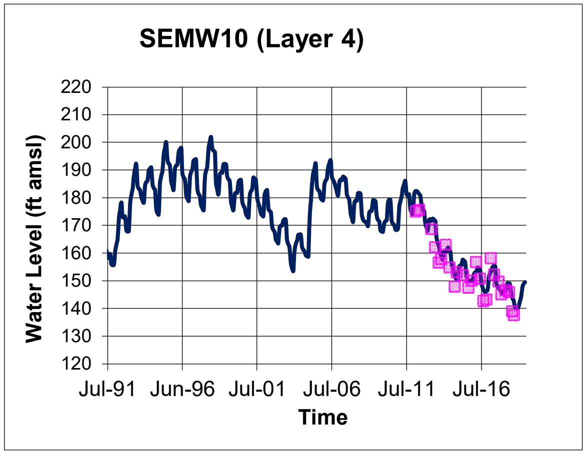
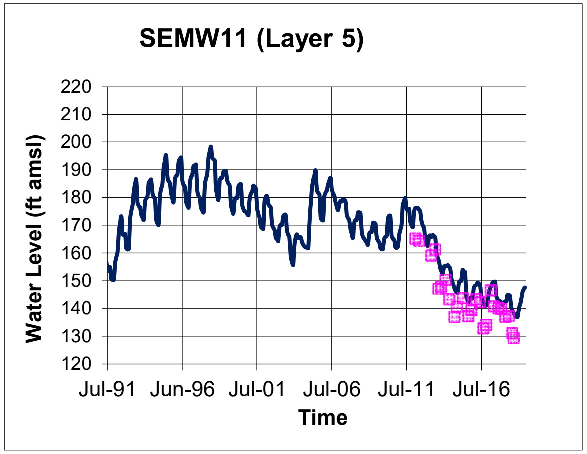
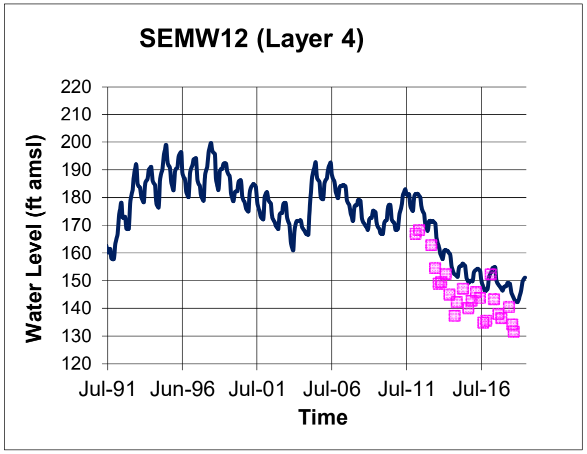


Figure 3 Measured vs. Simulated Hydrographs, Updated Regional SGB Model (Page 24/38)









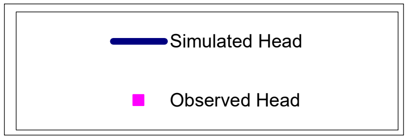
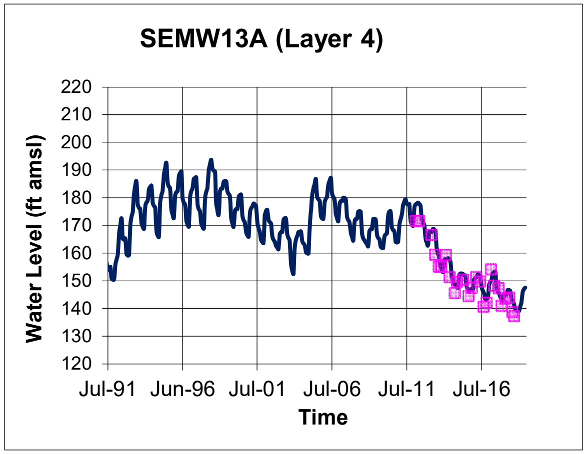
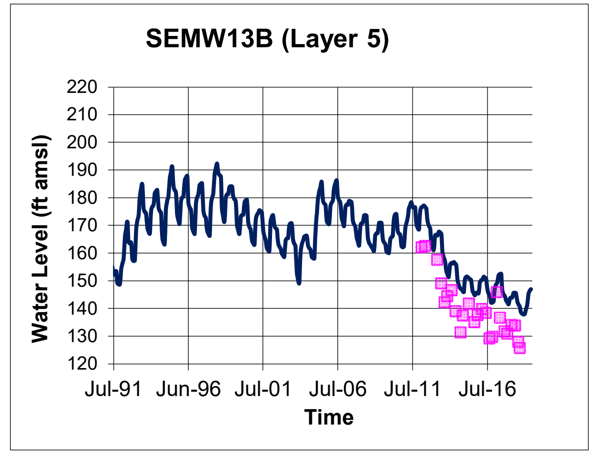
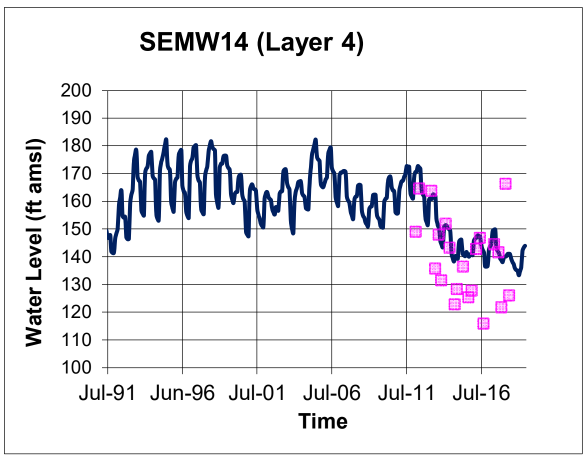
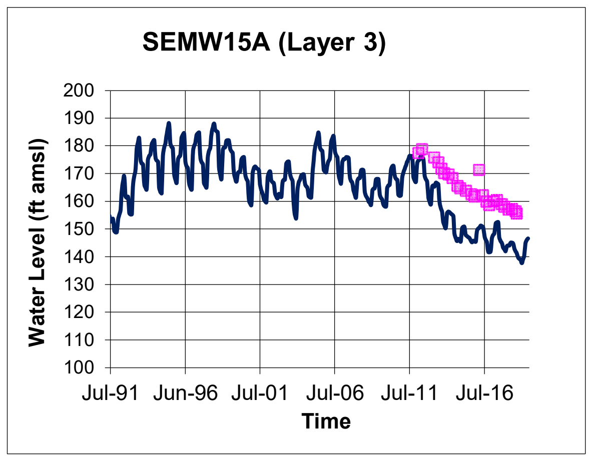


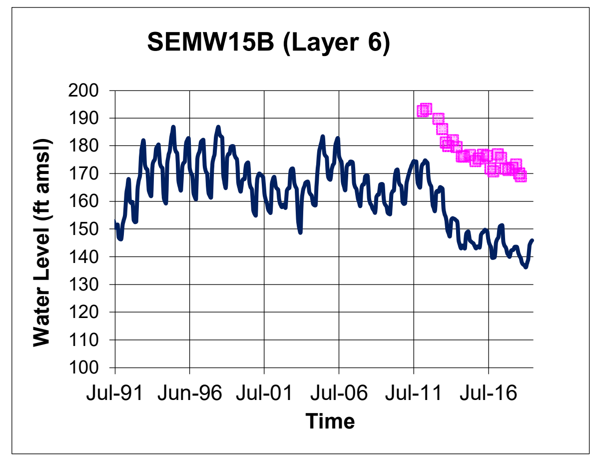
Figure 3 Measured vs. Simulated Hydrographs, Updated Regional SGB Model (Page 25/38)











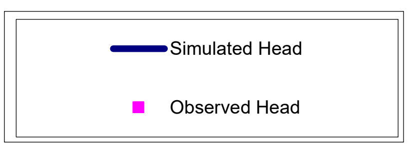
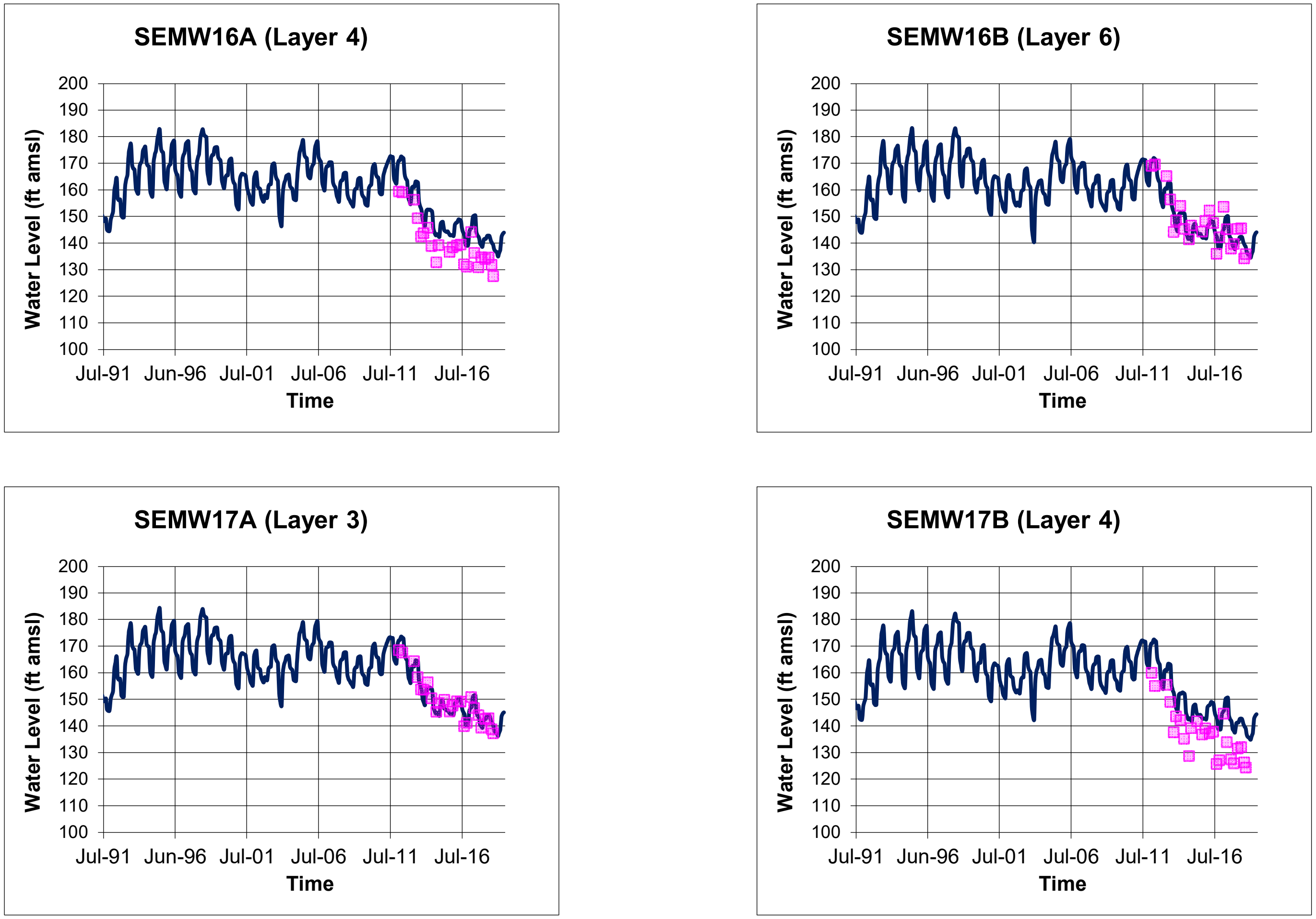


Figure 3 Measured vs. Simulated Hydrographs, Updated Regional SGB Model (Page 26/38)



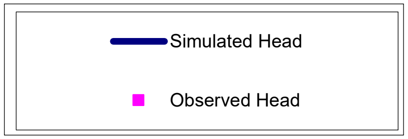


Figure 3 Measured vs. Simulated Hydrographs, Updated Regional SGB Model (Page 27/38)

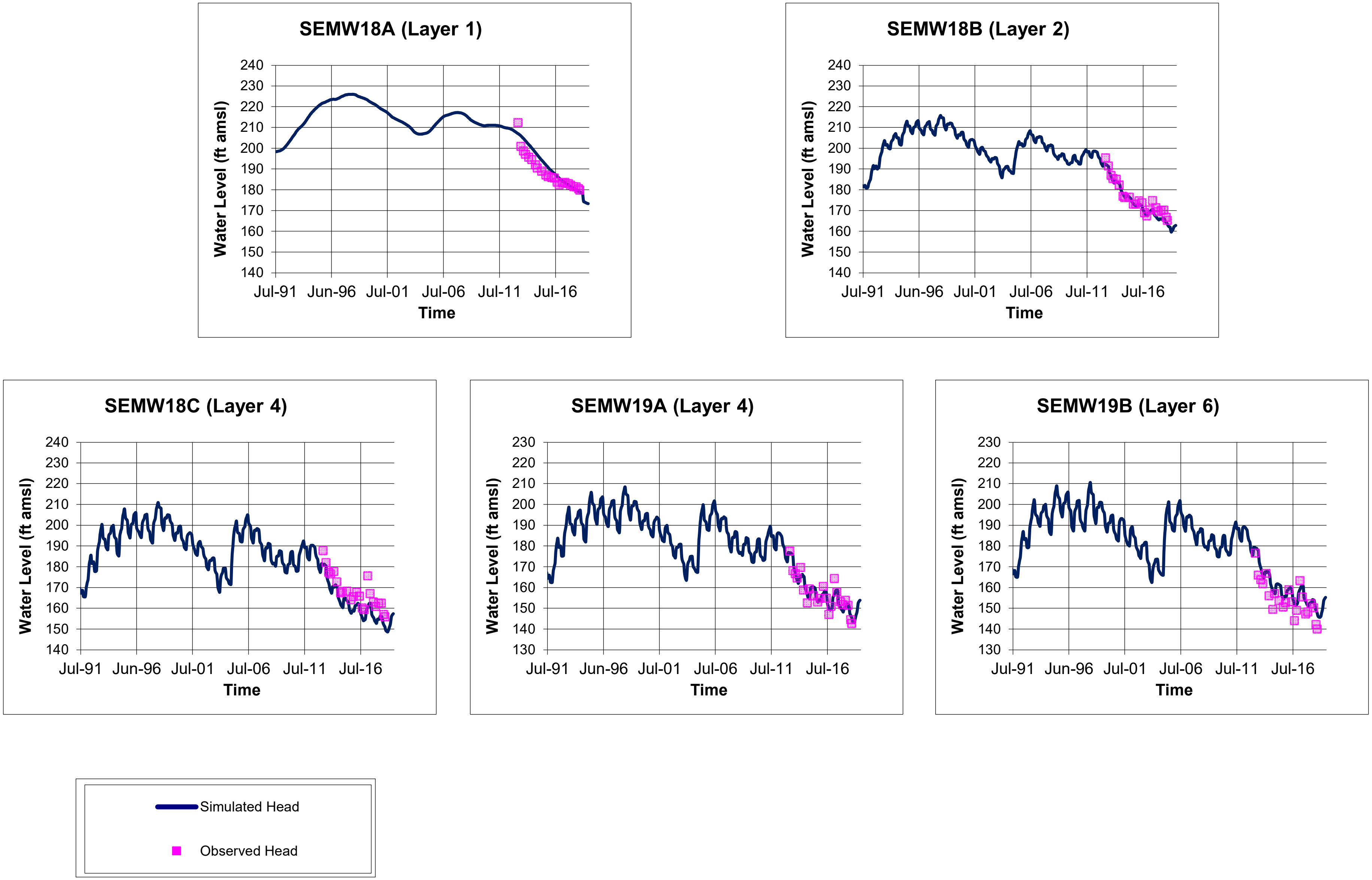


Figure 3 Measured vs. Simulated Hydrographs, Updated Regional SGB Model (Page 28/38)

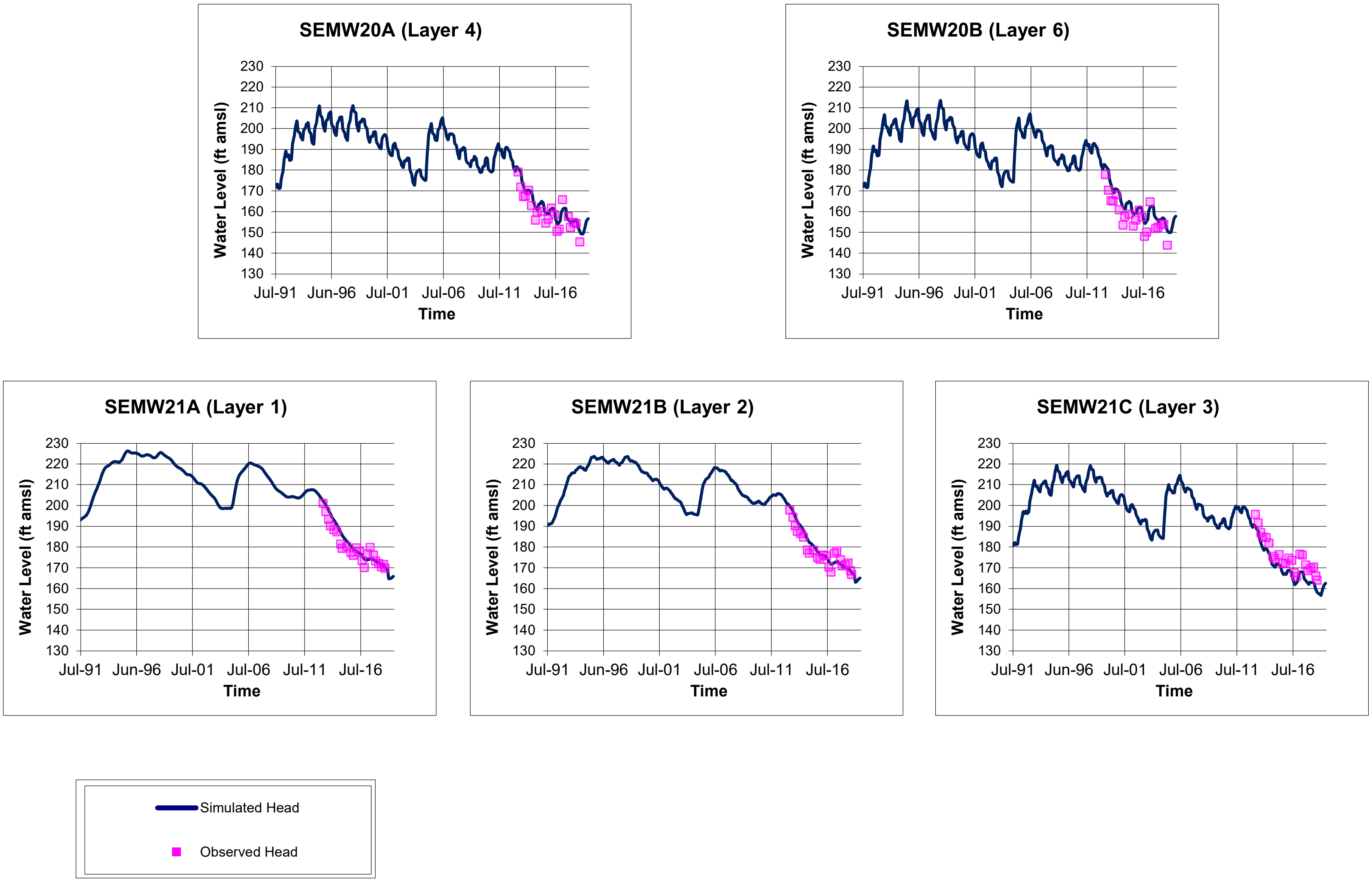
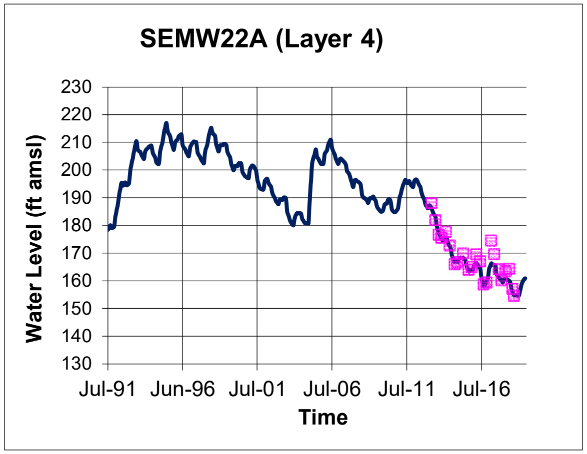
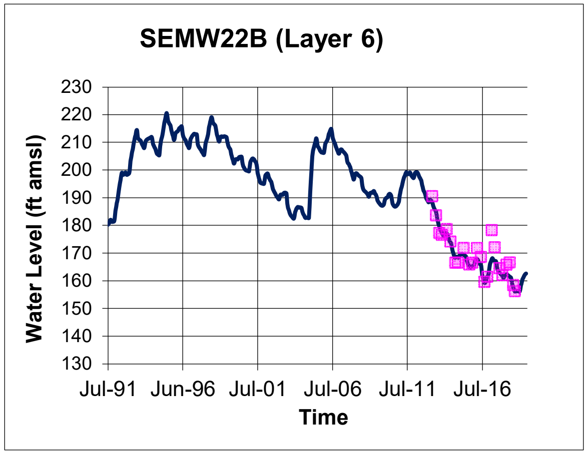
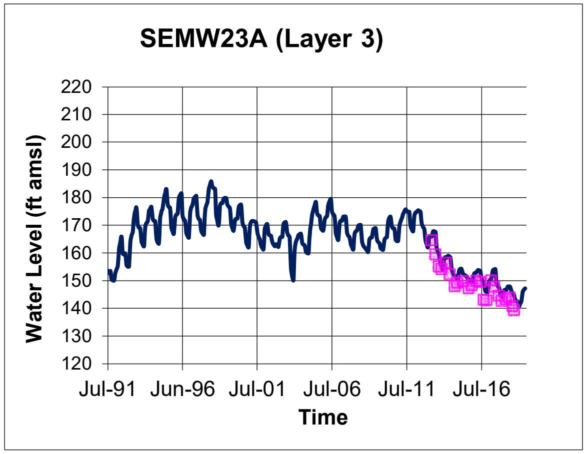
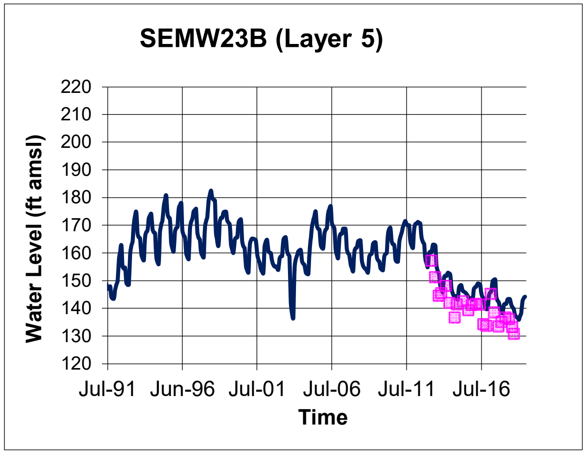


Figure 3 Measured vs. Simulated Hydrographs, Updated Regional SGB Model (Page 29/38)









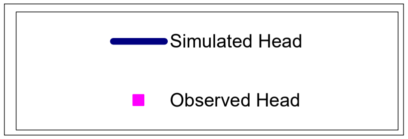


Figure 3 Measured vs. Simulated Hydrographs, Updated Regional SGB Model (Page 30/38)

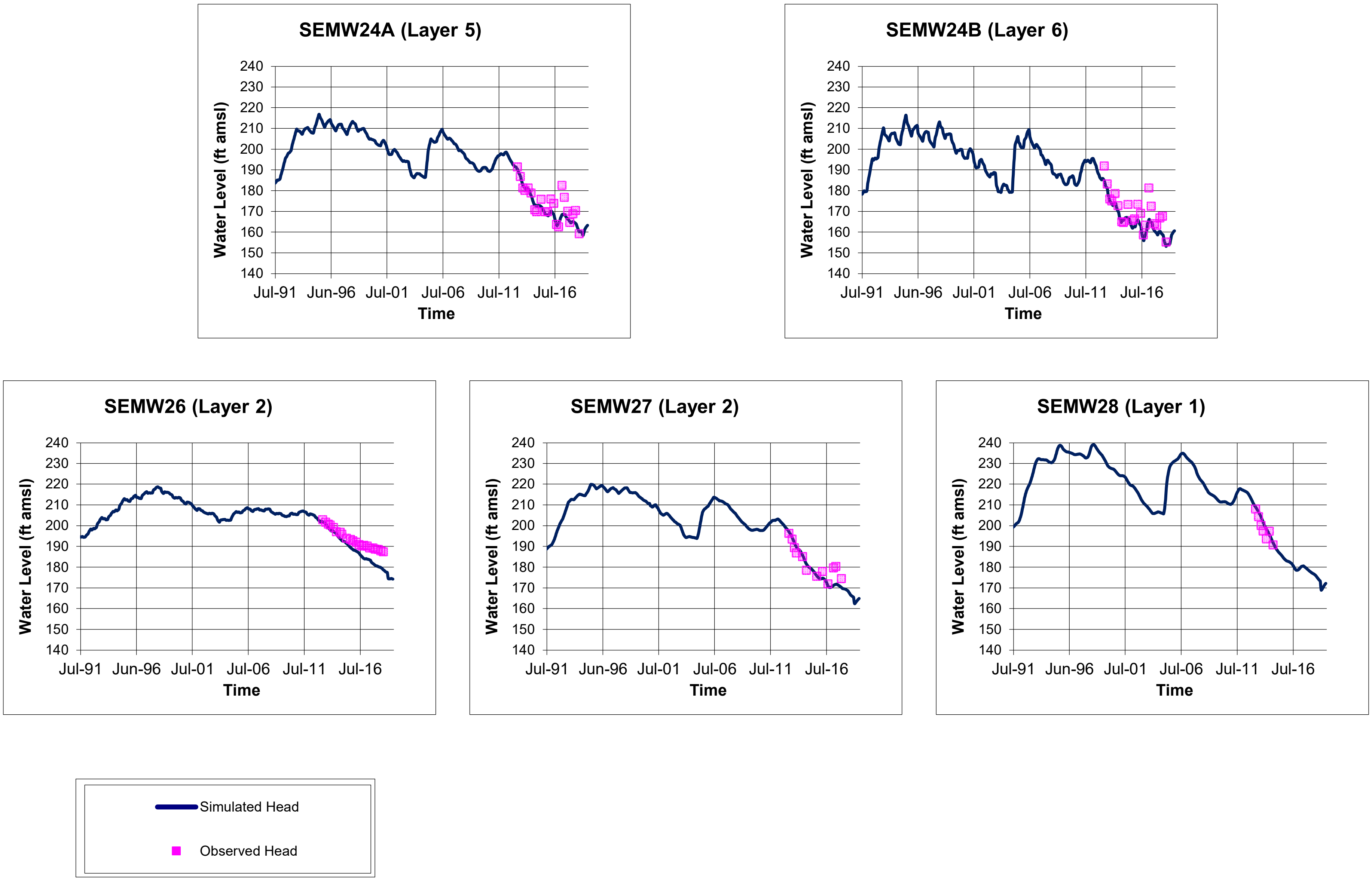
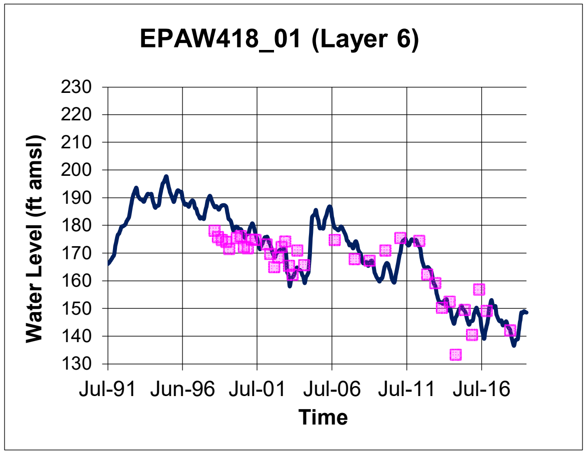
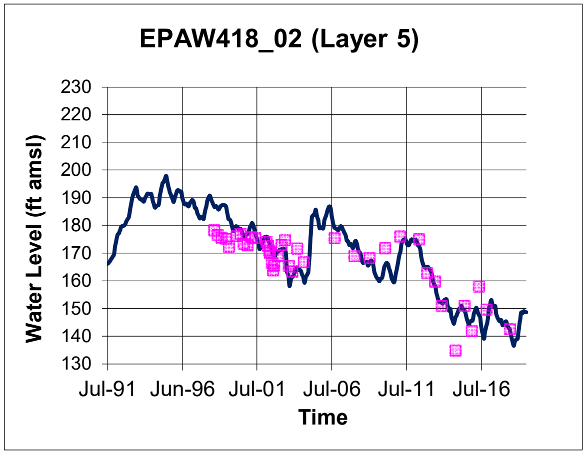
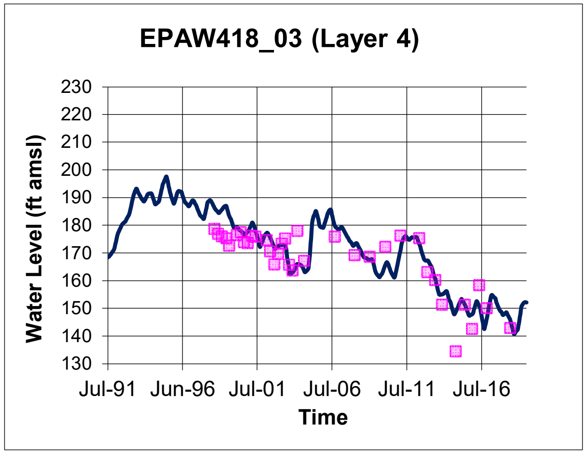
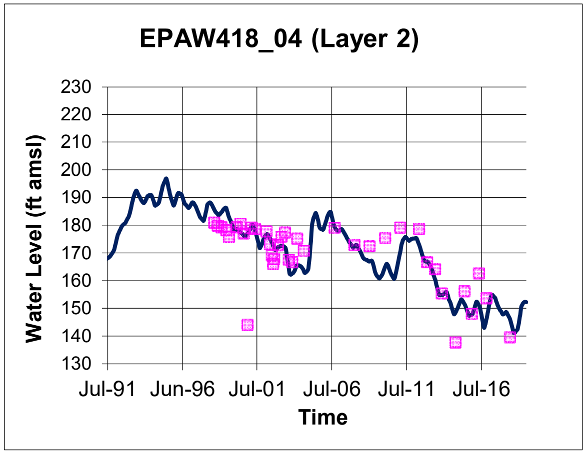


Figure 3 Measured vs. Simulated Hydrographs, Updated Regional SGB Model (Page 31/38)









Simulated Head

Observed Head

Figure 3 Measured vs. Simulated Hydrographs, Updated Regional SGB Model (Page 32/38)

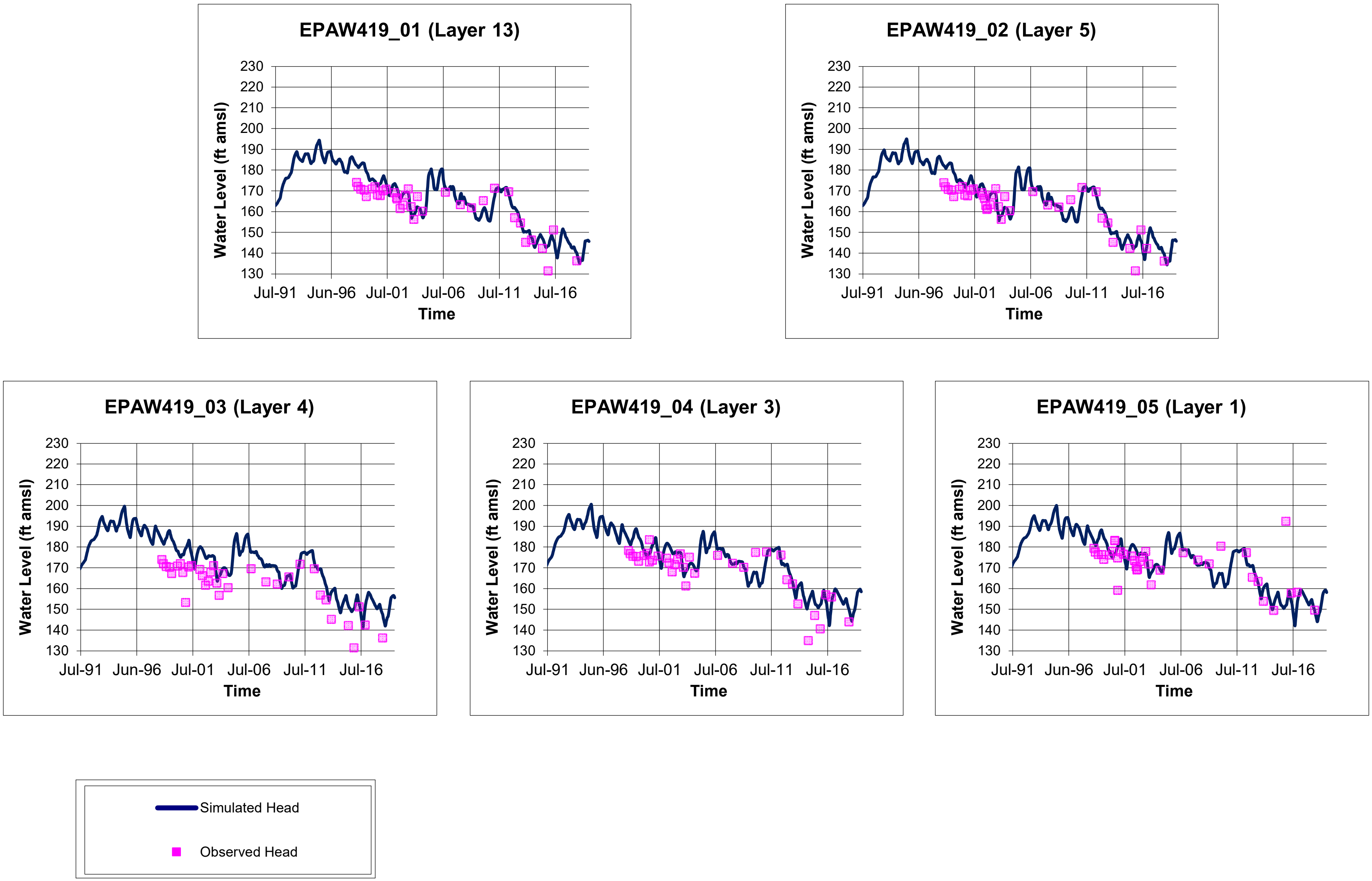
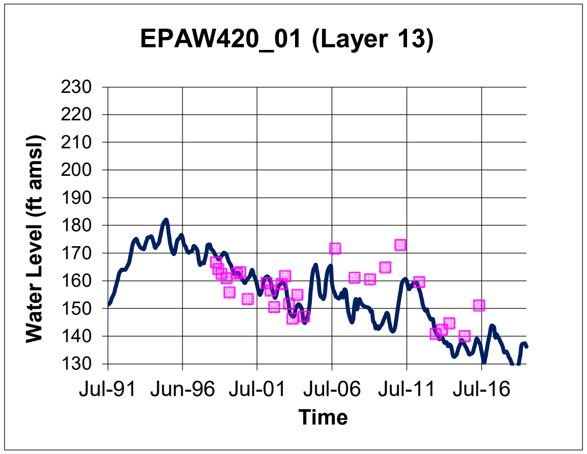
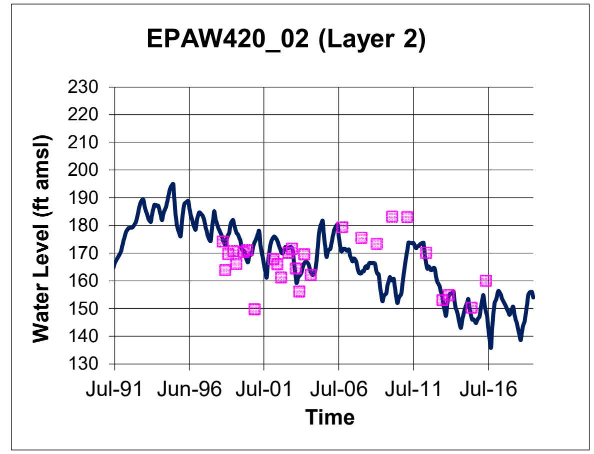
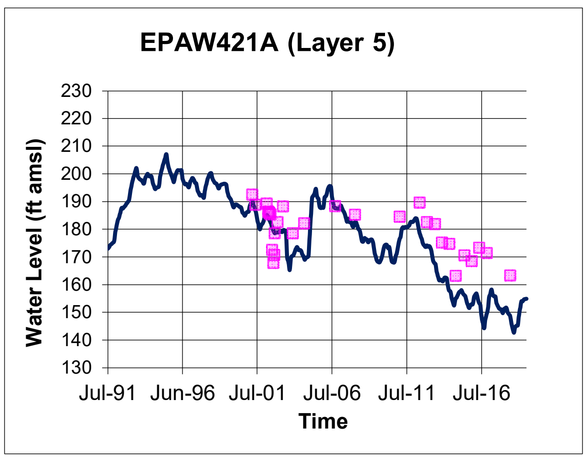
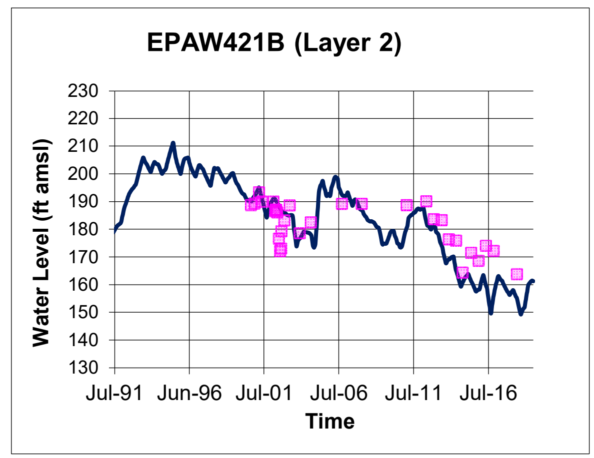


Figure 3 Measured vs. Simulated Hydrographs, Updated Regional SGB Model (Page 33/38)









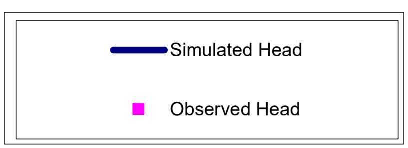
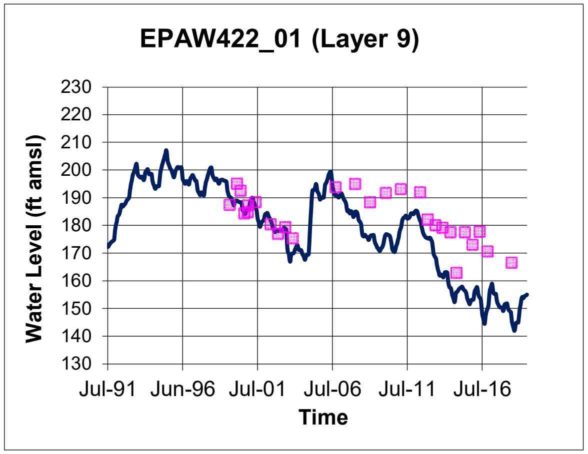
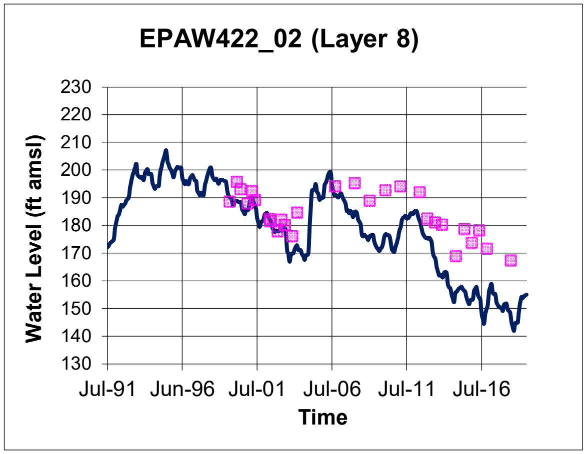
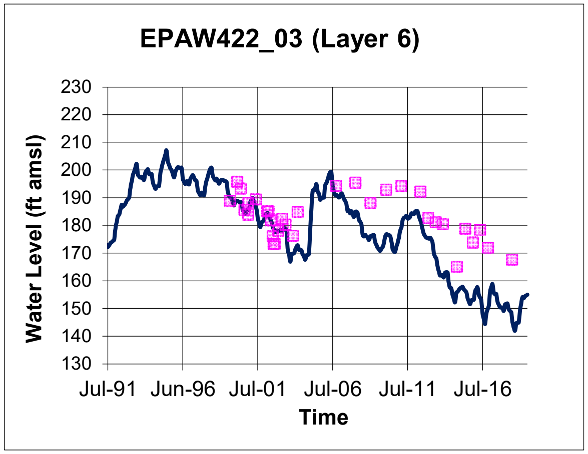
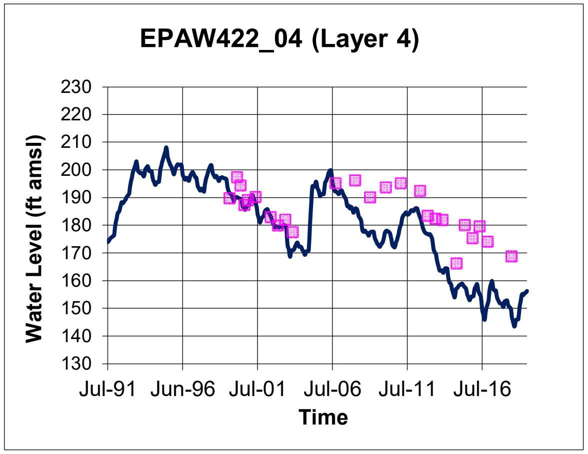


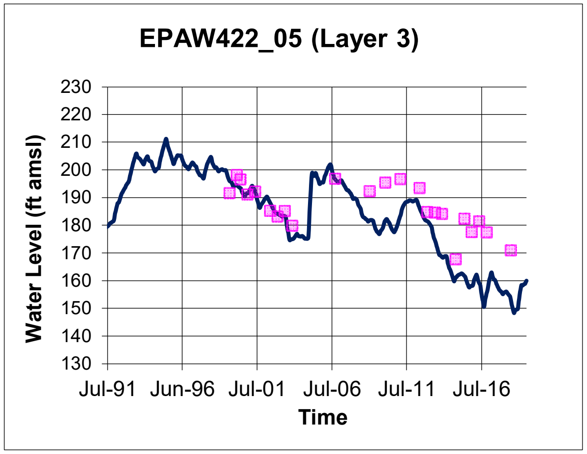
Figure 3 Measured vs. Simulated Hydrographs, Updated Regional SGB Model (Page 34/38)

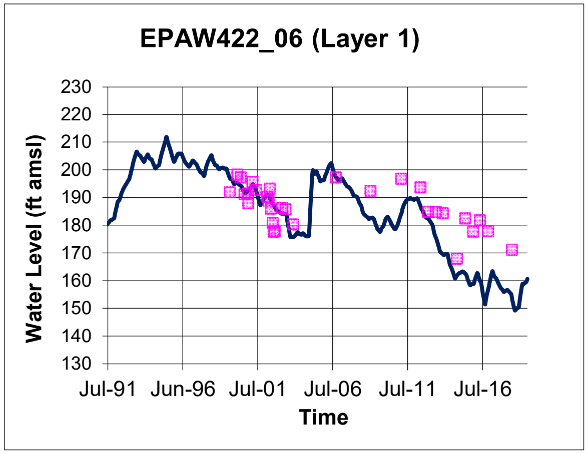












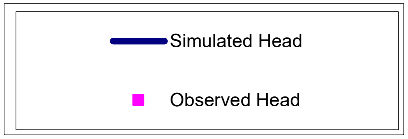
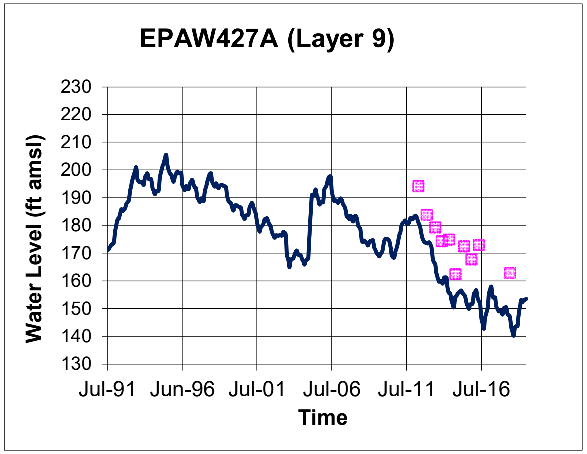
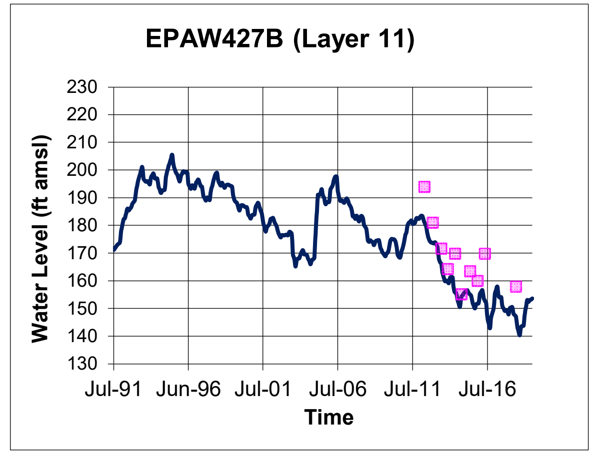
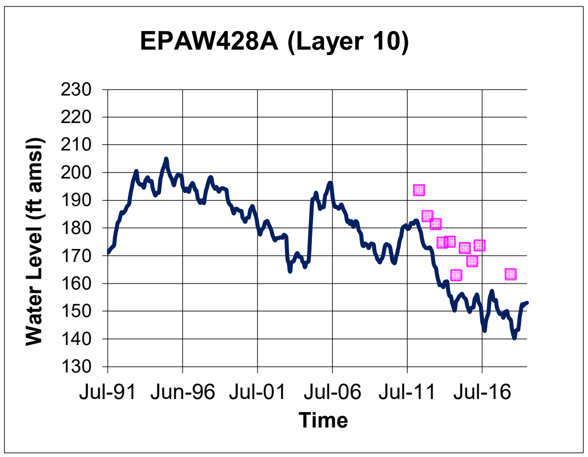
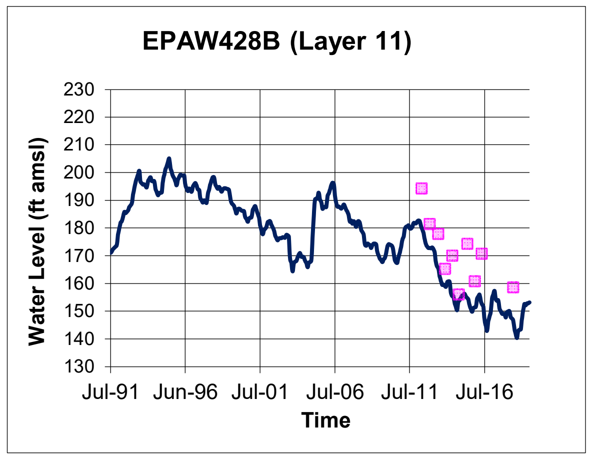


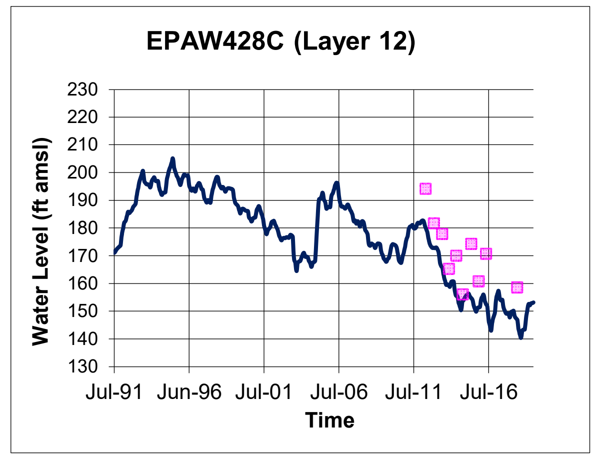
Figure 3 Measured vs. Simulated Hydrographs, Updated Regional SGB Model (Page 35/38)











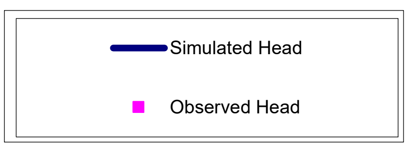
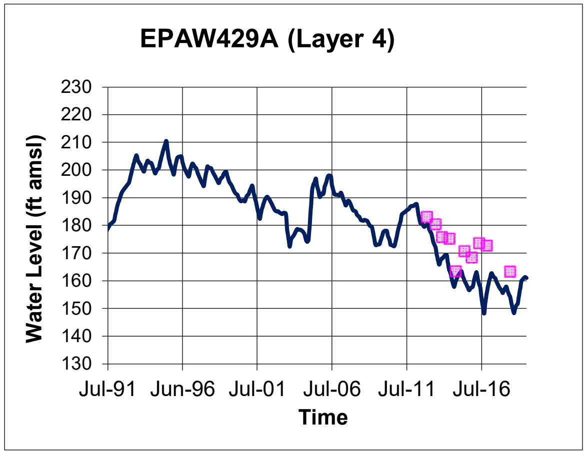
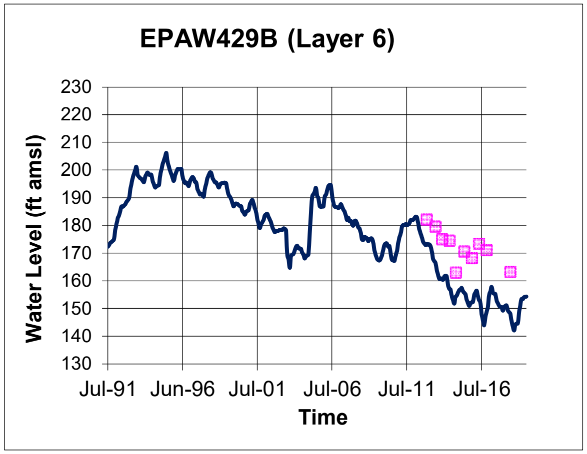


Figure 3 Measured vs. Simulated Hydrographs, Updated Regional SGB Model (Page 36/38)





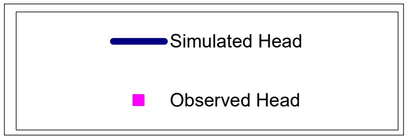
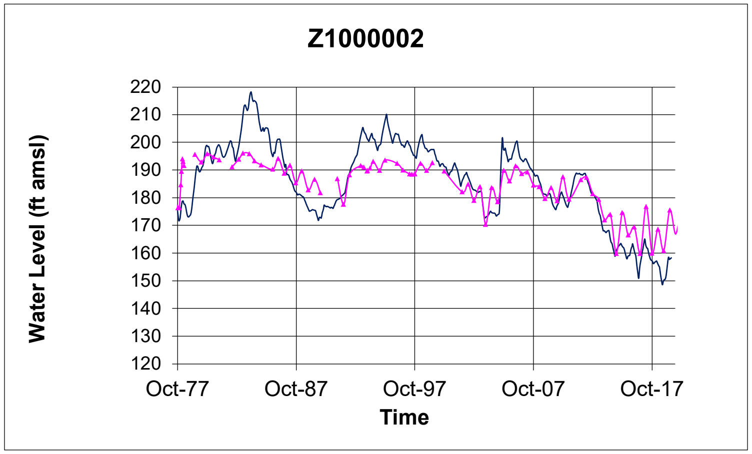
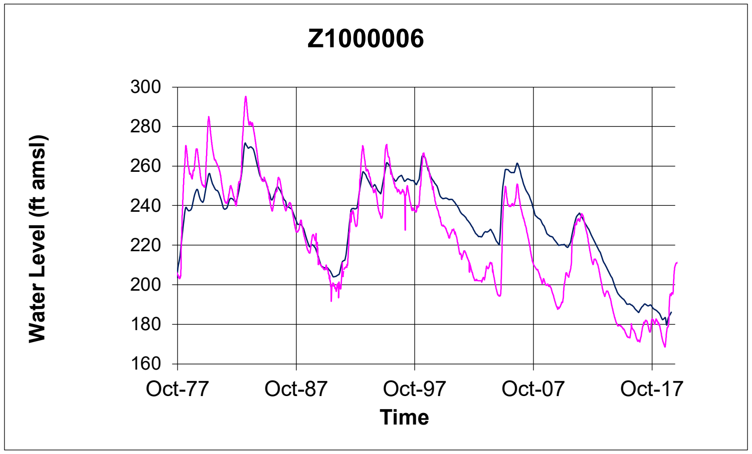
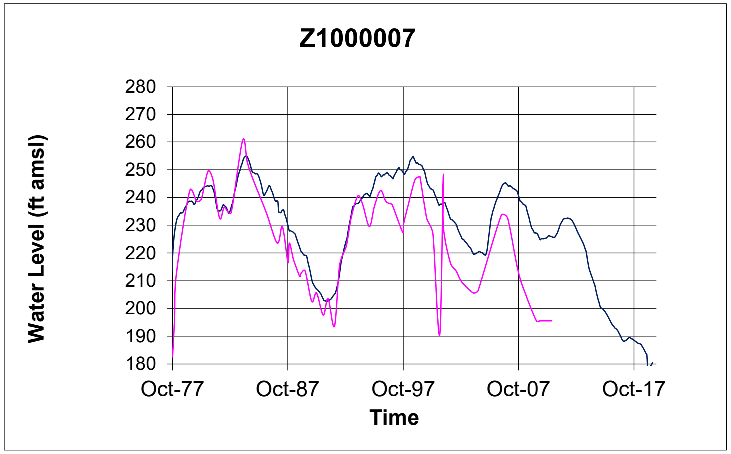
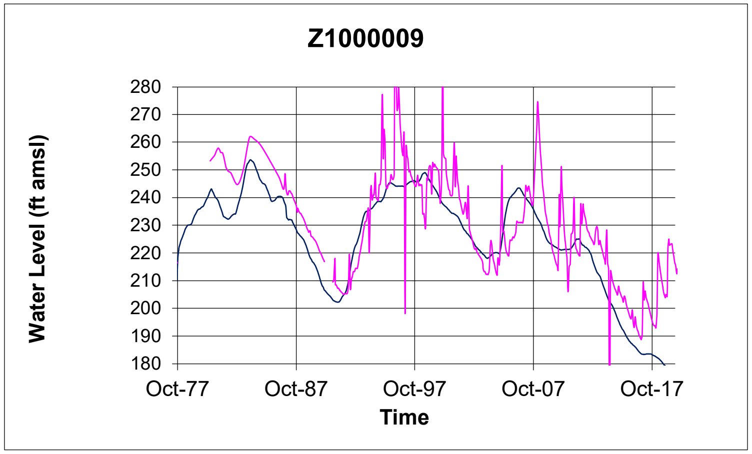


