Univar Solutions USA Inc.

FEASIBILITY STUDY REPORT

East Grand Avenue Water Quality Assurance Revolving Fund Registry Site Phoenix, Arizona

June 2020

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Phoenix, Arizona

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ACRONYMS AND ABBREVIATIONS

1,1-DCE	1,1-dichloroethene
1,1,1-TCA	1,1,1-trichloroethane
µg/L	micrograms per liter
$µg/m^3$	micrograms per cubic meter
A.A.C.	Arizona Administrative Code
ADEQ	Arizona Department of Environmental Quality
ADWR	Arizona Department of Water Resources
Agreement	Agreement between Univar Solutions and the ADEQ dated January 14, 2003
amsl	above mean sea level
AOP	Advanced Oxidation Process
Arcadis	Arcadis U.S., Inc
A.R.S.	Arizona Revised Statue
AWQS	Arizona Aquifer Water Quality Standards
bgs	below the ground surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COC	constituents of concern
COP	City of Phoenix
EGA	East Grand Avenue
ERA	Early Response Action
FS	Feasibility Study
ft/ft	feet per foot
GAC	Granulated Activated Carbon
GCA	G.M. Clement & Associates, Inc.
GPL	Groundwater Protection Levels
gpm	gallons per minute
HBGL	Health Based Guidance Levels
HLA	Harding Lawson Associates, Inc.
HRI	Harry Ross Industries
ITRC	Interstate Technology and Regulatory Council
LAU	lower alluvial unit

MAU	middle alluvial unit
MCL	Maximum Contaminant Level
MM	million
MTP	Michigan Trailer Park
PA	Preliminary Assessment
PAH	polycyclic aromatic hydrocarbons
PCE	tetrachloroethene
P-RAP	proposed remedial action plan
Property	2930/2940 West Osborn Road in Phoenix, Arizona
RA	Human Health and Environmental Risk Assessment
RI	Remedial Investigation
RI Addendum	2018 Final Remedial Investigation Report
RRARP	Reference Remedy and Alternative Remedies Proposal
RO	remedial objectives
RO Report	Remedial Objectives Report
SI	Site Inspection
SRL	Soil Remediation Levels
SRP	Salt River Project
SRV	Salt River Valley
SVE	soil vapor extraction
SVOC	semi-volatile organic compounds
TCE	trichloroethene
the EGA Site	West Central Phoenix East Grand Avenue Water Quality Assurance Revolving Fund Registry Site
UAU	upper alluvial unit
Univar Solutions	Univar Solutions USA Inc.
USEPA	United States Environmental Protection Agency
VWR	Van Waters & Rogers
VOC	volatile organic compounds
WCP	West Central Phoenix
Weston	Weston Solutions, Inc.
WQARF	Water Quality Assurance Revolving Fund

ZVI	Zero Valent Iron

1 SUMMARY

The West Central Phoenix (WCP) East Grand Avenue (EGA) Water Quality Assurance Revolving Fund (WQARF) Registry Site (the EGA Site) is in Phoenix, Arizona (Figure 1). The Final Remedial Investigation (RI) Report (Weston Solutions, Inc. [Weston] 2006) identified the former Univar Solutions USA Inc. (Univar Solutions) facility (previously Van Waters & Rogers [VWR]) and the former Mogul facility as sources of constituents of concern (COCs) to the EGA Site. The RI also noted that an additional unidentified upgradient source may be present (Weston 2006). Univar Solutions later suggested that additional, unidentified source areas were present upgradient and side gradient from the former Univar Solutions facility (Univar Solutions USA Inc. 2012). Subsequently the Arizona Department of Environmental Quality (ADEQ) conducted additional investigations and reported the findings in the 2018 Final Remedial Investigation Report Addendum (RI Addendum; ADEQ 2018; Arcadis 2018a). The confirmed and potential sources of COCs are described further in Section 2.4.

Groundwater impacts were discovered in the WCP area in 1982; the WCP WQARF Site was added to the WQARF priority list in 1987. In 1998, the ADEQ split the WCP WQARF Site into five separate and distinct WQARF sites, including the EGA Site. Since 1998, the EGA Site has been an individual site administered under the WQARF program. The COC-affected groundwater at the EGA Site is separate from the four other WQARF sites within the WCP area, and no current or historical data indicate that COCs originating from the EGA Site have extended into the other WCP WQARF sites.

The COCs at the EGA Site include three chlorinated volatile organic compounds (VOCs): trichloroethene (TCE), tetrachloroethene (PCE), and 1,1-dichloroethene (1,1-DCE) (Weston 2006). This Feasibility Study (FS) Report was developed by Arcadis U.S., Inc. (Arcadis) on behalf of Univar Solutions and is being submitted pursuant to the Agreement between Univar Solutions and the ADEQ dated January 14, 2003 (Agreement) (ADEQ 2003). The Agreement stated the FS would consist of the preparation of the FS Work Plan, Reference Remedy and Alternative Remedies Proposal (RRARP), and FS Report for the EGA Site. The FS Work Plan was prepared on behalf of Univar Solutions by G.M. Clement & Associates, Inc. (GCA; 2009a) and approved by ADEQ in a letter dated March 28, 2012 (ADEQ 2012). The RRARP was prepared on behalf of Univar Solutions by Arcadis (Arcadis 2014a) and approved by ADEQ in a letter dated March 17, 2015. The FS Report is based on the July 2009 FS Work Plan (GCA 2009a), Final RI Report (Weston 2006), 2013 Annual Groundwater Monitoring Report (GCA 2014), 2014 through 2019 Annual Groundwater Monitoring Reports (Arcadis 2014b, 2015b, 2016b, 2017b, 2018d, 2020a), the RRARP (Arcadis 2014a), the RI Addendum (ADEQ 2018 and Arcadis 2019), and Well installation and Sampling Report (Arcadis 2020b). This FS Report satisfies the requirements of Arizona Revised Statute (A.R.S.) §§ 49-175(B) and 49-282.06 and Arizona Administrative Code (A.A.C.) R18-16-401 through R18-16-407.

1.1 Purpose

This FS Report evaluates alternative remedial strategies for the COC-affected groundwater and remedial measures that, if necessary, would be implemented as those strategies. The COCs present in groundwater at the EGA Site in excess of Arizona Aquifer Water Quality Standards (AWQS) are TCE, PCE, and 1,1-DCE. The report concludes with a recommendation of a preferred remedial strategy and remedial measures to implement that strategy.

1.2 Report Organization

The remainder of this FS Report is organized as follows:

Section 2 – Site Background and Conceptual Site Model: establishment of the WQARF WCP sites, chronology of EGA Site activities, constituents of concern and applicable standards, confirmed and potential sources of the COCs, the conceptual site model for the COCs including affected media, distribution of COCs, delineation of COCs in groundwater, current conditions, early response action, and groundwater users and potential receptors, and an assessment of human health risks.

Section 3 – Remedial Objectives: discusses the remedial objectives (ROs) for the EGA Site that are identified in the ADEQ-approved Remedial Objectives Report (RO Report [ADEQ 2006]).

Section 4 – Screening of Remedial Strategies: discusses potential remedial strategies pursuant to A.A.C. R18-16-407(F); identifies the strategies that are capable of achieving the ROs for the EGA Site pursuant to A.A.C. R18-16-407(A) and (E); and specifies three strategies to be evaluated for the EGA Site.

Section 5 – Screening of Remedial Measures: discusses potential remedial measures pursuant to A.A.C. R18-16-407(G); identifies the measures that are necessary for each of the three strategies to achieve the ROs for the EGA Site pursuant to A.A.C. R18-16-407(A) and (E); and specifies the remedial measures to be evaluated.

Section 6 – Development of Remedies: organizes the three remedial strategies and corresponding remedial measures described above into a reference remedy and alternative remedies to be evaluated in accordance with A.A.C. R18-16-407(E)(1) through (3).

Section 7 – Individual Evaluations of Remedies: evaluates the reference remedy and alternative less aggressive and more aggressive remedies described in Section 6 according to the remedy selection criteria of A.A.C. R18-16-407(H)(1) and (2).

Section 8 – Comparative Evaluation of Remedies: compares the reference remedy and alternative less aggressive and more aggressive remedies to each other using the criteria of A.A.C. R18-16-407(H)(3)(a) through (e).

Section 9 – Contingency Measure: describes contingency measures that could be implemented, if necessary.

Section 10 – Recommendation: recommends the preferred remedial strategy (monitoring) and remedial measures to implement that strategy (continued groundwater monitoring), pursuant to A.A.C. R18-16-407(I) and A.R.S.§ 49-282.06(A) and (D) pursuant to A.A.C. R18-16-407(E)(1).

Section 11 – References

2 SITE BACKGROUND AND CONCEPTUAL SITE MODEL

The EGA Site is located in Section 26, Township 2 North, Range 2 East of the Gila and Salt River Baseline and Meridian system in Maricopa County. The EGA Site is approximately bounded by the Salt

River Project (SRP) SRP Grand Canal to the north, 27th Avenue to the east, Thomas Road to the south, and 35th Avenue to the west. The EGA Site is in an older commercial and industrial area that includes numerous small- to medium-sized businesses including fabricators and manufacturers (Weston 2006). The EGA Site elevation is approximately 1,120 feet above mean sea level (amsl) (Figure 1).

2.1 Water Quality Assurance Revolving Fund Registry

Groundwater impacts were discovered in the WCP area in 1982 when TCE was detected in several nearby City of Phoenix (COP) municipal wells. Subsequent groundwater sampling confirmed the presence of TCE at concentrations above the United States Environmental Protection Agency (USEPA) Maximum Contaminant Level (MCL). ADEQ designated the area of groundwater impact as the WCP WQARF Site and recommended further investigation under the State Superfund WQARF program. The WCP WQARF Site was placed on the WQARF Priority List in 1987. In 1998, the WCP WQARF Site was split into five separate and distinct WQARF sites: the West Osborn Complex Site, the West Grand Avenue Site, the North Canal Site, the North Plume Site, and the EGA Site (Figure 1). ADEQ separately administers each of these sites, including the EGA Site, under the WQARF program.

2.2 Chronology of East Grand Avenue Site Activities

A number of investigations have been conducted at the EGA Site and nearby areas since 1993. These included site inspections, surface and subsurface soil sampling, soil-gas surveys, soil borings, groundwater monitoring well installation, groundwater sampling, and aquifer pumping tests. Remedial investigations were conducted between 1997 and 2002, and the Final RI Report was prepared in 2006 by Weston Solutions. Soil vapor extraction (SVE) was implemented at the former Univar Solutions facility as an Early Response Action (ERA) from 2003 until 2013. Supplemental investigations were conducted between 2016 and 2018 by ADEQ and an RI Addendum was prepared in 2018 (ADEQ 2018) and Univar Solutions provided comments (Arcadis 2018b). Univar Solutions installed replacement and data gap wells to evaluate the current extent of COC sources near the former Univar Solutions facility and prepared a Well Installation and Sampling Report (Arcadis 2020b).

The following is a brief chronology of these investigative activities. A more detailed account of the RI and the results can be found in the Final RI Report (Weston 2006) and the RI Addendum (ADEQ 2018). Groundwater monitoring well locations are shown on Figure 2.

1990: ADEQ conducted a Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Preliminary Assessment (PA) at the former Mogul facility on behalf of the USEPA (ADEQ 1990).

1992: ADEQ conducted a CERCLA Site Inspection (SI) at the former Mogul facility on behalf of the USEPA (ADEQ 1993a).

1993: ADEQ conducted a CERCLA PA and SI at the former Univar Solutions facility on behalf of the USEPA (ADEQ 1993b). This included site reconnaissance, review of historical aerial photographs, and collection of surficial and subsurface soil and soil-gas samples.

1994: Univar Solutions conducted a preliminary site characterization of its former Property. Harding Lawson Associates, Inc. (HLA) conducted a soil-gas survey in July 1994 and a subsurface soil investigation and risk assessment in December 1994. HLA advanced seven soil borings in locations of elevated soil-gas concentrations and measured VOC concentrations in soil samples (HLA 1995).

1997: Fluor Daniel GTI conducted Phase I of the RI for ADEQ. This included installation of WCP-15, WCP-16, and WCP-17 and collection and analysis of soil and groundwater samples for VOCs (Weston 2006).

1998: Weston conducted Phase II of the RI for ADEQ between May 1998 and July 1998. Weston installed monitoring wells WCP-28, WCP-29, and WCP-30 and conducted two rounds of groundwater sampling (Weston 2006). Groundwater samples were analyzed for VOCs. Soil samples were not analyzed.

1999-2000: Weston conducted Phase III of the RI for ADEQ between August 1999 and December 2000. Weston conducted a vadose zone investigation that included drilling ten soil borings (SB-8 through SB-17) at the former Univar Solutions facility. Groundwater samples from each borehole were analyzed for VOCs. Soil samples were not analyzed. Weston also installed monitoring wells WCP-40 through WCP-46 and WCP-48 and conducted Rounds 1 through 6 of groundwater monitoring between December 1999 and December 2000 (Weston 2006).

2001-2002: Weston conducted Phase IV of the RI for ADEQ between January 2001 and June 2001. Weston installed monitoring wells WCP-47 and WCP-83 through WCP-90 and conducted rounds 7 through 10 of groundwater monitoring between February 2001 and June 2001. Groundwater samples were analyzed for VOCs. Nine soil samples were analyzed for physical properties (grain size, porosity, moisture content, density, specific gravity, total organic carbon, and permeability) (Weston 2006).

Step drawdown tests were conducted at monitoring wells WCP-28 and WCP-29 on May 10, 2001, and an aquifer pumping test was conducted at monitoring well WCP-29 on May 23, 2001 (Weston 2006).

Weston conducted Phase V of the RI for ADEQ between July 2001 and November 2001. Weston installed monitoring wells WCP-92 through WCP-98 and conducted Rounds 11 through 13 of groundwater monitoring. Groundwater samples were analyzed for VOCs. Fourteen soil samples were analyzed for physical properties (Weston 2006).

Weston conducted Phase VI of the RI for ADEQ between November 2001 and February 2002. Weston installed monitoring wells WCP-99, WCP-100, and WCP-200 through WCP-204 and conducted Rounds 14 and 15 of groundwater sampling. Groundwater samples were analyzed for VOCs. No soil samples were analyzed. Pressure transducers were installed in select monitoring wells to monitor groundwater levels and to assess the effects of infiltration water from the SRP Grand Canal (Weston 2006).

2003-present: Univar Solutions initiated periodic groundwater monitoring in January 2003. Groundwater samples were analyzed for VOCs. Sampling was conducted quarterly during 2003 and semi-annually from 2004 through 2013 (GCA 2003; 2004a; 2004b; 2004c; 2006a; 2006b; 2008; 2009a; 2010; 2011; 2012; 2013; and 2014). Since 2014, groundwater sampling has been conducted annually, while groundwater elevation monitoring has continued to be conducted and reported semi-annually and groundwater monitoring results are reported semi-annually (Arcadis 2014b, 2015a, 2015b, 2016a, 2016b, 2017a, 2017b, 2018a, 2018b, 2019, 2020a).

Univar Solutions installed monitoring well EGA-1 in March 2005 and added it to the monitoring program. Univar Solutions performed an SVE ERA from 2003 to 2013. The ERA is described in more detail in Section 2.5.6.

2017-2018: ADEQ conducted investigations of potential COC sources upgradient of the former Univar Solutions facility. During the investigation ADEQ conducted a soil-gas investigation and installed a monitoring well EGA-02. Following the investigation, the ADEQ issued the RI Addendum (2018a) and Arcadis provided comments (2018a).

2019: Univar Solutions installed replacement and data gap wells to evaluate the current extent of COC sources near the former Univar Solutions facility. During the investigation, Univar Solutions collected soil-gas samples and installed five monitoring wells EGA-03, EGA-04A, EGA-04B, EGA-05A, and EGA-05B. Following the investigation, Univar Solutions prepared a Well Installation and Sampling Report (Arcadis 2020b) and ADEQ approved the report on April 2, 2020.

2.3 Constituents of Concern and Applicable Standards

Based on data collected prior to, during, and after the RI, only TCE, PCE, and 1,1-DCE have historically been detected at groundwater concentrations greater than their AWQSs (A.A.C. R18-11-406) beyond the former Univar Solutions facility boundary (Weston 2006; GCA 2003; 2004a; 2004b; 2004c; 2006a; 2006b; 2008; 2009a; 2010; 2011; 2012; 2013; and 2014; Arcadis 2014b, 2015b, 2016b, 2017b, 2018d, 2020a).

TCE, PCE, and/or 1,1-DCE have been detected in vadose zone soil samples collected at the former Univar Solutions facility (Section 2.4.1), at the former Mogul facility (Section 2.4.2), and at the source area near EGA-02 (Sections 2.4.4 and 2.4.5), but at concentrations below residential and non-residential Arizona Soil Remediation Levels (SRLs) (A.A.C. R18-7-205) and minimum Groundwater Protection Levels (GPLs) (Weston 2006; ADEQ 2018, Arcadis 2018b, Arcadis 2020b).

For these reasons, and based on the ADEQ-approved land and water use study, RO Report, FS Work Plan, and RRARP, TCE, PCE, and 1,1-DCE in groundwater are the only COCs considered in this FS Report.

2.4 Confirmed and Potential Sources

The RI identified two confirmed sources of COCs to the EGA Site: the former Univar Solutions facility and the former Mogul facility. The RI also recognized an unidentified potential upgradient source of COCs to the EGA Site (Weston 2006). Additionally, Univar Solutions identified the former Granberry facility as a potential source of COCs to the EGA Site (Univar Solutions 2012). These source areas are discussed briefly in the following sections. More detailed information can be found in the Final RI Report (Weston 2006), the Additional Potential Sources letter (Univar Solutions 2012), and the RI Addendum (ADEQ 2018). The RI Addendum identified one additional, potential historical source area near EGA-02 (Sections 2.4.4 and 2.4.5). The distribution of the COCs in each of these source areas is discussed in more detail in Section 2.5.4.

2.4.1 Former Univar Solutions Facility

The former Univar Solutions facility is within the EGA Site boundary at 2930/2940 West Osborn Road in Phoenix, Arizona (Property; Figure 3). Beginning in 1957, the former Univar Solutions facility was used for warehousing and distribution of scientific and laboratory equipment by BKH, a subsidiary of VWR. In the mid-1960s, BKH expanded to include warehousing and the distribution of industrial and agricultural chemical products, upholstery supplies, and laundry and dry-cleaning supplies (Weston 2006). Motor Rim and Wheel Service of California purchased and began operating at the Property in 1970, and VWR ceased all operations at the Property by 1971 (Weston 2006). Motor Rim and Wheel Service sold the Property to Harry Ross Industries (HRI) and their partners, and HRI became the sole owner of the Property in 2004. HRI is the current owner of the Property, which now includes two parcels at 2930 and 2940 West Osborn Road.

Motor Rim and Wheel Service of California changed their name to Century Wheel and Rim and then to Rockwell American. Rockwell American is a manufacturer and distributor of trailer products and is the current operator on the parcel at 2930 West Osborn Road. Energy Task Force is an insulated piping company and is the current operator of the parcel at 2940 West Osborn Road.

The distribution of COCs in soil-gas, soil, and groundwater, which is discussed in more detail in Section 2.5.4.1, indicated the area near and under the former building foundation at the former Univar Solutions facility had been a historical source of COCs to the EGA Site (Weston 2006). However, all vadose zone soil concentrations were less than the SRLs and Minimum GPLs (Arcadis 2018b, 2018c, and 2020b). Thus, the vadose zone soils are not a media of concern and the former Univar Solutions facility is not a continuing source of COCs to groundwater.

2.4.2 Former Mogul Facility

The former Mogul facility is south of the EGA Site boundary at 3030 North 30th Avenue (Figure 3). Several owners operated a water treatment materials and services supply business at the former Mogul facility from 1962 to 1995 (ADEQ 1993a). Willmore Manufacturing, which produced accessories for cars and trucks, purchased the property in 1997 (SCS Engineers 1998). ACP Real Estate LLC currently owns the property (Maricopa County Assessor 2020). The Maricopa County Assessor (2020) states that the property is used as a warehouse and light commercial.

The distribution of COCs in soil and groundwater, which is discussed in more detail in Section 2.5.4.2, indicated that there had been a release of COCs at or near the former Mogul facility (ADEQ 1993a), and the RI identified the former Mogul facility as an additional source of COCs to the EGA Site (Weston 2006). However, COC concentrations in groundwater affected by the facility have decreased to below their respective AQWSs. See also section 2.5.4.2.

2.4.3 Former Granberry Supply Facility

The former Granberry Supply facility was southeast and just outside the EGA Site boundary. The address of this facility was identified as 2901 West Osborn Road in Phoenix, Arizona (Univar Solutions 2012); however, the address at this location is now listed as 2901 and 2905 West Osborn Road (Figure 3). The current owner is listed as Francisco Gamez since 2008 (Maricopa County Assessor 2020). A visual assessment indicated that the property was occupied by Paradise Mattress and Furniture and All About Sunscreens and Rain Gutters.

The former Granberry Supply facility began operation in 1982, and regulatory records indicated that Granberry Supply was a generator of characteristic hazardous waste, including TCE and PCE (Univar Solutions 2012). However, no documented site investigation of Granberry Supply was performed. Because of its past generation of waste TCE and PCE, Granberry Supply may have been a historical source of TCE and/or PCE to the environment and the EGA Site (Univar Solutions 2012).

The groundwater concentrations in vicinity of the former Granberry Supply facility have generally been low in recent years and the soil gas investigation conducted by the ADEQ (2018a) indicated soil-gas concentrations were either low or below laboratory detection limits in the vicinity of the former Granberry Supply facility. The ADEQ's calculated soil concentrations indicated soil concentrations in this area were less than the industrial soil SRLs and the minimum GPLs. Thus, the former Granberry Supply facility likely is not a continuing source of COCs to groundwater. See also Section 2.5.4.3.

2.4.4 Unidentified Upgradient Source

TCE has been detected at concentrations above the AWQS in monitoring wells located upgradient of the former Univar Solutions facility (Weston 2006) and upgradient of the former Mogul and Granberry facilities (Section 2.4.1 to 2.4.3). However, historical PCE and 1,1-DCE concentrations in upgradient monitoring wells did not exceed the AWQS. Weston (2006) concluded that there may have been an additional potential source of TCE upgradient and separate from the former Univar Solutions facility (Figure 3); however, the data were insufficient to determine the source of the upgradient TCE. Data collected during and after the RI have consistently shown that TCE concentrations were detected upgradient from the former Univar Solutions, Mogul, and Granberry facilities, which suggests that there might also have been an upgradient source of TCE. The probable source of this TCE has not been identified but may be located within the green dashed area shown on Figure 3.

During the 2017 to 2018 soil-gas investigation, elevated COCs were detected in soil-gas samples east of the former Univar Solutions facility (ADEQ 2018). The ADEQ's calculated soil concentrations indicated soil concentrations were less than the non-residential SRLs and the Minimum GPLs. Based on the soil-gas investigation (ADEQ 2018) and that COC concentrations upgradient from the former Univar Solutions and Granberry facility have been less than the AWQS in more recent years, this source area is not considered a continuing source of COCs to the EGA Site groundwater. See also Section 2.5.4.4.

2.4.5 Unidentified Cross-gradient Source

ADEQ investigations (ADEQ 2018, Arcadis 2018b), identified elevated COCs (including TCE) in soil gas near monitoring well EGA-02 along 29th Avenue between Osborn Road and Cheery Lynn Road. The probable source of the COCs in this area was not identified but may be located within the green dashed area shown on Figure 3. The soil-gas concentrations, converted to a soil concentration, were less than the Minimum GPLs and non-residential SRLs. TCE was also detected in monitoring well EGA-02 in 2018, but concentrations were less than the AWQS at the time the well was sampled. Therefore, this source area is not considered a continuing source of COCs to the EGA Site. See also Section 2.5.4.4.

2.5 Conceptual Site Model

2.5.1 Geology

The EGA Site is in the West Salt River Valley (SRV) sub-basin, which is part of Arizona's Basin and Range physiographic province. The West SRV is an alluvial basin consisting of basin fill deposits of unconsolidated to semi-consolidated sediments. The basin fill deposits range in thickness from 100 feet near the margins to 10,000 feet in central areas and consist of interbedded gravel, sand, silt, clay, and evaporites of Late Tertiary to Quaternary age. The alluvial deposits are divided into Upper, Middle, and Lower Units. The West SRV is surrounded by generally northwest to southeast trending, fault-blocked mountain ranges that are comprised of Precambrian to Quaternary rocks and include crystalline rock and extrusive rhyolites and basalts (Brown and Pool 1989). The nearest, uplifted mountains are located 6 miles to the northeast (Phoenix Mountains).

Subsurface sediments beneath the EGA Site are predominantly unconsolidated sandy silts to silty sands with varying amounts of sands, gravels, silts, and clays interbedded throughout. A cross-section (Figure 4) illustrates the geology beneath the EGA Site. The vadose zone (currently from land surface to approximately 150 feet below the ground surface (bgs) is characterized by unconsolidated alluvial sediments with calcified zones ranging from approximately 60 feet bgs to 90 feet bgs. Several coarse-grained layers (gravelly sands to sands) are present within the vadose zone in the upper 110 feet. A laterally continuous silt layer was encountered from approximately 110 feet to 125 ft bgs. A silty sand layer with varying amounts of silt and sands and occasional interbedded fine layers underlies the silt layer from approximately 125 feet to 200 feet bgs. Most shallow (A-Unit) monitoring wells are installed in this layer or above. Another laterally continuous fine-grained layer is present below the A-Unit and separates the A-Unit wells from the B-Unit wells (confining layer, see Section 2.5.2). The B-Unit wells (WCP-48, EGA-04B, and EGA-05B) are installed within a sandy unit below and partially within the bottom of the fines layer (Arcadis 2020b).

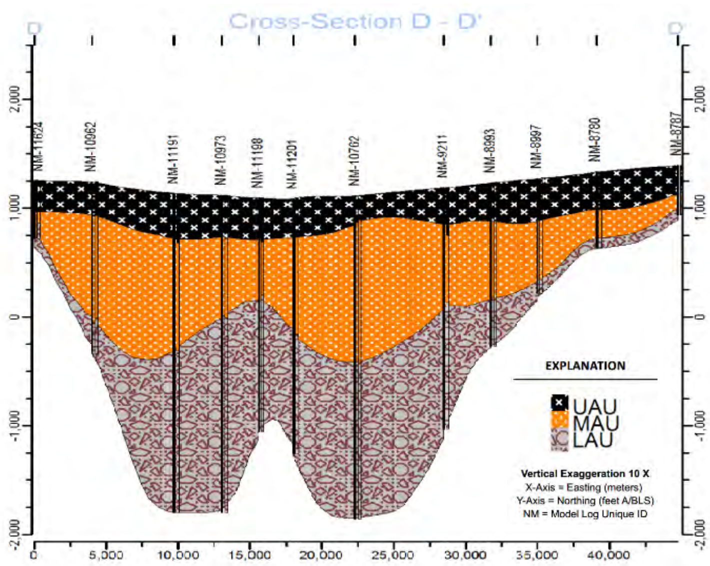
2.5.2 Hydrogeology

The regional aquifer in the West SRV is divided into three major hydrogeologic units: the upper alluvial unit (UAU), which consists of gravels, sands, and silts and which is mostly unconfined; the middle alluvial unit (MAU), which consists of finer-grained sediments, silts and clays, and some sand and gravel; and the lower alluvial unit (LAU), which is mostly conglomerate and gravel with some mudstone (Arizona Department of Water Resources [ADWR] 2009). In general, groundwater flow in the basin fill deposits is from the margins toward the central areas in a direction parallel to the surface drainage patterns. Regional groundwater flow in the west SRV is greatly influenced by groundwater pumping and localized sources of recharge (Brown and Poole 1989, ADWR 2009). The three regional aquifers are generally present at to the following depths near the EGA Site:

- UAU: from 0 to 220 feet bgs
- MAU: from 220 to 500 feet bgs
- LAU: from 500 to 1,000 feet bgs

The aquifer boundaries vary significantly spatially and generally decrease in depth and thickness to the east and north and increase in thickness and/or depth toward the south and west (ADWR 2009). A generalized cross-section showing the UAU, MAU, and LAU in the West Salt River Valley is shown below.

Generalized Cross-Section (West to East) of the West Salt River Valley (ADWR 2009)



Regionally groundwater flow in the West Salt River Valley is to the west in both the UAU and MAU (ADWR 2009). However, more local flows are controlled by recharge, groundwater supply wells, and the geology (Arcadis 2019).

The A-Unit wells are installed within the UAU and the deeper B-Unit wells are either within the lower UAU or upper MAU (likely the upper MAU). The only aquifer affected by COCs greater than the AWQS at the EGA Site is the UAU (Section 2.5.5). The groundwater elevations in A-Unit are slightly lower on than the B-Unit (Arcadis 2020b). The higher heads in the B-Unit and the fine-grained layer present between the A- and the B-Unit, indicate the B-Unit is a confined aquifer and hydraulically separated from the A-Unit. This further suggests the B-Unit could be installed within the upper portion of the MAU.

Inflow to the UAU in the vicinity of the EGA Site is primarily infiltration from the SRP Grand Canal to the north and from upgradient UAU groundwater north and east of the EGA Site. There is minimal recharge from irrigation, landscaping, or precipitation. However, recharge from the SRP Grand Canal appears to be significant and affects local groundwater flow. Historical groundwater potentiometric surface maps show groundwater flow in the upper UAU is away from the SRP Grand Canal. Outflow from the UAU beneath the EGA Site is from groundwater production by local water users and groundwater flow (underflow) downgradient of the EGA Site west and southwest of the EGA Site. Hydraulic conductivity in the UAU varies greatly within the West Salt River Valley but is expected to be between 21 and 75 feet per day near the EGA Site (ADWR 2009).

The MAU inflow near the EGA Site is primarily underflow from upgradient aquifers. The MAU is likely recharged from the overlying UAU, by mountain front recharge (Phoenix Mountains), and by incidental recharge near the mountains (primarily irrigated lands, lakes, and canals). Outflow from the MAU near the EGA Site is similar to the A-Unit and primarily discharges to water supply wells and to downgradient aquifers (underflow). Hydraulic conductivity in the MAU also varies and is expected to be between 11 and 50 feet per day near the EGA Site (ADWR 2009). Most of the water supply wells are installed within the MAU near the EGA Site.

The A-Unit wells are installed within the UAU and the deeper B-Unit wells are either within the lower UAU or upper MAU (likely the upper MAU). The only aquifer affected by COCs greater than the AWQS at the EGA Site is the UAU (Section 2.5.5). The groundwater elevations in A-Unit are slightly lower on than the B-Unit (Arcadis 2020b). The higher heads in the B-Unit and the fine-grained layer present between the A- and the B-Unit, indicate the B-Unit is a confined aquifer and hydraulically separated from the A-Unit. This further suggests the B-Unit could be installed within the upper portion of the MAU. No monitoring wells at the EGA site are installed within the LAU. However, the Danone water supply wells (Section 2.6.2) are installed partially in the MAU and the underlying LAU.

2.5.3 EGA Site Groundwater Elevations and Flow Direction

Groundwater flow directions were historically to the southwest as indicated by the current and historical plume orientation. However, over the past two decades groundwater elevations have decreased and the groundwater flow directions have shifted more to the west. During this time groundwater elevations decreased between 15 to 30 feet depending on the location (Appendix A). As of January 2020, the groundwater at the EGA Site is approximately 150 feet bgs and the groundwater elevations decreased below the screen of many of the monitoring wells (Arcadis 2020a, 2020b). The declining groundwater elevations are primarily attributed to sequential lining of the SRP Grand Canal[1], regional groundwater pumping, and local groundwater pumping.

Groundwater flow direction in the A-Unit, which has fluctuated since monitoring began at the EGA Site, appears to be controlled by regional flows (pumping), the canal recharge, and nearby shallow groundwater pumping. Historically groundwater has flowed away from the SRP Grand Canal except in the vicinity of SRP well 10.5E-7.5N located west of the former Univar Solutions facility. When SRP well 10.5E-7.5N was pumping extensively, groundwater flow was to the west to northwest near monitoring well WCP-87; when SRP well 10.5E-7.5N was not pumping, groundwater flow was generally to the west/southwest. As discussed in Section 2.5.9.4, SRP well 10.5E-7.5N was shut off under an agreement with ADEQ from April 1999 until 2009 when the agreement expired (Weston 2006; Arcadis 2019). From 2009 until 2011, groundwater flow was generally to the southwest; in 2011 the groundwater flow direction began to shift to the west (GCA 2012).

Local groundwater A-Unit flow was also affected by the Former Fedmart remedial actions from 2010 to 2016 in the vicinity of monitoring wells WCP-44 and WCP-88. The influence of SRP well 11.2E-7.7N (located east north-east and upgradient from the EGA Site) is expected to have only small influences on groundwater plume flow due to the pumping depth, the canal recharge, and location upgradient from EGA Site. The groundwater flow and elevations also have been influenced by the partial to full lining of segments of the SRP Grand Canal which would have reduced recharge along the SRP Grand Canal.

[1] The Grand Canal was historically only partially lined and most of the segments near the EGA Site were incrementally lined during the last two decades. Although the liners vary spatially between full concrete/shotcrete liners to one-sided liners (e.g. bottom or sides only liners). The effects of the lining appear to have reduced recharge to the UAU contributing to the decrease in groundwater elevations at the EGA Site.

Additional discussion of the nearby water supply wells and canal are described in a letter from Arcadis to ADEQ (Arcadis 2019).

The groundwater elevations in the A-Unit are more complex as alluded to above. In 2018, WCP WQARF Site (including EGA) groundwater elevations indicated overall groundwater flow near the EGA Site was westerly and then southwesterly. However, closer inspection of groundwater elevations near the EGA Site show that flow converges toward a 'channel' along Osborn Road where the water flows west (Figure 5 and 6). North of this "channel" groundwater flows to the south away from the Grand Canal and North Canal Plume; east of the 'channel' groundwater flows westerly, and south of the 'channel' groundwater flows northwesterly. The cause of the channeling is attributed to recharge from the Grand Canal, groundwater pumping, and preferential flow. Only three B-Unit wells are present at the EGA-Site. Overall groundwater flow for the respective units in 2019/2020 was:

- A-Unit: to the west at an approximate gradient of 0.005 feet per foot (ft/ft); however, gradients and direct vary spatially (Figure 5 and 6).
- B-Unit: to the south at an approximate gradient of 0.003 ft/ft

An upward gradient is present between the A- and the B-Unit, indicating the dissolved phase COCs would generally not migrate into the B-Unit at the EGA Site (Arcadis 2019, 2020b).

2.5.4 Historical Distribution of Constituents of Concern in the Source Areas

As discussed in Section 2.4, there are two confirmed sources and at least two potential sources of COCs to the EGA Site. The historical distribution of COCs in each of the source areas is discussed below.

2.5.4.1 Former Univar Solutions Facility

The 1993 CERCLA PA and SI results showed that VOCs, semi-volatile organic compounds (SVOCs), including polycyclic aromatic hydrocarbons (PAHs), phthalates, metals, and pesticides, were detected in the soil at the former Univar Solutions facility. Only certain PAHs were detected at concentrations above the historical, 1993 Health Based Guidance Levels (HBGLs), and these exceedances were limited to surficial soils (6 to 12 inches bgs). 1,1,1-trichloroethane (1,1,1-TCA), TCE, and PCE were detected in about half of the subsurface soil samples, but at concentrations below 1993 HBGLs and current SRLs and Minimum GPLs (Arcadis 2018c). 1,1,1-TCA, TCE, PCE, 1,1-DCE, ethylbenzene, and toluene were detected in soil-gas samples. Concentrations of TCE, PCE, and 1,1-DCE were elevated in soil-gas samples collected beneath the former aboveground storage tank, storage drum, and potentially stained soil areas noted in the historical aerial photographs.

Results of the 1994 soil-gas survey revealed that concentrations of TCE, PCE, and 1,1-DCE were elevated in almost all soil-gas samples collected near the central portion of the former Univar Solutions facility (HLA 1995), particularly beneath and south/southwest of the former building foundation and approximately 120 feet northwest of the former building foundation (See Figures 1-4, 1-5, and 1-6 of the Final RI Report [Weston 2006]).

Results of the 1994 subsurface soil investigation and risk assessment showed that only 1,1,1-TCA, TCE, PCE, and Freon 11 were present at concentrations above the method detection limit in soil at the former Univar Solutions facility, and that none of the detected soil concentrations exceeded the Minimum GPLs or the residential or non-residential SRLs. The risk assessment concluded that the residual COCs in soil did not pose a human health risk and would not impact groundwater above the AWQS (HLA 1995; Weston 2006).

The subsequent RI confirmed the presence of TCE and PCE in subsurface soils in the areas of elevated soil-gas VOC concentrations at the former Univar Solutions facility; however, soil concentrations did not exceed the Minimum GPLs or residential and non-residential SRLs. Two zones of elevated TCE and PCE concentrations were identified in the vadose zone at the EGA Site, both occurring at lithological transitions from coarse- to fine-grained materials. One zone occurred at approximately 56 to 71 feet bgs, and the other zone occurred at the unsaturated zone directly above the water table. Both zones represent a transition from coarse- to fine-grained, lower permeability sediments, or lateral migration across the fine-grained sediments as well as increased diffusion of the VOCs into the fine-grained sediments (Weston 2006).

TCE, PCE, and 1,1-DCE concentrations in all soil samples were less than the Minimum GPLs and residential and non-residential SRLs. Therefore, no further investigations or soil remediation was necessary (Weston 2006; ADEQ 2006). Additional information and data on the soils is presented in the RI Report, Univar Solutions request for a soils no further action (Arcadis 2018a, Arcadis 2018b), and the Well Installation and Sampling Report (Arcadis 2020b). Univar Solutions also implemented an ERA in 2004 at its former facility using SVE and carbon treatment of the extracted vapor to remediate soil and reduce COC mass flux from the vadose zone to groundwater. Subsequent investigations in 2019, confirmed soils concentrations in the vadose zone were less than the Minimum GPLs and SRLs (Arcadis 2020b). Thus, the former Univar Solutions facility is not a continuing source of COCs to groundwater.

Historical concentrations of VOCs in groundwater were evaluated using Hydropunch® samples collected during drilling of soil borings and groundwater samples collected from installed monitoring wells at the former Univar Solutions facility and surrounding areas. The highest concentrations of TCE, PCE, and 1,1-DCE measured in Hydropunch® samples were observed in borings installed beneath and southwest of the former building foundation at the former Univar Solutions facility (Weston 2006), consistent with the soil-gas and soil results.

Historically, concentrations of TCE, PCE, and 1,1-DCE in groundwater have been above the AWQS at and near the former Univar Solutions facility in samples collected from groundwater monitoring wells WCP-16, WCP-17, WCP-28, WCP-29, WCP-30, WCP-86, WCP-87, WCP-88, WCP-93, WCP-200, and WCP-201 (see Figures 7-17 through 7-52 of the Final RI Report [Weston 2006]; GCA 2003; 2004a; 2004b; 2004c; 2006a; 2006b; 2008; 2009a; 2010; 2011; 2012; 2013; and 2014; and Arcadis 2014b, 2015b, 2016b, 2017b, 2018d, 2019, 2020a). Concentrations of COCs in groundwater at the former Univar Solutions facility have declined significantly over time (Section 2.5) as a result of soil-gas remediation (Section 2.5.6) and natural attenuation (Section 2.5.7).

Due to the water table dropping, multiple groundwater monitoring wells at the Former Univar Solutions facility and the EGA Site have gone dry in recent years (Section 2.5). Therefore, five additional monitoring wells were installed at and downgradient from the former Univar Solutions facility in 2019 (Arcadis 2020b). The concentrations of COCs in groundwater from the monitoring wells installed on the former Univar Solutions facility (EGA-05A and EGA-05B) were less than their respective AWQS. Therefore, the former Univar Solutions facility is not an ongoing source of COCs to groundwater based on soil-gas, soil, and groundwater results.

2.5.4.2 Former Mogul Facility

Initial investigations at the former Mogul facility were conducted as part of the WCP WQARF area investigation, but subsequent investigations were separate from investigations at the EGA Site. ADEQ conducted a PA in 1990, several property owners conducted soil and groundwater sampling between 1990 and 1992, and the USEPA conducted a CERCLA SI in 1992. The results of the SI indicated a release of metals and VOCs had occurred at the former Mogul facility (ADEQ 1993a).

The monitoring wells located at the former Mogul facility were added to the EGA Site groundwater monitoring well network during Round 8 of the RI. TCE, PCE, 1,1-DCE, dibromochloromethane, 1,2-DCA, benzene, and chromium were detected in groundwater collected from monitoring wells installed at the former Mogul facility (Weston 2006). Historical TCE concentrations exceeded the AWQS; however, historical PCE and 1,1-DCE concentrations were less than the AWQS (Weston 2006). No active remediation of soil or groundwater or source control was conducted at the former Mogul facility.

ADEQ submitted a letter to the owner of the former Mogul facility dated December 27, 1999 stating that ADEQ was not considering the facility for additional investigation. Additionally, the last groundwater sample collected in 2003 from monitoring well WCP-92, which was downgradient of the former Mogul facility at that time, had COC concentrations less than the AWQS. Therefore, this facility is not considered a continuing source of COCs to the EGA Site.

2.5.4.3 Former Granberry Supply Facility

The former Granberry Supply facility was identified as a potential source of COCs to the EGA Site (Univar Solutions 2012). No site investigations have been conducted at this location, and the potential source area has not been confirmed. However, the lateral extent of COCs in groundwater has been adequately defined.

In 2017, ADEQ conducted a soil-gas investigation near the former Granberry Supply facility (ADEQ 2018). COC soil-gas concentrations were either below the laboratory reporting limit or were low adjacent to the former Granberry Supply facility. Detected soil-gas concentrations converted to soil concentrations were less than the Minimum GPL and non-residential SRL (ADEQ 2018). Therefore, this facility is not considered a continuing source of COCs to the EGA Site.

2.5.4.4 Unidentified Sources

COCs have been detected historically in groundwater monitoring wells located upgradient of the former Univar Solutions and former Granberry facility. Groundwater samples collected from monitoring wells WCP-41, WCP-83, and WCP-85 contained up to 11 micrograms per liter (µg/L) TCE, up to 20 µg/L TCE, and up to 8 µg/L TCE, respectively. PCE and 1,1-DCE were also detected in these monitoring wells, but at concentrations below the AWQS further indicating a different source of COCs. Groundwater samples collected from monitoring wells WCP-43, WCP-84, and WCP-99 also had detections of COCs, but at lower concentrations (Weston 2006). Based on these results, Weston (2006) suspected that there was an additional upgradient source of COCs; however, the lateral extent of COCs in groundwater has been adequately defined.

In 2017 and 2018, ADEQ conducted investigations to identify potential upgradient and cross-gradient sources of COCs. The results of the investigation are summarized in the 2018 Final Remedial Investigation Report Addendum memorandum (ADEQ 2018). The investigation identified areas of elevated of COCs in soil gas. Soil-gas TCE concentrations varied from less than 10 micrograms per cubic meter (µg/m^3) to 45,000 µg/m^3 at parcel 108-04-014. The locations are shown on Figure 3 as Area 1 and Area 2. Area 2 (near parcel 108-04-014) was investigated further by drilling and installing a soil boring and monitoring well EGA-02 near one of the suspected sources areas. The investigation identified elevated COCs in soils down to groundwater and in groundwater adjacent (cross- to upgradient) from known source areas. The COC concentrations in soil-gas (after they were converted to total soil concentrations) were less than their respective non-residential SRLs and Minimum GPLs and the COC concentrations in groundwater were less than their respective AWQSs. The ADEQ concluded “the soil gas and groundwater data collected from the investigation did not identify any additional sources that have impacted groundwater above the AWQS east and southeast (up-gradient) of the former Univar facility” (ADEQ 2018). Therefore, these unidentified source areas are not considered a continuing source of COCs to groundwater at the EGA Site.

2.5.5 Delineation of Constituents of Concern in Groundwater

Concentrations of TCE, PCE, and 1,1-DCE have been above the AWQS in groundwater monitoring wells at the EGA Site over the course of the RI and subsequent periodic sampling events (Arcadis 2020a). The following sections describe the historical delineation of the COCs in groundwater, the changes in concentration over time, and the current concentrations.

2.5.5.1 Historical Horizontal Delineation

Historically, TCE, PCE, and 1,1-DCE concentrations have been detected above the AWQS in A-Unit monitoring wells: EGA-01, EGA-04A, ENT-MW-2, MGL-01, MGL-02, MGL-03, MWB-005, WCP-15, WCP-16, WCP-17, WCP-28, WCP-29, WCP-30, WCP-41, WCP-44, WCP-45, WCP-83, WCP-85, WCP-86, WCP-87, WCP-88, WCP-93, WCP-94, WCP-100, WCP-200, and WCP-201 (see Figures 7-17 through 7-52 of the Final RI Report [Weston 2006]; Arcadis 2020a). While TCE, PCE, and 1,1-DCE concentrations were generally more elevated at the former Univar Solutions facility, the distribution of the COCs (and relative ratios of TCE, PCE, and 1,1-DCE) suggest there were multiple source areas.

TCE was detected above the AWQS upgradient of the former Univar Solutions facility at monitoring wells WCP-41, WCP-83, and WCP-85. TCE also was detected above the AWQS at the former Mogul facility. COCs were detected as far south as EGA-02, but, those COCs are attributed to a different source and were less than the AWQS from 2017 through 2020. Historical data indicate that TCE in groundwater extended from upgradient monitoring well WCP-99 to downgradient monitoring well WCP-94. Concentrations of TCE were above the AWQS upgradient and downgradient of the former Univar Solutions facility as well as at the former Mogul facility, reflecting multiple sources of TCE to the EGA Site, including the former Univar Solutions facility, the former Mogul facility, and the unidentified upgradient source (see Section 2.4; Weston 2006) and possibly south to EGA-02 where concentrations, as of 2017, were less than the AWQS.

PCE in groundwater extended from upgradient monitoring well WCP-99 to downgradient monitoring well WCP-96. 1,1-DCE in groundwater extended from upgradient monitoring well WCP-84 to downgradient monitoring well EGA-1. PCE and 1,1-DCE concentrations in groundwater were only above the AWQS at and in the immediate vicinity of the former Univar Solutions facility.

Historical delineation of the Site COCs was completed and the data indicated that COCs from the EGA Site were separate from and had not migrated to the nearby downgradient West Grand Avenue and West Osborn Complex WQARF sites.

2.5.5.2 Historical Vertical Delineation

Historically, one deep monitoring well was present at the EGA site. The deepest, historical monitoring well sampled at the EGA Site is monitoring well WCP-48, which is screened from 225 to 245 feet bgs. All COCs concentrations were less than the AWQS in WCP-48; however, concentrations of 1,1-DCE were detected when it was sampled from 2000 to 2003. 1,1-DCE was detected in groundwater samples collected from monitoring well WCP-48 at concentrations between 0.5 µg/L and 0.8 µg/L. The absence of COC concentrations exceeding the AWQS in deep monitoring well WCP-48 and the lack of downward vertical gradients suggests that impacts greater than AWQS were limited to the shallow portion of the aquifer (Arcadis 2014c).

Hydropunch® samples were collected from two soil borings (SB-16 and SB-17) at approximately 122 feet bgs, 142 feet bgs, and 182 feet bgs. Concentrations of VOCs were not detected above the method detection limit at 182 feet bgs in these borings. VOCs were present at concentrations greater than the AWQS in Hydropunch® samples collected at approximately 153 feet bgs prior to the installation of monitoring wells WCP-87, WCP-100, and WCP-200. Based on these data, Weston (2006) suggested that the vertical extent of COCs in groundwater was between 153 feet bgs and 235 feet bgs.

Vertical groundwater samples were subsequently collected from EGA-02 in 2017 and EGA-03, EGA04A/B, and EGA-05A/B in 2019 during drilling (ADEQ 2018, Arcadis 2020b). The results indicated the following:

- EGA-02:
  - only TCE was detected, but all concentrations were less than the AWQS
  - TCE was detected from 160 to 200 feet bgs
- EGA-03:
  - All COC results were less than the AWQS and laboratory reporting limits
- EGA-04A/B:
  - TCE and PCE were detected but all concentrations were less than the AWQS
  - TCE was the only COC detected deeper than 165 feet bgs
  - TCE was detected at 165 feet and from 220 to 240 feet bgs and was highest between 220 and 240 feet bgs
- EGA-05A/B:
  - TCE, PCE, and 1,1-DCE were detected at concentrations greater than the AWQS at 161 feet bgs near and below the water table

- o All results were less than the AWQS below the 161 feet bgs sample
- o No COCs were detected between 201 to 211 feet bgs and again from 241 to 261 feet bgs

In 2019, three A-Unit and two B-Unit monitoring wells were installed. The A-Unit wells were installed between approximately 140 feet and 195 feet bgs. The B-Unit wells were installed between approximately 215 feet and 255 feet bgs. COC concentrations in groundwater from both new B-Unit monitoring wells and WCP-48 (also in the B-Unit) were less than their respective AWQSs (Arcadis 2020b).

Additionally, COC concentrations in samples collected from water supply wells installed in deeper hydrologic units in the vicinity of the EGA Site are less than AWQSs (see Section 2.5.7; Arcadis 2019). This indicates that the deeper aquifers (the MAU and LAU) have not been affected by COCs emanating from the EGA Site over the last thirty years or more even when COC concentrations were higher and the plume extent was greatest.

2.5.5.3 Current Groundwater Concentrations

The areal extent of COCs in groundwater at the EGA Site is well-characterized and shrinking in size. The current extent of COCs above AWQSs is approximately 60 percent smaller than the historical extent, and the COC-affected groundwater at the EGA Site is separate from the four other WQARF sites within the WCP area. COC concentrations in the majority of monitoring wells at the EGA Site have decreased to below the AWQS over the course of the monitoring history, and concentrations that remain above the AWQS show either stable or decreasing trends (Section 2.5.7). Peak A-Unit TCE and PCE concentrations in groundwater have decreased from 1,100 µg/L and 920 µg/L to 22.6 µg/L and 38.5 µg/L, respectively. The reductions are primarily attributed to remedial actions and continuing natural attenuation (see Sections 2.5.6 and 2.5.7).

During recent years, a number of monitoring wells have gone dry (Arcadis 2017b). Therefore, five new monitoring wells were installed in 2019 (Arcadis 2020b). The current COC plume configuration is shown on Figure 7. Only groundwater concentrations in monitoring well EGA-05A exceeds the AWQSs for TCE, PCE and 1,1-DCE of 5 µg/L, 5 µg/L, and 7 µg/L respectively. The maximum COC concentrations detected at EGA-05A between 2019 and 2020 was:

- TCE = 38.5 µg/L
- PCE = 22.6 µg/L
- 1,1-DCE = 20.1 µg/L.

Dissolved-phase COC concentrations in remaining wells are less than the AWQS, below laboratory detection limit of 1 µg/L. The current plume is estimated to be 1,200 feet long, 600 feet wide, and approximately 13 acres in size, based on current and historical groundwater monitoring data. Comparatively, the historical plume was estimated to be over 100 acres in size (inclusive of all sources areas).

2.5.6 Early Response Action and Source Remediation

Univar Solutions initiated an ERA in 2004 at its former facility using SVE and carbon treatment of the extracted vapor to remediate soil and reduce COC mass flux from the vadose zone to groundwater. The objectives were to achieve source control and removal of mass from soil (VWR 2001). Installation of the SVE system began in 2003, the SVE system was tested during start-up in January 2004, and the system became fully operational in February 2004. The original SVE system consisted of four SVE wells with three screened intervals. In 2008 and 2009 the system was expanded to include extraction of vapor from the deeper unsaturated screen intervals of groundwater monitoring wells WCP-16 and WCP-17. The specific wells and screened intervals that were used for extraction were varied over time to enhance the removal of VOCs spatially (laterally and vertically). As groundwater elevations declined, thus exposing additional vadose zone soil, extraction was focused on the deeper intervals, utilizing WCP-16, and WCP-17 (GCA 2014).

The system was originally operated under Maricopa County Air Quality Control Permit Number 020174, but in June 2012 Maricopa County determined that the permit was no longer required because air emissions were below the permitted threshold levels. In 2013, ADEQ requested that Univar Solutions discontinue operation of the SVE system since VOC removal averaged less than or equal to one pound of total VOCs per month (ADEQ 2013). The SVE system was shut down on February 12, 2013. The system was restarted to conduct a rebound test on June 12, 2013. Because there was no appreciable increase in VOC recovery after the shutdown phase, the SVE system was shut down again on September 12, 2013 and has remained off-line. A total of approximately 2,000 pounds of VOCs were removed by the SVE system from January 2004 to September 2013 (GCA 2014). Current COC concentrations in soils, groundwater, and historical SVE operational data indicate that soil and vapor-phase COCs at the former Univar Solutions facility source area have been remediated (Arcadis 2018c). The soil-gas sampling conducted in 2019 indicated that soil concentrations at the former Univar Solutions facility are less than Minimum GPLs and SRLs, confirming that the soils are not a continuing source of COCs and no further action is necessary for soils at the former Univar Solutions facility (Arcadis 2018b, 2020b).

