PROPOSED REMEDIAL ACTION PLAN

WEST CENTRAL PHOENIX NORTH CANAL PLUME
WATER QUALITY ASSURANCE REVOLVING FUND SITE

PHOENIX, ARIZONA

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Prepared by:

Waste Programs Division
Remedial Projects Unit
1110 West Washington Street
Phoenix, Arizona 85007

Table of Contents

Tables

Figures

Appendices

Acronyms

A.A.C.	Arizona Administrative Code
ADEQ	Arizona Department of Environmental Quality
AWQS	Aquifer Water Quality Standard
A.R.S.	Arizona Revised Statute
CAB	Community Advisory Board
COC	Contaminant(s) of Concern
DEUR	Declaration of Environmental Use Restriction
DCE	Dichloroethene
HGC	Hydro Geo Chem
ERA	Early Response Action(s)
FS	Feasibility Study
GPM	Gallons per Minute
ISCO	In-Situ Chemical Oxidation
LGAC	Liquid Phase Granular Activated Carbon
MCL	Maximum Contaminant Level(s)
µg/L	Micrograms per Liter
MNA	Monitored Natural Attenuation
PCE	Tetrachloroethene
PRAP	Proposed Remedial Action Plan
RI	Remedial Investigation
RO(s)	Remedial Objective(s)
ROD	Record of Decision
RSL	Regional Screening Level
SVE	Soil Vapor Extraction
TCE	Trichloroethene
TEP	Tucson Electric Power
USEPA	United States Environmental Protection Agency
VGAC	Vapor Phase Granular Activated Carbon
VOC	Volatile Organic Compound(s)
WQARF	Water Quality Assurance Revolving Fund

1.0 INTRODUCTION

The Arizona Department of Environmental Quality (ADEQ) prepared this Proposed Remedial Action Plan (PRAP) for the West Central Phoenix (WCP) North Canal Plume (NCP) Water Quality Assurance Revolving Fund (WQARF) Site (Site), located in Phoenix, Arizona (Figure 1). This PRAP was prepared in accordance with Arizona Revised Statute (A.R.S.) Section (§) 49-287.04 and Arizona Administrative Code (A.A.C.) R18-16-408. The PRAP is based on information contained in the following documents:

- *Remedial Investigation Report, West Central Phoenix North Canal Plume Water Quality Assurance Revolving Fund Registry Site, Phoenix, Arizona* (HGC, 2017)

- *Final Feasibility Study, West Central Phoenix Water Quality Assurance Revolving Fund Site, Phoenix, Arizona* (Geosyntec, 2020)

Information presented in the PRAP is taken directly from the above-referenced reports without attribution other than that noted in this document. The detailed history of environmental investigations, Early Response Actions (ERAs), and preliminary screening of remedial alternatives completed for the Site is presented in the referenced documents and is not reiterated in detail in this document.

The purpose of the PRAP is to inform the public of the remedy selected from the alternatives evaluation presented in the Feasibility Study (FS), which addresses the site-specific Remedial Objectives (ROs). The PRAP is part of the final remedy selection process under the WQARF program during which public input is solicited on the selected remedy and on the rationale for proposing the selected remedy. ADEQ will review the public comments and prepare a responsiveness summary to address the public comments. The responsiveness summary will be part of the Record of Decision (ROD). The remedy for the Site will be finalized by ADEQ in the ROD.

This PRAP, in accordance with A.R.S. §49-287.04, describes the following:

- The boundaries of the Site that is the subject of the remedial action;

- The results of the Remedial Investigation (RI) and the FS;

- The proposed remedy and estimated cost; and

- How the remediation goals and selection factors in A.R.S. §49-282.06 have been considered.

2.0 SITE BOUNDARIES

The boundaries of the Site subject to remedial action include the area approximately bounded by Indian School Road to the north, West Flower Street to the south, Grand Avenue to the east, and 41st Avenue to the west (Figure 1). The boundaries include the area that encompasses the soil and groundwater impacted with compounds that exceed state regulatory levels.

3.0 REMEDIAL INVESTIGATION RESULTS

This section presents a summary of the remedial investigations conducted at the Site as presented in the following documents:

- *Remedial Investigation Report, West Central Phoenix North Canal Plume Water Quality Assurance Revolving Fund Registry Site, Phoenix, Arizona* (HGC, 2017)
- *Vapor Intrusion Evaluation Technical Memorandum, North Canal Plume WQARF Site, Phoenix, Arizona* (Geosyntec, 2018)
- *Vapor Intrusion Evaluation Technical Memorandum Addendum, North Canal Plume WQARF Site, Phoenix, Arizona* (Geosyntec, 2019)

3.1 Site History and Description

The Site is in an urban setting that includes a mixture of commercial and light industrial businesses, warehouses, and manufacturing facilities. The Site was initially utilized for agricultural purposes after irrigation was made possible by the construction of the Grand Canal in 1878, which is just north of the southern edge of the Site. The Canal was an unlined, earthen-bottomed canal for over 100 years, providing a source of recharge to the groundwater and creating a water table mound. As a result, the groundwater flowed in a northerly direction with a steep gradient. The Canal was lined in 1998, which eliminated the mounding effect and caused the groundwater to flow in a southerly direction with a flatter gradient.