Figure 3 Measured vs. Simulated Hydrographs, Updated Regional SGB Model (Page 37/38)









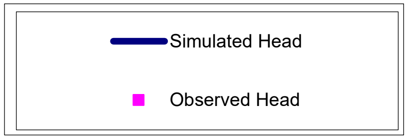
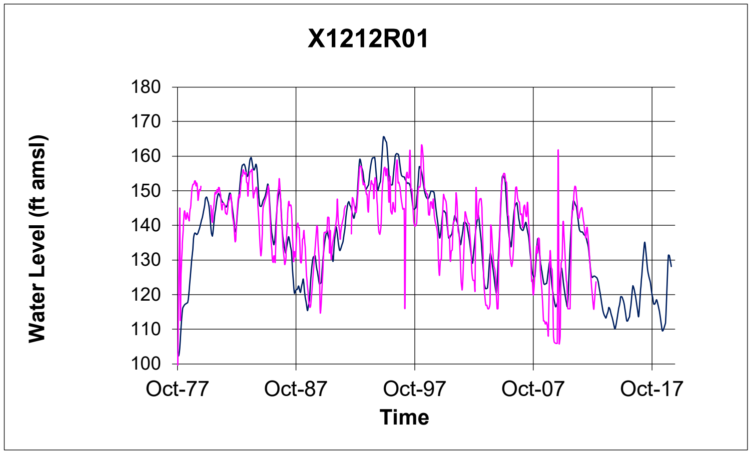
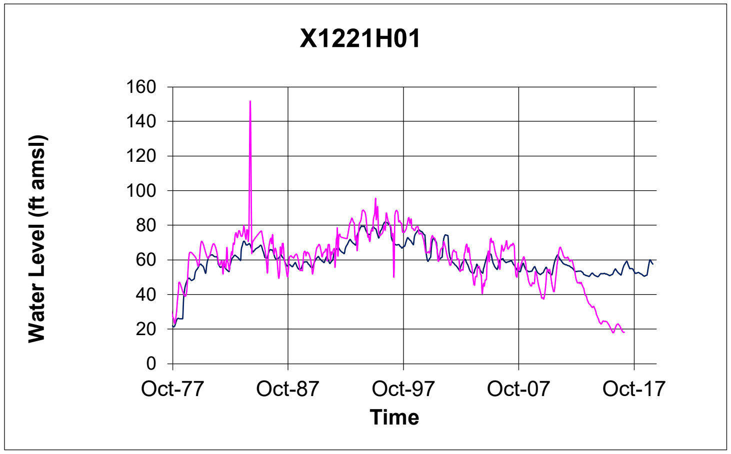
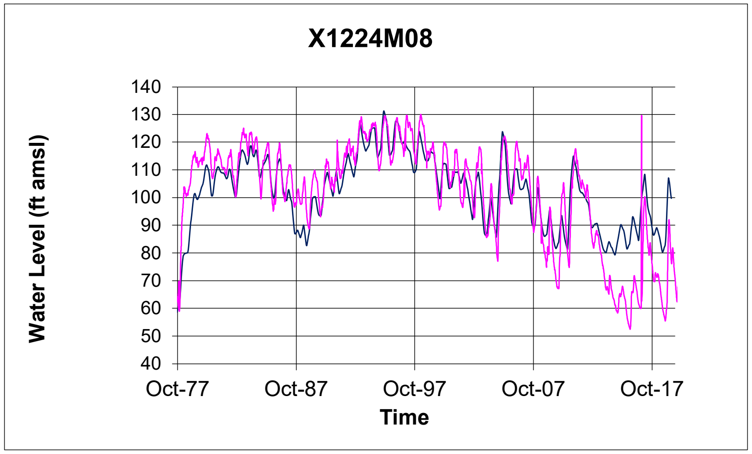


Figure 3 Measured vs. Simulated Hydrographs, Updated Regional SGB Model (Page 38/38)







Simulated Head

Observed Head

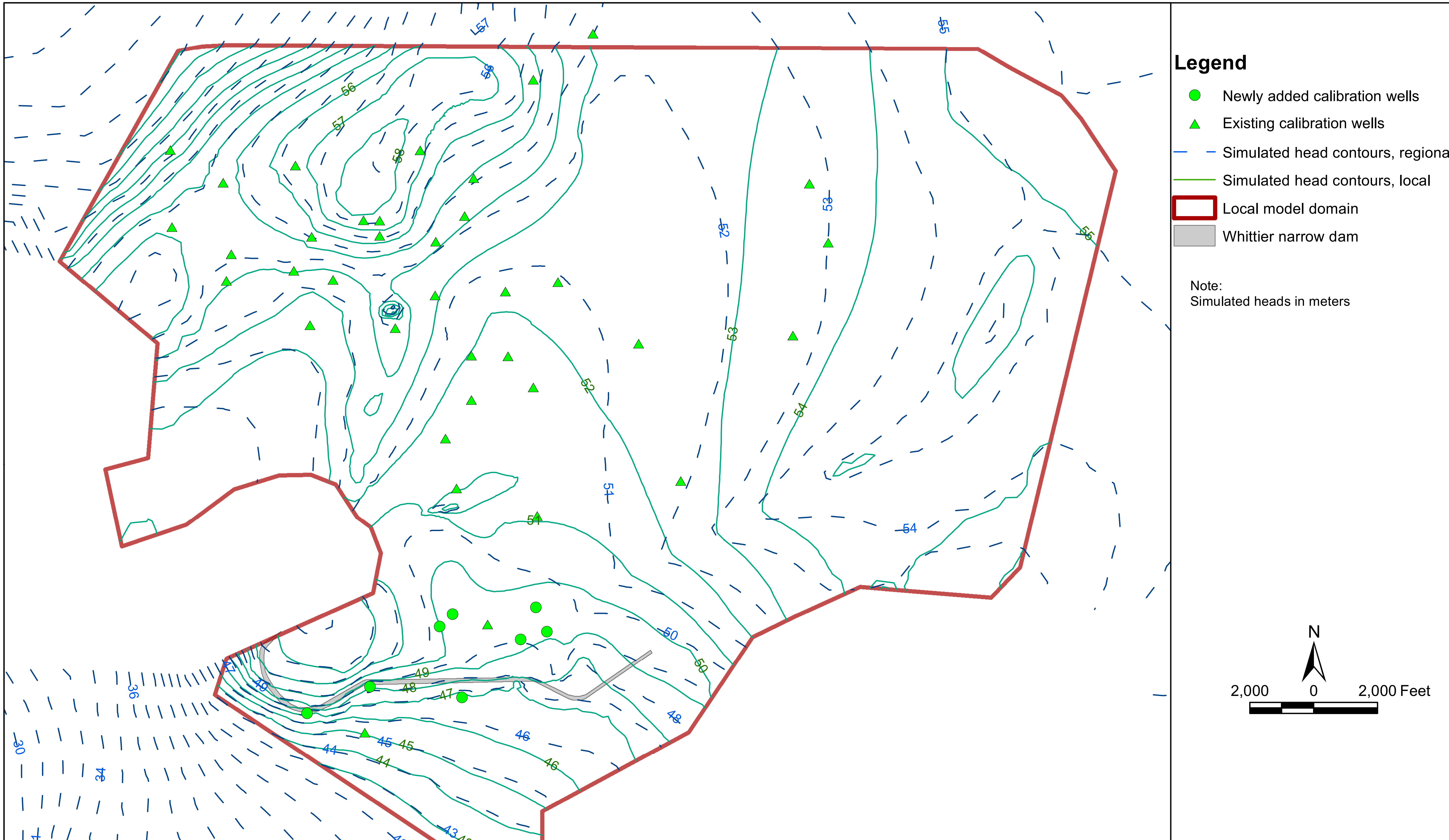


Figure 4a
Water Table (Slice 1)
Simulated Head Contours
Local vs. Regional Model

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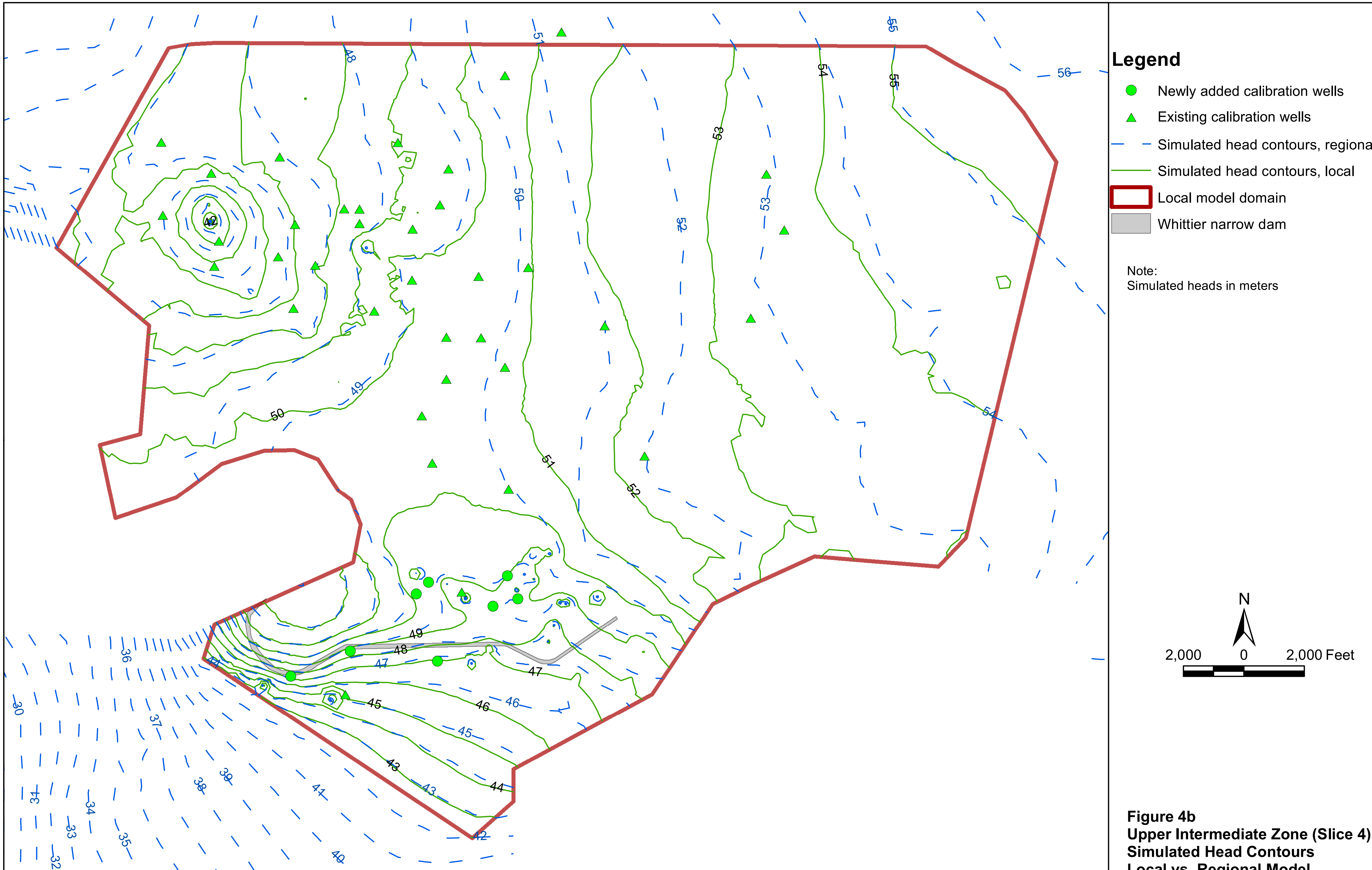

Figure 4b
Upper Intermediate Zone (Slice 4)
Simulated Head Contours
Local vs. Regional Model

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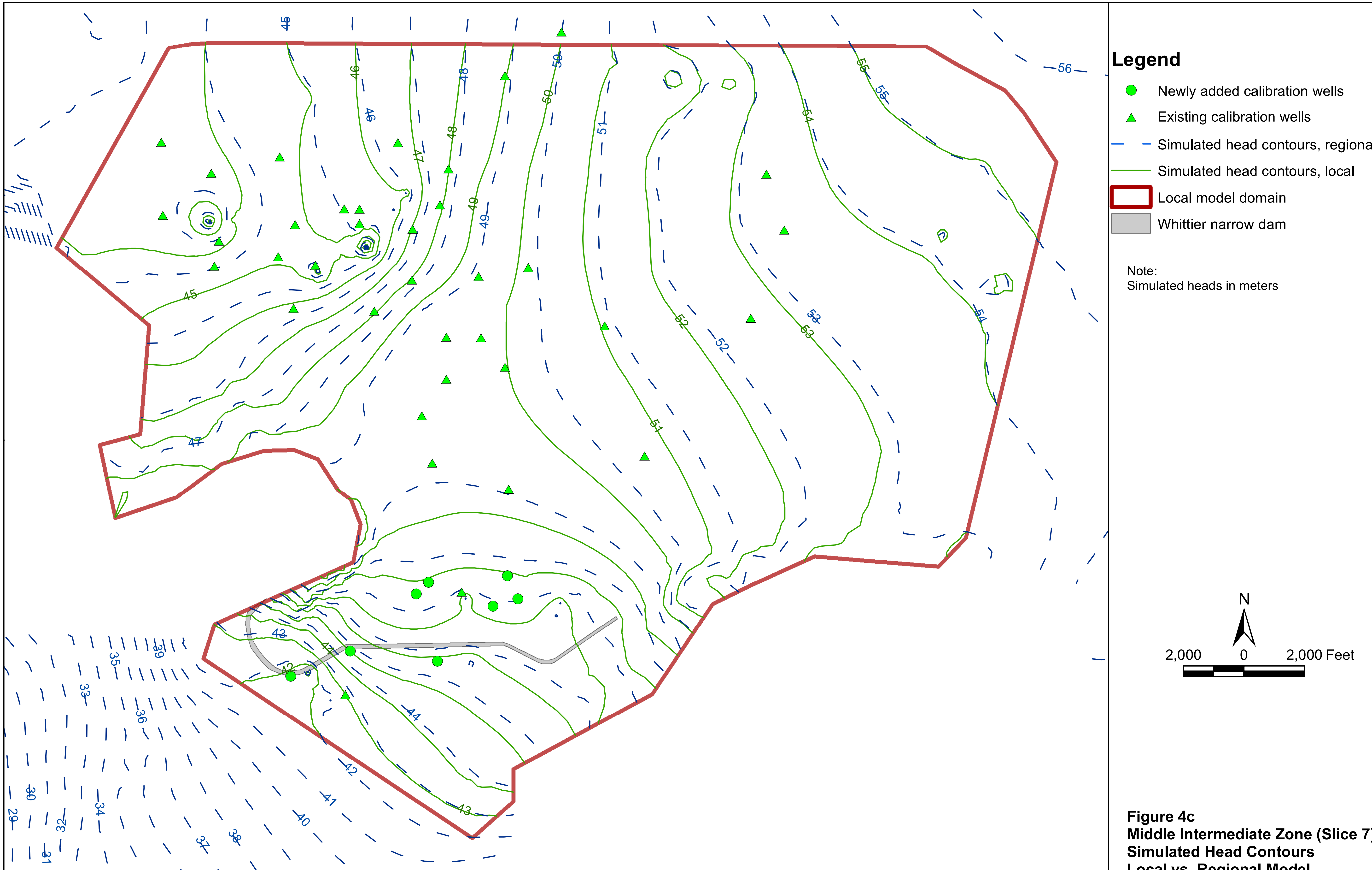

Figure 4c
Middle Intermediate Zone (Slice 7)
Simulated Head Contours
Local vs. Regional Model

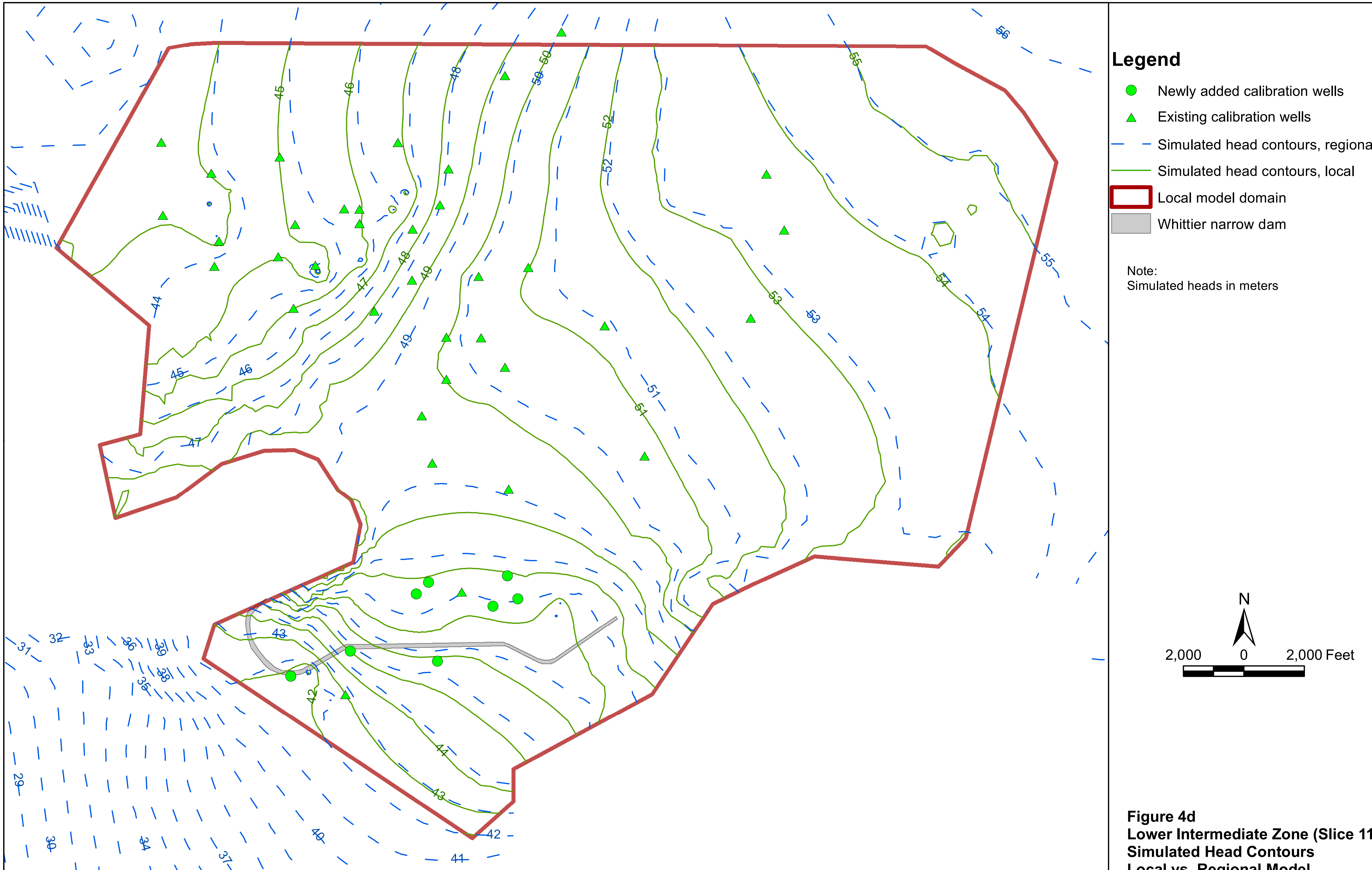

Figure 4d
Lower Intermediate Zone (Slice 11)
Simulated Head Contours
Local vs. Regional Model

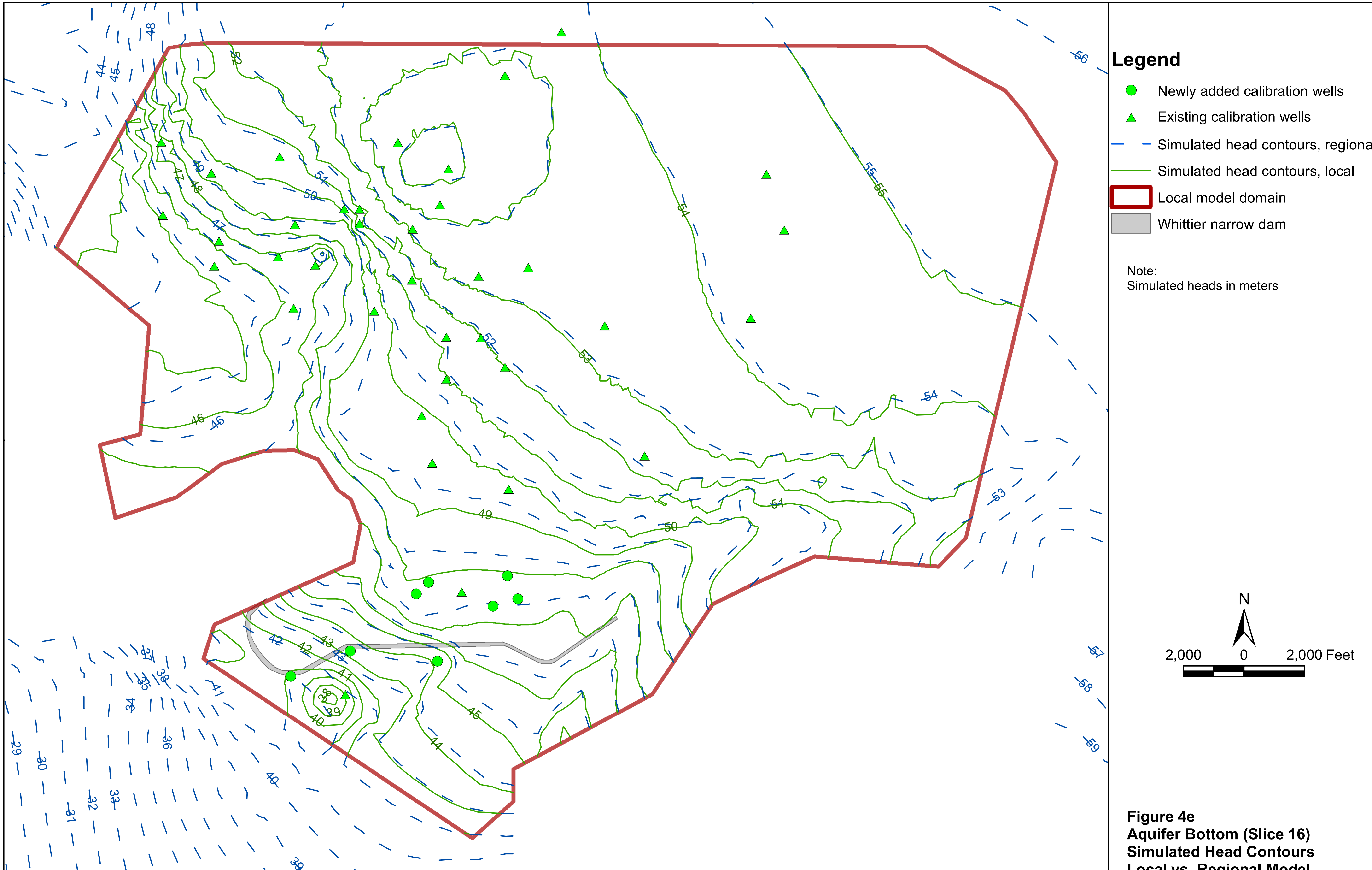

Figure 4e
Aquifer Bottom (Slice 16)
Simulated Head Contours
Local vs. Regional Model

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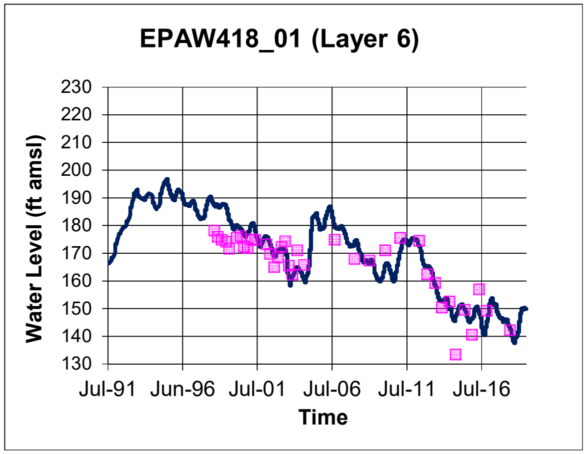
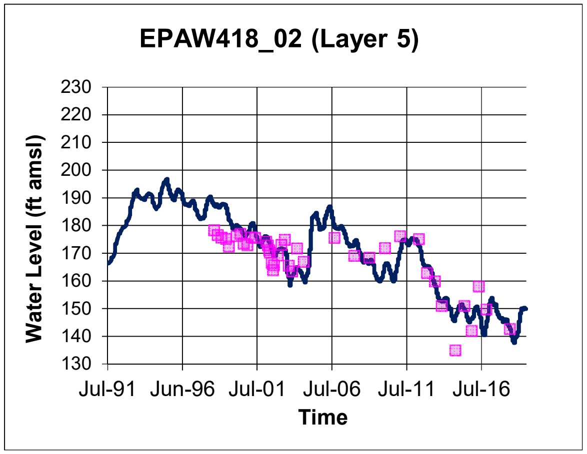
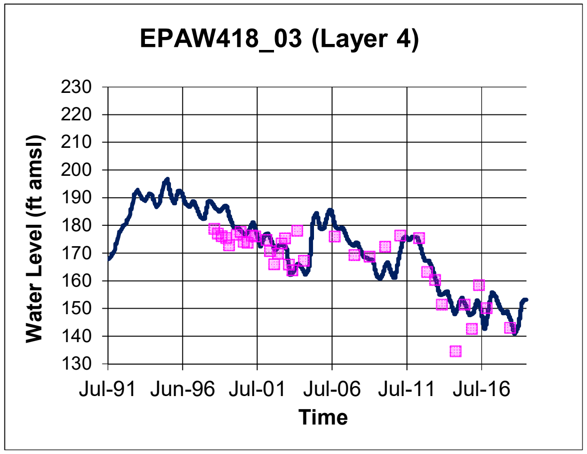
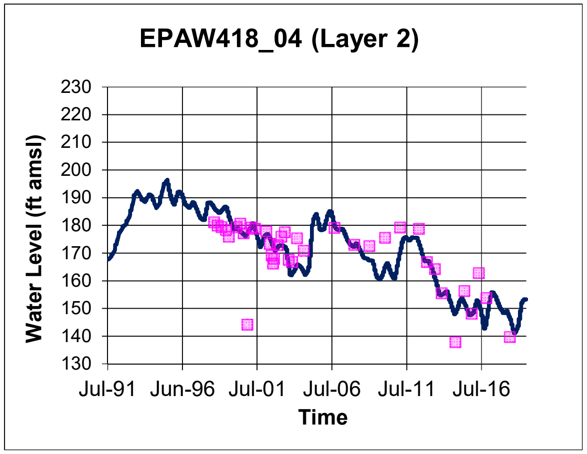
Figure 5 Measured vs. Simulated Hydrographs by Local Model, Newly Added Calibration Wells (Page 1/6)









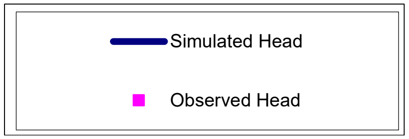
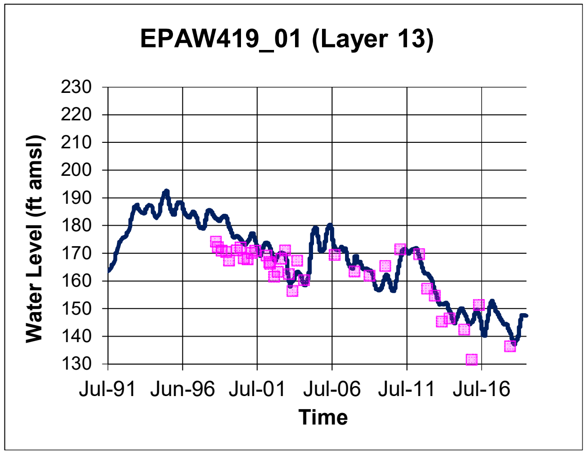
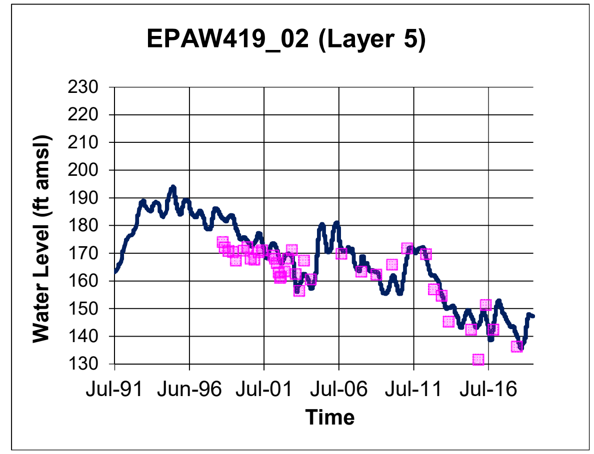
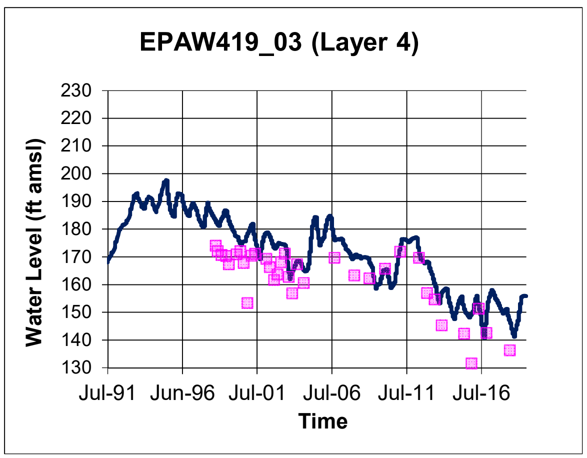
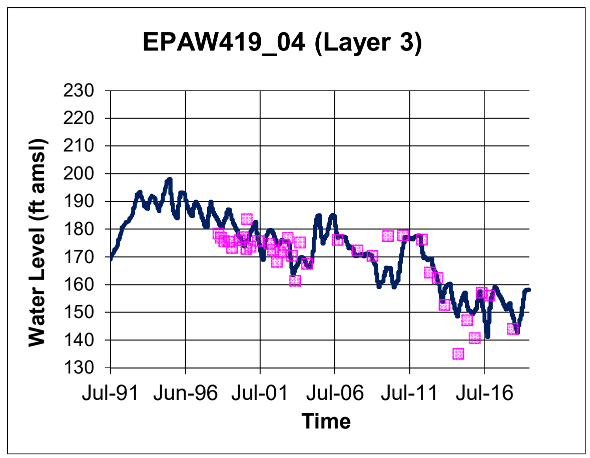


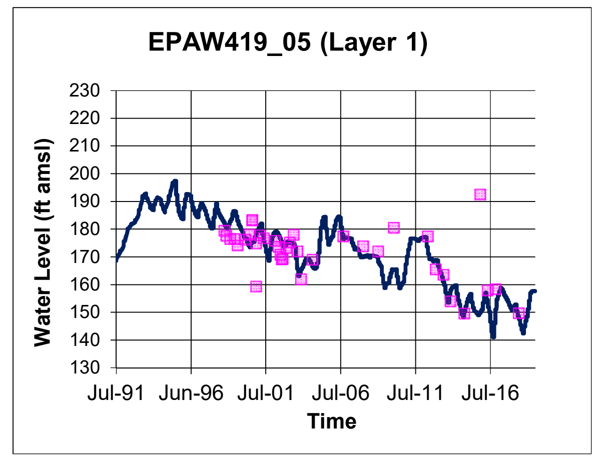
Figure 5 Measured vs. Simulated Hydrographs by Local Model, Newly Added Calibration Wells (Page 2/6)











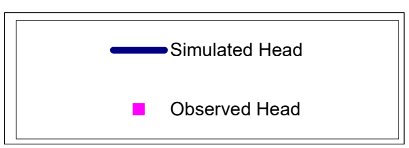


Figure 5 Measured vs. Simulated Hydrographs by Local Model, Newly Added Calibration Wells (Page 3/6)

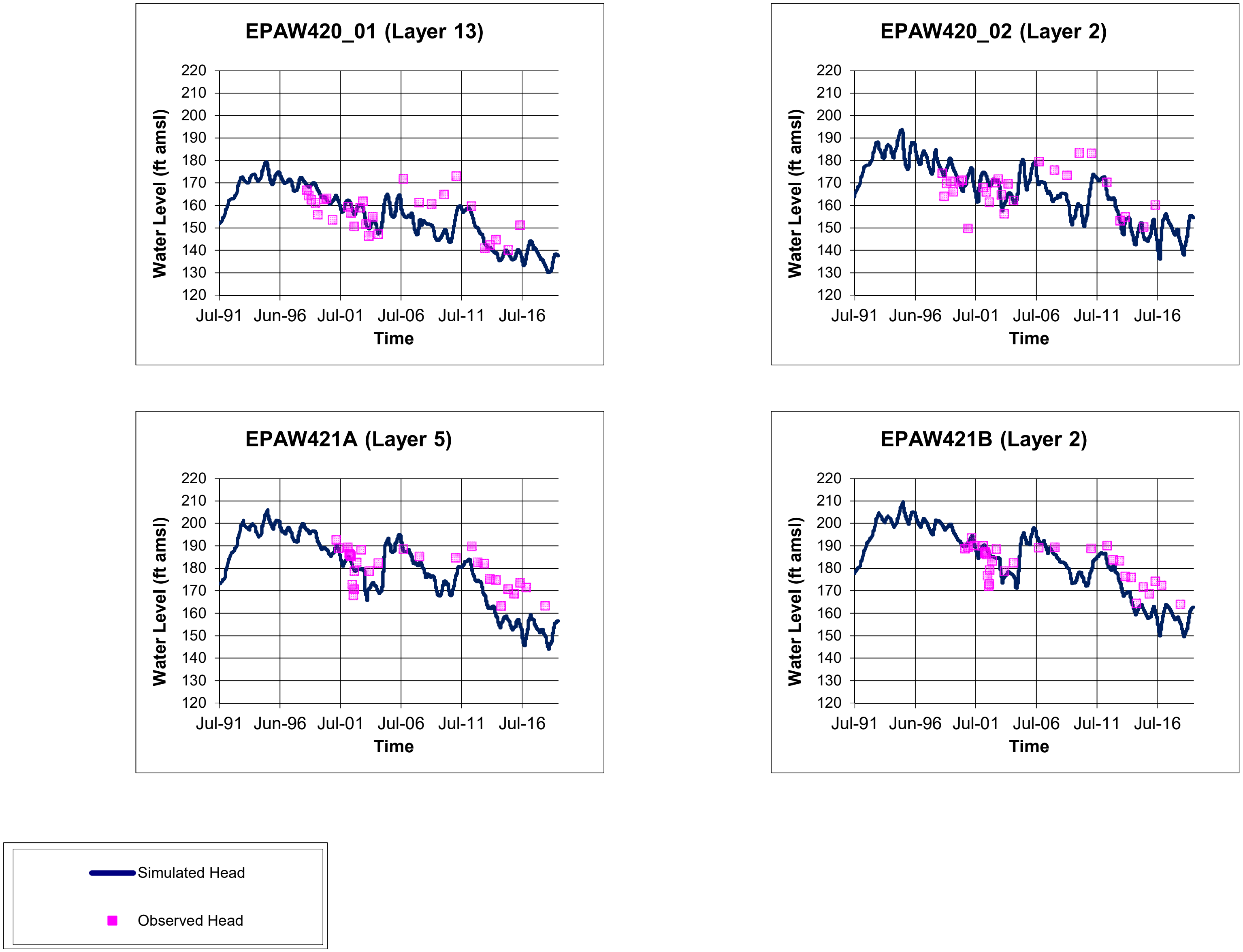


Figure 5 Measured vs. Simulated Hydrographs by Local Model, Newly Added Calibration Wells (Page 4/6)

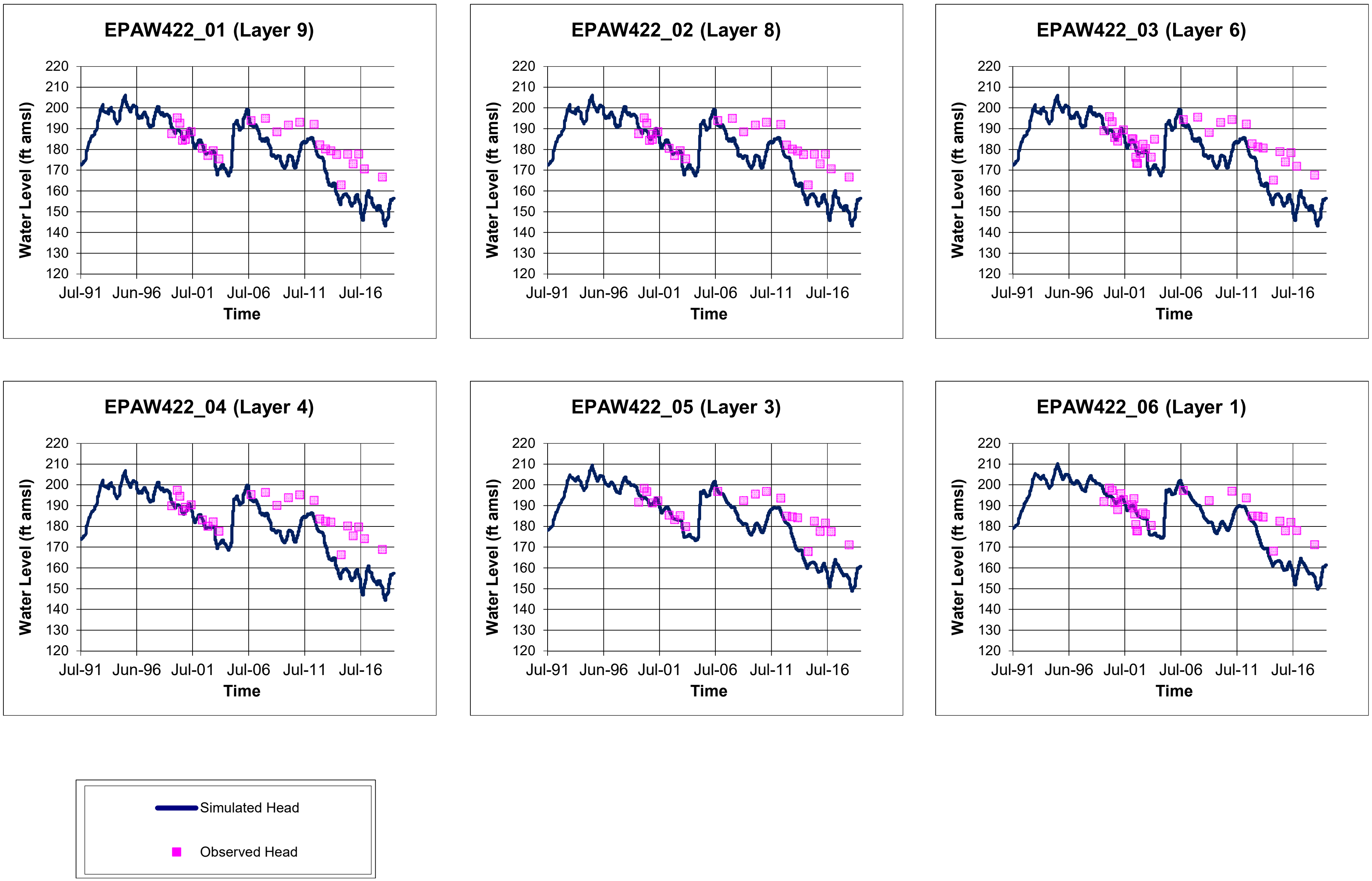


Figure 5 Measured vs. Simulated Hydrographs by Local Model, Newly Added Calibration Wells (Page 6/6)

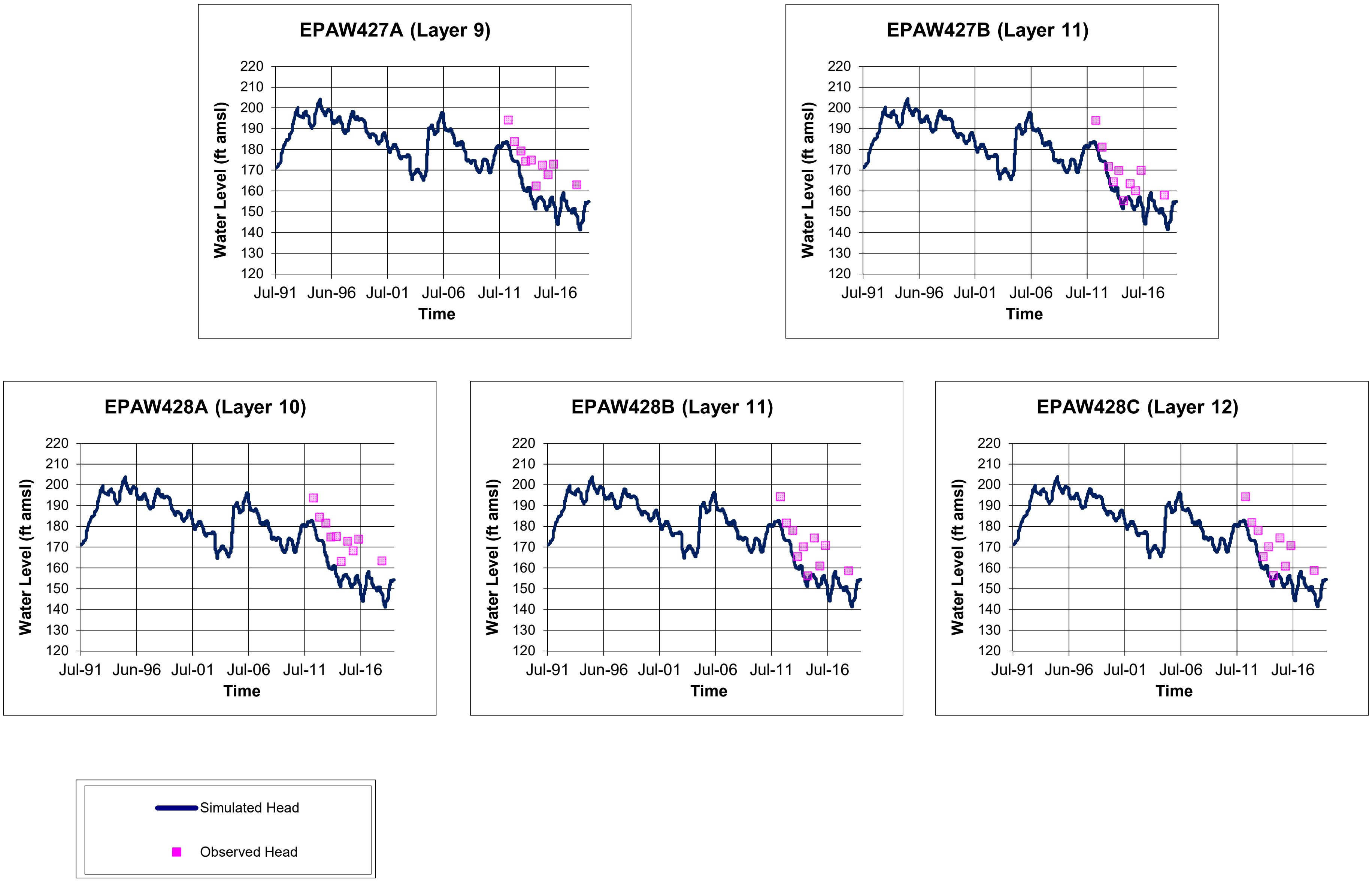
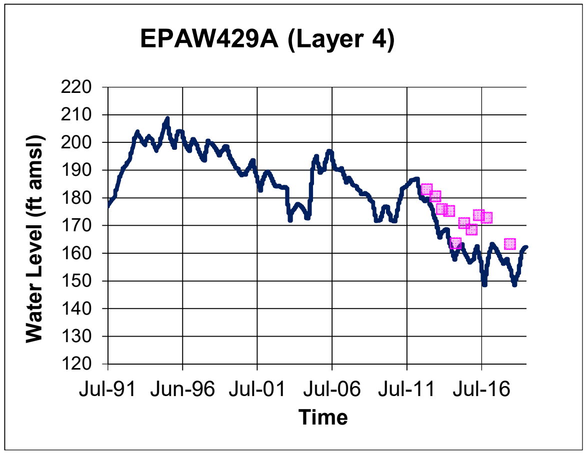
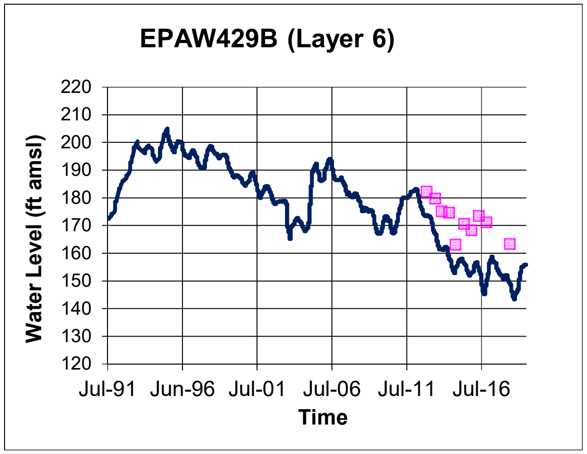
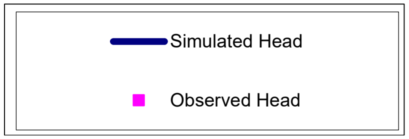


Figure 5 Measured vs. Simulated Hydrographs by Local Model, Newly Added Calibration Wells (Page 6/6)







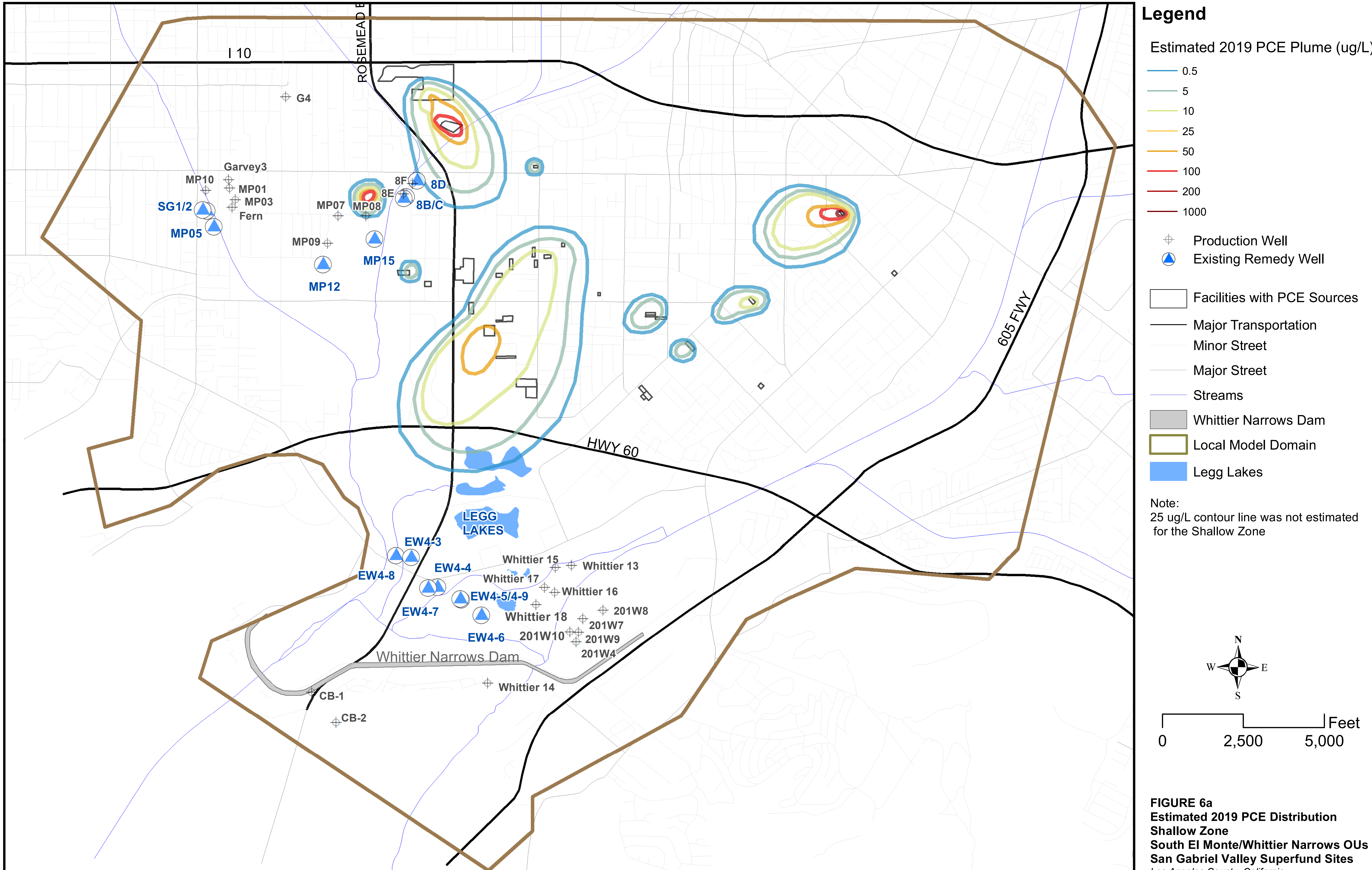


FIGURE 6a
Estimated 2019 PCE Distribution
Shallow Zone
South El Monte/Whittier Narrows OUs
San Gabriel Valley Superfund Sites
Los Angeles County, California

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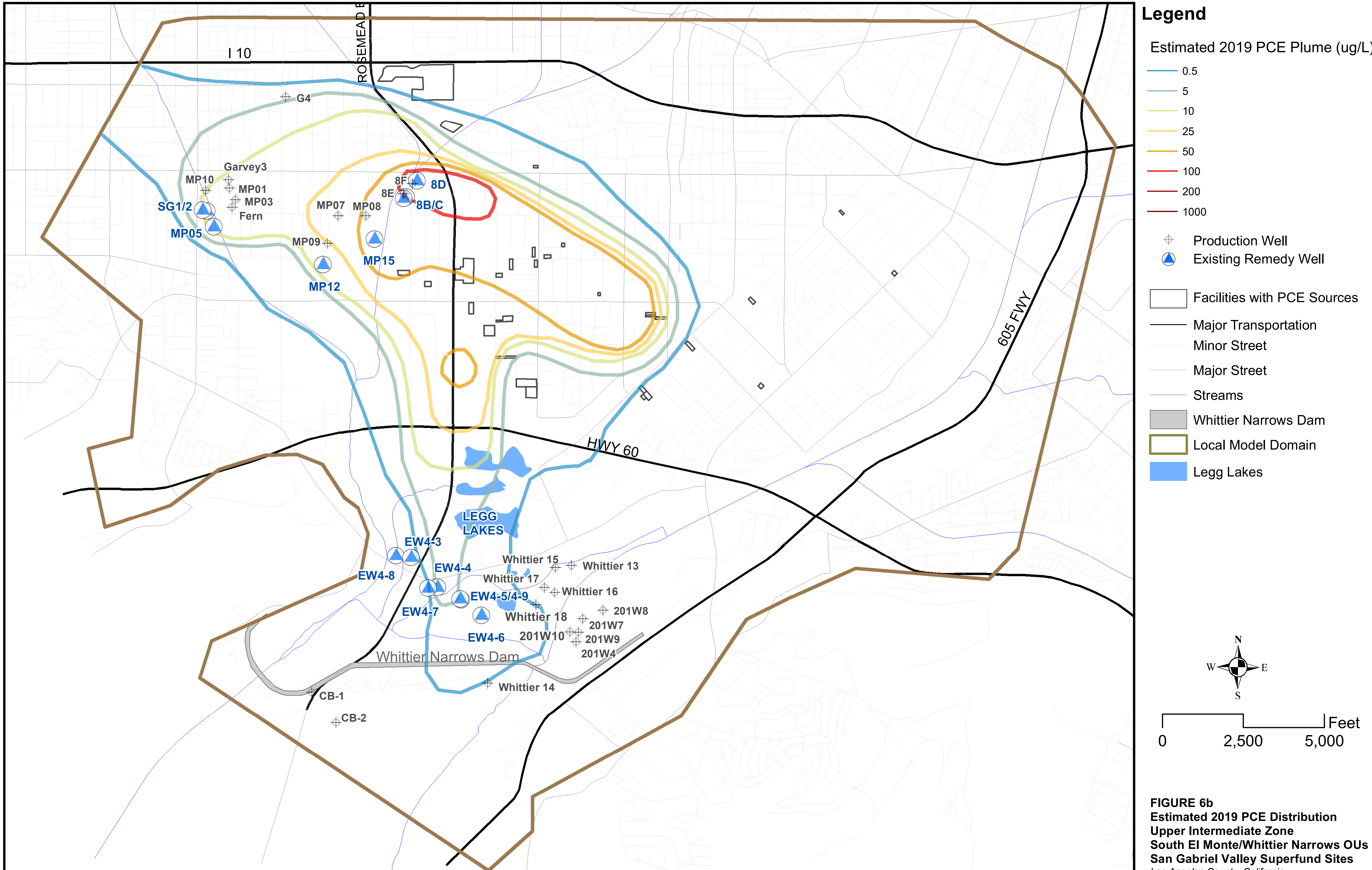

FIGURE 6b
Estimated 2019 PCE Distribution
Upper Intermediate Zone
South El Monte/Whittier Narrows OUs
San Gabriel Valley Superfund Sites
Los Angeles County, California

