

DRAFT FINAL REPORT

**REVISED
REMEDIAL ACTION PLAN**

**Maricopa County
Cave Creek Landfill
Phoenix, Arizona**

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May 6, 2016
Project No. 14-2014-2020



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LIST OF ACRONYMS AND ABBREVIATIONS

%	percent
§	Section
µg/L	micrograms per liter
µg/m ³	micrograms per cubic meter
1,1-DCE	1,1-dichloroethene
ADEQ	Arizona Department of Environmental Quality
ADWR	Arizona Department of Water Resources
AMEC	AMEC Environment & Infrastructure, Inc. (now known as Amec Foster Wheeler Environment & Infrastructure, Inc.)
Amec Foster Wheeler	Amec Foster Wheeler Environment & Infrastructure, Inc.
Amsl	above mean sea level
APP	Aquifer Protection Permit
AS	air sparging
ASCWP	Additional Site Characterization Work Plan
ASR	Aquifer Storage and Recovery
AWQS	Aquifer Water Quality Standard
BAS	Bryan A Stirrat & Associates
Bgs	below ground surface
CCL	Maricopa County Cave Creek Landfill
CFR	Code of Federal Regulations
cfm	cubic feet per minute
cis-1,2-DCE	cis-1,2-dichloroethene
cm ²	square centimeters
COC	contaminant of concern
Consent Order	Consent Order Docket Number S-2-10
COP	City of Phoenix
CSM	conceptual site model
DCE	dichloroethene
DHC	Dehalococcoides etheneogenes
ESRV	East Salt River Valley
ft	feet
ft/day	feet per day
ft/ft	feet per foot
ft/yr	feet per year
ft ³	cubic feet
g/cm ³	grams per cubic centimeter
GCWP	Cave Creek Landfill Groundwater Characterization Work Plan
GCWP Addendum	Addendum to the Cave Creek Landfill Groundwater Characterization Work Plan
gpm	gallons per minute
HDPE	high-density polyethylene
hp	horsepower
IGA	intergovernmental agreement
ISB	in situ bioremediation

LIST OF ACRONYMS AND ABBREVIATIONS (CONTINUED)

ISCO	in situ chemical oxidation
kg	kilograms
L-GAC	liquid phase granular activated carbon
LAU	Lower Alluvial Unit
Lbs	pounds
LEL	lower explosive limit
LFG	landfill gas
MAU	Middle Alluvial Unit
MCRM	Maricopa County Risk Management Department
MCWRRM	Maricopa County Waste Resources & Recycling Management
mg/m ³	milligrams per cubic meter
MNA	monitored natural attenuation
MSU	municipal solid waste
No.	Number
O&M	operation and maintenance
ORP	oxidation-reduction potential
P&T	pump-and-treat
PCE	tetrachloroethene
pcf	pounds per cubic foot
PDB	passive diffusion bag
ppmv	parts per million by volume
PQGWP	Poor Quality Groundwater Withdrawal Permit
PRB	permeable reactive barrier
PVC	polyvinyl chloride
PW	production well
RAP	Remedial Action Plan
RCRA	Resource Conservation and Recovery Act
RO	remedial objective
SVE	soil vapor extraction
TCE	trichloroethene
UAU	Upper Alluvial Unit
USEPA	United States Environmental Protection Agency
V-GAC	vapor phase granular activated carbon
VC	vinyl chloride
VI	vapor intrusion
VLS	vapor liquid separator
VOCs	volatile organic compounds
ZVI	zero valent iron

1.0 INTRODUCTION

1.1 Purpose

Pursuant to Consent Order Docket Number (No.) S-2-10 (the Consent Order [ADEQ, 2010]), this document presents a revised Remedial Action Plan (RAP) for the Maricopa County Cave Creek Landfill (CCL) site located in Phoenix, Arizona (the Site). This revised RAP was prepared on behalf of Maricopa County Risk Management (MCRM) and Maricopa County Waste Resources & Recycling Management (MCWRRM) by Amec Foster Wheeler Environment & Infrastructure, Inc. (Amec Foster Wheeler; formerly AMEC Environment & Infrastructure, Inc.) for review and approval by the Arizona Department of Environmental Quality (ADEQ).

The original RAP was prepared in 2008 by Bryan A Stirrat & Associates, Inc. (BAS); submittal of the document was determined to be premature by ADEQ. Since the original RAP was developed, Maricopa County has conducted additional site characterization activities with ADEQ oversight to support the remedial action planning documented herein. Based on the findings of these activities, the extent of a dissolved phase trichloroethene (TCE) groundwater plume underlying CCL has been characterized and the source of the plume has been identified as TCE contamination present in soil vapor originating from CCL.

This revised RAP presents the development and evaluation of potential corrective measures for TCE-contaminated groundwater at the Site and describes the proposed remedy selected from the alternatives evaluated. In accordance with the Consent Order, this evaluation was conducted in accordance with 40 Code of Federal Regulations (CFR) Section (§)258.56 which states “the assessment shall include an analysis of the effectiveness of potential corrective measures in meeting all of the requirements and objectives of the remedy as described under §258.57, addressing at least the following:

- 1) The performance, reliability, ease of implementation, and potential impacts of appropriate potential remedies, including safety impacts, cross-media impacts, and control of exposure to any residual contamination;
- 2) The time required to begin and complete the remedy;
- 3) The costs of remedy implementation; and
- 4) The institutional requirements such as State or local permit requirements or other environmental or public health requirements that may substantially affect implementation of the remedy(s).”

This revised RAP is part of the final remedy selection process for the Site where public comment and input is sought in accordance with 40 CFR §258.56(d). New information received from public meetings or public involvement activities could result in changes or modifications to the proposed remedy.

1.2 Plan Organization

This RAP is organized into the following sections:

- *Section 1.0 – Introduction.* This section discusses the purpose and scope of the revised RAP.
- *Section 2.0 – Site Background.* This section provides a summary description of the Site and historical activities that occurred at the Site.
- *Section 3.0 – Conceptual Site Model.* This section presents the conceptual site model (CSM), including a description of the physical setting, geology, hydrogeology, nature and extent of contamination (including the volume and area of affected media), contaminant fate and transport, and potential receptors of Site contamination.
- *Section 4.0 – Remedial Objectives.* This section presents Site remedial objectives (ROs) for remedies implemented at the Site.
- *Section 5.0 – Identification of Remediation Technologies and Screening of Preliminary Remedial Alternatives.* This section identifies the presumptive technology for impacted soil vapor, presents applicable remedial technologies for groundwater, and screens preliminary remediation alternatives for Site contamination.
- *Section 6.0 – Remedy Development.* This section develops the retained remediation alternatives that were screened in Section 5.0 for further evaluation.
- *Section 7.0 – Comparison of Alternative Remedies.* The selected remedies are compared to each other based on the criteria of practicability, cost, risk, and benefit/value. Uncertainties associated with developed remedies and the evaluation process are discussed.
- *Section 8.0 – Selection of the Proposed Remedy.* This section presents: (1) the selection of the proposed remedy and how the comparison criteria were considered in selecting the proposed remedy; (2) how the proposed remedy will achieve ROs and applicable regulatory standards; and (3) an overview of how the proposed remedy will be implemented with two potential remedy enhancements to control costs/risk.
- *Section 9.0 – Community Involvement.* This section documents the community involvement activities that will be conducted in association with this RAP.
- *Section 10.0 – References.* This section presents the references cited to prepare this RAP.

2.0 SITE BACKGROUND

2.1 Site Description

The Site is located in Maricopa County, approximately one half mile south of Carefree Highway and two miles west of Cave Creek Road. Site access is from Carefree Highway and the address is 3955 East Carefree Highway, Phoenix, Arizona. Figure 2-1 presents a recent site aerial with property boundaries and the estimated extent of past landfill operations. The following section describes landfill construction, operating history, and other site infrastructure.

Landfill Construction. CCL consists of two landfills that were operated by Maricopa County on adjoining properties. The Old Landfill waste placement area is approximately 35 acres in extent and is located on the 40-acre Bureau of Land Management property in the northeast portion of the site. There is limited available information regarding construction of this landfill but boring logs from relatively recent soil vapor well installation activities indicate that the cover is approximately 2 feet (ft) thick and the base of waste (which was placed directly on native soil) is at approximately 17 to 22 ft below ground surface (bgs) (SCS Engineers, 2005). At an average surface elevation of 1,897 ft above mean sea level (amsl), these depths correspond to elevations of 1,875 ft to 1,880 ft amsl.

The New Landfill waste placement area is approximately 32 acres in extent and is located on the 74.7-acre property owned by Maricopa County. The New Landfill was constructed in phases and includes cells constructed before and after federal regulations were promulgated that established minimum technical standards and guidelines for the management of nonhazardous municipal solid waste (MSU) (i.e., Resource Conservation and Recovery Act [RCRA] Subtitle D). The pre-Subtitle D region includes Cell A in the northern portion of the New Landfill and Cell B in the central portion of the New Landfill (see Figure 2-1; cell boundaries are approximate). Both of these cells are unlined (the base of waste was placed directly on native soil). Cell C, which is about 5.8 acres in extent, is the post-Subtitle D region of the New Landfill; this cell is underlain with a high-density polyethylene (HDPE) liner and includes a leachate collection and recovery system. The depth of waste in the New Landfill varies by cell:

Cell A: Given boring logs for wells installed in the northern portion of Cell A which indicate the depth to the base of the landfill is approximately 38 to 58 ft bgs (SCE Engineers, 2005) and current topographic survey data for the site (which indicates the surface elevation of Cell A currently ranges from approximately 1,899 to 1,903 ft amsl), the base of the waste is between 1,843 and 1,863 ft amsl. This range in elevation includes the elevation for the base of the waste reported in the design drawings for the landfill which is 1,850 ft amsl (Dames & Moore, 1994).

Cell B: Design drawings for the landfill indicate the base of the waste in Cell B is at approximately 1,820 ft amsl (Dames & Moore, 1994). According to current topographic survey data for the site, the surface elevation of Cell B ranges from approximately 1,895 to 1,910 ft amsl, which results in a landfill thickness of between 75 and 90 ft.

Cell C: The base of the waste in Cell C is approximately 1,820 ft amsl per landfill design drawings (Dames & Moore, 1994). There are no wells located in Cell C; however, the surface elevation of Cell C is consistent with Cell B so the landfill thickness in this region of the landfill is expected to be comparable to Cell B.

The thickness of cover in the New Landfill is 3 ft. A landfill gas (LFG) collection system was installed in Cells A and B of the New Landfill but is not currently in operation.

Landfill Operations. CCL began operations in 1965 at the Old Landfill, transitioned to the New Landfill in 1984 and ceased accepting waste in 1998. In the early 1990s, the daily tonnage averaged between 500 and 750 tons per day. The CCL was permitted to accept residential and commercial MSU and other wastes including: appliances, barnyard and stable waste, demolition material, non-infectious medical waste, domestic animals (large and small), green waste, foods, and inert materials.

Other Site Infrastructure. The remainder of the CCL site consists of the currently operating Maricopa County Cave Creek Waste Transfer Station (directly west of the Old Landfill and north of the New Landfill), a buffer zone located to the north, west, and south of the New Landfill, and multiple storm water retention areas located throughout the site. The transfer station is open to the public and receives both refuse and recyclables which are temporarily stored in bins and then removed to appropriate off-site facilities on a regular basis.

A groundwater production well (PW) is located adjacent to the transfer station; this well was installed in 1982 to supply water for fire and dust control purposes. Figure 2-2 presents the location of PW and numerous groundwater, LFG, and soil vapor monitoring wells installed to support regulatory compliance and site characterization. Appendix A summarizes well construction information for these wells.

The entrance to the CCL site at Carefree Highway is gated and locked during non-business hours. A chain-link fence surrounds the transfer station; other accessible areas are fenced with four-strand barbed wire.

Adjacent Land Use. Adjoining properties include the City of Phoenix (COP) Sonoran Preserve to the north, west, and south of the site and the Dove Valley Ranch Golf Course and residential community to the east of the site. The Sonoran Preserve is undeveloped desert designated as open space that has restrictions on development. A golf course club house and maintenance building are located on golf course property directly south of the CCL access road and east of the New Landfill. Single-family homes are located along the eastern toe of the New Landfill property in the southern portion of the site.

The COP provides drinking water to these commercial and residential properties using groundwater wells and surface water supplies sourced from outside the immediate vicinity of CCL.

2.2 Involved Parties

Responsibility for CCL site investigation and remediation is shared between two Maricopa County departments. The MCWRRM (formerly the Solid Waste Management Department) maintains the closed CCL, performs routine soil vapor and groundwater monitoring, and operates the Cave Creek Waste Transfer Station. The MCRM directs activities conducted to address the Consent Order and has contracted Amec Foster Wheeler to investigate environmental impacts of past landfilling operations and support Maricopa County with regulatory compliance. Contact information is provided as follows:

MCRM Environmental Programs Manager:	Rita Neill, PE
Address:	222 North Central Avenue, Suite 1110 Phoenix, Arizona 85004
Phone:	(602) 506-5063
Facsimile	(602) 506-5939
MCWRRM Manager:	Brian Kehoe
Address:	2919 West Durango Phoenix, Arizona 85009
Phone:	(602) 506-8997
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Amec Foster Wheeler Project Manager:	Natalie Chrisman Lazarr, PE
Address:	4600 East Washington Street, Suite 600 Phoenix, Arizona 85034
Phone:	(602) 733-6000
Facsimile	(602) 733-6100

2.3 Chronology of Site Activities

Table 2-1 presents a chronological summary of CCL site history to date, including operational, regulatory and site characterization information. An overview of significant CCL site characterization activities follows:

- In response to the detection of TCE in groundwater at concentrations exceeding the Arizona Aquifer Water Quality Standard (AWQS) of 5 micrograms per liter ($\mu\text{g/L}$) in samples collected from site well MW-1, Maricopa County entered into a Consent Order in 1999 with ADEQ requiring characterization of the nature and source of Site groundwater contamination. Preliminary soil vapor and LFG sampling was conducted in 1999 to evaluate potential site contamination; the concentrations of TCE observed in LFG extracted from the New Landfill (2.2 to 2.7 milligrams per cubic meter [mg/m^3]) were consistent with concentrations typically present in MSW landfills (BAS, 2008). TCE was also detected at trace levels (0.14 mg/m^3) in a shallow soil vapor sample collected from a perimeter well (P well) located southwest of the Old Landfill, in the vicinity of the transfer station. On the basis that low concentrations of TCE were detected in groundwater samples collected from PW in 1985 (only a year after operations began at the New Landfill), Maricopa County's consultant, Dames & Moore, concluded that the Old Landfill contained the source of TCE groundwater contamination.
- Following installation of soil vapor monitoring wells screened below the Old and New Landfills, soil vapor sampling was conducted in 2004. Results presented in the *Soil Vapor Assessment Report, Cave Creek Landfill* (SCS Engineers, 2005) indicated the presence of relatively low concentrations of TCE, 1,1-dichloroethene (1,1-DCE), and tetrachloroethene (PCE) beneath the New Landfill. The primary compounds associated

with samples collected from beneath the Old Landfill included 1,1-DCE and PCE. The report concluded that mobilized LFG, contaminated with TCE derived from landfill waste, could be the contaminant pathway responsible for groundwater impacts. LFG is produced during the biological degradation of waste placed in landfills and can migrate from unlined landfills both laterally and vertically due to diffusion, pressure gradients, and the permeability of subsurface strata.

- The *Cave Creek Landfill Groundwater Characterization Work Plan* (GCWP) prepared by BAS in 2005 further advanced the LFG-groundwater contamination pathway and identified the need for an additional groundwater monitoring well (i.e., MW-3) to define the extent of groundwater impacts. On August 31, 2006, ADEQ issued a letter to Maricopa County accepting the work plan with the provision that additional monitoring wells would need to be installed if MW-3 "...fails its intended purposes of assessment and characterization of the nature and extent of releases." (ADEQ, 2006).
- The GCWP also discussed a video survey that took place in December 2004 at wells MW-1, MW-2, and PW. The video survey was conducted to evaluate well construction and screen conditions after regional water table declines prevented collection of representative groundwater samples in these wells. Video logs indicated groundwater at the time of the video survey was between 676 and 696 ft bgs in MW-2 and PW, respectively. In response to this survey, the casing in PW was perforated with an in-hole perforating tool in January 2005 from 680 to 760 ft below the top of casing. To accommodate the declining water table, MW-1 and MW-2 were deepened by drilling through the base of these existing wells to 820 and 805 ft bgs, respectively, during January and February 2005.
- In August 2007, Maricopa County attempted to raise the dedicated electrical submersible pump in MW-1 for servicing. During the attempted removal, the pump became firmly lodged inside the well casing, rendering it inoperable. Additional attempts to remove the pump were unsuccessful and as a result, sampling of MW-1 is not possible. The last groundwater sample collected from MW-1 was analyzed in June 2007. The well remains unused, but not abandoned.
- Meetings between ADEQ and Maricopa County on March 24, 2008 and April 8, 2008 resulted in a general consensus that groundwater characterization was not complete and the installation of additional monitoring wells was necessary to adequately delineate the extent of groundwater contamination at the site. In response, an *Addendum to the Cave Creek Landfill Groundwater Characterization Work Plan* (GCWP Addendum) prepared on behalf of Maricopa County by AMEC Environment & Infrastructure, Inc. (AMEC) was submitted to ADEQ in May 2009. The purpose of the GCWP Addendum was to outline a groundwater characterization approach including the installation of test borings and sampling of associated groundwater in advance of monitoring well completion to appropriately locate permanent monitoring wells. The GCWP Addendum also included plans for the vertical characterization of groundwater contamination in MW-2 with passive diffusion bag (PDB) samplers and the adjustment of dedicated pump depths in site monitoring wells to support the collection of samples from comparable depths below the water table across the site.
- In July 2012, Maricopa County submitted a draft version of the *Additional Site Characterization Work Plan* (ASCWP) prepared by AMEC which documented the activities

identified in the GCWP Addendum including installation of groundwater characterization wells MW-4 through MW-7 and a supplemental well downgradient of the Old Landfill (MW-8). Installation and testing of the first deep soil vapor monitoring well installed at the Site (TSSV-1) was also presented. Based on the information obtained from these activities, the ASCWP concluded that contamination from one or both of the landfills has migrated vertically and laterally in the vadose zone resulting in a dispersed soil vapor plume at depth that is impacted with TCE and has served as a source of TCE contamination in groundwater underlying CCL. To support remedial action planning, additional site characterization activities were identified: the installation of additional deep soil vapor monitoring wells, a soil vapor treatment technology evaluation, development of a groundwater transport model, initiation of soil vapor extraction (SVE) operations, and continued groundwater monitoring activities. The finalized ASCWP was approved by ADEQ on February 13, 2013.

- In October 2012, Maricopa County submitted a technical memorandum entitled *Soil Vapor Well Planning Evaluation and Technical Approach* for ADEQ review and concurrence. The memorandum presented the results of a soil vapor well planning evaluation and a technical approach for well installation activities identified in the ASCWP. Three new nested vapor wells/groundwater piezometers (TSSV-2, TSSV-3, and TSSV-4) were installed in accordance with the technical approach to delineate the vertical and lateral extent of volatile organic compounds (VOCs), specifically TCE and its daughter products, in the deep vadose zone. Following completion of vapor monitoring wells in June 2013, the wells were purged and air samples were collected. Maricopa County then installed passive soil vapor samplers in 23 site vapor wells including the wells completed in 2013 and PDBs in associated groundwater piezometers. The data collected from these monitoring activities was reported in the *2013-2014 Data Compilation Report* (AMEC, 2014a) and indicated that the extent of elevated TCE concentrations in soil vapor appeared limited to the region underlying the Transfer Station and the northern portion of the New Landfill.
- In May 2013, Maricopa County submitted a *Soil Vapor Treatment Technology Evaluation* (AMEC, 2013a) to ADEQ for review and concurrence. The report identified granular activated carbon as the air treatment technology to be implemented at the Site during both testing of TSSV wells and for long-term treatment of extracted soil vapors. ADEQ formally approved the report and approach in their letter dated June 6, 2013.
- In October 2013, Maricopa County submitted a letter report entitled *Eastern Perimeter Vapor Well Sampling of P-5 and P-5X with Vapor Screening Analysis* to ADEQ documenting the results of sampling. TCE concentrations were consistent with previous perimeter well sampling results but were generally lower than those in the northern portion of the eastern landfill boundary. A screening level vapor intrusion (VI) analysis was performed as a precautionary measure due to the proximity of residential structures located east of the landfill boundary. Potential risks calculated from the United States Environmental Protection Agency (USEPA) Johnson & Ettinger model for TCE and benzene (1E-07 and 6E-08, respectively) were less than the ADEQ acceptable risk threshold of 1E-06 for known human carcinogens using data collected from both intervals of P-5X. These results indicate no immediate VI threat to residential structures in the vicinity of P-5X.

- In July and August 2014, an extended (six week) SVE pilot test was conducted in soil vapor wells TSSV-2 and TSSV-4 to evaluate extraction and assess vacuum response at nearby wells (Amec Foster Wheeler, 2015a). Although vacuum measurements at wells located in the vicinity of test wells were recorded using pressure transducer data loggers, the observed response to SVE in test wells was not sufficient to exceed diurnal pressure fluctuations. The highest TCE concentration observed during SVE operations at evaluated wells was 3,470 mg/m³ in the deep interval of TSSV-4; this was the highest TCE concentration observed in soil vapor at the Site through August 2014.
- On February 9, 2015 Maricopa County submitted the *Draft Revised Remedial Action Plan* to ADEQ (Amec Foster Wheeler, 2015b). Based on ADEQ comments received, additional groundwater modeling activities were performed and the community involvement section expanded. A complete copy was submitted to ADEQ and stakeholders (the COP and Arizona State Land Department) on July 24, 2015. The public comment period occurred between August 17, 2015 and September 15, 2015. A public meeting was held on September 1, 2015 to present and discuss the Revised RAP, and a separate meeting held with representatives from the COP on September 3, 2015. On November 6, 2015, responses to comments received during the public comment period were transmitted to ADEQ. On December 14, 2015, Maricopa County met with ADEQ to provide a status update, discuss public involvement requirements, the potential incorporation of a golf course discharge, the administrative process for RAP implementation, and the RAP implementation schedule.
- Between February and June 2015, Maricopa County installed three new soil vapor monitoring wells (TSSV-5, TSSV-6, and TSSV-7) and two SVE wells (SVE-1 and SVE-2). The new monitoring wells further define the soil vapor plume and the SVE wells are part of the full-scale SVE treatment system.
- Construction of the piping and treatment components of this system began in May 2015 and was completed in August 2015. Start-up of the full-scale SVE treatment system began on September 15, 2015 and operations have been ongoing since that time.

3.0 CONCEPTUAL SITE MODEL

The CSM is a three-dimensional representation of site conditions that illustrates contaminant distribution, release mechanisms, exposure pathways/migration routes, and potential receptors. A CSM that combines known site information into a comprehensive understanding of site conditions is a necessary tool for comparison of potential remedial technologies. As an evolving model, the following CSM for CCL will be modified as needed to continually evaluate the relationship between the sources of contaminants, release mechanisms, migration pathways, and receptors as new data become available.

In summary, the CCL CSM incorporates the following:

- One undifferentiated hydrostratigraphic unit:
 - In the area of CCL, due to the closeness to the basin margin, the three alluvial units identified by the Arizona Department of Water Resources (ADWR) for the East Salt River Valley (ESRV) sub-basin (the Upper Alluvial Unit [UAU], the Middle Alluvial Unit [MAU], and Lower Alluvial Unit [LAU]) are difficult to distinguish from each other and are treated as a single hydrogeological unit of generally undifferentiated alluvial deposits (sands, gravels, cobbles, and boulders with little to essentially no clay content).
 - The total thickness of the alluvium underlying CCL is estimated to range from 900 to 1,000 ft.
- A dynamic groundwater system:
 - The alluvial aquifer is unconfined and currently present at a depth of approximately 700 ft bgs at the Site.
 - The water table has declined in response to regional groundwater pumping; the water table declined approximately 3.5 feet per year (ft/yr) from 2001 to 2010 but was relatively stable between 2010 and 2012. Recently, the water table decline has resumed but at a rate lower than observed in the past (on the order of 1 to 2 ft/yr).
 - The direction of groundwater flow fluctuates from east to west but the predominant current direction of groundwater flow is to the south to southeast. The historic direction of groundwater flow was to the southwest, towards Cave Creek. Fluctuations in flow direction are potentially a response to regional groundwater withdrawals (from municipal wells located to the east and southeast of the site), large precipitation events, and storm water runoff recharge.
 - The average hydraulic gradient is about 0.003 feet per foot (ft/ft).
- The release of VOCs, primarily TCE, into the environment from a source or sources placed in one or more of the landfills:
 - Contaminant-impacted soil vapors dispersed both laterally and vertically from the landfills at some time in the past.

- Contaminant-impacted soil vapors have contributed to groundwater contamination at the Site in excess of AWQSSs; the soil vapors have the potential to be a continuing source of groundwater contamination if left untreated.
- The soil vapor source area appears to be limited to the region underlying the northern portion of the New Landfill and the Transfer Station. Groundwater impacted by contaminated soil vapor has migrated to the south with groundwater flow and the highest groundwater concentrations currently underlie the southern CCL property boundary at MW-2.
- TCE concentrations in downgradient groundwater monitoring wells (i.e., MW-4, MW-5, MW-6, and MW-7) have increased recently after a sustained period of relatively stable concentrations; these results suggest that the TCE groundwater plume is migrating off-site to the south.
- Incomplete contaminant exposure pathways:
 - Impacted soil vapor near ground surface does not appear to pose a VI threat to nearby residential structures.
 - Drinking water is not sourced from contaminated Site groundwater; regional drinking water supply wells are located approximately two miles east and southeast of the Site. Two irrigation supply wells are also located within two miles of the site. These drinking water and irrigation supply wells are not currently impacted by Site contamination but have the potential to be impacted in the future.

This CSM takes into account historical information reported in previous technical reports and reflects the current conceptual understanding of subsurface conditions at CCL affecting the occurrence and movement of contamination in soil vapor and groundwater. Elements of this CSM are further discussed in the following subsections. Additional detail is available in the ASCWP (AMEC, 2012a).

3.1 Environmental Setting

3.1.1 Regional Hydrogeology

The site lies within the Basin and Range Physiographic Province in Central Arizona. In this area, the mountains are generally comprised of crystalline rocks separated by broad alluvial valleys. Mountains represent upthrown fault blocks which sediments have been eroded and deposited in the basins below. In the center of these basins, the depth to bedrock can exceed 10,000 ft bgs.

CCL is located in the northern margin of the ESRV sub-basin of the Phoenix Active Management Area, which consists of up to 9,000-ft thick alluvial deposits of unconsolidated to semi-consolidated clastic sediment overlying bedrock. As discussed in BAS (2005), ESRV stratigraphy consists of a thick sequence of alluvial and lacustrine valley deposits. These units are identified by the ADWR (2006) as the UAU, the MAU, and the LAU. The UAU is comprised mainly of unconsolidated gravel, sand, and silt deposited in alluvial channel, terrace, and floodplain deposits (Corell and Corkhill, 1994). This unit is generally a very good producer of

groundwater. The MAU is comprised mainly of clay, silt, mudstone and gypsiferous mudstone with some interbedded sand and gravel.

Near the margins of the alluvial basins, the MAU consists mainly of sand and gravel and is reported as difficult or impossible to distinguish from other units (ADWR, 2006). The LAU is subdivided into two parts in the area of the CCL: the lower part is composed of evaporite deposits (gypsum and anhydrite) interbedded with sand and gravel, whereas the upper part is composed of semi-consolidated sand, gravel and silt.

3.1.2 Site Hydrogeology

Subsurface geology beneath CCL is typical for the ESRV and for the Phoenix area. Geology has been interpolated in the area surrounding CCL due to the large amount of undeveloped land present in the region and the lack of deep lithologic interpretative data. According to ADWR (2006), the bottom elevation of the UAU ranges from approximately 1,600 to 1,500 ft amsl, the bottom of the MAU ranges from approximately 1,200 to 1,000 ft amsl, and the bottom of the LAU ranges from approximately 1,000 to 800 ft amsl at the site.

In the area of CCL, due to the closeness to the basin margin, the UAU, MAU, and LAU are difficult to distinguish from each other. Therefore, the alluvial deposits are treated as a single hydrogeological unit of undifferentiated deposits. The bottom of the alluvial deposits slopes downward from the basin margin on the north, west, and east toward the south. In the vicinity of CCL, the total thickness of the alluvial deposits ranges from 900 to 1,000 ft.

Vadose Zone

Geology. Stratigraphic data collected during visual logging of cuttings and geophysical logging of site borings indicate the vadose zone consists of unconsolidated alluvial deposits (sands, gravels, cobbles, and boulders) with little to essentially no clay content. The deposition is highly heterogeneous but a relatively thin zone of increasing finer-grained materials (layered silts and fine sands) at depths of 200 to 250 ft bgs, or approximately 1,650 to 1,600 ft amsl in elevation, is indicated in the southern portion of the site. In the northern portion of the site, a similar zone occurs at a shallower depth, approximately 110 ft bgs or about 1,780 ft amsl. This slight change in grading may indicate the transition from the UAU to the MAU.

Permeability and Porosity. Based on the composition of the unconsolidated alluvial deposits, the formation is likely characterized by high permeabilities. The results of SVE testing (of screened intervals ranging from 150 to 600 ft bgs) suggest that the air permeability of deep sediments is on the order of $1\text{E-}8$ square centimeters (cm^2) to $1\text{E-}7$ cm^2 (1 to 10 darcys).

Samples were collected for dry (bulk) density testing during the installation of TSSV-03. Soil testing showed the bulk density ranged from 96.4 pounds (lbs) per cubic foot (pcf) to 119.4 pcf or 1.54 grams per cubic centimeter (g/cm^3) to 1.9 g/cm^3 . Assuming a particle density of 2.65 g/cm^3 , the total porosity ranges from 28 percent (%) to 42% by volume (AMEC, 2014a).

Depth to Groundwater. In the vicinity of CCL, the vadose zone is approximately 650 to 700 ft thick based on water levels collected at site monitoring wells between 2001 and 2015. The

groundwater elevation at the CCL ranges from approximately 1,158 to 1,206 ft amsl. Based on ADWR (2006) estimates, the entire UAU and a significant portion of the MAU is unsaturated at CCL.

Saturated Zone

Geology. Groundwater at the site occurs in an unconfined aquifer that likely consists of the LAU and the lower portion of the MAU. The UAU appears to be dry beneath the CCL site. The saturated zone is highly heterogeneous, as it consists of fine to very coarse grained unconsolidated to semi-consolidated alluvial deposits.

Aquifer Hydraulic Properties. The ability of the aquifer to transmit water at CCL is estimated based on materials encountered during drilling and regionally documented information. The saturated zone, at depth, consists of fine to very coarse grained unconsolidated sediments deposited in an alluvial environment. This depositional environment yields a highly heterogeneous aquifer making it difficult to fully define transport properties. Limited on-site aquifer test data (i.e., slug testing) suggest that the horizontal hydraulic conductivity may range from 5 to 19 feet per day (ft/day) in the vicinity of CCL (Dames & Moore, 1993). Based on values reported in the literature, the aquifer hydraulic conductivity may range from 1 to 200 ft/day and the specific yield ranges from 7% to 12% (Freihoefer et al, 2009).

Inflow. The primary source of recharge in the vicinity of CCL occurs from the infiltration of precipitation runoff from the surrounding mountains, the infiltration of surface water along Cave Creek (see Section 3.1.4), the infiltration of urban stormwater runoff, and underflow from adjacent basins of higher altitudes. In addition, the COP has implemented an Aquifer Storage and Recovery (ASR) program to artificially recharge groundwater through aquifer injection of surplus potable water.

Outflow. Prior to groundwater development in the early 1960s, the aquifer system was considered to be at equilibrium. However, aquifer outflows due to groundwater pumping have increased substantially since the 1960s, causing a deficit in the hydrologic budget and contributing to significant declines in groundwater elevations at the site over time.

3.1.3 Groundwater Flow Direction and Gradient

Groundwater elevations at PW, MW-2, MW-3, MW-4, MW-5, MW-6, MW-7, and MW-8 are used to estimate groundwater flow gradient and direction at CCL on a monthly basis. Calculated gradients from 2005 to 2015 range from 0.002 to 0.009 ft/ft and the average gradient is 0.003 ft/ft. These data indicate that the groundwater gradient at the site is relatively flat and does not vary significantly (AMEC, 2012a).

Flow direction can be measured in a clockwise rotation from north; north is 0 degrees, east is 90 degrees, south is 180 degrees, and west is 270 degrees. From 2005 to 2015, the calculated groundwater flow direction has ranged from 92 to 266 degrees from north. The average groundwater flow direction during this period was 159 degrees from north. These data indicate that although groundwater flow at the site fluctuates from east to west, the predominant recent direction of groundwater flow is to the southeast. Fluctuations in gradient and flow direction are

likely a response to regional groundwater withdrawals (predominantly from municipal wells located to the east and southeast of the site), large precipitation events, and storm water runoff recharge. Prior to the development of the municipal well fields, the predominant direction of groundwater flow in the vicinity of CCL was to the southwest (Littin, 1979).

Between 2000 and 2015, the depth to groundwater at CCL ranged from approximately 650 ft to 700 ft bgs, which corresponds to a groundwater elevation ranging from approximately 1,150 to 1,200 ft amsl. In general, the water table has been steadily declining over time, due to regional groundwater withdrawal for agricultural and municipal use. The water table declined approximately 3.5 ft/yr from 2001 to 2010 but was stable between 2010 and 2012. In recent years, the water table decline has resumed but at a rate lower than observed in the past (on the order of 1 to 2 ft/yr).

Saturated thickness increases from north to south across CCL, as a result of the sloping bottom of alluvial deposits near the ESRV basin margin. Based on recent water level measurements and the estimated thickness of the alluvium at the Site, the saturated thickness is estimated to be approximately 180 ft on the northern end of CCL to 340 ft on the southern end of CCL.

3.1.4 Surface Water

There are several creeks/washes near the CCL Site. The only significant natural surface water body located within one-mile radius of CCL is Cave Creek, which is located approximately 400 ft northwest of the Site. Cave Creek is generally dry and only flows in response to precipitation events. It should be noted that Cave Creek receives surface water flow from multiple braided washes that drain the region surrounding CCL following significant precipitation events. One of these natural washes is located directly south of the New Landfill on the COP Sonoran Preserve (see Figure 2-1).

Four retention basins are present on the CCL Site to retain and intercept run-on (Figure 2-1). Prior to development of the site as a landfill, a natural wash conveyed surface flow through the region that is now the New Landfill (a remnant of this wash is identifiable to the west of the New Landfill in Figures 2-1 and 2-2). Development to the east of the landfill has significantly altered natural drainage channels, diverted water away from the landfill area, and reduced the quantity of storm water run-on to the CCL site.

In addition to the retention basins, multiple ponds are present at the golf course located to the east of CCL.

3.1.5 Regional Groundwater Use

Since the 1960s, groundwater in the CCL area has been developed as potable and non-potable water sources, with the largest increase in production starting in the mid to late 1980s. The COP and City of Scottsdale have pumped municipal supply wells to supplement drinking water supplies approximately two miles east and southeast of the site. Figure 3-1 presents the location of wells located within 3 miles of the Site and Appendix B presents a summary of ADWR registration information for these wells. Water supply wells with the capacity to extract significant annual volumes and are located to the south and east of the Site include:

Location	Well	Owner	Alternative Designation	2010 Extraction [acre-ft]	2011 Extraction [acre-ft]	2012 Extraction [acre-ft]	2013 Extraction [acre-ft]
1 to 2 mi S	55-527549	COP	Well No. 280	505.7	333.01	291.2	228.9
2 to 3 mi SE	55-518789	COS	Well No. 65	241	10.05	5.23	1.38
2 to 3 mi S	55-603807	COP	Well No. 276	286.43	308.14	375.08	291.23
3 mi S	55-540078	COP	Well No. 288	99.61	111.78	208.75	NA

Since the last review of wells registered in the vicinity of CCL (AMEC, 2012a), two new private non-exempt wells have been installed:

- 55-221637; installed on October 29, 2012, located approximately 1 mile southeast of the Site near Lone Mountain Road and 43rd Street and owned by a plant nursery; and
- 55-221450; installed on June 9, 2013, located approximately 2 miles southeast of the Site at the Tatum Ranch Golf Course and owned by CLP Southwest Golf.

Annual extraction data are not yet available for these wells.

3.2 Environmental Impacts

3.2.1 Current Nature and Extent of Contamination

The results of soil vapor and groundwater sampling at the site indicate that both are impacted with VOCs that likely originated from one or both of the landfills. As discussed in Section 2.0, CCL consists of two landfill regions located on adjoining properties (see Figure 2-1). The following subsections present a current summary of the nature and extent of contamination at the Site.

Soil. Direct characterization of soil underlying the landfills has been limited. During the installation of TSSV-3, four ring-barrel samples collected from TSSV-3 were analyzed for VOCs using USEPA Method 8260. No VOCs were reported in collected samples above reporting limits (AMEC, 2014a). There was also no evidence of odors or staining in soils underlying the landfill to indicate potential impacts from landfill leachate or organic debris in the drill cuttings from any of the deep soil vapor monitoring wells completed in the landfills (i.e., TSSV-3 and TSSV-4). This suggests that the presence of landfill leachate is minimal underneath the landfill waste, which is typical in many municipal landfills in arid/semi-arid regions such as Arizona. On this basis, the soil underneath the landfill does not appear to be significantly impacted by VOCs.

Soil Vapor. Soil vapor concentrations of VOCs vary with location and depth at the site. There is a fair amount of data collected from 2004 to date at shallow vapor monitoring wells. However, the current availability to assess the extent of impacted soil vapor at depth is limited by the location and construction of available monitoring wells used to collect soil vapor samples from below 150 ft bgs.

Appendix C summarizes available halogenated soil vapor data collected from the site, including sample results from the 2014 Extended SVE Pilot Test which evaluated the concentrations of

VOCs in extracted soil vapors from each of the TSSV-2 and TSSV-4 wells during SVE (Amec Foster Wheeler, 2015a). Based on concentration and prevalence, the primary contaminant of concern (COC) in soil vapor is TCE. With the exception of vapors reported in TSSV-2D, 1,1-DCE, cis-1,2-dichloroethene (cis-1,2-DCE), and vinyl chloride (VC) were detected sporadically in the extracted vapors from individual vapor wells. In TSSV-2D, 1,1-DCE, cis-1,2-DCE, VC and methylene chloride were consistently detected above their respective reporting limits.

Figures 3-2 through 3-6 present updated TCE soil vapor isoconcentration maps for five depth-specific vadose zone intervals:

- *Near Ground Surface (1,822 to 1,855 ft amsl, corresponding to 50 to 90 ft bgs)*. Figure 3-2 shows the distribution of TCE in soil vapor in near surface soil. The lateral extent of near-surface TCE concentrations was inferred beyond the boundary of the survey using active soil vapor sample data collected in 2011 and 2012. TCE concentrations in near ground surface vapor monitoring wells ranged from 7.6 mg/m³ to 59 mg/m³.
- *Shallow Vadose Zone (1,681 to 1,772 ft amsl corresponding to the 150 to 200 ft bgs shallow screen of TSSV-1 with the exception of ODP-03 and NDP-02 which are 20 ft shallower)*. TCE concentrations in the shallow vadose zone were highest in the Waste Transfer area as represented by TSSV-1 and TSSV-2. TCE levels dropped off considerably in TSSV-4S beneath the New Landfill and were below the reporting limit in TSSV-3 (see Figure 3-3). Average TCE concentrations in the Waste Transfer Area ranged from 910 mg/m³ to 1,005 mg/m³.
- *Middle Vadose Zone (1,481 to 1,531 ft amsl corresponding to the 350 to 400 ft bgs middle screen of TSSV-1)*. TCE concentrations in the middle vadose zone were also highest in the Waste Transfer area as represented by TSSV-1 and TSSV-2. Similar to shallow soil vapor, TCE levels dropped off considerably in TSSV-4M beneath the New Landfill (see Figure 3-4). The average TCE concentrations in the Waste Transfer Area ranged from 670 mg/m³ to 755 mg/m³. Values were less than but comparable to levels observed in the shallow zone and lower than the deep zone.
- *Deep Vadose Zone (1,282 to 1,332 ft amsl corresponding to the 550 to 600 ft bgs deep screen of TSSV-1)*. TCE concentrations in the deep zone were highest beneath the New Landfill (TSSV-4D) as well as in the vicinity of Waste Transfer area as represented by TSSV-1D (see Figure 3-5). Concentrations were significantly lower at TSSV-2D (based on data collected in 2011/2012). TCE concentrations in TSSV-01-D and TSSV-04-D ranged from 2,630 mg/m³ to 3,470 mg/m³. These values are approximately 40% higher than the other zones.
- *Above Groundwater (approximately 1,162 to 1,201 ft amsl, varies by location, but generally ranging from 660 to 720 ft bgs)*. TCE concentrations in the vadose zone directly above the groundwater table were highest in the Waste Transfer area, as indicated at PW and TSSV-2PZ (see Figure 3-6). The average TCE concentrations in TSSV-2PZ and PW ranged from 84 mg/m³ to 240 mg/m³. These levels are generally lower than those observed at other depth intervals.

Figure 3-7 presents a depiction in cross section of inferred Site soil vapor contamination in the vadose zone. Deep soil vapor data suggest that contamination from the landfills migrated

vertically and laterally in the past and has resulted in a dispersed plume at depth that principally contains TCE and associated dehalogenation daughter products. 1,1-DCE, PCE, and Freon-113 are also present at elevated concentrations. Despite the limited amount of data collected in the southern portion of the New Landfill, deep soil vapor results indicate that the northern portion of site (near the Old Landfill and in the northern portion of the new Landfill) is more impacted with contaminated soil vapor than the southern portion of the site. The results also indicate that biologically mediated reductive dechlorination of TCE is occurring at depth and/or that these activities have occurred in the past in the landfills and associated indicators of reductive dechlorination and reduced conditions (i.e., cis-1,2-DCE, methane, and carbon dioxide) have migrated as vapors to depth.

Based on vapor monitoring at the soil vapor monitoring wells and the extended SVE testing activities conducted at the Site in 2014, the volume of contaminated soil vapor is estimated to be approximately 5.4 million m³ or 190 million cubic feet (ft³). Given this volume and the inferred TCE concentrations presented in Figures 3-2 through 3-6, the estimated mass of TCE present in the impacted soil vapor in the vadose zone is approximately 1,700 kilograms (kg) or 3,800 lbs. The total mass of TCE present in the vadose zone could be two to three times greater based on assumed values for soil moisture (10%) and the fraction of organic carbon (0.00015) in the soil.

Groundwater. TCE is the primary COC in groundwater at CCL based on the results of groundwater monitoring; however, other VOCs present in the contaminated soil vapor underlying the Site have impacted groundwater. Thru the end of 2014, compounds present at concentrations exceeding respective AWQS values are as follows:

COC	Well	Range in Concentration	AWQS
TCE	MW-1, MW-2, MW-4, MW-7, MW-8 and PW	<0.5-464 µg/L	5 µg/L
PCE	MW-2 and PW	<0.5-23.7 µg/L	5 µg/L
1,1-DCE	MW-2 and PW	<0.5-15.8 µg/L	7 µg/L
cis-1,2-DCE	PW	<0.5-164 µg/L	70 µg/L
Vinyl Chloride	PW	<0.5-10.3 µg/L	2 µg/L

The maximum concentrations reported above are all associated with a single sampling event and well: a sample collected from PW on November 2011 during SVE pilot testing conducted in this well. Although elevated concentrations of TCE, PCE, and 1,1-DCE have been detected during other sampling events, cis-1,2-DCE and VC have not been detected in groundwater at concentrations exceeding their respective AWQS values in any other samples collected from the site.

Excluding the November 2011 sample collected from PW, PCE and 1,1-DCE have only been detected at concentrations exceeding respective AWQS values in groundwater monitoring MW-2. In this well, concentrations of PCE first exceeded the AWQS of 5 µg/L in April 2010; 1,1-DCE was first detected above the AWQS of 7 µg/L in May 2011. While concentrations of these compounds have fluctuated above and below the respective AWQS values since these dates, levels remain elevated.

Figure 3-8 depicts the inferred extent of TCE present at the Site as of May 2014. As indicated by the figure, the bulk of the TCE plume footprint is located inside the CCL property boundary and the highest TCE concentration (117 µg/L) is currently present at MW-2. A small portion of the TCE plume with low concentrations is located off-site, downgradient from the southern CCL property boundary. The area of contaminated groundwater based on the 5 µg/L contour in Figure 3-8 is estimated to be 4,000 ft long by 1,200 ft wide with a total area of 4.8 million square ft; the total volume of contaminated aquifer is estimated to be 173 million ft³ if a total porosity value of 0.3 is used. The estimated mass of dissolved phase TCE present in groundwater plume is 496 kg (1,100 lbs).

Historical TCE concentration trends in groundwater for the CCL monitoring well network are shown in Figure 3-9 along with groundwater elevation trends. As indicated in Figure 3-9, TCE concentrations at MW-02 appeared to peak in 2009/2010. Groundwater levels continue to steadily decline, most likely due to ongoing regional extraction activities. A summary of ranges in TCE concentrations in samples collected from site wells is as follows:

Well	Minimum TCE Concentration	Date(s) Observed	Maximum TCE Concentration	Date Observed
PW	< 1.9 µg/L	November 1985 to December 1987	464 µg/L	November 2011
MW-1	< 2 µg/L	June 1993, March 1999 and August 1999	75 µg/L	April 2007
MW-2	<2 µg/L	Multiple dates in 1993 and 2000 through 2006	450 µg/L	April 2010
MW-3	<0.5 µg/L	Multiple dates in 2008 to 2010	2.6 µg/L	November 2011
MW-4	4.7 µg/L	May 2011	43 µg/L	May 2014
MW-5	<0.5 µg/L	March 2011 to August 2013	1.9 µg/L	November 2014
MW-6	0.9 µg/L	May 2011	4.7 µg/L	May and August 2014
MW-7	<0.5 µg/L	February 2012 to May 2012	8 µg/L	November 2014
MW-8	<0.5 µg/L	February 2012 to August 2014	11.9 µg/L	November 2014

As indicated by these data, recent increases in TCE concentrations observed at downgradient monitoring wells (MW-4, MW-5, MW-6, and MW-7) have resulted in peak concentrations at these wells after a relatively sustained period of stable concentrations since the wells were installed. These results suggest that the Site TCE plume no longer appears stable and could be migrating to the south. TCE concentrations currently exceed the AWQS at on-site wells PW and MW-2 and off-site wells MW-4 and MW-7. An exceedance of the AWQS was also observed in November 2014 at MW-8 (located downgradient of the Old Landfill). This was the first time TCE was detected in this well and will be further evaluated during upcoming monitoring events.

It is notable that all on-site groundwater wells are screened in the upper portion of the aquifer and there is no available information for the lower portion of the aquifer. As of December 2014, the pump intake depth in each of the monitored groundwater wells ranged from approximately 11 to

26 ft below the water table. The submerged screen length below the water table ranged from 37 to 108 ft.

3.2.2 Contaminant Fate and Transport

Fate and transport analysis is used to identify potential routes and relative rates of contaminant migration or degradation from source areas to potential receptors in site-specific environments. Estimates of contaminant mobility, persistence, and potential to impact air, soil, surface water, and/or groundwater are developed based on physical, chemical, and biological properties of both the contaminants and the soil and/or groundwater environment in which they occur.

Following placement of contaminated waste in landfills, VOCs can migrate rapidly downward from the landfill into vadose zone soils and subsequently dissolve in groundwater. The VOCs are carried by LFG that creates a gas pressure gradient downward (and outwards as well) into underlying vadose soils. Although most of the LFG VOCs may migrate upward through the soil cover, sufficient VOCs can be transported downward by advection and diffusion to result in groundwater contamination. After 20 to 30 years, continuing LFG generation and anaerobic biodegradation depletes the landfill of most of the VOCs, reversing the concentration gradient and leading to VOC concentrations that increase with depth and distance from the original source area (Walter et al., 2003).

Mechanisms Affecting Contaminant Transport at the Site. Based on available site history; soil vapor, soil, and groundwater data; and the results of SVE testing, the following primary mechanisms likely influenced and may continue to influence contaminant transport at the Site:

- In early stages of waste placement, LFG generating processes produce a significant amount of heat which contributes to the volatilization of VOCs present in waste and creates soil vapor with elevated concentrations of methane, carbon dioxide, and VOCs in the landfill waste. Given that the monitored concentrations of VOCs present in the landfill are currently low, this mechanism no longer contributes significantly to the fate and transport of VOCs at the Site.
- Pressure and temperature gradients generated by the production of LFG in the landfills results in both lateral and vertical migration of VOC-impacted soil vapor from the landfills to the region surrounding the landfill waste. LFG generation is ongoing but the rates of production have decreased significantly in recent years. The vadose zone at the Site is primarily composed of sand and gravel and this lithology is conducive to vapor advection.
- During the early stages of LFG generation, density-driven bulk-dense vapor movement can drive the vapor downward through the vadose zone until it is diluted to low enough concentrations that density-driven advection is no longer an important factor in the vapor transport process. Currently at CCL, density-gradient driven downward advection is no longer a significant driving force, as research shows that density-driven advection is minimal at vapor concentrations less than 15,000 parts per million by volume (ppmv) (Cotel et al., 2011; Oostrom et al., 2010, 2014). The highest TCE concentration in soil vapor at the Site observed to date is 3,470 mg/m³ (or 640 ppmv) at TSSV-4D during extended SVE testing conducted in 2014.

- Diffusion of contaminated soil vapors due to concentration gradients is likely the predominant current transport mechanism for VOCs in the vadose zone and drives contaminated vapor further downward to the groundwater surface (vapor diffusion occurs in all directions).
- Vapor-phase VOCs may enter groundwater by dissolving into infiltrated water that passes through contaminated soil vapor present in the vadose zone as a result of infiltration from heavy rainstorms. However, advective transport of aqueous phase COCs in infiltrating soil water is not considered to be a significant source of COCs to groundwater based on low net infiltration rates and an apparent lack of landfill leachate observed at the Site.
- Contaminants may dissolve directly from the contaminated soil vapor into the groundwater present in the capillary fringe of the water table, as governed by Henry's Law. Aqueous-phase advective transport of contaminated groundwater in the capillary fringe to the saturated aquifer can occur due to a falling water table (which has been modeled as an equivalent infiltration event by Walter et al. [2003]) and/or localized fluctuations of the water table into contaminated soil vapor.
- Once contamination is dissolved into groundwater, contaminants migrate with groundwater flow through advection, dispersion, and diffusion processes or are retained via adsorption onto soil or degraded by abiotic or biotic mechanisms. Since the soil vapor source area appears to be limited to the region underlying the northern portion of the New Landfill and the Transfer Station, groundwater impacts likely occur in this region of the Site and then contaminated groundwater subsequently migrates to the south with groundwater flow. The highest groundwater concentrations currently underlie the southern CCL property boundary at MW-2, in a region that is not impacted with high soil vapor concentrations at depth.

A graphical depiction of the CSM, including these potential transport mechanisms, is provided in Figure 3-11.

Routes of Potential Future Migration in the Vadose Zone. Unless removed, the high VOC concentrations in soil vapor present at depth in the vadose zone represent a potential continuing source of contamination to groundwater. To conservatively estimate the TCE mass flux from the contaminated soil vapor to groundwater, VLEACH model simulations (Ravi and Johnson, 1997) were conducted using estimated Site soil parameters and the inferred extent of TCE in soil. Although this approach is based on modeling soil leaching, VLEACH has been successfully used in desert aquifers to evaluate groundwater impacts from soil vapor plumes and represents an approximation of vapor contamination flux from the vadose zone to groundwater if no source removal is conducted. Model input concentrations were calculated using the following soil data collected from the Site:

Soil Parameter	Value
Dry Bulk Density	1.91 kg/L
Water Content (fraction)	0.10
Total Porosity	0.28
Air-Filled Porosity (fraction)	0.18

With these soil parameters, an assumed fraction of organic carbon of 0 (i.e., no adsorption onto soil surfaces) and a dimensionless Henry's Law Constant of 0.422 at 25 degrees Celsius, average soil vapor TCE concentrations at each depth-specific vadose zone interval of the source area were used to calculate TCE concentrations in soil used as input concentrations into VLEACH:

Soil Interval	Depth [ft bgs]	Average Equivalent Soil Vapor TCE Concentration [mg/m ³]	Calculated Soil TCE Concentration [µg/Kg]
Near Surface	0 to 125	14	2.9
Shallow	125 to 225	207	43
Shallow/Middle	225 to 325	177	36
Middle	325 to 425	178	37
Middle/Deep	425 to 525	484	101
Deep	525 to 625	567	118
Above Water Table	625 to 690	23	4.7

Since VLEACH only allows one continuous column of soil contamination as a model input, the size of the source area was assumed to be the same as the TCE vapor extent in the near surface soil interval (0 to 125 ft bgs), which has the largest extent among defined depth intervals. To address the varying extents of contaminated vapor in each soil interval, average soil vapor concentrations were normalized to the near surface area and represent equivalent mass concentrations for each interval. A recharge rate of 0.5 inches/year was used.

Simulation results showed that the current extent and mass of contaminated soil vapor can sustain a substantial TCE mass flux to groundwater for more than 1,000 years (see Figure 3-10). These TCE fluxes would likely result in TCE groundwater concentrations above the AWQS. Modeling results suggest that after 1,000 years, approximately 60% of current estimated TCE mass is still present in the vadose zone soil vapor if the contaminated soil vapor is left untreated.

Routes of Potential Future Migration in Groundwater. The most likely potential routes of future contaminant migration in groundwater are advection (movement with groundwater flow), diffusion, and dispersion, including possible migration to greater depth and deeper aquifers. Given the depth of groundwater and absence of any discharge points in the vicinity of the Site, discharge to surface water will not occur.

Contaminant Persistence. Persistence is a measure of how long a chemical will exist in the environment before it degrades or transforms into another chemical via biotic or abiotic processes. Factors that can affect chemical persistence include the quantity present, availability of oxygen and nutrients, the types and quantities of microorganisms present, temperature, pH, alkalinity, oxidation-reduction potential (ORP), exposure to sunlight, and the presence of other substances that might inhibit or enhance degradation. Many factors that affect chemical persistence and degradation kinetics are often difficult to predict for a specific chemical at a given site. However, a qualitative evaluation of chemical degradation potential can be made on the basis of published results or previous laboratory and/or field studies conducted at other locations.

The results of soil gas monitoring and SVE short-term testing indicate that reductive dehalogenation has occurred at the site, most likely in the waste buried in the landfill where methanogenesis produced methane and created a reducing environment facilitating the reduction of TCE and associated daughter products. The presence of reductive dehalogenation daughter products (cis-1,2-DCE and VC) in groundwater is likely the result of contaminant dissolution from contaminated soil vapor. The lack of an electron donor and presence of dissolved oxygen, nitrate, and sulfate in groundwater underlying the Site, along with elevated ORP values, suggest that the rate of intrinsic anaerobic TCE biodegradation will not be significant.

Without treatment, TCE is expected to be persistent in Site vadose zone soil vapor at depth. In addition to the anticipated slow rate of dissolution into groundwater, TCE present in deep soil vapor will likely adsorb on soil surfaces, dissolve in soil moisture and/or migrate to shallow depths and dissipate to atmosphere through barometric pumping and diffusion. The rate of removal due to dissipation to atmosphere is anticipated to be low on the basis that the release of TCE from the landfill likely occurred in the distant past and the concentration gradient in vadose zone soil generally increases with depth and distance from the original source area.

3.2.3 Exposure Points, Routes and Receptors

A receptor comes into contact with COCs only if a complete or potentially complete exposure pathway exists under current (or future) land use or groundwater use conditions. For an exposure pathway to be considered complete, it must be possible for a chemical to be transported via an environmental medium (i.e., exposure point) to a potential receptor location, and then for the receptor to come in contact with the chemical and assimilate it into their bodies via one or more exposure routes (for instance, ingestion, inhalation, or dermal contact).

Depending on site conditions, receptors can be based on surrounding land use and/or downgradient users of groundwater. Land use surrounding the Site principally includes undeveloped desert (which is part of the COP Sonoran Preserve); however there is a golf course club house (for Dove Valley Ranch Golf Course) and a maintenance building on golf course property located directly south of the CCL access road and east of the New Landfill. Single-family homes are also located near the eastern toe of the New Landfill in the southern portion of the Site, approximately 100 ft east of the landfill waste boundary. People who work in or frequent golf course buildings are potential receptors of Site soil vapor contamination as are residents who live in homes that are located adjacent the New Landfill. Inhalation via VI of COCs in shallow soil vapor originating from the landfill into structures would be the primary exposure pathway for these potential receptors.

Given the duration of potential exposure and age of inhabitants, residents living in homes adjacent to the New Landfill are considered the most sensitive potential receptors to shallow Site vapor contamination. To evaluate whether the VI exposure pathway is complete, a screening level VI analysis assuming a residential exposure scenario was performed (AMEC, 2013b). The concentrations of TCE and other contaminants in soil vapor collected from perimeter well P-5X were used in the evaluation due to the location of the well (see Figure 2-2) and its construction. Potential VI risks associated with soil vapor concentrations observed in May 2013 of 96.2 micrograms per cubic meter ($\mu\text{g}/\text{m}^3$) TCE and 16.5 $\mu\text{g}/\text{m}^3$ benzene at 15 ft bgs and 236 $\mu\text{g}/\text{m}^3$ TCE and 53 $\mu\text{g}/\text{m}^3$ benzene at 50 ft bgs were modeled using the USEPA Johnson & Ettinger

model. Results of modeling indicated that the potential incremental VI risks to a theoretical resident located in a residential structure constructed over P-5X were 1E-07 for TCE (at both depths) and 5E-08 and 6E-08 for benzene at 15 ft and 50 ft bgs, respectively. These risks are significantly less than the ADEQ acceptable risk threshold of 1E-06 for known human carcinogens and indicate no immediate VI threat to residential structures in the vicinity of P-5X (i.e. the current VI contaminant exposure pathway from shallow soil vapor is considered incomplete). On the basis that shallow soil vapor concentrations are anticipated to dissipate with time, the VI contaminant exposure pathway will likely remain incomplete in the future.

It is notable that the inferred extent of impacted groundwater exceeding the AWQS extends beyond the Site boundary and underlies buildings located at the Dove Valley Ranch Golf Club and residences located to the east and south of the landfill property (see Figure 3-8). Although there is a potential for small amounts of TCE present in the groundwater to volatilize into the soil vapor above the groundwater, impacted groundwater is located at approximately 700 ft bgs. EPA guidance (2002) indicates that vapor sources (e.g. impacted groundwater) located at depths greater than 100 ft should not pose a VI risk to overlying structures; on this basis, both the current and future VI contaminant exposure pathway from deep soil vapor are considered incomplete.

As indicated in Section 3.1.5, users of groundwater downgradient from the Site are currently comprised of private well owners (using extracted groundwater for irrigation) and municipal water suppliers (using the extracted groundwater for drinking water use). Since the known extent of the groundwater TCE plume exceeding the AWQS is no more than 1,000 ft from the southern Site property boundary, potential receptors that use water from these supply wells are not currently impacted and associated exposure pathways for Site contamination in groundwater are considered incomplete. However, regional groundwater withdrawal appears to impact the direction of groundwater flow at CCL and if attenuation mechanisms controlling the fate and transport of TCE present in groundwater from the Site are not sufficient or the quantity of mass released to groundwater over time is significant, TCE in groundwater may migrate to these wells in the future. On this basis, potential future receptors of site contamination via exposure to extracted groundwater through inhalation (during irrigation use) or ingestion (during drinking water use) include recipients of groundwater extracted from existing water supply wells downgradient of the Site if the contaminated groundwater plume migrates to these wells.

Additional users of groundwater include owners of hydraulically downgradient properties that could install groundwater supply wells in the future. Although development within the Sonoran Preserve is restricted (i.e., no wells can be installed), property owners with water rights located south and east of the Sonoran Preserve could install water supply wells and become future receptors of contamination through extracted groundwater use.

4.0 REMEDIAL OBJECTIVES

In accordance with 40 CFR §258.56 which is referenced in Section III.B.2 of the Consent Order (ADEQ, 2010) as the basis for corrective measures assessment, the following three threshold criteria (per 40 CFR §258.57b) serve as the basis for final cleanup goals for RCRA corrective actions:

- 1) Be protective of human health and the environment;
- 2) Attain the groundwater protection standard as specified pursuant to 40 CFR §258.55(h) or (i); and
- 3) Control the source(s) of releases so as to reduce or eliminate, to the maximum extent practicable, further releases of appendix II constituents into the environment that may pose a threat to human health or the environment.

In Arizona, the maximum contaminant levels for drinking water referred to in 40 CFR §258.55(h) are promulgated as numeric AWQS's in AAC R18-11-406. Thus, the AWQS for each COC present in Site groundwater is the applicable groundwater protection and media cleanup standard at the Site:

COC	AWQS
TCE	5 µg/L
PCE	5 µg/L
1,1-DCE	7 µg/L
cis-1,2-DCE	70 µg/L
Vinyl Chloride	2 µg/L

Given the current nature and extent, future fate and transport, and potential exposure routes and receptors of Site contamination presented in Section 4.0, ROs developed for the Site to protect human health and the environment are as follows:

- For current land use at the Sonoran Preserve by the COP and nearby property owners located within the areal extent of the groundwater plume exceeding the AWQS for TCE: Restore the groundwater hydraulically downgradient of the Site boundary that has been impacted by Site releases of COCs to concentrations that comply with AWQS's within a reasonable remediation timeframe (i.e., 30 years) to return this resource to its maximum beneficial use and protect the rights of property owners with water rights to install future water supply wells.
- For future water use by the COP and private owners of existing wells located hydraulically downgradient of the Site: Prevent the migration of contaminated groundwater from the Site at concentrations that would result in the withdrawal of groundwater with COC concentrations in excess of AWQS's (which are drinking water standards) at COP municipal wells 55-527549 (Well No. 280), 55-603807 (Well No. 276), and 55-540078 (Well No. 288). For existing private irrigation well 55-221637 and golf course well 55-221450, prevent the migration of contaminated groundwater which would result in the withdrawal of groundwater from these wells with COC concentrations in excess of those corresponding to applicable risk thresholds for the protection of human health and the environment.

- For future land use by adjacent residential property owners: Limit exposure of soil vapors contaminated with COCs at nearby residential structures to levels that are below risk thresholds for human health (i.e., levels that result in a cumulative excess lifetime cancer risk of less than 1E-05 and a Hazard Index no greater than 1 based on residential exposure assumptions).

ROs developed for the Site to control the sources of future releases that may pose a threat to human health and the environment are as follows:

- For current land use by Maricopa County: Remove COC mass present in Site soil vapor with the potential to serve as a source of contamination to groundwater at concentrations exceeding AWQS's.

These ROs are applicable at the Site for as long as COC concentrations in groundwater underlying and downgradient of the Site exceed AWQS's.

5.0 IDENTIFICATION OF REMEDIATION TECHNOLOGIES AND SCREENING OF PRELIMINARY REMEDIAL ALTERNATIVES

This section identifies applicable remediation technologies for both soil vapor and groundwater at CCL. The identification process begins with a review of technologies that may be used to satisfy the ROs. Within each technology, multiple approaches and process options may be assessed prior to incorporation into preliminary alternatives. These preliminary alternatives are then screened prior to selection of remedies retained for further development in Section 6.0 and evaluation in Section 7.0.

5.1 Soil Vapor Remediation Technologies

SVE is identified as the presumptive treatment technology for remediating soil vapor VOC contamination at the Site on the basis that it is only practicable approach to contain and remediate the deep and generally diffuse soil vapor contaminant plume underlying CCL. Full-scale implementation of SVE may include both the extraction of contaminated soil vapors and the injection of ambient (i.e., clean) air to promote expedited declines in VOC concentrations. Anticipated components of the SVE system consist of:

- Extraction/injection wells;
- Vapor monitoring wells;
- Soil vapor conveyance piping and appurtenances;
- Condensate management equipment (e.g., sumps and a vapor-liquid separator);
- One or more process blowers with associated instrumentation and controls; and
- A vapor treatment process unit.

Vapor phase granular activated carbon (V-GAC) with potassium permanganate (e.g., Hydrosil HS-600) post treatment for VC, thermal/catalytic oxidation, and vapor condensation were previously evaluated for remediation of extracted soil vapor in advance of SVE testing of soil vapor monitoring wells (AMEC, 2013a). Implementation of V-GAC with potassium permanganate post treatment was determined to be the most readily implementable alternative for both the short-term and long-term at the Site and was assessed as cost competitive with other alternatives evaluated.

5.2 Groundwater Remediation Technologies

This section identifies the remedial technologies considered for groundwater remediation at the Site based on response actions that are routinely used for remediating groundwater impacted by VOCs in environmental applications. For preliminary assessment purposes, the following summary requirements and assumptions were incorporated into the analysis:

- Contaminant – TCE is the predominant groundwater contaminant (although PCE, cis-1,2-DCE, VC, and 1,1-DCE are also present). The highest concentration of TCE is on the order of 100 µg/L at monitoring well MW-2 (as of December 2014). Contamination is confined to the monitored portion of the aquifer (the top 120 ft) and is assumed to be relatively homogeneous in distribution.

- Media Cleanup Standard – Treatment technologies must achieve drinking water standards for VOCs (AWQS's).
- End Use – For ex situ treatment technologies, end use of treated water would likely be sewer discharge, groundwater reinjection/recharge, or domestic consumption.

The remediation technologies that pass technology assessment will be retained for use in the development of preliminary alternatives for further screening.

5.2.1 Identification of Applicable Technologies

Groundwater remediation technologies that are applicable to Site COCs include:

- Monitored Natural Attenuation (MNA)
- Groundwater Pump-and-Treat (P&T)
- Air Sparging (AS)
- Wellhead Treatment
- In Situ Bioremediation (ISB)
- In Situ Chemical Oxidation (ISCO)
- Permeable Reactive Barriers (PRBs)

General descriptions of each of these technologies follows:

Monitored Natural Attenuation. MNA relies on natural processes to decrease or attenuate concentrations of contaminants in soil and groundwater. Besides intrinsic biodegradation, natural attenuation includes natural physical processes that can immobilize contaminants and natural chemical reactions that can destroy contaminants. Some processes that occur during natural attenuation can transform contaminants to less harmful forms or immobilize them to reduce risks. Such transformation and immobilization processes result from biological, chemical, and physical reactions that take place in the subsurface. It also includes dilution, dispersion, volatilization, adsorption, and other processes that destroy or immobilize the contaminant. Clearly, the concept that natural attenuation processes can, under the proper conditions, cause the destruction or transformation of contaminants in the environment is valid. However, natural attenuation is not a "no further action" approach. The cause-and-effect link between a decrease in contaminant concentration and the process or processes causing it must be appropriately monitored and documented throughout the period that natural attenuation is retained as a remedy. For MNA to be implemented, it must be demonstrated that the natural attenuation processes occurring at the site protect human health and the environment; this generally implies that the contaminated groundwater plume is stable and does not pose a threat to potential receptors of contamination. Long-term groundwater monitoring programs that evaluate natural attenuation typically include long-term monitoring wells that evaluate whether the behavior of the plume is changing and point of compliance wells that detect plume migration and trigger an action to manage the risk associated with this expansion. Long-term monitoring must continue to occur for as long as is necessary to protect human health and the environment.

Groundwater Pump-and-Treat. Groundwater P&T remediates contaminated groundwater through extraction, treatment of the water at the surface, and then either discharging it to an appropriate end use or reinjecting it back into the aquifer. When the extraction wells are properly located, this approach has the advantage of creating a capture zone which contains and prevents the contamination from migrating. Pumping is an important aspect for recovery of contaminants that are not easily degraded or attenuated in the subsurface. Treatment technologies are selected based on the types of contaminants present. For the Site contaminants in groundwater, presumptive treatment technologies are liquid phase granular activated carbon (L-GAC) or air stripping.

Air Sparging. AS is an in situ treatment technique applicable to VOCs in which air is injected into saturated groundwater below or within the areas of contamination through a system of AS injection wells. As the injected air rises through the formation, it volatilizes and desorbs contamination present in soils, as well as strips dissolved contaminants from groundwater. AS is most effective at sites with homogeneous, high-permeability soils and unconfined aquifers contaminated with VOCs. AS is routinely implemented with SVE to remove the volatilized VOCs from the subsurface.

Wellhead Treatment. This remedy treats contaminated groundwater that has been extracted by water supply wells and removes contaminants prior to distribution of the water to end users. The treated water can be used for irrigation or drinking water depending on the purpose of the supply well. Similar to P&T, the presumptive treatment technologies for treatment of Site contaminants in groundwater are L-GAC and air stripping.

In Situ Bioremediation. Highly oxidized chlorinated solvents such as PCE and TCE are known to undergo a variety of microbially mediated biodegradation reactions. In anaerobic environments, PCE and TCE can undergo reductive dechlorination (dehalorespiration) if an electron donor (e.g., hydrogen, methanol, etc.) is available to promote microbial activity. PCE is sequentially reduced to TCE, dichloroethene (DCE), VC, and benign end products such as ethene, ethane, carbon dioxide, water, and chloride. A variety of microorganisms reduce PCE to TCE and TCE to DCE including *Dehalospirillum multivorans*, *Dehalobacter restrictus*, and *Dehalococcoides etheneogenes* (DHC). *Dehalospirillum multivorans* and *Dehalobacter restrictus* are reported to express only one of the two required corrinoid enzymes required to biodegrade TCE completely to ethene. In contrast, DHC is the only known halo-respiring microorganism reported to catalyze complete dechlorination and may not be present in all subsurface environments. When present, DHC cells may not be initially active or in sufficiently high number to promote complete dechlorination without a significant lag phase before activity.

Under aerobic conditions, TCE is known to be cometabolically degraded in the presence of an electron donor (e.g., methane, aromatic hydrocarbons, ammonia) by a variety of microorganisms. Cometabolic degradation is incidental to microbial metabolism; oxidation of the contaminant (i.e. TCE) does not yield any energy or growth benefit for the microorganism. While the microorganism is oxidizing the electron donor, a monooxygenase enzyme (e.g., methane monooxygenase in the case of methanotrophic bacteria) is produced which can also degrade TCE into an unstable epoxide. The epoxide rapidly degrades to alcohols and fatty acids.

Biostimulation and bioaugmentation are commonly used strategies employed to implement ISB. Biostimulation is the addition of amendments such as electron donors or nutrients to promote microbial activity. Bioaugmentation, or the addition of a microbial culture that degrades the COC, promotes chlorinated solvent bioremediation at sites where complete dechlorination reactions would not otherwise occur. Bioaugmentation with non-indigenous microbial consortia has been successfully and extensively demonstrated at other contaminated sites.

In Situ Chemical Oxidation. ISCO is the injection of oxidizing agents directly into the subsurface to degrade contamination. These reagents increase the oxidation state of certain materials. As a result, they convert hazardous contaminants to non-hazardous or less toxic compounds that are more stable, less mobile, and/or inert. ISCO can be applied to groundwater and a variety of soil types and sizes. It can also be used to treat VOCs, including TCE. In order for destruction of VOC mass to occur, sufficient contact with the oxidant must be maintained. Typical oxidizing agents include permanganate, persulfate, ozone, and hydrogen peroxide:

- The most common forms of permanganate are potassium permanganate and sodium permanganate. Application of permanganate causes the rapid and complete destruction of many VOCs, including TCE, cis-1,2-DCE, and VC. The process results in the formation of manganese oxides, carbon dioxide, and various ions.
- Sodium persulfate is typically applied together with an activating agent such as temperature (thermal activation), extreme basic chemical conditions (sodium hydroxide), and/or a chemical activator such as a modified Fenton's reagent, chelated iron, or zero valent iron (ZVI). Activation of persulfate results in the formation of a sulfate radical, which directly oxidizes contaminants.
- Ozone and/or hydrogen peroxide, along with ultraviolet light (or iron) as a catalyst, can be used to oxidize organic materials in groundwater. When complete destruction is achieved, this process results in the production of carbon dioxide, water, and salts.

Permeable Reactive Barriers. A PRB is defined as an in situ permeable treatment zone designed to intercept and remediate a contaminant plume. ZVI is the most common media used in PRBs to treat a variety of chlorinated organics, metals, and radionuclides. Reactive media such as carbon sources (compost), limestone, granular activated carbon, zeolites, and others have also been deployed in recent years to treat metals and some organic compounds.

5.2.2 Applicable Technology Assessment

Prior to further evaluation, a general assessment of applicable groundwater technologies was performed based on the size of the TCE plume (approximately 4,000 ft long by 1,200 ft wide) and depth to groundwater (650 to 700 ft bgs). This assessment was performed to remove technologies that would not be technically viable or would be considered impractical for installation and operation at the Site. An overview of assessment results by technology follows:

Monitored Natural Attenuation. Natural attenuation of COCs is currently occurring at the Site and is anticipated to continue throughout implementation of the selected remedy. Given

the low organic carbon concentrations in Site groundwater and soil however, the rate of COC biodegradation is anticipated to be quite low, especially with distance from the soil vapor source area where methane concentrations are elevated. To date there is limited evidence that significant intrinsic biodegradation of contaminants is occurring in the groundwater. The daughter products of reductive dechlorination detected in groundwater are also present in soil vapor and likely dissolved in the groundwater with TCE. However, the relatively low concentrations of COCs in groundwater will decrease over time due to dilution, dispersion, volatilization, and adsorption of these contaminants. Some intrinsic biodegradation will occur (most likely near the landfill). The current size and depth of the Site plume do not generally impact whether MNA will be effective in meeting cleanup levels at some point in the future given the low cost to implement MNA.

Groundwater Pump-and-Treat. The primary impetus for P&T is plume containment when migration is occurring. Although there is limited information regarding localized hydraulic properties of the aquifer in the vicinity of the site, P&T is anticipated to be effective in containing the width and depth of the plume. The COCs are readily amenable to ex situ treatment and alternatives for disposal or reuse of the water (e.g., discharge to sewer and aquifer recharge) are practicable at the Site.

Air Sparging. The radius of influence for AS is highly dependent on the permeability of aquifer sediments which has been difficult to characterize at the Site due to the depth to groundwater and unconsolidated nature of underlying sediments (drilling approaches have not been conducive to logging undisturbed soils). Even if adequate characterization for AS system design was not cost prohibitive and the sediments were determined to be relatively homogeneous and highly permeable, the size of the impacted plume would require a high number of very deep sparge points to remediate the groundwater and SVE to prevent recontamination of groundwater with stripped vapors. Given that the highest concentrations of TCE in groundwater are not within the extent of high concentrations of TCE in vapor, AS would likely require an expansion of SVE operations. These constraints make this technology infeasible and impractical due to the high cost associated with and potentially limited effectiveness of implementing AS at the site.

Wellhead Treatment. If contamination migrates to existing water supply wells, wellhead treatment could be a viable approach to address COCs in extracted groundwater prior to use. As indicated previously, the COCs are readily amenable to ex situ treatment. Private irrigation well 55-221637 is the closest downgradient water supply well and would likely be impacted before remaining water supply wells located in the vicinity of the Site. However, the rate of extraction is anticipated to be low and will not significantly remediate the entire extent of the plume. Although the COP wells are located approximately 2 miles away from the Site, these water supply wells are anticipated to intercept and extract a significant portion of the plume (due to their size and location) in the distant future. This approach would not address Site contamination until the plume migrates to the COP water supply wells. Based on these limitations, wellhead treatment is likely limited to use as a contingency measure.

In Situ Bioremediation. For ISB, site conditions would require biostimulation because there are insufficient concentrations of electron donor to promote expedient COC degradation in the groundwater. Depending on the approach implemented, bioaugmentation may also be

required to completely degrade COCs given the low concentrations of these contaminants in groundwater. The most appropriate approach to promote biodegradation at the Site may be sequenced reductive dechlorination/oxidation or cometabolic aerobic degradation but additional bench and pilot testing would be required to develop a successful ISB strategy. Regardless of approach, a multi-array of injection points/boreholes/remediation wells would be necessary to distribute bioremediation amendments and enable effective remediation. Further, there could be a significant lag period required to promote growth of an appropriate microbial population in the treatment area and establish acceptable conditions for the complete degradation of COCs. On the basis that there would be an extended upfront research effort to implement ISB, some uncertainty of success given the complexity of the technology, and a high cost of implementation due to the size and depth of the plume, this technology is considered less feasible than other more practicable technologies under consideration.

In Situ Chemical Oxidation. Like ISB, ISCO is dependent on the distribution of an appropriate amount of an amendment (i.e., oxidant) to enable effective remediation. A multi-array of injection and/or recirculation wells is required to distribute the oxidant which would be expensive to implement over the entire extent and depth of the plume. However, implementation of ISCO would be less sensitive to existing unknowns than ISB, especially when both COC concentrations and natural oxidant demand are expected to be low (oxidation of TCE using permanganate is a demonstrated technology; reaction times are relatively short and the oxidant is generally persistent in Arizona aquifers). For this reason, implementation of ISCO on a limited basis in combination with other treatment technologies may be feasible if benefits outweigh potential costs.

Permeable Reactive Barriers. PRBs are generally implemented at sites with relatively shallow groundwater due to limitations associated with how PRBs are installed. PRBs are typically constructed in trenches or with funnel and gate configurations but have also been implemented with injection and fracturing techniques. Injection of reactive material would likely be the only practical approach applicable to the Site. In addition to the costs associated with comprehensive characterization to assess appropriate spacing of injection points and volume of reactive material necessary for constructing an effective barrier, the cost to construct the PRB would likely be prohibitive due to the depth to groundwater at the Site. Thus, implementation of a PRB is not considered feasible.

On the basis of this assessment, AS, ISB, and PRBs were eliminated from further consideration and MNA and P&T were retained as potential technologies appropriate for Site implementation. Wellhead treatment was retained as a contingency measure. Although full-scale implementation of ISCO would be limited by both the depth of groundwater and the extent of groundwater contamination as noted above, this technology was retained as a potential future enhancement of other retained technologies to expedite groundwater remediation at the Site.

5.3 Discussion and Screening of Preliminary Alternatives

Retained technologies were combined into a variety of preliminary remedial alternatives for screening:

- 1) MNA Only

- 2) MNA and SVE for Source Control
- 3) MNA, SVE for Source Control, and Wellhead Treatment as a Contingency Measure
- 4) On-Site P&T, MNA and SVE for Source Control
- 5) Off-Site P&T and SVE for Source Control

The groundwater flow and transport model developed for the Site was used to facilitate alternative comparisons and a technical memorandum summarizing model construction and simulation results is attached in Appendix D. TCE was the only modeled contaminant in groundwater.

The following section presents a description of alternative components and summarizes transport simulation results so that an assessment of whether the alternative has the potential to achieve ROs can be made. Section 5.3.2 summarizes the results of this screening level analysis and presents justification for retaining alternatives for further development in Section 6.0.

5.3.1 Description of Preliminary Alternatives

Alternative 1: MNA Only. As indicated in Section 5.2.1, MNA involves the passive evaluation of ongoing natural processes that reduce the volume, toxicity, mobility, and/or concentration of contaminants in groundwater. Long-term monitoring is an essential component of MNA which is used to evaluate contaminant plume stability and demonstrate that the plume is attenuating at a rate that is protective of potential receptors of contamination.

Given the current off-site extent of groundwater contamination in the Sonoran Preserve (see Figure 3-8) and recent increases in TCE concentrations observed downgradient of the Site, plume stability is currently difficult to demonstrate and significantly affects the reliability of MNA to protect downgradient receptors.

At least one new downgradient monitoring well would be required to implement MNA at the Site. Ideally the well would serve as a point of compliance well and be located hydraulically downgradient of MW-2, outside the current extent of the plume. Additional wells would be sited as required to establish and monitor plume stability; the locations of these wells have not been specified at this time due to uncertainty regarding plume stability and well site access constraints. Source control with SVE is not implemented as part of this alternative.

To evaluate the potential impacts of the alternative, a predictive transport simulation of the Site groundwater flow and transport model was run with the conservative assumption that a continuous source of TCE contamination from the vadose zone impacts groundwater underlying the estimated extent of the soil vapor plume and negligible intrinsic biodegradation of TCE occurs in the groundwater as the plume migrates towards the groundwater supply wells. The continuous source was modeled using VLEACH. Modeling results for this alternative correspond to "Alternative 1" in Appendix D.

The results of modeling indicate that:

- TCE concentrations remain elevated above the AWQS in the aquifer below and downgradient of the Site over the entire 100-year modeled period (see Figures 5-1 through 5-7).

- Near the water table, soil vapor serves as a source of contamination to groundwater throughout the modeled period. Figures 5-1 through 5-3 and 5-5 through 5-6 show the shallow TCE plume elongating over time with elevated concentrations (between 5 and 35 µg/L) bifurcating into two separate portions of the plume (downgradient of the Site and upgradient of the water supply wells). Bifurcation is likely an artifact of using the source concentrations modeled by VLEACH which results in an increasing TCE flux into groundwater over the modeled period (see Figure 3-10) and the significant rate of groundwater extraction by the water supply wells that mobilizes the groundwater plume at a rate greater than natural attenuation can remediate the plume.
- The highest concentrations of the deeper portion of the groundwater TCE plume are not collocated with the highest concentrations of the shallow TCE plume. Figures 5-4 and 5-7 show this 'off-site plume' at time 30 years and 100 years.
- The peak TCE concentration observed at private irrigation well 55-221637 occurs at year 57 at a concentration of approximately 16 µg/L. Peak concentrations at COP well 55-527549 and golf course well 55-221450 are negligible (less than 0.4 µg/L) and occur at year 100 (see Figure 5-8).

Model results suggest that the plume will not be stable for the foreseeable future given the negligible rate of attenuation and the influence of nearby water supply wells. The model further suggests that a continuing source of contamination from the soil vapor would contribute to concentrations in excess of AWQS in the region downgradient of the Site throughout the duration of the modeled period (100 years).

Alternative 2: MNA with SVE for Source Control. This alternative is similar to Alternative 1 but would also include implementing SVE to control soil vapor VOC contamination with the potential to serve as a continuing source of contamination to groundwater. Components of this remedy would include the downgradient monitoring well to serve as a point of compliance well and additional unspecified wells to establish and monitor plume stability. SVE would include the anticipated process components described in Section 5.1.

For the purpose of predictive modeling, no continuous source of groundwater contamination from the vadose zone was included in the simulation but the effects of natural attenuation (assuming negligible intrinsic biodegradation) were incorporated. Modeling results for this alternative correspond to "Alternative 2" in Appendix D.

The results of modeling indicate that:

- Over the first 30 years of the modeled period, there are no significant changes in TCE concentrations in the aquifer below and downgradient of the Site when compared to Alternative 1 (concentrations remain above AWQS's; see Figures 5-9 through 5-11);
- By year 50 (see Figure 5-12), source control has resulted in most of the groundwater contamination migrating from the Site; however, concentrations in the downgradient plume exceed the AWQS and there is no significant impact on whether contamination migrates to downgradient water supply wells when compared to Alternative 1 (peak TCE concentrations observed at private irrigation well 55-221637, COP Well 55-527549, and golf course well 55-221450 are nearly identical to those in Alternative 1 ; see Figure 5-13).

- By Year 100, the TCE plume has migrated from the Site but concentrations still exceed the AWQS in the downgradient aquifer (see Figure 5-14).

Thus, the impact of removing the source of contamination is that the plume migrates away from the Site; however, the plume is not stable and does not attenuate to concentrations that are less than cleanup levels within a reasonable timeframe.

Alternative 3: MNA, SVE for Source Control, and Wellhead Treatment as a Contingency Measure. This alternative is similar to Alternative 2 but wellhead treatment is added as a contingency measure to protect potential future users of water extracted from downgradient water supply wells.

The addition of wellhead treatment does not impact the modeling performed for Alternative 2 and thus modeling results for this alternative correspond to “Alternative 2” in Appendix D. As discussed for Alternative 2, the primary peak TCE concentration that exceeds the AWQS during the modeled period is observed at private irrigation well 55-221637. Wellhead treatment at this well would be considered if a human health risk assessment evaluating contaminant exposure during use of extracted groundwater for irrigation purposes indicated COC concentrations in excess of applicable thresholds for the protection of human health and the environment. Wellhead treatment at COP well 55-527549 would be conducted if concentrations were greater than estimated by the model. The treatment approach used (e.g., L-GAC or air stripping) would be selected in the future based on the concentration and flow rates for the impacted well(s).

Alternative 4: On-Site P&T and SVE for Source Control. As indicated in Section 5.2.1, P&T is an ex situ groundwater remediation method that involves conventional extraction of groundwater from wells and post-extraction treatment by appropriate methods that will remove or reduce the contaminant concentrations to permissible levels prior to end use.

The primary defining feature of Alternative 4 is the extraction of groundwater near the southern CCL property boundary to provide complete hydraulic capture of the plume. The groundwater model was used to locate the well and evaluate the potential capture zone (see Figure 5-15 and Figure 5-20).

Installation of an extraction well on-site is considered the most feasible location to address Site groundwater contamination because access to other properties is not required. The goal of this effort was to provide complete hydraulic capture of the VOC plume. As indicated in Appendix D, the resulting location is approximately 150 ft west of MW-2. The screened interval of the extraction well corresponds to the top 120 ft of the current ambient water table (approximately 1,160 ft amsl as of December 2014 at MW-2).

There were two scenarios evaluated for Alternative 4 for siting the injection well. The primary injection well location is off-Site (Alternative 4A) and the secondary location is on-Site (Alternative 4B). These scenarios are further discussed in the following subsections.

Alternative 4A: Off-Site Injection Well

The model was used to evaluate suitability and effectiveness of an off-site injection well that will be used to recharge treated water back into the aquifer. The selected injection well location

minimizes re-extraction of treated water, eliminates the potential of injection in an area of deep soil vapor contamination, and mitigates the effect of potential plume migration beyond the capture zone of the extraction well. The injection well is planned to be sited south of the landfill property boundary as depicted in Figure 5-15. The COP has proposed an intergovernmental agreement (IGA) for installation of the injection well and conveyance piping off-site to utilize treated water as part of their ASR program after the site is remediated. The injection well would be screened across the top 390 ft below the current ambient water table.

The primary components of Alternative 4A include:

- An on-site groundwater extraction well designed to extract the on-site plume and provide complete capture of the off-site plume;
- An on-site groundwater treatment system to treat extracted groundwater (likely using L-GAC based on the flow rate and COC concentrations);
- A conveyance pipeline extending from the on-site groundwater treatment system to an off-site injection well located in the vicinity of East Sleepy Ranch Rd and North 40th Street;
- An off-site injection well to recharge the treated water back into the aquifer;
- The SVE process components described in Section 5.1 for source control; and
- At least one downgradient monitoring well to serve as a point of compliance well and additional unspecified wells to establish and monitor the stability of the plume, if not captured by the on-site groundwater extraction well.

To assess the potential impact of this alternative, a predictive transport simulation of the model was run with the attributes of the groundwater extraction well noted above, no continuous source of groundwater contamination from the vadose zone (due to SVE), treated water injection off-site at below detection levels, and the ongoing effects of natural attenuation (assuming negligible intrinsic biodegradation). Modeling results for this alternative correspond to “Alternative 4A” in Appendix D.

The results of modeling indicate that:

- The flow rate necessary to provide complete hydraulic capture of the plume is 190 gallons per minute (gpm).
- The TCE concentrations decrease over time, and drop below AWQS near the Sonoran Preserve boundary within the first 5 years. (see Figures 5-16 and 5-30).
- After approximately 27 years, TCE concentrations are less than the AWQS at all points in the aquifer (see Figure 5-16 through Figure 5-19).
- Private irrigation well 55-221637, COP Well 55-527549, and golf course well 55-221450 are negligibly impacted (less than 0.1 µg/L) during the modeled time duration (100 years).

Alternative 4B: On-Site Injection Well

The model was used to select the location of an on-site injection well that will be used to recharge treated water back into the aquifer. The selected injection well location is upgradient of the plume

to flush remaining contaminants in the northern portion of the site and assist with creating a hydraulic gradient to reduce the required remediation time. Like the extraction well, the injection well would be screened across the top 120 ft of the current ambient water table.

The primary components of Alternative 4B include:

- An on-site groundwater extraction well designed to extract the on-site plume and provide complete capture of the off-site plume;
- An on-site groundwater treatment system to treat extracted groundwater (likely using L-GAC based on the flow rate and COC concentrations);
- A conveyance pipeline extending from the on-site groundwater treatment system to an on-site injection well located northeast of the Transfer Station;
- An on-site injection well to recharge the treated water back into the aquifer;
- The SVE process components described in Section 5.1 for source control; and
- At least one downgradient monitoring well to serve as a point of compliance well and additional unspecified wells to establish and monitor the stability of the plume that is not captured by the on-site groundwater extraction well.

To assess the potential impact of this alternative, a predictive transport simulation of the model was run with the attributes of the groundwater extraction well noted above, no continuous source of groundwater contamination from the vadose zone (due to SVE), treated water injection on-site, and the ongoing effects of natural attenuation (assuming negligible intrinsic biodegradation). Modeling results for this alternative correspond to “Alternative 4B” in Appendix D.

The results of modeling indicate that:

- The flow rate necessary to provide complete hydraulic capture of the plume is 370 gpm, which is a higher flow rate when compared to Alternative 4A due to some injected water on-site being recaptured by the extraction well.
- The TCE concentrations decrease faster over time than Alternative 4A, as a result of a higher extraction rate, and drop below AWQS near the Sonoran Preserve boundary within the first 5 years (see Figures 5-21 and 5-31).
- After approximately 15 years, TCE concentrations are less than the AWQS at all points in the aquifer (see Figures 5-21 through 5-22).
- Private irrigation well 55-221637, COP Well 55-527549, and golf course well 55-221450 are negligibly impacted (less than 0.1 µg/L) during the modeled time duration (100 years).

When compared with the results of Alternatives 1 and 2, the primary advantage of incorporating groundwater extraction at the Site is the reduced footprint of the contaminated plume exceeding the AWQS off-site and the reduced timeframe required to achieve AWQS at all points in the aquifer.

Alternative 5: Off-Site P&T and SVE for Source Control. In this alternative, a deep groundwater extraction well is installed at a location downgradient from the existing plume to fully contain the groundwater plume. The groundwater model was used to optimally place this well; the location is shown on Figure 5-23. Modeling results presented in Appendix D indicate that to completely capture the existing plume, the screened interval of the extraction well needs to extend from the current water table to the top of bedrock (360 ft of screen) and the extraction rate needs to be approximately 200 gpm. The increase in screened interval and flow rate for the off-site extraction well compared to that required for the on-site extraction well in Alternative 4A is attributable to a tendency noted in the model of the plume to migrate downward as well as laterally as it moves off-site. This plume behavior is likely a result of the sloped basin floor (which dips towards the south in the vicinity of the Site) and possibly an effect of downgradient water supply pumping. The model was used to determine the screen length and flow rate based on the assumption that the top 120 ft of the alluvial aquifer is impacted at the southern Site boundary; this assumption is likely conservative. The primary components of this alternative include:

- An off-site groundwater extraction well designed to completely contain the groundwater plume;
- An off-site groundwater treatment system to treat extracted groundwater (likely using L-GAC based on the flow rates and COC concentrations);
- A conveyance pipeline extending from the off-site groundwater treatment system to an existing COP sewer line located in right-of-way adjacent to Black Mountain Parkway for disposal of the treated water;
- The SVE process components described in Section 5.1 for source control; and
- At least one downgradient monitoring well to serve as a point of compliance well and evaluate the effectiveness of groundwater capture.

For the purpose of predictive modeling, the simulation was run with the attributes of the groundwater extraction well noted above, no continuous source of groundwater contamination from the vadose zone (due to SVE), and the ongoing effects of natural attenuation (assuming negligible intrinsic biodegradation). Modeling results for this alternative correspond to “Alternative 5” in Appendix D.

The results of modeling indicate that:

- Over the first 30 years of extraction, there are significant reductions in the footprint and magnitude of TCE concentrations in the plume (see Figures 5-24 through 5-27))
- Concentrations decline to less than the AWQS at all points in the aquifer by year 35 (see Figure 5-28). There are no impacts on downgradient water supply wells because the extraction system completely contains the plume.

The duration required to achieve the AWQS at all points in the aquifer is slightly longer than Alternative 4A (by 8 years), due to the location of the extraction well, and considerably longer than Alternative 4B (by 20 years), due to the disparity in flow rate required to obtain hydraulic capture.

5.3.2 Screening of Preliminary Alternatives

Comparison of Time Required to Meet the AWQS. Figure 5-28 summarizes the simulated maximum concentrations of TCE in the model domain for each of the preliminary alternatives evaluated. As shown, Alternatives 1 and 2 (which are the same from a modeling perspective as Alternative 3) allow TCE concentrations in the aquifer downgradient of the Site to exceed the AWQS throughout the 100-year model period. Alternatives 4A, 4B, and 5 result in TCE concentrations that are less than 5 µg/L within 15 to 27 years of implementing the remedy.

Comparison of Effects on TCE Concentrations at the Sonoran Preserve Boundary. To further assess the impact of elevated TCE concentrations in groundwater during the time required to meet the AWQS, an evaluation of concentrations at the boundary of the Sonoran Preserve was performed. Although remediation of the plume underlying the Sonoran Preserve must be performed to achieve ROs, water use rights are not impacted by the contaminated plume unless the plume migrates past the boundary of the Sonoran Preserve. This is because water supply wells cannot be installed on the Sonoran Preserve due to land development restrictions.

Figure 5-29 summarizes simulated maximum TCE concentrations along the Sonoran Preserve boundary for each of the evaluated alternatives. As depicted in this figure, both Alternatives 1 and 2 result in a peak concentration at the preserve boundary of 51 µg/L in year 20 and do not attain the AWQS until sometime between year 50 and 60 (after which TCE concentrations increase again for Alternative 1). Alternatives 4A and 4B maintain concentrations of less than 10 µg/L throughout the modeled period and achieve the AWQS in 27 years and 15 years, respectively. For Alternative 5, TCE concentrations peak at approximately 22 µg/L at year 4 but quickly decline to less than the AWQS by year 18.

Figures 5-30, 5-31, and 5-32 depict the simulated plume (maximum concentration layer) for Alternatives 4A, 4B, and 5 relative to the Sonoran Preserve boundary at multiple time stops. These figures show that for Alternative 4A and 4B, peak concentrations occur (in year 1) near the southeastern corner of the Sonoran Preserve to the south of the Site. For Alternative 5, peak concentrations occur (in year 4) near the northeastern corner of the Sonoran Preserve, south of the Site.

Comparison of Potential Alternatives in Meeting ROs. Based on the modeling results summarized in Figures 5-28 through 5-32 and the alternative discussion presented in Section 5.3.1, the following matrix presents a qualitative assessment of the potential for each alternative to meet Site ROs:

Site Remedial Objective	Alt 1: MNA Only	Alt 2: MNA/SVE	Alt 3: MNA/SVE/ Well-head Treatment	Alt 4A: On-Site P&T/SVE Off-Site Injection	Alt 4B: On-Site P&T/SVE On-Site Injection	Alt 5: Off-Site P&T/SVE
1) Comply with AWQS's Downgradient of Site Boundary within a reasonable timeframe	Not Likely	Not Likely	Not Likely	Likely	Likely	Likely

Site Remedial Objective	Alt 1: MNA Only	Alt 2: MNA/SVE	Alt 3: MNA/SVE/ Well-head Treatment	Alt 4A: On-Site P&T/SVE Off-Site Injection	Alt 4B: On-Site P&T/SVE On-Site Injection	Alt 5: Off-Site P&T/SVE
2) Protect Water Supply wells from COC Concentrations Exceeding AWQS's	Possible	Possible	Likely	Likely	Likely	Likely
3) Protect Adjacent Residents from Soil Vapors	Possible	Likely	Likely	Likely	Likely	Likely
4) Control Soil Vapors with Potential to be a Source of Groundwater Contamination Above AWQS's	Not Likely	Likely	Likely	Likely	Likely	Likely

As indicated above, it is not likely that Alternative 1 (MNA only), Alternative 2 (MNA and SVE) or Alternative 3 (MNA, SVE, and Wellhead treatment) will achieve the Site ROs of compliance with AWQS's downgradient of the property boundary within any reasonable timeframe based on the groundwater modeling conducted to date. On this basis, these alternatives were eliminated from further evaluation.

Alternatives 4A, 4B, and 5 (the P&T options with SVE) will likely achieve Site ROs.

Retained Alternatives for Further Evaluation Based on Screening. On the basis that Alternatives 4A, 4B, and 5 are the only alternatives evaluated that have a likely potential to meet each of the ROs, the following preliminary alternatives were retained for further development in Section 6.0:

- On-Site Extraction Remedy: On-Site P&T, and SVE for Source Control (Alternatives 4A and 4B).
- Off-Site Extraction Remedy: Off-Site P&T and SVE for Source Control (Alternative 5).

6.0 Remedy Development

Two containment remedies that address the dissolved TCE groundwater plume at the Site have been retained for further development and evaluation. Selection of these remedies was based on an assessment of applicable remedial technologies and the results of a screening analysis of preliminary alternatives that achieve ROs for the Site (see Section 5.3.2). For each remedy, an overview of the basis for the remedial strategies and measures incorporated into the remedy is followed by a summary of associated remedy requirements. A conceptual level design that meets remedy requirements is then presented. These conceptual level designs were used to develop the estimated remedial costs of each remedy evaluated in Section 7.0.

6.1 On-Site Extraction Remedy – On-Site P&T, and SVE for Source Control

The On-Site Extraction Remedy includes on-site groundwater P&T for containment of the bulk of the groundwater plume and SVE to address soil vapor contamination in the source area.

6.1.1 Basis for Strategies and Measures Incorporated into the Remedy

The basis for the On-Site Extraction Remedy strategies and measures includes the following:

- Site data indicate that TCE concentrations in downgradient groundwater monitoring wells (i.e., MW-4, MW-6, and MW-7) have increased recently after a sustained period of relatively stable concentrations; given the TCE concentration in upgradient monitoring wells (particularly MW-2), concentrations in these downgradient wells may continue to increase (the plume no longer appears to be stable).
- Site data indicate that the current extent of TCE contamination in groundwater is extensive and the TCE plume has migrated off-site. If no remedial action is taken, there is a potential that the groundwater TCE plume will migrate further downgradient and continue to expand.
- Site data indicate that the vast majority of the TCE plume is located within the boundary of the CCL property and the highest TCE concentration is present near monitoring well MW-2, which is located north of the southern CCL property boundary.
- Existing monitoring wells (e.g., MW-2) are not sufficiently screened or sized to achieve optimal containment at the southern CCL property boundary. Maricopa County's ability to install an extraction well on property owned by Maricopa County will increase the implementability of installing an extraction well in an expedient manner.
- Site data indicate that there is significant contaminant mass of TCE and other VOC compounds in the soil vapor, which can potentially provide a continuing source of contamination to the groundwater at concentrations that would exceed AWQS's.

Current information does not suggest any existing adverse impact to local water supply wells or adjacent property owners at this time. However, based on groundwater flow direction and the locations of downgradient water supply wells, there is a potential that the TCE plume could migrate towards downgradient water supply wells in the future if left untreated.

6.1.2 Remedy Requirements

To meet ROs, On-Site Extraction Remedy requirements include:

- Capture and contain the high TCE concentration groundwater plume upgradient of the southern CCL property boundary and minimize contaminant mass flux to the region downgradient of the southern CCL boundary.
 - The results of Site groundwater modeling indicate that a purpose-built groundwater extraction well located 150 ft east of MW-2, screened from the current ambient water table to 120 ft below the current ambient water table, and operated at a flow rate of 190 gpm for an offsite injection well or 370 gpm for an onsite injection well, should meet this requirement. To achieve the rate of extraction required for the onsite injection scenario, an additional extraction well may be required.
 - Routine water level monitoring at surrounding wells (MW-2, MW-3, MW-4, MW-5, MW-6, and MW-7) will be required to demonstrate the extent of the capture zone induced by the new groundwater extraction well.
 - Routine extraction rate and COC concentration monitoring will be required for capture zone evaluation and compliance reporting.
- Provide for the appropriate treatment and disposal of extracted groundwater.
 - Based on current COC concentrations at MW-2, the groundwater treatment system must be designed to accommodate an influent TCE concentration on the order of 100 µg/L; as the system operates, concentrations are anticipated to decline and the treatment system must be capable of achieving treatment requirements over the long-term range of COC concentrations anticipated.
 - The level of treatment that is required will depend on the selected end use for the treated water; for evaluation purposes, AWQS's are selected as the treatment standard for the P&T system.
 - Routine monitoring of process operations will be required to demonstrate acceptable treatment in compliance with selected end use standards and meter flows for applicable end use reporting.
- Ensure the groundwater TCE plume that may not be captured by the containment system due to any uncertainties associated with the extents of the plume boundary, attenuates to concentrations that are compliant with AWQS's and does not exceed concentrations that would result in an exceedance of AWQS's in water extracted by downgradient water supply wells.
 - A minimum of one new monitoring well located downgradient of the groundwater extraction system and existing groundwater plume will be required to serve as an interim compliance well. If concentrations of TCE in excess of those predicted by the model migrate to this new monitoring well, further expansion of the Site monitoring network will likely be required and additional containment will be considered.
 - Routine monitoring of Site groundwater wells will be required to assess the adequacy of COC natural attenuation in the region downgradient of the containment system.

Groundwater sampling will be required and collected samples will be analyzed for COCs and pertinent MNA evaluation parameters.

- Remove COC mass from soil vapor in the source area to the extent that TCE concentrations in soil vapor no longer pose a threat to groundwater at concentrations that exceed AWQS's.
 - A minimum of two new purpose-built SVE wells in regions known to have high concentrations of COCs will be required to extract contaminated soil vapor; additional well requirements will be developed, as necessary, following the installation and testing of these wells.
 - On the basis of SVE monitoring conducted to date at the Site, SVE process equipment must be capable of achieving an applied vacuum on the order of 80 to 100 inches of water at each SVE wellhead to maximize flow from the formation (additional applied vacuum does not appear to result in further increases in flow; AMEC, 2012a).
 - On the basis of SVE testing conducted to date at the Site, the vapor treatment process unit must be designed to accommodate maximum influent COC concentrations on the order of 3,500 mg/m³ TCE, 1,400 mg/m³ cis-1,2-DCE, 260 mg/m³ 1,1-DCE, 240 mg/m³ of PCE, and 59 mg/m³ of VC; as the system operates, concentrations are anticipated to be variable in response to which wells are operational and the duration of extraction; the treatment system must be capable of achieving treatment requirements over the long-term range of COC concentrations anticipated.
 - Routine monitoring of SVE process operations will be required to demonstrate acceptable treatment of extracted vapors and fulfill requirements of air permit compliance reporting.
 - Routine monitoring of vacuum and COC concentrations at SVE process and monitoring wells will be required to evaluate the impacts of treatment.

6.1.3 Conceptual Design

Figure 6-1 provides the conceptual layout of On-Site Extraction Remedy components including: (1) a groundwater P&T system with one on-site extraction well and one off-site injection well (IW-1) located in the vicinity of East Sleepy Ranch Rd and North 40th Street (Alternative 4A) or one on-site injection well located northeast of the Transfer Station (Alternative 4B), (2) a groundwater monitoring well network to evaluate groundwater containment and natural attenuation of the groundwater plume which may not be contained, and (3) a source area SVE system. The following sections provide additional details regarding these components.

Groundwater Extraction Well. Based on modeling efforts, a total extraction rate of 190 gpm would be necessary to provide hydraulic capture of the plume for Alternative 4A (off-site injection well). It is likely that one extraction well will provide the necessary extraction rate and require one injection well. To optimally construct the on-site remediation extraction well (EW-1) for Alternative 4A (the offsite injection well), the well would be drilled to bedrock (estimated to be present at around 900 ft bgs) and depth-specific groundwater sampling would be conducted throughout the saturated thickness profile to characterize the distribution of contamination at this location. On the basis of these results, it is estimated that EW-1 would be constructed of 10-inch

diameter (minimum), low-carbon steel casing with stainless steel screen placed from a depth of 700 to 820 ft bgs (or 1,040 to 1,160 ft amsl). The well would be tested with a rental pump over a minimum 72-hour period prior to installation of a dedicated groundwater pump; water levels would be monitored in the extraction well, MW-2, MW-4, and MW-7. The pump would be sized to extract 190 gpm of flow from a groundwater elevation of 1,160 ft AMSL and pump the discharge through a groundwater treatment system to a new off-site treated water injection well (IW-1) located at approximately 1,860 ft amsl. It is initially estimated that a 6-inch 75-horsepower (hp) pump would be required; power would be supplied to the pump from the nearby groundwater treatment system compound.

Based on modeling efforts a total extraction rate of 370 gpm would be necessary to provide hydraulic capture of the plume for Alternative 4B (on-site injection well). It is likely that two extraction wells would be necessary to implement the on-site remediation extraction for Alternative 4B (the onsite injection well) to meet the total extraction rate determined by the modeling efforts. The total extraction rate of 370 gpm would also require two injection wells. Initially, one well would be constructed and tested. In order to optimally construct the first on-site remediation extraction well (EW-1), the well would be drilled to bedrock (estimated to be present at around 900 ft bgs) and depth-specific groundwater sampling would be conducted throughout the saturated thickness profile to characterize the distribution of contamination at this location. On the basis of these results, it is estimated that EW-1 would be constructed of 10-inch diameter (minimum), low-carbon steel casing with stainless steel screen placed from a depth of 700 to 820 ft bgs (or 1,040 to 1,160 ft amsl). The well would be tested with a rental pump over a minimum 72-hour period prior to installation of a dedicated groundwater pump; water levels would be monitored in the extraction well, MW-2, MW-4, and MW-7. Based on the testing results the pump would be sized accordingly to achieve the maximum anticipated yield within the limits of the well construction to reach the modeled hydraulic capture requirement of 370 gpm. If pump testing indicates that one well is not capable of providing the necessary yield, a second well would be constructed and tested. The pump(s) would be sized to extract a minimum combined flow of 370 gpm from a groundwater elevation of 1,160 ft amsl and pump the discharge through a groundwater treatment system to a new on-site treated water injection well (IW-1) located at approximately 1,887 ft amsl. It is initially estimated that a 6-inch 75-hp pump would be required for each well; power would be supplied to the pump from the nearby groundwater treatment system compound.