2.5.7 Natural Attenuation

To evaluate attenuation of TCE, PCE, and 1,1-DCE in Site groundwater, linear regression trend tests were conducted using historical groundwater monitoring data to assess dissolved-phase concentration trends over time at individual monitoring locations. The analysis was conducted following USEPA guidance (2002, 2009), and results are provided Appendix B and summarized below. Groundwater data collected from March 2003 through September 2016, presented as Table 6 of the 2016 Annual Groundwater Monitoring Report (Arcadis 2016b), were used in the analysis. Concentration trends were evaluated at monitoring locations that met the following criteria:

- Sufficient data were available (six or more data points)
- Less than 50 percent of the results at a select location were below reporting limits
- TCE, PCE, or 1,1-DCE concentration was above the screening level for at least one monitoring event since 2003.

Based on the above criteria, linear regression trend analyses were performed for TCE, PCE, and/or 1,1-DCE at nine monitoring wells (EGA-1, WCP-44, WCP-83, WCP-86, WCP-87, WCP-88, WCP-93, WCP-200 and WCP-201). Some of the wells went dry in recent years (see Section 2.5); therefore, the most recent historical results were used for the initial concentration to estimate the time to reach the AWQS. The time period evaluated for each well is summarized in Appendix B.

The analyses were conducted using natural log normalized concentration data to evaluate trend direction and to estimate attenuation rates and time to meet screening levels (USEPA 2002). The p-value of the correlation provides a measure of the significance of the slope, or the correlation between the x (time) and y (concentration) variables. Correlations were accepted as significant at the 90 percent confidence level, indicated by a p-value of 0.1 or less. The trend direction was defined as decreasing if the slope of the trend line was negative and increasing if the slope of the trend line was positive. The coefficient of determination, the R2 value, is a measure of how well the linear regression fits the data set; values close to one are considered a good fit, while values close to zero are considered a poor fit or a zero slope (trend). Regressions with non-significant trends and R2 values less than 0.1 were considered to have no apparent trend (no trend).

Results of the linear regression trend analysis indicate stable or statistically-significant decreasing concentration trends for all monitoring well/constituent pairs evaluated, supporting an overall stable or shrinking plume condition. The linear regressions indicate that dissolved-phase COCs in groundwater are expected to naturally attenuate to the respective AWQS in the next 0 to 12 years (2030) depending on the chemical, based on evaluation of data from the monitoring well with the highest, recent COC concentrations (WCP-200). However, monitoring well WCP-200 COC concentrations were below the AWQS prior to the well going dry. Sampling and analyses of groundwater from a monitoring well installed near monitoring well WCP-200 (EGA-04A), indicated that dissolved-phase COC concentrations in this area of the aquifer were below their respective AWQS's in 2019 and 2020 (Arcadis 2020b). Insufficient data was available to conduct a trend analysis for monitoring well EGA-04A (the only well currently greater than the AWQS).

In addition, the groundwater geochemical data described in the Semiannual Groundwater Monitoring Report, First and Second Quarters 2003 (GCA 2003) indicated higher concentrations of alkalinity, chloride and manganese within the plume, and lower concentrations at monitoring locations upgradient and cross-gradient to the plume; lower concentrations of nitrate and sulfate were also observed within the plume compared to upgradient and cross-gradient locations. These results are consistent with the occurrence of active anaerobic biodegradation processes and reducing conditions in the area of impact, including manganese reduction (resulting in higher concentration of soluble manganese in the plume), nitrate reduction (lower concentration of nitrate), sulfate reduction (lower concentration of sulfate), and reductive dechlorination (higher concentration of chloride).

2.5.8 Estimated Time to Reach the AWQS

Two methods were used to estimate the time for groundwater to reach the AWQS:

- Individual monitoring well linear regressions
- Plume pore-flushing calculations

The linear regressions are described in Section 2.5.7 and indicate the dissolved-phase COC concentrations in individual monitoring wells either currently meet the AWQS or will naturally attenuate to the AWQS by 2030 or sooner. However, numerous groundwater monitoring wells have gone dry and/or the results indicated the groundwater quality was already less than the AWQS. Thus, the linear regressions may overestimate the length of time for dissolved-phase COCs to naturally attenuate to the respective AWQSs.

Pore-flushing calculations were used to estimate the overall length of time for TCE, PCE, and 1,1-DCE plume(s) to attenuate to the AWQS under natural groundwater gradients and flushing rates as well as under enhanced groundwater gradients and flushing rates due to pumping groundwater from theoretical extraction wells. The pore-flushing calculations estimate the number of pore volume flushes that are necessary to “flush out” the COCs with clean, upgradient groundwater and subsequently the time it would take for this to occur. The pore flushing calculations do not account for degradation or volatilization and thus are more conservative. The pore-flushing calculations, including the inputs, assumptions, and equations, are provided in Appendix C.

The pore-flushing calculations uses the average 2019 to 2020 concentration for each COC from the monitoring well with the highest COC concentrations (EGA-05A) and conservatively assumes no degradation or volatilization is occurring. Two scenarios were evaluated 1) natural conditions (i.e., no groundwater pumping remediation) and 2) groundwater pumping (i.e., higher hydraulic gradient). Scenario #1 uses the most conservative hydraulic gradient (0.005) from the RI Report (Weston 2006, Arcadis 2020b). Scenario #2 assumes the current hydraulic gradient is increased by 50% on average due to groundwater extraction (0.008). Based on the pore-flushing calculations the expected lengths of time for dissolved-phase COCs in groundwater to attenuate to the respective AWQSs are:

- TCE: 12 years (Scenario #2) to 17 years (Scenario #1)
- PCE: 8 years (Scenario #2) to 12 years (Scenario #1)
- 1,1-DCE: 5 years (Scenario #2) to 7 years (Scenario #1)

2.5.9 Groundwater Users and Potential Receptors

There are four foreseeable, potential groundwater receptors (users) in the vicinity of the EGA Site: the COP, the Michigan Trailer Park (MTP), Danone, and SRP. This conclusion is based on the ADEQ-approved land and water use study (Weston 2006); the subsequent installation and commencement of operation of a second Danone well (ADWR 2014); consultations between Arcadis and the potential receptors (Appendix D); and the groundwater monitoring data, conceptual site model, and additional information described in Section 2.5 of this report.

2.5.9.1 City of Phoenix

The COP owns and operates groundwater wells within the WCP area; however, the COP does not operate any wells within a one-mile radius of the EGA Site (Weston 2006; Appendix D). Arcadis provided the FS Work Plan (GCA 2009b) and the RRARP (Arcadis 2014a) to the COP and provided an opportunity for consultation. In response to the FS Work Plan, the COP submitted a comment letter to Univar Solutions dated April 27, 2015 recommending “that the remedial selection strategy take into consideration a remedial objective of protecting the long-term water quality of the aquifer as a future drinking water resource” (COP 2015a; Appendix D). In response to the RRARP, the COP submitted a letter to Univar Solutions dated July 17, 2015 that stated, “future wells may be constructed to pump groundwater resources to mitigate against drought”. The July 17, 2015 letter further stated, “To ensure projection of this drinking water resource, the COP request the following RO: To protect future water supply should the COP need water that has been lost due to contamination of the deep aquifer with TCE, PCE, and/or 1,1-DCE contamination emanating from the WCP EGA site” (COP 2015b; Appendix D).

2.5.9.2 Michigan Trailer Park

The MTP has a drinking water well located west-northwest of the EGA Site that supplies water to the trailer park's residents. The MTP well was previously located cross-gradient to the EGA Site, but with the shift in groundwater flow from southwest to west, the MTP is now downgradient (Figures 5 and 6). The screened interval for the MTP well is unknown, but the total well depth is 400 feet bgs. This places the MTP well screen in the MAU, and it may extend upward into the lower portion of the UAU. Arcadis, on behalf of Univar Solutions and ADEQ, collected a groundwater sample from the MTP well in March 2014, and the sample was submitted to a laboratory and analyzed for VOCs according to USEPA Method 8260B. Concentrations of COCs in the groundwater sample collected from the MTP well were less than the laboratory reporting limits of 0.5 µg/L (Arcadis 2014d). COC concentrations in MTP's water supply well have historically been below the laboratory reporting limit of 0.5 µg/L and their respective AWQS's from 1994 to 2017 (Arcadis 2019). Arcadis provided the FS Work Plan (GCA 2009b) and the RRARP (Arcadis 2014a) to MTP and provided the opportunity for a consultation, but MTP did not respond.

2.5.9.3 DS Services of America, Inc. (formerly known as Danone Waters of North America)

Danone, a water processing, bottling, and distribution plant that was formerly known as Danone Waters of North America, is now operated by Sparkletts, a division of DS Services of America, Inc. The name Danone is used in this FS Report to ensure consistency with the RI (Weston 2006) and Remedial Objectives Report (ADEQ 2006). Danone has two deep water supply wells (screened in the LAU from 850 to 975 feet bgs) southwest of the EGA Site (ADWR 2014) that supply water for drinking water processing and bottling. These wells were previously downgradient of the EGA Site; however, with the shift in groundwater flow direction, the Danone wells are now cross-gradient (Figures 5 and 6). According to the Land and Water Use Report, Danone samples the groundwater from their wells frequently, and COCs have never been detected (Weston 2006). Arcadis provided the FS Work Plan (GCA 2009b) and the RRARP (Arcadis 2014a) to Danone and provided the opportunity for a consultation, but Danone did not respond.

2.5.9.4 Salt River Project

The SRP owns nine water supply wells in the WCP area, two of which (10.5E-7.5N and 11.2E-7.7N) are within a one-mile radius of the EGA Site (Weston 2006). SRP well 10.5E-7.5N is screened from 210 to 685 bgs, is west-northwest of the EGA Site, and is currently downgradient to cross-gradient of the EGA Site (Figures 5 and 6). SRP well 11.2E-7.7N is screened from 200 to 485 feet bgs and is northeast (upgradient) of the EGA Site (Figures 5 and 6). Both SRP wells are screened in the MAU. Groundwater extracted from the SRP wells is discharged to the SRP Grand Canal, the only surface water body in the vicinity of the EGA Site. The Grand Canal is fed by surface water but uses groundwater supply wells to maintain flows along its reach. The current uses of the Grand Canal are for irrigation (agricultural, landscaping, etc.) purposes (Appendix D).

SRP water supply well pumping has varied significantly over time (ranging from 0 acre-feet per year to a little over 1,000 acre-feet per year (Arcadis 2019). Pumping from the SRP well 10.5E-7.5N was suspended in April 1999 under an agreement with ADEQ (Weston 2006) and resumed in in 2010 after the agreement expired (Arcadis 2019). Subsequently in 2018, the pump was removed from SRP well 10.5E-7.5N (Arcadis 2019). SRP well 11.2E-7.7N, appears to still be in use (Arcadis 2019).

Based on data provided by SRP, concentrations of TCE and PCE were less than the reporting limit of 0.5 µg/L in downgradient well 10.5E-7.5N between September 2009 and May 2011. 1,1-DCE was not analyzed in this well during this timeframe, and this well was not sampled after 2011 (SRP 2014; 2015a).

Concentrations of TCE in upgradient well 11.2E-7.7N have ranged from less than the reporting limit of 0.5 µg/L to 4.1 µg/L between December 2001 and February 2015. The most recent TCE concentration in well 11.2E-7.7N was 0.6 µg/L in February 2015 (SRP 2015a). The concentrations of TCE detected in this well are less than the AWQS for TCE of 5 µg/L. This well is located 2,400 feet upgradient of the former Univar Solutions facility. The presence of TCE in this well and in the upgradient monitoring wells WCP-41, WCP-83, and WCP-85, supports the existence of an additional upgradient source of TCE. Concentrations of PCE were less than the reporting limit of 0.5 µg/L in upgradient well 11.2E-7.7N between December 2001 and February 2015. Concentrations of 1,1-DCE were only measured between January 2013 and February 2015 in upgradient well 11.2E-7.7N. Concentrations of 1,1-DCE were less than the reporting limit of 0.5 µg/L between January 2013 and February 2015 (SRP 2014; 2015a).

Arcadis provided the FS Work Plan (GCA 2009b) and the RRARP (Arcadis 2014a) to SRP and provided the opportunity for a consultation. In response to the FS Work Plan, SRP submitted an email dated April 15, 2015 (SRP 2015b; Appendix D) requesting that the final FS Report provide assurances that the SRP groundwater supply will be protected, replaced, or an alternative supply provided. In response to the RRARP, SRP submitted an email dated May 12, 2015 (SRP 2015c; Appendix D), clarifying that while the water from their wells in the WCP area is currently used for irrigation, future water use may be for drinking water. SRP indicated that there are future plans to construct a drinking water treatment plant at the end of the SRP Grand Canal, and when this occurs water sources discharged to the SRP Grand Canal system must comply with more stringent water quality criteria. SRP requested that this potential future scenario be accounted for in the FS Report.

2.6 Human Health Risk Assessment

Exposure to the EGA Site COCs could potentially occur from either soils or groundwater.

2.6.1 Soil Pathway

COCs in soils from the known source areas, were assessed during the Final RI Report (Weston 2006, see Section 2.5.4), the RI Addendum (ADEQ 2018), Univar Solutions' request for no further action (Arcadis 2018b), and the Well Installation and Sampling Report (Arcadis 2020b). Historical COC concentrations in source area soils at the former Univar Solutions facility, were below residential and non-residential SRLs and Minimum GPLs (Weston 2006, Arcadis 2018b, Arcadis 2020b). COC concentrations below residential SRLs demonstrate that the soils do not pose an adverse human health or environmental risk. COC concentrations below Minimum GPLs demonstrate protectiveness against COCs leaching from soil to groundwater, based on achieving the drinking water standards in groundwater, and thus are not a threat to groundwater quality. In addition, a screening Human Health and Environmental Risk Assessment (RA) was performed in 1995 to evaluate the potential human health and environmental risks associated with COCs detected in soil beneath the former Univar Solutions facility. The RA utilized soil data from samples collected in December 1994 from varying depths in seven soil borings drilled in areas of observed elevated soil gas concentrations. The RA evaluated the following potentially complete exposure pathways: inhalation of vapors and particulates, incidental ingestion of soil, and dermal contact with soil. The potential impact to groundwater was also estimated using fate and transport modeling (HLA 1995). The RA concluded that COCs in the soils do not pose a human health risk or a risk to groundwater (HLA 1995). In addition, the SVE ERA removed COCs from soil beneath the former Univar Solutions facility, further reducing soil and soil-gas concentrations.

The former Mogul facility soil concentrations were either below laboratory reporting limits or less than the SRLs and Minimum GPLs (Section 2.5.4.2). Therefore, the soils do not pose an adverse risk and are not a threat to groundwater.

Two additional potential sources were identified in Section 2.5.4.3 and 2.5.4.4. The soil-gas concentrations at these potential source areas indicated the soils were below non-residential SRLs and Minimum GPLs. Therefore, the soils likely do pose an adverse risk to non-residential uses and are not a threat to groundwater.

Based on the results summarized above, soils are not a media of concern for the EGA Site.

2.6.2 Groundwater and Surface Water Pathway

2.6.2.1 Current Pathways

Five active groundwater supply wells are identified as current potential receptors for the purposes of the FS Report (see Section 2.5.9). The MTP well and the two Danone wells are currently used for drinking water, which presents a human exposure pathway from ingestion of the water. The SRP wells discharge to the partially lined SRP Grand Canal, and this water is currently used for irrigation, which poses a potential human exposure pathway from ingestion of agricultural products irrigated with canal water. Other possible exposure pathways include consumption of fish from the canal as well as partial and full body contact from workers or trespassers.

Concentrations of COCs in the MTP and SRP water supply wells are below AWQS and the USEPA MCL, and the Danone wells are installed in the unaffected LAU (see Section 2.5.9). Further concentrations in the MTP well and SRP water supply wells have been less than the AWQS for twenty years or more, even when the COC plume was larger and COC concentrations were higher (i.e., when threats these water supply wells were greater). Therefore, groundwater and surface water migrating from the EGA Site do not pose a current risk to human health or the environment. Further, any chemicals hypothetically entering the SRP Grand Canal from the SRP water supply wells would be mixed with canal water, reducing chemical concentrations further via dilution, and thus ensuring the chemical concentrations in the canal would not pose an adverse risk to human health or the environment.

2.6.2.2 Reasonably Foreseeable Pathways

It is anticipated that the MTP well and the Danone wells will continue to be used for drinking water in the future. SRP has stated that a drinking water treatment plant may be installed at the downstream end of the SRP Grand Canal (SRP 2015b). Additionally, as discussed in Section 2.5.9.1, the COP recommended “that the remedial selection strategy take into consideration a remedial objective of protecting the long-term water quality of the aquifer as a future drinking water resource" (COP 2015a; Appendix D), and further stated "future wells may be constructed to pump groundwater resources to mitigate against drought". The COP requested the following RO: "To protect future water supply should the COP need water that has been lost due to contamination of the deep aquifer with TCE, PCE, and/or 1,1-DCE contamination emanating from the WCP EGA site" (COP 2015b; Appendix D). The deep aquifers (MAU or LAU) have not been affected by COCs from the EGA Site (Section 2.5).

In order to assess potential, future risks to the foreseeable uses of groundwater conservative a screening level mass discharge calculation was performed for the most conservative exposure scenario (MTP). The MTP well is the shallowest well, pumps at the lowest rate (less in well mixing), and is located closest to the COC-affected groundwater. The calculations assess whether the current (maximum) observed concentrations of COCs in groundwater at the EGA Site could, in the foreseeable future, result in COCs discharging from the water supply well at concentrations greater than the USEPA MCL (current and/or theoretical, foreseeable use).

This was assessed by calculating the mass discharge of the primary COC (TCE, which had the highest concentration relative to the AWQS) following the Interstate Technology and Regulatory Council (ITRC) guidance (2010). Then a mixed, in-well concentration was calculated. For this evaluation it was assumed:

- the MTP well was screened across all COC-affected aquifers
- assumes 100 percent of the COC mass would migrate to the downgradient well regardless of the gradient and where the well was screened
- no chemical transport limitations and no attenuation other than in-well dilution.

The calculations and the assumptions are provided in Appendix E.

Based on this very conservative screening level calculation, the maximum TCE discharge concentration in water supply well MTP-1 would be approximately 1 µg/L. The observed groundwater concentrations in MTP-1 were less than 0.5 ug/L (Arcadis 2019). Thus, current or future use of water in the existing water supply wells (Danone wells, MTP-1, and SRP well 10.5E-7.5N and 11.2E-7.7N) will not be adversely affected by the observed conditions (i.e., estimated discharge concentrations are lower than the AWQS and USEPA MCL) now and in the foreseeable future, and therefore, will not pose a future risk to human health. Further, as stated in Section 2.5, the COC-affected groundwater footprint has been retracting, concentrations of COCs in groundwater are stable or decreasing, and the COCs are not and will not advectively migrate to the existing nearby water supply wells at concentrations above the AWQS.

If in the future the COP decides to install a deep well (MAU or LAU aquifers) near the EGA Site area before groundwater quality meets the AWQSs, an evaluation will be performed to determine if the proposed COP well is threatened by COCs from the EGA Site. Since, the deep aquifers (MAU or LAU) have not been affected by COCs from the EGA Site (Section 2.5.5), there is an upward gradient, and based on the screening calculations, it is improbable a hypothetical COP well in the future could be adversely affected. However, in the unlikely event the proposed, hypothetical well is threatened, a contingency measure will be implemented to protect the COP well as a drinking water resource. The contingency measures are discussed in more detail in Section 9.

3 REMEDIAL OBJECTIVES

The RO Report (ADEQ 2006) was based on the Land and Water Use Report (Weston 2006) and identified current and/or potential groundwater uses for each of the potential receptors of groundwater at the EGA Site, with the exception of the COP. They included the current and future use of groundwater for drinking water by the MTP well, the current and future use of groundwater for drinking water by Danone wells, and the current use of groundwater for irrigation by the SRP wells 10.5E-7.5N and 11.2E-7.7N (SRP wells). Based on these groundwater uses, ADEQ established the following ROs for the EGA Site:

To protect, replace, or otherwise provide alternative water supply should use of the MTP drinking water well be lost in the future due to changes in groundwater flow direction that would contaminate the well with TCE, PCE, and/or 1,1-DCE contamination emanating from the WCP EGA Site.

To protect, replace, or otherwise provide alternative water supply should use of the Danone Waters drinking water well[s] be lost in the future due to contamination of the deeper aquifer by the TCE, PCE, and/or 1,1-DCE contamination emanating from the WCP EGA Site.

To protect, replace, or otherwise provide alternative water supply should use of the SRP wells be lost in the future due to contamination of the wells with TCE, PCE, and/or 1,1-DCE contamination emanating from the WCP EGA Site.

In addition to the potential future groundwater uses identified in the RO Report (ADEQ 2006), recent consultations with the water providers indicated potential future use of groundwater for drinking water by SRP using existing wells and the potential future use of groundwater by the COP for drinking water (COP 2015a; 2015b; SRP 2015b; 2015c; Appendix D).

The feasibility of remedial strategies and measures discussed below is geared to the development of a remedial action plan that is generally consistent with the water management plans of the area water providers and achieves the ROs identified in the RO Report (ADEQ 2006).

4 SCREENING OF REMEDIAL STRATEGIES

This section discusses potential remedial strategies pursuant to A.A.C. R18-16-407(F); identifies the strategies that are capable of achieving the ROs for the EGA Site pursuant to A.A.C. R18-16-407(A) and (E); and specifies three strategies to be evaluated for the EGA Site. Since there are no current or future foreseeable threats to groundwater uses from existing water supply wells, as summarized in Section 2.6, any of the proposed remedial strategies, including no action, would be capable of meeting the ROs and are generally consistent with the water management plans of the area water providers.

If in the future the COP decides to install a deep well (MAU or LAU aquifers) in the EGA Site area before groundwater quality meets the AWQSs, an evaluation will be performed to determine if the proposed COP well is threatened by COCs from the EGA Site. The COCs are limited to the shallow, UAU aquifer. If the proposed well is threatened, a contingency measure will be implemented to protect the proposed COP well as a drinking water resource. The contingency measure(s) is discussed in more detail in Section 9.

The potential remedial strategies are as follows:

No Action Strategy – would not implement any affirmative remedial strategies and measures to address the COC-affected groundwater; and provides a baseline for comparison to other potential remedial strategies. Based on the natural attenuation of COCs and the groundwater risk assessment (Section 2.5.7 and 2.6.2, respectively), the ROs for the EGA Site presently are satisfied and could remain satisfied for the foreseeable future even if the no action strategy is followed. This is because the information in Sections 2.5 and 2.6 indicates: (i) the use of groundwater pumped from the MTP drinking water well is not threatened to be lost as a result of the COCs and such a threat would never develop even though the groundwater flow direction has changed; (ii) the use of groundwater pumped from the Danone drinking water wells is not threatened to be lost as a result of the COCs and such a threat would never develop even if the COCs migrated to the deeper aquifer; and (iii) the use of groundwater pumped from the SRP well is not threatened to be lost as a result of the COCs and such a threat would never develop. However, according to the ADEQ "The 'No Action Strategy' alone is not consistent with A.R.S. 49-282.06(A)(2). Specifically, it does not allow maximum beneficial use of groundwater if, for example, the City of Phoenix decides to install a [deep] water production well within the boundaries of the Site" (ADEQ 2018). Therefore, this strategy was not considered further.

Monitoring Strategy – would entail mid- to long-term groundwater monitoring of the ongoing natural attenuation process (through biological and chemical breakdown, adsorption, diffusion and dispersion) and anticipated limited advection of the COCs in the groundwater. This strategy could be used to determine: (i) whether there develops a threat of loss of the MTP drinking water well use as a result of COCs; (ii) whether there develops a threat of loss of the Danone drinking water wells uses as a result of COCs; and (iii) whether there develops a threat of loss of the SRP well designated uses as a result of COCs. If, based on the monitoring results, such a threat develops, implementation of a more aggressive remedial strategy and corresponding remedial measures could be implemented to safeguard or achieve the ROs.

Controlled Migration Strategy – would control or otherwise influence the direction or rate of advection or attenuation of COCs in the groundwater but not necessarily contain or eliminate all advection of COCs in the groundwater. This remedial strategy could be used to: (i) decrease the advection of COCs; (ii) further reduce COC concentrations in groundwater at the receptor locations through extraction of groundwater upgradient; or (iii) a combination of these controls. Such a strategy would be appropriate to safeguard or achieve the ROs, if monitoring results indicate the following: (i) a threat of losing the MTP drinking water well use as a result of COCs; (ii) a threat of losing the Danone drinking water wells uses as a result of COCs; or (iii) a threat of losing the SRP well designated uses as a result of COCs. Any one of these developments would trigger the requirement of the controlled migration strategy and corresponding remedial measures to safeguard or achieve the ROs for the EGA Site. However, a controlled migration strategy is not necessary to safeguard or achieve the ROs at this time as indicated in Section 2.6.2.

Source Control Strategy – would eliminate or mitigate a continuing source of dissolved-phase COCs in groundwater, if any. Based on the removal of chemicals from the former Univar Solutions facility and the soil investigation described in the Final RI Report (Weston 2006), the RI Addendum (ADEQ 2018), no COCs remain in the subsurface soils at the identified sources areas that could be considered a continuing source of COCs for purposes of remedial action. Additionally, Univar Solutions implemented an ERA using SVE which substantially reduced the concentrations of COCs in soil and reduced COC mass flux from the vadose zone to groundwater at the former Univar Solutions facility source area. The remaining COC concentrations and SVE operational data indicate the COCs in the source area at the former Univar

Solutions facility have been remediated. As discussed in Section 2.4 and 2.5.4, the former Mogul facility, the former Granberry Supply Facility, and two unidentified sources were identified. However, these source areas are not considered significant ongoing sources of COCs to groundwater. Therefore, a source control remedial strategy is not appropriate to safeguard or achieve the ROs at this time.

Physical Containment Strategy – would contain the COCs within definite boundaries of the aquifer by extraction and re-injection of groundwater or the installation and maintenance of barriers to groundwater flow. Given the EGA Site conditions, the ROs, and the diffuse nature of the dissolved-phase COCs in groundwater, a physical containment strategy is not necessary or cost-effective to safeguard or achieve the ROs.

Plume Remediation Strategy – would achieve the AWQS of 5 µg/L for TCE and PCE and 7 µg/L for 1,1-DCE in the groundwater throughout the EGA Site by in-situ treatment of dissolved-phase COCs using enhanced reductive dechlorination, aquifer flushing, chemical oxidation, and/or pump-and-treat. Given the EGA Site conditions (multiple source areas, hydrogeology, etc.), the ROs, and the diffuse nature of the COC plume, a plume remediation strategy is not necessary or cost-effective to safeguard or achieve the ROs.

Based on the foregoing, the remedial strategies of monitoring and controlled migration are evaluated in this FS Report.

5 SCREENING OF REMEDIAL MEASURES

This section discusses potential remedial measures pursuant to A.A.C. R18-16-407(G); identifies the measures that are necessary for each of the three strategies to achieve the ROs for the EGA Site pursuant to A.A.C. R18-16-407(A) and (E); and specifies the remedial measures to be evaluated. The identification of remedial measures occurred in consultation with the COP, Danone, MTP, and SRP (Arcadis 2014a, ADEQ 2015). The requests and responses are provided in Appendix D, if applicable.

Potential remedial measures may include, but are not limited to, well replacement, well modification, wellhead treatment, provisions of replacement water supplies, engineering controls, groundwater monitoring, and groundwater treatment. Well replacement and provisions of replacement water supplies would not be appropriate to safeguard or achieve the ROs for the Danone, MTP, and SRP wells. This is because: (a) these remedial measures would not be necessary for the monitoring and controlled migration strategies; (b) the Danone Wells, the MTP well, or SRP wells cannot be readily replaced or modified and would require the consent of the well owners; and (c) given the information described in Sections 2.5 and 2.6, well replacement or replacement of water supplies would not be reasonable, necessary, or cost-effective to protect against a loss or impairment of the designated uses for the Danone, MTP, and the SRP wells. However, the remedial measure of well head treatment will be retained as a contingency remedial measure (Section 9) in the unlikely event one of the water supply well's use(s) is threatened.

Well modification may be appropriate to protect the use of a potential future COP well as a drinking water source. If in the future the COP decides to install a deep well in the EGA Site area before groundwater quality meets the AWQSs, an evaluation will be performed to determine if the proposed COP well is threatened by COCs from the EGA Site. If the proposed well is threatened, a contingency measure will be implemented to protect the proposed COP well as a drinking water resource. The contingency measure will include a well siting study to determine an equivalent well location to be used as an alternative to installing a well in an area that may be threatened by COCs from the EGA Site. In addition, the ADWR would restrict the capacity of the new well to protect the capacity of existing wells. The contingency measure can be considered for the retained remedial strategies.

5.1 Remedial Measures for the Monitoring Strategy

Remedial measures that would enable the monitoring strategy to safeguard or achieve the ROs and that are generally consistent with the water management plans of the area water providers are as follows:

Continued groundwater monitoring using the same monitoring wells, for the same analytical parameters, and at the same frequencies as those employed as of the date of ADEQ’s approval of the FS Report; or

Continued groundwater monitoring using different, fewer, or additional monitoring wells; a different or lesser suite of analytical parameters; or different or lower monitoring frequencies than those employed as of the date of ADEQ’s approval of the FS Report.

The identification of wells to be installed or monitored, analytical parameters to be tested, and monitoring frequencies would be selected to, over the mid- to long-term, further confirm the on-going attenuation of the COCs in groundwater and determine: (i) whether there develops a threat of losing the MTP drinking water well use as a result of COCs; (ii) whether there develops a threat of losing the Danone drinking water wells uses as a result of COCs; and (iii) whether there develops a threat of losing the SRP well uses as a result of COCs. Additionally, if in the future the COP decides to install a deep well in the EGA Site area before groundwater quality meets the AWQSs (or risk-based clean-up levels), the monitoring strategy would allow for a determination of whether the proposed COP well is threatened by COCs from the EGA Site and would, therefore, allow for implementation of the contingency measure, if necessary.

5.2 Remedial Measures for the Controlled Migration Strategy

Remedial measures that could enable the controlled migration strategy to safeguard or achieve the ROs for the EGA Site and that are generally consistent with the water management plans of the area water providers are continued groundwater monitoring and groundwater extraction and treatment.

5.2.1 Continued Groundwater Monitoring

Continued groundwater monitoring using the same or different monitoring wells, the same or different analytical parameters, or the same or different monitoring frequencies as those employed for the monitoring strategy (see Section 5.1) could be used to:

A. Verify the ability of a controlled migration strategy and remedial measures other than continued groundwater monitoring that are used as part of the controlled migration strategy (see Section 7.3) to safeguard or achieve the ROs; and

B. Determine if: (i) amendments of the FS Report and remedial action plan are ever required to evaluate and employ a remedial strategy that is more aggressive than controlled migration in order to safeguard or achieve the ROs; or (ii) controlled migration may be suspended as part of a reversion to a monitoring strategy for the COCs.

Additionally, if in the future the COP decides to install a well in the EGA Site area before groundwater quality meets the AWQSs, the monitoring component of the controlled migration strategy would allow for a determination of whether the proposed COP well is threatened by COCs from the EGA Site and would, therefore, allow for implementation of the contingency measure(s), if necessary.

5.2.2 Groundwater Treatment

Groundwater treatment measures that could enable the controlled migration strategy to safeguard or achieve the ROs for the EGA Site and that are generally consistent with the water management plans of the area water providers are as follows (Table 1):

Natural Attenuation - would involve monitoring the COCs and bio-geochemical groundwater parameters to determine if natural attenuation of the COCs in groundwater was occurring and capable of achieving the ROs. Natural attenuation assessments generally include an evaluation of biological and/or abiotic degradation of COCs as well as degradation rates.

Enhanced Anaerobic Bioremediation – would involve increasing the native microorganism populations in a portion of the aquifer that are capable of degrading the COCs. A biodegradable organic carbon substrate is introduced into the aquifer over a period of time, requiring multiple applications to stimulate a progression from aerobic to anaerobic microbial respiratory processes; sustained anaerobic conditions, in turn, support the growth of organisms capable of dechlorinating TCE, PCE, and 1,1-DCE and their breakdown products to non-hazardous and non-toxic end-products. The organic substrate consists of food-grade substances (such as molasses, corn syrup, or natural chemicals) that are a source of carbon.

SVE – would involve a process where air is removed from the subsurface to remove volatilized COCs from vadose zone soil. Removing COC mass from the soil will result in a reduction of COC mass flux from the vadose zone to groundwater. SVE has been successfully implemented at the EGA Site (see Section 2.5.6).

Air Sparging – would involve physical removal of COCs from the groundwater. Typically, atmospheric air is injected into the groundwater saturated zone enabling a phase transfer of the COCs to the vapor phase. The vapor is either allowed to attenuate naturally or ventilated through the unsaturated zone using vapor extraction wells into an aboveground SVE system.

In-Well Air Stripping – would involve the counter-current flow of water and air in a double-screened well. Air is extracted from the well via SVE, while groundwater that is collected from the lower screen is sprayed into the well and forced out of the upper screen. The COCs are transferred to the vapor phase within the air stream and treated ex-situ.

Chemical Oxidation – would involve the chemical conversion of COCs to non-hazardous and non- or less toxic compounds that are more stable, less mobile or inert. A chemical oxidant is injected into COC-bearing groundwater using injection wells to cause chemical breakdown of the COCs. Oxidants commonly used are hydrogen peroxide, potassium or sodium permanganate, chlorine dioxide, hypochlorite, and ozone and typically require two or more applications. Competing reactions and difficulties in distributing the reagent can reduce the effectiveness of the measure.

Zero Valent Iron (ZVI) Treatment – would involve the introduction of elemental iron into COC-bearing groundwater to create reducing conditions and enhance chloro-elimination reactions to dechlorinate the

COCs. Micro-scale ZVI is applied via trenching and nano-scale ZVI is injected using wells. Both measures require direct contact with the COC and typically require multiple applications.

Groundwater Extraction and Air Stripping – would involve pumping dissolved-phase COCs in groundwater to an aboveground aeration tank, shallow tray air stripper, or packed tower air stripper. Air is injected into the tank or vessel to facilitate the partitioning of COCs from the dissolved-phase to the vapor phase. Emissions control such as granular activated carbon is required to remove COCs from the vapor phase because ADEQ does not support the transfer of contaminants from one media to another. The stripped water is then either discharged to a publicly owned treatment works, water distribution system, or water body, or reinjected into the aquifer pursuant to applicable permitting.

Groundwater Extraction and Advanced Oxidation Process (AOP) – would involve pumping COC-affected groundwater into an aboveground treatment tank and exposing the water to ultraviolet radiation, ozone, or hydrogen peroxide which oxidizes the COCs to the end products of carbon dioxide and water. Pretreatment of the groundwater is often required to minimize interferences with the AOP. Also, off-gas from the treatment vessel may require additional treatment by carbon adsorption or catalytic oxidation. The treated water is then either discharged to a publicly owned treatment works, water distribution system, or surface water body, or reinjected into the aquifer pursuant to applicable permitting.

Groundwater Extraction and Granulated Activated Carbon (GAC) Adsorption – would involve pumping dissolved-phase COCs in groundwater into one or more aboveground vessels containing GAC. The COCs would adsorb onto the GAC as the groundwater passes through the vessel. The GAC must be periodically removed and regenerated in order to maintain its adsorption capacity and to eliminate sediment buildup. The treated water is then either discharged to a publicly owned treatment works, water distribution system, or surface water body, or reinjected into the aquifer pursuant to applicable permitting.

The above in-situ groundwater treatment measures or the extraction component of the ex-situ measures could occur at an intercept location of groundwater containing high concentrations of COCs.

Given the ROs, the EGA Site conditions (diffuse nature of the COCs in groundwater, relatively low concentrations of COCs in groundwater, complex flow, deep groundwater, limited access, etc.), and based on the best available scientific information concerning the remedial technologies and other considerations which are stated above and in Table 1 of this report, the remedial measure of groundwater extraction and GAC adsorption is recommended for evaluation in this FS Report as part of the controlled migration remedial strategy. The remaining remedial measures (enhanced anaerobic bioremediation, SVE, air sparging, in-well air stripping, chemical oxidation, ZVI treatment, groundwater extraction and air stripping, and groundwater extraction and AOP) would not be reasonable, necessary, or cost-effective to safeguard or achieve the ROs.

5.3 Contingency Remedial Measures

A series of contingency remedial measures could be implemented to evaluate and mitigate the unlikely potential future threat(s) to nearby groundwater supply wells from EGA Site COCs. The remedial measures would include one or more of the following:

1. Assessment of threats to existing water supply wells by continued groundwater monitoring and mass discharge assessments

2. Assessment of the potential threat to the potential future COP deep well by coordination with ADEQ, ADWR, and the COP and mass discharge assessments
3. Well modification(s) includes: a well siting study, adjusting the well location, modifying the well screen, or deepening of the well
4. Wellhead treatment.

The contingency remedial measures are developed in Section 9. Additionally, wellhead treatment costs are detailed in Appendix F.

6 DEVELOPMENT OF REMEDIES

This section organizes the two remedial strategies and corresponding remedial measures described above into a reference remedy and the less aggressive and more aggressive remedies to be evaluated in accordance with A.A.C. R18-16-407(E)(1) through (3).

Based on the information described in Section 2: (i) the MTP drinking water well use is not presently threatened as a result of the COCs; (ii) the Danone wells uses are not presently threatened as a result of the COCs; and (iii) the SRP well uses are not presently threatened as a result of the COCs. Therefore, the following remedies were developed for consideration:

- Less aggressive remedy = Annual groundwater monitoring with a contingency
- Reference Remedy = Semi-annual natural attenuation groundwater monitoring with a contingency
- More Aggressive Remedy = Controlled migration using groundwater extraction and GAC adsorption with a contingency

The developed remedies are described in more detail in Sections 6.1, 6.2, and 6.3, respectively. All remedies include the cost to closure including the costs to abandon wells for comparison purposes. The contingency remedial measure(s) is described in Section 9.

Based on the information described in Section 2, ROs stated in Section 3, and the remedial strategies and measures in Sections 4 and 5, the remedies each have the potential to safeguard or achieve the ROs, maintain the foreseeable maximum beneficial use of groundwater of the EGA Site, are reasonable, and assure the protection of the public health and welfare and the environment, pursuant to A.R.S. § 49-282.06(D). Further, all remedies are consistent with the current water management plans of the area water providers because they provide protection for existing and foreseeable water supply wells.

6.1 Less Aggressive Remedy – Annual Groundwater Monitoring

Annual groundwater monitoring was selected as the less aggressive remedy in accordance with A.A.C. R-18-16-407(E), because it is: 1) capable of meeting the ROs, 2) less aggressive than the reference remedy, 3) generally consistent with the water management plans of the area water providers, and 4) would allow for verification of whether a potential threat arises to water supply well uses. Groundwater monitoring would use an array of existing monitoring wells to assess 1) the attenuation of the COCs until the general groundwater quality meets the AWQSs or there is no appreciable risk to existing and foreseeable groundwater uses and 2) potential threats to nearby water supply well uses. Groundwater samples would be collected every 1 to 2 years depending on the purpose of the monitoring well (sentinel well, etc.). The groundwater samples would be collected using a no-purge method (e.g., passive diffusion bags).

COC concentrations are expected to reach the AWQS within 17 years (Section 2.5.8). The duration of the remedy was assumed to be 17 years plus one additional year of verification monitoring and another year for site closure.

The key elements of the remedy are summarized below.

Elements of the Less Aggressive Remedy

Element	Value
Strategy	Monitoring
Measure(s)	Monitoring
Monitoring Frequency	1/year & 1/2 years
No. Monitoring Wells Sampled	7 & 3 (10 total)
Monitoring Duration	18 years
Analytical Method	COCs by USEPA Method 8260
Total Duration	19 years
New Wells	None
Contingency	See Section 9
Cost	**$1.8MM***

Notes:
* Costs are for cost comparison purposes only. The cost estimate including cost assumptions and net present values costs are provided in Appendix F. Actual remedy durations/costs will vary and will be evaluated following remedy selection.
MM = million

Groundwater monitoring would allow a determination: (i) whether a threatened loss of the MTP drinking water well use arises as a result of the COCs; (ii) whether a threatened loss of the Danone drinking water wells arises as a result of the COCs; (iii) whether a threatened loss of the SRP wells arises as a result of the COCs; and/or (iv) whether no further action is necessary at the EGA Site (i.e., no or low threat to foreseeable groundwater uses). If in the future the COP decides to install a well in the EGA Site area before groundwater quality meets the AWQSs, continued groundwater monitoring would allow for a determination of whether the proposed COP well is threatened by COCs from the EGA Site. The monitoring could allow for implementation of the contingency measure(s) described in Section 9, if necessary.

6.2 Reference Remedy – Semi-annual Groundwater Monitoring

Semi-annual groundwater monitoring was selected as the reference remedy, because it is 1) capable of meeting the ROs, 2) generally consistent with the water management plans of the area water providers, and 3) would allow for verification of whether a potential threat arises to water supply well uses.

Groundwater monitoring would use an array of existing monitoring wells to assess 1) the attenuation of the COCs until the general groundwater quality meets the AWQSs or there is no appreciable risk to existing and foreseeable groundwater uses and 2) potential threats to nearby water supply well uses. The groundwater samples would be collected twice a year or once a year depending on the purpose of the monitoring well (sentinel well, etc.). The groundwater samples would be collected using a no-purge method (e.g., passive diffusion bags). The key elements of the remedy are summarized below.

Elements of the Reference Remedy

Element	Value
Strategy	Monitoring
Measure(s)	Natural Attenuation and Monitoring
Monitoring Frequency	2/year & 1/year
No. Monitoring Wells	12
Monitoring Duration	18 years
Analytical Method	COCs by USEPA Method 8260
Total Duration	19 years
Contingency	See Section 9
Cost	**$2.1MM***

Notes:
* Costs are for assessment purposes only. The cost estimate including cost assumptions and net present values costs are provided in Appendix F. Actual remedy durations/costs will vary and will be evaluated following remedy selection.
MM = million

Groundwater monitoring would allow a determination: (i) whether a threatened loss of the MTP drinking water well use arises as a result of the COCs; (ii) whether a threatened loss of the Danone drinking water wells arises as a result of the COCs; (iii) whether a threatened loss of the SRP wells arises as a result of the COCs; and/or (iv) whether a no action strategy would be consistent with the ROs for the EGA Site. If in the future the COP decides to install a well in the EGA Site area before groundwater quality meets the AWQSs, continued groundwater monitoring would allow for a determination of whether the proposed COP well is threatened by COCs from the EGA Site. The monitoring, therefore will allow for implementation of the contingency measure(s) described in Section 9, if necessary.

6.3 More Aggressive Remedy – Controlled Migration and Groundwater Treatment

Controlled migration using groundwater extraction and GAC adsorption was selected as the more aggressive remedy because it is: 1) capable of meeting the ROs, 2) generally consistent with the water management plans of the area water providers, and 3) would reduce COC concentrations in groundwater, 4) is more aggressive than the reference remedy, and 5) further reduce the potential for advection of the COCs to downgradient water supply wells.

Elements of the Aggressive Remedy

Element	Value
Strategy	Controlled Migration/Remediation
Measure(s)	Groundwater Extraction with GAC Adsorption and Groundwater Monitoring
Monitoring Frequency	2/year#
No. Monitoring Wells	15
Monitoring Duration	13 years
Analytical Method	COCs by USEPA Method 8260
Groundwater Extraction Duration	11 years
Total Duration	13 years
New Wells	2 soil borings + 3 extraction wells (15 gpm each)
Contingency	See Section 9
Cost	**$7.0MM***

Notes:
Groundwater samples would be collected annually initially and then semi-annually during system operation and the closure monitoring period from key wells. Sampling frequency would vary depending on the well's purpose.
* Costs are for assessment purposes only. The cost estimate including cost assumptions and net present values costs are provided in Appendix F. Actual remedy durations/costs will vary and will be evaluated following remedy selection.
gpm = gallons per minute
MM = million

The location of proposed monitoring wells, extraction wells, and the treatment system is shown on Figure 8. The groundwater extraction would focus on the upper UAU where COCs exceed the AWQS. Additional studies like (aquifer testing), two soil borings with higher-resolution characterization (detailed lithologic logging and soil sampling) would be necessary to properly design a controlled migration remedy to capture and/or treat the primary mass flux.

One to two groundwater extraction wells would be used to control the COC-affected groundwater before it migrates to potentially threatened water supply wells and one extraction well would be installed near the area of elevated COC concentrations to accelerate cleanup time. The supporting calculations are provided in Appendix C. The groundwater pumping rates and locations are based on the following:

- transmissivity = 230 feet squared per day
- hydraulic gradient = 0.005 ft/ft
- plume width = 600 feet.

Aboveground vessels containing GAC would be used to treat the groundwater through adsorption. The GAC periodically would be regenerated to maintain its adsorption capacity and to eliminate sediment buildup. The extracted groundwater would either be: 1) discharged to the COP sewer, 2) discharged to

SRP's Grand Canal, or 3) reinjected at optimal locations to control groundwater flow and/or accelerate cleanup times. For costing purposes, it was assumed:

- treatment system capacity of 20 to 50 gpm (average of 30 gpm)
- the system operated 11 months a year (1 month of maintenance/downtime)
- weekly operation and maintenance visits
- sampling
- semi-annual carbon changeout
- water would be discharged to the COP sewer.

7 INDIVIDUAL EVALUATIONS OF REMEDIES

This section individually evaluates the less aggressive, reference, and more aggressive remedies described in Section 6 according to the remedy selection criteria of A.A.C. R18-16-407(H)(1) and (2).

7.1 Less Aggressive Remedy – Annual Groundwater Monitoring

Annual groundwater monitoring was selected as the less aggressive remedy, because it is: 1) capable of meeting the ROs, 2) reasonable, 3) less aggressive than the reference remedy, 4) generally consistent with the water management plans of the area water providers, and 5) would allow for verification of whether a potential threat arises to water supply well uses. Groundwater monitoring would use an array of existing monitoring wells to assess 1) the attenuation of the COCs until the general groundwater quality meets the AWQSs or there is no appreciable risk to existing or foreseeable groundwater uses and 2) potential threats to nearby water supply well uses.

The annual groundwater monitoring remedy would be consistent with the COP land use plans (Weston 2006). Further, the information described in Section 2.6 indicates there is no potential risk to human health associated with the COCs in the soils or foreseeable groundwater uses and the deeper aquifers (MAU or LAU) are not adversely affected or threatened.

The duration of groundwater monitoring is uncertain but expected to be on the order of 17 years based on pore flushing estimates of COCs in groundwater at the Site. Groundwater monitoring would be suspended once COC concentrations are less than the AWQS or there is no appreciable threat to foreseeable groundwater uses.

The annual groundwater monitoring remedy is generally consistent with the water management plans of potentially affected water providers; because it provides periodic reviews of its potential to safeguard or achieve the ROs until the general groundwater quality meets the AWQS. Additionally, if in the future the COP decides to install a deep well in the EGA Site area before groundwater quality meets the AWQSs, continued groundwater monitoring would allow for a determination of whether the proposed COP well is threatened by COCs from the EGA Site. If a threat of loss develops, a contingency remedial action could be initiated to safeguard or achieve the ROs. The contingency measure(s) is described in Section 9.

7.2 Reference Remedy – Semi-Annual Groundwater Monitoring

The groundwater monitoring remedy would be capable of safeguarding or achieving the ROs and is generally consistent with the water management plans of the area water providers because it will further confirm the on-going attenuation of the COCs in groundwater and would enable a determination over the long term of: (i) whether there develops a threat of loss of groundwater pumped from MTP drinking well as a result of the COCs; (ii) whether there develops a threat of loss of groundwater pumped from Danone wells as a result of the COCs; (iii) whether there develops a threat of loss of groundwater pumped from the SRP well as a result of the COCs; and/or (iv) whether a no further action would be consistent with the ROs.

The duration of groundwater monitoring is uncertain but expected to be on the order of 17 years based on linear regression analysis and pore flushing estimates of COCs in groundwater at the Site (Sections 2.5.7 and 2.5.8). Once general COC concentrations are less than the AWQS, another four rounds of confirmation groundwater monitoring will be conducted to verify that concentrations remain less than the AWQS.

The groundwater monitoring remedy would be consistent with the general COP land use plans (Weston 2006) because the information described in Section 2.6 indicates there is no potential for risk to human health associated with the COCs in the soils or groundwater.

The continued groundwater monitoring remedy would also be consistent with the water management plans of potentially affected water providers because it would enable a determination over the long term of whether there develops a threat of loss of groundwater pumped from the MTP drinking water well, the Danone drinking water wells, or the SRP well as a result of the COCs. If a threat of loss develops it would be used to determine if amendments to the FS Report and remedial action plan are required to evaluate and employ a remedial strategy that is more aggressive than the reference remedy in order to safeguard or achieve the ROs. Additionally, if in the future the COP decides to install a deep well in the EGA Site area before groundwater quality meets the AWQSs, continued groundwater monitoring would allow for a determination of whether the proposed COP well is threatened by COCs from the EGA Site. If a threat of loss develops, a contingency remedial action could be initiated to safeguard or achieve the ROs. The contingency measure is described in Section 9.

7.3 More Aggressive Remedy - Controlled Migration and Groundwater Treatment Remedy

The More Aggressive Remedy of Controlled Migration and Groundwater Treatment achieves and safeguards the ROs and is generally consistent with the water management plans of the area water providers. Controlled Migration and Groundwater Treatment would consist of extracting groundwater an intercept location of groundwater (two wells) containing high concentrations of COCs and at the zone of highest concentrations (one well). The locations of the wells would be determined following the installation of the three proposed monitoring wells. For costing purposes, it is assumed the water would be discharged to a publicly owned treatment work.

The duration of groundwater extraction and groundwater monitoring is uncertain but expected to be on the order of 12 years for the groundwater extraction component and 2 years of post-remediation groundwater monitoring component, based on pore-flushing calculations (Section 2.5.8).

The More Aggressive Remedy of Controlled Migration and Groundwater Treatment would be coupled with continued groundwater monitoring using the same monitoring wells and analytical parameters relative to those employed for the reference remedy at a semi-annual frequency, in order to: (i) verify the effectiveness of and the ability of the groundwater extraction and GAC adsorption to safeguard or achieve the ROs; and (ii) determine if amendments of the FS Report and remedial action plan are ever required to evaluate and employ a remedial strategy that is more aggressive in order to safeguard or achieve the ROs or suspended More Aggressive Remedy.

The More Aggressive Remedy would be consistent with the COP land use plans (Weston 2006) because the information described in Section 2.6 indicates there is no potential risk to human health associated with the COCs in the soils or groundwater.

The More Aggressive Remedy would also be consistent with the water management plans of potentially affected water providers because it would further reduce the potential for advection of the COCs to downgradient water supply wells and enable a determination over the longer term of whether there develops a threat of loss of groundwater pumped from the MTP drinking water well, the Danone drinking water wells, or the SRP well as a result of the COCs. Additionally, if in the future the COP decides to install a deep well in the EGA Site area before groundwater quality meets the AWQSs, continued groundwater monitoring would allow for a determination of whether the proposed COP well is threatened by COCs from the EGA Site. If a threat of loss develops, a contingency remedial action could be initiated to safeguard or achieve the ROs. The contingency measure(s) is described in Section 9.

8 COMPARATIVE EVALUATION OF REMEDIES

Table 2 compares the reference remedy, less aggressive remedy, and the more aggressive remedy to each other using the criteria of A.A.C. R18-16-407(H)(3)(a) through (e). The criteria are summarized below:

- The remedy's feasibility, short- and long-term effectiveness, and reliability considering the information described in Section 2 and the performance capabilities of the less aggressive, reference, and more aggressive remedies[2]
- The remedies' overall protectiveness of public health and aquatic and terrestrial biota under reasonably foreseeable exposure scenarios including end uses of water considering the COCs' behavior and toxicity over the life of the remedies, current and future land and water uses, and residual risk after the conclusion of the remedies.
- The remedies' value for lowering risk to human and aquatic and terrestrial biota, reducing the COC concentrations in the groundwater, decreasing liability, securing public acceptance of the remedies,

[2] Institutional considerations are not evaluated in this FS Report because the safeguarding or achievement of the ROs using the reference would not depend on the use of institutional or engineering controls.

preservation of the uses of groundwater pumped from the aquifers, enhancement of future uses of groundwater pumped from the aquifers, and the effects on local economies.

- The remedies' capital, operating, maintenance and life cycle costs, including contingency costs and the cost of financial assurance of the performance of the remedies.

The following summarizes the remedial alternative comparative evaluation in Table 2 for the key evaluation criteria:

- **Feasibility**: all three alternatives rank similarly; however, the more aggressive remedy has added challenges due to access limitations
- **Effectiveness**: the more aggressive remedy ranked slightly better than the reference and less aggressive remedies by reaching the AWQS approximately 35% faster than the monitoring only (natural attenuation) remedies
- **Protectiveness**: all three alternatives rank similarly; but the more aggressive remedy reduced the potential for a contingency remedy slightly
- **Risk Reduction Value**: the less aggressive remedy ranks the highest for overall risk-reduction value, as it mitigates potential risks but at a substantially lower cost (particularly compared to the more aggressive remedy)
- **Enhanced Groundwater Use Value**: the most aggressive remedy scored slightly higher in overall enhancement, but at a much higher cost and with little or no appreciable impact on present and future uses of groundwater
- **Costs**: less aggressive remedy was the lowest costs at $1.8MM and the aggressive remedy was the highest cost at $7.0MM.

All three alternatives would safeguard or achieve the ROs and assure the protection of the public health and welfare and the environment, pursuant to A.R.S. § 49-282.06(D). All three remedies could also employ the same contingency remedy of well modification and/or well replacement which effectively eliminates potential risks to the foreseeable groundwater uses. Generally, the less aggressive remedy provides the greatest value and is able to achieve the ROs at the lowest cost. Section 10 describes the recommended remedy.