Development of industrial activities at the Site began circa 1956 and included metal plating, metal casting, machining and tool manufacturing, furniture manufacturing, and automobile salvage and repair operations. The contaminants of concern (COCs) include trichloroethene (TCE), tetrachloroethene (PCE), 1,1-dichloroethene (1,1-DCE), and chromium which were all related to industrial processes. When the Site was first developed, there was no municipal water service and on-site systems consisted of septic tanks and seepage pits used for wastewater disposal. Drywells were also constructed across the Site. Some of the facilities were found to have had releases of chemicals to the environment from equipment failures, overflows, and leaking underground storage tanks (LUSTs) that impacted the soil and groundwater.

The Site is located in the West Salt River Valley of the Phoenix Basin, which is a broad alluvial valley filled with layers of unconsolidated sand, gravel, silt, and consists of three alluvial units:

- Upper Alluvial Unit (UAU) - composed of silty to gravely sand, sandy silt, and gravel with interbedded clay lenses, extending 300 to 400 feet (ft) below ground surface (bgs)

- Middle Alluvial Unit (MAU) - composed of silt and clay interbedded with silty sand and gravel, extending to a depth of more than 800 ft bgs
- Lower Alluvial Unit (LAU) - which includes evaporate deposits and overlies the crystalline and volcanic bedrock

Two distinct aquifers are present in the UAU underlying the Site. The Shallow Groundwater System (SGWS) is located in the upper UAU. The groundwater table coincides with the top of the SGWS and is currently present at an average depth of 130 ft bgs. Below approximately 240 ft bgs, a course-grained zone commonly referred to as the Lower Sand and Gravel Subunit (LSGS) of the UAU extends to the top of the MAU. The two aquifers are separated by a semi-confining fine-grained unit, the Middle Fine-Grained Subunit (MFGS). The LSGS is regarded as the primary regional water-bearing unit for production. Large vertical hydraulic gradients exist between the different hydrostratigraphic units underlying the site, and downward vertical gradients from the SGWS to the LSGS subunit potentially exist.

The volatile organic compound (VOC) impacts at the site are primarily located in the SGWS. The groundwater flow direction is generally toward the south. Groundwater potentiometric surface elevation contours for the SGWS for the most recent reported monitoring event (April/May 2019) are shown on Figure 2.

There are three geographically and chemically distinct groundwater plumes within the Site with contaminants of concern (COCs) above the Arizona Aquifer Water Quality Standards (AWQS) and are described as follows:

- ***West Plume***: centered near 39th Avenue, between Indian School Road and the Grand Canal.
- ***Central Plume*****:** The Central Plume is centered near an abandoned drywell at the former Southwest Metal Industries facility, extending northward to the former Osborn Products Company facility, and southward across the former Magic Metals Plating Company facility.
- ***East Plume*****:** The East Plume is centered within Grand Avenue, 35th Avenue and the Grand Canal.

The approximate boundaries of the three plumes for the most recent reported monitoring event are shown on Figure 3.

3.2 Source of Contamination

Data collected during the RI indicate that contaminant releases occurred in soil and groundwater at the three groundwater plumes within the Site. These data identified the likely sources of contamination as follows:

West Plume

- Former Precise/Paraflex Companies
- 4001 West Indian School Road
- Former Giltspur Exhibits
- Stevens Engineering

Central Plume

- Former Triad Trucking
- Former Southwest Metals Industries
- Former Pyramid Industries
- Former Osborn Products Company
- Former Magic Metals

East Plume

- HCZ Custom Homes/34th and Clarendon Avenue area

3.3 Contaminants of Concern

The COCs include TCE, PCE, 1,1-DCE, and chromium, which are all suspected to all be related to industrial processes, although some of the chromium that has been observed is presumed to be naturally occurring.

3.3.1 Groundwater

The COCs occur in the three groundwater plumes within the Site as follows:

- ***West Plume***: TCE and 1,1-DCE
- ***Central Plume*****:** TCE, 1,1-DCE, and chromium with hexavalent chromium being the dominant species
- ***East Plume*****:** PCE

These contaminants have been detected at concentrations that exceed the AWQS of 5 micrograms per liter (µg/L) for TCE and PCE, 7 (µg/L) for 1,1-DCE, and 0.1 milligrams per liter (mg/L) for hexavalent and total chromium. Concentration isopleths for TCE, 1,1-DCE, PCE, hexavalent chromium, and total chromium for the most recent reported monitoring event (April/May 2019) are shown on Figures 4, 5, 6, 7, and 8, respectively.