Permitting associated with EW-1 installation and operation would include a drilling permit from the ADWR to authorize and register the well and a Poor Quality Groundwater Withdrawal Permit (PQGWP) to operate the well.

Groundwater Treatment System. A treatment compound for the groundwater remediation system would be constructed near EW-1 on the southern property boundary (see Figure 6-1). Preliminary scoping of the remediation system indicates that an L-GAC process unit system consisting of two 5,000-lb vessels arranged in series would accommodate the liquid loading and contamination levels present in extracted groundwater for Alternative 4A. Two L-GAC process unit systems configured in parallel (i.e. a total of four 5,000-lb vessels) would be required to accommodate the liquid loading for Alternative 4B. These vessels are anticipated to be slightly oversized for the liquid loading rate anticipated and would provide flexibility if higher flows were required for containment. Bag filters would be installed upstream of the carbon vessels to

minimize sediment accumulation in the L-GAC. A flow meter would be installed to totalize treated water flow. At a minimum, instrumentation and process controls would monitor liquid levels in the extraction well and injection well, extraction pump operation, and differential pressures across process components. In the event of an alarm condition requiring treatment system shutdown, an operator would be notified via telemetry.

Permitting associated with groundwater treatment system installation would include a construction permit for treatment system infrastructure. New electrical service sourced likely from a transformer near Black Canyon Parkway would be required.

Carbon adsorption systems are reliable and require little maintenance. The system would be designed for unattended operation; weekly checks by an experienced operator would be conducted (the anticipated level of effort would be eight hours per week). Routine operation would consist of periodic checks of operations and sampling for contaminant breakthrough in the vessel effluent. Given that the impacts on groundwater containment would be negligible, the system would be shut down temporarily for routine maintenance (e.g., backwashing and carbon changeouts of the L-GAC vessels, bag filter changeouts). The primary consumables anticipated for operation and maintenance (O&M) of the groundwater treatment system include electricity, carbon (changeout of one vessel every four months is assumed), and bag filters.

Treated Groundwater End Use. Following treatment, the extracted groundwater would be pumped to a new injection well located in the vicinity of East Sleepy Ranch Rd and North 40th Street (Alternative 4A) or an on-site injection well(s) located northeast of the Transfer Station (Alternative 4B) near the northeast corner of the site (see Figure 6-1). The preliminary design of the injection well for Alternative 4A would be in accordance with COP ASR program specifications. The preliminary design of the Alternative 4B well is that it would be a 10-inch diameter (minimum), low-carbon steel casing with stainless steel screen placed from a depth of 700 to 820 ft bgs (or 1,040 to 1,160 ft amsl). The treated water would be discharged via gravity flow into the injection well for Alternative 4A or pumped to the injection well for Alternative 4B

Permitting associated with IW-1 installation would include a drilling permit from the ADWR to authorize and register the well. Per Arizona Revised Statutes § 49-250(B)(18)(c), operation of the well as part of a RCRA corrective measure should be exempt from Aquifer Protection Permit (APP) requirements. In the case of the onsite injection well scenario (Alternative 4B), the exemption is clear. However, due to the offsite location of the injection well for Alternative 4A, an APP determination of applicability review will be sought to ensure regulatory requirements are met.

Groundwater Monitoring Network Expansion. A minimum of one new groundwater monitoring well (MW-9) would be installed hydraulically downgradient of EW-1 on either COP right-of-way (located to the east of the Sonoran Preserve) or near the southern Sonoran Preserve boundary on State Trust Land (see Figure 6-1) depending on negotiations with these project stakeholders. Ideally the well would be a nested installation with two well screens to monitor shallow and deep intervals; however, the depths involved may not allow for this design. Like the extraction well, the boring for MW-9 would be drilled to bedrock (estimated to be at 1,100 ft bgs) and depth-specific sampling would be conducted throughout the saturated thickness profile to characterize the distribution of contamination at this location. It is estimated that MW-9 would be constructed of

6-inch diameter, low-carbon steel casing with stainless steel screen placed from a depth of 720 to 800 ft bgs. A dedicated sampling pump would be installed in MW-9.

Permitting associated with MW-9 installation would include a drilling permit from the ADWR to authorize and register the well. An access agreement would also be required to construct and access the well on either COP property or State Trust Land.

Groundwater monitoring would continue at the Site and incorporate MW-9. Groundwater levels would be gauged on a quarterly basis and groundwater sampling of Site wells for COCs would be conducted on a semiannual basis. This well would serve as an interim compliance well to evaluate the extent of groundwater containment and whether the plume is migrating as predicted by the model. If concentrations observed at this well are greater than AWQS, additional containment actions will be considered.

The model predicts concentrations at MW-9 do not increase to levels that exceed the AWQS. Additional downgradient wells may be required to monitor the plume attenuation. Given the uncertainty associated with the model, these additional wells have not been sited at this time.

SVE Wells. Two SVE wells (SVE-1 and SVE-2) were installed in the Transfer Station Area and the northern portion of the New Landfill, respectively (see Figure 6-1). SVE-1 targets shallow, intermediate and deep zone contamination and SVE-2 targets intermediate and deep zone contamination based on the results of soil vapor testing conducted to date. Each of the SVE wells is constructed of 6-inch polyvinyl chloride (PVC) casing with screened intervals as follows:

- SVE-1 is a multi completion well screened from 120 to 220 ft bgs, 240 to 400 ft bgs and 420 to 600 ft bgs;
- SVE-2 is a multi completion well screened from 400 to 480 ft bgs and 500 to 620 ft bgs.

Three nested vapor monitoring well installations (TSSV-5 through TSSV-7; see Figure 6-1) were installed at the Site to refine the known extent of contaminated soil vapor. Each installation included shallow, intermediate, and deep zone wells (constructed of 2-inch PVC) and one groundwater piezometer (constructed of 4-inch PVC). Screened intervals are as follows:

- TSSV-5 wells are screened from 170 to 220 ft bgs (TSSV-5S), 370 to 420 ft bgs (TSSV-5M), 570 to 615 ft bgs (TSSV-5D), and 720 to 790 ft bgs (TSSV-5PZ).
- TSSV-6 wells are screened from 150 to 200 ft bgs (TSSV-6S), 360 to 400 ft bgs (TSSV-6M), 550 to 600 ft bgs (TSSV-6D), and 714 to 784 ft bgs (TSSV-6PZ).
- TSSV-7 wells are screened from 160 to 210 ft bgs (TSSV-7S), 360 to 410 ft bgs (TSSV-7M), 560 to 610 ft bgs (TSSV-7D), and 720 to 790 ft bgs (TSSV-7PZ).

SVE Conveyance Piping. HDPE SVE conveyance piping would be routed above ground surface from each SVE and TSSV well to the SVE treatment system (see Figure 6-1). In traffic areas such as the public entrance to the Transfer Station and within the roadways of the Transfer Station, conveyance piping would be installed in trenches below grade. The piping would be sloped to sumps for removal of condensate.

SVE Treatment System. A treatment compound for SVE system equipment would be constructed near the north end of the New Landfill, just south of the Transfer Station (see Figure 6-1). The system would include a 150-gallon vapor liquid separator (VLS) tank, a 50-hp positive displacement blower rated to supply 500 cubic feet per minute (cfm) of flow at 200 inches of water, an air to air after cooler on the blower discharge, and four 3,000-lb capacity vessels filled with either V-GAC or Hydrosil. The system would be designed for potential future expansion to 1,000 cfm with an additional VLS/blower skid. SVE equipment would be selected for Class I, Division II use and include lower explosive limit (LEL) monitoring for methane. At a minimum, instrumentation and process controls would monitor vacuum/pressure, LEL, temperature, and liquid levels in the VLS tank. In the event of an alarm condition requiring treatment system shutdown, an operator would be notified via telemetry.

Permitting associated with SVE treatment system installation would include a construction permit for treatment system infrastructure. New electrical service sourced from the transformer located southeast of the Transfer Station entrance would be required.

Routine operation would include extraction of vapors from multiple wells and treatment of vapors through two V-GAC vessels operated in a lead-lag configuration with one Hydrosil vessel for post carbon treatment of VC. The SVE system would be designed for unattended operation. Weekly checks by an experienced operator would be conducted to monitor process conditions and assess V-GAC breakthrough (the anticipated level of effort would be 24 hours per week). The primary consumables anticipated for O&M of the groundwater treatment system include electricity and carbon (a carbon usage rate of 557 lbs per day based on a flow of 1,000 cfm and medium loading is assumed).

Permitting associated with SVE treatment system operation would include maintenance of and compliance with existing Maricopa County Air Quality Department Permit 980398. This permit includes one SVE process blower rated at 500 cfm; a modification would be required to expand the system to 1,000 cfm.

6.2 Off-Site Extraction Remedy – Off-Site P&T and SVE for Source Control

The Off-Site Extraction Remedy selected for evaluation is off-site groundwater P&T for complete containment of the groundwater plume and SVE to address soil vapor contamination in the source area.

6.2.1 Basis for Strategies and Measures Incorporated into the Remedy

This basis for the Off-Site Extraction Remedy strategies and measures includes the following:

- Site data indicate that TCE concentrations in downgradient groundwater monitoring wells (i.e., MW-4, MW-5, MW-6, and MW-7) have increased recently after a long period of relatively stable concentrations; given the TCE concentration in upgradient monitoring wells (particularly MW-2), concentrations in these downgradient wells may continue to increase (the plume no longer appears to be stable).
- Site data indicate that the current extent of TCE contamination in groundwater is extensive and the TCE plume has migrated off-site. If no remedial action is taken, there is a potential

that the groundwater TCE plume will migrate further downgradient and continue to expand.

- Site data indicate that there is significant contaminant mass of TCE and other VOC compounds in the soil vapor, which can potentially provide a continuing source of contamination to the groundwater at concentrations that would exceed AWQS's.

Current information does not suggest any existing adverse impact to local water supply wells or adjacent property owners at this time. However, based on groundwater flow direction and the locations of downgradient water supply wells, there is a potential that the TCE plume could migrate towards downgradient water supply wells if left untreated.

6.2.2 Remedy Requirements

To meet ROs, the Off-Site Extraction Remedy requirements include:

- Capture and contain the groundwater plume exceeding AWQS's.
 - The results of Site groundwater modeling indicate that a purpose-built groundwater extraction well located on COP property (the Sonoran Preserve) screened from the current ambient water table to 360 ft below the water table (i.e., to the top of bedrock), and operated at a flow rate of 200 gpm should meet this requirement. To promote complete containment, the well would need to be installed prior to significant migration of the TCE groundwater plume to this location.
 - A minimum of one new monitoring well located downgradient of the groundwater extraction system and existing groundwater plume will be required to evaluate the extent and effectiveness of capture. If concentrations of TCE in excess of the AWQS migrate to this new monitoring well, further expansion of the Site monitoring network will likely be required.
 - Routine water level monitoring at surrounding wells (MW-2, MW-3, MW-4, MW-5, MW-6, and MW-7) will be required to demonstrate the extent of the capture zone induced by the new groundwater extraction well.
 - Routine extraction rate and COC concentration monitoring will be required for capture zone evaluation and compliance reporting.
- Provide for the appropriate treatment and disposal of extracted groundwater.
 - Based on current COC concentrations at MW-2, the groundwater treatment system must be designed to accommodate an influent TCE concentration on the order of 100 µg/L; given the current location of the plume, concentrations may be expected to increase and then decline depending on when this remedy is implemented; the treatment system must be capable of achieving treatment requirements over the long-term range of COC concentrations anticipated.
 - The level of treatment that is required will depend on the selected end use for the treated water; for evaluation purposes, AWQSs are selected as the treatment standard for the P&T system.
 - Routine monitoring of process operations will be required to demonstrate acceptable

treatment in compliance with selected end use standard and meter flows for applicable end use reporting.

- Remove COC mass from soil vapor in the source area to the extent that TCE concentrations in soil vapor no longer pose a threat to groundwater at concentrations that exceed AWQs.
 - A minimum of two new purpose-built SVE wells in regions known to have high concentrations of COCs will be required to extract contaminated soil vapor; additional well requirements will be developed, as necessary, following the installation and testing of these wells.
 - On the basis of SVE monitoring conducted to date at the Site, SVE process equipment must be capable of achieving an applied vacuum on the order of 80 to 100 inches of water at each SVE wellhead to maximize flow from the formation (additional applied vacuum does not appear to result in further increases in flow; AMEC, 2012a).
 - On the basis of SVE testing conducted to date at the Site, the vapor treatment process unit must be designed to accommodate maximum influent COC concentrations on the order of 3,500 mg/m³ TCE, 1,400 mg/m³ cis-1,2-DCE, 260 mg/m³ 1,1-DCE, 240 mg/m³ of PCE, and 59 mg/m³ of VC; as the system operates, concentrations are anticipated to be variable in response to which wells are operational and the duration of extraction; the treatment system must be capable of achieving treatment requirements over the long-term range of COC concentrations anticipated.
 - Routine monitoring of SVE process operations will be required to demonstrate acceptable treatment of extracted vapors and fulfill requirements of air permit compliance reporting.
 - Routine monitoring of vacuum and COC concentrations at SVE process and monitoring wells will be required to evaluate the impacts of treatment.

6.2.3 Conceptual Design

Figure 6-2 provides the conceptual layout of Off-Site Extraction Remedy components including: (1) a groundwater P&T system with one off-site extraction well located on COP property south of the Site, (2) an expanded groundwater monitoring well network to evaluate the effectiveness of groundwater containment and (3) a source area SVE system. The following sections provide additional details regarding these components.

Groundwater Extraction Well. Groundwater modeling indicates that for complete containment of the groundwater plume, the off-site remediation extraction well (EW-1) would have to be located approximately 500 ft southwest of the existing monitoring well MW-06 (see Figure 6-2) and screened from the top of groundwater to the top of bedrock (approximately 700 to 1,060 ft bgs). It is anticipated that EW-1 would be constructed of 10-inch diameter (minimum), low-carbon steel casing with stainless steel screen. The well would be tested with a rental pump over a minimum 72-hour period prior to installation of a dedicated groundwater pump; water levels would be monitored in the extraction well, MW-4, MW-7, and MW-6. The pump would be sized to extract 200 gpm of flow from a groundwater elevation of approximately 1,160 ft amsl and pump the discharge to ground surface located at approximately 1,860 ft amsl. The groundwater pump would

also pump the groundwater through a temporary treatment system to the anticipated end use of the treated water (sewer discharge). It is conservatively estimated that an 8-inch 60-hp pump would be required; power would be supplied to the pump from the nearby groundwater treatment system compound.

Permitting associated with EW-1 installation and operation would include a drilling permit from ADWR to authorize and register the well and a PQGWP to operate the well (this may be difficult to obtain for sewer discharge).

Groundwater Treatment System. A treatment compound for the groundwater remediation system would be constructed near EW-1 on the southern property boundary (see Figure 6-2). Although the flow of this treatment system would be greater than the On-Site Extraction Remedy, the treatment system constructed for the Off-Site Extraction Remedy would be similar. The primary differences between the two systems would be pipe sizes and the liquid loading rate in the L-GAC which would also affect carbon usage. The flume required by the COP for discharge to sewer would likely be installed at the Off-Site Extraction Remedy treatment system because gravity flow from the treatment compound to the sewer tie in is considered feasible.

An access agreement would be required to construct the both the treatment system and sewer discharge pipeline on COP property. Permitting associated with groundwater treatment system installation would include a construction permit for treatment system infrastructure. New electrical service sourced likely from a transformer near Black Canyon Parkway would be required.

Treated Groundwater End Use. Following treatment, the extracted groundwater would be discharged via gravity flow to an existing sewer line located in the right-of-way between the Sonoran Preserve and nearby neighborhood (see Figure 6-2). Sewer usage fees would apply.

Permitting associated with treated groundwater end use would include a COP Industrial Wastewater Permit. Routine sampling would be required in the wastewater discharge permit.

Groundwater Monitoring Network Expansion. A new groundwater monitoring well (MW-9) would be installed hydraulically downgradient of EW-1 on either COP right-of-way (located to the east of the Sonoran Preserve) or near the southern Sonoran Preserve boundary on State Trust Land (see Figure 6-2). Ideally this well would be a nested installation with two well screens to monitor shallow and deep intervals; however, the depths involved may not allow for this design. Like the extraction well, the boring for MW-9 would be drilled to bedrock (estimated to be at 1,100 ft bgs) and depth-specific sampling would be conducted throughout the saturated thickness profile to characterize the distribution of contamination at this location. It is estimated that MW-9 would be constructed of 6-inch diameter, low-carbon steel casing with stainless steel screen placed from a depth of 720 to 800 ft bgs. A dedicated sampling pump would be installed in MW-9.

Permitting associated with MW-9 installation would include a drilling permit from the ADWR to authorize and register the well. An access agreement would also be required to construct and access the well on COP property.

Groundwater monitoring would continue at the Site and incorporate MW-9. Groundwater levels would be gauged on a quarterly basis and groundwater sampling of Site wells for COCs would be

conducted on a semiannual basis. This well would serve as a final compliance well to evaluate the extent of groundwater containment. If concentrations observed at this well increase to levels that exceed the AWQS, additional monitoring and containment actions will be considered.

SVE Wells, Conveyance Piping and Treatment System. These components would be identical to those scoped for the On-Site Extraction Remedy.

7.0 COMPARISON OF ALTERNATIVE REMEDIES

To simplify comparison of retained alternatives, the comparison criteria referenced in 40 CFR §258.56 were grouped into four comprehensive criteria: practicability, risk, cost, and benefit/value as follows:

Comparison Criterion Referenced in 40 CFR §258.56	Comparison Criterion	Description of Criterion
Performance, reliability, ease of implementation; time required to begin and complete the remedy; institutional requirements that substantially affect remedy implementation	Practicability	Feasibility, short and long-term effectiveness, and reliability
Adverse safety or cross-media impacts, exposure to any residual contamination	Risk	Overall protectiveness of public health and aquatic and terrestrial biota under reasonably foreseeable use scenarios and end uses of water.
Costs of remedy implementation	Cost	Expenses and losses including capital, operating, maintenance, and life cycle costs
Decreases in safety or cross-media impacts, control of exposure to any residual contamination	Benefit or Value	Includes: (i) lowered risk to human and aquatic/terrestrial biota; (ii) reduced concentration and reduced volume of contaminated water; (iii) decreased liability and acceptance of the public; (iv) aesthetics and preservation of existing uses; (v) enhancement of future uses; and (vii) improvements to local economies

7.1 Detailed Evaluation of Remedies

Each remedy was evaluated based on the comparison criteria of practicability, cost, risk, and benefit/value as described above. Since SVE for source control is currently being implemented at the Site and this remedial measure is a component of all three remedies, SVE implementation is not considered in the following comparison of remedies.

7.1.1 On-Site Extraction with Off-Site Injection Remedy (Alternative 4A) – On-Site P&T, and SVE for Source Control

Practicability. This remedy is generally implementable, highly feasible and expected to be both an effective and reliable means to achieving Site ROs. Groundwater P&T has a proven track record in plume containment and VOC mass removal at many sites. If designed and implemented properly, the migration of groundwater plumes can be effectively controlled over both the short and long term. Groundwater modeling simulation results indicate that at a pumping rate of 190 gpm, the proposed extraction well will be able to provide complete hydraulic capture of the TCE plume and thus would eliminate the off-site migration of contaminant mass flux. As a result, simulated TCE concentrations at the downgradient water supply wells are negligible. However, there is some uncertainty associated with the groundwater modeling on which the effectiveness

and reliability of this remedy is based; to address this uncertainty, additional investigation and monitoring is required to provide reassurance that the remedy will achieve remedial action goals.

Since the proposed groundwater extraction well and treatment system are on-site, site access should not be an issue. The conveyance pipeline that connects the treatment system to the offsite injection well would be constructed in the COP right-of-way. Drilling a new injection well on COP right-of-way may take some time, but it is currently considered implementable based on discussions with COP regarding establishing an IGA. There would be some time required to drill/test the extraction and injection wells, design/construct the groundwater treatment system, and install electrical service (16 months is estimated on an expedited schedule). Once groundwater extraction activities begin, COC concentrations are anticipated to decrease to AWQS's in the region upgradient of the extraction well within 27 years (see Appendix D). If a stable attenuating plume is demonstrated, extraction could cease.

Drilling a new monitoring well (MW-9) on COP right-of-way and/or State Trust Land may take some time but is currently considered implementable based on experience installing MW-4, MW-5, MW-6, and MW-7 when the land south of the Site was State Trust Land.

There is a potential that an off-Site injection well may require an APP. A pre-application meeting will be requested through ADEQ to determine the applicability of an APP to the injection of treated water off-Site. If an APP is required, additional time may be required to implement the remedy.

Risk. Given the depth to groundwater (approximately 700 ft) and nature of contamination, there are no potential exposure pathways for the groundwater to humans or terrestrial biota near the Site. In this instance, remedy protectiveness can be assessed based on the rights of nearby landowners to use groundwater impacted by Site activities. The On-Site Extraction with off-Site Injection Remedy will be generally protective of human health and the environment. The remedy is anticipated to be protective of the currently operating water supply wells given the distance these wells are located from the Site.

With respect to the potential for adverse safety, cross-media contamination, and exposure to residual contamination, there is a potential for any ex situ treatment technology to increase these types of risk because contamination is removed from the subsurface and treated at the surface where there are more potential receptors of contamination. Based on the relatively low concentrations of contamination in groundwater, the siting of the groundwater treatment facility on Maricopa County property, discharge of the treated water to an off-site injection well under an IGA, and the well-developed nature of the selected treatment technology (L-GAC), these potential risks are anticipated to be minimal. L-GAC does concentrate contamination prior to destruction during thermal media reactivation but these activities are conducted by companies that are appropriately trained and regulated to do so; on this basis, cross-media contamination and exposure to residual contamination are adequately controlled.

Cost. The cost to implement the P&T portion of the On-Site Extraction with off-Site Injection Remedy is estimated to be on the order of \$ 8,500,000 over a period of 27 years (see Table 7-1). The 27-year period was chosen based on the time the model predicts would be required for concentrations in the region to comply with AWQS's. Inflation and discount rates were not applied to estimated costs. Cost assumptions included:

- Groundwater will be pumped continuously at a pumping rate of 190 gpm from one well for 27 years (ideally pumping would be discontinued when plume concentrations have declined to levels that result in a stable plume).
- For the groundwater treatment system, monthly water samples will be collected from the L-GAC influent, mid-point, and effluent for VOC analysis.
- Only one additional monitoring well is required to demonstrate acceptable containment and attenuation of the plume; additional wells could be required in the future to monitor plume migration if concentrations exceeding the AWQS reach the interim compliance well.
- Semiannual groundwater samples are collected from existing and new monitoring wells for VOC analysis; annual groundwater samples are collected from these monitoring wells for general chemical analysis and MNA parameters.

Appendix E presents a breakdown of cost information for groundwater treatment system capital, construction, and O&M costs. High range estimates were used in calculations.

Benefit. The On-Site Extraction with off-Site Injection Remedy will reduce the concentration and volume of impacted groundwater, increase public acceptance of past Site operations and decrease Maricopa County's liability for Site contamination. The remedy will also reduce the risk that currently operating water supply wells will be impacted by Site contamination in the future by both containing the plume and diluting any potential contamination that may migrate beyond the extent of capture.

7.1.2 On-Site Extraction with On-Site Injection Remedy (Alternative 4B) – On-Site P&T and SVE for Source Control

Practicability. This remedy is generally implementable, highly feasible and expected to be both an effective and reliable means to achieving Site ROs. Groundwater P&T has a proven track record in plume containment and VOC mass removal at many sites. If designed and implemented properly, the migration of groundwater plumes can be effectively controlled over both the short and long term. Groundwater modeling simulation results indicate that at a pumping rate of 370 gpm, the proposed extraction well will be able to provide complete hydraulic capture of the TCE plume and thus would eliminate the off-site migration of contaminant mass flux. As a result, simulated TCE concentrations at the downgradient water supply wells are negligible. However, there is some uncertainty associated with the groundwater modeling on which the effectiveness and reliability of this remedy is based. In particular, the potential for spreading the plume laterally is greater with upgradient injection with Alternative 4B than Alternative 4A which may affect remedy effectiveness. To address this uncertainty, additional investigation and monitoring is required to provide reassurance that the remedy will achieve remedial action goals.

Since the proposed groundwater extraction well and treatment system are on-site, site access should not be an issue. There would be some time required to drill/test the extraction and injection wells, design/construct the groundwater treatment system, and install electrical service (16 months is estimated on an expedited schedule). Once groundwater extraction activities begin, COC concentrations are anticipated to decrease to AWQS's in the region within 15 years (see Appendix D). If a stable attenuating plume is demonstrated, extraction could cease.

Drilling a new monitoring well (MW-9) on COP right-of-way and/or State Trust Land may take some time but is currently considered implementable based on experience installing MW-4, MW-5, MW-6, and MW-7 when the land south of the Site was State Trust Land.

Risk. Given the depth to groundwater (approximately 700 ft) and nature of contamination, there are no potential exposure pathways for the groundwater to humans or terrestrial biota near the Site. In this instance, remedy protectiveness can be assessed based on the rights of nearby landowners to use groundwater impacted by Site activities. Alternative 4B will be generally protective of human health and the environment. The remedy is anticipated to be protective of the currently operating water supply wells given the distance these wells are located from the Site.

With respect to the potential for adverse safety, cross-media contamination, and exposure to residual contamination, there is a potential for any ex situ treatment technology to increase these types of risk because contamination is removed from the subsurface and treated at the surface where there are more potential receptors of contamination. Based on the relatively low concentrations of contamination in groundwater, the siting of the groundwater treatment facility on Maricopa County property, discharge of the treated water to an on-site injection well, and the well-developed nature of the selected treatment technology (L-GAC), these potential risks are anticipated to be minimal. L-GAC does concentrate contamination prior to destruction during thermal media reactivation but these activities are conducted by companies that are appropriately trained and regulated to do so; on this basis, cross-media contamination and exposure to residual contamination are adequately controlled.

Cost. The cost to implement the P&T portion of On-Site Extraction with On-Site Injection Remedy is estimated to be on the order of \$8,000,000 over a period of 15 years (see Table 7-1). The 15-year period was chosen based on the time the model predicts would be required for concentrations in the region to comply with AWQS's. Inflation and discount rates were not applied to estimated costs. Cost assumptions included:

- Groundwater will be pumped continuously at a pumping rate of 370 gpm from two wells for 15 years (ideally pumping would be discontinued when plume concentrations have declined to levels that result in a stable plume).
- For the groundwater treatment system, monthly water samples will be collected from the L-GAC influent, mid-point, and effluent for VOC analysis.
- Only one additional monitoring well is required to demonstrate acceptable containment and attenuation of the plume; additional wells could be required in the future to monitor plume migration if concentrations exceeding the AWQS reach the interim compliance well.
- Semiannual groundwater samples are collected from existing and new monitoring wells for VOC analysis; annual groundwater samples are collected from these monitoring wells for general chemical analysis and MNA parameters.

Appendix E presents a breakdown of cost information for groundwater treatment system capital, construction, and O&M costs. High range estimates were used in calculations.

Benefit. Alternative 4B will reduce the concentration and volume of impacted groundwater, increase public acceptance of past Site operations and decrease Maricopa County's liability for

Site contamination. The remedy will also reduce the risk that currently operating water supply wells will be impacted by Site contamination in the future by containing the groundwater plume.

7.1.3 Off-Site Extraction Remedy – Off-Site P&T and SVE for Source Control

Practicability. This remedy is feasible from a technical standpoint and expected to be both an effective and reliable means for achieving Site ROs; however, the Off-Site Extraction Remedy is not very implementable. As with the On-Site Extraction Remedy, groundwater P&T technology has been proven to be effective for plume containment and VOC mass removal at many sites over both the short and long term. Groundwater modeling simulation results indicate that at a pumping rate of 200 gpm over a 35-year operational period, the proposed extraction well will completely contain the TCE plume and thus prevent downgradient migration of the plume. The operating period is anticipated to be slightly longer for this remedy than the On-Site Extraction Remedy because the extraction well is located downgradient of the plume and operation of the extraction well is anticipated to occur for the duration required for the entire plume to migrate to the extraction well.

Land access will be the primary issue for this remedy. The proposed extraction well and treatment system are located on the Sonoran Preserve and preliminary discussions with the COP suggest that development of any kind on this property is prohibited. The extraction well, associated conveyance pipelines, and groundwater treatment system would require a sizable footprint and the facility will be necessary for the foreseeable future. If the system was moved south to State Trust Land, operation would not start until the plume was in this vicinity (which could require 5 to 10 years) to limit the amount of clean water extracted.

Risk. This remedy fully contains and captures the TCE plume near the CCL property and thus prevents migration of TCE mass downgradient of the extraction well. On this basis, the remedy is anticipated to be protective of both current and future users of groundwater downgradient of the planned extraction well.

As with the On-Site Extraction Remedy, there is some potential for adverse safety, cross-media contamination, and exposure to residual contamination due to treatment of the groundwater at the surface. In general these risks should be adequately controlled but since the extraction well and treatment system would be located on property that is generally accessible by the public (either the Sonoran Preserve or State Trust Land), more monitoring and/or surveillance of the treatment facility would likely be required to ensure public safety.

Cost. The estimated cost to implement the P&T portion of this remedy is estimated to be \$13,600,000 for a period of 35 years (see Table 7-1). The 35-year period was chosen based on the time the model predicts would be required for concentrations in the region upgradient of the extraction well to comply with AWQS's. Inflation and discount rates were not applied to estimated costs. Cost assumptions included:

- Groundwater will be pumped continuously at a pumping rate of 200 gpm for 35 years (ideally pumping would be discontinued when plume concentrations have declined to levels that result in a stable plume)

- For the groundwater treatment system, monthly water samples will be collected from the L-GAC influent, mid-point, and effluent for VOC analysis
- Discharge to sewer of treated water would be conducted; this option is anticipated to be more expensive than discharge to an injection well located in the vicinity of the treatment system (the total cost would likely be closer to \$10,000,000 if groundwater injection was incorporated into the remedy); if this remedy was selected, further assessment of groundwater injection would be conducted.
- Semiannual groundwater samples are collected from existing and new monitoring wells for VOC analysis; annual groundwater samples are collected from these monitoring wells for general chemical analysis and MNA parameters.

Appendix E presents a breakdown of cost information for groundwater treatment system capital, construction, and O&M costs. High range estimates were used in calculations.

Benefit. Like the On-Site Extraction and off-Site Injection Remedy, On-Site Extraction and on-Site Injection Remedy the Off-Site Extraction Remedy will reduce the concentration and volume of impacted groundwater, increase public acceptance of past Site operations and decrease Maricopa County's liability for Site contamination. The remedy will also protect both existing and potential future users of groundwater downgradient of the Site.

7.2 Comparison of Remedies to Each Other

Table 7-2 summarizes the assessment of practicability, risk, cost, and benefit/value presented in Section 7.1 so that a comparison of each remedy to each other can be presented. This analysis is discussed in the following sections.

7.2.1 Practicability

The On-Site Extraction Remedy is considered the most practicable based primarily on both effectiveness and implementability. This remedy appropriately balances these attributes, cleans up the Site in the shortest period, and limits the concentration of TCE in the plume migrating from the Sonoran Preserve. However, there is uncertainty in the groundwater model used to evaluate remediation timeframes and downgradient impacts which translates into less reliability of the remedy when compared to the Off-Site Extraction Remedy. The Off-Site Extraction Remedy is less practicable because siting the extraction well in the most appropriate location from a technical perspective (on land that is part of the Sonoran Preserve) is likely not feasible and relocating the well south to State Trust Land would delay implementation until the groundwater plume migrates to this location.

7.2.2 Risk

The Off-Site Extraction Remedy controls risk better than the other two alternatives because the TCE plume is completely contained and the rights of potential users of downgradient groundwater are protected. There is more risk associated with the On-Site Extraction Remedy because although the remedy has been design to completely capture the plume, the contamination has migrated beyond the southern boundary of the site. It is possible that a portion of the contaminated groundwater will migrate from the Site and concentrations exceeding AWQS's may persist in the

downgradient aquifer for some time. However, the contaminant flux that is not contained is anticipated to be low and thus this additional risk may not be significant.

7.2.3 Cost

Estimated costs for the remedies range from \$8.0 to \$13.6 million. The On-Site Extraction Remedy is less costly than the Off-Site Extraction Remedy due to the longer time period required to clean up the plume by the Off-Site Extraction Remedy and higher flow rate necessary to contain the plume in the Off-Site Extraction Remedy. If groundwater injection can be implemented into the Off-Site Extraction Remedy, costs would decrease to around \$10.0 million which would be more comparable to the On-Site Extraction Remedy.

7.2.4 Benefit or Value

Both remedies provide benefit and value because they reduce the contaminant concentration and volume of impacted groundwater, demonstrate to the public that action is being taken to address groundwater impacts, and decrease Maricopa County's future liability for Site contamination. Although the Off-Site Extraction Remedy has the greatest potential to cease migration of the plume, the On-Site Extraction Remedy may provide more benefit because less contaminant flux would theoretically migrate off-site past the southern property boundary.

7.3 Uncertainties

The most significant uncertainties impacting the comparison of remedies presented in Section 7.2 are:

- *The durations required to cleanup Site groundwater contamination.* Cleanup periods were estimated by the Site groundwater model which conservatively assumes that the TCE degradation rate in the aquifer is zero. Cleanup periods are likely biased high which artificially inflates remedy costs and perceived risk to downgradient users of groundwater. Costs developed using these durations are considered useful from a remedy comparison perspective but enhancement of the current groundwater model with more robust Site-derived aquifer characteristics would be required to develop more representative lifecycle estimates.
- *The vertical distribution of VOCs in groundwater.* The Site groundwater model used to develop plume containment requirements and estimate cleanup durations assumed that the vertical distribution of TCE is uniform within the top 120 ft of the aquifer and corresponds to the groundwater concentrations indicated by Site groundwater monitoring wells. This assumption is likely conservative but does impact both the quantity of water that must be extracted for containment. As of December 2014, the pump intake depth in each of the monitored groundwater wells ranged from approximately 11 to 26 ft below the water table. The submerged screen length below the water table ranged from 37 to 108 ft. It is also notable that the groundwater model assumed that the aquifer underlying the top 120 ft of the water table is not impacted with TCE. Depths greater than 120 ft below the top of the water table have not been characterized and if deeper contamination is present, the extraction requirements estimated by the model for the On-Site Extraction Remedy may not be adequate (for the Off-Site Extraction Remedy the extraction well is

screened to the estimated depth of bedrock).

- *Future impacts of water supply wells.* Regional pumping affects the direction of groundwater flow and rate of plume migration. The transport model relied upon for this comparison of remedies is based on a calibrated steady-state flow field that assumes regional water supply pumping will remain comparable to the average of the 2009 to 2013 period of record for municipal supply wells and the maximum permitted pumping rates for the private and golf course irrigation wells. If new wells are installed and/or existing wells are operated substantially differently than assumed in the model, the cleanup requirements derived from the model could be adversely impacted. The most significant change that could affect the remedies considered in this analysis is likely a change in the direction of groundwater flow. The Off-Site Extraction Remedy would likely be most sensitive to a change in the direction of groundwater flow due to the significant planning and capital expense associated with constructing a groundwater treatment facility and the current distance the planned extraction well is located from the plume.
- *Site aquifer characteristics.* Aquifer parameters such as porosity, hydraulic conductivity, transmissivity, contaminant retardation, dispersivity and saturated thickness impact the containment and remedy duration requirements estimated by the groundwater model. To date, some of these characteristics for the Site aquifer have been difficult to define due to site constraints. The groundwater model relied significantly on the limited aquifer testing conducted at the Site and regional data available in the ADWR Salt River Valley model for Site aquifer characteristics. If actual Site conditions vary substantially from the parameters used in the model, the extent of containment, peak concentrations observed at downgradient water supply wells, and plume migration timeframes estimated by the model would vary. These impacts are not anticipated to significantly affect how the remedies compare to each other but could impact future effectiveness of the selected remedy.

8.0 SELECTION OF THE PROPOSED REMEDY

8.1 Remedy Selection and Rationale

The On-Site Extraction with Off-Site Injection Remedy (Alternative 4A) which consists of on-site groundwater extraction and treatment, and SVE for source control of impacted soil vapors with the potential to impact groundwater is recommended as the proposed remedy. This remedy was selected on the basis that when compared to the On-Site Extraction with On-Site Injection (Alternative 4B), the remedy was the most protective of downgradient users of groundwater and reduces potential interference with remaining deep soil vapor contamination. However, the on-site extraction with onsite injection (Alternative 4B) is retained as a contingency remedy if implementation of an offsite injection well is impeded. When compared to the Off-Site Extraction Remedy, both of the onsite extraction scenarios are the most practicable and provide a generally comparable amount of benefit or value. Risks are potentially greater with the On-Site Extraction Remedy than with the Off-Site Extraction Remedy; however, this additional risk may not be significant. Costs associated with the Off-Site Extraction Remedy are anticipated to be at minimum slightly higher than for the On-Site Remedy.

Uncertainties in remedy assessment should be addressed during implementation of the proposed remedy as described in Section 8.3. If the groundwater monitoring program indicates that groundwater contamination above the AWQS is migrating beyond the hydraulic capture zone of the extraction well(s), contingent measures will be evaluated.

8.2 Demonstration that the Remedy Meets Regulatory Requirements

Relevant remedy requirements for RCRA corrective measures are principally found in 40 CFR §258.57(b) which were used to develop ROs (see Section 4.0); however, 40 CFR §258.57(d) requires specification of a schedule for implementation of the proposed remedy. Table 8-1 identifies how the proposed remedy will achieve ROs and Section 8.3.3 presents an estimated schedule for remedy implementation.

8.3 Implementation of the Proposed Remedy

8.3.1 Potential Enhancements to the Proposed Remedy

Two potential enhancements to the proposed remedy will be evaluated following remedy selection. Both are intended to reduce the duration that the groundwater remedy is in place.

The first enhancement is onsite ISCO in select portions of the TCE groundwater plume. The potential effect of ISCO on the duration of groundwater extraction operations was simulated in the groundwater model as Alternative 4A Enhancement and Alternative 4B Enhancement (see Appendix D). On the basis of this modeling, the timeframe required to reduce COC concentrations to AWQS's in the region upgradient of the extraction well decreases from 27 to 10 years for Alternative 4A and from 15 to 10 years for Alternative 4B. This decrease could significantly affect costs. These two options will be further evaluated after groundwater treatment operations yield enough information to refine the required duration of P&T operation, assess the effects of alternate extraction scenarios after well design, and design/cost an effective ISCO implementation program (see Section 8.3.2).

The second enhancement is the installation of an additional onsite groundwater extraction well approximately midway between PW and the new extraction well. A second extraction well location would intercept contamination north of the well and reduce the time required to treat the length of the existing plume.

8.3.2 Overview of Remedy Implementation

This revised RAP provides a framework for remedy implementation. If the proposed remedy is selected, implementation would include:

- *A Soil Vapor Extraction and Monitoring Well Installation Program.* This program was documented in the *Vapor Monitoring and Soil Vapor Extraction Well Design Basis and Work Plan* (AMEC, 2014b) and was completed in May 2015. Two new SVE wells and three new soil vapor monitoring well nests were installed.
- *Design and Construction of a Full-Scale SVE System for the Site.* Multiple design and construction efforts supporting full-scale SVE operations have recently been conducted. Submittal of an application for a construction permit to bring 3-phase electrical service to the SVE equipment treatment compound occurred in December 2014 and connection of the electrical service was initiated in May 2015. Construction of conveyance piping and installation of the 500-cfm rated SVE system was completed in August 2015.
- *Initiation of SVE Operations.* After the full-scale SVE system was constructed, the new SVE wells were tested to evaluate the radius of influence of operations. On the basis of this assessment and monitoring conducted at TSSV wells, the adequacy of existing wells in addressing soil vapor contamination will be evaluated and documented in an SVE Work Plan for ADEQ review. The plan will include as-built drawings, radius of influence testing results, carbon changeout procedures, sampling data, and proposed monitoring parameters (e.g. flow rate, vacuum, and temperature). An initial operating approach and presentation of proposed remediation criteria will be included. If additional wells are required to extract soil vapor or monitor operations, a plan for installation of these wells will be included. Following submittal of SVE Work Plan, quarterly progress reports will be submitted to ADEQ documenting operations. The reports will include flow rates from individual wells and operational parameters. An SVE System Termination Plan will be submitted to ADEQ for approval three months prior to the proposed shutdown. This plan will outline proposed testing to document achievement of the soil remediation standards.
- *Design and Construction of a Groundwater Treatment Facility.* Groundwater treatment design will include the development of equipment specifications, electrical requirements, and conveyance piping/site arrangement plans and specifications. Design will include the groundwater conveyance system to the reinjection well. Design drawings will be submitted to ADEQ for approval at 30% and 100% design stages. A design report will be submitted at the 30% design stage to ADEQ for approval. Construction of the groundwater treatment facility will not occur until the groundwater extraction and injection wells are installed and preliminary testing of the wells have occurred so that if additional capacity is required by the treatment facility to contain on-site groundwater, the design can be expanded to accommodate this requirement. Construction will commence after ADEQ approves the 100% design drawings. As-built drawings will be prepared after construction has been completed.

- *A Groundwater Extraction and Injection Well Installation Program.* Installation of new groundwater extraction and injection wells will be performed concurrently with treatment system design. As indicated in Section 6.1.3, depth-specific groundwater sampling will be performed during extraction well installation to properly screen this extraction well for containment of the on-site TCE plume exceeding the AWQS. Pump testing with a rental pump will also be conducted to appropriately size the groundwater extraction pump and treatment system prior to finalization of treatment system design. A Pump Test Work Plan will be submitted to ADEQ for approval prior to conducting pump testing. Following installation of the wells, a Well Installation Report will be submitted to ADEQ.
- *Initiation of Groundwater Treatment Operations.* One month following construction, a Groundwater Operational Plan will be submitted to ADEQ for approval. The plan will describe the operations and maintenance requirements of the system including proposed ADEQ reporting. The plan will include descriptions of data collection efforts and analysis needed to evaluate groundwater capture by the treatment system and document water quality changes. Upon approval of the plan by ADEQ, the groundwater treatment facility will begin continuous extraction and treatment of impacted groundwater. Progress reporting to ADEQ will be documented in quarterly Progress Reports in accordance with the format and content agreed upon in the Groundwater Operational Plan.
- *A Downgradient Monitoring Well Installation Program.* Maricopa County has had preliminary discussions with the COP regarding installation of this monitoring well at the Sonoran Preserve; however, it is likely that this well will be installed either on COP right-of-way or Arizona State Trust Land. Discussion with these stakeholders regarding siting of this well has been initiated. Once a final location is established, drilling will commence. After completion of the monitoring well, an installation report will be submitted to ADEQ.
- *Groundwater Modeling Update.* After two years of groundwater treatment system operation, the groundwater model will be updated with the most recently available data. An updated model report including an analysis of remedy timeframes will be submitted to ADEQ.
- *On-Site ISCO Treatment.* Initiation of On-Site ISCO Treatment is contingent future Site Groundwater modeling following groundwater treatment operations. The results of the updated model will assist in developing a conceptual design for ISCO treatment that can be further evaluated for potential implementation. If the results of this evaluation indicate ISCO is a practicable and cost-effective approach to reduce the duration of groundwater extraction at the site, an ISCO Implementation Work Plan will be prepared and submitted to ADEQ for review and comment.
- *Groundwater Extraction Termination Plan.* A Groundwater Extraction Termination Plan will be submitted to ADEQ for approval three months prior to the proposed groundwater extraction well shutdown. This plan will outline proposed testing to document achievement of the groundwater quality standards.

As noted above, proposed remedy components supporting SVE implementation for source control have been initiated based on ADEQ approval of this effort in the ASCWP (AMEC, 2012a).

8.3.3 Schedule for Initiating and Completing Remedial Activities

A preliminary schedule for initiating and completing remedial activities is provided in Table 8.2.

Estimated timeframes are aggressive to promote progress in implementing the remedy. This schedule will be updated, as required in quarterly progress reports submitted for the Site. Monthly status reports will be suspended as of regulatory approval of this RAP.

An operating period of 5 years is assumed for SVE operations and 15 to 27 years is assumed for groundwater P&T operations based on modeling results for Alternative 4B and Alternative 4A, respectively. These timeframes will require review after sufficient data are available for assessment of remedial progress. No later than two years after groundwater treatment operations begin, an update to the Site groundwater model will be initiated with data collected during groundwater extraction. The updated model will be used to refine the estimated P&T operating period.

9.0 COMMUNITY INVOLVEMENT

Stakeholder input (principally from the COP) and comments from surrounding property businesses and residents were considered during the remedy selection process documented in this revised RAP. This aided Maricopa County in adopting the most practicable remedy that protects public health and the environment and is supported by the community.

The first round of public involvement activities included:

- Providing a copy of this RAP to the COP Parks and Recreation Department (which is responsible for maintenance of the Sonoran Preserve), the COP Groundwater Hydrology Department, and the COP Office of Environmental Programs;
- Preparing a Fact Sheet that briefly discusses the history of the site, provides an overview of the contents of this RAP, summarizes the remedial alternatives evaluated in this RAP and presents the tentatively-selected remedy for the site (Appendix F presents a copy of the Fact Sheet prepared for the August 17, 2015 through September 15, 2015 public comment period);
- Posting the Fact Sheet and this RAP on the CCL document repository website (<http://www.maricopa.gov/groundwater>);
- Preparing and publishing a Public Notice in the Arizona Republic that announces:
 - The availability of the Fact Sheet and this RAP;
 - The start of a 30-day public comment period;
 - How comments can be lodged during the comment period (an email address and contact information for Maricopa County’s Communications Director will be included); and
 - The date, time, and location of a public meeting to present the RAP (the Public Notice will be published no less than 15 days before the scheduled date of the public meeting).

These activities were completed for the August 17, 2015 through September 15, 2015 public comment period held after submittal of the draft final version of this report (dated July 24, 2015); the Affidavit of Publication is presented in Appendix F;

- Developing a mailing list consisting of property owners located within 1,000 ft of CCL property as well as any homeowner’s associations identified for this area (see Figure 9-1);
- Mailing the Public Notice to the mailing list;
- Hosting a public meeting in the neighborhood adjacent to CCL to present the RAP and solicit verbal questions and written comments on the RAP (this meeting was conducted on September 1, 2015); and
- Updating the mailing list with participants in the community involvement process, including individuals who attend/sign in at the public meeting or submit written or oral comments prior to the close of the comment period.

At the September 1, 2015 public meeting, comments were gathered in writing on either preprinted comment slips or multiple computer interfaces available at the meeting. The meeting presentation and following question and answer session were recorded so that oral comments could be captured and documented.

Maricopa County compiled comments received during the September 1, 2015 public meeting and any additional comments received via email prior to the end of the public comment period. Appendix G presents a compilation of comments received and responses to comments prepared by Maricopa County. This document is also posted on the CCL document repository website.

For this version of the RAP, Maricopa County will similarly solicit, document and post document comments during a second public comment period held after regulatory acceptance of this revised RAP. When ADEQ agrees that Maricopa County has adequately responded to comments and made appropriate revisions to the RAP based on initial community feedback, a new Fact Sheet will be created and distributed, and a Public Notice will be published announcing the availability of this RAP and a second 30-day public comment period. Based on input from the COP during the first round of public involvement and implemented changes to the RAP, the area adjacent to the recommended remedy, Alternative 4A (off-Site Injection Well), affects additional residents. The new Fact Sheet will be distributed to the original area plus the property owners located within 1,000 ft of the pipeline and injection well for the recommended remedy (see Figure 9-1). Concerns received by property owners located within 1,000 ft of the pipeline and injection well during the second 30-day public comment period will be addressed on an individual basis.

If ADEQ agrees that Maricopa County has adequately responded to public comments on this version of the RAP, the RAP will be finalized within 60 days of receiving comments during the second 30-day public comment period in accordance with requirements of the Consent Order. Upon approval of the Final RAP, Maricopa County will mail a notice containing the final remedy selected for the site to the community involvement mailing list.

10.0 REFERENCES

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TABLES

Table 2-1. Site History**Cave Creek Landfill, Maricopa County**

Date	Event	Significance
1965 to 1984	County operation of the Old CCL on land leased from the BLM; this landfill closed in 1984.	Defines the period when waste was placed in the Old CCL.
1982	County leases New CCL property from the ASLD.	Allows for expansion of landfill operations.
1984 to 1998	County operation of the New CCL; the New CCL ceases accepting waste in 1998.	Defines the period when waste was placed in the New CCL.
October 1982	Installation of the Production Well.	Change in site infrastructure. The Production Well was installed to supply water for fire and dust control purposes.
September 1985	Intermittent groundwater sampling from Production Well begins; TCE detected in September and October 1985 and is not detected again until May 1998.	First indication of TCE contamination underlying the landfill.
1990	County purchases the New CCL property and landfill buffer areas (includes retention areas).	Change in property ownership and expansion of site.
1992	City of Phoenix annexes the site.	Defines period when the property is located within City boundaries.
1993	Installation of MW-1 and MW-2	Initiation of the site groundwater monitoring program.
April 1994	Installation of landfill perimeter soil gas monitoring wells (P Wells)	Initiation of the site landfill gas monitoring program.
September 23, 1994	Restrictive Covenant placed on landfill property at the County's request.	Administrative restriction placed on site use.
September 1995	Installation of supplemental P Wells.	Expansion of the site landfill gas monitoring program in response to elevated methane concentrations in select P Wells.
Circa 1996	Initiation of LFG collection system operation.	Change in site operations.
1997	Southern portion of New CCL lined.	Change in site infrastructure.
December 1997	TCE detected in groundwater from MW-1 at concentrations exceeding the applicable AWQS.	Impetus for Consent Order.
1998	County constructs transfer station in northern portion of the site.	Change in site infrastructure.
August 15, 1999	County enters into Consent Order (CO) with ADEQ to characterize the nature and source of groundwater contamination.	Impetus for additional groundwater monitoring and assessment of regional sources of TCE contamination.
1999	Soil gas samples collected from LFG collection system and select P wells evaluated for chlorinated VOCs.	TCE detected at concentrations typically observed in MSW landfills (2.2 to 2.7 mg/m ³); 0.14 mg/m ³ TCE detected in one P well located in the southwestern portion of the site.
January 2000	Water table drops below the screened interval in MW-1.	Collection of water samples from MW-1 no longer possible.
June 2002	Water table drops below the pump intake in MW-2.	Water samples collected from MW-2 with bailer after this date.
November 2004	Characterization of shallow soil gas in existing P wells, the Old CCL (via the installation of ODP-1 through ODP-4) and the New CCL (via the installation of NDP-1 and NDP-2).	TCE, DCE, and toluene detected in select P Wells (predominantly in the vicinity of the Transfer Station/Production Well) and the New CCL at low concentrations.

Table 2-1. Site History

Cave Creek Landfill, Maricopa County

Date	Event	Significance
January 20, 2005	Extension of Production Well perforations deeper into the aquifer.	Significant change in Production Well construction.
February 2005	Deepening of MW-1 and MW-2.	Significant change in MW-1 and MW-2 construction.
June 28, 2005	County enters into a CO with ADEQ to characterize and remediate contaminated groundwater.	Requires submittal of a groundwater characterization work plan and a well drilling plan; implementation and documentation of the work plan; notification of offsite impacts, as applicable; submittal of a remedial action plan; discussion of planned corrective measures in a public meeting; implementation of the remedial action plan; and status reporting.
August 25, 2005	County submittal of the <i>Cave Creek Landfill Groundwater Characterization Plan (Work Plan)</i> .	Identifies plan to install MW-3 and presents a CSM.
July 2007	LFG collection system shut down.	Change in site operations.
August 2007	MW-1 becomes obstructed during an attempt to raise the dedicated submersible pump.	No data collected from MW-1 after this date.
December 2007	Installation of MW-3.	Expansion of site groundwater monitoring program.
January 2008	Sampling of landfill vapor monitoring locations.	TCE detected at low concentrations in samples collected from the New CCL; concentrations are slightly higher than observed in 2004/2005.
November 5, 2008	County submittal of the <i>Cave Creek Landfill Groundwater Remedial Action Plan (RAP)</i> .	Documents an approach to address contamination based on a groundwater transport model. Remedial approach includes: operation of the LFG collection system; expansion of the LFG system if necessary; regular monitoring; installation and pumping of a new down-gradient pumping well; and installation of an irrigation system to treat extracted groundwater.
May 11, 2009	County submittal of the <i>Addendum to the Cave Creek Landfill Groundwater Characterization Plan (Addendum)</i> .	Identifies activities supporting downgradient and lateral groundwater contaminant plume definition through the installation of test borings and monitoring wells, vertical characterization of contamination at MW-2 with passive diffusion bag samplers, and adjustment of the pump depth at MW-3.
May - June 2009	Vertical water quality profiling of groundwater at MW-2.	TCE concentrations decrease with depth from the soil-water interface.
June 25, 2009	Pump depths in PW, MW-2 and MW-3 adjusted per the Addendum.	Pumps placed at a consistent depth below the water table for more comparable data.
December 2009 - January 2010	Installation of TSSV-1.	First deep soil vapor monitoring well installed.
January 19, 2010	ADEQ issues a Revised CO.	Requires implementation of the Work Plan and Addendum; the submittal of documentation describing the results of implementation activities; submittal of a Revised RAP; and monthly status reports.

Table 2-1. Site History

Cave Creek Landfill, Maricopa County

Date	Event	Significance
October 2010 - May 2011	Installation of MW-4, MW-5, and MW-6.	Expansion of site groundwater monitoring program; definition of the downgradient extent of groundwater impacts.
August 16, 2011	County submittal of <i>Revised Interim Technical Summary Memorandum</i> .	
September 6, 2011	County submittal of the <i>Focused Workplan for Groundwater Characterization Near Old Landfill</i> .	Presents a plan for evaluating whether the Old CCL is a significant source of groundwater contamination via the installation of MW-8.
November 2011 - February 2012	Installation of MW-7 and MW-8.	Expansion of site groundwater monitoring program.
November 2011 - February 2012	Extended Soil Vapor Extraction Pilot Test at TSSV-1.	Elevated concentrations of TCE detected in deep soil gas.
January and March 2012	Select P wells along the eastern perimeter of the New CCL sampled.	Low concentrations of TCE detected.
July 20, 2012	County submittal of the <i>Additional Site Characterization Work Plan</i> .	Concludes that contamination from one or both landfills migrated to depth and resulted in a contaminated soil vapor plume that impacted groundwater at the Site; identifies additional site characterization activities supporting remedial action planning.
October 24, 2012	County submittal of the <i>Soil Vapor Well Planning Evaluation and Technical Approach</i> .	Presents a plan for the installation of additional deep soil vapor monitoring wells.
March- June 2013	Installation of TSSV-2, TSSV-3, and TSSV-4; active and passive sampling of deep soil vapor monitoring wells.	Expansion of the site deep soil vapor monitoring program.
April 28, 2013	County submittal of the <i>2013/2014 Data Compilation Report</i> .	Concludes extent of elevated TCE concentrations in deep soil vapor appear limited to the region underlying the Transfer Station and northern portion of the New Landfill.
May 17, 2013	County submittal of the <i>Soil Vapor Treatment Technology Evaluation</i> .	Identifies granular activated carbon as the air treatment technology for both SVE testing and long-term treatment of extracted vapors.
October 4, 2013	County submittal of <i>Eastern Perimeter Vapor Well Sampling of P-5 and P5-X with Vapor Intrusion Screening Analysis</i> .	Indicates that VOC concentrations in southern portion of Eastern Perimeter are consistent with previous P well data and pose no immediate vapor intrusion treat to nearby residents.
December 18, 2013	County submittal of the <i>Phase 1 Groundwater Modeling Report</i>	Presents groundwater modeling objectives and approach to flow and transport modeling performed in support of remedial action planning.
February 26, 2014	Application for a minor modification to the site air permit for SVE operations.	
July 11, 2014	County submittal of the <i>Phase 2 Groundwater Modeling Report</i>	Documents the development, calibration, and assessment of a three-dimensional numerical groundwater flow model for the site.
July-August 2014	Extended Soil Vapor Extraction Pilot Test at TSSV-2 and TSSV-4.	Highest TCE concentrations observed at TSSV-4 in deep soil vapor.

Table 2-1. Site History**Cave Creek Landfill, Maricopa County**

Date	Event	Significance
February 2015	County submittal of the <i>Draft Revised Remedial Action Plan</i>	Establishment of remedial actions for site wide cleanup efforts
February-June 2015	Installation of TSSV-5, TSSV-6, and TSSV-7 monitoring wells and SVE-01 and SVE-02 soil vapor extraction wells.	Expansion of site deep soil vapor and groundwater monitoring program and vapor extraction network.
May - August 2015	Full-scale SVE treatment system construction	Commence contaminate soil vapor plume cleanup.
September 2015 - Present	Full-scale SVE operations	Cleanup of contaminated soil vapor plume.
August - September 2015	Draft Revised Remedial Action Plan public comment period and meeting	Provided the public the opportunity to communicate opinions on the remediation effort.

Table 2-1. Site History

Cave Creek Landfill, Maricopa County

Date	Event	Significance
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Notes:

- Addendum = Addendum to the Work Plan
- ADEQ = Arizona Department of Environmental Quality
- ASLD = Arizona State Land Department
- AWQS = Aquifer Water Quality Standard
- BLM = Bureau of Land Management
- CCL = Cave Creek Landfill
- CO = Consent Order
- DCE = Dichloroethene
- LFG = landfill gas
- mg/m³ = milligrams per cubic meter
- MSW = Municipal Solid Waste
- RAP = Remedial Action Plan
- SVE = soil vapor extraction
- SWICU = Solid Waste Inspection and Compliance Unit
- TCE = Trichloroethene
- Work Plan = CCL Groundwater Characterization Plan

Table 7-1. Remedy Cost Summary

Cave Creek Landfill, Maricopa County

On-Site Extraction Remedy off-Site Injection (Alternative 4A)

Description	Quantity	Unit	Unit Cost	Amount
<i>Implementation of Groundwater Treatment System</i>				
Groundwater Extraction Well Installation	1	Each	\$ 615,000	\$ 615,000
Groundwater Injection Well Installation	1	Each	\$ 615,000	\$ 615,000
Groundwater Treatment System	1	Each	\$ 937,000	\$ 937,000
Operation and Maintenance (O&M)	27	Years	\$ 168,000	\$ 4,536,000
<i>Groundwater Monitoring</i>				
Monitoring Well Installation	1	Each	\$ 450,000	\$ 450,000
Groundwater Monitoring Labor	27	Years	\$ 30,000	\$ 810,000
Equipment Rental	27	Years	\$ 14,400	\$ 388,800
Laboratory Analysis - VOCs	27	Years	\$ 3,500	\$ 94,500
Laboratory Analysis - General Chemistry	27	Years	\$ 1,500	\$ 40,500
Total:				\$ 8,486,800

On-Site Extraction Remedy on-Site Injection (Alternative 4B)

Description	Quantity	Unit	Unit Cost	Amount
<i>Implementation of Groundwater Treatment System</i>				
Groundwater Extraction Well Installation	2	Each	\$ 615,000	\$ 1,230,000
Groundwater Injection Well Installation	2	Each	\$ 615,000	\$ 1,230,000
Groundwater Treatment System Capital Cost	1	Each	\$ 986,000	\$ 986,000
Operation and Maintenance (O&M)	15	Years	\$ 228,000	\$ 3,420,000
<i>Groundwater Monitoring</i>				
Monitoring Well Installation	1	Each	\$ 450,000	\$ 450,000
Groundwater Monitoring Labor	15	Years	\$ 30,000	\$ 450,000
Equipment Rental	15	Years	\$ 14,400	\$ 216,000
Laboratory Analysis - VOCs	15	Years	\$ 3,500	\$ 52,500
Laboratory Analysis - General Chemistry	15	Years	\$ 1,500	\$ 22,500
Total:				\$ 8,057,000

Off-Site Extraction Remedy (Alternate 5)

Description	Quantity	Unit	Unit Cost	Amount
<i>Implementation of Groundwater Treatment System</i>				
Groundwater Extraction Well Installation	1	Each	\$ 763,000	\$ 763,000
Groundwater Treatment System Capital Cost	1	Each	\$ 603,000	\$ 603,000
Operation and Maintenance (O&M)	35	Years	\$ 287,000	\$ 10,045,000
<i>Groundwater Monitoring</i>				
Monitoring Well Installation	1	Each	\$ 450,000	\$ 450,000
Groundwater Monitoring Labor	35	Years	\$ 30,000	\$ 1,050,000
Equipment Rental	35	Years	\$ 14,400	\$ 504,000
Laboratory Analysis - VOCs	35	Years	\$ 3,500	\$ 122,500
Laboratory Analysis - General Chemistry	35	Years	\$ 1,500	\$ 52,500
Total:				\$ 13,590,000

Note : SVE for source control is a component of all remedies; SVE costs are excluded from this comparison.

Table 7-2. Remedy Comparison Summary

Comparison Criterion	On-Site Extraction and Off-Site Injection Remedy (Alternative 4A) On-Site P&T and SVE for Source Control	On-Site Extraction and On-Site Injection Remedy (Alternative 4B) On-Site P&T and SVE for Source Control	Off-Site Extraction Remedy (Alternative 5) Off-Site P&T and SVE for Source Control
Practicability	<ul style="list-style-type: none"> - Generally implementable, highly feasible - Effective in short and long term but some uncertainty exists based on the limited hydrogeologic information used in groundwater modeling - 12 month time to implement (minimum) - Cleanup in 27 years 	<ul style="list-style-type: none"> - Generally implementable, highly feasible - Effective in short and long term but some uncertainty exists based on the limited hydrogeologic information used in groundwater modeling - 12 month time to implement (minimum) - Cleanup in 15 years 	<ul style="list-style-type: none"> - Technically feasible, effective, and reliable in both the short and long term; less uncertainty in downgradient aquifer quality impacts - Not very implementable - 5 to 10 years to implement if the system must be constructed on State Trust Land - Cleanup in 35 years after extraction begins
Risk	<ul style="list-style-type: none"> - Current water supply wells are likely protected - Minimal risk to safety, cross-media contamination, and exposure to residual contamination 	<ul style="list-style-type: none"> - Current water supply wells are likely protected - Minimal risk to safety, cross-media contamination, and exposure to residual contamination 	<ul style="list-style-type: none"> - Rights of potential future downgradient groundwater users are protected - Current water supply wells are protected - Some potential risk to safety, cross-media contamination, and exposure to residual contamination
Cost	<ul style="list-style-type: none"> - \$8.5 M over 27 years (not including source control with SVE) 	<ul style="list-style-type: none"> - \$8.0 M over 15 years (not including source control with SVE) 	<ul style="list-style-type: none"> - \$13.6 M over 35 years (not including source control with SVE); on the order of \$10.0 M over 35 years if groundwater injection is the end use of the treated water
Benefit or Value	<ul style="list-style-type: none"> - Reduced concentration and volume of impacted groundwater - Increased public acceptance of past Site operations - Decreased liability 	<ul style="list-style-type: none"> - Reduced concentration and volume of impacted groundwater - Increased public acceptance of past Site operations - Decreased liability 	<ul style="list-style-type: none"> - Reduced concentration and volume of impacted groundwater - Increased public acceptance of past Site operations - Decreased liability

Notes:

M - million

P&T - pump and treat

SVE - soil vapor extraction

Table 8-1. How the Proposed Remedy Meets ROs

Cave Creek Landfill, Maricopa County

Remedial Objective	Components of the Proposed Remedy that are Incorporated to Meet the Remedial Objective
<p>(1) Restore the groundwater hydraulically downgradient of the Site boundary that has been impacted by Site releases of COCs to concentrations that comply with AWQS's within a reasonable remediation timeframe (i.e., 30 years) to return this resource to its maximum beneficial use and protect the rights of property owners with water rights to install future water supply wells.</p>	<ul style="list-style-type: none"> - A groundwater extraction well located at the southern Site boundary will be used to contain the width and depth of the TCE plume exceeding AWQS's in the region upgradient and potentially downgradient of the southern Site boundary. - An LGAC-based treatment system will be used to treat extracted groundwater at the surface prior to discharge to an appropriate end-use (i.e., sewer discharge). - Some groundwater present at concentrations that exceed the AWQS for TCE will not be captured given the current extent of contamination. This mass flux of uncaptured TCE is anticipated to be small and routine monitoring of a groundwater well network will be used to demonstrate that concentrations attenuate to concentrations that are less than the AWQS prior to migration to downgradient receptors
<p>(2) Prevent the migration of contaminated groundwater from the Site at concentrations that would result in the withdrawal of groundwater with COC concentrations in excess of AWQS's (which are drinking water standards) at hydraulically downgradient COP municipal wells 55-527549, 55-603807, and 55-540078. For existing private irrigation well 55-221637 and golf course well 55-221450, prevent the migration of contaminated groundwater which would result in the withdrawal of groundwater from these wells with COC concentrations in excess of those corresponding to applicable risk thresholds for the protection of human health and the environment.</p>	<p><i>Same as components that address RO No. 1.</i></p>
<p>(3) Limit exposure of soil vapors contaminated with COCs at nearby residential structures to levels that are below risk thresholds for human health.</p>	<ul style="list-style-type: none"> - Routine monitoring of the Site perimeter well network will be conducted during SVE implementation to assess that shallow soil vapor concentrations do not pose a VI threat to nearby residences.
<p>(4) Remove COC mass present in Site soil vapor with the potential to serve as a source of contamination to groundwater at concentrations exceeding AWQS's.</p>	<ul style="list-style-type: none"> - An SVE system will be used to treat deep soil vapor concentrations with the potential migrate to groundwater and cause an exceedance of an AWQS. - A VGAC-based treatment system will be used to treat extracted soil vapor at the surface prior to discharge at a mass rate that is protective of surrounding receptors.

Notes:

AWQS = Aquifer Water Quality Standard
 COC = contaminant of concern
 COP = City of Phoenix
 LGAC = liquid-phase granular activated carbon

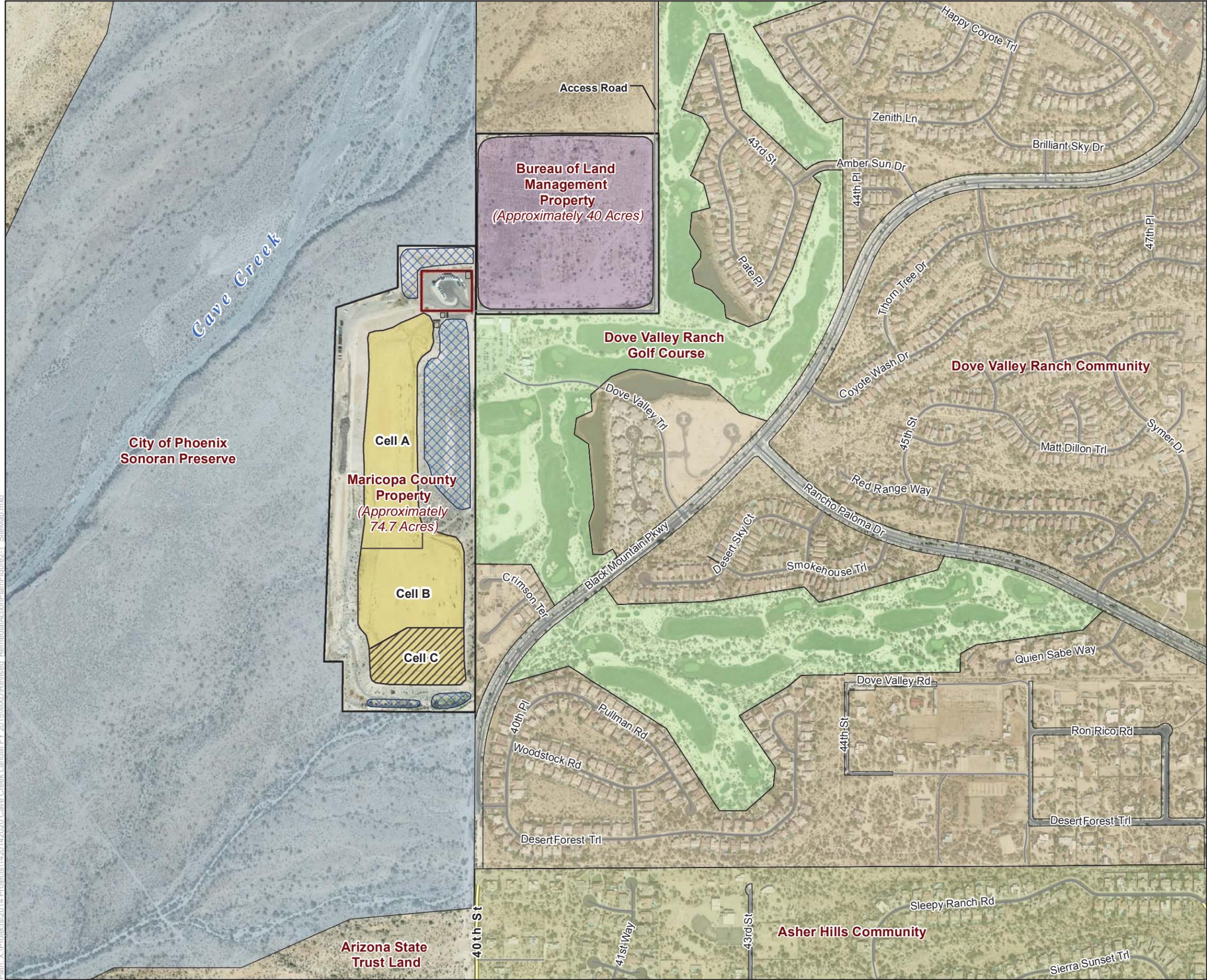
RO = remedial objective
 SVE = soil vapor extraction
 TCE = trichloroethene
 VGAC = vapor-phase granular activated carbon

Table 8-2. Preliminary Initiation and Completion Schedule

Cave Creek Landfill, Maricopa County

Activity	Start Date	Proposed Completion Date	Associated Deliverables
SVE and TSSV Well Installation Program	February-15	May-15	- 2015 Well Installation Report submitted for ADEQ approval (April 2016).
Design and Construction of Full-Scale SVE	September-14	August-15	- SVE Work Plan submitted for ADEQ approval (May 2016).
SVE Operations	September-15	August-20	- Quarterly progress reports will be submitted documenting SVE operation starting with the second calendar quarter of 2016 (startup and the first quarter will be documented in the SVE Work Plan).
SVE Operations Termination Plan			- SVE Operations Termination Plan submitted to ADEQ 3 months before proposed SVE shut down.
Design of Groundwater Treatment Facility	March-16	October-16	- 30% Design Submittal (Report and Drawings) submitted for ADEQ approval (August 2016) - 100% Design Submittal (Drawings Only) (October 2016)
Groundwater Extraction Well Installation Program	June-16	September-16	- Pump Test Work Plan submitted for ADEQ approval (July 2016) - 2016 Well Installation Report submitted to ADEQ 2 months following well construction completion.
Construction of Groundwater Treatment Facility	January-17	June-17	- As-Built Drawings will be submitted two months following construction completion.
Groundwater Treatment Operations Plan			- Groundwater Treatment Operations Plan will be submitted to ADEQ one month following completion of construction.
Initiation of Groundwater Treatment Operations	August-17	August-44	- Quarterly progress reports will be submitted to ADEQ.
Downgradient Monitoring Well Installation Program	June-16	July-16	- 2016 Well Installation Report will be submitted 2 months following well installation completion.
Groundwater Modeling Update	August-19	October-19	- The Groundwater Model Update will be submitted to ADEQ for approval three months following two years of groundwater treatment system operations.
Onsite ISCO Treatment (Contingent on Further Evaluation)	January-20	January-25	- ISCO Implementation Work Plan submitted for ADEQ approval 3 months following approval of the Groundwater Modeling Update (if ISCO Treatment is deemed appropriate).
Groundwater Extraction Termination Plan			- Groundwater Extraction Termination Plan will be submitted for ADEQ approval within 3 months of proposed termination of groundwater extraction activities.

FIGURES



Legend

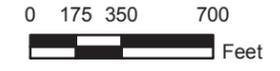
- Estimated Boundary of Old Landfill Waste Area
- Estimated Boundary of New Landfill Waste Area
- City of Phoenix Sonoran Preserve
- Dove Valley Ranch Community
- Dove Valley Ranch Golf Course
- Asher Hills Community
- Landfill Property Boundaries
- Lined Cell
- Retention Basin
- Transfer Station

Notes:

Cell boundaries are approximate

Reference:

Imagery Source: Flood Control District of Maricopa County, 2012



**Revised Remedial Action Plan
Maricopa County Cave Creek Landfill
Phoenix, Arizona**

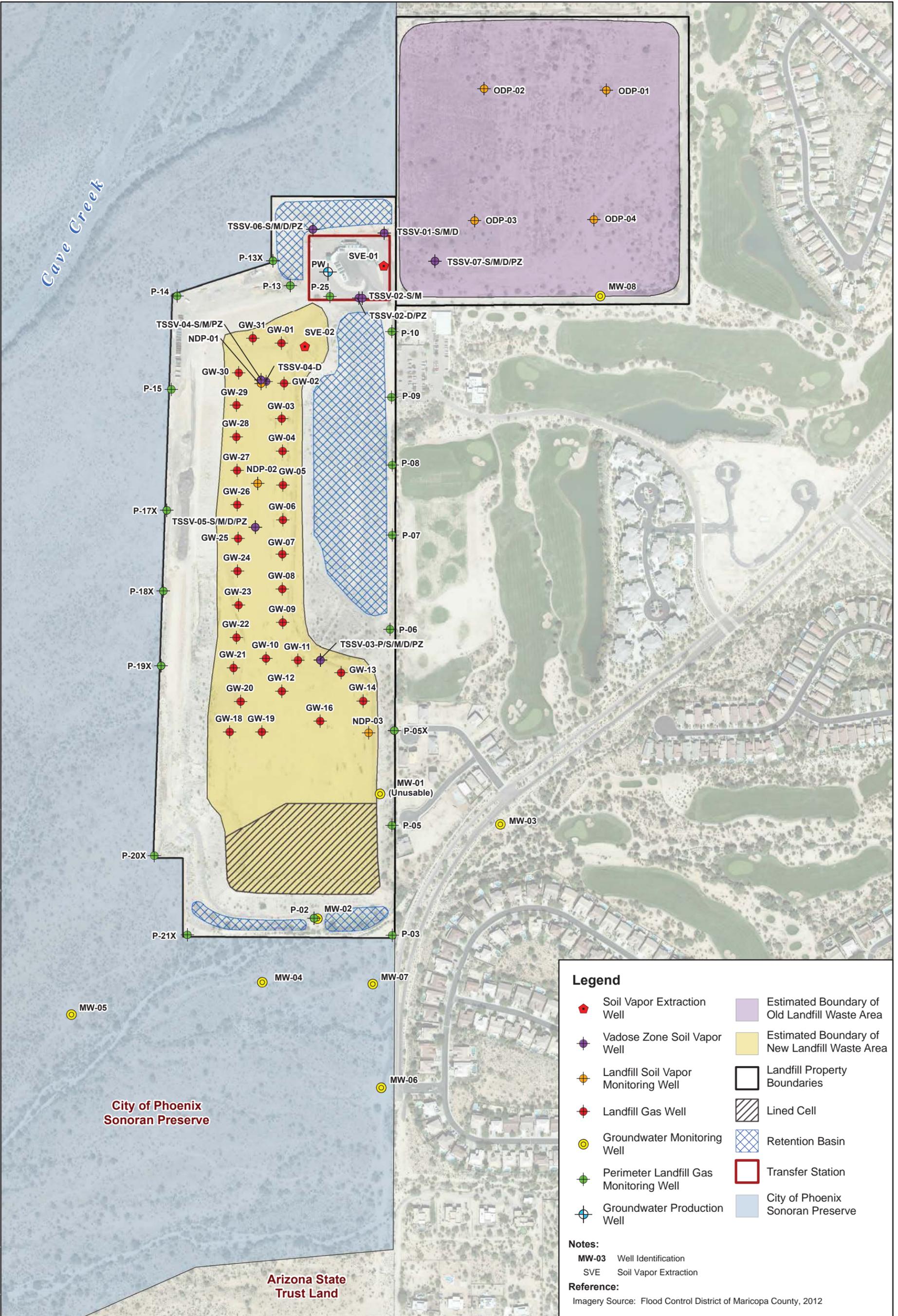
Site Map

FIGURE 2-1	Job No.:	1420142020
	PM:	NC
	Date:	4/30/2015
	Scale:	1" = 700'



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Path: \\PHX4-GIS1\GIS - share\Projects\2014 Projects\142014\Revised RemedialActionPlan\2016 Cave Creek Landfill_FY 2015\MXD\Revised RemedialActionPlan\2016 March Submittal\Figure2-2 Well Location Map.mxd

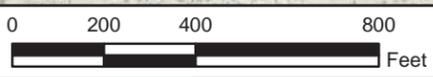


Legend

Soil Vapor Extraction Well	Estimated Boundary of Old Landfill Waste Area
Vadose Zone Soil Vapor Well	Estimated Boundary of New Landfill Waste Area
Landfill Soil Vapor Monitoring Well	Landfill Property Boundaries
Landfill Gas Well	Lined Cell
Groundwater Monitoring Well	Retention Basin
Perimeter Landfill Gas Monitoring Well	Transfer Station
Groundwater Production Well	City of Phoenix Sonoran Preserve

Notes:
 MW-03 Well Identification
 SVE Soil Vapor Extraction

Reference:
 Imagery Source: Flood Control District of Maricopa County, 2012



Job No.	1420142020
PM:	NC
Date:	4/13/2016
Scale:	1" = 400'



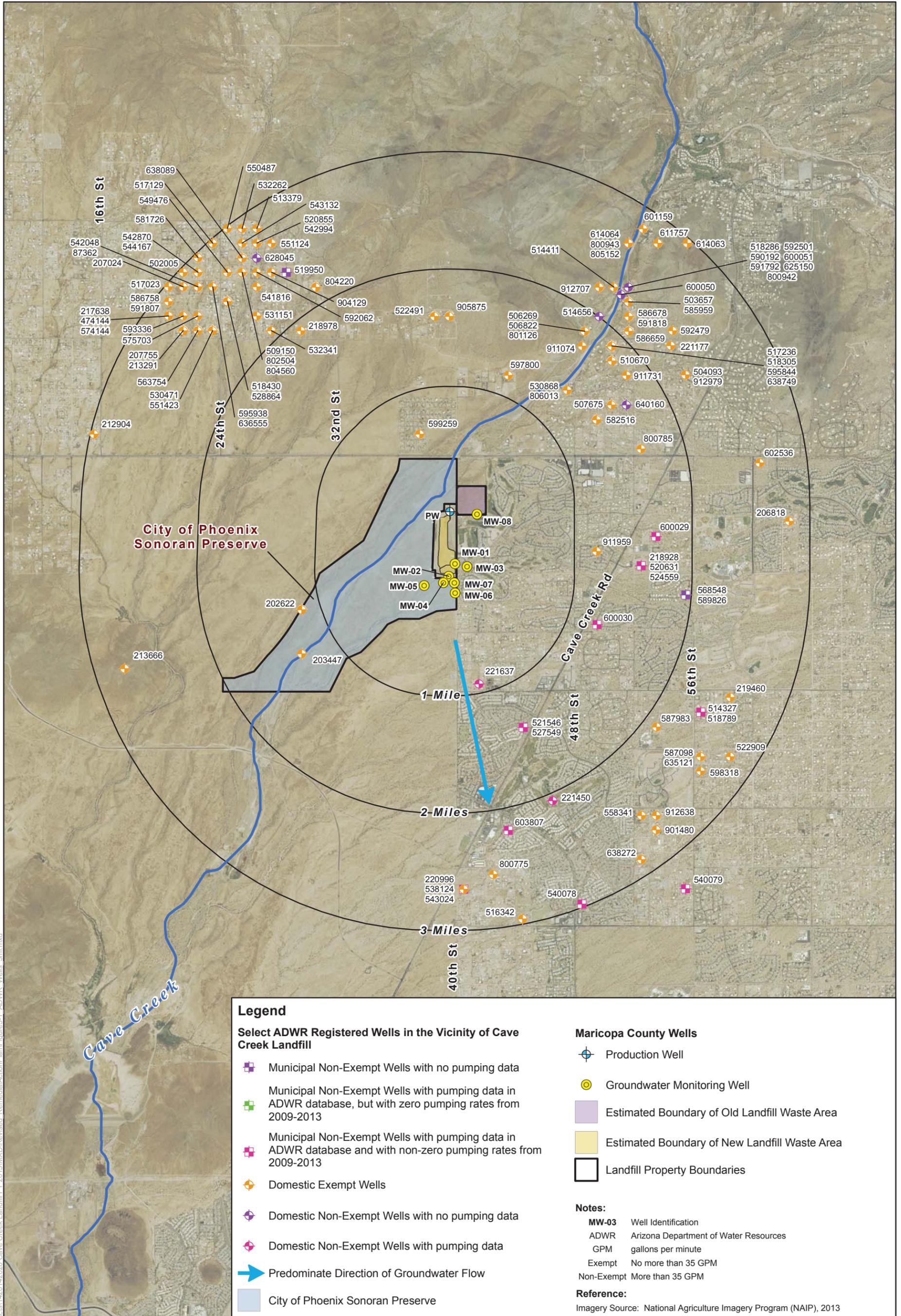
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Revised Remedial Action Plan
 Maricopa County Cave Creek Landfill
 Phoenix, Arizona

Well Location Map

FIGURE
2-2





Legend

Select ADWR Registered Wells in the Vicinity of Cave Creek Landfill

- Municipal Non-Exempt Wells with no pumping data
- Municipal Non-Exempt Wells with pumping data in ADWR database, but with zero pumping rates from 2009-2013
- Municipal Non-Exempt Wells with pumping data in ADWR database and with non-zero pumping rates from 2009-2013
- Domestic Exempt Wells
- Domestic Non-Exempt Wells with no pumping data
- Domestic Non-Exempt Wells with pumping data
- ➔ Predominate Direction of Groundwater Flow
- City of Phoenix Sonoran Preserve

Maricopa County Wells

- ⊕ Production Well
- Groundwater Monitoring Well
- Estimated Boundary of Old Landfill Waste Area
- Estimated Boundary of New Landfill Waste Area
- Landfill Property Boundaries

Notes:

- MW-03** Well Identification
- ADWR** Arizona Department of Water Resources
- GPM** gallons per minute
- Exempt** No more than 35 GPM
- Non-Exempt** More than 35 GPM

Reference:

Imagery Source: National Agriculture Imagery Program (NAIP), 2013



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Job No.	1420142020
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Date:	5/28/2015
Scale:	1" = 4000'

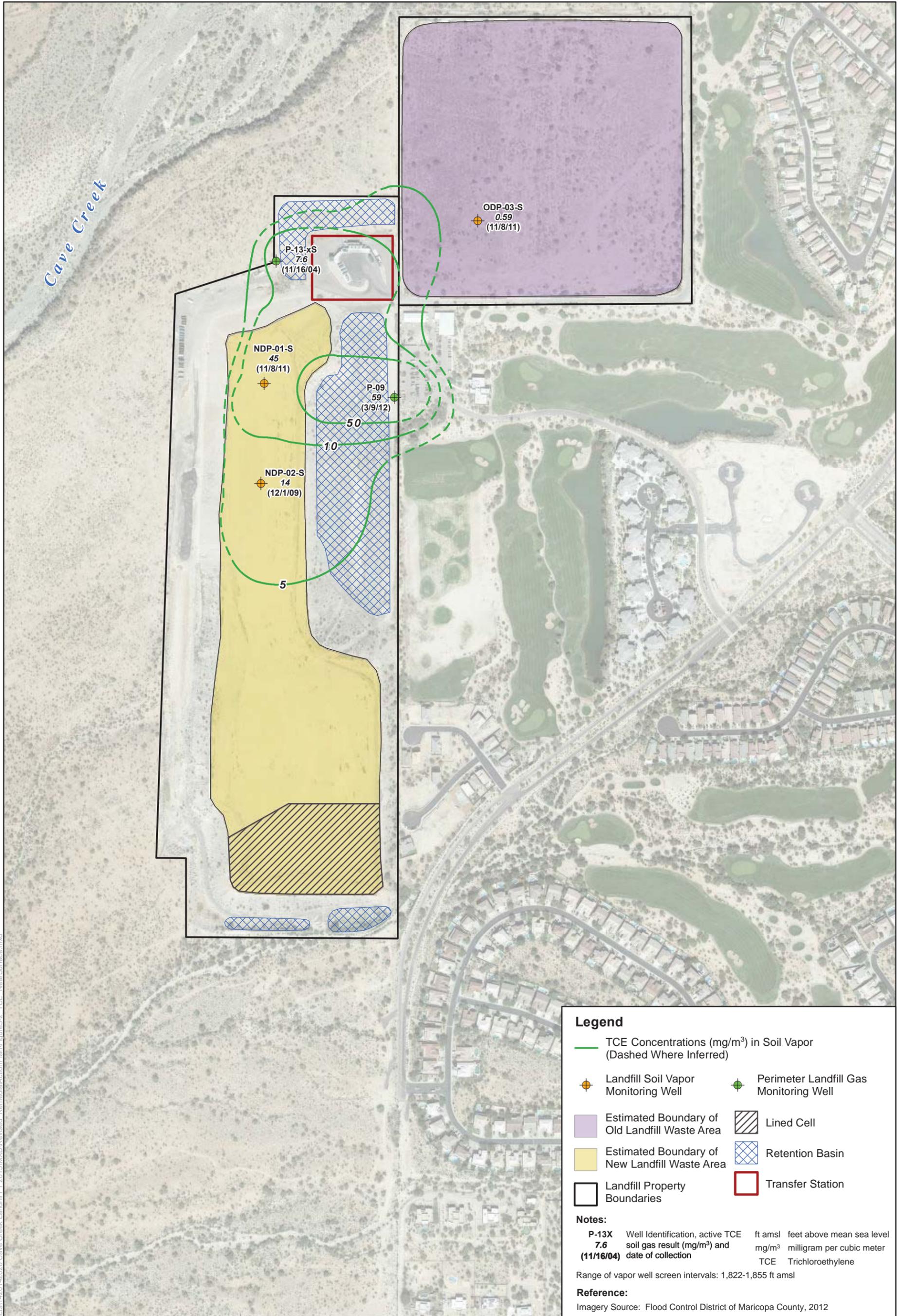
Revised Remedial Action Plan
Maricopa County Cave Creek Landfill
Phoenix, Arizona

**Select ADWR Registered Wells in the
Vicinity of Cave Creek Landfill**

**FIGURE
3-1**



Path: X:\Projects\2014\Projects\1420142020\Cave Creek Landfill\FY 2015\MXD\Revised Remedial Action Plan\Figure3-1_ADWR Wells_3mi.mxd



Legend

- TCE Concentrations (mg/m³) in Soil Vapor (Dashed Where Inferred)
- Landfill Soil Vapor Monitoring Well
- Perimeter Landfill Gas Monitoring Well
- Estimated Boundary of Old Landfill Waste Area
- Estimated Boundary of New Landfill Waste Area
- Landfill Property Boundaries
- Lined Cell
- Retention Basin
- Transfer Station

Notes:

P-13X Well Identification, active TCE ft amsl feet above mean sea level
7.6 soil gas result (mg/m³) and mg/m³ milligram per cubic meter
(11/16/04) date of collection TCE Trichloroethylene

Range of vapor well screen intervals: 1,822-1,855 ft amsl

Reference:
 Imagery Source: Flood Control District of Maricopa County, 2012



Job No. 1420142020
 PM: NC
 Date: 2/4/2015
 Scale: 1" = 400'



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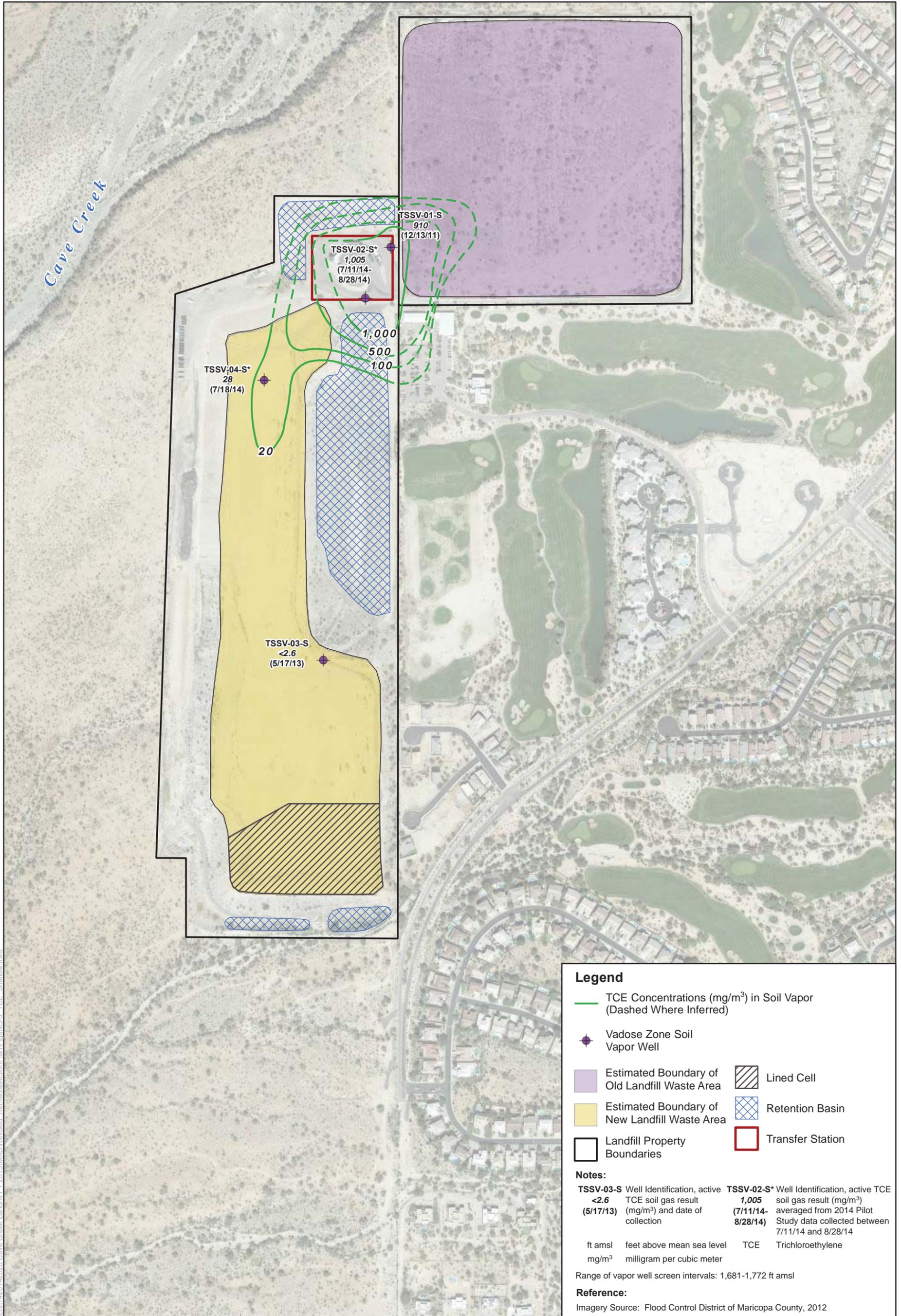
Revised Remedial Action Plan
 Maricopa County Cave Creek Landfill
 Phoenix, Arizona

**TCE Vapor Concentrations
 Near Ground Surface**

FIGURE
3-2



Path: X:\Projects\2014\Projects\1420142020\Cave Creek Landfill\FY 2015\MXD\Revised RemedialActionPlan\Figure3-2_TCE_NearSurface.mxd



Legend

- TCE Concentrations (mg/m³) in Soil Vapor (Dashed Where Inferred)
- Vadose Zone Soil Vapor Well
- Estimated Boundary of Old Landfill Waste Area
- Estimated Boundary of New Landfill Waste Area
- Landfill Property Boundaries
- Lined Cell
- Retention Basin
- Transfer Station

Notes:

TSSV-03-S Well Identification, active TCE <2.6 (5/17/13) (mg/m ³) and date of collection	TSSV-02-S* Well Identification, active TCE 1,005 (7/11/14-8/28/14) soil gas result (mg/m ³) averaged from 2014 Pilot Study data collected between 7/11/14 and 8/28/14
---	--

ft amsl feet above mean sea level TCE Trichloroethylene
 mg/m³ milligram per cubic meter

Range of vapor well screen intervals: 1,681-1,772 ft amsl

Reference:
 Imagery Source: Flood Control District of Maricopa County, 2012



Job No. 1420142020
 PM: NC
 Date: 2/4/2015
 Scale: 1" = 400'

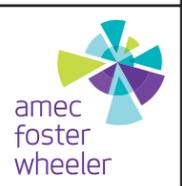


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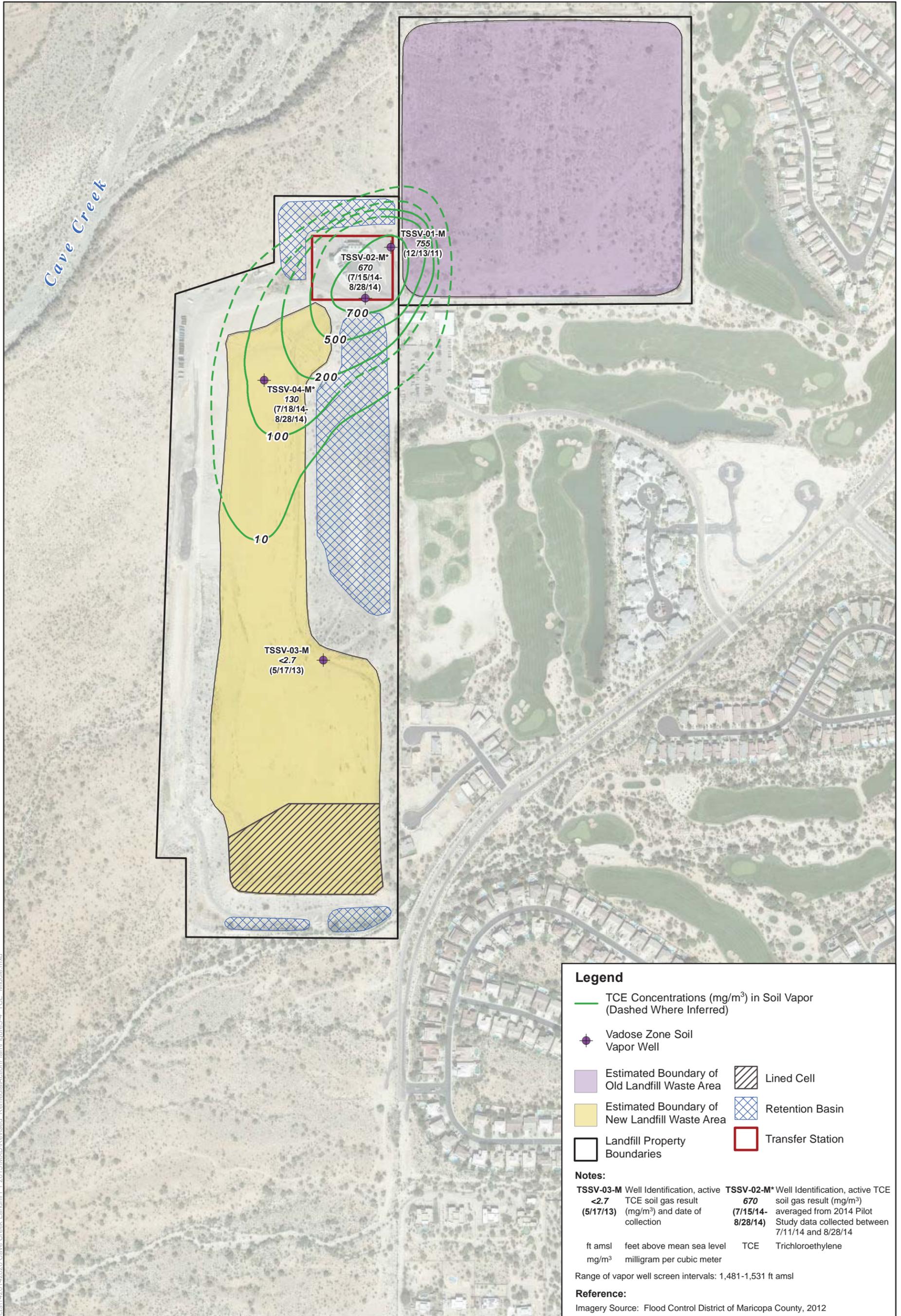
Revised Remedial Action Plan
 Maricopa County Cave Creek Landfill
 Phoenix, Arizona

**TCE Vapor Concentrations
 in Shallow Vadose Zone**

FIGURE
3-3



Path: X:\Projects\2014\Projects\1420142020\Cave Creek Landfill\FY 2015\MXD\Revised RemedialActionPlan\Figure3-3 TCE Shallow.mxd



Legend

- TCE Concentrations (mg/m³) in Soil Vapor (Dashed Where Inferred)
- Vadose Zone Soil Vapor Well
- Estimated Boundary of Old Landfill Waste Area
- Estimated Boundary of New Landfill Waste Area
- Landfill Property Boundaries
- Lined Cell
- Retention Basin
- Transfer Station

Notes:

TSSV-03-M Well Identification, active TCE soil gas result <2.7 (mg/m ³) and date of collection (5/17/13)	TSSV-02-M* Well Identification, active TCE soil gas result 670 (mg/m ³) averaged from 2014 Pilot Study data collected between 7/11/14 and 8/28/14
---	--

ft amsl feet above mean sea level TCE Trichloroethylene
 mg/m³ milligram per cubic meter

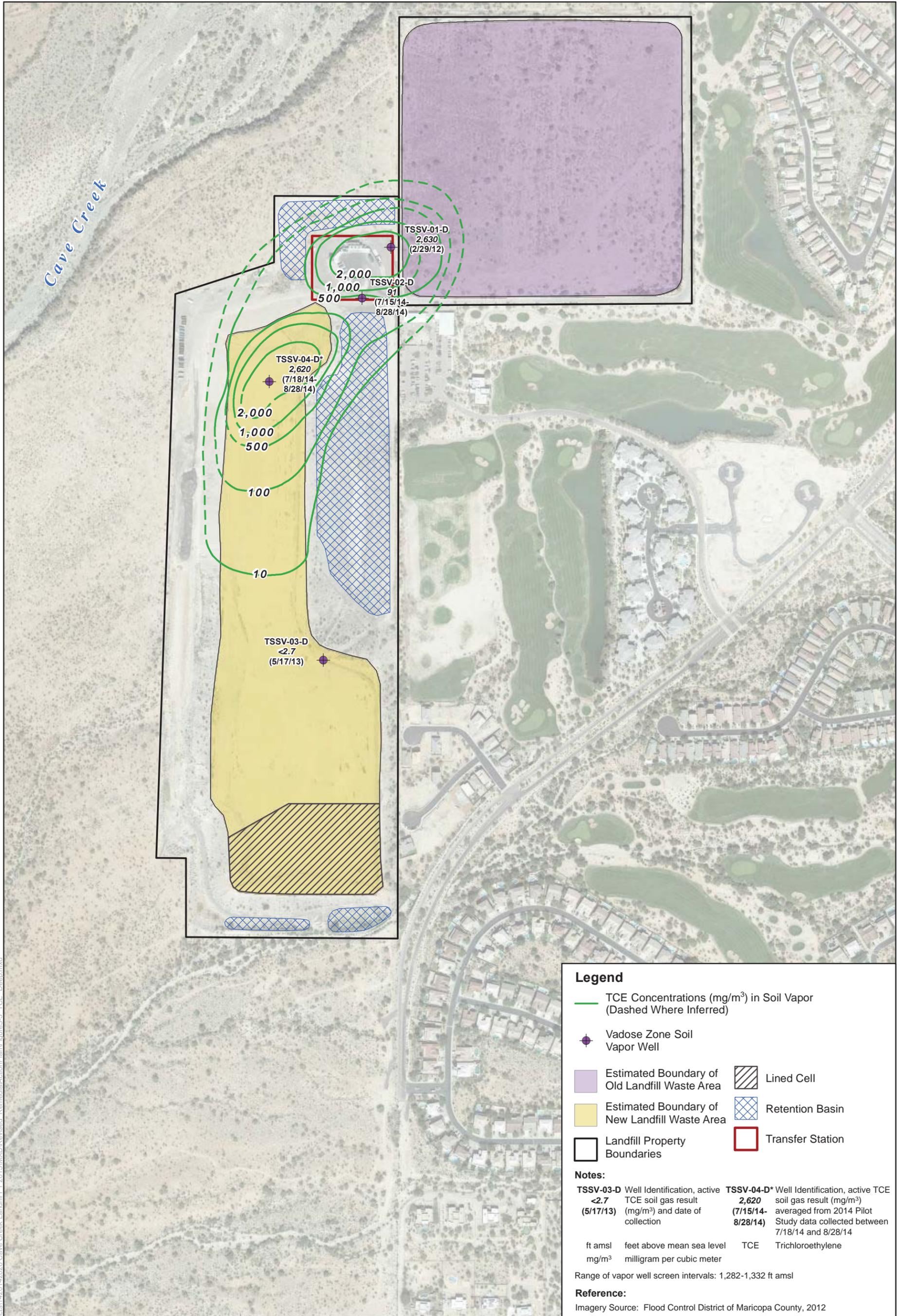
Range of vapor well screen intervals: 1,481-1,531 ft amsl

Reference:
 Imagery Source: Flood Control District of Maricopa County, 2012

Path: X:\Projects\2014\Projects\142014\2020 Cave Creek Landfill\FY 2015\MDR\Revised RemedialActionPlan\Figure3-4 TCE Middle.mxd

Job No. 1420142020 PM: NC Date: 2/4/2015 Scale: 1" = 400'		The map shown here has been created with all due and reasonable care and is strictly for use with Amec Foster Wheeler Project Number 1420142020. This map has not been certified by a licensed land surveyor, and any third party use of this map comes without warranties of any kind. Amec Foster Wheeler assumes no liability, direct or indirect, whatsoever for any such third party or unintended use.
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Revised Remedial Action Plan Maricopa County Cave Creek Landfill Phoenix, Arizona		
TCE Vapor Concentrations in Middle Vadose Zone	FIGURE 3-4	



Legend

- TCE Concentrations (mg/m³) in Soil Vapor (Dashed Where Inferred)
- Vadose Zone Soil Vapor Well
- Estimated Boundary of Old Landfill Waste Area
- Estimated Boundary of New Landfill Waste Area
- Landfill Property Boundaries
- Lined Cell
- Retention Basin
- Transfer Station

Notes:

TSSV-03-D Well Identification, active TCE soil gas result **<2.7** (mg/m³) and date of collection **(5/17/13)**

TSSV-04-D* Well Identification, active TCE soil gas result **2,620** (mg/m³) averaged from 2014 Pilot Study data collected between **7/18/14** and **8/28/14**

ft amsl feet above mean sea level TCE Trichloroethylene
 mg/m³ milligram per cubic meter

Range of vapor well screen intervals: 1,282-1,332 ft amsl

Reference:

Imagery Source: Flood Control District of Maricopa County, 2012



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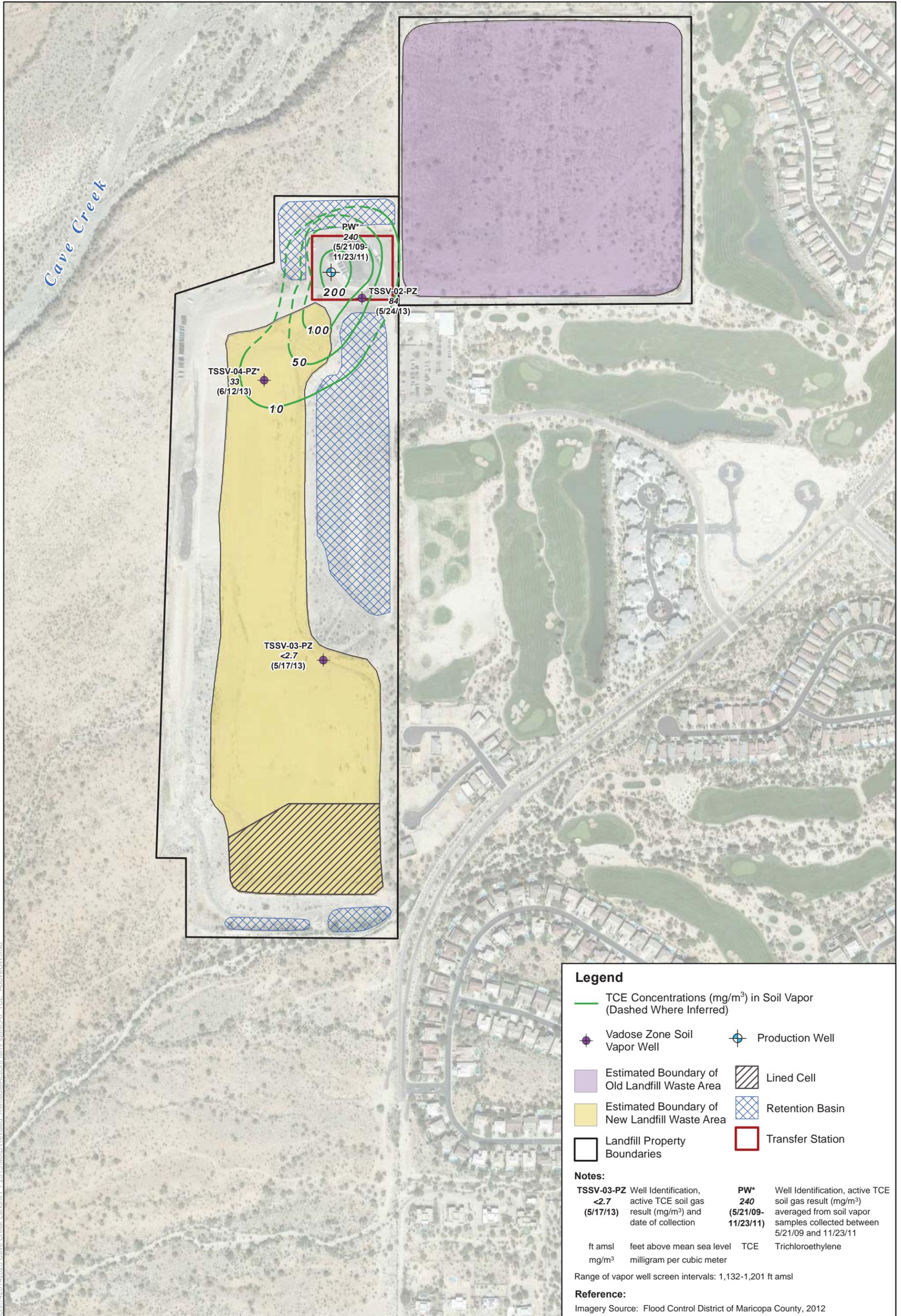
Revised Remedial Action Plan
 Maricopa County Cave Creek Landfill
 Phoenix, Arizona

**TCE Vapor Concentrations in
 Deep Vadose Zone**

FIGURE
3-5



Path: X:\Projects\2014\Projects\1420142020\Cave Creek Landfill\FY 2015\MXD\Revised RemedialActionPlan\Figure3-5_TCE_Deep.mxd



Legend

- TCE Concentrations (mg/m³) in Soil Vapor (Dashed Where Inferred)
- Estimated Boundary of Old Landfill Waste Area
- Estimated Boundary of New Landfill Waste Area
- Landfill Property Boundaries
- ⊕ Vadose Zone Soil Vapor Well
- ⊕ Production Well
- Lined Cell
- Retention Basin
- Transfer Station

Notes:

TSSV-03-PZ 2.7 (5/17/13)	Well Identification, active TCE soil gas result (mg/m ³) and date of collection	PW* 240 (5/21/09-11/23/11)	Well Identification, active TCE soil gas result (mg/m ³) averaged from soil vapor samples collected between 5/21/09 and 11/23/11
---------------------------------------	---	--------------------------------------	--

ft amsl feet above mean sea level TCE Trichloroethylene
mg/m³ milligram per cubic meter

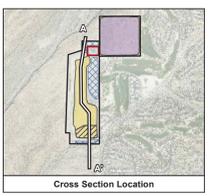
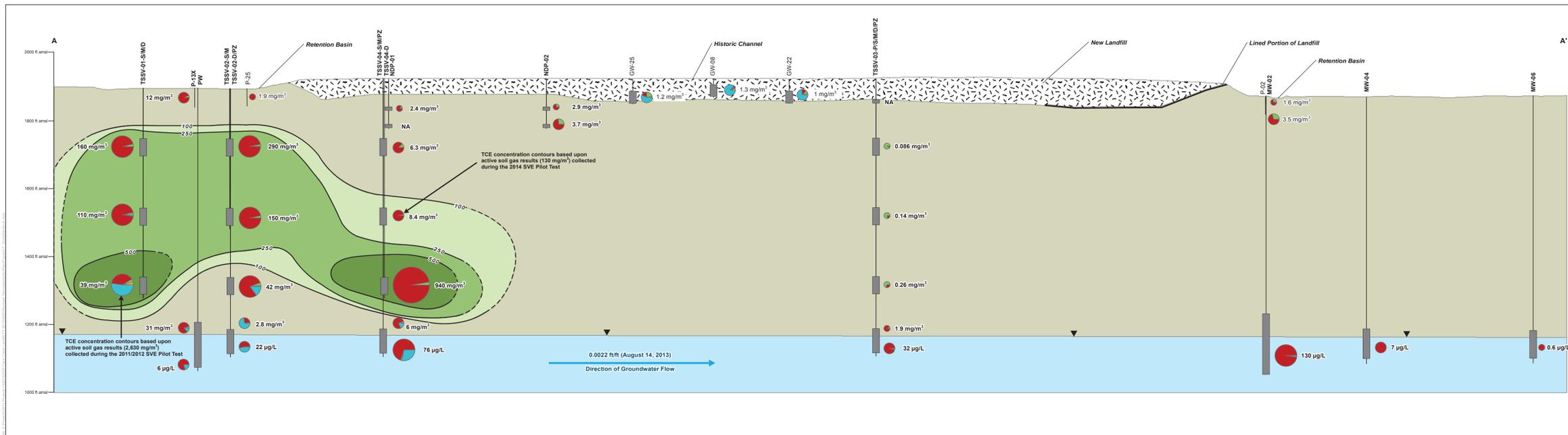
Range of vapor well screen intervals: 1,132-1,201 ft amsl

Reference:
Imagery Source: Flood Control District of Maricopa County, 2012

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Revised Remedial Action Plan Maricopa County Cave Creek Landfill Phoenix, Arizona		
TCE Vapor Concentrations Above Water Table	FIGURE 3-6	

Path: X:\Projects\2014\Projects\1420142020\Cave Creek Landfill\FY 2015\MXD\Revised RemedialActionPlan\Figure3-6 TCE AboveGW.mxd



Legend

TCE Concentrations (mg/m³) in Soil Vapor
 (Dashed Where Inferred)

- 100-250 mg/m³
- 250-500 mg/m³
- ≥500 mg/m³

Explanation of Presented VOC Data
 The colors of the pie chart correspond to each contaminant as follows:

- TCE
- cis-1,2-DCE
- PCE
- Vinyl Chloride

The size of the pie chart is proportional to the total VOC concentration at each sampling location. Soil vapor concentrations are measured in units of mg/m³. Groundwater concentrations are measured in units of µg/L.