9 CONTINGENCY MEASURE

If the Director approves either an ERA or an Interim Remedial Action (IRA) to protect future municipal supply wells from EGA Site COCs, in accordance with A.R.S. R18-16-405, and A.R.S. R18-16- Article 5, the following contingency measures could be implemented:

1. Assessment of the potential threat to the potential future COP deep well by coordination with ADEQ, ADWR, and the COP and mass discharge assessments
2. Well modification(s) includes: a well siting study, adjusting the well location, or deepening of the well
3. Wellhead treatment.

These remedial measures would be implemented in a phased, adaptive approach depending on the potential threat and cost-benefit and would further ensure future groundwater uses are not adversely affected.

The well modification contingency could be used to protect the potential future COP well as a drinking water source before the COCs decrease to the AWQSs. If in the future the COP decides to install a deep well in the EGA Site area before groundwater quality meets the AWQSs, an evaluation will be performed to determine if the proposed COP well is threatened by COCs from the EGA Site. If the proposed well is threatened, a contingency measure could be implemented to protect the proposed COP well as a drinking water resource. The contingency measure could include a well siting study to determine an equivalent well location (water rights, cost, water quality, depth, etc.) to be used as an alternative to installing a well in an area or aquifer that may be threatened by COCs from the EGA Site. In addition, the ADWR would restrict the capacity of the new well to protect the water supply of existing water supply wells. This contingency measure would require institutional controls, ongoing communications with ADWR and/or COP. ADWR has authority to permit and restrict groundwater wells within Arizona prior to installation.

In the event an equivalent well site could not be identified, the well could be modified by either deepening the well or repositioning the well to mitigate the potential threat to the potential well. The costs for these modifications would be reimbursed to COP.

Wellhead treatment would include the installation of a GAC unit at a potentially affected well. The GAC periodically would be regenerated to maintain its adsorption capacity and to eliminate sediment buildup. For costing purposes, it was assumed:

- GAC treatment system capacity of 1,200 gpm
- year-round system operation for 12 years
- bi-monthly operation, maintenance, and monitoring
- annual carbon changeout.

The costs for the most conservative, aggressive contingency measure (wellhead treatment for 12 years is estimated to be $6.6MM (Appendix F). The costs will be significantly less, if the lesser contingency is implemented, the treatment system size is smaller, or if the system operates for a shorter duration. As noted in previous sections, it is improbable, a contingency remedy is needed.

10 RECOMMENDATION

Based on the information and evaluations in the preceding sections of this FS Report and Table 2, the less aggressive remedy of groundwater monitoring with a contingency is recommended as the remedy for the COCs in groundwater at the EGA Site. The less aggressive remedy provides essentially the same levels of protection to existing and foreseeable uses of groundwater as the reference remedy and the more aggressive remedy but more cost effectively. The selected remedy:

- safeguards the ROs (no water supply well uses are threatened, Section 2.6.2)
- is generally consistent with the water management plans of the area water providers (Section 2.5.9, 2.6.2)

- is protective of foreseeable groundwater uses including the potential future COP well as a drinking water source (Section 2.5.9 and 2.6.2)
- will allow for implementation of a contingency remedy, if needed (Section 9).
- maintains the beneficial uses of groundwater (no uses are threatened or likely to be threatened, Section 2.6.2)
- assures the protection of the public health and welfare and the environment (Section 2.6)
- will allow for continued verification that groundwater uses are not threatened (Section 2.6 and 9) and that groundwater will reach the AWQSs within a reasonable time frame (Section 2.5.8)
- is reasonable (Section 5 and 6)
- is the most cost effective remedial alternative (Section 8)
- is technically feasible to implement (Section 7).

The less aggressive groundwater sampling schedule could be adaptive (i.e., adjust the monitoring schedule based on the results of recent groundwater monitoring) to provide additional value. For example, if the plume is retracting, groundwater samples could be reduced or if the plume is advecting, the wells monitored could be modified or the frequency could be increased, as needed. The more aggressive remedy of controlled migration could also be implemented as a contingency remedy in conjunction with the contingency measures outlined in Section 9, if necessary.

Upon ADEQ’s approval of this FS Report, a proposed remedial action plan (P-RAP) for implementing the preferred remedy should be prepared in accordance with A.A.C. R18-16-408. The P-RAP would:

- Provide the details of the groundwater monitoring remedy, including: (i) identification of which existing monitoring wells would be used for the monitoring; (ii) specification of the suites of groundwater analytical parameters to be tested; and (iii) establishment of the groundwater monitoring frequencies to be employed.
- Provide details for setting contingency measures and triggers to protect the use of existing and potential future uses of groundwater.
- Contain other information as required under A.R.S. §§ 49-175 and 282.06 and A.A.C. R18-16-408.

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TABLES

Table 1
Screening of Remedial Measures
East Grand Avenue WQARF Site, Phoenix, Arizona

Remedial Measure	Technical Feasibility	Reasonableness	Necessity	Cost Effectiveness
Groundwater Monitoring	Groundwater monitoring has been used and approved for use at the site to evaluate groundwater conditions and is generally used to assess most or all groundwater remediation strategies.	Could be used to assess all remedial measures and to assess the need for groundwater remediation contingencies.	Groundwater monitoring could be deemed necessary to validate the controlled migration strategy. However, long-term monitoring is not necessary.[1]	Groundwater monitoring is cost effective. More cost-effective monitoring strategies and methodologies could also be applied and should be capable of meeting the objectives.
Monitored Natural Attenuation	Natural attenuation includes advection, dispersion, dilution, sorption, volatilization, as well as chemical destruction (abiotic and biotic). As described in Section 2.4.4, chemicals of concern (COCs) attenuation is occurring, however, the Site lacks direct evidence of chemical destruction. Since evidence of chemical destruction has not been demonstrated to-date and evidence of chemical destruction is generally required to employ monitored natural attenuation, this measure is not considered technically feasible at this time.	Without additional evidence of natural attenuation, this measure is not considered reasonable.	Not necessary to the controlled migration strategy.[1]	Groundwater monitoring is cost effective; however, additional bio-geochemical parameters and analyses and/or studies would be required to demonstrate chemical destruction which may not be achievable.
Enhanced Anaerobic Bioremediation	The ability to re-circulate amended groundwater to the microbial population would be limited. Complicating factors include: (i) the affected aquifers' stratification, heterogeneity and low permeability layers; (ii) biofouling of the extraction and reinjection wells; (iii) interferences with biological processes caused by alteration of pH or production of methane gas, that limit the reduction of COCs; and (iv) land use constraints on the extraction and reinjection wells' locations due to the commercial and industrial development of the Site.	Could cause naturally occurring metals such as arsenic and selenium to be reduced and mobilized in the groundwater. However, mobilization of these metals is generally limited spatially and temporally to the area of reduced conditions.	Not necessary to the controlled migration strategy.[1]	Studies conducted at the Site have been inconclusive as to the measure's ability to be cost effective on a large scale. Would require: (i) the extraction and reinjection of large volumes of groundwater and amended groundwater to achieve the three-dimensional coverage needed for the measure to be effective; and (ii) the use of directional injection wells due to the land use constraints. Treatment costs would be high relative to the mass of COCs removed.

Remedial Measure	Technical Feasibility	Reasonableness	Necessity	Cost Effectiveness
Soil Vapor Extraction (SVE) System Expansion	SVE has been successfully used at the Site to reduce concentrations in soil and groundwater. However, the existing SVE system would need to be modified and additional wells connected to the system to optimize remediation.	Could be used in combination with other remedies, as it is more suitable to enhance effectiveness of another controlled migration measure given the Site conditions and objectives. Less suitable as a standalone controlled migration measure and more suitable for higher concentration areas given the Site conditions and objectives.	Not necessary to the controlled migration strategy.[1]	Would require modification of existing SVE system and installation of additional SVE wells. Treatment costs would be high relative to the mass of COCs removed.
Air Sparging	The radius of influence and flow rates of the injection wells and soil vapor extractions wells would be limited. Complicating factors include: (i) the affected aquifer's stratification, heterogeneity and low permeability layers; and (ii) land use constraints on the injection wells and soil vapor extraction wells' locations due to the commercial and industrial development of the Site.	Could result in air entrapment in the confined aquifers, causing the displacement of groundwater and flow of COC affected groundwater to previously unaffected portions of the aquifers. Less suitable as a standalone controlled migration measure and more suitable for areas with elevated COC concentrations. Due to the site hydrogeologic conditions and the COC concentrations, this measure is not reasonable as a controlled migration strategy. .	Not necessary to the controlled migration strategy.[1]	Would require: (i) a very large number of injection wells and soil vapor extraction wells to remove approximately twice the volume of injected air; (ii) the use of directional injection wells due to the land use constraints; and (iii) twice as much conveyance piping as an injection system, given the vapor recovery component. Treatment costs would be high relative to the mass of COCs removed.
In-Well Air Stripping	The radius of influence of the stripping wells would be limited. Complicating factors include: (i) the affected aquifer's stratification, heterogeneity and low permeability layers; (ii) the limited number of zones where high rates of advective flow can be induced; (iii) biofouling and scaling caused by the supplied oxygen or use of chemicals to enhance stabilization; and (iv) land use constraints on the air stripping wells' locations due to the commercial and industrial development of the Site.	Could cause COCs to: (i) spread or smear through the circulation cell to higher groundwater elevations; and (ii) be transferred to vadose zone soils Less suitable as a standalone controlled migration measure and more suitable for areas with elevated COC concentrations. Due to the site hydrogeologic conditions and the COC concentrations, this measure is not reasonable as a controlled migration strategy.	Not necessary to the controlled migration strategy.[1]	Would require a very large number of air stripping wells to be effective. Treatment costs would be high relative to the mass of COCs removed.

Table 1
Screening of Remedial Measures
East Grand Avenue WQARF Site, Phoenix, Arizona

Remedial Measure	Technical Feasibility	Reasonableness	Necessity	Cost Effectiveness
Chemical Oxidation	Uniform distribution of the oxidation reagents and their contact with COCs would be limited. Complicating factors include: (i) the affected aquifer's stratification, heterogeneity and low permeability layers; (ii) temperature, pH and natural oxidant demand in the aquifer matrices; (iii) need for an activator reagent, and (iv) land use constraints on the injection wells' and reagent storage locations due to the commercial and industrial development of the Site.	Poses potential threat to human health and safety related to the storage and handling of large quantities of reagent(s). Storage and handling of the reagent(s) pose a potential threat of an accidental discharge or other release to the environment Could cause adverse chemical reactions with COCs in the water producing some toxic chlorinated byproducts (e.g., if the use of hypochlorite or chlorine dioxide is required). Less suitable as a standalone controlled migration measure and more suitable for areas with elevated COC concentrations. Due to the site hydrogeologic conditions and the COC concentrations, this measure is not reasonable as a controlled migration strategy.	Not necessary to the controlled migration strategy.[1]	Would require: (i) a very large number of injection wells; (ii) the use of directional injection wells due to the land use constraints; (iii) multiple reagent injections; and (iv) very large quantities of a more expensive reagent(s). Treatment costs would be high relative to the mass of COCs removed.
Zero Valent Iron (ZVI) Treatment	The extent of treatment would be limited by the iron's interaction with substances other than the COCs. Complicating factors include: (i) the affected aquifers' stratification, heterogeneity and low permeability layers; (ii) the tendency of the iron to fall out of solution and reduce the porosity/permeability of the aquifer or clog the injection wells; (iii) the tendency of the iron to react with dissolved oxygen, naturally occurring sulfate and nitrate, and water; and (iv) land use constraints on the injection wells' due to the commercial and industrial development of the Site.	The reduced conditions created by the ZVI reactions could cause naturally occurring metals such as arsenic and selenium to be mobilized in the groundwater. Less suitable as a standalone controlled migration measure and more suitable for areas with elevated COC concentrations. Due to the site hydrogeologic conditions and the COC concentrations, this measure is not reasonable as a controlled migration strategy.	Not necessary to the controlled migration strategy.[1]	Published studies have not established the measure's effectiveness in aquifers containing significant fine grained sediments, such as those observed at the Site. Would require: (i) a large number of injection wells; (ii) the use of directional injection wells due to the land use constraints; (iii) frequent ZVI injections; and (iv) very large quantities of costly nano-scale ZVI solution. Treatment costs would be high relative to the mass of COCs removed.

Table 1
Screening of Remedial Measures
East Grand Avenue WQARF Site, Phoenix, Arizona

Remedial Measure	Technical Feasibility	Reasonableness	Necessity	Cost Effectiveness
Pumping and Air Stripping	Hydraulic capture calculations indicate a few extraction wells could effectively reduce the migration of COCs at the Site to downgradient water supply wells. Published studies indicate the measure could remove 99.9% of the COCs in the water that is treated. Complicating factors include: (i) land use constraints on the locations of the extraction wells, air stripping system components, and any reinjection wells (if the treated water is not otherwise discharged) due to the commercial and industrial development of the Site; and (ii) the ability of air stripping to remove low concentrations of COCs from aqueous solution.	Could be used as a standalone measure for the controlled migration strategy or as a contingency. Above-ground storage and handling of the COC-affected groundwater pose a potential threat of an accidental discharge or other release to the environment.	Not necessary to the controlled migration strategy.[1]	Cost would be very high: (i) if the measure is implemented without regard to the results of the continued groundwater monitoring or the remedial objectives for the Site; or (ii) if the measure is implemented over a lengthy period of time. Costs would be manageable if the measure is employed as part of a contingency remedy involving pumping at an intercept location, pumping in a zone of groundwater containing high concentrations of COCs, or pumping at both an intercept location and in a zone of groundwater containing high concentrations of COCs. Would not be as cost-effective as a remedy involving Granulated Activated Carbon (GAC) adsorption (below) because of the relative inability of air stripping to remove low concentrations of COCs from aqueous solution.
Pumping and Advanced Oxidation Process (AOP)	Given Site conditions, a few groundwater extraction wells would be capable of capturing or reducing the migration of COCs. Complicating factors include: (i) land use constraints on the extraction wells, AOP system components, and any reinjection wells (if the treated water is not otherwise discharged) due to the commercial and industrial development of the Site; and (ii) interference with the oxidation process caused by the alkalinity and turbidity of the water and presence of nitrate, carbonates and some metals in the water.	Could be used as a standalone measure for the controlled migration strategy or as a contingency. Poses potential threat to human health and safety related to the storage and handling of large quantities of oxidant. Aboveground storage and handling of the COC-affected groundwater and oxidant pose a potential threat of an accidental discharge or other release to the environment. The alkalinity and turbidity of the water and presence of nitrate, carbonates and some metals in the water may reduce efficiency or cause the AOP process to create undesirable oxidation by-products.	Not necessary to the controlled migration strategy.[1]	Cost would be very high: (i) if the measure is implemented without regard to the results of the continued groundwater monitoring or the remedial objectives for the Site; or (ii) if the measure is implemented over a lengthy period of time. Published studies indicate the measure could be very expensive for the Site.

Table 1
Screening of Remedial Measures
East Grand Avenue WQARF Site, Phoenix, Arizona

Remedial Measure	Technical Feasibility	Reasonableness	Necessity	Cost Effectiveness
Pumping and Granulated Activated Carbon (GAC) Adsorption	Given Site conditions, a few groundwater extraction wells would be capable of capturing or reducing the migration of COCs, and GAC is effective for treating the COCs and is widely used in Arizona. Published studies indicate the measure could remove 99.9% of the COCs in the water that is treated. Complicating factors include: (i) land use constraints on the extraction wells, GAC adsorption system components, and any reinjection wells (if the treated water is not otherwise discharged) due to the commercial and industrial development of the Site; and (ii) the buildup of organic matter and microbial growth in the activated carbon, requiring monitoring of influent and effluent COC concentrations and relatively frequent carbon change-outs.	Could be used as a standalone measure for the controlled migration strategy or as a contingency. Aboveground storage and handling of the COC-affected groundwater pose a potential threat of an accidental discharge or other release to the environment.	Not necessary to the controlled migration strategy.[1]	Cost would be very high: (i) if the measure is implemented without regard to the results of the continued groundwater monitoring or the remedial objectives for the Site; or (ii) if the measure is implemented over a lengthy period of time. Costs would be manageable if the measure is employed as part of a contingency remedy involving pumping at an intercept location, pumping in a zone of groundwater containing high concentrations of COCs, or pumping at both an intercept location and in a zone of groundwater containing high concentrations of COCs.

Acronyms and Abbreviations
AOP – Advanced Oxidation Process
COC – chemicals of concern
GAC – Granulated Activated Carbon
SVE – Soil Vapor Extraction
ZVI – Zero Valent Iron

Note

1 None of the groundwater treatment measures considered would be essential to the controlled migration strategy. Any one of the measures could help the controlled migration strategy to safeguard or achieve the remedial objectives for the Site, if controlled migration is deemed necessary as a result of the continued groundwater monitoring data. The selection of the groundwater treatment measure of pumping and GAC adsorption for further evaluation as part of the controlled migration strategy is based on the other factors that are discussed in Section 5.2.2 of the Feasibility Study report and this Table 1.

Table 2
Comparative Evaluation of Reference and Alternative Remedies
East Grand Avenue WQARF Site, Phoenix, Arizona

Comparative Evaluation Criteria [i]	Less Aggressive Remedy – Annual Groundwater Monitoring	Reference Remedy – Semi-Annual Groundwater Monitoring	More Aggressive Remedy – Controlled Migration and Groundwater Treatment [ii]
Feasibility	**Moderate to High** – The less aggressive remedy employs groundwater monitoring to confirm recent and historical empirical data and conservative screening level calculations (see Sections 2.4 and 2.5) that indicate natural attenuation is occurring and a potential threat to nearby water supply wells will never develop. All are feasible as demonstrated historically at East Grand Avenue (EGA) as well as at other sites with similar conditions.	**Moderate to High** – Like the less aggressive remedy, the reference remedy employs groundwater monitoring like the Less Aggressive Remedy but on a more frequent basis.	**Moderate to High** – Groundwater extraction and Granulated Activated Carbon (GAC) adsorption have been demonstrated feasible for chemicals of concern (COC)-affected groundwater at other similar sites. However, access for the wells, treatment system, and appurtenances could be challenging and may influence the effectiveness and reliability.
Short-Term Effectiveness	**Moderate to High** – COC concentrations in groundwater at the Site are decreasing, stable, or less than the Arizona Water Quality Standards (AWQS)[iii] and only one monitoring well has COC concentrations greater than the AWQS. No monitoring wells are greater than the other applicable Arizona water use criteria[iv]. No foreseeable water uses are threatened based on Section 2.5 and 2.6. Groundwater concentrations are expected to reach the AWQS naturally within 17 years.	**Moderate to High** – Same a less aggressive remedy. However, the potential need for contingency actions will decrease with time as the COCs attenuate.	**Moderate to High** – groundwater extraction and GAC adsorption, either at an intercept location or a location of high concentrations of COCs, or at both locations, is slightly more effective in the short term at reducing the potential for unforeseen threats. It will only reduce the time to reach the AWQS from 17 to 12 years. Access challenges could influence the effectiveness over the short term.
Long-Term Effectiveness	**Moderate to High** – Same as short-term except the trends and pore flushing estimates indicate that groundwater quality will naturally meet in the AWQS in the long term (17 years). Thus, the potential for an unforeseen loss of foreseeable groundwater uses will diminish with time.	**Moderate to High** – Same as the less aggressive remedy.	**High** – Groundwater extraction and GAC adsorption continues to be effective in the long-term and potentially reduces the need for long-term monitoring. However, groundwater extraction and GAC adsorption's effectiveness will diminish over time due to heterogeneity, stagnation points, and solute transport dynamics (e.g., back diffusion).
Reliability	**Moderate to High** – This remedy relies on recent and historical data and conservative screening calculations (see Section 2.4 and 2.5) that indicate a potential threat to nearby water supply wells will not develop and continued groundwater monitoring to verify the conditions further. These combined actions are considered reliable and conservative.	**Moderate to High** – Same as the less aggressive remedy.	**Moderate to High** – Groundwater extraction and GAC adsorption have been demonstrated as reliable for COC-contaminated groundwater at other sites, but will require additional studies and on-going maintenance and monitoring to be effective. This remedy would also reduce the potential need for a contingency remedy slightly.

Table 2
Comparative Evaluation of Reference and Alternative Remedies
East Grand Avenue WQARF Site, Phoenix, Arizona

Comparative Evaluation Criteria [i]	Less Aggressive Remedy – Annual Groundwater Monitoring	Reference Remedy – Semi-Annual Groundwater Monitoring	More Aggressive Remedy – Controlled Migration and Groundwater Treatment [ii]
Protectiveness of Public Health	**Moderate to High** – The COCs in the groundwater do not pose an appreciable risk to human health from: (i) groundwater used for its beneficial purposes; (ii) water from Salt River Project (SRP) wells that is discharged into the Grand Canal, mixed with other water in the Grand Canal, and used for irrigation or other uses; or (iii) trespasser activity in the Grand Canal. [v] Provides continued gathering of empirical groundwater quality to further verify natural attenuation and determine if a potential and unforeseen threat develops.	**High** – Same as less aggressive remedy.	**High** – Slightly greater than the reference remedy, since the more aggressive controlled migration remedy would reduce the mid-term to longer term flux of COCs toward water supply wells (but only provide marginal reduction in the overall risk to human health).
Protectiveness of Aquatic Biota	**High** – The recent maximum COC concentrations in the groundwater do not pose a risk to aquatic biota from water discharged from SRP wells into the Grand Canal and mixed with other water in the Grand Canal. There is no risk that the discharge would cause a degradation of water quality relative to applicable receiving water quality standards protective of aquatic biota. [v]	**High** – Same as less aggressive remedy.	**High** – No appreciable improvement from the less aggressive and reference remedy.
Protectiveness of Terrestrial Biota	**High** – The recent maximum COC concentrations in the groundwater do not pose a risk to terrestrial biota and there is no risk that the discharge into the Grand Canal would cause a degradation of water quality relative to applicable receiving water quality standards protective of terrestrial biota. [v]	**High** – Same as the less aggressive remedy.	**High** – No appreciable improvement from the less aggressive and reference remedy.
Value for Lowering Risk to Human Biota	**None** – the COCs in the groundwater do not pose an appreciable risk to human health from: (i) water used for its beneficial purposes; (ii) water from Michigan Trailer Park (MTP) and Danone wells, or from water that is discharged from SRP wells into the Grand Canal, mixed with other water in the Grand Canal, and used for irrigation or other uses; or (iii) trespasser activity in the Grand Canal [v]. Provides continued gathering of empirical groundwater quality to determine if a potential and unforeseen threat develops and trigger a contingency action, if needed.	**None** – Same as less aggressive remedy but at a higher cost.	**None to Low** – Same as or slightly greater value than the reference remedy as it decreases COC concentrations in groundwater and mass flux, but at a higher cost.

Table 2
Comparative Evaluation of Reference and Alternative Remedies
East Grand Avenue WQARF Site, Phoenix, Arizona

Comparative Evaluation Criteria [i]	Less Aggressive Remedy – Annual Groundwater Monitoring	Reference Remedy – Semi-Annual Groundwater Monitoring	More Aggressive Remedy – Controlled Migration and Groundwater Treatment [ii]
Value for Lowering Risk to Aquatic and Terrestrial Biota	**None** – The COCs in the groundwater do not pose a risk to aquatic biota from water from the SRP wells that is discharged into the Grand Canal and mixed with other water in the Grand Canal and there is no risk that the discharge would cause a degradation of water quality relative to applicable receiving water quality standards protective of aquatic or terrestrial biota. [v]	**None** – Same as the less aggressive remedy but at a higher cost.	**None** – Same as the less aggressive remedy (no significant reduction to the COCs relative to the water quality standards protective of aquatic or terrestrial biota).
Value for Reducing COCs in Groundwater	**Low to Moderate** – Natural attenuation will further reduce COCs in groundwater at a low cost. Source area(s) and sitewide COC concentrations were significantly reduced by historical remedial actions and natural attenuation (see Section 2.5).	**Low to Moderate** – Same as the less aggressive remedy but at a slightly higher cost.	**Moderate** – Extraction of COC-affected groundwater would reduce COCs from the groundwater a few years faster than natural attenuation but at a significantly higher cost. This may have no appreciable impact on present and future uses of groundwater given the limited distribution and concentrations of COCs and the time to reach AWQSs everywhere.
Value for Decreasing Liability	**Moderate to High** – The less aggressive remedy verifies natural attenuation which will reduce the liability over the medium term at the lowest cost. Provides continued gathering of empirical groundwater quality to further verify natural attenuation and determine if a potential and unforeseen threat develops triggering a contingency action.	**Moderate to High** – Same as less aggressive remedy but at a slight higher cost.	**High** – Groundwater treatment would achieve the legal remedy more quickly at the highest cost, though it may have no appreciable impact on present and future uses of groundwater pumped from the MTP, Danone, and/or SRP wells.
Value for Securing Public Acceptance	**Moderate to High** – The less aggressive remedy use continued groundwater monitoring to further verify natural attenuation and determine if a potential and unforeseen threat develops and trigger a contingency action, if needed. This remedy is predicated on historical remedial efforts including vapor extraction and natural attenuation that have reduced the footprint and concentrations significantly.	**Moderate to High** – Same as the less aggressive remedy but the more frequent monitoring may be more acceptable to the public. This would come at a modest cost increase.	**High** – Groundwater treatment (i.e., a more active remedial actions) may be preferred by the public or a third party, though it may have no appreciable impact on present and future uses of groundwater.
Value for Preservation of Uses of Groundwater Pumped from the Aquifers	**Moderate to High** – Current uses of groundwater are not threatened to be impaired or lost. Natural attenuation will return groundwater to the AWQS in the next 17 years. Provides continued gathering of empirical groundwater quality to further verify natural attenuation and determine if a potential and unforeseen threat develops triggering a contingency action.	**Moderate to High** – Same as less aggressive remedy but at a slightly higher cost.	**Moderate to High** – Same as the reference remedy except controlled migration using groundwater extraction improve groundwater quality but would slightly reduce the available groundwater supply (unless treated groundwater is reinjected). This comes at a significantly higher cost.

Table 2
Comparative Evaluation of Reference and Alternative Remedies
East Grand Avenue WQARF Site, Phoenix, Arizona

Comparative Evaluation Criteria [i]	Less Aggressive Remedy – Annual Groundwater Monitoring	Reference Remedy – Semi-Annual Groundwater Monitoring	More Aggressive Remedy – Controlled Migration and Groundwater Treatment [ii]
Value for Enhancement of Future Uses of Groundwater Pumped from the Aquifers	**Moderate** – Natural attenuation will return groundwater to the AWQS in the next 17 years or less. In the meantime, it provides continued gathering of empirical groundwater quality to further verify natural attenuation and determine if a potential and unforeseen threat develops triggering a contingency action.	**Moderate** – Same as less aggressive remedy but at a slight increase in cost.	**Moderate to High** – Groundwater extraction and GAC adsorption may have a slight positive impact on future uses of groundwater. The remedy will improve the water quality at the EGA Site more quickly than natural attenuation.
Contingency Measures	The contingency measure for the reference remedy will be triggered and implemented if existing or new wells become threatened. The contingency measure includes: 1) threat assessments; 2) well siting study(s); 3) well modifications, and 4) well head treatment. The contingency would be implemented in a phased adaptive approach to protect all water uses so long as they are threatened.	Same as less aggressive remedy.	Same as less aggressive remedy.
Effects on Local Economies	**Neutral** – The less aggressive remedy will not enhance or limit foreseeable economic uses or pose an undue burden on the water supply well users.	**Neutral** – The same as the less aggressive remedy.	**Neutral** – Same as aggressive remedy; however, any economic benefits from remediation would be negatively offset by the PRP's expenses.
Total Approximate Costs[vi]	$1.8 million	$2.1 million	$7.0 million [vii]
Net Present Value (inflation only) [viii]	$2.6 million	$3 million	$8.0 million [vii]

Abbreviations and Acronyms
A.A.C – Arizona Administrative Code
ADEQ – Arizona Department of Environmental Quality
AWQS - Arizona Water Quality Standards
COC - chemicals of concern
CSM – conceptual site model
EGA - East Grand Avenue
GAC – Granulated Activated Carbon
MTP – Michigan Trailer Park
PRP – Potentially Responsible Party
RAP – remedial action plan
SRP - Salt River Project

[i] The comparative evaluation criteria are specified in Arizona Administrative Code (A.A.C.) R18-16-407(H)(3)(a) through (e). Blue shading indicates neutral or no ranking; green shading indicates positive/good ranking; yellow shading indicates moderate ranking; and orange shading indicates negative/poor ranking.

[ii] The continued groundwater monitoring component of the more aggressive remedy has the same attributes as the reference remedy in addition to the highlighted attributes associated with the groundwater extraction and GAC adsorption component of the remedy.

[iii] Arizona Aquifer Water Quality Standard, A.A.C. R18-11-406

[iv] A.A.C. R18-11 Appendix A

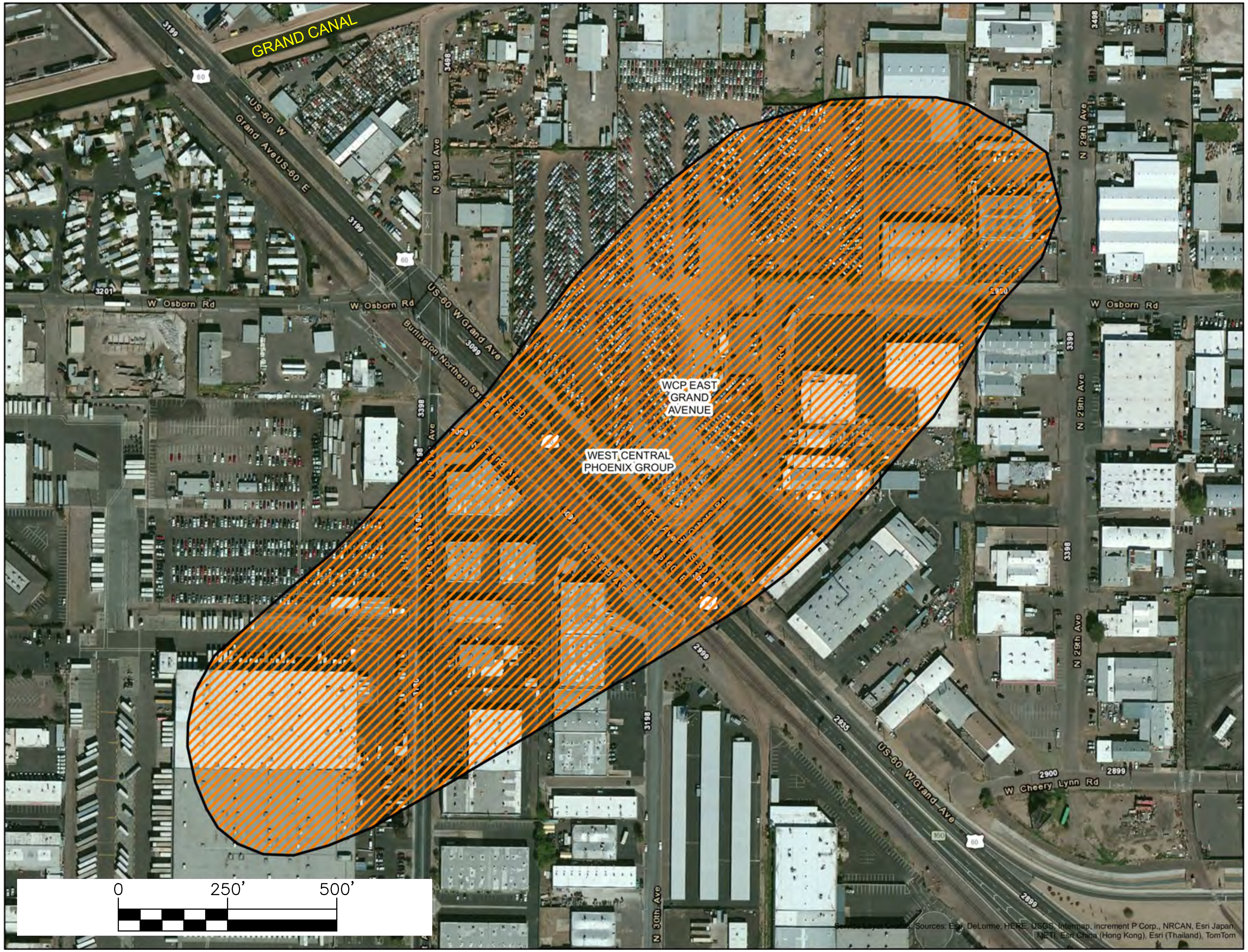
[v] See also Section 2.5 and A.A.C. Title 18, Ch. 11, Art. 1, Appendix B - stating Phoenix area canals below municipal water treatment plant intakes have surface water quality standards protective only of agricultural uses.

[vi] All cost estimates in this table are approximate and are for comparative use. The costs include well abandonments and contingency costs, where applicable, and are based on reasonable assumptions that are nonetheless significantly variable until the development of the remedial action plan (RAP) pursuant to A.A.C. R18-16-408 and R18-16-410 and the establishment of any required financial assurance mechanism for the cost of the implementation of the RAP pursuant to A.A.C. R18-16-407(G). The costs are detailed further in Appendix D.

[vii] Costs for the aggressive remedy are based on the current conceptual site model (CSM) and would require further studies to appropriately design and cost the remedy.

[viii] Net present value is based on an inflation rate of 3% and no discount rate, per Arizona Department of Environmental Quality (ADEQ). Per A.A.C. R18-16-407(G), “The Department may require financial mechanisms to provide for the cost of implementation of the remedial measures.” The financial assurance costs will be determined after the remedy is selected and Proposed Remedial Action Plan is prepared.

FIGURES



AERIAL IMAGE COURTESY AZDEQ wcp_epamap.pdf

WQARF Site
Water Quality Assurance Revolving Fund

Plume Data Update: 1/1/2013

N

Plume boundaries depicted on the site map represent ADEQ's interpretation of data available at the time the map was constructed. The map is intended to provide the public with basic information as to the estimated geographic extent of known contamination as of the date of map production. The actual extent of contamination may be different. Therefore, the plume for this site may change in the future as new information becomes available.

Date Map Saved: 5/14/2015

ADEQ Arizona Department of Environmental Quality

Publication Number: M 15 -15

WEST CENTRAL PHOENIX,
EAST GRAND AVENUE WQARF SITE

SITE LOCATION

ARCADIS Design & Consultancy for natural and built assets

FIGURE
1

Date\Time : Thu, 21 May 2020 – 11:32am
Path\Name : C:\Users\EKrahmer\BIM 360\Arcadis\ANA – UNIVAR USA\Project Files\UNIVAR WEST PHOENIX AZ\2020\30039154\01-DWG\W_PHX_Fig01 VMap.dwg

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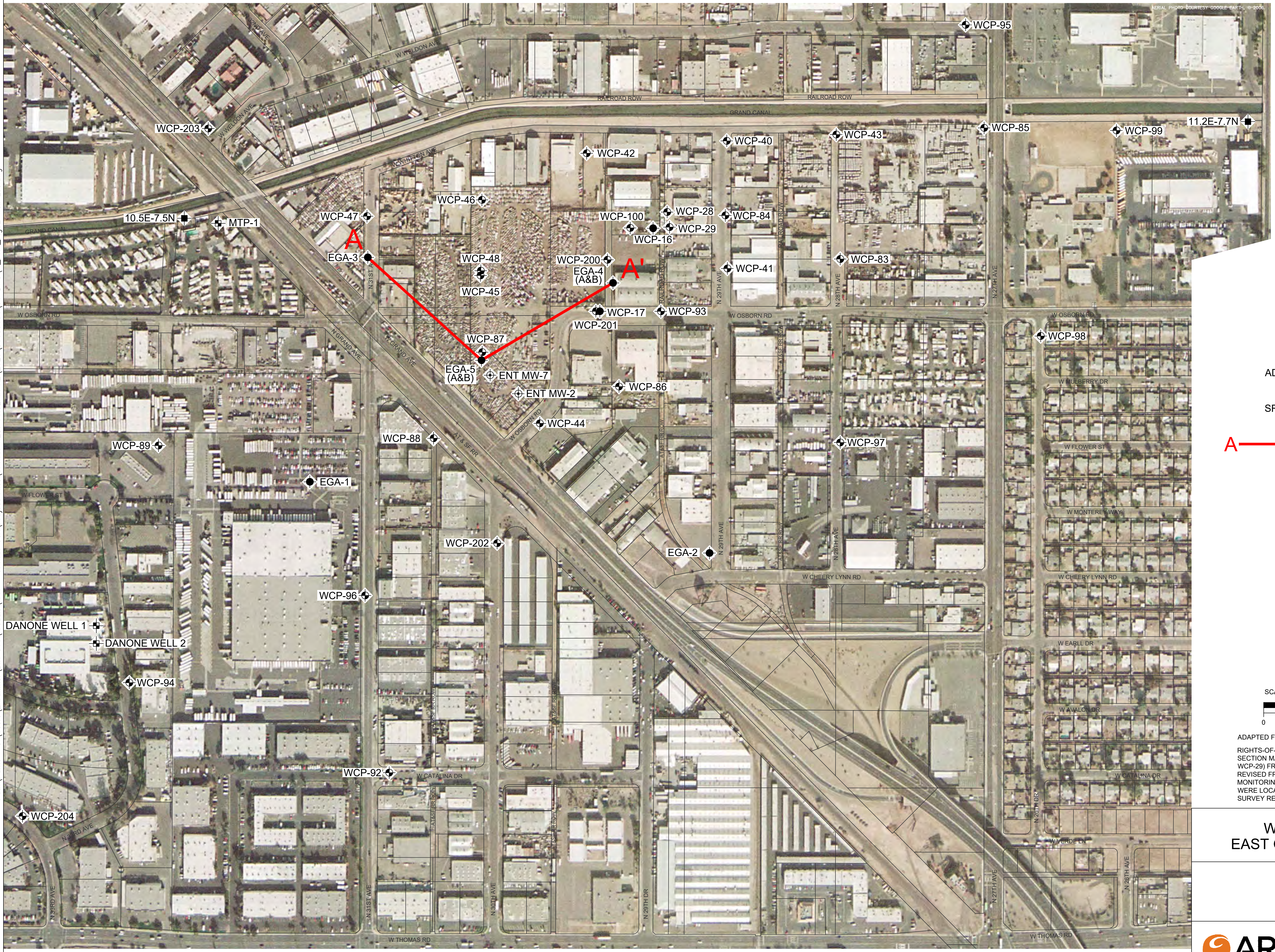


EXPLANATION

- MONITORING WELL, UNIVAR
- MONITORING WELL, ADEQ
- MONITORING WELL, OTHER
- PRODUCTION WELL, SRP
- PRODUCTION WELL, OTHER

ADEQ = ARIZONA DEPARTMENT OF ENVIRONMENTAL QUALITY

SRP = SALT RIVER PROJECT

A —— A' CROSS SECTION LOCATION

N

SCALE: 1 INCH = 400 FEET

0 200 400 800

ADAPTED FROM G.W. CLEMENT & ASSOCIATES, INC DRAWING DATED 12-11-13.

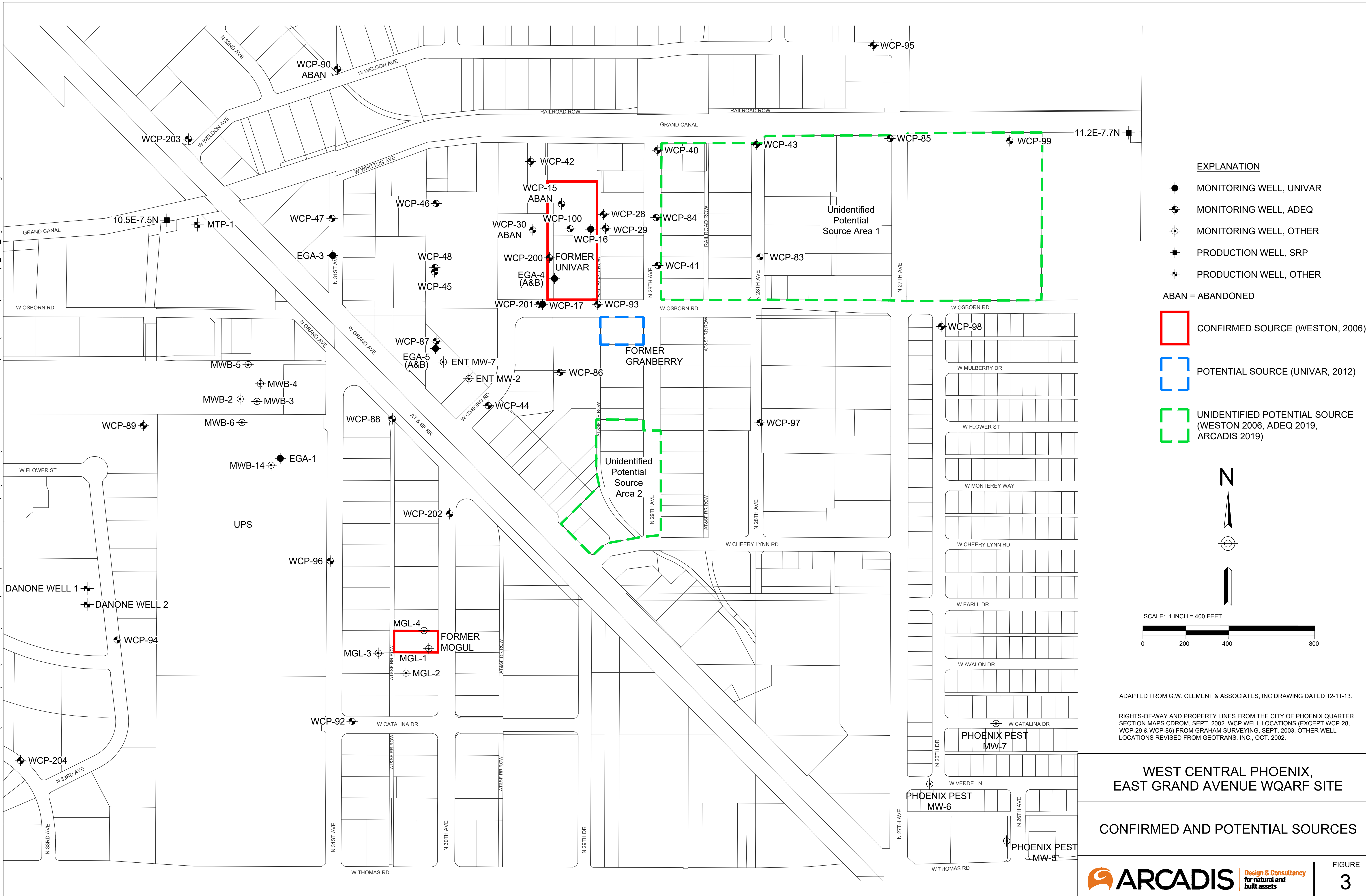
RIGHTS-OF-WAY AND PROPERTY LINES FROM THE CITY OF PHOENIX QUARTER SECTION MAPS CDROM, SEPT. 2002. WCP WELL LOCATIONS (EXCEPT WCP-28, WCP-29) FROM GRAHAM SURVEYING, SEPT. 2003. OTHER WELL LOCATIONS REVISED FROM GEOTRANS, INC., OCT. 2002.
MONITORING WELLS WCP-46, WCP-86, WCP-87, WCP-88, WCP-100 AND WCP-200 WERE LOCATED PER SUPPLEMENTAL INFORMATION PROVIDED BY AZTEC SURVEY REPORT DATED MARCH 12, 2015

WEST CENTRAL PHOENIX,
EAST GRAND AVENUE WQARF SITE

WELL LOCATIONS

ARCADIS Design & Consultancy for natural and built assets

FIGURE 2



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RIGHTS-OF-WAY AND PROPERTY LINES FROM THE CITY OF PHOENIX QUARTER SECTION MAPS CDROM, SEPT. 2002. WCP WELL LOCATIONS (EXCEPT WCP-28, WCP-29 & WCP-86) FROM GRAHAM SURVEYING, SEPT. 2003. OTHER WELL LOCATIONS REVISED FROM GEOTRANS, INC., OCT. 2002.

WEST CENTRAL PHOENIX,
EAST GRAND AVENUE WQARF SITE

CONFIRMED AND POTENTIAL SOURCES

ARCADIS Design & Consultancy for natural and built assets

FIGURE
3

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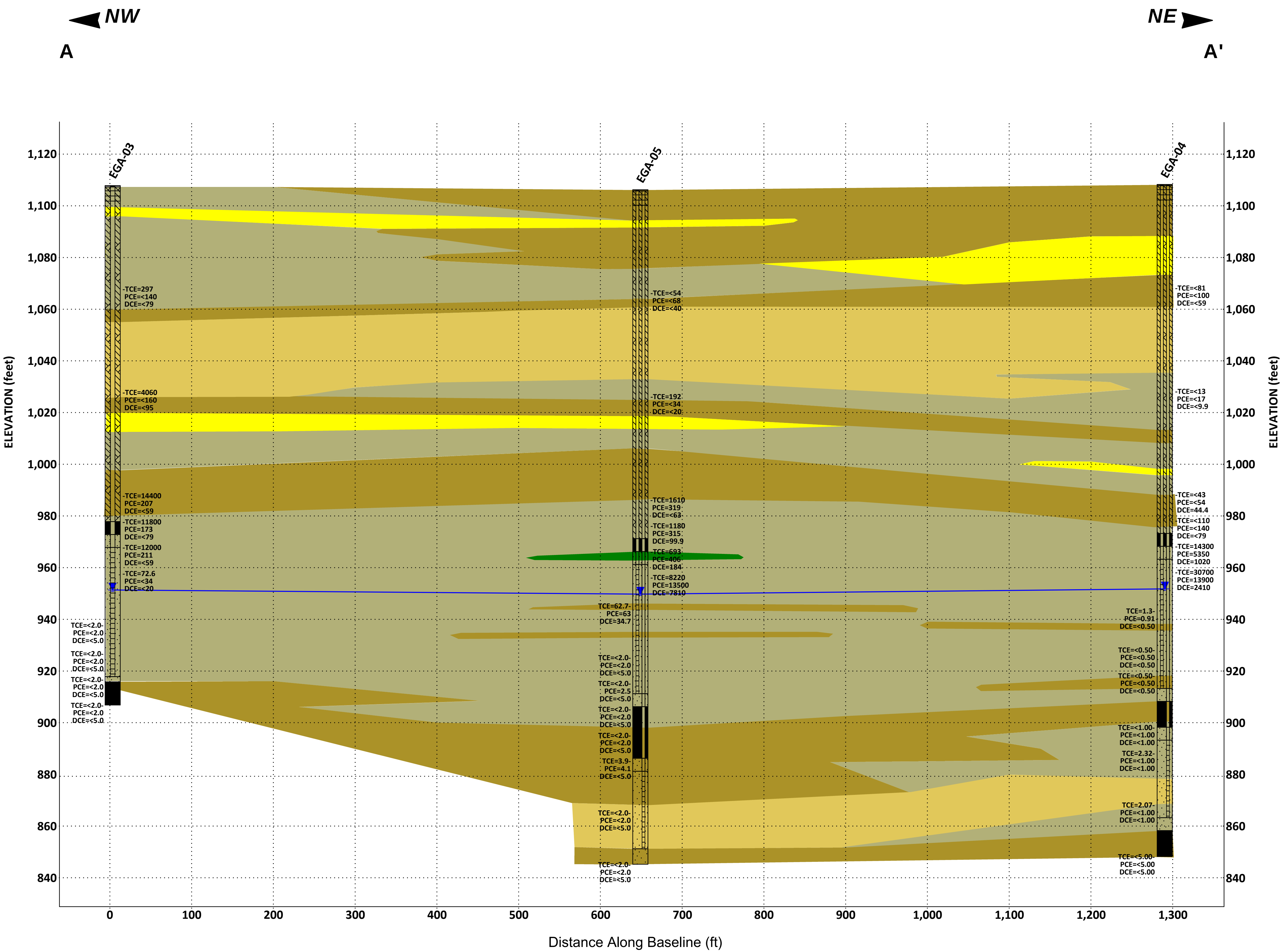


LEGEND

HYDROGEOLOGIC UNITS

- Sands with <10% fines
- Sands with 10-25% fines
- Silty Sands and Clayey Sands with >25% fines
- Silts
- Clays

Soil Boring

Soil Gas Analytical Data
-PCE=<20 - Trichloroethene ug/M3
TCE=20 - Tetrachloroethene ug/M3
DCE=20 - 1,1-Dichloroethene ug/M3

Groundwater Analytical Data
Trichloroethene ug/l - TCE=<20-
Tetrachloroethene ug/l - PCE=20
1,1-Dichloroethene ug/l - DCE=20

Water Level Encountered During Drilling

Soil Boring Lithology

NOTES:
1. ug/l = micrograms per liter
2. ug/M3 = micrograms per cubic meter
3. "-" Indicates the sample location

Vertical Scale (Feet) 40
Horizontal Scale (Feet) 125
Vertical Exaggeration: 3.1X

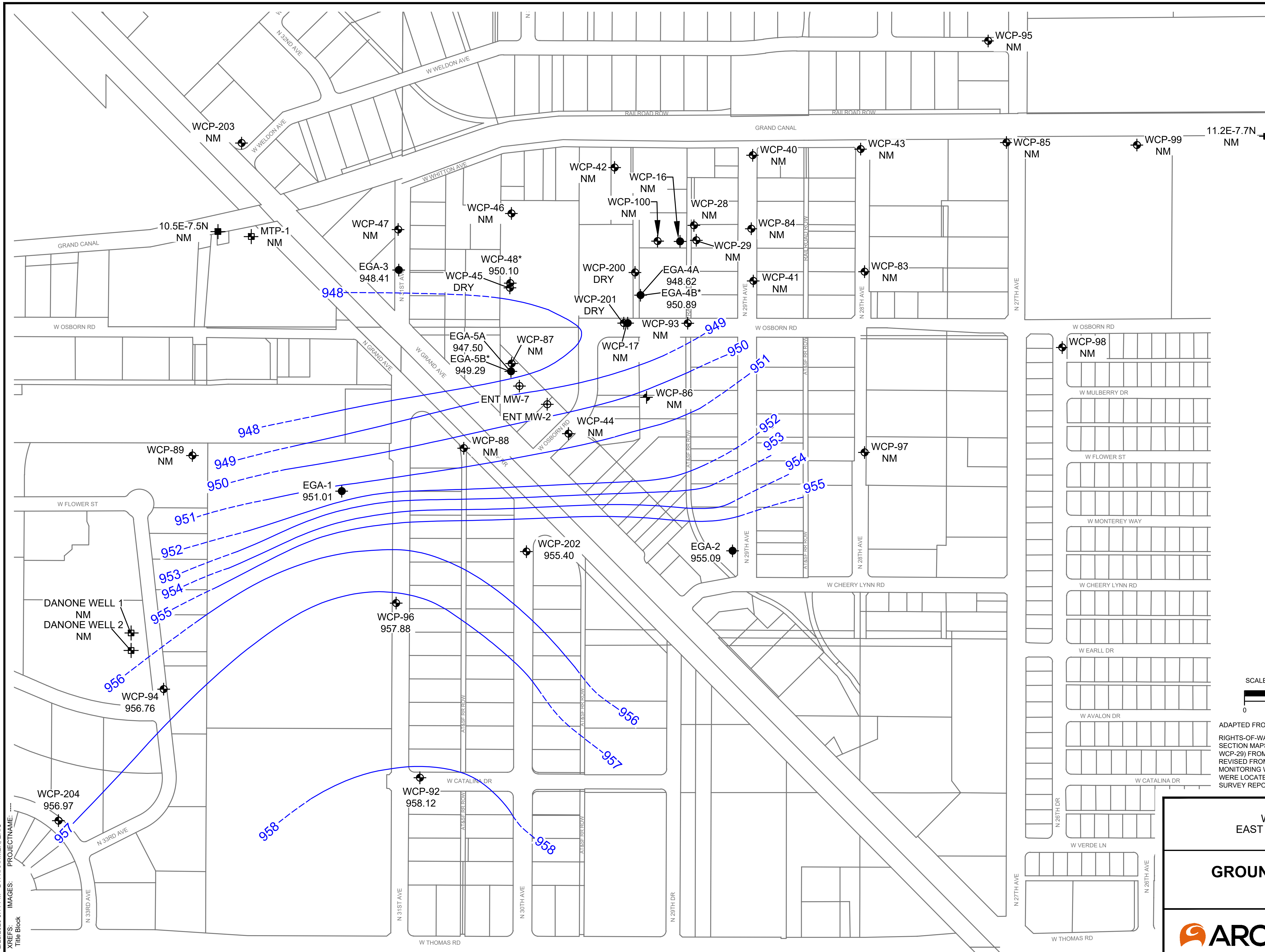
East Grand Avenue Site
Phoenix, Arizona

Cross Section A-A'

ARCADIS Design & Consultancy for natural and built assets

FIGURE 4

PIC: PM: TM: PROJECT NUMBER: 30008755
UNIVAR CROSS SECTION ANALYTICAL C:\USERS\DMAURER\ARCADIS\ONEDRIVE - ARCADIS\BENTLEY\PROJECTS\UNIVAR-PHOENIX\UNIVAR PHOENIX DRILLING 10-31-2019 REV4.GPJ UNIVAR PHOENIX REV2.GDT 5/12/20



EXPLANATION

- MONITORING WELL, UNIVAR
- MONITORING WELL, ADEQ
- MONITORING WELL, OTHER
- WATER SUPPLY WELL, SRP
- WATER SUPPLY WELL, OTHER

950.80 WATER LEVEL ELEVATIONS COLLECTED ON JANUARY 14, 2020. IN FEET ABOVE MEAN SEA LEVEL.

GROUNDWATER ELEVATION CONTOURS (DASHED WHERE INFERRED)

ADEQ= ARIZONA DEPARTMENT OF ENVIRONMENTAL QUALITY

DRY = GROUNDWATER ELEVATION BELOW BOTTOM OF SCREEN

NM = NOT MEASURED

SRP = SALT RIVER PROJECT

* = WELL IS SCREENED DEEPER THAN THE AVERAGE UAU WATER TABLE WELL

SCALE: 1 INCH = 400 FEET

0 200 400 800

ADAPTED FROM G.W. CLEMENT & ASSOCIATES, INC DRAWING DATED 12-11-13.