3.3.2 Soil

The COCs in soil samples collected from soil borings at the Site include PCE and TCE. These contaminants have been detected in the soil at concentrations that exceed the residential Soil Remediation Levels (SRLs) of 0.51 milligrams per kilogram (mg/kg) for PCE and 3.0 mg/kg for TCE.

3.3.3 Soil Vapor

The COCs in soil vapor detected at the Site include PCE and TCE. While inhalation exposure from outdoor air would be negligible due to the effects of atmospheric mixing, vapor intrusion into buildings and subsequent inhalation exposure is of potential concern. A vapor intrusion evaluation of nine properties was conducted to address the data gaps identified in the RI Report. The sampling results of the vapor intrusion evaluation do not appear to be indicative of vapor intrusion at eight of the nine properties. At one property, specifically the HCZ Custom Homes property, the indoor air sampling results indicate a complete exposure pathway for vapor intrusion for PCE. However, the highest detected PCE concentrations were less than the United States Environmental Protection Agency (USEPA) regional screening level (RSL) based on a 10^{-5} risk for commercial/industrial indoor air and did not indicate a need for a response action.

3.4 Nature and Extent of Contamination

The lateral distribution of the COCs in groundwater defines the extent of contamination at the Site. The current estimated extent of COCs in groundwater at concentrations exceeding the AWQS is presented on Figures 3 through 8. The maximum COC concentrations detected in the groundwater are 290 micrograms per liter (µg/L) for PCE, 110 µg/L for TCE, 78 µg/L, and 180 µg/L for chromium. Groundwater within the SGWS in the West Plume is impacted by TCE and 1,1-DCE. Central Plume impacts extend to both the SGWS and LSGS and include predominately TCE, 1,1-DCE and chromium. The SGWS contamination within the Central Plume appears to commingle with the West Central Phoenix West Osborn Complex plumes to the south. The East Plume consists primarily of PCE impacts in the SGWS.

COC impacts to soil are primarily identified within the property boundaries of the source areas. Soil and soil gas data collected at the source areas indicate that the COC impacts to soil extends from the surface to the vadose zone in certain areas.

3.5 Early Response Action

The following ERAs were performed to remove contamination at the Site and/or to mitigate the exposure of the contamination to potential receptors:

- 2007 – ADEQ operated a Soil Vapor Extraction (SVE) pilot test at the former Osborn Products facility to address vadose zone impacts

- 2013 – ADEQ operated an SVE/air sparge pilot test at the former Triad Trucking facility to address vadose zone impacts

- 2017 to present - SVE pilot testing and full-scale implementation has been implemented at the HCZ Custom homes facility to address vadose zone impacts

3.6 Risk Evaluation Summary

Multiple investigations have been conducted, beginning in 1984. The data from these investigations were used to evaluate the risks that the soil, soil vapor, and groundwater at the Site pose to the public and the environment. The risk evaluations indicate there is a potential human health risk from soil and groundwater contamination as well as vapor intrusion.

3.7 Remedial Objectives

The results of the RI, including the Land and Water Use Study, were used to develop the ROs for remediation at the Site pursuant to A.A.C. R18-16-406. The ROs were determined for each designated use which includes soil, potable water, and irrigation water.

The RO for land use (soil) at the Site is to protect against the loss or impairment of land threatened by COCs at the Site and restore land that has been impaired by COCs at the Site to below applicable remediation levels. Action is needed for the present time and for as long as necessary to ensure that the level of contamination in the soil associated with the Site no longer exceeds applicable remediation levels.

The ROs for groundwater use at the Site are as follows:

- ***Irrigation Use*:** Protect against the loss or impairment of irrigation water threatened by the COCs at the Site. Where protection cannot be achieved in a reasonable, necessary, or cost-effective manner; restore, replace, or otherwise provide for irrigation water that is lost or impaired by the COCs at the Site. Action is needed for as long as necessary to ensure that, while the water exists and the resource remains available, the contamination associated with the Site does not prohibit or limit the designated use of groundwater

- ***Potable Use*:** Protect against the loss or impairment of potable water threatened by the COCs at the Site. Where protection cannot be achieved in a reasonable, necessary, or cost-effective manner; restore, replace, or otherwise provide for irrigation water that is lost or impaired by the COCs at the Site. Action is needed for as long as necessary to ensure that, while the water exists and the resource remains available, the contamination associated with the Site does not prohibit or limit the designated use of groundwater

Current surface water within the Site is utilized for irrigation and is supplied by groundwater sources outside the Site. Salt River Project's (SRP) foreseeable plans are to use this surface water for drinking water purposes. However, the primary source of surface water is from a water supply outside the Site. Therefore, no RO for surface water is necessary.