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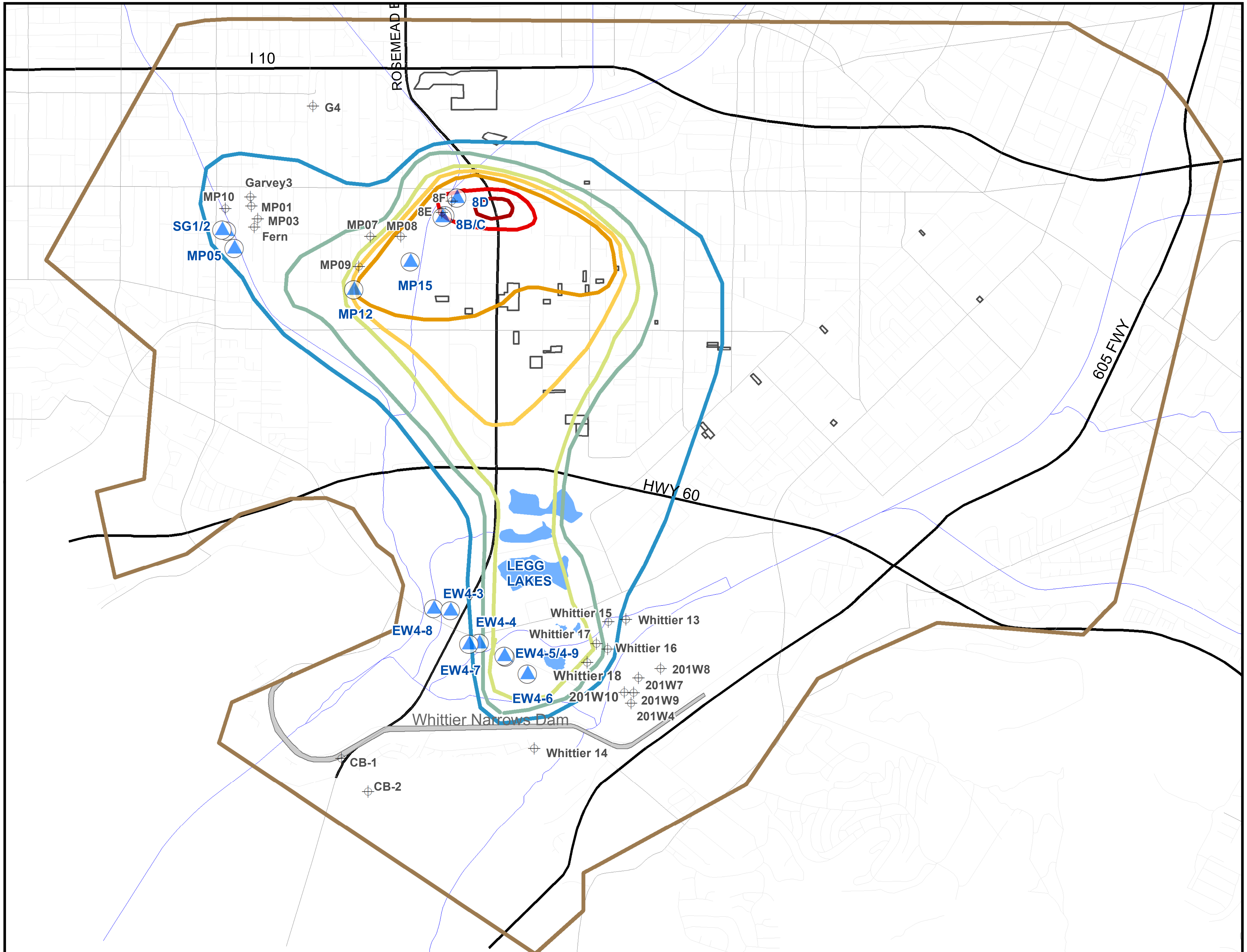

Legend

Estimated 2019 PCE Plume (ug/L)

- 0.5
- 5
- 10
- 25
- 50
- 100
- 200
- 1000

Production Well
Existing Remedy Well
Facilities with PCE Sources
Major Transportation
Minor Street
Major Street
Streams
Whittier Narrows Dam
Local Model Domain
Legg Lakes

FIGURE 6c
Estimated 2019 PCE Distribution
Middle Intermediate Zone
South El Monte/Whittier Narrows OUs
San Gabriel Valley Superfund Sites
Los Angeles County, California

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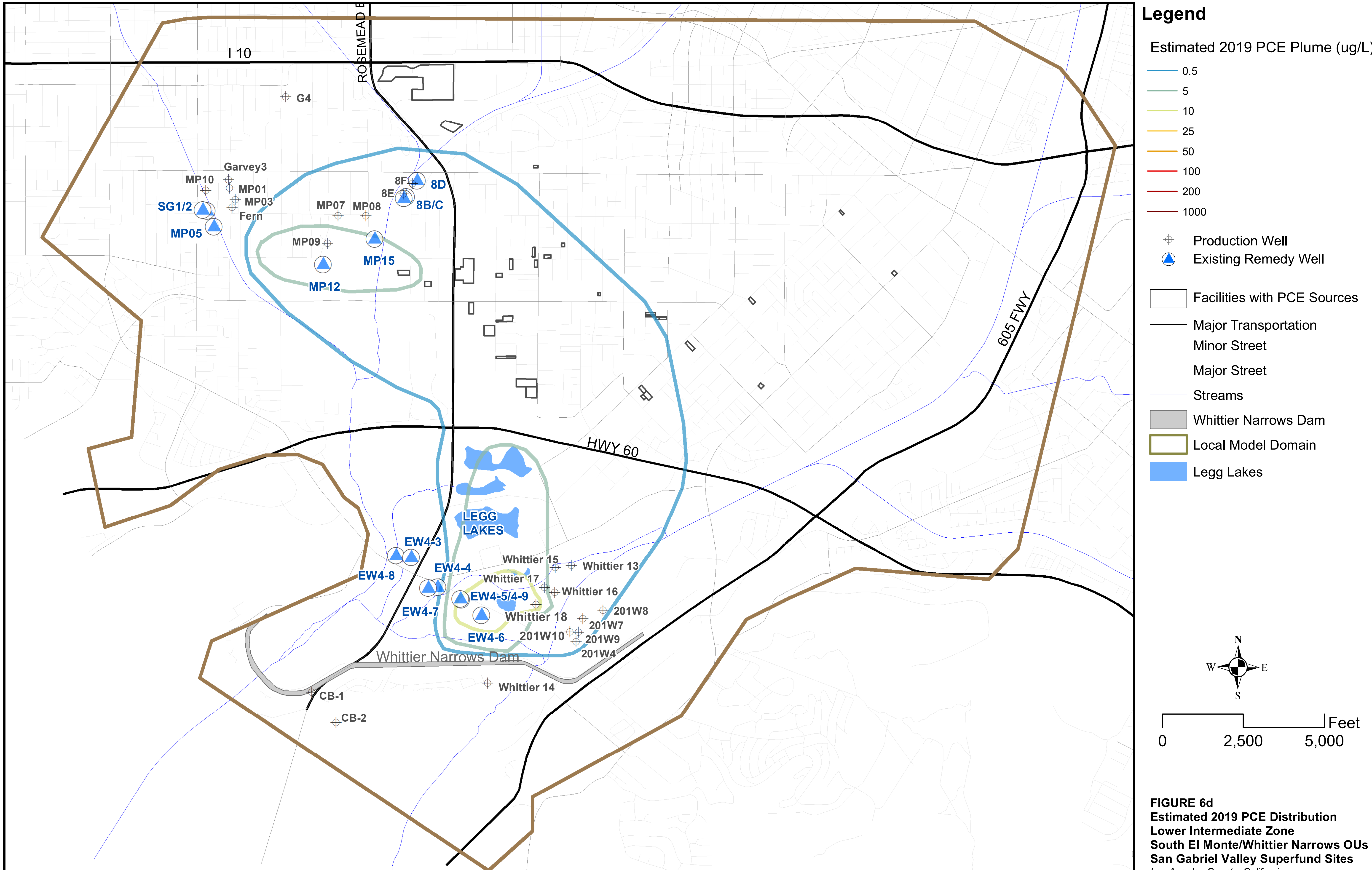

FIGURE 6d
Estimated 2019 PCE Distribution
Lower Intermediate Zone
South El Monte/Whittier Narrows OUs
San Gabriel Valley Superfund Sites
Los Angeles County, California

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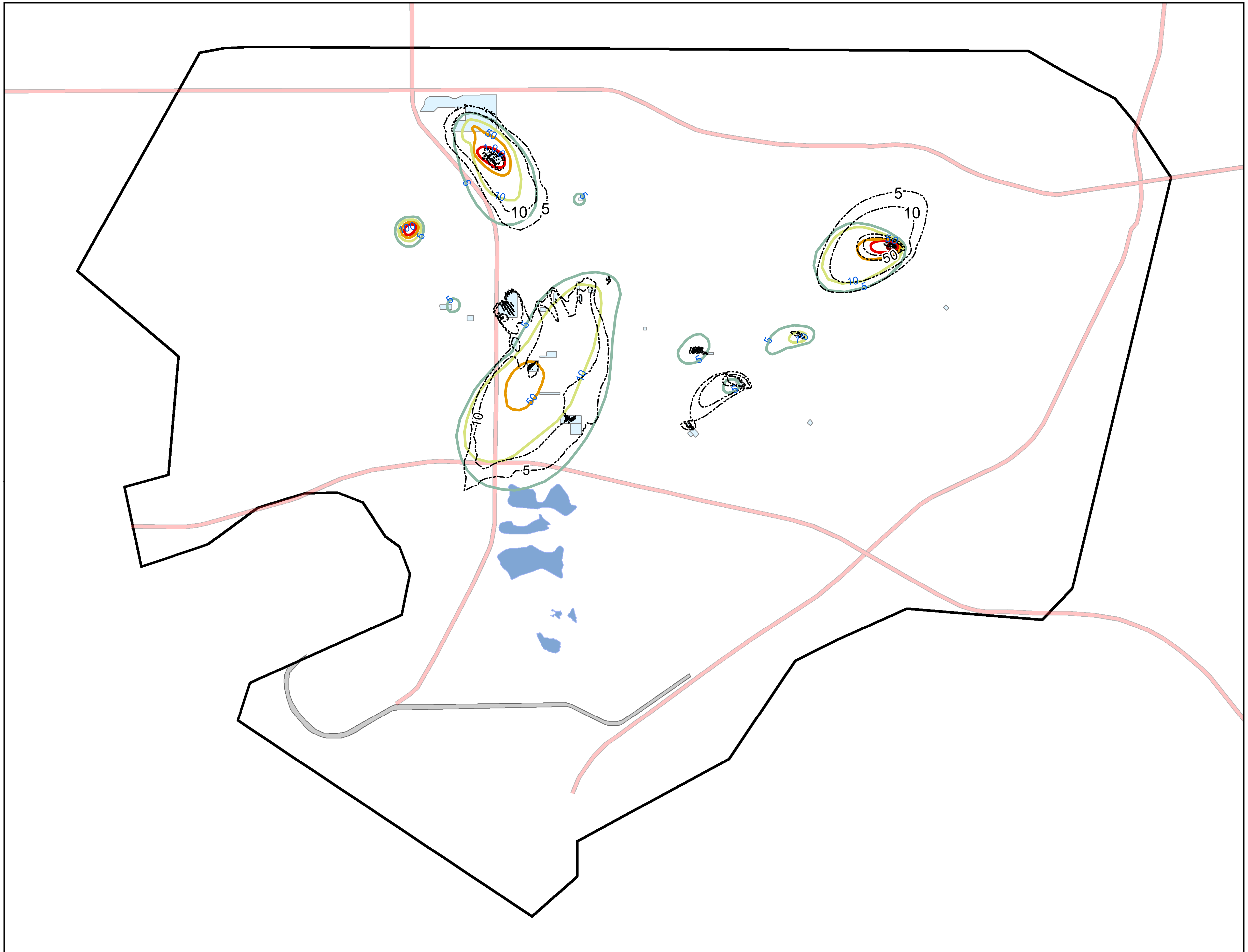

Legend

Estimated PCE Plume Extent in 2019

- 5
- 10
- 50
- 100
- 1000
- Simulated PCE Plume in 2019
- Local Model Domain
- Whittier Narrow Dam
- Major Transportation
- Source Facilities
- Lakes

Notes:
1. Concentration unit = micrograms per liter (ug/L)
2. Simulated contours lines:
   5, 10, 50, 100, and 1000 ug/L

N

0 0.5 1 Miles

FIGURE 7a
Simulated vs. Estimated 2019 PCE Distribution
Shallow Zone
South El Monte/Whittier Narrows OUs
San Gabriel Valley Superfund Sites
Los Angeles County, California

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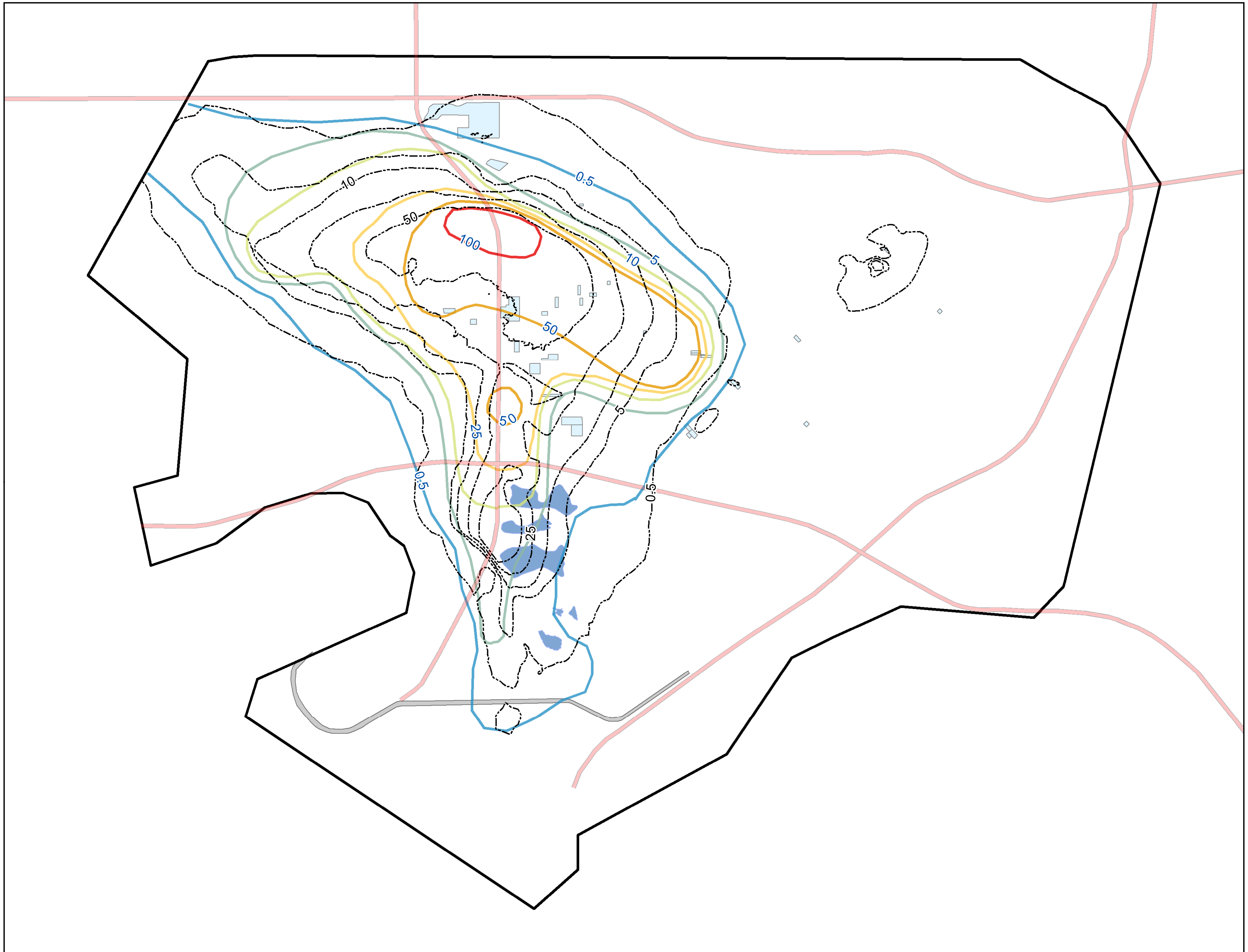

Legend

Estimated PCE Plume Extent in 2019

- 0.5
- 5
- 10
- 25
- 50
- 100
- 1000

Simulated PCE Plume in 2019

Local Model Domain

Whittier Narrow Dam

Major Transportation

Source Facilities

Lakes

Notes:
1. Concentration unit = micrograms per liter (ug/L)
2. Simulated contours lines:
   0.5, 5, 10, 25, 50, 100, and 1000 ug/L

N

0 0.5 1 Miles

FIGURE 7b
Simulated vs. Estimated 2019 PCE Distribution
Upper Intermediate Zone
South El Monte/Whittier Narrows OUs
San Gabriel Valley Superfund Sites
Los Angeles County, California

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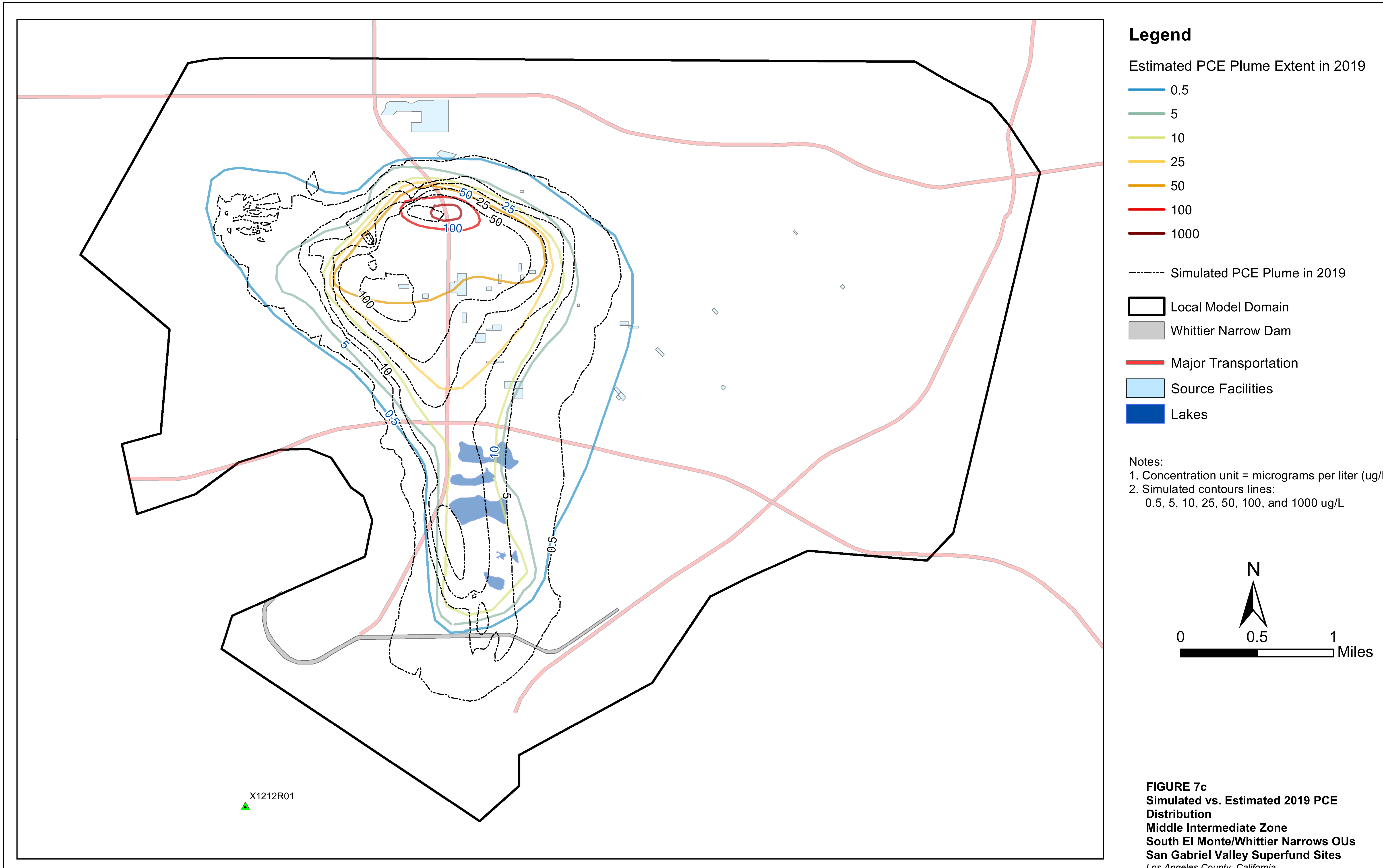

FIGURE 7c
Simulated vs. Estimated 2019 PCE Distribution
Middle Intermediate Zone
South El Monte/Whittier Narrows OUs
San Gabriel Valley Superfund Sites
Los Angeles County, California

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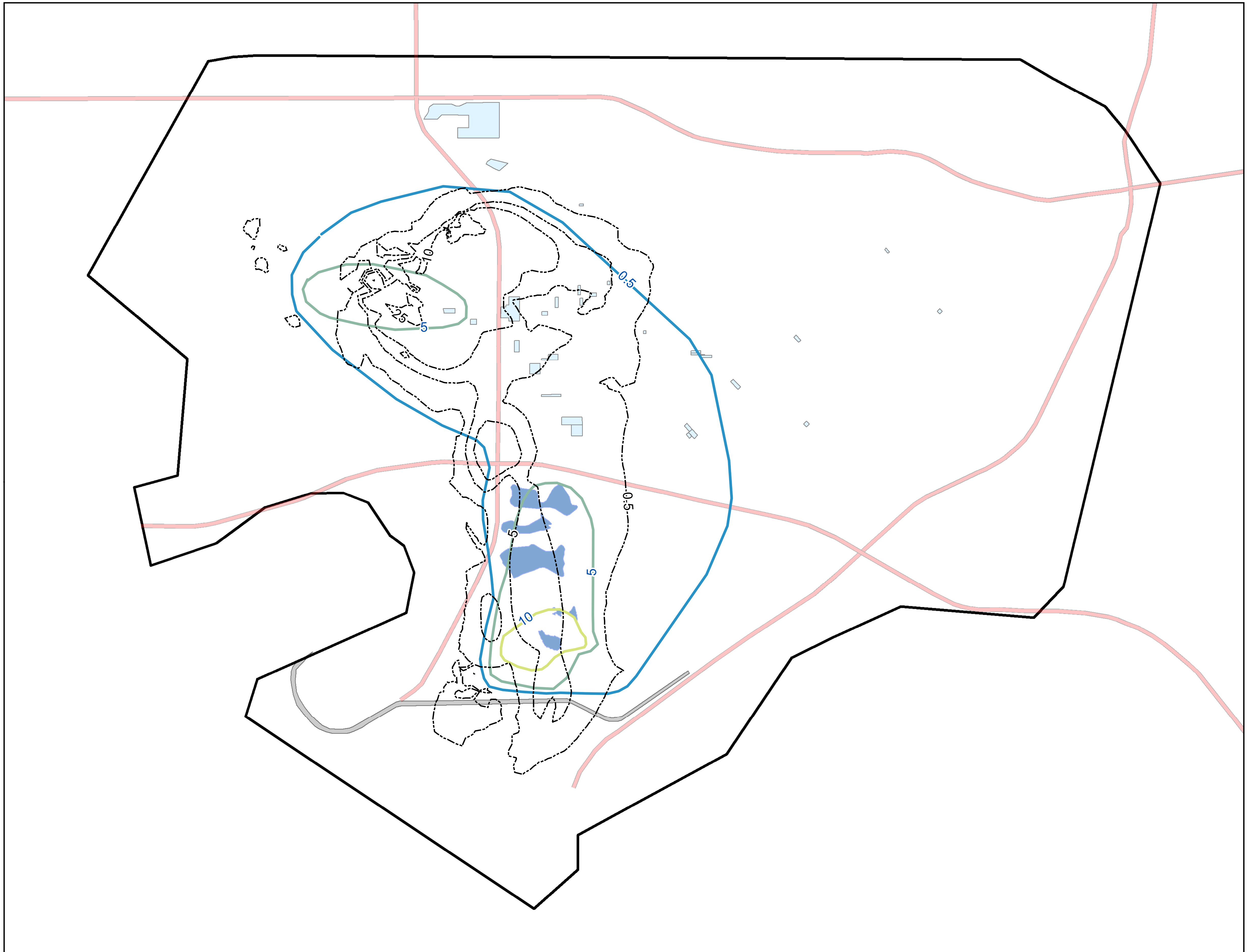

Legend

Estimated PCE Plume Extent in 2019
- 0.5
- 5
- 10
- 25
- 50
- 100
- 1000

Simulated PCE Plume in 2019

Local Model Domain

Whittier Narrow Dam

Major Transportation

Source Facilities

Lakes

Notes:
1. Concentration unit = micrograms per liter (ug/L)
2. Simulated contours lines:
   0.5, 5, 10, 25, 50, 100, 1000 ug/L

FIGURE 7d
Simulated vs. Estimated 2019 PCE Distribution
Lower Intermediate Zone
South El Monte/Whittier Narrows OUs
San Gabriel Valley Superfund Sites
Los Angeles County, California

ch2m

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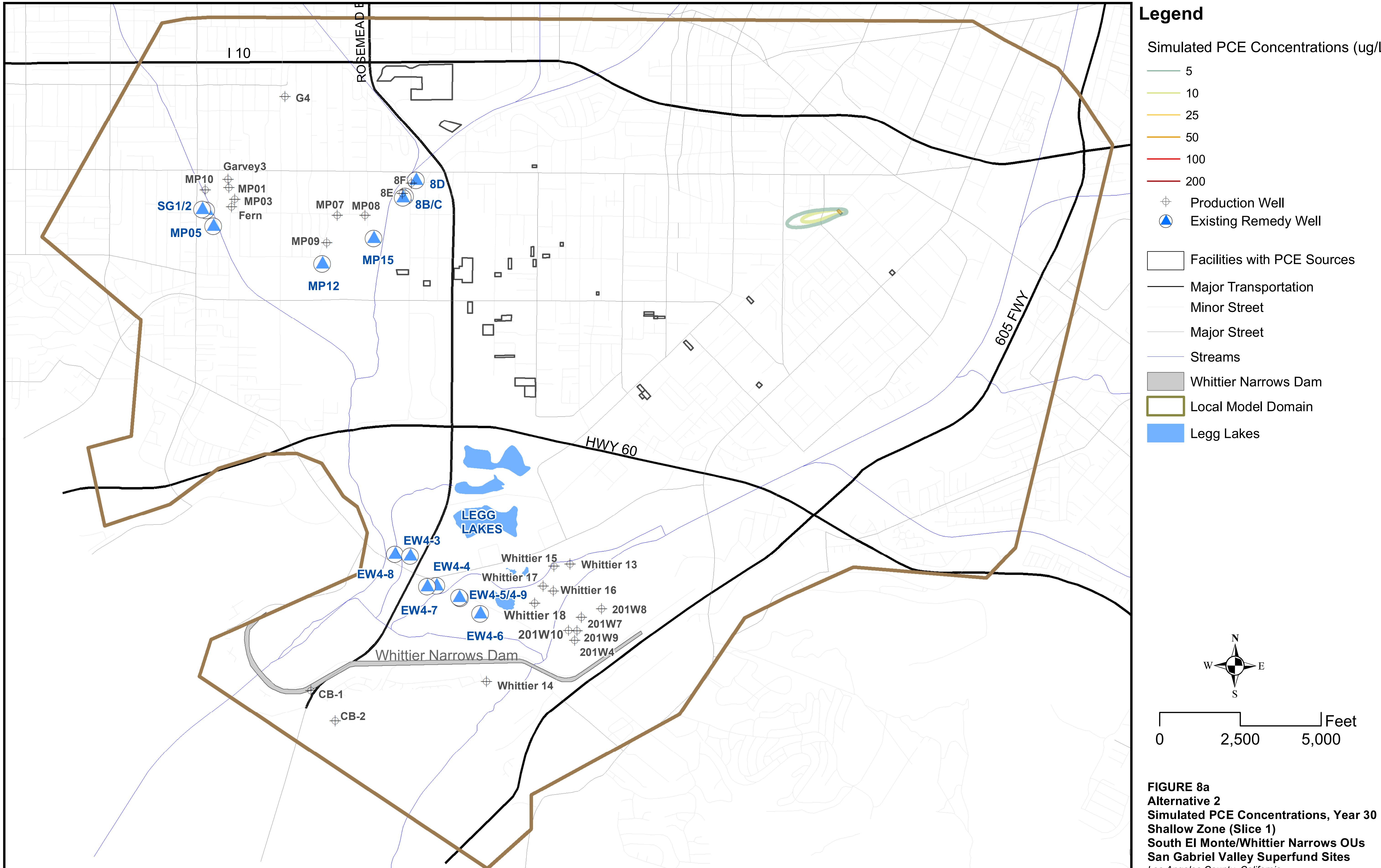

FIGURE 8a
Alternative 2
Simulated PCE Concentrations, Year 30
Shallow Zone (Slice 1)
South El Monte/Whittier Narrows OUs
San Gabriel Valley Superfund Sites
Los Angeles County, California

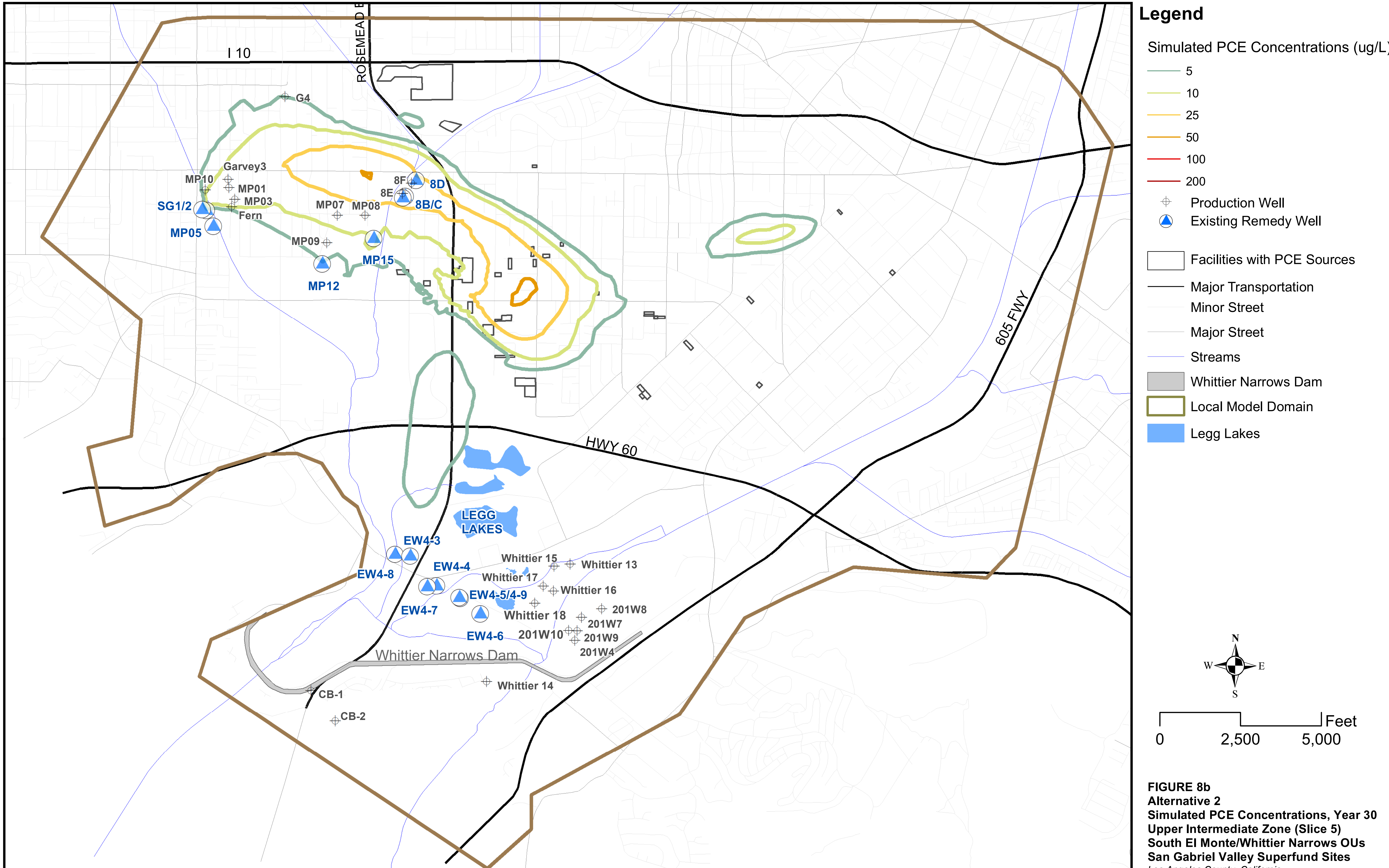

FIGURE 8b
Alternative 2
Simulated PCE Concentrations, Year 30
Upper Intermediate Zone (Slice 5)
South El Monte/Whittier Narrows OUs
San Gabriel Valley Superfund Sites
Los Angeles County, California

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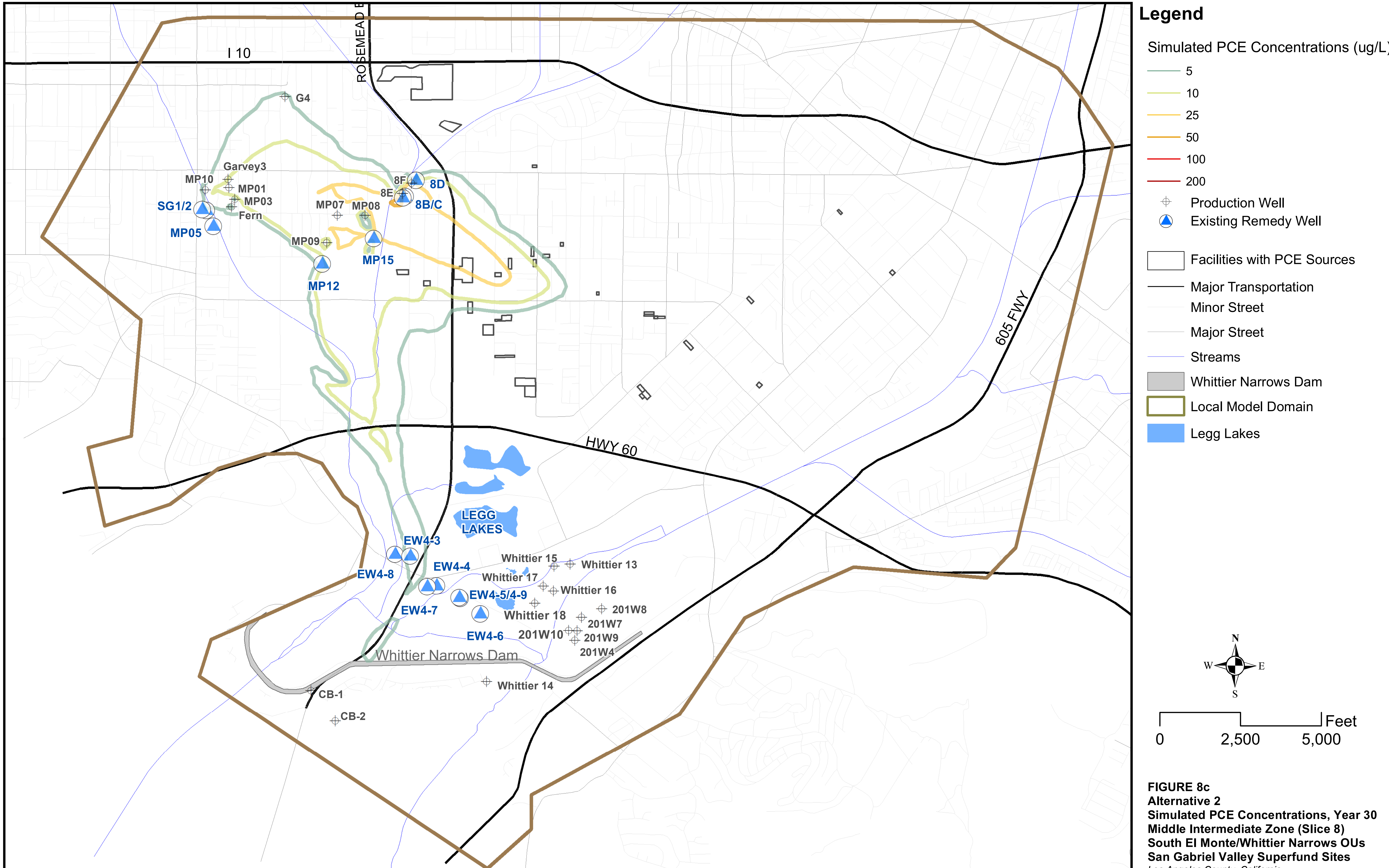

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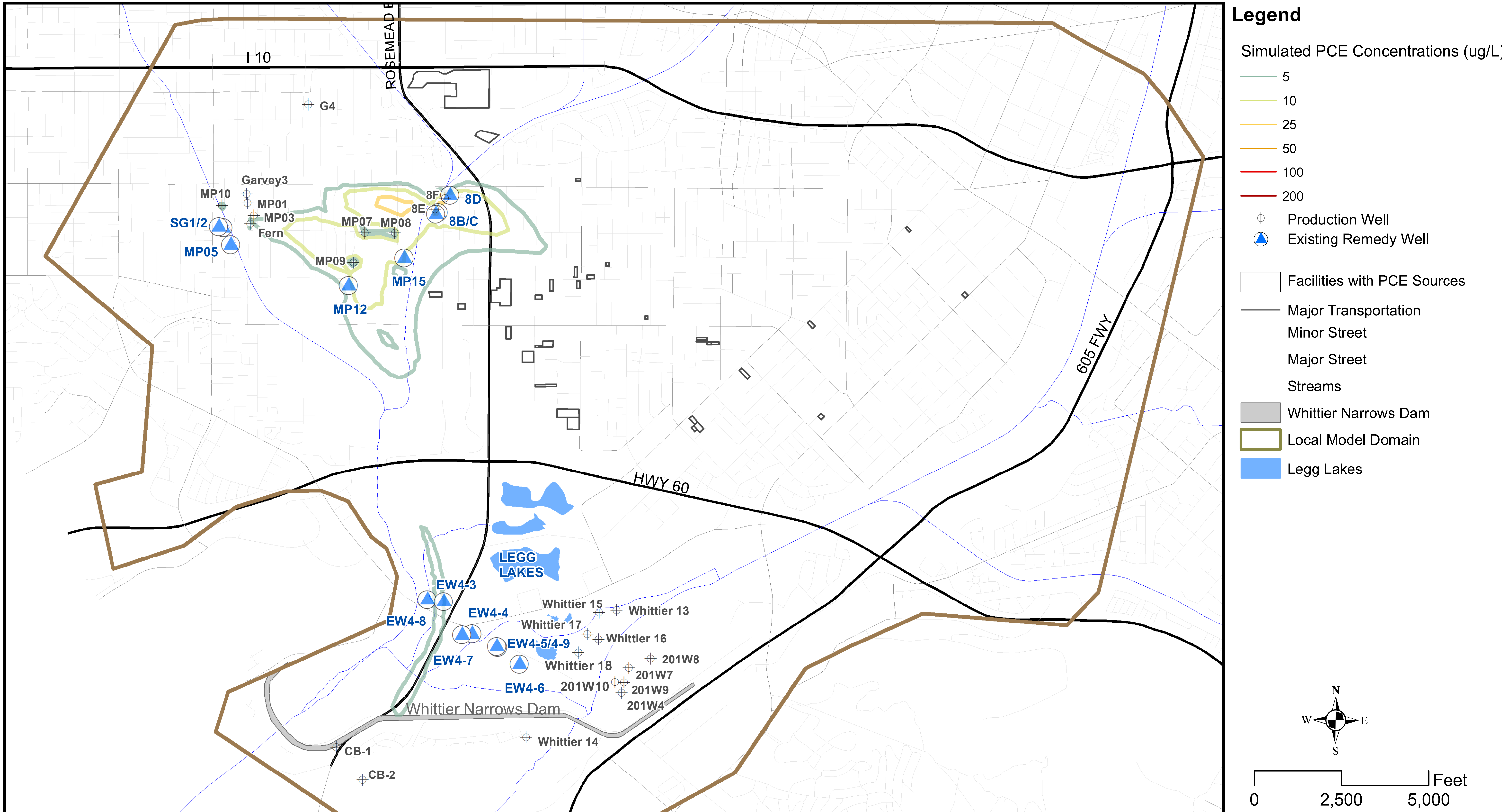

FIGURE 8d
Alternative 2
Simulated PCE Concentrations, Year 30
Lower Intermediate Zone (Slice 12)
South El Monte/Whittier Narrows OUs
San Gabriel Valley Superfund Sites
Los Angeles County, California

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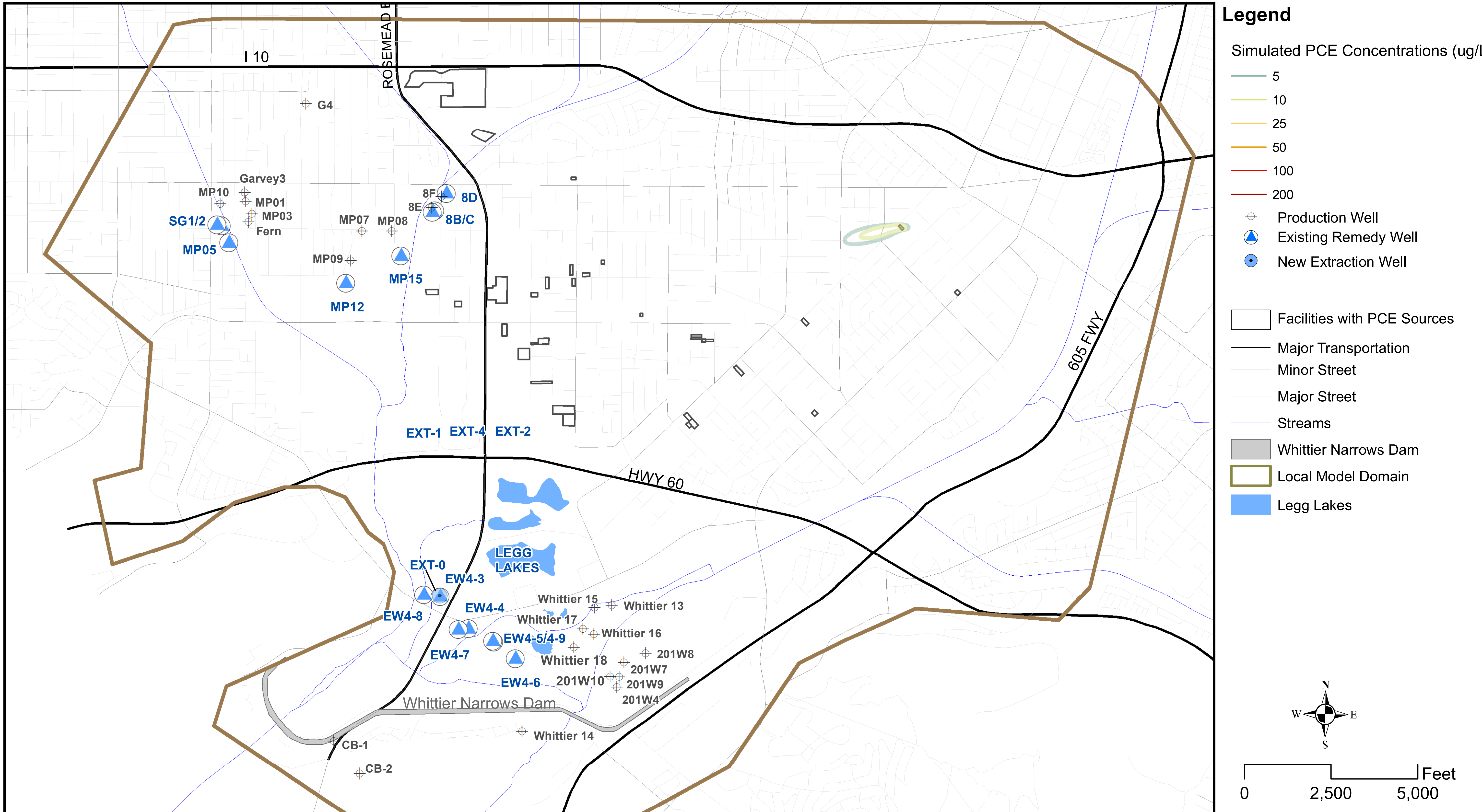

FIGURE 9a
Alternative 3
Simulated PCE Concentrations, Year 30
Shallow Intermediate Zone (Slice 1)
South El Monte/Whittier Narrows OUs
San Gabriel Valley Superfund Sites
Los Angeles County, California

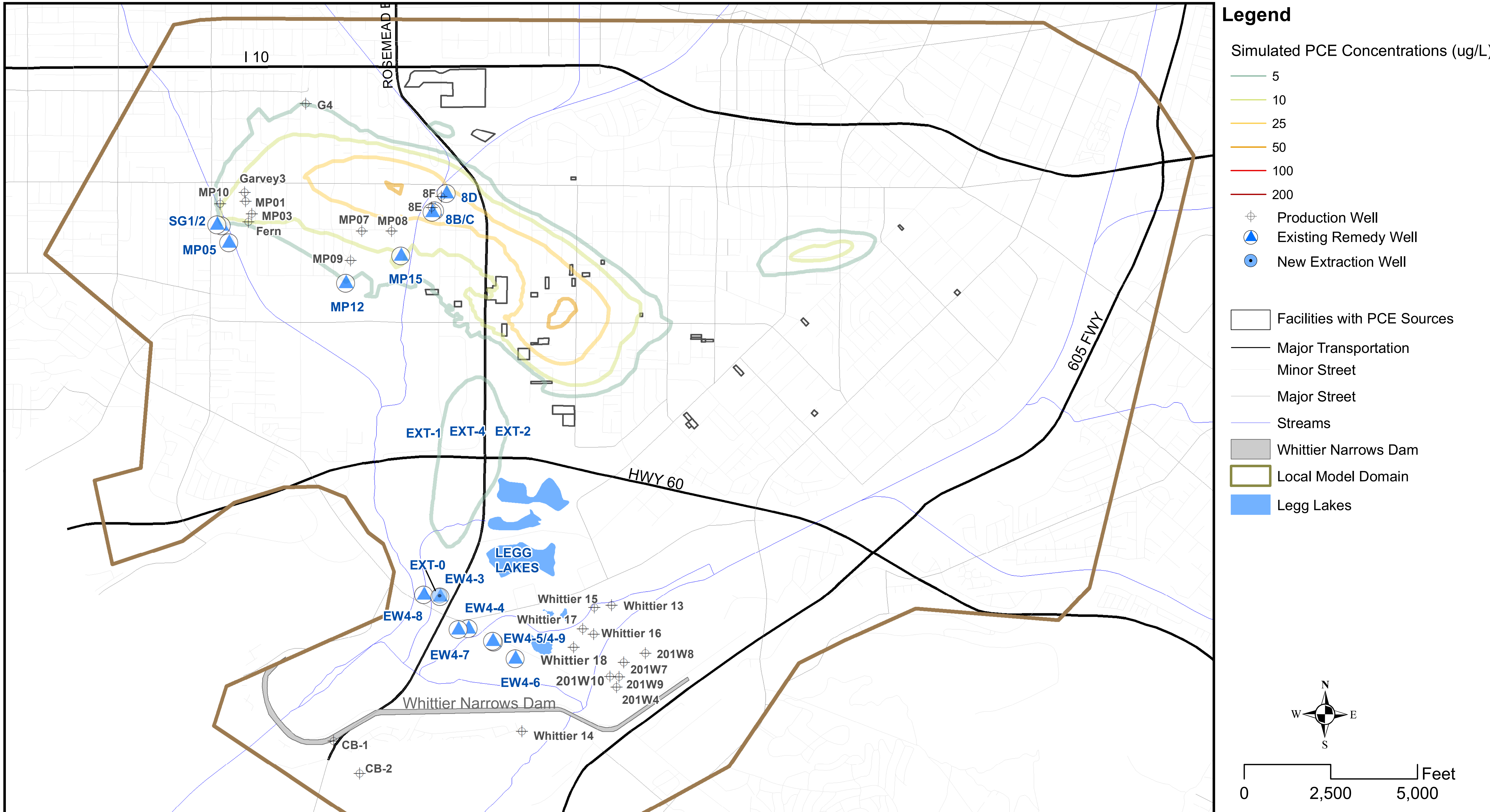

FIGURE 9b
Alternative 3
Simulated PCE Concentrations, Year 30
Upper Intermediate Zone (Slice 5)
South El Monte/Whittier Narrows OUs
San Gabriel Valley Superfund Sites
Los Angeles County, California

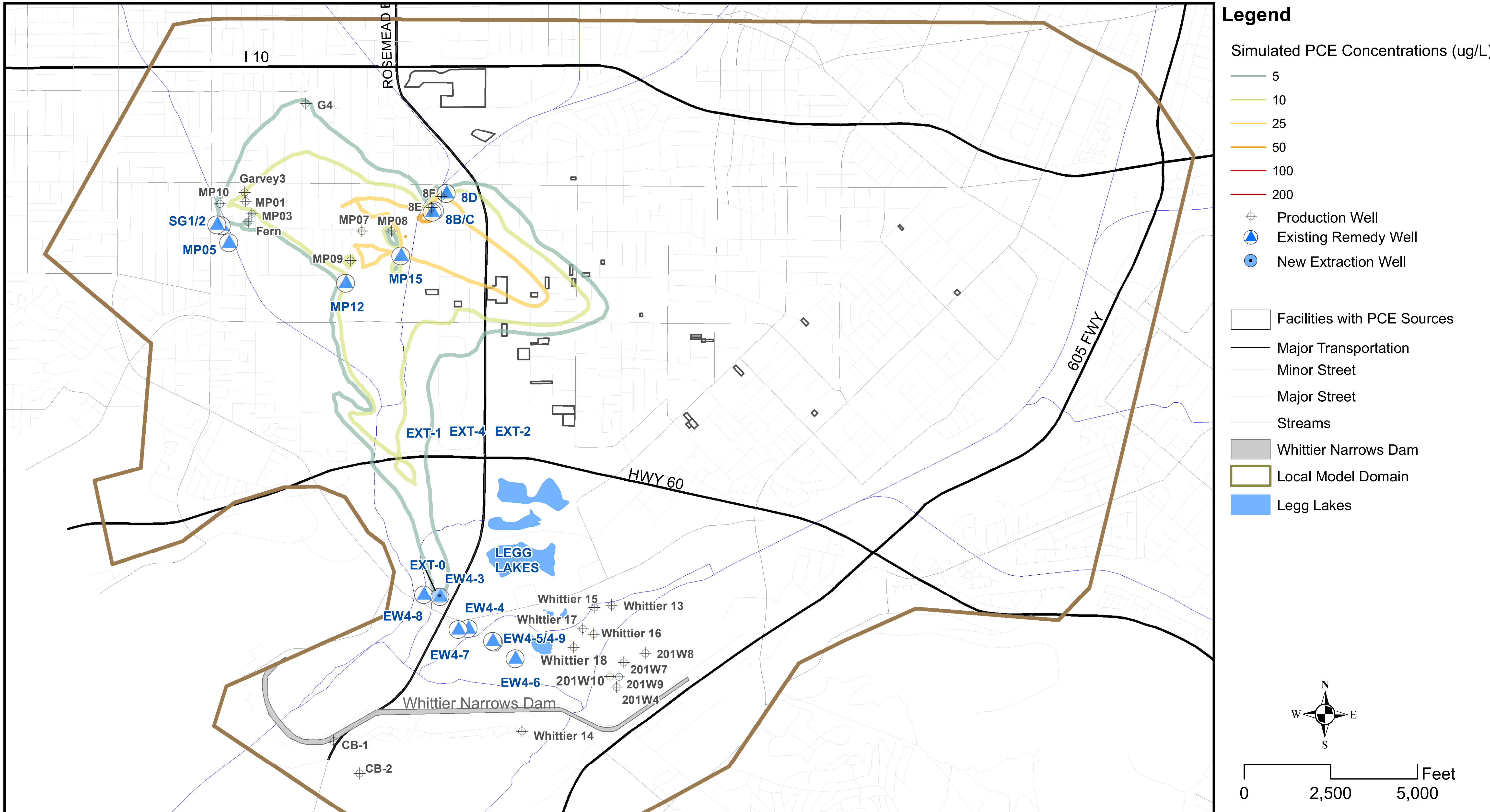

FIGURE 9c
Alternative 3
Simulated PCE Concentrations, Year 30
Middle Intermediate Zone (Slice 8)
South El Monte/Whittier Narrows OUs
San Gabriel Valley Superfund Sites
Los Angeles County, California

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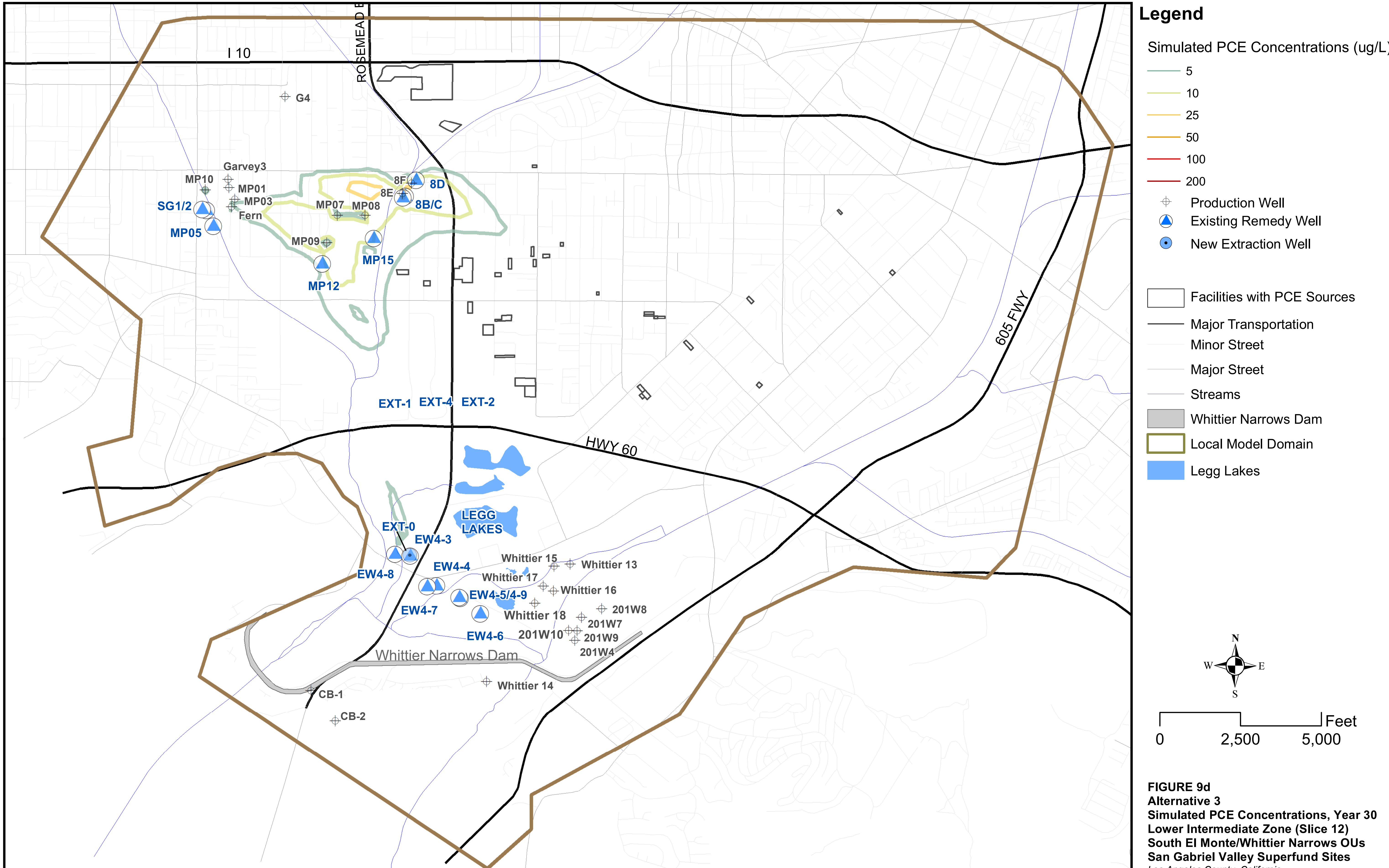