RIGHTS-OF-WAY AND PROPERTY LINES FROM THE CITY OF PHOENIX QUARTER SECTION MAPS CDROM, SEPT. 2002. WCP WELL LOCATIONS (EXCEPT WCP-28, WCP-29) FROM GRAHAM SURVEYING, SEPT. 2003. OTHER WELL LOCATIONS REVISED FROM GEOTRANS, INC., OCT. 2002.
MONITORING WELLS WCP-46, WCP-86, WCP-87, WCP-88, WCP-100 AND WCP-200 WERE LOCATED PER SUPPLEMENTAL INFORMATION PROVIDED BY AZTEC SURVEY REPORT DATED MARCH 12, 2015

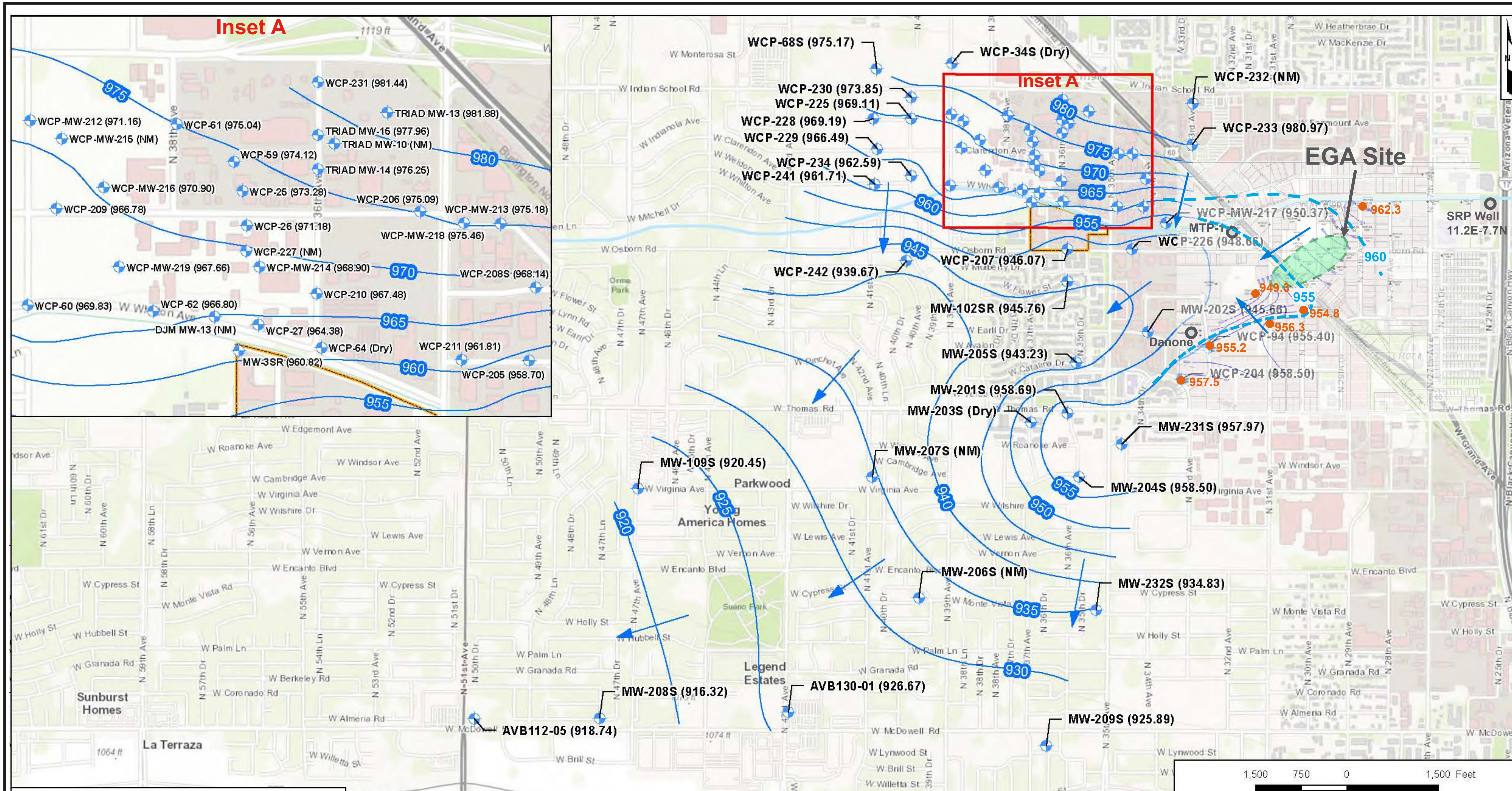
WEST CENTRAL PHOENIX
EAST GRAND AVENUE WQARF SITE

GROUNDWATER ELEVATIONS
JANUARY 2020

ARCADIS Design & Consultancy for natural and built assets

FIGURE
5

CITY: SYRACUSE NY DIV/GROUP: ENVCAD DB: E. KRAHMER PIC: PM: TM: TR: LYR:(Opt)ON=*;OFF=*REF*
C:\Users\EKrahmer\BIM 360\Arcadis\AUS - UNIVAR USA\Project Files\UNIVAR WEST PHOENIX AZ\2020\30008755\01-DWG\W_PHX_Fig02 GW Elev 2020-01.dwg LAYOUT: 2 SAVED: 2/28/2020 4:59 PM ACADVER: 23.1S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE: PLTFULL.CTB PLOTTED:
2/28/2020 5:11 PM BY: KRAHMER, ERIC
XREFS: Title Block IMAGES: PROJECTNAME: ----



Legend:

- 954.8 — East Grand Avenue (EGA) well and March 2018 groundwater elevation
- 958.50 — North Canal Plume / West Osborn Complex well and January 2018 groundwater elevation
- Danone — Active water supply well within 1/2 mile of the EGA site
- Groundwater flow direction
- Groundwater elevation contour (dashed where inferred)
- Approximate EGA Site Groundwater Greater than the AWQS 2014-2015

Sources:
Arcadis 2019. 2018 Annual Groundwater Monitoring Report, East Grand Avenue WQARF Site, Phoenix, Arizona. November 30.
Titus 2019. Personal Communication. March 11.

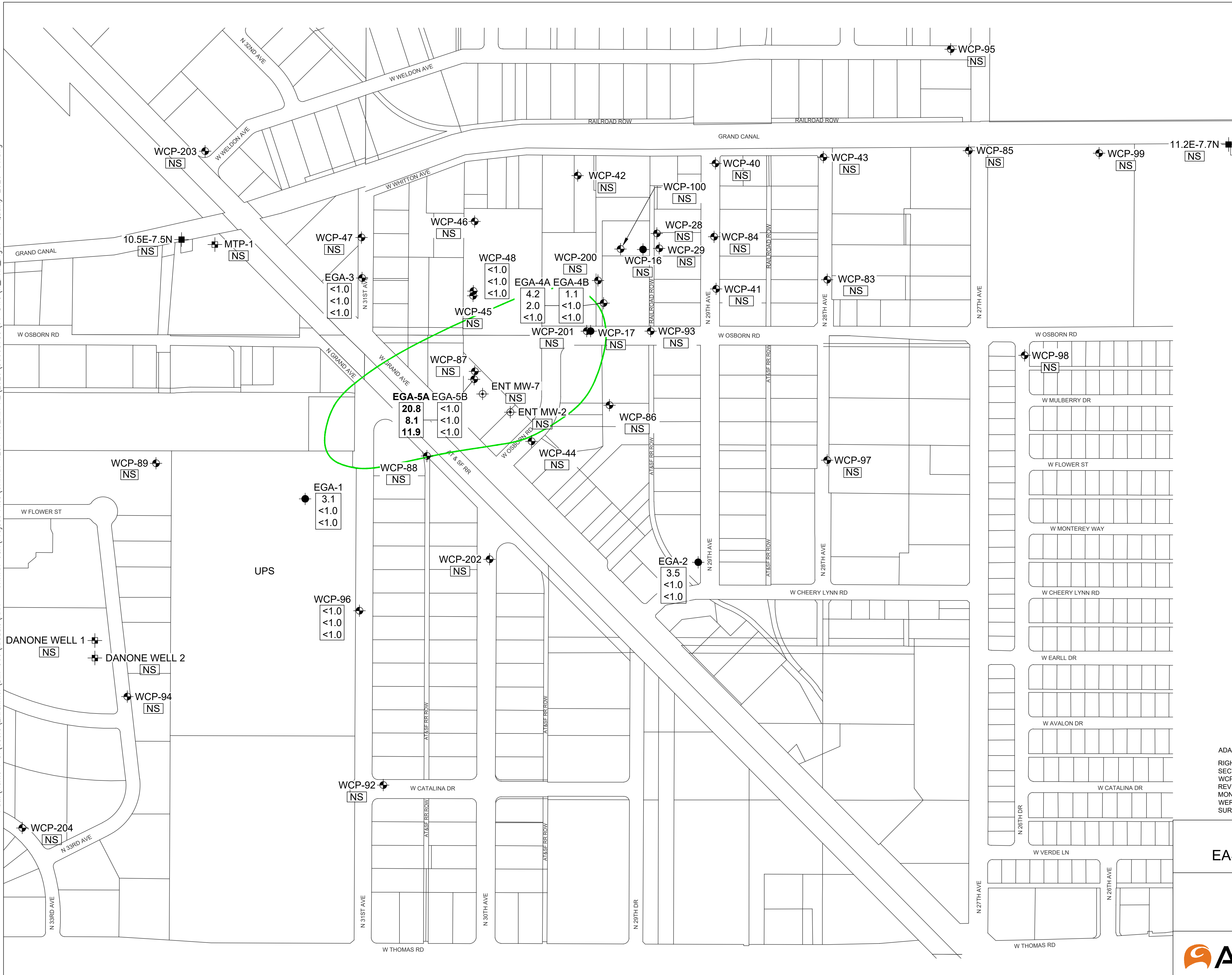
WEST CENTRAL PHOENIX, EAST GRAND AVENUE WQARF SITE

GROUNDWATER ELEVATIONS Q1-2018

ARCADIS Design & Consultancy for natural and built assets

FIGURE 6

5/12/2020 5:07:45 PM



EXPLANATION

- MONITORING WELL, UNIVAR
- MONITORING WELL, ADEQ
- MONITORING WELL, OTHER
- PRODUCTION WELL, SRP
- PRODUCTION WELL, OTHER

WCP-96	WELL I.D	AWQS
<1.0	TRICHLOROETHENE	5
<1.0	TETRACHLOROETHENE	5
<1.0	1,1- DICHLOROETHENE	7

CONCENTRATIONS SHOWN IN MICROGRAMS PER LITER (µg/L)

ADEQ = ARIZONA DEPARTMENT OF ENVIRONMENTAL QUALITY

AWQS = ARIZONA AQUIFER WATER QUALITY STANDARD

NS = NOT SAMPLED, WELL WAS DRY (IN JANUARY AND/OR HISTORICALLY)

SRP = SALT RIVER PROJECT

BOLD = RESULT GREATER THAN THE RESPECTIVE AWQS

TRICHLOROETHENE (TCE) ISOCONCENTRATION CONTOUR - TCE HAS THE HIGHEST CONCENTRATION RELATIVE TO THE AWQS

ADAPTED FROM G.W. CLEMENT & ASSOCIATES, INC DRAWING DATED 12-11-13.

RIGHTS-OF-WAY AND PROPERTY LINES FROM THE CITY OF PHOENIX QUARTER SECTION MAPS CDROM, SEPT. 2002. WCP WELL LOCATIONS (EXCEPT WCP-28, WCP-29) FROM GRAHAM SURVEYING, SEPT. 2003. OTHER WELL LOCATIONS REVISED FROM GEOTRANS, INC., OCT. 2002.
MONITORING WELLS WCP-46, WCP-86, WCP-87, WCP-88, WCP-100 AND WCP-200 WERE LOCATED PER SUPPLEMENTAL INFORMATION PROVIDED BY AZTEC SURVEY REPORT DATED MARCH 12, 2015

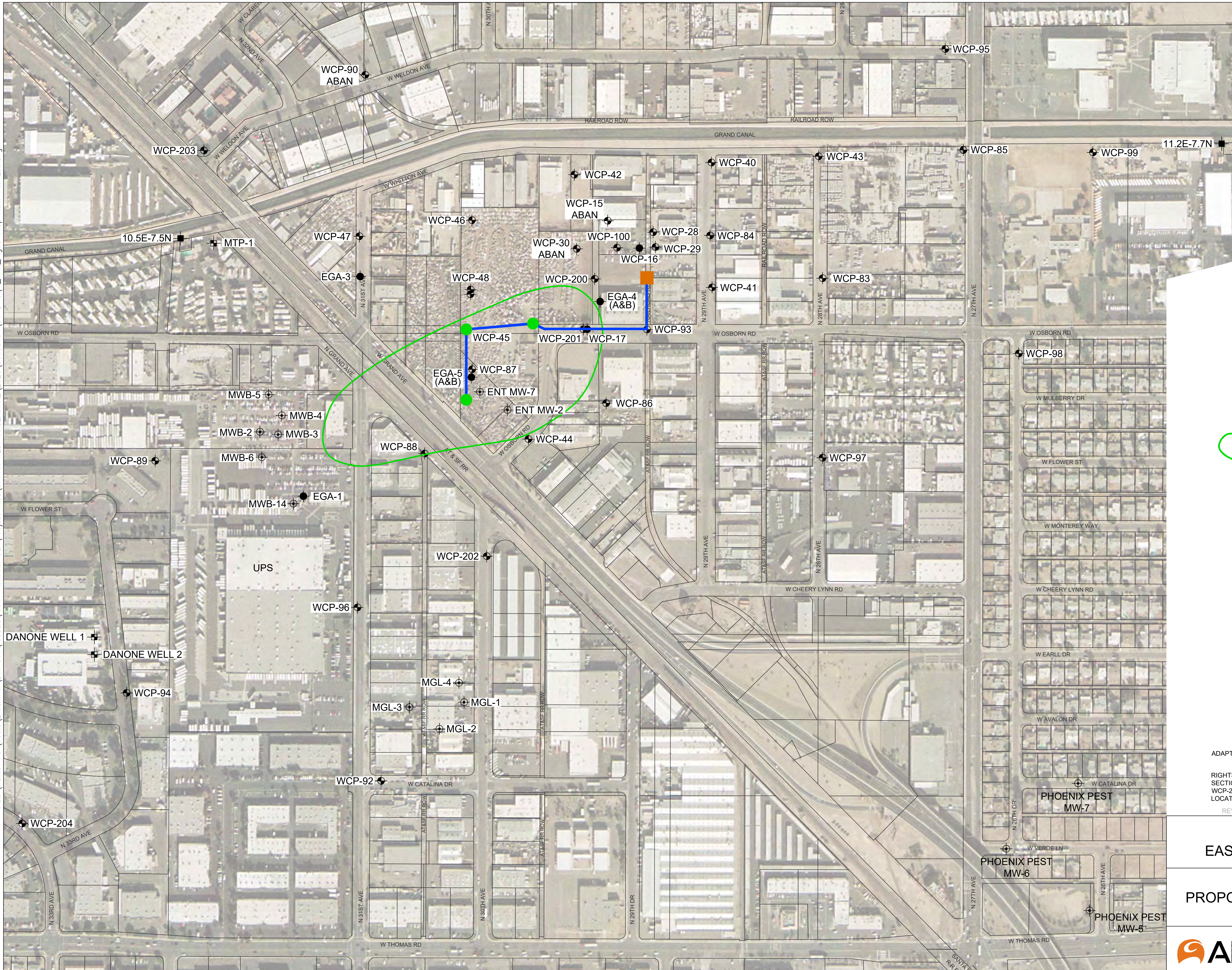
WEST CENTRAL PHOENIX,
EAST GRAND AVENUE WQARF SITE

GROUNDWATER QUALITY
JANUARY 2020

ARCADIS Design & Consultancy for natural and built assets

FIGURE 7

Date\Time : Tue, 26 May 2020 – 2:17pm
Path\Name : C:\Users\EKrahmer\BIM 360\Arcadis\ANA – UNIVAR USA\Project Files\UNIVAR WEST PHOENIX AZ\2020\30008755\01-DWG\W_PHX_Fig07 GW Quality 2020-01.dwg
Acad Version : R23.1s (LMS Tech)
User Name : ekrahmer



EXPLANATION

- MONITOR WELL, UNIVAR
- MONITOR WELL, ADEQ
- MONITOR WELL, OTHER
- PRODUCTION WELL, SRP
- PRODUCTION WELL, OTHER

ABAN = ABANDONED

- AGGRESSIVE REMEDY TREATMENT SYSTEM LOCATION
- AGGRESSIVE REMEDY EXTRACTION WELL
- TREATMENT SYSTEM LINE
- TRICHLOROETHENE (TCE) ISOCONCENTRATION CONTOUR

N

SCALE: 1 INCH = 400 FEET

0 200 400 800

ADAPTED FROM G.W. CLEMENT & ASSOCIATES, INC DRAWING DATED 12-11-13.

RIGHTS-OF-WAY AND PROPERTY LINES FROM THE CITY OF PHOENIX QUARTER SECTION MAPS CDROM, SEPT. 2002. WCP WELL LOCATIONS (EXCEPT WCP-28, WCP-29 & WCP-86) FROM GRAHAM SURVEYING, SEPT. 2003. OTHER WELL LOCATIONS REVISED FROM GEOTRANS, INC., OCT. 2002.

REVISED FROM GEOTRANS, INC. 10/02

WEST CENTRAL PHOENIX,
EAST GRAND AVENUE WQARF SITE

PROPOSED REMEDIAL WELL LOCATIONS

ARCADIS Design & Consultancy for natural and built assets

FIGURE
8

Acad Version : R23.1s (LMS Tech)
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Date\Time : Tue, 26 May 2020 – 2:15pm
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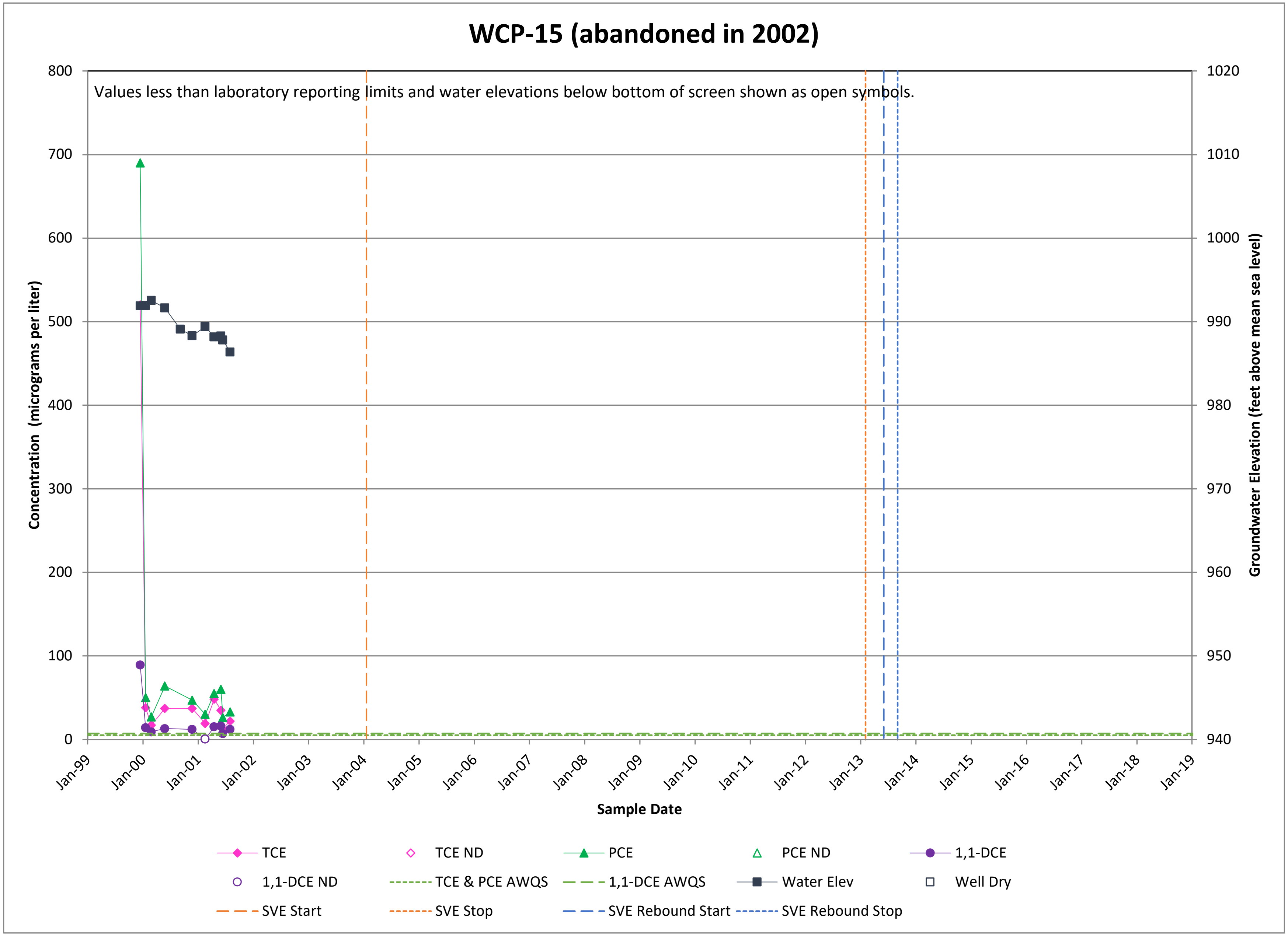
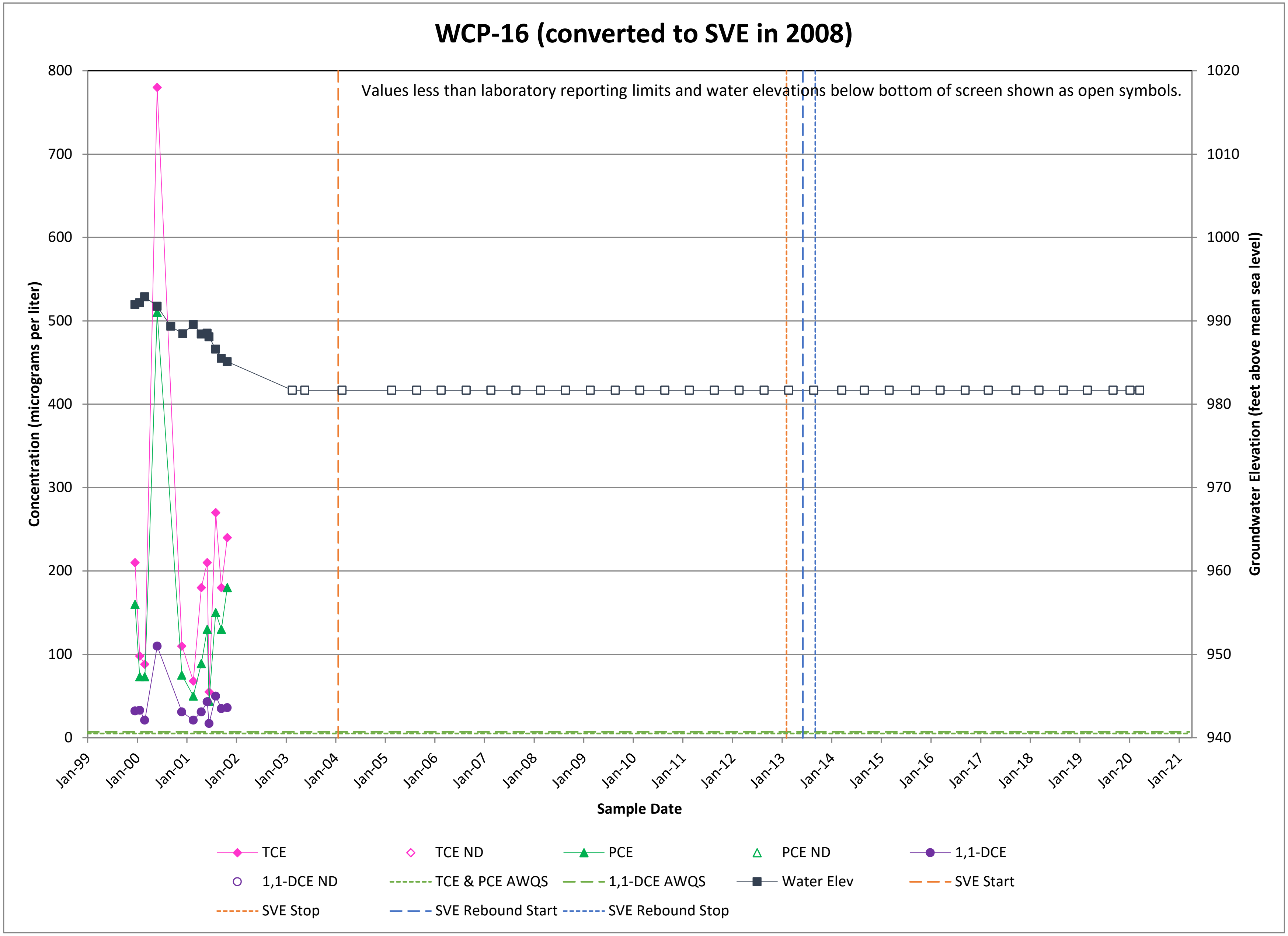
APPENDIX A

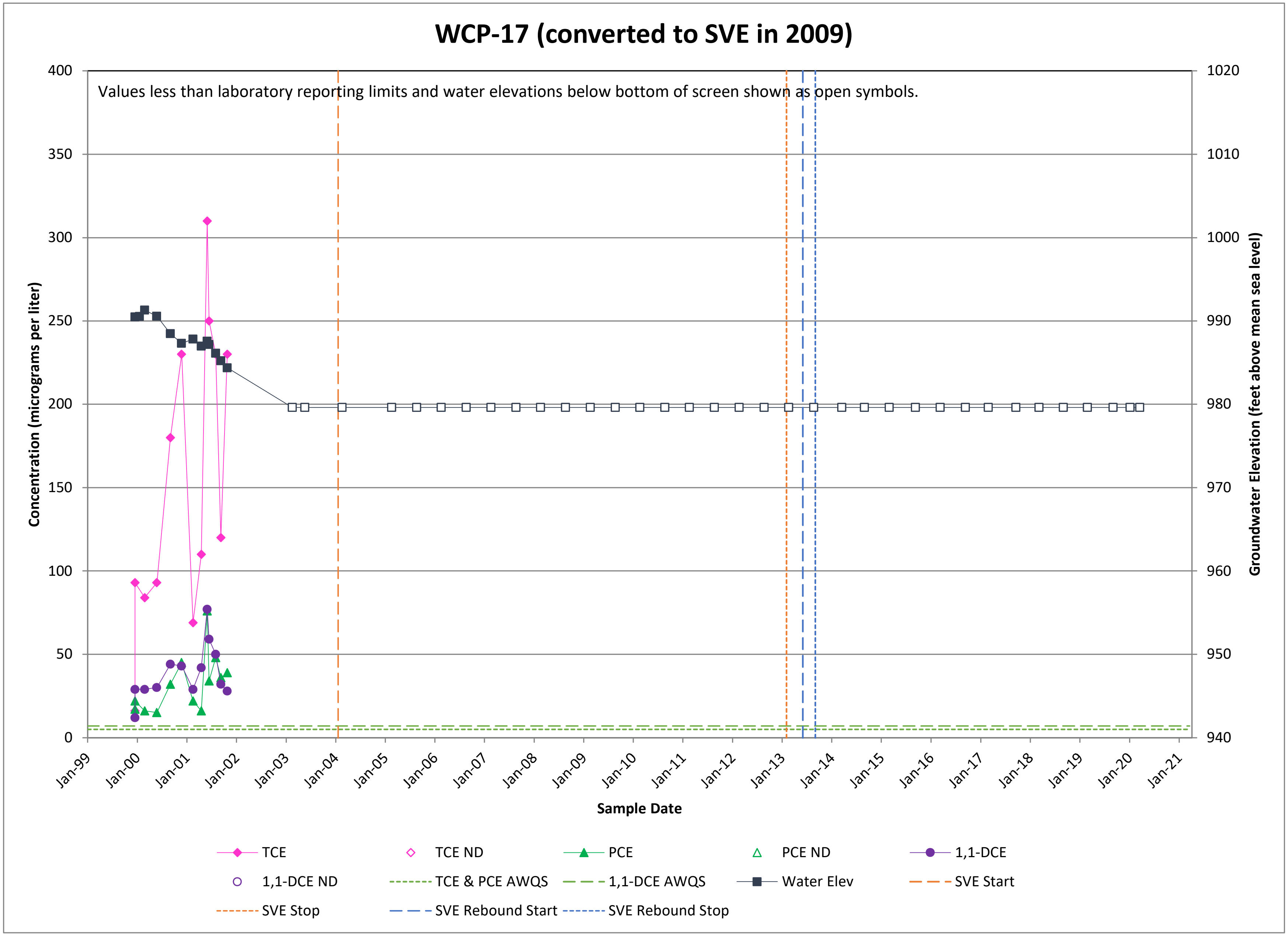
Time Concentration Curves and Hydrographs



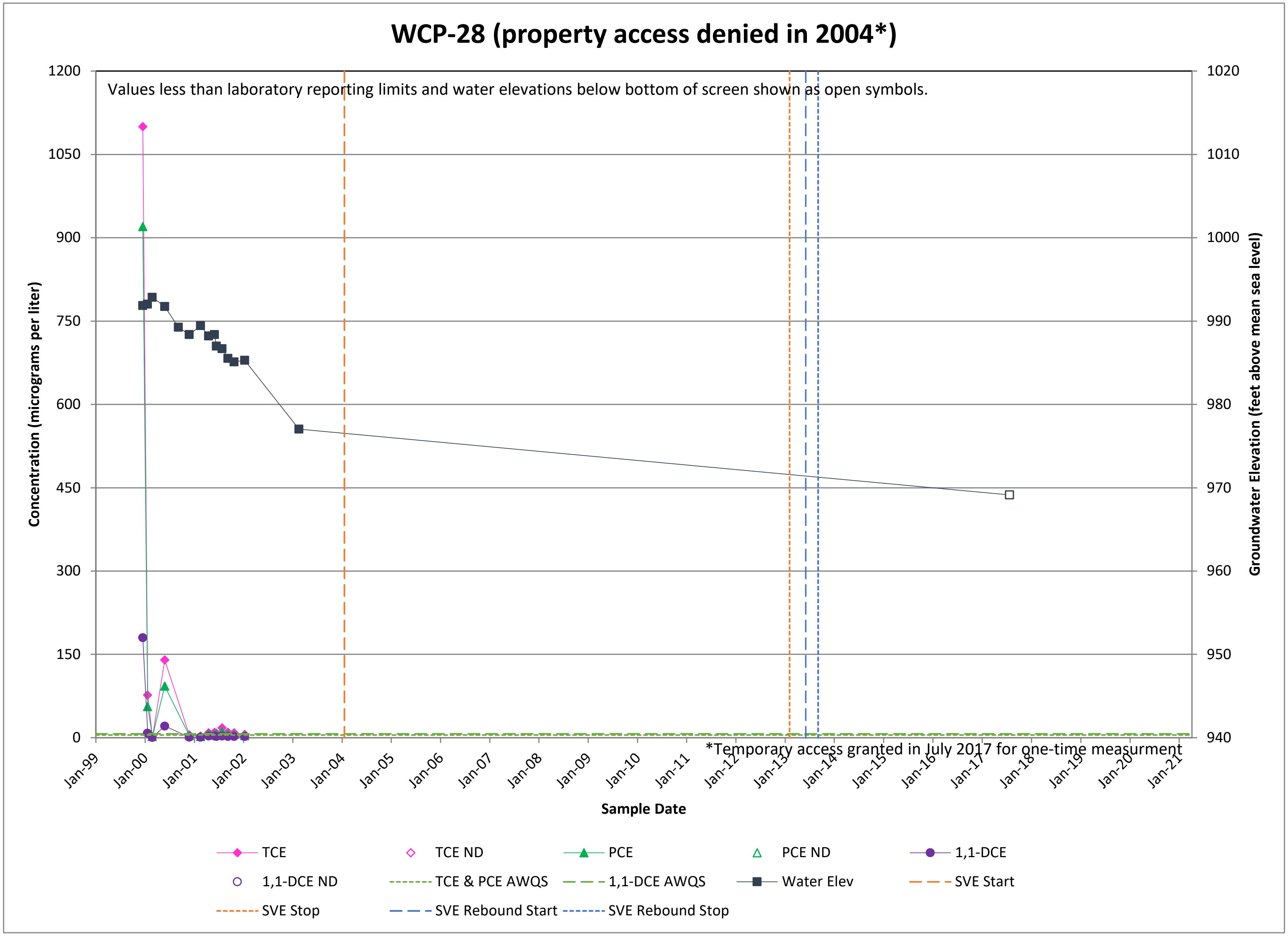
WCP-15 (abandoned in 2002)
Values less than laboratory reporting limits and water elevations below bottom of screen shown as open symbols.
Concentration (micrograms per liter)
Groundwater Elevation (feet above mean sea level)
Sample Date
0
100
200
300
400
500
600
700
800
940
950
960
970
980
990
1000
1010
1020
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Jan-19
TCE
TCE ND
PCE
PCE ND
1,1-DCE
1,1-DCE ND
TCE & PCE AWQS
1,1-DCE AWQS
Water Elev
Well Dry
SVE Start
SVE Stop
SVE Rebound Start
SVE Rebound Stop

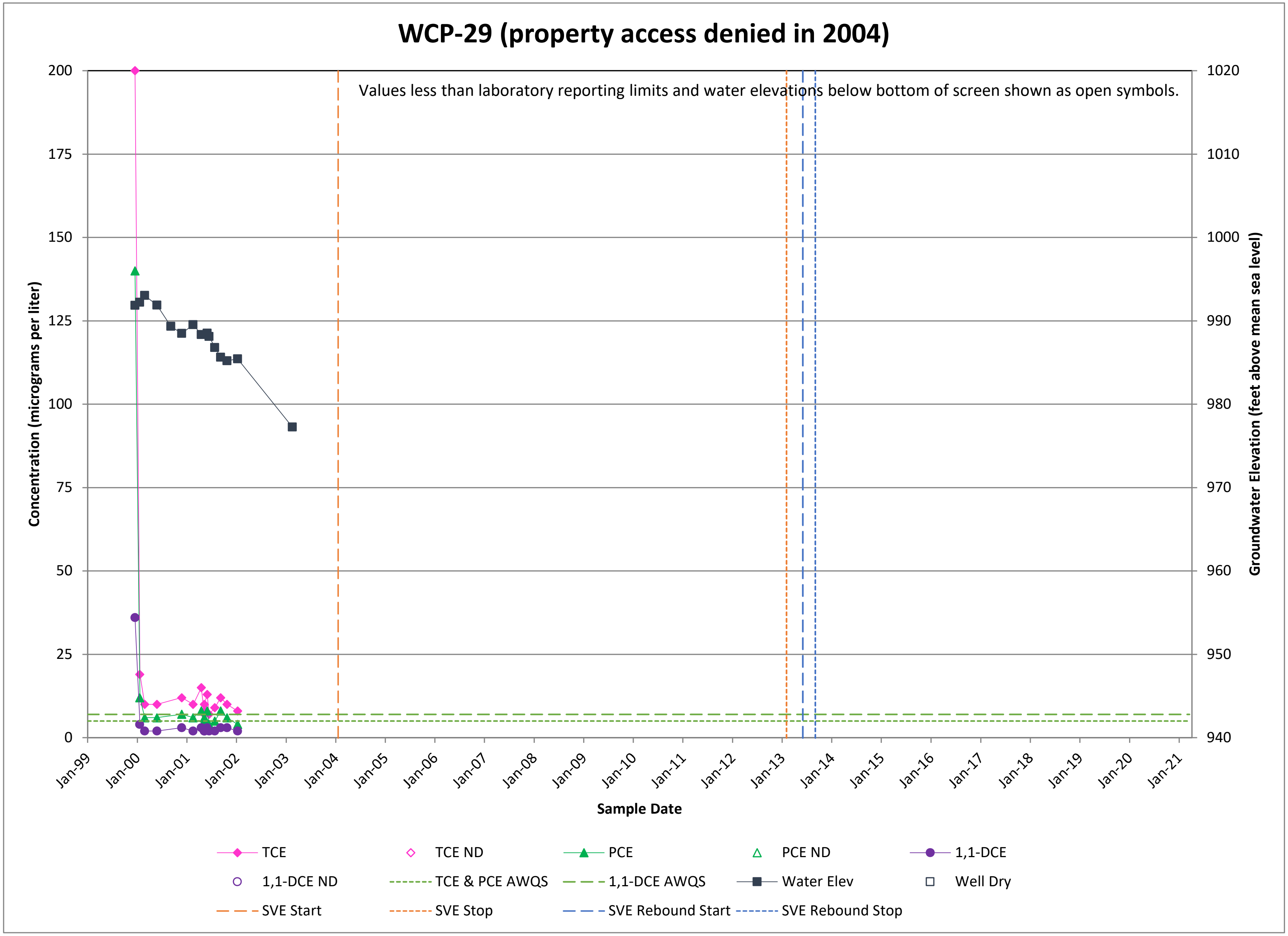


WCP-16 (converted to SVE in 2008)
Values less than laboratory reporting limits and water elevations below bottom of screen shown as open symbols.
Concentration (micrograms per liter)
Groundwater Elevation (feet above mean sea level)
Sample Date
0
100
200
300
400
500
600
700
800
940
950
960
970
980
990
1000
1010
1020
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Jan-19
Jan-20
Jan-21
TCE
TCE ND
PCE
PCE ND
1,1-DCE
1,1-DCE ND
TCE & PCE AWQS
1,1-DCE AWQS
Water Elev
SVE Start
SVE Stop
SVE Rebound Start
SVE Rebound Stop

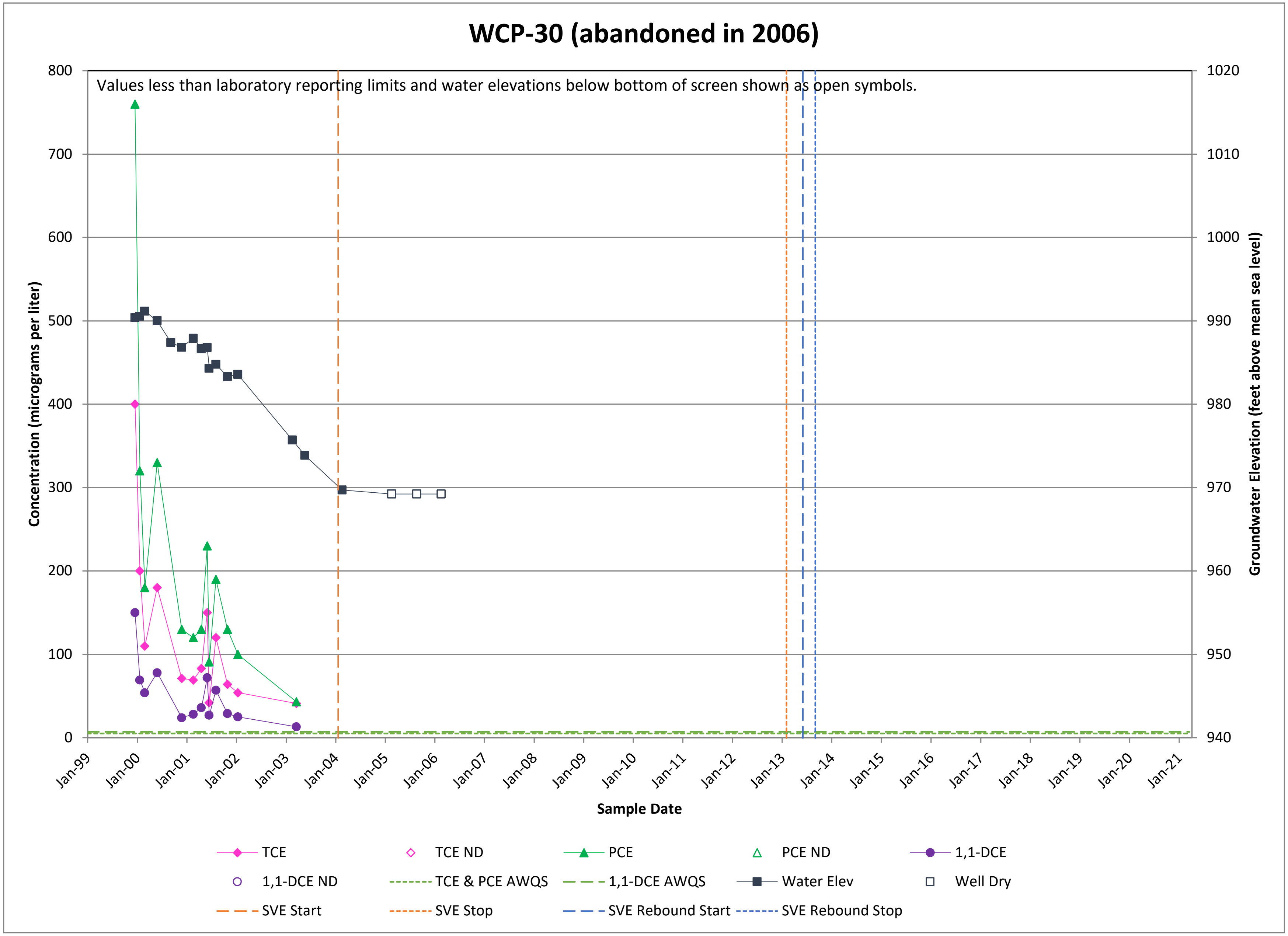


WCP-17 (converted to SVE in 2009)
Values less than laboratory reporting limits and water elevations below bottom of screen shown as open symbols.
Concentration (micrograms per liter)
Groundwater Elevation (feet above mean sea level)
Sample Date
400
350
300
250
200
150
100
50
0
1020
1010
1000
990
980
970
960
950
940
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Jan-19
Jan-20
Jan-21
TCE
TCE ND
PCE
PCE ND
1,1-DCE
1,1-DCE ND
TCE & PCE AWQS
1,1-DCE AWQS
Water Elev
SVE Start
SVE Stop
SVE Rebound Start
SVE Rebound Stop

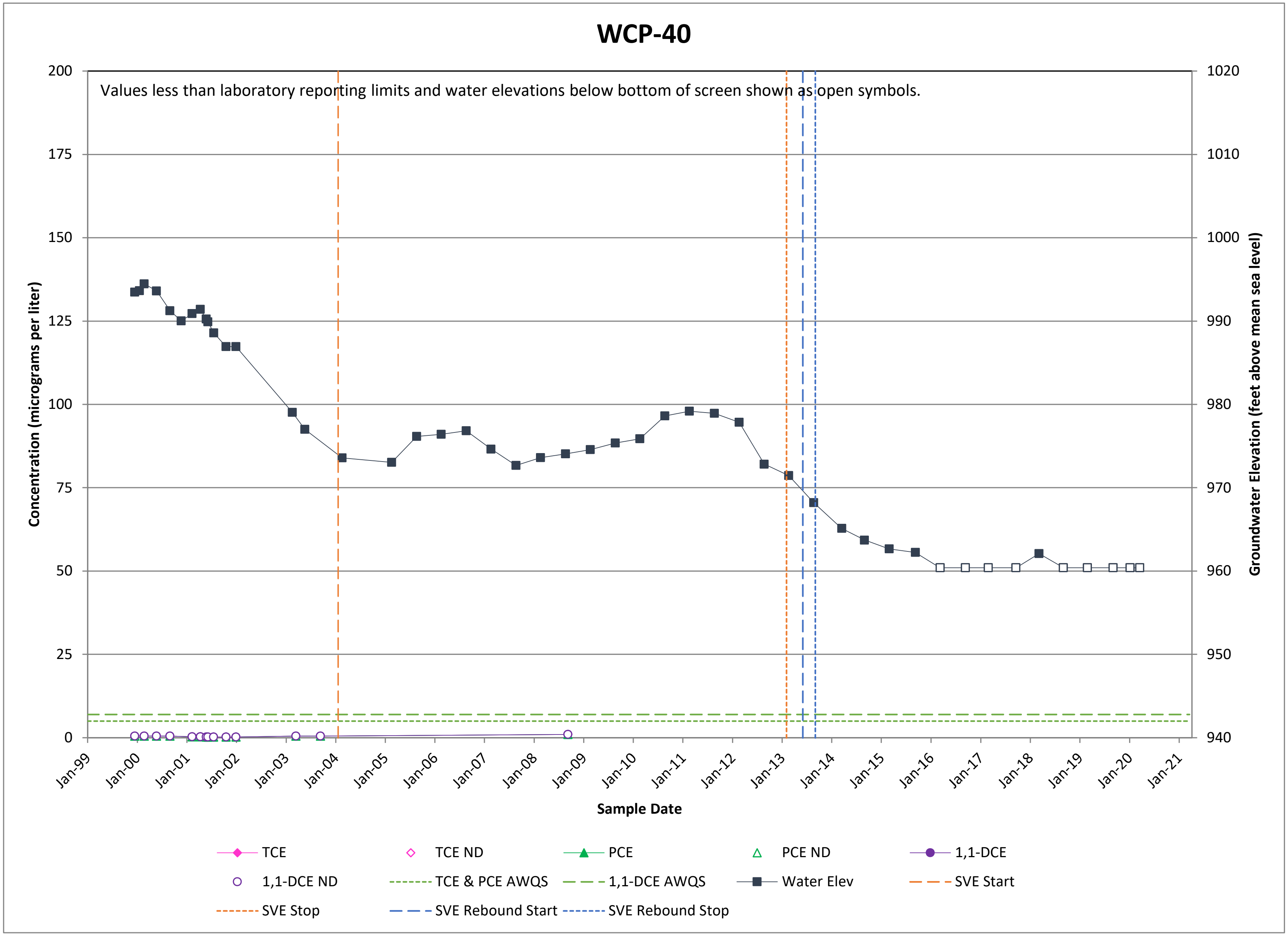

WCP-28 (property access denied in 2004*)
Values less than laboratory reporting limits and water elevations below bottom of screen shown as open symbols.
*Temporary access granted in July 2017 for one-time measurment
Concentration (micrograms per liter)
Groundwater Elevation (feet above mean sea level)
Sample Date
1200
1050
900
750
600
450
300
150
0
1020
1010
1000
990
980
970
960
950
940
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Jan-19
Jan-20
Jan-21
TCE
TCE ND
PCE
PCE ND
1,1-DCE
1,1-DCE ND
TCE & PCE AWQS
1,1-DCE AWQS
Water Elev
SVE Start
SVE Stop
SVE Rebound Start
SVE Rebound Stop



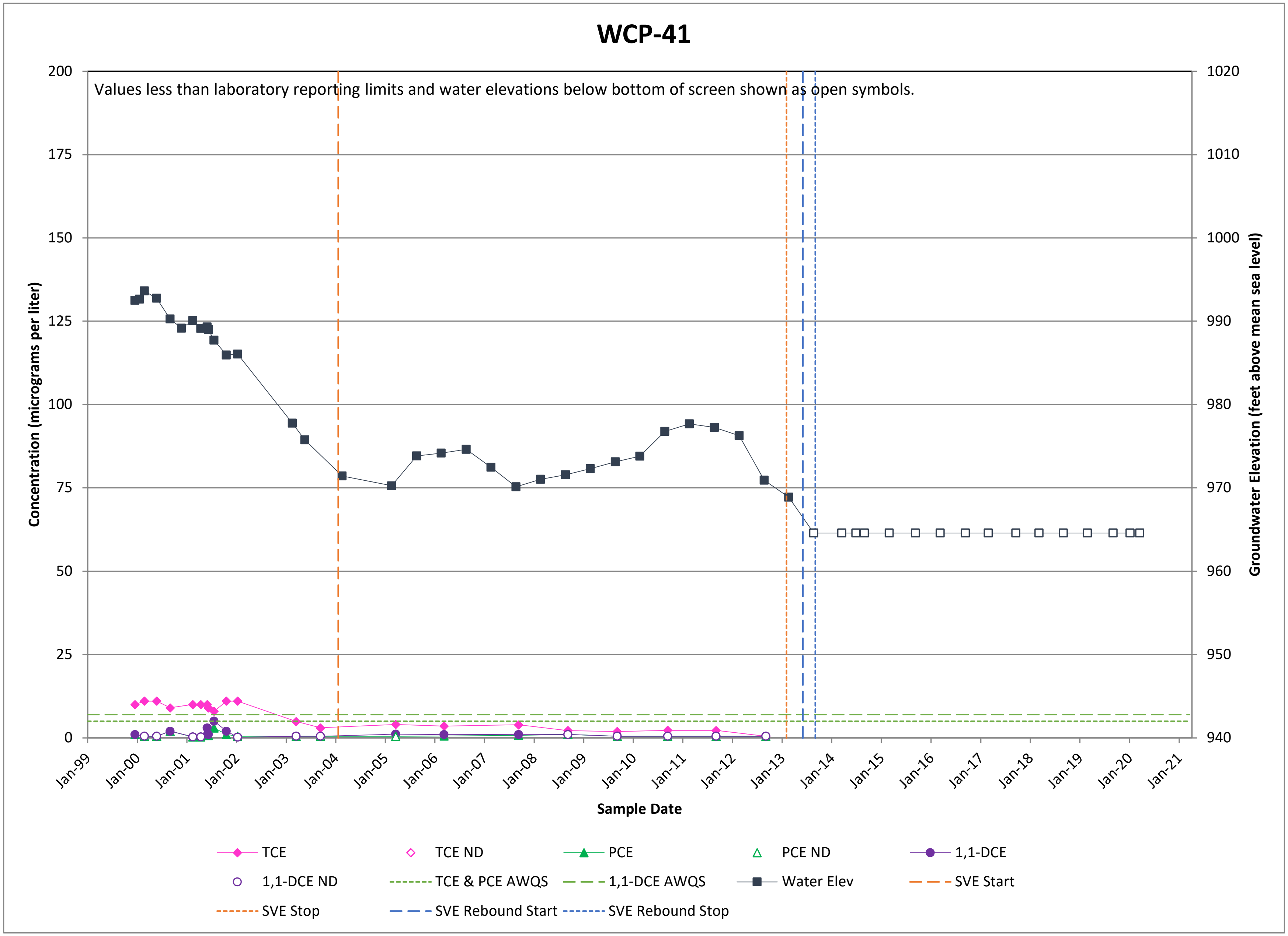
WCP-29 (property access denied in 2004)
Values less than laboratory reporting limits and water elevations below bottom of screen shown as open symbols.
Concentration (micrograms per liter)
Groundwater Elevation (feet above mean sea level)
200
175
150
125
100
75
50
25
0
1020
1010
1000
990
980
970
960
950
940
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Jan-19
Jan-20
Jan-21
Sample Date
TCE
TCE ND
PCE
PCE ND
1,1-DCE
1,1-DCE ND
TCE & PCE AWQS
1,1-DCE AWQS
Water Elev
Well Dry
SVE Start
SVE Stop
SVE Rebound Start
SVE Rebound Stop