4.0 FEASIBILITY STUDY RESULTS

This section presents a summary of the FS conducted for the Site. The results of the FS are presented in the following document:

- *Final Feasibility Study, West Central Phoenix Water Quality Assurance Revolving Fund Site, Phoenix, Arizona* (Geosyntec, 2020)

4.1 Identification and Screening of Remedial Technologies

The FS identified several remedial technologies for addressing the soil and groundwater contamination at Site including:

- Groundwater extraction and treatment (aka "pump and treat [P&T]), *in situ* chemical oxidation (ISCO),
- *In situ* chemical reduction (ISCR),
- *In situ* gaseous reduction (ISGR),
- Enhanced *in situ* bioremediation (EISB),
- Soil vapor extraction (SVE),
- Air sparge (AS),
- *In situ* thermal remediation (ISTR),
- Permeable reactive barriers (PRBs),
- Monitored natural attenuation (MNA).

These remedial technologies were screened based on the anticipated ability of the technology to address the ROs at the Site and reduce the contaminant concentration, mass, and/or toxicity. Each technology was screened for effectiveness, implementability, health and safety concerns, flexibility, expandability, and cost. Based on the screening results, P&T, ISCO, ISCR, ISGR, EISB, SVE, and MNA were retained as feasible for use at the Site.

4.2 Development of the Reference Remedy and Alternative Remedies

The retained remedial technologies were used to develop a Reference Remedy and two alternative remedies (a Less Aggressive Remedy and a More Aggressive Remedy). The Reference Remedy and the alternative remedies are capable of achieving the ROs. The development of the Reference Remedy and alternative remedies considered the following:

- The data obtained from the remedial investigations;
- The best available engineering and scientific information concerning available remedial technologies; and

- Preliminary analysis of the comparison criteria and the ability of the remedies to comply with A.R.S. §49-282.06.

4.2.1 Reference Remedy

The Reference Remedy includes the following technologies:

- **SVE** – SVE would remediate the soil contamination present in the vadose zone. Up to eight SVE wells would be constructed for the West and Central Plume source areas, and up to 11 SVE wells (five existing and six new wells) would be used for the East Plume.
- **P&T** – P&T would be implemented to provide hydraulic containment of groundwater impacts emanating from the source areas.
- **Additional Monitoring Wells (Contingency)** – new monitoring wells may be constructed during the implementation of MNA if existing wells become unusable, such as due to declining water levels.
- **ISCO (Contingency)** – ISCO may be implemented as a contingency if MNA is determined to not be sufficiently achieving the ROs within an acceptable timeframe.
- **Wellhead Treatment (Contingency)** – Wellhead treatment would be a contingency to treat impacted groundwater that is withdrawn if concentrations exceed an applicable standard.
- **Increased pumping rates (Contingency)** – Increased pumping rates for the P&T remedy would be a contingency to treat impacted groundwater that is withdrawn if concentrations exceed an applicable standard.

4.2.2 Less Aggressive Remedy

The Less Aggressive Remedy includes:

- **SVE** – SVE would remediate the soil contamination present in the vadose zone. Up to four SVE wells would be constructed for the West and Central Plume source areas, and the existing five SVE wells would be used for the East Plume.
- **MNA** – MNA would include groundwater monitoring and sampling to monitor the natural degradation of the groundwater contamination.

The Less Aggressive Remedy includes the same contingencies as the Reference Remedy, plus the contingency to implement P&T for hydraulic containment if warranted.

4.2.3 More Aggressive Remedy

The More Aggressive Remedy is similar to the Reference Remedy, with the following exceptions:

- **SVE** – SVE would remediate the soil contamination present in the vadose zone. Up to 12 SVE wells would be constructed for the West and Central Plume source areas, and up to 17 SVE wells (five existing and 12 new wells) would be used for the East Plume.

- **ISCO –** ISCO would be implemented within the groundwater source areas (not as a contingency).

4.3 Evaluation and Comparison of the Remedies

A comparative evaluation was conducted in the FS for the Reference, Less Aggressive, and More Aggressive Remedies to demonstrate that each remedial alternative will achieve the ROs in accordance with A.A.C. R18-16-407(H). The criteria used to evaluate each remedial alternative included practicability, risk, cost, and benefit. A summary of the evaluation for the remedial alternatives for the vadose zone and for groundwater are presented below in Tables 1a and 1b, respectively.