FIGURE 9d
Alternative 3
Simulated PCE Concentrations, Year 30
Lower Intermediate Zone (Slice 12)
South El Monte/Whittier Narrows OUs
San Gabriel Valley Superfund Sites
Los Angeles County, California

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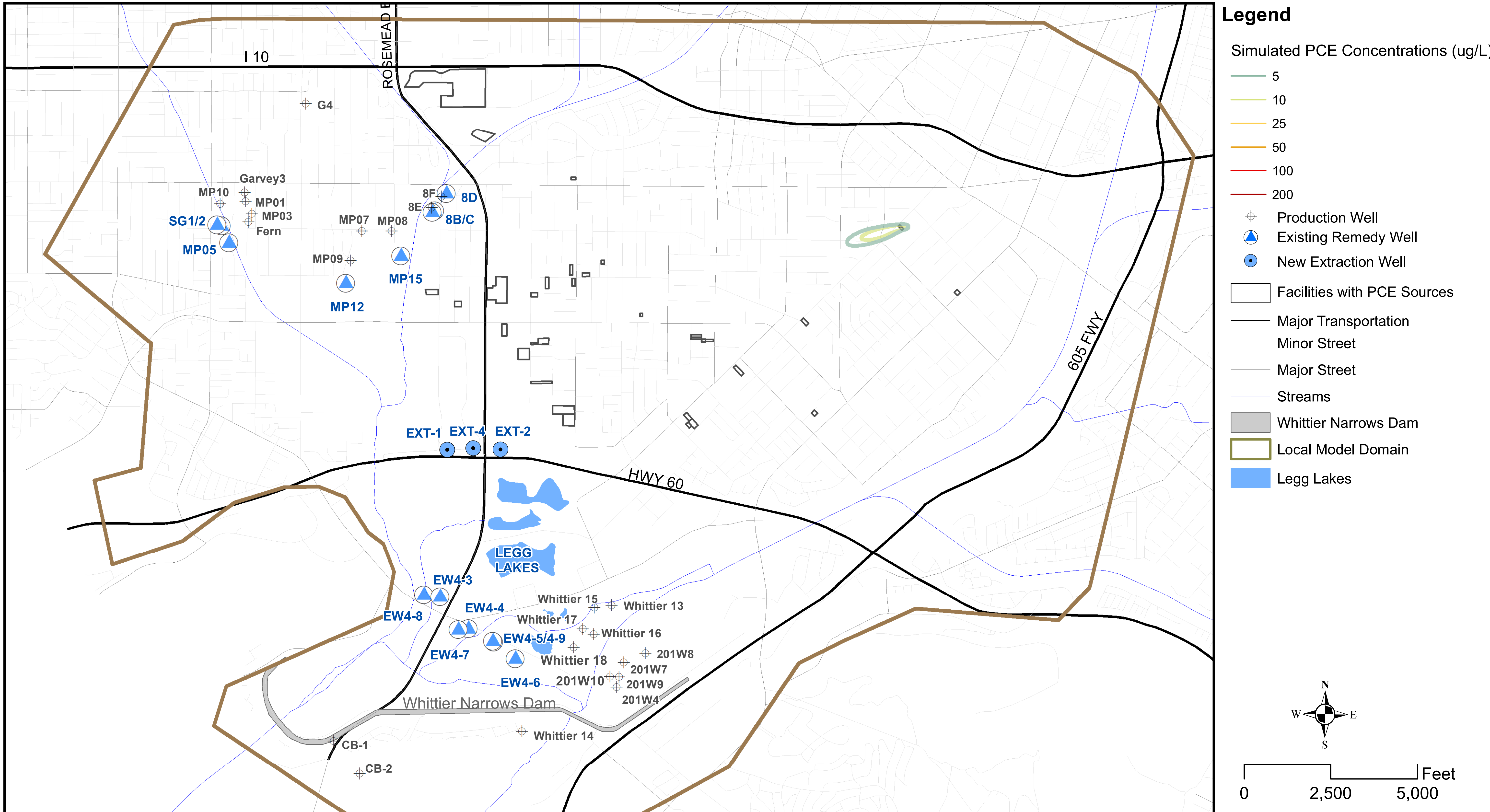

FIGURE 10a
Alternative 4
Simulated PCE Concentrations, Year 30
Shallow Zone (Slice 1)
South El Monte/Whittier Narrows OUs
San Gabriel Valley Superfund Sites
Los Angeles County, California

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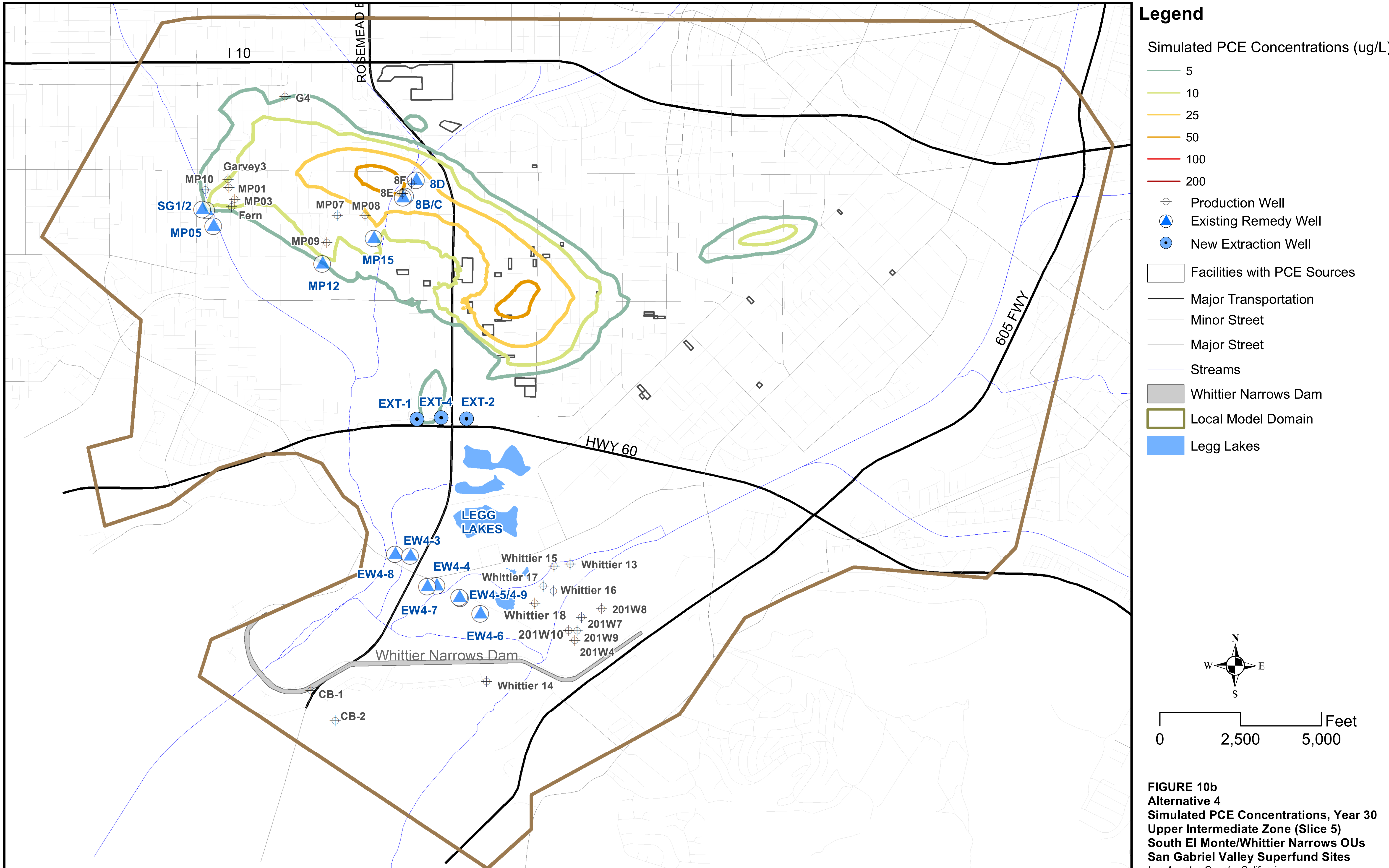

FIGURE 10b
Alternative 4
Simulated PCE Concentrations, Year 30
Upper Intermediate Zone (Slice 5)
South El Monte/Whittier Narrows OUs
San Gabriel Valley Superfund Sites
Los Angeles County, California

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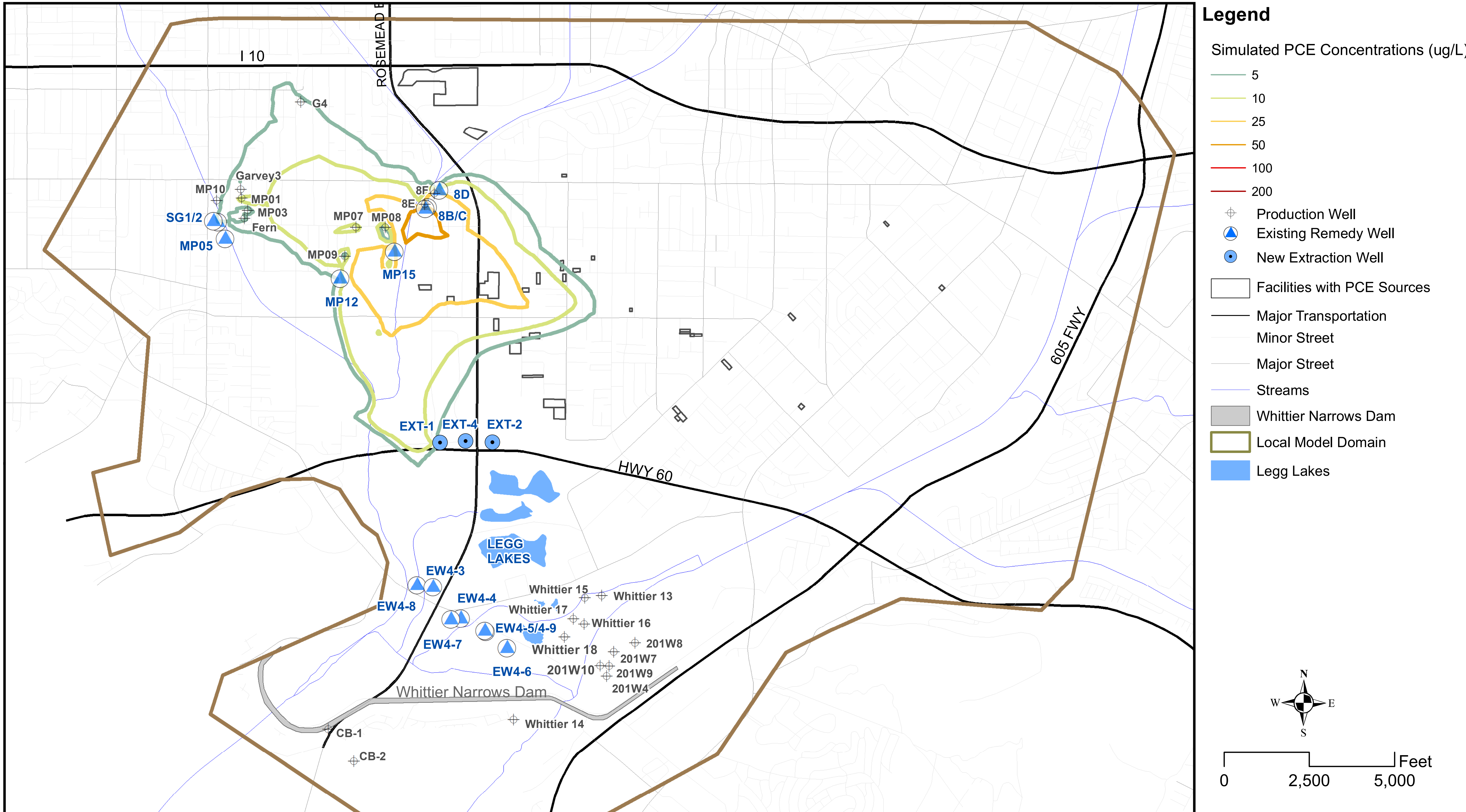

FIGURE 10c
Alternative 4
Simulated PCE Concentrations, Year 30
Middle Intermediate Zone (Slice 8)
South El Monte/Whittier Narrows OUs
San Gabriel Valley Superfund Sites
Los Angeles County, California

ch2m

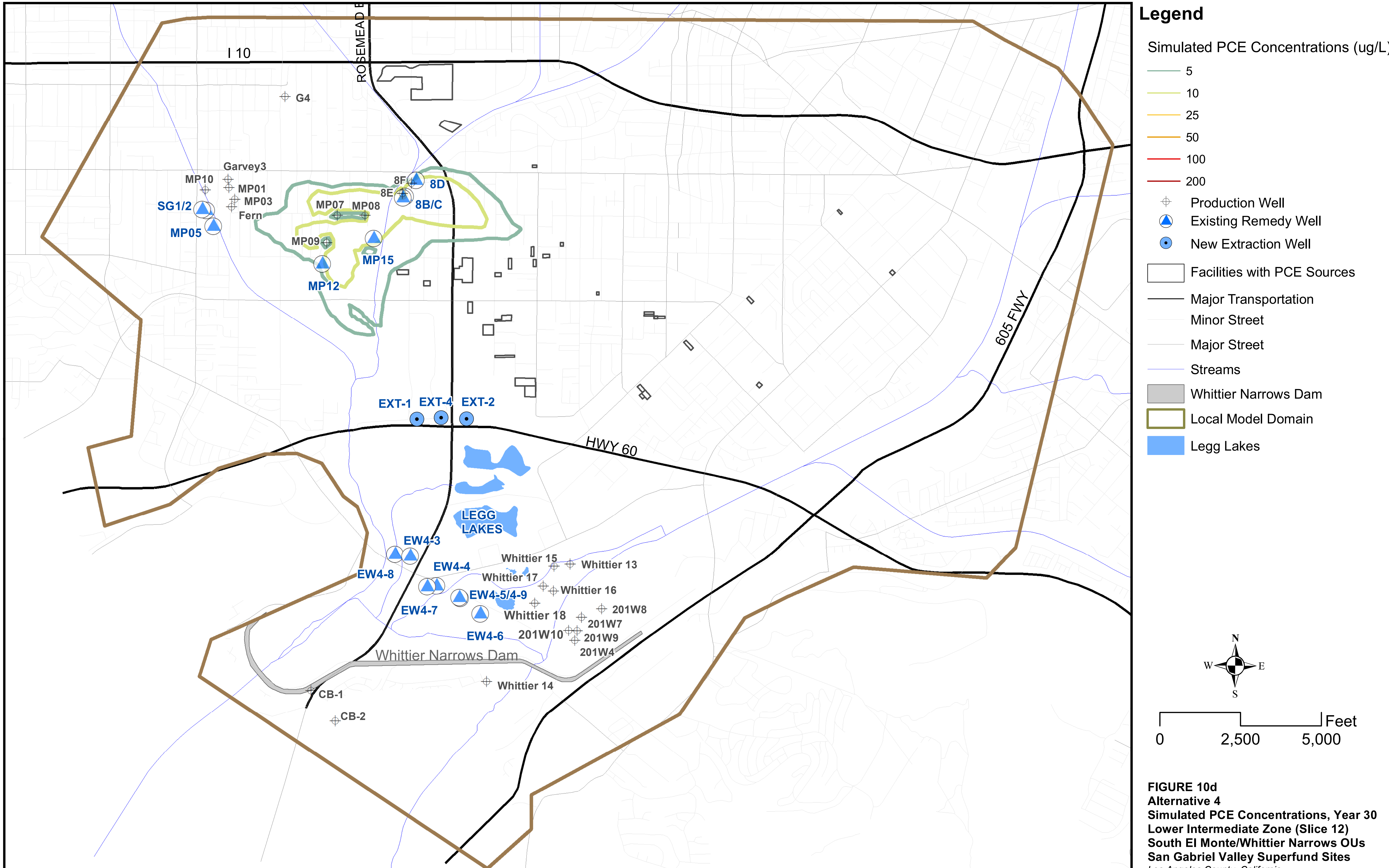

FIGURE 10d
Alternative 4
Simulated PCE Concentrations, Year 30
Lower Intermediate Zone (Slice 12)
South El Monte/Whittier Narrows OUs
San Gabriel Valley Superfund Sites
Los Angeles County, California

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ch2m

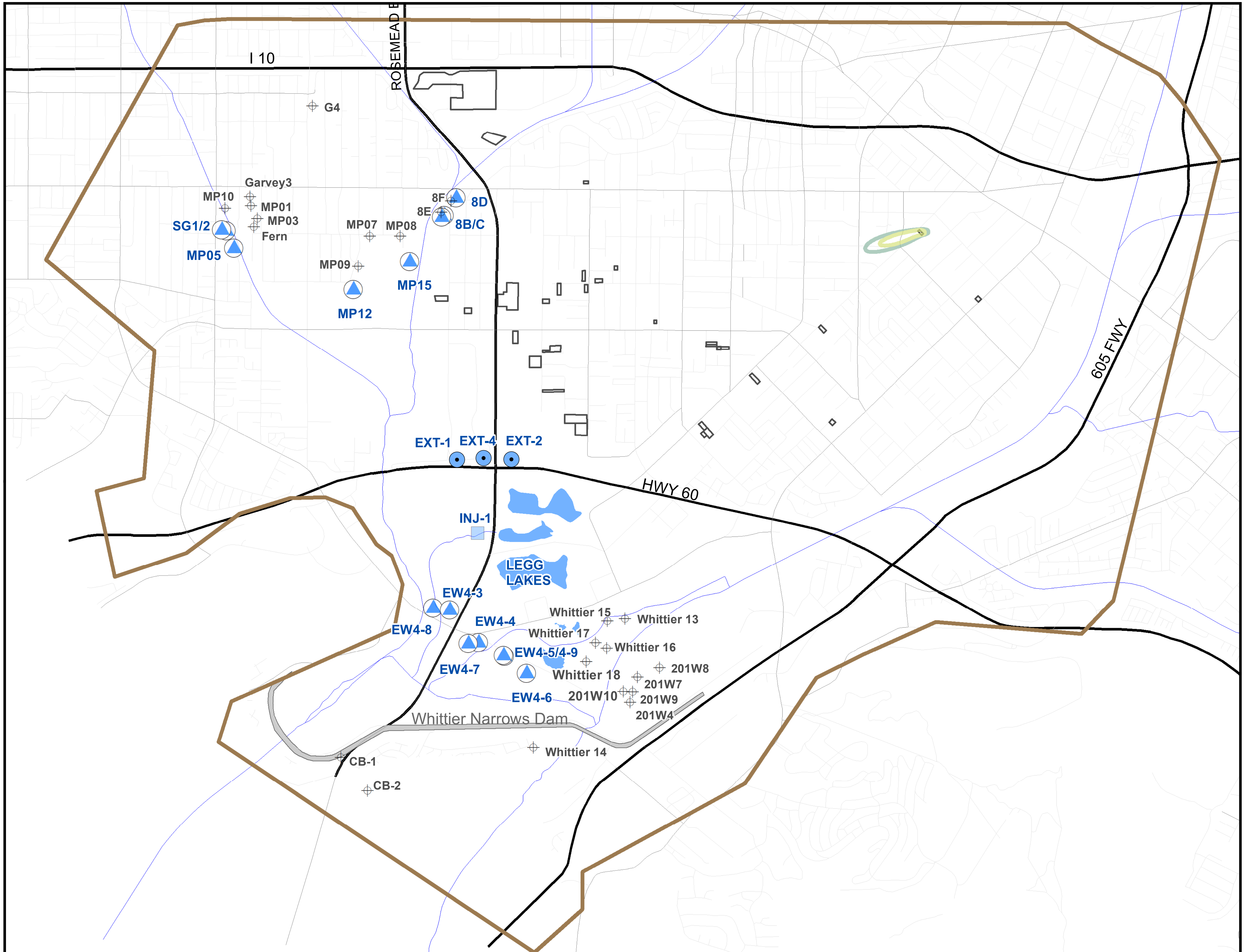

FIGURE 11a
Alternative 5
Simulated PCE Concentrations, Year 30
Shallow Zone (Slice 1)
South El Monte/Whittier Narrows OUs
San Gabriel Valley Superfund Sites
Los Angeles County, California

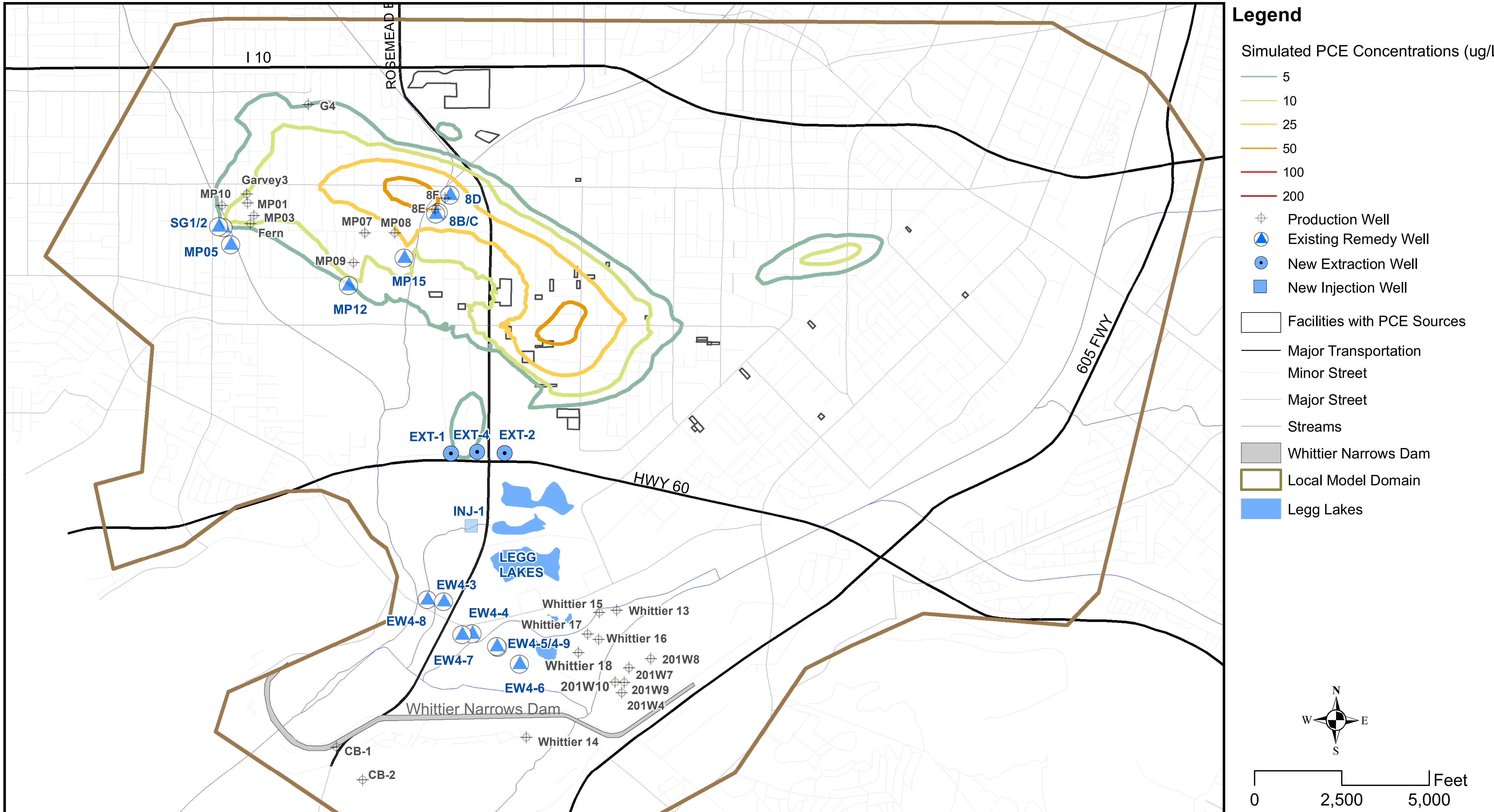

FIGURE 11b
Alternative 5
Simulated PCE Concentrations, Year 30
Upper Intermediate Zone (Slice 5)
South El Monte/Whittier Narrows OUs
San Gabriel Valley Superfund Sites
Los Angeles County, California

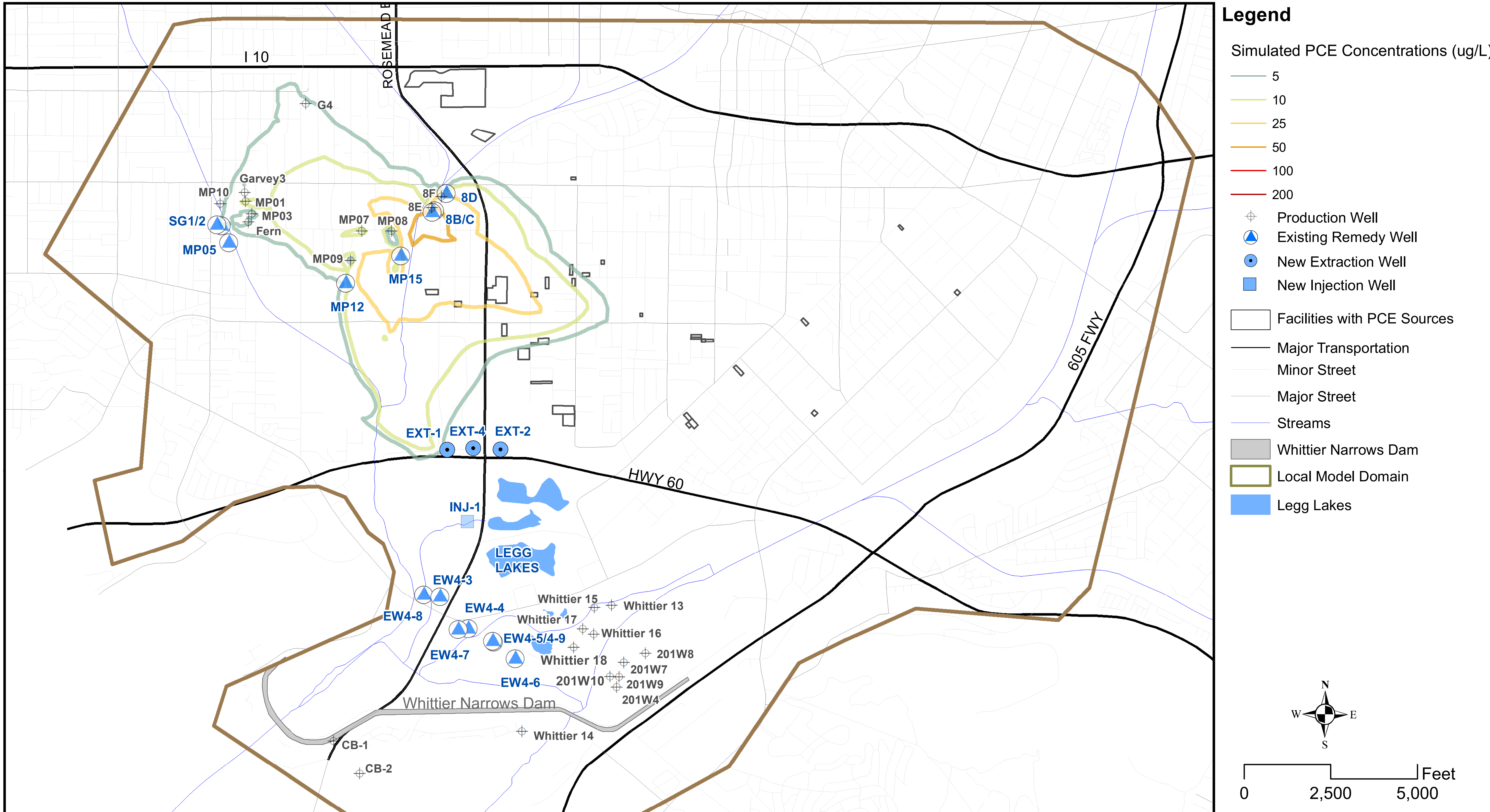

FIGURE 11c
Alternative 5
Simulated PCE Concentrations, Year 30
Middle Intermediate Zone (Slice 8)
South El Monte/Whittier Narrows OUs
San Gabriel Valley Superfund Sites
Los Angeles County, California

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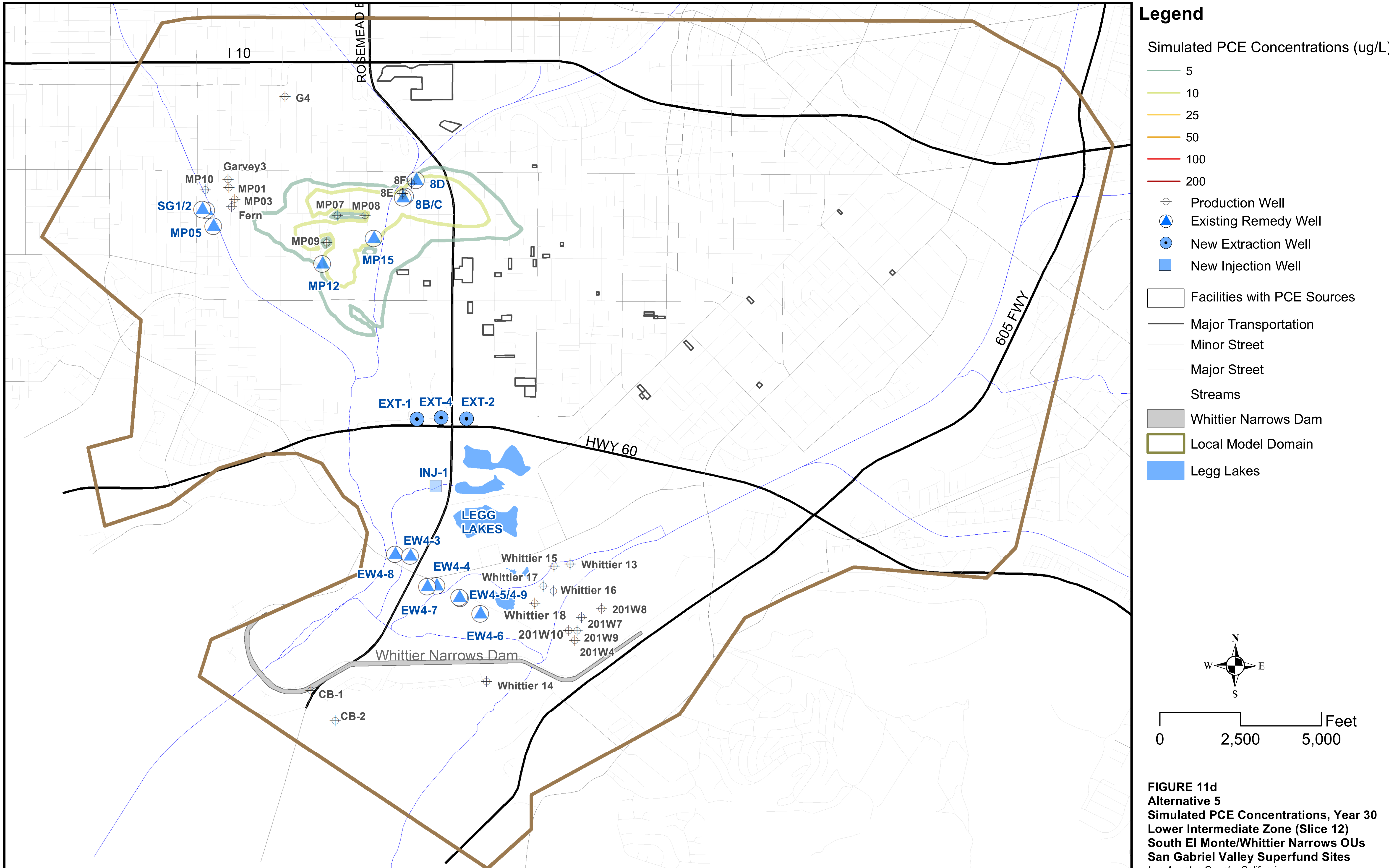

FIGURE 11d
Alternative 5
Simulated PCE Concentrations, Year 30
Lower Intermediate Zone (Slice 12)
South El Monte/Whittier Narrows OUs
San Gabriel Valley Superfund Sites
Los Angeles County, California

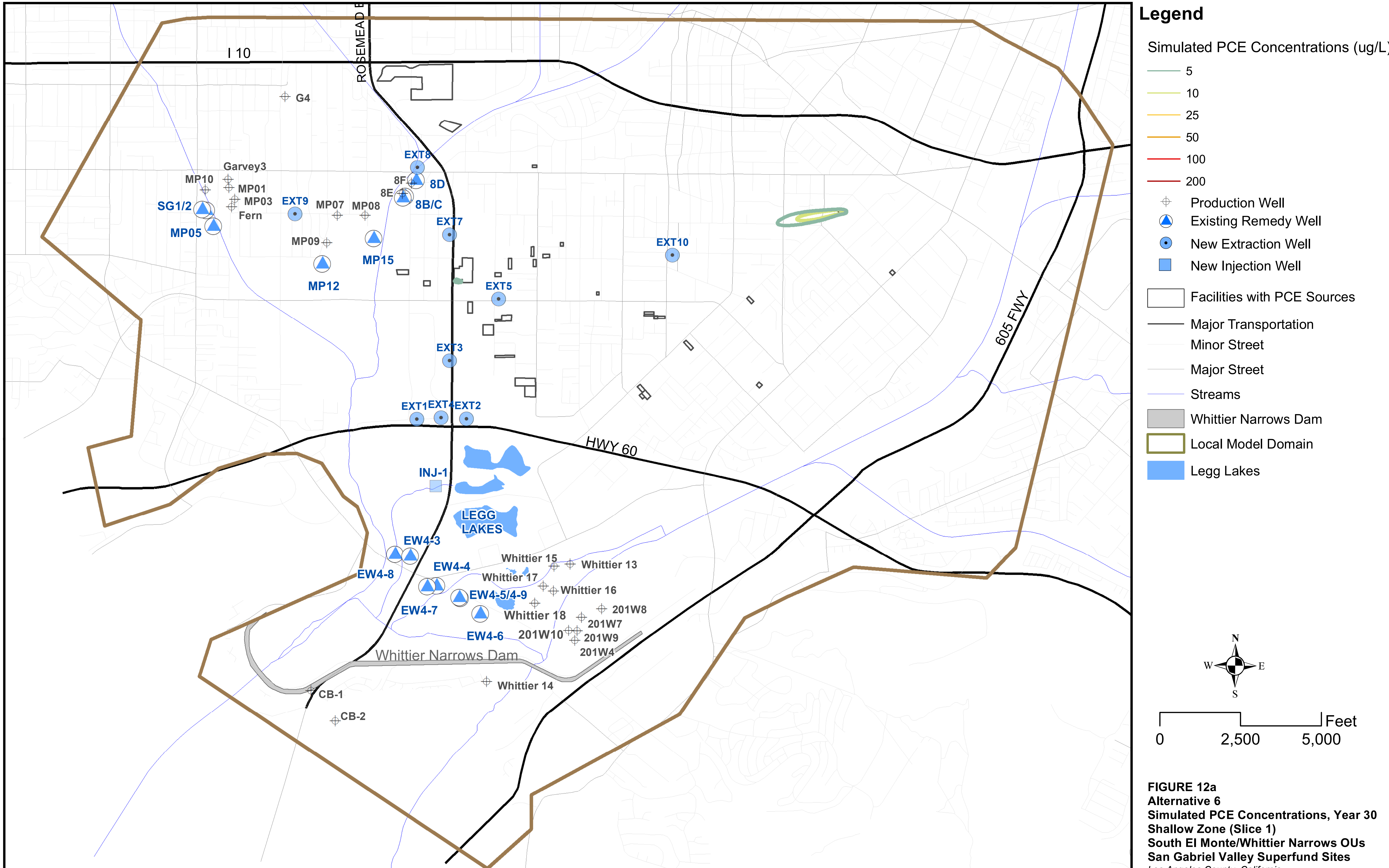

FIGURE 12a
Alternative 6
Simulated PCE Concentrations, Year 30
Shallow Zone (Slice 1)
South El Monte/Whittier Narrows OUs
San Gabriel Valley Superfund Sites
Los Angeles County, California

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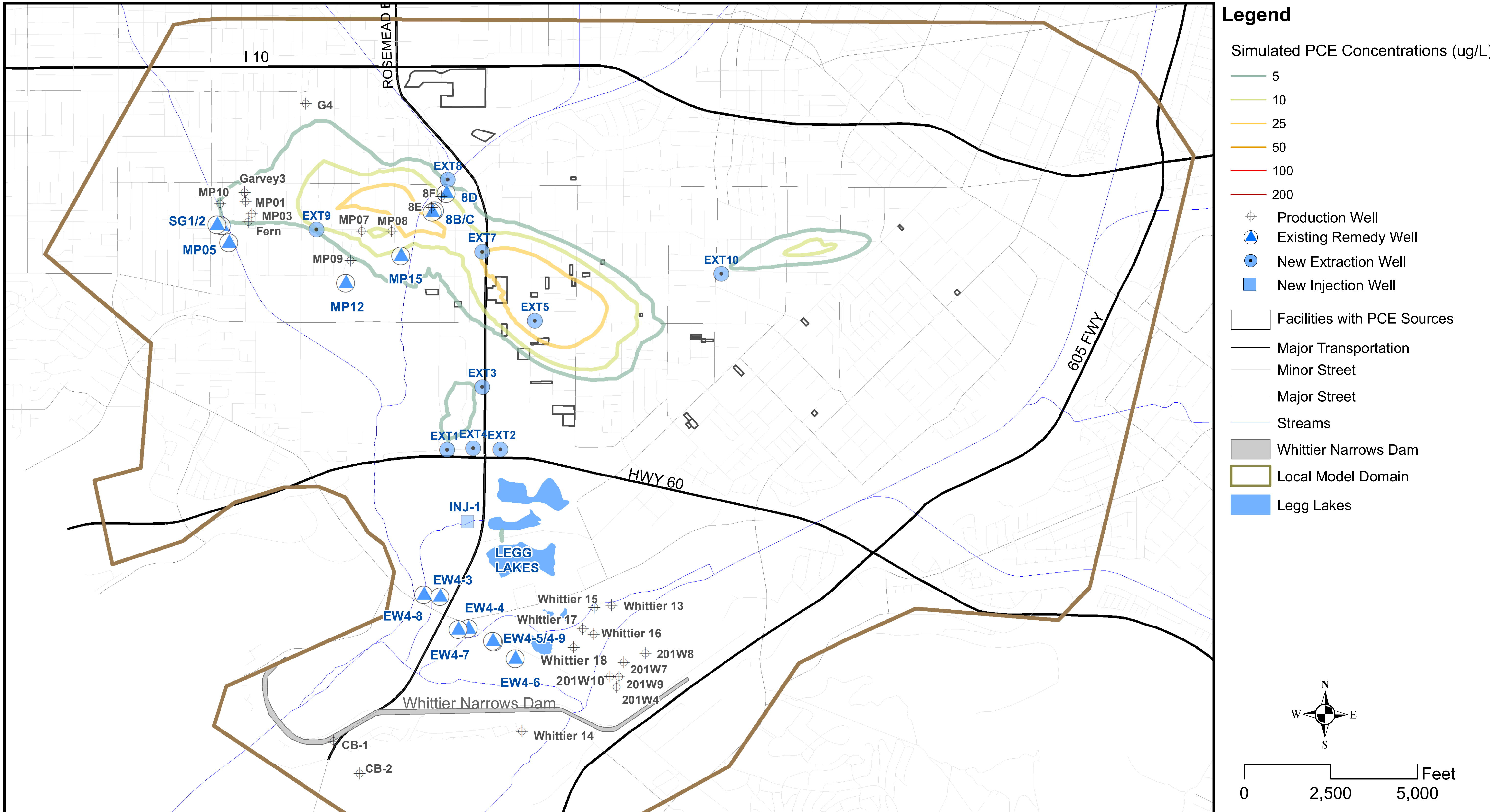

FIGURE 12b
Alternative 6
Simulated PCE Concentrations, Year 30
Upper Intermediate Zone (Slice 5)
South El Monte/Whittier Narrows OUs
San Gabriel Valley Superfund Sites
Los Angeles County, California

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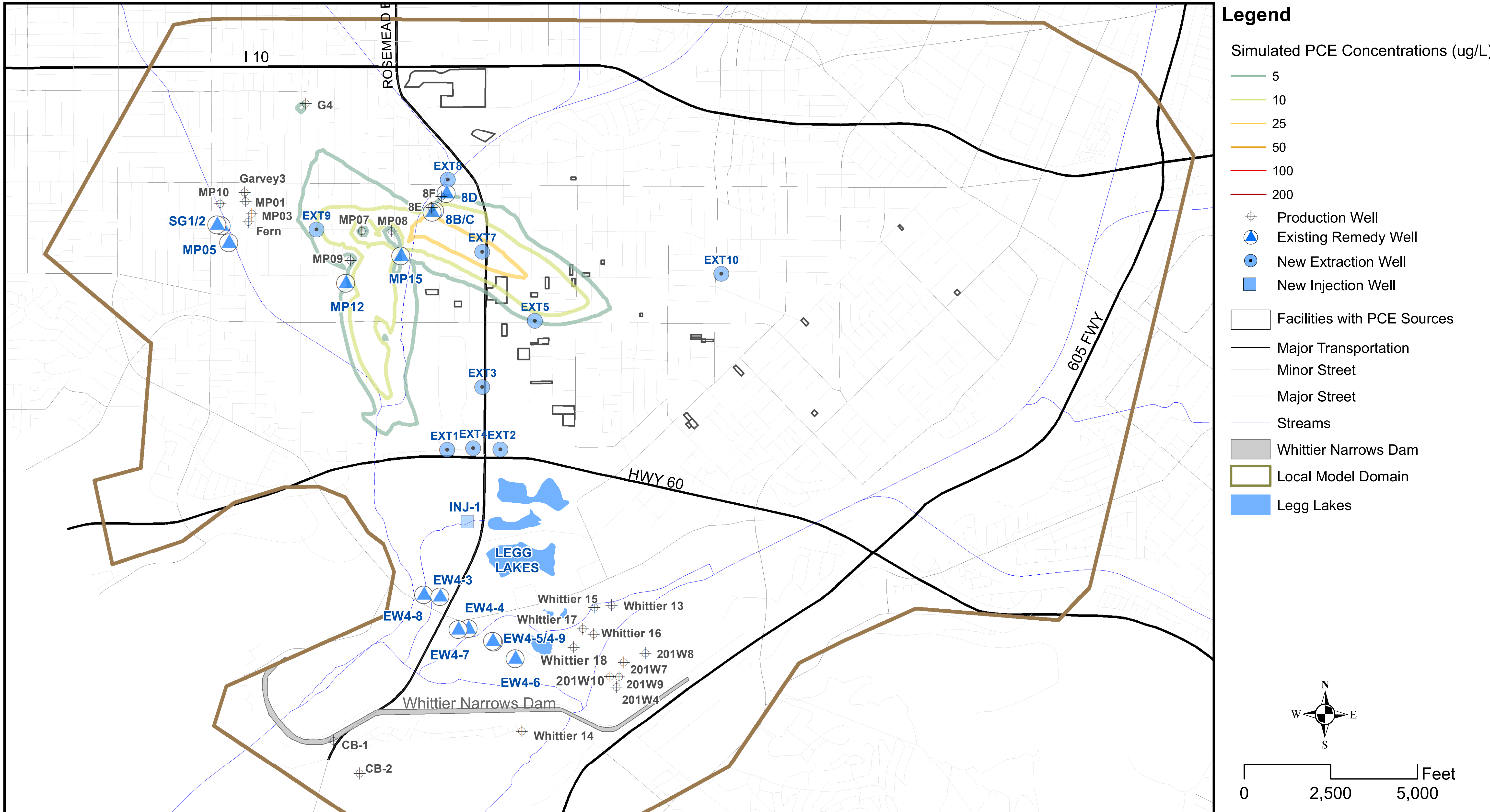

FIGURE 12c
Alternative 6
Simulated PCE Concentrations, Year 30
Middle Intermediate Zone (Slice 8)
South El Monte/Whittier Narrows OUs
San Gabriel Valley Superfund Sites
Los Angeles County, California

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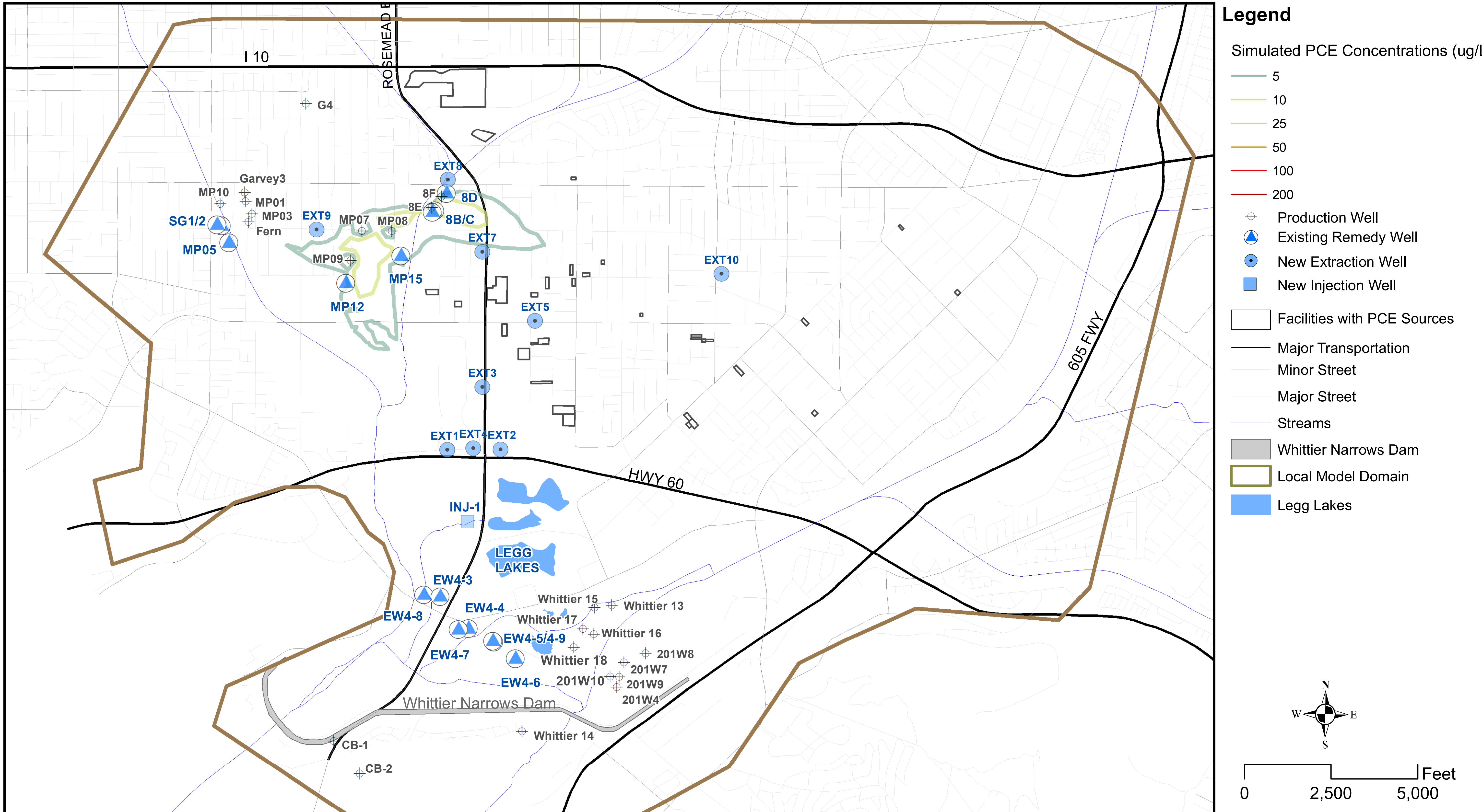

FIGURE 12d
Alternative 6
Simulated PCE Concentrations, Year 30
Lower Intermediate Zone (Slice 12)
South El Monte/Whittier Narrows OUs
San Gabriel Valley Superfund Sites
Los Angeles County, California

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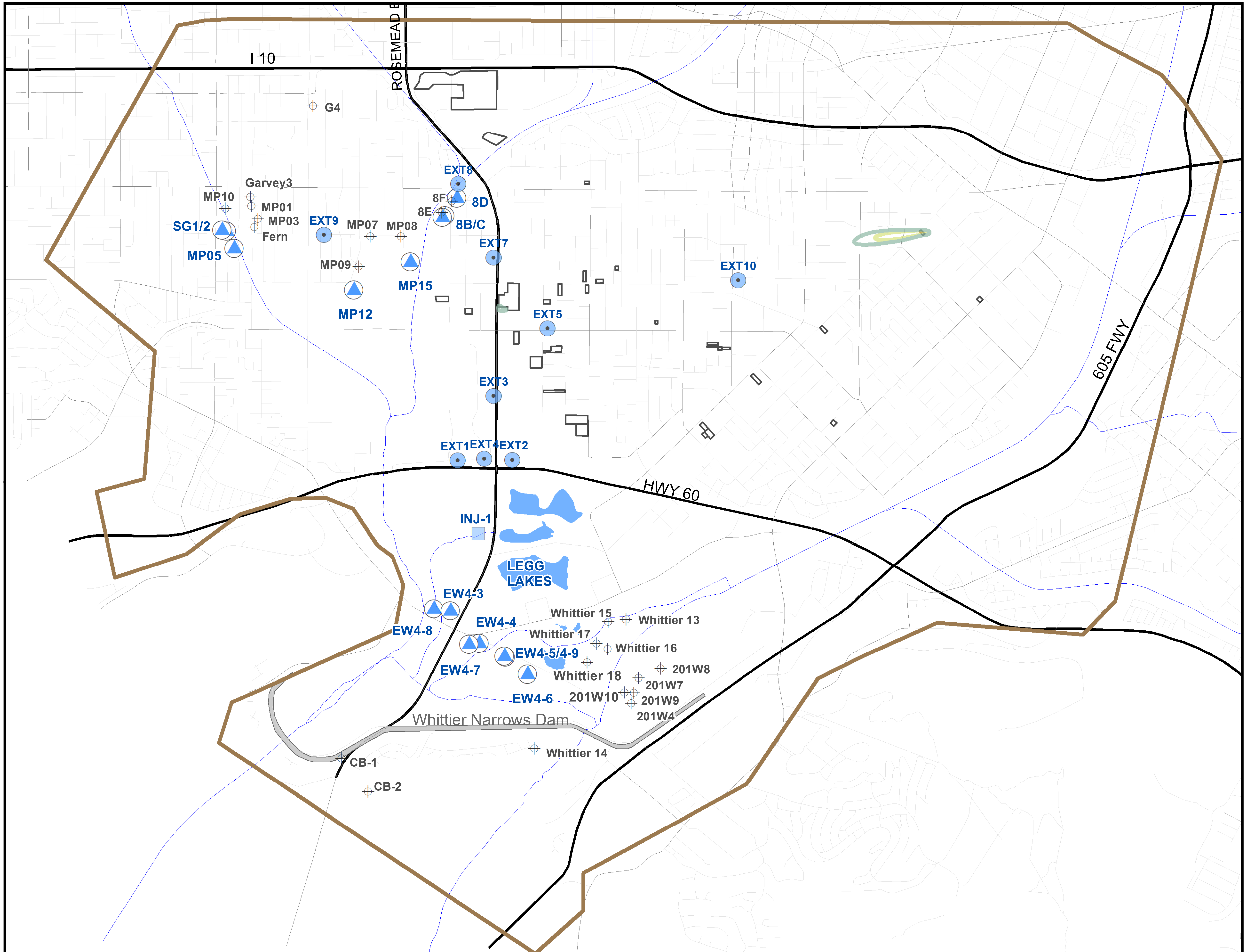