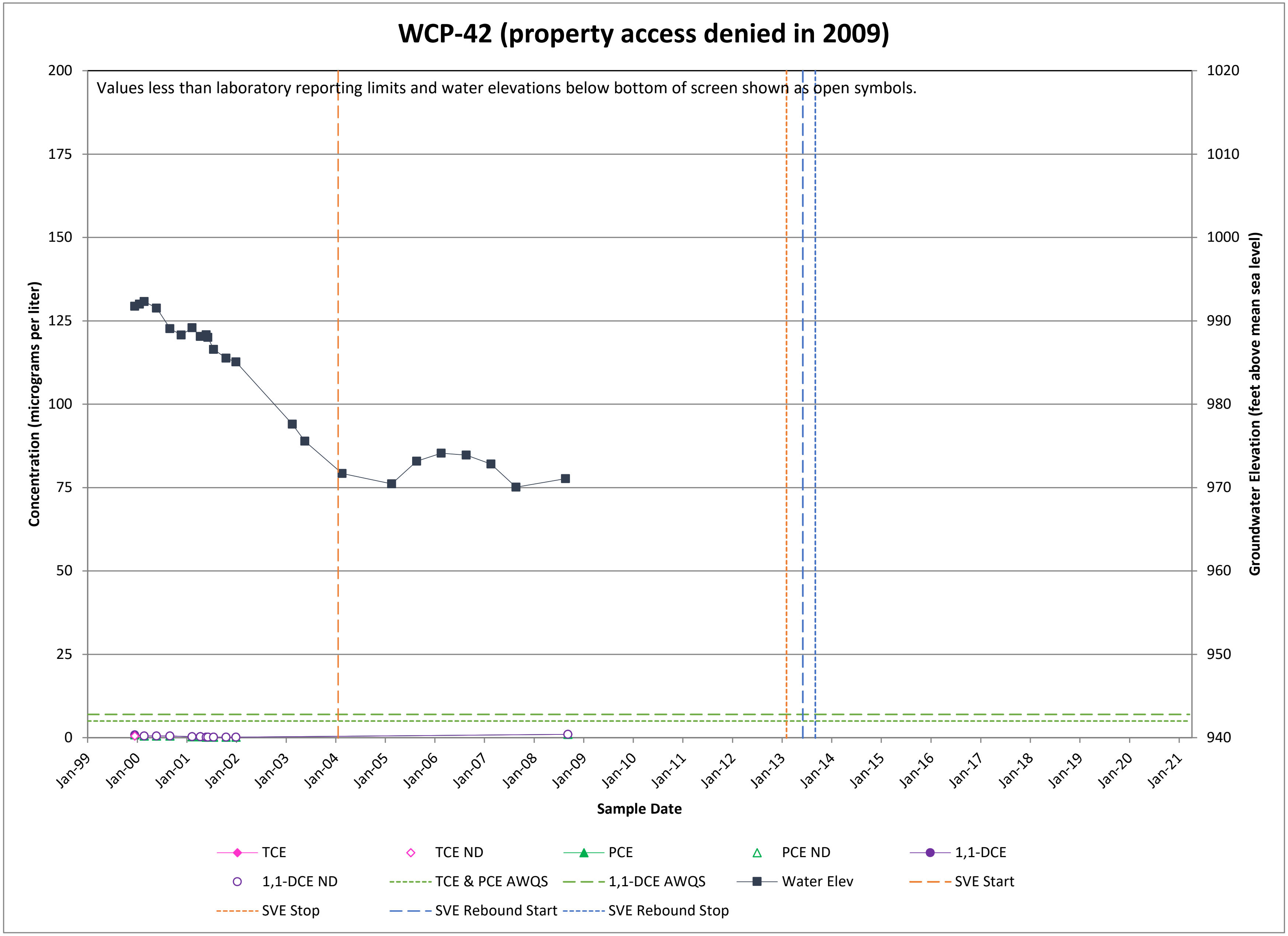
WCP-30 (abandoned in 2006)
Values less than laboratory reporting limits and water elevations below bottom of screen shown as open symbols.
Concentration (micrograms per liter)
Groundwater Elevation (feet above mean sea level)
0
100
200
300
400
500
600
700
800
940
950
960
970
980
990
1000
1010
1020
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Jan-19
Jan-20
Jan-21
Sample Date
TCE
TCE ND
PCE
PCE ND
1,1-DCE
1,1-DCE ND
TCE & PCE AWQS
1,1-DCE AWQS
Water Elev
Well Dry
SVE Start
SVE Stop
SVE Rebound Start
SVE Rebound Stop



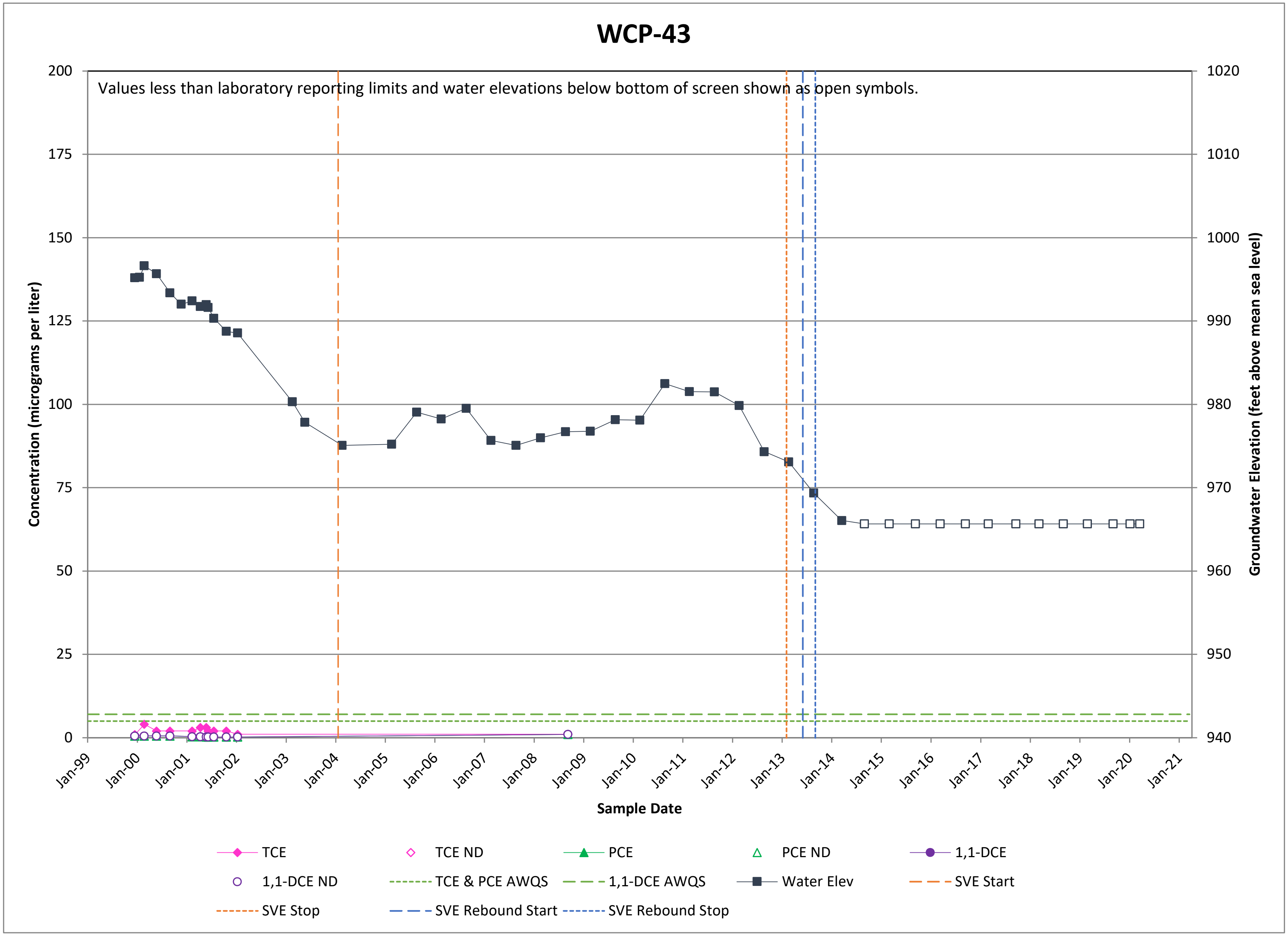
WCP-40
Values less than laboratory reporting limits and water elevations below bottom of screen shown as open symbols.
Concentration (micrograms per liter)
Groundwater Elevation (feet above mean sea level)
200
175
150
125
100
75
50
25
0
1020
1010
1000
990
980
970
960
950
940
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Jan-19
Jan-20
Jan-21
Sample Date
TCE
TCE ND
PCE
PCE ND
1,1-DCE
1,1-DCE ND
TCE & PCE AWQS
1,1-DCE AWQS
Water Elev
SVE Start
SVE Stop
SVE Rebound Start
SVE Rebound Stop

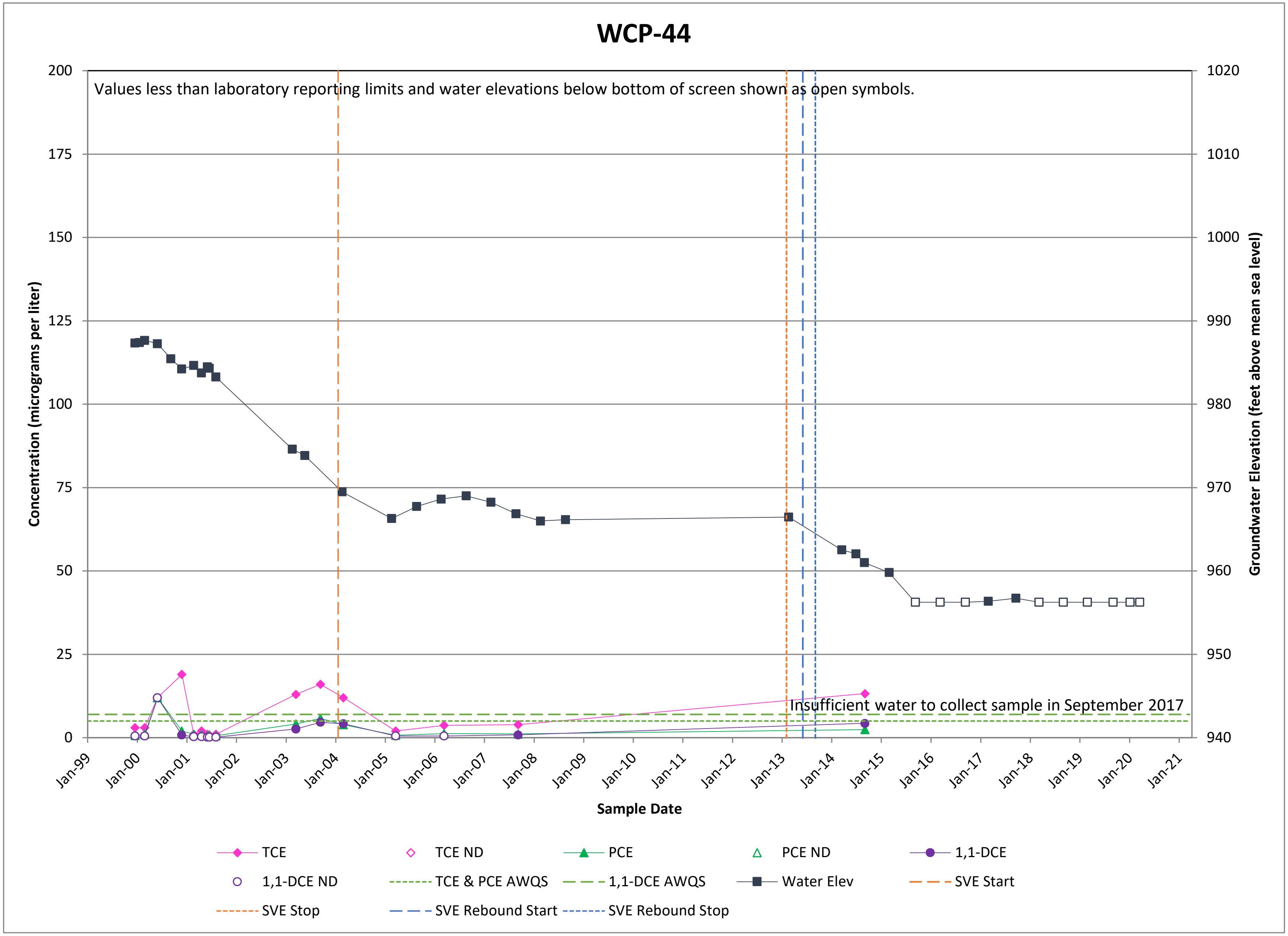


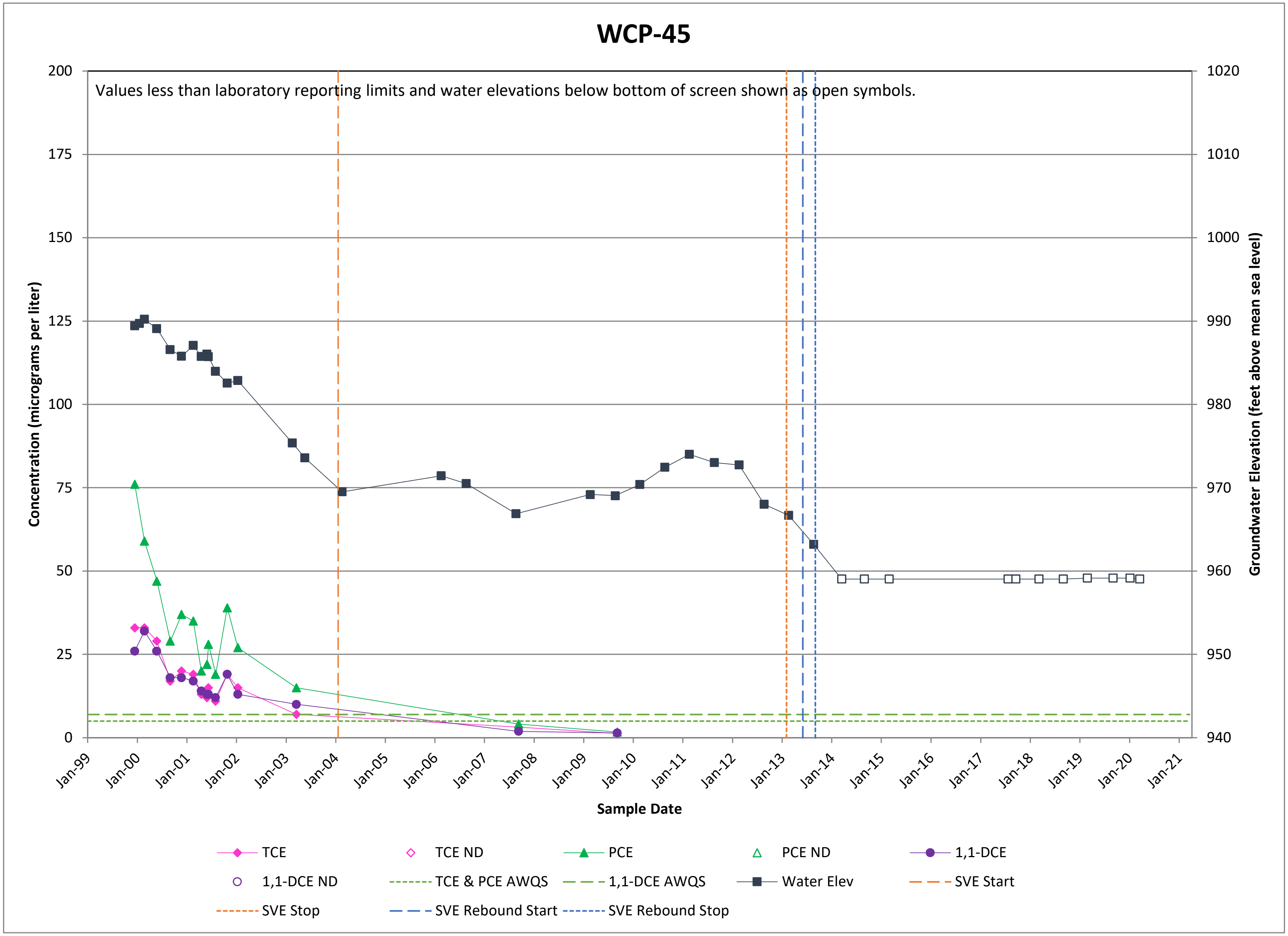
WCP-41
Values less than laboratory reporting limits and water elevations below bottom of screen shown as open symbols.
Concentration (micrograms per liter)
Groundwater Elevation (feet above mean sea level)
Sample Date
200
175
150
125
100
75
50
25
0
1020
1010
1000
990
980
970
960
950
940
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Jan-19
Jan-20
Jan-21
TCE
TCE ND
PCE
PCE ND
1,1-DCE
1,1-DCE ND
TCE & PCE AWQS
1,1-DCE AWQS
Water Elev
SVE Start
SVE Stop
SVE Rebound Start
SVE Rebound Stop

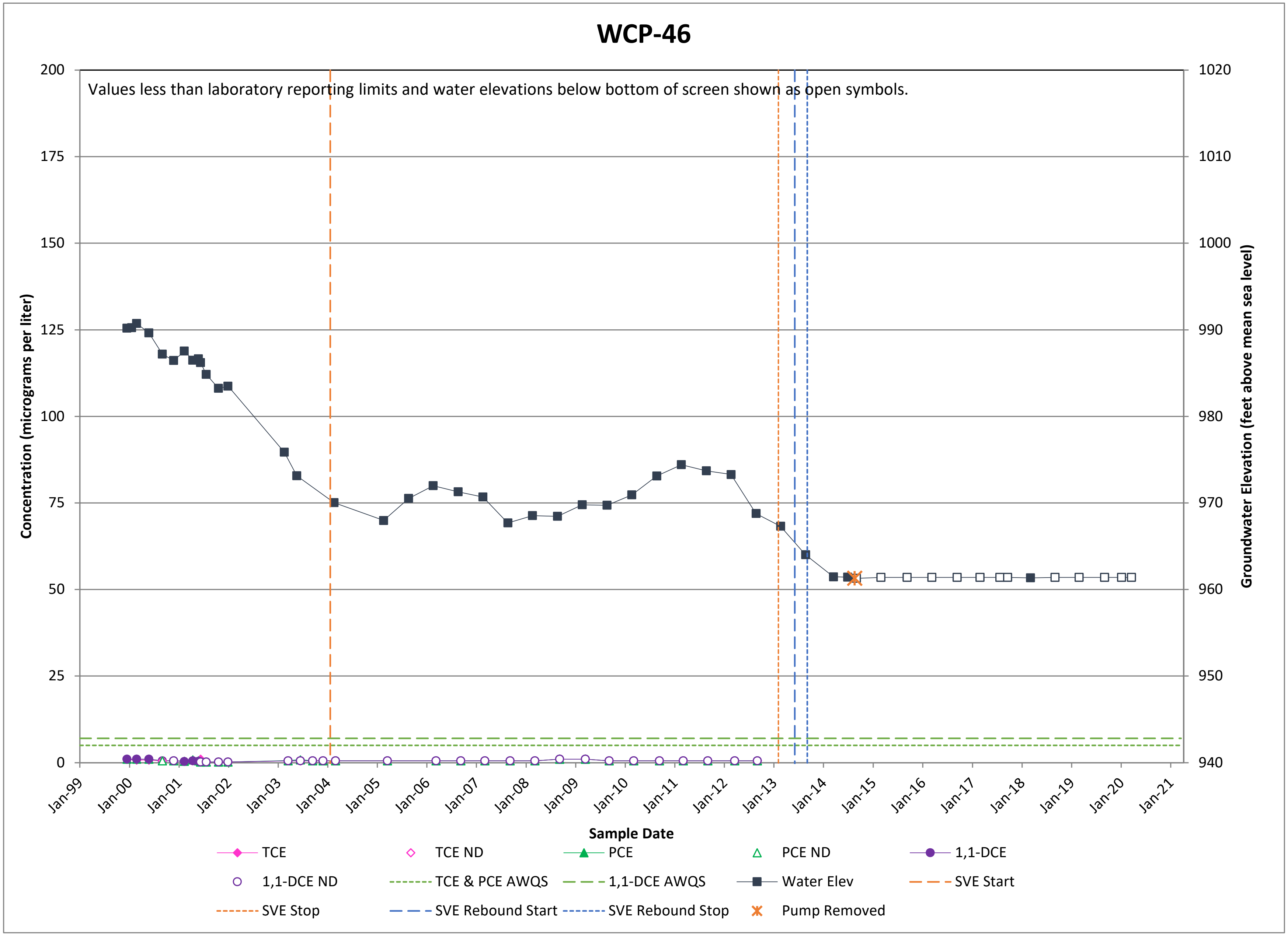


WCP-42 (property access denied in 2009)
Values less than laboratory reporting limits and water elevations below bottom of screen shown as open symbols.
Concentration (micrograms per liter)
Groundwater Elevation (feet above mean sea level)
Sample Date
0
25
50
75
100
125
150
175
200
940
950
960
970
980
990
1000
1010
1020
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Jan-19
Jan-20
Jan-21
TCE
TCE ND
PCE
PCE ND
1,1-DCE
1,1-DCE ND
TCE & PCE AWQS
1,1-DCE AWQS
Water Elev
SVE Start
SVE Stop
SVE Rebound Start
SVE Rebound Stop

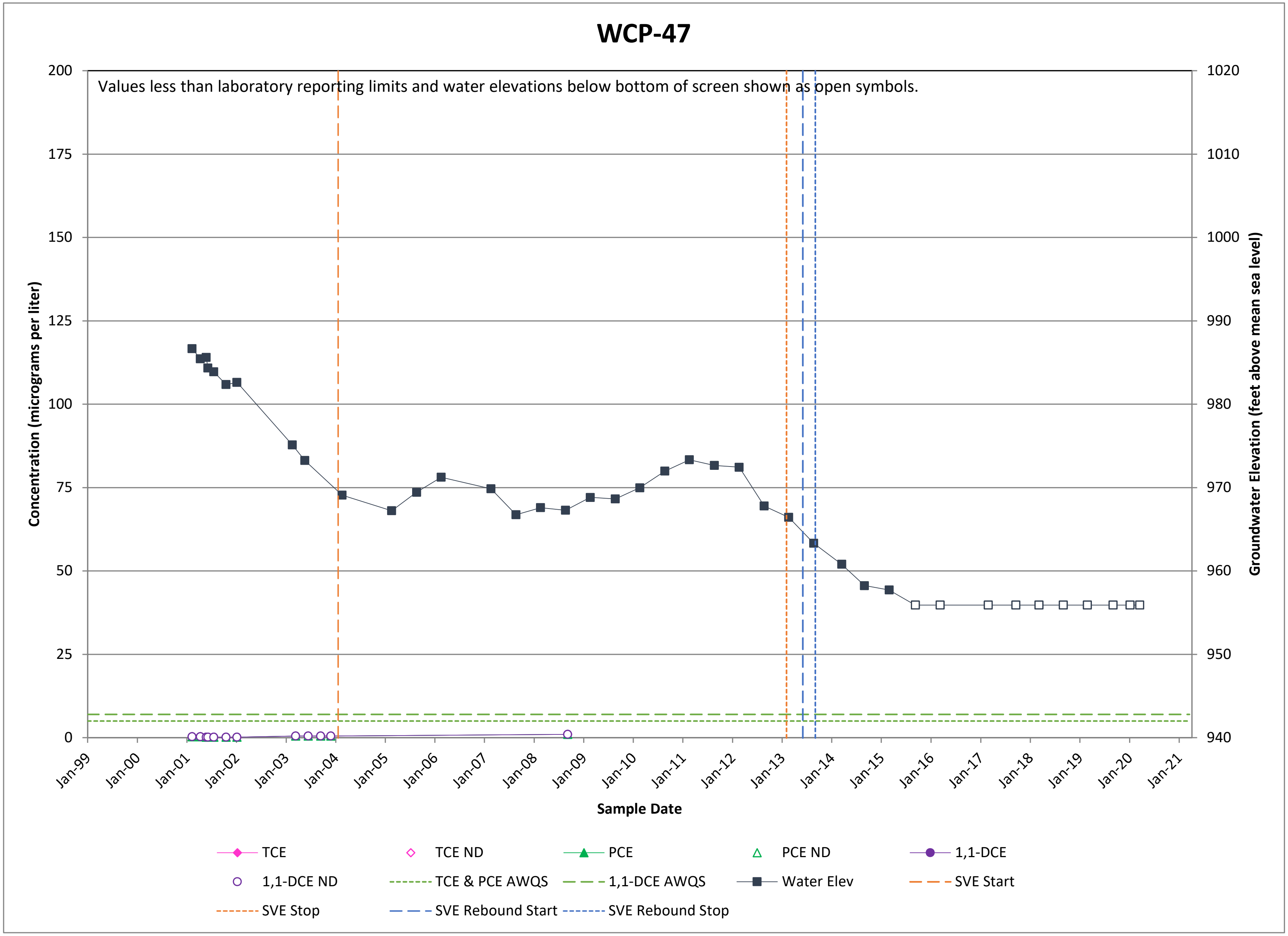

WCP-43
Values less than laboratory reporting limits and water elevations below bottom of screen shown as open symbols.
Concentration (micrograms per liter)
Groundwater Elevation (feet above mean sea level)
Sample Date
200
175
150
125
100
75
50
25
0
1020
1010
1000
990
980
970
960
950
940
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Jan-19
Jan-20
Jan-21
TCE
TCE ND
PCE
PCE ND
1,1-DCE
1,1-DCE ND
TCE & PCE AWQS
1,1-DCE AWQS
Water Elev
SVE Start
SVE Stop
SVE Rebound Start
SVE Rebound Stop


WCP-44
Values less than laboratory reporting limits and water elevations below bottom of screen shown as open symbols.
Insufficient water to collect sample in September 2017
Concentration (micrograms per liter)
Groundwater Elevation (feet above mean sea level)
Sample Date
0
25
50
75
100
125
150
175
200
940
950
960
970
980
990
1000
1010
1020
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Jan-19
Jan-20
Jan-21
TCE
TCE ND
PCE
PCE ND
1,1-DCE
1,1-DCE ND
TCE & PCE AWQS
1,1-DCE AWQS
Water Elev
SVE Start
SVE Stop
SVE Rebound Start
SVE Rebound Stop

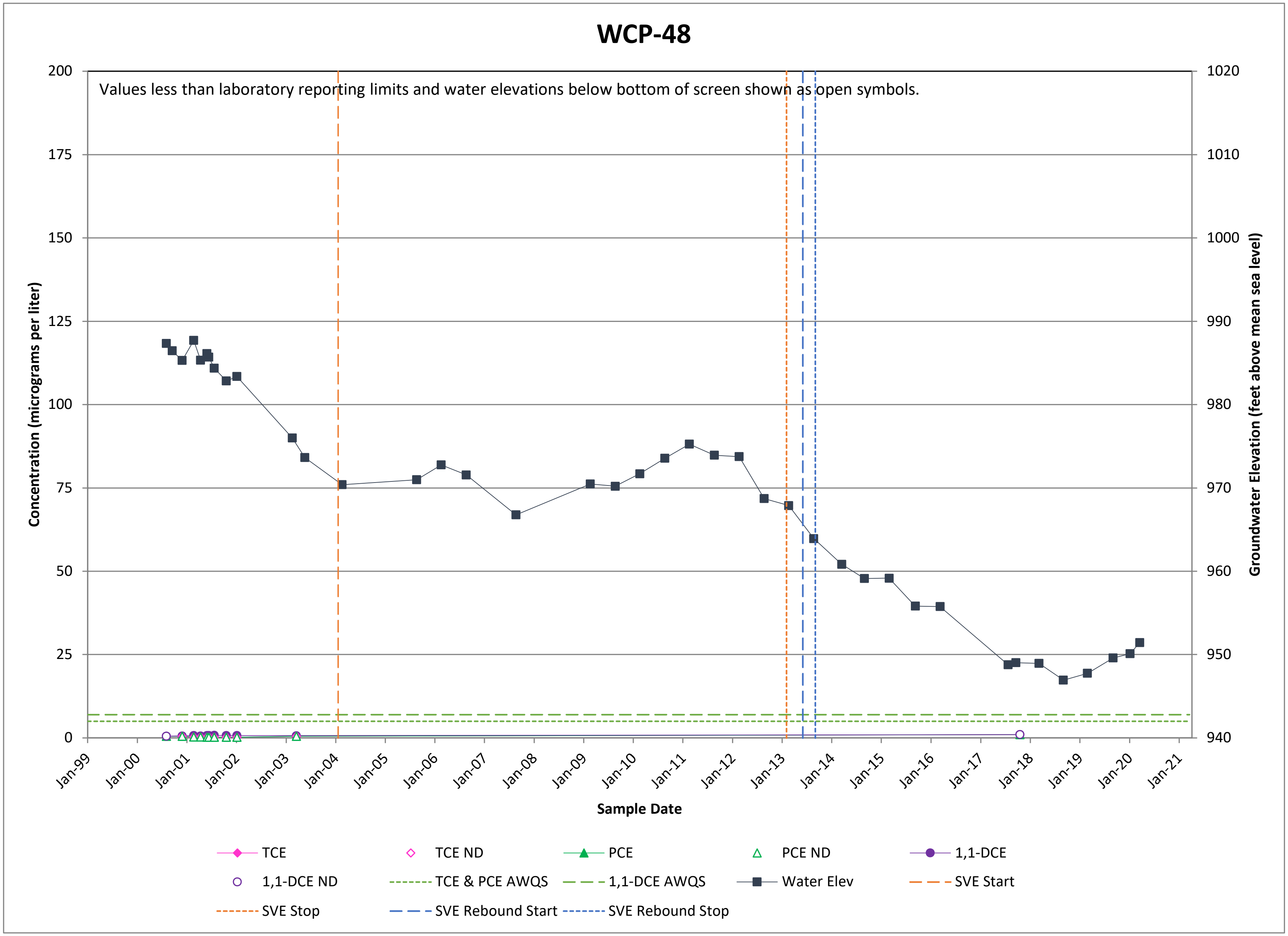

WCP-45
Values less than laboratory reporting limits and water elevations below bottom of screen shown as open symbols.
Concentration (micrograms per liter)
Groundwater Elevation (feet above mean sea level)
200
175
150
125
100
75
50
25
0
1020
1010
1000
990
980
970
960
950
940
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Jan-19
Jan-20
Jan-21
Sample Date
TCE
TCE ND
PCE
PCE ND
1,1-DCE
1,1-DCE ND
TCE & PCE AWQS
1,1-DCE AWQS
Water Elev
SVE Start
SVE Stop
SVE Rebound Start
SVE Rebound Stop



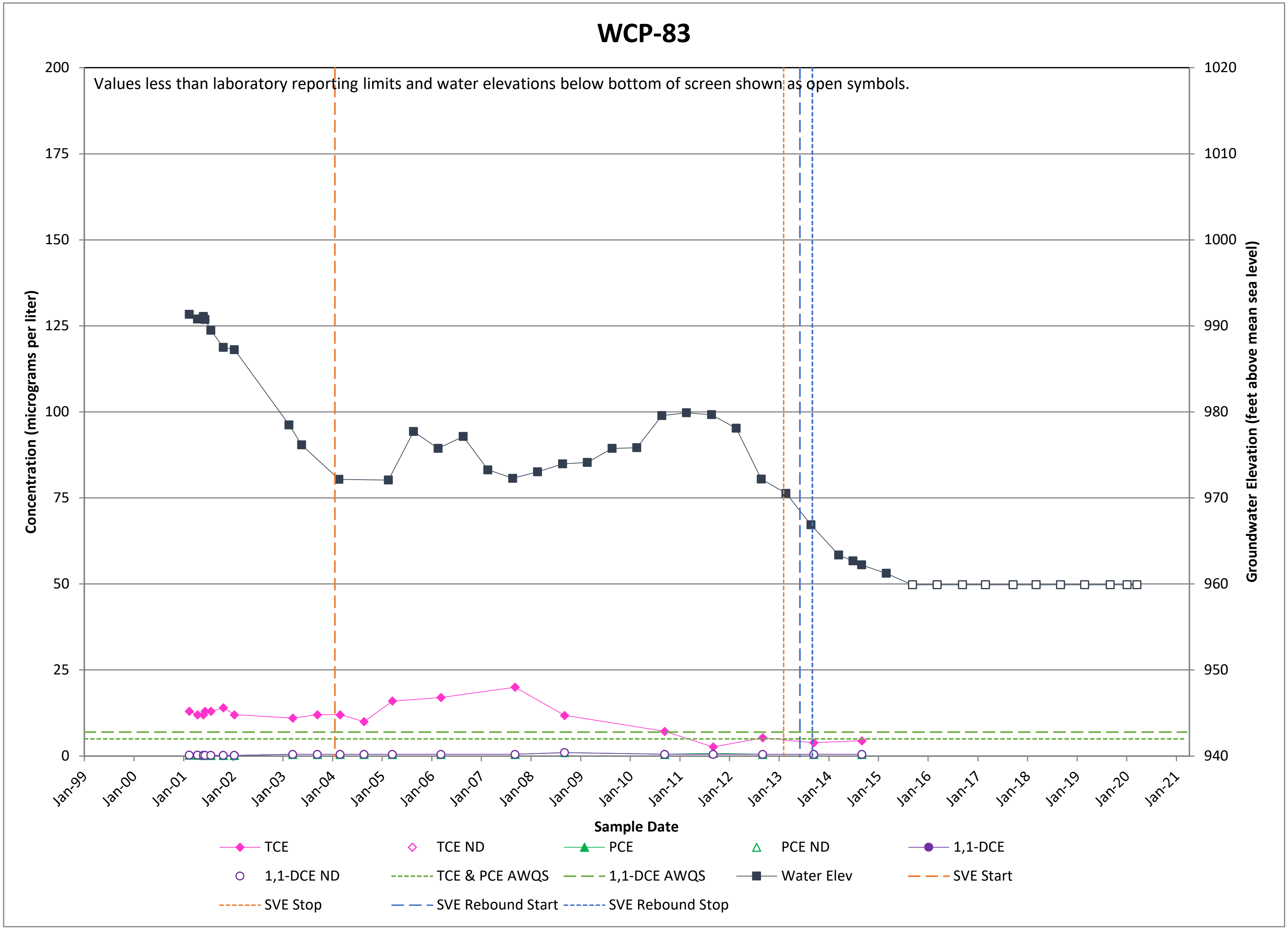
WCP-46
Values less than laboratory reporting limits and water elevations below bottom of screen shown as open symbols.
Concentration (micrograms per liter)
Groundwater Elevation (feet above mean sea level)
200
175
150
125
100
75
50
25
0
1020
1010
1000
990
980
970
960
950
940
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Jan-19
Jan-20
Jan-21
Sample Date
TCE
TCE ND
PCE
PCE ND
1,1-DCE
1,1-DCE ND
TCE & PCE AWQS
1,1-DCE AWQS
Water Elev
SVE Start
SVE Stop
SVE Rebound Start
SVE Rebound Stop
Pump Removed



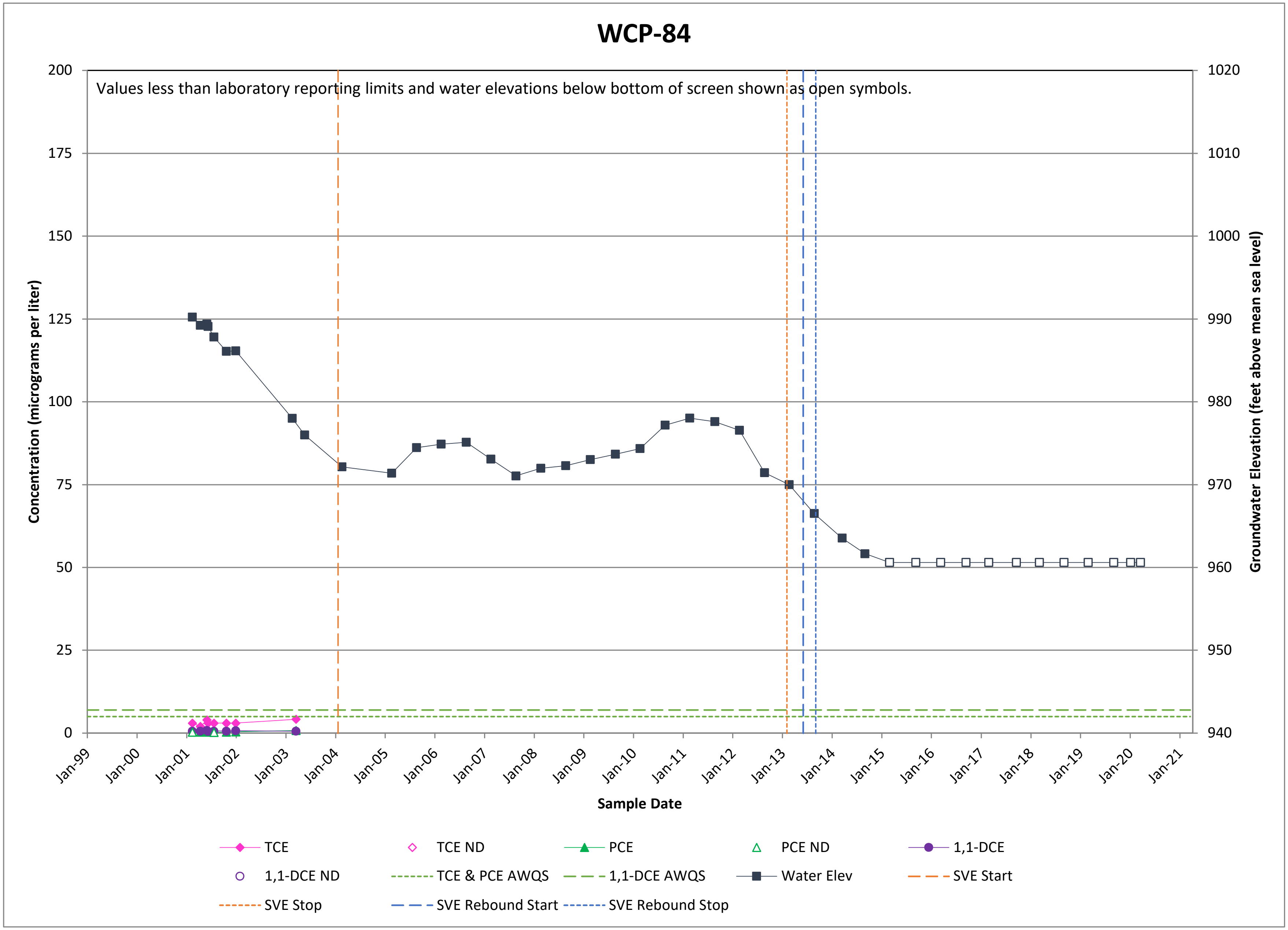
WCP-47
Values less than laboratory reporting limits and water elevations below bottom of screen shown as open symbols.
Concentration (micrograms per liter)
Groundwater Elevation (feet above mean sea level)
Sample Date
200
175
150
125
100
75
50
25
0
1020
1010
1000
990
980
970
960
950
940
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Jan-19
Jan-20
Jan-21
TCE
TCE ND
PCE
PCE ND
1,1-DCE
1,1-DCE ND
TCE & PCE AWQS
1,1-DCE AWQS
Water Elev
SVE Start
SVE Stop
SVE Rebound Start
SVE Rebound Stop



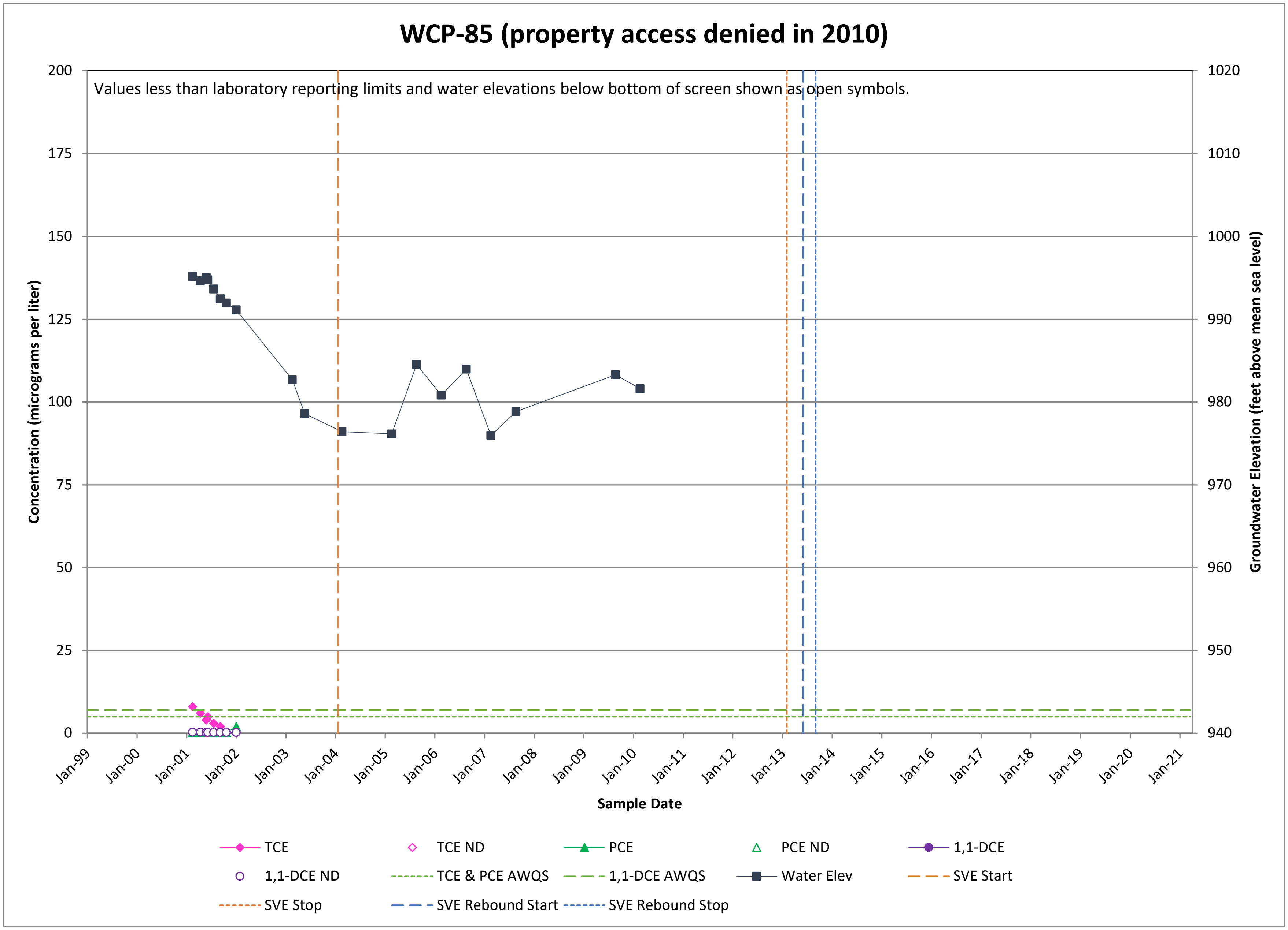
WCP-48
Values less than laboratory reporting limits and water elevations below bottom of screen shown as open symbols.
Concentration (micrograms per liter)
Groundwater Elevation (feet above mean sea level)
0
25
50
75
100
125
150
175
200
940
950
960
970
980
990
1000
1010
1020
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Jan-19
Jan-20
Jan-21
Sample Date
TCE
TCE ND
PCE
PCE ND
1,1-DCE
1,1-DCE ND
TCE & PCE AWQS
1,1-DCE AWQS
Water Elev
SVE Start
SVE Stop
SVE Rebound Start
SVE Rebound Stop



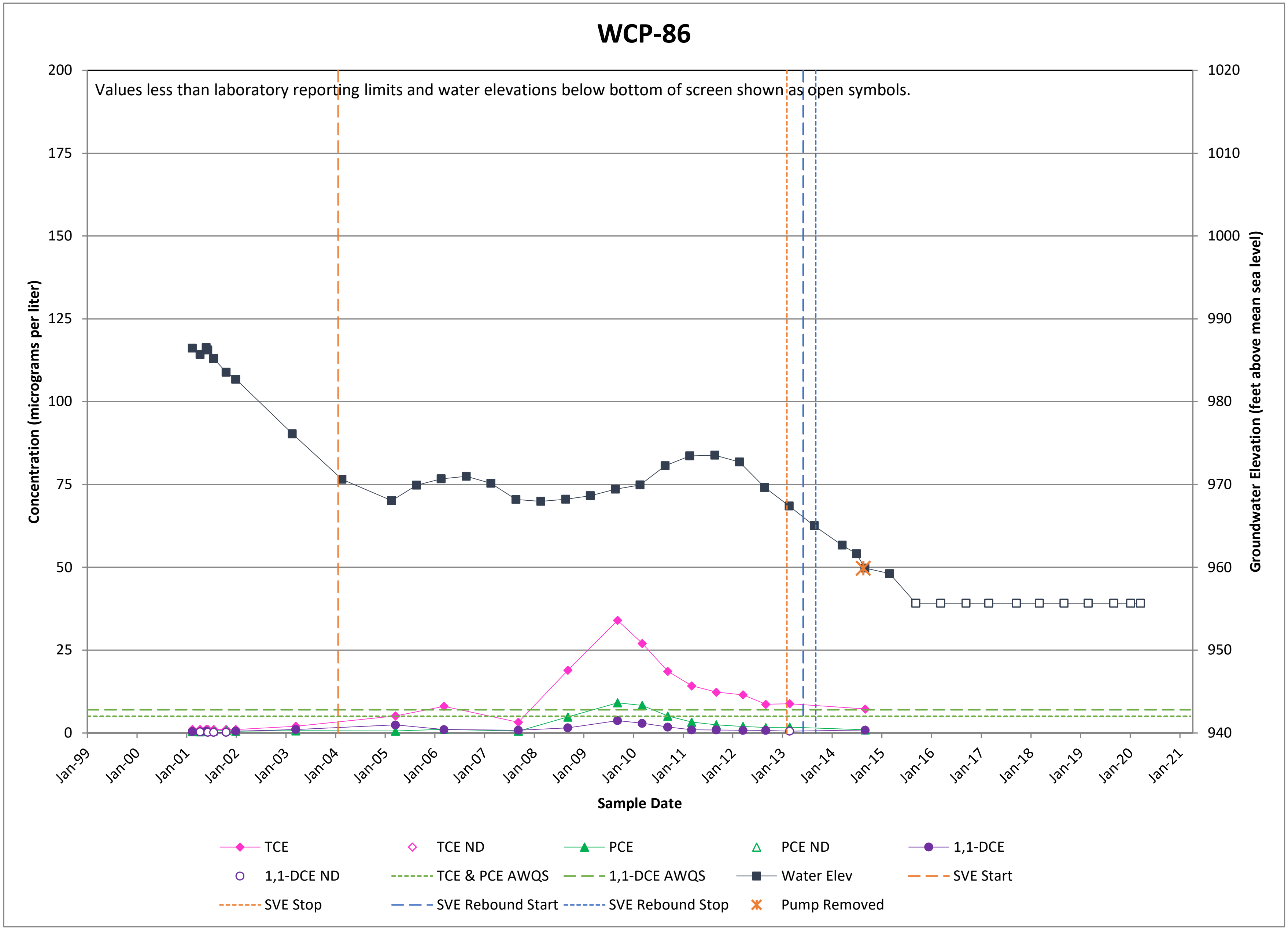
WCP-83
Values less than laboratory reporting limits and water elevations below bottom of screen shown as open symbols.
Concentration (micrograms per liter)
Groundwater Elevation (feet above mean sea level)
200
175
150
125
100
75
50
25
0
1020
1010
1000
990
980
970
960
950
940
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Jan-19
Jan-20
Jan-21
Sample Date
TCE
TCE ND
PCE
PCE ND
1,1-DCE
1,1-DCE ND
TCE & PCE AWQS
1,1-DCE AWQS
Water Elev
SVE Start
SVE Stop
SVE Rebound Start
SVE Rebound Stop

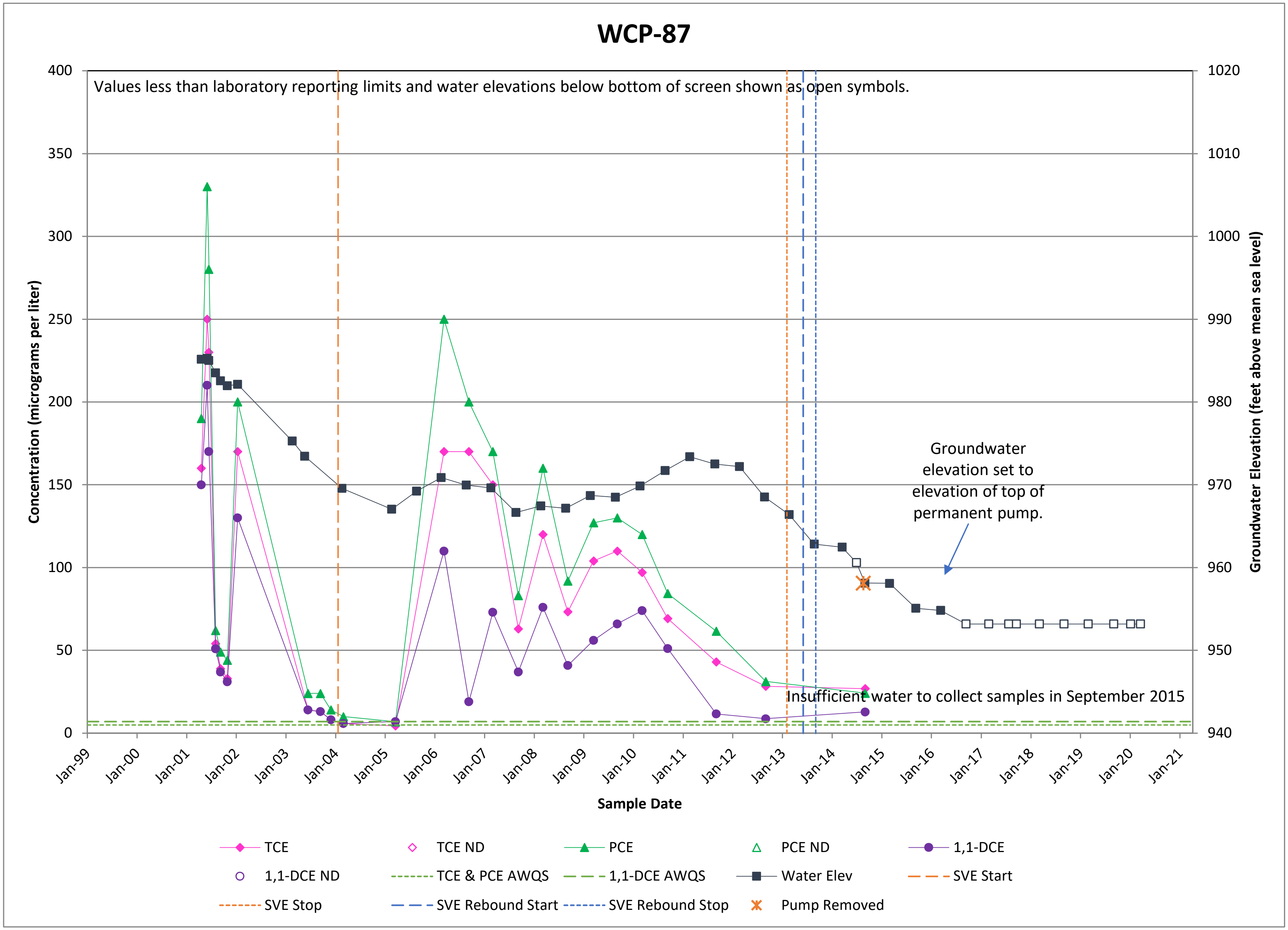


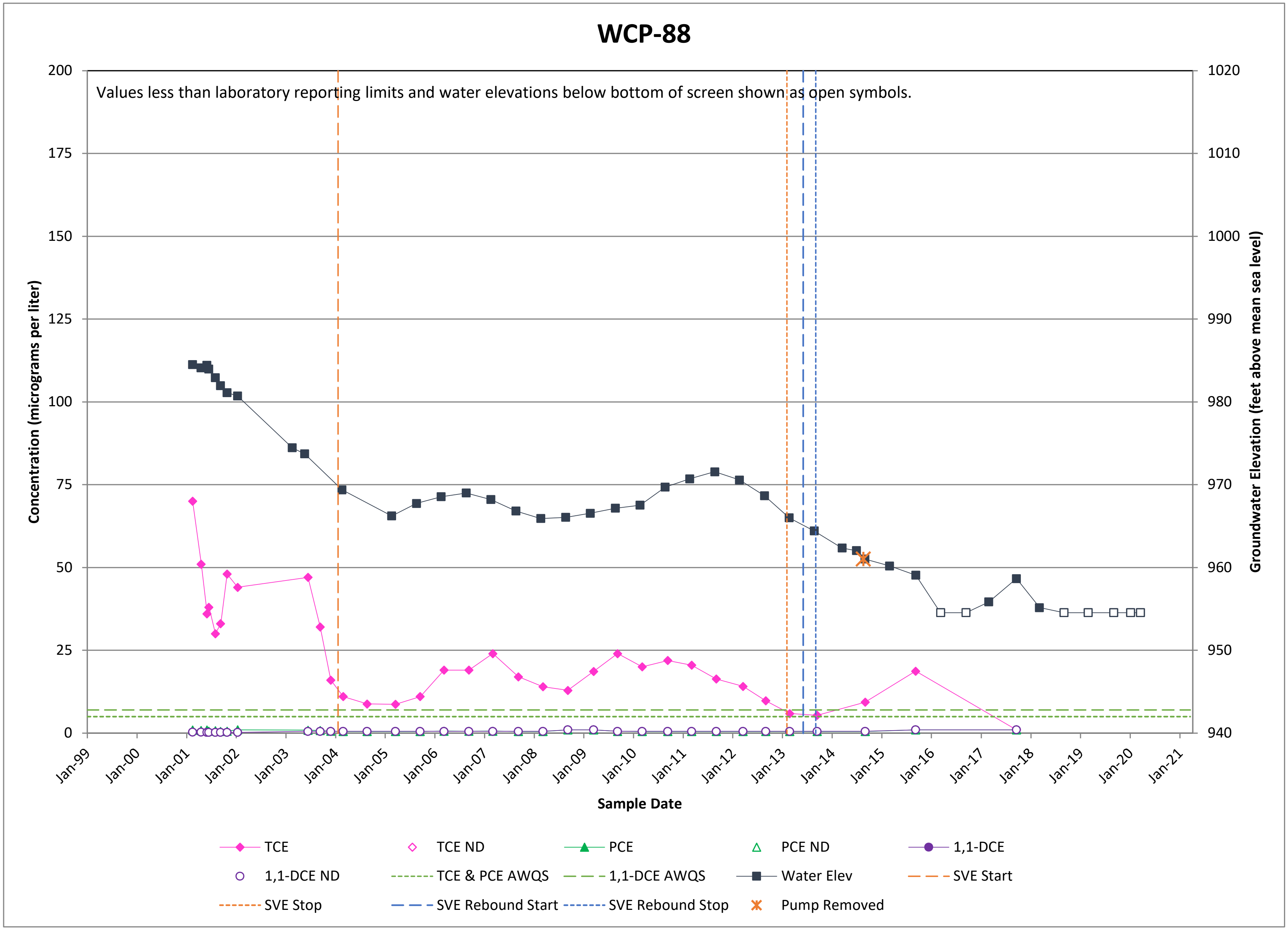
WCP-84
Values less than laboratory reporting limits and water elevations below bottom of screen shown as open symbols.
Concentration (micrograms per liter)
Groundwater Elevation (feet above mean sea level)
Sample Date
0
25
50
75
100
125
150
175
200
940
950
960
970
980
990
1000
1010
1020
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Jan-19
Jan-20
Jan-21
TCE
TCE ND
PCE
PCE ND
1,1-DCE
1,1-DCE ND
TCE & PCE AWQS
1,1-DCE AWQS
Water Elev
SVE Start
SVE Stop
SVE Rebound Start
SVE Rebound Stop