Table 1a - Summary of Remedial Alternatives – Vadose Zone				
Alternative	**Practicability**	**Risk**	**Cost***	**Benefit**
Reference Remedy	• Readily feasible and implementable. • Likely effective. • Relatively short duration (<5 Years) with the exception of the East Plume.	• Protective of human health and the environment. • Reduced residual risk after remediation.	WP: $550K CP: $550K EP: $560K	• Protects water supply. • Reduces potential for vapor intrusion.
Less Aggressive Remedy	• Readily feasible and implementable. • Likely effective. • Relatively longer duration (>5 Years).	• Protective of human health and the environment. Reduced residual risk after remediation.	WP: $460K CP: $460K EP: $410K	• Protects water supply. • Reduces potential for vapor intrusion.
More Aggressive Remedy	• Readily feasible and implementable. • Likely effective. • Relatively short duration (<5 Years).	• Protective of human health and the environment. • Reduced residual risk after remediation.	WP: $640K CP: $640K EP: $700K	• Protects water supply. • Reduces potential for vapor intrusion.
Notes: **WP – West Plume** **CP – Central Plume** **EP – East Plume** ***The costs presented in this table were taken directly from the FS Report and exclude worst-case scenarios (all identified contingencies are not implemented)**				

Table 1b - Summary of Remedial Alternatives – Groundwater				
Alternative	**Practicability**	**Risk**	**Cost***	**Benefit**
Reference Remedy	• Moderately feasible and implementable • Likely effective. • Potentially effective. • Potentially long duration (>30 Years).	• Protective of human health and the environment. Reduced residual risk after remediation.	WP: $2.6M CP: $2.6M EP: $2.6M	• Protects water supply.
Less Aggressive Remedy	• Readily feasible and implementable. • Potentially effective. • Potentially long duration (>30 Years).	• Protective of human health and the environment. Reduced residual risk after remediation.	WP: $570K CP: $570K EP: $570K	• Protects water supply.
More Aggressive Remedy	• Moderately feasible and implementable. • Likely effective. • Potentially shorter duration (<30 Years).	• Protective of human health and the environment. Reduced residual risk after remediation.	WP: $4.1M CP: $4.1M EP: $4.1M	• Protects water supply.
Notes: **RR – Reference Remedy** **MAR – More Aggressive Remedy** **LAR – Less Aggressive Remedy** ***The costs presented in this table were taken directly from the FS Report and exclude worst-case scenarios (all identified contingencies are not implemented)**				

Each of the three remedies are considered likely to achieve the ROs for the Site for both the vadose zone and the groundwater, however the Reference and More Aggressive Remedies may achieve the ROs more rapidly. Based on current data from the ERA in the East Plume, it was determined that the time to achieve the ROs for this portion of the Site would take longer with the vadose zone Reference Remedy than with the West and Central Plumes. The More Aggressive Remedy would be required, therefore, for the vadose zone in the East Plume to achieve the ROs in the same time frame as with the Reference Remedy in the West and Central Plumes.

4.4 Proposed Remedy

For the vadose zone, the Reference Remedy is the proposed remedy for the West and Central Plumes, and the More Aggressive Remedy was selected as the Remedy for the East Plume. For the groundwater, the Less Aggressive Remedy was selected the West Plume, Central Plume, and East Plume remedies. This recommendation is based on what is considered to be the best combination of remedial effectiveness, practicability, cost, and benefit for restoration and use of the groundwater resource. The Less Aggressive Remedies for groundwater scored the highest

when ranking in accordance with the comparison criteria specified in the Remedy Selection Rule, AAC R18 16-407 (H)(3)(e).

5.0 PROPOSED REMEDY AND ESTIMATED COST

The proposed remedy includes a combination of technologies for remediating vadose zone and groundwater for the West, Central, and East Plumes. The Proposed Remedy consists of the Reference Remedy from the FS for soil in the West Plume and Central Plume, and the More Aggressive Remedy for soil from the FS for the East Plume. The Less Aggressive Remedy from the FS for the groundwater is proposed for the three plumes. This section presents a description of the Proposed Remedies and the associated estimated costs. Potential contingencies and associated costs are also presented and discussed.

5.1 Remedy Description

The Proposed Remedy for the vadose zone of the three plumes includes SVE for the vadose zone and MNA for the groundwater impacts. These remedial technologies are described in the following subsections.

5.1.1 Proposed Remedial Action – Soil

The Proposed Remedy for the vadose zone for the three plumes is SVE. SVE is an established and proven remedial technology for VOCs in the vadose zone, particularly in conditions where excavation and off-site disposal of impacted soil is impractical. SVE involves the installation of a series of extraction wells in the impacted vadose zone and applying vacuum to extract soil vapors containing VOCs. SVE wells are connected via conveyance piping to an extraction system, followed by discharge to the atmosphere after first being treated to remove the VOCs. The treatment method used for VOCs is typically based on the concentration and chemical properties of the COCs. Vapor-phase granular activated carbon (VGAC) would likely be the most cost-effective treatment for the NCP plumes. Installation of SVE systems are proposed to remediate the elevated VOC concentrations in the soil vapor that are a source of groundwater contamination at the Site.

Implementation of SVE as the Proposed Remedy for the West and Central Plumes would comprise the following:

- Installation of one SVE system per plume consisting of an estimated 250 cubic foot per minute (cfm) flow rate capacity blower;
- Installation of eight SVE wells per plume (up to 100-ft deep assumed for cost estimating purposes); and
- Routine operation, maintenance, and monitoring (OMM) to assess remedial progress and system performance (assumed up to five years per plume for cost estimating purposes).