Legend

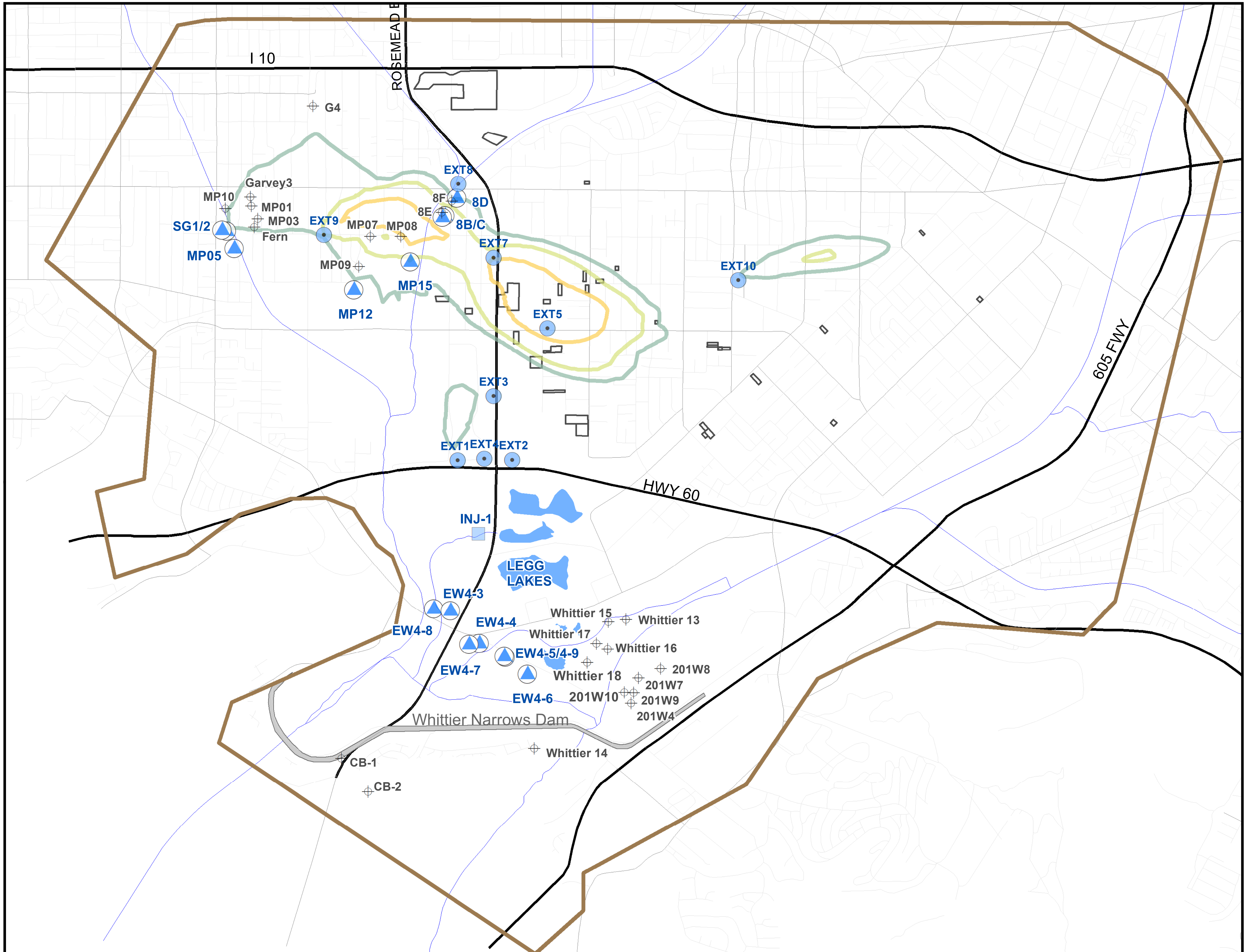
Simulated PCE Concentrations (ug/L)

- 5
- 10
- 25
- 50
- 100
- 200
- Production Well
- Existing Remedy Well
- New Extraction Well
- New Injection Well
- Facilities with PCE Sources
- Major Transportation
- Minor Street
- Major Street
- Streams
- Whittier Narrows Dam
- Local Model Domain
- Legg Lakes

N W E S

0 2,500 5,000 Feet

FIGURE 13a
Alternative 7
Simulated PCE Concentrations, Year 30
Shallow Zone (Slice 1)
South El Monte/Whittier Narrows OUs
San Gabriel Valley Superfund Sites
Los Angeles County, California



Legend

Simulated PCE Concentrations (ug/L)

- 5
- 10
- 25
- 50
- 100
- 200
- Production Well
- Existing Remedy Well
- New Extraction Well
- New Injection Well
- Facilities with PCE Sources
- Major Transportation
- Minor Street
- Major Street
- Streams
- Whittier Narrows Dam
- Local Model Domain
- Legg Lakes

N W E S

Feet
0 2,500 5,000

FIGURE 13b
Alternative 7
Simulated PCE Concentrations, Year 30
Upper Intermediate Zone (Slice 5)
South El Monte/Whittier Narrows OUs
San Gabriel Valley Superfund Sites
Los Angeles County, California

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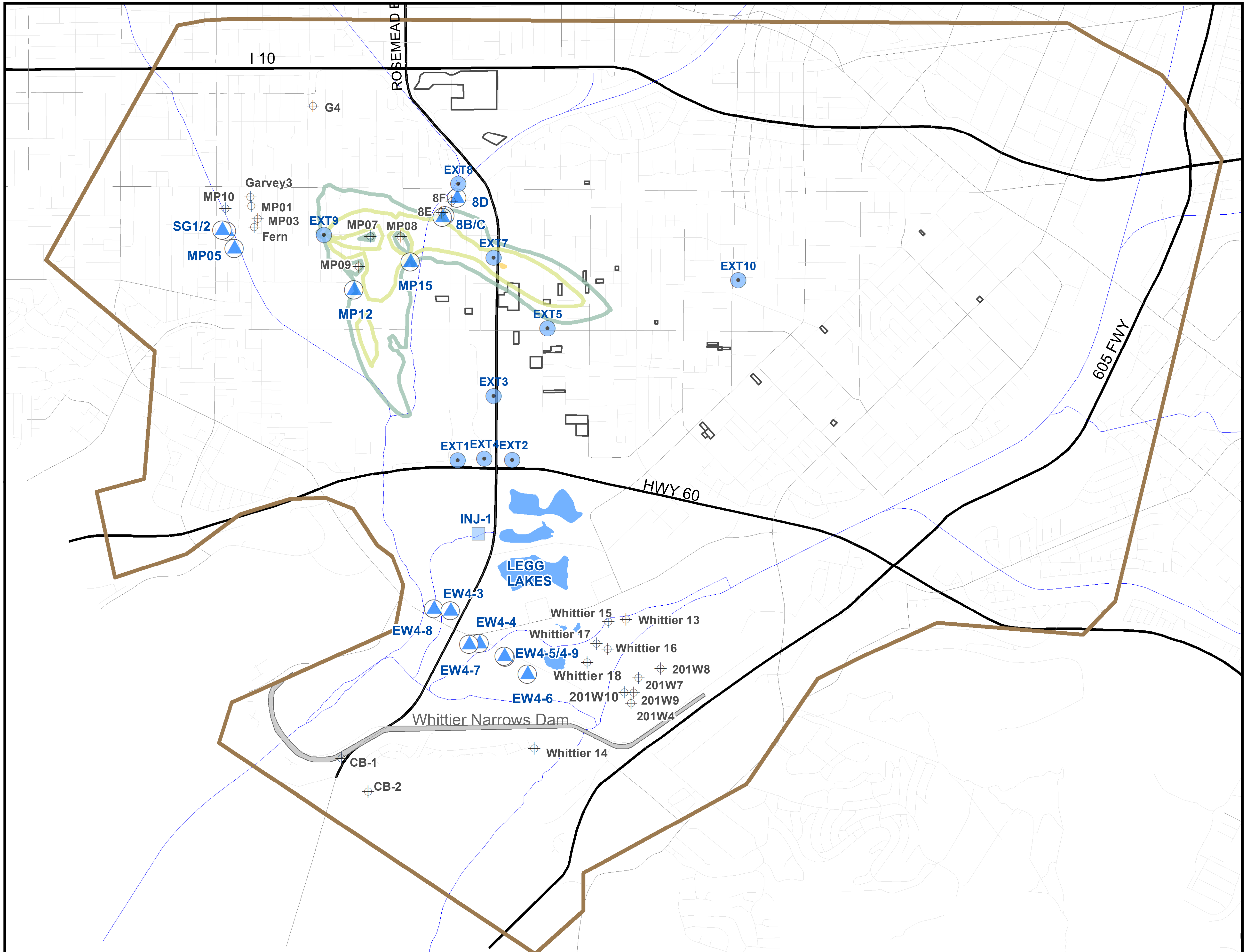

Legend

Simulated PCE Concentrations (ug/L)

- 5
- 10
- 25
- 50
- 100
- 200

- Production Well
- Existing Remedy Well
- New Extraction Well
- New Injection Well
- Facilities with PCE Sources
- Major Transportation
- Minor Street
- Major Street
- Streams
- Whittier Narrows Dam
- Local Model Domain
- Legg Lakes

N W E S

0 2,500 5,000 Feet

FIGURE 13c
Alternative 7
Simulated PCE Concentrations, Year 30
Middle Intermediate Zone (Slice 8)
South El Monte/Whittier Narrows OUs
San Gabriel Valley Superfund Sites
Los Angeles County, California

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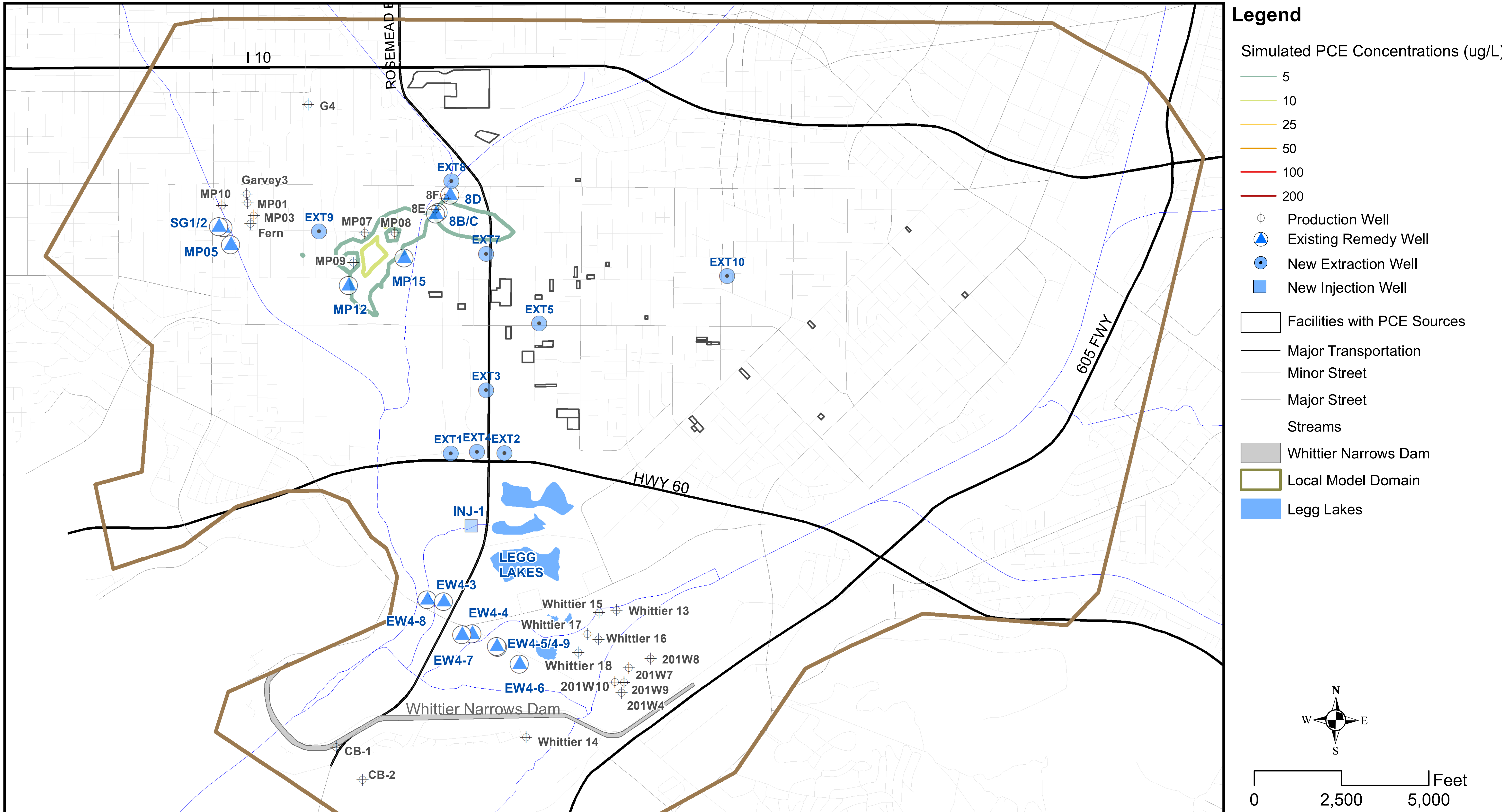

FIGURE 13d
Alternative 7
Simulated PCE Concentrations, Year 30
Lower Intermediate Zone (Slice 12)
South El Monte/Whittier Narrows OUs
San Gabriel Valley Superfund Sites
Los Angeles County, California

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Appendix B

Cost Estimate Details

INSTRUCTIONS

The detailed cost estimate is divided into three sections:

Comparative Cost Summary - Provides a brief summary of costs associated with each remedial alternative.
Remedial Alternative Cost Summaries - Breaks down the costs for each alternative into individual line items.
Cost Worksheets - Presents the development of the unit cost for each line item shown on the Remedial Alternative Cost Summaries.

COMPARATIVE COST SUMMARY

ALTERNATIVE		CONSTRUCTION TIME (YEARS) [a]	CAPITAL COSTS	O&M AND LTM TIMEFRAME (YEARS)	O&M AND LTM COSTS (PRESENT VALUE)	TOTAL COSTS (PRESENT VALUE)
1	No Action Purveyor Point-of-Use Treatment	Not Applicable	$ -	Not Applicable	$ -	**$ -**
CONTAINMENT REMEDIES						
2	No Further Action SEMOU/WNOU Interim Remedies	0.1	$ 76,600	70	$ 52,700,000	**$ 52,800,000**
3	Optimize Existing SEMOU/WNOU Interim Remedies	0.5	$ 1,850,000	70	$ 52,700,000	**$ 54,600,000**
CONTAINMENT (SEMOU ONLY) AND AQUIFER RESTORATION (WNOU ONLY) REMEDIES						
4	SEMOU/WNOU Hydraulic Control Plus Pumping to Enhance WNOU Cleanup	1.0	$ 16,700,000	70	$ 58,400,000	**$ 75,100,000**
5	SEMOU / WNOU Hydraulic Control Plus Pumping and Reinjection to Enhance WNOU Cleanup	0.9	$ 15,400,000	70	$ 58,400,000	**$ 73,800,000**
AQUIFER RESTORATION REMEDIES						
6	SEMOU/WNOU Enhanced Cleanup	1.7	$ 34,400,000	70	$ 69,000,000	**$ 103,000,000**
7	SEMOU/WNOU Enhanced and Accelerated Cleanup	2.5	$ 51,000,000	40	$ 80,100,000	**$ 131,000,000**

NOTES:
Costs are rounded to three significant figures.
(a) For Alternatives 4 and 5, EA estimated the construction time based on the conveyance piping (which is the task with the longest timeframe) under the assumption that EPA will perform other tasks concurrently. For Alternatives 6 and 7, EA estimated the construction time based on the conveyance piping and construction of the proposed SEMOU treatment plant, assuming (i) EPA will build 50% of the treatment plant at the same time as the pipelines and 50% after the pipelines are completed and (ii) assuming EPA will perform other tasks concurrent with the pipeline and treatment system construction.

REMEDIAL ALTERNATIVE COST SUMMARY
ALTERNATIVE 2 - No Further Action SEMOU/WNOU Interim Remedies

ITEM	COMPONENT DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	TOTAL	Comments
4.01	Interconnection: WNTP to Whittier	LS	1	$46,400	$46,400	Includes 50 feet of piping, valves, fittings, backflow preventer, and flowmeter
Subtotal					**$46,400**	
NA	Contingency			**20%**	$9,280	
NA	Project Management			**10%**	$4,640	
NA	Remedial Design			**20%**	$9,280	
NA	Construction Management			**15%**	$6,960	
Total					**$76,600**	Rounded to three significant figures
O&M and LTM Costs						
6.01	O&M and LTM Costs (Present Value)	LS	1	$52,700,000	$52,700,000	None
Total (Present Value)					**$52,700,000**	Rounded to three significant figures
GRAND TOTAL					**$52,800,000**	Rounded to three significant figures

REMEDIAL ALTERNATIVE COST SUMMARY
ALTERNATIVE 3 - Optimize Existing SEMOU/WNOU Interim Remedies

ITEM	COMPONENT DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	TOTAL	Comments
2.06.A3	Modify Extraction Well MP12	LS	1	$60,000	$60,000	Shorten the existing screen with packers or by sealing perforations
2.07.A3	Extraction Well - New well in the WNOU	EA	1	$1,120,000	$1,120,000	Installation of new well adjacent to existing extraction well EW4-3 Pump: 1,100 gpm at 300 ft (total dynamic head), Well: 600 ft deep and 16-inch dia.
4.01	Interconnection: WNTP to Whittier	LS	1	$46,400	$46,400	Includes 50 feet of piping, valves, fittings, backflow preventer, and flowmeter
Subtotal					**$1,226,400**	
NA	Contingency			**25%**	$307,000	
NA	Project Management			**6%**	$74,000	
NA	Remedial Design			**12%**	$148,000	
NA	Construction Management			**8%**	$99,000	
Total					**$1,850,000**	Rounded to three significant figures
O&M and LTM Costs						
6.01	O&M and LTM Costs (Present Value)	LS	1	$52,700,000	$52,700,000	None
Total (Present Value)					**$52,700,000**	Rounded to three significant figures
GRAND TOTAL					**$54,600,000**	Rounded to three significant figures

REMEDIAL ALTERNATIVE COST SUMMARY
ALTERNATIVE 4 - SEMOU/WNOU Hydraulic Control Plus Pumping to Enhance WNOU Cleanup

ITEM	COMPONENT DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	TOTAL	Comments
1.01	Field office, storage, and support equipment	MONTH	**12**	$39,100	$469,200	Includes temporary utilities, security, dust control, and traffic control equipment
2.01	Extraction Wells - Type A	EA	**1**	$577,000	$577,000	Pump: 400 gpm at 225 feet (total dynamic head), Well: 150 ft deep and 12-inch dia.
2.02	Extraction Wells - Type B	EA	**4**	$953,000	$3,812,000	Pump: 800 gpm at 240 feet (total dynamic head), Well: 500 ft deep and 12-inch dia.
2.05	Well Conversion	LS	**1**	$31,500	$31,500	Convert extraction wells EW4-3 and EW4-4 to injection wells
3.01	Conveyance Piping - 6-inch dia.	LF	**8,800**	$160	$1,408,000	Includes concrete removal, pipe install, and restoration
3.02	Conveyance Piping - 12-inch dia.	LF	**21,200**	$180	$3,816,000	Includes concrete removal, pipe install, and restoration
3.04	Pipeline - Pomona Highway Xing	LS	**1**	$691,000	$691,000	Highway crossing via jack and bore, 36-inch casing pipe
3.05	Pipeline - Rio Hondo Channel Xing	LS	**1**	$413,000	$413,000	Channel crossing via jack and bore, 24-inch casing pipe
4.01	Interconnection: WNTP to Whittier	LS	**1**	$46,400	$46,400	Includes 50 feet of piping, valves, fittings, backflow preventer, and flowmeter
5.02.A4	Expand Capacity of WNOU Plant	LS	**1**	$114,000	$114,000	Includes tank inspections and LGAC refill
Subtotal					**$11,378,100**	
NA	Contingency			**30%**	$3,414,000	
NA	Project Management			**5%**	$569,000	
NA	Remedial Design			**6%**	$683,000	
NA	Construction Management			**6%**	$683,000	
Total					**$16,700,000**	Rounded to three significant figures
O&M and LTM Costs						
6.01	O&M and LTM Costs (Present Value)	LS	**1**	$58,400,000	$58,400,000	None
Total (Present Value)					**$58,400,000**	Rounded to three significant figures
GRAND TOTAL					**$75,100,000**	Rounded to three significant figures

REMEDIAL ALTERNATIVE COST SUMMARY
ALTERNATIVE 5 - SEMOU / WNOU Hydraulic Control Plus Pumping and Reinjection to Enhance WNOU Cleanup

ITEM	COMPONENT DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	TOTAL	Comments
1.01	Field office, storage, and support equipment	MONTH	10	$39,100	$391,000	Includes temporary utilities, security, dust control, and traffic control equipment
2.01	Extraction Wells - Type A	EA	1	$577,000	$577,000	Pump: 400 gpm at 225 feet (total dynamic head), Well: 150 ft deep and 12-inch dia.
2.02	Extraction Wells - Type B	EA	4	$953,000	$3,812,000	Pump: 800 gpm at 240 feet (total dynamic head), Well: 500 ft deep and 12-inch dia.
2.04	Injection Wells	EA	1	$583,000	$583,000	Well: 150 ft deep and 16-inch dia.
2.05	Well Conversion	LS	1	$31,500	$31,500	Convert extraction wells EW4-3 and EW4-4 to injection wells
3.02	Conveyance Piping - 12-inch dia.	LF	8,800	$180	$1,584,000	Includes concrete removal, pipe install, and restoration
3.03	Conveyance Piping - 24-inch dia.	LF	7,800	$290	$2,262,000	Includes concrete removal, pipe install, and restoration
3.04	Pipeline - Pomona Highway Xing	LS	1	$691,000	$691,000	Highway crossing via jack and bore, 36-inch casing pipe
4.01	Interconnection: WNTP to Whittier	LS	1	$46,400	$46,400	Includes 50 feet of piping, valves, fittings, backflow preventer, and flowmeter
5.02.A5	Expand Capacity of WNOU Plant	LS	1	$326,000	$326,000	Includes tank inspections and LGAC refill
Subtotal					**$10,303,900**	
NA	Contingency			30%	$3,100,000	
NA	Project Management			5%	$516,000	
NA	Remedial Design			8%	$825,000	
NA	Construction Management			6%	$619,000	
Total					**$15,400,000**	Rounded to three significant figures
O&M and LTM Costs						
6.01	O&M and LTM Costs (Present Value)	LS	1	$58,400,000	$58,400,000	None
Total (Present Value)					**$58,400,000**	Rounded to three significant figures
GRAND TOTAL					**$73,800,000**	Rounded to three significant figures

REMEDIAL ALTERNATIVE COST SUMMARY
ALTERNATIVE 6 - SEMOU/WNOU Enhanced Cleanup

ITEM	COMPONENT DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	TOTAL	Comments
1.01	Field office, storage, and support equipment	MONTH	**20**	$39,100	$782,000	Includes temporary utilities, security, dust control, and traffic control equipment
2.01	Extraction Wells - Type A	EA	**8**	$577,000	$4,616,000	Pump: 400 gpm at 225 feet (total dynamic head), Well: 150 ft deep and 12-inch dia.
2.02	Extraction Wells - Type B	EA	**2**	$953,000	$1,906,000	Pump: 800 gpm at 240 feet (total dynamic head), Well: 500 ft deep and 12-inch dia.
2.03	Extraction Wells - Type C	EA	**1**	$1,060,000	$1,060,000	Pump: 1,100 gpm at 300 ft (total dynamic head), Well: 500 ft deep and 16-inch dia.
2.04	Injection Wells	EA	**1**	$583,000	$583,000	Well: 150 ft deep and 16-inch dia.
2.05	Well Conversion	LS	**1**	$31,500	$31,500	Convert extraction wells EW4-3 and EW4-4 to injection wells
2.06.A6	Upgrade Existing Extraction Wells	LS	**1**	$151,000	$151,000	Replace pumps in extraction wells MP15 and SGVWC8C with higher capacity pumps
3.01	Conveyance Piping - 6-inch dia.	LF	**18,600**	$160	$2,976,000	Includes concrete removal, pipe install, and restoration
3.02	Conveyance Piping - 12-inch dia.	LF	**17,800**	$180	$3,204,000	Includes concrete removal, pipe install, and restoration
3.03	Conveyance Piping - 24-inch dia.	LF	**1,600**	$290	$464,000	Includes concrete removal, pipe install, and restoration
3.04	Pipeline - Pomona Highway Xing	LS	**1**	$691,000	$691,000	Highway crossing via jack and bore, 36-inch casing pipe
4.01	Interconnection: WNTP to Whittier	LS	**1**	$46,400	$46,400	Includes 50 feet of piping, valves, fittings, backflow preventer, and flowmeter
5.01	Treatment Plant	LS	**1**	$5,760,000	$5,760,000	Proposed SEMOU Treatment Plant. Treatment of 1,750 gpm of groundwater with LGAC
5.02.A6	Expand Capacity of WNOU Plant	LS	**1**	$326,000	$326,000	Includes tank inspections and LGAC refill
Subtotal					**$22,596,900**	
NA	Contingency			**35%**	$7,910,000	
NA	Project Management			**5%**	$1,130,000	
NA	Remedial Design			**6%**	$1,360,000	
NA	Construction Management			**6%**	$1,360,000	
Total					**$34,400,000**	Rounded to three significant figures
O&M and LTM Costs						
6.01	O&M and LTM Costs (Present Value)	LS	**1**	$69,000,000	$69,000,000	None
Total (Present Value)					**$69,000,000**	Rounded to three significant figures
GRAND TOTAL					**$103,000,000**	Rounded to three significant figures

REMEDIAL ALTERNATIVE COST SUMMARY

ALTERNATIVE 7 - SEMOU/WNOU Enhanced and Accelerated Cleanup

ITEM	COMPONENT DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	TOTAL	Comments
1.01	Field office, storage, and support equipment	MONTH	30	$39,100	$1,173,000	Includes temporary utilities, security, dust control, and traffic control equipment
2.01	Extraction Wells - Type A	EA	8	$577,000	$4,616,000	Pump: 400 gpm at 225 feet (total dynamic head), Well: 150 ft deep and 12-inch dia.
2.02	Extraction Wells - Type B	EA	2	$953,000	$1,906,000	Pump: 800 gpm at 240 feet (total dynamic head), Well: 500 ft deep and 12-inch dia.
2.03	Extraction Wells - Type C	EA	3	$1,060,000	$3,180,000	Pump: 1,100 gpm at 300 ft (total dynamic head), Well: 500 ft deep and 16-inch dia.
2.04	Injection Wells	EA	1	$583,000	$583,000	Well: 150 ft deep and 16-inch dia.
2.05	Well Conversion	LS	1	$31,500	$31,500	Convert extraction wells EW4-3 and EW4-4 to injection wells
2.06.A7	Upgrade Existing Extraction Wells	LS	1	$599,000	$599,000	Replace pumps in extraction wells MP12, MP15, SGVWC8B, and SGVWC8D with higher capacity pumps
3.01	Conveyance Piping - 6-inch dia.	LF	14,800	$160	$2,368,000	Includes concrete removal, pipe install, and restoration
3.02	Conveyance Piping - 12-inch dia.	LF	32,400	$180	$5,832,000	Includes concrete removal, pipe install, and restoration
3.03	Conveyance Piping - 24-inch dia.	LF	10,300	$290	$2,987,000	Includes concrete removal, pipe install, and restoration
3.04	Pipeline - Pomona Highway Xing	LS	2	$691,000	$1,382,000	Highway crossing via jack and bore, 36-inch casing pipe
3.05	Pipeline - Rio Hondo Channel Xing	LS	1	$413,000	$413,000	Channel crossing via jack and bore, 24-inch casing pipe
4.01	Interconnection: WNTP to Whittier	LS	1	$46,400	$46,400	Includes 50 feet of piping, valves, fittings, backflow preventer, and flowmeter
4.02	Interconnection: WNTP to Suburban	LS	1	$1,720,000	$1,720,000	Installation of 6,800 LF of 24-inch piping, San Gabriel River Xing, and taps into distribution pipes
5.01	Treatment Plant	LS	1	$5,760,000	$5,760,000	Proposed SEMOU Treatment Plant. Treatment of 1,750 gpm of groundwater with LGAC
5.02.A7	Expand Capacity of WNOU Plant	LS	1	$885,000	$885,000	Includes tank inspections, LGAC refill, and minor plumbing to reconnect vessels
Subtotal					**$33,481,900**	
NA	Contingency			35%	$11,800,000	
NA	Project Management			5%	$1,680,000	
NA	Remedial Design			6%	$2,010,000	
NA	Construction Management			6%	$2,010,000	
Total					**$51,000,000**	Rounded to three significant figures
O&M and LTM Costs						
6.01	O&M and LTM Costs (Present Value)	LS	1	$80,100,000	$80,100,000	None
Total (Present Value)					**$80,100,000**	Rounded to three significant figures
GRAND TOTAL					**$131,000,000**	Rounded to three significant figures

Project: Appendix B Detailed Cost Estimate
Subject: Cost Worksheet - Quantity and Cost Backup Calculations

Computed by: JRL
Date: 5/11/20

Checked by: KM
Date: 5/15/20

EA Project No. 1518929

Quantity Summary					Cost Summary			
Item	**Bid Item**	**Quantity**	**Units**			**Unit Cost**	**Total**	**Comments**
1.01	**Field office, storage, and support equipment**	1	MONTH			$39,100.00	$39,100.00	**Includes temporary utilities, security, dust control, and traffic control equipment**
	Rounding	**0**	(digits past 0)		Rounding	**-2**	(digits past 0)	
	Calculated Total Quantity	**1**	**MONTH**	(LS or EA, CY, TON, SY, LF, etc.)	Calc'd Cost	$39,063.33	$39,063.33	

Quantity Calculations					Cost Calculations							
Item	**Subitem**	**Quantity**	**Units**	**Notes**	**User**	**Material**	**Labor**	**Equipment**	**Factor**	**Unit Cost**	**Subtotal Cost**	**Cost Basis**
FIELD OFFICE												
	Office Trailer	1	MONTH	50 by 12 feet, furnished, with A/C		$553.08			100%	$553.08	$553.08	[1] 01 52 13.20 0550, 01 52 13.20 0700
	Office Equipment	1	MONTH			$226.55			100%	$226.55	$226.55	[1] 01 52 13.40 0100
	Office Supplies	1	MONTH			$94.56			100%	$94.56	$94.56	[1] 01 52 13.40 0120
	Telephone Service	1	MONTH			$94.56			100%	$94.56	$94.56	[1] 01 52 13.40 0140
	Lights and HVAC	1	MONTH			$176.32			100%	$176.32	$176.32	[1] 01 52 13.40 0160
MISCELLANEOUS												
	Temporary Water Service	1	MONTH			$83.23			100%	$83.23	$83.23	[1] 01 51 13.80 0700
	Electric Generator	1	MONTH	Diesel, 50KW				$6,668.12	100%	$6,668.12	$6,668.12	[1] 01 54 33.40 2600
	Portable Toilets	1	MONTH	Three units				$777.68	100%	$777.68	$777.68	[1] 01 54 33.40 6410
	Storage Box	1	MONTH	40 by 8 feet		$136.92			100%	$136.92	$136.92	[1] 01 52 13.20 1350
	Water Trailer	1	MONTH	5,000 gal, for dust control				$2,921.63	100%	$2,921.63	$2,921.63	[1] 01 54 33.40 6900
	Traffic Control Equipment	1	MONTH	Barrels (100), barricades (10), illuminated board (2)				$4,245.86	100%	$4,245.86	$4,245.86	[1] 01 54 33.40 1620 01 54 33.40 1670 01 54 33.40 1650
	Security	1	MONTH	Uniformed guard, 7-days a week, 8 hours per day	$16,574.26				100%	$16,574.26	$16,574.26	[1] 01 57 33.50 0100
	Overhead	1	LS	Prime Contractor	$32,552.78				10%	$3,255.28	$3,255.28	[2]
	Profit	1	LS	Prime Contractor	$32,552.78				10%	$3,255.28	$3,255.28	[2]

Supporting Calculations

This sheet estimates the monthly costs to maintain a field office during construction, rent traffic control equipment, and rent a water trailer for dust control.

References:

[1] Gordian®. 2020. RSMeans Online. Labor: Standard Union. Location: Los Angeles (900-902). Release: Year 2020.

RSMeans values include the following overhead and profit markups for the Installing Contractor:

Material Cost - 10%

Labor Cost - Variable

Equipment Cost - 10%

[2] U.S. EPA, 2000. *A Guide to Developing and Documenting Cost Estimates During the Feasibility Study* . Office of Solid Waste and Emergency Response, Washington D.C.

Quantity Summary					Cost Summary			
Item	Bid Item	Quantity	Units			Unit Cost	Total	Comments
2.01	**Extraction Wells - Type A**	1	EA			$577,000.00	$577,000.00	**Pump: 400 gpm at 225 feet (total dynamic head), Well: 150 ft deep and 12-inch dia.**
	Rounding	0	(digits past 0)		Rounding	-3	(digits past 0)	
	Calculated Total Quantity	1	EA	(LS or EA, CY, TON, SY, LF, etc.)	Calc'd Cost	$576,106.88	$576,106.88	

Item	Subitem	Quantity	Units	Notes	User	Material	Labor	Equipment	Factor	Unit Cost	Subtotal Cost	Cost Basis
DRILLING AND WELL INSTALLATION												
	Mobilization/Demobilization	1	LS		$35,000.00				100%	$35,000.00	$35,000.00	Professional Estimate
	Permits: SWPPP, traffic control	1	LS		$15,000.00				100%	$15,000.00	$15,000.00	Professional Estimate
	Sound control/noise abatement	1	LS		$20,000.00				100%	$20,000.00	$20,000.00	Professional Estimate
	Drill 32-in borehole for surface casing	40	LF		$400.00				100%	$400.00	$16,000.00	Professional Estimate
	24-in Steel Surface Casing, Cement in place	40	LF		$200.00				100%	$200.00	$8,000.00	Professional Estimate
	Drill 14-in diameter (max) pilot hole	150	LF		$75.00				100%	$75.00	$11,250.00	Professional Estimate
	Geophysical logging of pilot hole	1	LS		$5,000.00				100%	$5,000.00	$5,000.00	Professional Estimate
	Ream pilot hole to 20-in. diameter	150	LF		$125.00				100%	$125.00	$18,750.00	Professional Estimate
	Caliper and deviation logs of reamed hole	1	LS		$2,500.00				100%	$2,500.00	$2,500.00	Professional Estimate
	12.75-in HSLA steel blank casing, 0.313-in wall	40	LF		$160.00				100%	$160.00	$6,400.00	Professional Estimate
	12.75-in dielectric coupling	1	LS		$7,500.00				100%	$7,500.00	$7,500.00	Professional Estimate
	12.75-in stainless steel ful flo shutter screen, 0.313-in wall, 0.060-in slot	100	LF		$390.00				100%	$390.00	$39,000.00	Professional Estimate
	12.75-in stainless steel blank casing, 0.313-in wall	5	LF		$310.00				100%	$310.00	$1,550.00	Professional Estimate
	12.75-in stainless steel sump, 0.313-in wall	5	LF		$310.00				100%	$310.00	$1,550.00	Professional Estimate
	2.875-in gravel feed line	50	LF		$12.00				100%	$12.00	$600.00	Professional Estimate
	1.9-in gauge line	50	LF		$6.00				100%	$6.00	$300.00	Professional Estimate
	Filter pack, No. 8-12 gradation silica sand	110	LF		$55.00				100%	$55.00	$6,050.00	Professional Estimate
	Bentonite/No. 20-40 silica sand mix	10	LF		$30.00				100%	$30.00	$300.00	Professional Estimate
	Neat cement with 3% bentonite/2% calcium chloride annular seal	40	LF		$35.00				100%	$35.00	$1,400.00	Professional Estimate
	Development by initial flushing, swabbing / surging, bailing	8	HR		$500.00				100%	$500.00	$4,000.00	Professional Estimate
	Development by air-lift pumping	12	HR		$500.00				100%	$500.00	$6,000.00	Professional Estimate
	Mud dispersant addition, swabbing	8	LS		$2,500.00				100%	$2,500.00	$20,000.00	Professional Estimate
	Development by interval pumping/jetting	8	HR		$500.00				100%	$500.00	$4,000.00	Professional Estimate
	Supply, install, and remove test pump, and appurtenances	1	LS		$15,000.00				100%	$15,000.00	$15,000.00	Professional Estimate
	Construction fencing, fluid management pit, mud disposal	1	LS		$50,000.00				100%	$50,000.00	$50,000.00	Professional Estimate
	Development pumping	8	HR		$500.00				100%	$500.00	$4,000.00	Professional Estimate
	Pumping tests (step and constant rate)	24	HR		$500.00				100%	$500.00	$12,000.00	Professional Estimate
	Well video and alignment inspection	1	LS		$2,000.00				100%	$2,000.00	$2,000.00	Professional Estimate

Well head completion	1	LS		$7,500.00				100%	$7,500.00	$7,500.00	Professional Estimate
Site restoration/cleanup	1	LS		$15,000.00				100%	$15,000.00	$15,000.00	Professional Estimate
Performance/Payment Bonds	1	LS		$10,000.00				100%	$10,000.00	$10,000.00	Professional Estimate
DROP PIPE AND PUMP INSTALLATION											
New Extraction Pump	1	EA	See supporting calculations		$24,291.50	$2,648.60	$733.43	100%	$27,673.53	$27,673.53	AY McDonald, 2020, [1] 33 11 13.10 3100
Drop pipe	150	LF	8-inch dia. steel pipe, schedule 40, includes delivery, taxes (8.75%) and installation		$36.34	$32.76	$13.74	100%	$82.84	$12,425.63	Metals Depot List Price, 2020, [1] 33 11 13.10 8260
WELLHEAD PIPING, VALVES, INSTRUMENTATION, AND ELECTRICAL											
Butterfly Valve (6 inch)	1	EA	Val matic Flanged Style Butterfly valve *#2006/1B08AK*	$1,069.00		$122.24	$36.81	100%	$1,228.05	$1,228.05	Grainger, [1] 33 14 19.10 3180
Check Valve (6 inch)	1	EA	Flanged check valve		$1,392.58	$255.10	$36.67	100%	$1,684.35	$1,684.35	[1] 33 14 19.10 3714
ARV	2	EA	Air/vacuum relief valve		$861.82	$80.16		100%	$941.98	$1,883.96	[1] 33 14 19.20 1120
Flow Control Valve (6 inch)	1	EA	V-control ball valve + electric actuator	$8,500.00		$255.10	$36.67	100%	$8,791.77	$8,791.77	Vendor Quote
Flow Meter (6 inch)	1	EA	Mag meter	$3,857.14		$255.10	$36.67	100%	$4,148.91	$4,148.91	Vendor Quote
Steel pipe (8 inch)	15	LF	Sch 40 carbon steel pipe		$32.06	$19.17	$10.69	100%	$61.92	$928.80	[1] 33 14 13.40 1000
Flange Face (6 inch)	12	EA	Flange face and seat, buttweld		$330.00	$83.98		100%	$413.98	$4,967.76	[1] 22 11 13.48 5840
Gasket Set (6 inch)	4	EA	Gasket and bolt set		$28.50	$114.64		100%	$143.14	$572.56	[1] 22 11 13.47 0690
Elbow 90° (6 inch)	1	EA	Carbon steel buttweld	$133.75				100%	$133.75	$133.75	Weldbend, 2019
Wellhead electrical (460V service)	1	EA	Includes cable and conduit from control panel to wellhead (~100 ft) and connection and test of all electrical components. (Assumes access to a transformer is within 100 ft)	$35,000.00				100%	$35,000.00	$35,000.00	[2]
Controls and Integration	1	EA	Includes PLC control panel, pressure transmitter, set up and testing of FCV and flowmeter, and PLC integration into existing plant system.	$35,000.00				100%	$35,000.00	$35,000.00	[2]
Overhead	1	LS	Prime Contractor	$480,089.07				10%	$48,008.91	$48,008.91	[3]
Profit	1	LS	Prime Contractor	$480,089.07				10%	$48,008.91	$48,008.91	[3]

Supporting Calculations

This sheet estimates costs to install a new extraction well that is approximately 150 feet deep, 12-inches in diameter, and that has a 400 gpm pump.
The estimate includes installation of piping, valves, instrumentation, and electrical components at the well head.

New Extraction Pump (Material Costs)

Source: AY McDonald Catalog (2020)

			Model No.
Pump End =	$	5,024	400S30HP86
Motor =	$	5,180	SM0633 30HP460V
Check Valve =	$	1,281	6200-188
Control Panel =	$	8,971	6201-210
Taxes (8.75%) =	$	1,790	Assumed
Freight (10%) =	$	2,046	Assumed
Total =	**$**	**24,292**	

References:

[1] Gordian®. 2020. RSMeans Online. Labor: Standard Union. Location: Los Angeles (900-902). Release: Year 2020.
RSMeans values include the following overhead and profit markups for the Installing Contractor:
Material Cost - 10%
Labor Cost - Variable
Equipment Cost - 10%
[2] Engineering estimate based on vendor quote from another project.
[3] U.S. EPA, 2000. *A Guide to Developing and Documenting Cost Estimates During the Feasibility Study* . Office of Solid Waste and Emergency Response, Washington D.C.

Project: Appendix B Detailed Cost Estimate
Subject: Cost Worksheet - Quantity and Cost Backup Calculations

Computed by: TC, RM, JRL Date: 5/11/20
Checked by: KM Date: 5/15/20
EA Project No. 1518929

Quantity Summary				Cost Summary			
Item	**Bid Item**	**Quantity**	**Units**		**Unit Cost**	**Total**	**Comments**
2.02	**Extraction Wells - Type B**	1	EA		$953,000.00	$953,000.00	**Pump: 800 gpm at 240 feet (total dynamic head), Well: 500 ft deep and 12-inch dia.**
	Rounding	**0**	(digits past 0)	Rounding	**-3**	(digits past 0)	
	Calculated Total Quantity	**1**	**EA** (LS or EA, CY, TON, SY, LF, etc.)	Calc'd Cost	$952,527.39	$952,527.39	

Item	Subitem	Quantity	Units	Notes	User	Material	Labor	Equipment	Factor	Unit Cost	Subtotal Cost	Cost Basis
DRILLING AND WELL INSTALLATION												
	Mobilization/Demobilization	1	LS		$75,000.00				100%	$75,000.00	$75,000.00	Professional Estimate
	Permits: SWPPP, traffic control	1	LS		$20,000.00				100%	$20,000.00	$20,000.00	Professional Estimate
	Sound control/noise abatement	1	LS		$20,000.00				100%	$20,000.00	$20,000.00	Professional Estimate
	Drill 32-in borehole for surface casing	40	LF		$400.00				100%	$400.00	$16,000.00	Professional Estimate
	24-in Steel Surface Casing, Cement in place	40	LF		$200.00				100%	$200.00	$8,000.00	Professional Estimate
	Drill 14-in diameter (max) pilot hole	500	LF		$75.00				100%	$75.00	$37,500.00	Professional Estimate
	Geophysical logging of pilot hole	1	LS		$10,000.00				100%	$10,000.00	$10,000.00	Professional Estimate
	Ream pilot hole to 20-in. diameter	500	LF		$125.00				100%	$125.00	$62,500.00	Professional Estimate
	Caliper and deviation logs of reamed hole	1	LS		$3,500.00				100%	$3,500.00	$3,500.00	Professional Estimate
	12.75-in HSLA steel blank casing, 0.313-in wall	240	LF		$160.00				100%	$160.00	$38,400.00	Professional Estimate
	12.75-in dielectric coupling	1	LS		$7,500.00				100%	$7,500.00	$7,500.00	Professional Estimate
	12.75-in stainless steel ful flo shutter screen, 0.313-in wall, 0.060-in slot	250	LF		$390.00				100%	$390.00	$97,500.00	Professional Estimate
	12.75-in stainless steel blank casing, 0.313-in wall	5	LF		$310.00				100%	$310.00	$1,550.00	Professional Estimate
	12.75-in stainless steel sump, 0.313-in wall	5	LF		$310.00				100%	$310.00	$1,550.00	Professional Estimate
	2.875-in gravel feed line	250	LF		$12.00				100%	$12.00	$3,000.00	Professional Estimate
	1.9-in gauge line	250	LF		$6.00				100%	$6.00	$1,500.00	Professional Estimate
	Filter pack, No. 8-12 gradation silica sand	260	LF		$55.00				100%	$55.00	$14,300.00	Professional Estimate
	Bentonite/No. 20-40 silica sand mix	40	LF		$30.00				100%	$30.00	$1,200.00	Professional Estimate
	Neat cement with 3% bentonite/2% calcium chloride annular seal	200	LF		$35.00				100%	$35.00	$7,000.00	Professional Estimate
	Development by initial flushing, swabbing / surging, bailing	12	HR		$500.00				100%	$500.00	$6,000.00	Professional Estimate
	Development by air-lift pumping	20	HR		$500.00				100%	$500.00	$10,000.00	Professional Estimate
	Mud dispersant addition, swabbing	1	LS		$4,500.00				100%	$4,500.00	$4,500.00	Professional Estimate
	Development by interval pumping/jetting	12	HR		$750.00				100%	$750.00	$9,000.00	Professional Estimate
	Supply, install, and remove test pump, and appurtenances	1	LS		$20,000.00				100%	$20,000.00	$20,000.00	Professional Estimate
	Construction fencing, fluid management pit, mud disposal	1	LS		$75,000.00				100%	$75,000.00	$75,000.00	Professional Estimate
	Development pumping	12	HR		$500.00				100%	$500.00	$6,000.00	Professional Estimate
	Pumping tests (step and constant rate)	24	HR		$500.00				100%	$500.00	$12,000.00	Professional Estimate
	Well video and alignment inspection	1	LS		$2,000.00				100%	$2,000.00	$2,000.00	Professional Estimate

Well head completion	1	LS		$7,500.00				100%	$7,500.00	$7,500.00	Professional Estimate
Site restoration/cleanup	1	LS		$20,000.00				100%	$20,000.00	$20,000.00	Professional Estimate
Performance/Payment Bonds	1	LS		$15,000.00				100%	$15,000.00	$15,000.00	Professional Estimate
DROP PIPE AND PUMP INSTALLATION											
New Extraction Pump	1	EA	See supporting calculations		$33,805.75	$2,648.60	$733.43	100%	$37,187.78	$37,187.78	AY McDonald, 2020, [1] 33 11 13.10 3100
Drop Pipe	500	LF	10-inch dia. steel pipe, schedule 40, includes delivery, taxes (8.75%) and installation		$51.99	$32.76	$13.74	100%	$98.49	$49,245.13	Metals Depot List Price, 2020, [1] 33 11 13.10 8260
WELLHEAD PIPING, VALVES, INSTRUMENTATION, AND ELECTRICAL											
Butterfly Valve (6 inch)	1	EA	Val matic Flanged Style Butterfly valve *#2006/1B08AK*	$1,069.00		$122.24	$36.81	100%	$1,228.05	$1,228.05	Grainger, [1]33 14 19.10 3340
Check Valve (6 inch)	1	EA	Flanged check valve		$1,392.58	$255.10	$36.67	100%	$1,684.35	$1,684.35	[1] 33 14 19.10 3720
ARV	2	EA	Air/vacuum relief valve		$861.82	$80.16		100%	$941.98	$1,883.96	[1] 331419201120
Flow Control Valve (6 inch)	1	EA	V-control ball valve + electric actuator	$8,500.00		$255.10	$36.67	100%	$8,791.77	$8,791.77	Vendor Quote
Flow Meter (6 inch)	1	EA	Mag meter	$3,857.14		$255.10	$36.67	100%	$4,148.91	$4,148.91	Vendor Quote
Steel pipe (8 inch)	15	LF	Sch 40 carbon steel pipe		$32.06	$19.17	$10.69	100%	$61.92	$928.80	[1] 33 14 13.40 1000
Flange Face (6 inch)	12	EA	Flange face and seat, buttweld		$330.00	$83.98		100%	$413.98	$4,967.76	[1] 22 11 13.48 5840
Gasket Set (6 inch)	4	EA	Gasket and bolt set		$28.50	$114.64		100%	$143.14	$572.56	[1] 22 11 13.47 0690
Elbow 90° (6 inch)	1	EA	Carbon steel buttweld	$133.75				100%	$133.75	$133.75	Online price
Wellhead electrical (460V service)	1	EA	Includes cable and conduit from control panel to wellhead (~100 ft) and connection and test of all electrical components. (Assumes access to a transformer is within 100 ft)	$35,000.00				100%	$35,000.00	$35,000.00	[2]
Controls and Integration	1	EA	Includes PLC control panel, pressure transmitter, installation and set up of FCV and flowmeter, and PLC integration into existing plant system.	$35,000.00				100%	$35,000.00	$35,000.00	[2]
Overhead	1	LS	Prime Contractor	$793,772.82				10%	$79,377.28	$79,377.28	[3]
Profit	1	LS	Prime Contractor	$793,772.82				10%	$79,377.28	$79,377.28	[3]

Supporting Calculations

This sheet estimates costs to install a new extraction well that is approximately 500 feet deep, 12-inches in diameter, and that has an 800 gpm pump.
The estimate includes installation of piping, valves, instrumentation, and electrical components at the well head.

New Extraction Pump (Material Costs)

Source: AY McDonald Catalog (2020)			*Model No.*
Pump End =	$	4,995	800S60HP106
Motor =	$	8,960	SM0633 60HP460V
Check Valve =	$	1,281	6200-188
Control Panel =	$	13,232	6201-213
Taxes (8.75%) =	$	2,491	Assumed
Freight (10%) =	$	2,847	Assumed
Total =	**$**	**33,806**	

References:

[1] Gordian®. 2020. RSMeans Online. Labor: Standard Union. Location: Los Angeles (900-902). Release: Year 2020.
RSMeans values include the following overhead and profit markups for the Installing Contractor:
Material Cost - 10%
Labor Cost - Variable
Equipment Cost - 10%
[2] Engineering estimate based on vendor quote from another project.
[3] U.S. EPA, 2000. *A Guide to Developing and Documenting Cost Estimates During the Feasibility Study* . Office of Solid Waste and Emergency Response, Washington D.C.

Quantity Summary					Cost Summary		
Item	**Bid Item**	**Quantity**	**Units**		**Unit Cost**	**Total**	**Comments**
2.03	**Extraction Wells - Type C**	1	EA		$1,060,000.00	$1,060,000.00	**Pump: 1,100 gpm at 300 ft (total dynamic head), Well: 500 ft deep and 16-inch dia.**
	Rounding	0	(digits past 0)	Rounding	-4	(digits past 0)	
	Calculated Total Quantity	1	EA	(LS or EA, CY, TON, SY, LF, etc.) Calc'd Cost	$1,056,013.90	$1,056,013.90	

Quantity Calculations / **Cost Calculations**

Item	Subitem	Quantity	Units	Notes	User	Material	Labor	Equipment	Factor	Unit Cost	Subtotal Cost	Cost Basis
DRILLING AND WELL INSTALLATION												
	Mobilization/Demobilization	1	LS		$75,000.00				100%	$75,000.00	$75,000.00	Professional Estimate
	Permits: SWPPP, traffic control	1	LS		$20,000.00				100%	$20,000.00	$20,000.00	Professional Estimate
	Sound control/noise abatement	1	LS		$20,000.00				100%	$20,000.00	$20,000.00	Professional Estimate
	Drill 36-in borehole for surface casing	40	LF		$400.00				100%	$400.00	$16,000.00	Professional Estimate
	26-in Steel Surface Casing, Cement in place	40	LF		$250.00				100%	$250.00	$10,000.00	Professional Estimate
	Drill 14-in diameter (max) pilot hole	500	LF		$75.00				100%	$75.00	$37,500.00	Professional Estimate
	Geophysical logging of pilot hole	1	LS		$10,000.00				100%	$10,000.00	$10,000.00	Professional Estimate
	Ream pilot hole to 24-in. diameter	500	LF		$150.00				100%	$150.00	$75,000.00	Professional Estimate
	Caliper and deviation logs of reamed hole	1	LS		$3,500.00				100%	$3,500.00	$3,500.00	Professional Estimate
	16.625-in HSLA steel blank casing, 0.375-in wall	240	LF		$200.00				100%	$200.00	$48,000.00	Professional Estimate
	16.625-in dielectric coupling	1	LS		$9,500.00				100%	$9,500.00	$9,500.00	Professional Estimate
	16.625-in stainless steel ful flo shutter screen, 0.375-in wall, 0.060-in slot	250	LF		$450.00				100%	$450.00	$112,500.00	Professional Estimate
	16.625-in stainless steel blank casing, 0.375-in wall	5	LF		$350.00				100%	$350.00	$1,750.00	Professional Estimate
	16.625-in stainless steel sump, 0.375-in wall	5	LF		$350.00				100%	$350.00	$1,750.00	Professional Estimate
	2.875-in gravel feed line	250	LF		$12.00				100%	$12.00	$3,000.00	Professional Estimate
	1.9-in gauge line	250	LF		$6.00				100%	$6.00	$1,500.00	Professional Estimate
	Filter pack, No. 8-12 gradation silica sand	260	LF		$55.00				100%	$55.00	$14,300.00	Professional Estimate
	Bentonite/No. 20-40 silica sand mix	40	LF		$30.00				100%	$30.00	$1,200.00	Professional Estimate
	Neat cement with 3% bentonite/2% calcium chloride annular seal	200	LF		$35.00				100%	$35.00	$7,000.00	Professional Estimate
	Development by initial flushing, swabbing / surging, bailing	12	HR		$500.00				100%	$500.00	$6,000.00	Professional Estimate
	Development by air-lift pumping	20	HR		$750.00				100%	$750.00	$15,000.00	Professional Estimate
	Mud dispersant addition, swabbing	1	LS		$4,500.00				100%	$4,500.00	$4,500.00	Professional Estimate
	Development by interval pumping/jetting	12	HR		$750.00				100%	$750.00	$9,000.00	Professional Estimate
	Supply, install, and remove test pump, and appurtenances	1	LS		$20,000.00				100%	$20,000.00	$20,000.00	Professional Estimate
	Construction fencing, fluid management pit, mud disposal	1	LS		$75,000.00				100%	$75,000.00	$75,000.00	Professional Estimate
	Development pumping	12	HR		$750.00				100%	$750.00	$9,000.00	Professional Estimate
	Pumping tests (step and constant rate)	24	HR		$750.00				100%	$750.00	$18,000.00	Professional Estimate
	Well video and alignment inspection	1	LS		$2,000.00				100%	$2,000.00	$2,000.00	Professional Estimate

Well head completion	1	LS		$7,500.00				100%	$7,500.00	$7,500.00	Professional Estimate
Site restoration/cleanup	1	LS		$20,000.00				100%	$20,000.00	$20,000.00	Professional Estimate
Performance/Payment Bonds	1	LS		$15,000.00				100%	$15,000.00	$15,000.00	Professional Estimate
DROP PIPE AND PUMP INSTALLATION											
New Extraction Pump	1	EA	See supporting calculations		$50,944.94	$2,648.60	$733.43	100%	$54,326.97	$54,326.97	AY McDonald, 2020, [1] 33 11 13.10 3100
Drop Pipe	500	LF	10-inch dia. steel pipe, schedule 40, includes delivery, taxes (8.75%) and installation		$51.99	$32.76	$13.74	100%	$98.49	$49,245.13	Metals Depot List Price, 2020, [1] 33 11 13.10 8260
WELLHEAD PIPING, VALVES, INSTRUMENTATION, AND ELECTRICAL											
Butterfly Valve (10 inch)	1	EA	Val matic Flanged Style Butterfly valve *#2010/1C12K*	$1,811.00		$255.10	$36.67	100%	$2,102.77	$2,102.77	Grainger, [1] 33 14 19.10 3340
Check Valve (10 inch)	1	EA	Flanged check valve		$5,005.39	$255.10	$36.67	100%	$5,297.16	$5,297.16	[1] 33 14 19.10 3720 (mid point between 8" and 12" material price)
ARV	2	EA	Air/vacuum relief valve		$861.82	$80.16		100%	$941.98	$1,883.96	[1] 33 14 19.20 1120
Flow Control Valve (10 inch)	1	EA	V-control ball valve + electric actuator	$12,000.00		$255.10		100%	$12,255.10	$12,255.10	[2]
Flow Meter (10 inch)	1	EA	Mag meter	$5,317.82				100%	$5,317.82	$5,317.82	Vendor Quote
Steel pipe (10 inch)	15	LF	Sch 40 carbon steel pipe		$40.99	$19.52	$10.90	100%	$71.41	$1,071.15	[1] 33 14 13.40 1020
Flange Face (10 inch)	12	EA	Flange face and seat, buttweld		$585.00	$137.30		100%	$722.30	$8,667.60	[1] 22 11 13.48 5860
Gasket Set (10 inch)	4	EA	Gasket and bolt set		$57.00	$153.30		100%	$210.30	$841.20	[1] 22 11 13.47 0710
Elbow 90° (10 inch)	1	EA	Carbon steel buttweld	$502.72				100%	$502.72	$502.72	
Wellhead electrical (460V service)	1	EA	Includes cable and conduit from control panel to wellhead (~100 ft) and connection and test of all electrical components. (Assumes access to a transformer is within 100 ft)	$35,000.00				100%	$35,000.00	$35,000.00	[2]
Controls and Integration	1	EA	Includes PLC control panel, pressure transmitter, installation and set up of FCV and flowmeter, and PLC integration into existing plant system.	$35,000.00				100%	$35,000.00	$35,000.00	[2]
Overhead	1	LS	Prime Contractor	$880,011.58				10%	$88,001.16	$88,001.16	[3]
Profit	1	LS	Prime Contractor	$880,011.58				10%	$88,001.16	$88,001.16	[3]

Supporting Calculations

This sheet estimates costs to install a new extraction well that is approximately 500 feet deep, 16-inches in diameter, and that has a 1,100 gpm pump.
The estimate includes installation of piping, valves, instrumentation, and electrical components at the well head.