Notes:

- NDP-82 Well Identification and Passive TCE Soil Gas Results
- GW-25 Well Identification and Active TCE Soil Gas Results
- µg/L Microgram per liter
- cm-1,2-DCE cis-1,2-dichloroethene
- ft. amsl Feet above mean sea level
- mg/m³ Milligram per cubic meter
- NA Not analyzed
- PCE Tetrachloroethylene
- TCE Trichloroethylene
- VOC Volatile organic compound

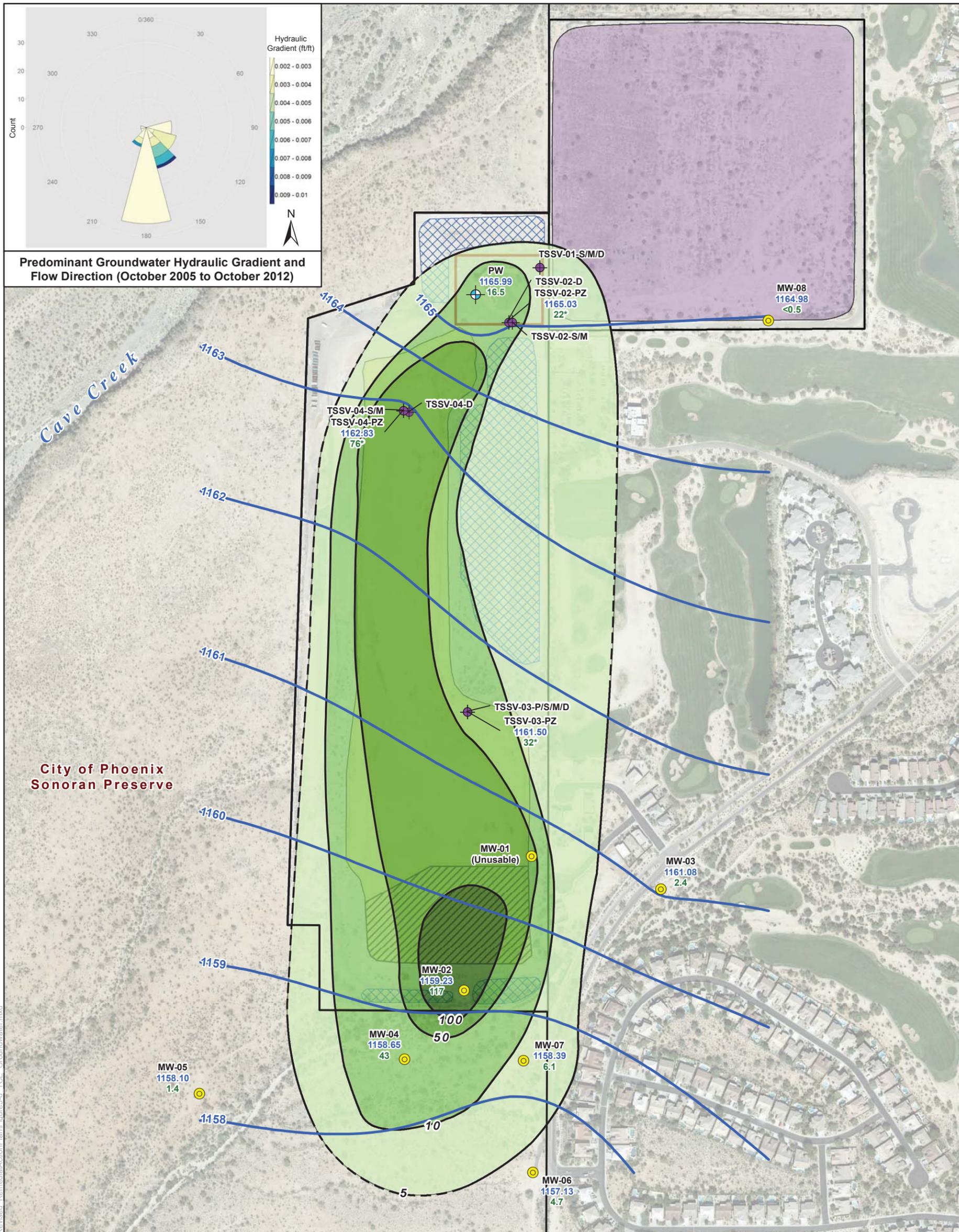
References: Vapor concentrations from June 2013 Passive Soil Gas Survey areas noted. GW and selected P wells collected between 2004 and 2012. Groundwater concentrations from May 2013 sampling event except for TSV-02P, TSV-03P/PZ and TSV-08P/PZ collected as Passive Diffusion Bag Samples in June 2013.

Job No. 1420142020
 Date: 2/4/2015
 Scale: 1" = 10'

Revised Remedial Action Plan
 Maricopa County Cave Creek Landfill
 Phoenix, Arizona

AMEC
 Foster
 Wheeler

Cross Section A to A'
 FIGURE 3-7



Predominant Groundwater Hydraulic Gradient and Flow Direction (October 2005 to October 2012)

**City of Phoenix
Sonoran Preserve**

Legend

TCE Concentrations (µg/L) in Groundwater (Dashed Where Inferred)

- 5-10 µg/L
- 10-50 µg/L
- 50-100 µg/L
- ≥100 µg/L

- Vadose Zone Soil Vapor Well
- Groundwater Monitoring Well
- Production Well

Groundwater Elevation Contour (ft amsl) Based upon May 2014 Sampling Data

- Estimated Boundary of Old Landfill Waste Area
- Estimated Boundary of New Landfill Waste Area
- Landfill Property Boundaries
- Lined Cell
- Retention Basin
- Transfer Station

Notes:

- MW-03** Well Identification, Groundwater Elevation (ft amsl) and TCE groundwater result (µg/L) collected in May 2014
- 1161.08** Elevation (ft amsl)
- 2.4** µg/L
- TSSV-03-PZ** Well Identification, Groundwater Elevation (ft amsl) collected in May 2014 and TCE groundwater PDB result (µg/L) collected in June 2013
- 1161.50** Elevation (ft amsl)
- 32*** µg/L

Reference:

Imagery Source: Flood Control District of Maricopa County, 2012



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PM: NC
Date: 5/27/2015
Scale: 1" = 400'

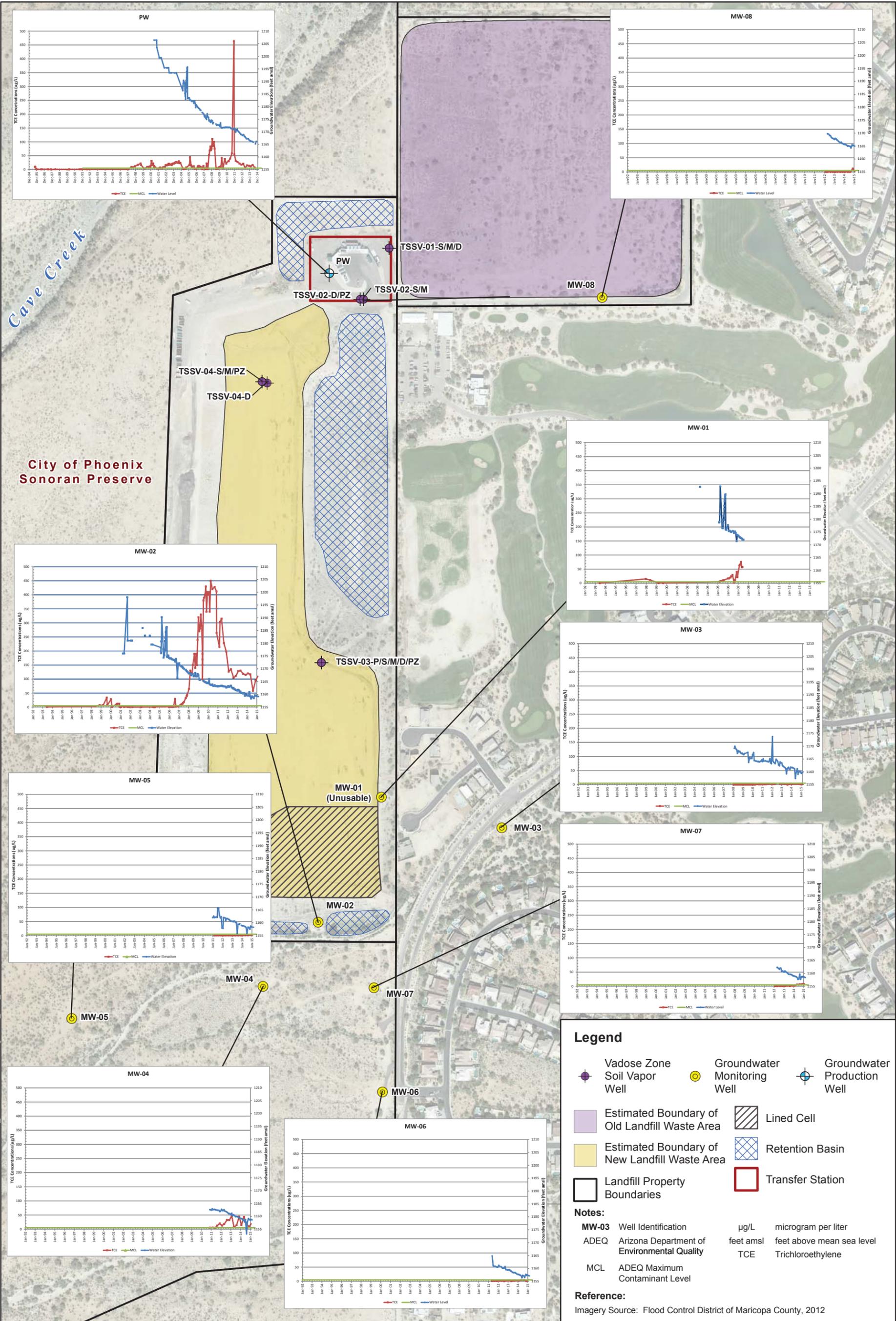
Revised Remedial Action Plan
Maricopa County Cave Creek Landfill
Phoenix, Arizona

**Estimated Extent of TCE Plume
in Groundwater (June 2013/May 2014)**

FIGURE
3-8



Path: X:\Projects\2014\Projects\1420142020 Cave Creek Landfill\FY 2015\MXD\Revised RemedialActionPlan\Figure9-9 TCE TrendsInGW.mxd



Legend

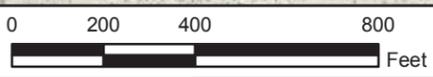
- Vadose Zone Soil Vapor Well
- Groundwater Monitoring Well
- Groundwater Production Well
- Estimated Boundary of Old Landfill Waste Area
- Estimated Boundary of New Landfill Waste Area
- Landfill Property Boundaries
- Lined Cell
- Retention Basin
- Transfer Station

Notes:

- MW-03 Well Identification
- ADEQ Arizona Department of Environmental Quality
- MCL ADEQ Maximum Contaminant Level
- µg/L microgram per liter
- feet amsl feet above mean sea level
- TCE Trichloroethylene

Reference:

Imagery Source: Flood Control District of Maricopa County, 2012



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 Date: 5/27/2015
 Scale: 1" = 400'

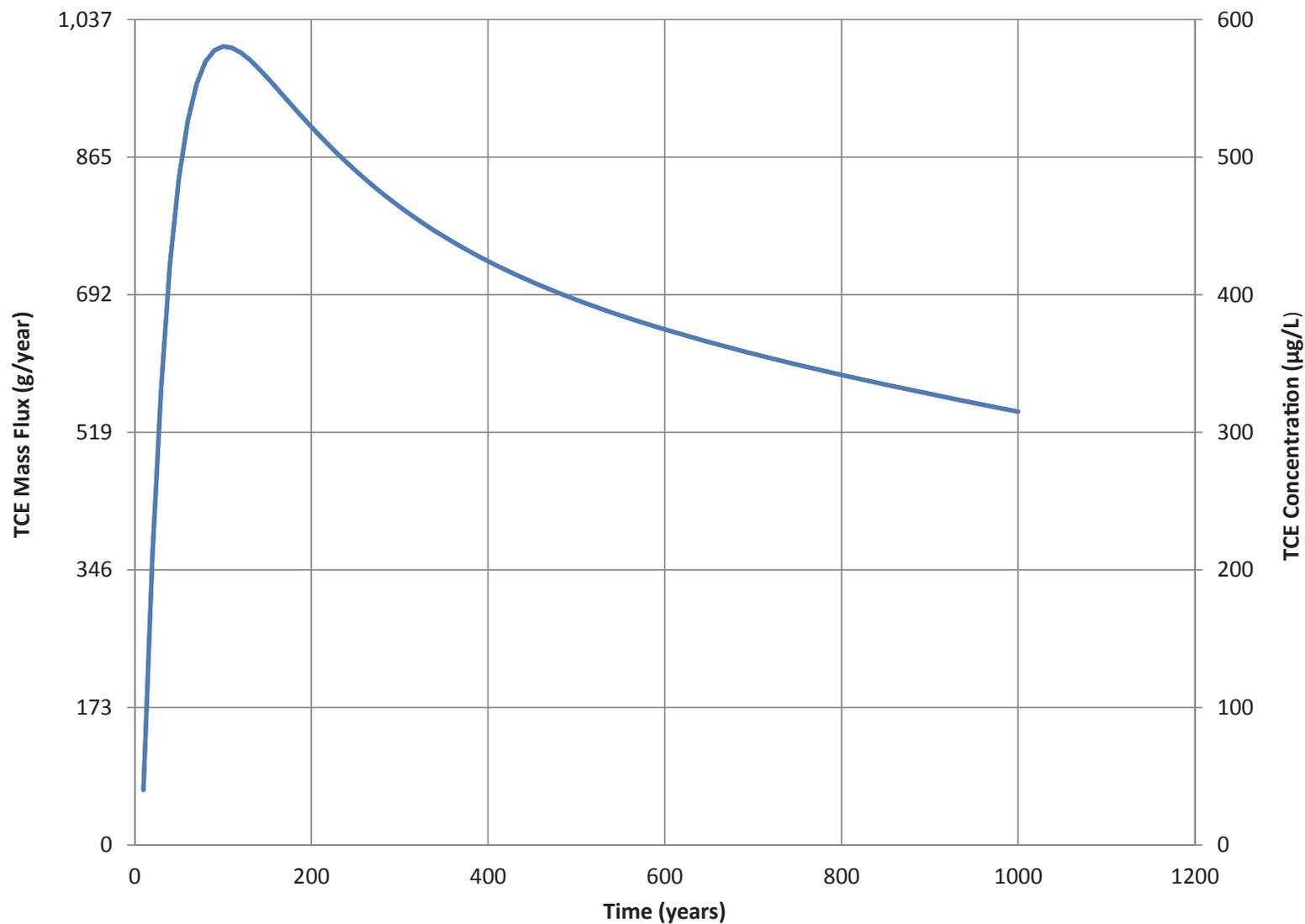
Revised Remedial Action Plan
 Maricopa County Cave Creek Landfill
 Phoenix, Arizona

**TCE Concentration Trends
 in Groundwater**

FIGURE
3-9



Path: X:\Projects\2014 Projects\1420142020 Cave Creek Landfill FY 2015\MXD\Revised RemedialActionPlan\Figure3-10_TCE_MassFlux_Leachate_Alt1.a



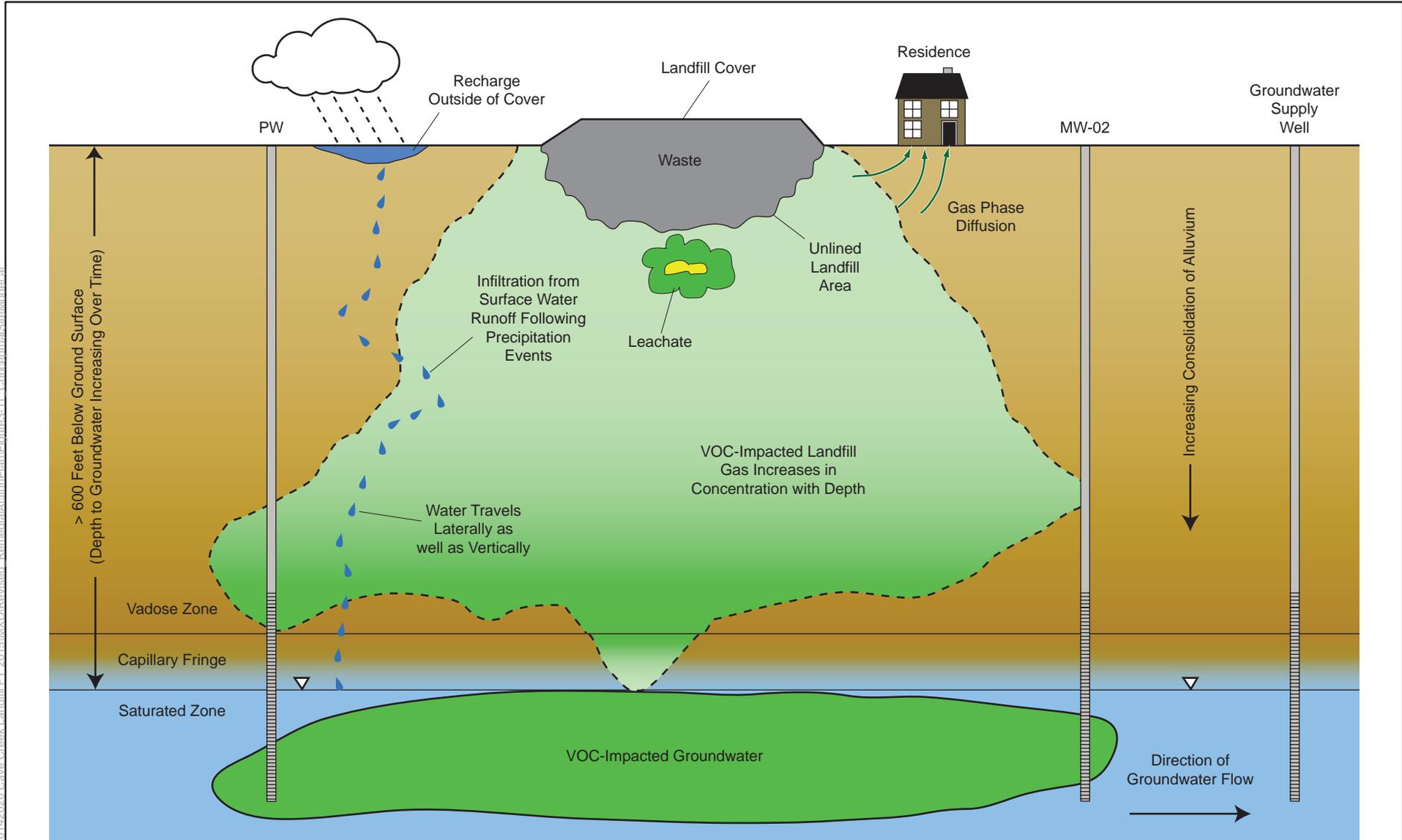
Job No.: 1420142020
PM: NC
Date: 5/29/2015
Scale: Not to scale

Revised Remedial Action Plan
Maricopa County Cave Creek Landfill
Phoenix, Arizona

TCE Mass Flux and Concentrations from Vapor to Groundwater

FIGURE
3-10





Note: Generalized depiction; not to scale

Job No.: 1420142020
 PM: NC
 Date: 5/28/2015
 Scale: Not to scale

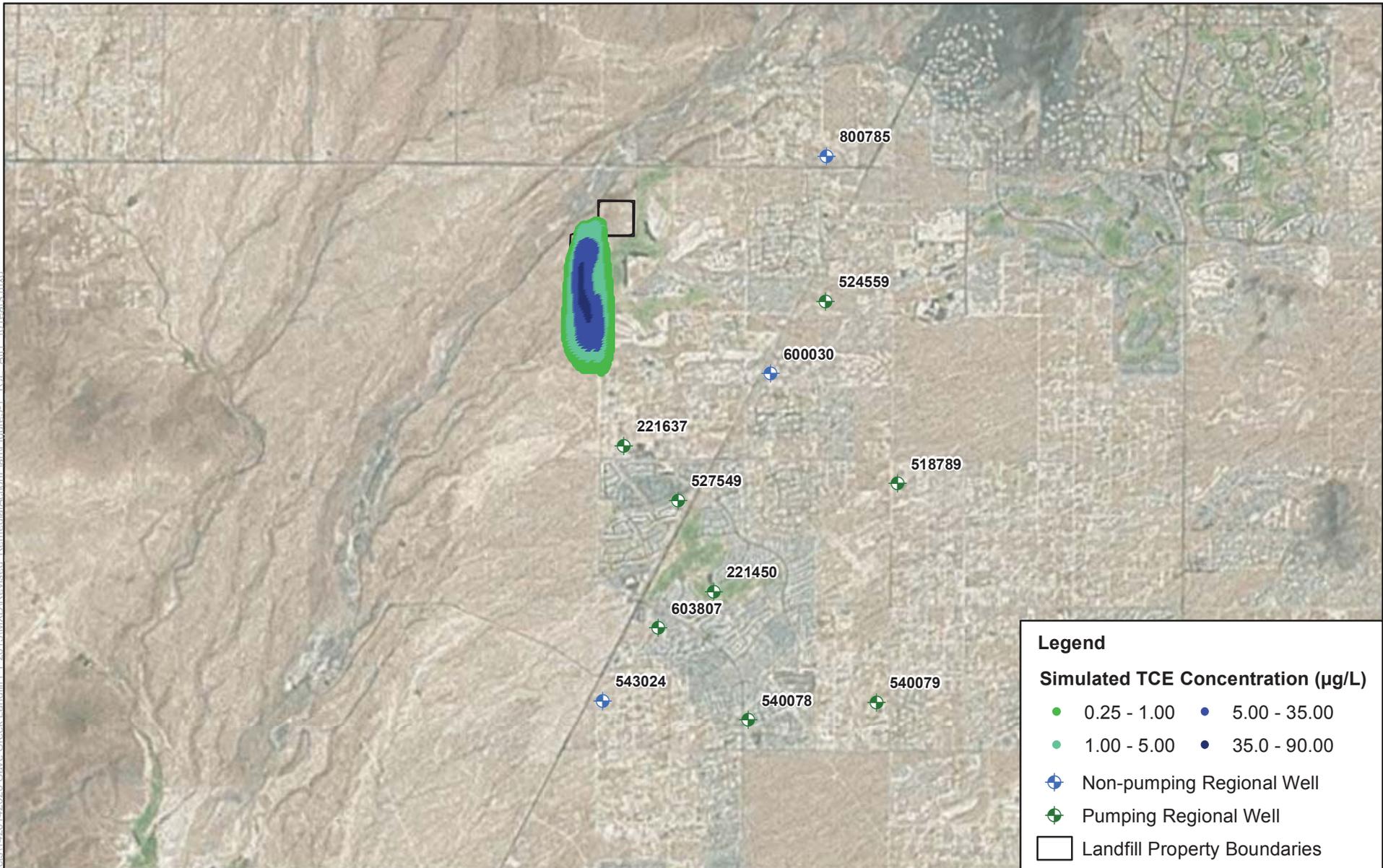
Revised Remedial Action Plan
 Maricopa County Cave Creek Landfill
 Phoenix, Arizona

Conceptual Site Model

FIGURE
3-11



Path: X:\Projects\2014_1420142020_Cave_Creek_Landfill_FY_2015\MXD\Revised_RemedialActionPlan\Figure5-1_TCE_Alt1_10Years.mxd



Legend

Simulated TCE Concentration (µg/L)

- 0.25 - 1.00
- 5.00 - 35.00
- 1.00 - 5.00
- 35.0 - 90.00
- ◆ Non-pumping Regional Well
- ◆ Pumping Regional Well
- Landfill Property Boundaries



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 PM: NC
 Date: 5/29/2015
 Scale: 1" = 5000'

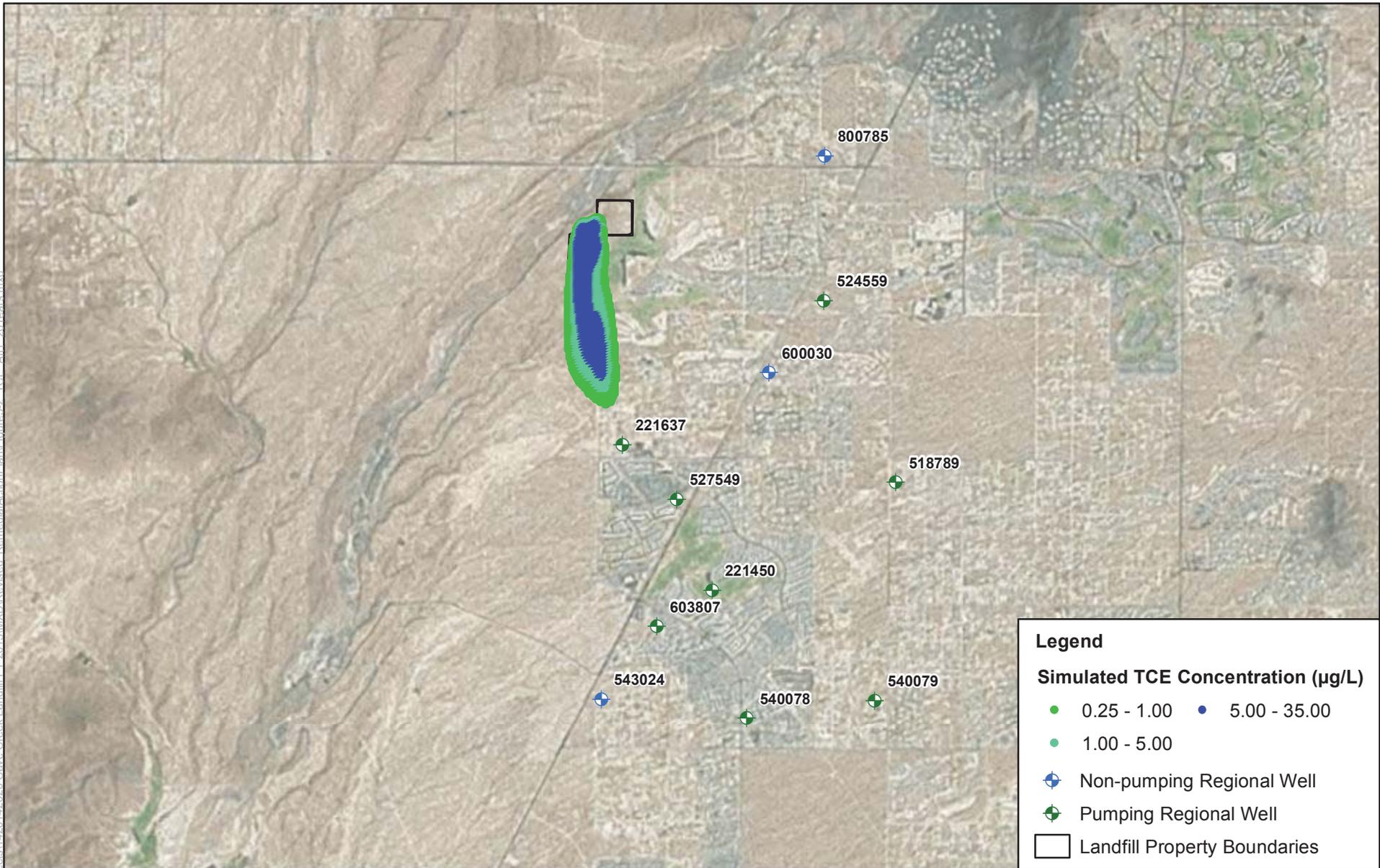
Revised Remedial Action Plan
 Maricopa County Cave Creek Landfill
 Phoenix, Arizona

**Simulated TCE Concentrations for Alternative 1
 10 Years, Water Table**

**FIGURE
 5-1**



Path: X:\Projects\2014\Projects\1420142020\Cave Creek Landfill\FY 2015\MXD\Revised Remedial Action Plan\Figure5-2_TCE_Alt1_20Years.mxd

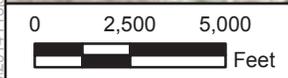


Legend

Simulated TCE Concentration (µg/L)

- 0.25 - 1.00
- 1.00 - 5.00
- 5.00 - 35.00

- ◆ Non-pumping Regional Well
- ◆ Pumping Regional Well
- Landfill Property Boundaries



Imagery Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

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 PM: NC
 Date: 5/29/2015
 Scale: 1" = 5000'



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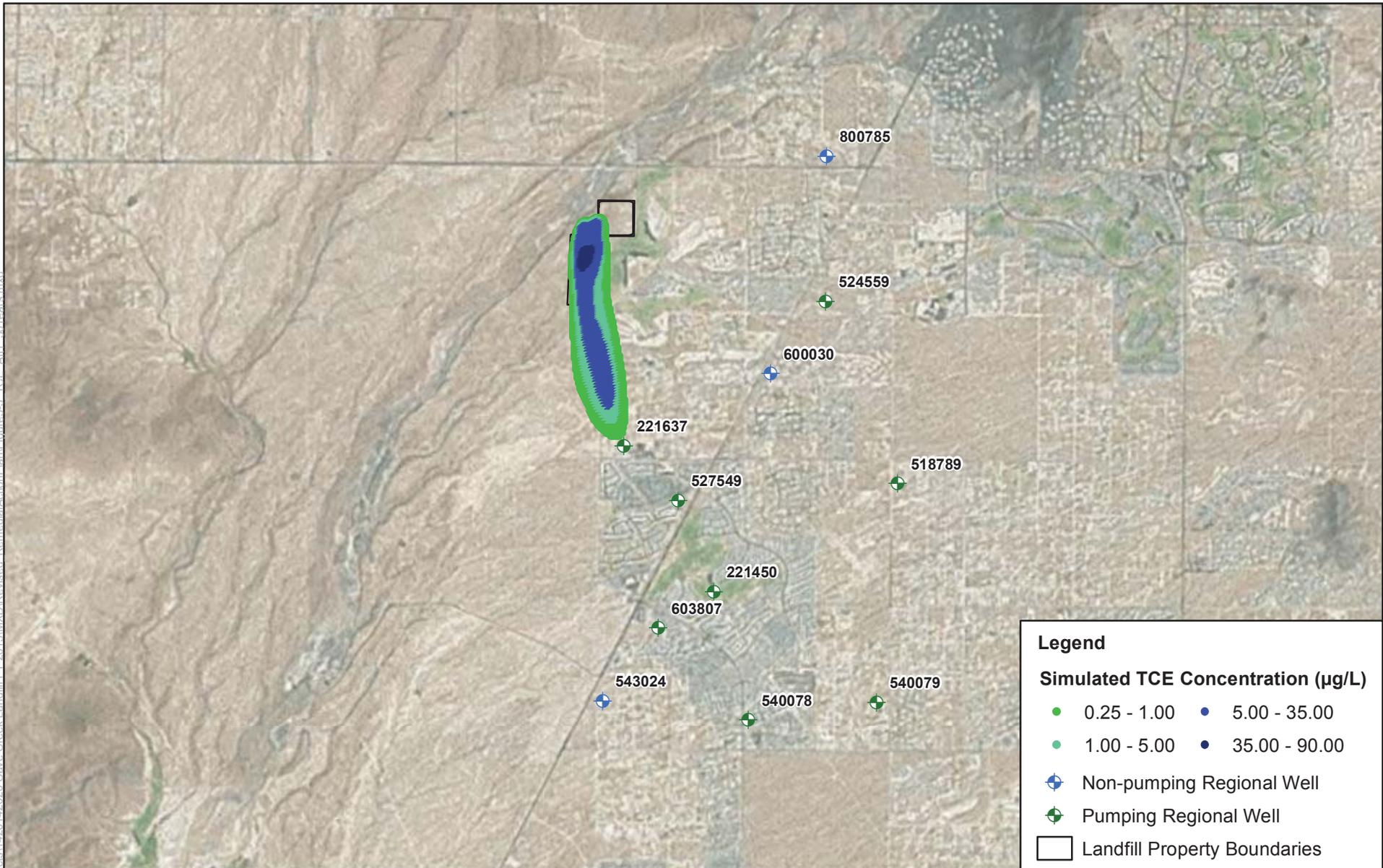
Revised Remedial Action Plan
 Maricopa County Cave Creek Landfill
 Phoenix, Arizona

**Simulated TCE Concentrations for Alternative 1
 20 Years, Water Table**



**FIGURE
 5-2**

Path: X:\Projects\2014_1420142020_Cave_Creek_Landfill_FY_2015\MXD\Revised_RemedialActionPlan\Figure5-3_TCE_Alt1_30Years.mxd

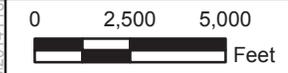


Legend

Simulated TCE Concentration (µg/L)

- 0.25 - 1.00
- 1.00 - 5.00
- 5.00 - 35.00
- 35.00 - 90.00

- ◆ Non-pumping Regional Well
- ◆ Pumping Regional Well
- Landfill Property Boundaries



Imagery Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Job No. 1420142020
 PM: NC
 Date: 5/29/2015
 Scale: 1" = 5000'

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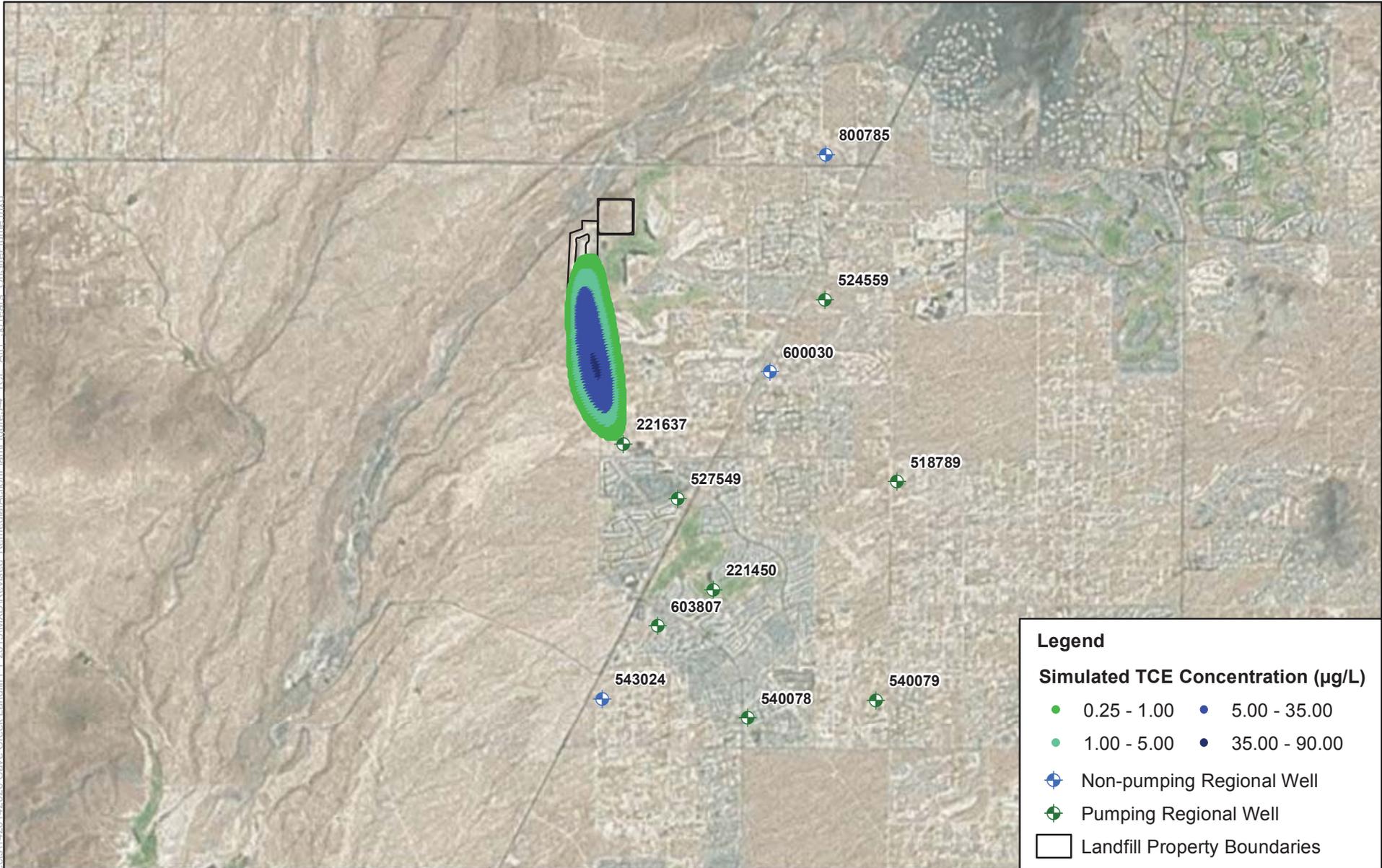
Revised Remedial Action Plan
 Maricopa County Cave Creek Landfill
 Phoenix, Arizona

**Simulated TCE Concentrations for Alternative 1
 30 Years, Water Table**

**FIGURE
 5-3**



Path: X:\Projects\2014_1420142020_Cave_Creek_Landfill_FY_2015\MXD\Revised_RemedialActionPlan\Figure5-4_TCE_Alt1_30Years_OffSitePlume.mxd



Legend

Simulated TCE Concentration (µg/L)

- 0.25 - 1.00
- 1.00 - 5.00
- 5.00 - 35.00
- 35.00 - 90.00

- ◆ Non-pumping Regional Well
- ◆ Pumping Regional Well
- Landfill Property Boundaries

0 2,500 5,000
 Feet

Imagery Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Job No. 1420142020
 PM: NC
 Date: 5/29/2015
 Scale: 1" = 5000'



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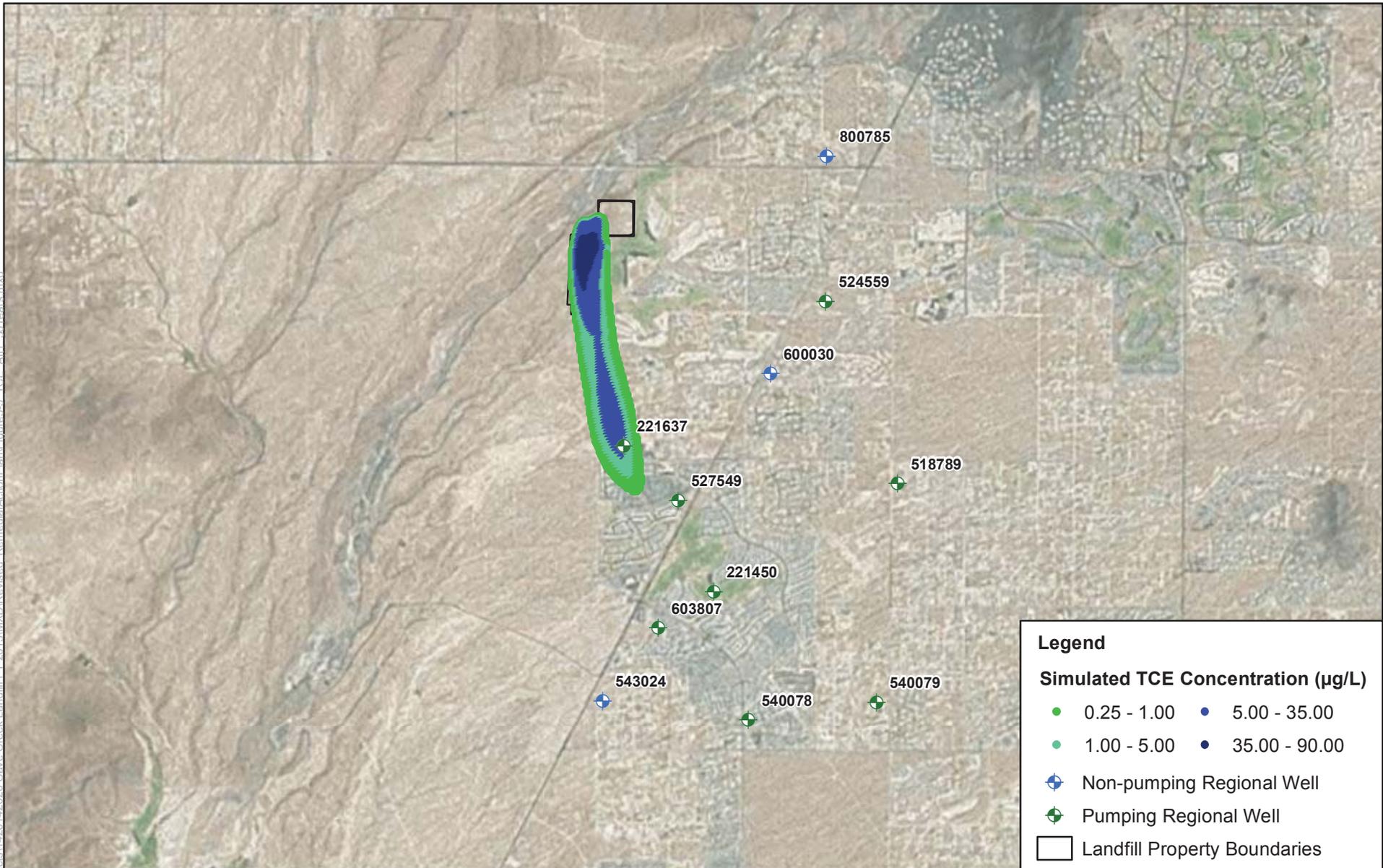
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 Maricopa County Cave Creek Landfill
 Phoenix, Arizona

**Simulated TCE Concentrations for Alternative 1
 30 Years, Off-Site Plume**

**FIGURE
 5-4**



Path: X:\Projects\2014_1420142020_Cave_Creek_Landfill_FY_2015\MXD\Revised_RemedialActionPlan\Figure5-5_TCE_Alt1_50Years.mxd



Legend

Simulated TCE Concentration (µg/L)

- 0.25 - 1.00
- 1.00 - 5.00
- 5.00 - 35.00
- 35.00 - 90.00

- ◆ Non-pumping Regional Well
- ◆ Pumping Regional Well
- Landfill Property Boundaries



Imagery Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

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 PM: NC
 Date: 5/29/2015
 Scale: 1" = 5000'

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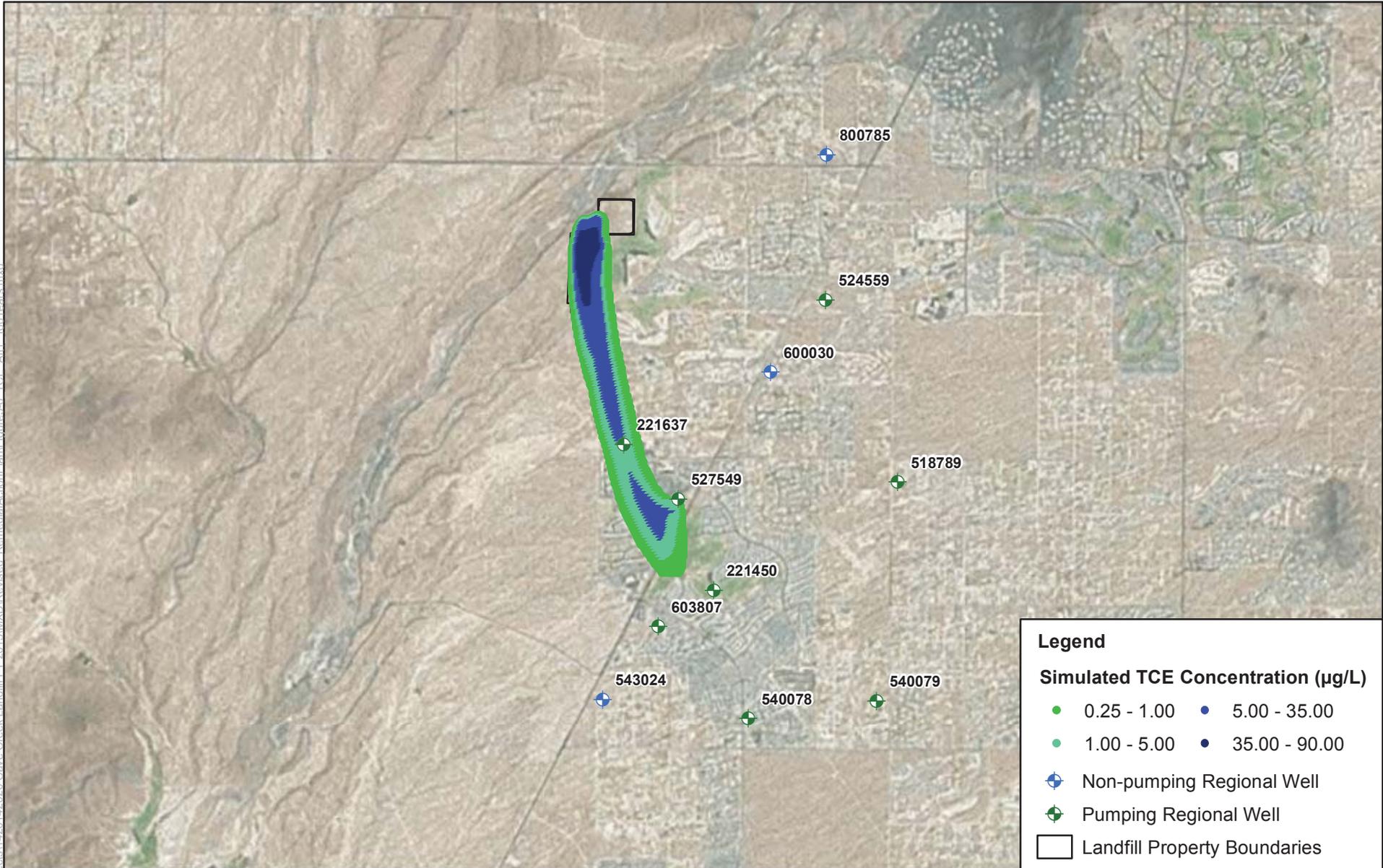
Revised Remedial Action Plan
 Maricopa County Cave Creek Landfill
 Phoenix, Arizona

**Simulated TCE Concentrations for Alternative 1
 50 Years, Water Table**

**FIGURE
 5-5**



Path: X:\Projects\2014_1420142020_Cave_Creek_Landfill_FY_2015\MXD\Revised_RemedialActionPlan\Figure5-6_TCE_100Years.mxd



Legend

Simulated TCE Concentration (µg/L)

- 0.25 - 1.00
- 5.00 - 35.00
- 1.00 - 5.00
- 35.00 - 90.00
- ◆ Non-pumping Regional Well
- ◆ Pumping Regional Well
- Landfill Property Boundaries

0 2,500 5,000

 Feet

Imagery Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Job No. 1420142020
 PM: NC
 Date: 5/29/2015
 Scale: 1" = 5000'



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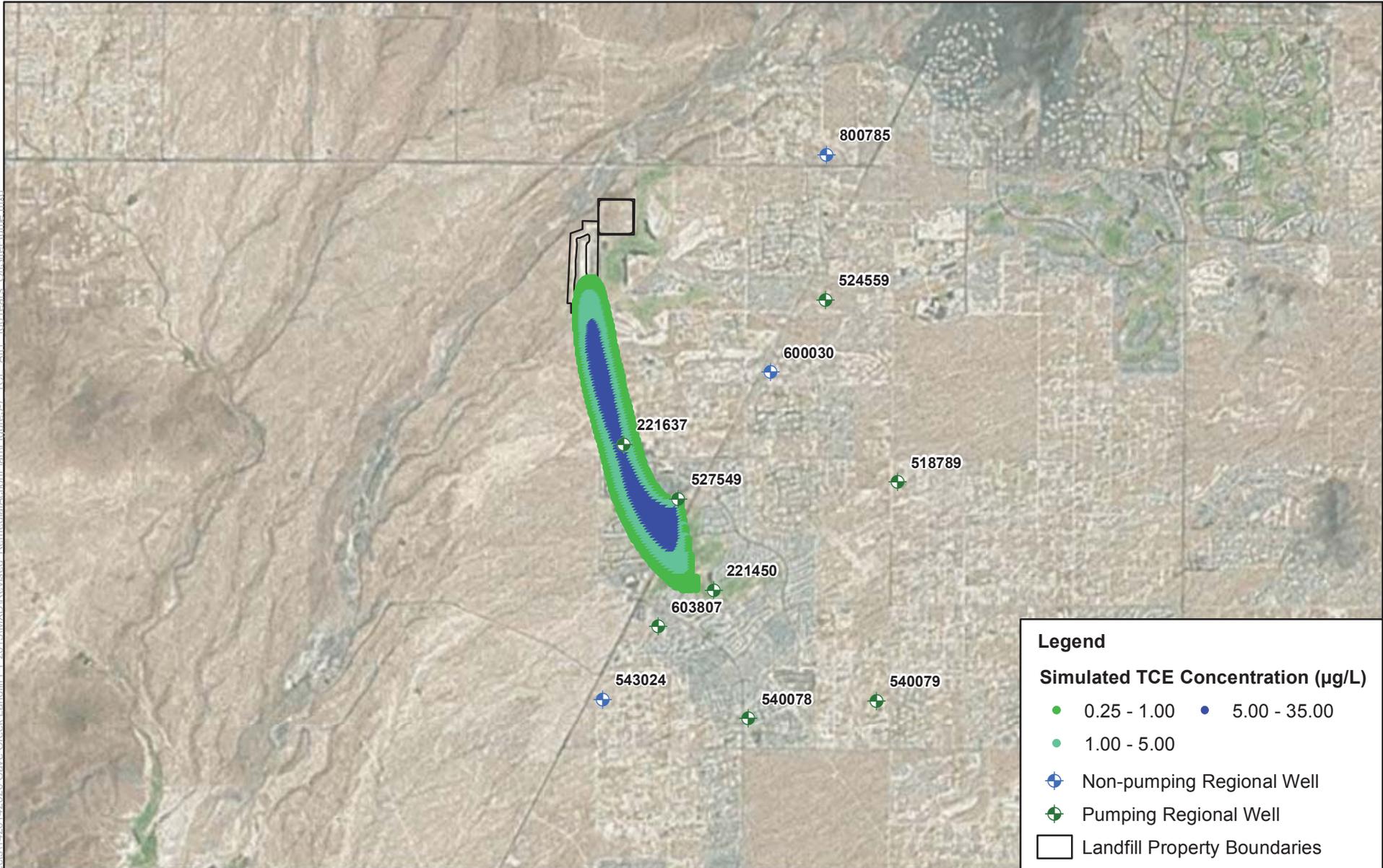
Revised Remedial Action Plan
 Maricopa County Cave Creek Landfill
 Phoenix, Arizona

**Simulated TCE Concentrations for Alternative 1
 100 Years, Water Table**



**FIGURE
 5-6**

Path: X:\Projects\2014 Projects\1420142020 Cave Creek Landfill FY 2015\MXD\Revised Remedial Action Plan\Figure5-7_TCE_Alt1_100Years_OffSitePlume.mxd

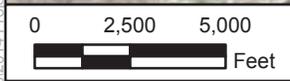


Legend

Simulated TCE Concentration (µg/L)

- 0.25 - 1.00
- 5.00 - 35.00
- 1.00 - 5.00

- ◆ Non-pumping Regional Well
- ◆ Pumping Regional Well
- Landfill Property Boundaries



Imagery Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Job No. 1420142020
 PM: NC
 Date: 5/29/2015
 Scale: 1" = 5000'



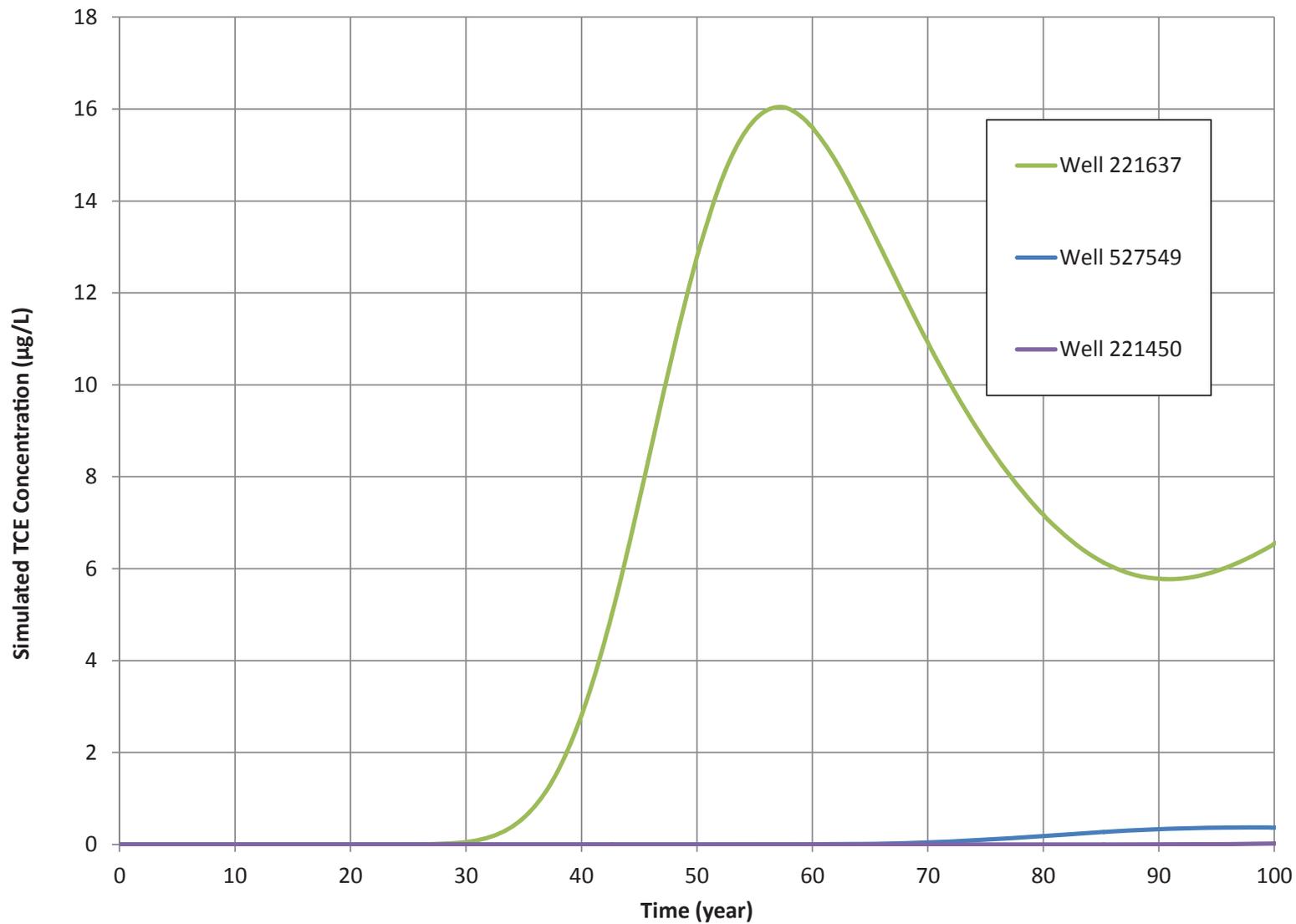
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 Maricopa County Cave Creek Landfill
 Phoenix, Arizona

**Simulated TCE Concentrations for Alternative 1
 100 Years, Off-Site Plume**

FIGURE
5-7

Path: X:\Projects\2014-Projects\1420142020 Cave Creek Landfill FY 2015\MXD\Revised RemedialActionPlan\Figure5-8_Simulated WaterSupplyWells -Alt 1.ai



Job No.: 1420142020
PM: NC
Date: 5/29/2015
Scale: Not to scale

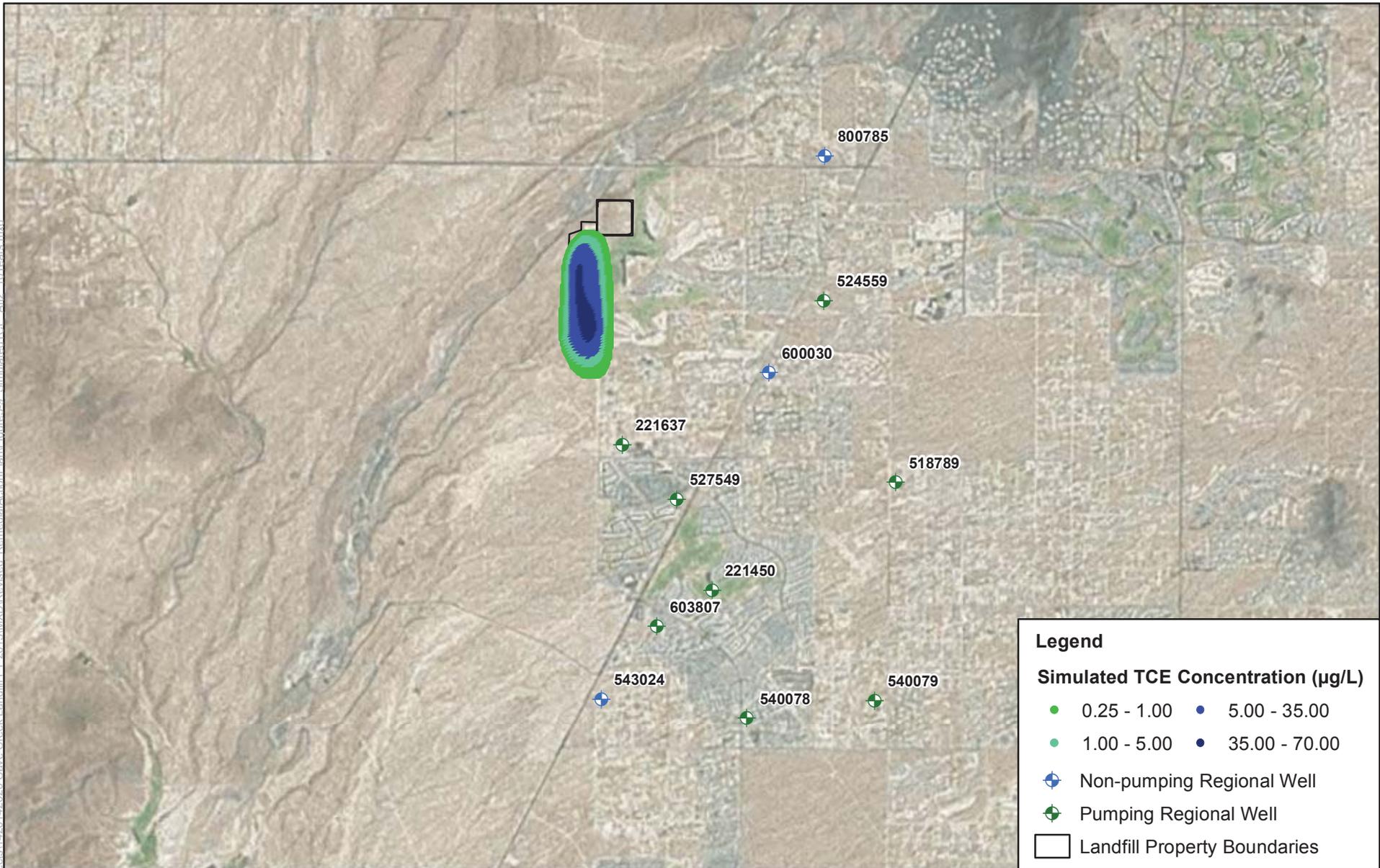
Revised Remedial Action Plan
Maricopa County Cave Creek Landfill
Phoenix, Arizona

Simulated Peak Concentrations in Water Supply Wells for Alternative 1

**FIGURE
5-8**



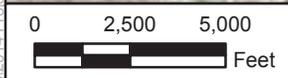
Path: X:\Projects\2014_2015\Projects\1420142020\Cave Creek Landfill\FY 2015\MXD\Revised Remedial Action Plan\Figure5-9_SimulatedTCE_10Years.mxd



Legend

Simulated TCE Concentration (µg/L)

- 0.25 - 1.00 ● 5.00 - 35.00
- 1.00 - 5.00 ● 35.00 - 70.00
- ◆ Non-pumping Regional Well
- ◆ Pumping Regional Well
- Landfill Property Boundaries



Imagery Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Job No. 1420142020
 PM: NC
 Date: 5/29/2015
 Scale: 1" = 5000'



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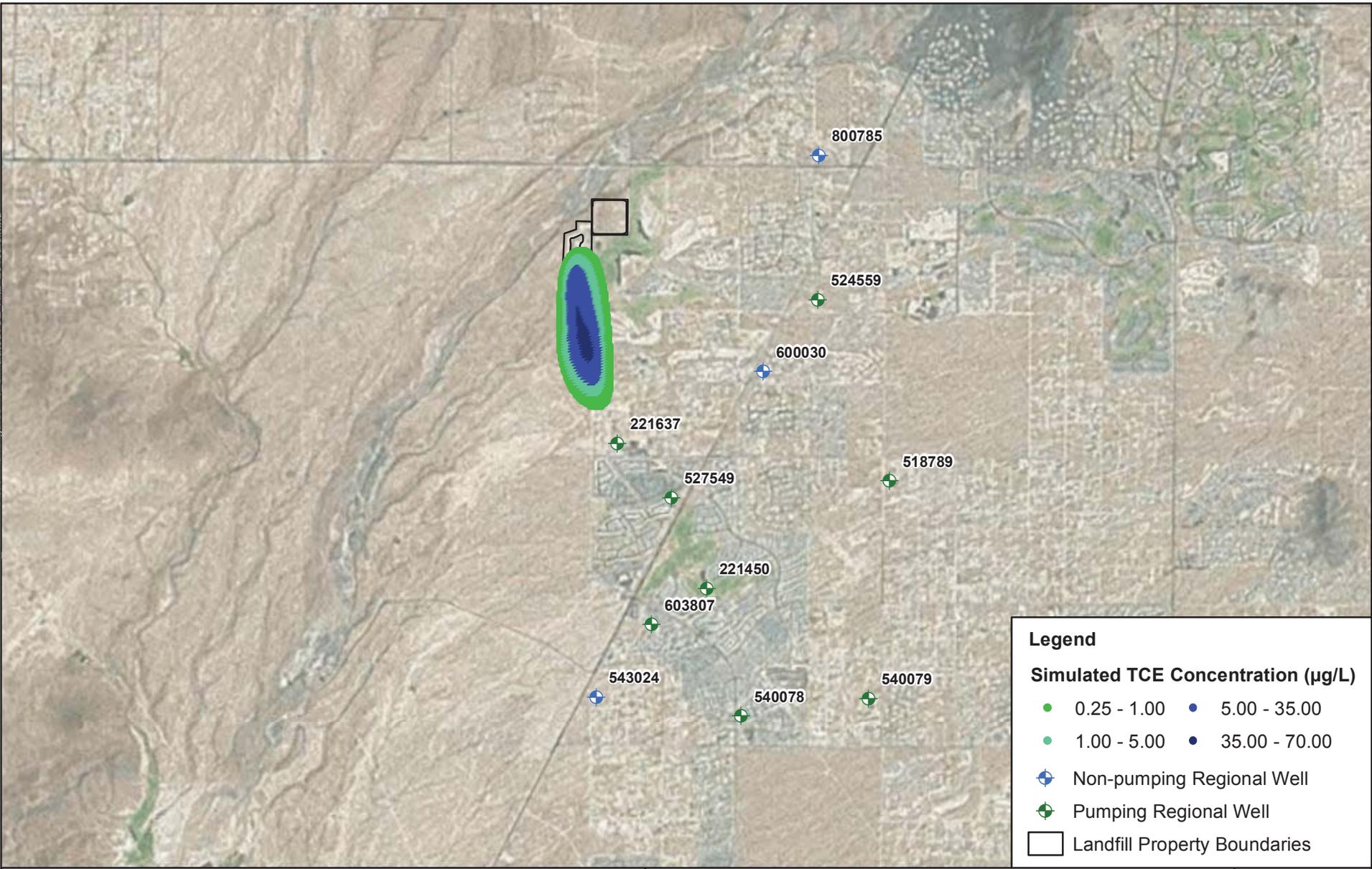
**Revised Remedial Action Plan
 Maricopa County Cave Creek Landfill
 Phoenix, Arizona**

**Simulated TCE Concentrations for
 Alternative 2 - 10 Years**

**FIGURE
 5-9**



Path: X:\Projects\2014\Projects\1420142020\Cave Creek Landfill\FY 2015\MXD\Revised Remedial Action Plan\Figure5-10_SimulatedTCE_Alt2_20Years.mxd

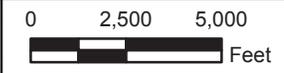


Legend

Simulated TCE Concentration (µg/L)

- 0.25 - 1.00
- 1.00 - 5.00
- 5.00 - 35.00
- 35.00 - 70.00

- ◆ Non-pumping Regional Well
- ◆ Pumping Regional Well
- Landfill Property Boundaries



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 Date: 5/29/2015
 Scale: 1" = 5000'

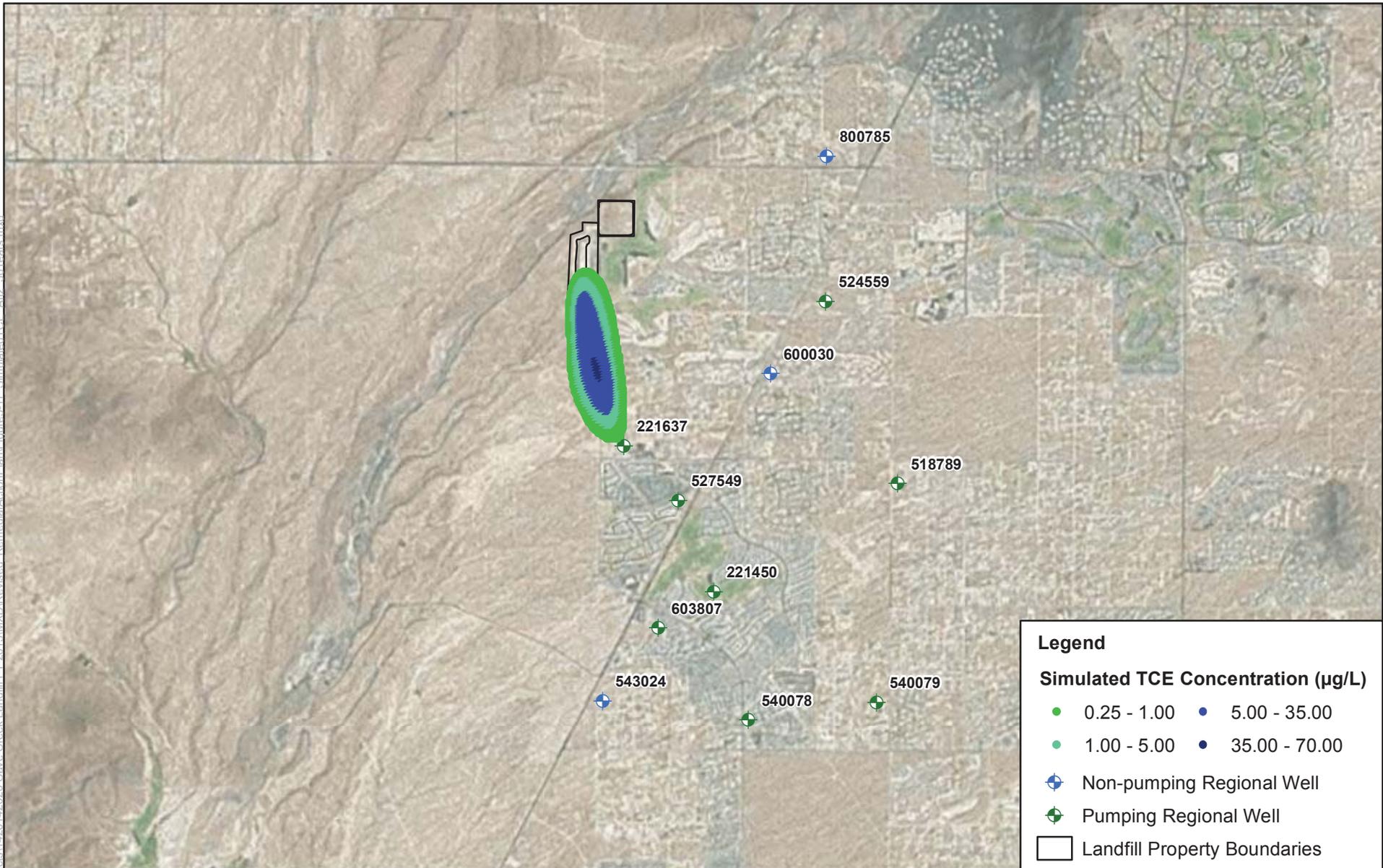
Revised Remedial Action Plan
 Maricopa County Cave Creek Landfill
 Phoenix, Arizona

**Simulated TCE Concentrations for
 Alternative 2 - 20 Years**

**FIGURE
 5-10**



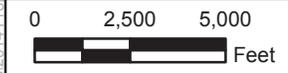
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Legend

Simulated TCE Concentration (µg/L)

- 0.25 - 1.00
- 5.00 - 35.00
- 1.00 - 5.00
- 35.00 - 70.00
- ◆ Non-pumping Regional Well
- ◆ Pumping Regional Well
- Landfill Property Boundaries



Imagery Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

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 PM: NC
 Date: 5/29/2015
 Scale: 1" = 5000'



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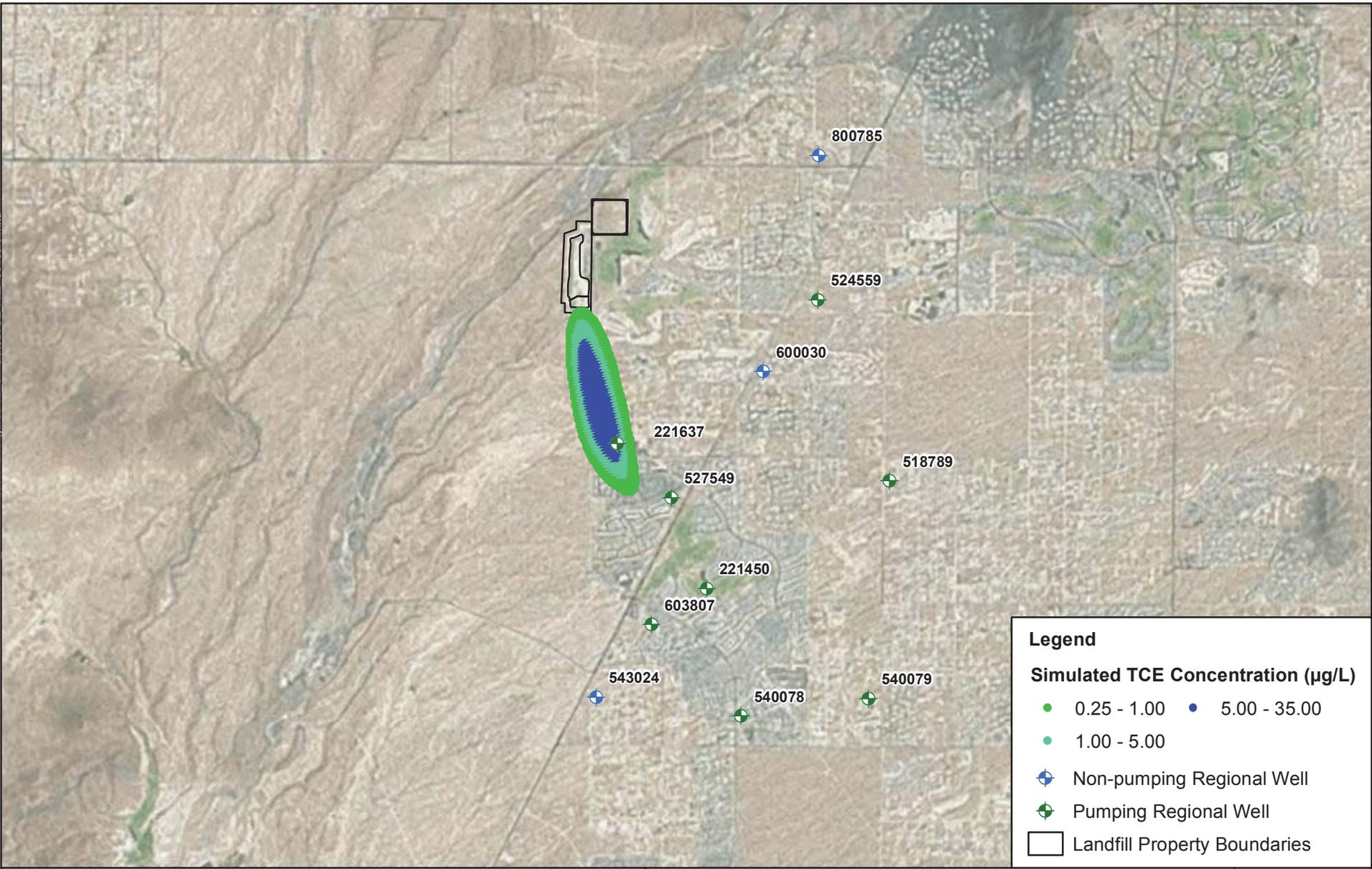
**Revised Remedial Action Plan
 Maricopa County Cave Creek Landfill
 Phoenix, Arizona**

**Simulated TCE Concentrations for
 Alternative 2 - 30 Years**

**FIGURE
 5-11**



Path: X:\Projects\2014_1420142020_Cave_Creek_Landfill_FY_2015\MXD\Revised_RemedialActionPlan\Figure5-12_SimulatedTCE_Alt2_50Years.mxd

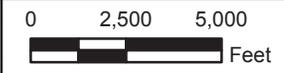


Legend

Simulated TCE Concentration (µg/L)

- 0.25 - 1.00
- 1.00 - 5.00
- 5.00 - 35.00

- ◆ Non-pumping Regional Well
- ◆ Pumping Regional Well
- Landfill Property Boundaries



Imagery Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Job No. 1420142020
 PM: NC
 Date: 5/29/2015
 Scale: 1" = 5000'

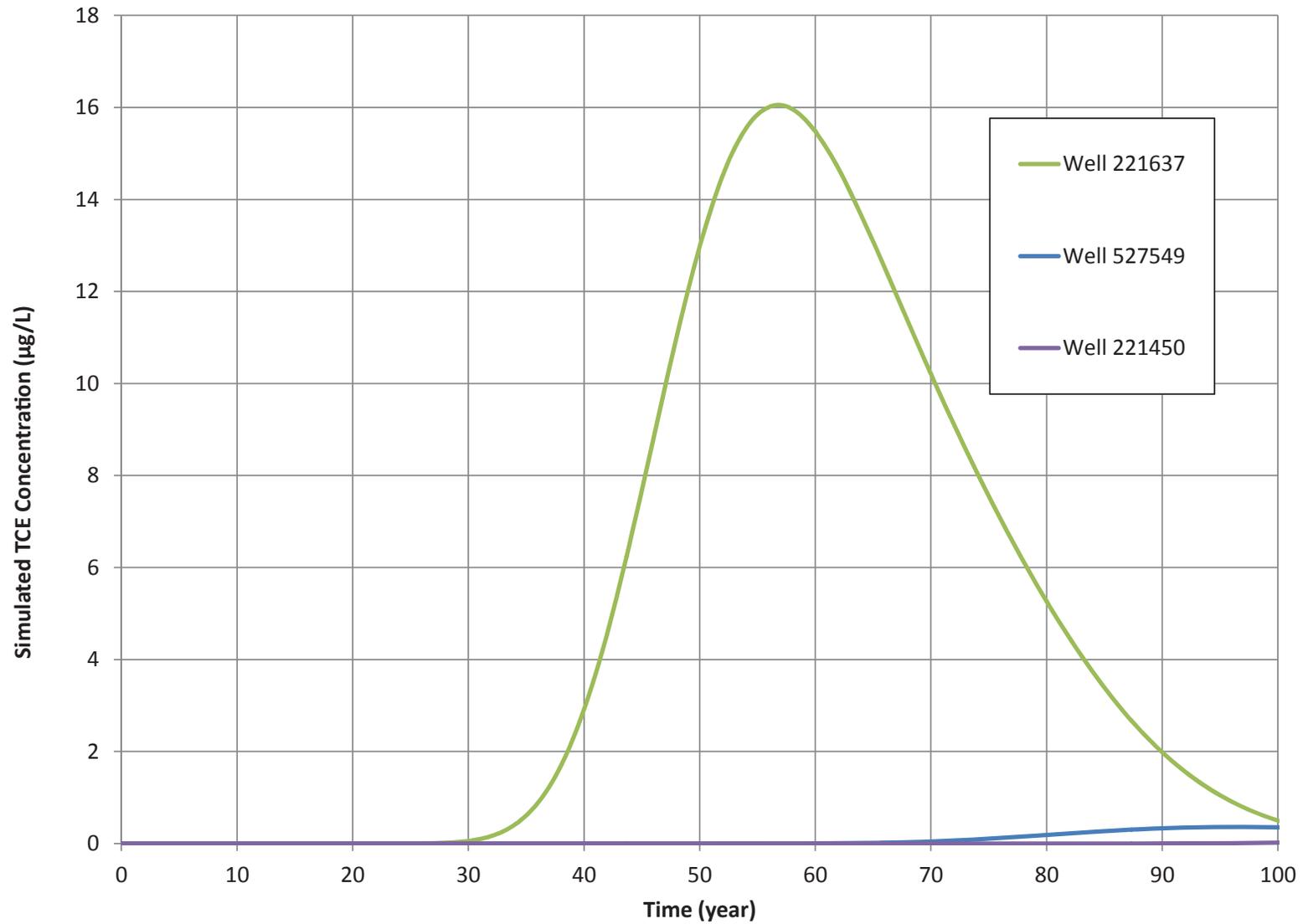
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 Maricopa County Cave Creek Landfill
 Phoenix, Arizona

**Simulated TCE Concentrations for
 Alternative 2 - 50 Years**

FIGURE
5-12





Job No.: 1420142020
PM: NC
Date: 5/29/2015
Scale: Not to scale

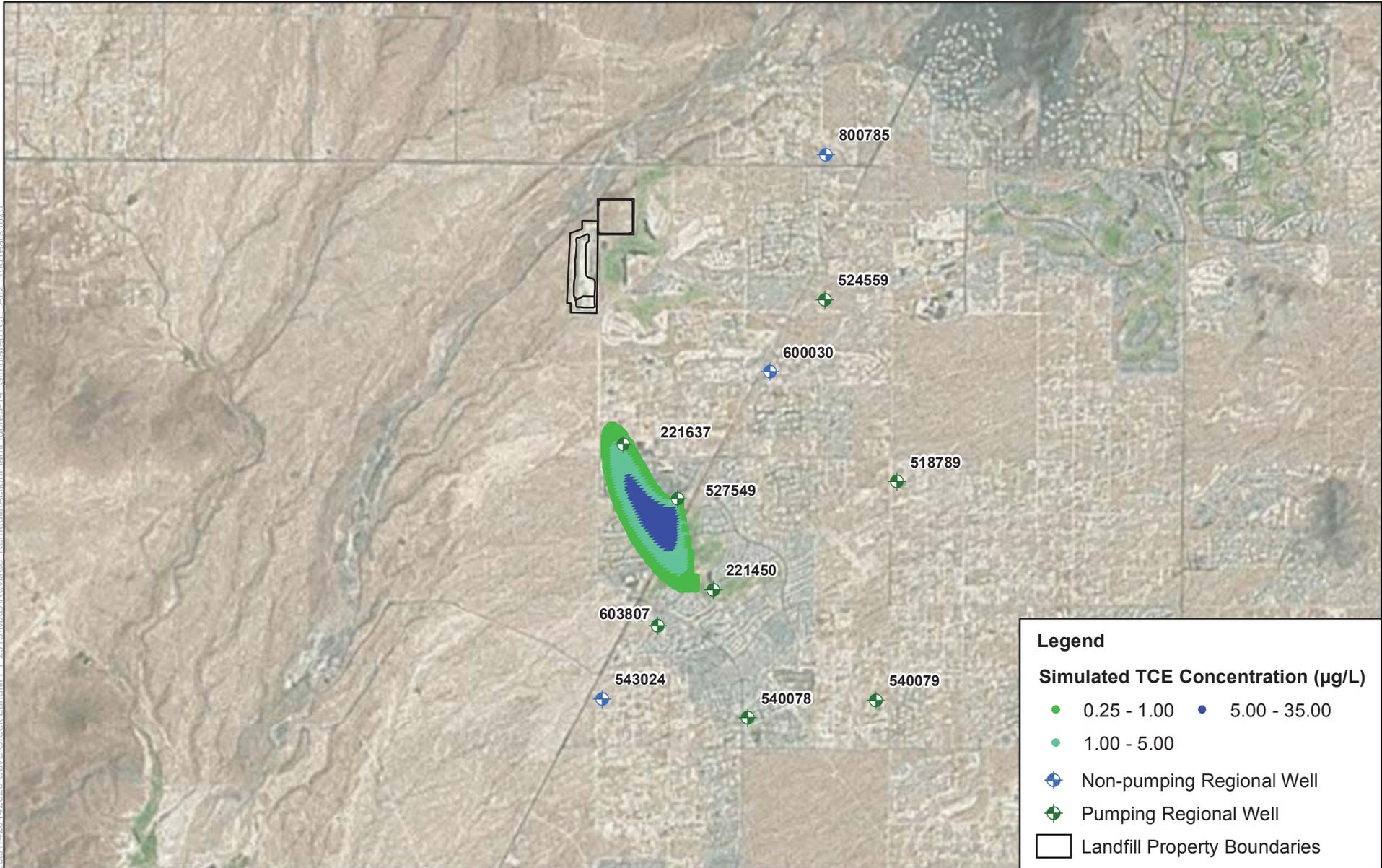
Revised Remedial Action Plan
Maricopa County Cave Creek Landfill
Phoenix, Arizona

Simulated Concentrations in Water Supply Wells for Alternative 2

**FIGURE
5-13**



Path: X:\Projects\2014-Projects\1420142020.Cave Creek Landfill.FY 2015\MXD\Revised Remedial Action Plan\Figure5-14 - SimulatedTCE - Alt2 - 100Years.mxd

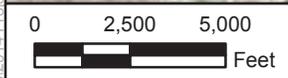


Legend

Simulated TCE Concentration (µg/L)

- 0.25 - 1.00
- 1.00 - 5.00
- 5.00 - 35.00

- ◆ Non-pumping Regional Well
- ◆ Pumping Regional Well
- Landfill Property Boundaries



Imagery Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

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 PM: NC
 Date: 5/29/2015
 Scale: 1" = 5000'



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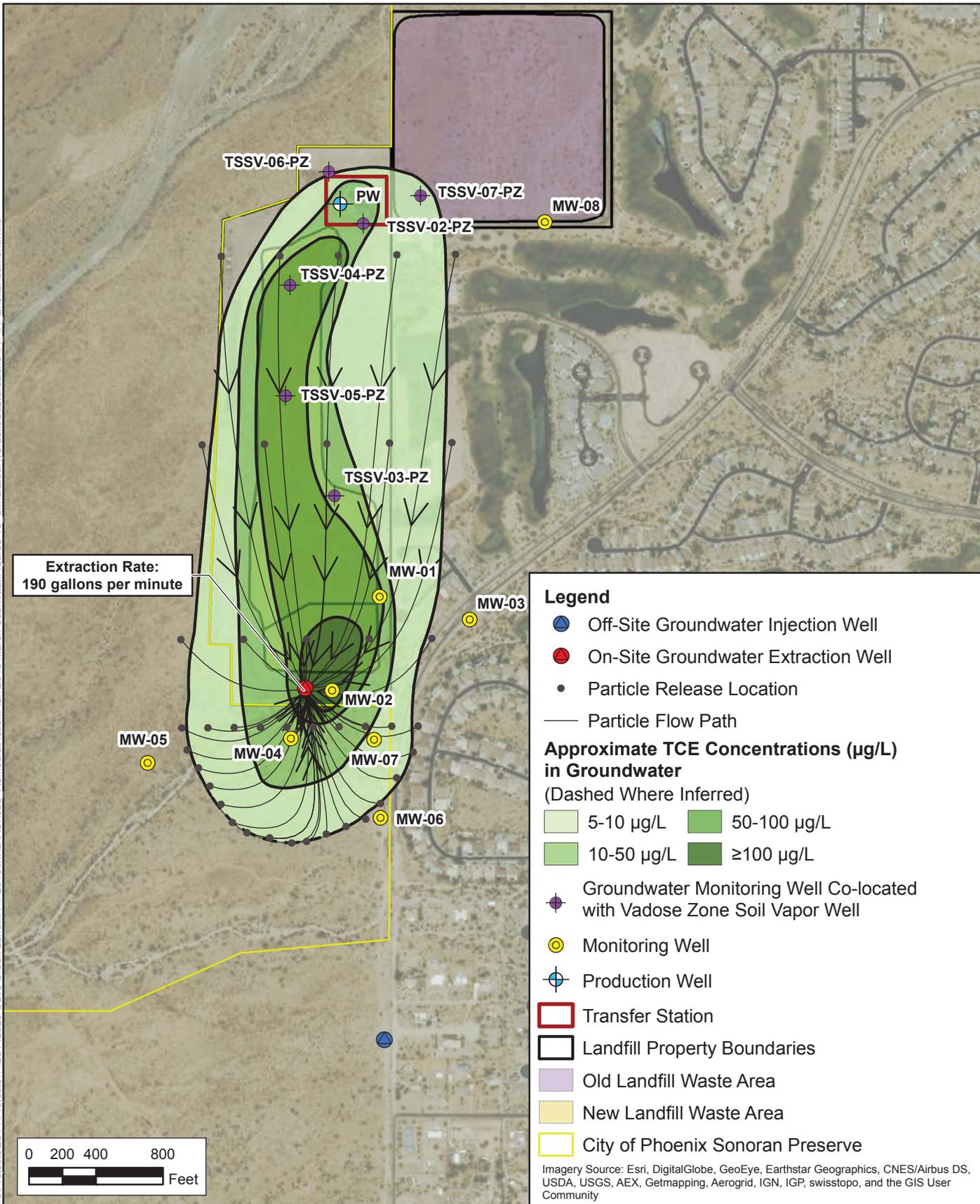
Revised Remedial Action Plan
 Maricopa County Cave Creek Landfill
 Phoenix, Arizona

**Simulated TCE Concentrations for
 Alternative 2 - 100 Years**

amec
 foster
 wheeler

FIGURE
5-14

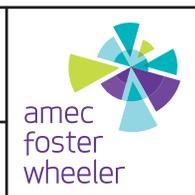
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Job No.	1420142020
PM:	NC
Date:	4/13/2016
Scale:	1" = 800'



Revised Remedial Action Plan
Maricopa County Cave Creek Landfill
Phoenix, Arizona

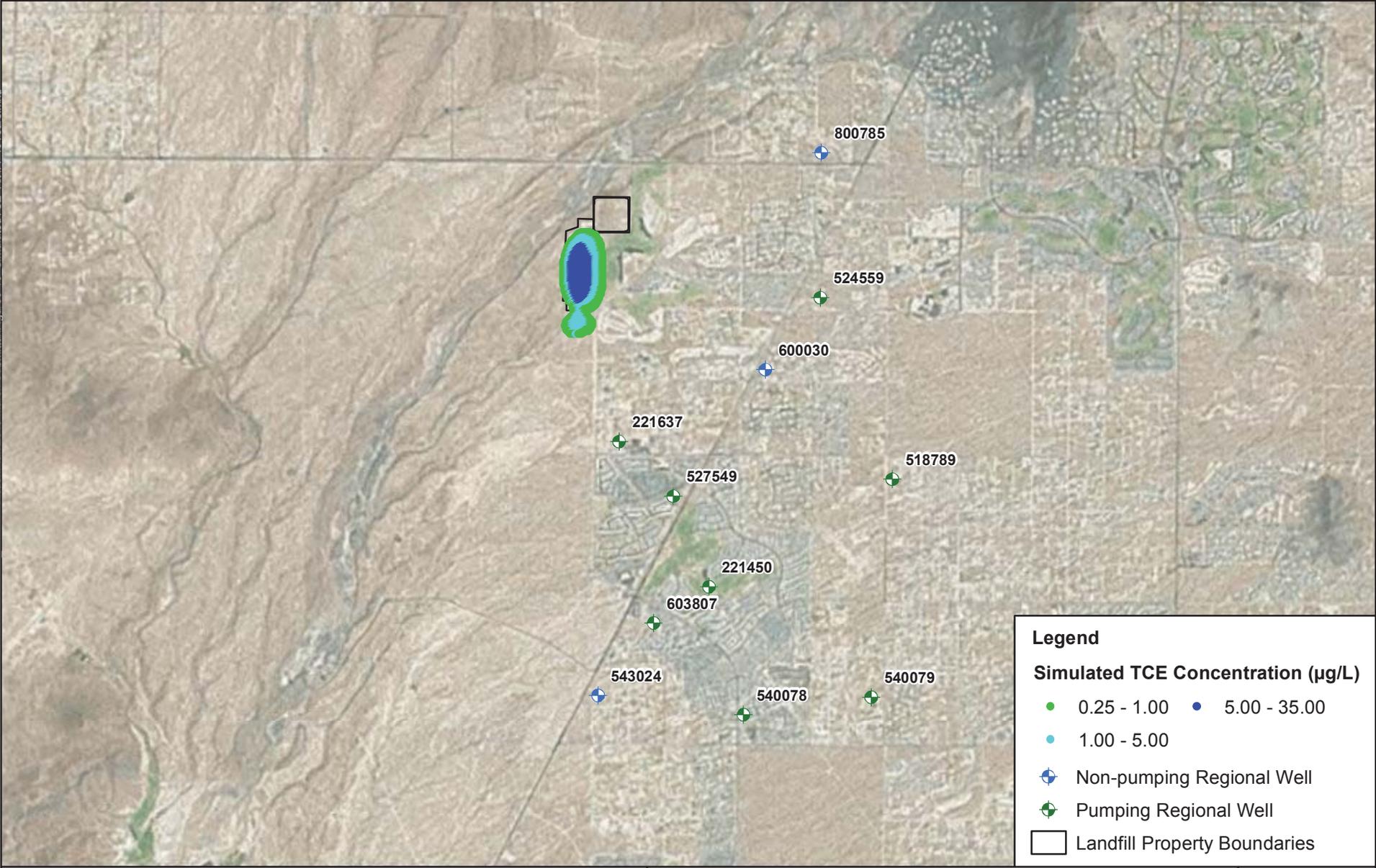


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Simulated Hydraulic Capture Zone – Alternative 4A

FIGURE 5-15

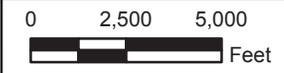
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Legend

Simulated TCE Concentration (µg/L)

- 0.25 - 1.00
- 5.00 - 35.00
- 1.00 - 5.00
- ◆ Non-pumping Regional Well
- ◆ Pumping Regional Well
- Landfill Property Boundaries



Imagery Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Job No. 1420142020
 PM: NC
 Date: 3/8/2016
 Scale: 1" = 5000'



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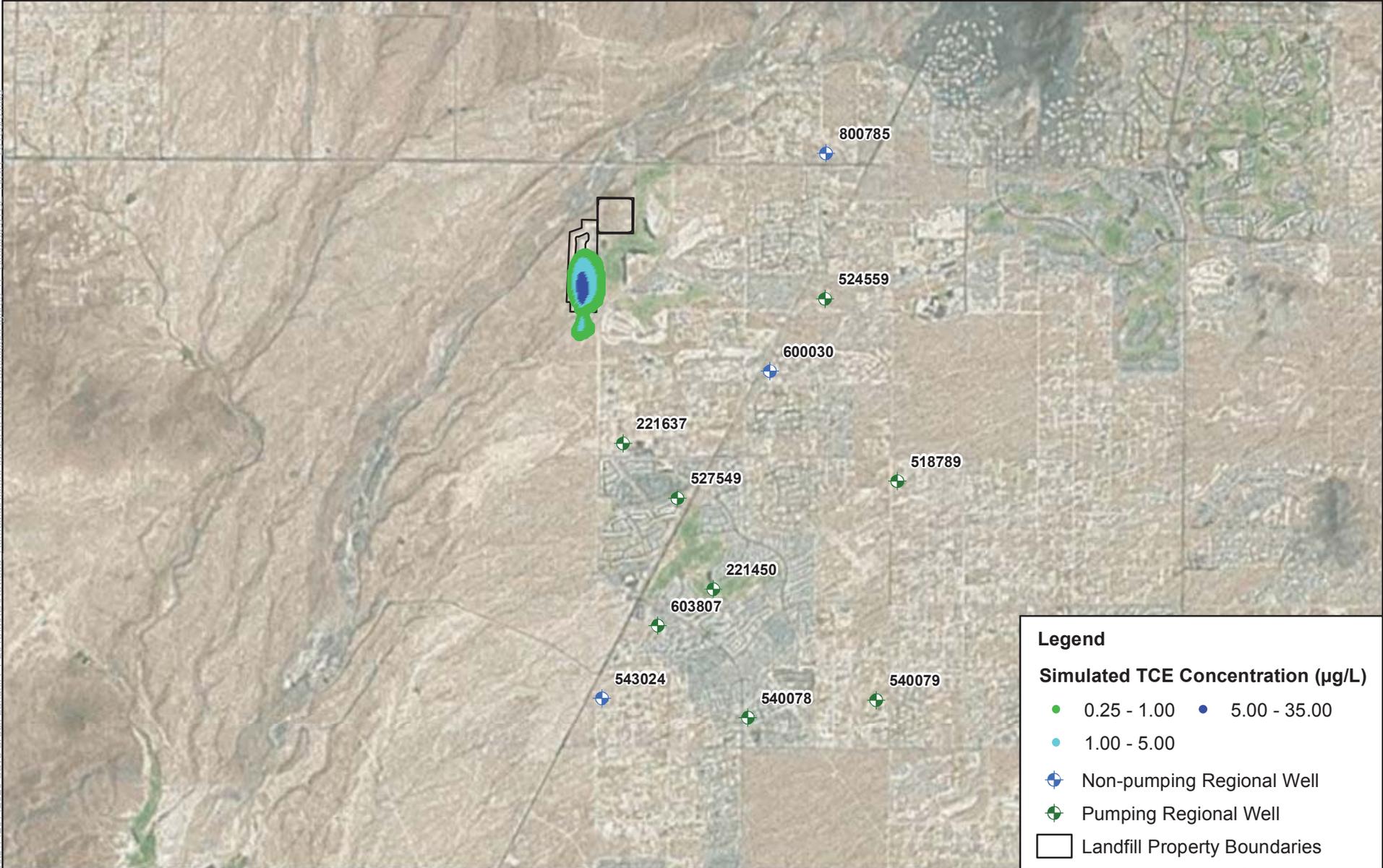
**Revised Remedial Action Plan
 Maricopa County Cave Creek Landfill
 Phoenix, Arizona**

**Simulated TCE Concentrations for
 Alternative 4A - 10 Years**

**FIGURE
 5-16**

amec
 foster
 wheeler

Path: X:\Projects\2014 Projects\1420142020 Cave Creek Landfill FY 2015\MXD\Revised RemedialActionPlan\2016 March_Submital\Figure5-17 - SimulatedTCE - Alt4A - 20Years.mxd

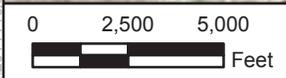


Legend

Simulated TCE Concentration (µg/L)

- 0.25 - 1.00
- 1.00 - 5.00
- ◆ 5.00 - 35.00

- ◆ Non-pumping Regional Well
- ◆ Pumping Regional Well
- Landfill Property Boundaries



Imagery Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Job No. 1420142020
 PM: NC
 Date: 3/8/2016
 Scale: 1" = 5000'



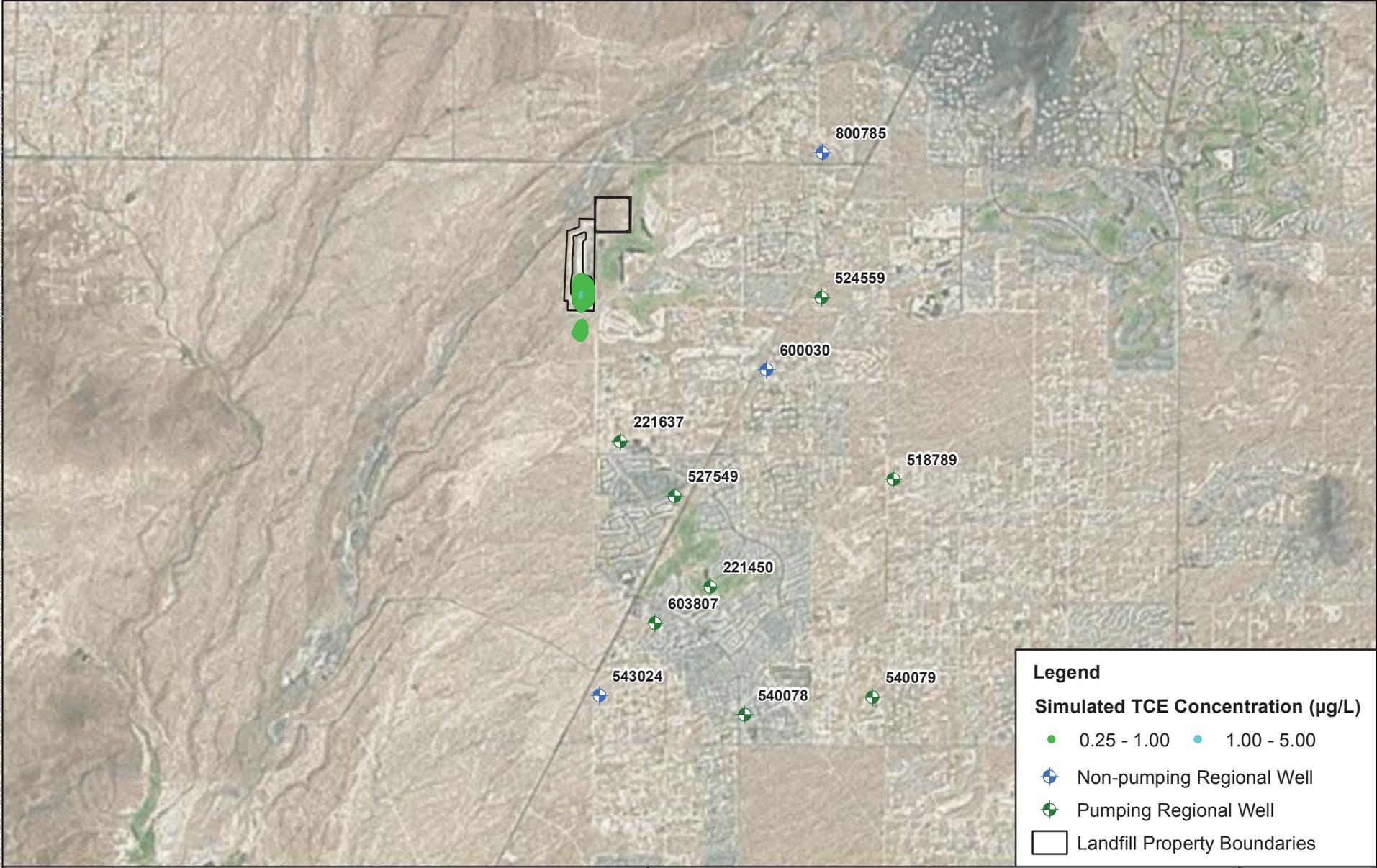
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Revised Remedial Action Plan
 Maricopa County Cave Creek Landfill
 Phoenix, Arizona

**Simulated TCE Concentrations for
 Alternative 4A - 20 Years**

FIGURE
5-17

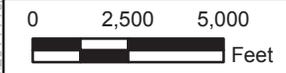
Path: X:\Projects\2014 Projects\1420142020 Cave Creek Landfill FY 2015\MXD\Revised RemedialActionPlan\2016 March Submission\Figure5-18 - SimulatedTCE - Alt4A - 30Years.mxd



Legend

Simulated TCE Concentration (µg/L)

- 0.25 - 1.00
- 1.00 - 5.00
- ◆ Non-pumping Regional Well
- ◆ Pumping Regional Well
- Landfill Property Boundaries



Imagery Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Job No.	1420142020
PM:	NC
Date:	3/8/2016
Scale:	1" = 5000'