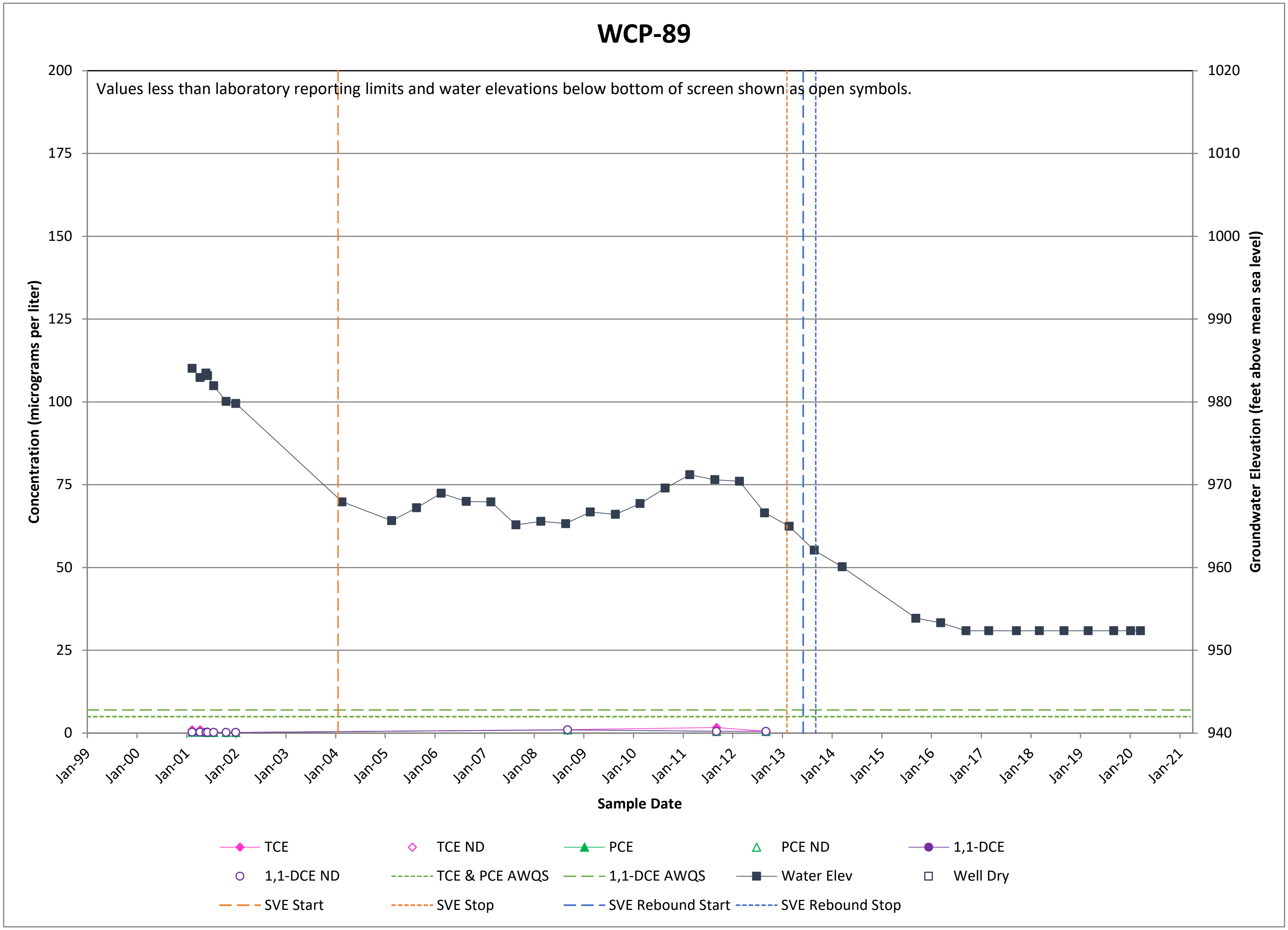


WCP-85 (property access denied in 2010)
Values less than laboratory reporting limits and water elevations below bottom of screen shown as open symbols.
Concentration (micrograms per liter)
Groundwater Elevation (feet above mean sea level)
Sample Date
200
175
150
125
100
75
50
25
0
1020
1010
1000
990
980
970
960
950
940
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Jan-19
Jan-20
Jan-21
TCE
TCE ND
PCE
PCE ND
1,1-DCE
1,1-DCE ND
TCE & PCE AWQS
1,1-DCE AWQS
Water Elev
SVE Start
SVE Stop
SVE Rebound Start
SVE Rebound Stop

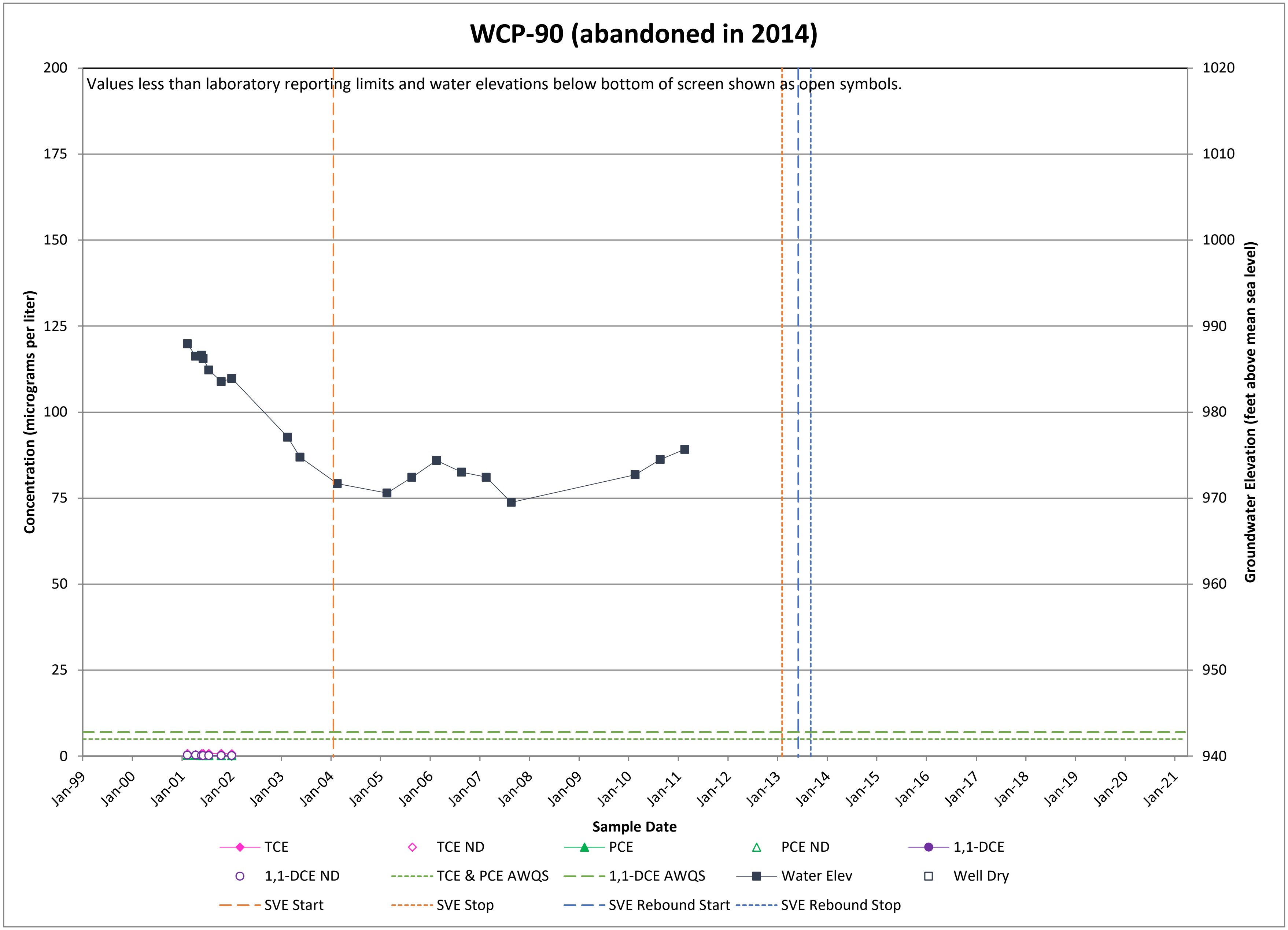

WCP-86
Values less than laboratory reporting limits and water elevations below bottom of screen shown as open symbols.
Concentration (micrograms per liter)
Groundwater Elevation (feet above mean sea level)
Sample Date
200
175
150
125
100
75
50
25
0
1020
1010
1000
990
980
970
960
950
940
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Jan-19
Jan-20
Jan-21
TCE
TCE ND
PCE
PCE ND
1,1-DCE
1,1-DCE ND
TCE & PCE AWQS
1,1-DCE AWQS
Water Elev
SVE Start
SVE Stop
SVE Rebound Start
SVE Rebound Stop
Pump Removed


WCP-87
Values less than laboratory reporting limits and water elevations below bottom of screen shown as open symbols.
Concentration (micrograms per liter)
Groundwater Elevation (feet above mean sea level)
Sample Date
Groundwater elevation set to elevation of top of permanent pump.
Insufficient water to collect samples in September 2015
400
350
300
250
200
150
100
50
0
1020
1010
1000
990
980
970
960
950
940
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Jan-19
Jan-20
Jan-21
TCE
TCE ND
PCE
PCE ND
1,1-DCE
1,1-DCE ND
TCE & PCE AWQS
1,1-DCE AWQS
Water Elev
SVE Start
SVE Stop
SVE Rebound Start
SVE Rebound Stop
Pump Removed

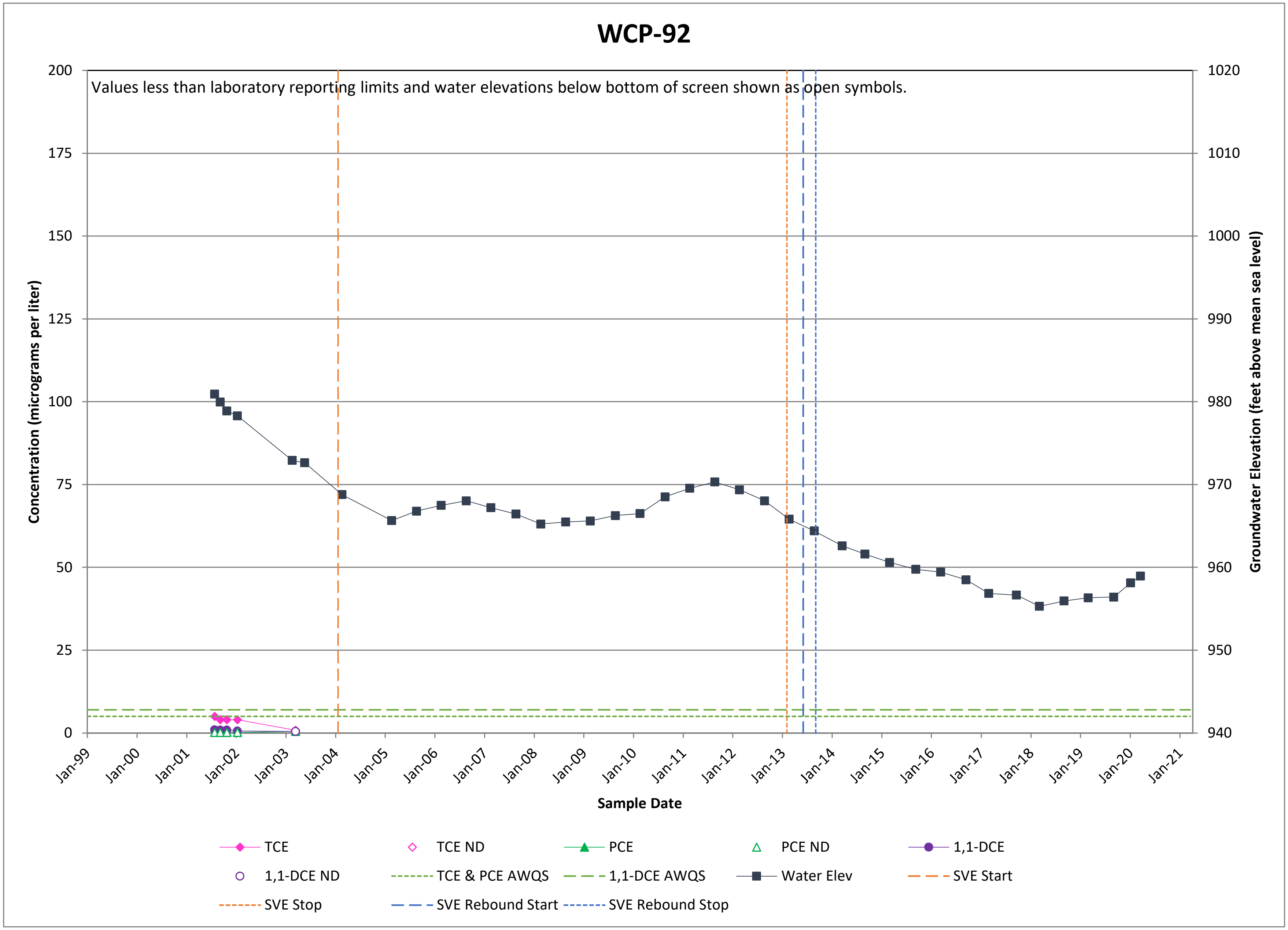

WCP-88
Values less than laboratory reporting limits and water elevations below bottom of screen shown as open symbols.
Concentration (micrograms per liter)
Groundwater Elevation (feet above mean sea level)
Sample Date
200
175
150
125
100
75
50
25
0
1020
1010
1000
990
980
970
960
950
940
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Jan-19
Jan-20
Jan-21
TCE
TCE ND
PCE
PCE ND
1,1-DCE
1,1-DCE ND
TCE & PCE AWQS
1,1-DCE AWQS
Water Elev
SVE Start
SVE Stop
SVE Rebound Start
SVE Rebound Stop
Pump Removed

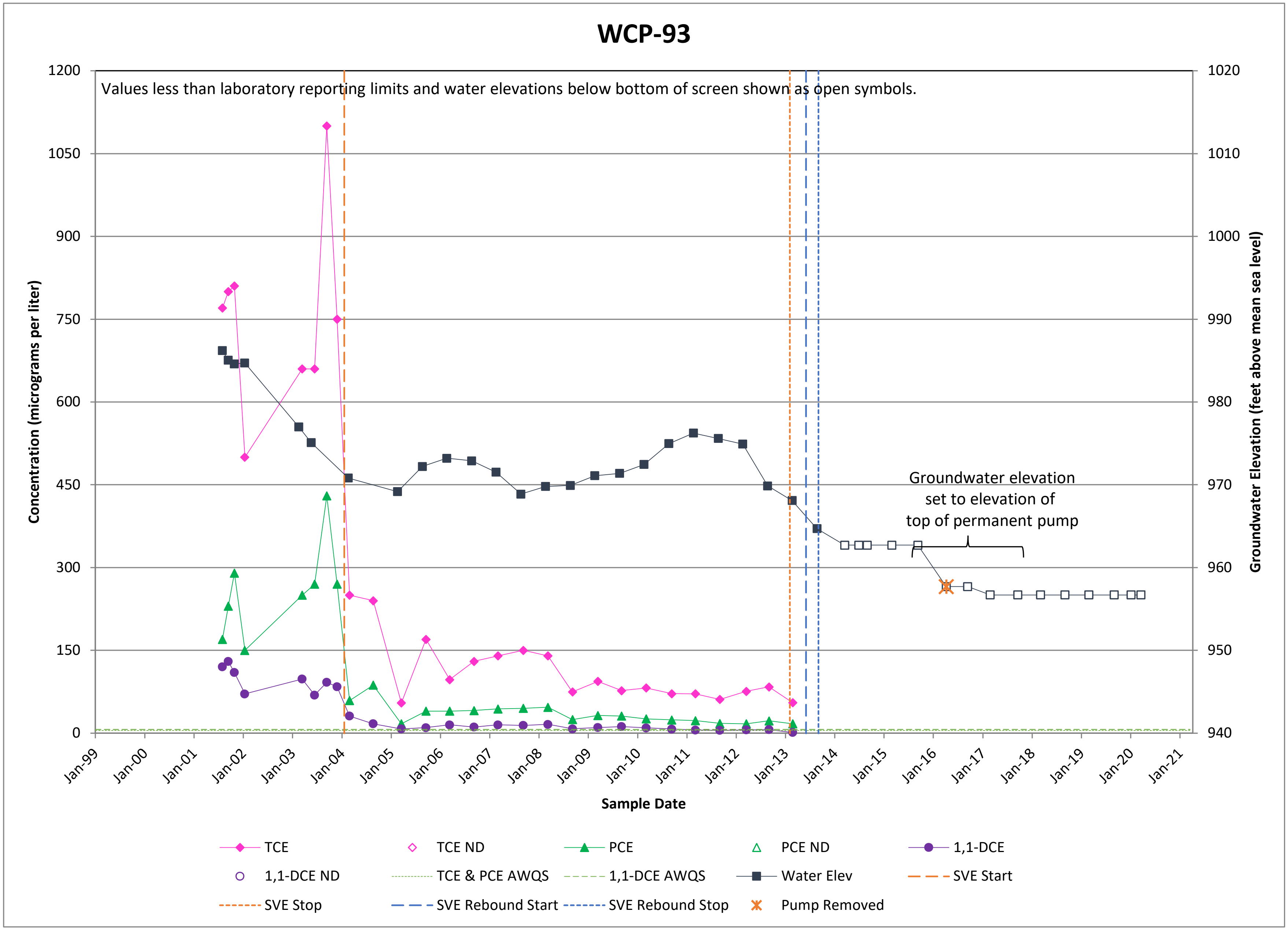


WCP-89
Values less than laboratory reporting limits and water elevations below bottom of screen shown as open symbols.
Concentration (micrograms per liter)
Groundwater Elevation (feet above mean sea level)
Sample Date
200
175
150
125
100
75
50
25
0
1020
1010
1000
990
980
970
960
950
940
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Jan-19
Jan-20
Jan-21
TCE
TCE ND
PCE
PCE ND
1,1-DCE
1,1-DCE ND
TCE & PCE AWQS
1,1-DCE AWQS
Water Elev
Well Dry
SVE Start
SVE Stop
SVE Rebound Start
SVE Rebound Stop

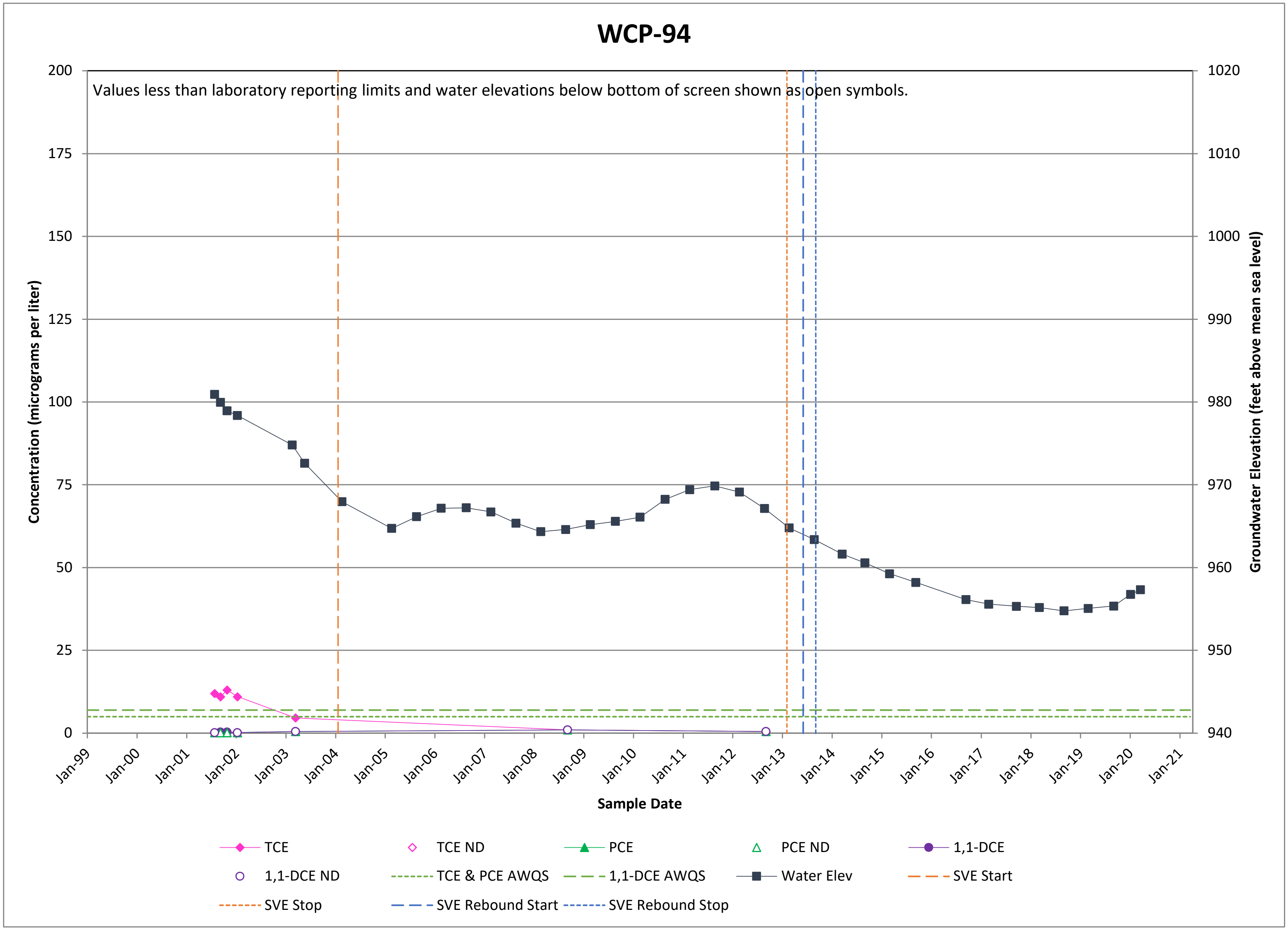


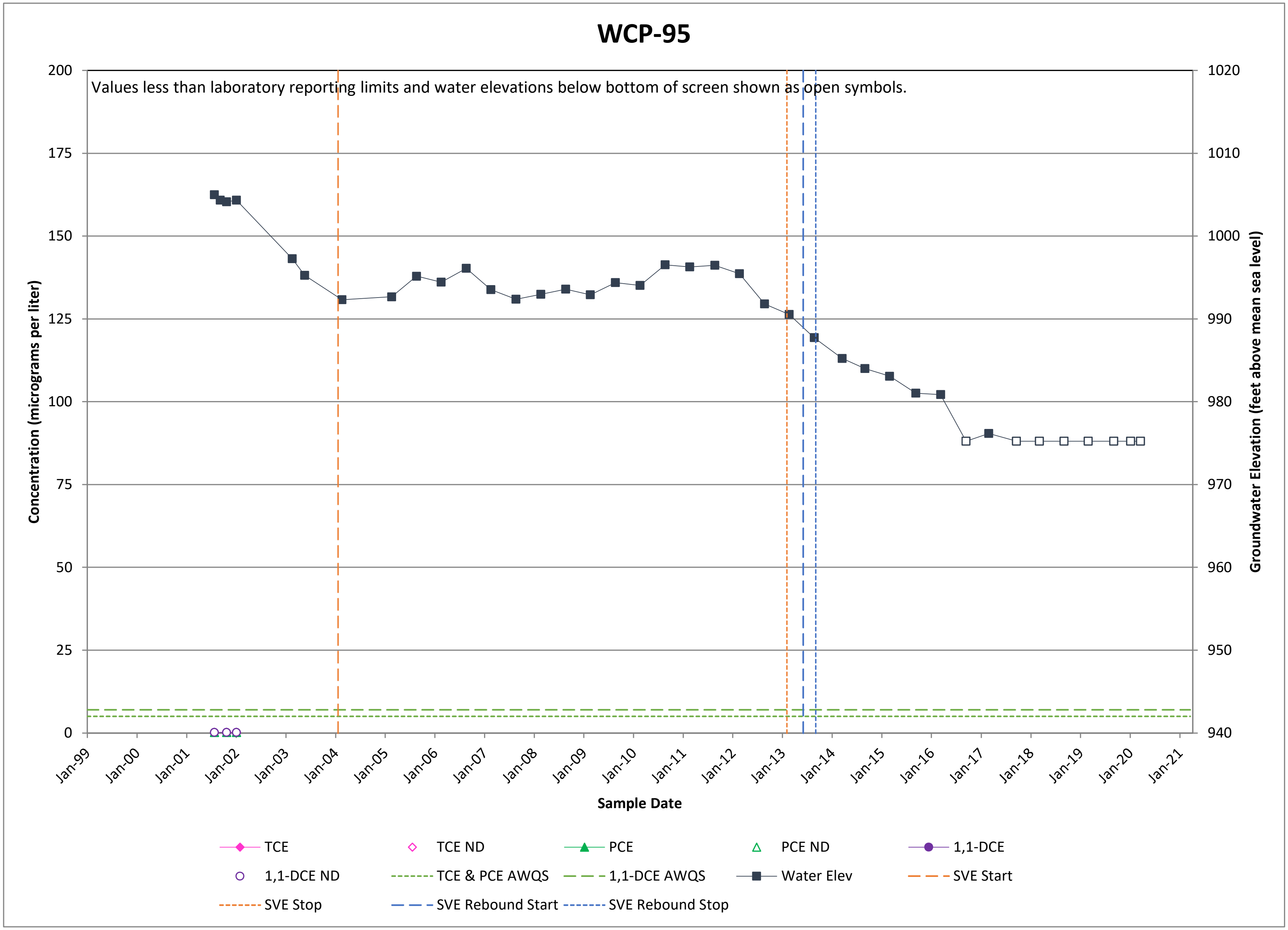
WCP-90 (abandoned in 2014)
Values less than laboratory reporting limits and water elevations below bottom of screen shown as open symbols.
Concentration (micrograms per liter)
Groundwater Elevation (feet above mean sea level)
Sample Date
200
175
150
125
100
75
50
25
0
1020
1010
1000
990
980
970
960
950
940
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Jan-19
Jan-20
Jan-21
TCE
TCE ND
PCE
PCE ND
1,1-DCE
1,1-DCE ND
TCE & PCE AWQS
1,1-DCE AWQS
Water Elev
Well Dry
SVE Start
SVE Stop
SVE Rebound Start
SVE Rebound Stop

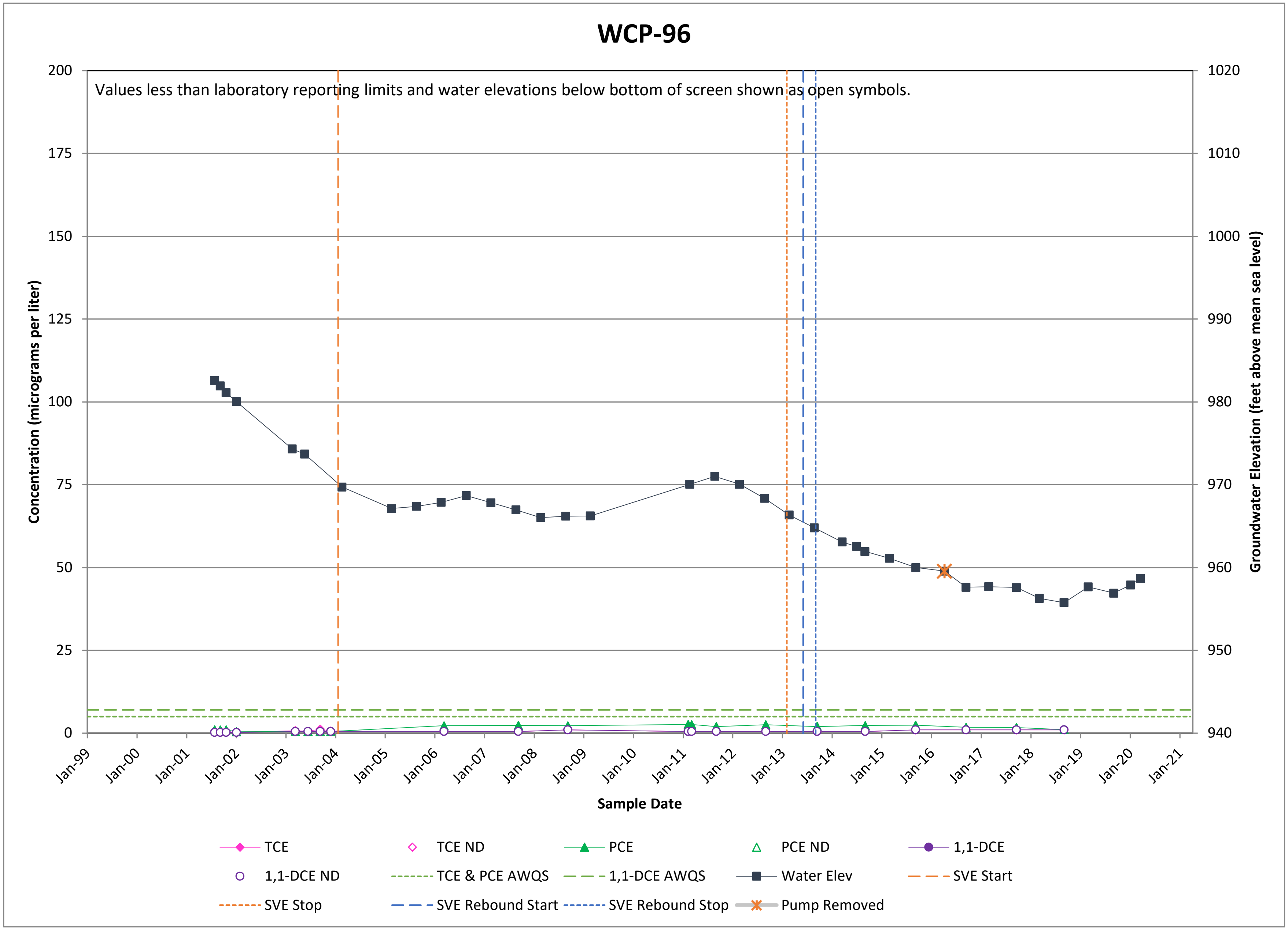

WCP-92
Values less than laboratory reporting limits and water elevations below bottom of screen shown as open symbols.
Concentration (micrograms per liter)
Groundwater Elevation (feet above mean sea level)
Sample Date
0
25
50
75
100
125
150
175
200
940
950
960
970
980
990
1000
1010
1020
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Jan-19
Jan-20
Jan-21
TCE
TCE ND
PCE
PCE ND
1,1-DCE
1,1-DCE ND
TCE & PCE AWQS
1,1-DCE AWQS
Water Elev
SVE Start
SVE Stop
SVE Rebound Start
SVE Rebound Stop



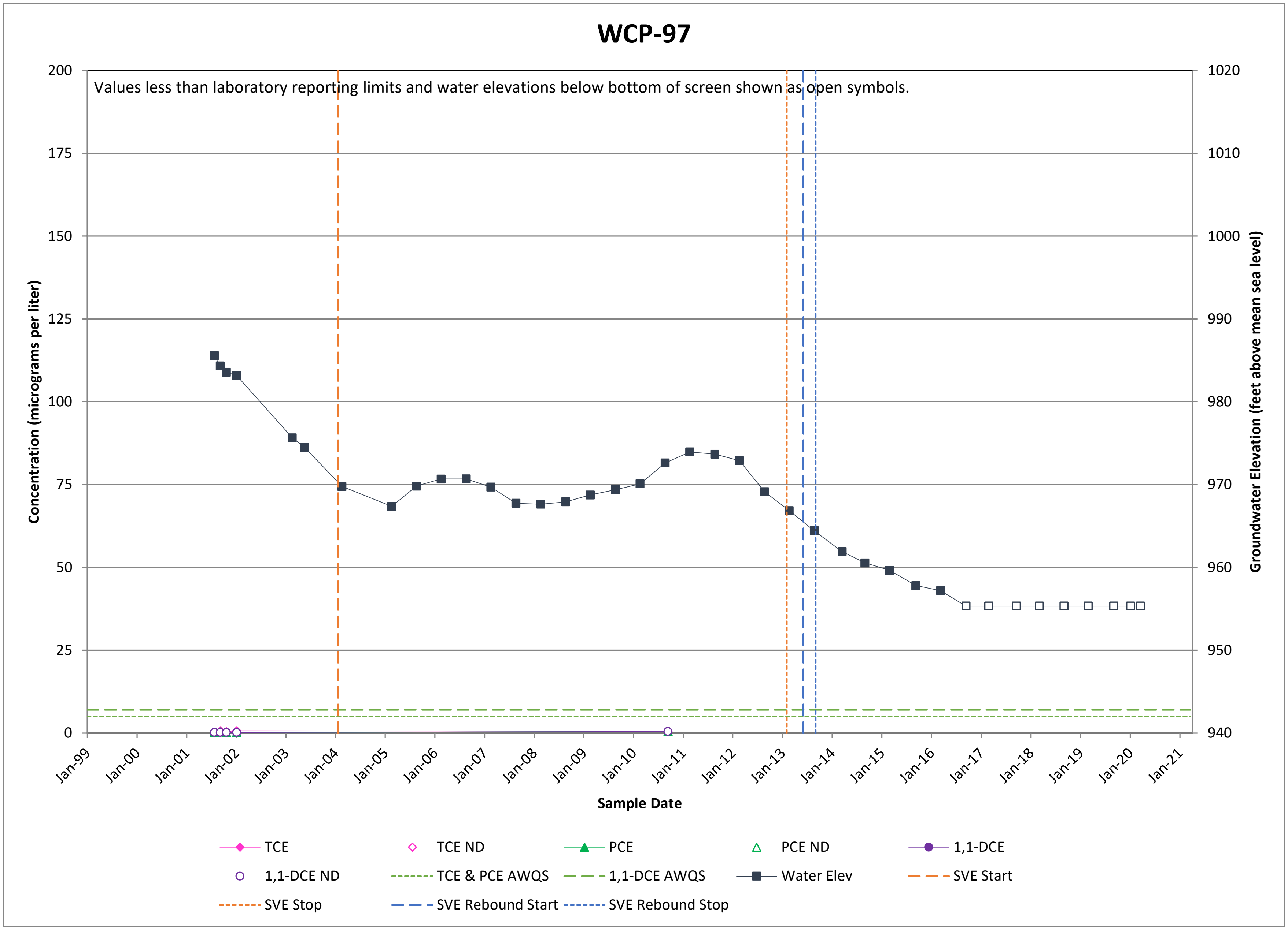
WCP-93
Values less than laboratory reporting limits and water elevations below bottom of screen shown as open symbols.
Concentration (micrograms per liter)
Groundwater Elevation (feet above mean sea level)
Groundwater elevation set to elevation of top of permanent pump
Sample Date
1200
1050
900
750
600
450
300
150
0
1020
1010
1000
990
980
970
960
950
940
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Jan-19
Jan-20
Jan-21
TCE
TCE ND
PCE
PCE ND
1,1-DCE
1,1-DCE ND
TCE & PCE AWQS
1,1-DCE AWQS
Water Elev
SVE Start
SVE Stop
SVE Rebound Start
SVE Rebound Stop
Pump Removed


WCP-94
Values less than laboratory reporting limits and water elevations below bottom of screen shown as open symbols.
Concentration (micrograms per liter)
Groundwater Elevation (feet above mean sea level)
Sample Date
200
175
150
125
100
75
50
25
0
1020
1010
1000
990
980
970
960
950
940
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Jan-19
Jan-20
Jan-21
TCE
TCE ND
PCE
PCE ND
1,1-DCE
1,1-DCE ND
TCE & PCE AWQS
1,1-DCE AWQS
Water Elev
SVE Start
SVE Stop
SVE Rebound Start
SVE Rebound Stop

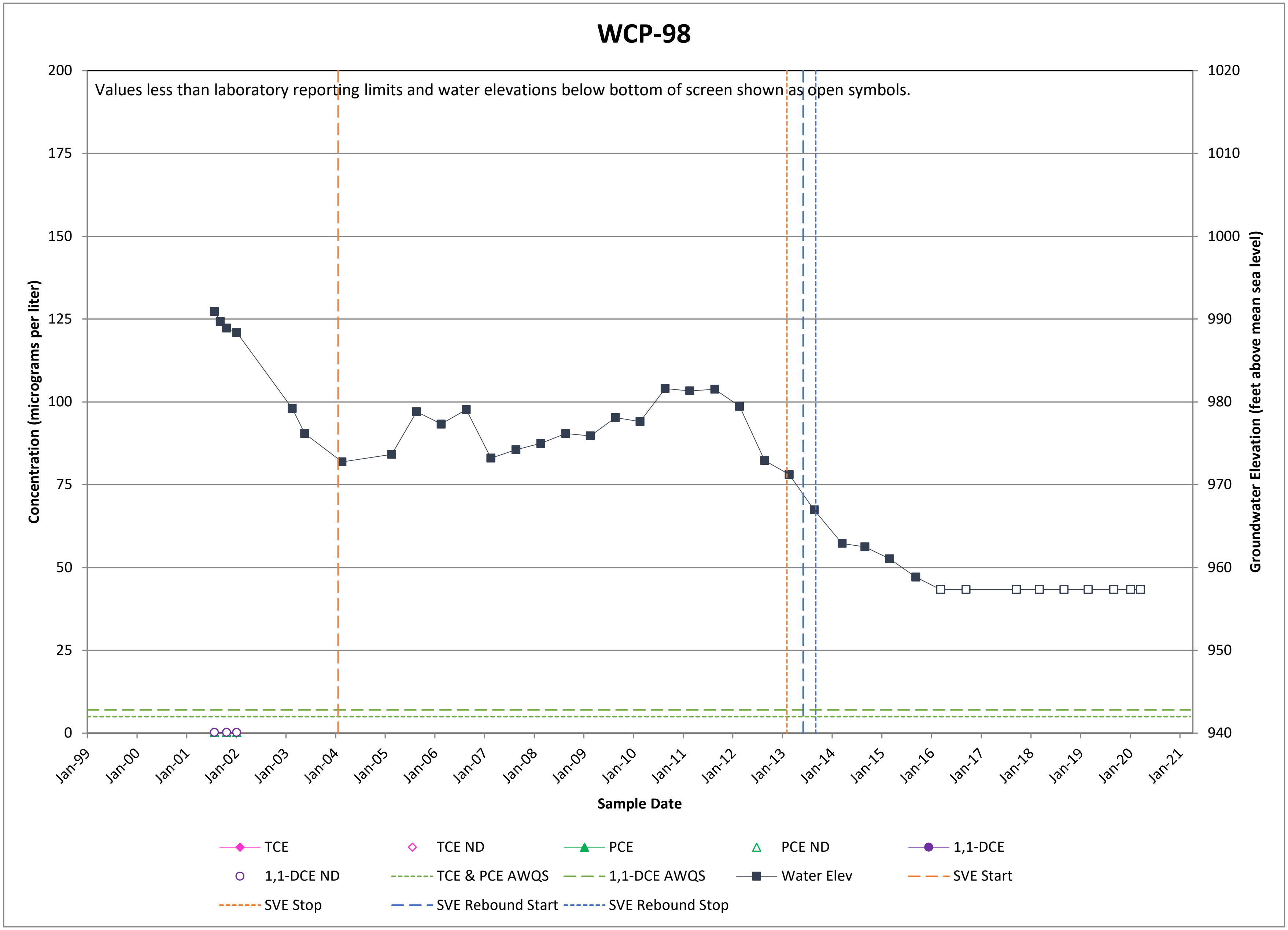

WCP-95
Values less than laboratory reporting limits and water elevations below bottom of screen shown as open symbols.
Concentration (micrograms per liter)
Groundwater Elevation (feet above mean sea level)
Sample Date
200
175
150
125
100
75
50
25
0
1020
1010
1000
990
980
970
960
950
940
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Jan-19
Jan-20
Jan-21
TCE
TCE ND
PCE
PCE ND
1,1-DCE
1,1-DCE ND
TCE & PCE AWQS
1,1-DCE AWQS
Water Elev
SVE Start
SVE Stop
SVE Rebound Start
SVE Rebound Stop

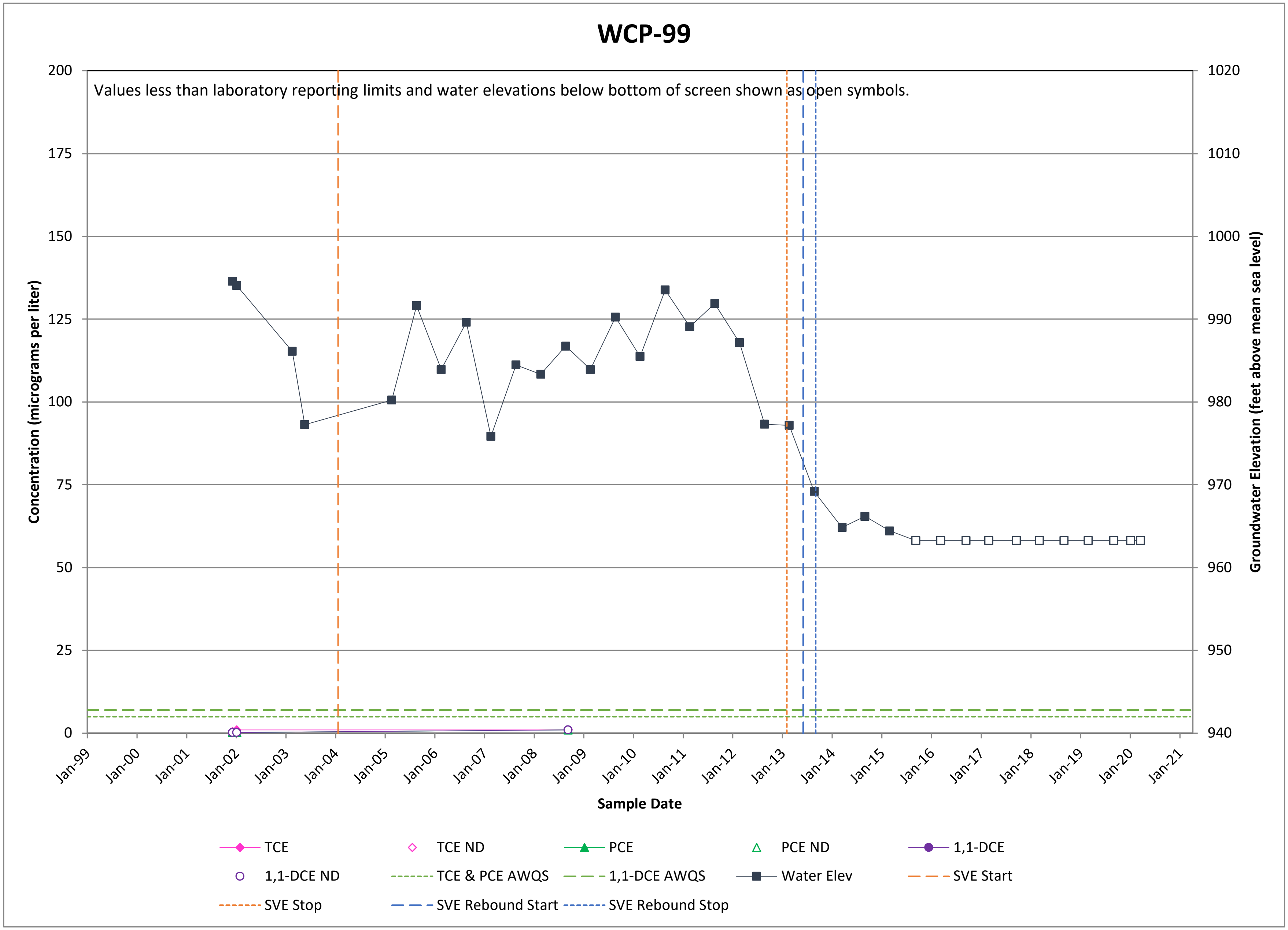


WCP-96
Values less than laboratory reporting limits and water elevations below bottom of screen shown as open symbols.
Concentration (micrograms per liter)
Groundwater Elevation (feet above mean sea level)
0
25
50
75
100
125
150
175
200
940
950
960
970
980
990
1000
1010
1020
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Jan-19
Jan-20
Jan-21
Sample Date
TCE
TCE ND
PCE
PCE ND
1,1-DCE
1,1-DCE ND
TCE & PCE AWQS
1,1-DCE AWQS
Water Elev
SVE Start
SVE Stop
SVE Rebound Start
SVE Rebound Stop
Pump Removed



WCP-97
Values less than laboratory reporting limits and water elevations below bottom of screen shown as open symbols.
Concentration (micrograms per liter)
Groundwater Elevation (feet above mean sea level)
Sample Date
200
175
150
125
100
75
50
25
0
1020
1010
1000
990
980
970
960
950
940
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Jan-19
Jan-20
Jan-21
TCE
TCE ND
PCE
PCE ND
1,1-DCE
1,1-DCE ND
TCE & PCE AWQS
1,1-DCE AWQS
Water Elev
SVE Start
SVE Stop
SVE Rebound Start
SVE Rebound Stop


WCP-98
Values less than laboratory reporting limits and water elevations below bottom of screen shown as open symbols.
Concentration (micrograms per liter)
200
175
150
125
100
75
50
25
0
Groundwater Elevation (feet above mean sea level)
1020
1010
1000
990
980
970
960
950
940
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Jan-19
Jan-20
Jan-21
Sample Date
TCE
TCE ND
PCE
PCE ND
1,1-DCE
1,1-DCE ND
TCE & PCE AWQS
1,1-DCE AWQS
Water Elev
SVE Start
SVE Stop
SVE Rebound Start
SVE Rebound Stop



WCP-99
Values less than laboratory reporting limits and water elevations below bottom of screen shown as open symbols.
Concentration (micrograms per liter)
Groundwater Elevation (feet above mean sea level)
Sample Date
0
25
50
75
100
125
150
175
200
940
950
960
970
980
990
1000
1010
1020
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
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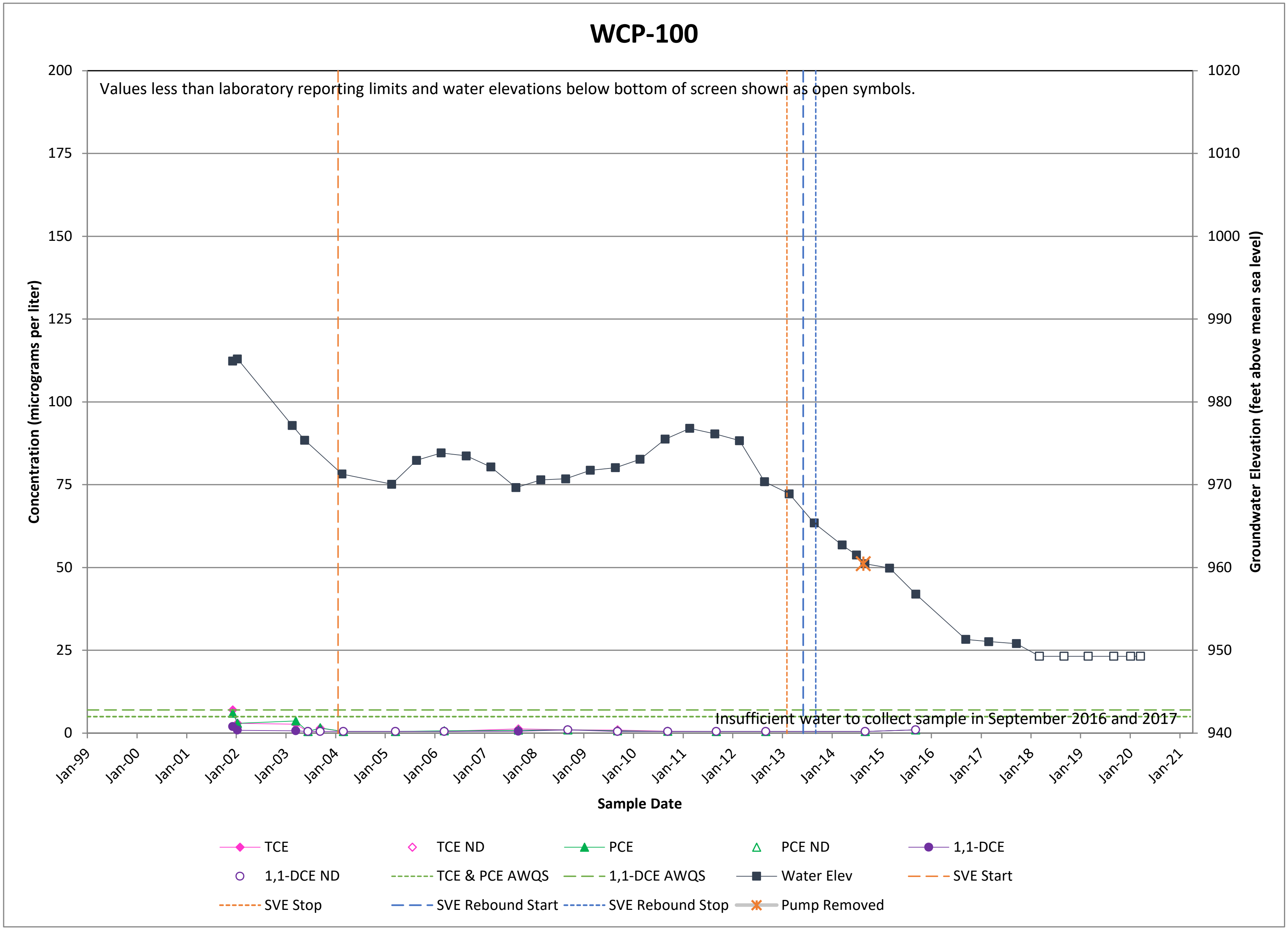
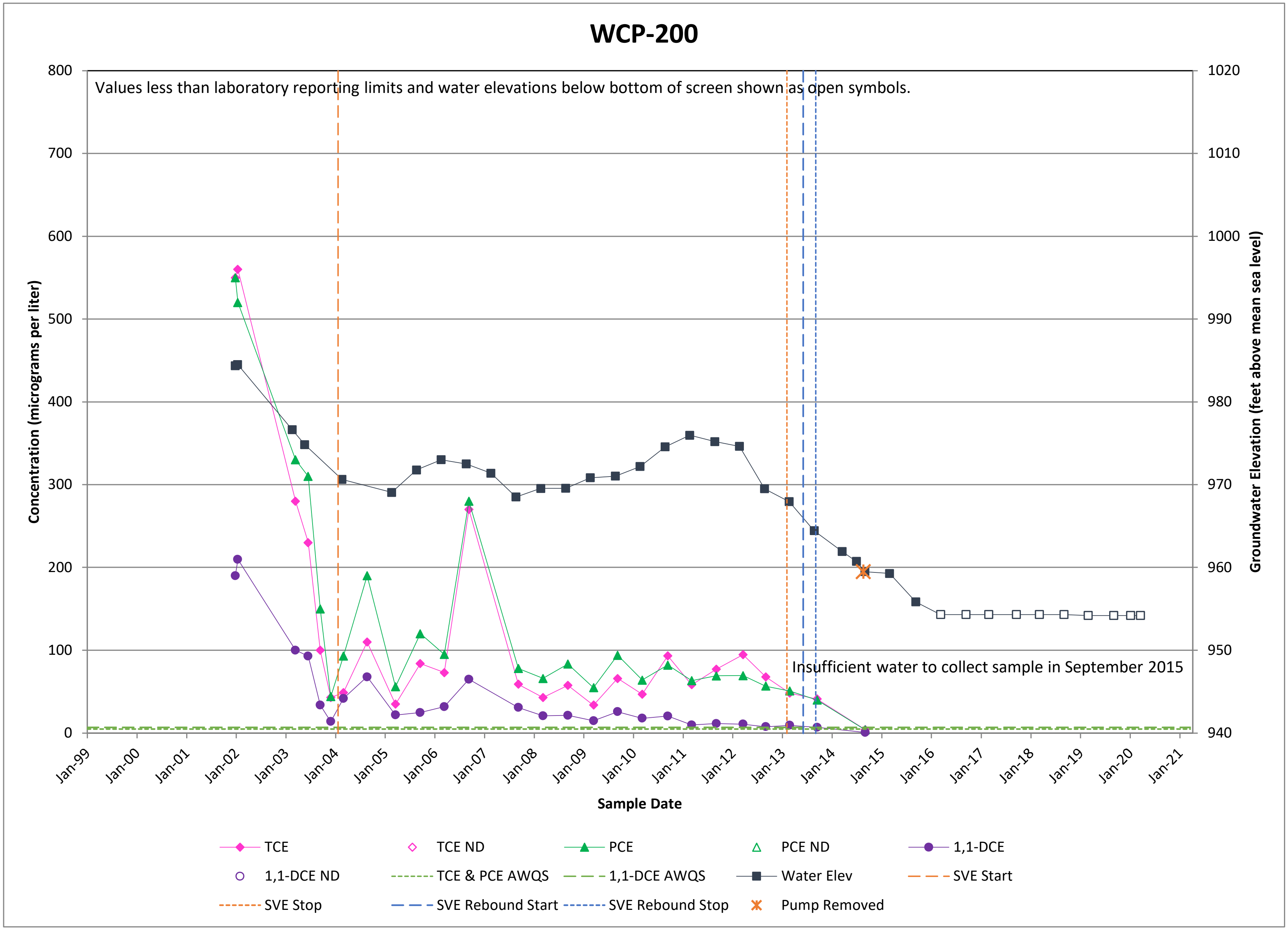
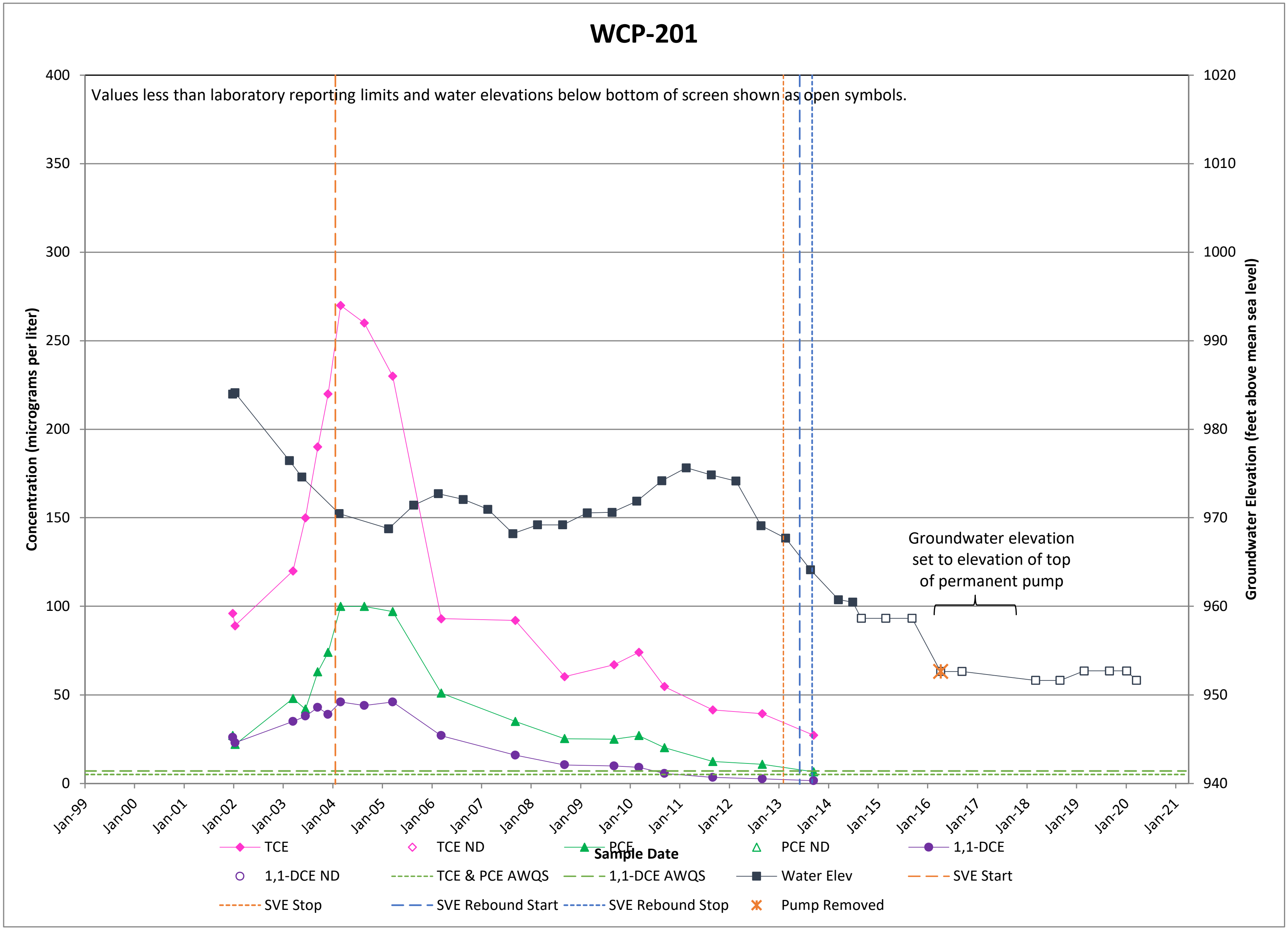
Jan-16
Jan-17
Jan-18
Jan-19
Jan-20
Jan-21
TCE
TCE ND
PCE
PCE ND
1,1-DCE
1,1-DCE ND
TCE & PCE AWQS
1,1-DCE AWQS
Water Elev
SVE Start
SVE Stop
SVE Rebound Start
SVE Rebound Stop