New Extraction Pump (Material Costs)

Source: AY McDonald Catalog (2020)

			Model No.
Pump End =	$	6,403	1100S100HP108H
Motor =	$	21,400	SM0833 100HP460V
Check Valve =	$	1,281	6200-188
Control Panel =	$	13,817	6201-215
Taxes (8.75%) =	$	3,754	Assumed
Freight (10%) =	$	4,290	Assumed
Total =	**$**	**50,945**	

References:

[1] Gordian®. 2020. RSMeans Online. Labor: Standard Union. Location: Los Angeles (900-902). Release: Year 2020.
RSMeans values include the following overhead and profit markups for the Installing Contractor:
Material Cost - 10%
Labor Cost - Variable
Equipment Cost - 10%
[2] Engineering estimate based on vendor quote from another project.
[3] U.S. EPA, 2000. *A Guide to Developing and Documenting Cost Estimates During the Feasibility Study* . Office of Solid Waste and Emergency Response, Washington D.C.

Project: Appendix B Detailed Cost Estimate
Subject: Cost Worksheet - Quantity and Cost Backup Calculations

Computed by: TC, RM Date: 5/11/20
Checked by: KM Date: 5/15/20
EA Project No. 1518929

Quantity Summary / **Cost Summary**

Item	Bid Item	Quantity	Units		Unit Cost	Total	Comments
2.04	Injection Wells	1	EA		$583,000.00	$583,000.00	Well: 150 ft deep and 16-inch dia.
	Rounding	0	(digits past 0)	Rounding	-3	(digits past 0)	
	Calculated Total Quantity	1	EA (LS or EA, CY, TON, SY, LF, etc.)	Calc'd Cost	$582,834.05	$582,834.05	

Quantity Calculations / **Cost Calculations**

Item	Subitem	Quantity	Units	Notes	User	Material	Labor	Equipment	Factor	Unit Cost	Subtotal Cost	Cost Basis
DRILLING AND WELL INSTALLATION												
	Mobilization/Demobilization	1	LS		$35,000.00				100%	$35,000.00	$35,000.00	Professional Estimate
	Permits: SWPPP, traffic control	1	LS		$20,000.00				100%	$20,000.00	$20,000.00	Professional Estimate
	Sound control/noise abatement	1	LS		$20,000.00				100%	$20,000.00	$20,000.00	Professional Estimate
	Drill 36-in borehole for surface casing	40	LF		$400.00				100%	$400.00	$16,000.00	Professional Estimate
	26-in Steel Surface Casing, Cement in place	40	LF		$250.00				100%	$250.00	$10,000.00	Professional Estimate
	Drill 14-in diameter (max) pilot hole	150	LF		$75.00				100%	$75.00	$11,250.00	Professional Estimate
	Geophysical logging of pilot hole	1	LS		$10,000.00				100%	$10,000.00	$10,000.00	Professional Estimate
	Ream pilot hole to 24-in. diameter	150	LF		$150.00				100%	$150.00	$22,500.00	Professional Estimate
	Caliper and deviation logs of reamed hole	1	LS		$3,500.00				100%	$3,500.00	$3,500.00	Professional Estimate
	16.625-in HSLA steel blank casing, 0.375-in wall	40	LF		$200.00				100%	$200.00	$8,000.00	Professional Estimate
	16.625-in dielectric coupling	1	LS		$9,500.00				100%	$9,500.00	$9,500.00	Professional Estimate
	16.625-in stainless steel ful flo shutter screen, 0.375-in wall, 0.060-in slot	100	LF		$450.00				100%	$450.00	$45,000.00	Professional Estimate
	16.625-in stainless steel blank casing, 0.375-in wall	5	LF		$350.00				100%	$350.00	$1,750.00	Professional Estimate
	16.625-in stainless steel sump, 0.375-in wall	5	LF		$350.00				100%	$350.00	$1,750.00	Professional Estimate
	2.875-in gravel feed line	50	LF		$12.00				100%	$12.00	$600.00	Professional Estimate
	1.9-in gauge line	50	LF		$6.00				100%	$6.00	$300.00	Professional Estimate
	Filter pack, No. 8-12 gradation silica sand	110	LF		$55.00				100%	$55.00	$6,050.00	Professional Estimate
	Bentonite/No. 20-40 silica sand mix	10	LF		$30.00				100%	$30.00	$300.00	Professional Estimate
	Neat cement with 3% bentonite/2% calcium chloride annular seal	30	LF		$35.00				100%	$35.00	$1,050.00	Professional Estimate
	Development by initial flushing, swabbing / surging, bailing	8	HR		$500.00				100%	$500.00	$4,000.00	Professional Estimate
	Development by air-lift pumping	12	HR		$750.00				100%	$750.00	$9,000.00	Professional Estimate
	Mud dispersant addition, swabbing	1	LS		$4,500.00				100%	$4,500.00	$4,500.00	Professional Estimate
	Development by interval pumping/jetting	8	HR		$750.00				100%	$750.00	$6,000.00	Professional Estimate
	Supply, install, and remove test pump, and appurtenances	1	LS		$20,000.00				100%	$20,000.00	$20,000.00	Professional Estimate
	Construction fencing, fluid management pit, mud disposal	1	LS		$50,000.00				100%	$50,000.00	$50,000.00	Professional Estimate
	Development pumping	8	HR		$750.00				100%	$750.00	$6,000.00	Professional Estimate
	Pumping tests (step and constant rate)	24	HR		$750.00				100%	$750.00	$18,000.00	Professional Estimate
	Well video and alignment inspection	1	LS		$2,000.00				100%	$2,000.00	$2,000.00	Professional Estimate

Well head completion	1	LS		$7,500.00				100%	$7,500.00	$7,500.00	Professional Estimate
Site restoration/cleanup	1	LS		$20,000.00				100%	$20,000.00	$20,000.00	Professional Estimate
Performance/Payment Bonds	1	LS		$15,000.00				100%	$15,000.00	$15,000.00	Professional Estimate
WELLHEAD PIPING, VALVES, INSTRUMENTATION, AND ELECTRICAL											
Butterfly Valve (10 inch)	1	EA	Val matic Flanged Style Butterfly valve *#2010/1C12K*	$1,811.00		$255.10	$36.67	100%	$2,102.77	$2,102.77	Grainger, [1] 33 14 19.10 3340
ARV	2	EA	Air/vacuum relief valve		$861.82	$80.16		100%	$941.98	$1,883.96	[1] 33 14 19.20 1120
Flow Control Valve (10 inch)	1	EA	V-control ball valve + electric actuator	$10,000.00		$255.10		100%	$10,255.10	$10,255.10	[2]
Flow Meter (10 inch)	1	EA	Mag meter	$5,317.82				100%	$5,317.82	$5,317.82	Vendor Quote
Steel pipe (10 inch)	15	LF	Sch 40 carbon steel pipe		$40.99	$19.52	$10.90	100%	$71.41	$1,071.15	[1] 33 14 13.40 1020
Flange Face (10 inch)	12	EA	Flange face and seat, buttweld		$585.00	$137.30		100%	$722.30	$8,667.60	[1] 22 11 13.48 5860
Gasket Set (10 inch)	4	EA	Gasket and bolt set		$57.00	$153.30		100%	$210.30	$841.20	[1] 22 11 13.47 0710
Elbow 90° (10 inch)	2	EA	Carbon steel buttweld	$502.72				100%	$502.72	$1,005.44	
Wellhead electrical	1	EA	Includes cable and conduit from control panel to wellhead (~100 ft) and connection and test of all electrical components. (Assumes access to a transformer is within 100 ft)	$35,000.00				100%	$35,000.00	$35,000.00	[2]
Controls and Integration	1	EA	Includes PLC control panel, pressure transmitter, installation and set up of FCV and flowmeter, and PLC integration into existing plant system.	$35,000.00				100%	$35,000.00	$35,000.00	[2]
Overhead	1	LS	Prime Contractor	$485,695.04				10%	$48,569.50	$48,569.50	[3]
Profit	1	LS	Prime Contractor	$485,695.04				10%	$48,569.50	$48,569.50	[3]

Supporting Calculations

This sheet estimates costs to install a new injection well that is approximately 150 feet deep and 16-inches in diameter.
The estimate includes installation of piping, valves, instrumentation, and electrical components at the well head.

References:

[1] Gordian®. 2020. RSMeans Online. Labor: Standard Union. Location: Los Angeles (900-902). Release: Year 2020.

RSMeans values include the following overhead and profit markups for the Installing Contractor:
Material Cost - 10%
Labor Cost - Variable
Equipment Cost - 10%

[2] Engineering estimate based on vendor quote from another project.

[3] U.S. EPA, 2000. *A Guide to Developing and Documenting Cost Estimates During the Feasibility Study* . Office of Solid Waste and Emergency Response, Washington D.C.

Quantity Summary					Cost Summary			
Item	**Bid Item**	**Quantity**	**Units**			**Unit Cost**	**Total**	**Comments**
2.05	**Well Conversion**	1	LS			$31,500.00	$31,500.00	**Convert extraction wells EW4-3 and EW4-4 to injection wells**
	Rounding	**0**	(digits past 0)		Rounding	**-2**	(digits past 0)	
	Calculated Total Quantity	**1**	**LS**	(LS or EA, CY, TON, SY, LF, etc.)	Calc'd Cost	$31,497.88	$31,497.88	

Item	Subitem	Quantity	Units	Notes	User	Material	Labor	Equipment	Factor	Unit Cost	Subtotal Cost	Cost Basis
	Mobilization/Demobilization	1	LS	Crew of four workers, $60/HR labor rate, assuming 4-hours each way	$1,920.00				100%	$1,920.00	$1,920.00	Professional Estimate
	Labor	60	HR	Crew of four workers, $60/HR labor rate	$240.00				100%	$240.00	$14,400.00	Professional Estimate
	Per Diem	6	DAY	Crew of four workers	$247.00				100%	$247.00	$1,482.00	GSA, 2020
	Equipment	10	HR	truck-mounted hydraulic crane, 12 ton capacity				$711.29	100%	$711.29	$7,112.90	[1] 01 54 33.60 2400
	Reprogram control panels	1	LS		$1,333.33				100%	$1,333.33	$1,333.33	Vendor Invoice, 2019
	Overhead	1	LS	Prime Contractor	$26,248.23				10%	$2,624.82	$2,624.82	[2]
	Profit	1	LS	Prime Contractor	$26,248.23				10%	$2,624.82	$2,624.82	[2]

Supporting Calculations

This sheet estimates costs to convert two existing extraction wells into injection wells.
The estimate assumes the material costs (e.g., for new piping and pipe supports) are negligible.

Time Estimate - convert one extraction well to an injection well

Task	Days	Notes
Remove pump and drop pipe	1	crane, or similar equipment, will be needed
Modify piping, valves, and instrumentation at well head	1	
Modify piping, valves, and instrumentation at WNOU facility	1	
Subtotal =	3	days
Number of well conversions =	2	
Total =	**6**	**days**
Total =	**60**	**hours (assuming 10-hour workdays)**

References:

[1] Gordian®. 2020. RSMeans Online. Labor: Standard Union. Location: Los Angeles (900-902). Release: Year 2020.
RSMeans values include the following overhead and profit markups for the Installing Contractor:
Material Cost - 10%
Labor Cost - Variable
Equipment Cost - 10%

[2] U.S. EPA, 2000. *A Guide to Developing and Documenting Cost Estimates During the Feasibility Study* . Office of Solid Waste and Emergency Response, Washington D.C.

Quantity Summary | **Cost Summary**

Item	Bid Item	Quantity	Units		Unit Cost	Total	Comments
2.06.A3	**Modify Extraction Well MP12**	1	LS		$60,000.00	$60,000.00	**Shorten the existing screen with packers or by sealing perforations**
	Rounding	0	(digits past 0)	Rounding	-2	(digits past 0)	
	Calculated Total Quantity	1	LS (LS or EA, CY, TON, SY, LF, etc.)	Calc'd Cost	$60,000.00	$60,000.00	

Quantity Calculations | **Cost Calculations**

Item	Subitem	Quantity	Units	Notes	User	Material	Labor	Equipment	Factor	Unit Cost	Subtotal Cost	Cost Basis
	Modify screen interval	1	LS	Pull existing pump, video log, seal perforations, reinstall pump. Includes mobilization and planning costs.	$50,000.00				100%	$50,000.00	$50,000.00	Professional Estimate
									100%	$0.00	$0.00	
									100%	$0.00	$0.00	
	Overhead	1	LS	Prime Contractor	$50,000.00				10%	$5,000.00	$5,000.00	[1]
	Profit	1	LS	Prime Contractor	$50,000.00				10%	$5,000.00	$5,000.00	[1]

Supporting Calculations

References:

[1] U.S. EPA, 2000. *A Guide to Developing and Documenting Cost Estimates During the Feasibility Study* . Office of Solid Waste and Emergency Response, Washington D.C.

Quantity Summary					**Cost Summary**			
Item	**Bid Item**	**Quantity**	**Units**			**Unit Cost**	**Total**	**Comments**
2.06.A6	**Upgrade Existing Extraction Wells**	1	LS			$151,000.00	$151,000.00	**Replace pumps in extraction wells MP15 and SGVWC8C with higher capacity pumps**
	Rounding	**0**	(digits past 0)		Rounding	**-3**	(digits past 0)	
	Calculated Total Quantity	**1**	**LS**	(LS or EA, CY, TON, SY, LF, etc.)	Calc'd Cost	$150,852.35	$150,852.35	

Quantity Calculations					**Cost Calculations**							
Item	**Subitem**	**Quantity**	**Units**	**Notes**	**User**	**Material**	**Labor**	**Equipment**	**Factor**	**Unit Cost**	**Subtotal Cost**	**Cost Basis**
	Mobilization/Demobilization	1	LS	Crew of four workers, $60/HR labor rate, assuming 4-hours each way	$1,920.00				100%	$1,920.00	$1,920.00	Professional Estimate
	Labor	40	HR	Crew of four workers, $60/HR labor rate	$240.00				100%	$240.00	$9,600.00	Professional Estimate
	Per Diem	4	DAY	Crew of four workers	$247.00				100%	$247.00	$988.00	GSA, 2020
	Equipment	40	HR	truck-mounted hydraulic crane, 12 ton capacity				$711.29	100%	$711.29	$28,451.60	[1] 01 54 33.60 2400
	New submersible pump - MP15	1	EA	800 gpm at 240 feet TDH	$33,805.75				100%	$33,805.75	$33,805.75	AY McDonald, 2020
	New submersible pump - SGVWC8C	1	EA	1,100 gpm at 300 feet TDH	$50,944.94				100%	$50,944.94	$50,944.94	AY McDonald, 2020
									100%	$0.00	$0.00	
									100%	$0.00	$0.00	
									100%	$0.00	$0.00	
									100%	$0.00	$0.00	
									100%	$0.00	$0.00	
									100%	$0.00	$0.00	
	Overhead	1	LS	Prime Contractor	$125,710.29				10%	$12,571.03	$12,571.03	[2]
	Profit	1	LS	Prime Contractor	$125,710.29				10%	$12,571.03	$12,571.03	[2]

Supporting Calculations

This sheet estimates the costs to remove pumps from several existing extraction wells and install new pumps that have a higher flow capacity.

Time Estimate - replace pump at one extraction well

Task	Days	Notes
Remove old pump and drop pipe	1	crane, or similar equipment, will be needed
Install new pump and drop pipe	1	
Subtotal =	2	days
Number of pump replacements =	2	
Total =	**4**	**days**
Total =	**40**	**hours (assuming 10-hour workdays)**

New Extraction Pump (Material Costs) - applies to MP15

Source: AY McDonald Catalog (2020)			*Model No.*
Pump End =	$	4,995	800S60HP106
Motor =	$	8,960	SM0633 60HP460V
Check Valve =	$	1,281	6200-188
Control Panel =	$	13,232	6201-213
Taxes (8.75%) =	$	2,491	Assumed
Freight (10%) =	$	2,847	Assumed
Total =	**$**	**33,806**	

New Extraction Pump (Material Costs) - applies to SGVWC8C

Source: AY McDonald Catalog (2020)			*Model No.*
Pump End =	$	6,403	1100S100HP108H
Motor =	$	21,400	SM0833 100HP460V
Check Valve =	$	1,281	6200-188
Control Panel =	$	13,817	6201-215
Taxes (8.75%) =	$	3,754	Assumed
Freight (10%) =	$	4,290	Assumed
Total =	**$**	**50,945**	

References:

[1] Gordian®. 2020. RSMeans Online. Labor: Standard Union. Location: Los Angeles (900-902). Release: Year 2020.
RSMeans values include the following overhead and profit markups for the Installing Contractor:
Material Cost - 10%
Labor Cost - Variable
Equipment Cost - 10%

[2] U.S. EPA, 2000. *A Guide to Developing and Documenting Cost Estimates During the Feasibility Study* . Office of Solid Waste and Emergency Response, Washington D.C.

Quantity Summary / Cost Summary

Item	Bid Item	Quantity	Units		Unit Cost	Total	Comments
2.06.A7	Upgrade Existing Extraction Wells	1	LS		$599,000.00	$599,000.00	Replace pumps in extraction wells MP12, MP15, SGVWC8B, and SGVWC8D with higher capacity pumps
	Rounding	0	(digits past 0)	Rounding	-3	(digits past 0)	
	Calculated Total Quantity	1	LS	(LS or EA, CY, TON, SY, LF, etc.) Calc'd Cost	$598,266.77	$598,266.77	

Quantity Calculations / Cost Calculations

Item	Subitem	Quantity	Units	Notes	User	Material	Labor	Equipment	Factor	Unit Cost	Subtotal Cost	Cost Basis
	Mobilization/Demobilization	1	LS	Crew of four workers, $60/HR labor rate, assuming 4-hours each way	$1,920.00				100%	$1,920.00	$1,920.00	Professional Estimate
	Labor	80	HR	Crew of four workers, $60/HR labor rate	$240.00				100%	$240.00	$19,200.00	Professional Estimate
	Per Diem	8	DAY	Crew of four workers	$247.00				100%	$247.00	$1,976.00	GSA, 2020
	Equipment	80	HR	truck-mounted hydraulic crane, 12 ton capacity				$711.29	100%	$711.29	$56,903.20	[1] 01 54 33.60 2400
	New Extraction Pump - MP12	1	EA	3,000 gpm at 200 feet TDH, includes discharge piping, downhole wiring, check valves, and installation		$300,000.00			100%	$300,000.00	$300,000.00	Professional Estimate
	New submersible pump - MP15	1	EA	800 gpm at 240 feet TDH	$33,805.75				100%	$33,805.75	$33,805.75	AY McDonald, 2020
	New submersible pump - SGVWC8B	1	EA	800 gpm at 240 feet TDH	$33,805.75				100%	$33,805.75	$33,805.75	AY McDonald, 2020
	New submersible pump - SGVWC8D	1	EA	1,100 gpm at 300 feet TDH	$50,944.94				100%	$50,944.94	$50,944.94	AY McDonald, 2020
	Overhead	1	LS	Prime Contractor	$498,555.64				10%	$49,855.56	$49,855.56	[2]
	Profit	1	LS	Prime Contractor	$498,555.64				10%	$49,855.56	$49,855.56	[2]

Supporting Calculations

This sheet estimates the costs to remove pumps from several existing extraction wells and install new pumps that have a higher flow capacity.

Time Estimate - replace pump at one extraction well

Task	Days	Notes
Remove old pump and drop pipe	1	crane, or similar equipment, will be needed
Install new pump and drop pipe	1	
Subtotal =	2	days
Number of pump replacements =	4	
Total =	**8**	**days**
Total =	**80**	**hours (assuming 10-hour workdays)**

New Extraction Pump (Material Costs) - applies to MP15 and SGVWC8B

Source: AY McDonald Catalog (2020)			*Model No.*
Pump End =	$	4,995	800S60HP106
Motor =	$	8,960	SM0633 60HP460V
Check Valve =	$	1,281	6200-188
Control Panel =	$	13,232	6201-213
Taxes (8.75%) =	$	2,491	Assumed
Freight (10%) =	$	2,847	Assumed
Total =	**$**	**33,806**	

New Extraction Pump (Material Costs) - applies to SGVWC8D

Source: AY McDonald Catalog (2020)			*Model No.*
Pump End =	$	6,403	1100S100HP108H
Motor =	$	21,400	SM0833 100HP460V
Check Valve =	$	1,281	6200-188
Control Panel =	$	13,817	6201-215
Taxes (8.75%) =	$	3,754	Assumed
Freight (10%) =	$	4,290	Assumed
Total =	**$**	**50,945**	

References:

[1] Gordian®. 2020. RSMeans Online. Labor: Standard Union. Location: Los Angeles (900-902). Release: Year 2020.
RSMeans values include the following overhead and profit markups for the Installing Contractor:
Material Cost - 10%
Labor Cost - Variable
Equipment Cost - 10%
[2] U.S. EPA, 2000. *A Guide to Developing and Documenting Cost Estimates During the Feasibility Study* . Office of Solid Waste and Emergency Response, Washington D.C.

Quantity Summary					Cost Summary			
Item	**Bid Item**	**Quantity**	**Units**			**Unit Cost**	**Total**	**Comments**
2.07.A3	**Extraction Well - New well in the WNOU**	1	EA			$1,120,000.00	$1,120,000.00	**Installation of new well adjacent to existing extraction well EW4-3 Pump: 1,100 gpm at 300 ft (total dynamic head), Well: 600 ft deep and 16-inch dia.**
	Rounding	0	(digits past 0)		Rounding	-4	(digits past 0)	
	Calculated Total Quantity	1	EA	(LS or EA, CY, TON, SY, LF, etc.)	Calc'd Cost	$1,116,432.73	$1,116,432.73	

Quantity Calculations / **Cost Calculations**

Item	Subitem	Quantity	Units	Notes	User	Material	Labor	Equipment	Factor	Unit Cost	Subtotal Cost	Cost Basis
DRILLING AND WELL INSTALLATION												
	Mobilization/Demobilization	1	LS		$75,000.00				100%	$75,000.00	$75,000.00	Professional Estimate
	Permits: SWPPP, traffic control	1	LS		$20,000.00				100%	$20,000.00	$20,000.00	Professional Estimate
	Sound control/noise abatement	1	LS		$20,000.00				100%	$20,000.00	$20,000.00	Professional Estimate
	Drill 36-in borehole for surface casing	40	LF		$400.00				100%	$400.00	$16,000.00	Professional Estimate
	26-in Steel Surface Casing, Cement in place	40	LF		$250.00				100%	$250.00	$10,000.00	Professional Estimate
	Drill 14-in diameter (max) pilot hole	600	LF		$75.00				100%	$75.00	$45,000.00	Professional Estimate
	Geophysical logging of pilot hole	1	LS		$10,000.00				100%	$10,000.00	$10,000.00	Professional Estimate
	Ream pilot hole to 24-in. diameter	600	LF		$150.00				100%	$150.00	$90,000.00	Professional Estimate
	Caliper and deviation logs of reamed hole	1	LS		$3,500.00				100%	$3,500.00	$3,500.00	Professional Estimate
	16.625-in HSLA steel blank casing, 0.375-in wall	340	LF		$200.00				100%	$200.00	$68,000.00	Professional Estimate
	16.625-in dielectric coupling	1	LS		$9,500.00				100%	$9,500.00	$9,500.00	Professional Estimate
	16.625-in stainless steel ful flo shutter screen, 0.375-in wall, 0.060-in slot	250	LF		$450.00				100%	$450.00	$112,500.00	Professional Estimate
	16.625-in stainless steel blank casing, 0.375-in wall	5	LF		$350.00				100%	$350.00	$1,750.00	Professional Estimate
	16.625-in stainless steel sump, 0.375-in wall	5	LF		$350.00				100%	$350.00	$1,750.00	Professional Estimate
	2.875-in gravel feed line	250	LF		$12.00				100%	$12.00	$3,000.00	Professional Estimate
	1.9-in gauge line	250	LF		$6.00				100%	$6.00	$1,500.00	Professional Estimate
	Filter pack, No. 8-12 gradation silica sand	260	LF		$55.00				100%	$55.00	$14,300.00	Professional Estimate
	Bentonite/No. 20-40 silica sand mix	40	LF		$30.00				100%	$30.00	$1,200.00	Professional Estimate
	Neat cement with 3% bentonite/2% calcium chloride annular seal	200	LF		$35.00				100%	$35.00	$7,000.00	Professional Estimate
	Development by initial flushing, swabbing / surging, bailing	12	HR		$500.00				100%	$500.00	$6,000.00	Professional Estimate
	Development by air-lift pumping	20	HR		$750.00				100%	$750.00	$15,000.00	Professional Estimate
	Mud dispersant addition, swabbing	1	LS		$4,500.00				100%	$4,500.00	$4,500.00	Professional Estimate
	Development by interval pumping/jetting	12	HR		$750.00				100%	$750.00	$9,000.00	Professional Estimate
	Supply, install, and remove test pump, and appurtenances	1	LS		$20,000.00				100%	$20,000.00	$20,000.00	Professional Estimate
	Construction fencing, fluid management pit, mud disposal	1	LS		$75,000.00				100%	$75,000.00	$75,000.00	Professional Estimate
	Development pumping	12	HR		$750.00				100%	$750.00	$9,000.00	Professional Estimate
	Pumping tests (step and constant rate)	24	HR		$750.00				100%	$750.00	$18,000.00	Professional Estimate

Well video and alignment inspection	1	LS		$2,000.00				100%	$2,000.00	$2,000.00	Professional Estimate
Well head completion	1	LS		$7,500.00				100%	$7,500.00	$7,500.00	Professional Estimate
Site restoration/cleanup	1	LS		$20,000.00				100%	$20,000.00	$20,000.00	Professional Estimate
Performance/Payment Bonds	1	LS		$15,000.00				100%	$15,000.00	$15,000.00	Professional Estimate
DROP PIPE AND PUMP INSTALLATION											
New Extraction Pump	1	EA	See supporting calculations		$50,944.94	$2,648.60	$733.43	100%	$54,326.97	$54,326.97	AY McDonald, 2020, [1] 33 11 13.10 3100
Drop Pipe	600	LF	10-inch dia. steel pipe, schedule 40, includes delivery, taxes (8.75%) and installation		$51.99	$32.76	$13.74	100%	$98.49	$59,094.16	Metals Depot List Price, 2020, [1] 33 11 13.10 8260
WELLHEAD PIPING, VALVES, INSTRUMENTATION, AND ELECTRICAL											
Butterfly Valve (10 inch)	1	EA	Val matic Flanged Style Butterfly valve *#2010/1C12K*	$1,811.00		$255.10	$36.67	100%	$2,102.77	$2,102.77	Grainger, [1] 33 14 19.10 3340
Check Valve (10 inch)	1	EA	Flanged check valve		$5,005.39	$255.10	$36.67	100%	$5,297.16	$5,297.16	[1] 33 14 19.10 3720 (mid point between 8" and 12" material price)
ARV	2	EA	Air/vacuum relief valve		$861.82	$80.16		100%	$941.98	$1,883.96	[1] 33 14 19.20 1120
Flow Control Valve (10 inch)	1	EA	V-control ball valve + electric actuator	$10,000.00		$255.10		100%	$10,255.10	$10,255.10	[2]
Flow Meter (10 inch)	1	EA	Mag meter	$5,317.82				100%	$5,317.82	$5,317.82	Vendor Quote
Steel pipe (10 inch)	15	LF	Sch 40 carbon steel pipe		$40.99	$19.52	$10.90	100%	$71.41	$1,071.15	[1] 33 14 13.40 1020
Flange Face (10 inch)	12	EA	Flange face and seat, buttweld		$585.00	$137.30		100%	$722.30	$8,667.60	[1] 22 11 13.48 5860
Gasket Set (10 inch)	4	EA	Gasket and bolt set		$57.00	$153.30		100%	$210.30	$841.20	[1] 22 11 13.47 0710
Elbow 90° (10 inch)	1	EA	Carbon steel buttweld	$502.72				100%	$502.72	$502.72	
Wellhead electrical (460V service)	1	EA	Includes cable and conduit from control panel to wellhead (~100 ft) and connection and test of all electrical components. (Assumes access to a transformer is within 100 ft)	$35,000.00				100%	$35,000.00	$35,000.00	[2]
Controls and Integration	1	EA	Includes PLC control panel, pressure transmitter, installation and set up of FCV and flowmeter, and PLC integration into existing plant system.	$35,000.00				100%	$35,000.00	$35,000.00	[2]
Overhead	1	LS	Prime Contractor	$930,360.61				10%	$93,036.06	$93,036.06	[3]
Profit	1	LS	Prime Contractor	$930,360.61				10%	$93,036.06	$93,036.06	[3]

Supporting Calculations

This sheet estimates costs to install a new extraction well in the intermediate aquifer in the WNOU. The new well will be located in the vicinity of existing extraction well EW4-3.

New Extraction Pump (Material Costs)

Source: AY McDonald Catalog (2020)			*Model No.*
Pump End =	$	6,403	1100S100HP108H
Motor =	$	21,400	SM0833 100HP460V
Check Valve =	$	1,281	6200-188
Control Panel =	$	13,817	6201-215
Taxes (8.75%) =	$	3,754	Assumed
Freight (10%) =	$	4,290	Assumed
Total =	**$**	**50,945**	

References:

[1] Gordian®. 2020. RSMeans Online. Labor: Standard Union. Location: Los Angeles (900-902). Release: Year 2020.
RSMeans values include the following overhead and profit markups for the Installing Contractor:
Material Cost - 10%
Labor Cost - Variable
Equipment Cost - 10%

[2] Engineering estimate based on vendor quote from another project.

[3] U.S. EPA, 2000. *A Guide to Developing and Documenting Cost Estimates During the Feasibility Study* . Office of Solid Waste and Emergency Response, Washington D.C.

Quantity Summary					Cost Summary			
Item	**Bid Item**	**Quantity**	**Units**			**Unit Cost**	**Total**	**Comments**
3.01	**Conveyance Piping - 6-inch dia.**	1,000	LF			$160.00	$160,000.00	**Includes concrete removal, pipe install, and restoration**
	Rounding	**0**	(digits past 0)		Rounding	**-1**	(digits past 0)	
	Calculated Total Quantity	**1,000**	**LF**	(LS or EA, CY, TON, SY, LF, etc.)	Calc'd Cost	$155.53	$155,525.97	

Quantity Calculations					Cost Calculations							
Item	**Subitem**	**Quantity**	**Units**	**Notes**	**User**	**Material**	**Labor**	**Equipment**	**Factor**	**Unit Cost**	**Subtotal Cost**	**Cost Basis**
	Concrete Removal	333	SY	Remove pavement and curb, rod reinforced, up to 6 inches thick			$15.56	$7.08	100%	$22.64	$7,546.67	[1] 02 41 13.17 5300
	Excavation	667	BCY	1/2CY Excavator, 4-6 ft deep, w/ trench box			$7.04	$5.84	100%	$12.88	$8,586.67	[1] 31 23 16.13 1352
	Piping	1,000	LF	HDPE, 6-inch dia., SDR 21, includes tracer tape		$6.91	$10.70	$2.41	100%	$20.02	$20,018.30	[1] 33 14 13.35 0200, 33 05 97.10 0500
	Fittings	1	EA	HDPE, 6-inch dia., SDR 21, includes one elbow and one tee with thrust blocks		$213.35	$351.92	$79.14	100%	$644.41	$644.41	[1] 33 14 13.35 1300, 33 14 13.35 2300, 33 14 13.90 0115, 33 14 13.90 0215
	Sand	583	TON	Backfill material, excludes delivery (see hauling)	$16.28				100%	$16.28	$9,496.67	Vendor Quote, 2019
	Backfill	833	LCY	1CY F.E. Loader, 200 ft haul			$10.15	$3.43	100%	$13.58	$11,316.67	[1] 31 23 16.13 3060
	Compaction	667	ECY	Sheepsfoot (riding), 3 passes, 6-inch lifts and 3,000 gal water truck w/ 3 mile haul		$1.24	$1.32	$1.39	100%	$3.95	$2,633.33	[1] 31 23 23.23 5620, 31.23 23.23 9000
	Hauling	59	PER LOAD	Delivery of sand to site and excess soil to landfill, 20CY load	$118.40				100%	$118.40	$6,985.60	Vendor Quote, 2019
	Disposal	583	TON	Non-hazardous waste disposal - soil	$50.00				100%	$50.00	$29,166.67	Vendor Quote, 2019
	Concrete Restoration	1,000	LF	Restore curbs and gutters, 30 inches wide, 6 inches thick, wood forms		$20.62	$12.59		100%	$33.21	$33,210.00	[1] 32 16 13.13 0435
	Overhead	1	LS	Prime Contractor	$129,604.98				10%	$12,960.50	$12,960.50	[2]
	Profit	1	LS	Prime Contractor	$129,604.98				10%	$12,960.50	$12,960.50	[2]

Supporting Calculations

This sheet estimates the costs to install conveyance piping in an area covered with concrete, which is typical in a developed city like South El Monte, CA.
The pipe size, trench dimensions, and fill calculations are presented below.

<u>Pipe</u>

Diameter =	6	IN
Length =	1000	FT
Area =	28	IN^2
Volume =	7.3	CY

Trench Excavation					
Bedding Thickness =	1 FT	i.e., pipe will be surrounded by X FT of bedding material			
Depth =	6 FT	Assumed			
Width =	3 FT				
Volume =	666.7 BCY				
	833 LCY				
	600.0 CCY				
Backfill					
Bedding Volume =	388.9 BCY		Mass =	583	tons
	486.1 LCY				
	350.0 CCY				
Native Backfill Volume =	277.8 BCY		Mass =	417	tons
	347.2 LCY				
	250.0 CCY				
Native Volume (Excess) =	Same as Bedding Volumes				

References:

[1] Gordian®. 2020. RSMeans Online. Labor: Standard Union. Location: Los Angeles (900-902). Release: Year 2020.

RSMeans values include the following overhead and profit markups for the Installing Contractor:
Material Cost - 10%
Labor Cost - Variable
Equipment Cost - 10%

[2] U.S. EPA, 2000. *A Guide to Developing and Documenting Cost Estimates During the Feasibility Study* . Office of Solid Waste and Emergency Response, Washington D.C.

Project: Appendix B Detailed Cost Estimate
Subject: Cost Worksheet - Quantity and Cost Backup Calculations

Computed by: JRL Date: 5/11/20
Checked by: KM Date: 5/15/20
EA Project No. 1518929

Quantity Summary					**Cost Summary**			
Item	**Bid Item**	**Quantity**	**Units**			**Unit Cost**	**Total**	**Comments**
3.02	**Conveyance Piping - 12-inch dia.**	1,000	LF			$180.00	$180,000.00	**Includes concrete removal, pipe install, and restoration**
	Rounding	**0**	(digits past 0)		Rounding	**-1**	(digits past 0)	
	Calculated Total Quantity	**1,000**	**LF**	(LS or EA, CY, TON, SY, LF, etc.)	Calc'd Cost	$171.08	$171,076.84	

Quantity Calculations / **Cost Calculations**

Item	Subitem	Quantity	Units	Notes	User	Material	Labor	Equipment	Factor	Unit Cost	Subtotal Cost	Cost Basis
	Concrete Removal	333	SY	Remove pavement and curb, rod reinforced, up to 6 inches thick			$15.56	$7.08	100%	$22.64	$7,546.67	[1] 02 41 13.17 5300
	Excavation	667	BCY	1/2CY Excavator, 4-6 ft deep, w/ trench box			$7.04	$5.84	100%	$12.88	$8,586.67	[1] 31 23 16.13 1352
	Piping	1,000	LF	HDPE, 12-inch dia., SDR 21, includes tracer tape		$18.89	$15.65	$3.52	100%	$38.06	$38,058.30	[1] 33 14 13.35 0500, 33 05 97.10 0500
	Fittings	1	EA	HDPE, 12-inch dia., SDR 21, includes one elbow and one tee with thrust blocks		$1,029.99	$915.86	$206.55	100%	$2,152.40	$2,152.40	[1] 33 14 13.35 1600, 33 14 13.35 2600, 33 14 13.90 0130, 33 14 13.90 0230
	Sand	500	TON	Backfill material, excludes delivery (see hauling)	$16.28				100%	$16.28	$8,140.00	Vendor Quote, 2019
	Backfill	833	LCY	1CY F.E. Loader, 200 ft haul			$10.15	$3.43	100%	$13.58	$11,316.67	[1] 31 23 16.13 3060
	Compaction	667	ECY	Sheepsfoot (riding), 3 passes, 6-inch lifts and 3,000 gal water truck w/ 3 mile haul		$1.24	$1.32	$1.39	100%	$3.95	$2,633.33	[1] 31 23 23.23 5620, 31.23 23.23 9000
	Hauling	50	PER LOAD	Delivery of sand to site and excess soil to landfill, 20CY load	$118.40				100%	$118.40	$5,920.00	Vendor Quote, 2019
	Disposal	500	TON	Non-hazardous waste disposal - soil	$50.00				100%	$50.00	$25,000.00	Vendor Quote, 2019
	Concrete Restoration	1,000	LF	Restore curbs and gutters, 30 inches wide, 6 inches thick, wood forms		$20.62	$12.59	$0.00	100%	$33.21	$33,210.00	[1] 32 16 13.13 0435
	Overhead	1	LS	Prime Contractor	$142,564.03				10%	$14,256.40	$14,256.40	[2]
	Profit	1	LS	Prime Contractor	$142,564.03				10%	$14,256.40	$14,256.40	[2]

Supporting Calculations

This sheet estimates the costs to install conveyance piping in an area covered with concrete, which is typical in a developed city like South El Monte, CA.
The pipe size, trench dimensions, and fill calculations are presented below.

Pipe		
Diameter =	12	IN
Length =	1000	FT
Area =	113	IN^2
Volume =	29.1	CY

<u>Trench Excavation</u>

Bedding Thickness =	1 FT	i.e., pipe will be surrounded by X FT of bedding material			
Depth =	6 FT	Assumed			
Width =	3 FT				
Volume =	666.7 BCY				
	833 LCY				
	600.0 CCY				

<u>Backfill</u>

Bedding Volume =	333.3 BCY	Mass =	500	tons
	416.7 LCY			
	300.0 CCY			
Native Backfill Volume =	333.3 BCY	Mass =	500	tons
	416.7 LCY			
	300.0 CCY			
Native Volume (Excess) =	Same as Bedding Volumes			

References:

[1] Gordian®. 2020. RSMeans Online. Labor: Standard Union. Location: Los Angeles (900-902). Release: Year 2020.
RSMeans values include the following overhead and profit markups for the Installing Contractor:
Material Cost - 10%
Labor Cost - Variable
Equipment Cost - 10%

[2] U.S. EPA, 2000. *A Guide to Developing and Documenting Cost Estimates During the Feasibility Study* . Office of Solid Waste and Emergency Response, Washington D.C.

Project: Appendix B Detailed Cost Estimate
Subject: Cost Worksheet - Quantity and Cost Backup Calculations

Computed by: JRL Date: 5/11/20
Checked by: KM Date: 5/15/20
EA Project No. 1518929

Quantity Summary / **Cost Summary**

Item	Bid Item	Quantity	Units		Unit Cost	Total	Comments
3.03	**Conveyance Piping - 24-inch dia.**	1,000	LF		$290.00	$290,000.00	**Includes concrete removal, pipe install, and restoration**
	Rounding	0	(digits past 0)	Rounding	-1	(digits past 0)	
	Calculated Total Quantity	1,000	LF (LS or EA, CY, TON, SY, LF, etc.)	Calc'd Cost	$286.92	$286,916.82	

Quantity Calculations / **Cost Calculations**

Item	Subitem	Quantity	Units	Notes	User	Material	Labor	Equipment	Factor	Unit Cost	Subtotal Cost	Cost Basis
	Concrete Removal	444	SY	Remove pavement and curb, rod reinforced, up to 6 inches thick			$15.56	$7.08	100%	$22.64	$10,062.22	[1] 02 41 13.17 5300
	Excavation	889	BCY	1/2CY Excavator, 4-6 ft deep, w/ trench box			$7.04	$5.84	100%	$12.88	$11,448.89	[1] 31 23 16.13 1352
	Piping	1,000	LF	HDPE, 24-inch dia., SDR 21, includes tracer tape		$64.50	$40.47	$16.53	100%	$121.50	$121,498.30	[1] 33 14 13.35 0900, 33 05 97.10 0500
	Fittings	1	EA	HDPE, 24-inch dia., SDR 21, includes one elbow and one tee with thrust blocks		$3,962.28	$4,007.75	$1,522.13	100%	$9,492.16	$9,492.16	[1] 33 14 13.35 2000, 33 14 13.35 3000, 33 14 13.90 0155, 33 14 13.90 0255
	Sand	444	TON	Backfill material, excludes delivery (see hauling)	$16.28				100%	$16.28	$7,235.56	Vendor Quote, 2019
	Backfill	1,111	LCY	1CY F.E. Loader, 200 ft haul			$10.15	$3.43	100%	$13.58	$15,088.89	[1] 31 23 16.13 3060
	Compaction	889	ECY	Sheepsfoot (riding), 3 passes, 6-inch lifts and 3,000 gal water truck w/ 3 mile haul		$1.24	$1.32	$1.39	100%	$3.95	$3,511.11	[1] 31 23 23.23 5620, 31.23 23.23 9000
	Hauling	45	PER LOAD	Delivery of sand to site and excess soil to landfill, 20CY load	$118.40				100%	$118.40	$5,328.00	Vendor Quote, 2019
	Disposal	444	TON	Non-hazardous waste disposal - soil	$50.00				100%	$50.00	$22,222.22	Vendor Quote, 2019
	Concrete Restoration	1,000	LF	Restore curbs and gutters, 30 inches wide, 6 inches thick, wood forms		$20.62	$12.59		100%	$33.21	$33,210.00	[1] 32 16 13.13 0435
	Overhead	1	LS	Prime Contractor	$239,097.35				10%	$23,909.73	$23,909.73	[2]
	Profit	1	LS	Prime Contractor	$239,097.35				10%	$23,909.73	$23,909.73	[2]

Supporting Calculations

This sheet estimates the costs to install conveyance piping in an area covered with concrete, which is typical in a developed city like South El Monte, CA.
The pipe size, trench dimensions, and fill calculations are presented below.

Pipe		
Diameter =	24	IN
Length =	1000	FT
Area =	452	IN^2
Volume =	116.4	CY

Trench Excavation

Bedding Thickness =	1	FT	i.e., pipe will be surrounded by X FT of bedding material		
Depth =	6	FT	Assumed		
Width =	4	FT			
Volume =	888.9	BCY			
	1111	LCY			
	800.0	CCY			

Backfill

Bedding Volume =	296.3	BCY	Mass =	444	tons
	370.4	LCY			
	266.7	CCY			
Native Backfill Volume =	592.6	BCY	Mass =	889	tons
	740.7	LCY			
	533.3	CCY			

Native Volume (Excess) = Same as Bedding Volumes

References:

[1] Gordian®. 2020. RSMeans Online. Labor: Standard Union. Location: Los Angeles (900-902). Release: Year 2020.

RSMeans values include the following overhead and profit markups for the Installing Contractor:
Material Cost - 10%
Labor Cost - Variable
Equipment Cost - 10%

[2] U.S. EPA, 2000. *A Guide to Developing and Documenting Cost Estimates During the Feasibility Study* . Office of Solid Waste and Emergency Response, Washington D.C.

Quantity Summary				Cost Summary			
Item	**Bid Item**	**Quantity**	**Units**		**Unit Cost**	**Total**	**Comments**
3.04	**Pipeline - Pomona Highway Xing**	1	LS		$691,000.00	$691,000.00	**Highway crossing via jack and bore, 36-inch casing pipe**
	Rounding	**0**	(digits past 0)	Rounding	**-3**	(digits past 0)	
	Calculated Total Quantity	**1**	**LS** (LS or EA, CY, TON, SY, LF, etc.)	Calc'd Cost	$690,822.13	$690,822.13	

Item	Subitem	Quantity	Units	Notes	User	Material	Labor	Equipment	Factor	Unit Cost	Subtotal Cost	Cost Basis
	Jacking Pits	2	EA	Includes mobilization/demobilization	$26,622.00				100%	$26,622.00	$53,244.00	[1] 33 05 07.23 1101
	Casing	750	LF	1/2-inch thick wall, 36-inch dia. casing		$221.13	$313.40	$73.86	100%	$608.39	$456,292.50	[1] 33 05 07.23 0200
	Casing Spacers	127	EA	Stainless steel, 6 runners, 12-inch band width, 36-inch dia., center constrained, includes PVC/EPDM liner		$477.87	$36.58		100%	$514.45	$65,335.15	[1] 33 05 97.15 1270
	Casing End Seals	2	EA	Rubber, 1/8-inch thick, 36-inch dia., banding steel straps		$370.15	$36.58		100%	$406.73	$813.46	[1] 33 05 97.15 2070
	Overhead	1	LS	Prime Contractor	$575,685.11				10%	$57,568.51	$57,568.51	[2]
	Profit	1	LS	Prime Contractor	$575,685.11				10%	$57,568.51	$57,568.51	[2]

Supporting Calculations

This sheet estimates the costs to install a casing pipe via jack and bore across the Pomona Highway. Conveyance piping (costed on a separate sheet) would be routed through the casing pipe.
This estimate assumes the boring will be between 100 and 1,000 feet.

Quantities			
Length of boring =	750	LF	estimate
Number of borings =	1		each boring will have 1 casing pipe and require 2 jacking pits
Number of end seals =	2		two per casing pipe
Number of spacers =	127		[3] 1 spacer per 6 LF of casing pipe and two at each end of the pipe

Number of pipes to be routed through the casing, for use on the *RA Cost Summaries* sheet.

	Alternative 4	Alternative 5	Alternative 6	Alternative 7
# of pipes D ≤ 6"	1	0	0	0
# of pipes 6" < D ≤ 12"	1	2	2	2
# of pipes 12 < D ≤ 20" dia.	0	0	0	1

The pipes for Alternatives 4 through 6 can fit inside the 36" casing, therefore only one boring is needed.
Alternative 7 needs two borings due to the number and size of pipes that need to cross the highway.

References:
[1] Gordian®. 2020. RSMeans Online. Labor: Standard Union. Location: Los Angeles (900-902). Release: Year 2020.
RSMeans values include the following overhead and profit markups for the Installing Contractor:
Material Cost - 10%
Labor Cost - Variable
Equipment Cost - 10%
[2] U.S. EPA, 2000. *A Guide to Developing and Documenting Cost Estimates During the Feasibility Study*. Office of Solid Waste and Emergency Response, Washington D.C.
[3] CCI Pipeline Systems, LLC. *Casing Spacers and End Seals*. Brochure. www.ccipipe.com. Accessed on 11 April 2020.

Quantity Summary / **Cost Summary**

Item	Bid Item	Quantity	Units		Unit Cost	Total	Comments
3.05	**Pipeline - Rio Hondo Channel Xing**	1	LS		$413,000.00	$413,000.00	**Channel crossing via jack and bore, 24-inch casing pipe**
	Rounding	0	(digits past 0)	Rounding	-3	(digits past 0)	
	Calculated Total Quantity	1	LS (LS or EA, CY, TON, SY, LF, etc.)	Calc'd Cost	$412,371.89	$412,371.89	

Quantity Calculations / **Cost Calculations**

Item	Subitem	Quantity	Units	Notes	User	Material	Labor	Equipment	Factor	Unit Cost	Subtotal Cost	Cost Basis
	Jacking Pits	2	EA	Includes mobilization/demobilization	$26,622.00				100%	$26,622.00	$53,244.00	[1] 33 05 07.23 1101
	Casing	600	LF	1/2-inch thick wall, 24-inch dia. casing		$125.56	$250.07	$59.40	100%	$435.03	$261,018.00	[1] 33 05 07.23 0100
	Casing Spacers	102	EA	Stainless steel, 6 runners, 12-inch band width, 24-inch dia., center constrained, includes PVC/EPDM liner		$254.86	$27.85		100%	$282.71	$28,836.42	[1] 33 05 97.15 1250
	Casing End Seals	2	EA	Rubber, 1/8-inch thick, 24-inch dia., banding steel straps		$244.56	$27.85		100%	$272.41	$544.82	[1] 33 05 97.15 2050
	Overhead	1	LS	Prime Contractor	$343,643.24				10%	$34,364.32	$34,364.32	[2]
	Profit	1	LS	Prime Contractor	$343,643.24				10%	$34,364.32	$34,364.32	[2]

Supporting Calculations

This sheet estimates the costs to install a casing pipe via jack and bore across the Rio Hondo Channel. Conveyance piping (costed on a separate sheet) would be routed through the casing pipe.
This estimate assumes the boring will be between 100 and 1,000 feet.

Quantities			
Length of boring =	600	LF	estimate
Number of borings =	1		each boring will have 1 casing pipe and require 2 jacking pits
Number of end seals =	2		two per casing pipe
Number of spacers =	102		[3] 1 spacer per 6 LF of casing pipe and two at each end of the pipe

Number of pipes to be routed through the casing, for use on the *RA Cost Summaries* sheet.

	Alternative 4	Alternative 7
# of pipes D ≤ 6"	0	1
# of pipes 6" < D ≤ 12"	1	1
# of pipes 12 < D ≤ 20" dia.	0	0

The pipes for Alternatives 4 and 7 can fit inside the 24" casing, therefore only one boring is needed.

References:

[1] Gordian®. 2020. RSMeans Online. Labor: Standard Union. Location: Los Angeles (900-902). Release: Year 2020.
RSMeans values include the following overhead and profit markups for the Installing Contractor:
Material Cost - 10%
Labor Cost - Variable
Equipment Cost - 10%
[2] U.S. EPA, 2000. *A Guide to Developing and Documenting Cost Estimates During the Feasibility Study*. Office of Solid Waste and Emergency Response, Washington D.C.
[3] CCI Pipeline Systems, LLC. *Casing Spacers and End Seals*. Brochure. www.ccipipe.com. Accessed on 11 April 2020.

Quantity Summary				Cost Summary			
Item	**Bid Item**	**Quantity**	**Units**		**Unit Cost**	**Total**	**Comments**
4.01	**Interconnection: WNTP to Whittier**	1	LS		$46,400.00	$46,400.00	**Includes 50 feet of piping, valves, fittings, backflow preventer, and flowmeter**
	Rounding	**0**	(digits past 0)	Rounding	**-2**	(digits past 0)	
	Calculated Total Quantity	**1**	**LS** (LS or EA, CY, TON, SY, LF, etc.)	Calc'd Cost	$46,355.06	$46,355.06	

Item	Subitem	Quantity	Units	Notes	User	Material	Labor	Equipment	Factor	Unit Cost	Subtotal Cost	Cost Basis
	Piping	50	LF	8-inch dia. black steel, schedule 40		$93.00	$77.98		100%	$170.98	$8,549.00	[1] 22 11 13.48 1140
	Butterfly Valve	1	EA	8-inch, steel, includes couplings		$2,044.00	$297.26		100%	$2,341.26	$2,341.26	[1] 22 11 13.48 8080 22 11 13.48 5070
	Tee	1	EA	8-inch, steel, includes couplings		$1,364.00	$342.55		100%	$1,706.55	$1,706.55	[1] 22 11 13.48 4830 22 11 13.48 5070
	Backflow Preventer	1	EA	8-inch, iron		$10,500.00	$1,432.98		100%	$11,932.98	$11,932.98	[1] 22 11 19.38 2700
	Flowmeter	1	EA	8-inch, bronze, up to 1,800 gpm		$11,800.00	$2,299.43		100%	$14,099.43	$14,099.43	[1] 22 11 19.42 5250
	Overhead	1	LS	Prime Contractor	$38,629.22				10%	$3,862.92	$3,862.92	[2]
	Profit	1	LS	Prime Contractor	$38,629.22				10%	$3,862.92	$3,862.92	[2]

Supporting Calculations

This sheet estimates costs to re-activate the existing connection at the WNOU Treatment Plant that used to deliver treated water to the City of Whittier.
The estimate assumes only minor modifications are needed to re-activate the connection (e.g., new process piping, valves, fittings, and instrumentation).

References:

[1] Gordian®. 2020. RSMeans Online. Labor: Standard Union. Location: Los Angeles (900-902). Release: Year 2020.
RSMeans values include the following overhead and profit markups for the Installing Contractor:
Material Cost - 10%
Labor Cost - Variable
Equipment Cost - 10%

[2] U.S. EPA, 2000. *A Guide to Developing and Documenting Cost Estimates During the Feasibility Study* . Office of Solid Waste and Emergency Response, Washington D.C.