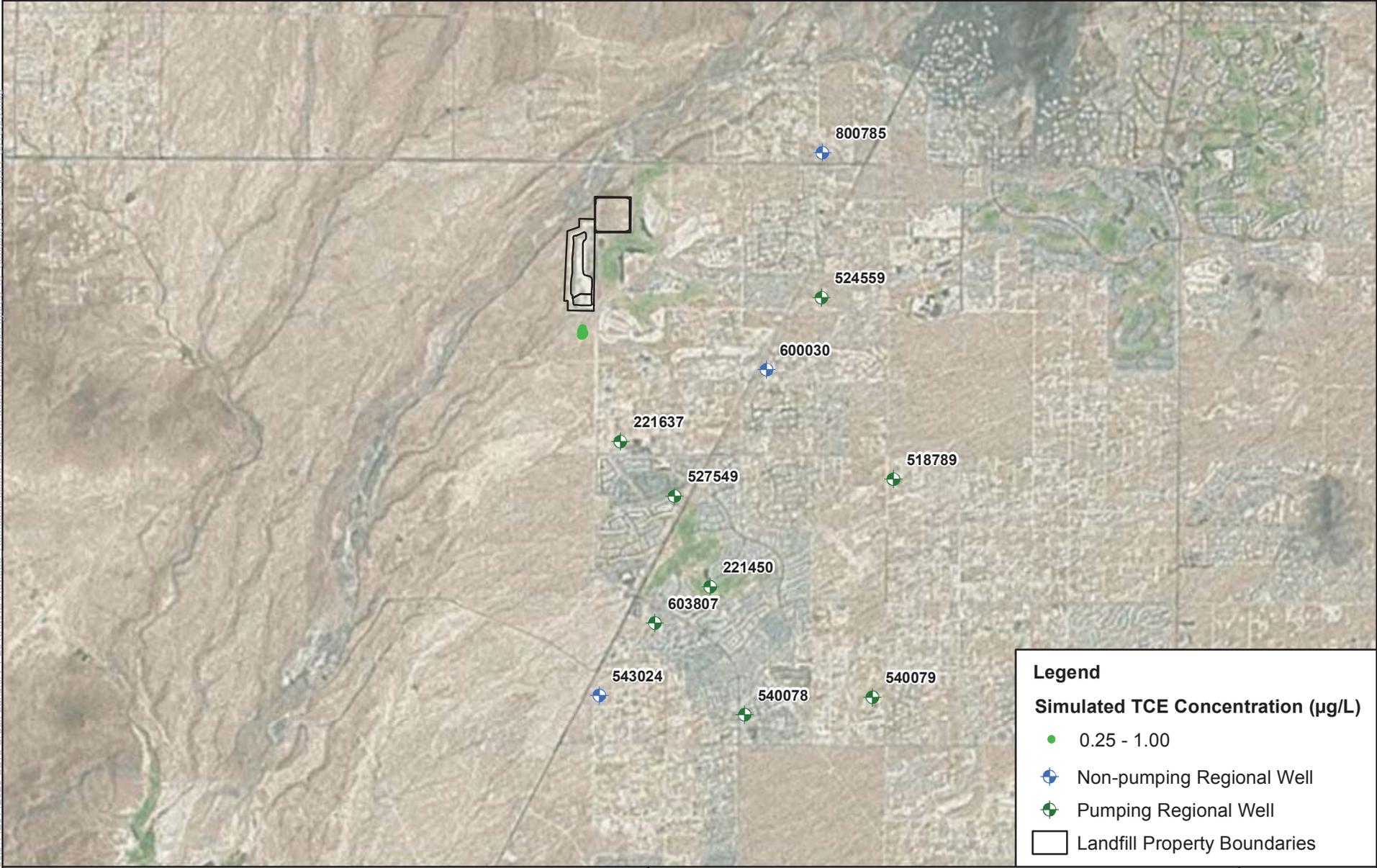
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**Revised Remedial Action Plan
Maricopa County Cave Creek Landfill
Phoenix, Arizona**

**Simulated TCE Concentrations for
Alternative 4A - 30 Years**

**FIGURE
5-18**

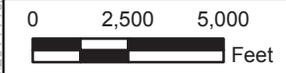
Path: X:\Projects\2014 Projects\1420142020 Cave Creek Landfill FY 2015\MXD\Revised RemedialActionPlan\2016 March Submission\Figure5-19 - SimulatedTCE - Alt4A - 50Years.mxd



Legend

Simulated TCE Concentration (µg/L)

- 0.25 - 1.00
- ◆ Non-pumping Regional Well
- ◆ Pumping Regional Well
- Landfill Property Boundaries



Imagery Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Job No.	1420142020
PM:	NC
Date:	3/8/2016
Scale:	1" = 5000'



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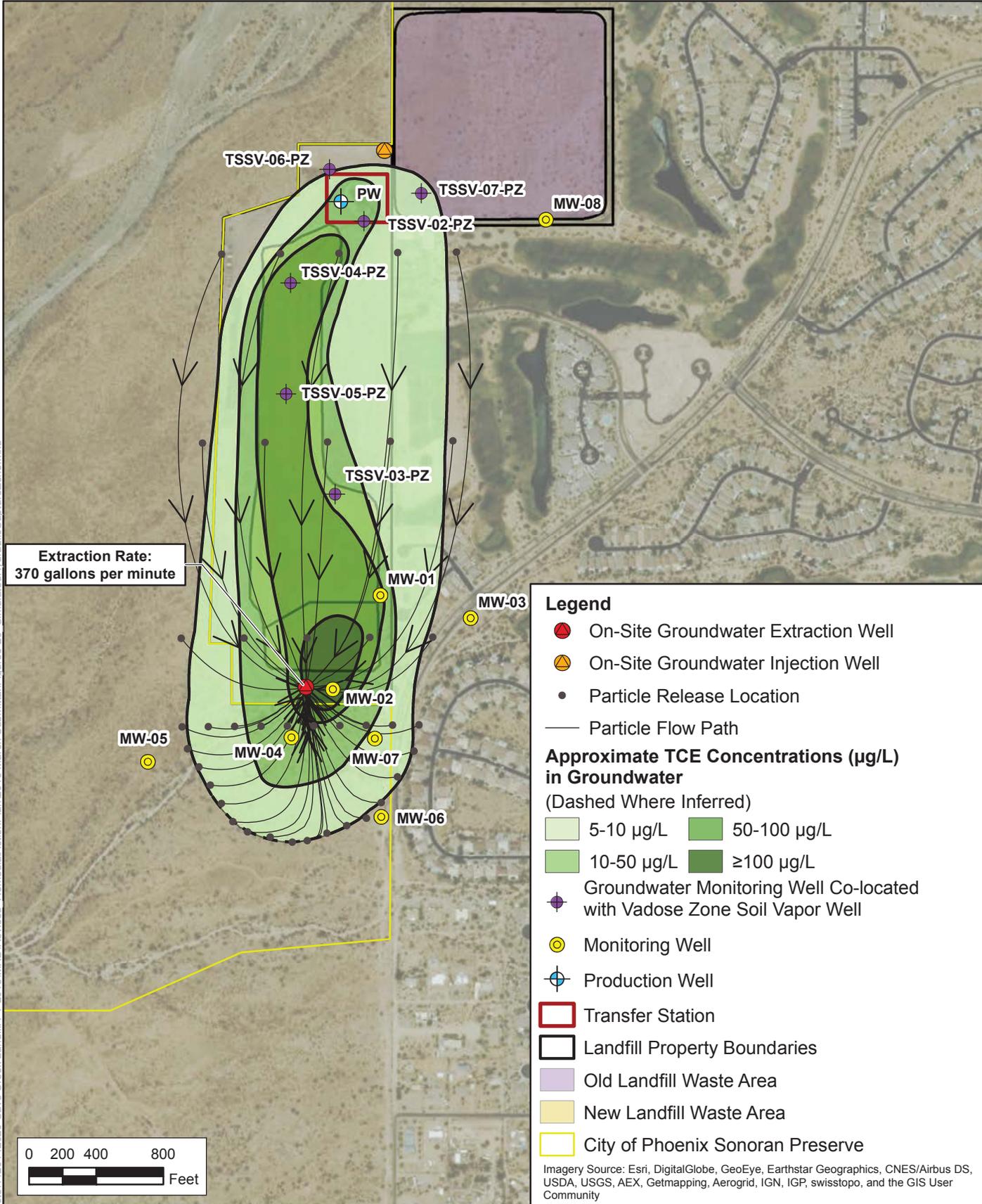
Revised Remedial Action Plan
Maricopa County Cave Creek Landfill
Phoenix, Arizona

**Simulated TCE Concentrations for
Alternative 4A - 50 Years**

amec
foster
wheeler

FIGURE
5-19

Path: X:\Projects\2014\20142020 Cave Creek Landfill FY 2015\MXD\Revised RemedialActionPlan\2016 March Submittal\Figure5-20 SimulatedHydraulicCaptureZone.mxd



Extraction Rate:
370 gallons per minute

Legend

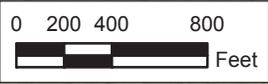
- On-Site Groundwater Extraction Well
- On-Site Groundwater Injection Well
- Particle Release Location
- Particle Flow Path

Approximate TCE Concentrations ($\mu\text{g/L}$) in Groundwater
(Dashed Where Inferred)

 5-10 $\mu\text{g/L}$	 50-100 $\mu\text{g/L}$
 10-50 $\mu\text{g/L}$	 $\geq 100 \mu\text{g/L}$

- Groundwater Monitoring Well Co-located with Vadose Zone Soil Vapor Well
- Monitoring Well
- Production Well
- Transfer Station
- Landfill Property Boundaries
- Old Landfill Waste Area
- New Landfill Waste Area
- City of Phoenix Sonoran Preserve

Imagery Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community



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PM:	NC
Date:	4/13/2016
Scale:	1" = 800'



Revised Remedial Action Plan
Maricopa County Cave Creek Landfill
Phoenix, Arizona

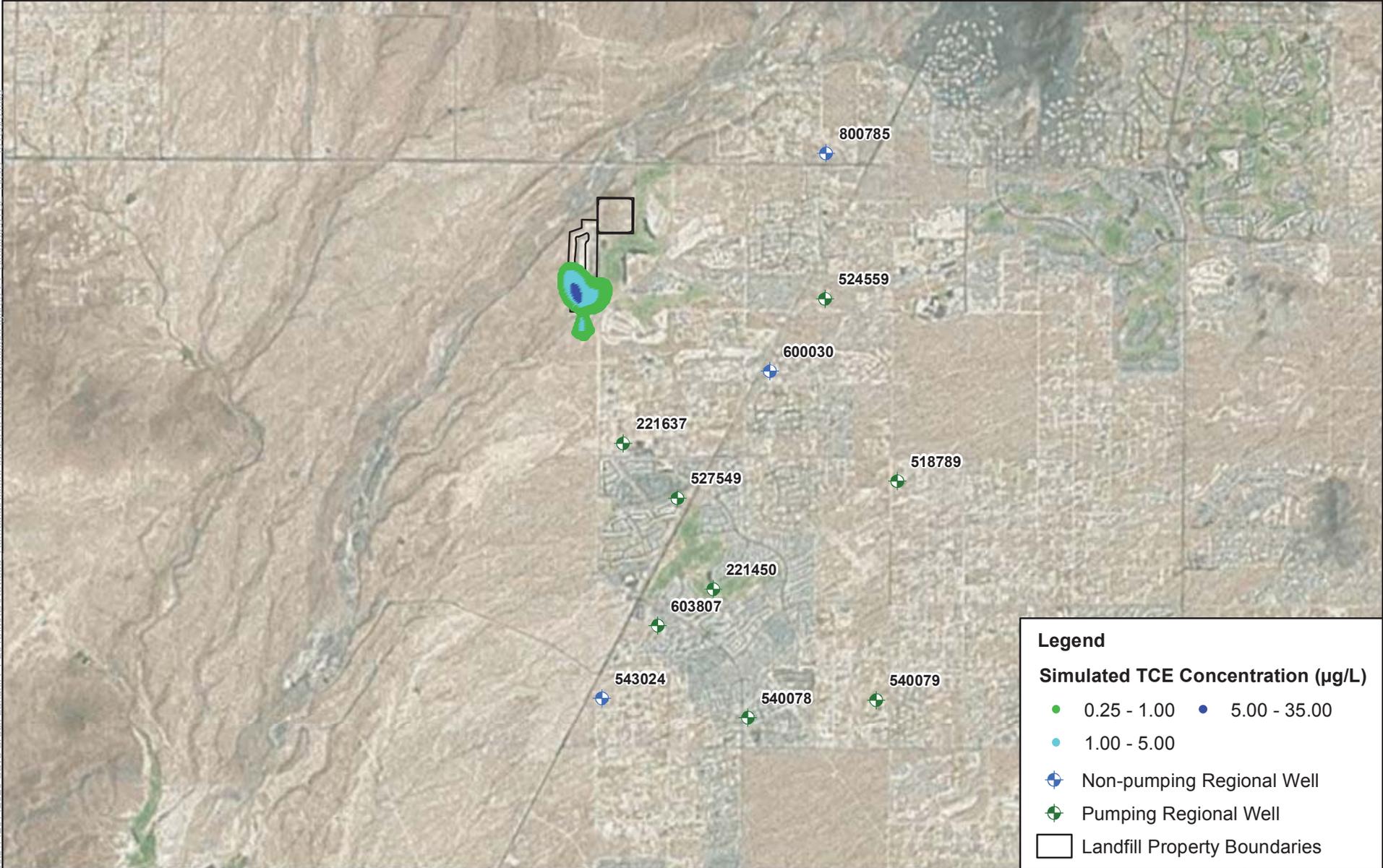


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Simulated Hydraulic Capture Zone - Alternative 4B

FIGURE 5-20

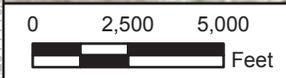
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Legend

Simulated TCE Concentration (µg/L)

- 0.25 - 1.00
- 1.00 - 5.00
- 5.00 - 35.00
- ◆ Non-pumping Regional Well
- ◆ Pumping Regional Well
- Landfill Property Boundaries



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 PM: NC
 Date: 3/8/2016
 Scale: 1" = 5000'

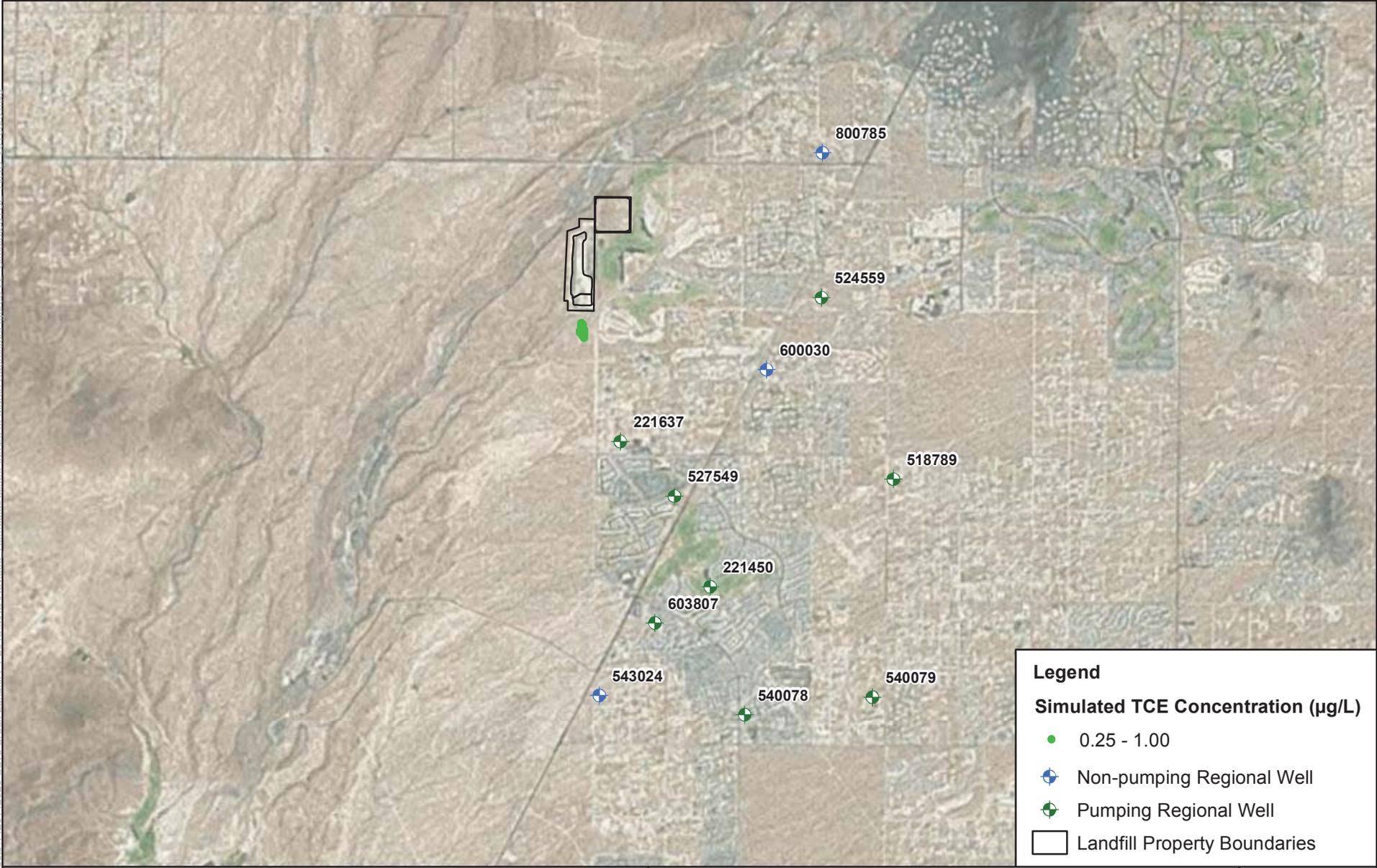
Revised Remedial Action Plan
 Maricopa County Cave Creek Landfill
 Phoenix, Arizona

**Simulated TCE Concentrations for
 Alternative 4B - 10 Years**

FIGURE
5-21



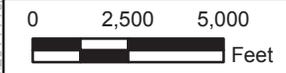
Path: X:\Projects\2014_1420142020_Cave_Creek_Landfill_FY_2015\MXD\Revised_RemedialActionPlan\2016_March_Submittal\Figure5-22_SimulatedTCE_Al4B_20Years.mxd



Legend

Simulated TCE Concentration (µg/L)

- 0.25 - 1.00
- ◆ Non-pumping Regional Well
- ◆ Pumping Regional Well
- Landfill Property Boundaries



Imagery Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Job No.	1420142020
PM:	NC
Date:	3/8/2016
Scale:	1" = 5000'

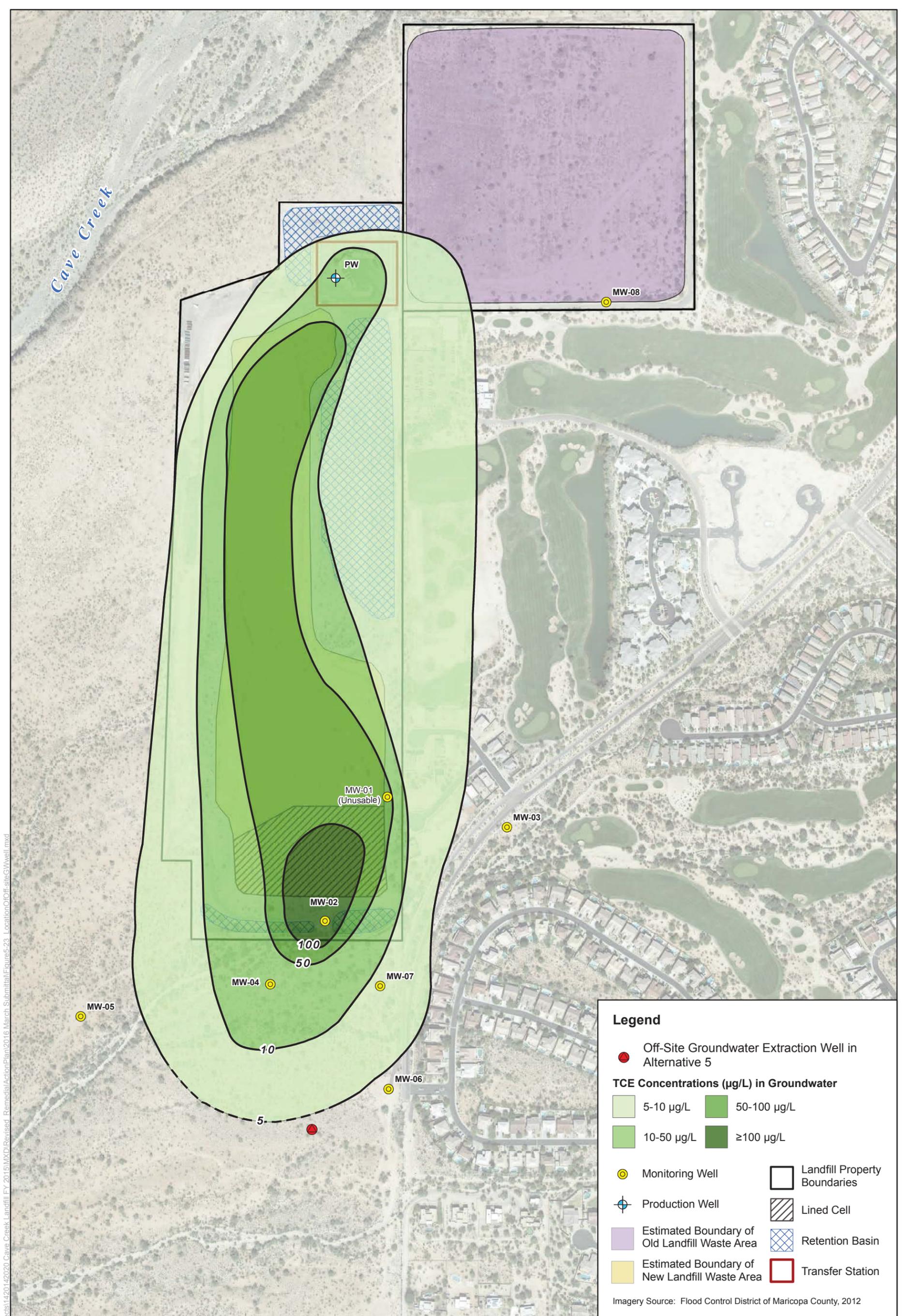


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Revised Remedial Action Plan
Maricopa County Cave Creek Landfill
Phoenix, Arizona

**Simulated TCE Concentrations for
Alternative 4B - 20 Years**

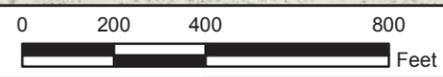
FIGURE
5-22



Legend

- Off-Site Groundwater Extraction Well in Alternative 5
- TCE Concentrations (µg/L) in Groundwater**
- 5-10 µg/L
- 10-50 µg/L
- 50-100 µg/L
- ≥100 µg/L
- Monitoring Well
- ⊕ Production Well
- Landfill Property Boundaries
- ▨ Lined Cell
- ▤ Retention Basin
- ▭ Estimated Boundary of Old Landfill Waste Area
- ▭ Estimated Boundary of New Landfill Waste Area
- ▭ Transfer Station

Imagery Source: Flood Control District of Maricopa County, 2012



Job No. 1420142020
 PM: NC
 Date: 3/8/2016
 Scale: 1" = 400'



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 Maricopa County Cave Creek Landfill
 Phoenix, Arizona

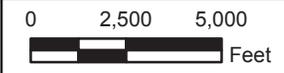
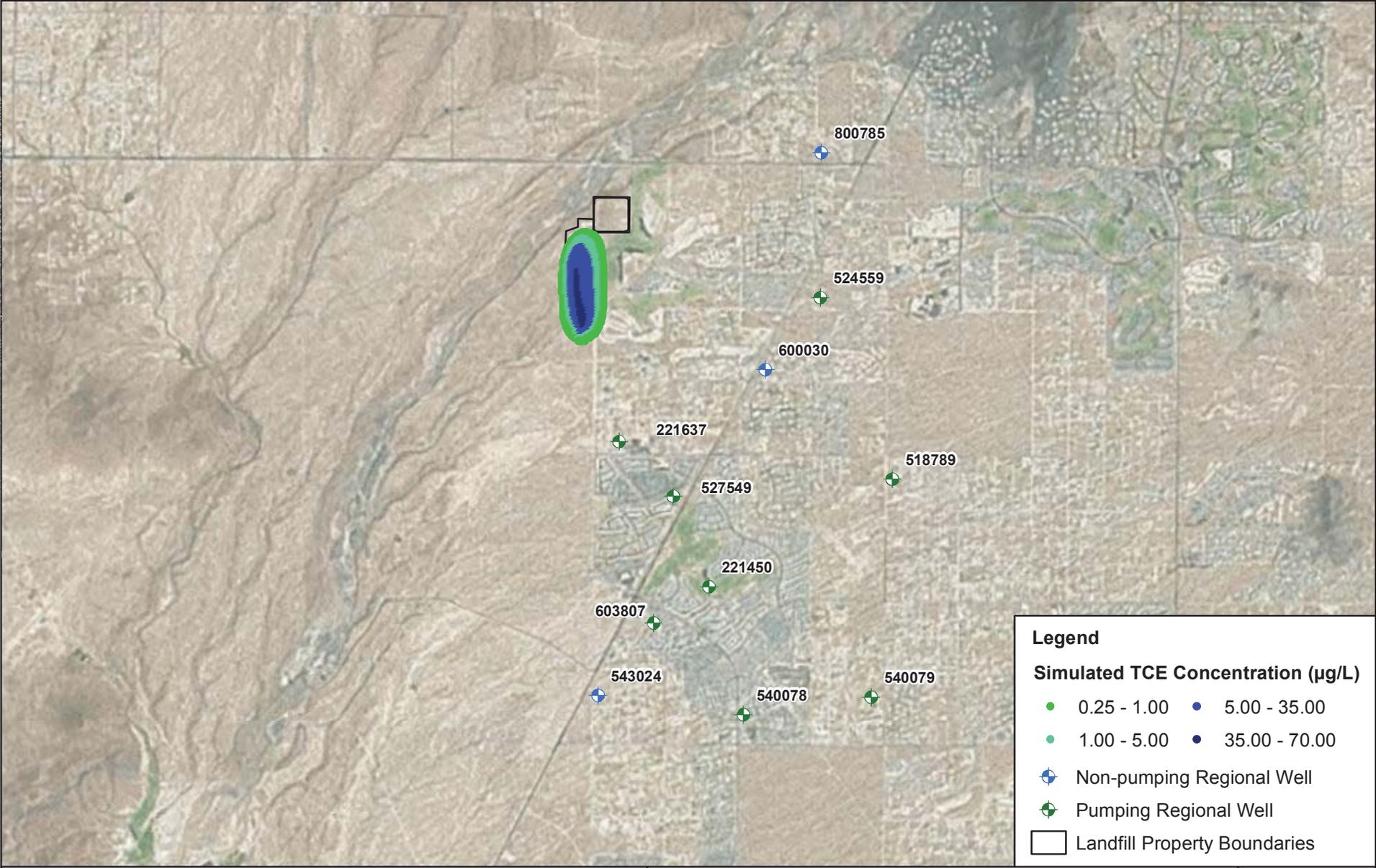
Location of Off-Site Groundwater Extraction Well in Alternative 5

FIGURE 5-23



Path: X:\Projects\2014\Projects\1420142020\Cave Creek Landfill\FY 2015\MXD\Revised RemedialActionPlan\2016 March Submittal\Figure5-23 Location\Off-siteGWWell.mxd

Path: X:\Projects\2014_1420142020_Cave_Creek_Landfill_FY2015\MXD\Revised_RemedialActionPlan\2016_March_Submittal\Figure5-24_SimulatedTCE_Alt5_10Years.mxd



Imagery Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Job No. 1420142020
 PM: NC
 Date: 3/8/2016
 Scale: 1" = 5000'



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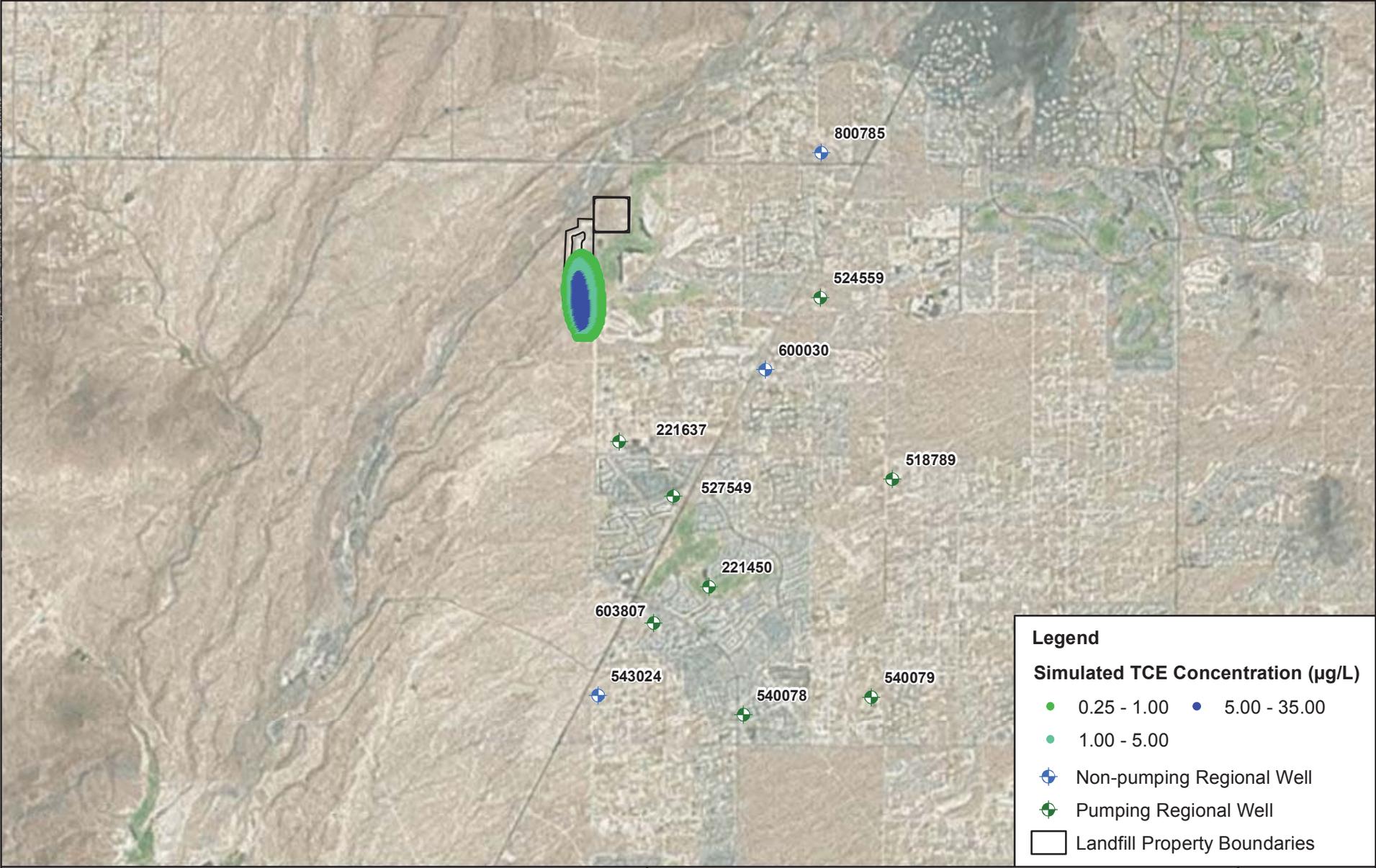
Revised Remedial Action Plan
 Maricopa County Cave Creek Landfill
 Phoenix, Arizona

**Simulated TCE Concentrations for
 Alternative 5 - 10 Years**

FIGURE
5-24



Path: X:\Projects\2014 Projects\1420142020 Cave Creek Landfill FY 2015\MXD\Revised RemedialActionPlan\2016 March_Submittal\Figure5-25_SimulatedTCE_Alt5_20Years.mxd

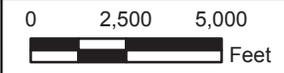


Legend

Simulated TCE Concentration (µg/L)

- 0.25 - 1.00
- 1.00 - 5.00
- 5.00 - 35.00

- ◆ Non-pumping Regional Well
- ◆ Pumping Regional Well
- Landfill Property Boundaries



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 PM: NC
 Date: 3/8/2016
 Scale: 1" = 5000'

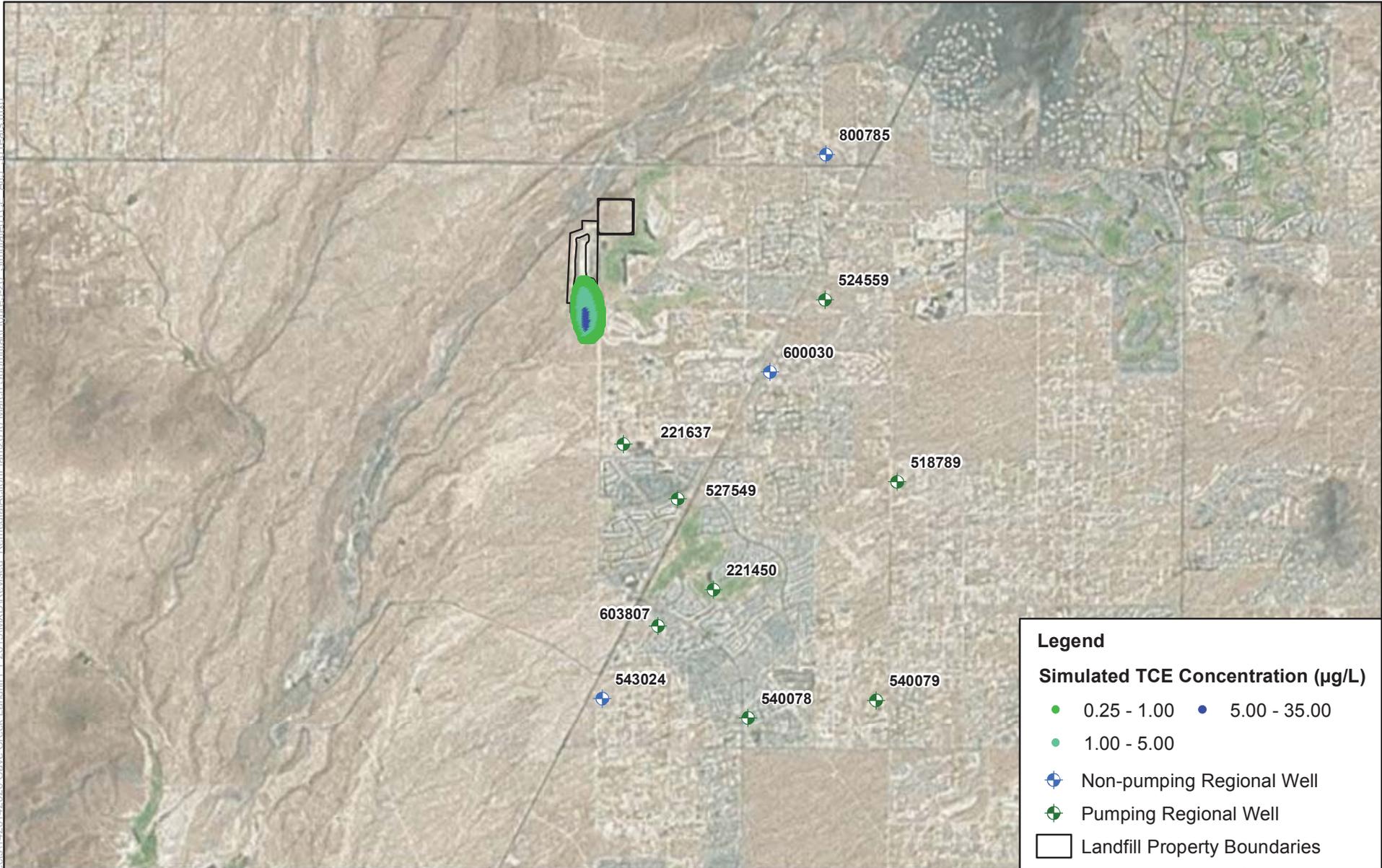
Revised Remedial Action Plan
 Maricopa County Cave Creek Landfill
 Phoenix, Arizona

**Simulated TCE Concentrations for
 Alternative 5 - 20 Years**

FIGURE
5-25



Path: X:\Projects\2014 Projects\1420142020 Cave Creek Landfill FY 2015\MXD\Revised RemedialActionPlan\2016 March_Submittal\Figure5-26_SimulatedTCE_Alt5_30Years.mxd

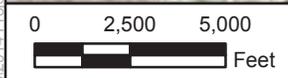


Legend

Simulated TCE Concentration (µg/L)

- 0.25 - 1.00
- 1.00 - 5.00
- 5.00 - 35.00

- ◆ Non-pumping Regional Well
- ◆ Pumping Regional Well
- Landfill Property Boundaries



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Job No. 1420142020
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 Date: 3/8/2016
 Scale: 1" = 5000'

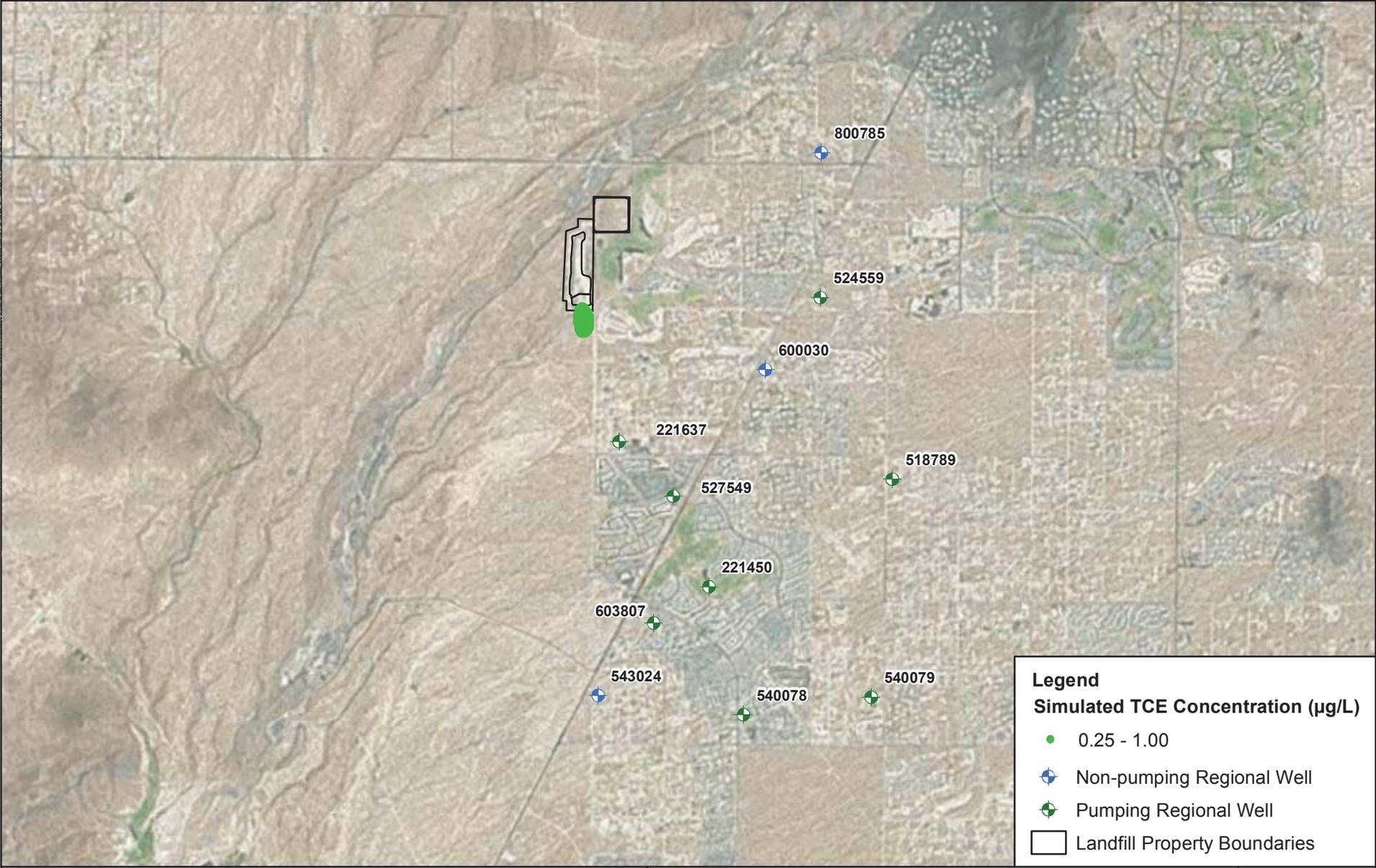
Revised Remedial Action Plan
 Maricopa County Cave Creek Landfill
 Phoenix, Arizona

**Simulated TCE Concentrations for
 Alternative 5 - 30 Years**

FIGURE
5-26



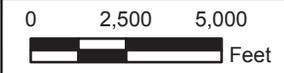
Path: X:\Projects\2014_1420142020_Cave_Creek_Landfill_FY2015\MXD\Revised_RemedialActionPlan\2016_March_Submittal\Figure5-27_SimulatedTCE_40Years.mxd



Legend

Simulated TCE Concentration (µg/L)

- 0.25 - 1.00
- ◆ Non-pumping Regional Well
- ◆ Pumping Regional Well
- Landfill Property Boundaries



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 Date: 3/8/2016
 Scale: 1" = 5000'

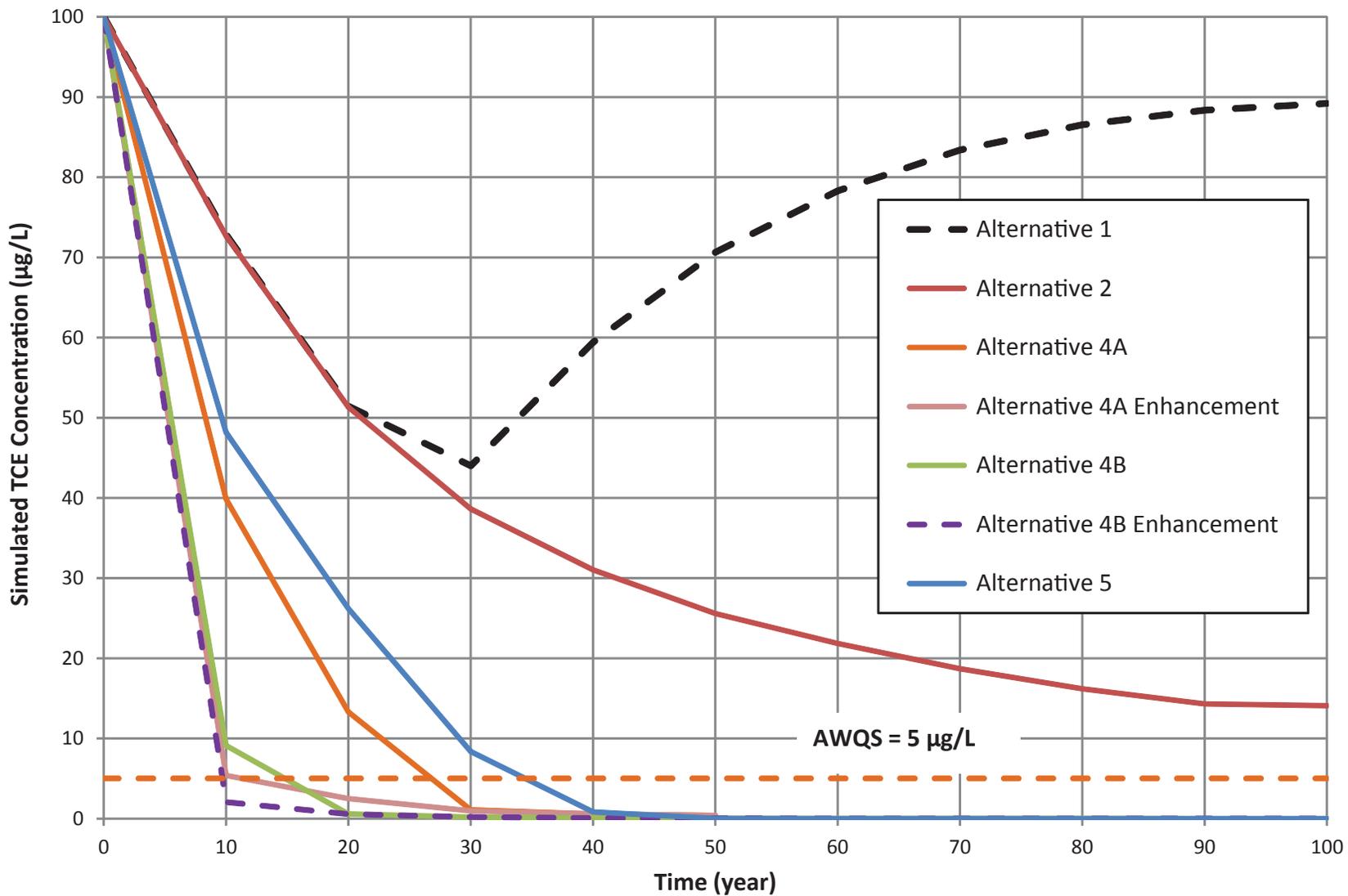
Revised Remedial Action Plan
 Maricopa County Cave Creek Landfill
 Phoenix, Arizona

**Simulated TCE Concentrations for
 Alternative 5 - 40 Years**

FIGURE
5-27



Path: X:\Projects\2014-Projects\1420142020-Cave-Creek-Landfill-FY-2015-MXD\Revised-Remedial-Action-Plan\2016-March-Submittal\Figures\28-Simulated-Max-Concentrations-Model-Domain.pl



Job No.: 1420142020
PM: NC
Date: 3/8/2016
Scale: Not to scale

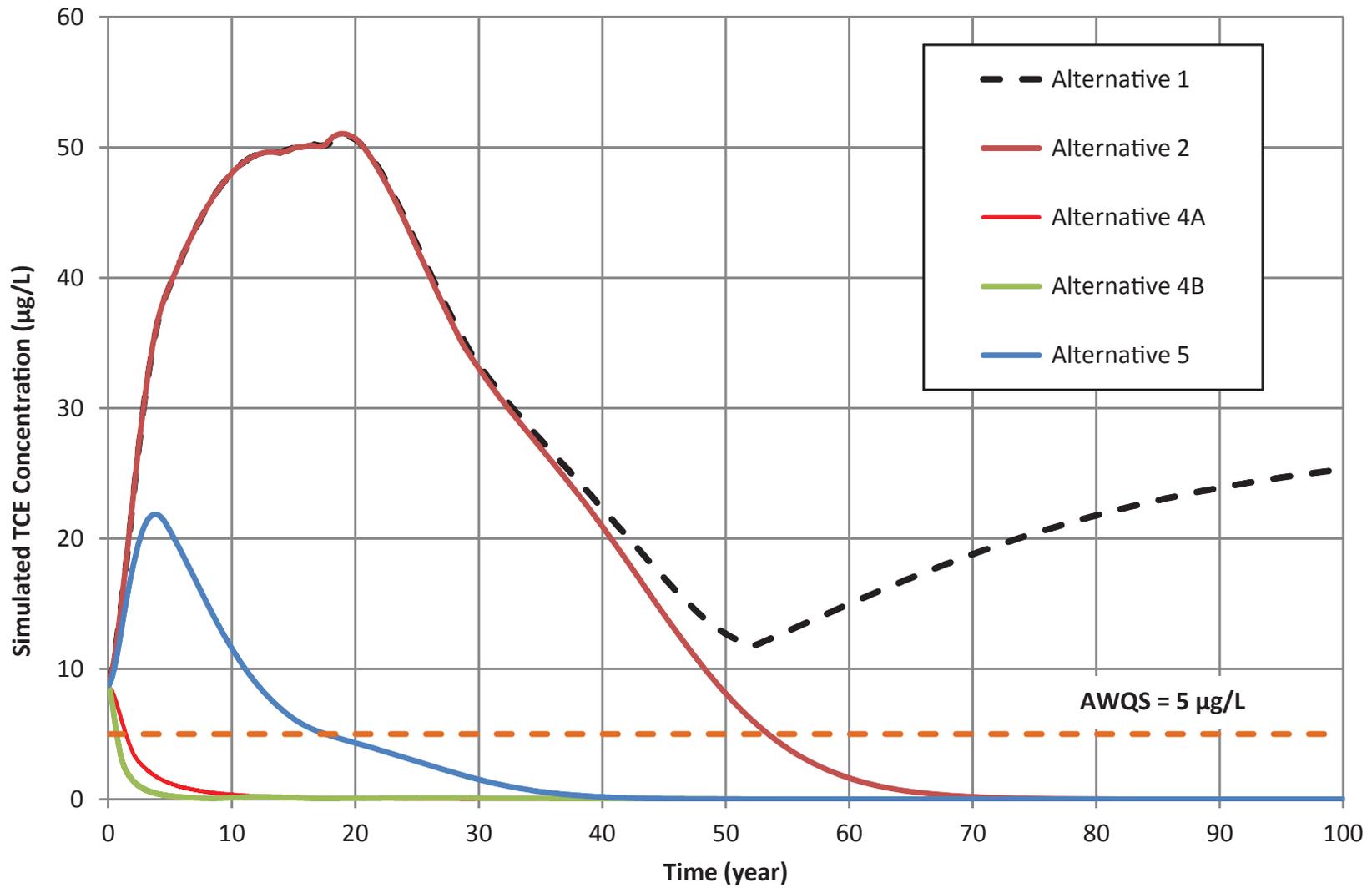
Revised Remedial Action Plan
Maricopa County Cave Creek Landfill
Phoenix, Arizona

Simulated Maximum Concentrations in Model Domain

FIGURE
5-28



Path: X:\Projects\2014\Projects\1420142020\Cave Creek Landfill\FY 2015\MXDN\Revised Remedial Action Plan\2016 March Submittal\Figure5-29 - Simulated Max Concentrations - Sonoran Preserve.al



Job No.: 1420142020
PM: NC
Date: 3/8/2016
Scale: Not to scale

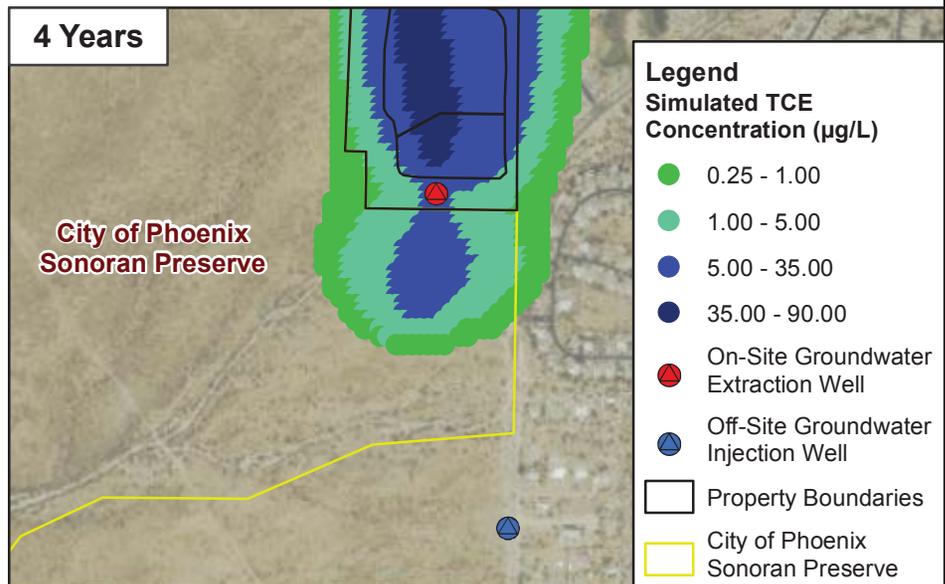
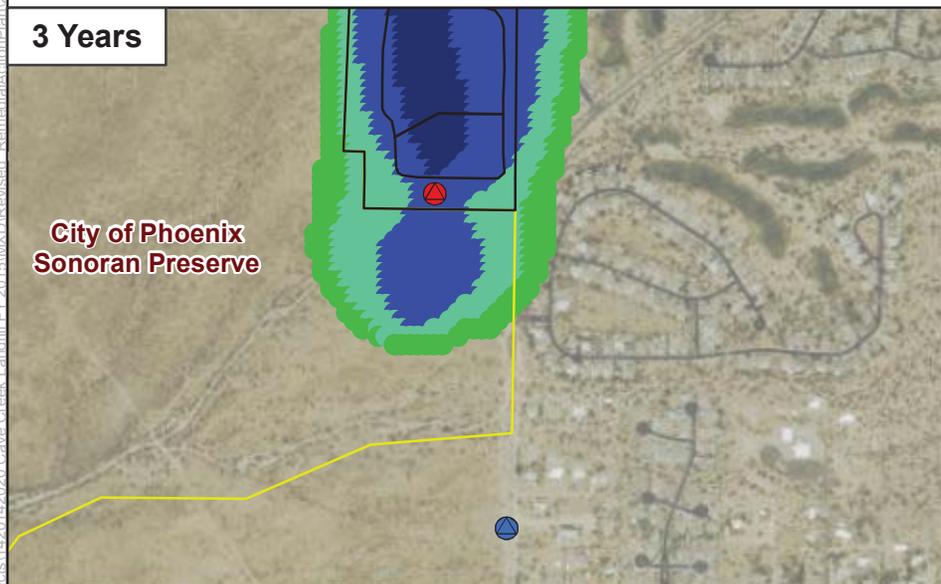
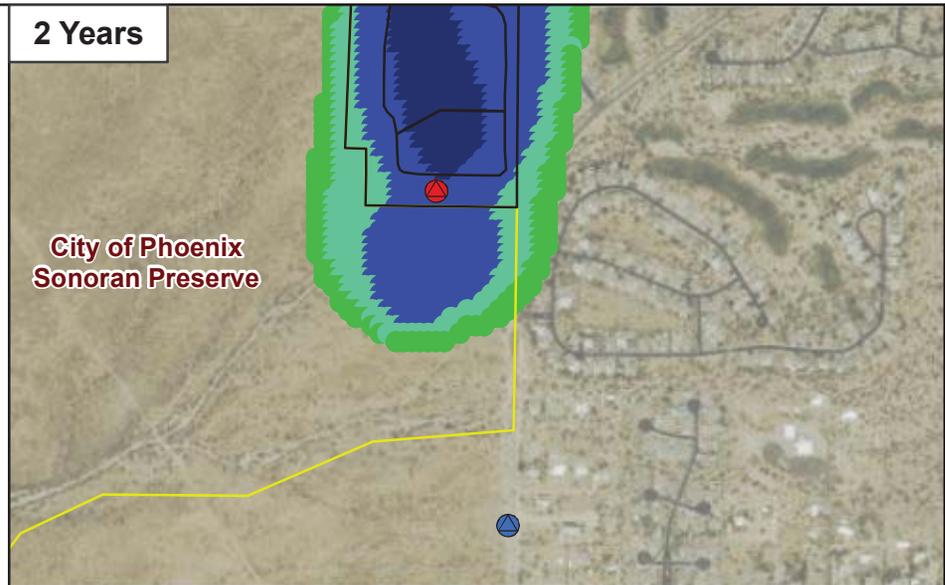
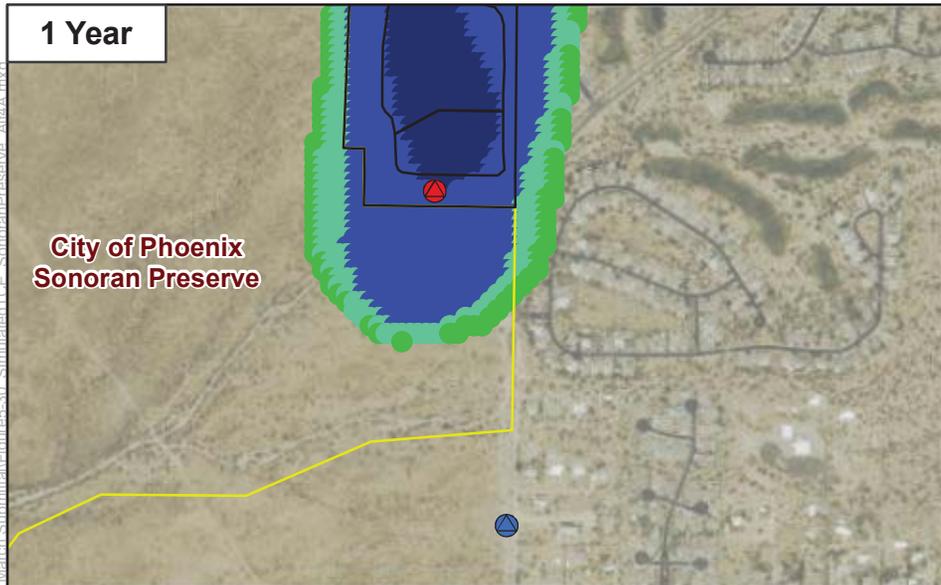
Revised Remedial Action Plan
Maricopa County Cave Creek Landfill
Phoenix, Arizona

Simulated Maximum Concentrations Along Sonoran Preserve Boundary

FIGURE
5-29



Path: X:\Projects\2014_1420142020_Cave_Creek_Landfill_FY_2015\MXD\Revised_RemedialActionPlan\2016_March_Submittal\Eauref-30_SimulatedTCE_SonoranPreserve_Alt4A.mxd



Legend

Simulated TCE Concentration (µg/L)

- 0.25 - 1.00
- 1.00 - 5.00
- 5.00 - 35.00
- 35.00 - 90.00

- ▲ On-Site Groundwater Extraction Well
- ▲ Off-Site Groundwater Injection Well
- Property Boundaries
- City of Phoenix Sonoran Preserve

0 600 1,200

 Feet

Imagery Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Job No. 1420142020
PM: NC
Date: 3/8/2016
Scale: 1" = 1200'

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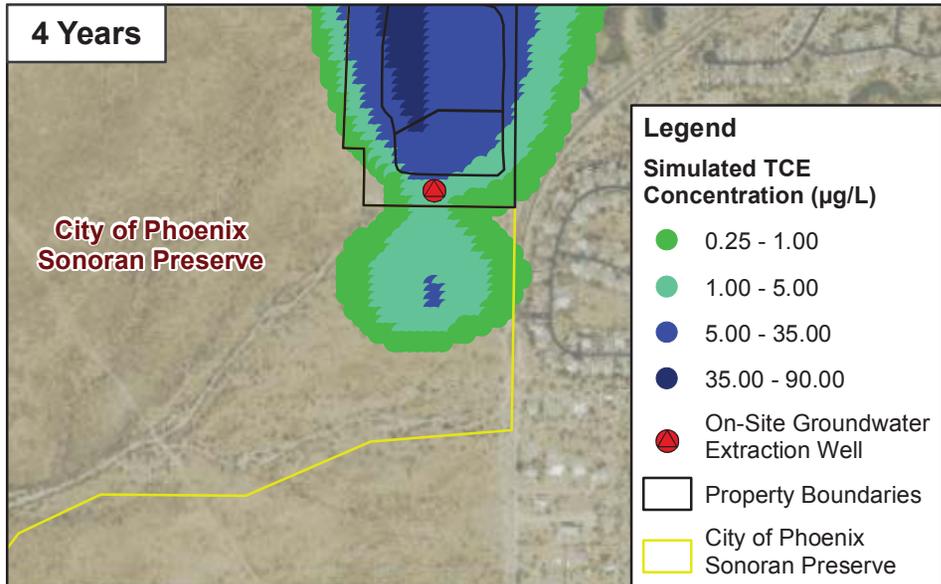
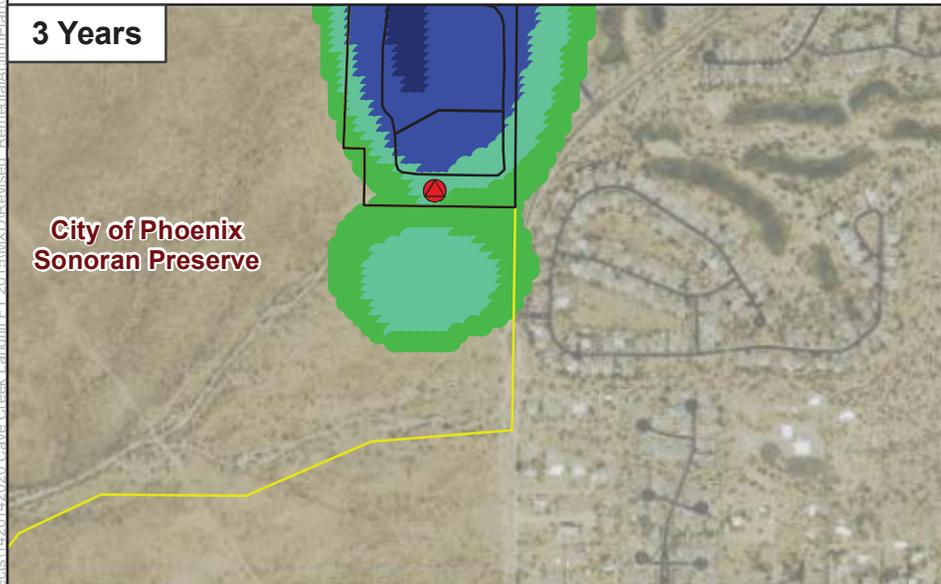
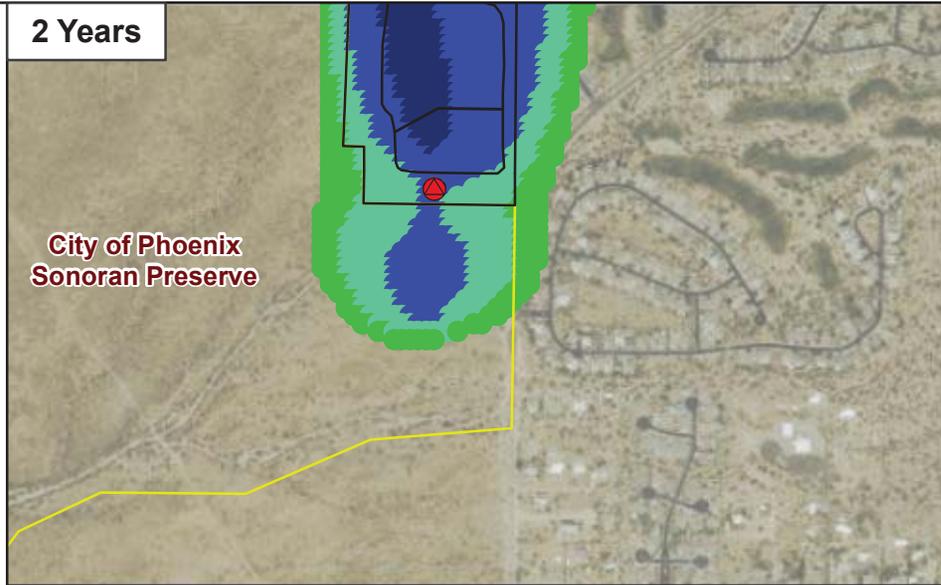
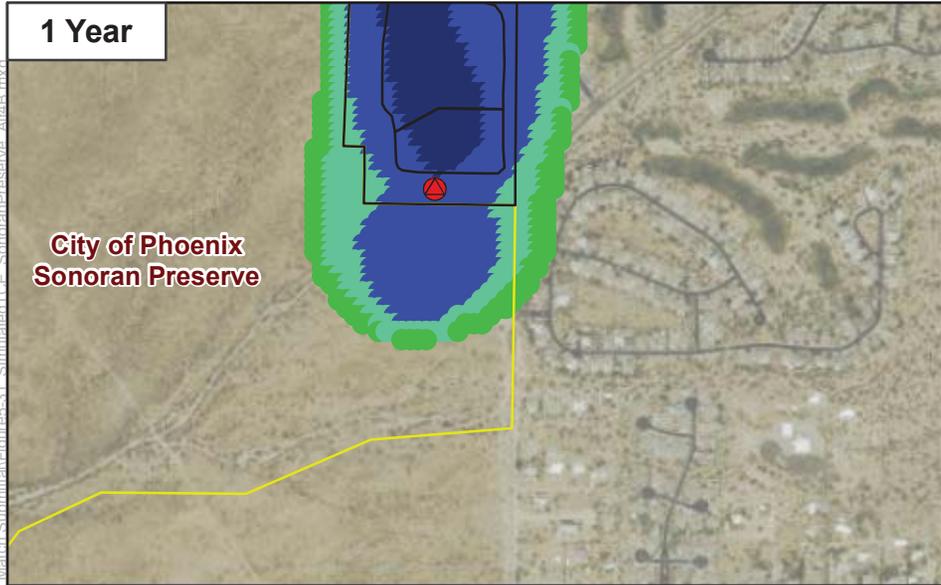
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Revised Remedial Action Plan
Maricopa County Cave Creek Landfill
Phoenix, Arizona

Simulated TCE Concentrations near Sonoran Preserve Boundary - Alternative 4A

FIGURE
5-30

Path: X:\Projects\2014 Projects\1420142020 Cave Creek Landfill FY 2015\MXD\Revised RemedialActionPlan\2016 March Submittal\Eauref-31 - SimulatedTCE - SonoranPreserve - Alt4B.mxd



Legend

Simulated TCE Concentration (µg/L)

- 0.25 - 1.00
- 1.00 - 5.00
- 5.00 - 35.00
- 35.00 - 90.00

- ▲ On-Site Groundwater Extraction Well
- Property Boundaries
- City of Phoenix Sonoran Preserve

0 600 1,200

 Feet

Imagery Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Job No. 1420142020
PM: NC
Date: 3/8/2016
Scale: 1" = 1200'

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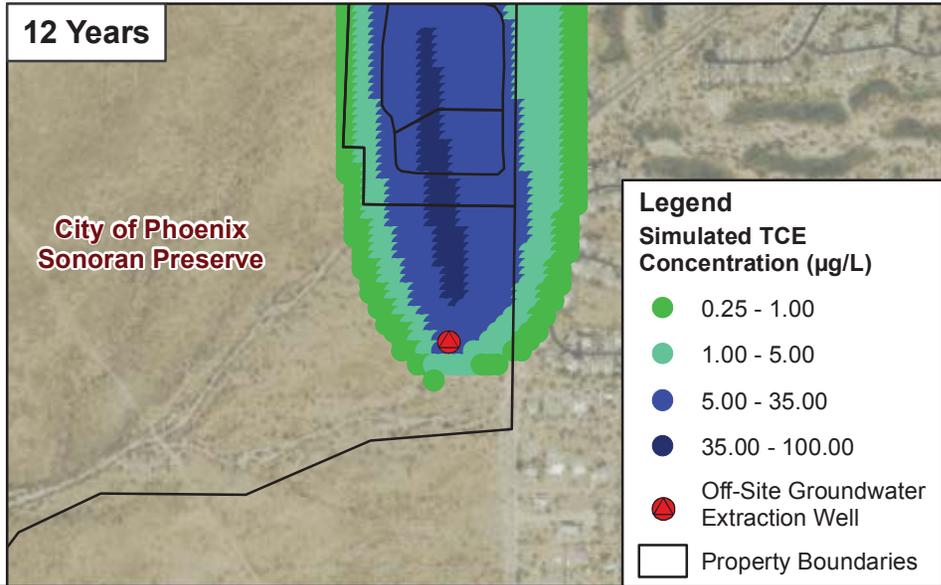
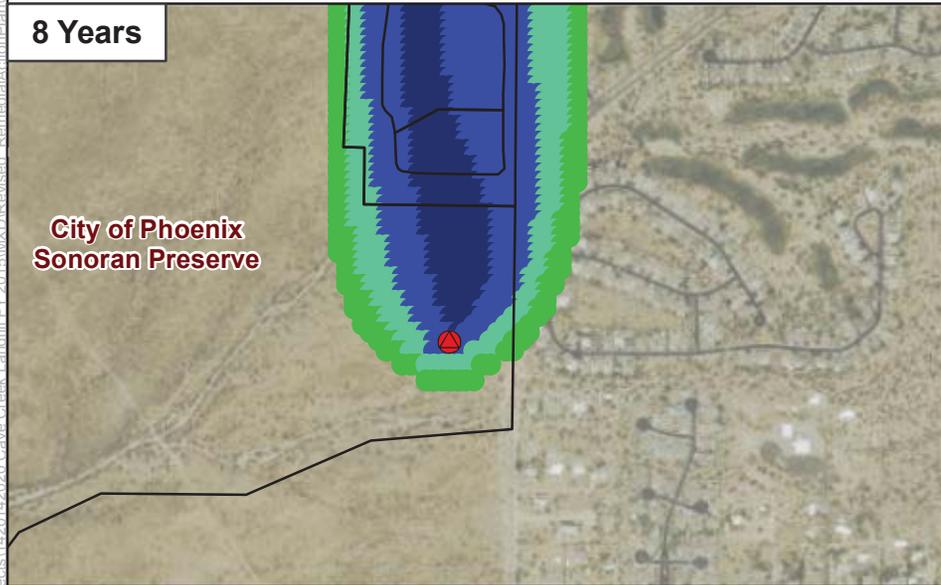
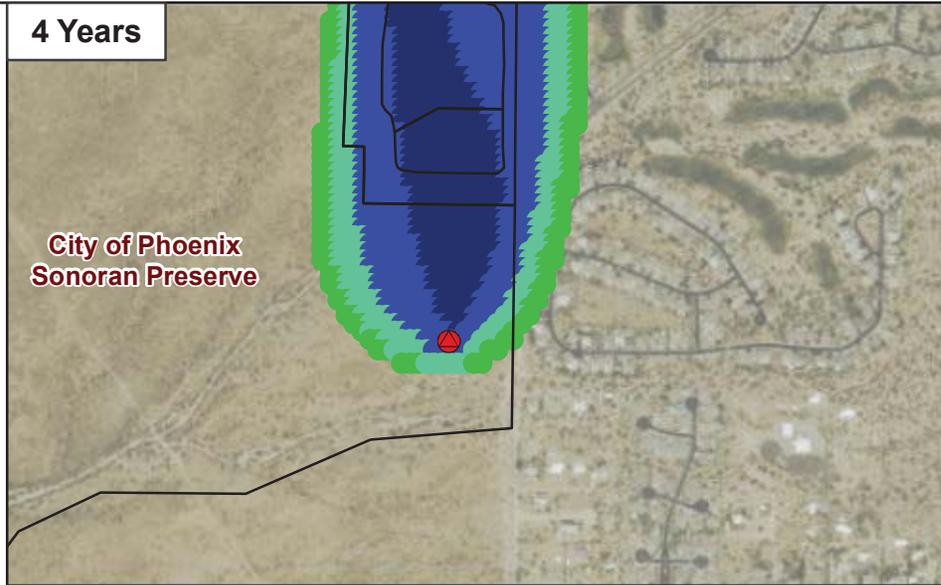
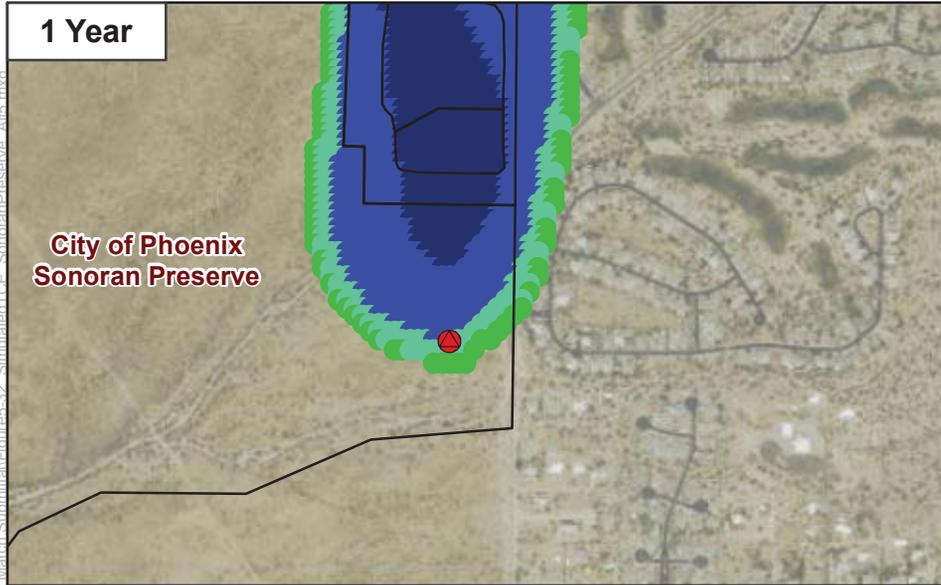
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Revised Remedial Action Plan
Maricopa County Cave Creek Landfill
Phoenix, Arizona

Simulated TCE Concentrations near Sonoran Preserve Boundary - Alternative 4B

FIGURE
5-31

Path: X:\Projects\2014_1420142020_Cave_Creek_Landfill_FY_2015\MXD\Revised_RemedialActionPlan\2016_March_Submittal\Eauref-32_SimulatedTCE_SonoranPreserve_A116.mxd



Legend

Simulated TCE Concentration (µg/L)

- 0.25 - 1.00
- 1.00 - 5.00
- 5.00 - 35.00
- 35.00 - 100.00
- ▲ Off-Site Groundwater Extraction Well
- Property Boundaries



Imagery Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

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 PM: NC
 Date: 3/8/2016
 Scale: 1" = 1200'



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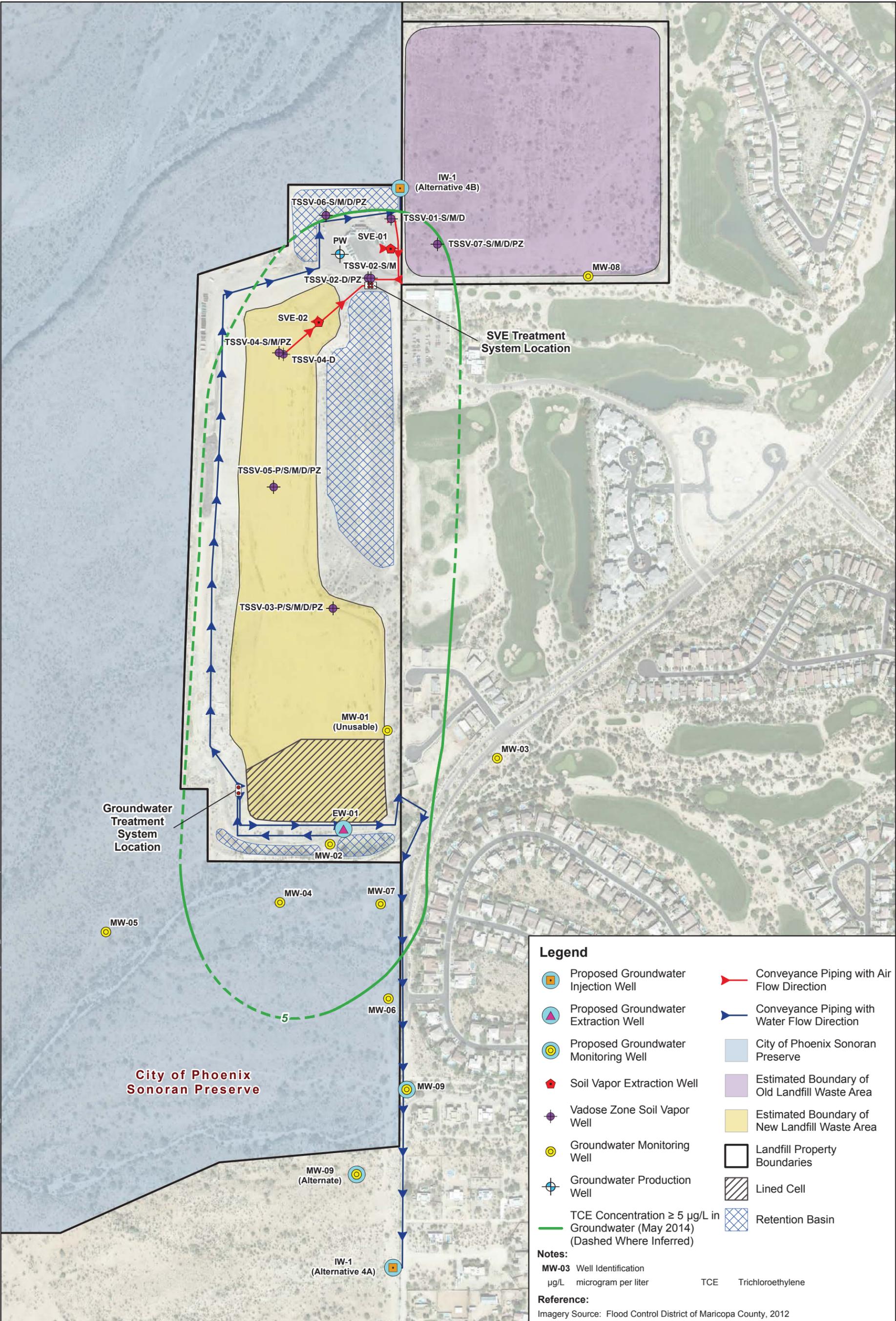
Revised Remedial Action Plan
 Maricopa County Cave Creek Landfill
 Phoenix, Arizona

**Simulated TCE Concentrations near
 Sonoran Preserve Boundary - Alternative 5**

FIGURE
5-32



Path: X:\Projects\2014\1420142020 Cave Creek Landfill\FY 2015\MXD\Revised RemedialActionPlan\2016 March Submittal\Figure6-1 On-SiteExtractionLayout.mxd



Legend

	Proposed Groundwater Injection Well		Conveyance Piping with Air Flow Direction
	Proposed Groundwater Extraction Well		Conveyance Piping with Water Flow Direction
	Proposed Groundwater Monitoring Well		City of Phoenix Sonoran Preserve
	Soil Vapor Extraction Well		Estimated Boundary of Old Landfill Waste Area
	Vadose Zone Soil Vapor Well		Estimated Boundary of New Landfill Waste Area
	Groundwater Monitoring Well		Landfill Property Boundaries
	Groundwater Production Well		Lined Cell
	TCE Concentration ≥ 5 µg/L in Groundwater (May 2014) (Dashed Where Inferred)		Retention Basin

Notes:
 MW-03 Well Identification
 µg/L microgram per liter TCE Trichloroethylene

Reference:
 Imagery Source: Flood Control District of Maricopa County, 2012



Job No.	1420142020
PM:	NC
Date:	4/20/2016
Scale:	1" = 440'



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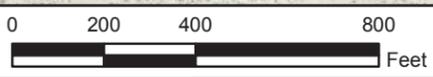
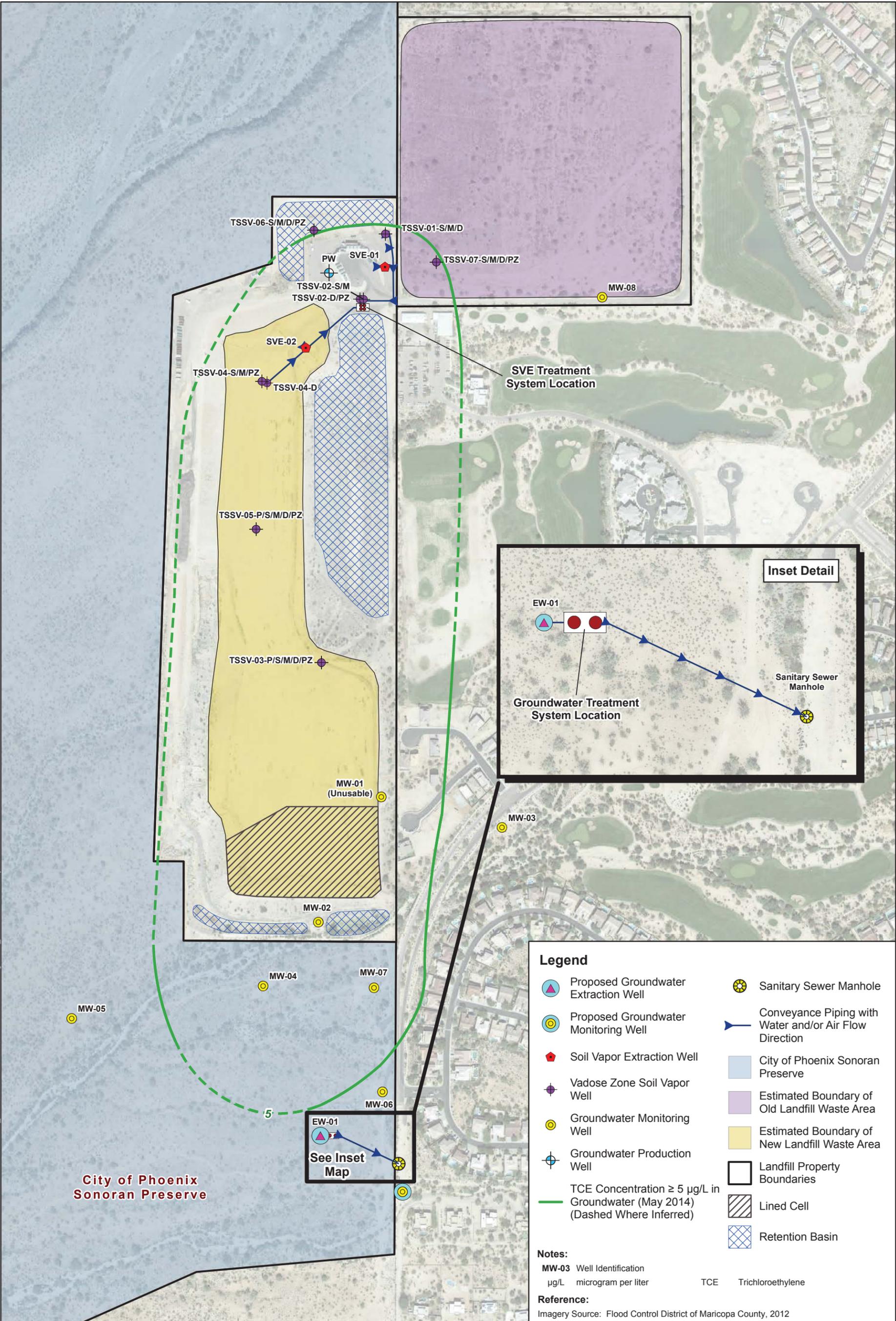
Revised Remedial Action Plan
Maricopa County Cave Creek Landfill
Phoenix, Arizona

On-Site Extraction Remedy Conceptual Layout

FIGURE 6-1



Path: X:\Projects\2014\Projects\1420142020 Cave Creek Landfill\FY 2015\MXD\Revised RemedialActionPlan\2016 March Submittal\Figure6-2 Off-SiteExtractionLayout.mxd



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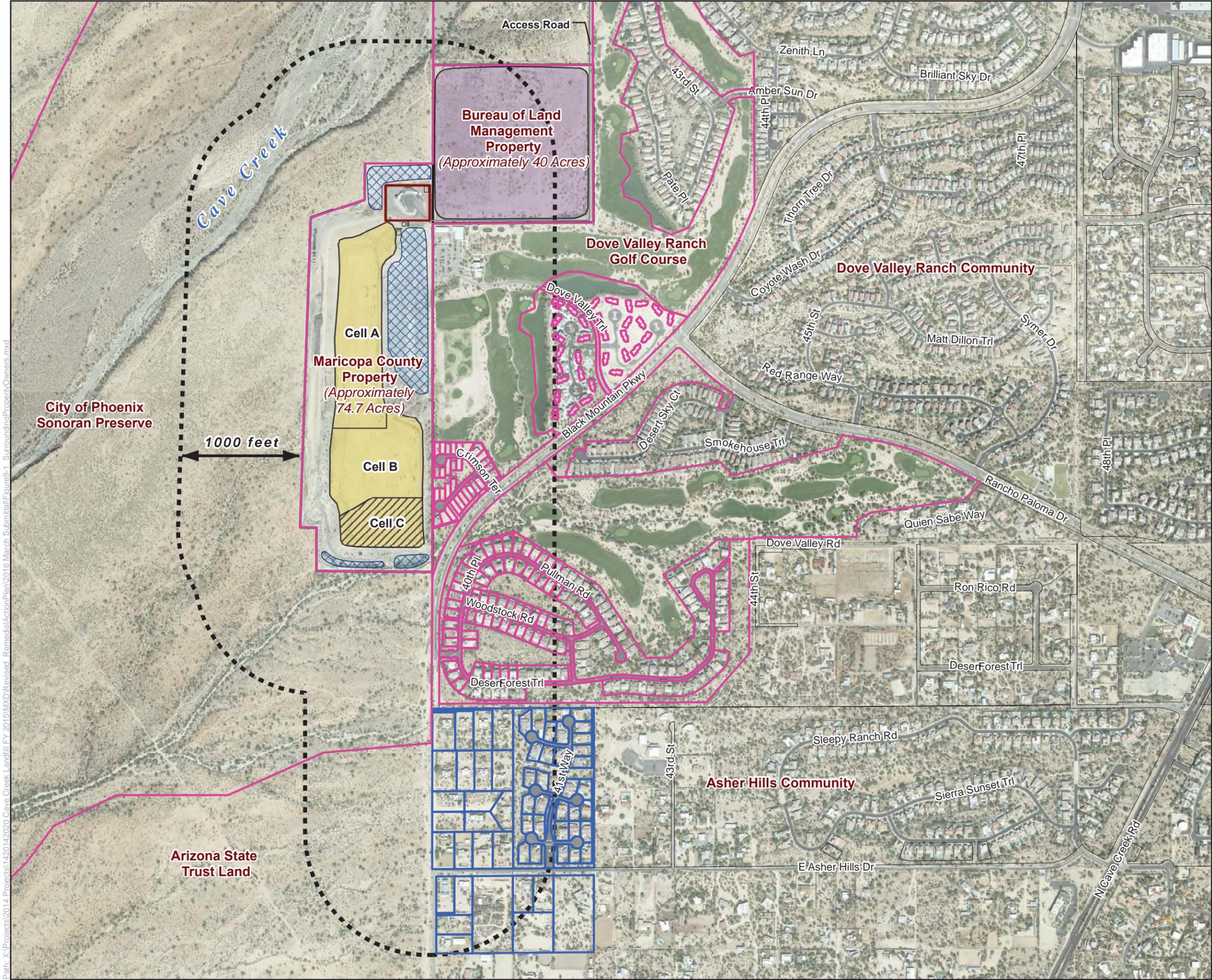
Job No.	1420142020
PM:	NC
Date:	4/20/2016
Scale:	1" = 400'

Revised Remedial Action Plan
 Maricopa County Cave Creek Landfill
 Phoenix, Arizona

Off-Site Extraction Remedy Conceptual Layout

FIGURE
6-2





- Legend**
- Parcels Located within 1000 feet of the Maricopa County Cave Creek Landfill Property
 - Parcels Located within 1000 feet of the Recommended Remedy Infrastructure (e.g. Off-Site Injection Well, Pipeline)
 - 1000-foot perimeter around Maricopa County Cave Creek Landfill Property
 - Estimated Boundary of Old Landfill Waste Area
 - Estimated Boundary of New Landfill Waste Area
 - Landfill Property Boundaries
 - Lined Cell
 - Retention Basin
 - Transfer Station

Notes:

Cell boundaries are approximate

Reference:

Imagery Source: Flood Control District of Maricopa County, 2012



**Revised Remedial Action Plan
Maricopa County Cave Creek Landfill
Phoenix, Arizona**

Surrounding Property Owners

FIGURE 9-1	Job No.: 1420142020
	PM: NC
	Date: 4/20/2016
	Scale: 1" = 700'



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Path: X:\Projects\2014\Projects\1420142020\Cave Creek Landfill\FY 2015\MXD\Revised Remedial Action Plan\2016 March Submittal\Figure 9-1 Surrounding Property Owners.mxd



APPENDIX A

WELL CONSTRUCTION SUMMARY

Appendix A. Well Construction Summary

Cave Creek Landfill, Maricopa County

WellName	Location Type	ADWR ID	Northing (NAD83SP Int'l Ft)	Easting (NAD83SP Int'l Ft)	TOC (ft amsl)	Ground Surface (ft amsl)	Total Well Depth (ft)	Date Installed	Casing Diameter (I.D.)	CasingType	Top Screen Depth (ft bgs)	Bottom Screen Depth (ft bgs)	Top Screen Elevation (ft amsl)	Pump Intake Depth (ft bgs)	Pump Intake Elevation (ft amsl)**	Comment
GW-01	Gas Well	-	1015486.0	675513.6	1,900.0*	-	57	1/6/1998	6 inch	HDPE	18	54	1,882.0	-	-	-
GW-02	Gas Well	-	1015305.8	675525.5	1,900.0*	-	43	1/6/1998	6 inch	HDPE	12	40	1,888.0	-	-	-
GW-03	Gas Well	-	1015146.8	675514.7	1,900.0*	-	49	1/7/1998	6 inch	HDPE	13	45	1,887.0	-	-	-
GW-04	Gas Well	-	1015000.7	675519.1	1,900.0*	-	47	1/7/1998	6 inch	HDPE	13	45	1,887.0	-	-	-
GW-05	Gas Well	-	1014847.9	675519.8	1,900.0*	-	49	1/7/1998	6 inch	HDPE	13	45	1,887.0	-	-	-
GW-06	Gas Well	-	1014691.8	675519.8	1,900.0*	-	62	1/8/1998	6 inch	HDPE	23	59	1,877.0	-	-	-
GW-07	Gas Well	-	1014537.7	675517.6	1,900.0*	-	53	1/8/1998	6 inch	HDPE	14	50	1,886.0	-	-	-
GW-08	Gas Well	-	1014380.8	675517.6	1,900.0*	-	51	1/11/1998	6 inch	HDPE	14	48	1,886.0	-	-	-
GW-09	Gas Well	-	1014230.9	675519.8	1,900.3	-	51	1/11/1998	6 inch	HDPE	14	47	1,886.3	-	-	-
GW-10	Gas Well	-	1014069.1	675444.5	1,900.1	-	63	1/12/1998	6 inch	HDPE	21	61	1,879.1	-	-	-
GW-11	Gas Well	-	1014061.1	675587.1	1,902.0*	-	53	1/12/1998	6 inch	HDPE	13	49	1,889.0	-	-	-
GW-12	Gas Well	-	1013921.5	675515.4	1,910.0*	-	70	1/14/1998	6 inch	HDPE	39	69	1,871.0	-	-	-
GW-13	Gas Well	-	1014005.2	675781.1	1,903.0*	-	47	1/13/1998	6 inch	HDPE	12	44	1,891.0	-	-	-
GW-14	Gas Well	-	1013877.7	675880.4	1,900.0*	-	53	1/13/1998	6 inch	HDPE	16	60	1,884.0	-	-	-
GW-16	Gas Well	-	1013786.9	675687.6	1,910.0*	-	78	1/13/1998	6 inch	HDPE	37	77	1,873.0	-	-	-
GW-18	Gas Well	-	1013738.2	675281.2	1,896.0*	-	71	1/16/1998	6 inch	HDPE	30	70	1,866.0	-	-	-
GW-19	Gas Well	-	1013738.0	675425.9	1,904.0*	-	71	1/14/1998	6 inch	HDPE	37	70	1,867.0	-	-	-
GW-20	Gas Well	-	1013875.5	675330.6	1,902.0*	-	71	1/18/1998	6 inch	HDPE	36	70	1,866.0	-	-	-
GW-21	Gas Well	-	1014026.1	675298.9	1,900.0*	-	76	1/18/1998	6 inch	HDPE	41	75	1,859.0	-	-	-
GW-22	Gas Well	-	1014162.6	675312.1	1,902.0*	-	70	1/19/1998	6 inch	HDPE	34	69	1,868.0	-	-	-
GW-23	Gas Well	-	1014308.8	675321.6	1,902.0*	-	72	1/20/1998	6 inch	HDPE	36	71	1,866.0	-	-	-
GW-24	Gas Well	-	1014461.4	675317.1	1,902.0*	-	70	1/21/1998	6 inch	HDPE	34	69	1,868.0	-	-	-
GW-25	Gas Well	-	1014608.1	675319.2	1,901.0*	-	70	1/21/1998	6 inch	HDPE	34	69	1,867.0	-	-	-

Appendix A. Well Construction Summary

Cave Creek Landfill, Maricopa County

WellName	Location Type	ADWR ID	Northing (NAD83SP Int'l Ft)	Easting (NAD83SP Int'l Ft)	TOC (ft amsl)	Ground Surface (ft amsl)	Total Well Depth (ft)	Date Installed	Casing Diameter (I.D.)	CasingType	Top Screen Depth (ft bgs)	Bottom Screen Depth (ft bgs)	Top Screen Elevation (ft amsl)	Pump Intake Depth (ft bgs)	Pump Intake Elevation (ft amsl)**	Comment
GW-26	Gas Well	-	1014759.9	675315.5	1,901.0*	-	65	1/22/1998	6 inch	HDPE	29	64	1,872.0	-	-	-
GW-27	Gas Well	-	1014913.9	675314.8	1,901.0*	-	68	1/27/1998	6 inch	HDPE	32	67	1,869.0	-	-	-
GW-28	Gas Well	-	1015065.2	675311.7	1,900.0*	-	55	1/27/1998	6 inch	HDPE	19	54	1,881.0	-	-	-
GW-29	Gas Well	-	1015207.2	675312.4	1,900.0*	-	47	1/27/1998	6 inch	HDPE	15	47	1,885.0	-	-	-
GW-30	Gas Well	-	1015353.2	675321.8	1,899.0*	-	50	1/28/1998	6 inch	HDPE	15	49	1,884.0	-	-	-
GW-31	Gas Well	-	1015508.2	675385.2	1,899.0*	-	51	1/28/1998	6 inch	HDPE	16	50	1,883.0	-	-	-
MW-01	Groundwater	55-538298	1013459.3	675955.8	1,895.6	-	820	5/1/1993	6 inch	LCS	660	820	1,235.6	740	1,155.6	Originally installed at 695 ft bgs; moved to 740 ft bgs (at bottom of pump) on 3/2/2005
MW-02	Groundwater	55-538299	1012899.0	675673.9	1,856.0	-	805	5/1/1993	6 inch	LCS	630	805	1,226.0	714	1,142.0	Originally installed at 675 ft bgs; moved to 704 ft bgs (at bottom of pump) on 3/1/2005; moved to 714 ft bgs on 6/26/2009
MW-03	Groundwater	55-216293	1013322.7	676495.0	1,866.6	-	830	12/13/2007	6 inch	LCS	679	799	1,187.6	724	1,142.6	Originally installed at 777 ft bgs; moved to 724 ft bgs on 6/25/2009
MW-04	Groundwater	55-912575	1012612.7	675427.1	1,850.0	-	768	10/26/2010	6 inch	LCS	667.5	752.7	1,182.5	718	1,132.0	-
MW-05	Groundwater	55-912728	1012467.6	674571.7	1,845.2	-	767	12/15/2010	6 inch	LCS	660	740.2	1,185.2	701	1,144.2	-
MW-06	Groundwater	55-912942	1012139.0	675961.0	1,860.8	-	776.9	5/16/2011	6 inch	LCS	683	763	1,177.8	720	1,140.8	-
MW-07	Groundwater	55-914001	1012605.2	675922.7	1,859.7	-	765	2/8/2012	8.25 inch	LCS	674.8	754.8	1,184.9	718	1,141.7	-
MW-08	Groundwater	55-913859	1015697.8	676942.5	1,889.2	-	766.5	1/9/2012	8.25 inch	LCS	691.5	761.5	1,197.7	736	1,153.2	-
NDP-01-S	Soil Vapor	-	1015304.9	675423.0	1,902.0*	-	142	11/2/2004	1 inch	PVC	80	90	1,822.0	-	-	-
NDP-01-D	Soil Vapor	-	1015304.9	675423.0	1,902.0*	-	142	11/2/2004	1 inch	PVC	130	140	1,772.0	-	-	-
NDP-02-S	Soil Vapor	-	1014855.3	675407.7	1,902.0*	-	142	11/4/2004	1 inch	PVC	80	90	1,822.0	-	-	-
NDP-02-D	Soil Vapor	-	1014855.3	675407.7	1,902.0*	-	142	11/4/2004	1 inch	PVC	130	140	1,772.0	-	-	-
NDP-03	Soil Vapor	-	1013734.0	675905.1	1,902.0	1,902.0	122	-	-	Sch 80 PVC	80	120	1,822.0	-	-	-
ODP-01-S	Soil Vapor	-	1016623.2	676970.8	1,903.0*	-	142	11/9/2004	1 inch	PVC	80	90	1,823.0	-	-	-
ODP-01-D	Soil Vapor	-	1016623.2	676970.8	1,903.0*	-	142	11/9/2004	1 inch	PVC	130	140	1,773.0	-	-	-

Appendix A. Well Construction Summary

Cave Creek Landfill, Maricopa County

WellName	Location Type	ADWR ID	Northing (NAD83SP Int'l Ft)	Easting (NAD83SP Int'l Ft)	TOC (ft amsl)	Ground Surface (ft amsl)	Total Well Depth (ft)	Date Installed	Casing Diameter (I.D.)	CasingType	Top Screen Depth (ft bgs)	Bottom Screen Depth (ft bgs)	Top Screen Elevation (ft amsl)	Pump Intake Depth (ft bgs)	Pump Intake Elevation (ft amsl)**	Comment
ODP-02-S	Soil Vapor	-	1016630.4	676422.3	1,897.0*	-	142	11/10/2004	1 inch	PVC	80	90	1,817.0	-	-	-
ODP-02-D	Soil Vapor	-	1016630.4	676422.3	1,897.0*	-	142	11/10/2004	1 inch	PVC	130	140	1,767.0	-	-	-
ODP-03-S	Soil Vapor	-	1016036.6	676379.9	1,892.0*	-	142	11/12/2004	1 inch	PVC	80	90	1,812.0	-	-	-
ODP-03-D	Soil Vapor	-	1016036.6	676379.9	1,892.0*	-	142	11/12/2004	1 inch	PVC	130	140	1,762.0	-	-	-
ODP-04-D	Soil Vapor	-	1016041.7	676914.7	1,897.0*	-	142	11/13/2004	1 inch	PVC	130	140	1,767.0	-	-	-
ODP-04-S	Soil Vapor	-	1016041.7	676914.7	1,897.0*	-	142	11/13/2004	1 inch	PVC	80	90	1,817.0	-	-	-
P-02-S	Soil Vapor	-	1012900.7	675659.9	1,850.2	-	20	4/1/1994	1 inch	PVC	-	-	-	-	-	-
P-02-D	Soil Vapor	-	1012900.7	675659.9	1,850.2	-	50	4/1/1994	1 inch	PVC	-	-	-	-	-	-
P-03	Soil Vapor	-	1012824.2	676010.7	1,857.8	-	53.5	4/1/1994	3 inch	PVC	-	-	-	-	-	-
P-05	Soil Vapor	-	1013318.4	676009.3	1,865.0*	-	50	4/1/1994	3 inch	PVC	6	50	1,859.0	-	-	-
P-05-xS	Soil Vapor	-	1013744.2	676020.2	1,868.5	1,865.6	26	5/3/2013	0.804 inch	Sch 40 PVC	15	25	1,853.5	-	-	-
P-05-xD	Soil Vapor	-	1013744.2	676020.2	1,868.5	1,865.6	62.2	5/3/2013	0.804 inch	Sch 40 PVC	50	60	1,818.5	-	-	-
P-06	Soil Vapor	-	1014199.2	676000.7	1,868.0	-	20	4/1/1994	3 inch	PVC	-	-	-	-	-	-
P-07	Soil Vapor	-	1014623.7	676010.8	1,870.0	-	55	4/1/1994	3 inch	PVC	-	-	-	-	-	-
P-08	Soil Vapor	-	1014938.2	676010.5	1,867.0	-	20	4/1/1994	3 inch	PVC	-	-	-	-	-	-
P-09	Soil Vapor	-	1015242.7	676007.2	1,872.0	-	51	4/1/1994	3 inch	PVC	-	51	-	-	-	-
P-10	Soil Vapor	-	1015538.5	676008.8	1,877.0	-	20	4/1/1994	3 inch	PVC	-	-	-	-	-	-
P-11	Soil Vapor	-	1015994.4	675986.6	1,880.0*	-	50	4/1/1994	3 inch	PVC	-	-	-	-	-	-
P-12	Soil Vapor	-	1015958.7	675644.6	1,879.0*	-	20	4/1/1994	3 inch	PVC	-	-	-	-	-	-
P-13-S	Soil Vapor	-	1015744.8	675553.4	1,876.0*	-	20	4/1/1994	1 inch	PVC	-	-	-	-	-	-
P-13-D	Soil Vapor	-	1015744.8	675553.4	1,876.0*	-	55	4/1/1994	1 inch	PVC	-	-	-	-	-	-
P-13-xS	Soil Vapor	-	1015856.1	675475.6	1,877.0*	-	30	9/1/1995	1 inch	PVC	-	-	-	-	-	-
P-13-xD	Soil Vapor	-	1015856.1	675475.6	1,877.0*	-	55	9/1/1995	1 inch	PVC	-	-	-	-	-	-

Appendix A. Well Construction Summary

Cave Creek Landfill, Maricopa County

WellName	Location Type	ADWR ID	Northing (NAD83SP Int'l Ft)	Easting (NAD83SP Int'l Ft)	TOC (ft amsl)	Ground Surface (ft amsl)	Total Well Depth (ft)	Date Installed	Casing Diameter (I.D.)	CasingType	Top Screen Depth (ft bgs)	Bottom Screen Depth (ft bgs)	Top Screen Elevation (ft amsl)	Pump Intake Depth (ft bgs)	Pump Intake Elevation (ft amsl)**	Comment
P-14	Soil Vapor	-	1015698.1	675046.0	1,876.5	1,876.6	20	6/1/2011	0.75 inch	Sch 40 PVC	-	-	-	-	-	-
P-15	Soil Vapor	-	1015277.9	675020.1	1,872.3	1,872.2	20	6/1/2012	0.75 inch	Sch 40 PVC	-	-	-	-	-	-
P-17-S	Soil Vapor	-	1014734.4	675208.4	1,882.0*	-	55	4/1/1994	1 inch	PVC	-	-	-	-	-	-
P-17-D	Soil Vapor	-	1014734.4	675208.4	1,882.0*	-	20	4/1/1994	1 inch	PVC	-	-	-	-	-	-
P-17-xS	Soil Vapor	-	1014734.7	674999.5	1,865.0*	-	30	9/1/1995	1 inch	PVC	-	-	-	-	-	-
P-17-xD	Soil Vapor	-	1014734.7	674999.5	1,865.0*	-	55	9/1/1995	1 inch	PVC	-	-	-	-	-	-
P-18-S	Soil Vapor	-	1014362.0	675203.2	1,886.0*	-	5	4/1/1994	1 inch	PVC	-	-	-	-	-	-
P-18-M	Soil Vapor	-	1014362.0	675203.2	1,886.0*	-	20	4/1/1994	1 inch	PVC	-	-	-	-	-	-
P-18-D	Soil Vapor	-	1014362.0	675203.2	1,886.0*	-	50	4/1/1994	1 inch	PVC	-	-	-	-	-	-
P-18-xS	Soil Vapor	-	1014372.3	674984.0	1,859.4	-	30	9/1/1995	1 inch	PVC	-	-	-	-	-	-
P-18-xD	Soil Vapor	-	1014372.3	674984.0	1,859.4	-	55	9/1/1995	1 inch	PVC	-	-	-	-	-	-
P-19-S	Soil Vapor	-	1014023.5	675185.0	1,876.0*	-	55	4/1/1994	1 inch	PVC	-	-	-	-	-	-
P-19-D	Soil Vapor	-	1014023.5	675185.0	1,876.0*	-	20	4/1/1994	1 inch	PVC	-	-	-	-	-	-
P-19-xS	Soil Vapor	-	1014036.2	674973.8	1,854.0*	-	30	9/1/1995	1 inch	PVC	-	-	-	-	-	-
P-19-xD	Soil Vapor	-	1014036.2	674973.8	1,854.0*	-	55	9/1/1995	1 inch	PVC	-	-	-	-	-	-
P-20-x	Soil Vapor	-	1013182.1	674943.2	1,857.4	1,857.4	50	9/1/1995	0.75 inch	PVC	-	-	-	-	-	-
P-21-x	Soil Vapor	-	1012826.3	675091.8	1,853.4	1,853.4	20	6/1/2013	0.75 inch	Sch 40 PVC	-	-	-	-	-	-
P-22	Soil Vapor	-	1015690.7	675978.9	1,879.0*	-	50	4/1/1994	3 inch	PVC	-	-	-	-	-	-
P-23	Soil Vapor	-	1015736.6	675846.2	1,880.0*	-	20	4/1/1994	3 inch	PVC	-	-	-	-	-	-
P-25	Soil Vapor	-	1015659.9	675745.2	1,879.0*	-	55	4/1/1994	1 inch	PVC	-	-	-	-	-	-
PW	Groundwater	55-503913	1015806.1	675722.2	1,881.4	-	820	10/1/1982	8 inch	LCS	680	810	1,201.4	729	1,152.4	Originally installed at 750 ft bgs; moved to 729 ft bgs on 6/25/2009
SVE-01	Soil Vapor Extraction	55-917896	1015834.8	675971.9	1,882.1	1,882.1	610	5/18/2015	5.709 inch	Sch 80 PVC	120	600	1,762.1	-	-	-
SVE-01-S	Soil Vapor	-	1015834.8	675971.9	1,882.1	1,882.1	610	5/18/2015	1 inch	Sch 80 PVC	180	200	1,702.1	-	-	-

Appendix A. Well Construction Summary

Cave Creek Landfill, Maricopa County

WellName	Location Type	ADWR ID	Northing (NAD83SP Int'l Ft)	Easting (NAD83SP Int'l Ft)	TOC (ft amsl)	Ground Surface (ft amsl)	Total Well Depth (ft)	Date Installed	Casing Diameter (I.D.)	CasingType	Top Screen Depth (ft bgs)	Bottom Screen Depth (ft bgs)	Top Screen Elevation (ft amsl)	Pump Intake Depth (ft bgs)	Pump Intake Elevation (ft amsl)**	Comment
SVE-01-M	Soil Vapor	-	1015834.8	675971.9	1,882.1	1,882.1	610	5/18/2015	1 inch	Sch 80 PVC	360	380	1,522.1	-	-	-
SVE-01-D	Soil Vapor	-	1015834.8	675971.9	1,882.1	1,882.1	610	5/18/2015	1 inch	Sch 80 PVC	480	500	1,402.1	-	-	-
SVE-02	Soil Vapor Extraction	55-917947	1015472.6	675617.9	1,900.4	1,900.4	630	5/5/2015	5.709 inch	Sch 80 PVC	400	620	1,500.4	-	-	-
SVE-02-S	Soil Vapor	-	1015472.6	675617.9	1,900.4	1,900.4	-	5/5/2015	1 inch	Sch 80 PVC	150	170	1,750.4	-	-	-
SVE-02-M	Soil Vapor	-	1015472.6	675617.9	1,900.4	1,900.4	-	5/5/2015	1 inch	Sch 80 PVC	300	350	1,600.4	-	-	-
TSSV-01-S	Soil Vapor	-	1015918.8	675991.0	1,881.0	-	610	1/22/2010	1.913 inch	Sch 80 PVC	150	200	1,731.0	-	-	-
TSSV-01-M	Soil Vapor	-	1015918.8	675991.0	1,881.0	-	610	1/22/2010	1.913 inch	Sch 80 PVC	350	400	1,531.0	-	-	-
TSSV-01-D	Soil Vapor	-	1015918.8	675991.0	1,881.0	-	610	1/22/2010	1.913 inch	Sch 80 PVC	549	599	1,332.0	-	-	-
TSSV-02-S	Soil Vapor	55-915432	1015688.3	675875.9	1,880.2	1,881.4	210	5/3/2013	1.913 inch	Sch 80 PVC	150.3	200.3	1,729.9	-	-	-
TSSV-02-M	Soil Vapor	55-915432	1015688.3	675875.9	1,880.2	1,881.4	410	5/3/2013	1.913 inch	Sch 80 PVC	350.3	400.3	1,529.9	-	-	-
TSSV-02-D	Soil Vapor	55-915279	1015688.8	675860.8	1,880.2	1,881.2	609	4/24/2013	1.913 inch	Sch 80 PVC	549.3	599.3	1,330.9	-	-	-
TSSV-02-PZ	Groundwater	55-915279	1015688.8	675860.8	1,880.2	1,881.2	779	4/24/2013	1.913 inch	Sch 80 PVC	699.3	769.3	1,180.9	-	-	-
TSSV-03-S	Soil Vapor	55-915281	1014061.5	675688.5	1,902.7	1,901.8	230	4/26/2013	1.913 inch	Sch 80 PVC	170.5	220.5	1,732.2	-	-	-
TSSV-03-M	Soil Vapor	55-915281	1014061.5	675688.5	1,902.7	1,901.8	430	4/26/2013	1.913 inch	Sch 80 PVC	370.5	420.5	1,532.2	-	-	-
TSSV-03-D	Soil Vapor	55-915281	1014061.5	675688.5	1,902.7	1,901.8	629	4/26/2013	1.913 inch	Sch 80 PVC	569.5	619.5	1,333.2	-	-	-
TSSV-03-PZ	Groundwater	55-915281	1014061.5	675688.5	1,902.7	1,901.8	799	4/26/2013	1.913 inch	Sch 80 PVC	719.5	789.5	1,183.2	-	-	-
TSSV-03-P	Soil Vapor	55-915281	1014061.5	675688.5	1,902.7	1,901.8	73	4/26/2013	0.936 inch	Sch 80 PVC	60	70	1,842.7	-	-	-
TSSV-04-S	Soil Vapor	55-915282	1015320.7	675423.1	1,905.9	1,905.4	235	5/31/2013	1.913 inch	Sch 80 PVC	174.5	224.5	1,731.4	-	-	-
TSSV-04-M	Soil Vapor	55-915282	1015320.7	675423.1	1,905.9	1,905.4	435	5/31/2013	1.913 inch	Sch 80 PVC	374.5	424.5	1,531.4	-	-	-
TSSV-04-D	Soil Vapor	55-915629	1015313.6	675445.4	1,905.9	1,905.0	635	6/10/2013	1.913 inch	Sch 80 PVC	575	625	1,330.9	-	-	-
TSSV-04-PZ	Groundwater	55-915282	1015320.7	675423.1	1,905.9	1,905.5	804	5/31/2013	2.864 inch	Sch 80 PVC	723.5	793.5	1,182.4	-	-	-
TSSV-05-S	Soil Vapor	55-917870	1014657.4	675381.7	1,905.7	1,904.7	430	3/8/2015	1.913 inch	Sch 80 PVC	170	220	1,735.7	-	-	-
TSSV-05-M	Soil Vapor	55-917870	1014657.4	675381.7	1,905.7	1,904.7	430	3/8/2015	1.913 inch	Sch 80 PVC	370	420	1,535.7	-	-	-

Appendix A. Well Construction Summary

Cave Creek Landfill, Maricopa County

WellName	Location Type	ADWR ID	Northing (NAD83SP Int'l Ft)	Easting (NAD83SP Int'l Ft)	TOC (ft amsl)	Ground Surface (ft amsl)	Total Well Depth (ft)	Date Installed	Casing Diameter (I.D.)	CasingType	Top Screen Depth (ft bgs)	Bottom Screen Depth (ft bgs)	Top Screen Elevation (ft amsl)	Pump Intake Depth (ft bgs)	Pump Intake Elevation (ft amsl)**	Comment
TSSV-05-D	Soil Vapor	55-917892	1014659.1	675396.6	1,905.7	1,905.1	805	4/21/2015	1.913 inch	Sch 80 PVC	570	620	1,335.7	-	-	-
TSSV-05-PZ	Groundwater	55-917892	1014659.1	675396.6	1,905.7	1,905.1	805	4/21/2015	3.786 inch	Sch 80 PVC	720	790	1,185.7	-	-	-
TSSV-06-S	Soil Vapor	55-917894	1015980.4	675656.7	1,876.9	1,876.5	610	3/18/2015	1.913 inch	Sch 80 PVC	150	200	1,726.9	-	-	-
TSSV-06-M	Soil Vapor	55-917894	1015980.4	675656.7	1,876.9	1,876.5	610	3/18/2015	1.913 inch	Sch 80 PVC	350	400	1,526.9	-	-	-
TSSV-06-D	Soil Vapor	55-917894	1015980.4	675656.7	1,876.9	1,876.5	610	3/18/2015	1.913 inch	Sch 80 PVC	550	600	1,326.9	-	-	-
TSSV-06-PZ	Groundwater	55-917895	1015997.6	675654.5	1,876.9	1,876.1	794	4/8/2015	3.786 inch	Sch 80 PVC	714	784	1,162.9	-	-	-
TSSV-07-S	Soil Vapor	55-917947	1015852.8	676186.8	1,890.0	1,889.5	620	3/30/2015	1.913 inch	Sch 80 PVC	160	210	1,730.0	-	-	-
TSSV-07-M	Soil Vapor	55-917947	1015852.8	676186.8	1,890.0	1,889.5	620	3/30/2015	1.913 inch	Sch 80 PVC	360	410	1,530.0	-	-	-
TSSV-07-D	Soil Vapor	55-917947	1015852.8	676186.8	1,890.0	1,889.5	620	3/30/2015	1.913 inch	Sch 80 PVC	560	610	1,330.0	-	-	-
TSSV-07-PZ	Groundwater	55-917948	1015855.0	676202.1	1,890.0	1,889.0	795	4/13/2015	3.786 inch	Sch 80 PVC	710	780	1,180.0	-	-	-

Notes: LFG - Landfill Gas
 ft - Feet
 ft bgs - Feet below ground surface
 ft amsl - Feet above mean sea level
 I.D. - Inner Diameter
 * - Casing elevation interpreted from topographic data
 ** - For wells without permanently installed pumps, elevations are only presented for sampling events conducted concurrently with groundwater elevation monitoring.