Operation of the SVE system will provide source control through the removal of VOC mass in the vadose zone, which will mitigate the potential for both vapor intrusion and ongoing groundwater impacts. SVE system optimization, such as flow balancing and focused extraction, will be conducted throughout the five year period.

Once the ROs have been achieved, the SVE system will be shut down for a 'rebound' analysis. VOCs in soil vapor will be monitored for rebound for a period of three months. If soil vapor VOC concentrations remain below cleanup goals, the system will be formally decommissioned. If VOCs rebound to above cleanup criteria, the system will be restarted and operated with a focus on the areas where residual VOCs remain.

An SVE system already exists and is currently operating at the East Plume. The system is operating with five SVE wells is located at the current active HCZ Custom Homes facility (HCZ). This business is not suspected of causing the release of PCE. The current SVE system configuration, which includes five SVE wells, represents the Less Aggressive Remedy presented in the FS, but the More Aggressive Remedy is proposed. The More Aggressive Remedy would comprise the following:

- Continued system OMM to assess remedial progress and system performance; and
- Installation of up to 12 additional SVE wells, for a total of 17 wells.

The HCZ system will be operated with the same objectives and contingencies as the proposed SVE systems for the West and Central Plumes, with the same rebound evaluation period following implementation.

5.1.2 Proposed Remedial Action - Groundwater

The proposed remedy for the three groundwater plumes is MNA. MNA is a remedial measure that involves routine groundwater sampling and analysis and predictive modeling to assess when cleanup objectives may be achieved passively through transformation processes that reduce the mass, toxicity, volume, or concentration of chemicals in groundwater. MNA is a mechanism by which COCs are reduced by natural means without other control, removal, treatment, or aquifer-modifying activities. These *in-situ* processes may include dilution, chemical and biological degradation, adsorption, and volatilization of the contaminants in groundwater.

MNA would consist of groundwater modeling, including trend analyses, and routine groundwater monitoring using the full existing groundwater network of 34 monitoring wells for a period of up to 30 years. Groundwater monitoring would be semi-annual for the first five years, followed by annual monitoring for the remaining 25 years. Monitoring would include groundwater

potentiometric surface level measurements and sampling for the relevant COCs and MNA parameters.

The number of wells to be monitored and the frequency of monitoring may be adjusted over time in response to changing conditions. At a minimum, the number of wells and the frequency of monitoring will be evaluated and updated every five years. The existing monitoring well network would be used to collect data to monitor and evaluate the nature and extent of impacts to the Site during groundwater remediation. ISCO will be implemented as a contingency after the first five year evaluation, or sooner based on professional judgement, if it is determined that the concentrations of contaminants are not declining at a rate to where Site closure will be possible within 30 years.

5.1.3 Proposed Contingencies

This section presents contingency remedial alternatives that may be warranted during implementation of the Proposed Remedies. The contingencies may be implemented due to changing conditions, to expedite cleanup based on future findings, to treat water for a purveyor with rights to the groundwater who is not currently pumping, but may do so in the future, or for other reasons. Details for how the contingencies may be implemented are discussed below. Cost estimates for these contingencies are summarized in Subsection 6.2 and associated cost detail tables are provided in Appendix A.

<u>Pump and Treat</u>
Extraction and treatment, i.e., "pump-and-treat," (P&T) is a technology for groundwater that can be effective for hydraulic containment for sites impacted by VOCs and soluble metals such as hexavalent chromium. P&T systems typically utilize submersible pumps in extraction wells to extract groundwater and transfer it via conveyance piping into an aboveground treatment system. The post-treatment water is subsequently discharged to a municipal sewer, a canal or other surface water conveyance, an infiltration basin, or re-injected into the subsurface with an injection well. P&T systems can control the subsurface flow of impacted groundwater, mitigating migration and/or reducing the footprint of the impacts. P&T systems can be used for aggressive remediation of a source area or may be used for hydraulic containment to mitigate the migration of VOCs for broad, dilute plumes (such as the plumes at the Site). Liquid-phase granular activated carbon (LGAC) is typically utilized for removal of VOCs from groundwater, while ion exchange (IX) resin is commonly employed for the removal of soluble metals.

As a contingency, P&T systems could be installed downgradient of the suspected source areas of the three plumes to intercept and hydraulically contain VOC migrating in groundwater. A potential P&T implementation is a contingency for achieving the ROs if it is determined by the

future data collected at the Site that the MNA Remedy will take longer than 30 years and that the ISCO contingency is not sufficient in achieving Site closure within the 30 year time frame.