Quantity Summary					Cost Summary			
Item	**Bid Item**	**Quantity**	**Units**			**Unit Cost**	**Total**	**Comments**
4.02	**Interconnection: WNTP to Suburban**	1	LS			$1,720,000.00	$1,720,000.00	**Installation of 6,800 LF of 24-inch piping, San Gabriel River Xing, and taps into distribution pipes**
	Rounding	**0**	(digits past 0)		Rounding	**-4**	(digits past 0)	
	Calculated Total Quantity	**1**	**LS**	(LS or EA, CY, TON, SY, LF, etc.)	Calc'd Cost	$1,718,118.84	$1,718,118.84	

Quantity Calculations					Cost Calculations							
Item	**Subitem**	**Quantity**	**Units**	**Notes**	**User**	**Material**	**Labor**	**Equipment**	**Factor**	**Unit Cost**	**Subtotal Cost**	**Cost Basis**
CONVEYANCE PIPING												
	Concrete Removal	444	SY	Remove pavement and curb, rod reinforced, up to 6 inches thick		$0.00	$15.56	$7.08	100%	$22.64	$10,062.22	[1] 02 41 13.17 5300
	Excavation	889	BCY	1/2CY Excavator, 4-6 ft deep, w/ trench box			$7.04	$5.84	100%	$12.88	$11,448.89	[1] 31 23 16.13 1352
	Piping	6,800	LF	HDPE, 24-inch dia., SDR 21, includes tracer tape		$64.50	$40.47	$16.53	100%	$121.50	$826,188.44	[1] 33 14 13.35 0900, 33 05 97.10 0500
	Fittings	7	EA	HDPE, 24-inch dia., SDR 21, includes one elbow and one tee with thrust blocks		$3,962.28	$4,007.75	$1,522.13	100%	$9,492.16	$66,445.12	[1] 33 14 13.35 2000, 33 14 13.35 3000, 33 14 13.90 0155, 33 14 13.90 0255
	Sand	444	TON	Backfill material, excludes delivery (see hauling)	$16.28				100%	$16.28	$7,235.56	Vendor Quote, 2019
	Backfill	1,111	LCY	1CY F.E. Loader, 200 ft haul			$10.15	$3.43	100%	$13.58	$15,088.89	[1] 31 23 16.13 3060
	Compaction	889	ECY	Sheepsfoot (riding), 3 passes, 6-inch lifts and 3,000 gal water truck w/ 3 mile haul		$1.24	$1.32	$1.39	100%	$3.95	$3,511.11	[1] 31 23 23.23 5620, 31.23 23.23 9000
	Hauling	45	PER LOAD	Delivery of sand to site and excess soil to landfill, 20CY load	$118.40				100%	$118.40	$5,328.00	Vendor Quote, 2019
	Disposal	444	TON	Non-hazardous waste disposal - soil	$50.00				100%	$50.00	$22,222.22	Vendor Quote, 2019
	Concrete Restoration	1,000	LF	Restore curbs and gutters, 30 inches wide, 6 inches thick, wood forms		$20.62	$12.59		100%	$33.21	$33,210.00	[1] 32 16 13.13 0435
SAN GABRIEL RIVER CROSSING												
	Jacking Pits	2	EA	Includes mobilization/demobilization	$26,622.00				100%	$26,622.00	$53,244.00	[1] 33 05 07.23 1101
	Casing	400	LF	1/2-inch thick wall, 36-inch dia. casing		$221.13	$313.40	$73.86	100%	$608.39	$243,356.00	[1] 33 05 07.23 0200
	Casing Spacers	69	EA	Stainless steel, 6 runners, 12-inch band width, 36-inch dia., center constrained, includes PVC/EPDM liner		$477.87	$36.58		100%	$514.45	$35,497.05	[1] 33 05 97.15 1270
	Casing End Seals	2	EA	Rubber, 1/8-inch thick, 36-inch dia., banding steel straps		$370.15	$36.58		100%	$406.73	$813.46	[1] 33 05 97.15 2070
TAPS												
	Drill into main, tap, and install valve	2	EA	18-inch branch to 24-inch main			$4,879.00	$365.68	100%	$5,244.68	$10,489.36	[1] 33 14 17.15 4850 (adjusted; x4)
	Gate Valve	2	EA	20-inch dia, cast iron, includes valve box		$29,638.20	$571.54	$60.95	100%	$30,270.69	$60,541.38	[1] 33 14 19.10 3828
	Tapping Sleeve	2	EA	Includes rubber gaskets, 24-inch by 18-inch		$13,032.40	$473.96	$35.64	100%	$13,542.00	$27,084.00	[1] 33 14 17.15 8420
	Overhead	1	LS	Prime Contractor	$1,431,765.70				10%	$143,176.57	$143,176.57	[2]
	Profit	1	LS	Prime Contractor	$1,431,765.70				10%	$143,176.57	$143,176.57	[2]

Supporting Calculations

This sheet estimates the costs connect WNOU Treatment Plant to the Suburban drinking water distribution network.
The estimate includes installation of conveyance piping between, approximately, the WNOU Treatment Plant and nearby Interstate 605. Costs to cross the San Gabriel River via jack and bore and to tap into the distribution network are also included.

CONVEYANCE PIPING

Pipe						
Diameter =	24	IN				
Length =	1000	FT				
Area =	452	IN^2				
Volume =	116.4	CY				
Trench Excavation						
Bedding Thickness =	1	FT	i.e., pipe will be surrounded by X FT of bedding material			
Depth =	6	FT	Assumed			
Width =	4	FT				
Volume =	888.9	BCY				
	1111	LCY				
	800.0	CCY				
Backfill						
Bedding Volume =	296.3	BCY		Mass =	444	tons
	370.4	LCY				
	266.7	CCY				
Native Backfill Volume =	592.6	BCY		Mass =	889	tons
	740.7	LCY				
	533.3	CCY				
Native Volume (Excess) =	Same as Bedding Volumes					

JACK AND BORE

Quantities			
Length of boring =	400	LF	estimate
Number of borings =	1		each boring will have 1 casing pipe and require 2 jacking pits
Number of end seals =	2		two per casing pipe
Number of spacers =	69		[3] 1 spacer per 6 LF of casing pipe and two at each end of the pipe

Note:
This estimate assumes the boring will be between 100 and 1,000 feet.

Number of pipes to be routed through the casing

	Alternative 7
# of pipes D ≤ 6"	0
# of pipes 6" < D ≤ 12"	0
# of pipes 12 < D ≤ 20" dia.	1

The pipe for Alternatives 7 can fit inside the 36" casing, therefore only one boring is needed.

References:

[1] Gordian®. 2020. RSMeans Online. Labor: Standard Union. Location: Los Angeles (900-902). Release: Year 2020.

RSMeans values include the following overhead and profit markups for the Installing Contractor:

Material Cost - 10%

Labor Cost - Variable

Equipment Cost - 10%

[2] U.S. EPA, 2000. *A Guide to Developing and Documenting Cost Estimates During the Feasibility Study* . Office of Solid Waste and Emergency Response, Washington D.C.

Quantity Summary					**Cost Summary**			
Item	**Bid Item**	**Quantity**	**Units**			**Unit Cost**	**Total**	**Comments**
5.01	**Treatment Plant**	1	LS			$5,760,000.00	$5,760,000.00	**Proposed SEMOU Treatment Plant. Treatment of 1,750 gpm of groundwater with LGAC**
	Rounding	**0**	(digits past 0)		Rounding	**-4**	(digits past 0)	
	Calculated Total Quantity	1	**LS**	(LS or EA, CY, TON, SY, LF, etc.)	Calc'd Cost	$5,757,053.82	$5,757,053.82	

Quantity Calculations					**Cost Calculations**							
Item	**Subitem**	**Quantity**	**Units**	**Notes**	**User**	**Material**	**Labor**	**Equipment**	**Factor**	**Unit Cost**	**Subtotal Cost**	**Cost Basis**
CONCRETE SLAB, STRUCTURES, AND PERIMETER WALL												
	Clearing and grubbing	0.62	acre	cut and chip light trees, up to 6-inches dia., and grub and remove stumps			$4,531.80	$2,892.40	100%	$7,424.20	$4,601.78	[1] 31 11 10.10 0020, 31 11 10.10 0150
	Fine grading	3,000	SY	small irregular areas, up to 15,000 SY			$1.95	$1.59	100%	$3.54	$10,620.00	[1] 31 22 16.10 1050
	Cast-in-place concrete	333	CY	slab-on-grade, 4-inches thick, includes forms, rebar, concrete, and placing		$136.24	$145.85	$0.51	100%	$282.60	$94,200.00	[1] 03 30 53.40 4650
	Concrete finishing	27,000	SF	hardener, for heavy service		$0.78	$0.91		100%	$1.69	$45,630.00	[1] 03 35 16.30 1850
	Thickened edge for concrete slab	740	LF	16-inches x 16 inches, includes forms, rebar, concrete, placing, and finishing		$18.50	$9.92	$0.03	100%	$28.45	$21,053.00	[1] 03 30 53.40 4730
	Pre-engineered steel building	4	EA	Clear span rigid frame, 40 ft by 40ft, 16 ft tall, includes roofing, siding, two double leaf doors (6 ft by 7 ft) and two entrance canopies (4 ft by 8 ft)		$18,570.00	$25,522.12	$7,626.46	100%	$51,718.58	$206,874.32	[1] 13 34 19.50 0400, 13 34 19.50 5550, 13 34 19.50 5950
	Perimeter wall	5,920	SF	brick masonry, 13.5 bricks per SF, 8-inches thick, includes extra to account for brick and mortar waste		$9.66	$31.57		100%	$41.23	$244,081.60	[1] 04 27 10.30 1250
	Bollards	6	EA	pipe bollard, 8-feet long, 12-inches in dia., 4-foot deep hole, concrete filled and painted		$1,104.75	$159.74	$20.25	100%	$1,284.74	$7,708.44	[1] 32 17 13.13 1500
	Hydroseeding	20	MSF	athletic field mix with mulch and fertilizer, 8 lbs per M.S.F.		$10.75	$24.24	$8.26	100%	$43.25	$865.00	[1] 32 92 19.14 0200
PROCESS MATERIALS AND EQUIPMENT												
	20,000 gal Flat-bottom Tank	4	EA	Two influent tanks and two effluent tanks	$37,406.24				100%	$37,406.24	$149,624.95	National Tank Outlet, list price, 2020
	11,500 gal Cone-bottom Tank	2	EA	Two backwash tanks	$40,782.30				100%	$40,782.30	$81,564.60	National Tank Outlet, list price, 2020
	Influent/Effluent Pump	4	EA	General utility pump, single stage, double suction, 75 HP to 2,500 gpm, includes motor		$18,100.00	$13,996.50		100%	$32,096.50	$128,386.00	[1] 22 11 23.10 3190
	Backwash Pump	2	EA	General utility pump, single stage, double suction, 150 HP to 4,000 gpm, includes motor		$26,000.00	$16,262.60		100%	$42,262.60	$84,525.20	[1] 22 11 23.10 3240
	Bag Filter	2	EA	Eaton, HD Maxiline, 7 by 32-inch, 12 bags, 304SS, Max. flow = 2,600 gpm, includes taxes and 10% markup for freight	$57,397.53				100%	$57,397.53	$114,795.05	Vendor Quote, 2020
	Liquid-phase GAC Skid (2 vessels)	4	EA	EVOQUA HP1220SYS, two LGAC vessels on a skid, 20,000 lbs GAC capacity each, Max flow (series/parallel) = 1,100/2,200 gpm, Backwash rate = 1,000 gpm, includes markup for freight (10%) and taxes (8.75%)	$356,250.00				100%	$356,250.00	$1,425,000.00	Vendor Quote, 2020
	Liquid-phase GAC	160,000	LBS	initial carbon fill, AquaCarb 1230C AC1230CPB55, ANSI/NSF 61	$1.99				100%	$1.99	$317,847.27	EVOQUA, list price, 2020

pH adjustment system	1	LS	to inject HCl into raw water before air stripping and NaOH into treated water prior to discharge, includes markup for freight (10%) and taxes (8.75%)	$146,729.50			100%	$146,729.50	$146,729.50	Multiple vendors, list prices, 2020
Piping, valves, and instrumentation	1	LS	10% of the equipment costs	$2,448,472.58			10%	$244,847.26	$244,847.26	Professional Estimate
Power Service	1	LS	Assumes the nearest 3-phase power source is at the WNOU plant and overhead lines will be installed to extend the service to the new treatment plant	$391,703.68			100%	$391,703.68	$391,703.68	Professional Estimate
Electrical/Control Components	1	LS	Includes control panels, SCADA, MCC, computer	$330,132.00			100%	$330,132.00	$330,132.00	Invoice for system of similar complexity, 2009
INSTALLATION OF PROCESS MATERIALS AND EQUIPMENT										
Labor	5	MONTH	Crew of ten construction workers, 10-hours a day, $60/HR labor rate	$129,000.00			100%	$129,000.00	$645,000.00	assumed
Skidsteer	5	MONTH	1 CY 78 HP, diesel, includes grappel and fork attachments			$9,047.43	100%	$9,047.43	$45,237.17	[1] 01 54 33.20 4890, 01 54 33.20 4896, 01 54 33.20 4895
Forklift	5	MONTH	All-terrain, telescoping boom, 6600 lb, 29-ft reach, 42-ft lift			$6,210.71	100%	$6,210.71	$31,053.55	[1] 01 54 33.40 2055
Crane	6	DAY	Crane crew and 80-ton truck-mounted hydraulic crane		$1,687.40	$2,556.68	100%	$4,244.08	$25,464.48	[1] 01 54 19.50 0500
Overhead	1	LS	Prime Contractor	$4,797,544.85			10%	$479,754.49	$479,754.49	[2]
Profit	1	LS	Prime Contractor	$4,797,544.85			10%	$479,754.49	$479,754.49	[2]

Supporting Calculations

This sheet estimates the costs to construct a new goundwater treatment plant in the Whittier Narrows Recreational Area, near the intersection of Rosemead Boulevard and the Pomona Highway.

This estimates makes the following major assumptions regarding the treatment plant:

- The plant will have the treatment processes listed below. These processes were chosen based on the contaminants at the site and on the processes currently used at the existing treament plants.
  - Liquid-Phase GAC adsorption
  - pH adjustment
- The plant will not require chlorine addition and processes to reduce nitrate concentrations.
- The plant infrastructure will consist of a large concrete pad, several small sheds to house pumps and bag filters, and a perimeter wall made of brick and mortar. Large equipment (e.g., carbon vessels) will be installed outdoors within the perimeter wall.

SYSTEM PARAMETERS

System flowrate = 1,750 gpm
Flow Velocity = 5 ft/s
Influent pipe diameter = 12 inches

TANKS

Influent Tank

Scenario: Tank high level alarm fails and it takes approx. 10 minutes to shutoff the pumps. Assuming tank typically operates 1/3 full.

Time = 10 minutes

20,000 Gallon Flat-bottom Tank (Material Costs)

List Price = $ 31,499.99 NORWESCO #44344
Taxes = $ 2,756.25 8.75%, assumed

Influent flow volume =	17,500	gallons
Typical tank use =	33%	of total tank volume
Total tank volume =	26,119	gallons
Safety Factor =	150%	
Total tank volume =	**40,000**	**gallons***

***This volume must be greater than the backwash tank volume.**

Backwash Tank

Backwash Runtime =	10	minutes, assumed
Backwash Volume =	17,500	gallons
Tank volume taken up by sludge solids =	10%	of total tank volume, assumed
Total tank volume =	19,444	gallons
Safety Factor =	125%	
Total tank volume =	**25,000**	**gallons**

Effluent Tank

Backwash Volume =	25,000	gallons
Tank volume below suction pipe =	10%	of total tank volume, assumed
Total tank volume =	27,778	gallons
Safety Factor =	150%	
Total tank volume =	**42,000**	**gallons**

Freight =	$ 3,150.00	10%, assumed
Total =	**$ 37,406.24**	

11,500 Gallon Cone-bottom Tank (Material Costs)

List Price =	$ 34,342.99	SNYDER #5340100N (Cone Bottom Tank) and #79500000 (Stand)
Taxes =	$ 3,005.01	8.75%, assumed
Freight =	$ 3,434.30	10%, assumed
Total =	**$ 40,782.30**	

PUMPS

Number of pumps:

Influent pumps =	2	(1) active + (1) redundant
Backwash pumps =	1	(1) active
Backwash reclaim pumps =	1	(1) active
Effluent pumps =	2	(1) active + (1) redundant

Influent and effluent pumps need to pump at **1,750 gpm** (to match system flow rate).
The LGAC vessels have a backwash flow rate of 1,000 gpm each.
Four LGAC vessels are needed to treat system flowrate. Need a **4,000 gpm** pump to backwash 4 vessels.
Assuming reclaim pump will have same flowrate as backwash pump.

LGAC VESSELS

Model # =	Evoqua HP® 1220SYS
	Two adsorbers and piping skid module
Height =	17 ft
Length =	29 ft
Width =	14 ft
Pipe diameter =	8 inches
Operating weight =	155,000 lbs
Maximum flowrate =	1,100 gpm (series)
	2,200 gpm (parallel)
Backwash flowrate =	1,000 gpm
Pressure loss =	7 psi at 1,100 gpm (series)

One skid in parallel is needed to maintain the system flowrate.
Assuming four skids will be needed. Two will operate in series (lead/lag) and the other two will be redundant.

\# of skids = 4

PH ADJUSTMENT SYSTEM

	List Price	Number	Description
Tanks =	$ 36,904.00	2	8,700 gal, double wall, 12 ft dia., HDPE, Snyder Industrial # 1006400N45, Vendor: National Tank Outlet
pH meter =	$ 2,784.96	2	HACH SC200 Controller, PHD SC inline process pH sensor, Vendor: EVOQUA
Metering pump =	$ 3,755.76	2	Motor-driven diaphragm pump, up to 53 gph, Walchem Corp # LKN55, Vendor: Ryan Herco
Static mixer =	$ 18,336.12	2	12-inch dia., 4 elements, Volcrest #VXM-A4A-1200-04-F1-F, Vendor: Volcrest

pH adjustment system includes two of the items listed above to inject hydrochloric acid and sodium hydroxide into untreated and treated water, respectfully.

Total = $ 123,561.68

BAG FILTERS

Model # =	Eaton Maxiline MBF HD; MBF-1202-AB10-100A-UT-11HD	
Height =	6	ft
Diameter =	5	ft
Weight =	1,500	lbs
Pipe diameter =	10	inch
Maximum flowrate =	2,600	gpm
Number of bags =	12	
Bag size =	#2	

One bag filter can process the system flowrate.
Assuming two are needed, one active and one redundant.

\# of bag filters = 2

TREATMENT PLANT

Dimension

Estimated size of plant based on the size of the tanks, GAC vessels, air strippers, and pumps.

Length =	270	ft
Width =	100	ft
Area (plan view) =	27,000	SF
	0.62	acres
Perimeter =	740	ft
Perimeter wall height =	8	ft
Perimeter wall area =	5,920	SF
Concrete slab thickness =	4	inches
Volume of concrete slab =	333	CY

Electricity	*Quantity*	*Power (HP)*	*Total Power (HP)*	
Influent Pump =	2	75	150	
Effluent Pump =	2	75	150	
Backwash Pump =	1	150	150	
Reclaim Pump =	1	150	150	
Miscellaneous (e.g., lighting) =	1	20	20	<-- Assumed
		Subtotal =	620	HP
		Safety Factor =	125%	
		Total =	775	HP
			578	KW

References:

[1] Gordian®. 2020. RSMeans Online. Labor: Standard Union. Location: Los Angeles (900-902). Release: Year 2020.
RSMeans values include the following overhead and profit markups for the Installing Contractor:
Material Cost - 10%
Labor Cost - Variable
Equipment Cost - 10%

[2] U.S. EPA, 2000. *A Guide to Developing and Documenting Cost Estimates During the Feasibility Study* . Office of Solid Waste and Emergency Response, Washington D.C.

[3] U.S. EPA. 2013. *Remedial Action Report. San Gabriel Area 1 Superfund Site - South El Monte Operable Unit (OU 5)* . August.

Project: Appendix B Detailed Cost Estimate
Subject: Cost Worksheet - Quantity and Cost Backup Calculations

Computed by: JRL Date: 2/15/21
Checked by: KM Date: 2/16/21
EA Project No. 1518929

Quantity Summary / Cost Summary

Item	Bid Item	Quantity	Units			Unit Cost	Total	Comments
5.02.A4	**Expand Capacity of WNOU Plant**	1	LS			$114,000.00	$114,000.00	**Includes tank inspections and LGAC refill**
	Rounding	0	(digits past 0)		Rounding	-3	(digits past 0)	
	Calculated Total Quantity	1	LS	(LS or EA, CY, TON, SY, LF, etc.)	Calc'd Cost	$113,525.33	$113,525.33	

Quantity Calculations / Cost Calculations

Item	Subitem	Quantity	Units	Notes	User	Material	Labor	Equipment	Factor	Unit Cost	Subtotal Cost	Cost Basis
TANK INSPECTION												
	Labor - Construction Worker	1	DAY	Crew of one construction worker, 10-hours a day, $60/HR labor rate	$600.00				100%	$600.00	$600.00	assumed
	Labor - Plumber	1	DAY	Crew of two plumbers, 10-hours a day, $100/HR labor rate	$2,000.00				100%	$2,000.00	$2,000.00	assumed
	Vacuum Truck	1	DAY	5000 gallons truck				$618.33	100%	$618.33	$618.33	[1] 01 54 33.40 7625
	Waste Management - Transportation	280	MILE	hazardous waste, transportation to disposal site (Buttonwillow, CA), truckload = 20 tons, average cost	$6.94				100%	$6.94	$1,943.20	[1] 02 81 20.10 1260, [1] 02 81 20.10 1270
	Waste Management - Disposal	20	TON	hazardous waste, dumpsite disposal charge, average cost	$340.69				100%	$340.69	$6,813.80	[1] 02 81 20.10 6000, [1] 02 81 20.10 6020
GAC REFILL												
	Labor - Construction Worker	1	DAY	Crew of one construction worker, 10-hours a day, $60/HR labor rate	$600.00				100%	$600.00	$600.00	assumed
	Labor - Plumber	1	DAY	Crew of two plumbers, 10-hours a day, $100/HR labor rate	$2,000.00				100%	$2,000.00	$2,000.00	assumed
	Forklift	1	DAY	All-terrain, telescoping boom, 6600 lb, 29-ft reach, 42-ft lift				$567.29	100%	$567.29	$567.29	[1] 01 54 33.40 2055
	Liquid-phase GAC	40,000	LBS	initial carbon fill, AquaCarb 1230C AC1230CPB55, ANSI/NSF 61	$1.99				100%	$1.99	$79,461.82	EVOQUA, list price, 2020
	Overhead	1	LS	Prime Contractor	$94,604.44				10%	$9,460.44	$9,460.44	[2]
	Profit	1	LS	Prime Contractor	$94,604.44				10%	$9,460.44	$9,460.44	[2]

Supporting Calculations

This sheet estimates the costs to bring on-line existing LGAC vessel pairs that are currently off-line at the WNOU Treatment Plant.
This estimates makes the following major assumptions:

- All vessels will require inspection to ensure the internals and shell are not damaged. All vessels will pass the inspection and will not require replacement.
- All vessels will require LGAC replacement, even if they currently are filled with LGAC.
- Existing GAC will be removed from vessels and disposed of as hazardous waste.
- If the additional flow rate required is less than 3,750 gpm, then new pipe, fittings, and valves are not required.

<u>Number of GAC Vessel Pairs Required</u>

Additional Flow Rate Required = 500 gpm (obtained from Table 4-4a, Alternative 4)
Flow Rate Capacity per Vessel Pair = 750 gpm
Number of GAC Vessel Pairs Required = 1 vessel pairs

<u>Mass of GAC Required</u>

Mass of GAC per Vessel = 20,000 lbs
Mass of GAC per Vessel Pair = 40,000 lbs

Mass of GAC required = 40,000 lbs

References:

[1] Gordian®. 2020. RSMeans Online. Labor: Standard Union. Location: Los Angeles (900-902). Release: Year 2020.
RSMeans values include the following overhead and profit markups for the Installing Contractor:
Material Cost - 10%
Labor Cost - Variable
Equipment Cost - 10%

[2] U.S. EPA, 2000. *A Guide to Developing and Documenting Cost Estimates During the Feasibility Study* . Office of Solid Waste and Emergency Response, Washington D.C.

[3] U.S. EPA. 2013. *Remedial Action Report. San Gabriel Area 1 Superfund Site - South El Monte Operable Unit (OU 5)* . August.

Project: Appendix B Detailed Cost Estimate
Subject: Cost Worksheet - Quantity and Cost Backup Calculations

Computed by: JRL Date: 2/15/21
Checked by: KM Date: 2/16/21

EA Project No. 1518929

Quantity Summary					Cost Summary			
Item	**Bid Item**	**Quantity**	**Units**			**Unit Cost**	**Total**	**Comments**
5.02.A5	**Expand Capacity of WNOU Plant**	1	LS			$326,000.00	$326,000.00	**Includes tank inspections and LGAC refill**
	Rounding	**0**	(digits past 0)		Rounding	**-3**	(digits past 0)	
	Calculated Total Quantity	**1**	**LS**	(LS or EA, CY, TON, SY, LF, etc.)	Calc'd Cost	$325,250.49	$325,250.49	

Quantity Calculations / **Cost Calculations**

Item	Subitem	Quantity	Units	Notes	User	Material	Labor	Equipment	Factor	Unit Cost	Subtotal Cost	Cost Basis
TANK INSPECTION												
	Labor - Construction Worker	1	DAY	Crew of one construction worker, 10-hours a day, $60/HR labor rate	$600.00				100%	$600.00	$600.00	assumed
	Labor - Plumber	1	DAY	Crew of two plumbers, 10-hours a day, $100/HR labor rate	$2,000.00				100%	$2,000.00	$2,000.00	assumed
	Vacuum Truck	1	DAY	5000 gallons truck				$618.33	100%	$618.33	$618.33	[1] 01 54 33.40 7625
	Waste Management - Transportation	840	MILE	hazardous waste, transportation to disposal site (Buttonwillow, CA), truckload = 20 tons, average cost	$6.94				100%	$6.94	$5,829.60	[1] 02 81 20.10 1260, [1] 02 81 20.10 1270
	Waste Management - Disposal	60	TON	hazardous waste, dumpsite disposal charge, average cost	$340.69				100%	$340.69	$20,441.40	[1] 02 81 20.10 6000, [1] 02 81 20.10 6020
GAC REFILL												
	Labor - Construction Worker	1	DAY	Crew of one construction worker, 10-hours a day, $60/HR labor rate	$600.00				100%	$600.00	$600.00	assumed
	Labor - Plumber	1	DAY	Crew of two plumbers, 10-hours a day, $100/HR labor rate	$2,000.00				100%	$2,000.00	$2,000.00	assumed
	Forklift	1	DAY	All-terrain, telescoping boom, 6600 lb, 29-ft reach, 42-ft lift				$567.29	100%	$567.29	$567.29	[1] 01 54 33.40 2055
	Liquid-phase GAC	120,000	LBS	initial carbon fill, AquaCarb 1230C AC1230CPB55, ANSI/NSF 61	$1.99				100%	$1.99	$238,385.45	EVOQUA, list price, 2020
	Overhead	1	LS	Prime Contractor	$271,042.08				10%	$27,104.21	$27,104.21	[2]
	Profit	1	LS	Prime Contractor	$271,042.08				10%	$27,104.21	$27,104.21	[2]

Supporting Calculations

This sheet estimates the costs to bring on-line existing LGAC vessel pairs that are currently off-line at the WNOU Treatment Plant.
This estimates makes the following major assumptions:

- All vessels will require inspection to ensure the internals and shell are not damaged. All vessels will pass the inspection and will not require replacement.
- All vessels will require LGAC replacement, even if they currently are filled with LGAC.
- Existing GAC will be removed from vessels and disposed of as hazardous waste.
- If the additional flow rate required is less than 3,750 gpm, then new pipe, fittings, and valves are not required.

Number of GAC Vessel Pairs Required

Additional Flow Rate Required = 2,250 gpm (obtained from Table 4-5a, Alternative 5)
Flow Rate Capacity per Vessel Pair = 750 gpm
Number of GAC Vessel Pairs Required = 3 vessel pairs

Mass of GAC Required

Mass of GAC per Vessel = 20,000 lbs
Mass of GAC per Vessel Pair = 40,000 lbs

Mass of GAC required = 120,000 lbs

References:

[1] Gordian®. 2020. RSMeans Online. Labor: Standard Union. Location: Los Angeles (900-902). Release: Year 2020.
RSMeans values include the following overhead and profit markups for the Installing Contractor:
Material Cost - 10%
Labor Cost - Variable
Equipment Cost - 10%

[2] U.S. EPA, 2000. *A Guide to Developing and Documenting Cost Estimates During the Feasibility Study* . Office of Solid Waste and Emergency Response, Washington D.C.

[3] U.S. EPA. 2013. *Remedial Action Report. San Gabriel Area 1 Superfund Site - South El Monte Operable Unit (OU 5)* . August.

Quantity Summary					Cost Summary			
Item	Bid Item	Quantity	Units			Unit Cost	Total	Comments
5.02.A6	**Expand Capacity of WNOU Plant**	1	LS			$326,000.00	$326,000.00	**Includes tank inspections and LGAC refill**
	Rounding	**0**	(digits past 0)		Rounding	**-3**	(digits past 0)	
	Calculated Total Quantity	1	**LS**	(LS or EA, CY, TON, SY, LF, etc.)	Calc'd Cost	$325,250.49	$325,250.49	

Item	Subitem	Quantity	Units	Notes	User	Material	Labor	Equipment	Factor	Unit Cost	Subtotal Cost	Cost Basis
TANK INSPECTION												
	Labor - Construction Worker	1	DAY	Crew of one construction worker, 10-hours a day, $60/HR labor rate	$600.00				100%	$600.00	$600.00	assumed
	Labor - Plumber	1	DAY	Crew of two plumbers, 10-hours a day, $100/HR labor rate	$2,000.00				100%	$2,000.00	$2,000.00	assumed
	Vacuum Truck	1	DAY	5000 gallons truck				$618.33	100%	$618.33	$618.33	[1] 01 54 33.40 7625
	Waste Management - Transportation	840	MILE	hazardous waste, transportation to disposal site (Buttonwillow, CA), truckload = 20 tons, average cost	$6.94				100%	$6.94	$5,829.60	[1] 02 81 20.10 1260, [1] 02 81 20.10 1270
	Waste Management - Disposal	60	TON	hazardous waste, dumpsite disposal charge, average cost	$340.69				100%	$340.69	$20,441.40	[1] 02 81 20.10 6000, [1] 02 81 20.10 6020
GAC REFILL												
	Labor - Construction Worker	1	DAY	Crew of one construction worker, 10-hours a day, $60/HR labor rate	$600.00				100%	$600.00	$600.00	assumed
	Labor - Plumber	1	DAY	Crew of two plumbers, 10-hours a day, $100/HR labor rate	$2,000.00				100%	$2,000.00	$2,000.00	assumed
	Forklift	1	DAY	All-terrain, telescoping boom, 6600 lb, 29-ft reach, 42-ft lift				$567.29	100%	$567.29	$567.29	[1] 01 54 33.40 2055
	Liquid-phase GAC	120,000	LBS	initial carbon fill, AquaCarb 1230C AC1230CPB55, ANSI/NSF 61	$1.99				100%	$1.99	$238,385.45	EVOQUA, list price, 2020
	Overhead	1	LS	Prime Contractor	$271,042.08				10%	$27,104.21	$27,104.21	[2]
	Profit	1	LS	Prime Contractor	$271,042.08				10%	$27,104.21	$27,104.21	[2]

Supporting Calculations

This sheet estimates the costs to bring on-line existing LGAC vessel pairs that are currently off-line at the WNOU Treatment Plant.
This estimates makes the following major assumptions:

- All vessels will require inspection to ensure the internals and shell are not damaged. All vessels will pass the inspection and will not require replacement.
- All vessels will require LGAC replacement, even if they currently are filled with LGAC.
- Existing GAC will be removed from vessels and disposed of as hazardous waste.
- If the additional flow rate required is less than 3,750 gpm, then new pipe, fittings, and valves are not required.

Number of GAC Vessel Pairs Required

Additional Flow Rate Required = 1,750 gpm (obtained from Table 4-6a, Alternative 6)
Flow Rate Capacity per Vessel Pair = 750 gpm
Number of GAC Vessel Pairs Required = 3 vessel pairs

Mass of GAC Required

Mass of GAC per Vessel = 20,000 lbs
Mass of GAC per Vessel Pair = 40,000 lbs

Mass of GAC required = 120,000 lbs

References:

[1] Gordian®. 2020. RSMeans Online. Labor: Standard Union. Location: Los Angeles (900-902). Release: Year 2020.
RSMeans values include the following overhead and profit markups for the Installing Contractor:
Material Cost - 10%
Labor Cost - Variable
Equipment Cost - 10%

[2] U.S. EPA, 2000. *A Guide to Developing and Documenting Cost Estimates During the Feasibility Study*. Office of Solid Waste and Emergency Response, Washington D.C.

[3] U.S. EPA. 2013. *Remedial Action Report. San Gabriel Area 1 Superfund Site - South El Monte Operable Unit (OU 5)*. August.

Quantity Summary					Cost Summary			
Item	**Bid Item**	**Quantity**	**Units**			**Unit Cost**	**Total**	**Comments**
5.02.A7	**Expand Capacity of WNOU Plant**	1	LS			$885,000.00	$885,000.00	**Includes tank inspections, LGAC refill, and minor plumbing to reconnect vessels**
	Rounding	**0**	(digits past 0)		Rounding	**-3**	(digits past 0)	
	Calculated Total Quantity	**1**	**LS**	(LS or EA, CY, TON, SY, LF, etc.)	Calc'd Cost	$884,916.94	$884,916.94	

Quantity Calculations / Cost Calculations

Item	Subitem	Quantity	Units	Notes	User	Material	Labor	Equipment	Factor	Unit Cost	Subtotal Cost	Cost Basis
TANK INSPECTION												
	Labor - Construction Worker	2	DAY	Crew of one construction worker, 10-hours a day, $60/HR labor rate	$600.00				100%	$600.00	$1,200.00	assumed
	Labor - Plumber	2	DAY	Crew of two plumbers, 10-hours a day, $100/HR labor rate	$2,000.00				100%	$2,000.00	$4,000.00	assumed
	Vacuum Truck	2	DAY	5000 gallons truck				$618.33	100%	$618.33	$1,236.66	[1] 01 54 33.40 7625
	Waste Management - Transportation	2,240	MILE	hazardous waste, transportation to disposal site (Buttonwillow, CA), truckload = 20 tons, average cost	$6.94				100%	$6.94	$15,545.60	[1] 02 81 20.10 1260, [1] 02 81 20.10 1270
	Waste Management - Disposal	160	TON	hazardous waste, dumpsite disposal charge, average cost	$340.69				100%	$340.69	$54,510.40	[1] 02 81 20.10 6000, [1] 02 81 20.10 6020
GAC REFILL												
	Labor - Construction Worker	2	DAY	Crew of one construction worker, 10-hours a day, $60/HR labor rate	$600.00				100%	$600.00	$1,200.00	assumed
	Labor - Plumber	2	DAY	Crew of two plumbers, 10-hours a day, $100/HR labor rate	$2,000.00				100%	$2,000.00	$4,000.00	assumed
	Forklift	2	DAY	All-terrain, telescoping boom, 6600 lb, 29-ft reach, 42-ft lift				$567.29	100%	$567.29	$1,134.58	[1] 01 54 33.40 2055
	Liquid-phase GAC	320,000	LBS	initial carbon fill, AquaCarb 1230C AC1230CPB55, ANSI/NSF 61	$1.99				100%	$1.99	$635,694.55	EVOQUA, list price, 2020
MINOR PLUMBING TO RECONNECT VESSELS TO SYSTEM												
	Labor - Construction Worker	2	DAY	Crew of one construction worker, 10-hours a day, $60/HR labor rate	$600.00				100%	$600.00	$1,200.00	assumed
	Labor - Plumber	2	DAY	Crew of two plumbers, 10-hours a day, $100/HR labor rate	$2,000.00				100%	$2,000.00	$4,000.00	assumed
	Forklift	2	DAY	All-terrain, telescoping boom, 6600 lb, 29-ft reach, 42-ft lift				$567.29	100%	$567.29	$1,134.58	[1] 01 54 33.40 2055
	Piping	30	LF	ductile iron pipe, cement lined, 8-inches diameter		$62.01		$3.65	100%	$65.66	$1,969.80	[1] 33 14 13.15 2060
	Elbow Fitting	6	EA	ductile iron pipe, cement lined, 8-inches diameter		$578.05		$0.00	100%	$578.05	$3,468.30	[1] 33 14 13.15 8040
	Gate Valve	3	EA	cast iron, 8-inch diameter		$2,338.48		$40.29	100%	$2,378.77	$7,136.31	[1] 33 14 19.10 3816
	Overhead	1	LS	Prime Contractor	$737,430.79				10%	$73,743.08	$73,743.08	[2]
	Profit	1	LS	Prime Contractor	$737,430.79				10%	$73,743.08	$73,743.08	[2]

Supporting Calculations

This sheet estimates the costs to bring on-line existing LGAC vessel pairs that are currently off-line at the WNOU Treatment Plant.

This estimates makes the following major assumptions:

- All vessels will require inspection to ensure the internals and shell are not damaged. All vessels will pass the inspection and will not require replacement.
- All vessels will require LGAC replacement, even if they currently are filled with LGAC.
- Existing GAC will be removed from vessels and disposed of as hazardous waste.
- If the additional flow rate required is less than 3,750 gpm, then new pipe, fittings, and valves are not required.

Number of GAC Vessel Pairs Required

Additional Flow Rate Required =	5,700	gpm (obtained from Table 4-7a, Alternative 7)
Flow Rate Capacity per Vessel Pair =	750	gpm
Number of GAC Vessel Pairs Required =	8	vessel pairs

Mass of GAC Required

Mass of GAC per Vessel =	20,000	lbs
Mass of GAC per Vessel Pair =	40,000	lbs
Mass of GAC required =	320,000	lbs

References:
[1] Gordian®. 2020. RSMeans Online. Labor: Standard Union. Location: Los Angeles (900-902). Release: Year 2020.
RSMeans values include the following overhead and profit markups for the Installing Contractor:
Material Cost - 10%
Labor Cost - Variable
Equipment Cost - 10%
[2] U.S. EPA, 2000. *A Guide to Developing and Documenting Cost Estimates During the Feasibility Study* . Office of Solid Waste and Emergency Response, Washington D.C.
[3] U.S. EPA. 2013. *Remedial Action Report. San Gabriel Area 1 Superfund Site - South El Monte Operable Unit (OU 5)* . August.

Item	Bid Item	Comments
6.01	O&M and LTM Costs (Present Value)	None

Supporting Calculations

Step 1 - Estimate O&M Costs as a function of groundwater extracted:

It is estimated that the O&M costs will be approximately $255/gpm for SEMOU and $500/gpm for WNOU.

EPA and CH2MHill estimated the SEMOU costs based on the average costs to operate the existing pump and treat systems at the SEMOU between July 2015 and June 2019. DTSC provided. a 2022 yearly operational cost of $500/gpm.

O&M Costs = 255 $/gpm (SEMOU)
500 $/gpm (WNOU)

Step 2 - Estimate Present Value O&M and LTM Costs

The following tables estimate the present value O&M and LTM costs for each alternative based the following discount rate:

Discount Rate = 7.0% Source: U.S. EPA, 2000. *A Guide to Developing and Documenting Cost Estimates During the Feasibility Study*. Office of Solid Waste and Emergency Response, Washington D.C.

Alternative 2

Year	Target Flow Rate (gpm)			O&M Costs [a]		LTM Costs [b]	Periodic Costs [c]	Total	Discount Factor	O&M Costs (Present Value)
	SEMOU	WNOU	Total	SEMOU	WNOU					
1	5,850	3,500	9,350	$ 1,491,750	$ 1,750,000	$ 602,000	$ -	$ 3,843,750	0.9346	$ 3,592,290
2	5,850	3,500	9,350	$ 1,491,750	$ 1,750,000	$ 602,000	$ -	$ 3,843,750	0.8734	$ 3,357,280
3	5,850	3,500	9,350	$ 1,491,750	$ 1,750,000	$ 602,000	$ -	$ 3,843,750	0.8163	$ 3,137,645
4	5,850	3,500	9,350	$ 1,491,750	$ 1,750,000	$ 602,000	$ -	$ 3,843,750	0.7629	$ 2,932,378
5	5,850	3,500	9,350	$ 1,491,750	$ 1,750,000	$ 602,000	$ -	$ 3,843,750	0.7130	$ 2,740,541
6	5,850	3,500	9,350	$ 1,491,750	$ 1,750,000	$ 602,000	$ -	$ 3,843,750	0.6663	$ 2,561,253
7	5,850	3,500	9,350	$ 1,491,750	$ 1,750,000	$ 602,000	$ -	$ 3,843,750	0.6227	$ 2,393,694
8	5,850	3,500	9,350	$ 1,491,750	$ 1,750,000	$ 602,000	$ -	$ 3,843,750	0.5820	$ 2,237,097
9	5,850	3,500	9,350	$ 1,491,750	$ 1,750,000	$ 602,000	$ -	$ 3,843,750	0.5439	$ 2,090,745
10	5,850	3,500	9,350	$ 1,491,750	$ 1,750,000	$ 602,000	$ -	$ 3,843,750	0.5083	$ 1,953,968
11	5,850	3,500	9,350	$ 1,491,750	$ 1,750,000	$ 602,000	$ -	$ 3,843,750	0.4751	$ 1,826,138
12	5,850	3,500	9,350	$ 1,491,750	$ 1,750,000	$ 602,000	$ -	$ 3,843,750	0.4440	$ 1,706,671
13	5,850	3,500	9,350	$ 1,491,750	$ 1,750,000	$ 602,000	$ -	$ 3,843,750	0.4150	$ 1,595,020
14	5,850	3,500	9,350	$ 1,491,750	$ 1,750,000	$ 602,000	$ -	$ 3,843,750	0.3878	$ 1,490,673
15	5,850	3,500	9,350	$ 1,491,750	$ 1,750,000	$ 602,000	$ -	$ 3,843,750	0.3624	$ 1,393,152
16	5,850	3,500	9,350	$ 1,491,750	$ 1,750,000	$ 602,000	$ -	$ 3,843,750	0.3387	$ 1,302,011
17	5,850	3,500	9,350	$ 1,491,750	$ 1,750,000	$ 602,000	$ -	$ 3,843,750	0.3166	$ 1,216,833
18	5,850	3,500	9,350	$ 1,491,750	$ 1,750,000	$ 602,000	$ -	$ 3,843,750	0.2959	$ 1,137,227
19	5,850	3,500	9,350	$ 1,491,750	$ 1,750,000	$ 602,000	$ -	$ 3,843,750	0.2765	$ 1,062,829
20	5,850	3,500	9,350	$ 1,491,750	$ 1,750,000	$ 602,000	$ 1,460,000	$ 5,303,750	0.2584	$ 1,370,590
21	5,850	3,500	9,350	$ 1,491,750	$ 1,750,000	$ 602,000	$ -	$ 3,843,750	0.2415	$ 928,316
22	5,850	3,500	9,350	$ 1,491,750	$ 1,750,000	$ 602,000	$ -	$ 3,843,750	0.2257	$ 867,585
23	5,850	3,500	9,350	$ 1,491,750	$ 1,750,000	$ 602,000	$ -	$ 3,843,750	0.2109	$ 810,827
24	5,850	3,500	9,350	$ 1,491,750	$ 1,750,000	$ 602,000	$ -	$ 3,843,750	0.1971	$ 757,782
25	5,850	3,500	9,350	$ 1,491,750	$ 1,750,000	$ 602,000	$ -	$ 3,843,750	0.1842	$ 708,208
26	5,850	3,500	9,350	$ 1,491,750	$ 1,750,000	$ 602,000	$ -	$ 3,843,750	0.1722	$ 661,876
27	5,850	3,500	9,350	$ 1,491,750	$ 1,750,000	$ 602,000	$ -	$ 3,843,750	0.1609	$ 618,576
28	5,850	3,500	9,350	$ 1,491,750	$ 1,750,000	$ 602,000	$ -	$ 3,843,750	0.1504	$ 578,109
29	5,850	3,500	9,350	$ 1,491,750	$ 1,750,000	$ 602,000	$ -	$ 3,843,750	0.1406	$ 540,288
30	5,850	3,500	9,350	$ 1,491,750	$ 1,750,000	$ 602,000	$ -	$ 3,843,750	0.1314	$ 504,942
31	5,850	1,750	7,600	$ 1,491,750	$ 875,000	$ 602,000	$ -	$ 2,968,750	0.1228	$ 364,482

32	5,850	1,750	7,600	$ 1,491,750	$ 875,000	$ 602,000	$ -	$ 2,968,750	0.1147	$ 340,638
33	5,850	1,750	7,600	$ 1,491,750	$ 875,000	$ 602,000	$ -	$ 2,968,750	0.1072	$ 318,353
34	5,850	1,750	7,600	$ 1,491,750	$ 875,000	$ 602,000	$ -	$ 2,968,750	0.1002	$ 297,526
35	5,850	1,750	7,600	$ 1,491,750	$ 875,000	$ 602,000	$ -	$ 2,968,750	0.0937	$ 278,062
36	5,850	1,750	7,600	$ 1,491,750	$ 875,000	$ 602,000	$ -	$ 2,968,750	0.0875	$ 259,871
37	5,850	1,750	7,600	$ 1,491,750	$ 875,000	$ 602,000	$ -	$ 2,968,750	0.0818	$ 242,870
38	5,850	1,750	7,600	$ 1,491,750	$ 875,000	$ 602,000	$ -	$ 2,968,750	0.0765	$ 226,981
39	5,850	1,750	7,600	$ 1,491,750	$ 875,000	$ 602,000	$ -	$ 2,968,750	0.0715	$ 212,132
40	5,850	1,750	7,600	$ 1,491,750	$ 875,000	$ 602,000	$ 1,460,000	$ 4,428,750	0.0668	$ 295,754
41	5,850	0	5,850	$ 1,491,750	$ -	$ 602,000	$ -	$ 2,093,750	0.0624	$ 130,674
42	5,850	0	5,850	$ 1,491,750	$ -	$ 602,000	$ -	$ 2,093,750	0.0583	$ 122,125
43	5,850	0	5,850	$ 1,491,750	$ -	$ 602,000	$ -	$ 2,093,750	0.0545	$ 114,136
44	5,850	0	5,850	$ 1,491,750	$ -	$ 602,000	$ -	$ 2,093,750	0.0509	$ 106,669
45	5,850	0	5,850	$ 1,491,750	$ -	$ 602,000	$ -	$ 2,093,750	0.0476	$ 99,691
46	5,850	0	5,850	$ 1,491,750	$ -	$ 602,000	$ -	$ 2,093,750	0.0445	$ 93,169
47	5,850	0	5,850	$ 1,491,750	$ -	$ 602,000	$ -	$ 2,093,750	0.0416	$ 87,074
48	5,850	0	5,850	$ 1,491,750	$ -	$ 602,000	$ -	$ 2,093,750	0.0389	$ 81,377
49	5,850	0	5,850	$ 1,491,750	$ -	$ 602,000	$ -	$ 2,093,750	0.0363	$ 76,054
50	5,850	0	5,850	$ 1,491,750	$ -	$ 602,000	$ -	$ 2,093,750	0.0339	$ 71,078
51	5,850	0	5,850	$ 1,491,750	$ -	$ 602,000	$ -	$ 2,093,750	0.0317	$ 66,428
52	5,850	0	5,850	$ 1,491,750	$ -	$ 602,000	$ -	$ 2,093,750	0.0297	$ 62,082
53	5,850	0	5,850	$ 1,491,750	$ -	$ 602,000	$ -	$ 2,093,750	0.0277	$ 58,021
54	5,850	0	5,850	$ 1,491,750	$ -	$ 602,000	$ -	$ 2,093,750	0.0259	$ 54,225
55	5,850	0	5,850	$ 1,491,750	$ -	$ 602,000	$ -	$ 2,093,750	0.0242	$ 50,678
56	5,850	0	5,850	$ 1,491,750	$ -	$ 602,000	$ -	$ 2,093,750	0.0226	$ 47,362
57	5,850	0	5,850	$ 1,491,750	$ -	$ 602,000	$ -	$ 2,093,750	0.0211	$ 44,264
58	5,850	0	5,850	$ 1,491,750	$ -	$ 602,000	$ -	$ 2,093,750	0.0198	$ 41,368
59	5,850	0	5,850	$ 1,491,750	$ -	$ 602,000	$ -	$ 2,093,750	0.0185	$ 38,662
60	5,850	0	5,850	$ 1,491,750	$ -	$ 602,000	$ 1,460,000	$ 3,553,750	0.0173	$ 61,328
61	5,850	0	5,850	$ 1,491,750	$ -	$ 602,000	$ -	$ 2,093,750	0.0161	$ 33,769
62	5,850	0	5,850	$ 1,491,750	$ -	$ 602,000	$ -	$ 2,093,750	0.0151	$ 31,560
63	5,850	0	5,850	$ 1,491,750	$ -	$ 602,000	$ -	$ 2,093,750	0.0141	$ 29,495
64	5,850	0	5,850	$ 1,491,750	$ -	$ 602,000	$ -	$ 2,093,750	0.0132	$ 27,565
65	5,850	0	5,850	$ 1,491,750	$ -	$ 602,000	$ -	$ 2,093,750	0.0123	$ 25,762
66	5,850	0	5,850	$ 1,491,750	$ -	$ 602,000	$ -	$ 2,093,750	0.0115	$ 24,077
67	5,850	0	5,850	$ 1,491,750	$ -	$ 602,000	$ -	$ 2,093,750	0.0107	$ 22,502
68	5,850	0	5,850	$ 1,491,750	$ -	$ 602,000	$ -	$ 2,093,750	0.0100	$ 21,029
69	5,850	0	5,850	$ 1,491,750	$ -	$ 602,000	$ -	$ 2,093,750	0.0094	$ 19,654
70	5,850	0	5,850	$ 1,491,750	$ -	$ 602,000	$ -	$ 2,093,750	0.0088	$ 18,368
									Total =	**$ 52,700,000**

Alternative 3

Year	Target Flow Rate (gpm)			O&M Costs [a]		LTM Costs [b]	Periodic Costs [c]	Total	Discount Factor	O&M Costs (Present Value)
	SEMOU	WNOU	Total	SEMOU	WNOU					
1	5,850	3,500	9,350	$ 1,491,750	$ 1,750,000	$ 602,000	$ -	$ 3,843,750	0.9346	$ 3,592,290
2	5,850	3,500	9,350	$ 1,491,750	$ 1,750,000	$ 602,000	$ -	$ 3,843,750	0.8734	$ 3,357,280
3	5,850	3,500	9,350	$ 1,491,750	$ 1,750,000	$ 602,000	$ -	$ 3,843,750	0.8163	$ 3,137,645
4	5,850	3,500	9,350	$ 1,491,750	$ 1,750,000	$ 602,000	$ -	$ 3,843,750	0.7629	$ 2,932,378
5	5,850	3,500	9,350	$ 1,491,750	$ 1,750,000	$ 602,000	$ -	$ 3,843,750	0.7130	$ 2,740,541
6	5,850	3,500	9,350	$ 1,491,750	$ 1,750,000	$ 602,000	$ -	$ 3,843,750	0.6663	$ 2,561,253
7	5,850	3,500	9,350	$ 1,491,750	$ 1,750,000	$ 602,000	$ -	$ 3,843,750	0.6227	$ 2,393,694
8	5,850	3,500	9,350	$ 1,491,750	$ 1,750,000	$ 602,000	$ -	$ 3,843,750	0.5820	$ 2,237,097
9	5,850	3,500	9,350	$ 1,491,750	$ 1,750,000	$ 602,000	$ -	$ 3,843,750	0.5439	$ 2,090,745
10	5,850	3,500	9,350	$ 1,491,750	$ 1,750,000	$ 602,000	$ -	$ 3,843,750	0.5083	$ 1,953,968
11	5,850	3,500	9,350	$ 1,491,750	$ 1,750,000	$ 602,000	$ -	$ 3,843,750	0.4751	$ 1,826,138
12	5,850	3,500	9,350	$ 1,491,750	$ 1,750,000	$ 602,000	$ -	$ 3,843,750	0.4440	$ 1,706,671
13	5,850	3,500	9,350	$ 1,491,750	$ 1,750,000	$ 602,000	$ -	$ 3,843,750	0.4150	$ 1,595,020
14	5,850	3,500	9,350	$ 1,491,750	$ 1,750,000	$ 602,000	$ -	$ 3,843,750	0.3878	$ 1,490,673
15	5,850	3,500	9,350	$ 1,491,750	$ 1,750,000	$ 602,000	$ -	$ 3,843,750	0.3624	$ 1,393,152
16	5,850	3,500	9,350	$ 1,491,750	$ 1,750,000	$ 602,000	$ -	$ 3,843,750	0.3387	$ 1,302,011
17	5,850	3,500	9,350	$ 1,491,750	$ 1,750,000	$ 602,000	$ -	$ 3,843,750	0.3166	$ 1,216,833
18	5,850	3,500	9,350	$ 1,491,750	$ 1,750,000	$ 602,000	$ -	$ 3,843,750	0.2959	$ 1,137,227
19	5,850	3,500	9,350	$ 1,491,750	$ 1,750,000	$ 602,000	$ -	$ 3,843,750	0.2765	$ 1,062,829
20	5,850	3,500	9,350	$ 1,491,750	$ 1,750,000	$ 602,000	$ 1,460,000	$ 5,303,750	0.2584	$ 1,370,590
21	5,850	3,500	9,350	$ 1,491,750	$ 1,750,000	$ 602,000	$ -	$ 3,843,750	0.2415	$ 928,316
22	5,850	3,500	9,350	$ 1,491,750	$ 1,750,000	$ 602,000	$ -	$ 3,843,750	0.2257	$ 867,585
23	5,850	3,500	9,350	$ 1,491,750	$ 1,750,000	$ 602,000	$ -	$ 3,843,750	0.2109	$ 810,827
24	5,850	3,500	9,350	$ 1,491,750	$ 1,750,000	$ 602,000	$ -	$ 3,843,750	0.1971	$ 757,782
25	5,850	3,500	9,350	$ 1,491,750	$ 1,750,000	$ 602,000	$ -	$ 3,843,750	0.1842	$ 708,208
26	5,850	3,500	9,350	$ 1,491,750	$ 1,750,000	$ 602,000	$ -	$ 3,843,750	0.1722	$ 661,876
27	5,850	3,500	9,350	$ 1,491,750	$ 1,750,000	$ 602,000	$ -	$ 3,843,750	0.1609	$ 618,576
28	5,850	3,500	9,350	$ 1,491,750	$ 1,750,000	$ 602,000	$ -	$ 3,843,750	0.1504	$ 578,109
29	5,850	3,500	9,350	$ 1,491,750	$ 1,750,000	$ 602,000	$ -	$ 3,843,750	0.1406	$ 540,288
30	5,850	3,500	9,350	$ 1,491,750	$ 1,750,000	$ 602,000	$ -	$ 3,843,750	0.1314	$ 504,942
31	5,850	1,750	7,600	$ 1,491,750	$ 875,000	$ 602,000	$ -	$ 2,968,750	0.1228	$ 364,482
32	5,850	1,750	7,600	$ 1,491,750	$ 875,000	$ 602,000	$ -	$ 2,968,750	0.1147	$ 340,638
33	5,850	1,750	7,600	$ 1,491,750	$ 875,000	$ 602,000	$ -	$ 2,968,750	0.1072	$ 318,353
34	5,850	1,750	7,600	$ 1,491,750	$ 875,000	$ 602,000	$ -	$ 2,968,750	0.1002	$ 297,526
35	5,850	1,750	7,600	$ 1,491,750	$ 875,000	$ 602,000	$ -	$ 2,968,750	0.0937	$ 278,062
36	5,850	1,750	7,600	$ 1,491,750	$ 875,000	$ 602,000	$ -	$ 2,968,750	0.0875	$ 259,871
37	5,850	1,750	7,600	$ 1,491,750	$ 875,000	$ 602,000	$ -	$ 2,968,750	0.0818	$ 242,870
38	5,850	1,750	7,600	$ 1,491,750	$ 875,000	$ 602,000	$ -	$ 2,968,750	0.0765	$ 226,981
39	5,850	1,750	7,600	$ 1,491,750	$ 875,000	$ 602,000	$ -	$ 2,968,750	0.0715	$ 212,132
40	5,850	1,750	7,600	$ 1,491,750	$ 875,000	$ 602,000	$ 1,460,000	$ 4,428,750	0.0668	$ 295,754
41	5,850	0	5,850	$ 1,491,750	$ -	$ 602,000	$ -	$ 2,093,750	0.0624	$ 130,674
42	5,850	0	5,850	$ 1,491,750	$ -	$ 602,000	$ -	$ 2,093,750	0.0583	$ 122,125
43	5,850	0	5,850	$ 1,491,750	$ -	$ 602,000	$ -	$ 2,093,750	0.0545	$ 114,136