APPENDIX B

ARIZONA DEPARTMENT OF WATER RESOURCES REGISTERED WELLS LOCATED WITHIN 3 MILES OF CAVE CREEK LANDFILL

PROGRAM	REGISTRY_I	OWNER_NAME	WELL_TYPE_	INSTALLED	WELL_DEPTH	CASING_DIA	PUMPRATE
55	87362	BARTON,B	EXEMPT	1/1/81	700	6	0
55	202622	GEORGE HEILAND	EXEMPT		0	9	0
55	203447	MMK CAPITAL PARTNERS LLC	EXEMPT		0	0	0
55	206818	LISA KLEIN	EXEMPT	2/27/06	800	5	5
55	207024	MARILYN TROMBLEY	EXEMPT		0	0	0
55	207755	SHERI ROESE	EXEMPT		0	0	0
55	212904	JIM/JEANETTE RAINAL/MORAVEK	EXEMPT	9/29/06	700	5	10
55	213291	SHERI ROESE	EXEMPT		0	0	0
55	213666	J AND S HOLDINGS LLC	EXEMPT		0	0	0
55	217638	DAVID LUDEN	EXEMPT	8/8/08	760	5	0
55	218928	CITY OF PHOENIX	NON-EXEMPT	12/14/09	1320	16	0
55	218978	DAN M BAXLEY	EXEMPT	6/15/09	805	5	5
55	219460	GREG & TRICIA OHANESSIAN	EXEMPT	12/10/09	720	6	0
55	220996	WITTS, LLC	EXEMPT		0	0	0
55	221177	DONALD & SUSAN TURNER	EXEMPT		0	0	0
55	221450	CLP Southwest Golf LLC	NON-EXEMPT	6/9/13	1195	16	625
55	221637	WILLIAM COX	NON-EXEMPT	10/29/12	955	7	100
55	474144	AOBALDO RAMIREZ	EXEMPT		0	0	0
55	502005	TRACY S & BARBARA D MIDDLETON	EXEMPT	2/26/82	820	8	0
55	503657	BOWLES,G F	NON-EXEMPT		0	0	0
55	504093	KIEFER,E	EXEMPT		0	0	0
55	506269	DAVIS,K	EXEMPT	9/12/83	175	6	24
55	506822	BOWLES,B W	EXEMPT	12/15/83	140	8	35
55	507675	JOHNSON JR,J	EXEMPT	4/28/84	600	6	0
55	509150	MULLENS,C	EXEMPT	10/4/84	780	9	10
55	510670	MERLE & DEBORAH KINGHAM	EXEMPT	5/13/85	520	7	10
55	513379	STEPHEN AND MARIA DISMUKE	EXEMPT	2/20/86	550	8	0
55	514411	WILLIAMS, RICHARD,	EXEMPT	11/29/86	340	8	0
55	514656	GRATHER PROPERTIES,	NON-EXEMPT		0	0	0
55	516342	D.R. HORTON, INC.	EXEMPT	11/19/87	820	8	20
55	517023	BABBIN, STEWART,	EXEMPT	3/20/87	700	8	10
55	517129	BECHTOLD, PHILLIP,	EXEMPT		0	0	0
55	517236	JOHNSON JOHNSON,	EXEMPT	6/20/87	700	8	15
55	518286	FLACH & SOICH,	EXEMPT	7/29/88	85	8	30
55	518305	NICK & LYNN SCHULZ	EXEMPT	6/25/87	535	8	10
55	518430	COMBS, JASPER,	EXEMPT	8/10/87	400	8	5
55	518789	CITY OF SCOTTSDALE	NON-EXEMPT	2/5/01	1690	16	2000
55	519950	DESERT FOOTHILLS,	EXEMPT	1/9/88	915	8	0
55	520631	CITY OF PHOENIX WATER SERVICES	NON-EXEMPT		0	0	0

PROGRAM	REGISTRY_I	OWNER_NAME	WELL_TYPE_	INSTALLED	WELL_DEPTH	CASING_DIA	PUMPRATE
55	520855	LOPEZ, RON,J	EXEMPT	4/16/88	600	8	0
55	521546	CITY OF PHOENIX	NON-EXEMPT		0	0	0
55	522491	SWANSON, KIM,	EXEMPT		0	0	0
55	522909	JOSEPH M, JR. & PATRICIA L. KEZELE	EXEMPT	12/6/88	1060	6	15
55	524559	CITY OF PHOENIX	NON-EXEMPT	9/25/90	1400	13	0
55	527549	PHOENIX, CITY OF,	NON-EXEMPT	9/24/90	1490	19	0
55	528864	GISELA VELOZ	EXEMPT	8/27/90	800	9	10
55	530471	PATRICIA ANN BONGARD	EXEMPT	5/25/91	835	9	5
55	530868	JOY RIDGE INC,	EXEMPT	2/15/91	800	6	15
55	531151	CABLE, ROBERT,	EXEMPT	3/30/91	800	8	4
55	532262	EMMETT, JAMES T JR.,	EXEMPT	10/16/91	738	8	10
55	532341	FANTIN, JIM,	EXEMPT	7/26/91	795	9	15
55	538124	PHOENIX, CITY OF,	NON-EXEMPT		0	0	0
55	541816	BENSON, DONNY,C	EXEMPT	12/29/93	840	8	0
55	542048	JORDON, RAYMOND,	EXEMPT		0	0	0
55	542870	BURCHETT, LARAE,	EXEMPT	5/26/94	980	8	0
55	542994	REALMONTE, CHARLIE,	EXEMPT	4/7/94	865	8	0
55	543024	PHOENIX, CITY OF,	NON-EXEMPT	12/15/94	1635	36	1000
55	543132	KELLEY, JOHN,P	EXEMPT	4/14/94	905	8	10
55	544167	BURCHETT, LA RAE,	EXEMPT	6/25/94	800	8	0
55	549476	GREVE, GUILLAUME,	EXEMPT		0	0	0
55	550487	CROWE, RONALD,	EXEMPT	7/28/95	840	8	10
55	551124	MCCONNELL, THAD,	EXEMPT	9/16/95	795	8	0
55	551423	SANDRA DAVIS-MOORWESSEL	EXEMPT	10/16/95	835	8	0
55	558341	LUGO, ANDRE,M	EXEMPT	6/28/96	920	6	18
55	563754	CANFIELD, WILLIAM,	EXEMPT	7/23/98	855	8	0
55	568548	CITY OF PHOENIX WATER SERVICES	NON-EXEMPT		0	0	0
55	574144	AOBALDO RAMIREZ	EXEMPT	4/26/99	815	5	0
55	575703	CARL GROVES	EXEMPT	7/21/99	860	5	0
55	581726	TERRY J STINES	EXEMPT	6/30/00	800	5	0
55	582516	WILLIAM GRIFFIN	EXEMPT	10/5/00	600	8	0
55	585959	DAVID ELLETT	EXEMPT	3/23/01	350	5	10
55	586659	A S R L LLC	EXEMPT		0	0	0
55	586660	GREGORY SCHUBERT	EXEMPT		0	0	0
55	586678	BRUCE & KAREN COMBE	EXEMPT		0	0	0
55	586758	JAMES & JOAN LEACH	EXEMPT	5/22/01	780	5	0
55	587098	MARK BAILEY	EXEMPT	6/21/01	1005	5	0
55	587983	LYMAN MITCHELL	EXEMPT		960	5	0
55	589826	CITY OF PHOENIX WATER SERVICES DEPARTMENT	NON-EXEMPT		0	0	0

PROGRAM	REGISTRY_I	OWNER_NAME	WELL_TYPE_	INSTALLED	WELL_DEPTH	CASING_DIA	PUMPRATE
55	590192	GREGORY SCHUBERT	EXEMPT	8/7/02	140	7	10
55	591792	GEORGE & CARLETTE BOWLES TRUST	EXEMPT		250	8	0
55	591807	WILL AND JINA ANDERSON	EXEMPT	4/19/02	600	0	20
55	591818	BRUCE & KAREN COMBE	EXEMPT		400	5	0
55	592062	JOSE LUIS ACOSTA	EXEMPT		910	6	0
55	592479	A S R L LLC	EXEMPT		320	5	0
55	592501	JAMES R FLACH	EXEMPT		400	6	0
55	593336	TONY & YVETTE D MOLINA	EXEMPT		860	6	0
55	595844	SCOTT & CHERYL HOWIE	EXEMPT		280	4	0
55	595938	PHILLIP & CAROLYN BECHTOLD	EXEMPT	11/26/02	720	9	0
55	597800	RAY A & DEBBY BORZINI	EXEMPT		0	0	0
55	598318	REID STINNETT	EXEMPT	5/20/03	1120	6	12
55	599259	WESTEND LAND INVESTORS	EXEMPT		0	0	0
55	600029	CITY OF PHOENIX WATER SERVICES DEPARTMENT	NON-EXEMPT	2/1/61	1100	10	250
55	600030	CITY OF PHOENIX WATER SERVICES	NON-EXEMPT	12/18/69	864	14	650
55	600050	BOWLES,G F	NON-EXEMPT	9/1/44	80	10	450
55	600051	BOWLES,G F	NON-EXEMPT	10/1/45	106	12	500
55	601159	PAULA SCULLY	EXEMPT	12/1/78	335	8	25
55	602536	CAREFREE BLK MNTN,	EXEMPT	1/1/81	1400	8	35
55	603807	PHOENIX, CITY OF,	NON-EXEMPT	2/24/78	1157	16	2000
55	611757	OMUNDSON,R T	EXEMPT	1/1/76	320	6	0
55	614063	AZ STATE LAND DEPT,	EXEMPT		10	10	0
55	614064	DESERT FOOTHILLS LAND TRUST, INC.	NON-EXEMPT	9/1/44	80	10	0
55	625150	SCHUBERT,G J	EXEMPT	10/1/45	106	12	500
55	628045	WILLIAMS,L E	NON-EXEMPT	6/15/74	685	9	6
55	635121	HOLBROOK,J B	EXEMPT	11/29/73	200	8	5
55	636555	PEREZ, RAUL M, SR.,	EXEMPT	3/19/78	685	8	25
55	638089	STEVENS,H	EXEMPT	2/9/75	665	6	5
55	638272	NOLTE ET AL,J	EXEMPT	1/19/73	825	8	30
55	638749	PATRICK & HEATHER PUTNAM	EXEMPT	1/28/77	462	8	12
55	640160	HATCHER,N	NON-EXEMPT		875	10	0
55	800775	SHORT,D E	EXEMPT	6/1/66	600	8	12
55	800785	FORMON,E M	EXEMPT	1/1/66	997	8	30
55	800942	THOMPSON,J E	NON-EXEMPT	3/26/46	106	12	500
55	800943	THOMSON III,J E	NON-EXEMPT	3/15/46	80	10	450
55	801126	BOWLES ET AL,G F	EXEMPT		38	8	35
55	802504	STEWART FAMLY TRUST	EXEMPT	2/15/78	672	5	20
55	804220	ANSICK, PAUL R. JR.,	EXEMPT		1000	6	1
55	804560	OGDEN, LINDA,	EXEMPT	10/22/84	200	8	4

PROGRAM	REGISTRY_I	OWNER_NAME	WELL_TYPE_	INSTALLED	WELL_DEPTH	CASING_DIA	PUMPRATE
55	805152	AZ STATE LAND DEPT,	EXEMPT		0	12	0
55	806013	JOY RIDGE INC,	EXEMPT	12/31/70	240	6	0
55	901480	ROBERT HORTON	EXEMPT	8/12/05	1000	5	0
55	904129	RPW DELTA DEVELOPMENT LLC	EXEMPT		1060	8	0
55	905875	MARK SATRAN	EXEMPT	2/28/07	1000	4	0
55	911074	BETTY CLAYTON	EXEMPT	8/7/10	510	4	0
55	911731	MICHAEL DIXON	EXEMPT		700	5	0
55	911959	GEORGE PINGITORE	EXEMPT		0	0	0
55	912638	THOMAS DEMPSTER	EXEMPT	10/30/10	1020	5	0
55	912707	LARRY LIPPON	EXEMPT		320	6	0
55	912979	CHARLES DIXON	EXEMPT	3/11/11	700	4	0



APPENDIX C

SUMMARY OF HALOGENATED SOIL VAPOR DATA

Appendix C. Summary of Halogenated Soil Vapor Data

Well Name	Sample Date	Sample Elevation (ft amsl)	Units	Allyl chloride	Carbon tetrachloride	Chloroethane	Chloroform	Chloromethane	1,1-Dichloroethane	1,2-Dichloroethane	1,1-Dichloroethane	cis-1,2-Dichloroethane	trans-1,2-Dichloroethane	1,2-Dichloropropane	cis-1,3-Dichloropropene	1,4-Dioxane	Hexachlorobutadiene	Methylene chloride	1,1,2,2-Tetrachloroethane	Tetrachloroethene	trans-1,3-Dichloropropene	1,1,1-Trichloroethane	1,1,2-Trichloroethane	Trichloroethane	Vinyl Chloride	Comments
GW-08	12/3/2009	1,886.0	µg/m³	-	<170	170	<130	<220	710	<110	520	25,000	320	<120	<120	<380	<1,100	<92	<180	470	<120	<140	<140	1,300	1,600	--
GW-13	12/3/2009	1,891.0	µg/m³	-	<230	700	<180	<300	570	<150	420	8,100	150	<170	<170	<530	<1,600	470	<250	2,200	<170	<200	<200	1,900	650	--
GW-19	12/3/2009	1,867.0	µg/m³	-	<75	47	<58	<98	72	<48	140	2,200	<47	<55	<54	<170	<510	78	<82	1,400	<54	<65	<65	1,500	36	--
GW-22	12/3/2009	1,868.0	µg/m³	-	<140	<60	<110	<190	<93	<93	120	5,400	<91	<100	<100	<330	<980	<80	<160	710	<100	<120	<120	1,000	300	--
GW-25	12/3/2009	1,867.0	µg/m³	-	<150	82	<120	<200	<96	<96	160	4,000	<94	<110	<110	<340	<1,000	97	<160	1,600	<110	<130	<130	1,200	190	--
GW-29	12/3/2009	1,885.0	µg/m³	-	<140	120	<110	<190	<93	<93	120	1,600	<91	<100	<100	<330	<980	<80	<160	970	<100	<120	<120	1,000	270	--
MW-02	5/19/2009	1,226.0	µg/m³	-	<8	<3.3	<6.2	<10	<5.1	<5.1	<5	5.7	<5	<5.8	<5.7	<18	<54	<4.4	<8.7	<8.6	<5.7	<6.9	<6.9	110	<3.2	--
NDP-01-S	11/15/2004	1,822.0	µg/m³	-	<500	<5,000	<500	<5,000	<500	<500	<1,000	<500	<500	<500	<500	-	-	<5,000	<1,000	930	<500	<500	<500	870	<5,000	--
	12/8/2004	1,822.0	µg/m³	-	<500	<5,000	<500	<5,000	<500	<500	<1,000	<500	<500	<500	<500	-	-	<5,000	<1,000	1,500	<500	<500	<500	1,500	<5,000	--
	6/9/2005	1,822.0	µg/m³	-	<500	<5,000	-	<5,000	-	<500	-	-	<500	<500	<500	-	-	<5,000	<1,000	-	<500	<500	<500	-	-	--
	6/10/2005	1,822.0	µg/m³	-	-	-	<500	-	<500	-	<1,000	1,100	-	-	-	-	-	-	<1,000	8,000	-	-	-	8,300	<1,000	--
	1/17/2008	1,822.0	µg/m³	-	-	-	<500	-	<500	-	1,600	1,800	-	-	-	-	-	-	<1,000	2,000	-	-	-	26,000	<1,000	--
	12/1/2009	1,822.0	µg/m³	-	<380	<160	440	<500	<240	<240	2,500	2,900	<240	<280	<270	<870	<2,600	<210	<420	5,300	<270	<330	<330	60,000	1,000	--
	11/8/2011	1,822.0	µg/m³	<156.5	<314.5	<132	434.3	<207	<202.5	<202.5	992.5	3,450	<198	<231	<227	<720	<1,070	<173.5	<343.5	4,480	<227	<273	<273	45,100	1,230	--
	6/28/2013	1,822.0	µg/m³	-	-	-	-	-	-	-	40	41	<3.5	-	-	-	-	-	-	400	-	-	-	2,400	<19	WMS Passive Soil Gas Survey
NDP-01-D	11/15/2004	1,772.0	µg/m³	-	<500	<5,000	<500	<5,000	<500	<500	<1,000	560	<500	<500	<500	-	-	<5,000	<1,000	<500	<500	<500	<500	520	<5,000	--
	12/8/2004	1,772.0	µg/m³	-	<500	<5,000	<500	<5,000	<500	<500	<1,000	1,400	<500	<500	<500	-	-	<5,000	<1,000	1,300	<500	<500	<500	1,600	5,700	--
	6/9/2005	1,772.0	µg/m³	-	<500	<5,000	-	<5,000	-	<500	-	-	<500	<500	<500	-	-	<5,000	<1,000	-	<500	<500	<500	-	-	--
	6/10/2005	1,772.0	µg/m³	-	-	-	<500	-	510	-	<1,000	1,600	-	-	-	-	-	-	<1,000	9,600	-	-	-	15,000	<1,000	--
	1/17/2008	1,772.0	µg/m³	-	-	-	<500	-	<500	-	1,000	1,600	-	-	-	-	-	-	<1,000	1,700	-	-	-	19,000	<1,000	--
	12/1/2009	1,772.0	µg/m³	-	<500	<210	760	<650	<320	<320	3,400	1,300	<310	<360	<360	<1,100	<3,400	<270	<540	6,300	<360	<430	<430	95,000	500	--
	11/8/2011	1,772.0	µg/m³	<782.5	<1,570	<660	<1,220	<1,040	<1,010	<1,010	2,030	2,500	<990	<1,160	<1,140	<3,600	<5,340	<867.5	<1,720	8,140	<1,140	<1,370	<1,370	86,000	742.4	--
NDP-02-S	11/15/2004	1,822.0	µg/m³	-	<500	<5,000	<500	<5,000	<500	<500	<1,000	<500	<500	<500	<500	-	-	<5,000	<1,000	<500	<500	<500	<500	<500	<5,000	--
	12/8/2004	1,822.0	µg/m³	-	<500	<5,000	<500	<5,000	<500	<500	<1,000	<500	<500	<500	<500	-	-	<5,000	<1,000	1,400	<500	<500	<500	880	<5,000	--
	6/9/2005	1,822.0	µg/m³	-	<500	<5,000	-	<5,000	-	<500	-	-	<500	<500	<500	-	-	<5,000	<1,000	-	<500	<500	<500	4,700	-	--
	6/10/2005	1,822.0	µg/m³	-	-	-	<500	-	<500	-	<1,000	<500	-	-	-	-	-	-	<1,000	5,200	-	-	-	470	<5,000	--
	1/17/2008	1,822.0	µg/m³	-	-	-	790	-	<500	-	1,200	<500	-	-	-	-	-	-	<1,000	3,500	-	-	-	11,000	<5,000	--

Appendix C. Summary of Halogenated Soil Vapor Data

Cave Creek Landfill, Maricopa County

Well Name	Sample Date	Sample Elevation (ft amsl)	Units	Allyl chloride	Carbon tetrachloride	Chloroethane	Chloroform	Chloromethane	1,1-Dichloroethane	1,2-Dichloroethane	1,1-Dichloroethane	cis-1,2-Dichloroethane	trans-1,2-Dichloroethane	1,2-Dichloropropane	cis-1,3-Dichloropropene	1,4-Dioxane	Hexachlorobutadiene	Methylene chloride	1,1,2,2-Tetrachloroethane	Tetrachloroethene	trans-1,3-Dichloropropene	1,1,1-Trichloroethane	1,1,2-Trichloroethane	Trichloroethane	Vinyl Chloride	Comments	
NDP-02-S																											
	12/1/2009	1,822.0	µg/m³	-	<510	<210	430	<660	<320	<320	1,000	<320	<320	<370	<360	<1,200	<3,400	<280	<550	4,300	<360	<440	<440	14,000	<200	--	
	6/28/2013	1,822.0	µg/m³	-	-	-	-	-	-	-	170	67	<3.5	-	-	-	-	-	-	990	-	-	-	2,900	24	WMS Passive Soil Gas Survey	
NDP-02-D																											
	11/15/2004	1,772.0	µg/m³	-	<500	<5,000	<500	<5,000	<500	<500	<1,000	<500	<500	<500	<500	-	-	<5,000	<1,000	1,400	<500	<500	<500	890	<5,000	--	
	12/8/2004	1,772.0	µg/m³	-	<500	<5,000	<500	<5,000	1,100	<500	<1,000	<500	<500	<500	<500	-	-	<5,000	<1,000	3,800	<500	<500	<500	1,600	<5,000	--	
	6/9/2005	1,772.0	µg/m³	-	<500	<5,000	-	<5,000	-	<500	-	-	<500	<500	<500	-	-	<5,000	<1,000	-	<500	<500	<500	-	-	--	
	6/10/2005	1,772.0	µg/m³	-	-	-	<500	-	910	-	<1,000	<500	-	-	-	-	-	-	<1,000	6,400	-	-	-	3,400	<5,000	--	
	1/17/2008	1,772.0	µg/m³	-	-	-	<500	-	<500	-	<1,000	<500	-	-	-	-	-	-	<1,000	1,800	-	-	-	4,700	<5,000	--	
	12/1/2009	1,772.0	µg/m³	-	<740	<310	750	<970	<480	<480	1,500	<460	<460	<540	<530	<1,700	<5,000	<410	<810	4,300	<530	<640	<640	19,000	<300	--	
	6/28/2013	1,772.0	µg/m³	-	-	-	-	-	-	-	210	2.3	<3.5	-	-	-	-	-	-	1,300	-	-	-	3,700	<19	WMS Passive Soil Gas Survey	
NDP-03																											
	10/7/2013	1,822.0	µg/m³	<313	<629	<264	<488	<828	2,590	<405	<397	6,340	<396	<462	<454	<1,440	<2,130	17,400	<687	4,290	<454	<546	<546	794.8	<256	--	
	11/13/2013	1,822.0	mg/m³	-	<.5	<.5	<.5	<.5	1.6	<.5	<.1	.8	<.5	<.5	<.5	-	-	9.5	<.1	2.5	<.5	<.5	<.5	.7	<.5	--	
ODP-01-S																											
	11/18/2004	1,823.0	µg/m³	-	<500	<5,000	<500	<5,000	<500	<500	<1,000	<500	<500	<500	<500	-	-	<5,000	<1,000	1,500	<500	<500	<500	<500	<5,000	--	
	12/8/2004	1,823.0	µg/m³	-	<500	<5,000	<500	<5,000	<500	<500	3,300	<500	<500	<500	<500	-	-	<5,000	<1,000	<500	<500	<500	<500	<500	<5,000	--	
	12/1/2009	1,823.0	µg/m³	-	<260	<110	<200	<340	<170	<170	43,000	220	<160	<190	<190	<600	<1,800	380	<280	5,300	<190	<230	<230	3,600	380	--	
ODP-01-D																											
	11/18/2004	1,773.0	µg/m³	-	<500	<5,000	<500	<5,000	<500	<500	<1,000	<500	<500	<500	<500	-	-	<5,000	<1,000	<500	<500	<500	<500	<500	<5,000	--	
	12/8/2004	1,773.0	µg/m³	-	<500	<5,000	<500	<5,000	<500	<500	<1,000	<500	<500	<500	<500	-	-	<5,000	<1,000	<500	<500	<500	<500	<500	<5,000	--	
	12/1/2009	1,773.0	µg/m³	-	<970	<410	<750	<1,300	800	<620	380,000	<610	<610	<710	<700	<2,200	<6,600	2,600	<1,000	14,000	<700	<840	<840	21,000	1,000	--	
ODP-02-S																											
	11/18/2004	1,817.0	µg/m³	-	<500	<5,000	<500	<5,000	<500	<500	<1,000	<500	<500	<500	<500	-	-	<5,000	<1,000	<500	<500	<500	<500	<500	<5,000	--	
	12/8/2004	1,817.0	µg/m³	-	<500	<5,000	<500	<5,000	<500	<500	<1,000	<500	<500	<500	<500	-	-	<5,000	<1,000	<500	<500	<500	<500	<500	<5,000	--	
	12/1/2009	1,817.0	µg/m³	-	<20	35	<15	<26	25	<13	2,400	320	19	<15	<14	<46	<130	98	<22	2,100	<14	<17	<17	1,900	780	--	
ODP-02-D																											
	11/18/2004	1,767.0	µg/m³	-	<500	<5,000	<500	<5,000	<500	<500	<1,000	<500	<500	<500	<500	-	-	<5,000	<1,000	<500	<500	<500	<500	<500	<5,000	--	
	12/8/2004	1,767.0	µg/m³	-	<500	<5,000	<500	<5,000	<500	<500	<1,000	<500	<500	<500	<500	-	-	<5,000	<1,000	<500	<500	<500	<500	<500	<5,000	--	
	12/1/2009	1,767.0	µg/m³	-	<30	23	30	<39	38	<19	5,800	720	42	<22	<21	<68	<200	250	<32	3,400	<21	<26	<26	4,100	2,200	--	
ODP-03-S																											
	11/18/2004	1,812.0	µg/m³	-	<500	<5,000	<500	<5,000	<500	<500	<1,000	<500	<500	<500	<500	-	-	<5,000	<1,000	13,000	<500	<500	<500	<500	<5,000	--	
	12/8/2004	1,812.0	µg/m³	-	<500	<5,000	<500	<5,000	<500	<500	<1,000	<500	<500	<500	<500	-	-	<5,000	<1,000	1,900	<500	<500	<500	<500	<5,000	--	
	1/17/2008	1,812.0	µg/m³	-	-	-	<500	-	<500	-	<1,000	<500	-	-	-	-	-	-	<1,000	<500	-	-	-	<500	<5,000	--	
	12/1/2009	1,812.0	µg/m³	-	<9.9	<4.2	<7.7	<13	11	<6.4	940	56	<6.3	<7.3	<7.2	<23	<67	30	<11	1,000	<7.2	<8.6	<8.6	1,600	33	--	
	11/8/2011	1,812.0	µg/m³	<7.8	<15.7	<6.6	<12.2	<10.4	<10.1	<10.1	<9.9	29.7	<9.9	<11.6	<11.4	<36	<53.4	<8.7	<17.2	183.1	<11.4	<13.7	<13.7	590.7	15.6	--	
	6/28/2013	1,812.0	µg/m³	-	-	-	-	-	-	-	<11	<1.2	<3.5	-	-	-	-	-	-	63	-	-	-	120	<19	WMS Passive Soil Gas Survey	

Appendix C. Summary of Halogenated Soil Vapor Data

Well Name	Sample Date	Sample Elevation (ft amsl)	Units	Allyl chloride	Carbon tetrachloride	Chloroethane	Chloroform	Chloromethane	1,1-Dichloroethane	1,2-Dichloroethane	1,1-Dichloroethane	cis-1,2-Dichloroethane	trans-1,2-Dichloroethane	1,2-Dichloropropane	cis-1,3-Dichloropropene	1,4-Dioxane	Hexachlorobutadiene	Methylene chloride	1,1,2,2-Tetrachloroethane	Tetrachloroethene	trans-1,3-Dichloropropene	1,1,1-Trichloroethane	1,1,2-Trichloroethane	Trichloroethane	Vinyl Chloride	Comments	
ODP-03-D																											
	11/18/2004	1,762.0	µg/m³	-	<500	<5,000	<500	<5,000	<500	<500	<1,000	<500	<500	<500	<500	-	-	<5,000	<1,000	11,000	<500	<500	<500	<500	<5,000	--	
	12/8/2004	1,762.0	µg/m³	-	<500	<5,000	<500	<5,000	<500	<500	<1,000	<500	<500	<500	<500	-	-	<5,000	<1,000	640	<500	<500	<500	<500	<5,000	--	
	1/17/2008	1,762.0	µg/m³	-	-	-	<500	-	<500	-	<1,000	<500	-	-	-	-	-	-	<1,000	<500	-	-	-	<500	<5,000	--	
	12/1/2009	1,762.0	µg/m³	-	<22	<9.1	41	<28	17	<14	2,600	130	<14	<16	<16	<50	<150	64	<24	1,800	<16	<19	<19	4,900	73	--	
	11/8/2011	1,762.0	µg/m³	<78.3	<157.3	<66	<122	<103.5	<101.3	<101.3	361.3	<99	<99	<115.5	<113.5	<360	<533.5	<86.8	<171.8	413.6	<113.5	<136.5	<136.5	3,280	<64	--	
	6/28/2013	1,762.0	µg/m³	-	-	-	-	-	-	-	110	6.9	<3.5	-	-	-	-	-	-	160	-	-	-	1,100	<19	WMS Passive Soil Gas Survey	
ODP-04-S																											
	11/18/2004	1,817.0	µg/m³	-	<500	<5,000	<500	<5,000	<500	<500	<1,000	<500	<500	<500	<500	-	-	<5,000	1,000	870	<500	<500	<500	<500	<5,000	--	
	11/18/2004	1,767.0	µg/m³	-	<500	<5,000	<500	<5,000	<500	<500	<1,000	<500	<500	<500	<500	-	-	<5,000	<1,000	740	<500	<500	<500	<500	<5,000	--	
	12/8/2004	1,817.0	µg/m³	-	<500	<5,000	<500	<5,000	<500	<500	<1,000	<500	<500	<500	<500	-	-	<5,000	<1,000	<500	<500	<500	<500	<500	<5,000	--	
	12/8/2004	1,767.0	µg/m³	-	<500	<5,000	<500	<5,000	<500	<500	<1,000	<500	<500	<500	<500	-	-	<5,000	<1,000	<500	<500	<500	<500	<500	<5,000	--	
	1/17/2008	1,767.0	µg/m³	-	-	-	<500	-	<500	-	<1,000	<500	-	-	-	-	-	-	<1,000	<500	-	-	-	<500	<5,000	--	
	1/17/2008	1,817.0	µg/m³	-	-	-	<500	-	6,200	-	<1,000	<500	-	-	-	-	-	-	<1,000	<500	-	-	-	2,100	<5,000	--	
	12/1/2009	1,767.0	µg/m³	-	<110	<46	<85	<140	<70	<70	28,000	260	<69	<80	<79	<250	<740	580	<120	2,600	<79	<95	<95	16,000	410	--	
	12/1/2009	1,817.0	µg/m³	-	<21	50	<16	<28	34	<13	1,600	92	<13	<15	<15	<48	<140	56	<23	1,200	<15	<18	<18	2,800	77	--	
P-02-S																											
	11/16/2004	-	µg/m³	-	<500	<5,000	<500	<5,000	<500	<500	<1,000	<500	<500	<500	<500	-	-	<5,000	<1,000	<500	<500	<500	<500	<500	<5,000	--	
	12/2/2009	-	µg/m³	-	<7.5	<3.1	13	<9.8	<4.8	<4.8	180	28	<4.7	<5.5	<5.4	<17	<51	6	<8.2	690	<5.4	<6.5	<6.5	1,600	<3	--	
	11/8/2011	-	µg/m³	<3.1	<6.3	<2.6	<4.9	<4.1	<4.1	<4.1	<4	<4	<4	<4.6	<4.5	<14.4	<21.3	<3.5	<6.9	<6.8	<4.5	<5.5	<5.5	33.3	<2.6	--	
P-02-D																											
	11/16/2004	-	µg/m³	-	<500	<5,000	<500	<5,000	<500	<500	<1,000	<500	<500	<500	<500	-	-	<5,000	<1,000	<500	<500	<500	<500	<500	<5,000	--	
	12/2/2009	-	µg/m³	-	<16	<6.5	29	<20	<10	<10	470	60	<9.8	<11	<11	<36	<100	14	<17	1,500	<11	<13	<13	3,500	<6.3	--	
P-03																											
	3/9/2012	-	µg/m³	<1.6	<3.1	<1.3	<2.4	<2.1	<2	<2	<2	<2	<2	<2.3	<2.3	<7.2	<10.7	<1.7	<3.4	<3.4	<2.3	<2.7	<2.7	<2.7	<1.3	--	
P-05																											
	11/18/2004	1,859.0	µg/m³	-	<500	<5,000	<500	<5,000	830	<500	<1,000	660	<500	<500	<500	-	-	<5,000	<1,000	1,600	<500	<500	<500	<500	<5,000	--	
	5/23/2013	1,859.0	µg/m³	<7.8	<15.7	<6.6	48.3	<10.4	25.9	<10.1	<9.9	<9.9	<9.9	<11.6	<11.4	<36	<53.4	<8.7	<17.2	515.3	<11.4	<13.7	<13.7	<13.4	<6.4	--	
P-05-xS																											
	5/23/2013	1,853.5	µg/m³	<3.1	<6.3	<2.6	<4.9	<4.1	79.1	4.4	4	151.1	<4	6.2	<4.5	<14.4	<21.3	42	<6.9	437	<4.5	<5.5	<5.5	96.2	<2.6	--	
P-05-xD																											
	5/23/2013	1,818.5	µg/m³	<31.3	<62.9	<26.4	<48.8	<41.4	444.7	<40.5	<39.7	396	<39.6	<46.2	<45.4	<144	<213.4	1,969.6	<68.7	652.2	<45.4	<54.6	<54.6	236.3	<25.6	--	
P-06																											
	11/16/2004	-	µg/m³	-	<500	<5,000	<500	<5,000	<500	<500	<1,000	<500	<500	<500	<500	-	-	<5,000	<1,000	<500	<500	<500	<500	<500	<5,000	--	
	1/5/2012	-	µg/m³	<1.6	<3.1	<1.3	<2.4	<2.1	<2	<2	<2	<2	<2	<2.3	<2.3	<7.2	<10.7	<1.7	<3.4	5.4	<2.3	<2.7	<2.7	<2.7	<1.3	--	
P-07																											
	11/16/2004	-	µg/m³	-	<500	<5,000	<500	<5,000	<500	<500	<1,000	<500	<500	<500	<500	-	-	<5,000	<1,000	<500	<500	<500	<500	<500	<5,000	--	

Appendix C. Summary of Halogenated Soil Vapor Data

Well Name	Sample Date	Sample Elevation (ft amsl)	Units	Allyl chloride	Carbon tetrachloride	Chloroethane	Chloroform	Chloromethane	1,1-Dichloroethane	1,2-Dichloroethane	1,1-Dichloroethane	cis-1,2-Dichloroethane	trans-1,2-Dichloroethane	1,2-Dichloropropane	cis-1,3-Dichloropropene	1,4-Dioxane	Hexachlorobutadiene	Methylene chloride	1,1,2,2-Tetrachloroethane	Tetrachloroethene	trans-1,3-Dichloropropene	1,1,1-Trichloroethane	1,1,2-Trichloroethane	Trichloroethane	Vinyl Chloride	Comments
P-07	1/5/2012	-	µg/m³	<1.6	<3.1	<1.3	<2.4	<2.1	<2	<2	<2	<2	<2	<2.3	<2.3	<7.2	<10.7	<1.7	<3.4	12.2	<2.3	<2.7	<2.7	<2.7	<1.3	--
P-08	11/16/2004	-	µg/m³	-	<500	<5,000	<500	<5,000	<500	<500	<1,000	<500	<500	<500	<500	-	-	<5,000	<1,000	<500	<500	<500	<500	<500	<5,000	--
	1/5/2012	-	µg/m³	<1.6	<3.1	<1.3	7.3	<2.1	<2	<2	<2	<2	<2	<2.3	<2.3	<7.2	<10.7	<1.7	<3.4	30.5	<2.3	<2.7	<2.7	<2.7	<1.3	--
P-09	3/9/2012	-	µg/m³	<313	<629	<264	<488	<414	<405	<405	1,349.8	<396	<396	<462	<454	<1,440	<2,130	<347	<687	1,830	<454	<546	<546	59,100	<256	--
	6/28/2013	-	µg/m³	-	-	-	-	-	-	-	3,100	5.7	<3.5	-	-	-	-	-	-	3,900	-	-	-	89,000	53	WMS Passive Soil Gas Survey
P-10	11/16/2004	-	µg/m³	-	<500	<5,000	<500	<5,000	<500	<500	<1,000	<500	<500	<500	<500	-	-	<5,000	<1,000	<500	<500	<500	<500	1,700	<5,000	--
	1/5/2012	-	µg/m³	<1.6	<3.1	<1.3	<2.4	<2.1	<2	<2	8.3	<2	<2	<2.3	<2.3	<7.2	<10.7	<1.7	<3.4	27.1	<2.3	<2.7	<2.7	590.7	<1.3	Duplicate Sample
	1/5/2012	-	µg/m³	<1.6	<3.1	<1.3	<2.4	<2.1	<2	<2	14.3	<2	<2	<2.3	<2.3	<7.2	<10.7	<1.7	<3.4	34.6	<2.3	<2.7	<2.7	751.8	<1.3	--
P-11	11/16/2004	-	µg/m³	-	<500	<5,000	<500	<5,000	<500	<500	<1,000	<500	<500	<500	<500	-	-	<5,000	<1,000	<500	<500	<500	<500	1,200	<5,000	--
P-12	11/16/2004	-	µg/m³	-	<500	<5,000	<500	<5,000	<500	<500	<1,000	<500	<500	<500	<500	-	-	<5,000	<1,000	<500	<500	<500	<500	<500	<5,000	--
P-13-S	11/16/2004	-	µg/m³	-	<500	<5,000	<500	<5,000	<500	<500	<1,000	<500	<500	<500	<500	-	-	<5,000	<1,000	<500	<500	<500	<500	7,600	<5,000	--
P-13-D	11/16/2004	-	µg/m³	-	<500	<5,000	<500	<5,000	<500	<500	<1,000	<500	<500	<500	<500	-	-	<5,000	<1,000	<500	<500	<500	<500	<500	<5,000	--
P-13-xD	6/28/2013	-	µg/m³	-	-	-	-	-	-	-	120	1.3	<3.5	-	-	-	-	-	-	830	-	-	-	12,000	<20	WMS Passive Soil Gas Survey
P-17-S	11/16/2004	-	µg/m³	-	<500	<5,000	<500	<5,000	<500	<500	<1,000	<500	<500	<500	<500	-	-	<5,000	<1,000	<500	<500	<500	<500	<500	<5,000	--
P-17-D	11/16/2004	-	µg/m³	-	<500	<5,000	<500	<5,000	<500	<500	<1,000	<500	<500	<500	<500	-	-	<5,000	<1,000	<500	<500	<500	<500	<500	<5,000	--
P-18-S	11/15/2004	-	µg/m³	-	<500	<5,000	<500	<5,000	<500	<500	<1,000	<500	<500	<500	<500	-	-	<5,000	<1,000	<500	<500	<500	<500	<500	<5,000	--
	12/2/2009	-	µg/m³	-	<30	<13	26	<40	<20	<20	180	31	<19	<22	<22	<70	<210	<17	<33	1,200	<22	<26	<26	1,700	<12	--
P-18-D	11/15/2004	-	µg/m³	-	<500	<5,000	<500	<5,000	<500	<500	<1,000	<500	<500	<500	<500	-	-	<5,000	<1,000	<500	<500	<500	<500	<500	<5,000	--
	12/2/2009	-	µg/m³	-	<15	<6.1	31	<19	<9.4	<9.4	400	46	<9.2	<11	<10	<34	<99	12	<16	1,200	<10	<13	<13	2,400	<6	--
P-19-S	11/15/2004	-	µg/m³	-	<500	<5,000	<500	<5,000	<500	<500	<1,000	<500	<500	<500	<500	-	-	<5,000	<1,000	<500	<500	<500	<500	<500	<5,000	--
P-19-D	11/15/2004	-	µg/m³	-	<500	<5,000	<500	<5,000	<500	<500	<1,000	<500	<500	<500	<500	-	-	<5,000	<1,000	<500	<500	<500	<500	<500	<5,000	--

Appendix C. Summary of Halogenated Soil Vapor Data

Well Name	Sample Date	Sample Elevation (ft amsl)	Units	Allyl chloride	Carbon tetrachloride	Chloroethane	Chloroform	Chloromethane	1,1-Dichloroethane	1,2-Dichloroethane	1,1-Dichloroethane	cis-1,2-Dichloroethane	trans-1,2-Dichloroethane	1,2-Dichloropropane	cis-1,3-Dichloropropene	1,4-Dioxane	Hexachlorobutadiene	Methylene chloride	1,1,2,2-Tetrachloroethane	Tetrachloroethene	trans-1,3-Dichloropropene	1,1,1-Trichloroethane	1,1,2-Trichloroethane	Trichloroethane	Vinyl Chloride	Comments
P-22	11/16/2004	-	µg/m³	-	<500	<5,000	<500	<5,000	<500	<500	<1,000	<500	<500	<500	<500	-	-	<5,000	<1,000	<500	<500	<500	<500	8,300	<5,000	--
P-23	11/16/2004	-	µg/m³	-	<500	<5,000	<500	<5,000	<500	<500	<1,000	<500	<500	<500	<500	-	-	<5,000	<1,000	<500	<500	<500	<500	<500	<5,000	--
P-25	11/15/2004	-	µg/m³	-	<500	<5,000	<500	<5,000	<500	<500	<1,000	<500	<500	<500	<500	-	-	<5,000	<1,000	<500	<500	<500	<500	1,900	<5,000	--
PW	5/21/2009	1,201.4	µg/m³	-	<780	<320	<600	<1,000	<500	<500	5,600	9,800	<490	<570	<560	<1,800	<5,300	<430	<850	12,000	<560	<670	<670	180,000	<320	--
	6/16/2010	1,201.4	µg/m³	<620	<620	<620	<620	<620	<620	<620	2,700	15,000	<620	<620	<620	<620	<620	<620	<620	6,300	<620	<620	<620	100,000	<620	One Day Preliminary SVE Test
	6/16/2010	1,201.4	µg/m³	<850	<850	<850	<850	<850	<850	<850	2,800	12,000	<850	<850	<850	<850	<850	<850	<850	7,100	<850	<850	<850	130,000	<850	One Day Preliminary SVE Test
	6/16/2010	1,201.4	µg/m³	<630	<630	<630	<630	<630	<630	<630	2,700	11,000	<630	<630	<630	<630	<630	<630	<630	7,500	<630	<630	<630	120,000	<630	One Day Preliminary SVE Test
	11/8/2011	1,201.4	µg/m³	<1,570	<3,150	<1,320	<2,440	<2,070	<2,030	<2,030	<1,990	7,130	<1,980	<2,310	<2,270	<7,200	<10,700	<1,740	<3,440	7,460	<2,270	<2,730	<2,730	140,000	<1,280	--
	11/23/2011	1,201.4	µg/m³	<1,570	<3,150	<1,320	<2,440	<2,070	<2,030	<2,030	24,200	285,000	<1,980	<2,310	<2,270	<7,200	<10,700	3,820	<3,440	37,300	<2,270	<2,730	<2,730	752,000	13,300	Extended SVE Pilot Test
	6/28/2013	1,201.4	µg/m³	-	-	-	-	-	-	-	930	5,300	6.1	-	-	-	-	-	-	1,800	-	-	-	31,000	<20	WMS Passive Soil Gas Survey
SP-01	7/11/2014	-	µgm³	-	-	-	<2,440	-	<2,030	<2,030	<1,990	<1,980	<1,980	-	-	-	-	<6,940	-	11,700	-	-	-	71,400	<1,280	--
	7/25/2014	-	µgm³	-	-	-	595.4	-	769.5	<405	5,720	5,310	<396	-	-	-	-	<1,390	-	23,100	-	-	-	698,000	1,850	--
	8/15/2014	-	µgm³	-	-	-	<9,760	-	<8,100	<8,100	14,000	15,000	<7,920	-	-	-	-	<27,800	-	49,600	-	-	-	1,420,000	5,220	--
	8/28/2014	-	µgm³	-	-	-	<9,760	-	<8,100	<8,100	11,100	14,300	<7,920	-	-	-	-	<27,800	-	40,100	-	-	-	865,000	-	--
SP-02	7/25/2014	-	µgm³	-	-	-	<4.9	-	<4.1	<4.1	<4	<4	<4	-	-	-	-	<13.9	-	<6.8	-	-	-	<5.4	31.8	--
	8/15/2014	-	µgm³	-	-	-	<48.8	-	<40.5	<40.5	<39.7	<39.6	<39.6	-	-	-	-	1,210	-	<67.8	-	-	-	<53.7	3,840	--
	8/28/2014	-	µgm³	-	-	-	<2,440	-	<2,030	<2,030	11,500	28,900	<1,980	-	-	-	-	<6,940	-	<3,390	-	-	-	368,000	2,740	--
SP-03	8/15/2014	-	µgm³	-	-	-	<48.8	-	<40.5	<40.5	<39.7	<39.6	<39.6	-	-	-	-	<138.8	-	<67.8	-	-	-	<53.7	1,870	--
	8/28/2014	-	µgm³	-	-	-	<48.8	-	<40.5	<40.5	<39.7	<39.6	<39.6	-	-	-	-	<138.8	-	<67.8	-	-	-	<53.7	1,790	--
SP-05	7/11/2014	-	µgm³	-	-	-	<4.9	-	<4.1	<4.1	<4	<4	<4	-	-	-	-	<13.9	-	<6.8	-	-	-	21.3	<2.6	--
	7/25/2014	-	µgm³	-	-	-	<4.9	-	<4.1	<4.1	<4	7.5	<4	-	-	-	-	22.5	-	18.3	-	-	-	8.3	<2.6	--
	8/15/2014	-	µgm³	-	-	-	<12.2	-	<10.1	<10.1	<9.9	<9.9	<9.9	-	-	-	-	<34.7	-	<17	-	-	-	32.2	<6.4	--
	8/28/2014	-	µgm³	-	-	-	<48.8	-	<40.5	<40.5	<39.7	<39.6	<39.6	-	-	-	-	<138.8	-	<67.8	-	-	-	<53.7	<25.6	--
TSSV-01-S	2/23/2010	1,731.0	µg/m³	-	<200	<83	200	<260	<130	<130	1,900	170	<120	<140	<140	<450	<1,300	<110	<220	3,800	<140	<170	<170	130,000	250	--
	6/16/2010	1,731.0	µg/m³	<270	<270	<270	480	<270	<270	<270	290	<270	<270	<270	<270	<270	<270	<270	<270	1,200	<270	<270	<270	36,000	<270	One Day Preliminary SVE Test
	6/16/2010	1,731.0	µg/m³	<1,000	<1,000	<1,000	<1,000	<1,000	<1,000	<1,000	1,200	<1,000	<1,000	<1,000	<1,000	<1,000	<1,000	<1,000	<1,000	5,400	<1,000	<1,000	<1,000	160,000	<1,000	One Day Preliminary SVE Test
	6/16/2010	1,731.0	µg/m³	<740	<740	<740	<740	<740	<740	<740	1,100	<740	<740	<740	<740	<740	<740	<740	<740	4,900	<740	<740	<740	140,000	<740	One Day Preliminary SVE Test
	6/16/2010	1,731.0	µg/m³	<1,200	<1,200	<1,200	<1,200	<1,200	<1,200	<1,200	1,700	<1,200	<1,200	<1,200	<1,200	<1,200	<1,200	<1,200	<1,200	7,900	<1,200	<1,200	<1,200	230,000	<1,200	One Day Preliminary SVE Test

Appendix C. Summary of Halogenated Soil Vapor Data

Cave Creek Landfill, Maricopa County

Well Name	Sample Date	Sample Elevation (ft amsl)	Units	Allyl chloride	Carbon tetrachloride	Chloroethane	Chloroform	Chloromethane	1,1-Dichloroethane	1,2-Dichloroethane	1,1-Dichloroethane	cis-1,2-Dichloroethane	trans-1,2-Dichloroethane	1,2-Dichloropropane	cis-1,3-Dichloropropene	1,4-Dioxane	Hexachlorobutadiene	Methylene chloride	1,1,2,2-Tetrachloroethane	Tetrachloroethene	trans-1,3-Dichloropropene	1,1,1-Trichloroethane	1,1,2-Trichloroethane	Trichloroethane	Vinyl Chloride	Comments	
TSSV-01-S																											
	11/8/2011	1,731.0	µg/m³	<3,130	<6,290	<2,640	<4,880	<4,140	<4,050	<4,050	4,760	<3,960	<3,960	<4,620	<4,540	<14,400	<21,300	<3,470	<6,870	17,600	<4,540	<5,460	<5,460	435,000	<2,560	--	
	11/16/2011	1,731.0	µg/m³	<3,130	<6,290	<2,640	<4,880	<4,140	<4,050	<4,050	4,760	<3,960	<3,960	<4,620	<4,540	<14,400	<21,300	<3,470	<6,870	11,500	<4,540	<5,460	<5,460	456,000	<2,560	Extended SVE Pilot Test	
	11/23/2011	1,731.0	µg/m³	<3,130	<6,290	<2,640	<4,880	<4,140	<4,050	<4,050	5,560	<3,960	<3,960	<4,620	<4,540	<14,400	<21,300	<3,470	<6,870	21,000	<4,540	<5,460	<5,460	806,000	<2,560	Extended SVE Pilot Test	
	12/13/2011	1,731.0	µg/m³	<6,260	<12,600	<5,280	<9,760	<8,280	<8,100	<8,100	8,340	<7,920	<7,920	<9,240	<9,080	<28,800	<42,700	<6,940	<13,700	27,100	<9,080	<10,900	<10,900	913,000	<5,120	Extended SVE Pilot Test	
	6/28/2013	1,731.0	µg/m³	-	-	-	-	-	-	-	2,600	290	6.8	-	-	-	-	-	-	6,400	-	-	-	160,000	320	WMS Passive Soil Gas Survey	
TSSV-01-M																											
	2/23/2010	1,531.0	µg/m³	-	<430	<180	2,200	<560	<280	<280	1,300	1,600	<270	<310	<310	<980	<2,900	<240	<470	6,000	<310	<370	<370	200,000	250	--	
	6/16/2010	1,531.0	µg/m³	<620	<620	<620	1,300	<620	<620	<620	<620	1,200	<620	<620	<620	<620	<620	<620	<620	3,900	<620	<620	<620	110,000	<620	One Day Preliminary SVE Test	
	6/16/2010	1,531.0	µg/m³	<580	<580	<580	1,400	<580	<580	<580	640	1,900	<580	<580	<580	<580	<580	<580	<580	4,400	<580	<580	<580	120,000	<580	One Day Preliminary SVE Test	
	6/16/2010	1,531.0	µg/m³	<940	<940	<940	1,900	<940	<940	<940	<940	2,900	<940	<940	<940	<940	<940	<940	<940	6,300	<940	<940	<940	170,000	<940	One Day Preliminary SVE Test	
	6/16/2010	1,531.0	µg/m³	<930	<930	<930	1,400	<930	<930	<930	<930	1,900	<930	<930	<930	<930	<930	<930	<930	4,200	<930	<930	<930	120,000	<930	One Day Preliminary SVE Test	
	11/8/2011	1,531.0	µg/m³	<3,130	<6,290	<2,640	<4,880	<4,140	<4,050	<4,050	<3,970	<3,960	<3,960	<4,620	<4,540	<14,400	<21,300	<3,470	<6,870	10,800	<4,540	<5,460	<5,460	279,000	<2,560	--	
	1/16/2012	1,531.0	µg/m³	<6,260	<12,600	<5,280	<9,760	<8,280	<8,100	<8,100	<7,940	<7,920	<7,920	<9,240	<9,080	<28,800	<42,700	<6,940	<13,700	18,306	<9,080	<10,900	<10,900	446,000	<5,120	Extended SVE Pilot Test	
	1/20/2012	1,531.0	µg/m³	<6,260	<12,600	<5,280	<9,760	<8,280	<8,100	<8,100	<7,940	15,400	<7,920	<9,240	<9,080	<28,800	<42,700	<6,940	<13,700	21,700	<9,080	<10,900	<10,900	510,000	<5,120	Extended SVE Pilot Test	
	1/31/2012	1,531.0	µg/m³	<6,260	<12,600	<5,280	<9,760	<8,280	<8,100	<8,100	<7,940	43,600	<7,920	<9,240	<9,080	<28,800	<42,700	<6,940	<13,700	36,600	<9,080	<10,900	<10,900	698,000	<5,120	Extended SVE Pilot Test	
	2/20/2012	1,531.0	µg/m³	<3,130	<6,290	<2,640	<4,880	<4,140	<4,050	<4,050	5,560	47,500	<3,960	<4,620	<4,540	<14,400	<21,300	<3,470	<6,870	27,800	<4,540	<5,460	<5,460	752,000	5,630	Extended SVE Pilot Test	
	6/28/2013	1,531.0	µg/m³	-	-	-	-	-	-	-	980	2,500	5.1	-	-	-	-	-	-	3,800	-	-	-	110,000	170	WMS Passive Soil Gas Survey	
TSSV-01-D																											
	2/23/2010	1,332.0	µg/m³	-	<780	<330	610	<1,000	870	<500	4,400	240,000	<490	<570	<560	<1,800	<5,300	18,000	<850	8,000	<560	<680	<680	74,000	18,000	--	
	6/16/2010	1,332.0	µg/m³	<220	<220	<220	330	<220	340	<220	2,700	90,000	<220	<220	<220	<220	<220	4,100	<220	3,200	<220	<220	<220	32,000	3,400	One Day Preliminary SVE Test	
	6/16/2010	1,332.0	µg/m³	<1,200	<1,200	<1,200	<1,200	<1,200	1,400	<1,200	24,000	230,000	<1,200	<1,200	<1,200	<1,200	<1,200	15,000	<1,200	19,000	<1,200	<1,200	<1,200	200,000	12,000	One Day Preliminary SVE Test	
	6/16/2010	1,332.0	µg/m³	<1,700	<1,700	<1,700	<1,700	<1,700	2,100	<1,700	37,000	340,000	<1,700	<1,700	<1,700	<1,700	<1,700	24,000	<1,700	30,000	<1,700	<1,700	<1,700	310,000	18,000	One Day Preliminary SVE Test	
	6/16/2010	1,332.0	µg/m³	<1,500	<1,500	<1,500	<1,500	<1,500	1,900	<1,500	34,000	310,000	<1,500	<1,500	<1,500	<1,500	<1,500	22,000	<1,500	26,000	<1,500	<1,500	<1,500	270,000	16,000	One Day Preliminary SVE Test	
	11/8/2011	1,332.0	µg/m³	<1,570	<3,150	<1,320	<2,440	<2,070	<2,030	<2,030	2,940	111,000	<1,980	<2,310	<2,270	<7,200	<10,700	6,590	<3,440	5,360	<2,270	<2,730	<2,730	47,000	7,170	--	
	2/20/2012	1,332.0	µg/m³	<1,570	<3,150	<1,320	2,930	<2,070	3,440	2,030	79,400	1,350,000	<1,980	<2,310	<2,270	<7,200	<10,700	41,600	<3,440	67,100	<2,270	<2,730	<2,730	1,340,000	33,300	Extended SVE Pilot Test	
	2/29/2012	1,332.0	µg/m³	<15,700	<31,500	<13,200	<24,400	<20,700	<20,300	<20,300	262,000	1,230,000	<19,800	<23,100	<22,700	<72,000	<107,000	111,000	<34,400	237,000	<22,700	<27,300	<27,300	2,630,000	58,900	Extended SVE Pilot Test	
	6/28/2013	1,332.0	µg/m³	-	-	-	-	-	-	-	5,600	52,000	220	-	-	-	-	-	-	4,300	-	-	-	39,000	4,400	WMS Passive Soil Gas Survey	
TSSV-02-S																											
	5/24/2013	1,729.9	µg/m³	<1,570	<3,150	<1,320	<2,440	<2,070	<2,030	<2,030	3,380	<1,980	<1,980	<2,310	<2,270	<7,200	<10,700	<1,740	<3,440	12,700	<2,270	<2,730	<2,730	329,000	<1,280	--	
	6/28/2013	1,729.9	µg/m³	-	-	-	-	-	-	-	5,100	120	<3.5	-	-	-	-	-	-	9,300	-	-	-	290,000	31	WMS Passive Soil Gas Survey	
	7/11/2014	1,729.9	µgm³	-	-	-	<4,880	-	<4,050	<4,050	12,000	<3,960	<3,960	-	-	-	-	<13,900	-	30,900	-	-	-	945,000	<2,560	--	
	7/15/2014	1,729.9	µgm³	-	-	-	<24,400	-	<20,300	<20,300	<19,900	<19,800	<19,800	-	-	-	-	<69,400	-	42,000	-	-	-	1,010,000	<12,800	--	
	8/15/2014	1,729.9	µgm³	-	-	-	<24,400	-	<20,300	<20,300	<19,900	<19,800	<19,800	-	-	-	-	<69,400	-	41,400	-	-	-	1,060,000	<12,800	--	
	8/28/2014	1,729.9	µgm³	-	-	-	<12,200	-	<10,100	<10,100	<9,930	<9,900	<9,900	-	-	-	-	<34,700	-	<17,000	-	-	-	347,000	<6,400	--	
TSSV-02-M																											
	5/24/2013	1,529.9	µg/m³	<782.5	<1,570	<660	<1,220	<1,030	<1,010	<1,010	1,170	<990	<990	<1,160	<1,140	<3,600	<5,340	<867.5	<1,720	4,240	<1,140	<1,370	<1,370	105,000	<640	--	

Appendix C. Summary of Halogenated Soil Vapor Data

Cave Creek Landfill, Maricopa County

Well Name	Sample Date	Sample Elevation (ft amsl)	Units	Allyl chloride	Carbon tetrachloride	Chloroethane	Chloroform	Chloromethane	1,1-Dichloroethane	1,2-Dichloroethane	1,1-Dichloroethane	cis-1,2-Dichloroethane	trans-1,2-Dichloroethane	1,2-Dichloropropane	cis-1,3-Dichloropropene	1,4-Dioxane	Hexachlorobutadiene	Methylene chloride	1,1,2,2-Tetrachloroethane	Tetrachloroethene	trans-1,3-Dichloropropene	1,1,1-Trichloroethane	1,1,2-Trichloroethane	Trichloroethane	Vinyl Chloride	Comments	
TSSV-02-M																											
	6/28/2013	1,529.9	µg/m³	-	-	-	-	-	-	-	3,100	160	<3.5	-	-	-	-	-	-	5,300	-	-	-	150,000	150	WMS Passive Soil Gas Survey	
	7/15/2014	1,529.9	µgm³	-	-	-	<24,400	-	<20,300	<20,300	<19,900	<19,800	<19,800	-	-	-	-	<69,400	-	38,600	-	-	-	671,000	<12,800	--	
	8/15/2014	1,529.9	µgm³	-	-	-	<12,200	-	<10,100	<10,100	10,500	<9,900	<9,900	-	-	-	-	<34,700	-	26,100	-	-	-	671,000	<6,400	--	
	8/28/2014	1,529.9	µgm³	-	-	-	<12,200	-	<10,100	<10,100	<9,930	<9,900	<9,900	-	-	-	-	<34,700	-	26,100	-	-	-	459,000	<6,400	--	
TSSV-02-D																											
	5/24/2013	1,331.0	µg/m³	<782.5	<1,570	<660	<1,220	<1,040	<1,010	<1,010	2,280	36,400	<990	<1,160	<1,140	<3,600	<5,340	4,510	<1,720	4,750	<1,140	<1,370	<1,370	69,800	1,680	--	
	6/28/2013	1,331.0	µg/m³	-	-	-	-	-	-	-	1,900	8,100	20	-	-	-	-	-	-	2,400	-	-	-	42,000	660	WMS Passive Soil Gas Survey	
	7/15/2014	1,331.0	µgm³	-	-	-	<2,440	-	<2,030	<2,030	6,030	66,900	<1,980	-	-	-	-	8,190	-	16,200	-	-	-	105,000	3,510	--	
	8/15/2014	1,331.0	µgm³	-	-	-	<2,440	-	<2,030	<2,030	7,660	80,000	<1,980	-	-	-	-	9,160	-	6,510	-	-	-	90,800	6,270	--	
	8/28/2014	1,331.0	µgm³	-	-	-	<2,440	-	<2,030	<2,030	4,920	49,500	<1,980	-	-	-	-	<6,940	-	10,200	-	-	-	49,400	3,170	--	
TSSV-02-PZ																											
	5/24/2013	1,181.0	µg/m³	<782.5	<1,570	<660	<1,220	<1,040	<1,010	<1,010	2,880	128,000	<990	<1,160	<1,140	<3,600	<5,340	8,190	<1,720	6,540	<1,140	<1,370	<1,370	84,300	4,710.4	--	
	6/28/2013	1,181.0	µg/m³	-	-	-	-	-	-	-	1,400	7,800	32	-	-	-	-	-	-	73	-	-	-	2,800	140	WMS Passive Soil Gas Survey	
TSSV-03-S																											
	5/17/2013	1,732.2	µg/m³	<782.5	<1,570	<660	<1,220	<1,040	<1,010	<1,010	<992.5	<990	<990	<1,160	<1,140	<3,600	<5,340	<867.5	<1,720	<1,700	<1,140	<1,370	<1,370	<2,690	<640	--	
	6/28/2013	1,732.2	µg/m³	-	-	-	-	-	-	-	14	9.3	<3.6	-	-	-	-	-	-	840	-	-	-	86	<20	WMS Passive Soil Gas Survey	
TSSV-03-M																											
	5/17/2013	1,532.2	µg/m³	<782.5	<1,570	<660	<1,220	<1,040	<1,010	<1,010	<992.5	<990	<990	<1,160	<1,140	<3,600	<5,340	<867.5	<1,720	<1,700	<1,140	<1,370	<1,370	<2,690	<640	--	
	6/28/2013	1,532.2	µg/m³	-	-	-	-	-	-	-	17	2.1	<3.6	-	-	-	-	-	-	520	-	-	-	140	<20	WMS Passive Soil Gas Survey	
TSSV-03-D																											
	5/17/2013	1,333.2	µg/m³	<782.5	<1,570	<660	<1,220	<1,040	<1,010	<1,010	<992.5	<990	<990	<1,160	<1,140	<3,600	<5,340	<867.5	<1,720	<1,700	<1,140	<1,370	<1,370	<2,690	<640	--	
	6/28/2013	1,333.2	µg/m³	-	-	-	-	-	-	-	36	<1.2	<3.6	-	-	-	-	-	-	620	-	-	-	260	<20	WMS Passive Soil Gas Survey	
TSSV-03-PZ																											
	5/17/2013	1,183.2	µg/m³	<782.5	<1,570	<660	<1,220	<1,040	<1,010	<1,010	<992.5	<990	<990	<1,160	<1,140	<3,600	<5,340	<867.5	<1,720	<1,700	<1,140	<1,370	<1,370	<2,690	<640	--	
	6/28/2013	1,183.2	µg/m³	-	-	-	-	-	-	-	110	4.4	<3.5	-	-	-	-	-	-	200	-	-	-	1,900	<20	WMS Passive Soil Gas Survey	
TSSV-04-S																											
	6/13/2013	1,731.4	µg/m³	<156.5	<314.5	<132	<244	<207	<202.5	<202.5	<198.5	245.5	<198	<231	<227	<720	<1,070	<173.5	<343.5	5,440	<227	<273	<273	19,000	<128	--	
	6/28/2013	1,731.4	µg/m³	-	-	-	-	-	-	-	100	38	<3.5	-	-	-	-	-	-	900	-	-	-	6,300	<19	WMS Passive Soil Gas Survey	
	7/18/2014	1,731.4	µgm³	-	-	-	546.6	-	<405	<405	603.4	744.5	<396	-	-	-	-	<1,390	-	5,710	-	-	-	27,800	<256	--	
TSSV-04-M																											
	6/13/2013	1,531.4	µg/m³	<156.5	<314.5	<132	<244	<207	<202.5	<202.5	<198.5	<198	<198	<231	<227	<720	<1,070	<173.5	<343.5	935.6	<227	<273	<273	7,520	<128	--	
	6/28/2013	1,531.4	µg/m³	-	-	-	-	-	-	-	260	22	<3.5	-	-	-	-	-	-	320	-	-	-	8,400	<19	WMS Passive Soil Gas Survey	
	7/18/2014	1,531.4	µgm³	-	-	-	<488	-	<405	<405	2,820	403.9	<396	-	-	-	-	<1,390	-	10,200	-	-	-	107,000	798.7	--	
	8/15/2014	1,531.4	µgm³	-	-	-	<2,440	-	<2,030	<2,030	5,280.1	<1,980	<1,980	-	-	-	-	<6,940	-	12,500	-	-	-	189,000	4,120	--	
	8/28/2014	1,531.4	µgm³	-	-	-	<2,440	-	<2,030	<2,030	2,580	<1,980	<1,980	-	-	-	-	<6,940	-	18,900	-	-	-	92,900	2,070	--	

Appendix C. Summary of Halogenated Soil Vapor Data

Well Name	Sample Date	Sample Elevation (ft amsl)	Units	Allyl chloride	Carbon tetrachloride	Chloroethane	Chloroform	Chloromethane	1,1-Dichloroethane	1,2-Dichloroethane	1,1-Dichloroethene	cis-1,2-Dichloroethene	trans-1,2-Dichloroethene	1,2-Dichloropropane	cis-1,3-Dichloropropene	1,4-Dioxane	Hexachlorobutadiene	Methylene chloride	1,1,2,2-Tetrachloroethane	Tetrachloroethene	trans-1,3-Dichloropropene	1,1,1-Trichloroethane	1,1,2-Trichloroethane	Trichloroethane	Vinyl Chloride	Comments	
TSSV-04-D																											
	6/12/2013	1,330.9	µg/m ³	<3,130	<6,290	<2,640	<4,880	<4,140	<4,050	<4,050	12,000	6,650	<3,960	<4,620	<4,540	<14,400	<21,300	<3,470	<6,870	44,500	<4,540	<5,460	<5,460	1,700,000	4,920	--	
	6/28/2013	1,330.9	µg/m ³	-	-	-	-	-	-	-	5,500	6,800	38	-	-	-	-	-	-	25,000	-	-	-	940,000	1,300	WMS Passive Soil Gas Survey	
	7/18/2014	1,330.9	µgm ³	-	-	-	<24,400	-	<20,300	<20,300	<19,900	<19,800	<19,800	-	-	-	-	<69,400	-	99,700	-	-	-	3,470,000	<12,800	--	
	8/15/2014	1,330.9	µgm ³	-	-	-	<24,400	-	<20,300	<20,300	<19,900	<19,800	<19,800	-	-	-	-	<69,400	-	75,300	-	-	-	2,560,000	<12,800	--	
	8/28/2014	1,330.9	µgm ³	-	-	-	<24,400	-	<20,300	<20,300	<19,900	<19,800	<19,800	-	-	-	-	<69,400	-	66,400	-	-	-	1,830,000	<12,800	--	
TSSV-04-PZ																											
	6/12/2013	1,182.3	µg/m ³	<782.5	<1,570	<660	<1,220	<1,040	<1,010	<1,010	<992.5	3,310	<990	<1,160	<1,140	<3,600	<5,340	<867.5	<1,720	<1,700	<1,140	<1,370	<1,370	33,100	<640	--	
	6/28/2013	1,182.3	µg/m ³	-	-	-	-	-	-	-	250	1,400	15	-	-	-	-	-	-	190	-	-	-	6,000	270	WMS Passive Soil Gas Survey	

Notes: Grey text indicates a non-detected compound
 µg/m³ - micrograms per cubic meter
 ft amsl - feet above mean sea level
 - = data not applicable or available



APPENDIX D

PHASE 3 GROUNDWATER MODELING MEMORANDUM



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MEMORANDUM

To: Natalie Chrisman Lazarr, P.E.
Amec Foster Wheeler

Date: March 1, 2016

From: Miao Zhang, Anchor QEA, LLC

Project: 140535-01.01

Cc: Michael Riley, Anchor QEA, LLC

Re: Draft Revised Phase 3 Modeling Memorandum – Revision 3
Cave Creek Landfill, Maricopa County, Arizona

This revised memorandum is prepared for Amec Foster Wheeler Environment & Infrastructure Americas (Amec Foster Wheeler) to document the development of the Phase 3 contaminant transport model and associated simulation results for the Cave Creek Landfill (Site; Figure 1) in Maricopa County, Arizona. The purpose of Phase 3 transport modeling is to support the Remedial Action Plan (RAP). In this document, on-site refers to within the landfill property, while off-site refers to outside the landfill property.

This memorandum is the third revision to the Revised Preliminary Draft Phase 3 Modeling Memorandum dated December 12, 2014, which was included as Appendix B of the *Regulatory Draft Revised Remedial Action Plan* dated February 2015. The first revision, Draft Revised Phase 3 Modeling Memorandum dated June 2, 2015, addressed the comments made by the Arizona Department of Environmental Quality (ADEQ) on the RAP. The second revision reflected updates to transport simulations to address comments made by the City of Phoenix (COP) on the RAP. The COP requested that an alternative that prevents migration of the off-site volatile organic compound (VOC) plume toward COP water supply wells be considered. The corresponding alternatives were updated in the second revision to achieve the objective of preventing further migration of the off-site VOC plume. The updates made in the first and second revisions were retained in this memorandum. The current revision reflects the addition of alternatives that include an off-site injection well. For the purpose of completeness, the revisions in all three updates are described below.

UPDATES IN REVISION 1 (JUNE 2, 2015 MEMORANDUM)

ADEQ's comments on the December 12, 2014, transport modeling memorandum included the following:

- *Figures should be added to demonstrate the effects of the more aggressive remedy on existing plume migration.*
- *Simulated concentrations along the boundary between the Sonoran Preserve and the State Trust Land should be shown.*
- *The simulation period should be limited to 100 years, which is the period for reasonable foreseeable uses as defined in Arizona Administrative Code (A.A.C.) R18-16-406.D.*
- *Potential impacts to two registered wells, 221637 and 221450, which were not in the previous transport models as potential receptors, should be evaluated.* Based on their permit applications, these two wells are used for irrigation of the nursery and golf course, instead of portable use. These two wells were not in the previous transport modeling work because they were installed in 2012 and 2013, respectively, and do not have annual extraction data in the Arizona Department of Water Resources database.

In addition, based on inputs provided by Amec Foster Wheeler, the following changes were made to the transport model:

- For alternatives that involve injection of treated groundwater, the injection well location was changed from off site to on site.
 - Pumping rates for the water supply wells were changed from those in the calibrated flow model, as follows:
 - The 2009 to 2013 average pumping rates, instead of 2010 to 2011 average rates, were used for the water supply wells, other than wells 221637 and 221450.
 - Wells 221637 and 221450 were installed in 2012 and 2013, respectively, and consequently, the permitted maximum pumping rates were used for these wells.
 - An organic carbon fraction (foc) value, 0.00016, was used. This value is lower than the previously used value of 0.0010 by a factor of 6. The foc value of 0.00016 is based on the foc values measured at the North Indian Bend Superfund site in the
-

Maricopa County (Montgomery & Associates 2013). This foc value results in a retardation factor of 1.41 compared to the previous value of 3.55.

UPDATES IN REVISION 2 (JANUARY 18, 2016 MEMORANDUM)

The following was the COP comment on the RAP:

- *Alternative 4 proposes to install the injection well on the western portion of the landfill. During the meeting we discussed if substitute locations were modeled to create a hydraulic barrier between the contamination plume and Phoenix water supply wells or injection at the toe of the contamination plume to reduce off-site migration. Although Amec confirmed that numerous alternative models were evaluated, we are requesting confirmation that none of the modeled alternatives would serve as a more effective injection location to contain the plume.*

Based on input provided by Amec Foster Wheeler, logistical reasons precluded locating the injection well outside the landfill. Under this logistical constraint, modifications were made to the alternatives that consist of on-site extraction and on-site injection to prevent further migration of the off-site VOC plume.

UPDATES IN REVISION 3 (THIS MEMORANDUM)

Because the COP offered to help locate the injection well outside the landfill property, alternatives were added that consist of on-site extraction and off-site injection to prevent further migration of the VOC plume. These updates and associated transport simulations are described in this memorandum.

INTRODUCTION

Previous landfill activities at the Site have resulted in chlorinated VOC contamination in groundwater. Amec Foster Wheeler is preparing an RAP to develop and evaluate potential remedial alternatives to address VOC contamination in groundwater. Groundwater flow and contaminant transport modeling was performed to support the RAP in three phases. During Phase 1, information was gathered, a technical approach was developed, and model inputs were identified. Phase 1 was completed by Amec Foster Wheeler and documented in the Phase 1 Groundwater Modeling Report (Amec Foster Wheeler 2013). During Phase 2, a

steady-state numerical groundwater flow model was constructed and calibrated (referred to herein as the Phase 2 flow model). Phase 2 was completed jointly by Amec Foster Wheeler and Anchor QEA, LLC, and was documented in the Phase 2 Modeling Report (Amec Foster Wheeler and Anchor QEA 2014). During Phase 3, a contaminant transport model was developed, and predictive simulations were performed to evaluate potential groundwater remediation alternatives, which are documented in this memorandum.

The objective of the Phase 3 modeling is to evaluate screening-level designs of potential groundwater remediation alternatives. This memorandum consists of the following sections:

- Update to the Conceptual Model for Groundwater Flow
- Conceptual Model for Contaminant Transport
- Groundwater Flow Model Development
- Transport Model Development
- Predictive Transport Simulations
- Model Uncertainty

Site history, regional geology, and local hydrogeology are described in detail in other project reports (Amec Foster Wheeler 2012; Amec Foster Wheeler and Anchor QEA 2014), and thus, are not repeated here.

UPDATE TO THE CONCEPTUAL MODEL FOR GROUNDWATER FLOW

The update to the conceptual model for groundwater flow includes adding an upgradient boundary flow component from an unnamed subbasin on the northeast of the Site (Figure 2). This upgradient boundary flow component was not included in the Phase 2 conceptual model because the Salt River Valley (SRV) model, which the Phase 2 conceptual model is based upon, conceptualizes the upgradient boundary in this area as a no-flow boundary. However, during Phase 2 model calibration, it was found that a high mountain-front recharge rate (17.4 inches/year; equivalent to twice the annual recharge) was required in this area to match the observed water level data and groundwater flow direction. As explained in the Phase 2 Modeling Report, this mountain-front recharge rate is high because it not only represents recharge due to local infiltration, but also an upgradient boundary flow from the unnamed subbasin to the northeast, which receives runoff from surrounding mountains and

discharges to the Cave Creek model domain between bedrock outcrops (Figure 2). This conceptual model update is reflected in the numerical flow model (see the Groundwater Flow Model Development section of this memorandum).

CONCEPTUAL MODEL FOR CONTAMINANT TRANSPORT

The conceptual model for transport of VOCs is described in the RAP. The essential components of the transport conceptual model include the following:

- VOCs likely have entered the vadose zone in vapor-phase, and have migrated laterally and vertically via pressure-driven advection, density-driven advection, and diffusion.
 - Vapor-phase VOCs may have migrated under pressure- and density-driven advection in the past. However, pressure- and density-driven advection are not the predominant transport mechanisms under current conditions, as explained below:
 - Pressure-driven advection had resulted from landfill gas (LFG) generation in the past, which is no longer a significant driving force as LFG was depleted. For example, the LFG collection system was shut down in July 2007 because of an insufficient amount of LFG for flare operation.
 - Density gradients can drive downward advection of vapor-containing VOCs because chlorinated VOCs have higher molecular weight than air or LFG (which predominantly consists of methane and carbon dioxide). However, research has suggested that density-driven vapor advection is non-negligible only when the vapor density is at least 1.15 or 1.20 times that of air or LFG (Cotel et al. 2011). Because the vapor-phase trichloroethylene (TCE) concentrations detected at the Site are orders of magnitude lower than the concentration threshold that corresponds to a vapor density 1.15 or 1.2 times that of air, density-driven vapor advection is likely insignificant for the current VOC vapor plume.
 - Vapor-phase diffusion is likely the predominant transport mechanism for VOCs in the vadose zone under current conditions.
 - Vapor-phase VOCs may have entered groundwater by dissolving into infiltrated water as a result of heavy rainstorms or flooding and by diffusing across the capillary fringe.
-

- Main transport mechanisms for VOCs in the saturated zone include advection, mechanical dispersion, diffusion, and adsorption.

GROUNDWATER FLOW MODEL DEVELOPMENT

Two variations on the Phase 2 numerical flow model were used in the Phase 3 modeling analysis. The two models have the same model grid, but have different vertical layering. One model has the same two layers as the Phase 2 flow model, and is referred to as “the 2-layer model.” The other model has 34 layers and was developed by subdividing the 2-layer model into multiple layers. This model is referred to as “the 34-layer model.” The 2-layer model is used for particle tracking to estimate the hydraulic capture zone. The 34-layer model is used for particle tracking and to provide a three-dimensional groundwater flow field for contaminant transport modeling so that the vertical distribution of TCE can be simulated.

In both the 2-layer and the 34-layer models, flow boundary conditions were modified to reflect the update to the conceptual flow model as described in the Update to the Conceptual Model for Groundwater Flow section of this memorandum. The extent of the model domain remained unchanged, and hydraulic properties (hydraulic conductivity and porosity) continue to be assumed to be uniform across the model domain. As a result of the update, refining of model calibration was also required. The flow models were calibrated to the average 2010 to 2011 condition, same as the Phase 2 flow model.

The flow model continues to use the United States Geological Survey modular finite-difference groundwater model MODFLOW 2005 code (Harbaugh 2005). The commercial software Groundwater Vistas (GWV; Environmental Simulations, Inc., Version 6.74 Build 46, 64-bit) was used for pre- and post-processing.

Model Grid Refinement

Model grid refinement includes using a uniform row spacing of 100 feet for the area between the southern end of the landfill and the southern model boundary, where VOC plume migration occurs (Figure 3). In contrast, in the Phase 2 flow model, this area has variable grid spacing ranging from 100 feet in the vicinity of the landfill to 2,640 feet near the

southern model boundary. The refined row spacing allows for more detailed simulation of plume migration from the landfill. The column spacing remained unchanged from the Phase 2 flow model because the area where the plume is located already had 50-foot column spacing in the model, which is considered sufficiently fine for contaminant transport modeling. After refinement, the model grid consisted of 312 rows and 138 columns.

Vertical Discretization

The 2-layer model consists of two layers separated by a flat surface, at an elevation of 1,050 feet above mean sea level (AMSL) North American Vertical Datum of 1988, as in the Phase 2 flow model.

In the 34-layer model, the domain was divided vertically into 34 layers, with a uniform layer thickness of 30 feet, except for the top layer (i.e., Layer 1), which is bounded at the top by ground surface, and the bottom layer (i.e., Layer 34), which is bounded at the bottom by bedrock. The bottom of Layer 1 is set at 30 feet below the simulated water table in the 2-layer model, which results in a uniform saturated thickness of 30 feet in Layer 1. The bottom of each subsequent layer, except for Layer 34, is set at 30 feet below the bottom of the layer above it. The bottom of Layer 34 is specified using the top of bedrock elevations in the SRV spatial dataset (ADWR 2014). This vertical discretization allows the water table to be contained within Layer 1, and all other layers to remain saturated. Correspondingly, Layer 1 is specified as a convertible layer with transmissivity that varies with head. All other layers are specified as a confined layer with constant transmissivity.

The purpose of using a uniform layer thickness is to avoid numerical errors associated with using vertically deformed model layers (Zheng and Bennett 2002). A thickness of 30 feet is based on input from ADEQ as a typical screen length for predicting groundwater contamination at a monitoring well.

Boundary Conditions

Boundary conditions in the 2-layer model are the same as those in the Phase 2 flow model (Figures 4 and 5), except that a General-Head Boundary (GHB) package was added along the northern boundary in Layer 1 (Figure 4) to represent the upgradient boundary flow

component from the unnamed subbasin, as described in the Update to the Conceptual Model for Groundwater Flow section of this document (Figure 2). The GHB head is set to an elevation of 2,000 feet AMSL, which is based on the 2002 measured groundwater elevations in the SRV geodatabase. The GHB conductance was adjusted during calibration refinement. The recharge rate for the corresponding mountain-front recharge Zone 3, which was previously used to represent flux along this segment of the model boundary in the Phase 2 model, was set at zero (Table 1).

In the 34-layer model, boundary condition modifications include specifying GHB and Well (WEL) packages in multiple layers. At a location with a GHB package (designated by a row number and a column number), GHB may be present in 1 to 34 layers of the 34-layer model, and may be present in one or two layers of the 2-layer model. At each location, the GHB conductance in the 2-layer model is summed vertically, and is evenly distributed between the corresponding GHB cells at the same location in the 34-layer model. For example, at the grid cell of Row 6 and Column 1, GHB is in Layers 1 and 2 in the 2-layer model, and has a total GHB conductance of 26.26 square feet per day (ft²/d); in the 34-layer model, GHB is in Layers 1 through 7. Therefore, each GHB cell in the 34-layer model is assigned a GHB conductance of 3.75 ft²/d, which is equal to 26.26 ft²/d divided by 7. The GHB heads remained unchanged between the 2-layer and 34-layer models.

The regional water supply wells, their pumping rates during the calibration period of 2010 to 2011, and their model layers for the WEL package are shown in Table 2. The pumping rates in the WEL package are distributed to the model layers that are within the screen elevations presented in Table 2. GWV allocates pumping rates between multiple layers within the screen interval based on the transmissivity of each layer.

Solver and Convergence Criteria

The geometric multigrid solver is used to solve the numerical flow model. The head change and flow residual convergence criterion remained unchanged at 0.001 foot and 1 cubic foot per day, respectively.

Model Calibration

Model calibration involves adjusting the horizontal hydraulic conductivity value to minimize head residuals. The calibrated horizontal hydraulic conductivity values in the 2-layer and 34-layer models are 13.03 and 11.61 feet per day, respectively. These values are only slightly different from 12.78 feet per day, the calibrated horizontal hydraulic conductivity value used in the Phase 2 flow model. The small difference between the calibrated horizontal hydraulic conductivity is a result of different vertical discretization for the two models, and is not expected to substantially affect contaminant transport evaluations. Vertical hydraulic conductivity remains fixed at 1.2 feet per day.

Calibration targets included water level targets and an estimated water budget. The water level targets and their weights are the same as those used in the Phase 2 flow model. In the 34-layer model, the water level targets were set in the model layer corresponding to the midpoint of screen interval. The water level targets are listed in Table 3.

Calibration to the calibration targets is acceptable for both the 2-layer and the 34-layer models. Calibration statistics for the 2-layer and 34-layer models are shown in Tables 4 and 5, respectively. A comparison of the estimated water budget to the simulated water budgets for the 2-layer and the 34-layer models are presented in Tables 6 and 7, respectively.

TRANSPORT MODEL DEVELOPMENT

The contaminant transport model for dissolved-phase TCE was developed based on the 34-layer model. The transport processes simulated by the contaminant transport model include advection, dispersion, and adsorption. In situ degradation of TCE is assumed to be negligible to provide a conservative (i.e., biased high) prediction of TCE concentrations at downgradient wells. The simulated steady-state groundwater flow field by the 34-layer model is used to simulate advection. Dispersion is simulated by specifying dispersivity parameters, while molecular diffusion is considered negligible compared to mechanical dispersion. Adsorption is simulated by specifying a retardation factor. The transport parameters for TCE are presented in Table 8. All of the transport parameter values are uniform across the model domain.

Five scenarios were simulated using the groundwater flow and transport models. They correspond to Alternatives 1, 2, 4, and 5 in the RAP, as well as an enhancement to Alternative 4, as described below:

1. **Alternative 1:** Consists of monitored natural attenuation (MNA) for the groundwater plume.
2. **Alternative 2:** Consists of soil vapor extraction (SVE) to control the VOCs in the vadose zone and MNA for the groundwater plume. Alternative 3 in the RAP consists of the same components as Alternative 2, plus wellhead treatment as a contingency measure. From the transport modeling perspective, Alternative 3 is the same as Alternative 2.
3. **Alternative 4:** Consists of SVE to control the VOCs in the vadose zone, on-site groundwater extraction to hydraulically contain the VOC plume, and injection of extracted groundwater following treatment.
 - **Alternative 4A:** The injection well is located at an off-site location.
 - **Alternative 4B:** The injection well is located at an on-site location.
4. **Alternative 4 Enhancement:** Consists of all the components of Alternatives 4A or 4B, plus on-site, in situ chemical oxidation (ISCO).
 - **Alternative 4A Enhancement:** Alternative 4A plus on-site ISCO.
 - **Alternative 4B Enhancement:** Alternative 4B plus on-site ISCO.
5. **Alternative 5:** Consists of SVE to control the VOCs in the vadose zone and off-site groundwater extraction to prevent further migration or expansion of the VOC plume.

Alternative 1 does not have source control for VOCs in the vadose zone. Therefore, a source term is specified in the transport model for Alternative 1. In contrast, because all of the other scenarios are accompanied by SVE to control the VOCs in the vadose zone, no source term is specified in the transport models for these scenarios. The transport model uses the MT3DMS code (Version 5.3; Zheng and Wang 1999; Zheng 2005).

Transport Boundary Conditions

The transport boundary conditions include specified concentration gradient boundary (i.e., Neumann Boundary) in the GHB cells on the southern model boundary. The specified

concentration gradient is zero. Therefore, the dispersive flux across the southern model boundary is zero. TCE can leave the model domain as advective flux where the simulated concentrations are non-zero.

The transport boundary conditions also include the WEL boundary to represent the regional pumping wells (Table 9). The differences between the WEL boundary in the transport model and the calibrated flow model include the following:

- The 2009 to 2013 average pumping rates, instead of the 2010 to 2011 average pumping rates, were used for the wells listed in Table 2.
- Besides the wells listed in Table 2, two additional wells, 221637 and 221450, were added in Table 9. These two wells were not in the calibrated flow model because they were installed after the 2010 to 2011 calibration period. No historical pumping data are available for these two wells. Therefore, the permitted maximum pumping rates for wells 221637 and 221450 were used in the transport model.

For Alternative 1 alone, the transport boundary conditions also include a specified flux boundary (i.e., Cauchy Boundary) over the known extent of VOCs in the vadose zone to represent the influx of TCE due to leaching, as shown on Figure 6. Although the specified flux should consist of advective and dispersive flux, it is customary to assume that the advective flux dominates the dispersive flux (Zheng and Wang 1999). Therefore, the specified flux is set equal to the TCE mass flux in leachate, which was simulated by Amec Foster Wheeler using the VLEACH model (Ravi and Johnson 1997). A recharge rate of 0.5 inch per year was used in the VLEACH model. The TCE mass flux in leachate is shown on Figure 7. The specified flux boundary is represented in the transport model as a recharge zone with a recharge rate of 0.5 inch per year. The extent of the recharge zone is shown on Figure 6. The TCE concentration in recharge, as shown on Figure 7, was calculated by dividing the mass flux by the product of the recharge rate and the recharge zone area. The concentration in recharge rises to a peak value of 581 micrograms per liter ($\mu\text{g/L}$) during the first 100 years, and then declines at a much flatter slope than the rise.

Solution Methods and Solver

A transport model requires a solution method for the advection term and a solution method for the dispersion term. The third-order total-variation-diminishing (TVD) method, with a Courant number of 1, is used to solve the advection term. The TVD method automatically calculates the transport time step size that satisfies its stability constraint. The implicit finite difference method is used to solve the dispersion term. The Generalized Conjugate Gradient solver is used with a convergence criterion for a relative concentration of 10^{-6} .

Initial Concentrations

TCE concentrations in groundwater under current conditions, as interpreted from groundwater sampling data, are shown in Figure 8. The highest concentration is 100 µg/L. The existing VOC plume is assumed to be present within the top 120 feet of the alluvial aquifer. The distribution of TCE concentrations is assumed to be the same in the top four layers of the transport model.

PREDICTIVE TRANSPORT SIMULATIONS

Predictive transport simulations were performed for a period of 100 years to evaluate the effects of remediation alternatives on the migration of the TCE plume. The transport simulation results for each scenario include the following:

- TCE distribution downgradient of the Site.
- TCE concentrations in the regional water supply wells downgradient of the Site that intercept the plume during the simulation period of 100 years, for comparison with the Arizona Water Quality Standard (AWQS) of 5 µg/L.
- TCE concentrations along the downgradient boundary of the COP Sonoran Preserve (Figure 1), for comparison with the AWQS.

For Alternatives 4 and 5, which consist of on-site or off-site groundwater extraction and injection, particle tracking using MODPATH (Pollock 1994) was first performed on the 34-layer model to estimate the required extraction and injection rate. The groundwater extraction well and injection well (if required by the alternative) are represented in the 34-layer model using the MODFLOW Multi-Node Well2 (MNW2) package. The MNW2 package allocates extraction rates between multiple layers crossed by the well screen, and

calculates a single water level elevation and solute concentration for the whole well at each transport time step.

Alternative 1

Alternative 1 consists of using MNA to monitor the attenuation of the TCE plume over time, without using SVE to control VOCs in the vadose zone. The simulated TCE concentrations in layer 1, which contains the water table, after 10, 20, 30, 50, and 100 years are shown in Figures 9a, 9b, 9c, 9d, and 9e, respectively. In layer 1, the peak concentration occurs beneath the landfill as a result of the TCE mass flux in the leachate (Figure 7). The TCE mass in the groundwater under existing conditions (Figure 8) migrates off site, and forms an off-site plume. The simulated TCE concentrations in the layer with peak concentrations in the off-site plume after 30 and 100 years are shown in Figures 9f and 9g, respectively. The assumed continuous source at the landfill, as shown on Figures 6 and 7, results in an elongated TCE plume that originates from the landfill. The plume reaches water supply wells 221637, 527549, and 221450 within the simulation period of 100 years.

Figure 10 shows the simulated concentrations at water supply wells 221637, 527549, and 221450 over time. Because each well is screened across multiple layers (Table 9), the concentration shown in Figure 10 at any given time is the highest concentration among all the layers at the same well location. The peak concentration at well 221637 of 16 $\mu\text{g/L}$ is predicted to occur at year 57. Peak concentrations at wells 221450 and 527549 are predicted to occur at year 100 at low concentrations of 0.02 and 0.4 $\mu\text{g/L}$, respectively.

Alternative 2

Alternative 2 consists of using SVE to control VOCs in the vadose zone and using MNA to monitor the attenuation of the TCE plume over time. The simulated TCE concentrations after 10, 20, 30, 50, and 100 years are shown in Figures 11a, 11b, 11c, 11d, and 11e, respectively. Because source control is implemented, the TCE plume detaches from the landfill, follows the predominant groundwater flow direction toward the south-southeast, attenuates through dispersion and adsorption, and reaches water supply wells 221637, 527549, and 221450 within the simulation period of 100 years.

Figure 12 shows the simulated concentrations at water supply wells 221637, 527549, and 221450 over time. The simulated maximum concentrations are nearly identical to Alternative 1 (Figure 10). The only difference from Alternative 1 is at year 100, the concentration at well 221637 is lower than Alternative 1 (0.5 µg/L versus 2 µg/L), due to the lack of contribution from the continuous source at the landfill.

Alternative 4

Alternative 4 relies on on-site groundwater extraction to prevent further migration of the VOC plume, and consists of two alternatives. In Alternative 4A, the extracted groundwater is injected into the aquifer at an off-site location following treatment. In Alternative 4B, the extracted groundwater is injected into the aquifer at an on-site location.

As presented below, the groundwater extraction rates in Alternatives 4A and 4B are 190 and 370 gallons per minute (gpm), respectively. These extraction rates are higher than the extraction rate used in the Phase 2 evaluation to provide hydraulic containment of the potential source of VOCs to groundwater, which was 30 gpm (Amec Foster Wheeler and Anchor QEA 2014). The difference is due to the different target capture zones in Phase 2 and Phase 3. The target capture zone in Phase 2 is the inferred extent of contaminated soil vapor on site, whereas the target capture zone in Phase 3 is the dissolved VOC plume on site and off site. Because the dissolved VOC plume is larger than the extent of on-site contaminated soil vapor, a higher extraction rate is required in Phase 3.

Alternative 4A

The extraction well is located approximately 150 feet west of MW-02, while the off-site injection well is located approximately 600 feet south of the southeastern corner of the Sonoran Preserve (Figure 13). The extraction well is screened across the top four model layers (i.e., 120 feet below ambient water table), while the injection well is screened across the top 13 model layers (i.e., 390 feet below ambient water table). The extraction rate and injection rate are distributed between the layers by the MNW2 package.

First, particle tracking was used to identify the extraction rate required to prevent further migration of the VOC plume. In the model, particles are released in the top four layers

around the perimeter of the VOC plume. The locations of the particles are tracked as time moves forward. The extraction/injection rates were adjusted until all the released particles were captured by the extraction well. Particle tracking results suggest that extraction and injection rates of 190 gpm provide complete hydraulic capture of the VOC plume, as shown in Figure 13. Particle tracking results using a lower extraction/injection rate of 175 gpm suggest that complete hydraulic capture of the plume would not be achieved, as shown in Figure 14.

The simulated TCE concentrations after 10, 20, 30, and 50 years are shown in Figures 15a through 15d, respectively. The plume is fully contained by the on-site extraction well and, therefore, does not migrate beyond its current extent. As a result, simulated TCE concentrations at the downgradient water supply wells are negligible.

Alternative 4B

The extraction well is located at the same place as Alternative 4A, while the on-site injection well is located northeast of the Transfer Station (Figure 16). Both the extraction well and the injection well are screened across the top four model layers (i.e., up to 120 feet below the ambient water table). The extraction rate and injection rate are distributed between the top four layers by the MNW2 package.

Particle tracing for Alternative 4B was performed in the same way as Alternative 4A. Particle tracking results suggest that extraction and injection rates of 370 gpm provide complete hydraulic capture of the VOC plume, as shown in Figure 16. This extraction rate is higher than the extraction rate in Alternative 4A. The reason is that some of the water injected at the on-site location is captured by the extraction well, whereas the water injected at the off-site location is not captured by the extraction well. Capturing injected water results in a smaller capture zone at the same extraction rate. Therefore, in order to achieve the same capture zone, the extraction rate is higher with an on-site injection well than with an off-site injection well. Particle tracking results using a lower extraction/injection rate of 300 gpm suggest that a lower rate does not provide complete hydraulic capture of the plume, as shown in Figure 17.

The simulated TCE concentrations after 10 and 20 years are shown in Figures 18a and 18b, respectively. The plume is fully contained by the on-site extraction well and, therefore, does not migrate beyond its current extent. As a result, simulated TCE concentrations at the downgradient water supply wells are negligible.

Alternative 4 Enhancement

Alternative 4 Enhancement consists of on-site ISCO, in addition to groundwater extraction/injection in Alternatives 4A and 4B. The goal of ISCO is to reduce the operation period of on-site groundwater extraction by removing VOC mass in the existing plume. ISCO works by injecting oxidizing reagents in the saturated zone, and as the reagents react with groundwater containing VOCs, the VOCs are oxidized into benign constituents. The effects of ISCO on the existing TCE plume is represented by setting the initial TCE concentrations in the area treated by ISCO to zero, as shown in Figure 19.

Alternative 4A Enhancement

The simulated TCE concentrations after 10, 20, 30, and 50 years are shown in Figures 20a through 20d, respectively. As in Alternative 4A, the plume is fully contained by the on-site extraction well, and, therefore, does not migrate beyond its current extent. As a result, simulated TCE concentrations at the downgradient water supply wells are negligible.

Alternative 4B Enhancement

The simulated TCE concentrations after 10 and 20 years are shown in Figures 21a and 21b, respectively. As in Alternative 4B, the plume is fully contained by the on-site extraction well, and, therefore, does not migrate beyond its current extent. As a result, simulated TCE concentrations at the downgradient water supply wells are negligible.

Alternative 5

Alternative 5 consists of using off-site groundwater extraction to prevent further migration or expansion of the existing TCE plume. The off-site groundwater extraction well would be located at the southern edge of the existing TCE plume in the Sonoran Preserve, as shown in Figure 22. The groundwater extraction well depth and extraction rate were adjusted until

the TCE plume was completely captured. The extraction well is required to have a 360-foot screen extending from the water table to bedrock, and have an extraction rate of 200 gpm.

The simulated TCE concentrations after 10, 20, 30, and 40 years are shown in Figures 23a, 23b, 23c, and 23d, respectively. The plume is fully contained by the off-site extraction well. As a result, the concentrations at the water supply wells are negligible.

Maximum Concentration Leaving the Sonoran Preserve Boundary

The simulated maximum TCE concentrations over time along the Sonoran Preserve boundary are shown in Figure 24 for the above alternatives. Because ISCO treatment does not affect the behavior of the off-site plume, the simulated maximum TCE concentrations along the Sonoran Preserve boundary are the same for Alternative 4 and Alternative 4 Enhancement. Therefore, only Alternative 4A and Alternative 4B are included in Figure 24. At any given time, the maximum concentration depicted in Figure 24 is the highest concentration in any model grid cell along the Sonoran Preserve boundary across all layers. The location and depth of the maximum concentration may change over time. The following observations are made from Figure 24:

- The concentrations for Alternative 1 are higher than the other alternatives. The peak concentration of 51 µg/L occurs at year 20. The concentration decreases to 12 µg/L at year 52, and increases subsequently. The concentration at year 100 is predicted to be 25 µg/L. The persistent presence of elevated levels of TCE along the Sonoran Preserve boundary is consistent with the elongated plume shown on Figures 9a through 9g, and is a result of continuous influx of TCE from the vadose zone source area.
 - The concentrations for Alternative 2 show the characteristics of a dissolved plume passing the Sonoran Preserve boundary (Figures 11a through 11e), and closely follow those of Alternative 1 until year 40, after which they fall below Alternative 1. The concentrations decrease below the AWQS after year 54. The decrease is a result of the removal of TCE influx from the vadose zone source area by SVE.
 - The concentrations for Alternative 4A and Alternative 4B decrease over time, and drop below the AWQS within the first 5 years. The concentrations for Alternative 4B decrease faster than Alternative 4A, as a result of the higher extraction rate.
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- The concentration for Alternative 5 reaches its peak of 22 µg/L at year 4, and decreases below the AWQS after year 18. The peak concentration results from groundwater, containing an elevated concentration of TCE, being pulled onto the Sonoran Preserve property by the off-site extraction well.

Figures 25, 26, 27, and 28 show the simulated TCE concentrations near the Sonoran Preserve boundary in the first 4 years for Alternatives 4A, Alternative 4B, Alternative 4A Enhancement, and Alternative 4B Enhancement, respectively. In all four cases, the off-site plume shrinks over time, which results in decreases in concentrations along the Sonoran Preserve boundary. By comparing Alternative 4A (Figure 25) to Alternative 4B (Figure 26) and comparing Alternative 4A Enhancement (Figure 27) to Alternative 4B Enhancement (Figure 28), it can be seen that the higher extraction rate results in faster removal of the off-site plume.

Figure 29 shows the simulated TCE concentrations near the Sonoran Preserve boundary at years 1, 4, 8, and 12 for Alternative 5. The location with the maximum concentration along the Sonoran Preserve boundary is at the northern end of the eastern boundary immediately adjacent to the landfill, and this location does not change over time. As the plume is being pulled toward the off-site extraction well, the maximum concentration initially increases, and then decreases due to the plume becoming narrower and diminishing over time.