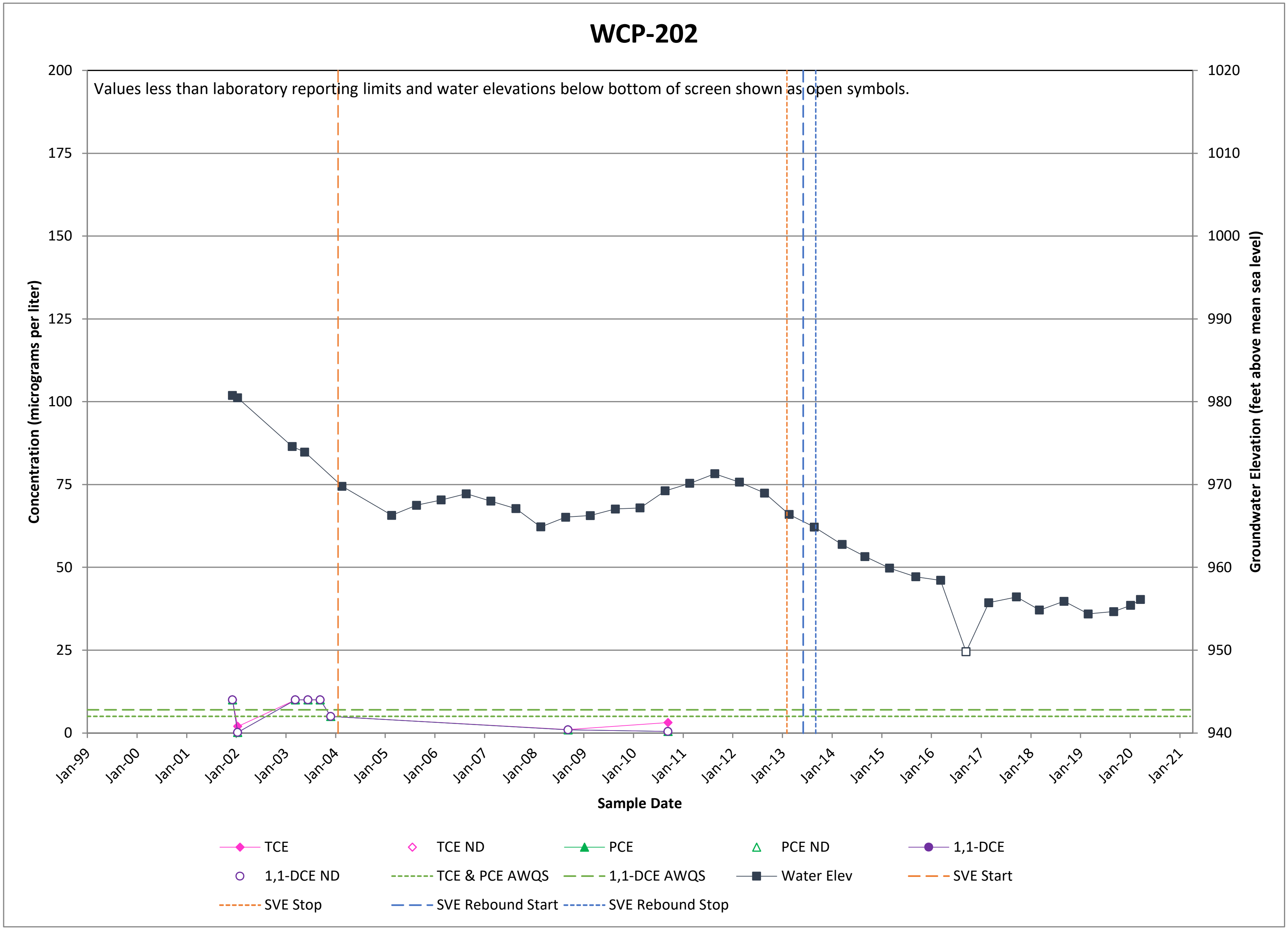
WCP-100
Values less than laboratory reporting limits and water elevations below bottom of screen shown as open symbols.
Insufficient water to collect sample in September 2016 and 2017
Concentration (micrograms per liter)
Groundwater Elevation (feet above mean sea level)
Sample Date
0
25
50
75
100
125
150
175
200
940
950
960
970
980
990
1000
1010
1020
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Jan-19
Jan-20
Jan-21
TCE
TCE ND
PCE
PCE ND
1,1-DCE
1,1-DCE ND
TCE & PCE AWQS
1,1-DCE AWQS
Water Elev
SVE Start
SVE Stop
SVE Rebound Start
SVE Rebound Stop
Pump Removed

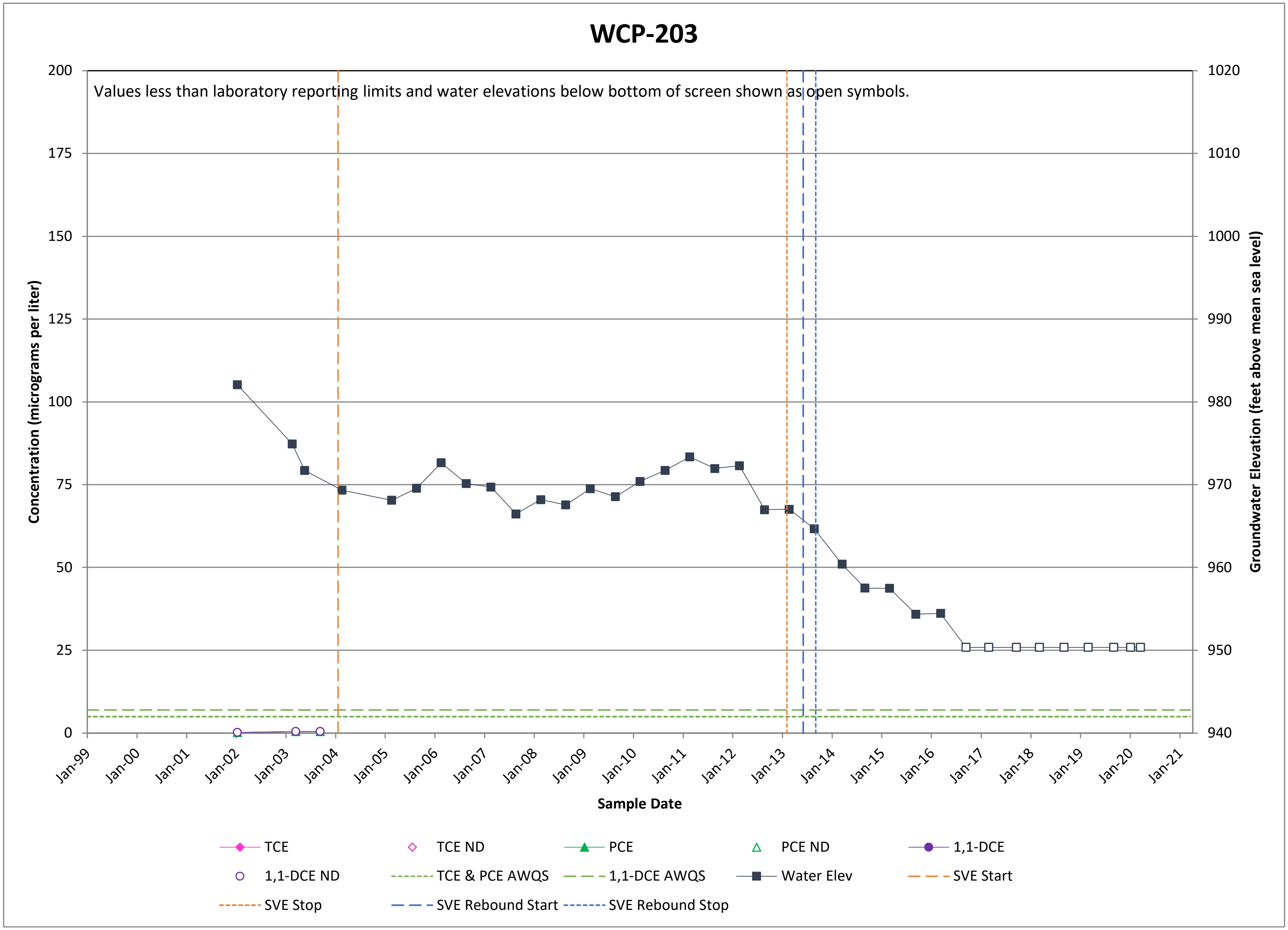


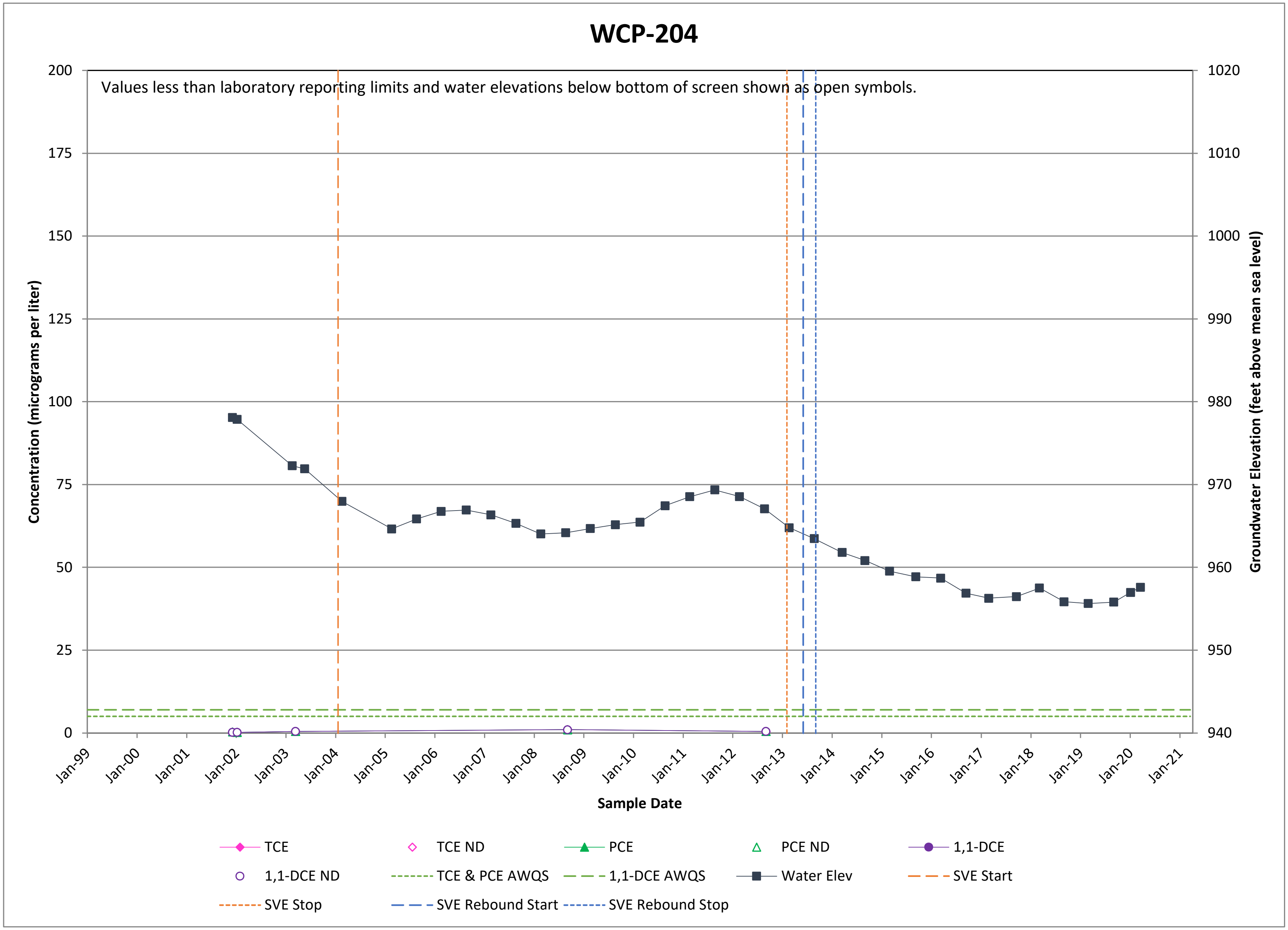
WCP-200
Values less than laboratory reporting limits and water elevations below bottom of screen shown as open symbols.
Insufficient water to collect sample in September 2015
Concentration (micrograms per liter)
Groundwater Elevation (feet above mean sea level)
Sample Date
0
100
200
300
400
500
600
700
800
940
950
960
970
980
990
1000
1010
1020
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Jan-19
Jan-20
Jan-21
TCE
TCE ND
PCE
PCE ND
1,1-DCE
1,1-DCE ND
TCE & PCE AWQS
1,1-DCE AWQS
Water Elev
SVE Start
SVE Stop
SVE Rebound Start
SVE Rebound Stop
Pump Removed



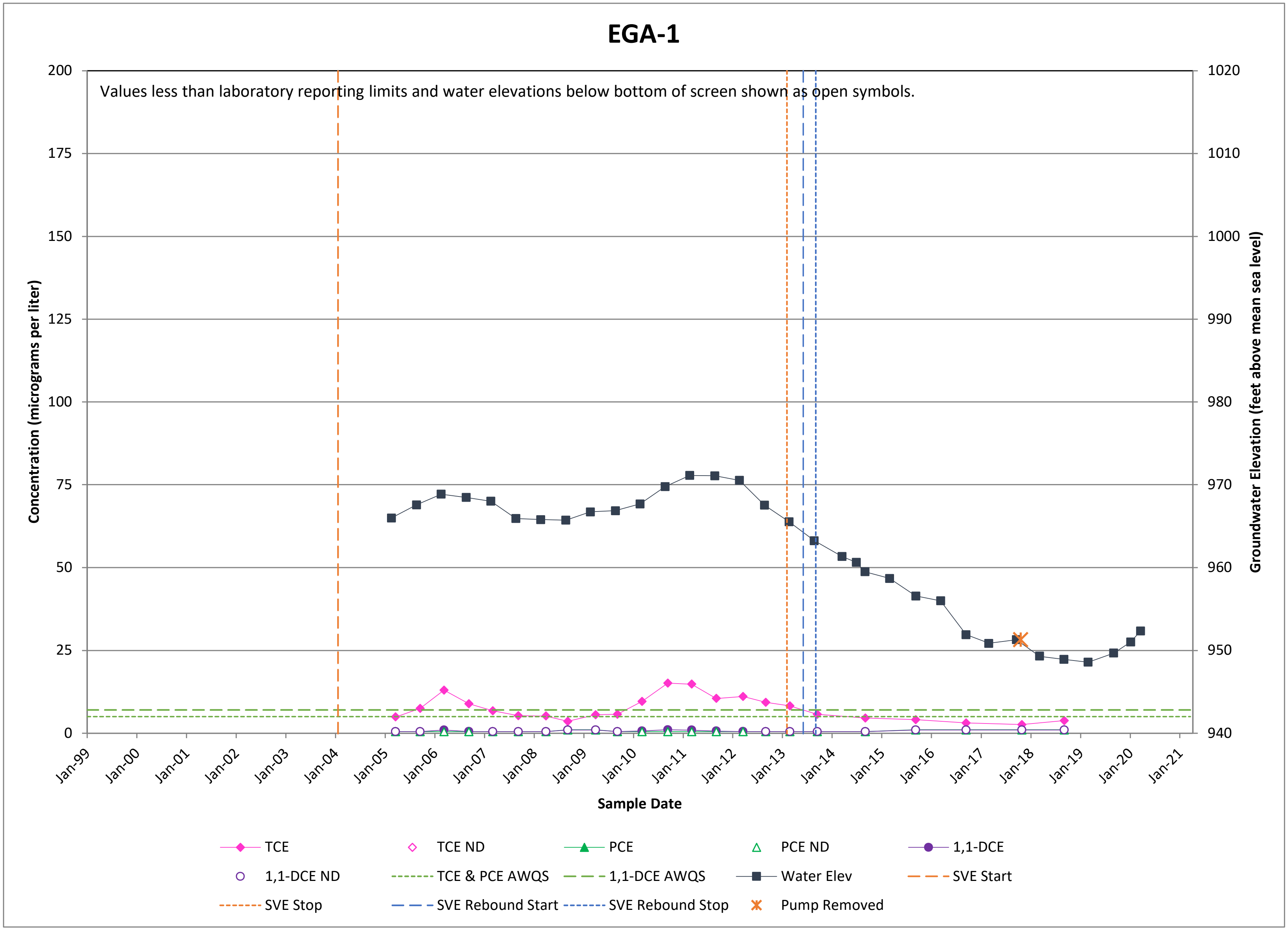
WCP-201
Values less than laboratory reporting limits and water elevations below bottom of screen shown as open symbols.
Concentration (micrograms per liter)
Groundwater Elevation (feet above mean sea level)
Sample Date
Groundwater elevation set to elevation of top of permanent pump
400
350
300
250
200
150
100
50
0
1020
1010
1000
990
980
970
960
950
940
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Jan-19
Jan-20
Jan-21
TCE
TCE ND
PCE
PCE ND
1,1-DCE
1,1-DCE ND
TCE & PCE AWQS
1,1-DCE AWQS
Water Elev
SVE Start
SVE Stop
SVE Rebound Start
SVE Rebound Stop
Pump Removed


WCP-202
Values less than laboratory reporting limits and water elevations below bottom of screen shown as open symbols.
Concentration (micrograms per liter)
Groundwater Elevation (feet above mean sea level)
Sample Date
200
175
150
125
100
75
50
25
0
1020
1010
1000
990
980
970
960
950
940
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Jan-19
Jan-20
Jan-21
TCE
TCE ND
PCE
PCE ND
1,1-DCE
1,1-DCE ND
TCE & PCE AWQS
1,1-DCE AWQS
Water Elev
SVE Start
SVE Stop
SVE Rebound Start
SVE Rebound Stop

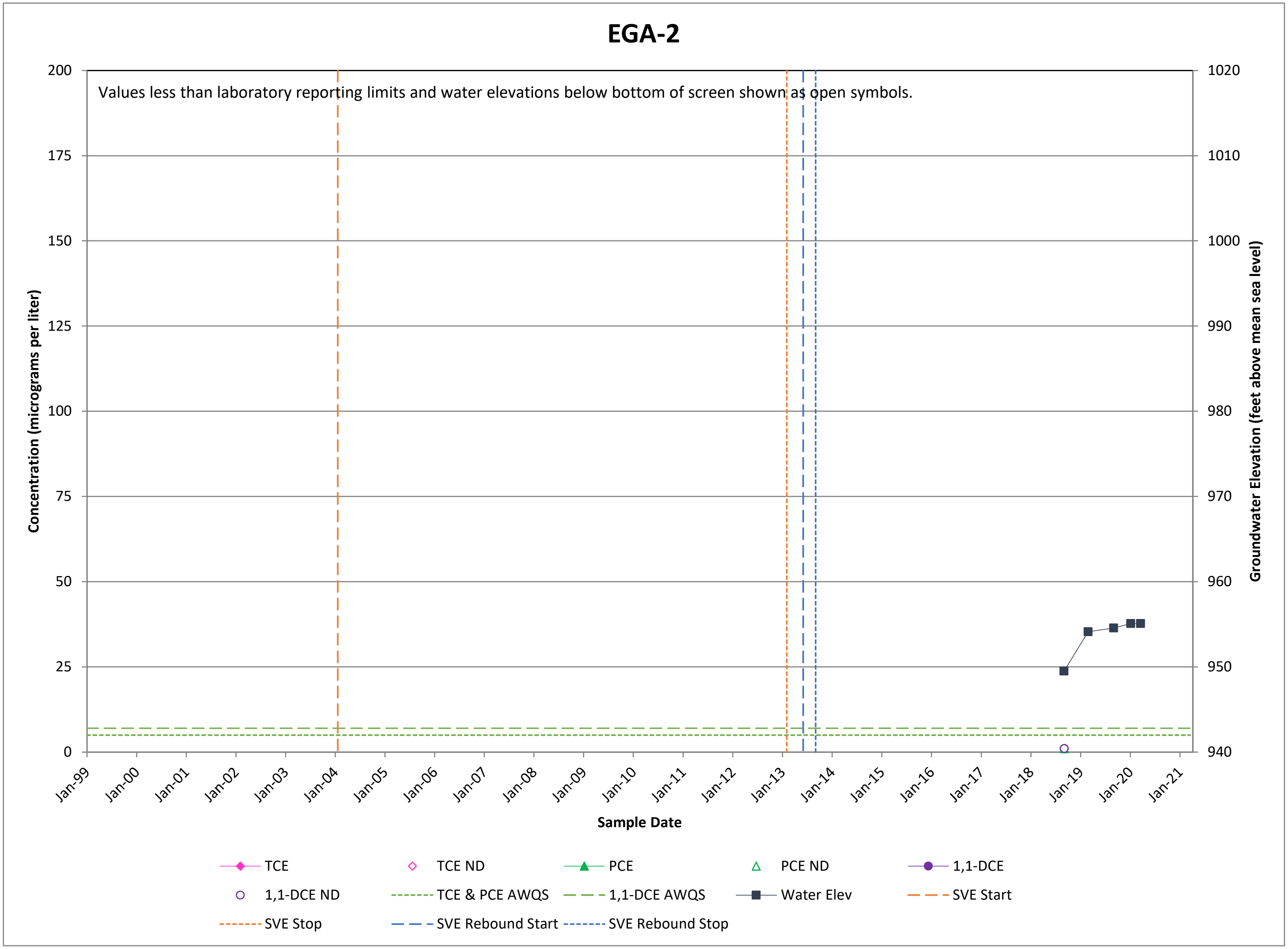

WCP-203
Values less than laboratory reporting limits and water elevations below bottom of screen shown as open symbols.
Concentration (micrograms per liter)
Groundwater Elevation (feet above mean sea level)
Sample Date
0
25
50
75
100
125
150
175
200
940
950
960
970
980
990
1000
1010
1020
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Jan-19
Jan-20
Jan-21
TCE
TCE ND
PCE
PCE ND
1,1-DCE
1,1-DCE ND
TCE & PCE AWQS
1,1-DCE AWQS
Water Elev
SVE Start
SVE Stop
SVE Rebound Start
SVE Rebound Stop

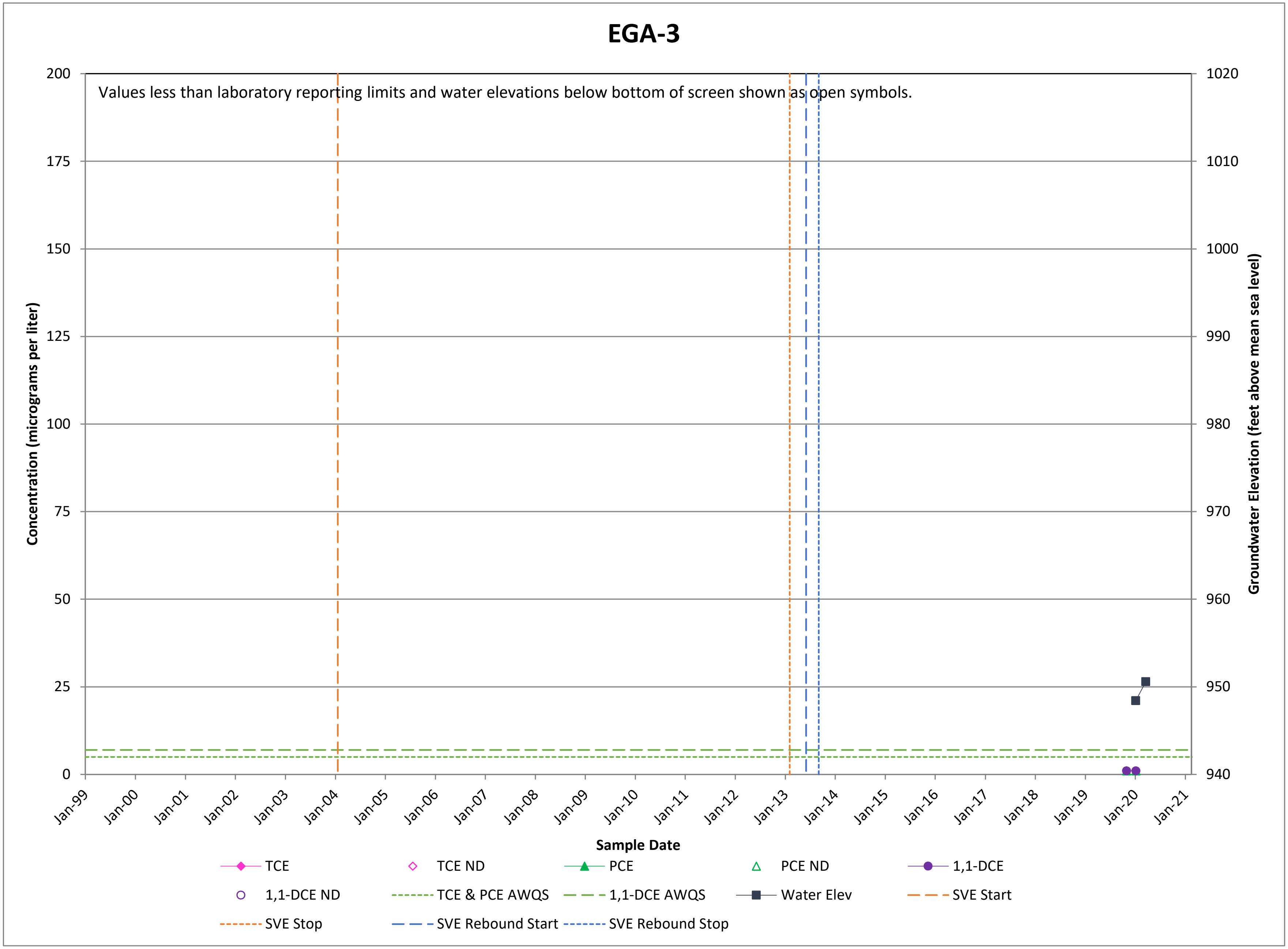


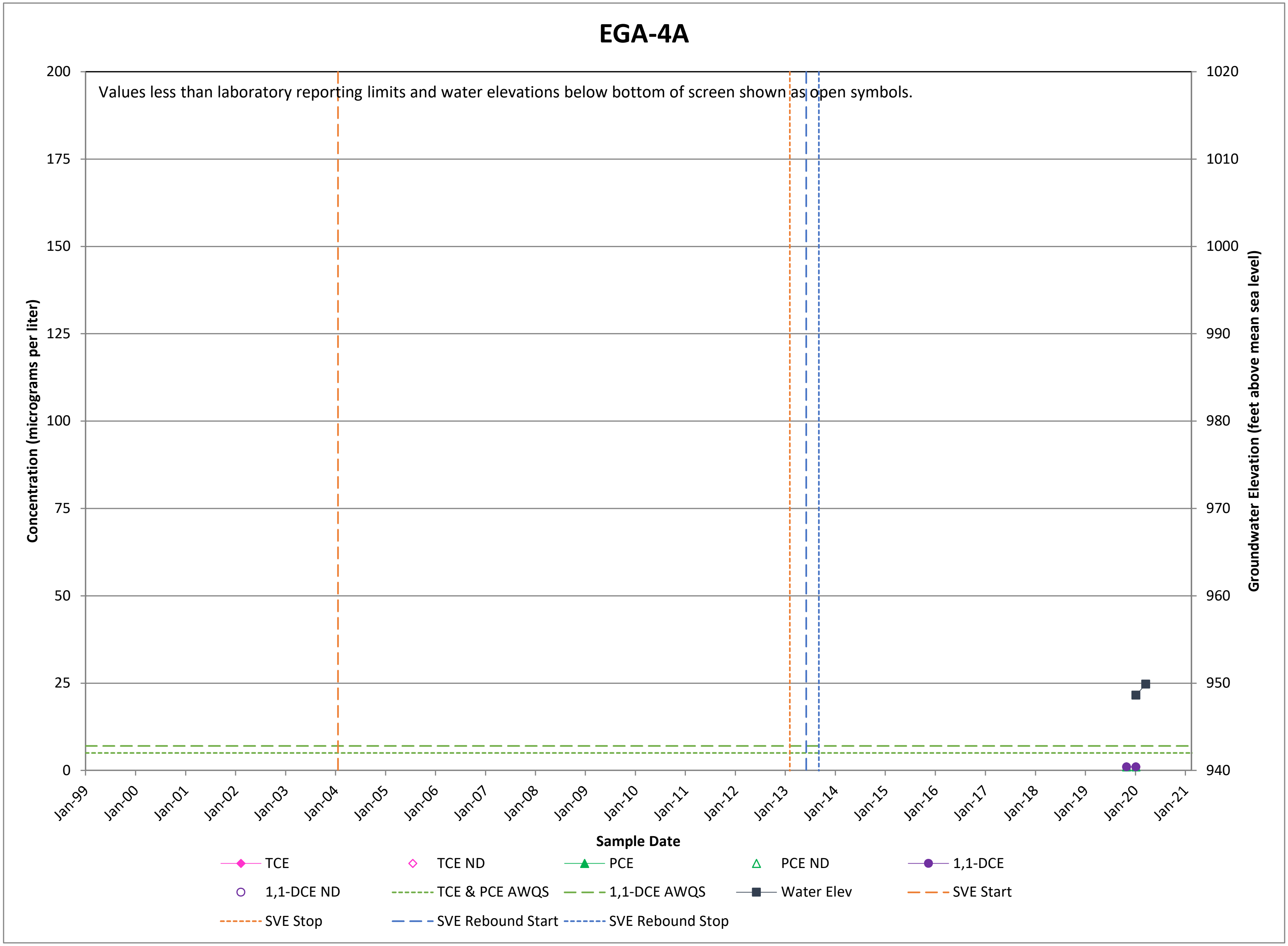
WCP-204
Values less than laboratory reporting limits and water elevations below bottom of screen shown as open symbols.
Concentration (micrograms per liter)
Groundwater Elevation (feet above mean sea level)
Sample Date
200
175
150
125
100
75
50
25
0
1020
1010
1000
990
980
970
960
950
940
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Jan-19
Jan-20
Jan-21
TCE
TCE ND
PCE
PCE ND
1,1-DCE
1,1-DCE ND
TCE & PCE AWQS
1,1-DCE AWQS
Water Elev
SVE Start
SVE Stop
SVE Rebound Start
SVE Rebound Stop



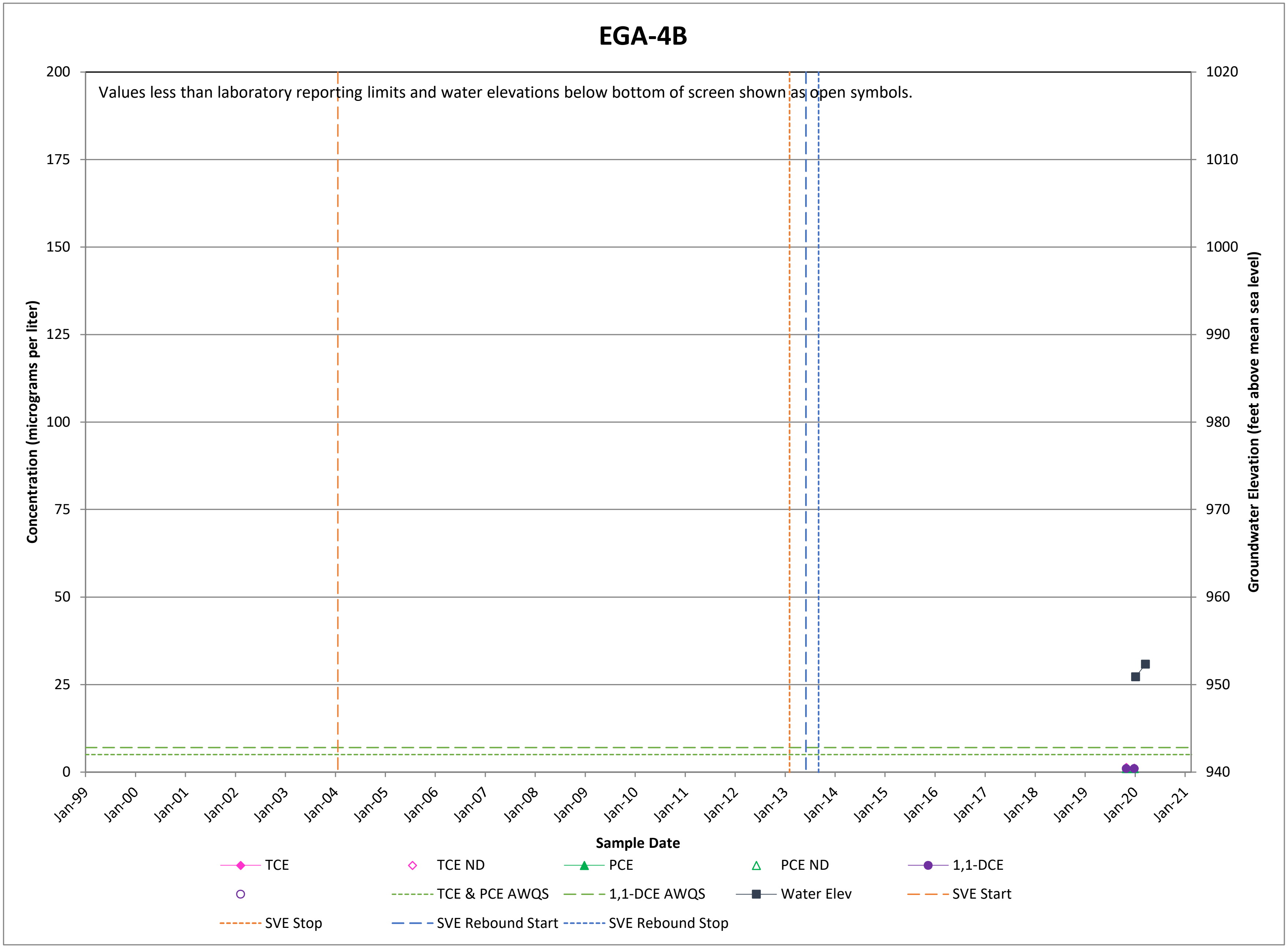
EGA-1
Values less than laboratory reporting limits and water elevations below bottom of screen shown as open symbols.
Concentration (micrograms per liter)
Groundwater Elevation (feet above mean sea level)
Sample Date
200
175
150
125
100
75
50
25
0
1020
1010
1000
990
980
970
960
950
940
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Jan-19
Jan-20
Jan-21
TCE
TCE ND
PCE
PCE ND
1,1-DCE
1,1-DCE ND
TCE & PCE AWQS
1,1-DCE AWQS
Water Elev
SVE Start
SVE Stop
SVE Rebound Start
SVE Rebound Stop
Pump Removed

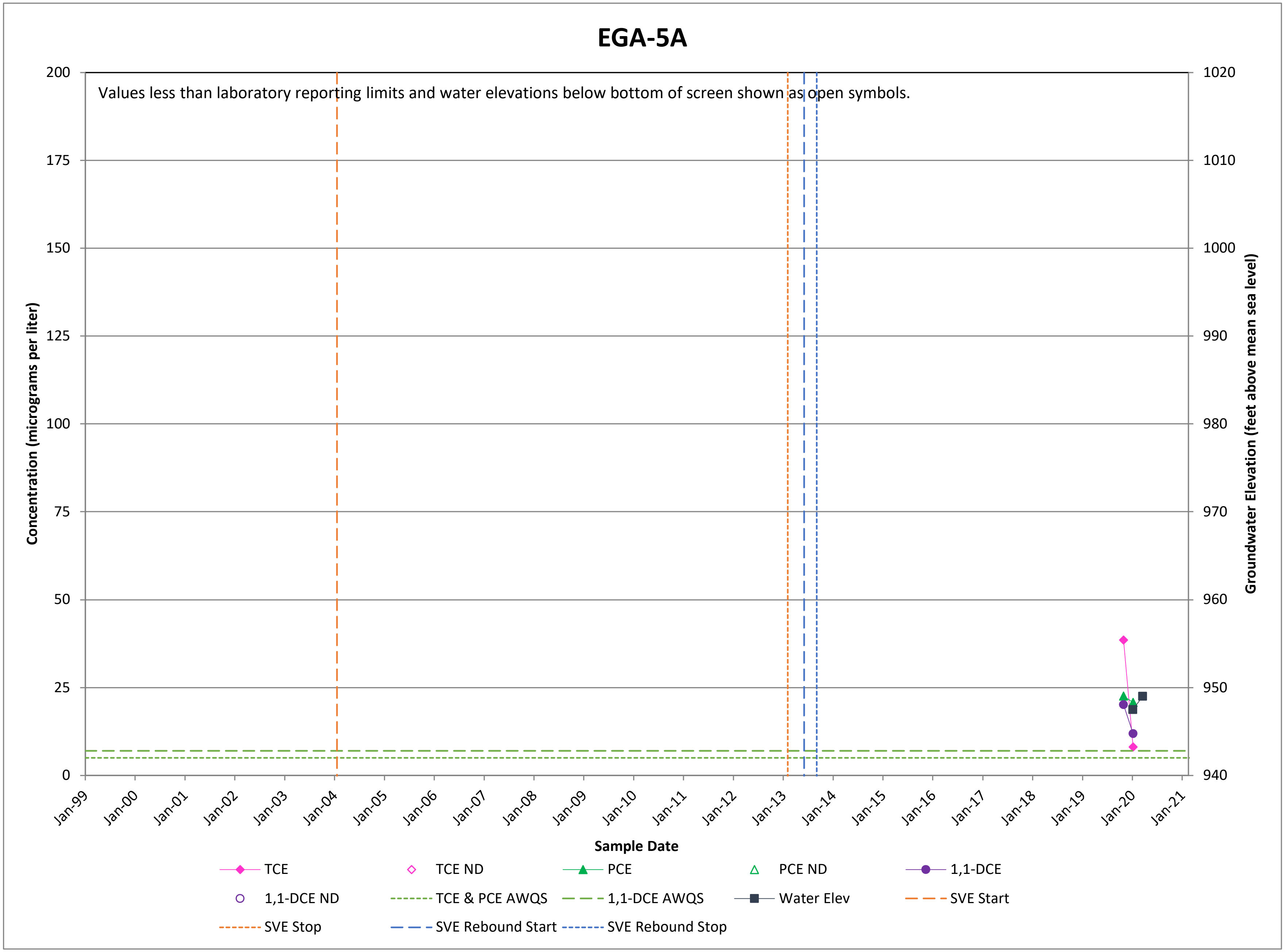

EGA-2
Values less than laboratory reporting limits and water elevations below bottom of screen shown as open symbols.
Concentration (micrograms per liter)
Groundwater Elevation (feet above mean sea level)
Sample Date
0
25
50
75
100
125
150
175
200
940
950
960
970
980
990
1000
1010
1020
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Jan-19
Jan-20
Jan-21
TCE
TCE ND
PCE
PCE ND
1,1-DCE
1,1-DCE ND
TCE & PCE AWQS
1,1-DCE AWQS
Water Elev
SVE Start
SVE Stop
SVE Rebound Start
SVE Rebound Stop

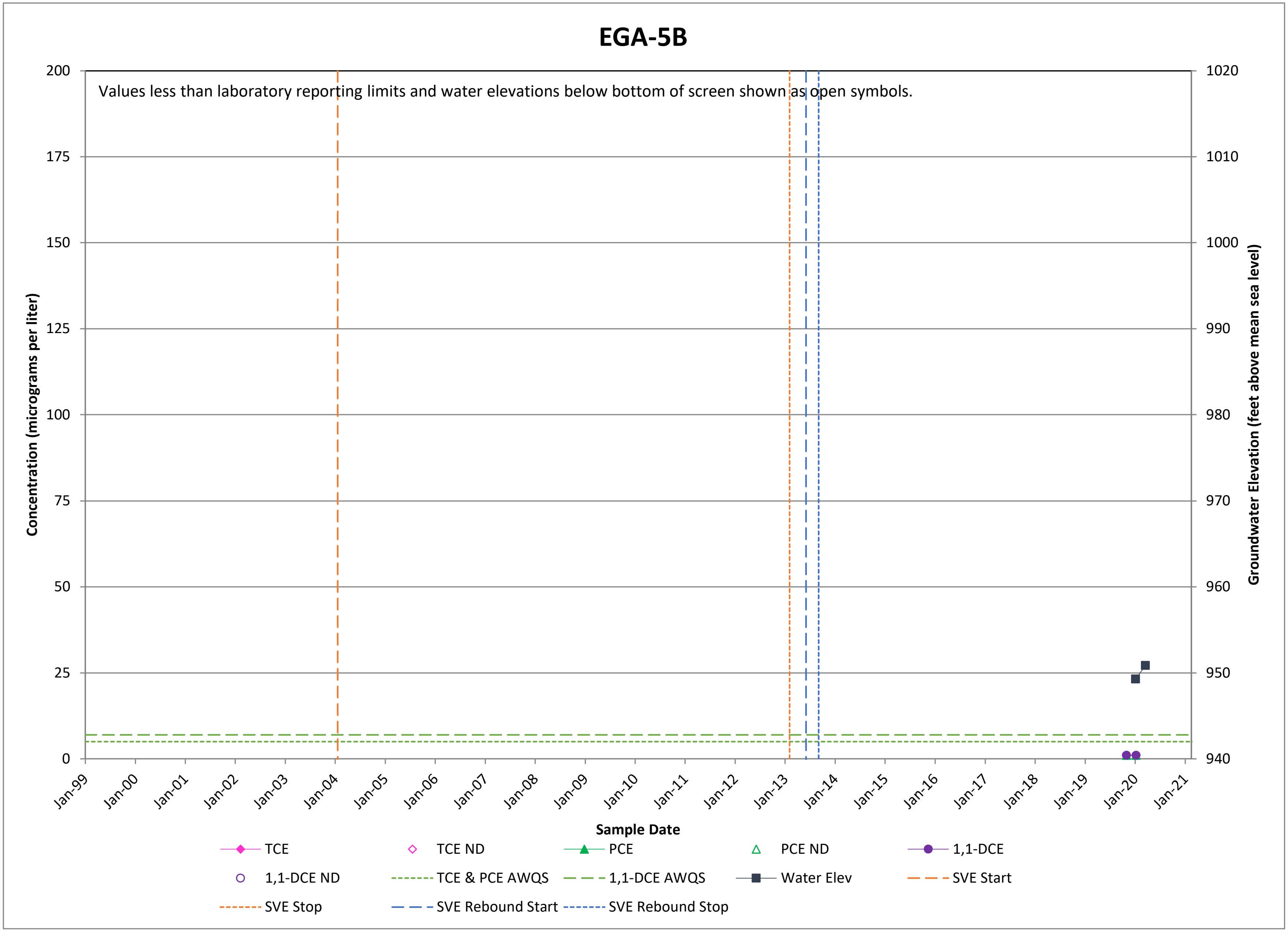

EGA-3
Values less than laboratory reporting limits and water elevations below bottom of screen shown as open symbols.
Concentration (micrograms per liter)
Groundwater Elevation (feet above mean sea level)
200
175
150
125
100
75
50
25
0
1020
1010
1000
990
980
970
960
950
940
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Jan-19
Jan-20
Jan-21
Sample Date
TCE
TCE ND
PCE
PCE ND
1,1-DCE
1,1-DCE ND
TCE & PCE AWQS
1,1-DCE AWQS
Water Elev
SVE Start
SVE Stop
SVE Rebound Start
SVE Rebound Stop



EGA-4A
Values less than laboratory reporting limits and water elevations below bottom of screen shown as open symbols.
Concentration (micrograms per liter)
Groundwater Elevation (feet above mean sea level)
0
25
50
75
100
125
150
175
200
940
950
960
970
980
990
1000
1010
1020
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Jan-19
Jan-20
Jan-21
Sample Date
TCE
TCE ND
PCE
PCE ND
1,1-DCE
1,1-DCE ND
TCE & PCE AWQS
1,1-DCE AWQS
Water Elev
SVE Start
SVE Stop
SVE Rebound Start
SVE Rebound Stop


EGA-4B
Values less than laboratory reporting limits and water elevations below bottom of screen shown as open symbols.
Concentration (micrograms per liter)
200
175
150
125
100
75
50
25
0
Groundwater Elevation (feet above mean sea level)
1020
1010
1000
990
980
970
960
950
940
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Jan-19
Jan-20
Jan-21
Sample Date
TCE
TCE ND
PCE
PCE ND
1,1-DCE
TCE & PCE AWQS
1,1-DCE AWQS
Water Elev
SVE Start
SVE Stop
SVE Rebound Start
SVE Rebound Stop


EGA-5A
Values less than laboratory reporting limits and water elevations below bottom of screen shown as open symbols.
Concentration (micrograms per liter)
Groundwater Elevation (feet above mean sea level)
200
175
150
125
100
75
50
25
0
1020
1010
1000
990
980
970
960
950
940
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Jan-19
Jan-20
Jan-21
Sample Date
TCE
TCE ND
PCE
PCE ND
1,1-DCE
1,1-DCE ND
TCE & PCE AWQS
1,1-DCE AWQS
Water Elev
SVE Start
SVE Stop
SVE Rebound Start
SVE Rebound Stop


EGA-5B
Values less than laboratory reporting limits and water elevations below bottom of screen shown as open symbols.
Concentration (micrograms per liter)
Groundwater Elevation (feet above mean sea level)
200
175
150
125
100
75
50
25
0
1020
1010
1000
990
980
970
960
950
940
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Jan-19
Jan-20
Jan-21
Sample Date
TCE
TCE ND
PCE
PCE ND
1,1-DCE
1,1-DCE ND
TCE & PCE AWQS
1,1-DCE AWQS
Water Elev
SVE Start
SVE Stop
SVE Rebound Start
SVE Rebound Stop

APPENDIX B

Linear Regression Analysis

Table B-1
Summary of Statistical Analysis of Groundwater Analytical Data
Feasibility Study Report
East Grand Avenue Site, Phoenix, Arizona

Constituent	Well	Cleanup Goal/Screening Level/Remediation goal (µg/L)[1]	Data Range						Linear Regression Analysis						Notes
			Minimum Concentration (µg/L)	Maximum Concentration (µg/L)	Concentration Measured Most Recently (µg/L)	% of Data Above Laboratory Reporting Limit	Start Date	End Date	Coefficient of Determination, R-squared[2]	p-value of Correlation (Significance of Slope)	Attenuation Half-life (days)	Trend Direction	Significance of Trend[3]	Projected Year to Screening Level	
PCE	WCP-44	5	1	7	2	100	3/28/2003	9/11/2014	0.07	0.58	NA	No Trend	NS	NA	BSL 3/10/2004
PCE	WCP-86	5	1	9	1	100	3/28/2003	9/11/2014	0.13	0.20	NA	Increasing	NS	NA	BSL 3/15/2011
PCE	WCP-86 partial dataset	5	1	9	1	100	9/16/2009	9/11/2014	0.94	<0.01	524	Decreasing	Significant	2010	BSL 3/15/2011
PCE	WCP-87	5	7	250	24	100	6/26/2003	9/11/2014	0.09	0.24	NA	No Trend	NS	NA	
PCE	WCP-87 partial dataset	5	24	250	24	100	3/21/2006	9/11/2014	0.83	<0.01	989	Decreasing	Significant	2021	
PCE	WCP-93	5	17	430	17	100	3/25/2003	3/5/2013	0.64	<0.01	1,044	Decreasing	Significant	2016	
PCE	WCP-200	5	4	330	4	100	3/25/2003	9/10/2014	0.45	<0.01	1,576	Decreasing	Significant	2025	BSL 9/10/2014
PCE	WCP-201	5	7	100	7	100	3/27/2003	9/23/2013	0.83	<0.01	1,207	Decreasing	Significant	2016	
TCE	WCP-44	5	2	17	13	100	3/28/2003	9/11/2014	<0.01	0.95	NA	No Trend	NS	NA	
TCE	WCP-83	5	3	20	4	100	3/27/2003	9/11/2014	0.60	<0.01	2,128	Decreasing	Significant	2012	BSL 9/23/2013
TCE	WCP-86	5	2	34	7	100	3/28/2003	9/11/2014	0.22	0.09	NA	Increasing	NS	NA	
TCE	WCP-86 partial dataset	5	7	34	7	100	9/16/2009	9/11/2014	0.89	<0.01	793	Decreasing	Significant	2015	
TCE	WCP-87	5	4	180	27	100	6/26/2003	9/11/2014	0.16	0.10	NA	Increasing	NS	NA	
TCE	WCP-87 partial dataset	5	27	180	27	100	3/21/2006	9/11/2014	0.79	<0.01	1,118	Decreasing	Significant	2021	
TCE	WCP-88	5	5	47	19	100	6/25/2003	9/17/2015	0.12	0.09	NA	Decreasing	NS	NA	
TCE	WCP-93	5	55	1,100	55	100	3/25/2003	3/5/2013	0.64	<0.01	1,134	Decreasing	Significant	2022	
TCE	WCP-200	5	4	280	4	100	3/25/2003	9/10/2014	0.26	0.01	2,167	Decreasing	Significant	2030	BSL 9/10/2014
TCE	WCP-201	5	27	270	27	100	3/27/2003	9/23/2013	0.85	<0.01	1,353	Decreasing	Significant	2023	
TCE	EGA-1	5	3	15	3	100	3/30/2005	9/21/2016	0.04	0.40	NA	No Trend	NS	NA	BSL 9/11/2014
TCE	EGA-1	5	3	15	3	100	9/21/2010	9/21/2016	0.97	<0.01	912	Decreasing	Significant	2014	BSL 9/11/2014
1,1-DCE	WCP-87	7	6	110	13	100	6/26/2003	9/11/2014	0.04	0.42	NA	No Trend	NS	NA	
1,1-DCE	WCP-87 partial dataset	7	9	110	13	100	3/21/2006	9/11/2014	0.42	0.02	1,152	Decreasing	Significant	2017	
1,1-DCE	WCP-93	7	1	98	1	100	3/25/2003	3/5/2013	0.72	<0.01	927	Decreasing	Significant	2010	BSL 3/15/2011
1,1-DCE	WCP-200	7	1	100	1	100	3/25/2003	9/10/2014	0.66	<0.01	1,149	Decreasing	Significant	2013	BSL 9/10/2014
1,1-DCE	WCP-201	7	2	46	2	100	3/27/2003	9/23/2013	0.95	<0.01	818	Decreasing	Significant	2009	BSL 9/21/2010

Notes, Abbreviations and Assumptions:
µg/L = micrograms per liter
NS = not significant
NA = not applicable due to increasing trend or non-significant trend
1 Screening levels are the Arizona Aquifer Water Quality Standards
2 Linear regression analysis with R^2 values <0.1 and no statistically significant trend were defined as having no apparent trend (No Trend).
3 Statistically significant trend defined as having p-value ≤ 0.05
Qualified data, if applicable, is converted to reported value

APPENDIX C

Pore-flushing Calculations and Capture Calculations

ARCADIS Design & Consultancy for natural and built assets

1,1-Dichloroethene

Parameter			Natural	Groundwater Extraction	Units	Notes
time to flush	t	=	**2568**	**1605**	**days**	$t = (l \cdot N_{pv})/Vx$
	t	=	**7**	**4**	**years**	
number of pore volumes	N_{pv}	=	1.0	1.0	unitless	$N_{pv} = -R \cdot ln(C_t/C_i)$
concentration initial	C_i	=	16.0	16.0	ug/L	EGA-05A average (2019-2020)
concentration target	C_t	=	7	7	ug/L	AWQS
plume length	l	=	500	500	ft	parallel to flow
retardation coefficient	R	=	**1.18**	**1.18**	**unitless**	$R = 1 + (p_b \cdot Kd/\theta_t)$
soil adsorption coefficient	K_d	=	0.032	0.032	L/kg	=foc*koc (ADEQ 2017, USEPA 2020)
porosity	θ_t	=	0.3	0.3	fraction	(Weston 2006)
soil bulk density	ρ_b	=	1.7	1.7	kg/L	
chemical velocity	v_c	=	**0.161**	**0.258**	**ft/day**	$v_c = v_x/R$
pore velocity	v_x	=	**0.19**	**0.30**	**ft/day**	$v_x = K \cdot i/\theta_t$
hydraulic conductivity	K	=	7.6	7.6	ft/day	A-Unit Average (Arcadis 2020)
hydraulic gradient	i	=	0.005	0.008	ft/ft	(Weston 2006, Arcadis 2020)
porosity, effective	θ_e	=	0.2	0.2	fraction	

Notes:
ft = feet
ft^3 = cubic feet
AWQS = Arizona Aquifer Water Quality Standard
L/kg = liters per kilogram
ug/L = micrograms per liter

Scenarios:
Natural = natural groundwater flow conditions
Groundwater extraction = enhanced gradient from groundwater extraction

References:
USEPA. 1997. Ground Water Issue, Design Guidelines for Conventional Pump-and-Treat Systems. September.
Arcadis 2020. Well Installation and Sampling Report. West Central Phoenix East Grand Avenue WQARF Site. March 31.
Fetter, C.W. 2008. Contaminant Hydrogeology. Second Edition.
Weston 2006. Final Remedial Investigation Report, WCP East Grand Avenue WQARF Site. June.