The P&T contingency approach is the Reference Remedy scenario presented in the FS. Based on the results of the previous aquifer testing performed, three extraction wells withdrawing groundwater from the SGWS; the shallowest groundwater aquifer beneath the Site) at a flow rate of approximately 10 gallons per minute (gpm) per well could provide a capture zone up to 300 ft wide at the transect. The extracted groundwater would be treated by a 50-gpm capacity system (the additional capacity included for contingency) comprised of submersible extraction pumps, conveyance piping to a treatment compound, pretreatment with bag filtration to remove particulates, LGAC to remove VOCs, and discharge to the Grand Canal. The P&T system for the Central Plume will also include IX for treatment of chromium and hexavalent chromium. This remedy assumes up to 20-years of operation per plume. This extraction well configuration would intercept the normal movement of the plume along the ambient hydraulic gradient. Hydraulic containment would be provided for the highest concentration portions of the plumes, as well as treatment of majority of the plume. The migration of the plume along a north/south axis toward the treatment system would be enhanced. The conceptual extraction well and treatment system locations are shown on Figure 9.

The Reference Remedy for groundwater in the FS described above also had contingencies for P&T system expansion and/or enhancement. Contingencies included:

- Adding up to four additional extraction wells for the West and Central Plumes, and up to three additional wells for the East Plume;
- Increasing pumping rates from individual extraction wells and upgrading the capacity of the extraction and treatment system; and
- Merging treatment systems for the three plumes for more efficient and economical operation.

The cost analysis for these additions to the P&T system, presented in the next section, assumes the worst-case scenario, which includes:

- Seven extraction wells each within the West Plume and the Central Plume;
- Six extraction wells within the East Plume; and
- Individual extraction and treatment systems for the three plumes, with total flow rate capacities of up to 300 gpm and treatment with LGAC.

<u>Additional Groundwater Monitoring Well Installation</u>

Due to declining groundwater levels in the SGWS, several groundwater monitor wells screened in the SGWS can no longer be sampled. Groundwater levels are anticipated to continue to

decline. Therefore, a contingency for construction of additional groundwater monitor wells is included to replace monitor wells that cannot be sampled currently or within the next 30 years due to declining water levels in the SGWS. It is assumed up to 15 replacement groundwater monitoring wells (three monitor wells per year for five years) would be required to be installed.

Wellhead Treatment

A contingency plan for wellhead treatment is included to meet City of Phoenix (COP) and/or SRP demands if groundwater production from the impacted plume area is required to meet water supply needs prior to the natural attenuation of COC impacts to below AWQSs. One existing production well, SRP well 9.5E-7.7N, could reasonably be impacted by VOCs emanating from the NCP site. SRP well 9.5E-7.7N is currently active, but is only operated intermittently. This well has documented VOC impacts, which are currently considered to be more likely attributable to the West Central Phoenix West Osborn Complex site.

SRP has groundwater rights within the NCP site. COP and SRP both could potentially construct new production wells in the future within areas with impacts that are clearly attributable to the NCP site. If future water supply demands necessitate groundwater withdrawal from the VOC-impacted groundwater plumes for municipal and/or agricultural needs, the new production well would be monitored for VOC concentrations in withdrawn groundwater. If COC concentrations exceed the applicable AWQS for PCE and TCE, then a contingency for wellhead treatment would be implemented. Wellhead treatment would consist of LGAC treatment to remove VOCs from extracted groundwater from the production well. This contingency assumes one production well would require treatment from each agency (COP and SRP), and that production rates would be similar for the new wells as they are for historical pumping rates for productions wells COP-157 and SRP well 9.5E-7.7N, which currently exist within the LSGS: 700 gpm and 3,900 gpm, respectively.

In-Situ Chemical Oxidation

If groundwater modeling or monitoring results indicate that VOCs are unlikely to naturally attenuate within a reasonable time frame, then a contingency for ISCO remediation may be implemented to accelerate the remedy. ISCO is a frequently used technology that includes the injection of chemical oxidants into the subsurface to treat soil and groundwater impacts. Common amendments used for ISCO include permanganate, persulfate, hydrogen peroxide, and ozone. These highly reactive amendments oxidize the COCs to produce innocuous byproducts. Chemical oxidizers are typically injected through wells or temporary injection points using gravity or pressurized injection methods to achieve the prescribed distribution. Catalysts may be included or required to promote reactions for some amendments, such as sodium persulfate.

An ISCO contingency remedy may be implemented in a suspected residual VOC source area within the individual NCP plumes. ISCO at an individual plume would likely consist of injecting a solution of liquid oxidant into eleven injection wells constructed on approximately 20-foot spacings, for treatment of an approximately 5,600 square foot area. Bench scale treatability and field hydraulic injection testing would be conducted prior to full-scale implementation of the ISCO remedy to optimize injection well spacing, injection rates, and to obtain other critical design information. The injection wells would to be constructed with two-inch diameter schedule 40 PVC casings and screens, with 10-foot screen intervals located just below the groundwater surface. Injection well surface completions would be constructed within 12-inch traffic rated well vaults.