Remediation Time

For the purpose of comparing the alternatives, the remediation time is defined as the amount of time it takes the maximum TCE concentration in groundwater to decrease below the AWQS of 5 µg/L. The simulated maximum concentrations in the model domain over time are shown in Figure 30. At any given time, the maximum concentration depicted in Figure 30 is the highest concentration in any model grid cell across all layers. The following observations are made from Figure 30:

- The maximum concentrations decrease monotonically, except in Alternative 1.
 - For Alternatives 1 and 2, the maximum concentration remains above the AWQS after 100 years. The maximum concentrations for Alternative 2 closely follow those of the Alternative 1 until year 30. After year 30, the maximum concentration for
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Alternative 2 continues to decrease, while that for Alternative 1 begins to increase. The increase in Alternative 1 is a result of rising concentrations in recharge in the first 100 years (Figure 7).

- The remediation times for Alternative 4A, Alternative 4B, and Alternative 5 are approximately 27, 15, and 35 years, respectively.
- The remediation times for Alternative 4A Enhancement and Alternative 4B Enhancement are approximately 10 years.
- The remediation times for Alternatives 4A Enhancement and Alternative 4B Enhancement are shorter than their counterparts without ISCO treatment because ISCO treatment results in a smaller on-site plume.

MODEL UNCERTAINTY

Potential sources of uncertainty in the Phase 3 transport model simulation results include the assumed steady-state flow field, the assumed initial concentration distribution, using GHB to represent upgradient boundary flow from the unnamed subbasin, and transport parameters, as described below.

The transport model is based on a steady-state flow field under the assumption that regional water supply pumping will remain the same as the averages of the 2009 to 2013 period. If new water supply wells are installed, or water supply well pumping rates change substantially in the future, the actual flow field may be different from the steady-state flow field, which may impact TCE plume migration direction and velocity. Such impacts can be evaluated during design of the selected alternative.

Initial concentrations for the transport model are based on two assumptions: 1) the existing TCE plume is present within the top 120 feet of the aquifer; and 2) vertical distribution of TCE within the top 120 feet is uniform. These assumptions are made based on available groundwater sampling data and the conceptual model for VOC transport (see the Conceptual Model for Contaminant Transport section of this memorandum). Existing groundwater monitoring wells are screened within the top 100 feet of the aquifer, and have screen lengths ranging from 60 to 100 feet. Based on the conceptual model for VOC transport (see the Conceptual Model for Contaminant Transport section of this memorandum), TCE concentrations are expected to decrease with depth. If the existing TCE plume is present in

the aquifer deeper than 120 feet, predicted peak concentrations in the downgradient area are expected to be higher and occur at deeper depth than the predictive simulation results in this memorandum. The vertical distribution of TCE in the aquifer is currently under investigation.

GHB is one of a few possible ways to represent upgradient boundary flow from the unnamed subbasin (Figure 2). Other types of boundary conditions, such as specified flux (WEL) package, could be used in place of GHB. Similarly, other sets of GHB parameters (GHB head and GHB conductance) can also be used. As long as the boundary condition results in acceptable flow model calibration (i.e., acceptable match to calibration targets and water budget), how the upgradient boundary flow from the unnamed subbasin is represented and parameterized in the flow model is not expected to substantially affect the transport simulation results.

Transport parameters that are important to predictive simulation results include effective porosity, the retardation factor, the degradation rate, and dispersivity. The parameter values in the Phase 3 model (Table 8) are based on the best available information. Although parameter values that are different from Table 8 may change the predicted peak concentrations or plume migration velocity for individual alternatives, such changes are not expected to substantially affect how the alternatives compare to one another.

The degradation rate was assumed to be zero. Consequently, the predicted concentrations should be considered conservatively high estimates.

SUMMARY

The contaminant transport modeling suggests the following:

- Alternative 1, in which no source control or active groundwater remedy is implemented, is predicted to result in the highest peak TCE concentration (16 µg/L) at well 221637 at year 57. Low levels of TCE concentration are predicted to persist along the migration path of the TCE plume due to continuous influx of TCE from the vadose zone source area. The maximum concentration along the Sonoran Preserve boundary is predicted to be above the AWQS beyond year 100. The maximum
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concentration in groundwater is predicted to remain above the AWQS beyond 100 years.

- Alternative 2 is also predicted to result in the highest peak concentrations at the water supply wells. The peak concentration is predicted to occur at well 221637 at 16 µg/L at year 57. The maximum concentrations along the Sonoran Preserve boundary are predicted to be above the AWQS for 54 years. The maximum concentration in groundwater is predicted to remain above the AWQS beyond 100 years.
 - Alternative 4 and Alternative 4 Enhancement do not result in impact to the water supply wells. The maximum concentrations along the Sonoran Preserve boundary are predicted to be above the AWQS for less than 5 years. The remediation time is predicted to be 10 to 27 years. Alternative 4B and Alternative 4B Enhancement have shorter remediation times than their Alternative 4A counterparts. ISCO treatment reduces remediation time by 17 and 5 years for Alternative 4A and Alternative 4B, respectively.
 - Alternative 5 can prevent further migration or expansion of the VOC plume. The maximum concentrations along the Sonoran Preserve boundary are predicted to be above the AWQS for 18 years. However, it requires a much deeper extraction well, and is predicted to have a longer remediation time than the alternatives that consist of on-site extraction and off-site/on-site injection.
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TABLES

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TABLE 1
Recharge Rates
Revised Phase 3 Modeling Memorandum
Cave Creek Landfill
Maricopa County, Arizona

Zone	Represented Area	Recharge Rate		Percentage of Average Annual Precipitation ¹	Equivalent Recharge Rate for SRV Model Grid (ac-ft/yr/cell) ²	Recharge Rate in the SRV Model (ac-ft/yr/cell)	
		(ft/d)	(in/yr)			Lower Range	Upper Range
4	Stream recharge zone	1.10E-03	4.8	55%	64	20	245
8	Stream recharge zone	3.42E-04	1.5	17%	20		
10	Mountain-front recharge zone	1.02E-04	0.4	5%	6	6	
9	Mountain-front recharge zone	6.80E-05	0.3	3%	4	4	
3	Mountain-front recharge zone ³	0	0.0	0%	0	40	
7	Mountain-front recharge zone	3.40E-05	0.1	2%	2	2	
2	Mountain-front recharge zone	1.00E-05	0.04	1%	1	40	
5	Golf courses	8.50E-04	3.7	43%	50	51	
6	Infiltration through New and Old Landfills	1.14E-04	0.5	6%	7	--	
1	Lined landfill and everywhere else	0	0	0%	0	0	

Notes:

1. Average annual precipitation is 8.7 in/yr.
2. Equivalent recharge rates for SRV model grid are calculated by multiplying the calibrated recharge rates by the cell area in the SRV model (2640 ft by 2640 ft).
3. Recharge zone 3 represents the recharge component that is replaced by upgradient boundary flow from the unnamed sub-basin (Figure 1).

Abbreviations:

ft/d = foot per day

in/yr = inch per year

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TABLE 2
Groundwater Withdrawal in Calibrated Flow Model
Revised Phase 3 Modeling Memorandum
Cave Creek Landfill
Maricopa County, Arizona

Well Registration ID	Ground Surface Elevation (ft)	Top Screen Depth (ft bgs)	Bottom Screen Depth (ft bgs)	Top Screen Elevation (ft amsl)	Bottom Screen Elevation (ft amsl)	Top Model Layer	Bottom Model Layer	2010 Pumping Rate (ac-ft/yr)	2011 Pumping Rate (ac-ft/yr)	2010-2011 Average Pumping Rate (ac-ft/yr)	2010-2011 Average Pumping Rate (cfd)
518789	2020	950	1690	1070	330	3	16	241	10	126	14980
524559	2005	740	1380	1265	625	1	9	9	13	11	1324
527549	1882	780	1470	1102	412	2	17	506	333	419	50047
540078	1860	775	1500	1085	360	2	26	100	112	106	12614
540079	1940	1100	1520	840	420	10	21	96	102	99	11821
603807	1837	--	1157	--	680	1	16	286	308	297	35479
TOTAL								1238	878	1058	126265

Notes:

1. The calibrated flow model uses the 2010-2011 average pumping rates.
2. Only the wells for which pumping data are available in the ADWR database are listed.
3. Ground surface elevations are extracted from digital elevation map made from 2-ft contour map generated by the Flood Control District of Maricopa County; project ID = 1311, flight date = 06/28/2010, date extracted = January 21, 2014.

Abbreviations:

-- = not available
ac-ft/yr = acre-foot per year
ADWR = Arizona Department of Water Resources
amsl = above mean sea level
cfd = cubic feet per day
bgs = below ground surface
ft = foot

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TABLE 3
Water Level Calibration Targets
Revised Phase 3 Modeling Memorandum
Cave Creek Landfill
Maricopa County, Arizona

Category	Well Registration ID	Top Screen Elevation (ft amsl)	Bottom Screen Elevation (ft amsl)	Water Level Calibration Target (ft amsl)	Standard Deviation (ft)	Number of Observations	Data Range	Pumping Well	Weight in Automated Calibration	Target Layer in 2-Layer Model	Target Layer in 34-Layer Model
CCL Wells	MW-02	1225	1050	1163.27	0.29	26	03/2010 through 02/2012	n	1	1	3
	MW-03	1188	1068	1164.14	0.40	25		n	1	1	3
	MW-04	1181	1095	1162.51	0.26	18		n	1	1	2
	MW-05	1183	1103	1162.22	0.31	12		n	1	1	2
	MW-06	1175	1095	1160.83	0.29	9		n	1	1	2
	PW	1204	1074	1171.48	0.44	26		n	1	1	3
Regional Wells	518789	1070	330	1136.30	--	1	12/2/2009	Y	0.1	2	10
	527549	1102	412	1144.00	--	1	1/30/2013	Y	0.1	2	10
	543024	1092	192	1136.90	--	1	2/1/2013	n	0.1	2	17
	600030	1272	1098	1151.22	--	2	7/21/2010 & 1/6/2011	n	0.1	1	2
	603807	--	680	1136.50	--	1	9/5/2010	Y	0.1	2	9
	800785	--	1012	1204.40	--	2	12/27/2010 & 12/21/2011	n	0.1	1	2

Note:

1. Target layer in the 34-layer model is set as the model layer corresponding to the mid-point of screen interval.

Abbreviations:

-- = not available

amsl = above mean sea level

ft = foot

TABLE 4
Simulated Water Levels and Calibration Statistics for 2-Layer Model
Revised Phase 3 Modeling Memorandum
Cave Creek Landfill
Maricopa County, Arizona

Category	Well Registration ID	Model Layer	Weight in Calibration	Water Level Calibration Target	Simulated Water Level	Weighted Head Residual	Non-weighted Head Residual	
				(ft amsl)	(ft amsl)	(ft)	(ft)	
CCL Wells	MW-02	1	1	1163.27	1163.09	0.19	0.19	
	MW-03	1	1	1164.14	1164.02	0.13	0.13	
	MW-04	1	1	1162.51	1162.43	0.09	0.09	
	MW-05	1	1	1162.22	1162.49	-0.27	-0.27	
	MW-06	1	1	1160.83	1160.83	0.01	0.01	
	PW	1	1	1171.48	1171.58	-0.09	-0.09	
Regional Wells	<i>518789</i>	3	0.1	1136.30	1144.01	-0.77		-7.71
	<i>527549</i>	2	0.1	1144.00	1137.59	0.64		6.41
	<i>543024</i>	18	0.1	1136.90	1133.43	0.35		3.47
	<i>600030</i>	2	0.1	1151.22	1156.16	-0.49		-4.94
	<i>603807</i>	9	0.1	1136.50	1133.15	0.33		3.35
	<i>800785</i>	1	0.1	1204.40	1203.15	0.12		1.25
Calibration Statistics						CCL and Regional Wells	CCL Wells	Regional Wells
Range of Observations						11	11	68
Mean Error						0.02	0.01	0.30
Mean Error/Range of Observations						0.2%	0.1%	0.4%
Mean Absolute Error						0.29	0.13	4.52
Mean Absolute Error/Range of Observations						3%	1%	7%
RMSE						0.37	0.15	5.00
RMSE/Range of Observations						3%	1%	7%

Notes:

1. Well IDs in *italic* indicate pumping wells.
2. Calibration statistics for weighted head residuals are shown in **bold**.
3. RMSE is equal to the square root of the mean squared head residuals.

Abbreviations:

amsl = above mean sea level

CCL = Cave Creek Landfill

ft = foot

RMSE = root mean square error

TABLE 5
Simulated Water Levels and Calibration Statistics for 34-Layer Model
Revised Phase 3 Modeling Memorandum
Cave Creek Landfill
Maricopa County, Arizona

Category	Well Registration ID	Model Layer	Weight in Calibration	Water Level Calibration Target	Simulated Water Level	Weighted Head Residual	Non-weighted Head Residual	
				(ft amsl)	(ft amsl)	(ft)	(ft)	
CCL Wells	MW-02	1	1	1163.27	1163.09	0.18	0.18	
	MW-03	1	1	1164.14	1164.08	0.06	0.06	
	MW-04	1	1	1162.51	1162.43	0.08	0.08	
	MW-05	1	1	1162.22	1162.49	-0.27	-0.27	
	MW-06	1	1	1160.83	1160.81	0.02	0.02	
	PW	1	1	1171.48	1171.33	0.15	0.15	
Regional Wells	<i>518789</i>	3	0.1	1136.30	1143.17	-0.69		-6.87
	<i>527549</i>	2	0.1	1144.00	1136.38	0.76		7.62
	<i>543024</i>	18	0.1	1136.90	1131.46	0.54		5.44
	<i>600030</i>	2	0.1	1151.22	1156.36	-0.51		-5.14
	<i>603807</i>	9	0.1	1136.50	1130.24	0.63		6.26
	<i>800785</i>	1	0.1	1204.40	1216.22	-1.18		-11.82
Calibration Statistics						CCL and Regional Wells	CCL Wells	Regional Wells
Range of Observations						11	11	68
Mean Error						-0.02	0.04	-0.75
Mean Error/Range of Observations						-0.2%	0.4%	-1.1%
Mean Absolute Error						0.42	0.13	7.19
Mean Absolute Error/Range of Observations						4%	1%	11%
RMSE						0.54	0.15	7.53
RMSE/Range of Observations						5%	1%	11%

Notes:

1. Well IDs in *italic* indicate pumping wells.
2. Calibration statistics for weighted head residuals are shown in **bold**.
3. RMSE is equal to the square root of the mean squared head residuals.

Abbreviations:

amsl = above mean sea level

CCL = Cave Creek Landfill

ft = foot

RMSE = root mean square error

TABLE 6
Simulated Water Budget for 2-Layer Model
Revised Phase 3 Modeling Memorandum
Cave Creek Landfill
Maricopa County, Arizona

Inflow/Outflow	Water Budget Component	Estimated Water Budget						Simulated Water Budget			
		Lower Range Flux (ac-ft/yr)	Upper Range Flux (ac-ft/yr)	Lower Range Flux (cfd)	Upper Range Flux (cfd)	Lower Percentage of Total Inflow/Outflow	Upper Percentage of Total Inflow/Outflow	Simulated Water Flux (ac-ft/yr)	Simulated Water Flux (cfd)	Percentage of Total Inflow/Outflow	
Inflow	Upgradient boundary flow from Lake Pleasant Subbasin	909	1445	108482	172450	22%	31%	1183	141170	25%	
	Upgradient boundary flow from northeast	--	--	--	--	--	--	2442	291421	52%	
	Recharge	Ephemeral recharge along Cave Creek	1664	1664	198586	198586			857	102319	
		Mountain-front recharge	1372	1372	163738	163738			92	10970	
		Infiltration of irrigation water on the golf courses	108	108	12873	12873			92	10943	
		Infiltration through landfill	2	2	190	190			3	304	
	TOTAL RECHARGE	3145	3145	375386	375386	78%	69%	1044	124536	22%	
TOTAL INFLOW	4054	4590	483869	547836			4668	557127			
Outflow	Downgradient boundary flow to the south	2996	3532	357604	421571	74%	77%	3622	432262	78%	
	Groundwater Withdrawal	1058	1058	126265	126265	26%	23%	1058	126265	23%	
	TOTAL OUTFLOW	4054	4590	483869	547836			4680	558527		
PERCENT DISCREPANCY BETWEEN SIMULATED INFLOW AND OUTFLOW								0	0		

Abbreviation:
ac-ft/yr = acre-foot per year
cfd = cubic feet per day

TABLE 7
Simulated Water Budget for 34-Layer Model
Revised Phase 3 Modeling Memorandum
Cave Creek Landfill
Maricopa County, Arizona

Inflow/Outflow	Water Budget Component	Estimated Water Budget						Simulated Water Budget			
		Lower Range Flux (ac-ft/yr)	Upper Range Flux (ac-ft/yr)	Lower Range Flux (cfd)	Upper Range Flux (cfd)	Lower Percentage of Total Inflow/Outflow	Upper Percentage of Total Inflow/Outflow	Simulated Water Flux (ac-ft/yr)	Simulated Water Flux (cfd)	Percentage of Total Inflow/Outflow	
Inflow	Upgradient boundary flow from Lake Pleasant Subbasin	909	1445	108482	172450	22%	31%	1148	136991	25%	
	Upgradient boundary flow from northeast	--	--	--	--	--	--	2317	276481	51%	
	Recharge	Ephemeral recharge along Cave Creek	1664	1664	198586	198586			857	102319	
		Mountain-front recharge	1372	1372	163738	163738			103	12335	
		Infiltration of irrigation water on the golf courses	108	108	12873	12873			92	10943	
		Infiltration through landfill	2	2	190	190			3	304	
	TOTAL RECHARGE		3145	3145	375386	375386	78%	69%	1055	125901	23%
TOTAL INFLOW		4054	4590	483869	547836			4520	539373		
Outflow	Downgradient boundary flow to the south	2996	3532	357604	421571	74%	77%	3462	413108	77%	
	Groundwater Withdrawal	1058	1058	126265	126265	26%	23%	1058	126265	23%	
	TOTAL OUTFLOW		4054	4590	483869	547836			4520	539373	
PERCENT DISCREPANCY BETWEEN SIMULATED INFLOW AND OUTFLOW								0	0		

Abbreviation:
ac-ft/yr = acre-foot per year
cfd = cubic feet per day

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TABLE 8
Transport Parameter Values
Revised Phase 3 Modeling Memorandum
Cave Creek Landfill
Maricopa County, Arizona

Parameters	Symbol	Value	Units	Notes
Soil Parameters				
Soil Bulk Density	ρ_b	1.68	cm ³ /g	assumed for sand and gravel
Effective Porosity	n	0.10	--	Phase 2 groundwater modeling report (Amec Foster Wheeler and Anchor QEA, 2014)
Fraction of Organic Carbon	f_{OC}	0.00016	--	Montgomery & Associates 2013
Dispersion Parameters				
Longitudinal Dispersivity	α_{XX}	60.0	ft	Xu-Eckstein formula based on a length of flow path of 2.4 miles (Fetter 1994)
Horizontal Transverse Dispersivity	α_{YX}	6.00	ft	assume $\alpha_{YX} = 0.1 \times \alpha_{XX}$
Vertical Transverse Dispersivity	α_{ZX}	0.60	ft	assume $\alpha_{ZX} = 0.01 \times \alpha_{XX}$
Chemical Parameters for TCE				
Organic Carbon Partition Coefficient	K_{OC}	152	cm ³ /g _{oc}	Fetter 1994
Soil-Water Distribution Coefficient	K_d	0.024	g/cm ³	$K_d = K_{OC} \times f_{OC}$
Retardation Factor	R	1.41	--	$R = 1 + (\rho_b \times K_d)/n$
First-order biodegradation rate constant	k	0	day ⁻¹	assume negligible
Aqueous Molecular Diffusion Coefficient	D_o	0	cm ³ /sec	considered negligible compared to mechanical dispersion

Abbreviations:

-- = unitless

cm³/g = cubic centimeter per gram

cm³/g_{oc} = cubic centimeter per grams of organic carbon

cm³/sec = cubic centimeter per second

ft = feet

g/cm³ = grams per cubic centimeter

OC = organic carbon

References:

Amec Foster Wheeler and Anchor QEA, LLC, 2014. *Phase 2 Groundwater Modeling Report*. Prepared for Maricopa County Risk Management and Maricopa County Waste Resources & Recycling Management. July 11, 2014. Job Number 14-2012-2015.

Fetter, C.W., 1994. *Applied Hydrogeology*. Third Ed. Prentice-Hall, Inc. Upper Saddle River, New Jersey.

Montgomery & Associates, 2013. 2013 Groundwater Threat Analysis for Area 7, North Indian Bend Wash Superfund Site, Maricopa County, Arizona. August 2013.

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TABLE 9
Groundwater Withdrawal in Transport Model
Revised Phase 3 Modeling Memorandum
Cave Creek Landfill
Maricopa County, Arizona

Well Registration ID	Ground Surface Elevation (ft)	Top Screen Depth (ft bgs)	Bottom Screen Depth (ft bgs)	Top Screen Elevation (ft amsl)	Bottom Screen Elevation (ft amsl)	Top Model Layer	Bottom Model Layer	Pumping Rate (ac-ft/yr)	Pumping Rate (cfd)
518789	2020	950	1690	1070	330	3	16	86	10245
524559	2005	740	1380	1265	625	1	9	9	1130
527549	1882	780	1470	1102	412	2	17	402	47931
540078	1860	775	1500	1085	360	2	26	153	18300
540079	1940	1100	1520	840	420	10	21	80	9533
603807	1837	--	1157	--	680	1	16	290	34596
221450	1879	735	1185	1144	694	1	15	441	52630
221637	1897	700	800	1197	1097	1	2	10	1193
							TOTAL	1471	175558

Notes:

1. The pumping rates for wells 55-221540 and 55-221637 are permitted maximum pumping rates.
2. The pumping rates for the other wells are 2009-2013 average pumping rates in the ADWR database.

Abbreviations:

-- = not available

ac-ft/yr = acre-foot per year

ADWR = Arizona Department of Water Resources

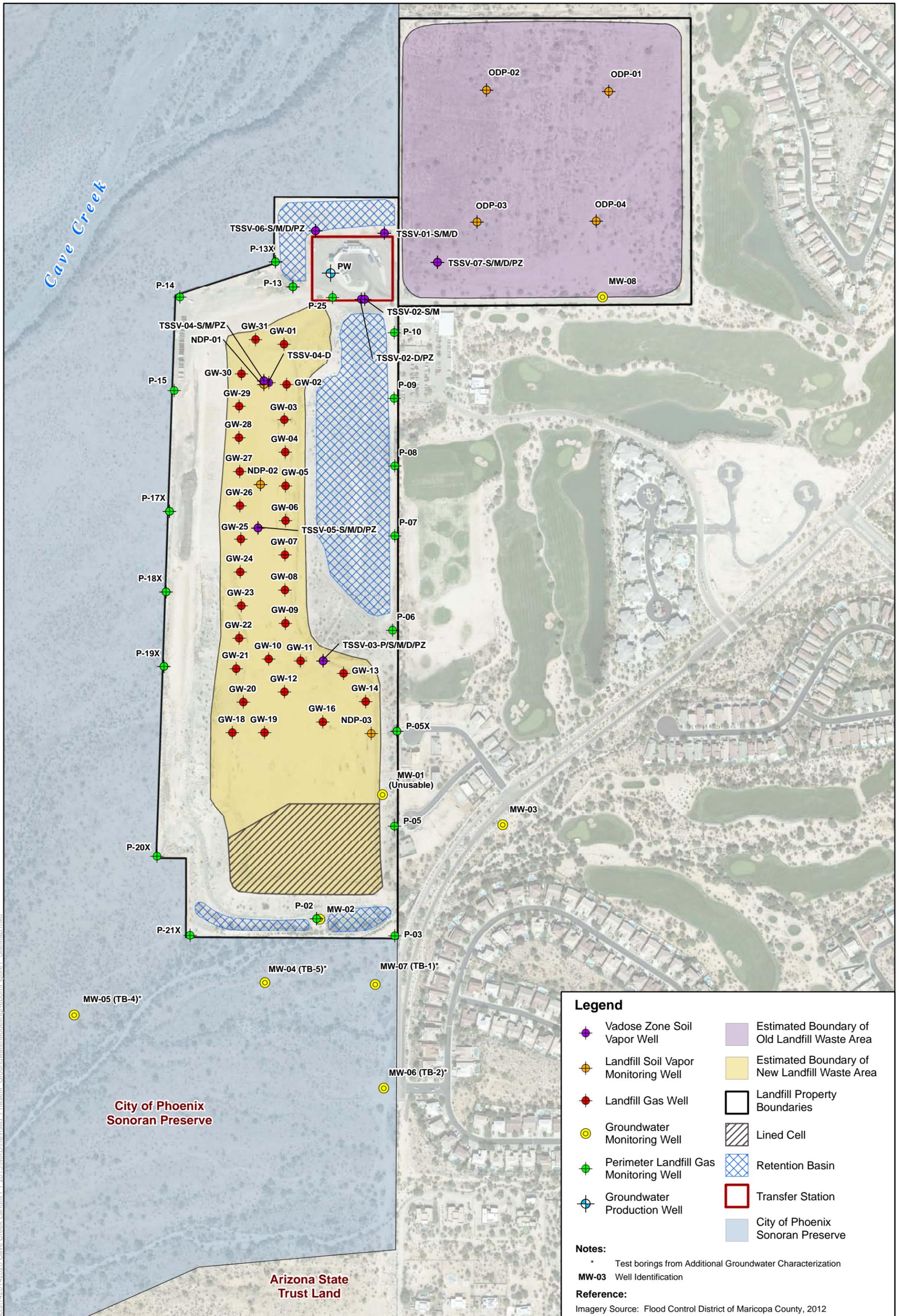
amsl = above mean sea level

bgs = below ground surface

cfd = cubic feet per day

ft = foot

FIGURES



Legend

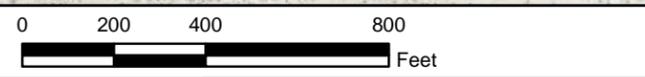
Vadose Zone Soil Vapor Well	Estimated Boundary of Old Landfill Waste Area
Landfill Soil Vapor Monitoring Well	Estimated Boundary of New Landfill Waste Area
Landfill Gas Well	Landfill Property Boundaries
Groundwater Monitoring Well	Lined Cell
Perimeter Landfill Gas Monitoring Well	Retention Basin
Groundwater Production Well	Transfer Station
	City of Phoenix Sonoran Preserve

Notes:

- * Test borings from Additional Groundwater Characterization

Reference:

Imagery Source: Flood Control District of Maricopa County, 2012



Job No. 1420142020
 PM: NC
 Date: 1/12/2016
 Scale: 1" = 400'



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 Maricopa County Cave Creek Landfill
 Phoenix, Arizona

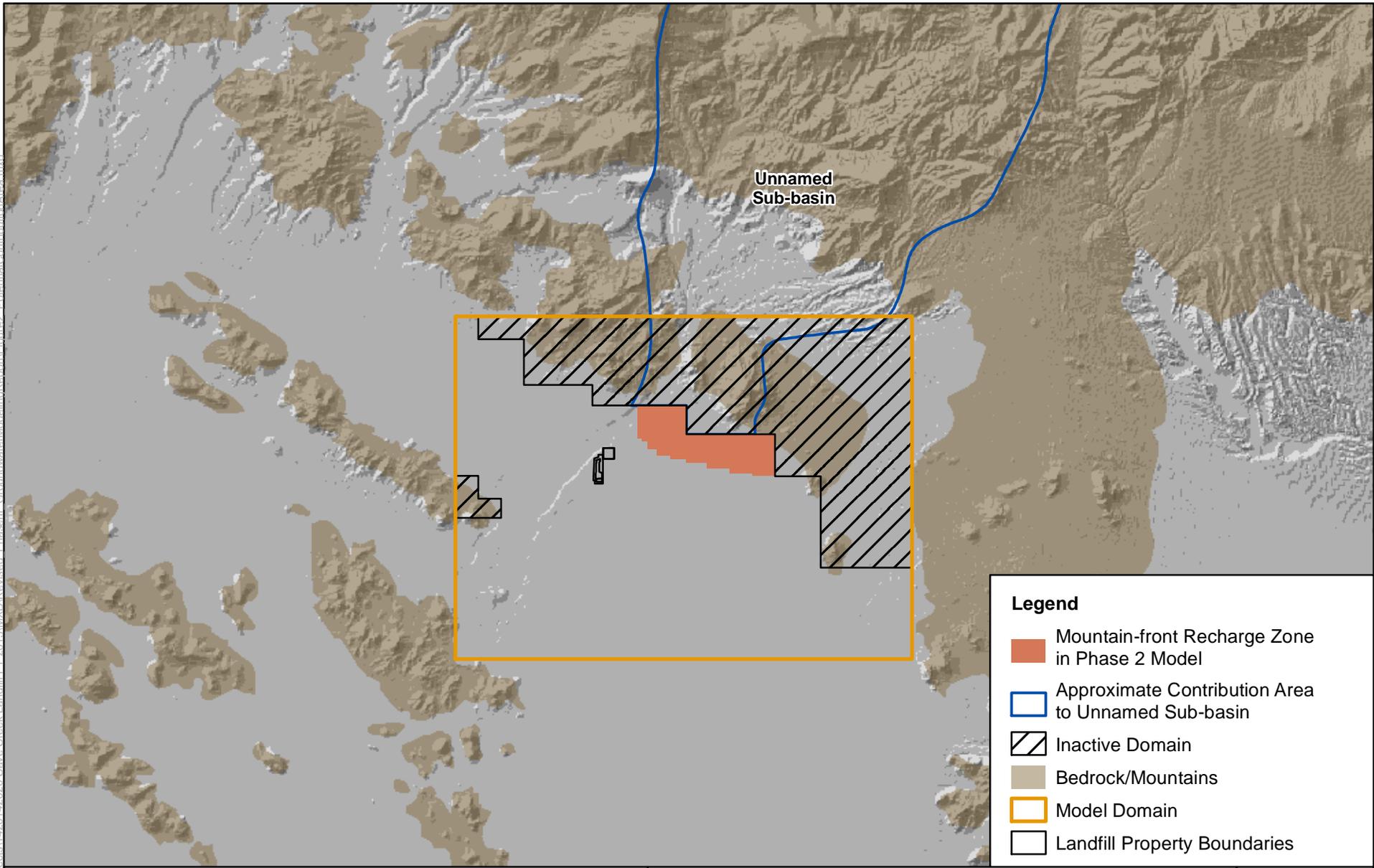
Site Map

FIGURE 1



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Unnamed Sub-basin

Legend

- Mountain-front Recharge Zone in Phase 2 Model
- Approximate Contribution Area to Unnamed Sub-basin
- Inactive Domain
- Bedrock/Mountains
- Model Domain
- Landfill Property Boundaries



Digital Elevation Model Source: Arizona Department of Water Resources, 2006

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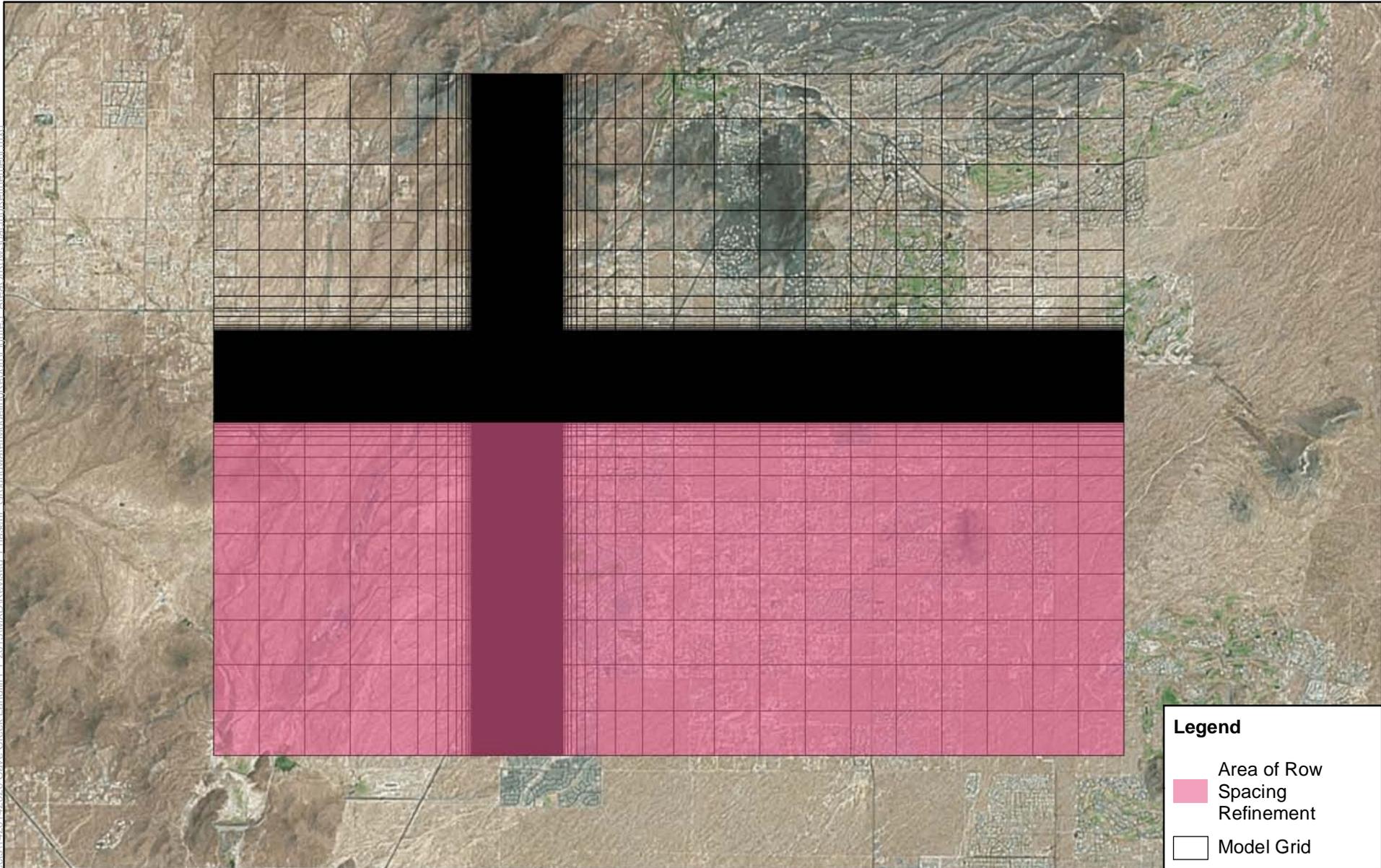
Revised Phase 3 Modeling Results Memorandum
 Maricopa County Cave Creek Landfill
 Phoenix, Arizona

Potential Contribution Area to Unnamed Sub-basin

FIGURE
2



Path: X:\Projects\2014 Projects\1420142020 Cave Creek Landfill FY 2015\MXD\Revised Phase3 Groundwater Modeling\Report\Figures3 AreaOfRowSpacingRefinement.mxd



Legend

- Area of Row Spacing Refinement
- Model Grid



Imagery Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

**Revised Phase 3 Modeling Results Memorandum
Maricopa County Cave Creek Landfill
Phoenix, Arizona**

Area of Row Spacing Refinement

**FIGURE
3**

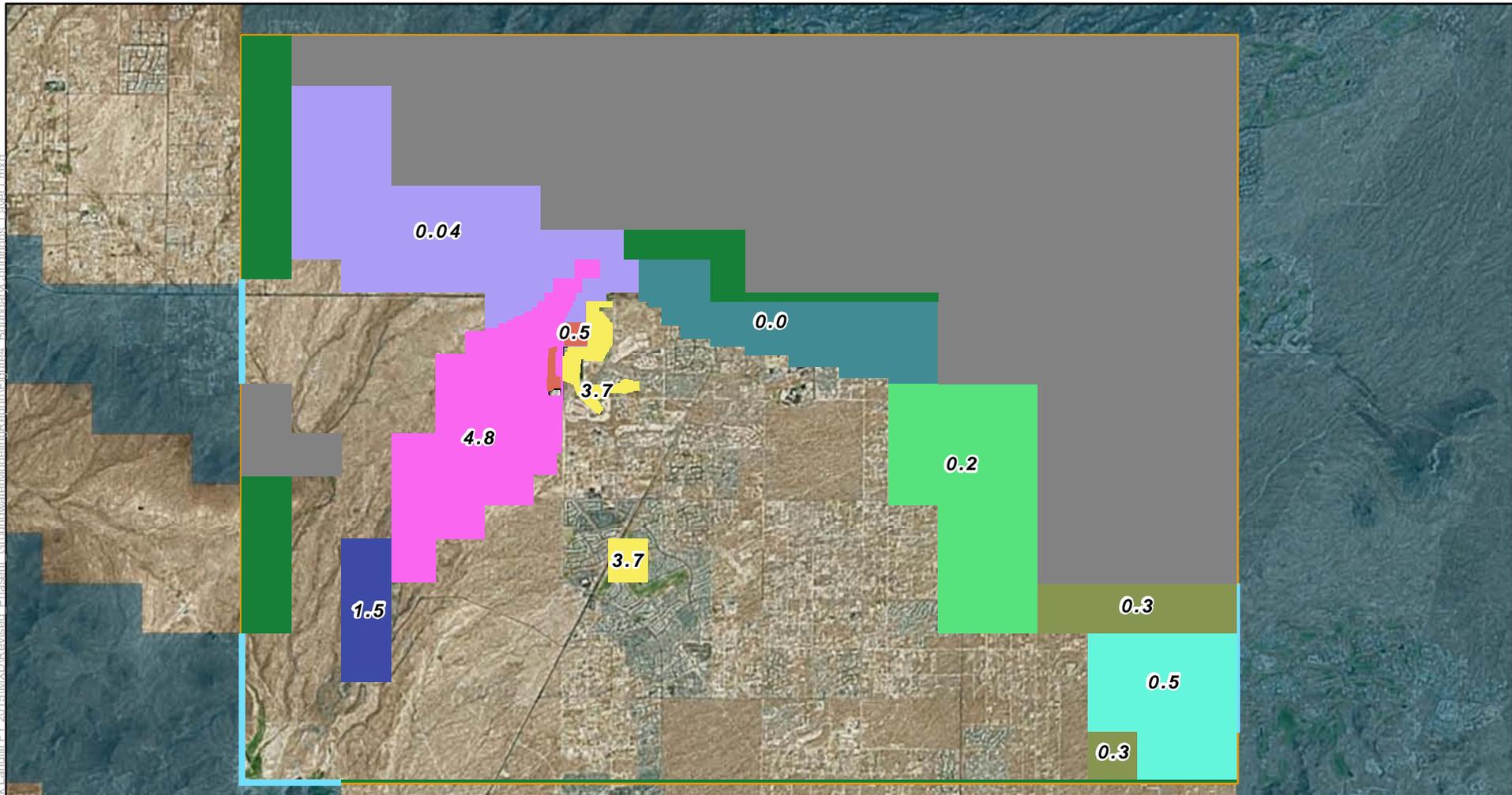


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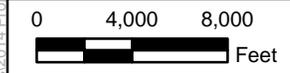
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Path: X:\Projects\2014_1420142020_Cave_Creek_Landfill_FY_2015\MXD\Revised_Phase3_III_GroundwaterModelingReport\Figured_BoundaryConditions_Layer1.mxd



Notes:
Numerical values represent recharge rates (unit = inches per year)

Legend		Recharge Zone	
General Head Boundary	No-Flow Boundary	No Color	1
Inactive Domain in Layer 1	Model Domain	3	5
Inactive SRV Model Domain	Landfill Property Boundaries	7	9
		2	4
		6	8
		10	



Imagery Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

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Date: 5/6/2015
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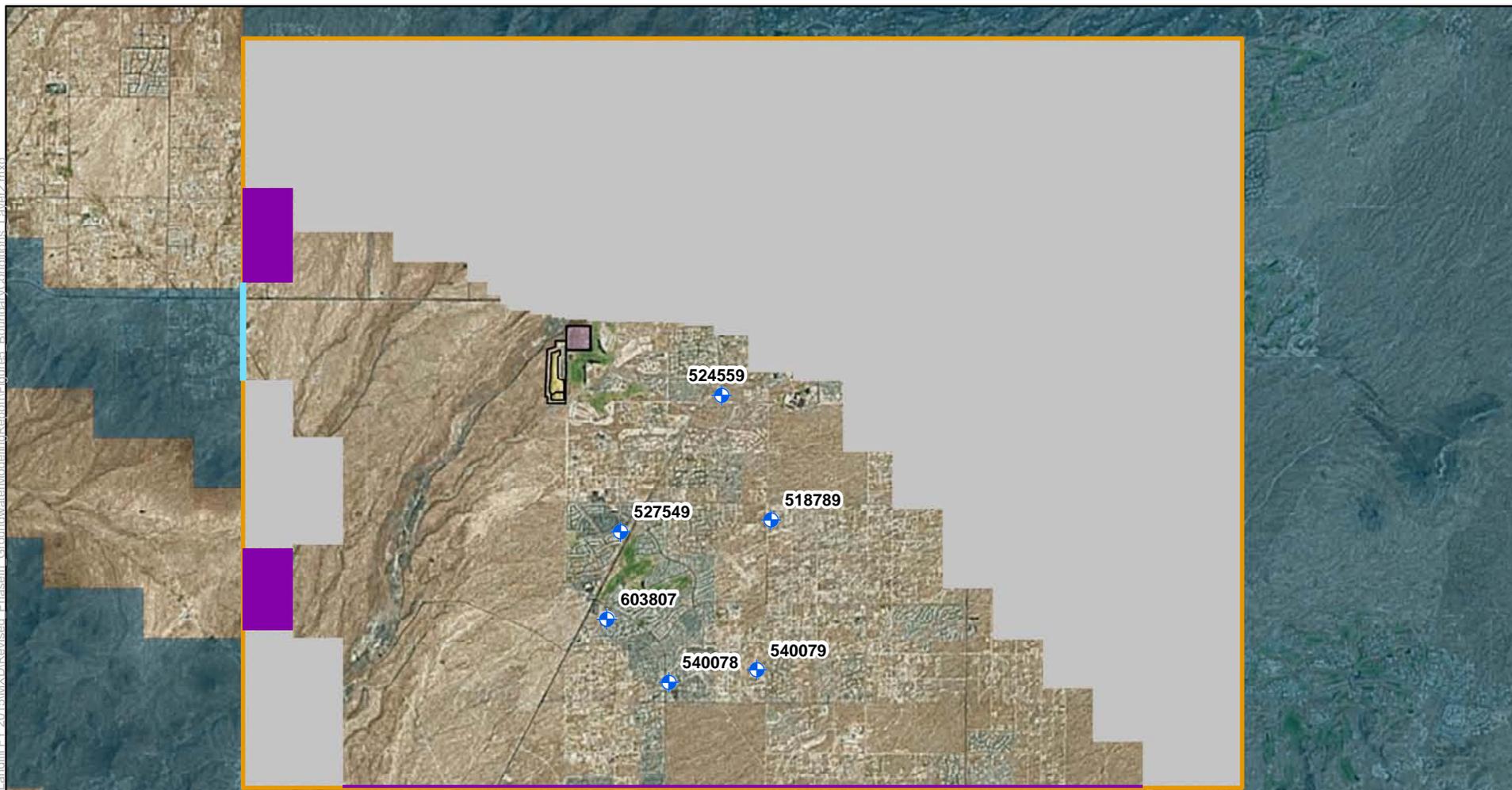
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Maricopa County Cave Creek Landfill
Phoenix, Arizona

Boundary Condition in Layer 1

FIGURE
4

Path: X:\Projects\2014_1420142020_Cave_Creek_Landfill_FY_2015\MXD\Revised_Phase3_III_GroundwaterModelingReport\Figures_5_Boundary_Conditions_Layer2.mxd



Notes:
524559 Identification of Regional Pumping Well

Legend

- Well Boundary
- General Head Boundary
- Inactive Domain in Layer 2
- Inactive SRV Model Domain
- No-Flow Boundary
- Model Domain
- Landfill Property Boundaries
- Old Landfill Waste Area
- New Landfill Waste Area



Imagery Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Air DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the User Community

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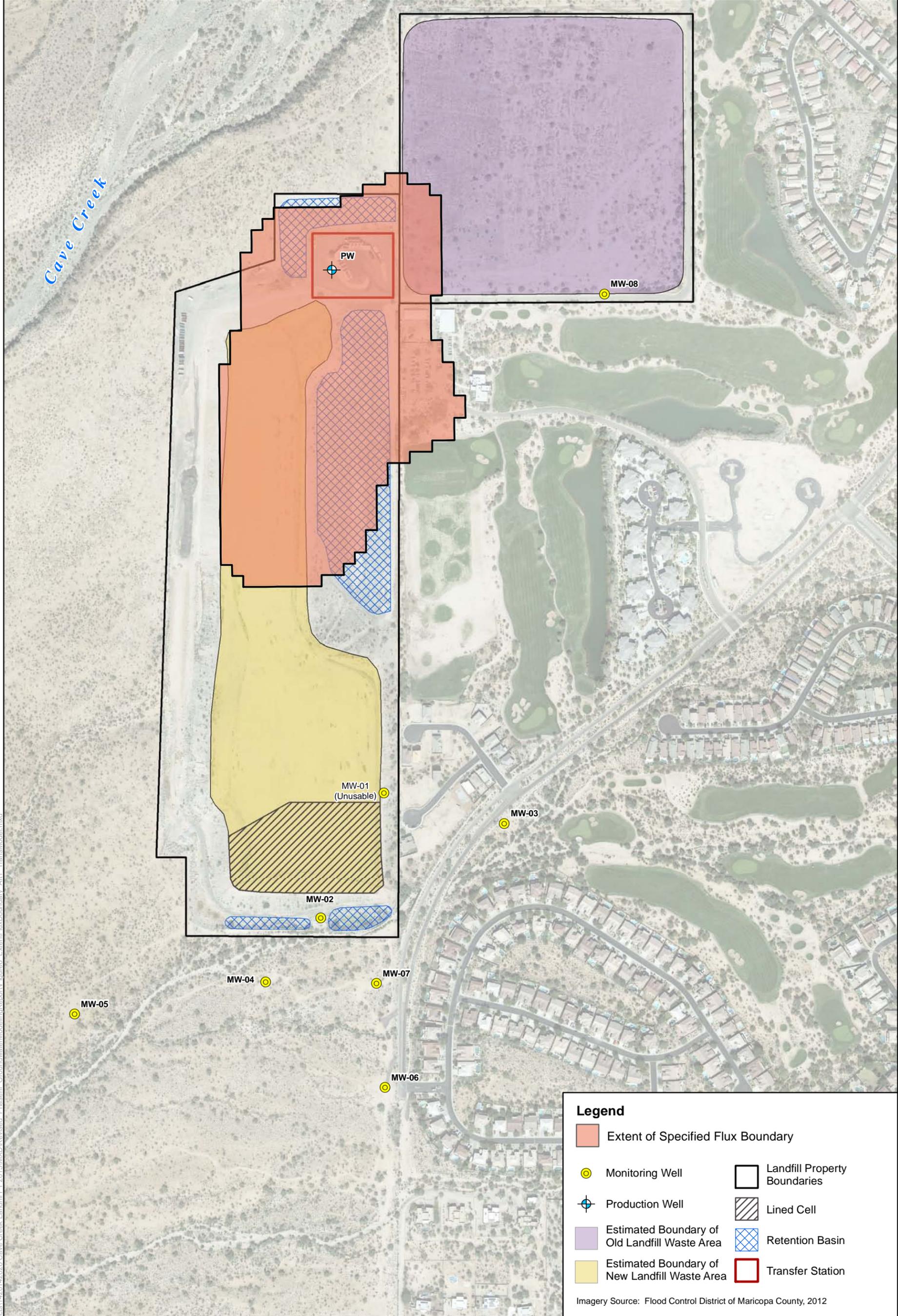
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 Maricopa County Cave Creek Landfill
 Phoenix, Arizona

Boundary Condition in Layer 2

FIGURE
5





Legend

Extent of Specified Flux Boundary	Landfill Property Boundaries
Monitoring Well	Lined Cell
Production Well	Retention Basin
Estimated Boundary of Old Landfill Waste Area	Transfer Station
Estimated Boundary of New Landfill Waste Area	

Imagery Source: Flood Control District of Maricopa County, 2012

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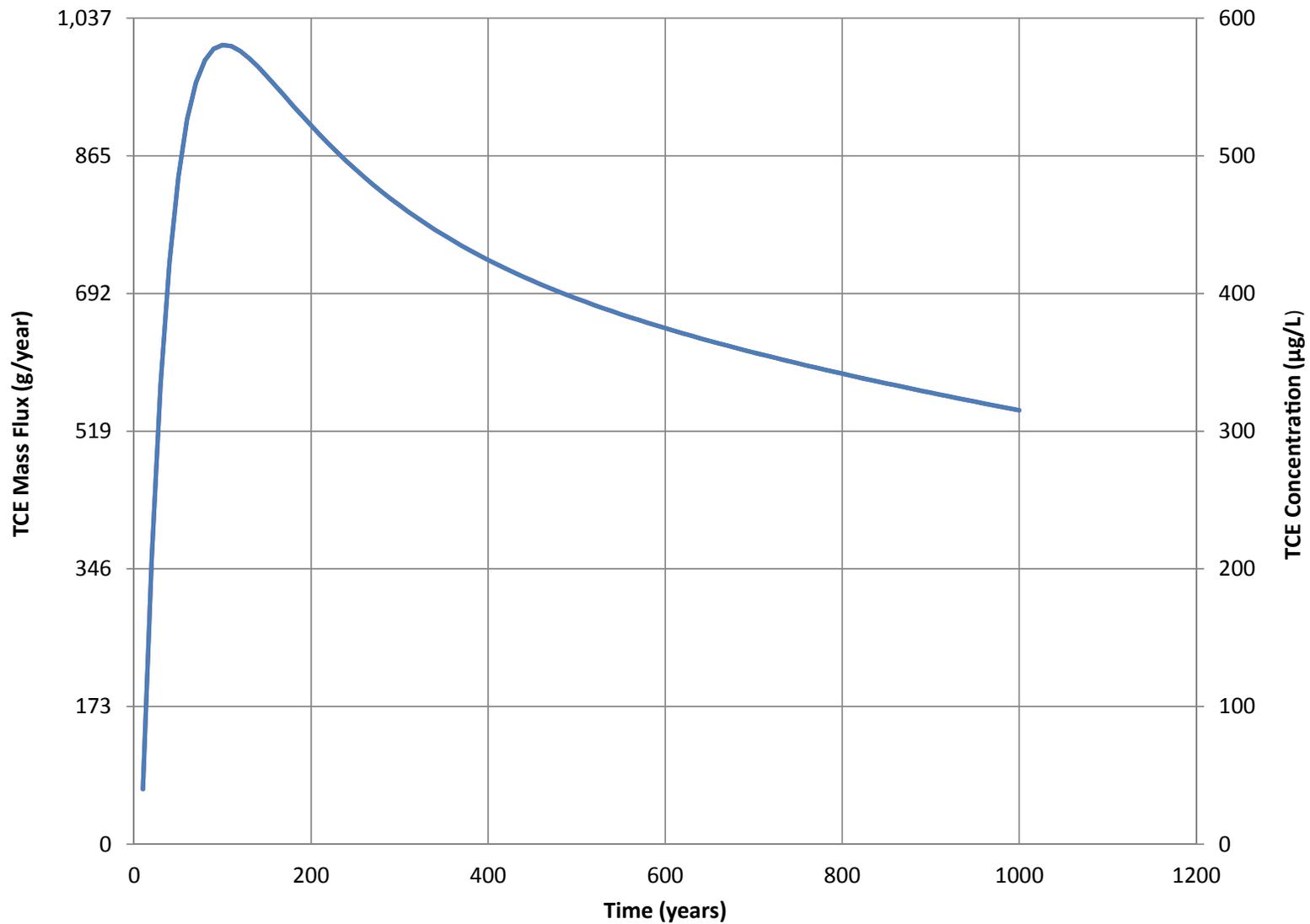
Revised Phase 3 Modeling Results Memorandum
Maricopa County Cave Creek Landfill
Phoenix, Arizona

**Extent of Specified Flux Boundary
in Alternative 1 Transport Model**

FIGURE
6

Path: X:\Projects\2014\Projects\1420142020\Cave Creek Landfill\FY 2015\MXD\Revised_Phase3 - Groundwater Modeling Report\Figure6 - Extent of Flux Boundary - Alt1 - Trans Model.mxd

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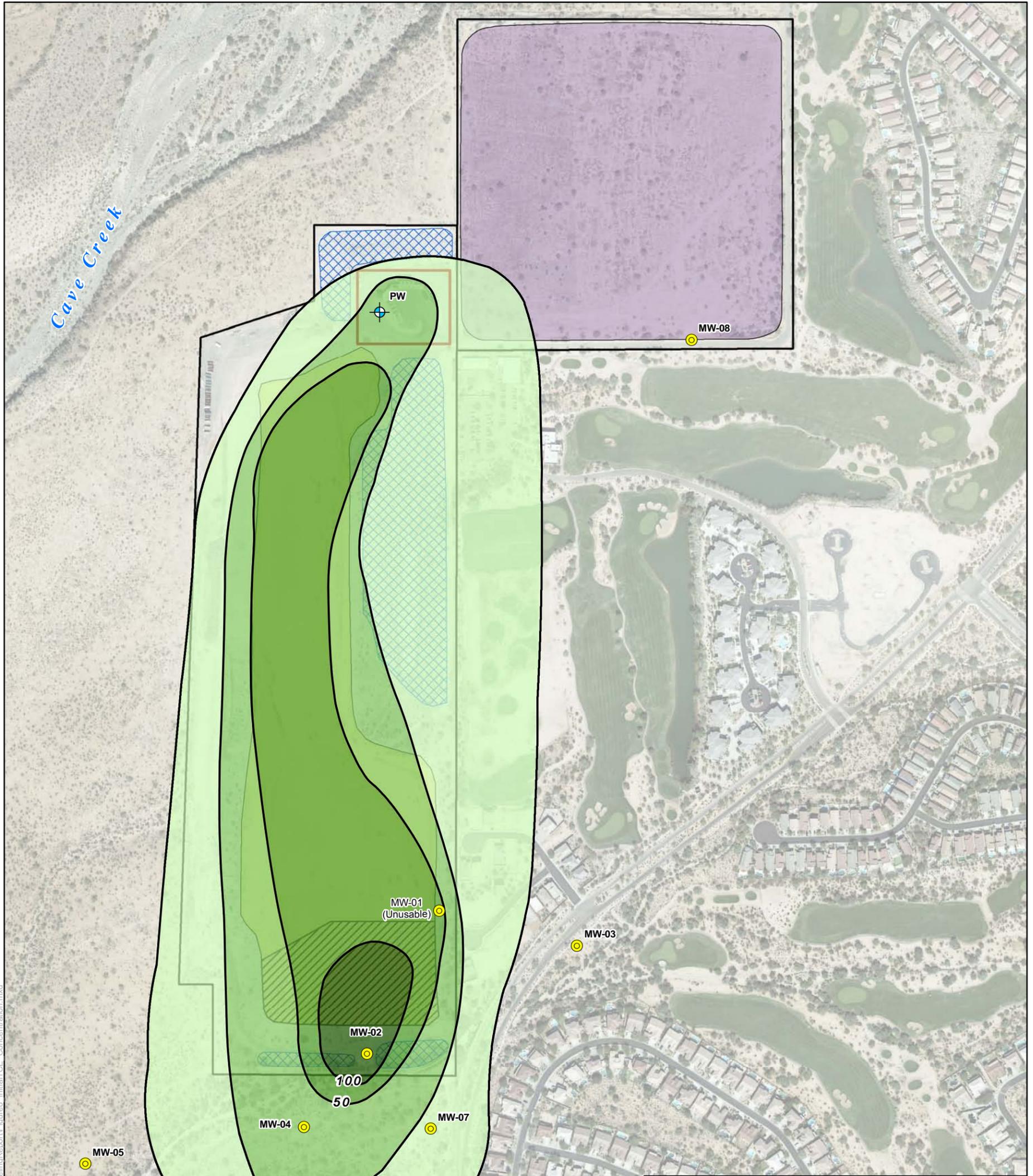
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Revised Phase 3 Modeling Results Memorandum
Maricopa County Cave Creek Landfill
Phoenix, Arizona

TCE Mass Flux and Concentrations in Leachate for Alternative 1

FIGURE
7





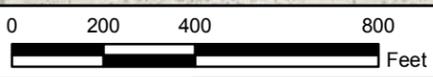
Legend

TCE Concentrations (µg/L) in Groundwater
(Dashed Where Inferred)

5-10 µg/L	50-100 µg/L
10-50 µg/L	≥100 µg/L

Monitoring Well	Landfill Property Boundaries
Production Well	Lined Cell
Estimated Boundary of Old Landfill Waste Area	Retention Basin
Estimated Boundary of New Landfill Waste Area	Transfer Station

Imagery Source: Flood Control District of Maricopa County, 2012



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 Maricopa County Cave Creek Landfill
 Phoenix, Arizona

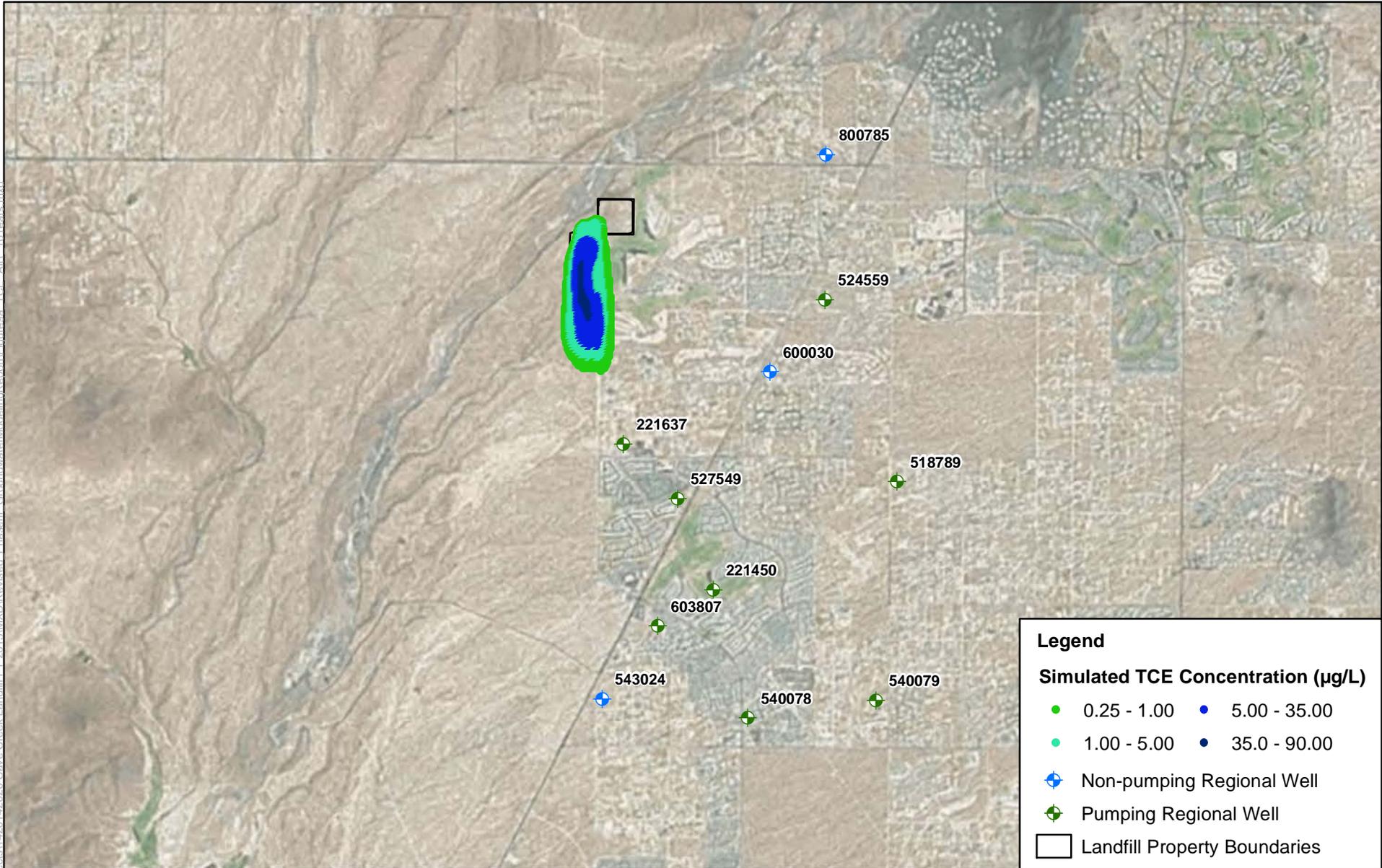
Initial TCE Concentration

FIGURE
 8



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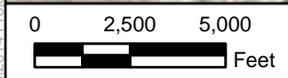


Legend

Simulated TCE Concentration (µg/L)

- 0.25 - 1.00
- 1.00 - 5.00
- 5.00 - 35.00
- 35.0 - 90.00

- ◆ Non-pumping Regional Well
- ◆ Pumping Regional Well
- Landfill Property Boundaries



Imagery Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

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 PM: NC
 Date: 6/2/2015
 Scale: 1" = 5000'

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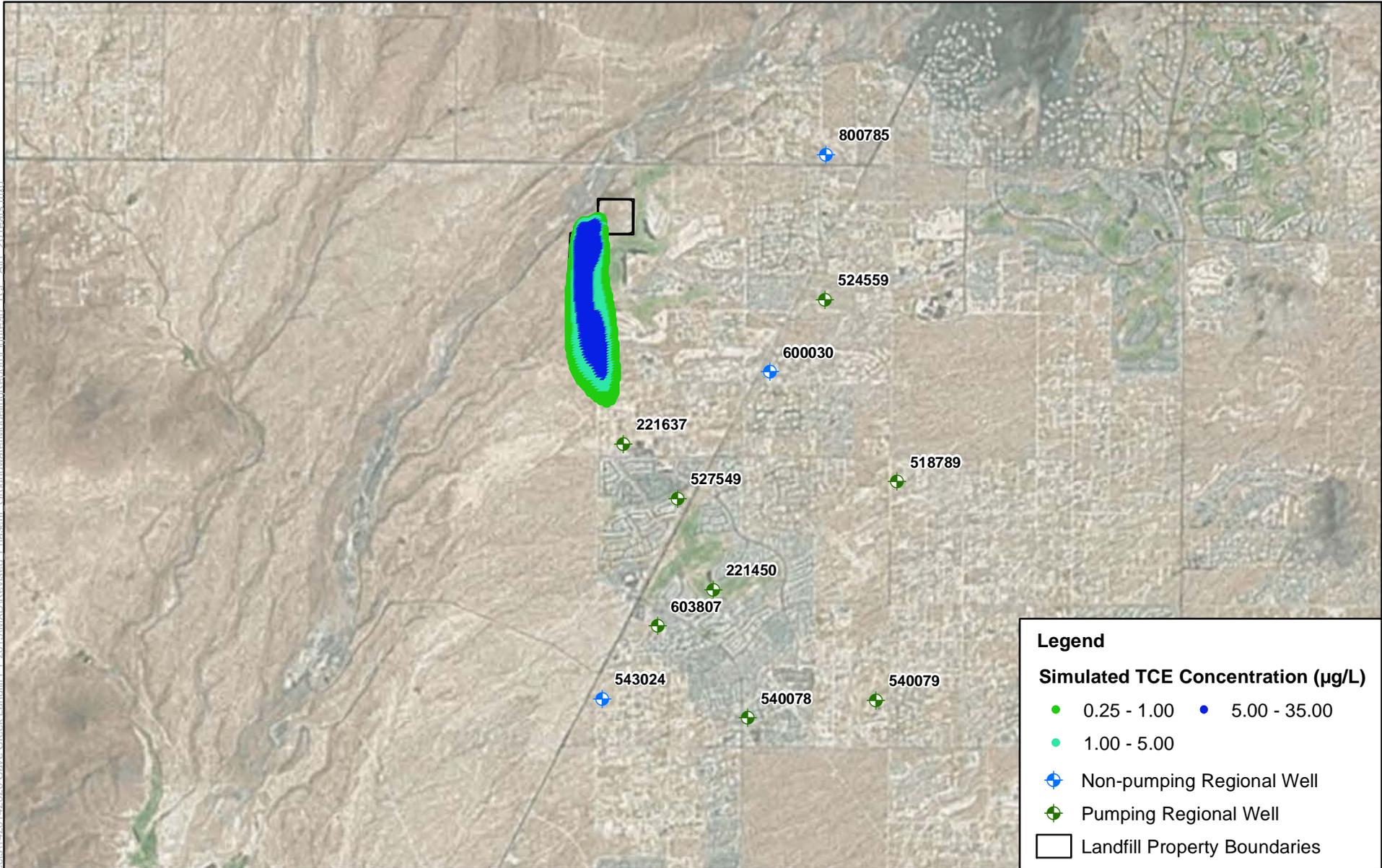
Revised Phase 3 Modeling Results Memorandum
 Maricopa County Cave Creek Landfill
 Phoenix, Arizona

**Simulated TCE Concentration for Alternative 1 -
 10 Years, Water Table Layer**



**FIGURE
 9a**

Path: X:\Projects\2014\Projects\1420142020\Cave Creek Landfill FY 2015\MXD\Revised Phase III Groundwater Modeling Report\Figure 9b_TCE Alt1 - 20Years.mxd

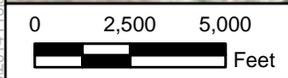


Legend

Simulated TCE Concentration (µg/L)

- 0.25 - 1.00
- 1.00 - 5.00
- 5.00 - 35.00

- ◆ Non-pumping Regional Well
- ◆ Pumping Regional Well
- Landfill Property Boundaries



Imagery Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

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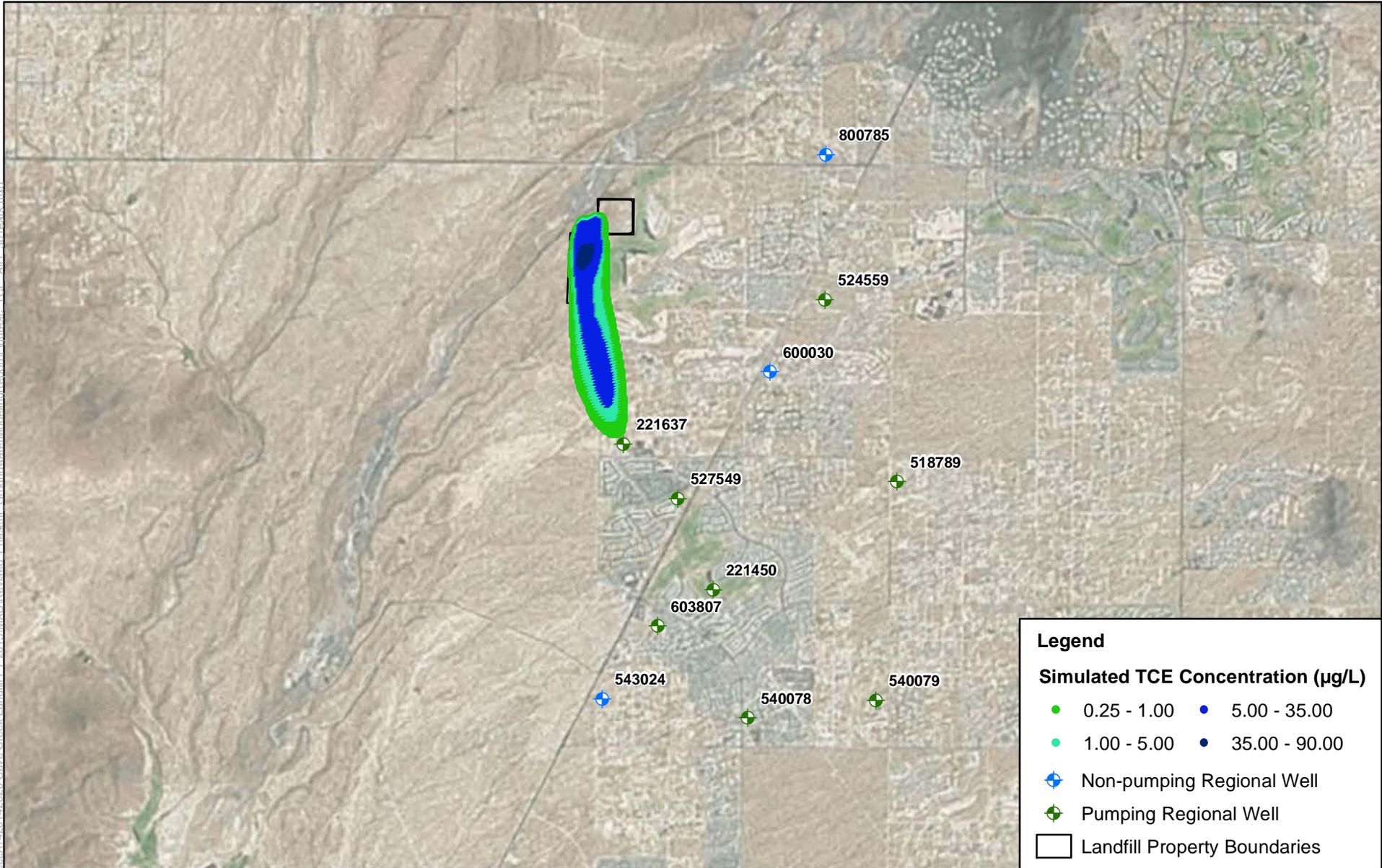
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 Maricopa County Cave Creek Landfill
 Phoenix, Arizona

Simulated TCE Concentration for Alternative 1 - 20 Years, Water Table Layer



FIGURE 9b

Path: X:\Projects\2014_1420142020_Cave_Creek_Landfill_FY_2015\MXD\Revised_Phase3\GroundwaterModelingReport\Figure9c_TCE_Alt1_30Years.mxd



Legend

Simulated TCE Concentration (µg/L)

- 0.25 - 1.00
- 5.00 - 35.00
- 1.00 - 5.00
- 35.00 - 90.00
- ◆ Non-pumping Regional Well
- ◆ Pumping Regional Well
- Landfill Property Boundaries

0 2,500 5,000

 Feet

Imagery Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

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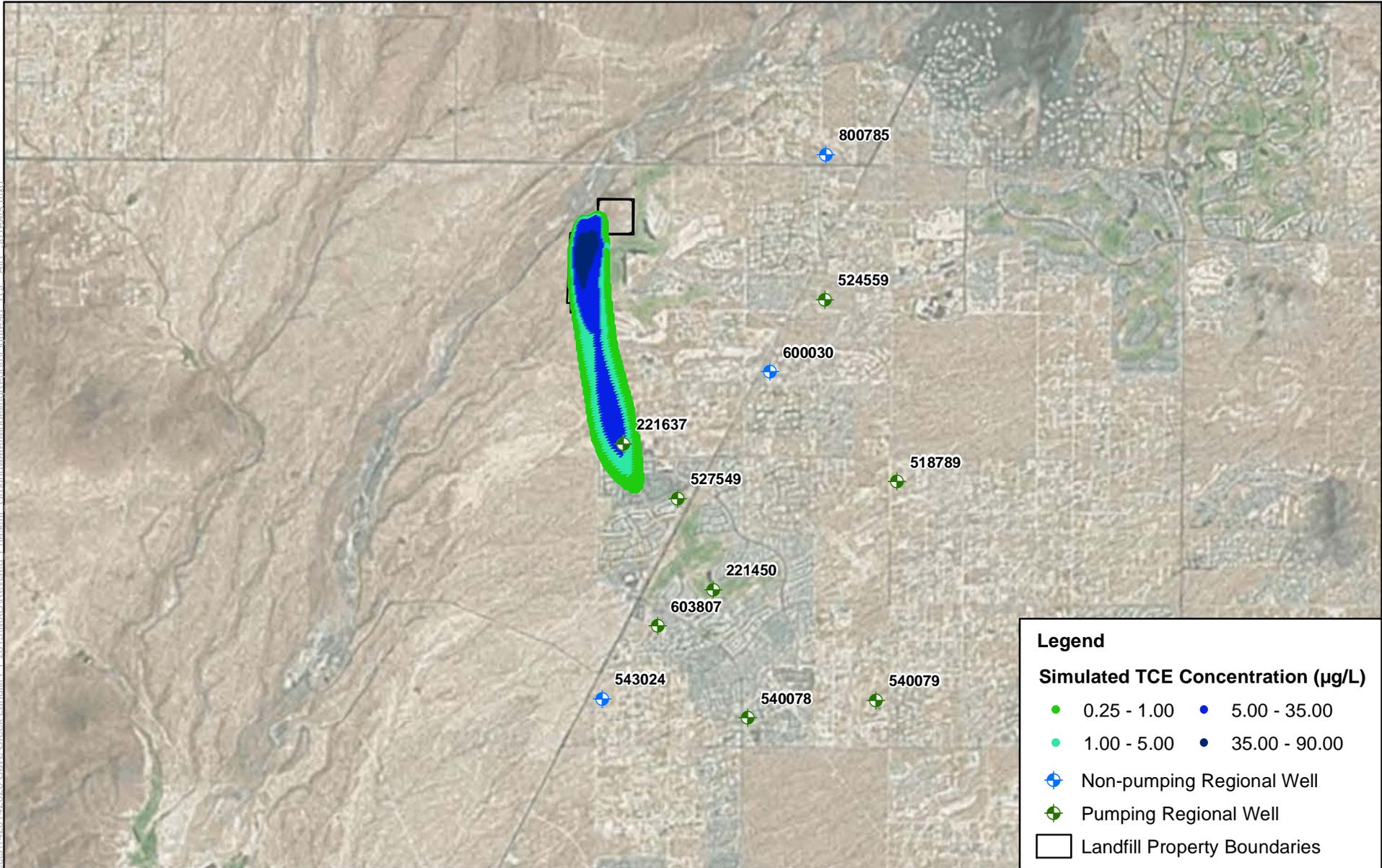
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 Maricopa County Cave Creek Landfill
 Phoenix, Arizona

**Simulated TCE Concentration for Alternative 1 -
 30 Years, Water Table Layer**

**FIGURE
 9c**



Path: X:\Projects\2014_1420142020_Cave_Creek_Landfill_FY_2015\MXD\Revised_Phase3\GroundwaterModelingReport\Figure9d_TCE_Alt1_50Years.mxd

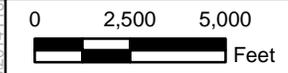


Legend

Simulated TCE Concentration (µg/L)

- 0.25 - 1.00
- 1.00 - 5.00
- 5.00 - 35.00
- 35.00 - 90.00

- ◆ Non-pumping Regional Well
- ◆ Pumping Regional Well
- Landfill Property Boundaries



Imagery Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

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 PM: NC
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 Scale: 1" = 5000'



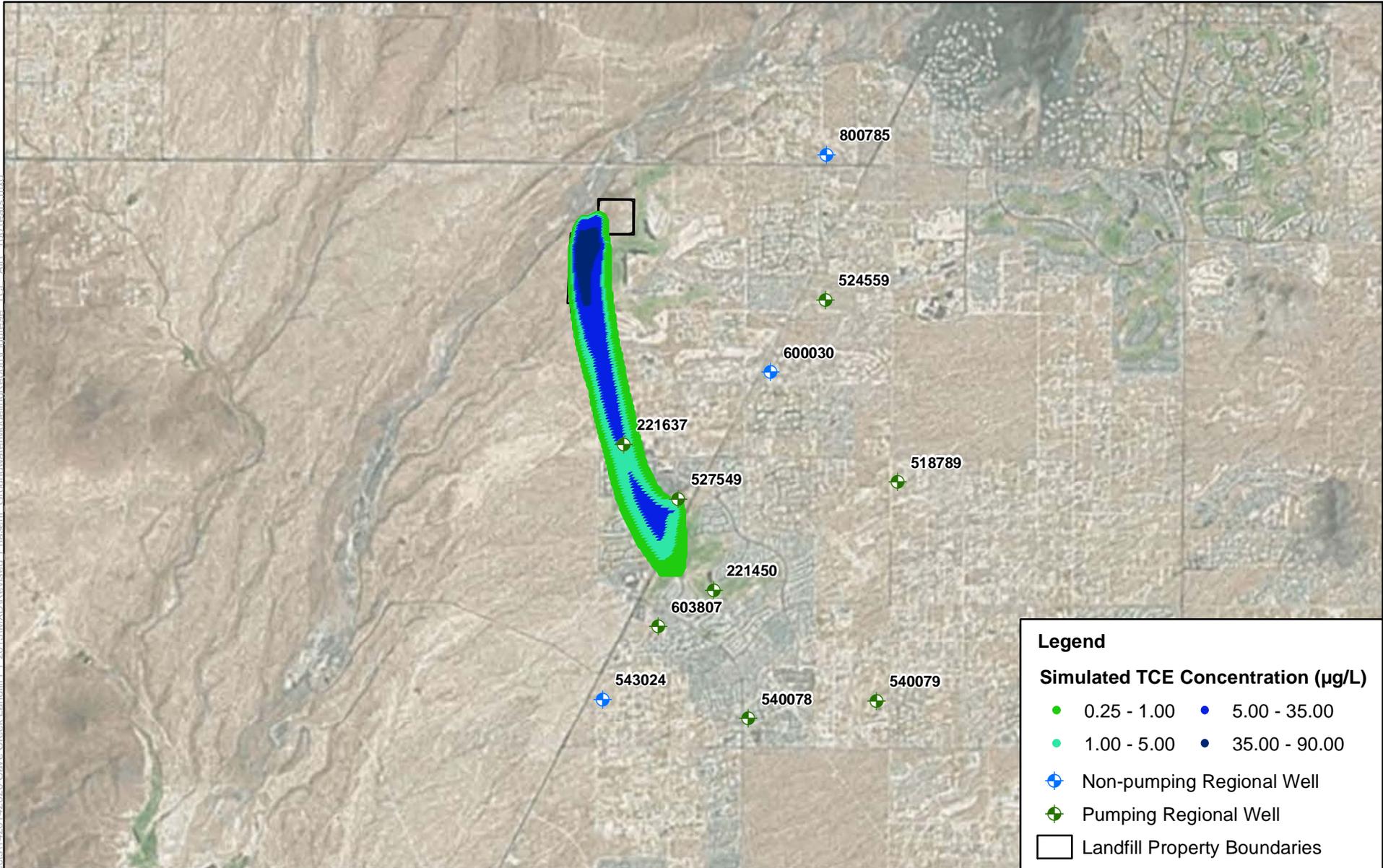
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 Maricopa County Cave Creek Landfill
 Phoenix, Arizona

Simulated TCE Concentration for Alternative 1 - 50 Years, Water Table Layer **FIGURE 9d**



Path: X:\Projects\2014_2020\Cave Creek Landfill\FY 2015\MXD\Revised_Phase3\GroundwaterModelingReport\Figure9e_TCE_Alt1_100Years.mxd



Legend

Simulated TCE Concentration (µg/L)

- 0.25 - 1.00
- 1.00 - 5.00
- 5.00 - 35.00
- 35.00 - 90.00
- ◆ Non-pumping Regional Well
- ◆ Pumping Regional Well
- Landfill Property Boundaries

0 2,500 5,000

 Feet

Imagery Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

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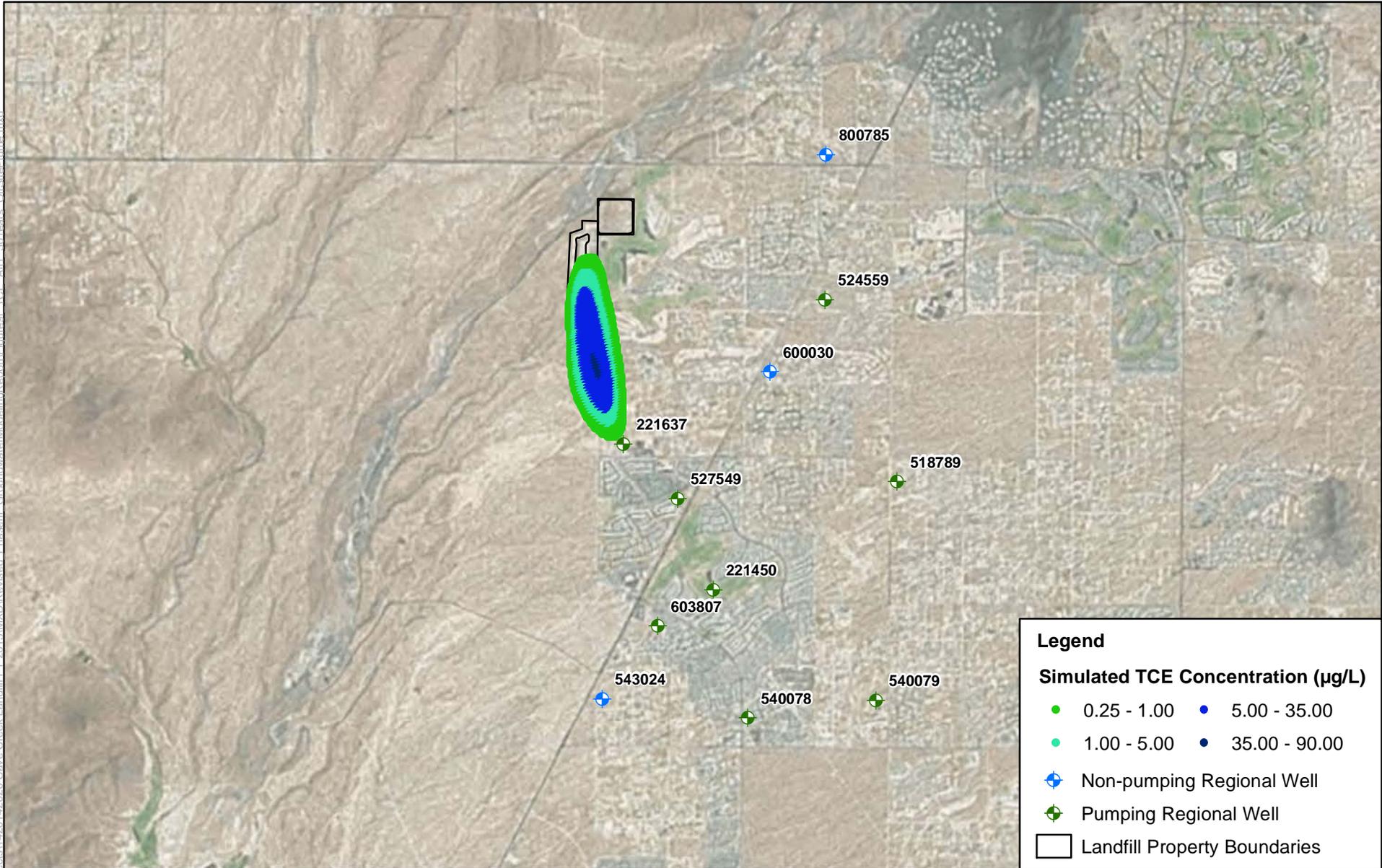
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**Simulated TCE Concentration for Alternative 1 -
 100 Years, Water Table Layer**

**FIGURE
 9e**

amec
 foster
 wheeler

Path: X:\Projects\2014_1420142020_Cave_Creek_Landfill_FY_2015\MXD\Revised_Phase3\GroundwaterModelingReport\Figure9f_TCE_Alt1_30Years_OffSitePlume.mxd



Legend

Simulated TCE Concentration (µg/L)

- 0.25 - 1.00
- 1.00 - 5.00
- 5.00 - 35.00
- 35.00 - 90.00

- ◆ Non-pumping Regional Well
- ◆ Pumping Regional Well
- Landfill Property Boundaries



Imagery Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

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 Maricopa County Cave Creek Landfill
 Phoenix, Arizona



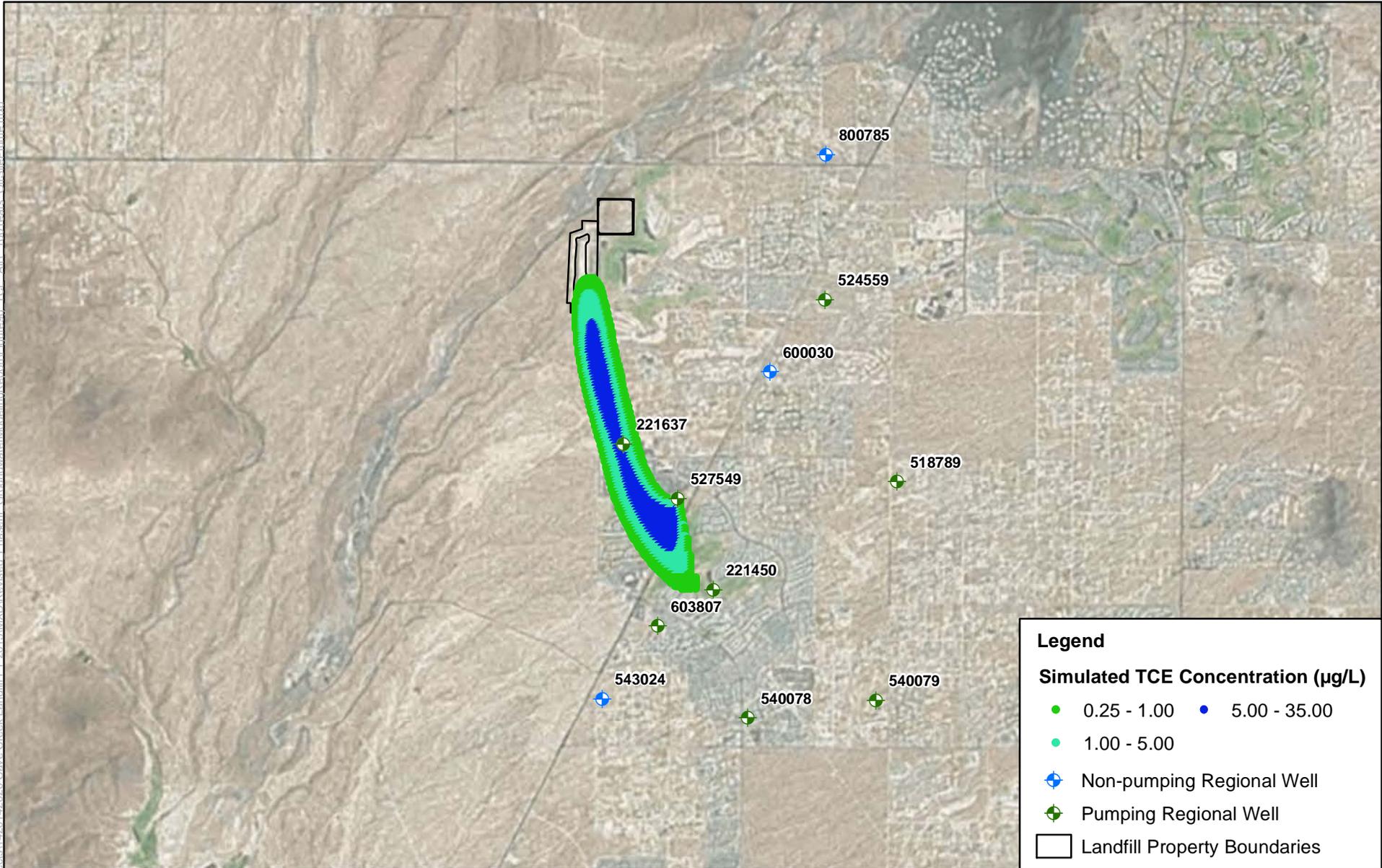
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 Scale: 1" = 5000'



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Peak Concentration Model Layer for Alternative 1 - FIGURE 9f
30 Years, Off-site Plume

Path: X:\Projects\2014_2020\Cave Creek Landfill\FY 2015\MXD\Revised_Phase3\GroundwaterModelingReport\Figure9p_TCE_Alt1_100Years_OffSitePlume.mxd



Legend

Simulated TCE Concentration (µg/L)

- 0.25 - 1.00
- 5.00 - 35.00
- 1.00 - 5.00
- ◆ Non-pumping Regional Well
- ◆ Pumping Regional Well
- Landfill Property Boundaries

0 2,500 5,000

 Feet

Imagery Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Job No. 1420142020
 PM: NC
 Date: 6/2/2015
 Scale: 1" = 5000'



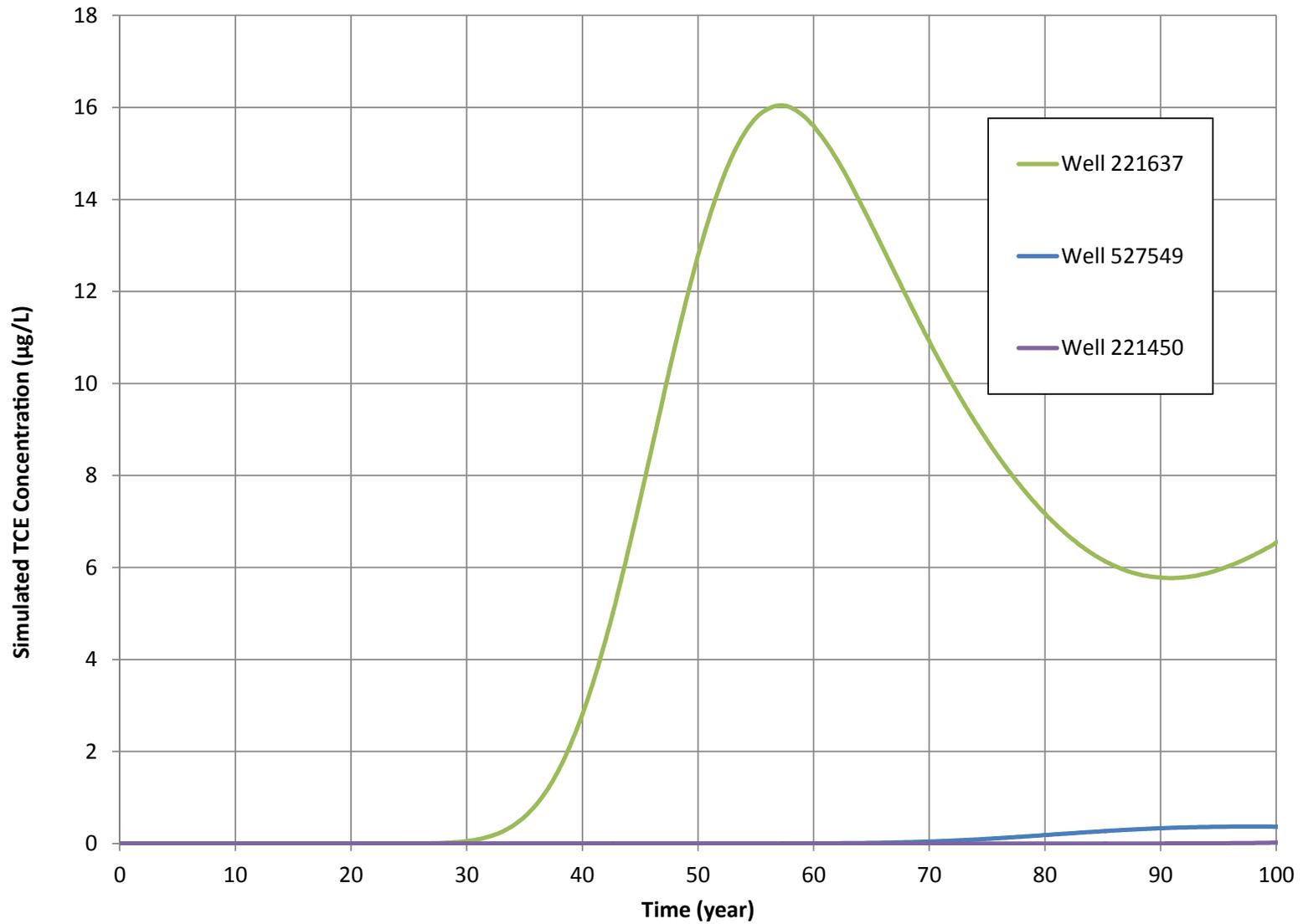
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Peak Concentration Model Layer for Alternative 1 - 100 Years, Off-site Plume - FIGURE 9g



Path: X:\Projects\2014-Projects\1420142020 Cave Creek Landfill FY 2015\MXD\Revised Phase III Groundwater Modeling Report\Figure10 - Simulated Water Supply Wells - Alt1.ai



Job No.: 1420142020
PM: NC
Date: 5/29/2015
Scale: Not to scale

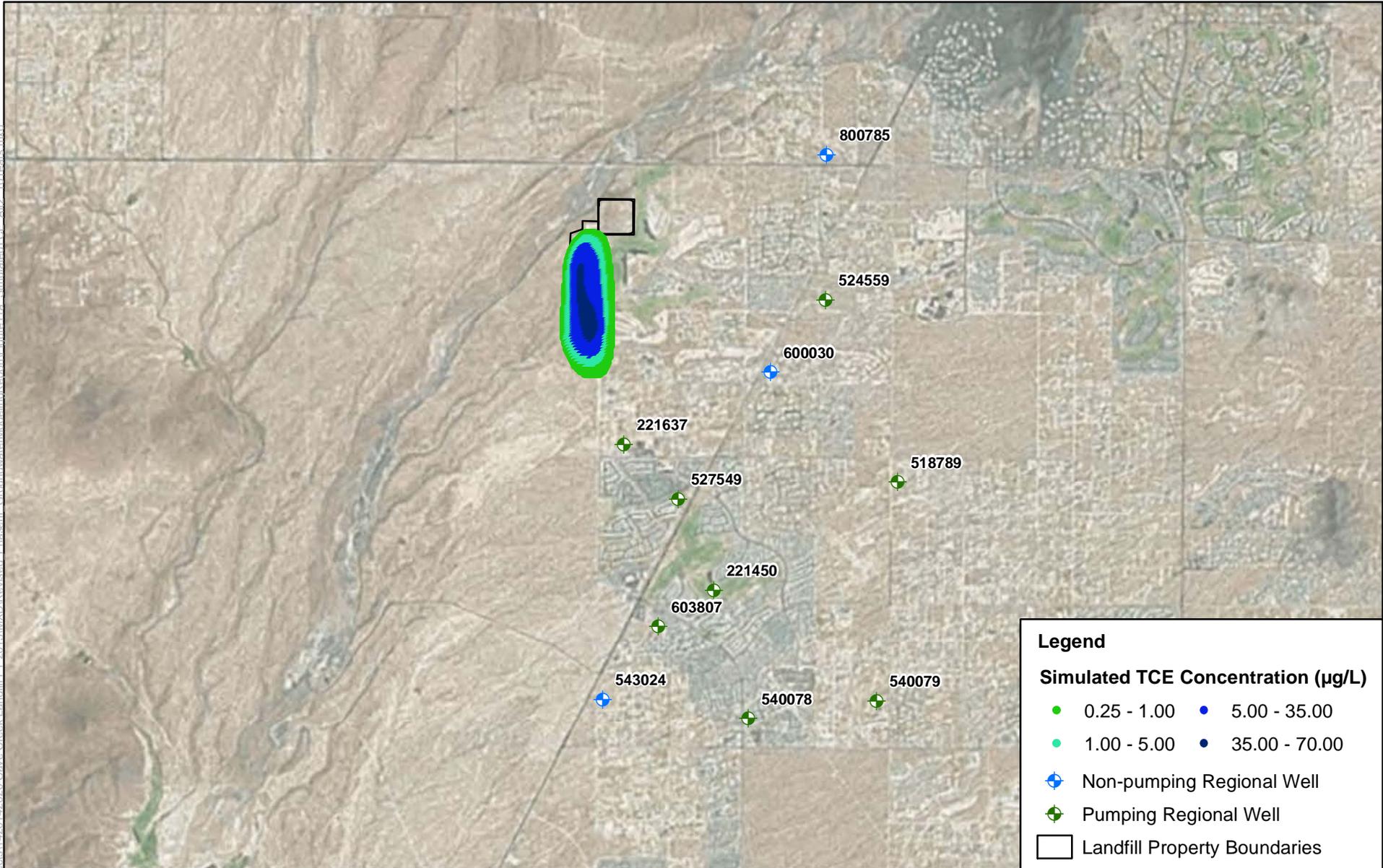
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Maricopa County Cave Creek Landfill
Phoenix, Arizona

Simulated Peak Concentrations in Water Supply Wells for Alternative 1

FIGURE
10



Path: X:\Projects\2014_1420142020.Cave.Creek.Landfill.FY.2015\MXD\Revised_Phase3\GroundwaterModelingReport\Figure11a_SimulatedTCE_Alt2_10Years.mxd



Legend

Simulated TCE Concentration (µg/L)

- 0.25 - 1.00
- 1.00 - 5.00
- 5.00 - 35.00
- 35.00 - 70.00
- ◆ Non-pumping Regional Well
- ◆ Pumping Regional Well
- Landfill Property Boundaries

0 2,500 5,000

 Feet

Imagery Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

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 Maricopa County Cave Creek Landfill
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Job No. 1420142020
 PM: NC
 Date: 5/12/2015
 Scale: 1" = 5000'



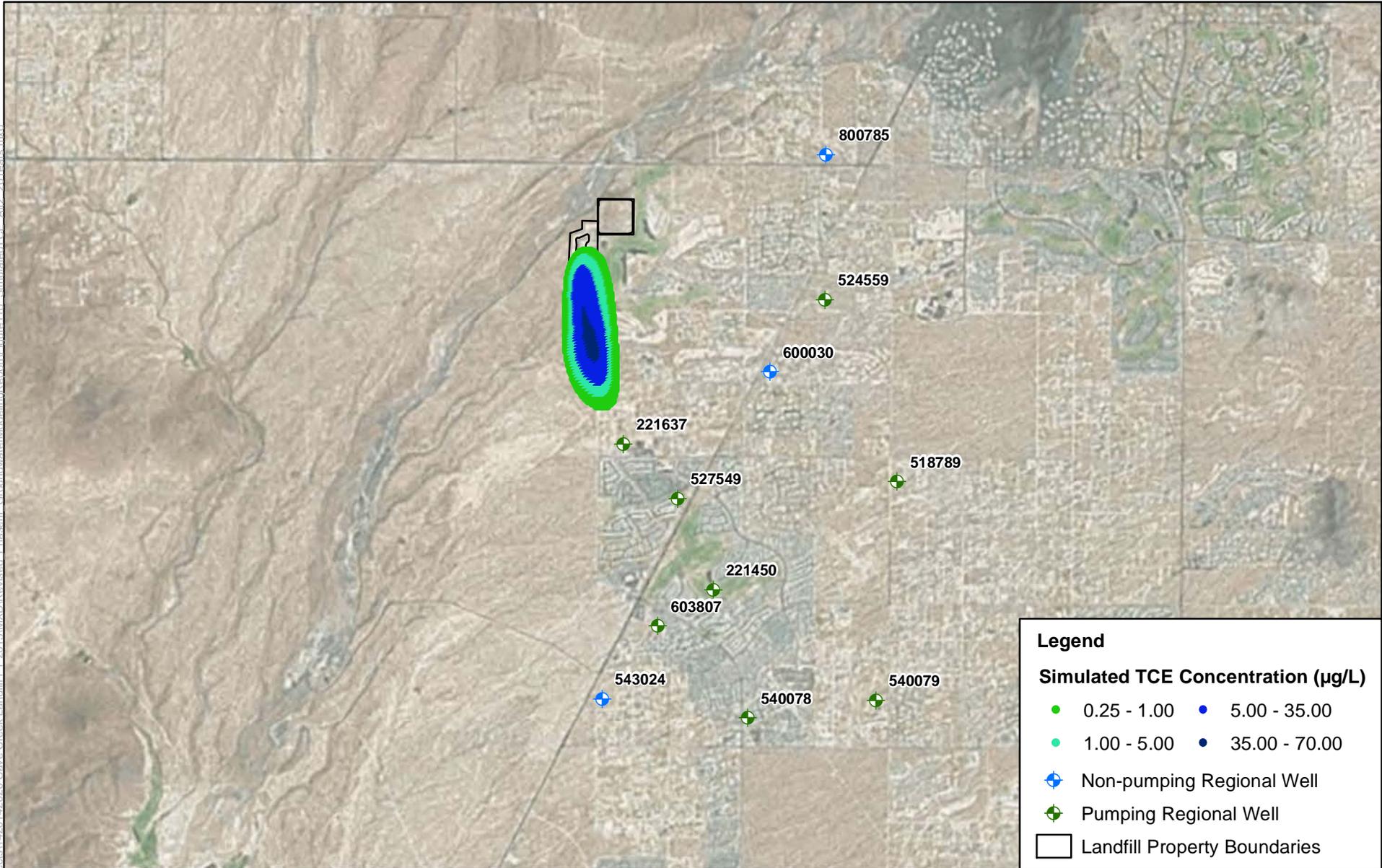
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**Simulated TCE Concentrations for
 Alternative 2 - 10 Years**

FIGURE
11a



Path: X:\Projects\2014_2020\Cave Creek Landfill FY 2015\MXD\Revised Phase III Groundwater Modeling Report\Figure 11b - Simulated TCE Air2 - 20 Years.mxd



Legend

Simulated TCE Concentration (µg/L)

- 0.25 - 1.00
- 5.00 - 35.00
- 1.00 - 5.00
- 35.00 - 70.00
- ◆ Non-pumping Regional Well
- ◆ Pumping Regional Well
- Landfill Property Boundaries

0 2,500 5,000

 Feet

Imagery Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

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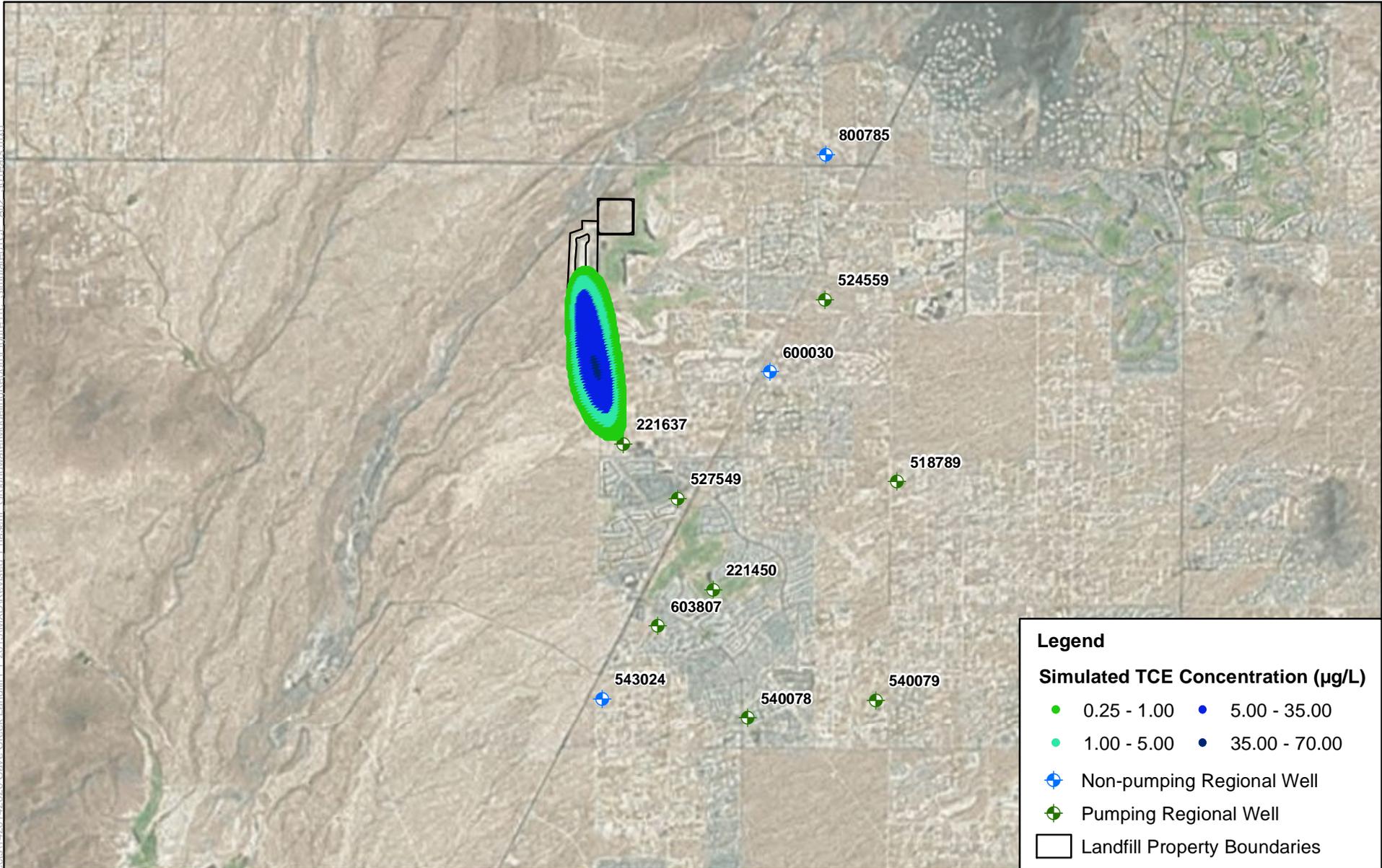
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 Maricopa County Cave Creek Landfill
 Phoenix, Arizona

**Simulated TCE Concentrations for
 Alternative 2 - 20 Years**

FIGURE
11b



Path: X:\Projects\2014_1420142020_Cave_Creek_Landfill_FY_2015\MXD\Revised_Phase3\GroundwaterModelingReport\Figure11c_SimulatedTCE_Alt2_30Years.mxd

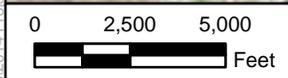


Legend

Simulated TCE Concentration (µg/L)

- 0.25 - 1.00
- 1.00 - 5.00
- 5.00 - 35.00
- 35.00 - 70.00

- ◆ Non-pumping Regional Well
- ◆ Pumping Regional Well
- Landfill Property Boundaries