44	5,850	0	5,850	$ 1,491,750	$ -	$ 602,000	$ -	$ 2,093,750	0.0509	$ 106,669
45	5,850	0	5,850	$ 1,491,750	$ -	$ 602,000	$ -	$ 2,093,750	0.0476	$ 99,691
46	5,850	0	5,850	$ 1,491,750	$ -	$ 602,000	$ -	$ 2,093,750	0.0445	$ 93,169
47	5,850	0	5,850	$ 1,491,750	$ -	$ 602,000	$ -	$ 2,093,750	0.0416	$ 87,074
48	5,850	0	5,850	$ 1,491,750	$ -	$ 602,000	$ -	$ 2,093,750	0.0389	$ 81,377
49	5,850	0	5,850	$ 1,491,750	$ -	$ 602,000	$ -	$ 2,093,750	0.0363	$ 76,054
50	5,850	0	5,850	$ 1,491,750	$ -	$ 602,000	$ -	$ 2,093,750	0.0339	$ 71,078
51	5,850	0	5,850	$ 1,491,750	$ -	$ 602,000	$ -	$ 2,093,750	0.0317	$ 66,428
52	5,850	0	5,850	$ 1,491,750	$ -	$ 602,000	$ -	$ 2,093,750	0.0297	$ 62,082
53	5,850	0	5,850	$ 1,491,750	$ -	$ 602,000	$ -	$ 2,093,750	0.0277	$ 58,021
54	5,850	0	5,850	$ 1,491,750	$ -	$ 602,000	$ -	$ 2,093,750	0.0259	$ 54,225
55	5,850	0	5,850	$ 1,491,750	$ -	$ 602,000	$ -	$ 2,093,750	0.0242	$ 50,678
56	5,850	0	5,850	$ 1,491,750	$ -	$ 602,000	$ -	$ 2,093,750	0.0226	$ 47,362
57	5,850	0	5,850	$ 1,491,750	$ -	$ 602,000	$ -	$ 2,093,750	0.0211	$ 44,264
58	5,850	0	5,850	$ 1,491,750	$ -	$ 602,000	$ -	$ 2,093,750	0.0198	$ 41,368
59	5,850	0	5,850	$ 1,491,750	$ -	$ 602,000	$ -	$ 2,093,750	0.0185	$ 38,662
60	5,850	0	5,850	$ 1,491,750	$ -	$ 602,000	$ 1,460,000	$ 3,553,750	0.0173	$ 61,328
61	5,850	0	5,850	$ 1,491,750	$ -	$ 602,000	$ -	$ 2,093,750	0.0161	$ 33,769
62	5,850	0	5,850	$ 1,491,750	$ -	$ 602,000	$ -	$ 2,093,750	0.0151	$ 31,560
63	5,850	0	5,850	$ 1,491,750	$ -	$ 602,000	$ -	$ 2,093,750	0.0141	$ 29,495
64	5,850	0	5,850	$ 1,491,750	$ -	$ 602,000	$ -	$ 2,093,750	0.0132	$ 27,565
65	5,850	0	5,850	$ 1,491,750	$ -	$ 602,000	$ -	$ 2,093,750	0.0123	$ 25,762
66	5,850	0	5,850	$ 1,491,750	$ -	$ 602,000	$ -	$ 2,093,750	0.0115	$ 24,077
67	5,850	0	5,850	$ 1,491,750	$ -	$ 602,000	$ -	$ 2,093,750	0.0107	$ 22,502
68	5,850	0	5,850	$ 1,491,750	$ -	$ 602,000	$ -	$ 2,093,750	0.0100	$ 21,029
69	5,850	0	5,850	$ 1,491,750	$ -	$ 602,000	$ -	$ 2,093,750	0.0094	$ 19,654
70	5,850	0	5,850	$ 1,491,750	$ -	$ 602,000	$ -	$ 2,093,750	0.0088	$ 18,368
									Total =	**$ 52,700,000**

Alternative 4

Year	Target Flow Rate (gpm)			O&M Costs [(a)]		LTM Costs [(b)]	Periodic Costs [(c)]	Total	Discount Factor	O&M Costs (Present Value)
	SEMOU	WNOU	Total	SEMOU	WNOU					
1	8,350	3,500	11,850	$ 2,129,250	$ 1,750,000	$ 602,000	$ -	$ 4,481,250	0.9346	$ 4,188,084
2	8,350	3,500	11,850	$ 2,129,250	$ 1,750,000	$ 602,000	$ -	$ 4,481,250	0.8734	$ 3,914,097
3	8,350	3,500	11,850	$ 2,129,250	$ 1,750,000	$ 602,000	$ -	$ 4,481,250	0.8163	$ 3,658,035
4	8,350	3,500	11,850	$ 2,129,250	$ 1,750,000	$ 602,000	$ -	$ 4,481,250	0.7629	$ 3,418,724
5	8,350	3,500	11,850	$ 2,129,250	$ 1,750,000	$ 602,000	$ -	$ 4,481,250	0.7130	$ 3,195,069
6	8,350	3,500	11,850	$ 2,129,250	$ 1,750,000	$ 602,000	$ -	$ 4,481,250	0.6663	$ 2,986,046
7	8,350	3,500	11,850	$ 2,129,250	$ 1,750,000	$ 602,000	$ -	$ 4,481,250	0.6227	$ 2,790,697
8	8,350	3,500	11,850	$ 2,129,250	$ 1,750,000	$ 602,000	$ -	$ 4,481,250	0.5820	$ 2,608,128
9	8,350	3,500	11,850	$ 2,129,250	$ 1,750,000	$ 602,000	$ -	$ 4,481,250	0.5439	$ 2,437,503
10	8,350	3,500	11,850	$ 2,129,250	$ 1,750,000	$ 602,000	$ -	$ 4,481,250	0.5083	$ 2,278,040
11	8,350	3,500	11,850	$ 2,129,250	$ 1,750,000	$ 602,000	$ -	$ 4,481,250	0.4751	$ 2,129,010
12	8,350	3,500	11,850	$ 2,129,250	$ 1,750,000	$ 602,000	$ -	$ 4,481,250	0.4440	$ 1,989,729
13	8,350	3,500	11,850	$ 2,129,250	$ 1,750,000	$ 602,000	$ -	$ 4,481,250	0.4150	$ 1,859,559
14	8,350	3,500	11,850	$ 2,129,250	$ 1,750,000	$ 602,000	$ -	$ 4,481,250	0.3878	$ 1,737,906
15	8,350	3,500	11,850	$ 2,129,250	$ 1,750,000	$ 602,000	$ -	$ 4,481,250	0.3624	$ 1,624,211
16	8,350	3,500	11,850	$ 2,129,250	$ 1,750,000	$ 602,000	$ -	$ 4,481,250	0.3387	$ 1,517,954
17	8,350	3,500	11,850	$ 2,129,250	$ 1,750,000	$ 602,000	$ -	$ 4,481,250	0.3166	$ 1,418,649
18	8,350	3,500	11,850	$ 2,129,250	$ 1,750,000	$ 602,000	$ -	$ 4,481,250	0.2959	$ 1,325,840
19	8,350	3,500	11,850	$ 2,129,250	$ 1,750,000	$ 602,000	$ -	$ 4,481,250	0.2765	$ 1,239,103
20	8,350	3,500	11,850	$ 2,129,250	$ 1,750,000	$ 602,000	$ 1,460,000	$ 5,941,250	0.2584	$ 1,535,332
21	8,350	1,000	9,350	$ 2,129,250	$ 500,000	$ 602,000	$ -	$ 3,231,250	0.2415	$ 780,389
22	8,350	1,000	9,350	$ 2,129,250	$ 500,000	$ 602,000	$ -	$ 3,231,250	0.2257	$ 729,336
23	8,350	1,000	9,350	$ 2,129,250	$ 500,000	$ 602,000	$ -	$ 3,231,250	0.2109	$ 681,622
24	8,350	1,000	9,350	$ 2,129,250	$ 500,000	$ 602,000	$ -	$ 3,231,250	0.1971	$ 637,030
25	8,350	1,000	9,350	$ 2,129,250	$ 500,000	$ 602,000	$ -	$ 3,231,250	0.1842	$ 595,355
26	8,350	1,000	9,350	$ 2,129,250	$ 500,000	$ 602,000	$ -	$ 3,231,250	0.1722	$ 556,407
27	8,350	1,000	9,350	$ 2,129,250	$ 500,000	$ 602,000	$ -	$ 3,231,250	0.1609	$ 520,006
28	8,350	1,000	9,350	$ 2,129,250	$ 500,000	$ 602,000	$ -	$ 3,231,250	0.1504	$ 485,987
29	8,350	1,000	9,350	$ 2,129,250	$ 500,000	$ 602,000	$ -	$ 3,231,250	0.1406	$ 454,194
30	8,350	1,000	9,350	$ 2,129,250	$ 500,000	$ 602,000	$ -	$ 3,231,250	0.1314	$ 424,480
31	8,350	0	8,350	$ 2,129,250	$ -	$ 602,000	$ -	$ 2,731,250	0.1228	$ 335,324
32	8,350	0	8,350	$ 2,129,250	$ -	$ 602,000	$ -	$ 2,731,250	0.1147	$ 313,387
33	8,350	0	8,350	$ 2,129,250	$ -	$ 602,000	$ -	$ 2,731,250	0.1072	$ 292,885
34	8,350	0	8,350	$ 2,129,250	$ -	$ 602,000	$ -	$ 2,731,250	0.1002	$ 273,724
35	8,350	0	8,350	$ 2,129,250	$ -	$ 602,000	$ -	$ 2,731,250	0.0937	$ 255,817
36	8,350	0	8,350	$ 2,129,250	$ -	$ 602,000	$ -	$ 2,731,250	0.0875	$ 239,081
37	8,350	0	8,350	$ 2,129,250	$ -	$ 602,000	$ -	$ 2,731,250	0.0818	$ 223,440
38	8,350	0	8,350	$ 2,129,250	$ -	$ 602,000	$ -	$ 2,731,250	0.0765	$ 208,823
39	8,350	0	8,350	$ 2,129,250	$ -	$ 602,000	$ -	$ 2,731,250	0.0715	$ 195,161
40	8,350	0	8,350	$ 2,129,250	$ -	$ 602,000	$ 1,460,000	$ 4,191,250	0.0668	$ 279,893
41	7,100	0	7,100	$ 1,810,500	$ -	$ 602,000	$ -	$ 2,412,500	0.0624	$ 150,568
42	7,100	0	7,100	$ 1,810,500	$ -	$ 602,000	$ -	$ 2,412,500	0.0583	$ 140,718
43	7,100	0	7,100	$ 1,810,500	$ -	$ 602,000	$ -	$ 2,412,500	0.0545	$ 131,512

44	7,100	0	7,100	$	1,810,500	$	-	$	602,000	$	-	$	2,412,500	0.0509	$	122,908
45	7,100	0	7,100	$	1,810,500	$	-	$	602,000	$	-	$	2,412,500	0.0476	$	114,868
46	7,100	0	7,100	$	1,810,500	$	-	$	602,000	$	-	$	2,412,500	0.0445	$	107,353
47	7,100	0	7,100	$	1,810,500	$	-	$	602,000	$	-	$	2,412,500	0.0416	$	100,330
48	7,100	0	7,100	$	1,810,500	$	-	$	602,000	$	-	$	2,412,500	0.0389	$	93,766
49	7,100	0	7,100	$	1,810,500	$	-	$	602,000	$	-	$	2,412,500	0.0363	$	87,632
50	7,100	0	7,100	$	1,810,500	$	-	$	602,000	$	-	$	2,412,500	0.0339	$	81,899
51	7,100	0	7,100	$	1,810,500	$	-	$	602,000	$	-	$	2,412,500	0.0317	$	76,541
52	7,100	0	7,100	$	1,810,500	$	-	$	602,000	$	-	$	2,412,500	0.0297	$	71,534
53	7,100	0	7,100	$	1,810,500	$	-	$	602,000	$	-	$	2,412,500	0.0277	$	66,854
54	7,100	0	7,100	$	1,810,500	$	-	$	602,000	$	-	$	2,412,500	0.0259	$	62,480
55	7,100	0	7,100	$	1,810,500	$	-	$	602,000	$	-	$	2,412,500	0.0242	$	58,393
56	7,100	0	7,100	$	1,810,500	$	-	$	602,000	$	-	$	2,412,500	0.0226	$	54,573
57	7,100	0	7,100	$	1,810,500	$	-	$	602,000	$	-	$	2,412,500	0.0211	$	51,003
58	7,100	0	7,100	$	1,810,500	$	-	$	602,000	$	-	$	2,412,500	0.0198	$	47,666
59	7,100	0	7,100	$	1,810,500	$	-	$	602,000	$	-	$	2,412,500	0.0185	$	44,548
60	7,100	0	7,100	$	1,810,500	$	-	$	602,000	$	1,460,000	$	3,872,500	0.0173	$	66,829
61	7,100	0	7,100	$	1,810,500	$	-	$	602,000	$	-	$	2,412,500	0.0161	$	38,910
62	7,100	0	7,100	$	1,810,500	$	-	$	602,000	$	-	$	2,412,500	0.0151	$	36,364
63	7,100	0	7,100	$	1,810,500	$	-	$	602,000	$	-	$	2,412,500	0.0141	$	33,985
64	7,100	0	7,100	$	1,810,500	$	-	$	602,000	$	-	$	2,412,500	0.0132	$	31,762
65	7,100	0	7,100	$	1,810,500	$	-	$	602,000	$	-	$	2,412,500	0.0123	$	29,684
66	7,100	0	7,100	$	1,810,500	$	-	$	602,000	$	-	$	2,412,500	0.0115	$	27,742
67	7,100	0	7,100	$	1,810,500	$	-	$	602,000	$	-	$	2,412,500	0.0107	$	25,927
68	7,100	0	7,100	$	1,810,500	$	-	$	602,000	$	-	$	2,412,500	0.0100	$	24,231
69	7,100	0	7,100	$	1,810,500	$	-	$	602,000	$	-	$	2,412,500	0.0094	$	22,646
70	7,100	0	7,100	$	1,810,500	$	-	$	602,000	$	-	$	2,412,500	0.0088	$	21,164
														Total =	**$**	**58,400,000**

Alternative 5

Year	Target Flow Rate (gpm) SEMOU	WNOU	Total	O&M Costs [(a)] SEMOU	WNOU	LTM Costs [(b)]	Periodic Costs [(c)]	Total	Discount Factor	O&M Costs (Present Value)
1	8,350	3,500	11,850	$ 2,129,250	$ 1,750,000	$ 602,000	$ -	$ 4,481,250	0.9346	$ 4,188,084
2	8,350	3,500	11,850	$ 2,129,250	$ 1,750,000	$ 602,000	$ -	$ 4,481,250	0.8734	$ 3,914,097
3	8,350	3,500	11,850	$ 2,129,250	$ 1,750,000	$ 602,000	$ -	$ 4,481,250	0.8163	$ 3,658,035
4	8,350	3,500	11,850	$ 2,129,250	$ 1,750,000	$ 602,000	$ -	$ 4,481,250	0.7629	$ 3,418,724
5	8,350	3,500	11,850	$ 2,129,250	$ 1,750,000	$ 602,000	$ -	$ 4,481,250	0.7130	$ 3,195,069
6	8,350	3,500	11,850	$ 2,129,250	$ 1,750,000	$ 602,000	$ -	$ 4,481,250	0.6663	$ 2,986,046
7	8,350	3,500	11,850	$ 2,129,250	$ 1,750,000	$ 602,000	$ -	$ 4,481,250	0.6227	$ 2,790,697
8	8,350	3,500	11,850	$ 2,129,250	$ 1,750,000	$ 602,000	$ -	$ 4,481,250	0.5820	$ 2,608,128
9	8,350	3,500	11,850	$ 2,129,250	$ 1,750,000	$ 602,000	$ -	$ 4,481,250	0.5439	$ 2,437,503
10	8,350	3,500	11,850	$ 2,129,250	$ 1,750,000	$ 602,000	$ -	$ 4,481,250	0.5083	$ 2,278,040
11	8,350	3,500	11,850	$ 2,129,250	$ 1,750,000	$ 602,000	$ -	$ 4,481,250	0.4751	$ 2,129,010
12	8,350	3,500	11,850	$ 2,129,250	$ 1,750,000	$ 602,000	$ -	$ 4,481,250	0.4440	$ 1,989,729
13	8,350	3,500	11,850	$ 2,129,250	$ 1,750,000	$ 602,000	$ -	$ 4,481,250	0.4150	$ 1,859,559
14	8,350	3,500	11,850	$ 2,129,250	$ 1,750,000	$ 602,000	$ -	$ 4,481,250	0.3878	$ 1,737,906
15	8,350	3,500	11,850	$ 2,129,250	$ 1,750,000	$ 602,000	$ -	$ 4,481,250	0.3624	$ 1,624,211
16	8,350	3,500	11,850	$ 2,129,250	$ 1,750,000	$ 602,000	$ -	$ 4,481,250	0.3387	$ 1,517,954
17	8,350	3,500	11,850	$ 2,129,250	$ 1,750,000	$ 602,000	$ -	$ 4,481,250	0.3166	$ 1,418,649
18	8,350	3,500	11,850	$ 2,129,250	$ 1,750,000	$ 602,000	$ -	$ 4,481,250	0.2959	$ 1,325,840
19	8,350	3,500	11,850	$ 2,129,250	$ 1,750,000	$ 602,000	$ -	$ 4,481,250	0.2765	$ 1,239,103
20	8,350	3,500	11,850	$ 2,129,250	$ 1,750,000	$ 602,000	$ 1,460,000	$ 5,941,250	0.2584	$ 1,535,332
21	8,350	1,000	9,350	$ 2,129,250	$ 500,000	$ 602,000	$ -	$ 3,231,250	0.2415	$ 780,389
22	8,350	1,000	9,350	$ 2,129,250	$ 500,000	$ 602,000	$ -	$ 3,231,250	0.2257	$ 729,336
23	8,350	1,000	9,350	$ 2,129,250	$ 500,000	$ 602,000	$ -	$ 3,231,250	0.2109	$ 681,622
24	8,350	1,000	9,350	$ 2,129,250	$ 500,000	$ 602,000	$ -	$ 3,231,250	0.1971	$ 637,030
25	8,350	1,000	9,350	$ 2,129,250	$ 500,000	$ 602,000	$ -	$ 3,231,250	0.1842	$ 595,355
26	8,350	1,000	9,350	$ 2,129,250	$ 500,000	$ 602,000	$ -	$ 3,231,250	0.1722	$ 556,407
27	8,350	1,000	9,350	$ 2,129,250	$ 500,000	$ 602,000	$ -	$ 3,231,250	0.1609	$ 520,006
28	8,350	1,000	9,350	$ 2,129,250	$ 500,000	$ 602,000	$ -	$ 3,231,250	0.1504	$ 485,987
29	8,350	1,000	9,350	$ 2,129,250	$ 500,000	$ 602,000	$ -	$ 3,231,250	0.1406	$ 454,194
30	8,350	1,000	9,350	$ 2,129,250	$ 500,000	$ 602,000	$ -	$ 3,231,250	0.1314	$ 424,480
31	8,350	0	8,350	$ 2,129,250	$ -	$ 602,000	$ -	$ 2,731,250	0.1228	$ 335,324
32	8,350	0	8,350	$ 2,129,250	$ -	$ 602,000	$ -	$ 2,731,250	0.1147	$ 313,387
33	8,350	0	8,350	$ 2,129,250	$ -	$ 602,000	$ -	$ 2,731,250	0.1072	$ 292,885
34	8,350	0	8,350	$ 2,129,250	$ -	$ 602,000	$ -	$ 2,731,250	0.1002	$ 273,724
35	8,350	0	8,350	$ 2,129,250	$ -	$ 602,000	$ -	$ 2,731,250	0.0937	$ 255,817
36	8,350	0	8,350	$ 2,129,250	$ -	$ 602,000	$ -	$ 2,731,250	0.0875	$ 239,081
37	8,350	0	8,350	$ 2,129,250	$ -	$ 602,000	$ -	$ 2,731,250	0.0818	$ 223,440
38	8,350	0	8,350	$ 2,129,250	$ -	$ 602,000	$ -	$ 2,731,250	0.0765	$ 208,823
39	8,350	0	8,350	$ 2,129,250	$ -	$ 602,000	$ -	$ 2,731,250	0.0715	$ 195,161
40	8,350	0	8,350	$ 2,129,250	$ -	$ 602,000	$ 1,460,000	$ 4,191,250	0.0668	$ 279,893
41	7,100	0	7,100	$ 1,810,500	$ -	$ 602,000	$ -	$ 2,412,500	0.0624	$ 150,568
42	7,100	0	7,100	$ 1,810,500	$ -	$ 602,000	$ -	$ 2,412,500	0.0583	$ 140,718
43	7,100	0	7,100	$ 1,810,500	$ -	$ 602,000	$ -	$ 2,412,500	0.0545	$ 131,512

44	7,100	0	7,100	$ 1,810,500	$ -	$ 602,000	$ -	$ 2,412,500	0.0509	$ 122,908
45	7,100	0	7,100	$ 1,810,500	$ -	$ 602,000	$ -	$ 2,412,500	0.0476	$ 114,868
46	7,100	0	7,100	$ 1,810,500	$ -	$ 602,000	$ -	$ 2,412,500	0.0445	$ 107,353
47	7,100	0	7,100	$ 1,810,500	$ -	$ 602,000	$ -	$ 2,412,500	0.0416	$ 100,330
48	7,100	0	7,100	$ 1,810,500	$ -	$ 602,000	$ -	$ 2,412,500	0.0389	$ 93,766
49	7,100	0	7,100	$ 1,810,500	$ -	$ 602,000	$ -	$ 2,412,500	0.0363	$ 87,632
50	7,100	0	7,100	$ 1,810,500	$ -	$ 602,000	$ -	$ 2,412,500	0.0339	$ 81,899
51	7,100	0	7,100	$ 1,810,500	$ -	$ 602,000	$ -	$ 2,412,500	0.0317	$ 76,541
52	7,100	0	7,100	$ 1,810,500	$ -	$ 602,000	$ -	$ 2,412,500	0.0297	$ 71,534
53	7,100	0	7,100	$ 1,810,500	$ -	$ 602,000	$ -	$ 2,412,500	0.0277	$ 66,854
54	7,100	0	7,100	$ 1,810,500	$ -	$ 602,000	$ -	$ 2,412,500	0.0259	$ 62,480
55	7,100	0	7,100	$ 1,810,500	$ -	$ 602,000	$ -	$ 2,412,500	0.0242	$ 58,393
56	7,100	0	7,100	$ 1,810,500	$ -	$ 602,000	$ -	$ 2,412,500	0.0226	$ 54,573
57	7,100	0	7,100	$ 1,810,500	$ -	$ 602,000	$ -	$ 2,412,500	0.0211	$ 51,003
58	7,100	0	7,100	$ 1,810,500	$ -	$ 602,000	$ -	$ 2,412,500	0.0198	$ 47,666
59	7,100	0	7,100	$ 1,810,500	$ -	$ 602,000	$ -	$ 2,412,500	0.0185	$ 44,548
60	7,100	0	7,100	$ 1,810,500	$ -	$ 602,000	$ 1,460,000	$ 3,872,500	0.0173	$ 66,829
61	7,100	0	7,100	$ 1,810,500	$ -	$ 602,000	$ -	$ 2,412,500	0.0161	$ 38,910
62	7,100	0	7,100	$ 1,810,500	$ -	$ 602,000	$ -	$ 2,412,500	0.0151	$ 36,364
63	7,100	0	7,100	$ 1,810,500	$ -	$ 602,000	$ -	$ 2,412,500	0.0141	$ 33,985
64	7,100	0	7,100	$ 1,810,500	$ -	$ 602,000	$ -	$ 2,412,500	0.0132	$ 31,762
65	7,100	0	7,100	$ 1,810,500	$ -	$ 602,000	$ -	$ 2,412,500	0.0123	$ 29,684
66	7,100	0	7,100	$ 1,810,500	$ -	$ 602,000	$ -	$ 2,412,500	0.0115	$ 27,742
67	7,100	0	7,100	$ 1,810,500	$ -	$ 602,000	$ -	$ 2,412,500	0.0107	$ 25,927
68	7,100	0	7,100	$ 1,810,500	$ -	$ 602,000	$ -	$ 2,412,500	0.0100	$ 24,231
69	7,100	0	7,100	$ 1,810,500	$ -	$ 602,000	$ -	$ 2,412,500	0.0094	$ 22,646
70	7,100	0	7,100	$ 1,810,500	$ -	$ 602,000	$ -	$ 2,412,500	0.0088	$ 21,164
									Total =	**$ 58,400,000**

Alternative 6

Year	Target Flow Rate (gpm)			O&M Costs [a]		LTM Costs [b]	Periodic Costs [c]	Total	Discount Factor	O&M Costs (Present Value)
	SEMOU	WNOU	Total	SEMOU	WNOU					
1	11,350	3,500	14,850	$ 2,894,250	$ 1,750,000	$ 602,000	$ -	$ 5,246,250	0.9346	$ 4,903,037
2	11,350	3,500	14,850	$ 2,894,250	$ 1,750,000	$ 602,000	$ -	$ 5,246,250	0.8734	$ 4,582,278
3	11,350	3,500	14,850	$ 2,894,250	$ 1,750,000	$ 602,000	$ -	$ 5,246,250	0.8163	$ 4,282,503
4	11,350	3,500	14,850	$ 2,894,250	$ 1,750,000	$ 602,000	$ -	$ 5,246,250	0.7629	$ 4,002,339
5	11,350	3,500	14,850	$ 2,894,250	$ 1,750,000	$ 602,000	$ -	$ 5,246,250	0.7130	$ 3,740,504
6	11,350	3,500	14,850	$ 2,894,250	$ 1,750,000	$ 602,000	$ -	$ 5,246,250	0.6663	$ 3,495,798
7	11,350	3,500	14,850	$ 2,894,250	$ 1,750,000	$ 602,000	$ -	$ 5,246,250	0.6227	$ 3,267,101
8	11,350	3,500	14,850	$ 2,894,250	$ 1,750,000	$ 602,000	$ -	$ 5,246,250	0.5820	$ 3,053,365
9	11,350	3,500	14,850	$ 2,894,250	$ 1,750,000	$ 602,000	$ -	$ 5,246,250	0.5439	$ 2,853,612
10	11,350	3,500	14,850	$ 2,894,250	$ 1,750,000	$ 602,000	$ -	$ 5,246,250	0.5083	$ 2,666,927
11	11,350	3,500	14,850	$ 2,894,250	$ 1,750,000	$ 602,000	$ -	$ 5,246,250	0.4751	$ 2,492,456
12	11,350	3,500	14,850	$ 2,894,250	$ 1,750,000	$ 602,000	$ -	$ 5,246,250	0.4440	$ 2,329,398
13	11,350	3,500	14,850	$ 2,894,250	$ 1,750,000	$ 602,000	$ -	$ 5,246,250	0.4150	$ 2,177,007
14	11,350	3,500	14,850	$ 2,894,250	$ 1,750,000	$ 602,000	$ -	$ 5,246,250	0.3878	$ 2,034,586
15	11,350	3,500	14,850	$ 2,894,250	$ 1,750,000	$ 602,000	$ -	$ 5,246,250	0.3624	$ 1,901,482
16	11,350	3,500	14,850	$ 2,894,250	$ 1,750,000	$ 602,000	$ -	$ 5,246,250	0.3387	$ 1,777,086
17	11,350	3,500	14,850	$ 2,894,250	$ 1,750,000	$ 602,000	$ -	$ 5,246,250	0.3166	$ 1,660,828
18	11,350	3,500	14,850	$ 2,894,250	$ 1,750,000	$ 602,000	$ -	$ 5,246,250	0.2959	$ 1,552,176
19	11,350	3,500	14,850	$ 2,894,250	$ 1,750,000	$ 602,000	$ -	$ 5,246,250	0.2765	$ 1,450,632
20	11,350	3,500	14,850	$ 2,894,250	$ 1,750,000	$ 602,000	$ 1,460,000	$ 6,706,250	0.2584	$ 1,733,022
21	11,350	1,000	12,350	$ 2,894,250	$ 500,000	$ 602,000	$ -	$ 3,996,250	0.2415	$ 965,147
22	11,350	1,000	12,350	$ 2,894,250	$ 500,000	$ 602,000	$ -	$ 3,996,250	0.2257	$ 902,006
23	11,350	1,000	12,350	$ 2,894,250	$ 500,000	$ 602,000	$ -	$ 3,996,250	0.2109	$ 842,996
24	11,350	1,000	12,350	$ 2,894,250	$ 500,000	$ 602,000	$ -	$ 3,996,250	0.1971	$ 787,847
25	11,350	1,000	12,350	$ 2,894,250	$ 500,000	$ 602,000	$ -	$ 3,996,250	0.1842	$ 736,306
26	11,350	1,000	12,350	$ 2,894,250	$ 500,000	$ 602,000	$ -	$ 3,996,250	0.1722	$ 688,136
27	11,350	1,000	12,350	$ 2,894,250	$ 500,000	$ 602,000	$ -	$ 3,996,250	0.1609	$ 643,118
28	11,350	1,000	12,350	$ 2,894,250	$ 500,000	$ 602,000	$ -	$ 3,996,250	0.1504	$ 601,045
29	11,350	1,000	12,350	$ 2,894,250	$ 500,000	$ 602,000	$ -	$ 3,996,250	0.1406	$ 561,724
30	11,350	1,000	12,350	$ 2,894,250	$ 500,000	$ 602,000	$ -	$ 3,996,250	0.1314	$ 524,976
31	11,350	0	11,350	$ 2,894,250	$ -	$ 602,000	$ -	$ 3,496,250	0.1228	$ 429,245
32	11,350	0	11,350	$ 2,894,250	$ -	$ 602,000	$ -	$ 3,496,250	0.1147	$ 401,164
33	11,350	0	11,350	$ 2,894,250	$ -	$ 602,000	$ -	$ 3,496,250	0.1072	$ 374,919
34	11,350	0	11,350	$ 2,894,250	$ -	$ 602,000	$ -	$ 3,496,250	0.1002	$ 350,392
35	11,350	0	11,350	$ 2,894,250	$ -	$ 602,000	$ -	$ 3,496,250	0.0937	$ 327,469
36	11,350	0	11,350	$ 2,894,250	$ -	$ 602,000	$ -	$ 3,496,250	0.0875	$ 306,046
37	11,350	0	11,350	$ 2,894,250	$ -	$ 602,000	$ -	$ 3,496,250	0.0818	$ 286,024
38	11,350	0	11,350	$ 2,894,250	$ -	$ 602,000	$ -	$ 3,496,250	0.0765	$ 267,312
39	11,350	0	11,350	$ 2,894,250	$ -	$ 602,000	$ -	$ 3,496,250	0.0715	$ 249,825
40	11,350	0	11,350	$ 2,894,250	$ -	$ 602,000	$ 1,460,000	$ 4,956,250	0.0668	$ 330,980
41	9,150	0	9,150	$ 2,333,250	$ -	$ 602,000	$ -	$ 2,935,250	0.0624	$ 183,194
42	9,150	0	9,150	$ 2,333,250	$ -	$ 602,000	$ -	$ 2,935,250	0.0583	$ 171,209
43	9,150	0	9,150	$ 2,333,250	$ -	$ 602,000	$ -	$ 2,935,250	0.0545	$ 160,008

44	9,150	0	9,150	$ 2,333,250	$ -	$ 602,000	$ -	$ 2,935,250	0.0509	$ 149,541
45	9,150	0	9,150	$ 2,333,250	$ -	$ 602,000	$ -	$ 2,935,250	0.0476	$ 139,757
46	9,150	0	9,150	$ 2,333,250	$ -	$ 602,000	$ -	$ 2,935,250	0.0445	$ 130,614
47	9,150	0	9,150	$ 2,333,250	$ -	$ 602,000	$ -	$ 2,935,250	0.0416	$ 122,070
48	9,150	0	9,150	$ 2,333,250	$ -	$ 602,000	$ -	$ 2,935,250	0.0389	$ 114,084
49	9,150	0	9,150	$ 2,333,250	$ -	$ 602,000	$ -	$ 2,935,250	0.0363	$ 106,620
50	9,150	0	9,150	$ 2,333,250	$ -	$ 602,000	$ -	$ 2,935,250	0.0339	$ 99,645
51	9,150	0	9,150	$ 2,333,250	$ -	$ 602,000	$ -	$ 2,935,250	0.0317	$ 93,126
52	9,150	0	9,150	$ 2,333,250	$ -	$ 602,000	$ -	$ 2,935,250	0.0297	$ 87,034
53	9,150	0	9,150	$ 2,333,250	$ -	$ 602,000	$ -	$ 2,935,250	0.0277	$ 81,340
54	9,150	0	9,150	$ 2,333,250	$ -	$ 602,000	$ -	$ 2,935,250	0.0259	$ 76,019
55	9,150	0	9,150	$ 2,333,250	$ -	$ 602,000	$ -	$ 2,935,250	0.0242	$ 71,046
56	9,150	0	9,150	$ 2,333,250	$ -	$ 602,000	$ -	$ 2,935,250	0.0226	$ 66,398
57	9,150	0	9,150	$ 2,333,250	$ -	$ 602,000	$ -	$ 2,935,250	0.0211	$ 62,054
58	9,150	0	9,150	$ 2,333,250	$ -	$ 602,000	$ -	$ 2,935,250	0.0198	$ 57,994
59	9,150	0	9,150	$ 2,333,250	$ -	$ 602,000	$ -	$ 2,935,250	0.0185	$ 54,200
60	9,150	0	9,150	$ 2,333,250	$ -	$ 602,000	$ 1,460,000	$ 4,395,250	0.0173	$ 75,850
61	9,150	0	9,150	$ 2,333,250	$ -	$ 602,000	$ -	$ 2,935,250	0.0161	$ 47,341
62	9,150	0	9,150	$ 2,333,250	$ -	$ 602,000	$ -	$ 2,935,250	0.0151	$ 44,244
63	9,150	0	9,150	$ 2,333,250	$ -	$ 602,000	$ -	$ 2,935,250	0.0141	$ 41,349
64	9,150	0	9,150	$ 2,333,250	$ -	$ 602,000	$ -	$ 2,935,250	0.0132	$ 38,644
65	9,150	0	9,150	$ 2,333,250	$ -	$ 602,000	$ -	$ 2,935,250	0.0123	$ 36,116
66	9,150	0	9,150	$ 2,333,250	$ -	$ 602,000	$ -	$ 2,935,250	0.0115	$ 33,753
67	9,150	0	9,150	$ 2,333,250	$ -	$ 602,000	$ -	$ 2,935,250	0.0107	$ 31,545
68	9,150	0	9,150	$ 2,333,250	$ -	$ 602,000	$ -	$ 2,935,250	0.0100	$ 29,481
69	9,150	0	9,150	$ 2,333,250	$ -	$ 602,000	$ -	$ 2,935,250	0.0094	$ 27,553
70	9,150	0	9,150	$ 2,333,250	$ -	$ 602,000	$ -	$ 2,935,250	0.0088	$ 25,750
									Total =	**$ 69,000,000**

Alternative 7

Year	Target Flow Rate (gpm)			O&M Costs [(a)]		LTM Costs [(b)]	Periodic Costs [(c)]	Total	Discount Factor	O&M Costs (Present Value)
	SEMOU	WNOU	Total	SEMOU	WNOU					
1	15,350	3,500	18,850	$ 3,914,250	$ 1,750,000	$ 602,000	$ -	$ 6,266,250	0.9346	$ 5,856,308
2	15,350	3,500	18,850	$ 3,914,250	$ 1,750,000	$ 602,000	$ -	$ 6,266,250	0.8734	$ 5,473,185
3	15,350	3,500	18,850	$ 3,914,250	$ 1,750,000	$ 602,000	$ -	$ 6,266,250	0.8163	$ 5,115,127
4	15,350	3,500	18,850	$ 3,914,250	$ 1,750,000	$ 602,000	$ -	$ 6,266,250	0.7629	$ 4,780,492
5	15,350	3,500	18,850	$ 3,914,250	$ 1,750,000	$ 602,000	$ -	$ 6,266,250	0.7130	$ 4,467,750
6	15,350	3,500	18,850	$ 3,914,250	$ 1,750,000	$ 602,000	$ -	$ 6,266,250	0.6663	$ 4,175,467
7	15,350	3,500	18,850	$ 3,914,250	$ 1,750,000	$ 602,000	$ -	$ 6,266,250	0.6227	$ 3,902,306
8	15,350	3,500	18,850	$ 3,914,250	$ 1,750,000	$ 602,000	$ -	$ 6,266,250	0.5820	$ 3,647,015
9	15,350	3,500	18,850	$ 3,914,250	$ 1,750,000	$ 602,000	$ -	$ 6,266,250	0.5439	$ 3,408,425
10	15,350	3,500	18,850	$ 3,914,250	$ 1,750,000	$ 602,000	$ -	$ 6,266,250	0.5083	$ 3,185,444
11	15,350	3,500	18,850	$ 3,914,250	$ 1,750,000	$ 602,000	$ -	$ 6,266,250	0.4751	$ 2,977,050
12	15,350	3,500	18,850	$ 3,914,250	$ 1,750,000	$ 602,000	$ -	$ 6,266,250	0.4440	$ 2,782,290
13	15,350	3,500	18,850	$ 3,914,250	$ 1,750,000	$ 602,000	$ -	$ 6,266,250	0.4150	$ 2,600,271
14	15,350	3,500	18,850	$ 3,914,250	$ 1,750,000	$ 602,000	$ -	$ 6,266,250	0.3878	$ 2,430,160
15	15,350	3,500	18,850	$ 3,914,250	$ 1,750,000	$ 602,000	$ -	$ 6,266,250	0.3624	$ 2,271,177
16	15,350	3,500	18,850	$ 3,914,250	$ 1,750,000	$ 602,000	$ -	$ 6,266,250	0.3387	$ 2,122,596
17	15,350	3,500	18,850	$ 3,914,250	$ 1,750,000	$ 602,000	$ -	$ 6,266,250	0.3166	$ 1,983,734
18	15,350	3,500	18,850	$ 3,914,250	$ 1,750,000	$ 602,000	$ -	$ 6,266,250	0.2959	$ 1,853,957
19	15,350	3,500	18,850	$ 3,914,250	$ 1,750,000	$ 602,000	$ -	$ 6,266,250	0.2765	$ 1,732,670
20	15,350	3,500	18,850	$ 3,914,250	$ 1,750,000	$ 602,000	$ 1,460,000	$ 7,726,250	0.2584	$ 1,996,610
21	15,350	1,000	16,350	$ 3,914,250	$ 500,000	$ 602,000	$ -	$ 5,016,250	0.2415	$ 1,211,490
22	15,350	1,000	16,350	$ 3,914,250	$ 500,000	$ 602,000	$ -	$ 5,016,250	0.2257	$ 1,132,234
23	15,350	1,000	16,350	$ 3,914,250	$ 500,000	$ 602,000	$ -	$ 5,016,250	0.2109	$ 1,058,162
24	15,350	1,000	16,350	$ 3,914,250	$ 500,000	$ 602,000	$ -	$ 5,016,250	0.1971	$ 988,937
25	15,350	1,000	16,350	$ 3,914,250	$ 500,000	$ 602,000	$ -	$ 5,016,250	0.1842	$ 924,240
26	15,350	1,000	16,350	$ 3,914,250	$ 500,000	$ 602,000	$ -	$ 5,016,250	0.1722	$ 863,776
27	15,350	1,000	16,350	$ 3,914,250	$ 500,000	$ 602,000	$ -	$ 5,016,250	0.1609	$ 807,267
28	15,350	1,000	16,350	$ 3,914,250	$ 500,000	$ 602,000	$ -	$ 5,016,250	0.1504	$ 754,455
29	15,350	1,000	16,350	$ 3,914,250	$ 500,000	$ 602,000	$ -	$ 5,016,250	0.1406	$ 705,098
30	15,350	1,000	16,350	$ 3,914,250	$ 500,000	$ 602,000	$ -	$ 5,016,250	0.1314	$ 658,970
31	15,350	0	15,350	$ 3,914,250	$ -	$ 602,000	$ -	$ 4,516,250	0.1228	$ 554,474
32	15,350	0	15,350	$ 3,914,250	$ -	$ 602,000	$ -	$ 4,516,250	0.1147	$ 518,200
33	15,350	0	15,350	$ 3,914,250	$ -	$ 602,000	$ -	$ 4,516,250	0.1072	$ 484,299
34	15,350	0	15,350	$ 3,914,250	$ -	$ 602,000	$ -	$ 4,516,250	0.1002	$ 452,616
35	15,350	0	15,350	$ 3,914,250	$ -	$ 602,000	$ -	$ 4,516,250	0.0937	$ 423,005
36	15,350	0	15,350	$ 3,914,250	$ -	$ 602,000	$ -	$ 4,516,250	0.0875	$ 395,332
37	15,350	0	15,350	$ 3,914,250	$ -	$ 602,000	$ -	$ 4,516,250	0.0818	$ 369,469
38	15,350	0	15,350	$ 3,914,250	$ -	$ 602,000	$ -	$ 4,516,250	0.0765	$ 345,298
39	15,350	0	15,350	$ 3,914,250	$ -	$ 602,000	$ -	$ 4,516,250	0.0715	$ 322,709
40	15,350	0	15,350	$ 3,914,250	$ -	$ 602,000	$ 1,460,000	$ 5,976,250	0.0668	$ 399,096
									Total =	$ 80,100,000

Notes:

(a) EA multiplied the O&M unit cost ($255/gpm for SEMOU and $500/gpm for WNOU) and the target flow rates to estimate the yearly O&M costs. The target flow rates and O&M/LTM timeframes were determined by CH2M Hill based on the groundwater model they developed for the site (Appendix A).

(b) See Item 6.02 for detailed breakdown of the LTM Costs.

(c) See Item 6.03 for detailed breakdown of the Periodic Costs.

Project: Appendix B Detailed Cost Estimate	Computed by: CS, JRL	Checked by: KM	EA Project No. 1518929
Subject: Cost Worksheet - Quantity and Cost Backup Calculations	Date: 5/11/20	Date: 5/15/20	

Quantity Summary / **Cost Summary**

Item	Bid Item	Quantity	Units			Unit Cost	Total	Comments
6.02	LTM Costs	1	LS			$602,000.00	$602,000.00	Annual costs, assuming one sampling event per year
	Rounding	0	(digits past 0)		Rounding	-3	(digits past 0)	
	Calculated Total Quantity	1	LS	(LS or EA, CY, TON, SY, LF, etc.)	Calc'd Cost	$601,797.17	$601,797.17	

Quantity Calculations / **Cost Calculations**

Item	Subitem	Quantity	Units	Notes	User	Material	Labor	Equipment	Factor	Unit Cost	Subtotal Cost	Cost Basis
LABOR, TRAVEL, AND FIELD EQUIPMENT/SUPPLIES									100%	$0.00	$0.00	
	Labor	1,000	HR		$100.00				100%	$100.00	$100,000.00	assumed
	Airfare	20	EA	Roundtrip, Sacramento, CA to Los Angeles, CA, assumes crew will travel home for the weekends	$550.00				100%	$550.00	$11,000.00	Southwest, 2020
	Airport Parking	5	DAY		$12.00				100%	$12.00	$60.00	SMF Airport, 2020
	Lodging	100	DAY		$181.00				100%	$181.00	$18,100.00	GSA, 2020
	Per Diem	100	DAY		$66.00				100%	$66.00	$6,600.00	GSA, 2020
	Rental Vehicle	40	DAY	SUV	$120.00				100%	$120.00	$4,800.00	Enterprise, 2020
	Fuel	40	GAL	assumes 10 miles per day at 10 mpg	$4.00				100%	$4.00	$160.00	assumed
	Other Direct Costs	1	LS	Includes field supplies, equipment, shipping, and IDW disposal	$72,812.14				100%	$72,812.14	$72,812.14	Professional Estimate
ANALYTICAL												
	VOCs EPA Method 8260C	170	EA		$50.00				100%	$50.00	$8,500.00	Vendor Quote, 2020
	1,4-dioxane by EPA Method 827D SIM	170	EA		$125.00				100%	$125.00	$21,250.00	Vendor Quote, 2020
	NDMA by EPA Method 1625	170	EA		$325.00				100%	$325.00	$55,250.00	Vendor Quote, 2020
	Perchlorate by EPA Method 300M	170	EA		$45.00				100%	$45.00	$7,650.00	Vendor Quote, 2020
	1,2,3-TCP by Method 524.2	170	EA		$150.00				100%	$150.00	$25,500.00	Vendor Quote, 2020
	Total metals + molybdenum and mercury	170	EA		$110.00				100%	$110.00	$18,700.00	Vendor Quote, 2020
	Cations by EPA Method 200.7	170	EA		$32.00				100%	$32.00	$5,440.00	Vendor Quote, 2020
	Hexavalent chromium by EPA Method 218.6	170	EA		$60.00				100%	$60.00	$10,200.00	Vendor Quote, 2020
	Nitrate by EPA Method 300	170	EA		$8.00				100%	$8.00	$1,360.00	Vendor Quote, 2020
	QA/QC	1	LS	3% of the analytical costs	$153,850.00				3%	$4,615.50	$4,615.50	assumed
ANNUAL COMPLIANCE MONITORING REPORT												
First Draft												
	Lump Sum	1	EA	Estimated at 10% of the monitoring cost	$37,000.00				100%	$37,000.00	$37,000.00	Estimate for technical support in U.S. EPA, 2000.
Second Draft												
	Lump Sum	1	HR	Assumed time needed = 50% that of 1st draft	$18,500.00				100%	$18,500.00	$18,500.00	assumed
Final Draft												
	Lump Sum	1	HR	Assumed time needed = 50% that of 2nd draft	$9,250.00				100%	$9,250.00	$9,250.00	assumed
ANNUAL PERFORMANCE EVALUATION REPORT												
First Draft												
	Lump Sum	1	EA	Estimated at 10% of the monitoring cost	$37,000.00				100%	$37,000.00	$37,000.00	Estimate for technical support in U.S. EPA, 2000.
Second Draft												
	Lump Sum	1	HR	Assumed time needed = 50% that of 1st draft	$18,500.00				100%	$18,500.00	$18,500.00	assumed
Final Draft												

Lump Sum	1	HR	Assumed time needed = 50% that of 2nd draft	$9,250.00	100%	$9,250.00	$9,250.00	assumed
Overhead	1	LS	Prime Contractor	$501,497.64	10%	$50,149.76	$50,149.76	[1]
Profit	1	LS	Prime Contractor	$501,497.64	10%	$50,149.76	$50,149.76	[1]

Supporting Calculations

This sheet estimates long-term monitoring costs.

The estimate assumes there will be one groundwater sampling event per year and that the number of monitoring wells sampled and the analyses will be similar to what is described in recent monitoring reports (see references [2] and [3]).

Assumptions

Number of samplers =	5
Number of field days =	20
Hours per day =	10
Number of rental vehicles =	2

Number of samples - estimated based on information available in sources [2] and [3]

Number of Monitoring Wells =	90	
% Westbay Wells =	25%	
Number of Westbay MWs =	23	
Number of Conventional MWs =	67	
Sample Intervals per Westbay MW =	3	
Subtotal =	136	
QC Samples =	34	30% of Subtotal
Total =	**170**	rounded to the tens

References:

[1] U.S. EPA, 2000. *A Guide to Developing and Documenting Cost Estimates During the Feasibility Study* . Office of Solid Waste and Emergency Response, Washington D.C.

[2] Gilbane Federal. 2019. Remedial Action 2018 Compliance Monitoring Report. San Gabriel Valley Area 1 Superfund Site. South El Monte Operable Unit. March.

[3] URS. 2019. Performance Evaluation Report. San Gabriel Valley Area 1 Superfund Site. Whittier Narrows Operable Unit. September.

Quantity Summary					Cost Summary			
Item	**Bid Item**	**Quantity**	**Units**			**Unit Cost**	**Total**	**Comments**
6.03	**Periodic Costs**	1	LS			$1,460,000.00	$1,460,000.00	**Replacement of 5% of monitoring wells (approximately 5 wells), a tank, two pumps, and an LGAC skid every 20 years**
	Rounding	**0**	(digits past 0)		Rounding	**-4**	(digits past 0)	
	Calculated Total Quantity	**1**	**LS**	(LS or EA, CY, TON, SY, LF, etc.)	Calc'd Cost	$1,458,088.74	$1,458,088.74	

Quantity Calculations					Cost Calculations							
Item	**Subitem**	**Quantity**	**Units**	**Notes**	**User**	**Material**	**Labor**	**Equipment**	**Factor**	**Unit Cost**	**Subtotal Cost**	**Cost Basis**
REPLACEMENT EQUIPMENT												
	20,000 gal Flat-bottom Tank	1	EA		$37,406.24				100%	$37,406.24	$37,406.24	National Tank Outlet, list price, 2020
	Influent/Effluent Pump	1	EA	General utility pump, single stage, double suction, 75 HP to 2,500 gpm, includes motor		$18,100.00	$13,996.50		100%	$32,096.50	$32,096.50	[1] 22 11 23.10 3190
	Backwash Pump	1	EA	General utility pump, single stage, double suction, 150 HP to 4,000 gpm, includes motor		$26,000.00	$16,262.60		100%	$42,262.60	$42,262.60	[1] 22 11 23.10 3240
	Liquid-phase GAC Skid (2 vessels)	1	EA	EVOQUA HP1220SYS, two LGAC vessels on a skid, 20,000 lbs GAC capacity each, Max flow (series/parallel) = 1,100/2,200 gpm, Backwash rate = 1,000 gpm, includes markup for freight (10%) and taxes (8.75%)	$356,250.00				100%	$356,250.00	$356,250.00	Vendor Quote, 2020
INSTALLATION OF REPLACEMENT EQUIPMENT (FOR TANK AND LGAC SKID ONLY)												
	Labor	1	WEEK	Crew of three workers, 10-hours a day, $60/HR labor rate	$9,000.00				100%	$9,000.00	$9,000.00	assumed
	Skidsteer	0.25	MONTH	1 CY 78 HP, diesel, includes grappel and fork attachments				$9,047.43	100%	$9,047.43	$2,261.86	[1] 01 54 33.20 4890, 01 54 33.20 4896, 01 54 33.20 4895
	Forklift	0.25	MONTH	All-terrain, telescoping boom, 6600 lb, 29-ft reach, 42-ft lift				$6,210.71	100%	$6,210.71	$1,552.68	[1] 01 54 33.40 2055
	Crane	1	DAY	Crane crew and 80-ton truck-mounted hydraulic crane			$1,687.40	$2,556.68	100%	$4,244.08	$4,244.08	[1] 01 54 19.50 0500
REPLACEMENT MONITORING WELLS												
	Monitoring Well	5	EA	500-ft monitoring well. See *Cost Basis* column for more details.	$146,000.00				100%	$146,000.00	$730,000.00	Based on costs for Type B Extraction Well in Cost Worksheet 2.02 (minus pump-related costs). Scaled down 75% to account for smaller borehole size for monitoring wells.
	Overhead	1	LS	Prime Contractor	$1,215,073.95				10%	$121,507.40	$121,507.40	[2]
	Profit	1	LS	Prime Contractor	$1,215,073.95				10%	$121,507.40	$121,507.40	[2]

Supporting Calculations

This sheet estimates periodic costs applicable to all alternatives with a treatment system. The costs include replacement of a tank, two pumps, and LGAC skid, and 10 monitoring wells every twenty years.

References:

[1] Gordian®. 2020. RSMeans Online. Labor: Standard Union. Location: Los Angeles (900-902). Release: Year 2020.

RSMeans values include the following overhead and profit markups for the Installing Contractor:

Material Cost - 10%
Labor Cost - Variable
Equipment Cost - 10%

[2] U.S. EPA, 2000. *A Guide to Developing and Documenting Cost Estimates During the Feasibility Study* . Office of Solid Waste and Emergency Response, Washington D.C.

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