Tetrachloroethene

Parameter			Natural	Groundwater Extraction	Units	Notes
time to flush	t	=	**4540**	**2837**	**days**	$t = (l \cdot N_{pv})/Vx$
	t	=	**12**	**8**	**years**	
number of pore volumes	N_{pv}	=	1.7	1.7	unitless	$N_{pv} = -R \cdot ln(C_t/C_i)$
concentration initial	C_i	=	15.4	15.4	ug/L	EGA-05A average (2019-2020)
concentration target	C_t	=	5	5	ug/L	AWQS
plume length	l	=	500	500	ft	parallel to flow
retardation coefficient	R	=	**1.54**	**1.54**	**unitless**	$R = 1 + (p_b \cdot Kd/\theta_t)$
soil adsorption coefficient	K_d	=	0.095	0.095	L/kg	=foc*koc (ADEQ 2017, USEPA 2020)
porosity	θ_t	=	0.3	0.3	fraction	(Weston 2006)
soil bulk density	ρ_b	=	1.7	1.7	kg/L	
chemical velocity	v_c	=	**0.124**	**0.198**	**ft/day**	$v_c = v_x/R$
pore velocity	v_x	=	**0.19**	**0.30**	**ft/day**	$v_x = K \cdot i/\theta_t$
hydraulic conductivity	K	=	7.6	7.6	ft/day	A-Unit Average (Arcadis 2020)
hydraulic gradient	i	=	0.005	0.008	ft/ft	(Weston 2006, Arcadis 2020)
porosity, effective	θ_e	=	0.2	0.2	fraction	

Notes:
ft = feet
ft^3 = cubic feet
AWQS = Arizona Aquifer Water Quality Standard
L/kg = liters per kilogram
ug/L = micrograms per liter

Scenarios:
Natural = natural groundwater flow conditions
Groundwater extraction = enhanced gradient from groundwater extraction

References:
USEPA. 1997. Ground Water Issue, Design Guidelines for Conventional Pump-and-Treat Systems. September.
Arcadis 2020. Well Installation and Sampling Report. West Central Phoenix East Grand Avenue WQARF Site. March 31.
Fetter, C.W. 2008. Contaminant Hydrogeology. Second Edition.
Weston 2006. Final Remedial Investigation Report, WCP East Grand Avenue WQARF Site. June.

Estimated Groundwater Pore Flushing Time Calculations
East Grand Avenue WQARF SIte
Phoenix, Arizona

ARCADIS Design & Consultancy for natural and built assets

Trichloroethene

Parameter			Natural	Groundwater Extraction	Units	Notes
time to flush	t	=	**6337**	**3961**	**days**	$t = (l \cdot N_{pv})/Vx$
	t	=	**17**	**11**	**years**	
number of pore volumes	N_{pv}	=	2.4	2.4	unitless	$N_{pv} = -R \cdot ln(C_t/C_i)$
concentration initial	C_i	=	30	30	ug/L	EGA-05A average (2019-2020)
concentration target	C_t	=	5	5	ug/L	AWQS
plume length	l	=	500	500	ft	20+ ug/L length parallel to flow
retardation coefficient	R	=	**1.34**	**1.34**	**unitless**	$R = 1 + (p_b \cdot Kd/\theta_t)$
soil adsorption coefficient	K_d	=	0.061	0.061	L/kg	=foc*koc (ADEQ 2017, USEPA 2020)
porosity	θ_t	=	0.3	0.3	fraction	(Weston 2006)
soil bulk density	ρ_b	=	1.7	1.7	kg/L	
chemical velocity	v_c	=	**0.141**	**0.226**	**ft/day**	$v_c = v_x/R$
pore velocity	v_x	=	**0.19**	**0.30**	**ft/day**	$v_x = K \cdot i/\theta_t$
hydraulic conductivity	K	=	7.6	7.6	ft/day	A-Unit Average (Arcadis 2020)
hydraulic gradient	i	=	0.005	0.008	ft/ft	(Weston 2006, Arcadis 2020)
porosity, effective	θ_e	=	0.2	0.2	fraction	

Notes:
ft = feet
ft^3 = cubic feet
AWQS = Arizona Aquifer Water Quality Standard
L/kg = liters per kilogram
ug/L = micrograms per liter

Scenarios:
Natural = natural groundwater flow conditions
Groundwater extraction = enhanced gradient from groundwater extraction

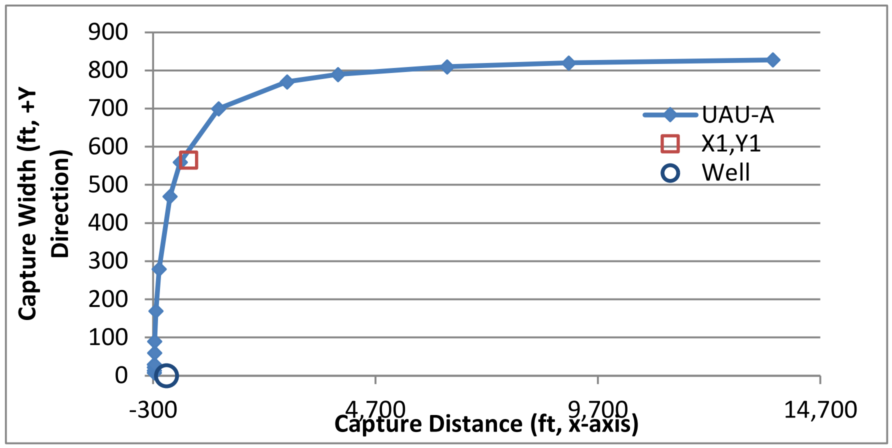
References:

USEPA. 1997. Ground Water Issue, Design Guidelines for Conventional Pump-and-Treat Systems. September.
Arcadis 2020. Well Installation and Sampling Report. West Central Phoenix East Grand Avenue WQARF Site. March 31.
Fetter, C.W. 2008. Contaminant Hydrogeology. Second Edition.
Weston 2006. Final Remedial Investigation Report, WCP East Grand Avenue WQARF Site. June.

Groundwater Capture Calculations
East Grand Avenue WQARF
Phoenix, Arizona

Aquifer	T (ft2/day)	Aquifer Thickness (b) (ft)	Gradient	Plume Width (ft)	Plume Discharge (ft^3/day)	Q - Pumping Rate (ft^3/day)	Q - Pumping Rate (gpm)	X_o (ft)	+/- Y_{max} (ft)	+/- Y_{well} (ft)	+/- Y_{x1} (ft)
UAU-A	228	30	0.005	600	684	1,925	10	-269	844	422	566

Notes:
T = Transmissivity = K*b
Q = Pumping rate
ft = feet
ft^2/day = square feet per day
ft^3/day = cubic feet per day
gpm = gallons per minute
Xo = - Q/(2πKbi)
Ymax = ± Q/(2Kbi)
Ywell = ± Q/(4Kbi)
192.5 ft3/day = 1 gpm
500 x_1 (specified distance (ft) upgradient from well)



References:

Fetter, C.W. 1994. Applied Hydrogeology. Third Edition. Prentice Hall, Upper Saddle, New Jersey.

APPENDIX D

Water Provider Consultation Responses

Appendix D
Water Provider Consultation Responses
East Grand Avenue WQARF Site, Phoenix, Arizona

Water Provider	Date FS WP Delivered	Response to FS WP Provided	Date RRARP Delivered	Response to RRARP Provided
City of Phoenix	April 7, 2015	yes	May 7, 2015	yes
Michigan Trailer Park	April 7, 2015	no	May 6, 2015	no
DS Services of America, Inc.	April 7, 2015	no	May 6, 2015	no
Salt River Project	April 7, 2015	yes	May 6, 2015	yes

NOTES:
FS WP = Feasibility Study Work Plan (GCA 2009b)
RRARP = Reference Remedy and Alternative Remedies Proposal (ARCADIS 2014a)

City of Phoenix
OFFICE OF ENVIRONMENTAL PROGRAMS

April 27, 2015

Mr. Kevin Snyder
Arizona Department of Environmental Quality
1110 West Washington Street
Phoenix, AZ 85007

Re: Feasibility Study Work Plan
West Central Phoenix East Grand Avenue WQARF Site
Phoenix, Arizona

Dear Mr. Snyder:

I am writing to provide you with comments on behalf of the City of Phoenix concerning the July 2009 Feasibility Study Work Plan (FS WP) for the West Central Phoenix East Grand Avenue WQARF site, prepared by G.M. Clement & Associates, Inc., forwarded to the Office of Environmental Programs on April 6, 2015.

Although this report was prepared and approved several years ago, it is our understanding that the Feasibility Study is still underway. As such, we would like to provide the following comments to consider during the evaluation and selection of the remedial strategies.

The City of Phoenix currently relies on groundwater for only a small percentage of our potable water needs. However, increased future demand coupled with potential extended drought conditions may necessitate greater reliance on groundwater resources in the future. Therefore, we recommend that the remedial selection strategy take into consideration a remedial objective of protecting the long term water quality of the aquifer as a future drinking water resource.

In addition, the G.M. Clement & Associates, Inc. report indicated that draft "Reference and Alternatives Remedy Proposal" will be prepared and provided to the well owners, MTP, Sparkletts and SRP for their review and comment." We appreciate that ADEQ has been providing copies of reports pertaining to WQARF sites within the City of Phoenix for our review and comment as the municipal water provider, and we would appreciate being included as a reviewer on this submittal as well.

Thank you for the opportunity to provide feedback on the FS WP.

Sincerely,

Joe Giudice
Acting Manager, Office of Environmental Programs

200 West Washington Street, 14th Floor • Phoenix, Arizona 85003 • 602-256-5669 • TTY: 602-534-5500
www.phoenix.gov

City of Phoenix
OFFICE OF ENVIRONMENTAL PROGRAMS

ARCADIS US, Inc.
JUL 23 2015
RECEIVED

July 17, 2015

Mr. Kevin Snyder
Project Hydrologist
Remedial Projects Unit
1110 W. Washington Street
Phoenix, Arizona 85007

Re: Reference Remedy and Alternative Remedies Proposal prepared by Arcadis on behalf of Univar, USA dated December 4, 2014, Arizona Department of Environmental Quality (ADEQ) Approval letter dated March 23, 2015, and Arcadis letter to City of Phoenix (COP) regarding the Reference Remedy and Alternative Remedies Proposal dated May 7, 2015, for West Central Phoenix (WCP), East Grand Avenue EGA) Water Quality Assurance Revolving Fund Site, Phoenix Arizona.

Dear Mr. Snyder,

The COP, Office of Environmental Programs has reviewed all the above referenced reports and letters. COP appreciates that ADEQ and Arcadis included us in this process.

In the report three (3) water providers are discussed, they are Michigan Trailer Park (MTP), Danone Water of North America (Danone) and Salt River Project (SRP). The Remedial Objective established for each of these water providers was:

- To protect, replace or otherwise provide an alternative water supply should the MTP drinking water well be lost in the future due to changes in groundwater flow direction that would contaminate the well with PCE, TCE, and/or 1,1-DCE contamination emanating from the WCP EGA site.
- To protect, replace or otherwise provide an alternative water supply should the use of Danone drinking water well(s) be lost in the future due to contamination of the deeper aquifer by the PCE, TCE, and/or 1,1-DCE contamination emanating from the WCP EGA site.
- To protect, replace or otherwise provide an alternative water supply should use of the SRP wells be lost in the future due to changes in groundwater flow direction that would contaminate the well with PCE, TCE, and/or 1, 1-DCE contamination emanating from the WCP EGA site.

COP currently does not have water supply wells in the immediate area of this site, however, future wells may be constructed to pump groundwater resources to mitigate against drought. To ensure protection of this drinking water resource the COP request the following RO:

- To protect future water supply should the COP need water that has been lost due to contamination of the deep aquifer with PCE, TCE, and/or 1, 1-DCE contamination emanating from the WCP EGA site.

Please contact me at 602-256-5681 with any comments or questions regarding this letter.

Thank you,

Julie Riemenschneider

Julie Riemenschneider
Environmental Programs Coordinator
Office of Environmental Programs, COP

CC
Joe Giudice, OEP (electronic copy)
Scott Green, ADEQ (electronic copy)
Tina LePage, ADEQ (electronic copy)
Kathryn Brantingham Arcadis

Noonan, Katie

From:	Brantingham, Katy
Sent:	Wednesday, April 15, 2015 9:54 AM
To:	Noonan, Katie; Shepherd, Christopher; Brockman, Brian
Subject:	FW: West Central Phoenix, East Grand Avenue Feasibility Study Work Plan, dated July 2009-SRP Comments

FYI

From: Martinez Andrea L [mailto:Andrea.Martinez@srpnet.com]
Sent: Wednesday, April 15, 2015 9:52 AM
To: Brantingham, Katy
Cc: Kevin C. Snyder (Snyder.Kevin@azdeq.gov)
Subject: West Central Phoenix, East Grand Avenue Feasibility Study Work Plan, dated July 2009-SRP Comments

Hi Katy,

Thanks for West Central Phoenix, East Grand Avenue Feasibility Study Work Plan (FS WP) provided by Arcadis. As we discussed this morning, SRP would like to make the following notes to the WQARF record:

1. The July 2009 FS WP prepared by G.M. Clement & Associates, Inc., names two SRP wells, 11.2E-7.7N and 10.5E-5.7N. The well coordinates of SRP well 10.5E-5.7N is incorrect, it should have read 10.5E-7.5N throughout the report. Please ensure the correct well is identified and subsequently protected within the Arcadis Feasibility Study (FS).
2. There are two additional SRP wells identified in SRP comments (made by Phyl Amadi)within the Remedial Objectives report, contained in Appendix A Proposed RO Report Comments of the July 2009 FS WP prepared by G.M. Clement & Associates, Inc. These wells are identified as 9.5E-7.7N and 8.5E-7.5N. As we discussed those wells will be studied and protected via the WCP North Canal Plume and West Osborne Complex Plume WQARF processes.
3. Within the Arcadis FS, SRP requests equal assurances to that of non-SRP wells, that our groundwater supply is protected, replaced, or otherwise provide an alternate water supply.

As ADEQ and Arcadis is aware, SRP's water supply wells are a critical resource especially during drought conditions and it is very important to SRP that it have a reliable supply of water to meet customer and shareholder needs.

Based on our discussion today, and the fact that the July 2009 FS WP prepared by G.M. Clement & Associates, Inc. report will not be modified, SRP does not need to meet with Arcadis regarding the subject FS WP. We look forward to reading the Arcadis draft FS.

Thanks,

Andrea Martinez | Principal Environmental EngineerI | 602.236.2618
Salt River Project | 1521 North Project Drive | Tempe, Arizona 85281

Noonan, Katie

From: Martinez Andrea L <Andrea.Martinez@srpnet.com>
Sent: Tuesday, May 12, 2015 11:08 AM
To: Brantingham, Katy; Kevin C. Snyder (Snyder.Kevin@azdeq.gov)
Cc: Mike Gaudette (michael.gaudette@univarusa.com); Noonan, Katie
Subject: RE: West Central Phoenix, East Grand Avenue WQARF, Reference Remedy and Alternative Remedies Proposal

Categories: Univar EGA

Thank you Katy,

Correct, no meeting is necessary at this time. The hard copy report Reference Remedy and Alternative Remedies Proposal sent on 5/5/15 is adequate for now. Have a good rest of your week.

Thanks,

Andrea Martinez
Principal Environmental Compliance Engineer | 602.236.2618
Salt River Project | 1521 North Project Drive | Tempe, Arizona 85281

From: Brantingham, Katy [mailto:Katy.Brantingham@arcadis-us.com]
Sent: Tuesday, May 12, 2015 11:05 AM
To: Martinez Andrea L; Kevin C. Snyder (Snyder.Kevin@azdeq.gov)
Cc: Mike Gaudette (michael.gaudette@univarusa.com); Noonan, Katie
Subject: RE: West Central Phoenix, East Grand Avenue WQARF, Reference Remedy and Alternative Remedies Proposal

---

Hi Andrea,
Thank you for your response. Just to clarify, your response below means you will not be requesting an in person meeting for consultation. Please let me know if I do not understand this correctly.
We appreciate your continued help in this matter.
Sincerely,
Katy

Katy Brantingham| Associate Vice President/CPM2 | katy.brantingham@arcadis-us.com

ARCADIS U.S., Inc. | 410 North 44th Street, Suite 1000 | Phoenix, AZ 85008
T. 602.438.0883 ext. 4523 | Direct 602.797.4523 | Mobile 480.229.6004 | F. 602.438.0102
Connect with us! www.arcadis-us.com | LinkedIn | Twitter | Facebook

From: Martinez Andrea L [mailto:Andrea.Martinez@srpnet.com]
Sent: Tuesday, May 12, 2015 10:59 AM
To: Brantingham, Katy; Kevin C. Snyder (Snyder.Kevin@azdeq.gov)
Subject: West Central Phoenix, East Grand Avenue WQARF, Reference Remedy and Alternative Remedies Proposal

Good afternoon Katy and Kevin,

Thank you for the opportunity to review the final West Central Phoenix (WCP), East Grand Avenue(EGA) WQARF, Reference Remedy and Alternative Remedies Proposal dated December 4, 2014.

As SRP indicated in June 2006 during the Remedial Investigation, Land and Water Use Report, there are future plans for the construction of a drinking water treatment plant at the end of the Grand Canal. SRP anticipates that its groundwater supply wells (11.2E-7.7N and 10.5E-7.5N) that are in the vicinity of the WCP EGA site will transition from irrigation to municipal service (potable supply). As you know, the water sources discharging to the SRP canal system must comply with more stringent water quality criteria. SRP wants to ensure this transition from irrigation to drinking water will be accommodated for within the Feasibility Study.

Thanks,

Andrea Martinez
Principal Environmental Compliance Engineer | 602.236.2618
Salt River Project | 1521 North Project Drive | Tempe, Arizona 85281

APPENDIX E

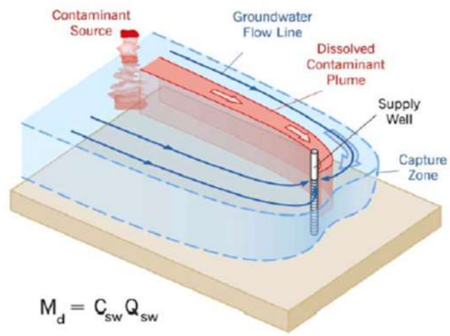
Discharge Concentration Calculations

MTP-1 Mass Discharge (Flux) Calculations
East Grand Avenue WQARF
Phoenix, Arizona

ARCADIS Design & Consultancy for natural and built assets

Well Discharge Concentration $C_{dj} = M_{dt} \div Q_t$

Extraction Well Flow	80	gpm
Extraction Well Flow (Q_t)	15,401	ft^3/day
Top Screen	180	ft bgs ?
Bottom Screen	400	ft bgs
Total Mass Flux (M_{dt})	5.74E+05	ug/day
Calculated Concentration	37	ug/ft^3
Calculated Concentration (C_{dj})	**1.3**	**ug/L**
Observed Concentration*	**< 0.5**	**ug/L**



(ITRC 2010)

Mass Disharge Profile (M_{dj}) (ug/day) $M_{dj} = C_j \cdot q_j \cdot A_j$

North ⇨ *South* *South*

	Zone	Bottom Depth (ft bgs)	EGA-03	WCP-45/ WCP-48	EGA-05A/ EGA-05B	EGA-01	WCP-96	Total Mass (ug/day)	% Flux	MTP Well Screened in Zone (Yes/No)
1	UAU-upper	180	1,614	3,228	**521,987**	20,014	3,228	546,844	95%	Unknown
2	UAU-lower	200	68	680	1,189	1,011	136	2,948	1%	Unknown
3	MAU-upper	250	552	5,522	9,663	8,216	1,104	23,954	4%	Unknown
4	MAU-lower	400	0	0	0	0	0	0	0%	Yes
5	LAU-upper	1000	0	0	0	0	0	0	0%	No
							M_{dt}	**5.74E+05**	ug/day	
								0.57	g/day	

$$M_d = \sum_{j=1}^{25} M_{dj} = \sum_{j=1}^{25} C_j \cdot q_j \cdot A_j$$

Supporting Calculations and Assumptions:

Concentration (C) Profile (ug/L)

North ⇨ *South*

Zone	Bottom Depth (ft bgs)	EGA-03	WCP-45/ WCP-48	EGA-05A/ EGA-05B	EGA-01	WCP-96	Zone average (ug/L)
UAU-upper	180	0.5	0.5	**38.5**	3.1	0.5	10.7
UAU-lower	200	0.10	0.5	0.50	0.62	0.10	0.4
MAU-upper	250	0.02	0.1	0.10	0.12	0.02	0.1
MAU-lower	400	0.000	0.000	0.000	0.000	0.000	0.0
LAU-upper	1000	0	0	0	0	0	0.0

Peak concentration from 2019-2020 *Yellow-shaded cells indicate value was input based on analytical results*

Unshaded areas assumed to be 1/5 of the greater of the overlying or underlying zone concentration. Except lower MAU & LAU assumed = 0

Used 1/2 method/reporting limit for non-detect results

Concentration (C) Profile (ug/ft^3)

North ⇨ *South* *South*

Zone	Bottom Depth (ft bgs)	EGA-03	WCP-45/ WCP-48	EGA-05A/ EGA-05B	EGA-01	WCP-96	Total Concentration (ug/ft^3)	% of Total
UAU-upper	180	14.2	14.2	1308.2	87.8	14.2	1,424	96%
UAU-lower	200	2.8	14.2	14.2	21.1	2.8	52	4%
MAU-upper	250	0.6	2.8	2.8	4.2	0.6	10	1%
MAU-lower	400	0.0	0.0	0.0	0.0	0.0	0	0%
LAU-upper	1000	0.0	0.0	0.0	0.0	0.0	0	0%
						Total =	**1,487**	ug/ft^3

Converted ug/L to ug/ft^3 *1 ft^3 = 28.3 L*

Peak concentration in each zone multiplied by peak multiplier = 1.2

MTP-1 Mass Discharge (Flux) Calculations
East Grand Avenue WQARF
Phoenix, Arizona

Width (w) Profile (feet)

Zone	Bottom Depth (ft bgs)	*North* EGA-03	WCP-45/ WCP-48	⇨ EGA-05A/ EGA-05B	*South* EGA-01	*South* WCP-96	Total Width (ft)	Peak Transect %
UAU-upper	180	100	200	350	200	200	850	41%
UAU-lower	200	100	200	350	200	200	850	41%
MAU-upper	250	100	200	350	200	200	850	41%
MAU-lower	400	100	200	350	200	200	850	41%
LAU-upper	1000	100	200	350	200	200	850	41%

Width of each area determined from isocontours and input into the yellow-shaded cells.
Unshaded areas assumed to be the greater of the overlying or underlying zone width

Area (A) Profile (ft^2)

$$A = w \cdot h$$

Zone	Bottom Depth (ft bgs)	*North* EGA-03	WCP-45/ WCP-48	⇨ EGA-05A/ EGA-05B	*South* EGA-01	*South* WCP-96	Total Area (ft^2)
UAU-upper	180	3,000	6,000	10,500	6,000	6,000	25,500
UAU-lower	200	2,000	4,000	7,000	4,000	4,000	17,000
MAU-upper	250	5,000	10,000	17,500	10,000	10,000	42,500
MAU-lower	400	15,000	30,000	52,500	30,000	30,000	127,500
LAU-upper	1000	60,000	120,000	210,000	120,000	120,000	510,000

Specific Discharge (q) Profile (ft/day)

$$q = K \cdot i$$

Zone	Bottom Depth (ft bgs)	*North* EGA-03	WCP-45/ WCP-48	⇨ EGA-05A/ EGA-05B	*South* EGA-01	*South* WCP-96	Total (ft/day)	K (ft/day)	i (ft/ft)
UAU-upper	180	0.038	0.038	0.038	0.038	0.038	0.152	7.6	0.0050
UAU-lower	200	0.012	0.012	0.012	0.012	0.012	0.048	2.4	0.0050
MAU-upper	250	0.195	0.195	0.195	0.195	0.195	0.780	39	0.0050
MAU-lower	400	0.195	0.195	0.195	0.195	0.195	0.780	39	0.0050
LAU-upper	1000	0.1	0.1	0.1	0.1	0.1	0.400	20	0.0050

Notes:

Reference: ITRC 2010. Use and Measurement of Mass Flux and Mass Discharge. August 2010.

ft/day = feet per day
ft^3/day = cubic feet per day
ft/ft = feet per foot
ft^2 = square feet
ft bgs = feet below ground surface
g/day = grams per day
gpm = gallons per minute
ug/day = micrograms per day
ug/L = micrograms per liter
ug/ft^3 = micrograms per cubic foot
% = percent

UAU = Upper Alluvial Unit
MAU = Middle Alluvial Unit
LAU = Lower Alluvial Unit
K = hydraulic conductivity
i = hydraulic gradient

APPENDIX F

Remedial Alternative Costing

Table F-1
Summary of Net Present Value
East Grand Avenue WQARF Site

		Less Aggressive Remedy (Annual Groundwater Monitoring)		**Reference Remedy (Semi-Annual Groundwater Monitoring)**		**More Aggressive Remedy (Plume Containment)**		**Contingency Remedy - Well Siting and Wellhead Treatment**	
Year	DISCOUNT RATE*	Total Undiscounted Cost ($)	Total Present Value ($)	Total Undiscounted Cost ($)	Total Present Value ($)	Total Undiscounted Cost ($)	Total Present Value ($)	Total Undiscounted Cost ($)	Total Present Value ($)
1	1.000	$ 127,000	$ 127,000	$ 151,000	$ 151,000	$ 1,337,000	$ 1,337,000	$ 2,320,000	$ 2,320,000
2	1.031	$ 49,000	$ 50,500	$ 66,000	$ 68,000	$ 1,227,000	$ 1,264,900	$ 369,000	$ 380,400
3	1.063	$ 49,000	$ 52,100	$ 66,000	$ 70,100	$ 430,000	$ 457,000	$ 369,000	$ 392,200
4	1.096	$ 49,000	$ 53,700	$ 66,000	$ 72,300	$ 430,000	$ 471,100	$ 369,000	$ 404,300
5	1.130	$ 88,000	$ 99,400	$ 106,000	$ 119,700	$ 476,000	$ 537,700	$ 369,000	$ 416,800
6	1.165	$ 49,000	$ 57,100	$ 66,000	$ 76,900	$ 421,000	$ 490,300	$ 369,000	$ 429,700
7	1.201	$ 49,000	$ 58,800	$ 66,000	$ 79,200	$ 401,000	$ 481,400	$ 369,000	$ 443,000
8	1.238	$ 49,000	$ 60,600	$ 66,000	$ 81,700	$ 421,000	$ 521,100	$ 369,000	$ 456,700
9	1.276	$ 49,000	$ 62,500	$ 66,000	$ 84,200	$ 362,000	$ 461,900	$ 369,000	$ 470,800
10	1.315	$ 88,000	$ 115,800	$ 106,000	$ 139,400	$ 388,000	$ 510,400	$ 369,000	$ 485,400
11	1.356	$ 49,000	$ 66,400	$ 66,000	$ 89,500	$ 342,000	$ 463,800	$ 369,000	$ 500,400
12	1.398	$ 49,000	$ 68,500	$ 66,000	$ 92,300	$ 461,000	$ 644,500	$ 482,000	$ 673,800
13	1.441	$ 49,000	$ 70,600	$ 66,000	$ 95,100	$ 275,000	$ 396,300	$ 95,000	$ 136,900
14	1.486	$ 49,000	$ 72,800	$ 66,000	$ 98,100	--	--		$ -
15	1.532	$ 88,000	$ 134,800	$ 106,000	$ 162,400	--	--		$ -
16	1.579	$ 49,000	$ 77,400	$ 66,000	$ 104,200	--	--		$ -
17	1.628	$ 49,000	$ 79,800	$ 66,000	$ 107,400	--	--		$ -
18	1.678	$ 272,000	$ 456,500	$ 289,000	$ 485,000	--	--		$ -
19	1.730	$ 490,000	$ 847,800	$ 486,000	$ 840,900	--	--		$ -
Totals		**$ 1,790,000**	**$ 2,620,000**	**$ 2,110,000**	**$ 3,020,000**	**$ 6,980,000**	**$ 8,040,000**	**$ 6,587,000**	**$ 7,510,400**

Notes:
*Discount factor based on 3% inflation rate only per ADEQ. -3.0%
Total costs are rounded up to the nearest 10,000 dollars.

Table F-2
Annual Groundater Monitoring (Less Aggressive) Estimated Costs
East Grand Avenue WQARF Site

Scope:	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Total Cost
Groundwater Monitoring & Reporting																				
Groundwater Monitoring	$ 24,000	$ 24,000	$ 24,000	$ 24,000	$ 24,000	$ 24,000	$ 24,000	$ 24,000	$ 24,000	$ 24,000	$ 24,000	$ 24,000	$ 24,000	$ 24,000	$ 24,000	$ 24,000	$ 24,000	$ 24,000	-	
Annual Reporting	$ 11,000	$ 11,000	$ 11,000	$ 11,000	$ 11,000	$ 11,000	$ 11,000	$ 11,000	$ 11,000	$ 11,000	$ 11,000	$ 11,000	$ 11,000	$ 11,000	$ 11,000	$ 11,000	$ 11,000	$ 11,000	-	
Subtotal	$ 35,000	$ 35,000	$ 35,000	$ 35,000	$ 35,000	$ 35,000	$ 35,000	$ 35,000	$ 35,000	$ 35,000	$ 35,000	$ 35,000	$ 35,000	$ 35,000	$ 35,000	$ 35,000	$ 35,000	$ 35,000	$ -	
Remedy & Closure:																				
RAP	$ 60,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
5-Year Periodic Site Review	-	-	-	-	$ 30,000	-	-	-	-	$ 30,000	-	-	-	-	$ 30,000	-	-	-		
Closure Request Report and NFA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$ 90,000	-	
Well/Piping Abandonment & Permitting/Reporting	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$ 78,000	$ 369,000	
Subtotal	$ 60,000	$ -	$ -	$ -	$ 30,000	$ -	$ -	$ -	$ -	$ 30,000	$ -	$ -	$ -	$ -	$ 30,000	$ -	$ -	$ 168,000	$ 369,000	
Miscellaneous:																				
Stakeholder Engagement & Communications (5%)	$ 5,000	$ 2,000	$ 2,000	$ 2,000	$ 4,000	$ 2,000	$ 2,000	$ 2,000	$ 2,000	$ 4,000	$ 2,000	$ 2,000	$ 2,000	$ 2,000	$ 4,000	$ 2,000	$ 2,000	$ 11,000	$ 19,000	
Project QA/QC (3%)	$ 3,000	$ 2,000	$ 2,000	$ 2,000	$ 2,000	$ 2,000	$ 2,000	$ 2,000	$ 2,000	$ 2,000	$ 2,000	$ 2,000	$ 2,000	$ 2,000	$ 2,000	$ 2,000	$ 2,000	$ 7,000	$ 12,000	
Health and Safety Planning (2%)	$ 2,000	$ 1,000	$ 1,000	$ 1,000	$ 2,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 2,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 2,000	$ 1,000	$ 1,000	$ 5,000	$ 8,000	
Strategy, Planning, Management (10%)	$ 10,000	$ 4,000	$ 4,000	$ 4,000	$ 7,000	$ 4,000	$ 4,000	$ 4,000	$ 4,000	$ 7,000	$ 4,000	$ 4,000	$ 4,000	$ 4,000	$ 7,000	$ 4,000	$ 4,000	$ 21,000	$ 37,000	
Subtotal	$ 20,000	$ 9,000	$ 9,000	$ 9,000	$ 15,000	$ 9,000	$ 9,000	$ 9,000	$ 9,000	$ 15,000	$ 9,000	$ 9,000	$ 9,000	$ 9,000	$ 15,000	$ 9,000	$ 9,000	$ 44,000	$ 76,000	
Totals																				
Yearly Subtotal of All Tasks	$ 115,000	$ 44,000	$ 44,000	$ 44,000	$ 80,000	$ 44,000	$ 44,000	$ 44,000	$ 44,000	$ 80,000	$ 44,000	$ 44,000	$ 44,000	$ 44,000	$ 80,000	$ 44,000	$ 44,000	$ 247,000	$ 445,000	
Contingency (10%)	$ 12,000	$ 5,000	$ 5,000	$ 5,000	$ 8,000	$ 5,000	$ 5,000	$ 5,000	$ 5,000	$ 8,000	$ 5,000	$ 5,000	$ 5,000	$ 5,000	$ 8,000	$ 5,000	$ 5,000	$ 25,000	$ 45,000	
Undiscounted Total	**$ 127,000**	**$ 49,000**	**$ 49,000**	**$ 49,000**	**$ 88,000**	**$ 49,000**	**$ 49,000**	**$ 49,000**	**$ 49,000**	**$ 88,000**	**$ 49,000**	**$ 49,000**	**$ 49,000**	**$ 49,000**	**$ 88,000**	**$ 49,000**	**$ 49,000**	**$ 272,000**	**$ 490,000**	**$ 1,790,000**

Key Assumptions:
Remedy = Groundwater Monitoring
Monitoring Frequency = 1/year
Reporting Frequency = 1/year
No. of wells = 8
Sampling Method = passive diffusion bag or Hydrasleeve
Analytical Method = USEPA 8260 for 1,1-dichloroethene, tetrachlorooethene, and trichloroethene only
Water levels = 20 wells 1/year
Duration = 17 years of monitoring and 1 year of closure confirmation monitoring
During off monitoring years, scope/costs for maintenance/permites/fees, project management, and communications
During Year 9 sample 2/year

Notes:
RAP = remedial action plan
NFA = no further action
QA/QC = quality assurance and quality control

Table F-3
Semi-Annual Groundater Monitoring (Reference) Remedy Estimated Costs
East Grand Avenue WQARF Site

Scope:	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Total Cost
Groundwater Monitoring & Reporting																				
Groundwater Monitoring & Maintenance	$ 36,000	$ 36,000	$ 36,000	$ 36,000	$ 36,000	$ 36,000	$ 36,000	$ 36,000	$ 36,000	$ 36,000	$ 36,000	$ 36,000	$ 36,000	$ 36,000	$ 36,000	$ 36,000	$ 36,000	$ 36,000	-	
Annual Reporting	$ 13,000	$ 13,000	$ 13,000	$ 13,000	$ 13,000	$ 13,000	$ 13,000	$ 13,000	$ 13,000	$ 13,000	$ 13,000	$ 13,000	$ 13,000	$ 13,000	$ 13,000	$ 13,000	$ 13,000	$ 13,000	-	
Subtotal	$ 49,000	$ 49,000	$ 49,000	$ 49,000	$ 49,000	$ 49,000	$ 49,000	$ 49,000	$ 49,000	$ 49,000	$ 49,000	$ 49,000	$ 49,000	$ 49,000	$ 49,000	$ 49,000	$ 49,000	$ 49,000	$ -	
Remedy Planning & Closure:																				
RAP	$ 63,000	-	-	-	-	-									-	-	-	-	-	
5-Year Periodic Site Review	-	-	-	-	$ 30,000	-	-	-	-	$ 30,000	-	-	-	-	$ 30,000	-	-			
Closure Request Report and NFA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$ 90,000	-	
Well/Piping Abandonment & Permitting/Reporting	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$ 78,000	$ 366,000	
Subtotal	$ 63,000	$ -	$ -	$ -	$ 30,000	$ -	$ -	$ -	$ -	$ 30,000	$ -	$ -	$ -	$ -	$ 30,000	$ -	$ -	$ 168,000	$ 366,000	
Miscellaneous:																				
Stakeholder Engagement & Communications (5%)	$ 6,000	$ 3,000	$ 3,000	$ 3,000	$ 4,000	$ 3,000	$ 3,000	$ 3,000	$ 3,000	$ 4,000	$ 3,000	$ 3,000	$ 3,000	$ 3,000	$ 4,000	$ 3,000	$ 3,000	$ 11,000	$ 19,000	
Project QA/QC (3%)	$ 4,000	$ 2,000	$ 2,000	$ 2,000	$ 3,000	$ 2,000	$ 2,000	$ 2,000	$ 2,000	$ 3,000	$ 2,000	$ 2,000	$ 2,000	$ 2,000	$ 3,000	$ 2,000	$ 2,000	$ 7,000	$ 11,000	
Health and Safety Planning (2%)	$ 3,000	$ 1,000	$ 1,000	$ 1,000	$ 2,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 2,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 2,000	$ 1,000	$ 1,000	$ 5,000	$ 8,000	
Strategy, Planning, Management (10%)	$ 12,000	$ 5,000	$ 5,000	$ 5,000	$ 8,000	$ 5,000	$ 5,000	$ 5,000	$ 5,000	$ 8,000	$ 5,000	$ 5,000	$ 5,000	$ 5,000	$ 8,000	$ 5,000	$ 5,000	$ 22,000	$ 37,000	
Subtotal	$ 25,000	$ 11,000	$ 11,000	$ 11,000	$ 17,000	$ 11,000	$ 11,000	$ 11,000	$ 11,000	$ 17,000	$ 11,000	$ 11,000	$ 11,000	$ 11,000	$ 17,000	$ 11,000	$ 11,000	$ 45,000	$ 75,000	
Totals																				
Yearly Subtotal of All Tasks	$ 137,000	$ 60,000	$ 60,000	$ 60,000	$ 96,000	$ 60,000	$ 60,000	$ 60,000	$ 60,000	$ 96,000	$ 60,000	$ 60,000	$ 60,000	$ 60,000	$ 96,000	$ 60,000	$ 60,000	$ 262,000	$ 441,000	
Contingency (10%)	$ 14,000	$ 6,000	$ 6,000	$ 6,000	$ 10,000	$ 6,000	$ 6,000	$ 6,000	$ 6,000	$ 10,000	$ 6,000	$ 6,000	$ 6,000	$ 6,000	$ 10,000	$ 6,000	$ 6,000	$ 27,000	$ 45,000	
Undiscounted Total	**$ 151,000**	**$ 66,000**	**$ 66,000**	**$ 66,000**	**$ 106,000**	**$ 66,000**	**$ 66,000**	**$ 66,000**	**$ 66,000**	**$ 106,000**	**$ 66,000**	**$ 66,000**	**$ 66,000**	**$ 66,000**	**$ 106,000**	**$ 66,000**	**$ 66,000**	**$ 289,000**	**$ 486,000**	**$ 2,102,000**

Key Assumptions:
Remedy = Groundwater Monitoring
Monitoring Frequency = 2/year to 1/year based on well purpose
Reporting Frequency = 1/year
No. of wells = 10
Sampling Method = passive diffusion bag or Hydrasleeve
Analytical Method = USEPA 8260 for 1,1-dichloroethene, tetrachlorooethene, and trichloroethene only
Water levels = 20 wells 1/year
Duration = 17 years of monitoring and 1 year of closure confirmation monitoring

Notes:
RAP = remedial action plan
NFA = no further action
QA/QC = quality assurance and quality control

Table F-4
Controlled Migration and Groundwater Treatment (More Aggressive) Remedy Estimated Costs
East Grand Avenue WQARF Site

Scope:	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Total Cost
Remedial System Modeling and Design														
RAP and System Design	$ 89,000	-	-	-	-	-	-	-	-	-	-	-	-	
5-Year Review	-	-	-	-	$ 35,000	-	-	-	-	$ 35,000				
Closure Request Report and NFA	-	-	-	-	-	-	-	-	-	-	-	$ 90,000	-	
Subtotal	$ 89,000	$ -	$ -	$ -	$ 35,000	$ -	$ -	$ -	$ -	$ 35,000	$ -	$ 90,000	$ -	
Extraction Well System Installation														
Permitting/Surveying/Utility Clearance	$ 57,000	-	-	-							-	-	-	
Install 3 Monitoring Wells	$ 130,000	-	-	-							-	-	-	
Install 3 Extraction Wells	$ 171,000	-	-	-							-	-	-	
Aquifer Testing	$ 15,000	-	-											
GW Treatment System Equipment	$ 352,000	-	-	-							-	-	-	
GW Treatment System Installation	-	$ 404,000	-	-							-	-	-	
GW System Startup and Shakedown	-	$ 87,000	-	-							-	-	-	
System Contingency (20%)	$ 145,000	$ 98,200	-	-							-	-	-	
Subtotal	$ 870,000	$ 589,200	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	
Groundwater Monitoring & Reporting														
Monitoring	$ 48,000	$ 48,000	$ 48,000	$ 48,000	$ 48,000	$ 48,000	$ 48,000	$ 48,000	$ 48,000	$ 48,000	$ 48,000	$ 48,000	-	
Reporting	$ 17,000	$ 17,000	$ 17,000	$ 17,000	$ 17,000	$ 17,000	$ 17,000	$ 17,000	$ 17,000	$ 17,000	$ 17,000	$ 17,000	-	
Well/System Abandonment & Permitting/Reporting	-	-	-	-	-	-	-	-	-	-	-		$ 143,000	
Subtotal	$ 65,000	$ 65,000	$ 65,000	$ 65,000	$ 65,000	$ 65,000	$ 65,000	$ 65,000	$ 65,000	$ 65,000	$ 65,000	$ 65,000	$ 143,000	
Pump and Treat System														
Operation & Maintenance	-	$ 264,000	$ 250,000	$ 250,000	$ 250,000	$ 243,000	$ 228,000	$ 243,000	$ 198,000	$ 183,000	$ 183,000	$ 183,000	-	
Evaluation and Reporting	-	$ 11,000	$ 11,000	$ 11,000	$ 11,000	$ 11,000	$ 11,000	$ 11,000	$ 11,000	$ 11,000	$ 11,000	$ 11,000	-	
System decommissioning		-	-	-	-	-	-	-	-	-	-	-	$ 65,000	
Subtotal	$ -	$ 275,000	$ 261,000	$ 261,000	$ 261,000	$ 254,000	$ 239,000	$ 254,000	$ 209,000	$ 194,000	$ 194,000	$ 194,000	$ 65,000	
Misc														
Stakeholder Engagement & Communications (5%)	$ 51,200	$ 46,460	$ 16,300	$ 16,300	$ 18,050	$ 15,950	$ 15,200	$ 15,950	$ 13,700	$ 14,700	$ 12,950	$ 17,450	$ 10,400	
Project QA/QC (3%)	$ 30,720	$ 27,876	$ 9,780	$ 9,780	$ 10,830	$ 9,570	$ 9,120	$ 9,570	$ 8,220	$ 8,820	$ 7,770	$ 10,470	$ 6,240	
Health and Safety Planning (2%)	$ 20,480	$ 18,584	$ 6,520	$ 6,520	$ 7,220	$ 6,380	$ 6,080	$ 6,380	$ 5,480	$ 5,880	$ 5,180	$ 6,980	$ 4,160	
Strategy, Planning, Management (10%)	$ 102,400	$ 92,920	$ 32,600	$ 32,600	$ 36,100	$ 31,900	$ 30,400	$ 31,900	$ 27,400	$ 29,400	$ 25,900	$ 34,900	$ 20,800	
Subtotal	$ 204,800	$ 185,840	$ 65,200	$ 65,200	$ 72,200	$ 63,800	$ 60,800	$ 63,800	$ 54,800	$ 58,800	$ 51,800	$ 69,800	$ 41,600	
Totals														
Yearly Subtotal of All Tasks	$ 1,228,800	$ 1,115,040	$ 391,200	$ 391,200	$ 433,200	$ 382,800	$ 364,800	$ 382,800	$ 328,800	$ 352,800	$ 310,800	$ 418,800	$ 249,600	
Contingency (10%)	$ 108,500	$ 112,000	$ 39,000	$ 39,000	$ 43,000	$ 38,000	$ 36,000	$ 38,000	$ 33,000	$ 35,000	$ 31,000	$ 42,000	$ 25,000	
Undiscounted Total	**$ 1,337,000**	**$ 1,227,000**	**$ 430,000**	**$ 430,000**	**$ 476,000**	**$ 421,000**	**$ 401,000**	**$ 421,000**	**$ 362,000**	**$ 388,000**	**$ 342,000**	**$ 461,000**	**$ 275,000**	**$ 6,971,000**

Key Assumptions:
Remedy = Groundwater Monitoring
- Monitoring Frequency = 2/year to 1/year depending on well purpose
- No. of wells = 16
- Sampling Method = passive diffusion bag & extraction well discharge
- Analytical Method = USEPA 8260 for 1,1-dichloroethene, tetrachlorooethene, and trichloroethene only
- Water levels = 20 wells 2/year
- Duration = 6 years of monitoring
- Extraction and treatment duration = 3 years
- Extraction wells = 3 to 200 ft @ ~30 gpm ea.
- Treatment = 2x 5,000-pound carbon vessels
- O&M = Carbon change out 4/year
- Discharge = City of Phoenix sewer

Notes:
RAP = remedial action plan
NFA = no further action
QA/QC = quality assurance and quality control

Table F-5
Contingency Remedy Estimated Costs
East Grand Avenue WQARF Site

Scope:	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Total Cost
System Design														
System Design	$ 107,000	-	-	-	-	-	-	-	-	-	-	-	-	
Closure Request Report and NFA	-	-	-	-	-	-	-	-	-	-	-	-	-	
Subtotal	$ 107,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	
Extraction Well System Installation														
Permitting/Surveying/Utility Clearance	$ 57,000	-	-	-							-	-	-	
GW Treatment System Equipment	$ 1,170,000	-	-	-							-	-	-	
GW Treatment System Installation	$ 399,000		-	-							-	-	-	
GW System Startup and Shakedown	$ 55,000		-	-							-	-	-	
System Contingency (20%)	$ 336,200	$ -	-	-							-	-	-	
	$ 2,017,200	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	
Pump and Treat System														
System Decommissioning													75000	
Operation & Maintenance	-	$ 283,000	$ 283,000	$ 283,000	$ 283,000	$ 283,000	$ 283,000	$ 283,000	$ 283,000	$ 283,000	$ 283,000	$ 283,000	-	
Evaluation and Reporting	-	$ 11,000	$ 11,000	$ 11,000	$ 11,000	$ 11,000	$ 11,000	$ 11,000	$ 11,000	$ 11,000	$ 11,000	$ 11,000	-	
Subtotal	$ -	$ 294,000	$ 294,000	$ 294,000	$ 294,000	$ 294,000	$ 294,000	$ 294,000	$ 294,000	$ 294,000	$ 294,000	$ 294,000	$ 75,000	
Misc														
Stakeholder Engagement & Communications (5%)	$ 5,350	$ 14,700	$ 14,700	$ 14,700	$ 14,700	$ 14,700	$ 14,700	$ 14,700	$ 14,700	$ 14,700	$ 14,700	$ 14,700	$ 3,750	
Project QA/QC (3%)	$ 3,210	$ 8,820	$ 8,820	$ 8,820	$ 8,820	$ 8,820	$ 8,820	$ 8,820	$ 8,820	$ 8,820	$ 8,820	$ 8,820	$ 2,250	
Health and Safety Planning (2%)	$ 1,070	$ 2,940	$ 2,940	$ 2,940	$ 2,940	$ 2,940	$ 2,940	$ 2,940	$ 2,940	$ 2,940	$ 2,940	$ 2,940	$ 750	
Strategy, Planning, Management (10%)	$ 5,350	$ 14,700	$ 14,700	$ 14,700	$ 14,700	$ 14,700	$ 14,700	$ 14,700	$ 14,700	$ 14,700	$ 14,700	$ 14,700	$ 3,750	
Subtotal	$ 14,980	$ 41,160	$ 41,160	$ 41,160	$ 41,160	$ 41,160	$ 41,160	$ 41,160	$ 41,160	$ 41,160	$ 41,160	$ 41,160	$ 10,500	
Totals														
Yearly Subtotal of All Tasks	$ 2,139,180	$ 335,160	$ 335,160	$ 335,160	$ 335,160	$ 335,160	$ 335,160	$ 335,160	$ 335,160	$ 335,160	$ 335,160	$ 335,160	$ 85,500	
Contingency (10%)	$ 180,380	$ 34,000	$ 34,000	$ 34,000	$ 34,000	$ 34,000	$ 34,000	$ 34,000	$ 34,000	$ 34,000	$ 34,000	$ 34,000	$ 9,000	
Undiscounted Total	**$ 2,320,000**	**$ 369,000**	**$ 369,000**	**$ 369,000**	**$ 369,000**	**$ 369,000**	**$ 369,000**	**$ 369,000**	**$ 369,000**	**$ 369,000**	**$ 369,000**	**$ 369,000**	**$ 95,000**	**$ 6,474,000**

Key Assumptions:
Contingency Remedy = Wellhead Treatment
Single water supply well add-on treatmennt system and operation costs
1,000 to 1,200 gallon per minute flow
Treatment = 2x 5,000-pound carbon vessels
Treatment duration = 12 years
O&M = Carbon change out 4/year
Discharge = City of Phoenix sewer
Analytical Method = USEPA 8260 for 1,1-dichloroethene, tetrachloroethene, and trichloroethene only

Notes:
NFA = no further action
QA/QC = quality assurance and quality control

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