Imagery Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

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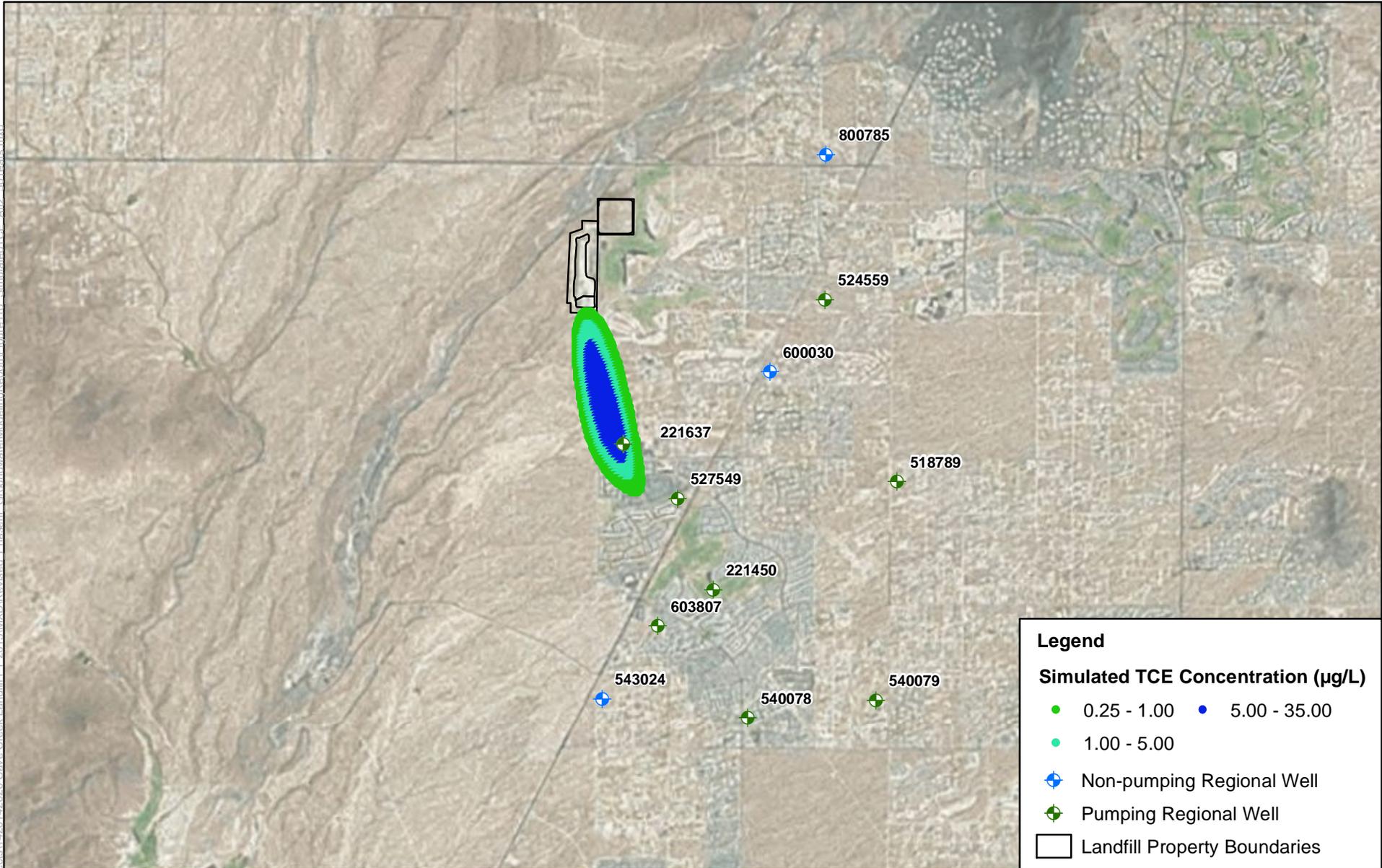
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**Simulated TCE Concentrations for
 Alternative 2 - 30 Years**

FIGURE
11c



Path: X:\Projects\2014_2020\Cave Creek Landfill FY 2015\MXD\Revised Phase III Groundwater Modeling Report\Figure 11d - Simulated TCE - Alt 2 - 50 Years.mxd



Legend

Simulated TCE Concentration (µg/L)

- 0.25 - 1.00
- 5.00 - 35.00
- 1.00 - 5.00
- ◆ Non-pumping Regional Well
- ◆ Pumping Regional Well
- Landfill Property Boundaries

0 2,500 5,000

 Feet

Imagery Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Job No. 1420142020
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 Date: 5/26/2015
 Scale: 1" = 5000'

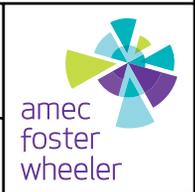


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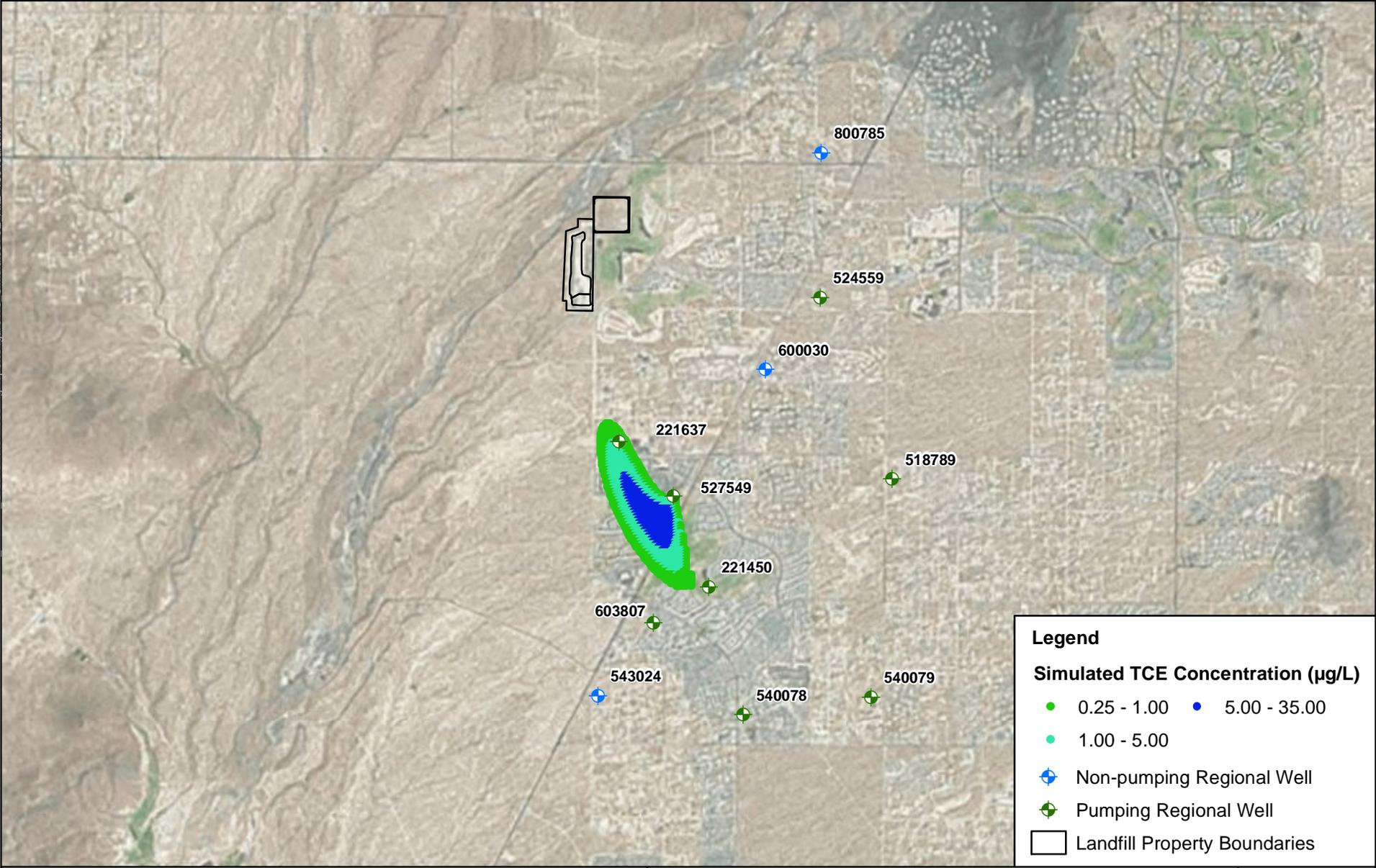
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 Maricopa County Cave Creek Landfill
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**Simulated TCE Concentrations for
 Alternative 2 - 50 Years**

FIGURE
11d



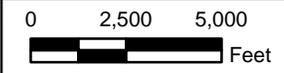
Path: X:\Projects\2014 Projects\1420142020 Cave Creek Landfill FY 2015\MXD\Revised Phase III Groundwater Modeling Report\Figure 11e Simulated TCE Alt 2 - 100 Years.mxd



Legend

Simulated TCE Concentration (µg/L)

- 0.25 - 1.00 ● 5.00 - 35.00
- 1.00 - 5.00
- ◆ Non-pumping Regional Well
- ◆ Pumping Regional Well
- Landfill Property Boundaries



Imagery Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

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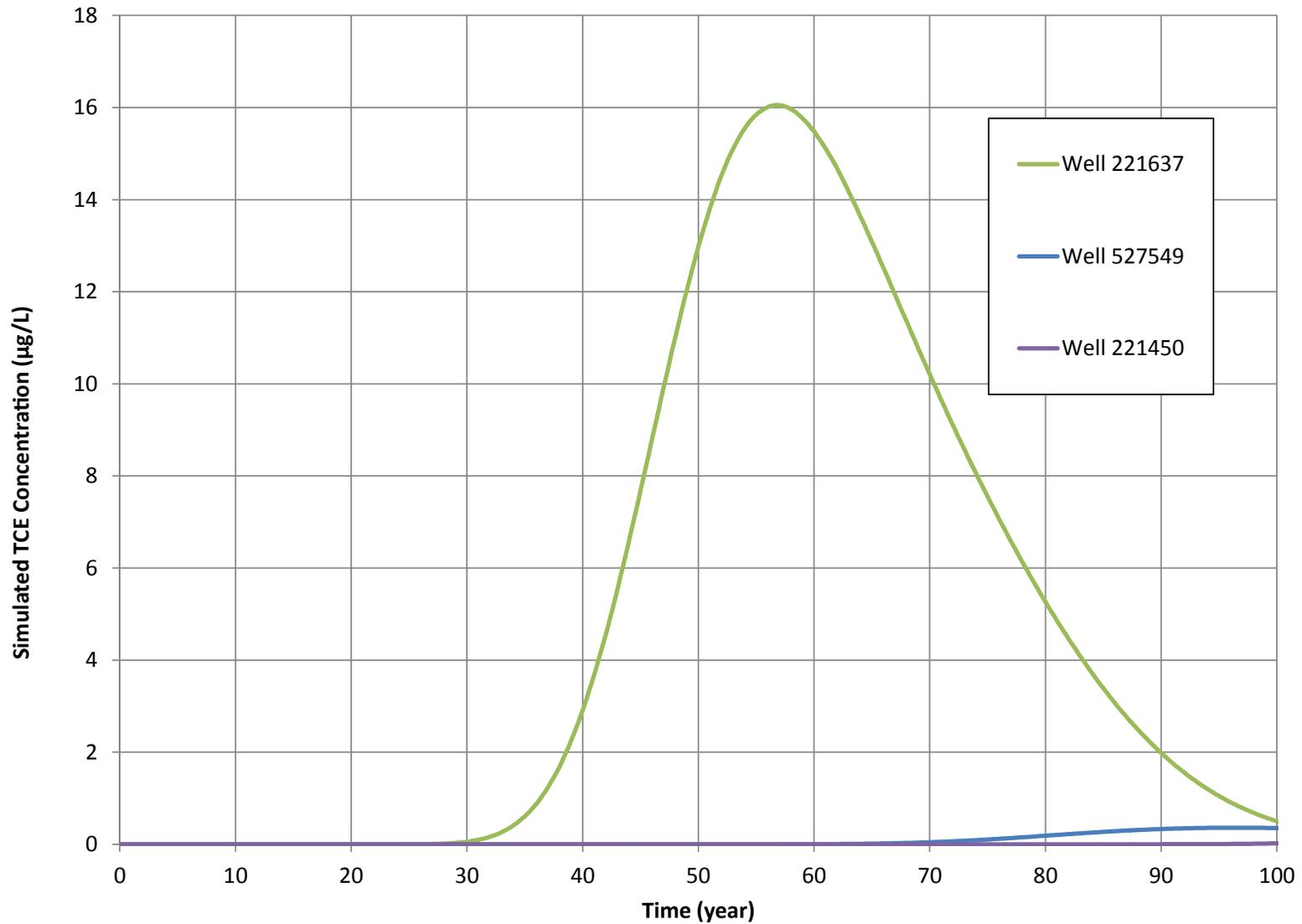
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**Simulated TCE Concentrations for
 Alternative 2 - 100 Years**



**FIGURE
 11e**

Path: X:\Projects\2014-Projects\1420142020 Cave Creek Landfill FY 2015\MXD\Revised Phase III Groundwater Modeling Report\Figure12_Simulated WaterSupplyWells_Alt2.at



Job No.: 1420142020
PM: NC
Date: 5/12/2015
Scale: Not to scale

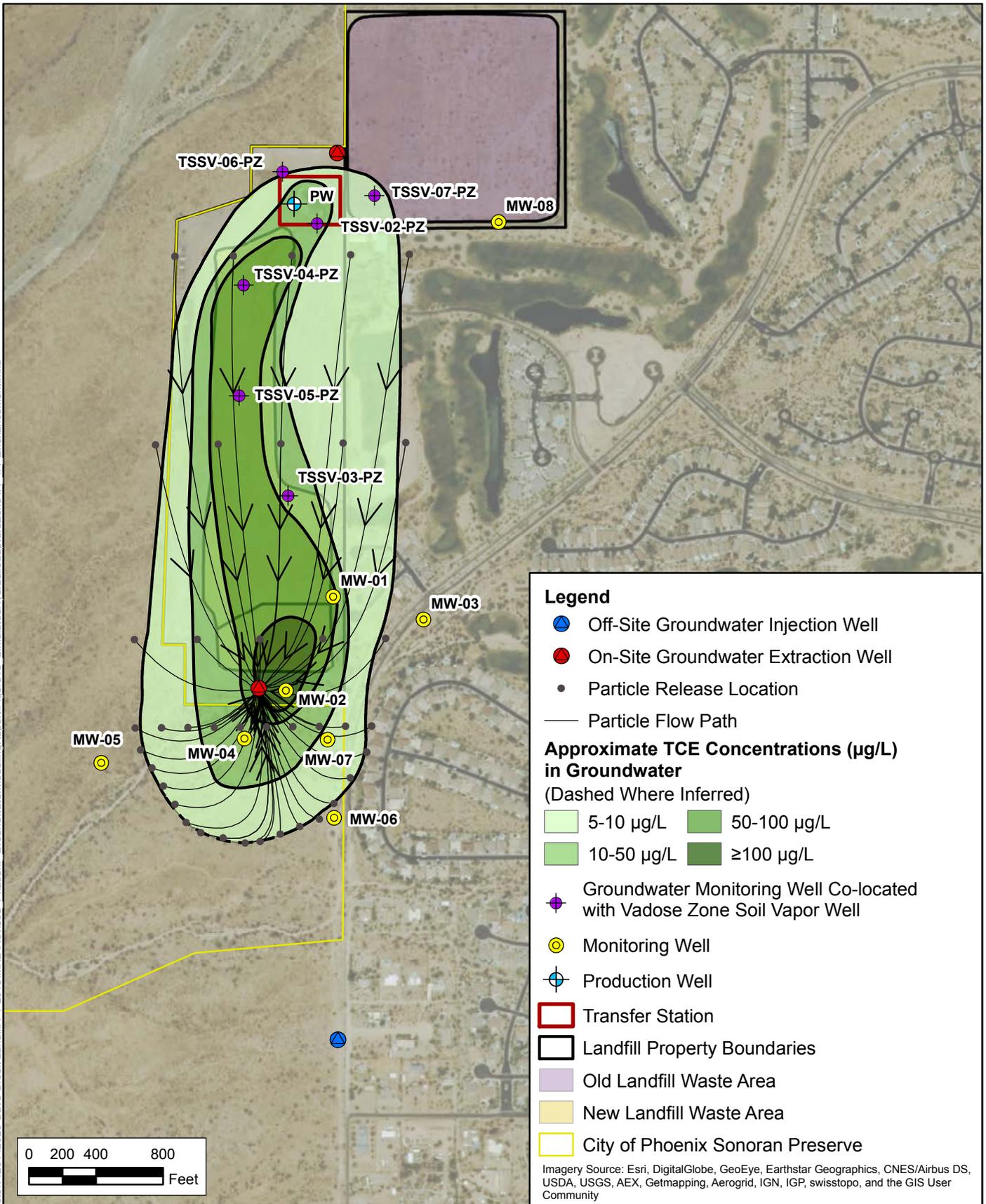
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Simulated Concentrations in Water Supply Wells for Alternative 2

FIGURE
12



Path: X:\Projects\2014\Projects\1420142020\Cave Creek Landfill EY 2015\MXD\Revised_PhaseIII_GroundwaterModelingReport\Figure13_SimulatedHydraulicCaptureZone4A_4A_Enhancement.mxd



Legend

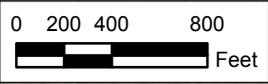
- Off-Site Groundwater Injection Well
- On-Site Groundwater Extraction Well
- Particle Release Location
- Particle Flow Path

Approximate TCE Concentrations (µg/L) in Groundwater
(Dashed Where Inferred)

	5-10 µg/L		50-100 µg/L
	10-50 µg/L		≥100 µg/L

- Groundwater Monitoring Well Co-located with Vadose Zone Soil Vapor Well
- Monitoring Well
- Production Well
- Transfer Station
- Landfill Property Boundaries
- Old Landfill Waste Area
- New Landfill Waste Area
- City of Phoenix Sonoran Preserve

Imagery Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community



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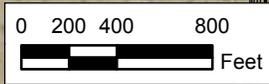
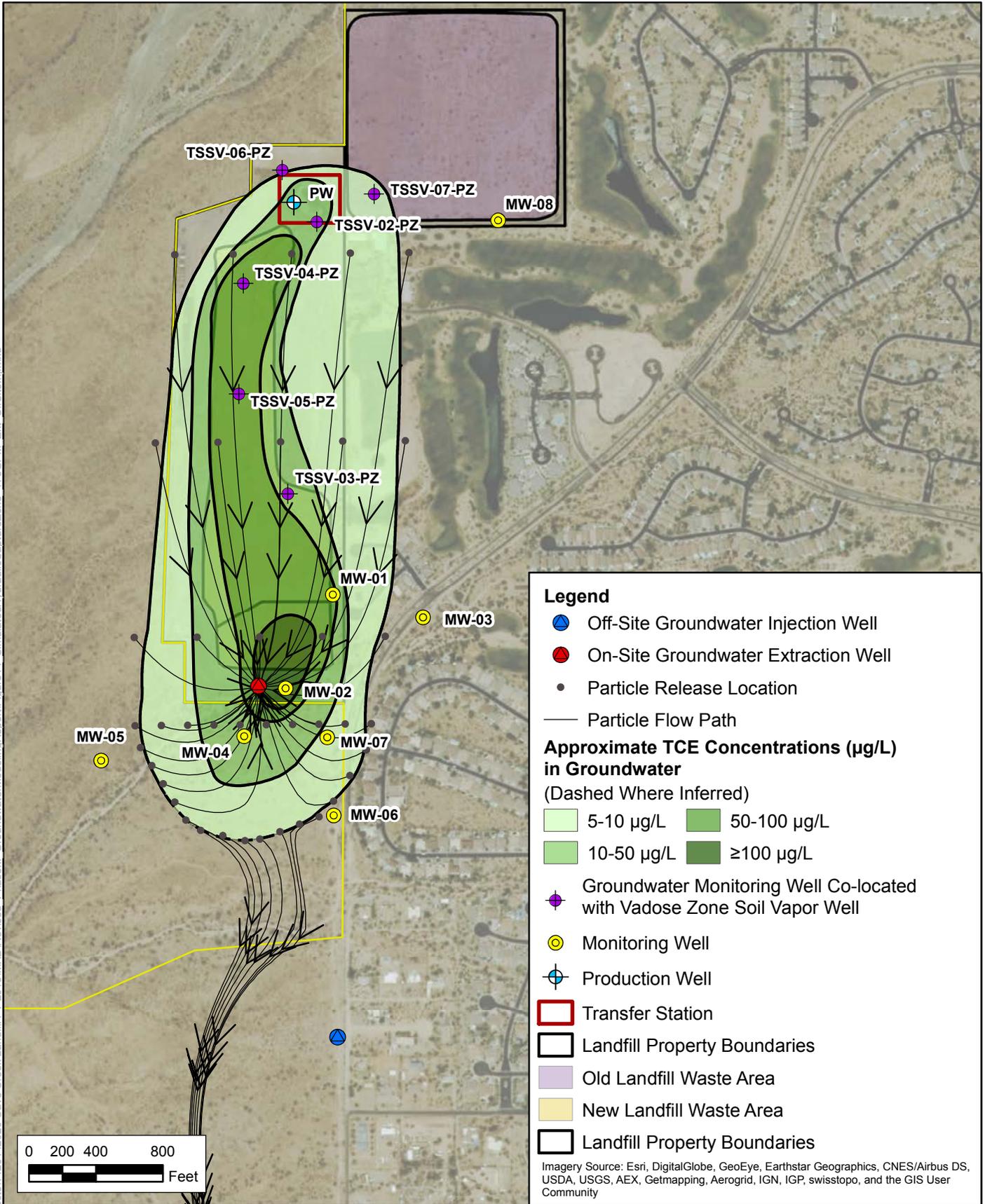
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Simulated Hydraulic Capture Zone –
190 gpm Extraction and Off-site Injection

Path: X:\Projects\2014\Projects\1420142020 Cave Creek Landfill EY 2015\MXD\Revised_PhaseIII_GroundwaterModelingReport\Figure14_SimulatedHydraulicCaptureZone_175GPM_Ext_OffSiteInj.mxd



Job No.	1420142020
PM:	NC
Date:	2/25/2016
Scale:	1" = 800'



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Maricopa County Cave Creek Landfill
Phoenix, Arizona

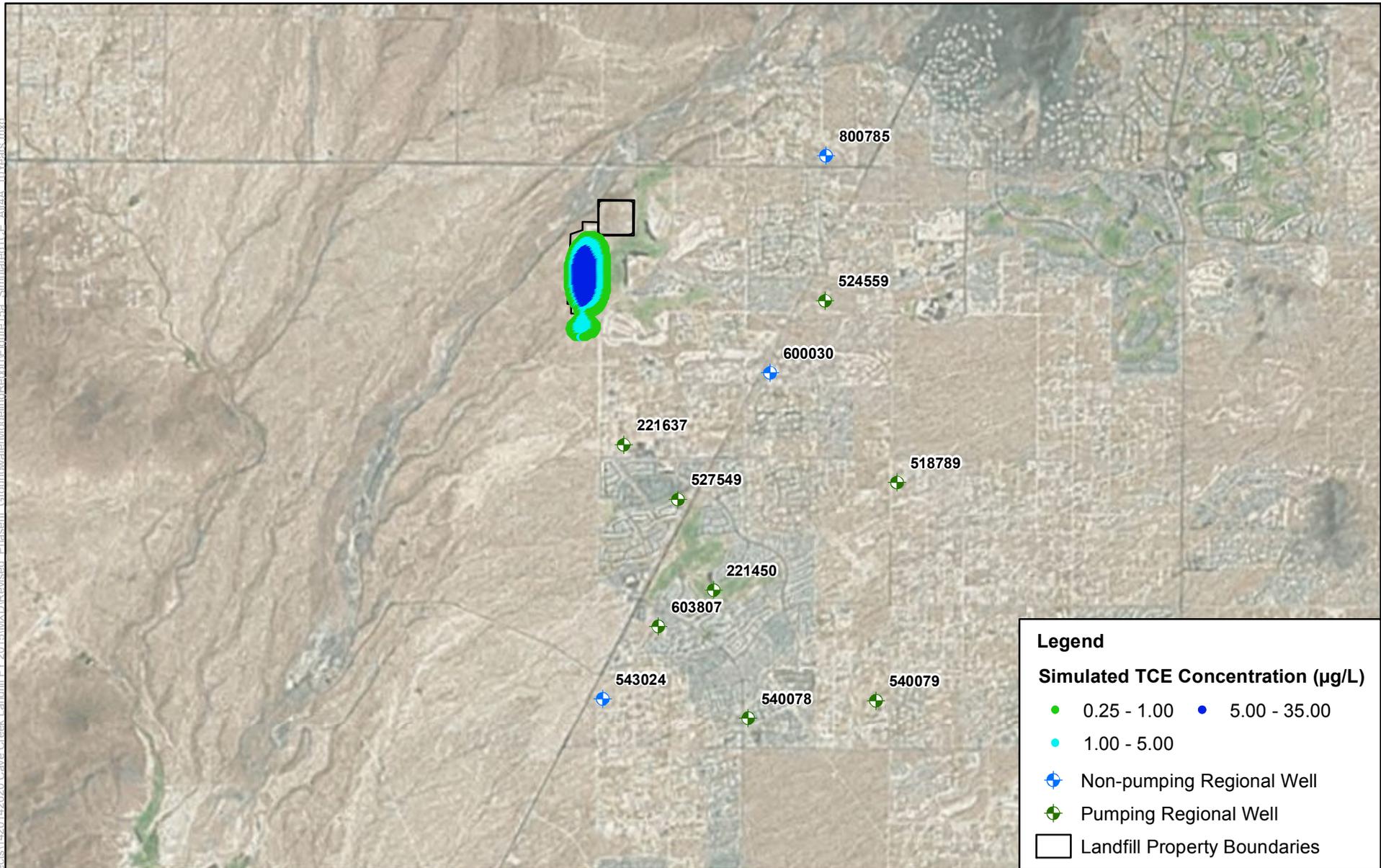
**Simulated Hydraulic Capture Zone –
175 gpm Extraction and Off-site Injection**

FIGURE
14



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Path: X:\Projects\2014_1420142020_Cave_Creek_Landfill_FY_2015\MXD\Revised_Phase3_GroundwaterModelingReport\Figure15a_SimulatedTCE_Alt4A_10Years.mxd

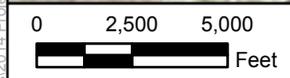


Legend

Simulated TCE Concentration (µg/L)

- 0.25 - 1.00
- 1.00 - 5.00
- ◆ 5.00 - 35.00

- ◆ Non-pumping Regional Well
- ◆ Pumping Regional Well
- Landfill Property Boundaries



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Date:	2/29/2016
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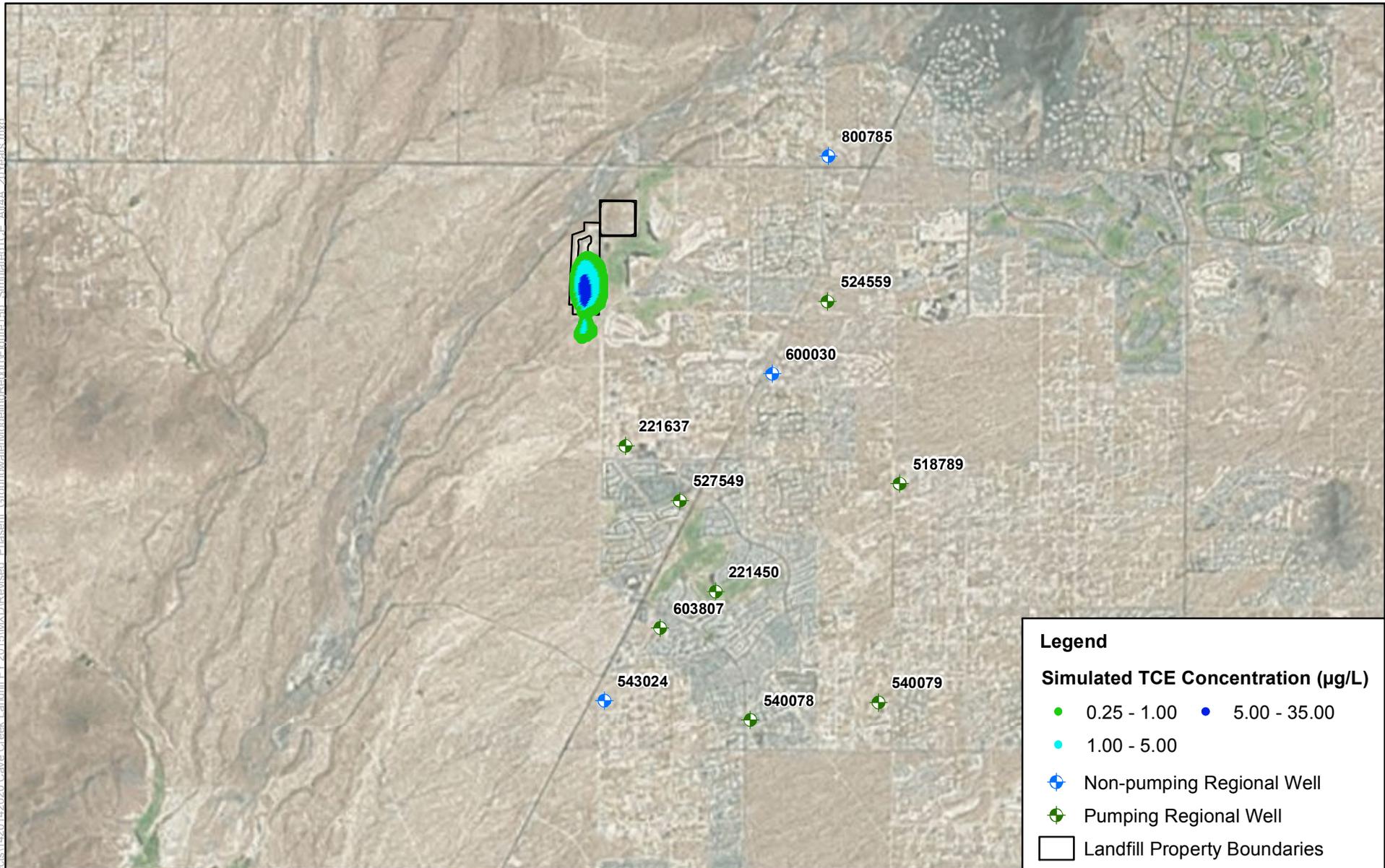
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 Maricopa County Cave Creek Landfill
 Phoenix, Arizona

**Simulated TCE Concentrations for Alternative 4A
 with Off-site Injection – 10 Years**



**FIGURE
15a**

Path: X:\Projects\2014_1420142020_Cave_Creek_Landfill_FY_2015\MXD\Revised_Phase3_GroundwaterModelingReport\Figure15b_SimulatedTCE_Alt4A_20Years.mxd

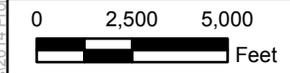


Legend

Simulated TCE Concentration (µg/L)

- 0.25 - 1.00
- 1.00 - 5.00
- 5.00 - 35.00

- ◆ Non-pumping Regional Well
- ◆ Pumping Regional Well
- Landfill Property Boundaries



Imagery Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

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**Simulated TCE Concentrations for Alternative 4A
 with Off-site Injection – 20 Years**



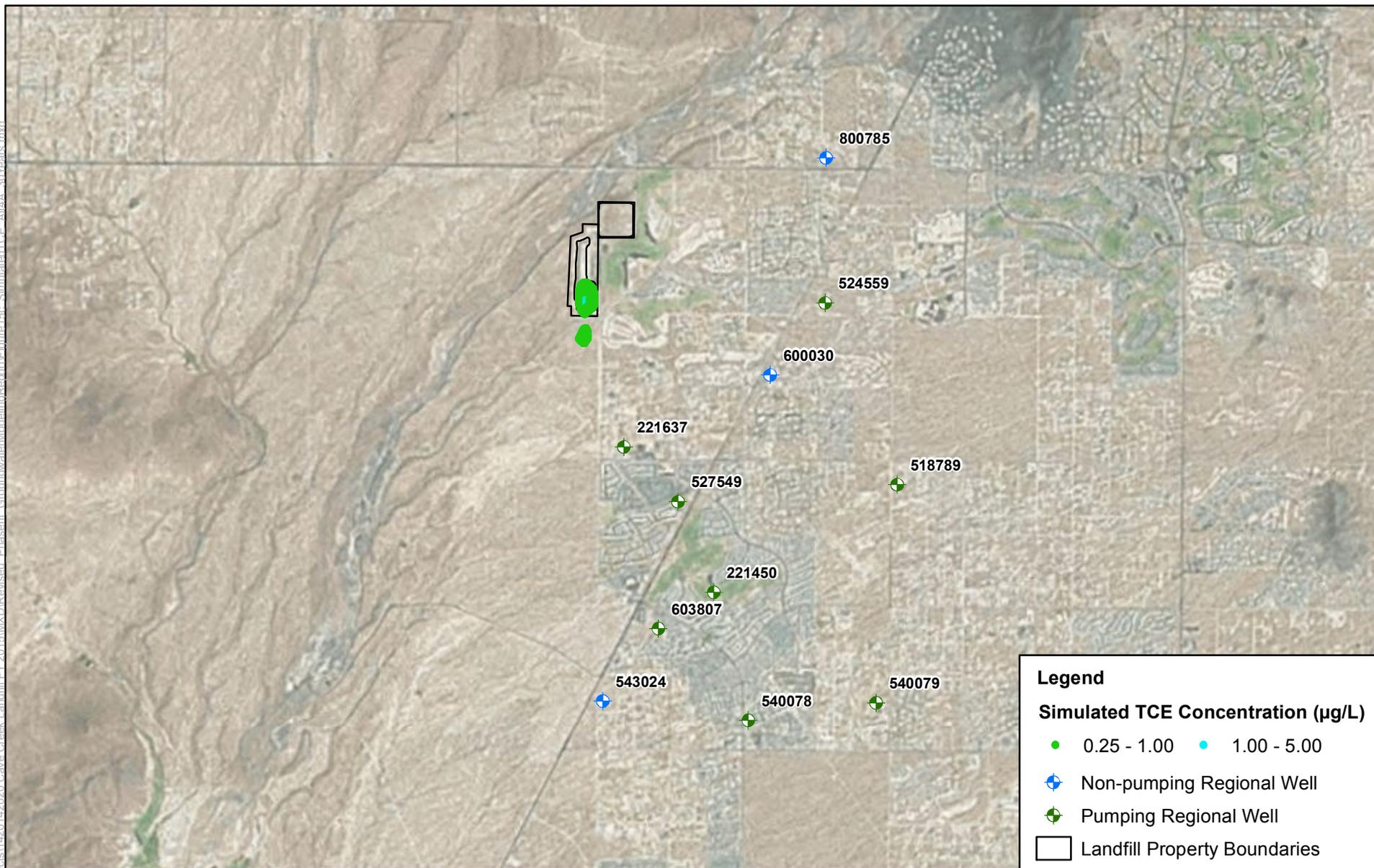
Job No.	1420142020
PM:	NC
Date:	2/29/2016
Scale:	1" = 5000'



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**FIGURE
 15b**

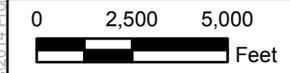
Path: X:\Projects\2014_1420142020_Cave_Creek_Landfill_FY_2015\MXD\Revised_Phase3_III_GroundwaterModelingReport\Figure15c_SimulatedTCE_Alt4A_30Years.mxd



Legend

Simulated TCE Concentration (µg/L)

- 0.25 - 1.00
- 1.00 - 5.00
- ◆ Non-pumping Regional Well
- ◆ Pumping Regional Well
- Landfill Property Boundaries



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 Date: 2/29/2016
 Scale: 1" = 5000'

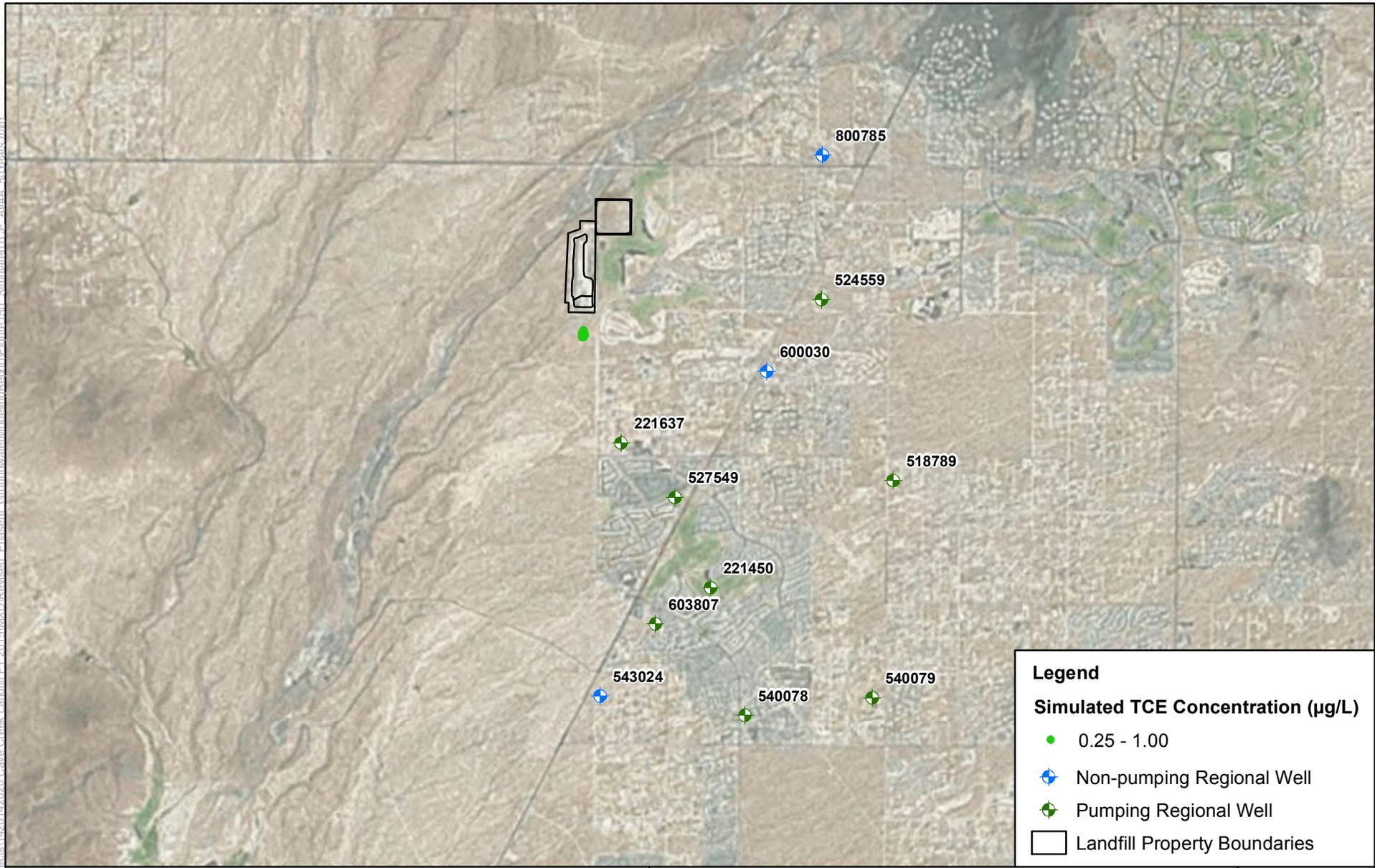
Revised Phase 3 Modeling Results Memorandum
 Maricopa County Cave Creek Landfill
 Phoenix, Arizona

**Simulated TCE Concentrations for Alternative 4A
 with Off-site Injection – 30 Years**



**FIGURE
 15c**

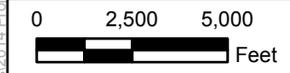
Path: X:\Projects\2014_1420142020_Cave_Creek_Landfill_FY_2015\MXD\Revised_Phase3_ GroundwaterModelingReport\Figure15d_SimulatedTCE_Alt4A_50Years.mxd



Legend

Simulated TCE Concentration (µg/L)

- 0.25 - 1.00
- ◆ Non-pumping Regional Well
- ◆ Pumping Regional Well
- Landfill Property Boundaries



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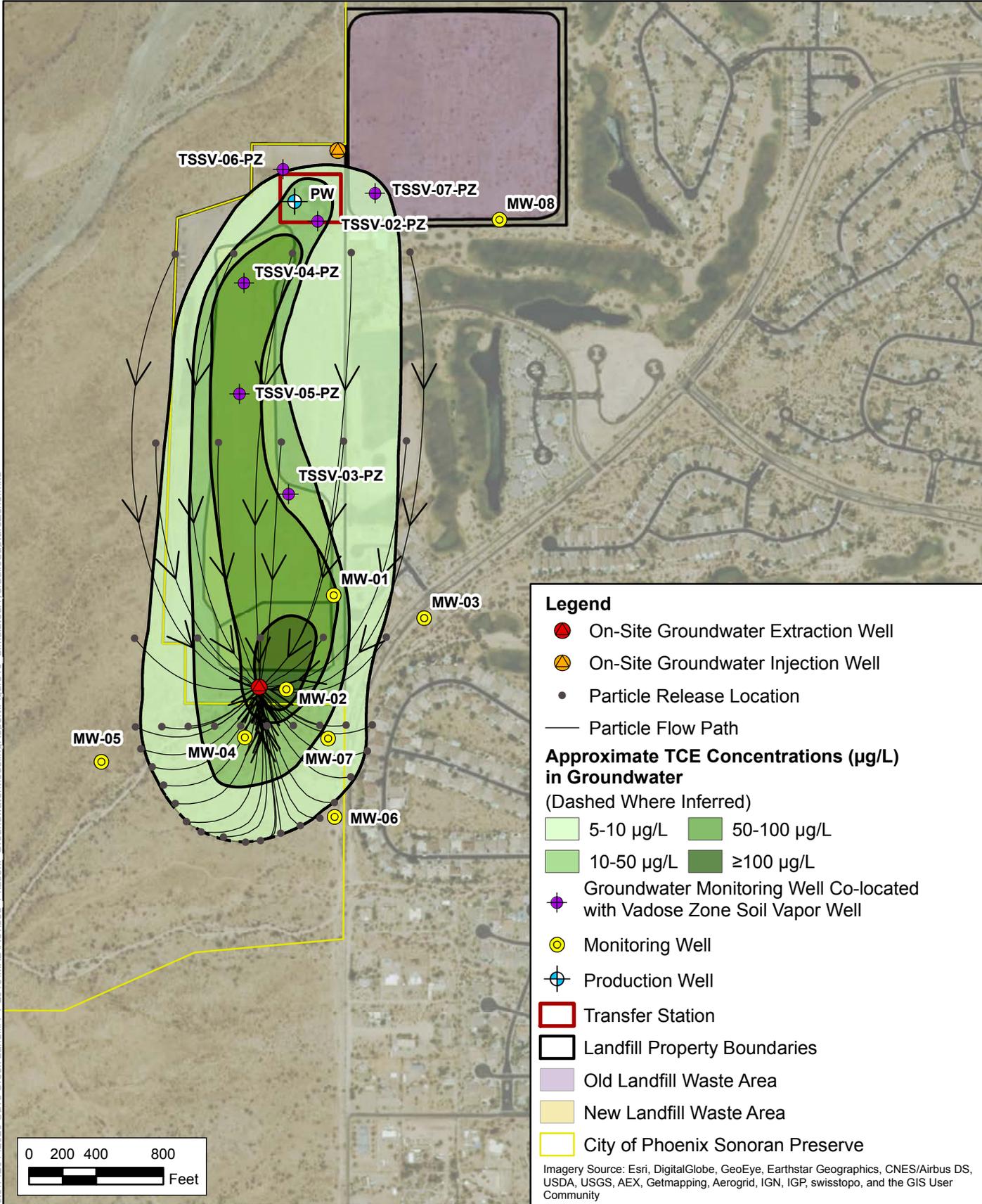
Revised Phase 3 Modeling Results Memorandum
 Maricopa County Cave Creek Landfill
 Phoenix, Arizona

**Simulated TCE Concentrations for Alternative 4A
 with Off-site Injection – 50 Years**



**FIGURE
 15d**

Path: X:\Projects\2014\Projects\1420142020 Cave Creek Landfill FY 2015\MXD\Revised_PhaseIII_GroundwaterModelingReport\Figure16_SimulatedHydraulicCaptureZone.mxd



Legend

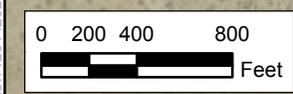
- On-Site Groundwater Extraction Well
- On-Site Groundwater Injection Well
- Particle Release Location
- Particle Flow Path

Approximate TCE Concentrations (µg/L) in Groundwater
(Dashed Where Inferred)

5-10 µg/L	50-100 µg/L
10-50 µg/L	≥100 µg/L

- Groundwater Monitoring Well Co-located with Vadose Zone Soil Vapor Well
- Monitoring Well
- Production Well
- Transfer Station
- Landfill Property Boundaries
- Old Landfill Waste Area
- New Landfill Waste Area
- City of Phoenix Sonoran Preserve

Imagery Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community



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Date:	2/25/2016
Scale:	1" = 800'



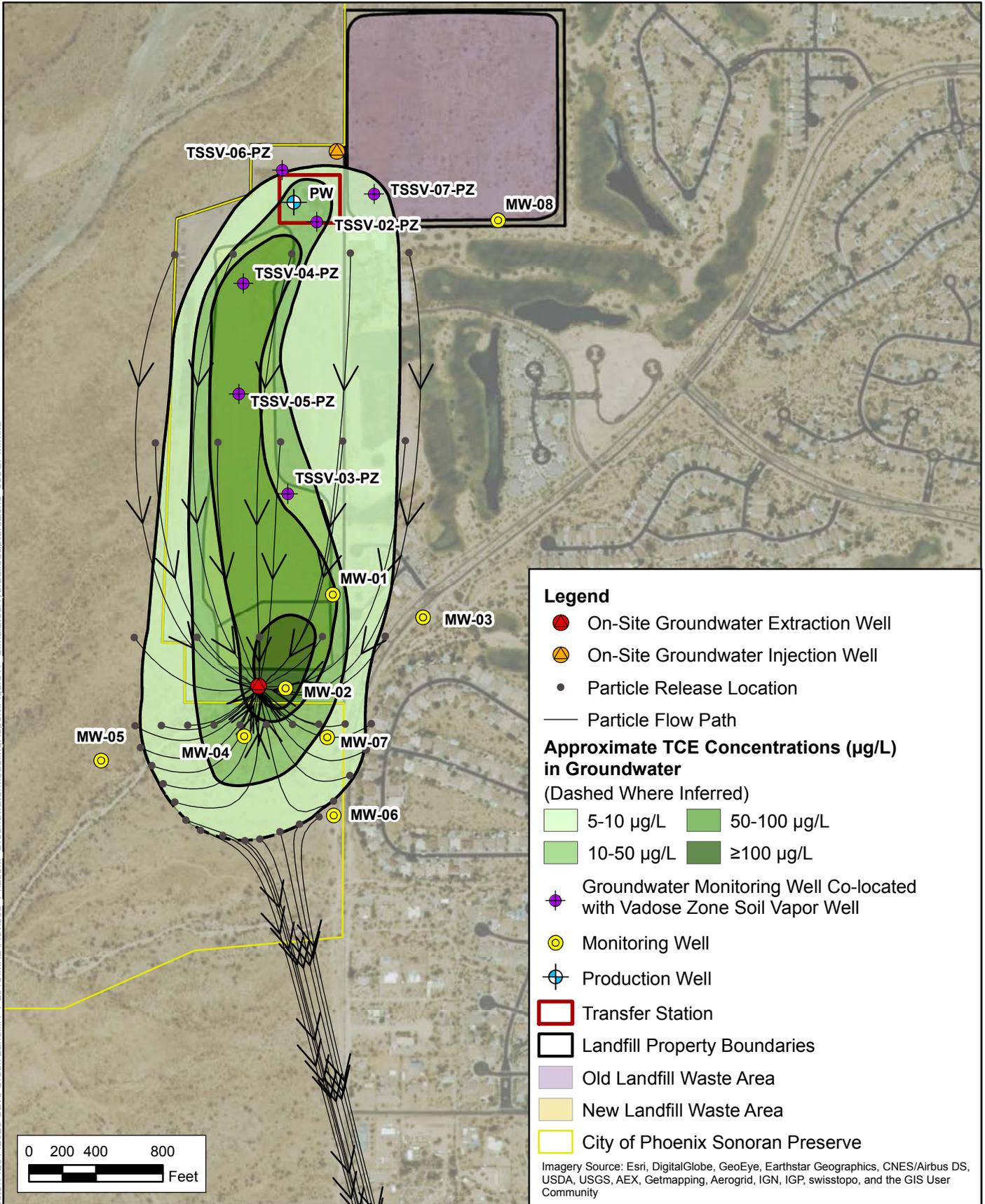
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Maricopa County Cave Creek Landfill
Phoenix, Arizona



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Simulated Hydraulic Capture Zone –
370 gpm Extraction and On-site Injection

Path: X:\Projects\2014\Projects\1420142020\Cave Creek Landfill FY 2015\MXD\Revised_PhaseIII_GroundwaterModelingReport\Figure17_SimulatedHydraulicCaptureZone_300GPM.mxd



Job No.	1420142020
PM:	NC
Date:	2/25/2016
Scale:	1" = 800'



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Maricopa County Cave Creek Landfill
Phoenix, Arizona

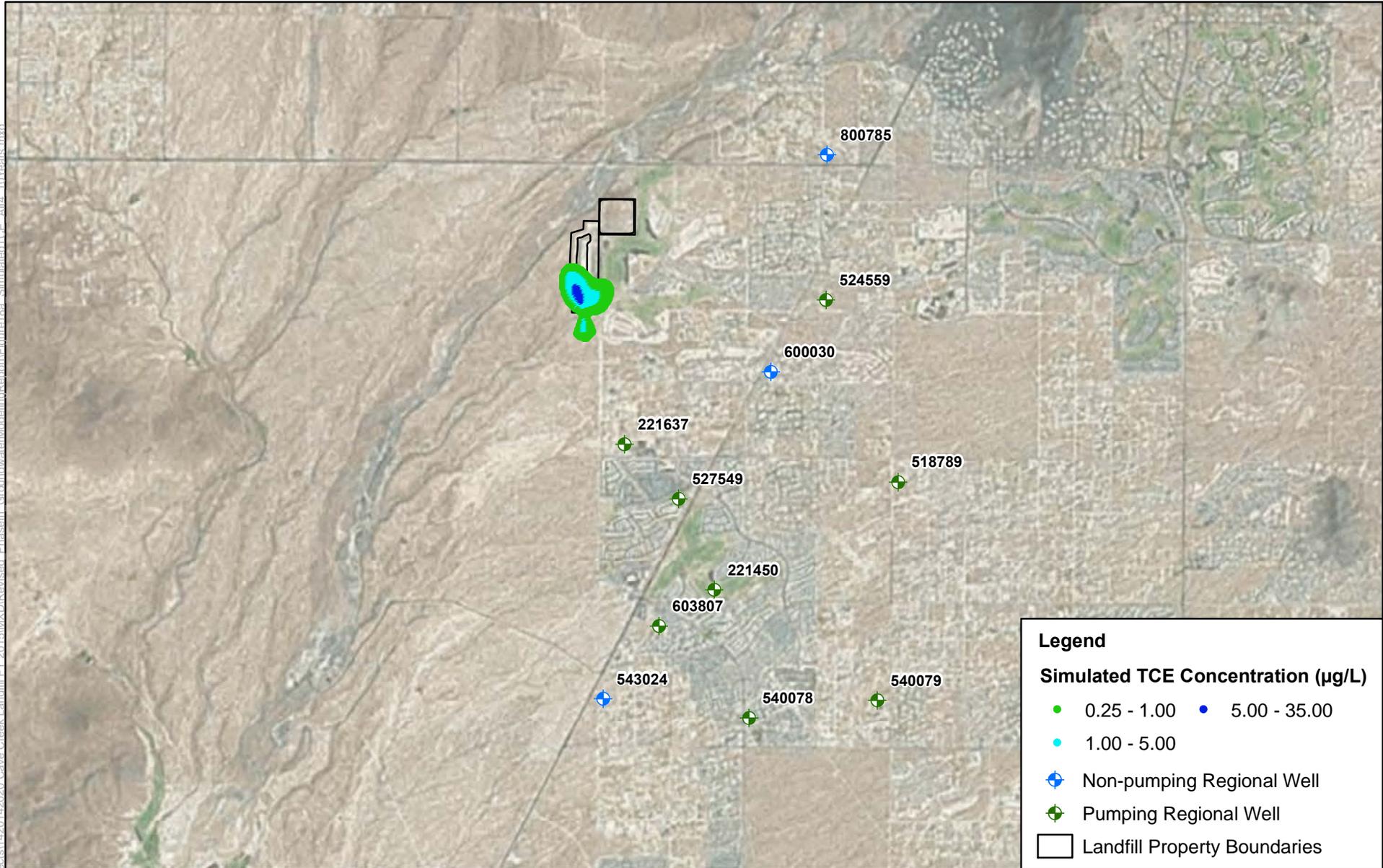


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Simulated Hydraulic Capture Zone –
300 gpm Extraction and On-site Injection

FIGURE
17

Path: X:\Projects\2014_Projects\1420142020_Cave Creek Landfill_FY 2015\MXD\Revised_Phase3_ GroundwaterModelingReport\Figure18a_SimulatedTCE_Alt4_10Years.mxd



Legend

Simulated TCE Concentration (µg/L)

- 0.25 - 1.00
- 1.00 - 5.00
- 5.00 - 35.00

- ◆ Non-pumping Regional Well
- ◆ Pumping Regional Well
- Landfill Property Boundaries



Imagery Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

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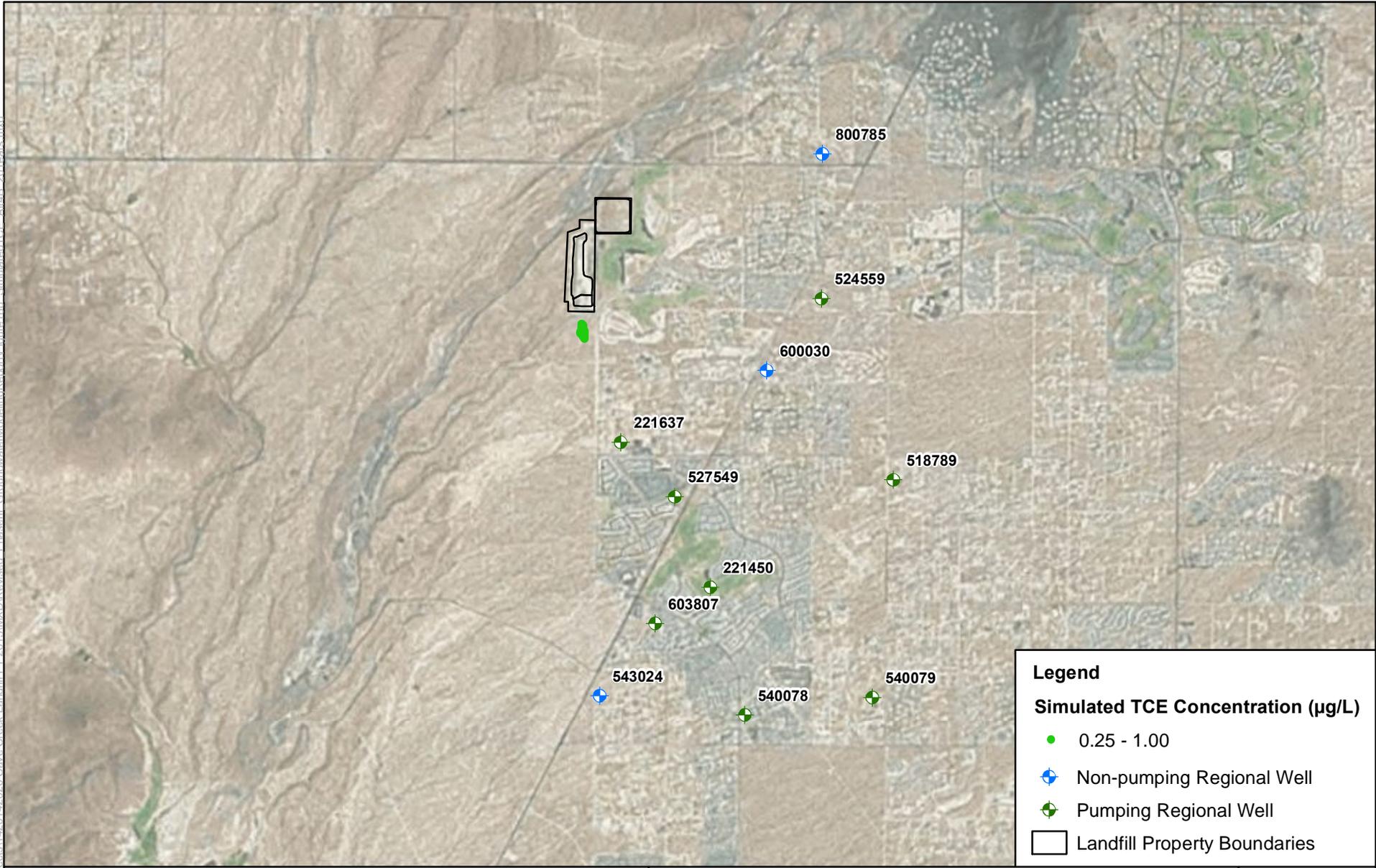
Revised Phase 3 Modeling Results Memorandum
 Maricopa County Cave Creek Landfill
 Phoenix, Arizona

**Simulated TCE Concentrations for Alternative 4B
 with On-site Injection - 10 Years**

FIGURE
18a



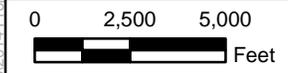
Path: X:\Projects\2014_2020\Cave Creek Landfill_FY 2015\MXD\Revised_Phase3\GroundwaterModelingReport\Figure18b_SimulatedTCE_Alt4B_20Years.mxd



Legend

Simulated TCE Concentration (µg/L)

- 0.25 - 1.00
- ◆ Non-pumping Regional Well
- ◆ Pumping Regional Well
- Landfill Property Boundaries



Imagery Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

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 Maricopa County Cave Creek Landfill
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 PM: NC
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 Scale: 1" = 5000'

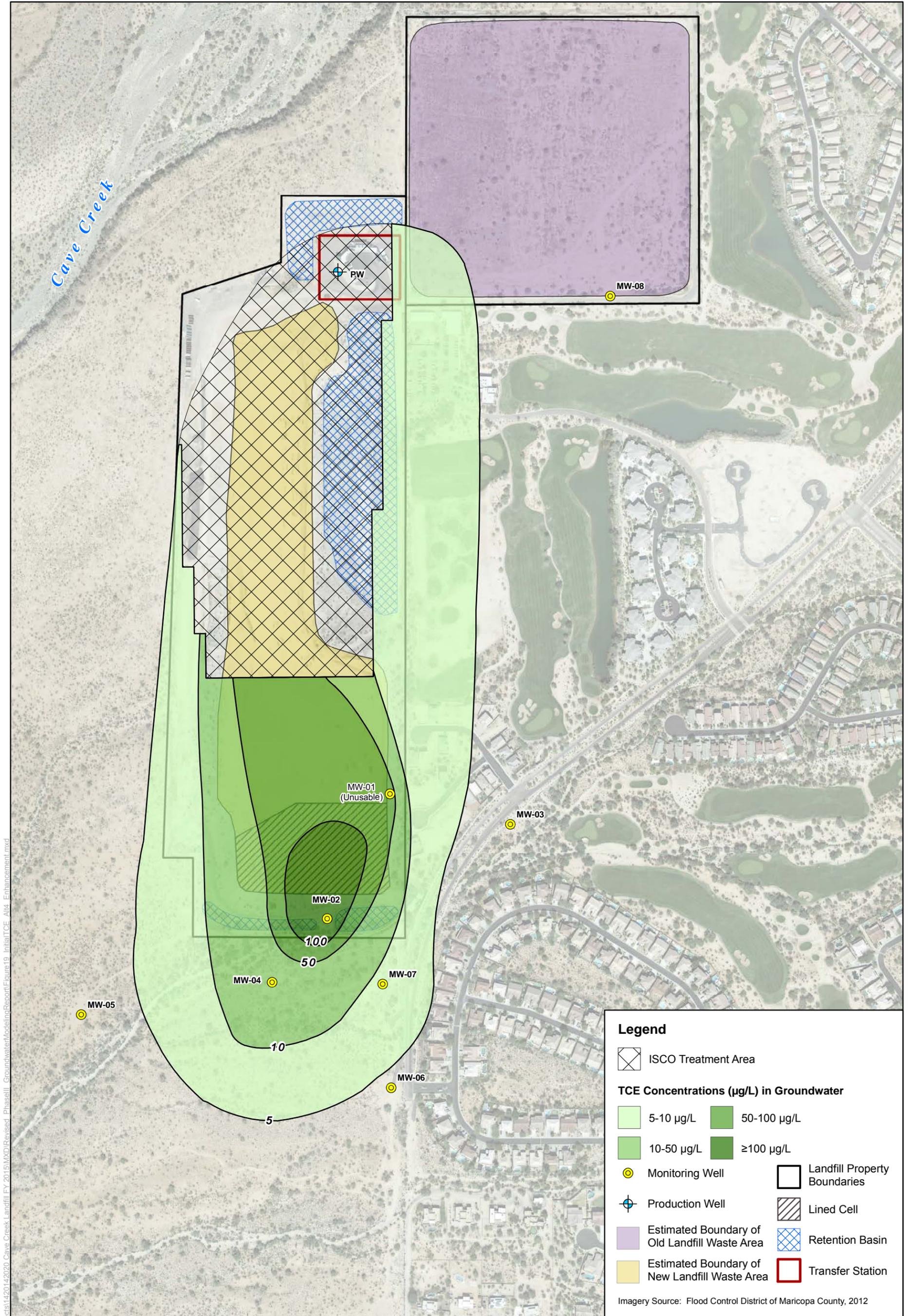


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**Simulated TCE Concentrations for Alternative 4B
 with On-site Injection – 20 Years**



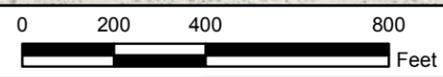
**FIGURE
 18b**



Legend

- ISCO Treatment Area
- TCE Concentrations (µg/L) in Groundwater**
- 5-10 µg/L
- 10-50 µg/L
- 50-100 µg/L
- ≥100 µg/L
- Monitoring Well
- Production Well
- Estimated Boundary of Old Landfill Waste Area
- Estimated Boundary of New Landfill Waste Area
- Landfill Property Boundaries
- Lined Cell
- Retention Basin
- Transfer Station

Imagery Source: Flood Control District of Maricopa County, 2012



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 Maricopa County Cave Creek Landfill
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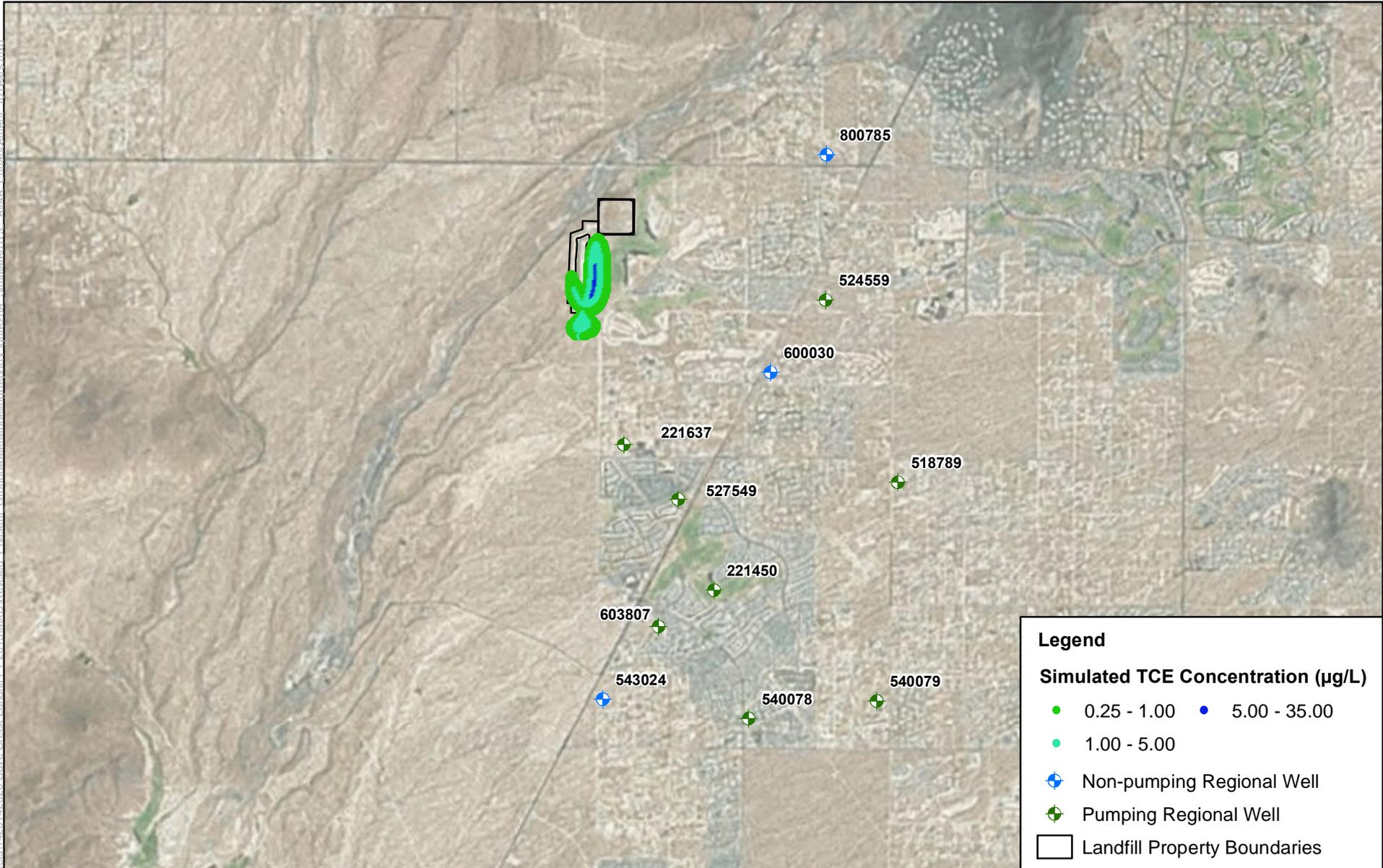
**Initial TCE Concentrations for
 Alternative 4 Enhancement**

FIGURE
19



Path: X:\Projects\2014\Projects\142014\2020 Cave Creek Landfill\FY 2015\MXD\Revised_Phase3_GroundwaterModelingReport\Figure19_InitialTCE_Alt4_Enhancement.mxd

Path: X:\Projects\2014_1420142020_Cave_Creek_Landfill_FY_2015\MXD\Revised_Phase3\GroundwaterModelingReport\Figure20a_SimulatedTCE_Alt4A_Enhancement_10Years.mxd

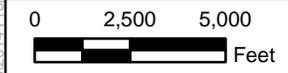


Legend

Simulated TCE Concentration (µg/L)

- 0.25 - 1.00
- 1.00 - 5.00
- ◆ 5.00 - 35.00

- ◆ Non-pumping Regional Well
- ◆ Pumping Regional Well
- Landfill Property Boundaries



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 PM: NC
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 Scale: 1" = 5000'

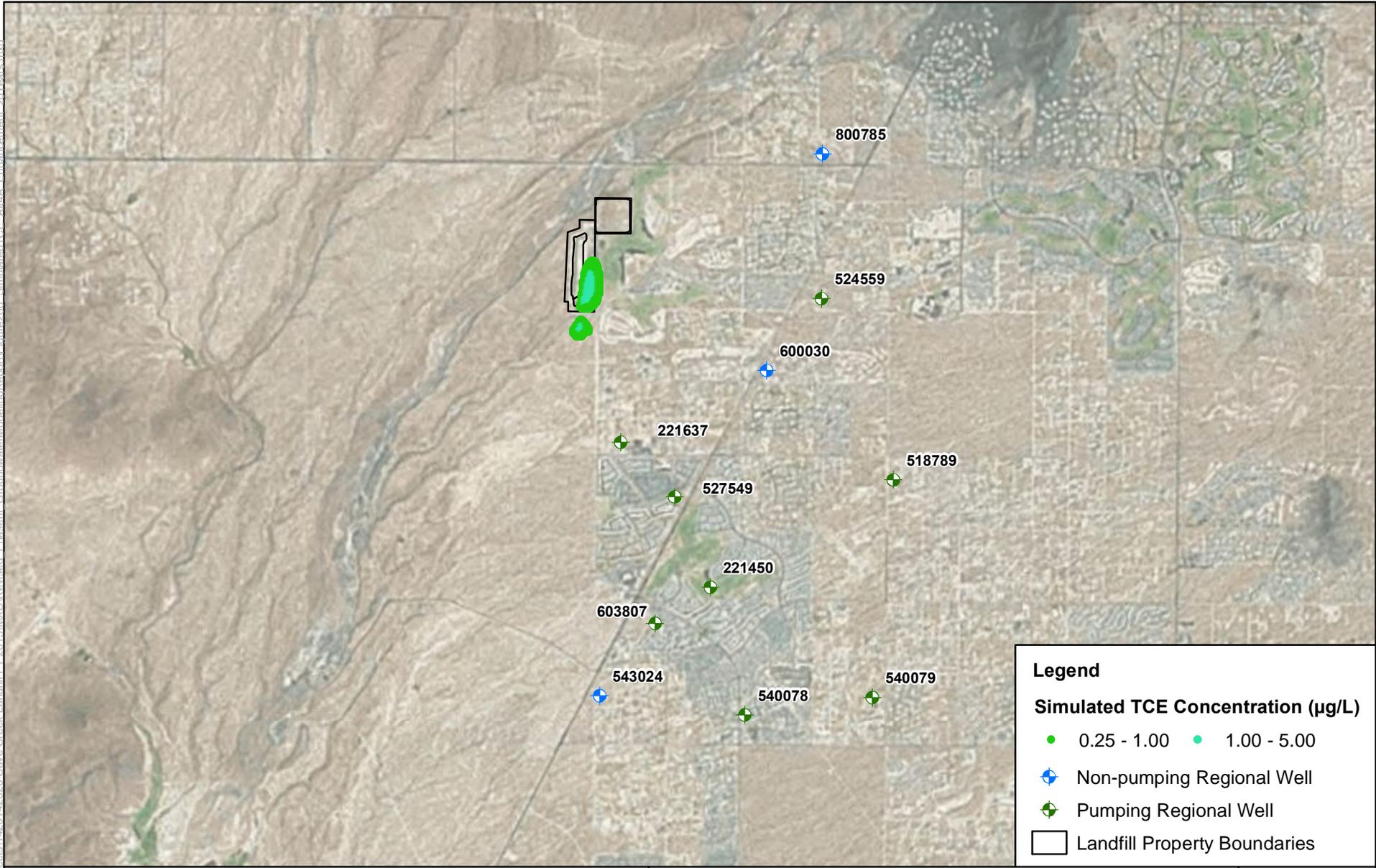
Revised Phase 3 Modeling Results Memorandum
 Maricopa County Cave Creek Landfill
 Phoenix, Arizona

**Simulated TCE Concentrations for Alternative 4A
 Enhancement with Off-site Injection – 10 Years**



**FIGURE
 20a**

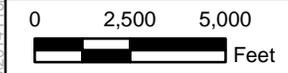
Path: X:\Projects\2014_1420142020_Cave_Creek_Landfill_FY_2015\MXD\Revised_Phase3_ GroundwaterModelingReport\Figure20b - SimulatedTCE_Alt4A_Enhancement - 20Years.mxd



Legend

Simulated TCE Concentration (µg/L)

- 0.25 - 1.00 ● 1.00 - 5.00
- ◆ Non-pumping Regional Well
- ◆ Pumping Regional Well
- Landfill Property Boundaries



Imagery Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

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 Maricopa County Cave Creek Landfill
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PM:	NC
Date:	2/24/2016
Scale:	1" = 5000'



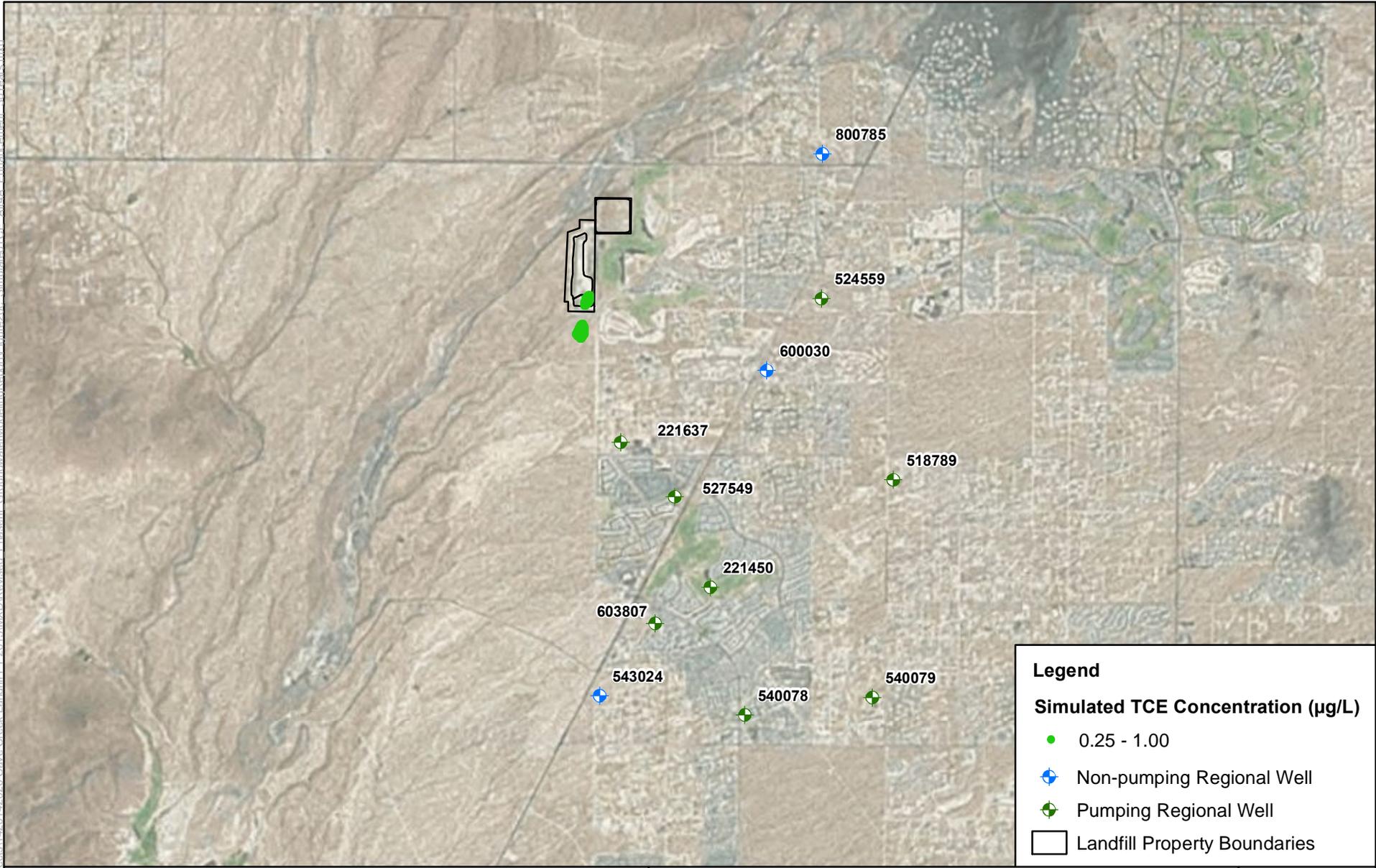
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**Simulated TCE Concentrations for Alternative 4A
 Enhancement with Off-site Injection – 20 Years**



**FIGURE
20b**

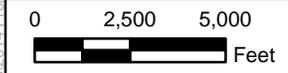
Path: X:\Projects\2014_1420142020_Cave_Creek_Landfill_FY_2015\MXD\Revised_Phase3_III_GroundwaterModelingReport\Figure20c_SimulatedTCE_Alt4A_Enhancement_30Years.mxd



Legend

Simulated TCE Concentration (µg/L)

- 0.25 - 1.00
- ◆ Non-pumping Regional Well
- ◆ Pumping Regional Well
- Landfill Property Boundaries



Imagery Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Revised Phase 3 Modeling Results Memorandum
 Maricopa County Cave Creek Landfill
 Phoenix, Arizona

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 Scale: 1" = 5000'



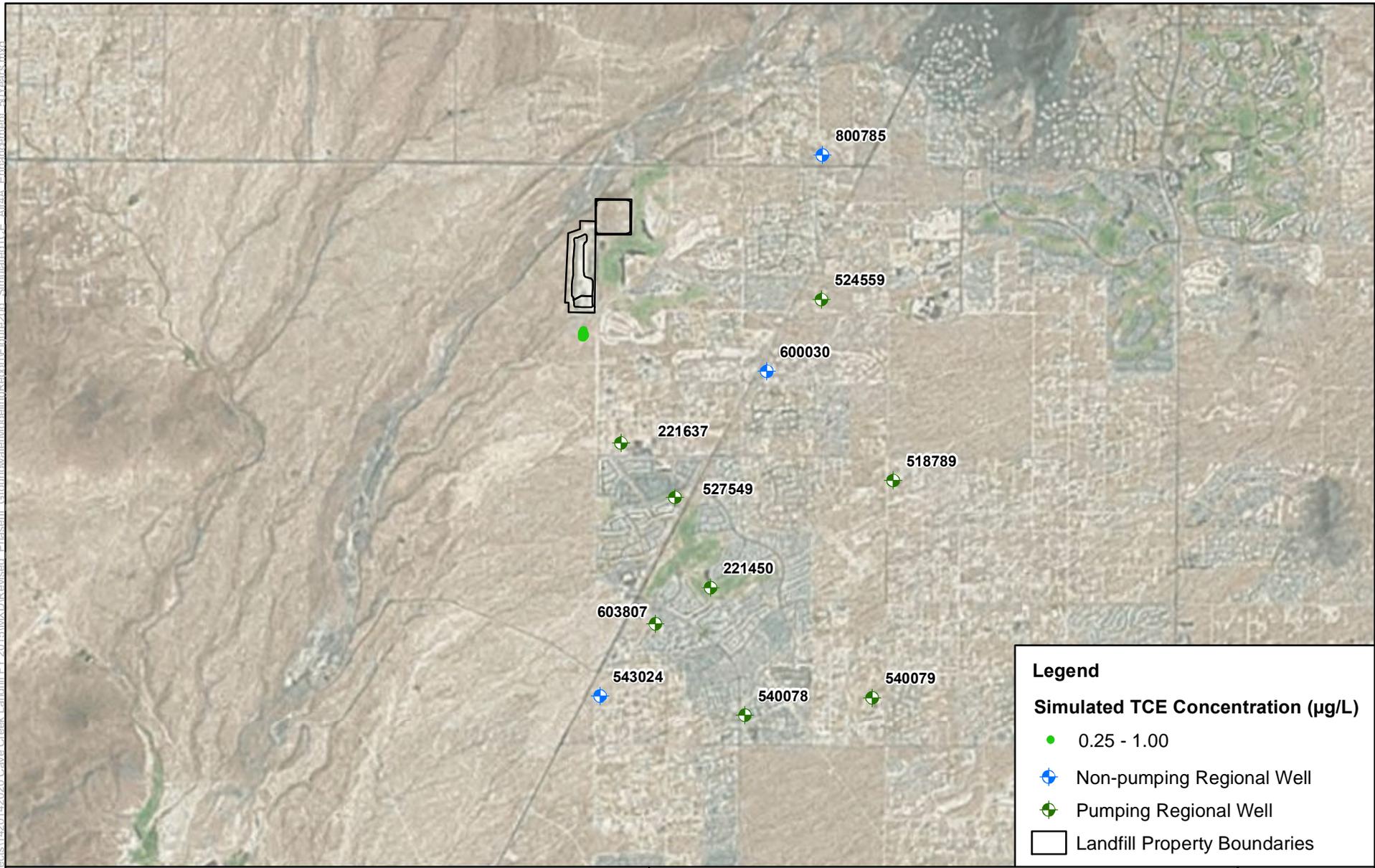
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**Simulated TCE Concentrations for Alternative 4A
 Enhancement with Off-site Injection – 30 Years**



**FIGURE
 20c**

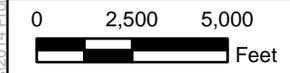
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Legend

Simulated TCE Concentration (µg/L)

- 0.25 - 1.00
- ◆ Non-pumping Regional Well
- ◆ Pumping Regional Well
- Landfill Property Boundaries



Imagery Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

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Maricopa County Cave Creek Landfill
Phoenix, Arizona

Job No. 1420142020
 PM: NC
 Date: 2/24/2016
 Scale: 1" = 5000'



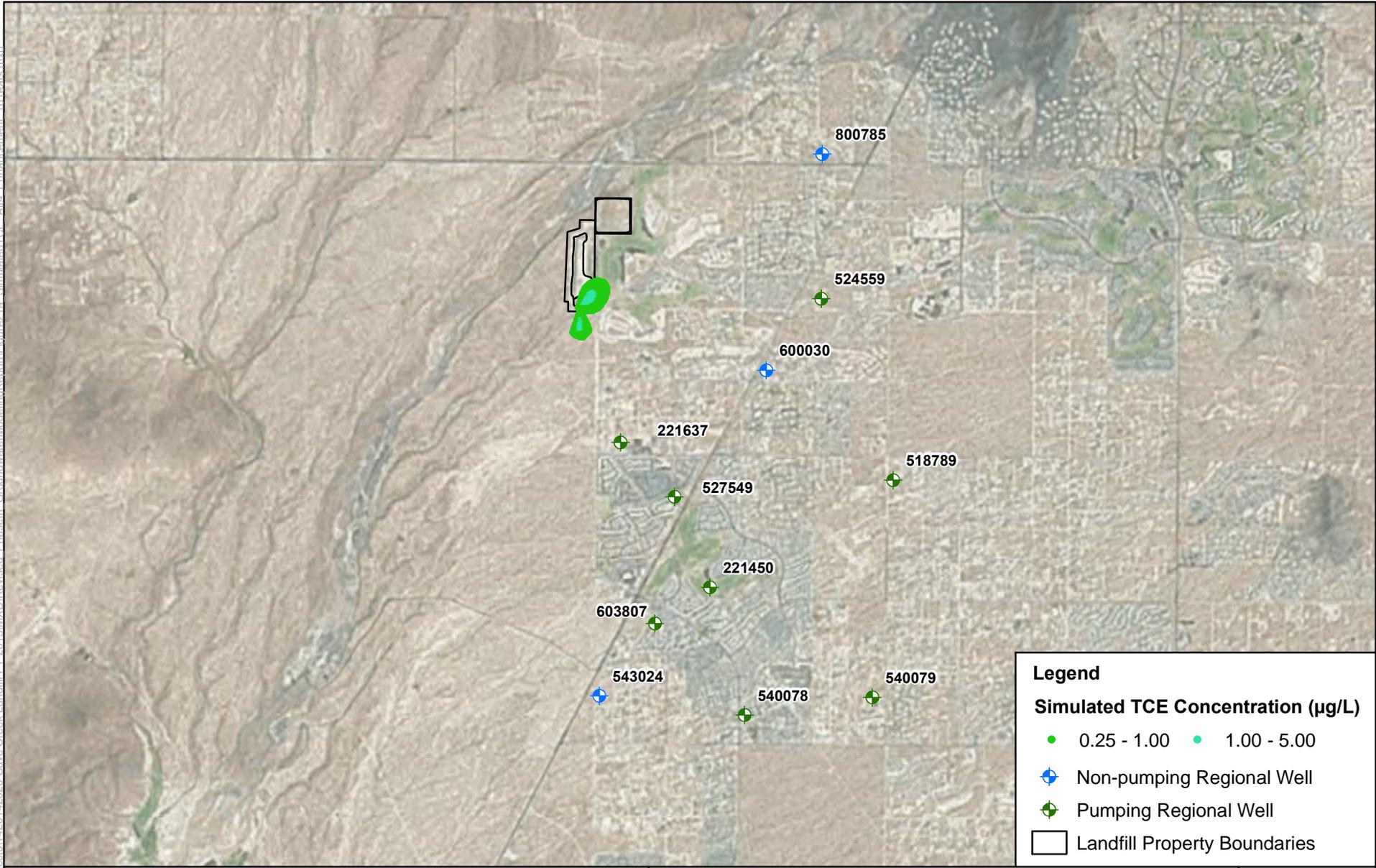
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Simulated TCE Concentrations for Alternative 4A
Enhancement with Off-site Injection – 50 Years



FIGURE
20d

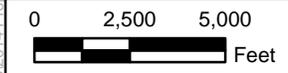
Path: X:\Projects\2014_Projects\1420142020_Cave_Creek_Landfill_FY_2015\MXD\Revised_Phase3_III_GroundwaterModelingReport\Figure21a_SimulatedTCE_Alt4_Enhancement_10Years.mxd



Legend

Simulated TCE Concentration (µg/L)

- 0.25 - 1.00
- 1.00 - 5.00
- ◆ Non-pumping Regional Well
- ◆ Pumping Regional Well
- Landfill Property Boundaries



Imagery Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

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 Maricopa County Cave Creek Landfill
 Phoenix, Arizona

**Simulated TCE Concentrations for Alternative 4B
 Enhancement with On-site Injection - 10 Years**



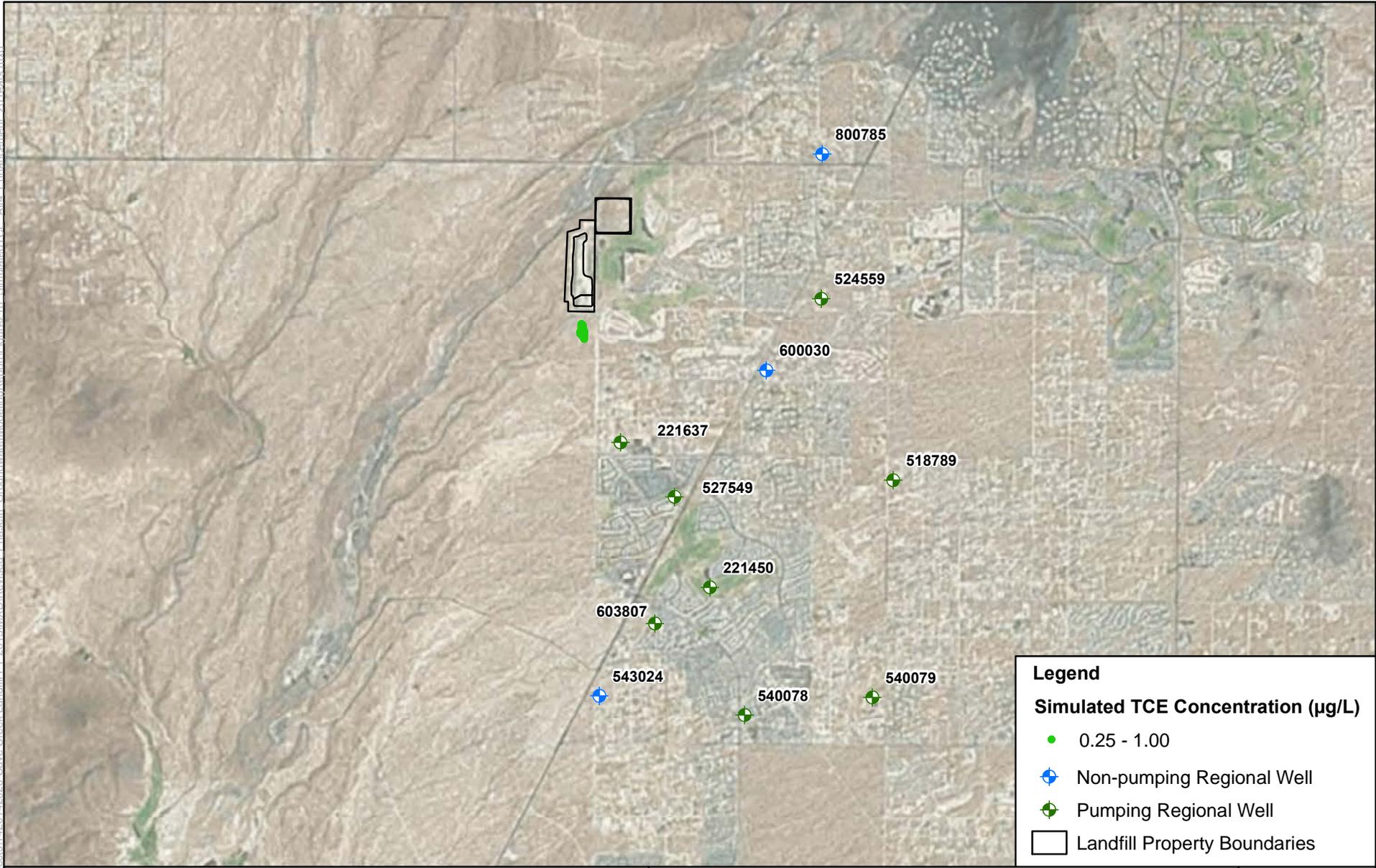
Job No.	1420142020
PM:	NC
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FIGURE
21a

Path: X:\Projects\2014_1420142020_Cave_Creek_Landfill_FY_2015\MXD\Revised_Phase3_III_GroundwaterModelingReport\Figure21b_SimulatedTCE_Alt4_Enhancement_20Years.mxd



Legend

Simulated TCE Concentration (µg/L)

- 0.25 - 1.00
- ◆ Non-pumping Regional Well
- ◆ Pumping Regional Well
- Landfill Property Boundaries



Imagery Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Job No. 1420142020
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 Date: 2/24/2016
 Scale: 1" = 5000'

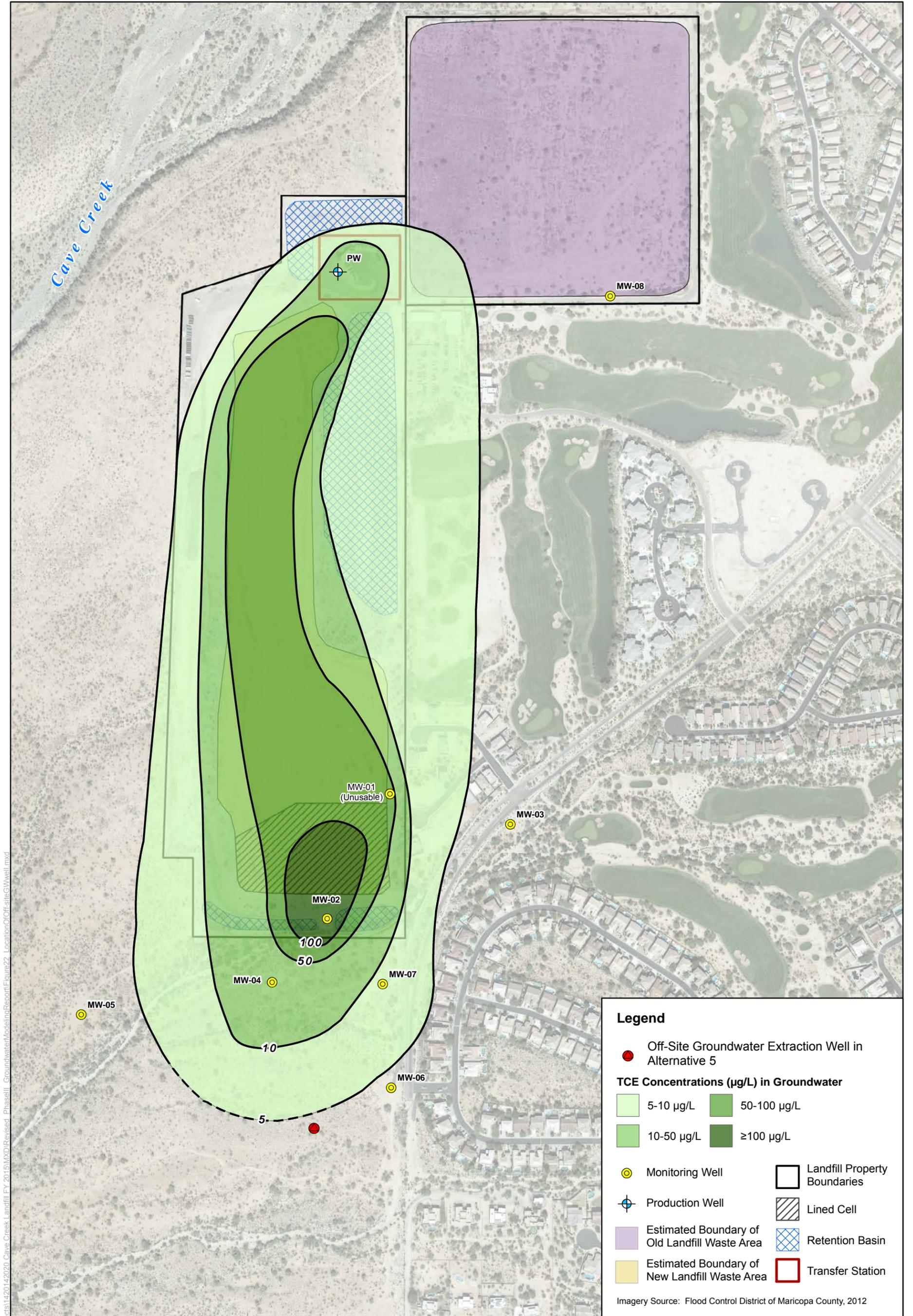
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 Maricopa County Cave Creek Landfill
 Phoenix, Arizona

**Simulated TCE Concentrations for Alternative 4B
 Enhancement with On-site Injection – 20 Years**

**FIGURE
 21b**





Legend

- Off-Site Groundwater Extraction Well in Alternative 5
- Monitoring Well
- ⊕ Production Well
- Estimated Boundary of Old Landfill Waste Area
- Estimated Boundary of New Landfill Waste Area
- Landfill Property Boundaries
- ▨ Lined Cell
- ▤ Retention Basin
- Transfer Station

TCE Concentrations (µg/L) in Groundwater

5-10 µg/L	50-100 µg/L
10-50 µg/L	≥100 µg/L

Imagery Source: Flood Control District of Maricopa County, 2012

0 200 400 800 Feet

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 Scale: 1" = 400'

N

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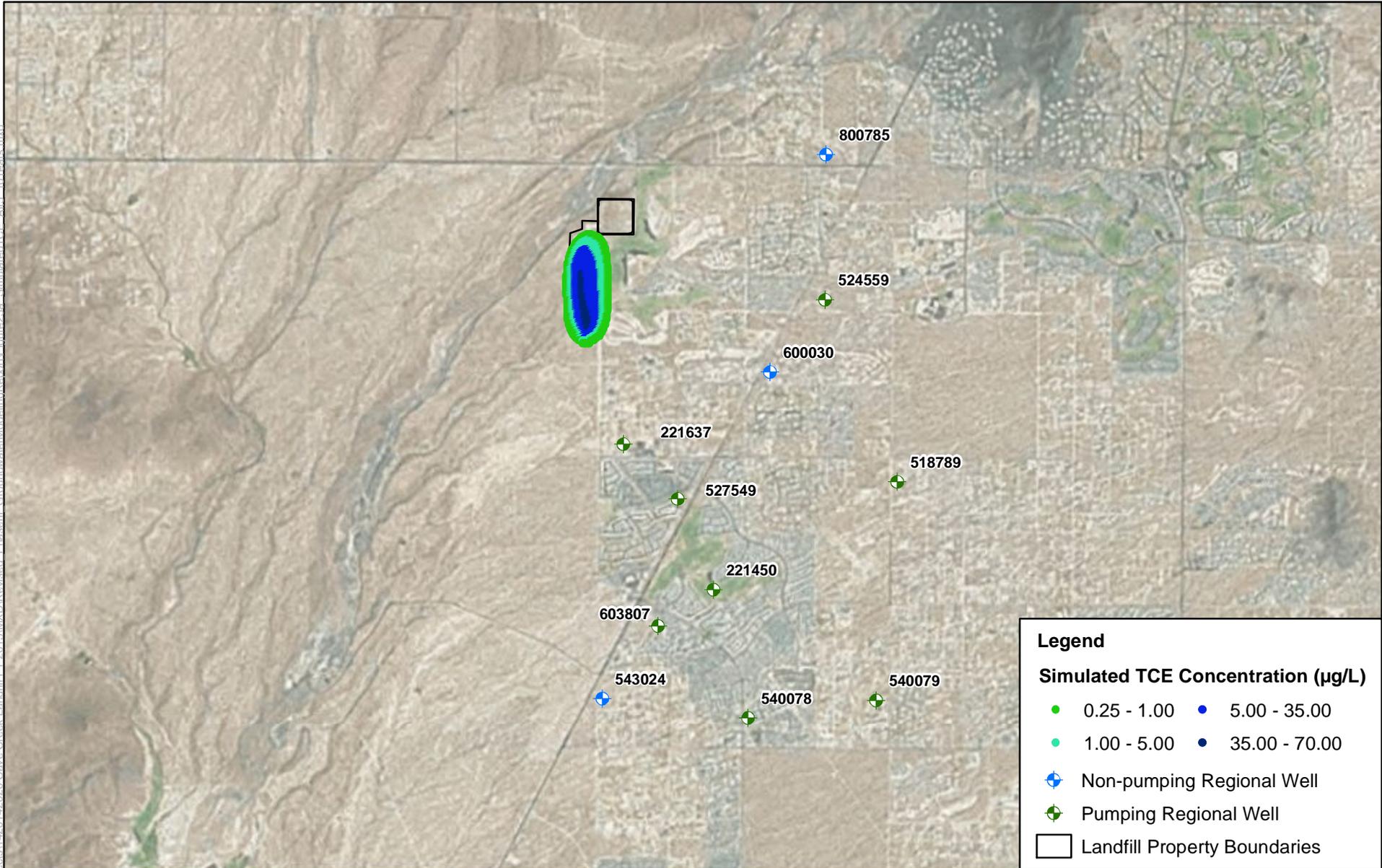
Location of Off-Site Groundwater Extraction Well in Alternative 5

FIGURE 22



Path: X:\Projects\2014\Projects\1420142020\Cave Creek Landfill\FY 2015\MXD\Revised_Phase3_GroundwaterModelingReport\Figure22_LocationOfOffSiteGWWell.mxd

Path: X:\Projects\2014_1420142020_Cave_Creek_Landfill_FY_2015\MXD\Revised_Phase3\GroundwaterModelingReport\Figure23a_SimulatedTCE_Alt5_10Years.mxd

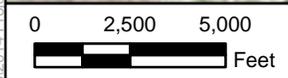


Legend

Simulated TCE Concentration (µg/L)

- 0.25 - 1.00
- 1.00 - 5.00
- 5.00 - 35.00
- 35.00 - 70.00

- ◆ Non-pumping Regional Well
- ◆ Pumping Regional Well
- Landfill Property Boundaries



Imagery Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

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 Maricopa County Cave Creek Landfill
 Phoenix, Arizona

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 PM: NC
 Date: 2/24/2016
 Scale: 1" = 5000'



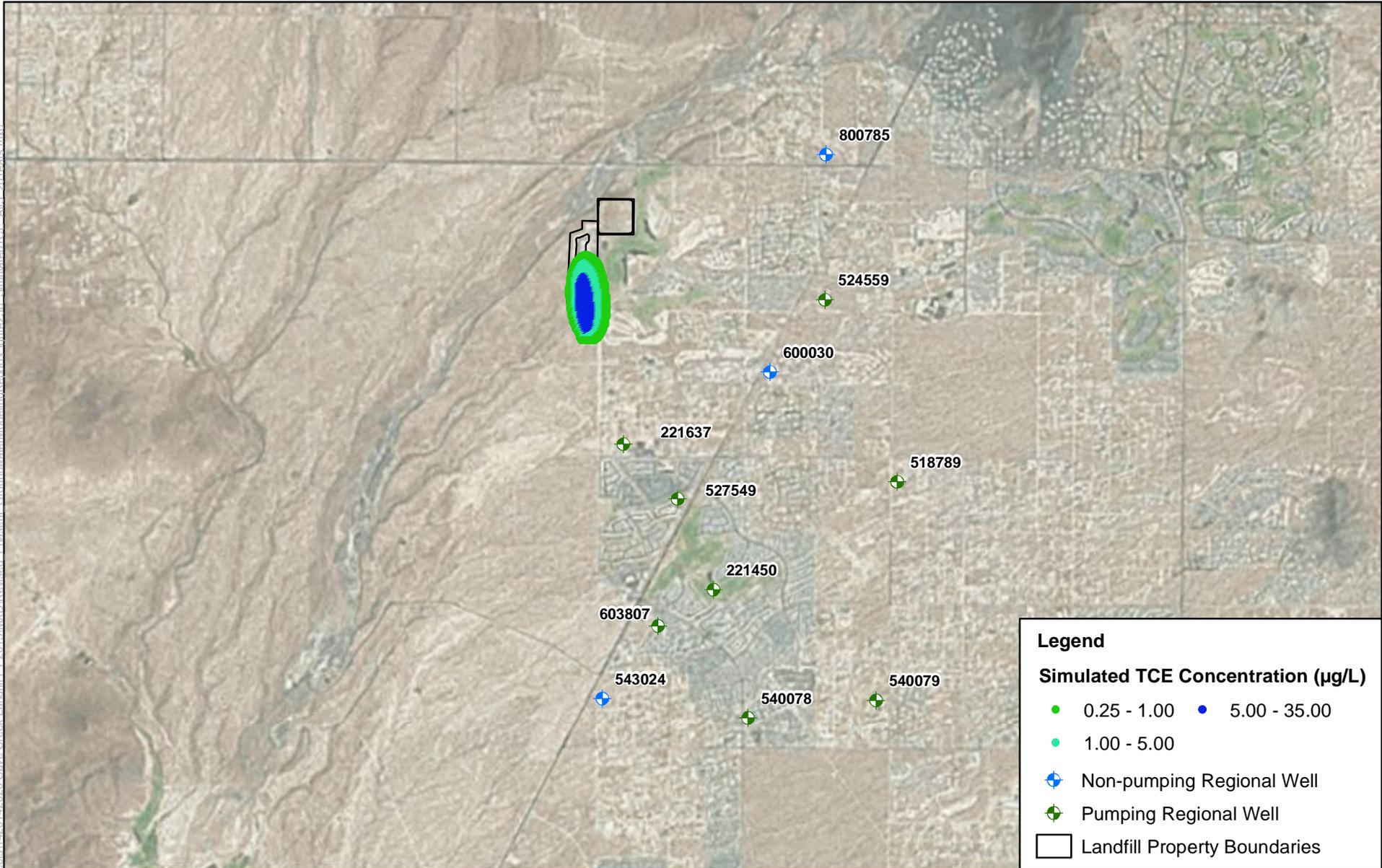
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**Simulated TCE Concentrations for
 Alternative 5 - 10 Years**



FIGURE
23a

Path: X:\Projects\2014_2020\Cave Creek Landfill\FY 2015\MXD\Revised_Phase3\GroundwaterModelingReport\Figure23b_SimulatedTCE_Alt5_20Years.mxd



Legend

Simulated TCE Concentration (µg/L)

- 0.25 - 1.00
- 1.00 - 5.00
- 5.00 - 35.00

- ◆ Non-pumping Regional Well
- ◆ Pumping Regional Well
- Landfill Property Boundaries

0 2,500 5,000
 Feet

Imagery Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

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 PM: NC
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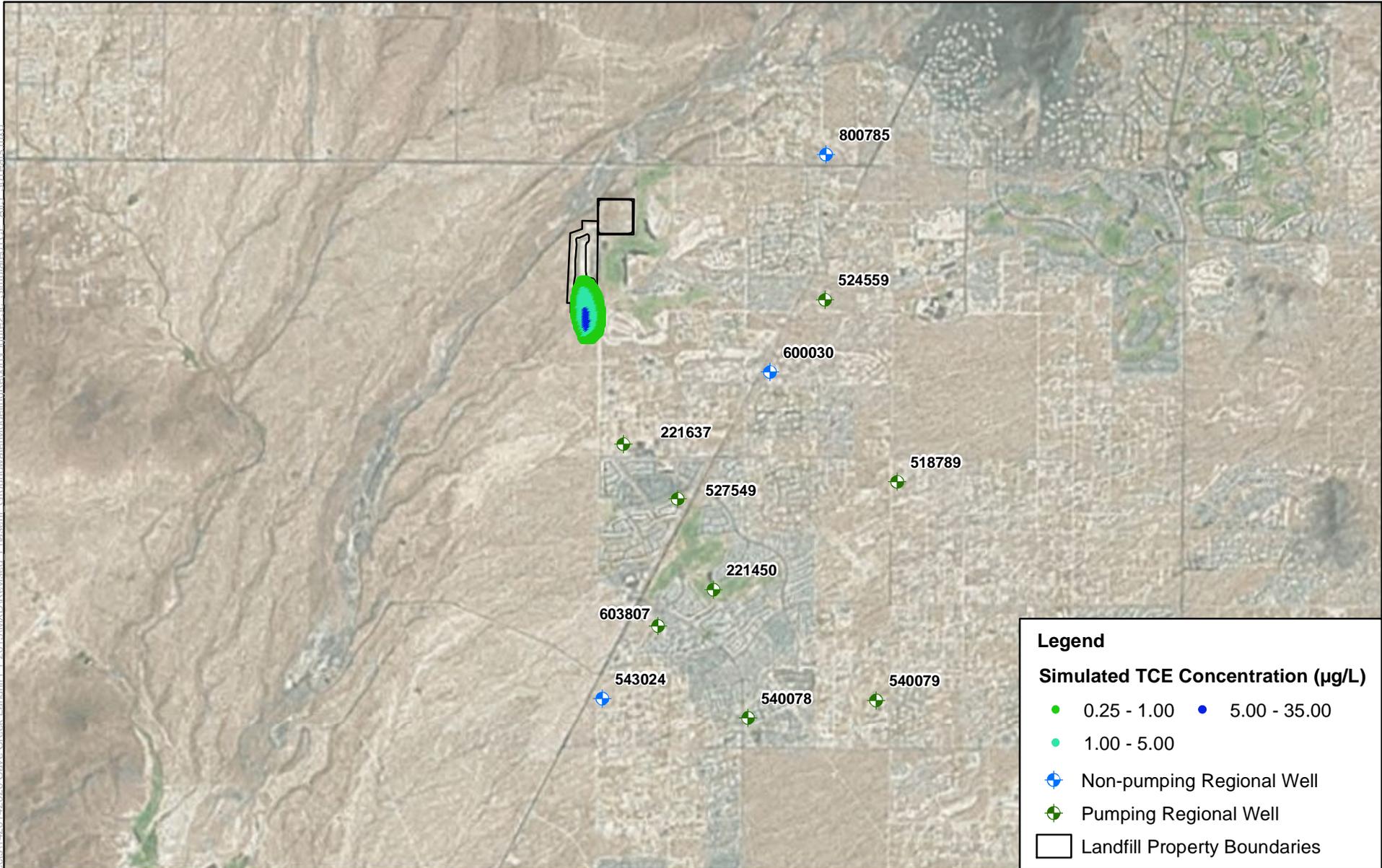
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**Simulated TCE Concentrations for
 Alternative 5 - 20 Years**

FIGURE
23b



Path: X:\Projects\2014_1420142020_Cave_Creek_Landfill_FY_2015\MXD\Revised_Phase3\GroundwaterModelingReport\Figure23c_SimulatedTCE_Alt5_30Years.mxd



Legend

Simulated TCE Concentration (µg/L)

- 0.25 - 1.00
- 1.00 - 5.00
- ◆ 5.00 - 35.00

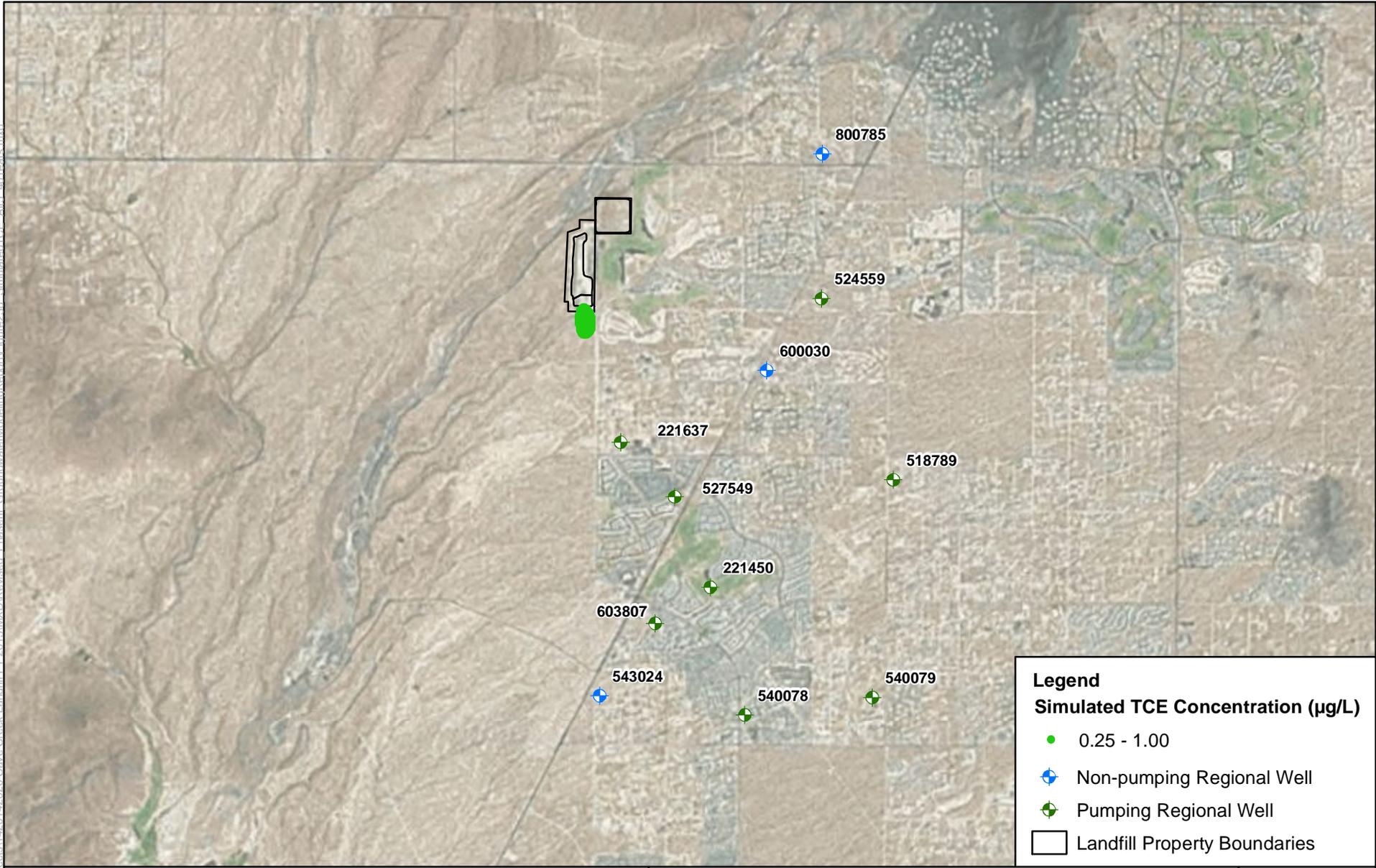
- ◆ Non-pumping Regional Well
- ◆ Pumping Regional Well
- Landfill Property Boundaries

<p>0 2,500 5,000</p> <p>Feet</p>	<p>Imagery Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community</p>	<p>The map shown here has been created with all due and reasonable care and is strictly for use with Amec Foster Wheeler Project Number 1420142020. This map has not been certified by a licensed land surveyor, and any third party use of this map comes without warranties of any kind. Amec Foster Wheeler assumes no liability, direct or indirect, whatsoever for any such third party or unintended use.</p>
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<p>Revised Phase 3 Modeling Results Memorandum Maricopa County Cave Creek Landfill Phoenix, Arizona</p>	
<p>Simulated TCE Concentrations for Alternative 5 - 30 Years</p>	<p>FIGURE 23c</p>



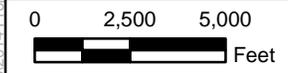
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Legend

Simulated TCE Concentration (µg/L)

- 0.25 - 1.00
- ◆ Non-pumping Regional Well
- ◆ Pumping Regional Well
- Landfill Property Boundaries



Imagery Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

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 Maricopa County Cave Creek Landfill
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 Scale: 1" = 5000'



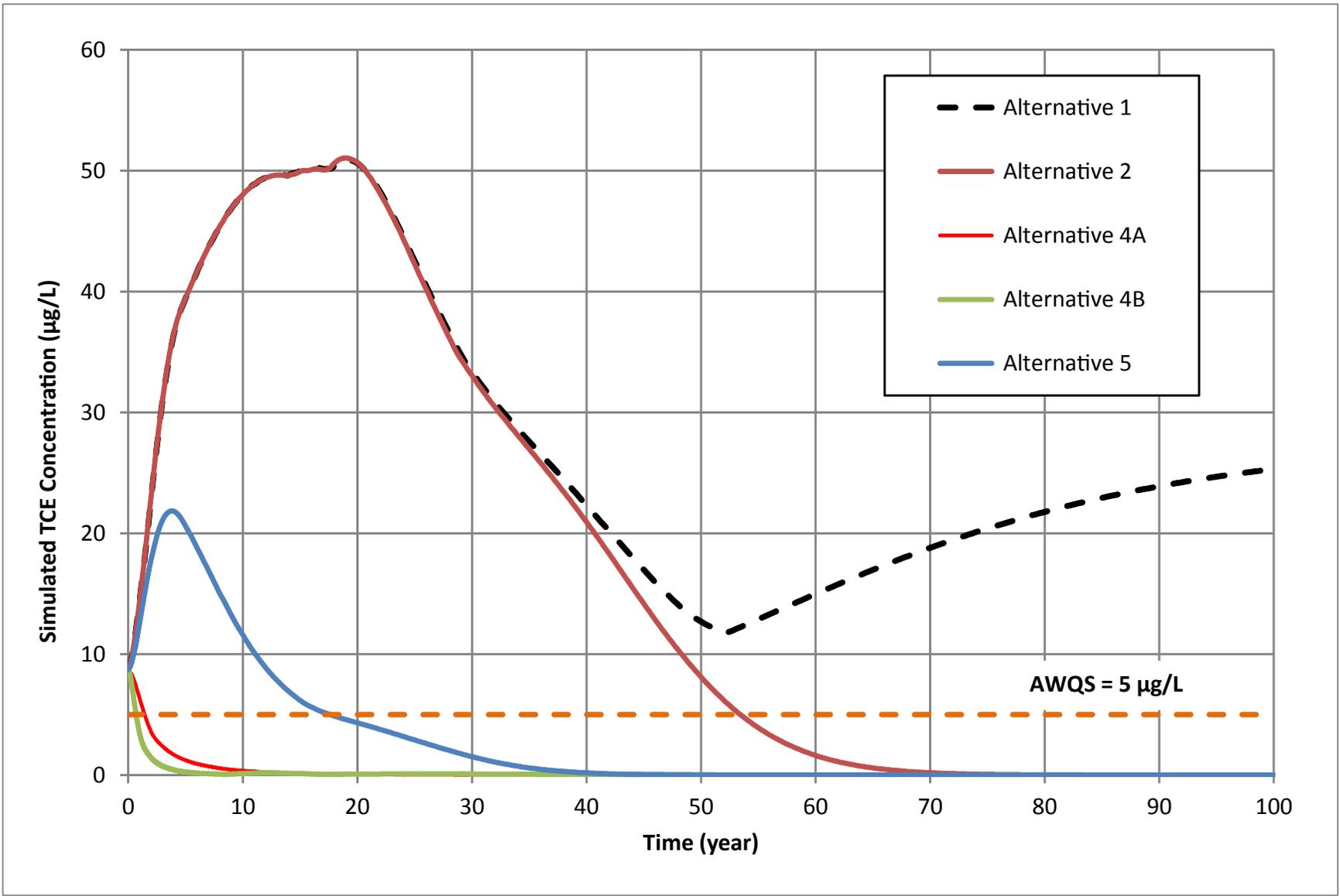
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**Simulated TCE Concentrations for
 Alternative 5 - 40 Years**



FIGURE
23d

Path: X:\Projects\2014\Projects\1420142020\Cave Creek Landfill\FY 2015\MXDN\Revised_Phase3\GroundwaterModelingReport\Figure24_Simulated_MaxConcentrations_SonoranPreserve.ai



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Maricopa County Cave Creek Landfill
Phoenix, Arizona

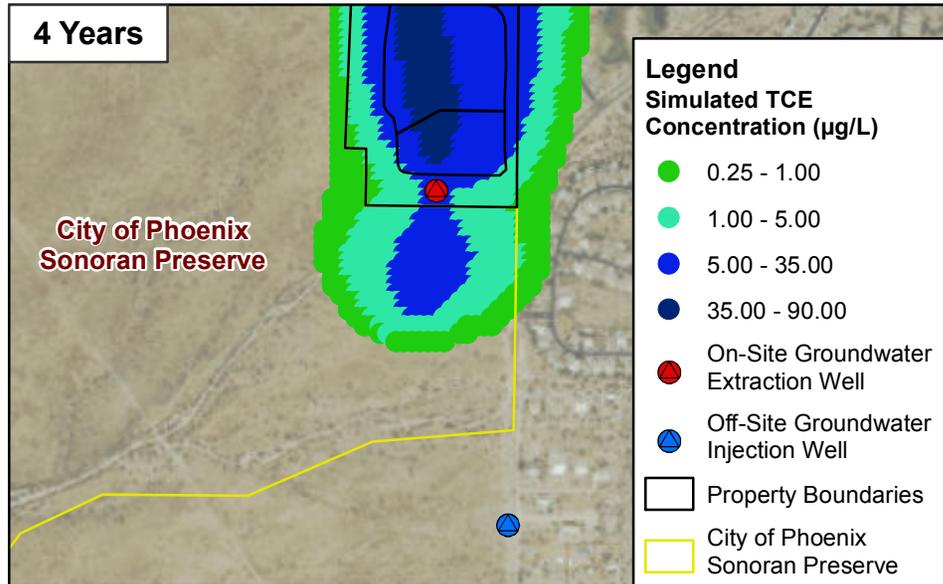
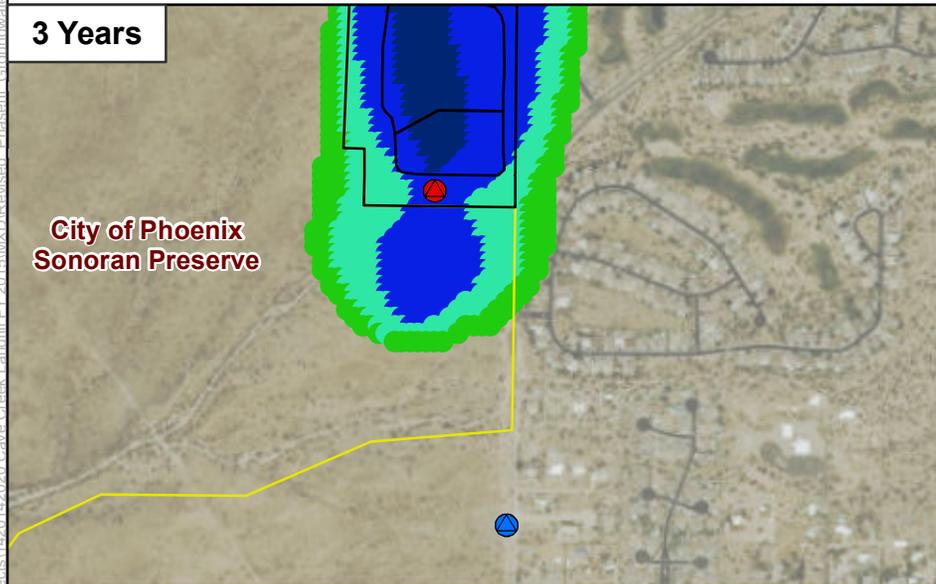
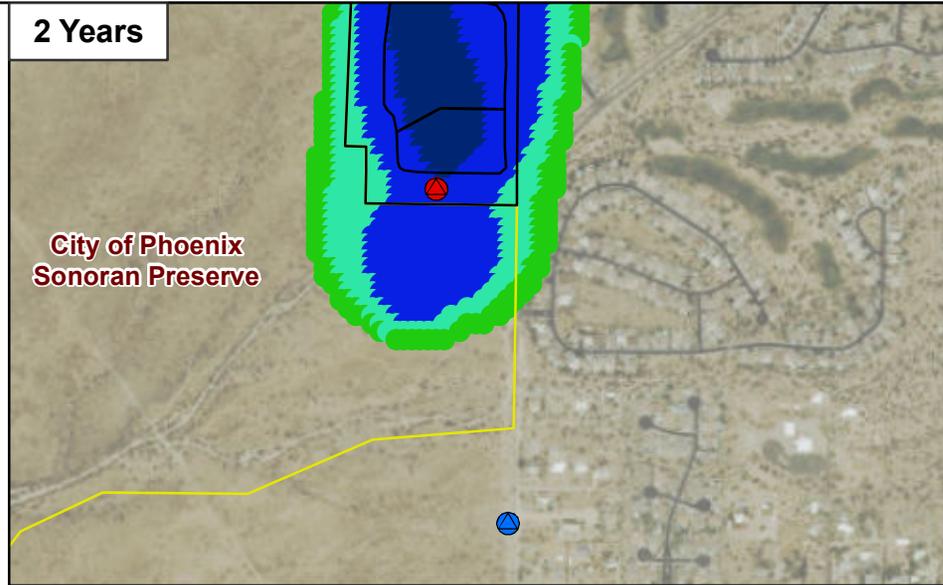
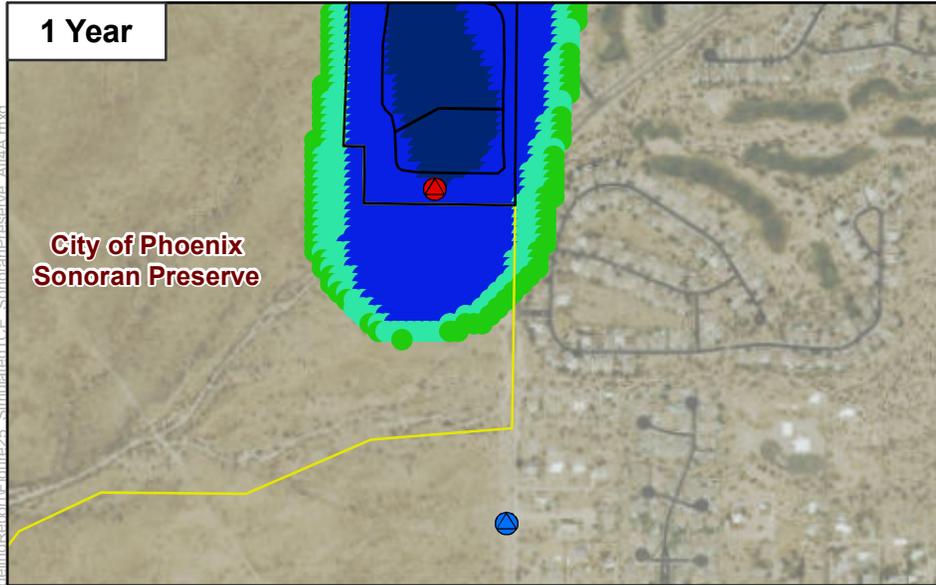
Job No.: 1420142020
PM: NC
Date: 2/24/2016
Scale: Not to scale

Simulated Maximum Concentrations Along Sonoran Preserve Boundary

FIGURE
24



Path: X:\Projects\2014_1420142020_Cave_Creek_Landfill_FY2015\MXD\Revised_Phase3\GroundwaterModeling\Report\Figure25_SimulatedTCE_SonoranPreserve_Alt4A.mxd



Legend
Simulated TCE Concentration (µg/L)

- 0.25 - 1.00
- 1.00 - 5.00
- 5.00 - 35.00
- 35.00 - 90.00

- ▲ On-Site Groundwater Extraction Well
- ▲ Off-Site Groundwater Injection Well
- Property Boundaries
- City of Phoenix Sonoran Preserve



Imagery Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Job No. 1420142020
 PM: NC
 Date: 3/1/2016
 Scale: 1" = 1200'



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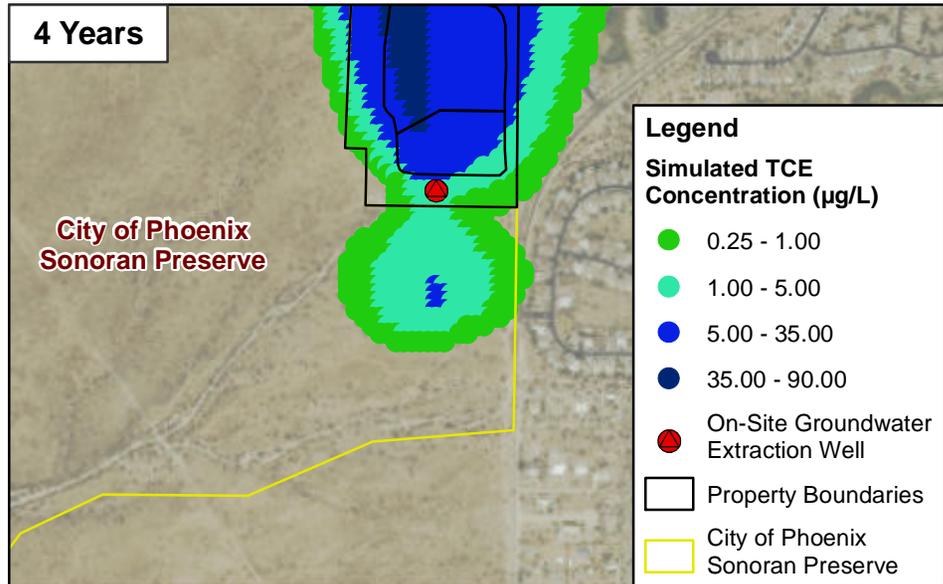
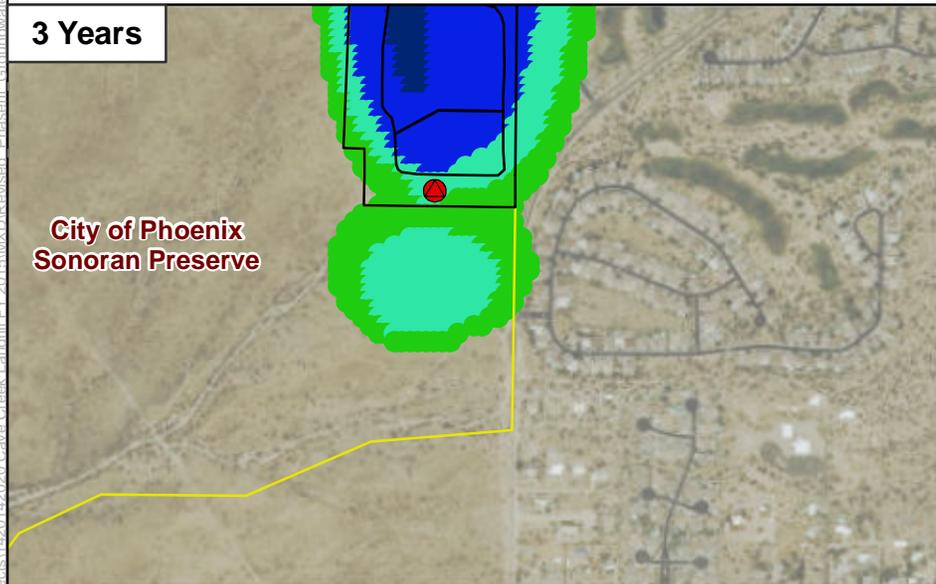
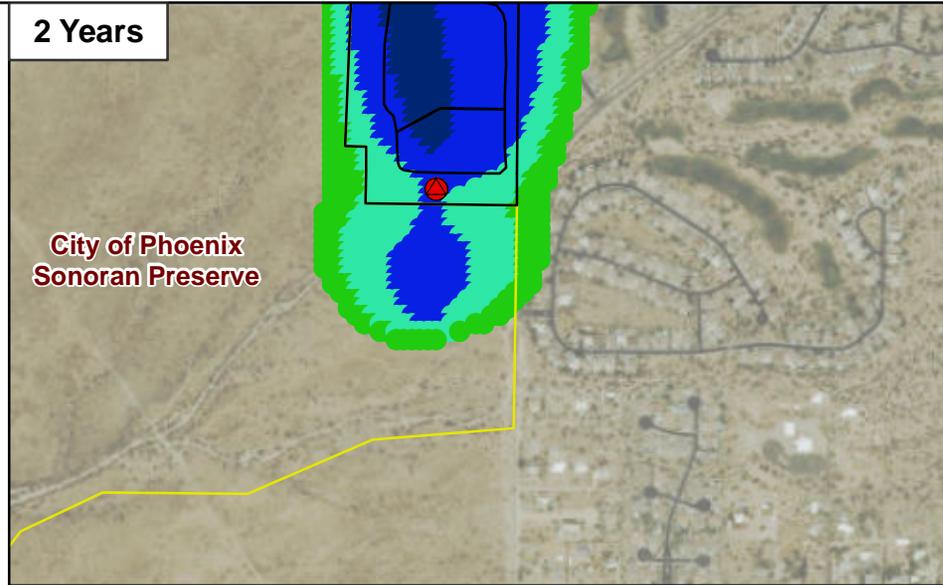
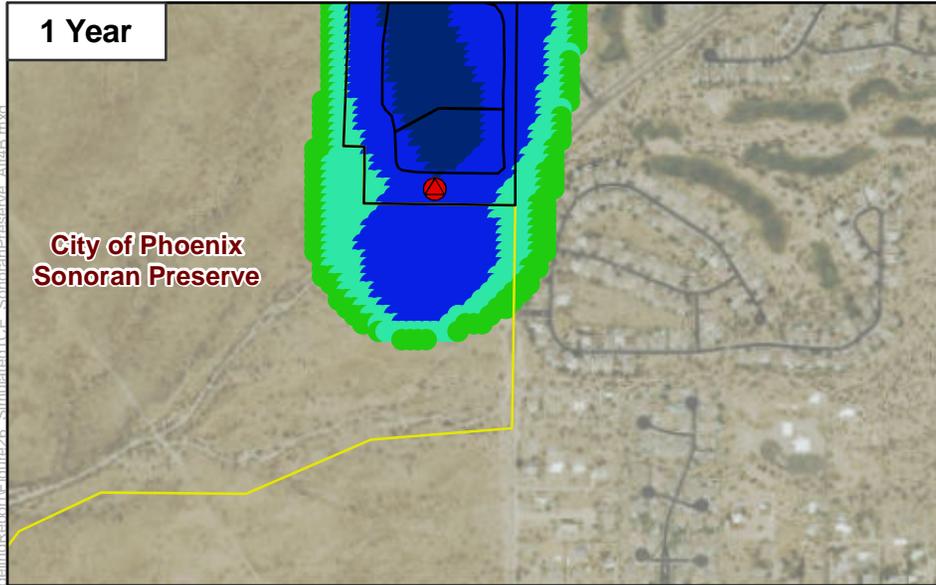
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 Maricopa County Cave Creek Landfill
 Phoenix, Arizona

Simulated TCE Concentrations near Sonoran Preserve Boundary - Alternative 4A

FIGURE
25



Path: X:\Projects\2014_1420142020_Cave_Creek_Landfill_FY2015\MXD\Revised_Phase3\GroundwaterModeling\Report\Figure26_SimulatedTCE_SonoranPreserve_Alt4B.mxd



Legend

Simulated TCE Concentration (µg/L)

- 0.25 - 1.00
- 1.00 - 5.00
- 5.00 - 35.00
- 35.00 - 90.00

- ▲ On-Site Groundwater Extraction Well
- Property Boundaries
- City of Phoenix Sonoran Preserve

0 600 1,200

 Feet

Imagery Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

N

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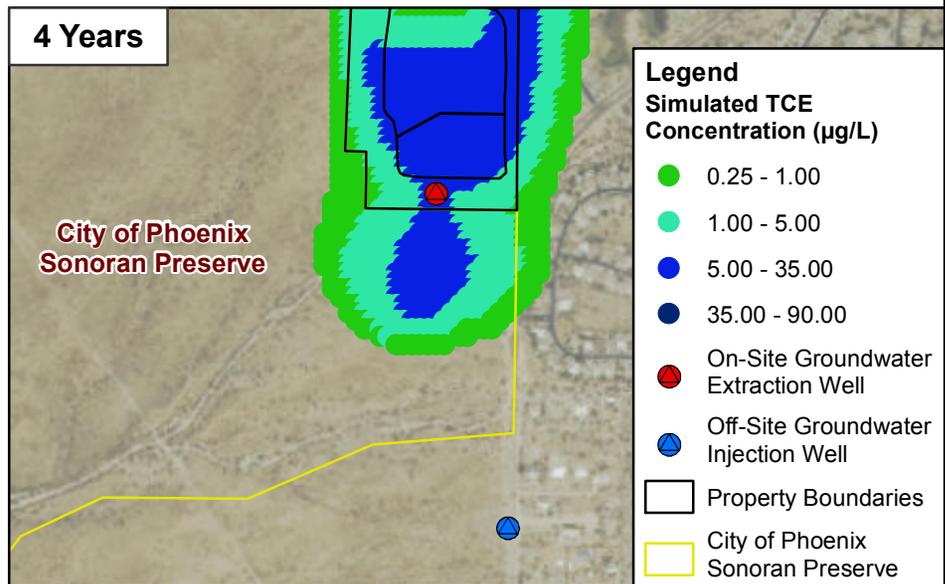
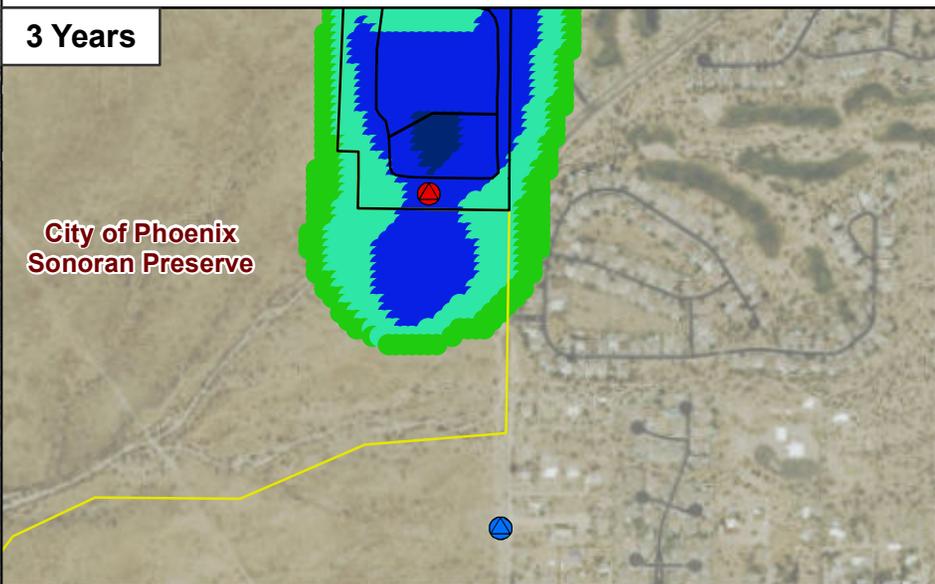
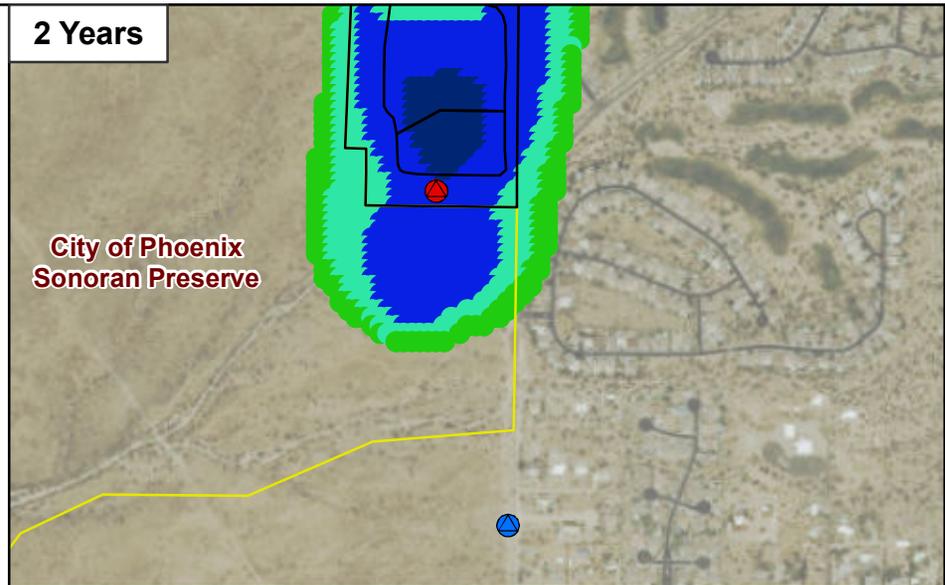
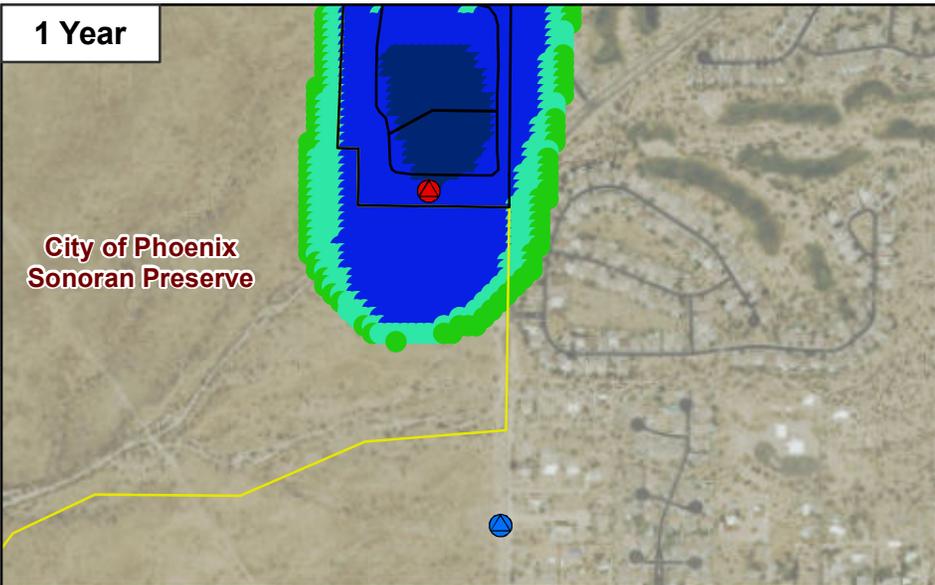
Revised Phase 3 Modeling Results Memorandum
 Maricopa County Cave Creek Landfill
 Phoenix, Arizona

Simulated TCE Concentrations near Sonoran Preserve Boundary - Alternative 4B

FIGURE 26

amec
 foster
 wheeler

Path: X:\Projects\2014_1420142020_Cave_Creek_Landfill_FY2015\MXD\Revised_Phase3\GroundwaterModeling\Report\Figure27_SimulatedTCE_SonoranPreserve_Al4A_Enhance.mxd



Legend

Simulated TCE Concentration (µg/L)

- 0.25 - 1.00
- 1.00 - 5.00
- 5.00 - 35.00
- 35.00 - 90.00

- ▲ On-Site Groundwater Extraction Well
- ▲ Off-Site Groundwater Injection Well
- Property Boundaries
- City of Phoenix Sonoran Preserve

0 600 1,200

 Feet

Imagery Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Job No.	1420142020
PM:	NC
Date:	3/1/2016
Scale:	1" = 1200'



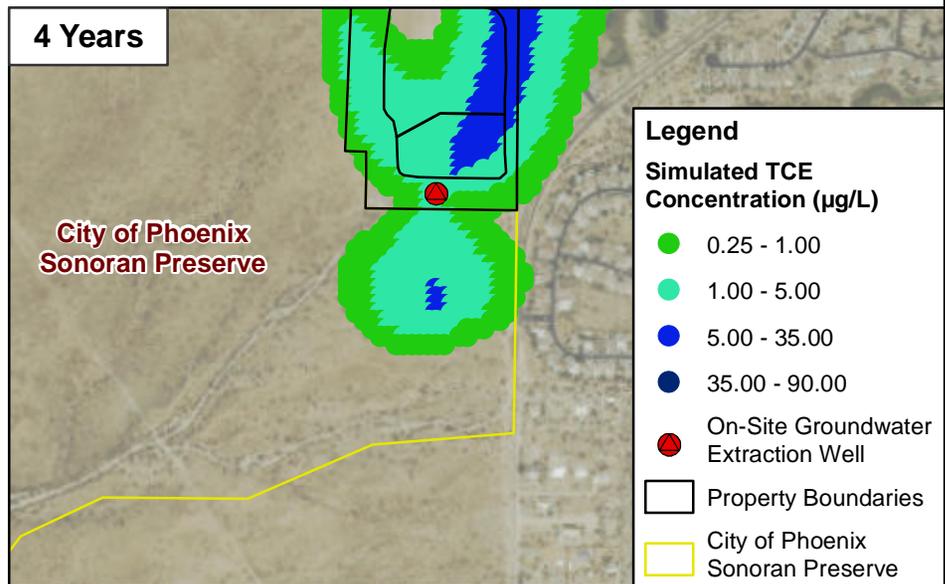
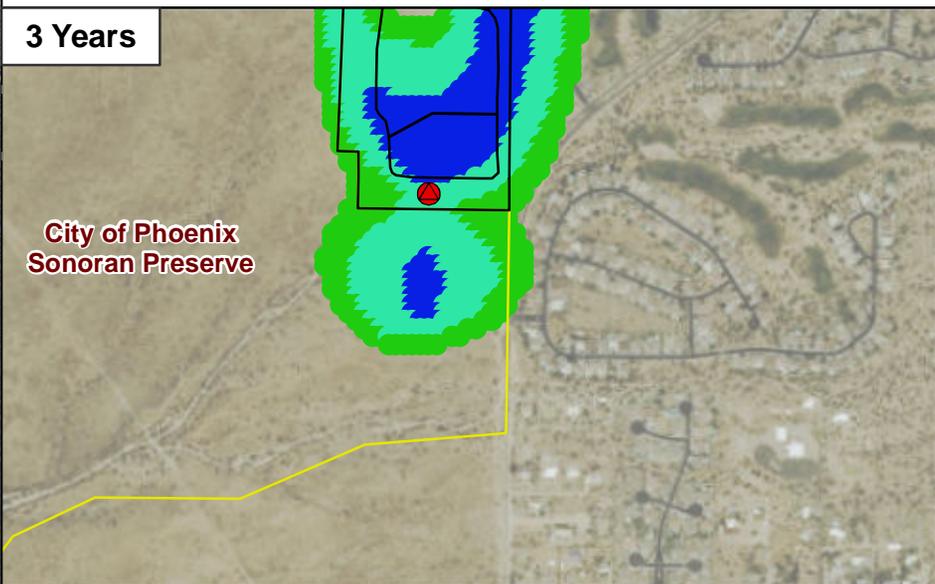
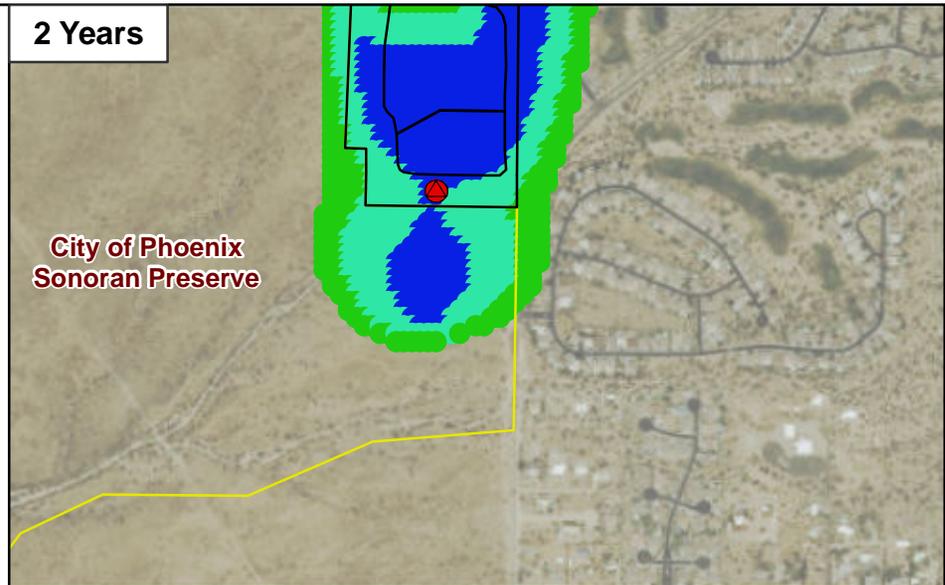
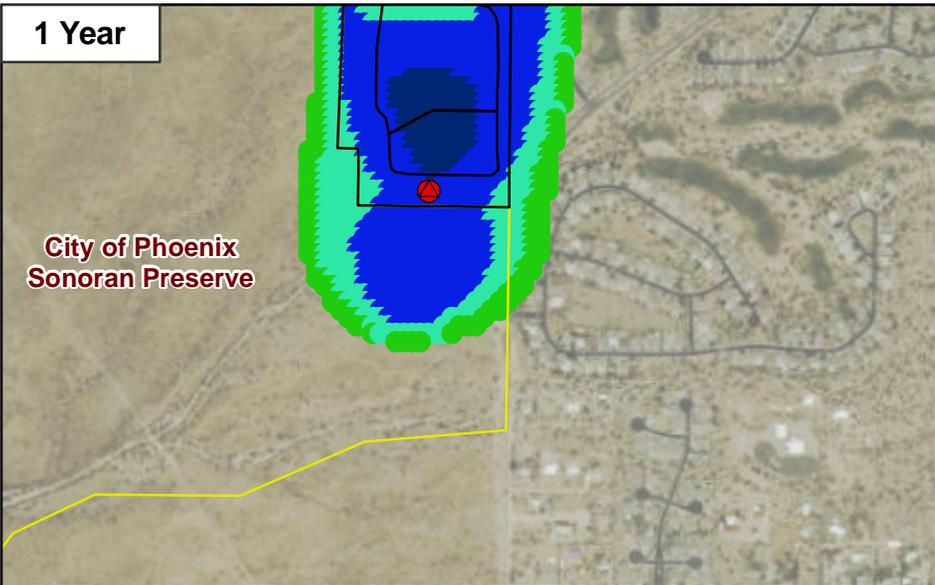
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 Maricopa County Cave Creek Landfill
 Phoenix, Arizona

Simulated TCE Concentrations near Sonoran Preserve Boundary - Alternative 4A Enhancement

FIGURE
27

Path: X:\Projects\2014_Projects\1420142020_Cave_Creek_Landfill_FY2015\MXD\Revised_Phase3\GroundwaterModeling\Report\Figure28_SimulatedTCE_SonoranPreserve_Alt4B_Enhance.mxd



Legend

Simulated TCE Concentration (µg/L)

- 0.25 - 1.00
- 1.00 - 5.00
- 5.00 - 35.00
- 35.00 - 90.00

- ▲ On-Site Groundwater Extraction Well
- Property Boundaries
- City of Phoenix Sonoran Preserve

0 600 1,200

 Feet

Imagery Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Job No.	1420142020
PM:	NC
Date:	2/24/2016
Scale:	1" = 1200'



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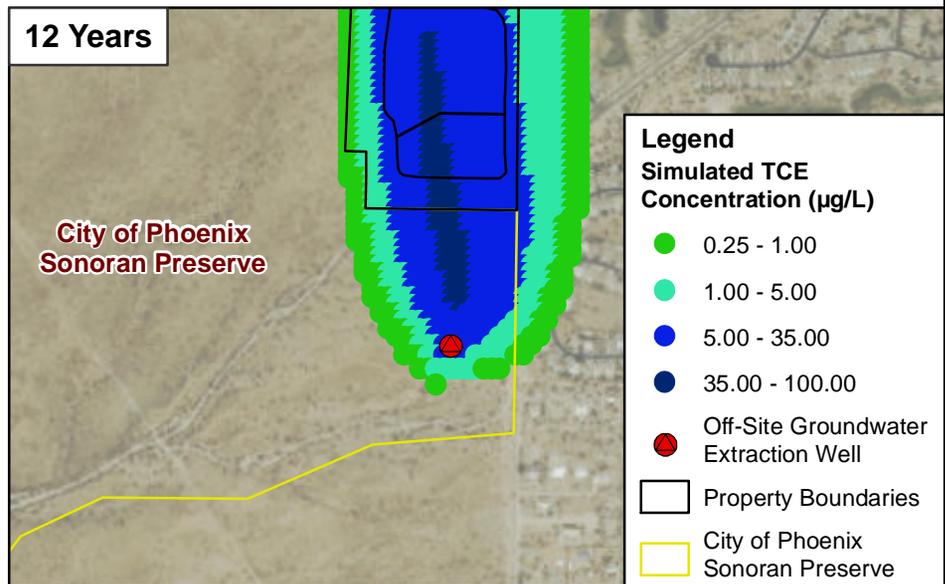
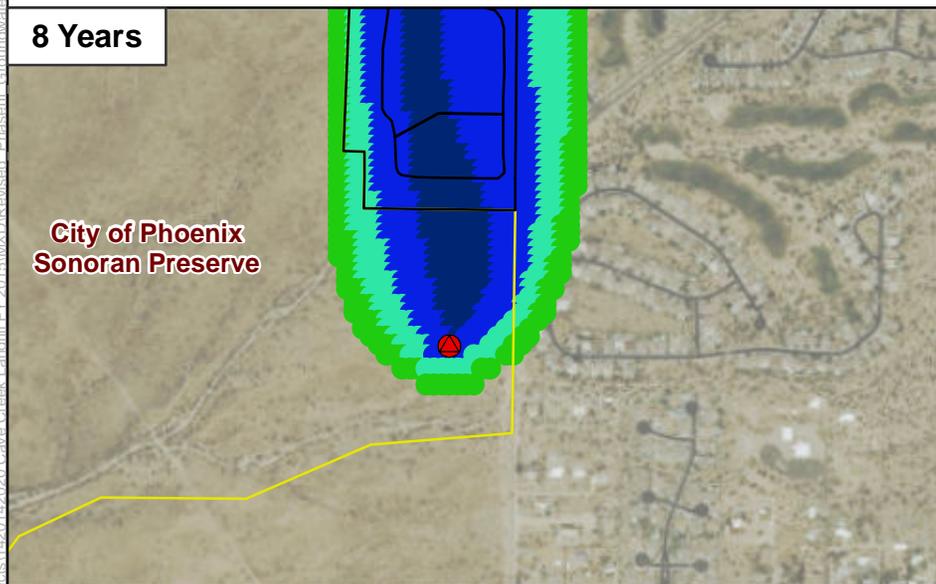
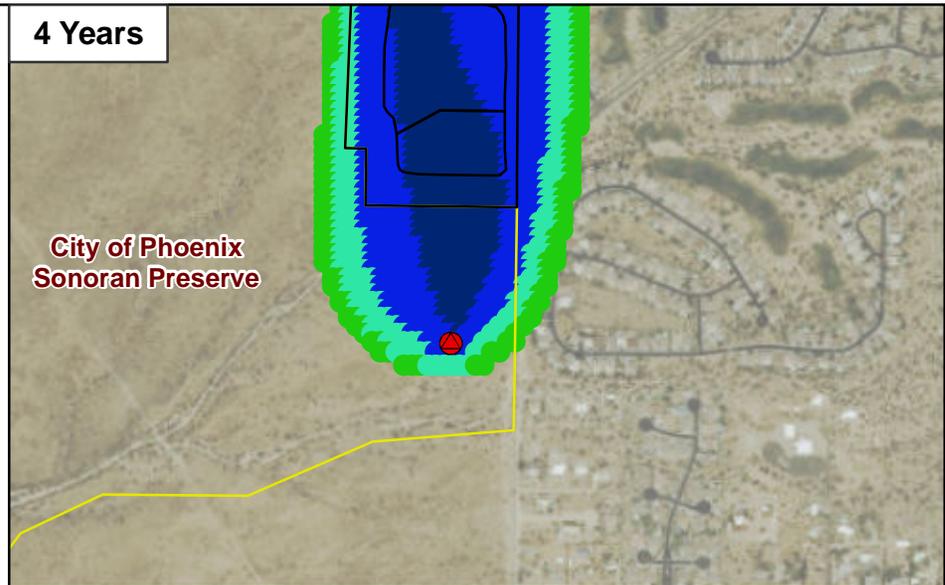
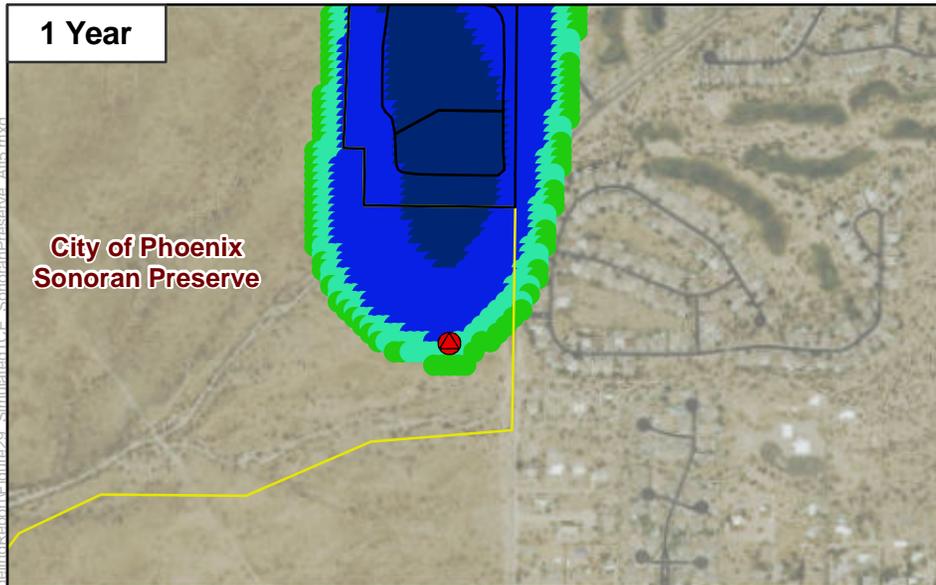
Revised Phase 3 Modeling Results Memorandum
 Maricopa County Cave Creek Landfill
 Phoenix, Arizona

Simulated TCE Concentrations near Sonoran Preserve Boundary - Alternative 4B Enhancement

FIGURE 28

amec
foster
wheeler

Path: X:\Projects\2014_2020_Cave_Creek_Landfill_FY_2015\MXD\Revised_Phase3\GroundwaterModeling\Report\Figure29_SimulatedTCE_SonoranPreserve_Alt5.mxd



Legend

Simulated TCE Concentration (µg/L)

- 0.25 - 1.00
- 1.00 - 5.00
- 5.00 - 35.00
- 35.00 - 100.00

- ▲ Off-Site Groundwater Extraction Well
- Property Boundaries
- City of Phoenix Sonoran Preserve

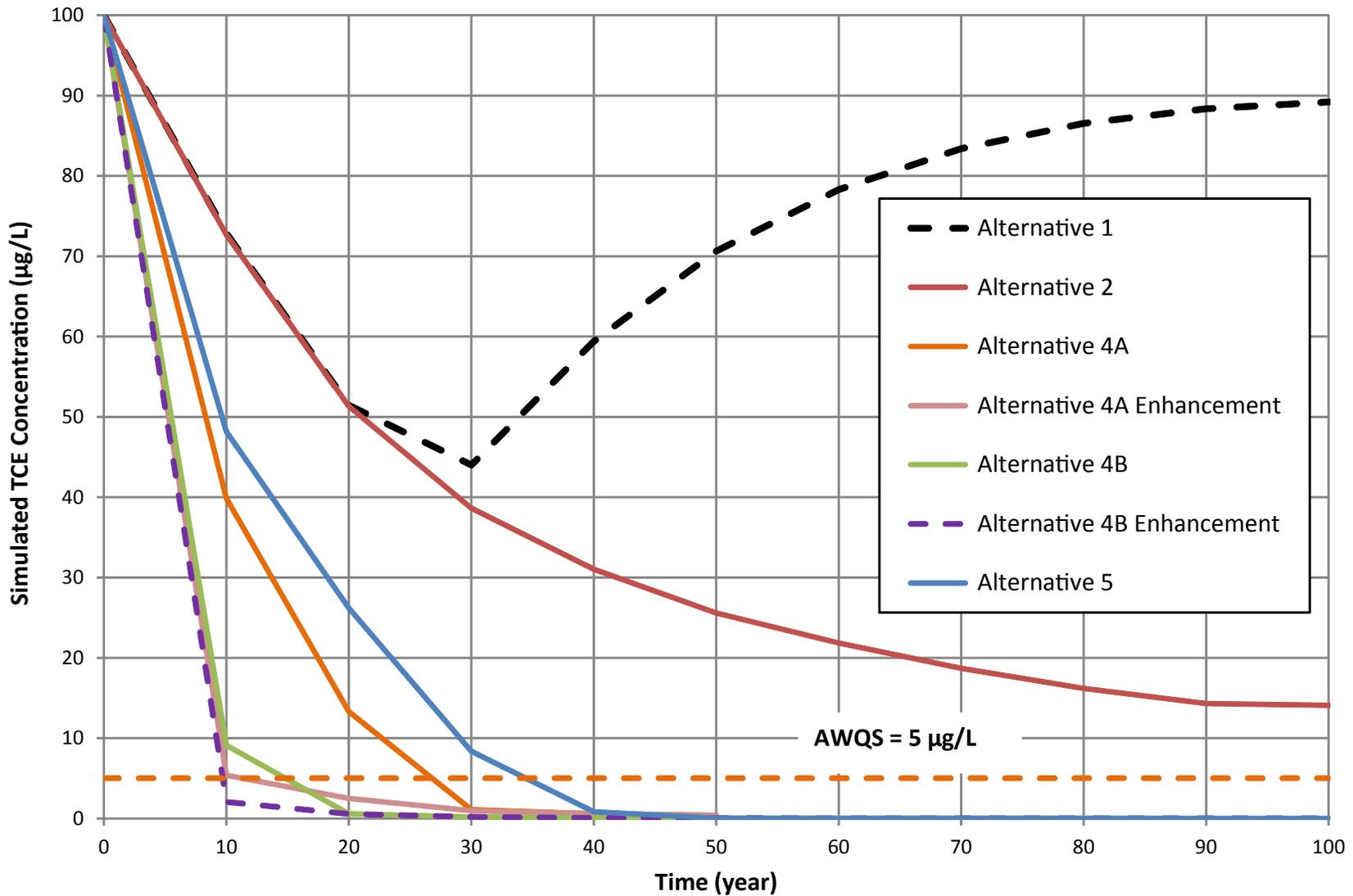
<p>0 600 1,200</p> <p> Feet</p>	<p>Imagery Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community</p>
<p>Job No. 1420142020</p> <p>PM: NC</p> <p>Date: 2/24/2016</p> <p>Scale: 1" = 1200'</p>	<p style="text-align: center;">N</p> <p style="font-size: small;">The map shown here has been created with all due and reasonable care and is strictly for use with Amec Foster Wheeler Project Number 1420142020. This map has not been certified by a licensed land surveyor, and any third party use of this map comes without warranties of any kind. Amec Foster Wheeler assumes no liability, direct or indirect, whatsoever for any such third party or unintended use.</p>

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Maricopa County Cave Creek Landfill
Phoenix, Arizona

Simulated TCE Concentrations near Sonoran Preserve Boundary - Alternative 5

FIGURE
29

Path: X:\Projects\2014\Projects\1420142020\Cave Creek Landfill\FY 2015\MXDN\Revised_Phase3\GroundwaterModelingReport\Figure30_Simulated_MaxConcentrations_ModelDomain.ai



Revised Phase 3 Modeling Results Memorandum
Maricopa County Cave Creek Landfill
Phoenix, Arizona

Job No.: 1420142020
PM: NC
Date: 2/24/2016
Scale: Not to scale

Simulated Maximum Concentrations in Model Domain

FIGURE
30





APPENDIX E

COST BREAKDOWN FOR GROUNDWATER TREATMENT SYSTEM

Remedy Cost Development - On-Site Extraction with Off-Site Injection (Alternative 4A) Pump and Treat System

Component	Cost (\$)	Quantity	Units	Low	Mid	High	Extended Low Estimate (\$)	Extended Mid Estimate (\$)	Extended High Estimate (\$)	
				Estimate Modifier	Estimate Modifier	Estimate Modifier				
Extraction Wellhead Completion	\$ 14,975.00	1	Each	0.75	1	1.25	\$ 11,231.25	\$ 14,975.00	\$ 18,718.75	
Conveyance Piping (unpaved)	\$ 125,066.67	1	Each	0.75	1	1.25	\$ 93,800.00	\$ 125,066.67	\$ 156,333.34	
Conveyance Piping (paved)	\$ 41,982.02	1	Each	0.75	1	1.25	\$ 31,486.52	\$ 41,982.02	\$ 52,477.53	
Injection Well Site Improvements	\$ 11,402.40	1	Each	0.75	1	1.25	\$ 8,551.80	\$ 11,402.40	\$ 14,253.00	
Treatment System/Electrical	\$ 196,806.70	1	Each	0.75	1	1.25	\$ 147,605.03	\$ 196,806.70	\$ 246,008.38	
Injection Wellhead Completion	\$ 6,975.00	1	Each	0.75	1	1.25	\$ 5,231.25	\$ 6,975.00	\$ 8,718.75	
Injection Wellhead SCADA/Electrical	\$ 30,000.00	1	Each	0.75	1	1.25	\$ 22,500.00	\$ 30,000.00	\$ 37,500.00	
Traffic Control	\$ 7,500.00	1	Each	0.75	1	1.25	\$ 5,625.00	\$ 7,500.00	\$ 9,375.00	
Labor/Equipment	\$ 116,350.00	1	Each	0.75	1	1.25	\$ 87,262.50	\$ 116,350.00	\$ 145,437.50	
Surveying (1%)	\$ 5,510.58	1	Each	0.75	1	1.25	\$ 4,132.93	\$ 5,510.58	\$ 6,888.22	
Mobilization (8%)	\$ 44,084.62	1	Each	0.75	1	1.25	\$ 33,063.47	\$ 44,084.62	\$ 55,105.78	
Engineering/Permitting (20%)	\$ 110,211.56	1	Each	0.75	1	1.25	\$ 82,658.67	\$ 110,211.56	\$ 137,764.45	
Construction Management (5%)	\$ 27,552.89	1	Each	0.75	1	1.25	\$ 20,664.67	\$ 27,552.89	\$ 34,441.11	
Quality Assurance Testing (2%)	\$ 11,021.16	1	Each	0.75	1	1.25	\$ 8,265.87	\$ 11,021.16	\$ 13,776.44	
Construction Total							\$ 562,078.95	\$ 749,438.59	\$ 936,798.24	
OM&M (Annual)	Utilities	\$ 0.08	337,751	KWH	0.75	1	1.25	\$ 20,265.03	\$ 27,020.04	\$ 33,775.06
	Carbon	\$ 1.15	14,450	lbs.	0.75	1	1.25	\$ 12,463.13	\$ 16,617.50	\$ 20,771.88
	IW Maintenance	\$ 25,000.00	1	LS	0.75	1	1.25	\$ 18,750.00	\$ 25,000.00	\$ 31,250.00
	Parts/Supplies	\$ 25,000.00	1	LS	0.75	1	1.25	\$ 18,750.00	\$ 25,000.00	\$ 31,250.00
	O&M Labor	\$ 85.00	416	Hrs.	0.75	1	1.25	\$ 26,520.00	\$ 35,360.00	\$ 44,200.00
	Sampling	\$ 150.00	36	Each	0.75	1	1.25	\$ 4,050.00	\$ 5,400.00	\$ 6,750.00
O&M Total							\$ 100,798.16	\$ 134,397.54	\$ 167,996.93	

Assumptions

- 1) Carbon vessels are sized for a 6.7 minute contact time; Evoqua PV-5000 or equivalent used for costing purposes (6-ft dia, 5,000-lb GAC capacity).
- 2) Preliminary sizing for groundwater pump is a 6-inch 75-horsepower submersible pump fractionally driven (60-hp equivalent load).
- 3) Stainless steel bag filter housing unit assumed (150 gpm capacity per bag filter); Harmso Filters or equivalent used for costing purposes.
- 4) Operating costs assume the system operates 85% of the time.

Remedy Cost Development - On-Site Extraction with On-Site Injection (Alternative 4B) Pump and Treat System

Component	Cost (\$)	Quantity	Units	Low	Mid	High	Extended Low Estimate (\$)	Extended Mid Estimate (\$)	Extended High Estimate (\$)	
				Estimate Modifier	Estimate Modifier	Estimate Modifier				
Extraction Wellhead Completions (2)	\$ 29,950.00	1	Each	0.75	1	1.25	\$ 22,462.50	\$ 29,950.00	\$ 37,437.50	
Conveyance Piping (unpaved)	\$ 110,068.56	1	Each	0.75	1	1.25	\$ 82,551.42	\$ 110,068.56	\$ 137,585.70	
Treatment System/Electrical	\$ 289,641.70	1	Each	0.75	1	1.25	\$ 217,231.28	\$ 289,641.70	\$ 362,052.13	
Injection Wellhead Completion	\$ 6,975.00	1	Each	0.75	1	1.25	\$ 5,231.25	\$ 6,975.00	\$ 8,718.75	
Injection Wellhead SCADA	\$ 15,000.00	1	Each	0.75	1	1.25	\$ 11,250.00	\$ 15,000.00	\$ 18,750.00	
Labor/Equipment	\$ 128,200.00	1	Each	0.75	1	1.25	\$ 96,150.00	\$ 128,200.00	\$ 160,250.00	
Surveying (1%)	\$ 5,798.35	1	Each	0.75	1	1.25	\$ 4,348.76	\$ 5,798.35	\$ 7,247.94	
Mobilization (8%)	\$ 46,386.82	1	Each	0.75	1	1.25	\$ 34,790.12	\$ 46,386.82	\$ 57,983.53	
Engineering/Permitting (20%)	\$ 115,967.05	1	Each	0.75	1	1.25	\$ 86,975.29	\$ 115,967.05	\$ 144,958.82	
Construction Management (5%)	\$ 28,991.76	1	Each	0.75	1	1.25	\$ 21,743.82	\$ 28,991.76	\$ 36,239.70	
Quality Assurance Testing (2%)	\$ 11,596.71	1	Each	0.75	1	1.25	\$ 8,697.53	\$ 11,596.71	\$ 14,495.88	
Construction Total							\$ 591,431.97	\$ 788,575.95	\$ 985,719.94	
OM&M (Annual)	Utilities	\$ 0.08	675,501	KWH	0.75	1	1.25	\$ 40,530.07	\$ 54,040.09	\$ 67,550.11
	Carbon	\$ 1.15	28,050	lbs.	0.75	1	1.25	\$ 24,193.13	\$ 32,257.50	\$ 40,321.88
	IW Maintenance	\$ 25,000.00	1	LS	0.75	1	1.25	\$ 18,750.00	\$ 25,000.00	\$ 31,250.00
	Parts/Supplies	\$ 25,000.00	1	LS	0.75	1	1.25	\$ 18,750.00	\$ 25,000.00	\$ 31,250.00
	O&M Labor	\$ 85.00	416	Hrs.	0.75	1	1.25	\$ 26,520.00	\$ 35,360.00	\$ 44,200.00
	Sampling	\$ 150.00	72	Each	0.75	1	1.25	\$ 8,100.00	\$ 10,800.00	\$ 13,500.00
O&M Total							\$ 136,843.19	\$ 182,457.59	\$ 228,071.99	

Assumptions

- 1) Carbon vessels are sized for a 6.7 minute contact time; Evoqua PV-5000 or equivalent used for costing purposes (6-ft dia, 5,000-lb GAC capacity).
- 2) Preliminary sizing for groundwater pumps are 6-inch 75-horsepower submersible pump fractionally driven (60-hp equivalent load).
- 3) Stainless steel bag filter housing unit assumed (150 gpm capacity per bag filter); Harmso Filters or equivalent used for costing purposes.
- 4) Operating costs assume the system operates 85% of the time.

Remedy Cost Development - Off-Site Extraction and Treatment (Alternative 5) Pump and Treat System

Component	Cost (\$)	Quantity	Units	Low	Mid	High	Extended Low Estimate (\$)	Extended Mid Estimate (\$)	Extended High Estimate (\$)	
				Estimate Modifier	Estimate Modifier	Estimate Modifier				
Extraction Wellhead Completion	\$ 14,975.00	1	Each	0.75	1	1.25	\$ 11,231.25	\$ 14,975.00	\$ 18,718.75	
Conveyance Piping (unpaved)	\$ 19,311.89	1	Each	0.75	1	1.25	\$ 14,483.92	\$ 19,311.89	\$ 24,139.86	
Treatment System/Electrical	\$ 196,806.70	1	Each	0.75	1	1.25	\$ 147,605.03	\$ 196,806.70	\$ 246,008.38	
Sewer Connection	\$ 6,822.90	1	Each	0.75	1	1.25	\$ 5,117.18	\$ 6,822.90	\$ 8,528.63	
Labor/Equipment	\$ 116,575.00	1	Each	0.75	1	1.25	\$ 87,431.25	\$ 116,575.00	\$ 145,718.75	
Surveying (1%)	\$ 3,544.91	1	Each	0.75	1	1.25	\$ 2,658.69	\$ 3,544.91	\$ 4,431.14	
Mobilization (8%)	\$ 28,359.32	1	Each	0.75	1	1.25	\$ 21,269.49	\$ 28,359.32	\$ 35,449.15	
Engineering/Permitting (20%)	\$ 70,898.30	1	Each	0.75	1	1.25	\$ 53,173.72	\$ 70,898.30	\$ 88,622.87	
Construction Management (5%)	\$ 17,724.57	1	Each	0.75	1	1.25	\$ 13,293.43	\$ 17,724.57	\$ 22,155.72	
Quality Assurance Testing (2%)	\$ 7,089.83	1	Each	0.75	1	1.25	\$ 5,317.37	\$ 7,089.83	\$ 8,862.29	
Construction Total							\$ 361,581.32	\$ 482,108.43	\$ 602,635.53	
OM&M (Annual)	Utilities	\$ 0.08	337,751	KWH	0.75	1	1.25	\$ 20,265.03	\$ 27,020.04	\$ 33,775.06
	Carbon	\$ 1.15	15,300	lbs.	0.75	1	1.25	\$ 13,196.25	\$ 17,595.00	\$ 21,993.75
	Sewer Discharge	\$ 0.00133168	89,352,000	Gal	0.75	1	1.25	\$ 89,241.20	\$ 118,988.27	\$ 148,735.34
	Parts/Supplies	\$ 25,000.00	1	LS	0.75	1	1.25	\$ 18,750.00	\$ 25,000.00	\$ 31,250.00
	O&M Labor	\$ 85.00	416	Hrs.	0.75	1	1.25	\$ 26,520.00	\$ 35,360.00	\$ 44,200.00
	Sampling	\$ 150.00	36	Each	0.75	1	1.25	\$ 4,050.00	\$ 5,400.00	\$ 6,750.00
O&M Total							\$ 172,022.49	\$ 229,363.32	\$ 286,704.15	

Assumptions

- 1) Carbon vessels are sized for a 6.7 minute contact time; Evoqua PV-5000 or equivalent used for costing purposes (6-ft dia, 5,000-lb GAC capacity).
- 2) Preliminary sizing for groundwater pumps are 6-inch 75-horsepower submersible pump fractionally driven (60-hp equivalent load).
- 3) Stainless steel bag filter housing unit assumed (150 gpm capacity per bag filter); Harmso Filters or equivalent used for costing purposes.
- 4) Operating costs assume the system operates 85% of the time.



APPENDIX F

FACT SHEET AND AFFIDAVIT OF PUBLICATION



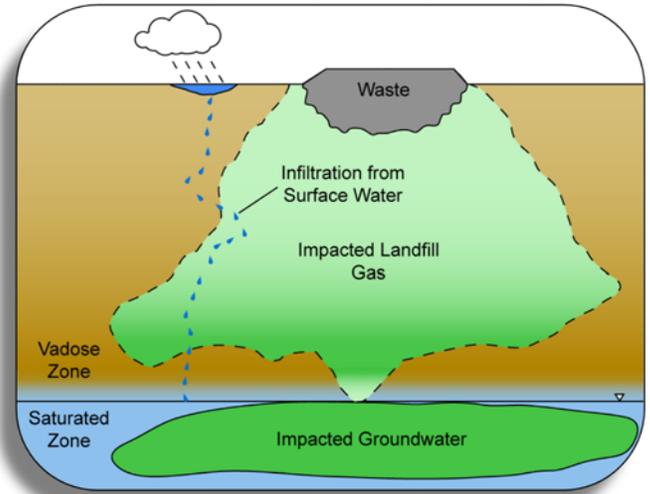
Remedial Action Plan Fact Sheet

Maricopa County presents the Cave Creek Landfill Remedial Action Plan

The next step in cleaning up groundwater underlying the landfill...

Maricopa County has prepared a revised Remedial Action Plan (RAP) for groundwater impacted by waste in Cave Creek Landfill. The contaminated groundwater is not a drinking water source but the RAP presents potential corrective measures and describes Maricopa County's preferred remedy based on our evaluation of alternatives.

Preparation of the RAP is part of the final remedy selection process for groundwater restoration which includes public participation. This Fact Sheet gives you summary information regarding the site and the RAP. Maricopa County encourages public comment during the public comment period. See the back page of this Fact Sheet for more information regarding how you can be involved. New information received during a public meeting presenting the RAP could result in changes or modification to the preferred remedy. Maricopa County and the Arizona Department of Environmental Quality (ADEQ) will work together to choose the final cleanup remedy after all comments have been considered.



Site Background

Cave Creek Landfill is located approximately one half mile south of Carefree Highway and two miles west of Cave Creek Road. The property consists of two landfill regions: the Old Landfill located in the northeastern portion of the site and the New Landfill located in the central portion of the site. Cave Creek Landfill began receiving waste at the Old Landfill in 1965. Operations transitioned to the New Landfill in 1984 and ceased in 1998. While operational, Cave Creek Landfill received residential and commercial municipal solid waste (MSW).

There has been routine monitoring conducted since closure to evaluate if waste placed in Cave Creek Landfill has impacted the environment. Based on the results of this ongoing monitoring, trichloroethene (TCE), a common solvent, has been detected in both the soil vapor (i.e., the gas portion of the soil matrix) under the landfill and groundwater which is located more than 600 feet below the surface. Although it is highly unlikely that people will be exposed to TCE contamination deep below the landfill, TCE concentrations in groundwater at the site exceed the Arizona Aquifer Water Quality Standard for this compound which is 5 micrograms per liter. To comply with Arizona law and the requirements of the Resource Conservation and Recovery Act (RCRA), Maricopa County will clean up the TCE contamination under Cave Creek Landfill with oversight by ADEQ.

Maricopa County currently operates the Cave Creek Waste Transfer Station at the landfill site. The transfer station is open to the public and receives both trash and recyclables which are temporarily stored in bins and then sent to appropriate facilities. TCE contamination at the site does not impact these operations.

Remedial Alternative Development and Evaluation

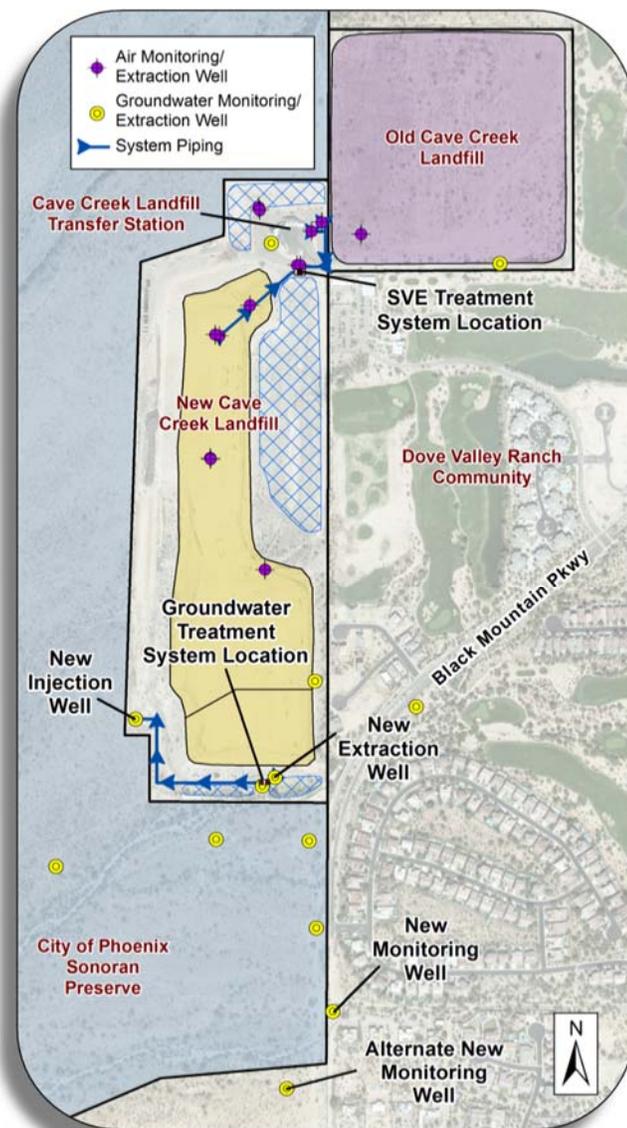
As part of the RAP assessment, we looked at the effectiveness of potential corrective measures that meet the requirements of RCRA and address the site-specific objectives of protecting human health and the environment. Based on a preliminary screening analysis, two retained alternatives are capable of meeting cleanup goals:

- *An On-Site Extraction Remedy.* This remedy includes an on-site groundwater pump and treat (P&T) system combined with monitored natural attenuation (MNA) for TCE plume clean up and soil vapor extraction (SVE) from the deep soils underlying the landfill to control the source of TCE contamination to the groundwater.
- *An Off-Site Extraction Remedy.* This remedy includes an off-site groundwater P&T system located south of the site for TCE plume clean up and SVE for source control.

Tentatively-Selected Remedy

Maricopa County's preferred remedy for the Site is the On-Site Extraction Remedy. We came to this conclusion after comparing the practicability, risk, cost, and benefit or value of each alternative. The Off-Site Extraction Remedy was considered more effective in containing the migration of TCE impacted groundwater but it would not be as practicable as the On-Site Extraction Remedy because the P&T system would have to be built on property that is not owned by Maricopa County. The On-Site Extraction Remedy is considered effective in controlling the migration of contaminated groundwater without this logistical concern.

Physical components of the On-Site Extraction Remedy (see the figure to the right) consist principally of a new P&T system located in the southern portion of the property. This includes a groundwater extraction well, piping, groundwater treatment equipment, and an injection well to recharge treated water back into the aquifer. There will also be one new off-site monitoring well to test any impacted groundwater that may not be contained by the P&T system and a soil vapor extraction system located in the northern portion of the site. The SVE system includes multiple vapor extraction wells and air treatment equipment. This cleanup operation is expected to last 30 years.



For more information:

The RAP and supporting documents may be viewed at the Maricopa County Cave Creek Landfill document repository website:

<http://www.maricopa.gov/groundwater>

The RAP is also available for review during the comment period at:

Desert Broom Public Library
29710 N. Cave Creek Rd.
Phoenix, Arizona 85331

Comments can also be provided at the Public Meeting

How you can participate:

E-mail written comments by September 15, 2015 to:

Fields Moseley
Maricopa County Communications Director
cavecreeklandfill@mail.maricopa.gov

30-Day Public Comment Period:
August 17, 2015 through September 15, 2015

Public Meeting:
September 1, 2015 at 6 pm
Community Room of the
Phoenix Police Department
Black Mountain Precinct
33355 N. Cave Creek Rd.



THE ARIZONA REPUBLIC

Public Notice
Maricopa County presents
Cave Creek Landfill
Remedial Action Plan
September 1, 2015 at 6 pm

Maricopa County has prepared a revised Remedial Action Plan (RAP) for groundwater impacted by waste in Cave Creek Landfill. The RAP presents potential corrective measures and describes Maricopa County's preferred remedy based on an evaluation of alternatives. Preparation of the RAP is part of the final remedy selection process for groundwater restoration, which includes public participation. A public meeting will be held September 1, 2015 to present the RAP and additional site information to the community. Maricopa County encourages public comment during the public comment period from August 17, 2015 through September 15, 2015. The RAP and a Fact Sheet providing further site information are available for public review at the Desert Broom Library service desk, 29710 N Cave Creek Rd, Cave Creek, AZ 85331. They may also be viewed online at all hours at: <http://www.maricopa.gov/groundwater>.

How to Participate:
Attend the Public Meeting to provide verbal or written comments, or email your comments to cavecreeklandfill@mail.maricopa.gov by September 15, 2015.

Public Meeting Time and Location:
September 1, 2015 at 6 pm
Community Room of the Phoenix Police Department
Black Mountain Precinct
33355 N. Cave Creek Rd.
Pub: Aug. 17, 20, 22, 23, 2015

STATE OF ARIZONA }
COUNTY OF MARICOPA } SS.

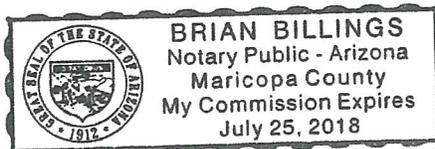
Manuel Vargas, being first duly sworn, upon oath deposes and says: That he is a legal advertising representative of the Arizona Business Gazette, a newspaper of general circulation in the county of Maricopa, State of Arizona, published at Phoenix, Arizona, by Phoenix Newspapers Inc., which also publishes The Arizona Republic, and that the copy hereto attached is a true copy of the advertisement published in the said paper on the dates as indicated.

The Arizona Republic

August 17, 20, 22, 23, 2015



Sworn to before me this
24TH day of
August A.D. 2015




Notary Public



APPENDIX G

COMPILATION OF RESPONSES TO COMMENTS

**TABLE 1 - PUBLIC COMMENTS ON THE CAVE CREEK LANDFILL REMEDIAL ACTION PLAN
RECEIVED DURING THE PUBLIC COMMENT PERIOD (AUGUST 17 THROUGH SEPTEMBER 15, 2015)
AND THE PUBLIC MEETING HELD ON SEPTEMBER 1, 2015**

Date Received and Commenter Name	Method Provided	Comments	Summary Comment Numbers
8/25/2015 Brad Burdick	via email	<ul style="list-style-type: none"> - I favor removing the entire landfill completely. - I am a resident of Dove Valley Ranch since it's [sic] inception in 1999. I recall reading a news article in the early 2000's indicating the Cave Creek School District pulled out of a site for a future new school within Dove Valley Ranch because of TCE in the ground water. Granted, this was before the CAP pipe was built to supply our water. I remember the construction of the CAP pipeline.....it was along Cave Creek Road and traveled North from Deer Valley Road. If the CAP water ever ceases or dries up, we will need this groundwater. It should be clean! - It's absolutely asinine to see the landfill was built within close proximity to a creek! Who thought of this brilliant idea and are they alive today? Why did they build landfills next to washes and rivers (i.e.: Salt River has at least one dump right on the banks of the creek) like this one? - As for clean up, it seems no matter what is done, pumping the water out of groundwater will have the same effect of spraying deodorizer on a pile of dog waste inside a home to get rid of the smell. We all know you need to REMOVE the pet waste to get rid of the problem. Thus, I ask, why can't the entire landfill be excavated and removed permanently, and have the desert put back the way it was pre 1960? - I seriously question how much TCE has contaminated local wells in the area, much less the City of Scottsdale's water. Where is the Town of Cave Creek getting their water from across the street? Do homes North of Carefree Highway get water from wells that could also be contaminated? Does Scottsdale (2 miles to the East) use wells or are they on CAP water like us? Also, how much of this could have traveled down Cave Creek to it's [sic] lower sections by Thunderbird Road. Your tests indicate it is only moving at 6 inches per year. Is that accurate? Isn't it batteries and chemicals that are causing TCE? Again, it seems that digging this mess up and disposing of it elsewhere would be the best and most effective result, then flushing the ground water would come later. - And finally, why can't plants or trees be planted on this mess of a dirt pile? I understand Mr. Pritchard (The developer of Dove Valley Ranch) tried planting seeds and trees on the banks of this thing in the early 2000's, but it failed due to heavy rains that year that washed the seeds and saplings away. The entire landfill is an eyesore. 	1, 15, 16, 17 and 19

**TABLE 1 - PUBLIC COMMENTS ON THE CAVE CREEK LANDFILL REMEDIAL ACTION PLAN
RECEIVED DURING THE PUBLIC COMMENT PERIOD (AUGUST 17 THROUGH SEPTEMBER 15, 2015)
AND THE PUBLIC MEETING HELD ON SEPTEMBER 1, 2015**

Date Received and Commenter Name	Method Provided	Comments	Summary Comment Numbers
9/1/2015 Elaine Alexander	At meeting	<p>Heard about meeting via: Mailed notice and HOA Landfill Status presented: Very Well Sufficient Level of Detail?: Yes</p> <ul style="list-style-type: none"> - Very happy this issue is being addressed. - Who's responble [sic] for keeping up the landfill appearance? - Is it possible to get this area facing our homes to be landsaped. [sic] Possible trees or large scrubs to make it look better. - Who could we contact to ask the question? - Please please [sic] pressure the preserve to allow some wells on there [sic] land. 	3, 8, 19 and 20
9/1/2015 Brent Gifford	At meeting	<p>Heard about meeting via: Mailed notice Landfill Status presented: Well Sufficient Level of Detail?: Yes</p> <ul style="list-style-type: none"> - Thank you. I agree that the RAP makes sense and is well thought out given the constraints that need to be dealt with. - I appreciate that the County is trying to get out in front of this and taking action now. - I think that the monitoring well is in a good location so that it shows data to provide evidence that the RAP is working. 	3, 4 and 6
9/3/2015 Nancy Olen	via email	<p>Heard about meeting via: HOA Landfill Status presented: Well Sufficient Level of Detail?: Yes</p> <ul style="list-style-type: none"> - There is obviously an ongoing problem that needs to be remediated. The County thus far is not considering what the residents are incurring with the wells that have already been dug, the equipment used, the noise, the dust, and location near the residences. Also that this is a problem that has been present for a long time. If it were not for the County wanting to put a test well next to our home in 2011 this would have just been put under the rug like it had been for years. The County employees that were involved in the test wells in 2011 had no answers and no idea of what was in the ground supposedly. If it were not for several neighbors in Emerald Greens to bring this problem to light there most likely would not be any remedial plan today. 	2, 5, 7, 8, 10, 11, 18, 19, 21 and 22

**TABLE 1 - PUBLIC COMMENTS ON THE CAVE CREEK LANDFILL REMEDIAL ACTION PLAN
RECEIVED DURING THE PUBLIC COMMENT PERIOD (AUGUST 17 THROUGH SEPTEMBER 15, 2015)
AND THE PUBLIC MEETING HELD ON SEPTEMBER 1, 2015**

Date Received and Commenter Name	Method Provided	Comments	Summary Comment Numbers
		<ul style="list-style-type: none"> - What the county is not recognizing still to this date, is what effect the poor management of the landfill is having on the DVR, Emerald Greens residents. The location chosen is not favorable location at all, to the residents of Emerald Greens. It is too near the homes. - The noise, the dirt, the dust the equipment, and the test well post that will remain after it is drilled will remain forever next to the properties. The woman that gave the, presentation stated herself that it probably would be a better location if it were to be on the Sonoran Preserve land west of the proposed location of the new monitoring well. She stated that the City of Phoenix does not want to put it on the Preserve land. What is not being considered is what the tax payers/residents would like. The residents do not want it in the back of their homes either. All of the other test well are on the City of Phoenix Sonoran land or skirted around it. Why put it next to homes? - When it comes to resale there could inevitably [sic] a drop in property values and interest of future homebuyers with a well located near the current homes. If you google the Cave Creek Landfill you will see there is buyers questioning the landfill location and danger. Test wells and posts near the homes is a reg [sic] flag to most buyers. - Also, the season of next spring to begin the drilling of the new well. That is one of the worst times to make noise and have an eye sore near the residences. Windows are normally open at that time of year residents are outside. The county has no idea the volume of noise and dust, dirt, the eye sore of the equipment that we residents have already incurred from the other wells that have been drilled. It additionally takes away any enjoyment of one's home and yard. - It is my request that the location, and time of drilling be looked at again. Is it necessary to do this now? Change your proposed new monitoring well to accommodate the residents versus the City of Phoenix Sonoran Preserve. - The proposed location of the ground water treatment system should be located further from residences or choose the off site location. This too brings questions to future home buyers and possible noise and commercial traffic. The possibility of the TCE and other contaminates being removed near homes is upsetting. We were told doing research with the EPA and private labs that the air born possibilities of at least 2 contaminates in the ground are very harmful, and cancer causing. - Landscape what you have left open posts and the landfill itself. Don't make it stand out. - I would request your return comments and future updating regarding the issue at hand. 	

**TABLE 1 - PUBLIC COMMENTS ON THE CAVE CREEK LANDFILL REMEDIAL ACTION PLAN
RECEIVED DURING THE PUBLIC COMMENT PERIOD (AUGUST 17 THROUGH SEPTEMBER 15, 2015)
AND THE PUBLIC MEETING HELD ON SEPTEMBER 1, 2015**

Date Received and Commenter Name	Method Provided	Comments	Summary Comment Numbers
9/4/2015 Robert Olen	via email	<p>Heard about meeting via: HOA Landfill Status presented: Well</p> <ul style="list-style-type: none"> - We thought the issue was presented well and was aware of the issue from a meeting several years ago. But was never informed of the remediation plans when we purchased our home, only that the danger was 600 feet below the surface and would have no effect on our health or enjoyment. - My comments are that this is an issue that has been known for over 30 years and now the County has decided to remediate the issue at the expense of my enjoyment of my senior years. The ground water 600 feet below the surface does not affect me in any manner. So if this issue must be resolved now please do it with the least inconvenience to my life. - I think drilling the monitoring well close to the community would be invasive and deprive me the enjoyment of my property. Therefore I would like to see the monitoring well positioned at the alternative site or on the preserve. This may not be the optimal site, but then had the County not neglected this issue for 30 years I would not have to pay for their negligence. I also think it will devalue our property values. - I also do not like the fact that the Groundwater Treatment System will be located close to my home and will not be supervised 24/7. I would prefer the Treatment System be located further north or use the off-site option. The last thing I want to hear is a pump running 24/7. - Finally it would be nice if you could landscape the dump to make it look more presentable. There are all kinds of rules to keep the landscape natural but yet the well heads are exposed with four concrete poles around them. Get creative and camouflage the wells to blend in. 	5, 7, 8, 11, 12, 19 and 23

**TABLE 1 - PUBLIC COMMENTS ON THE CAVE CREEK LANDFILL REMEDIAL ACTION PLAN
RECEIVED DURING THE PUBLIC COMMENT PERIOD (AUGUST 17 THROUGH SEPTEMBER 15, 2015)
AND THE PUBLIC MEETING HELD ON SEPTEMBER 1, 2015**

Date Received and Commenter Name	Method Provided	Comments	Summary Comment Numbers
9/14/2015 Marsha Miller	via email	<p>Heard about meeting via: HOA Landfill Status presented: Very Well Sufficient Level of Detail?: Yes</p> <ul style="list-style-type: none"> - If the proposed monitoring well cannot be moved to the Phoenix Sonoran Preserve (south of the site) – please make sure the wellhead is not blocking the ped [sic] gate to the preserve. Also, try to keep that access gate open to the public during the drilling. - Please notify the residents in Emerald Green prior to drilling no matter what location is chosen. Make sure there is a hotline number. - Thank you for investing in the cleanup! 	8, 9, 21, and 22
9/14/2015 Tracy Mimoun	via email	<ul style="list-style-type: none"> - I attended the August meeting. - My concern is regarding the possibility of leakages including but not limited to operator errors and equipment malfunctions during the cleanup process. I am asking for extra safety measures to be put in place prior to the clean up. Since the extraction is not monitored 24/7, I believe the more safety measures in place the better. I'd like to see an alert system where managers would be notified immediately if there's a malfunction. An automatic shut-off feature on the pumps would be a benefit too. Frequent testing of the air quality around the site would be wise. I'd like to see the operations protected from vandalism/trespassing with surveillance cameras and a security patrol around the clock. Likely there are other safety measures that can be put into place as well. - I would appreciate seeing an update about these things as well as regular updates on the the [sic] progress being made online or posted on the Dove Valley Ranch community service boards. - Ideally the drilling could take place after the fall/winter months when residents are outside enjoying the cooler temperatures. - Thanks for considering my feedback. 	10, 11, 12, 13, 14, 21 and 22
9/14/2015 Nancy Burkhart	via email	<ul style="list-style-type: none"> - My concerns are basically the same as Tracy Mimoun's. - Also, as an owner, I have a concern about property values in the area and whether they will be adversely affected. My tenant has said that she may consider moving because of all this. If I disclose this to prospective tennants [sic], which I am required to do, I may not be able to get my house re-rented. I hope she stays!! 	7

**TABLE 2 - SUMMARY OF PUBLIC COMMENTS ON THE CAVE CREEK LANDFILL REMEDIAL ACTION PLAN
WITH RESPONSES PREPARED BY MARICOPA COUNTY**

Maricopa County Cave Creek Landfill – Phoenix, Arizona

Summary Comment Topic	Summary Comment Number	Summary Comment	Maricopa County Response to Summary Comment
Remedial Approach	1	Without removing the landfill entirely, the source of contamination will continue to impact groundwater.	Contaminated vapor located in soil underlying the landfill at depth is the source of groundwater contamination at the site. Implementation of the Remedial Action Plan (RAP) includes soil vapor extraction (SVE) to remove this vapor. Contaminant vapor concentrations within the landfill are much lower than concentrations underlying the landfill and thus removal of the landfill would not remove the source of groundwater contamination. Groundwater monitoring will continue until remediation efforts are completed.
Remedial Approach	2	The groundwater should be remediated and the duration required to address the problem has been too long.	Site characterization for remediation projects can be difficult and expensive for complex sites such as Cave Creek Landfill. However, without adequate characterization, effective remedial approaches cannot be developed. Maricopa County is committed to cleaning up Cave Creek Landfill and also supports expedited remediation since this contributes to protection of the public, risk reduction and cost control.
Remedial Approach	3	We are happy the issue is being addressed and the County is taking action.	As a steward of our natural resources, Maricopa County accepts our obligation to protect public health and the environment.
Remedial Approach	4	The RAP makes sense and is well thought out given project constraints.	Maricopa County has made great efforts to develop a remediation plan that is effective and protective of public health.
Remedial Approach	5	The groundwater should be remediated with the least inconvenience to nearby residents.	Maricopa County will endeavor to limit the inconvenience of remediation activities to nearby residents.
Monitoring Well Location	6	The proposed monitoring well is in a good location because it will provide evidence that the RAP is working.	At the time the draft final version of the RAP was prepared, the proposed monitoring well location was sited to provide useful data and minimize impact to nearby residents within the limits of project constraints.

**TABLE 2 - SUMMARY OF PUBLIC COMMENTS ON THE CAVE CREEK LANDFILL REMEDIAL ACTION PLAN
WITH RESPONSES PREPARED BY MARICOPA COUNTY**

Maricopa County Cave Creek Landfill – Phoenix, Arizona

Summary Comment Topic	Summary Comment Number	Summary Comment	Maricopa County Response to Summary Comment
Monitoring Well Location	7	The County needs to consider the adverse impacts of wells installed near residents: <ul style="list-style-type: none"> – The equipment used is noisy and generates dust; – The presence of wells in the neighborhood has the potential to result in lowering property values; – The wells are unsightly and remain indefinitely; measures should be taken to make existing and future wellheads less intrusive. 	Maricopa County will implement control measures to mitigate noise and dust during drilling activities. Maricopa County is unable to comment on the correlation between groundwater wells and property values; however, there are numerous wells located throughout the Phoenix Metropolitan Area with a wide variety of very useful purposes. Maricopa County will keep the public's concern regarding obtrusiveness in mind when designing the wellheads of future wells. At the completion of remediation activities when the wells no longer serve a purpose, wells will be abandoned and the wellheads will be removed.
Monitoring Well Location	8	The new monitoring well should be located on the Sonoran Preserve or at the alternative location to keep it away from nearby residents.	Maricopa County is currently advocating for placement of proposed monitoring well in the Sonoran Preserve with the City of Phoenix. If the City of Phoenix grants permission to drill in the Preserve, the location of the well will be changed to this location.
Monitoring Well Location	9	The new monitoring wellhead should not block the pedestrian gate to the Sonoran Preserve; gate access should remain open to the public during drilling.	Well siting will address access requirements of surrounding features.
Monitoring Well Location	10	If new wells are installed, drilling should take place after fall/winter months when residents are outside enjoying cooling temperatures. How long will it take to complete installation of the monitoring well?	Drilling and installation of planned wells located near residents will be performed during the late Spring and Summer months. Appropriate measures to reduce disturbance to nearby residents during drilling activities will be utilized. Monitoring well construction is expected to take approximately four weeks.

**TABLE 2 - SUMMARY OF PUBLIC COMMENTS ON THE CAVE CREEK LANDFILL REMEDIAL ACTION PLAN
WITH RESPONSES PREPARED BY MARICOPA COUNTY**

Maricopa County Cave Creek Landfill – Phoenix, Arizona

Summary Comment Topic	Summary Comment Number	Summary Comment	Maricopa County Response to Summary Comment
Treatment Facility	11	The groundwater treatment facility should be located further from residences or an off-site treatment strategy should be employed. Treating extracted groundwater near residents is upsetting and could adversely impact the health of nearby residents.	The location of the groundwater treatment facility is currently proposed on the western side of the landfill property. Figure 6-1 of the RAP will be revised to show this updated location which will assist with obscuring the treatment equipment from view by residents. Groundwater treated at the facility will be contained in closed remediation equipment that is similar in function to drinking water purification filters used in homes (i.e. liquid-phase granular activated carbon).
Treatment Facility	12	Since the treatment facility will not be staffed 24/7, the groundwater treatment system should have extra safety measures to protect the environment and nearby residents from the possibility of leakages (e.g., an alert system notifying operators immediately of malfunctions, an automatic shut-off feature on pumps in the event of a malfunction, etc.).	A comprehensive Operations and Maintenance Plan will be prepared for the treatment facility that outlines all the safety measures, response requirements, and monitoring frequencies necessary to ensure the safety of the public and the environment. The groundwater treatment system will be designed with appropriate physical containment infrastructure and control systems to monitor and immediately shutdown the system should a malfunction or failure occur. The control system will also be equipped with telemetry to notify a properly trained technician (and backup personnel) of alarm conditions so that an appropriate response can be conducted in a timely manner.
Treatment Facility	13	Frequent testing of the air quality around the treatment facility would be wise.	Groundwater treated at the facility is contained in closed remediation equipment. Extracted water is not exposed to the atmosphere nor does the process discharge to the atmosphere. The Soil Vapor Extraction (SVE) treatment system discharges treated vapor and is tested per Maricopa County Air Permit requirements.
Treatment Facility	14	The treatment facility should be protected from vandalism/trespassing with surveillance cameras and a security patrol around the clock.	The treatment system will be constructed with appropriate security measures.

**TABLE 2 - SUMMARY OF PUBLIC COMMENTS ON THE CAVE CREEK LANDFILL REMEDIAL ACTION PLAN
WITH RESPONSES PREPARED BY MARICOPA COUNTY**

Maricopa County Cave Creek Landfill – Phoenix, Arizona

Summary Comment Topic	Summary Comment Number	Summary Comment	Maricopa County Response to Summary Comment
History/Impacts of Contamination	15	Has the TCE associated with the site impacted drinking water supplies?	Residents of Dove Valley Ranch receive drinking water from the City of Phoenix. Drinking water is not sourced from contaminated Site groundwater; regional drinking water supply wells are located approximately two miles east and southeast of the Site. Two irrigation supply wells are also located within two miles of the site. These drinking water and irrigation supply wells are not currently impacted by Site contamination but have the potential to be impacted in the distant future if no action is taken. The Remedial Action Plan serves to address the potential for future impact to the drinking and irrigation supply wells.
History/Impacts of Contamination	16	What is the source of TCE in the landfill?	Residential and commercial solid waste was disposed of at Cave Creek Landfill. TCE is an ingredient in a number of consumer and industrial products such as adhesives, cleaning fluids, degreasers, paint removers/strippers, spot removers, and typewriter correction fluids. The source of TCE at Cave Creek Landfill is likely from products such as these disposed of as waste in the landfill.
Landfill Presence	17	Landfills should not be built in close proximity to creeks.	Regulatory landfill construction requirements change over time. Cave Creek Landfill was in compliance with siting requirements at the time it was built.
Landfill Presence	18	Poor management of the landfill is having an adverse effect on nearby residents.	Efforts are being made to reduce adverse effects that have been caused by the landfill.
Landfill Maintenance	19	Can the landfill slopes adjacent to Dove Valley Ranch be landscaped?	Evaluation of additional vegetation measures at the landfill will be explored. However, due to the steep slope and limited access of the landfill slopes adjacent to Dove Valley Ranch, options are limited and must not promote erosion or compromise the integrity of the landfill.

**TABLE 2 - SUMMARY OF PUBLIC COMMENTS ON THE CAVE CREEK LANDFILL REMEDIAL ACTION PLAN
WITH RESPONSES PREPARED BY MARICOPA COUNTY**

Maricopa County Cave Creek Landfill – Phoenix, Arizona

Summary Comment Topic	Summary Comment Number	Summary Comment	Maricopa County Response to Summary Comment
Landfill Maintenance	20	Who is responsible for keeping up the landfill appearance and can residents contact that individual?	The Maricopa County Waste Resources & Recycling Department is responsible for Cave Creek Landfill maintenance activities. The department website has a contact form that can be used to submit questions and comments: http://swm.maricopa.gov/contact.htm .
Resident Notification	21	Residents should be routinely updated of site progress (perhaps through Dove Valley Ranch community service boards).	Communication efforts will include progress updates to residents in the affected area in advance of significant field activities. Dove Valley Ranch Community will be included in the communication efforts and they may provide communication to the residents as the community deems appropriate. Maricopa County's Cave Creek Landfill Cleanup website will also be updated with the latest site progress information at http://www.maricopa.gov/groundwater/ .
Resident Notification	22	Residents should be notified in advance of drilling activities. A drilling hotline number should be provided to residents.	A Public Notification Flyer that summarizes planned drilling activities will be prepared and circulated to residents within 1,000 feet of Maricopa County landfill property at least 30 days in advance of drilling activities. The flyer will include a general description of the drilling work activities, location of planned work, start date, planned duration, and contact information for lead project representatives.
Resident Notification	23	Residents should have been informed of the contamination and remedial plans when they purchased their homes. Residents were told that the contamination was 600 feet below ground surface and would not impact resident's health or enjoyment.	All information concerning the landfill is in the public domain. Remediation efforts to protect human health while limiting impact to nearby residents are being performed.
Groundwater	24	What is the direction of the groundwater flow?	Groundwater flow direction fluctuates due to influence from surrounding water supply well pumping. Generally groundwater flow is to the south but ranges from south-southeast to south-southwest.

**TABLE 2 - SUMMARY OF PUBLIC COMMENTS ON THE CAVE CREEK LANDFILL REMEDIAL ACTION PLAN
WITH RESPONSES PREPARED BY MARICOPA COUNTY**

Maricopa County Cave Creek Landfill – Phoenix, Arizona

Summary Comment Topic	Summary Comment Number	Summary Comment	Maricopa County Response to Summary Comment
Soil Vapor Extraction System	25	Why is the soil vapor extraction system located near the northern portion of the landfill?	Data obtained from on-Site monitoring wells indicate the highest concentration of TCE in soil is located in the northern portion the new landfill.
Soil Vapor Extraction System	26	Will equipment working on the landfill be necessary?	Drilling equipment may be necessary on the landfill should additional soil vapor monitoring or extraction be necessary. Drilling equipment should not be necessary on top of the landfill for construction of the groundwater treatment system.
Landfill Methane	27	Is it possible to use the methane generated at the landfill?	Methane was previously captured and flared on-Site. Over time, the methane concentration extracted from the site decreased to levels that made operation of the system no longer cost effective. The system was removed from service in 2007.
Contaminants of Concern	28	Are there contaminants of concern other than TCE present at the landfill?	TCE is the only contaminant routinely present in groundwater underlying the landfill at concentrations in excess of regulatory thresholds. Other contaminants are present at concentrations that are less than regulatory limits. Most of these contaminants are by-products of the degradation of TCE into less complex chemicals. Monitoring of TCE and these additional contaminants in groundwater occurs on a routine basis with regulatory oversight.
Remedy Selection	29	If the off-Site remedy was selected would the water be hauled off-Site for treatment?	Due to the flow rates and duration required to remediate the plume, it is not cost effective to haul (e.g. truck) extracted water off-Site for treatment. The Off-Site Remedy includes a treatment system located in the immediate vicinity of the off-site extraction well to allow extracted groundwater to be treated near the wellhead(s).

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Maricopa County Cave Creek Landfill – Phoenix, Arizona

Summary Comment Topic	Summary Comment Number	Summary Comment	Maricopa County Response to Summary Comment
Remedy Selection	30	What remedy would be recommended if the treatment system, or components of the system, could be built on the Sonoran Preserve?	If it was feasible to do so, the extraction well and supporting piping would be most appropriately located on the Sonoran Preserve while the treatment system location would remain on-Site at the landfill. There are many administrative and engineering constraints that make this alternative less implementable than the preferred remedy.
Contaminated Vapors	31	Will vapors from the contaminants affect residents?	Subsurface soil vapor monitoring along the perimeter of the landfill has been conducted and levels do not exceed human health-based limits. Continued monitoring is part of the RAP.

**TABLE 3 - CITY OF PHOENIX COMMENTS ON THE CAVE CREEK LANDFILL REMEDIAL ACTION PLAN
WITH RESPONSES PREPARED BY MARICOPA COUNTY**

Maricopa County Cave Creek Landfill – Phoenix, Arizona

Comment Type	Document Reference	Comment Number	Comment	Maricopa County Response to Summary Comment
General		1	The County...proposed using two existing monitoring wells on the Sonoran Preserve as injection wells to enhance the remediation action. Phoenix understands that MW 4 and MW 7 are the proposed wells to complete this remediation action. Phoenix requests clarification if the wells listed are not the correct wells for this proposal. The remediation would include the injection of sodium permanganate into the wells and circulating it between them to help break down the contamination.	The City of Phoenix’s understanding is correct. The proposed wells for the ISCO Early Response Action are MW-4 and MW-7. Section 8.3 of the RAP will be revised.
General		2	Phoenix is concerned that the recommended alternative will allow a portion of the contaminant plume to migrate down gradient without containment by the planned treatment system. This aquifer is a drinking water resource for Phoenix and there are drinking water wells down-gradient from the contamination plume. In response to this concern, the County and ADEQ agreed to clarify in the RAP contingency language that would include having all water suppliers be consulted in the decision making for future remediation actions, if warranted. More specifically, if monitoring were to indicate contamination with the potential to impact water supply wells, additional contingencies would be implemented by the County to eliminate the concern. Phoenix requests that the RAP be updated to be clear that contingent measures will be implemented to protect the water supply.	Section 8 of the RAP will be revised with language that states contingent measures will be implemented if the results of the groundwater monitoring program indicate that contamination with the potential to impact water supply wells at concentrations exceeding drinking water standards will occur. The RAP will also indicate that water suppliers potentially affected by site contamination will be consulted in the decision making process for future remedial actions.
General		3	In response to comments from the County about the desire to implement injection into MW 4 and MW 7, located on the Sonoran Preserve, Phoenix supports this recommendation and requests that this be included in the RAP. Phoenix would also request periodic updates on the success of the entire remedy.	Periodic updates on the success of the entire remedy will be provided to the City of Phoenix.

**TABLE 3 - CITY OF PHOENIX COMMENTS ON THE CAVE CREEK LANDFILL REMEDIAL ACTION PLAN
WITH RESPONSES PREPARED BY MARICOPA COUNTY**

Maricopa County Cave Creek Landfill – Phoenix, Arizona

Comment Type	Document Reference	Comment Number	Comment	Maricopa County Response to Summary Comment
General		4	Regarding the request to place an additional monitoring well on the Sonoran Preserve, Phoenix would like to work with the County and ADEQ to identify a location for this monitoring well that is least disruptive to the Preserve and meets its intended objective of monitoring for plume containment and treatment progress.	Comment noted. Maricopa County looks forward to discussing alternative well locations with the City of Phoenix.
Specific	Section 3.1.5 (Regional Groundwater)	5	<p>This section summaries Phoenix's water supply wells in the immediate area. Well 55-603807 is denoted as owned by City of Phoenix, but was sold in 2001.</p> <p>Phoenix initiated an Aquifer Restoration Program in 2010, where treated Central Arizona Project water supplies are directly injected into the Northeast Aquifer. Storing these supplies are necessary for mitigating future droughts. Since that time, we have constructed three Aquifer Storage and Recovery (ASR) well systems (55-218928, 55-214540, and 55-221212). These wells are registered with the Arizona Department of Water Resource (ADWR) and annual recharge volumes are reported to the ADWR Recharge Division. Recharge from Phoenix's ASR wells to the northeast aquifer should be evaluated by the County to understand the impact of this storage on the flow of the contaminant plume.</p>	<p>Section 3.1.5 of the RAP will be revised to reflect the status of the current owner of Well 55-603807.</p> <p>Maricopa County has acknowledged the City of Phoenix ASR project in previous site documentation and understands that these operations can affect both the direction of regional groundwater flow and the rate of plume migration. Given the uncertain nature of future water supply requirements, Maricopa County maintains that extracting contaminated groundwater onsite (as proposed in the preferred remedy) will be the most resilient strategy to address future changing conditions in the regional aquifer.</p>

**TABLE 3 - CITY OF PHOENIX COMMENTS ON THE CAVE CREEK LANDFILL REMEDIAL ACTION PLAN
WITH RESPONSES PREPARED BY MARICOPA COUNTY**

Maricopa County Cave Creek Landfill – Phoenix, Arizona

Comment Type	Document Reference	Comment Number	Comment	Maricopa County Response to Summary Comment
Specific	Section 5.3.1 (Description of Preliminary Alternatives)	6	<p>As was discussed during our meeting, is there an opportunity to increase extraction well pumping rates or add an additional well on-site, that might serve to capture the contaminant plume from off-site? This would satisfy Phoenix's concern that Alternative 4, as recommended, would allow a portion of the plume to escape containment.</p> <p>Alternative 4 proposes to install the injection well on the western portion of the landfill. During the meeting we discussed if substitute locations were modeled to create a hydraulic barrier between the contamination plume and Phoenix water supply wells or injection at the toe of the contamination plume to reduce off-site migration. Although Amec confirmed that numerous alternative models were evaluated, we are requesting confirmation that none of the modeled alternatives would serve as a more effective injection location to contain the plume.</p>	<p>Maricopa County is further optimizing the preferred remedy's ability to enhance capture by evaluating varying extraction well rates, extraction and injection well locations and the number of wells installed. The results of this effort will be presented in a modeling report update included with the final RAP.</p> <p>Maricopa County is also evaluating the recent possibility that the treated water (or a portion thereof) be reused by Dove Valley Ranch Golf Course. To accommodate this potential opportunity, alternatives with and without groundwater reinjection will be considered.</p>
Specific	Section 7.2.2 (Risk)	7	<p><i>However, the contaminant flux that is not contained is anticipated to be low and thus this additional risk may not be significant.</i>" Having any groundwater contaminants near Phoenix's potable water supply wells is a significant risk to our residents and there is a long-standing Phoenix policy that mere wellhead treatment of man-made contaminants at a potable water supply is not an acceptable solution/remedy. During the September meeting the County agreed to add contingency language into the RAP. Phoenix asked that all water suppliers be part of the decision making should the treatment system not fully capture the contamination plume and a contingency would have to be implemented.</p>	<p>Comment noted. See response to Comment 2.</p>