Two new groundwater monitoring wells would also be constructed as part of the ISCO remediation contingency per plume to monitor the effectiveness of the ISCO remedy. The additional groundwater monitoring wells would be advanced to approximately five feet below the bottom of the screen intervals of the injection wells. An increased monitoring frequency for the new wells would be performed to evaluate the effectiveness of the ISCO remedy, which is anticipated to consist of quarterly monitoring for the first year. This contingency also conservatively assumes that a re-application of the oxidant would be required approximately one year following the initial injection. Semiannual monitoring would be implemented for one year following the second application.

5.1.4 Performance Monitoring, and Periodic Reviews

Inspections, performance monitoring, and periodic reviews, including for potentially implemented contingencies, will be used to judge the effectiveness and adequacy of the implemented remedies. Monitoring will include the following:

- **SVE System Monitoring** – Routine OMM will be conducted for the SVE system at the West, Central, and East Plumes to monitor that the systems are operating effectively and achieving the ROs. OMM will include the collection of soil vapor samples from the process train. Flow rates, vacuum influence, temperatures, and other performance metrics will also be monitored.

- **Soil Vapor Monitoring** – Soil vapor sampling will be conducted to monitor that VOC concentrations have not rebounded after discontinuing SVE operations at the Site. The results of the monitoring will be used to demonstrate that the soil vapor concentrations are below the cleanup criteria and that residual VOCs are no longer contributing significantly to ongoing groundwater impacts.

- **Groundwater Monitoring** – Routine groundwater monitoring will be performed to assess MNA and VOC concentration reductions associated with vadose zone cleanup activities. Groundwater monitoring and reporting will be performed on a semiannual basis for the first five years, and annually thereafter. Focused groundwater monitoring, in addition to MNA, will be conducted to evaluate the performance and the post treatment impacts of a potential ISCO implementation at the Site. The performance monitoring would include up to eight sampling events conducted at up to 11 wells located within the target treatment zone during the implementation of ISCO.

- **Periodic Reviews** - Periodic reviews of remedial progress will be conducted as necessary to assess the effectiveness of the remedy in achieving the ROs. These reviews will be conducted on a 5-year basis, at a minimum.

5.2 Estimated Cost

The estimated cost of the Proposed Remedy, without contingencies, is $5.4 million. The estimated cost with contingencies is $32.0 million. A summary of the costs associated with the remedy is presented in Table 2 below. The detailed cost breakdowns are presented in Appendix A.

Table 2 - Summary of Costs for Proposed Remedy	
Remedial Technology	**Cost**
Vadose Zone	
Soil Vapor Extraction (OMM for up to 5 years)	$2,569,000
Groundwater	
Monitored Natural Attenuation (up to 30 years)	$2,856,000
SUBTOTAL	**$5,425,000**
Contingencies	
Groundwater	
Pump and Treat	$13,287,000
Wellhead Treatment	$9,789,000
In-Situ Chemical Oxidation	$2,689,000
Additional Groundwater Monitor Well Installation	$820,000
SUBTOTAL	**$26,585,000**
TOTAL	**$32,010,000**
Note: costs assume 3% annual inflation rate	

5.3 Duration

The overall duration of the remedy is up to 30 years. The duration is the estimated number of years required for the proposed remedy to achieve the ROs.

6.0 CONSIDERATION OF REMEDIATION GOALS AND SELECTION FACTORS

This section presents how the remediation goals and selection factors outlined in A.R.S. §49-282.06 were considered for the proposed remedy.

6.1 Rationale for Selection of the Remedy

The Proposed Remedies include source control, containment, and monitoring of the contamination. The Proposed Remedy provides the best combination of remedial effectiveness, practicability, cost, and benefit for the restoration and use of the groundwater resource. There is currently a human health risk associated with the contaminated groundwater at the Site and the components of the Proposed Remedy will be protective of public health and the environment.

The components of the Proposed Remedy are proven, reliable remedial alternatives that will be protective of the public health and the environment. The risk to human health and the environment with these remedies is low and known exposure pathways have been addressed. Over time, the remedial actions will reduce the concentrations and the volume of contaminated soil, soil vapor, and groundwater. Environmental sampling is included to monitor that the remedy is protective of public health and the environment during and after remedy implementation. The combined components of the Proposed Remedies are consistent and compatible with current and anticipated future land and resource use. Upon implementation, these remedies are considered to have a positive impacts in terms of enhancement of future land uses and the local economy.

6.2 Achievement of Remedial Objectives

Per A.A.C. R18-16-408(B)(3), the proposed remedies must achieve the ROs established by ADEQ for the Site. The proposed remedy for soil will achieve ROs for land use by restricting environmental and human exposure to vapor intrusion and ongoing impacts to groundwater by removing contaminants from the soil through SVE. The proposed remedy for groundwater will achieve the ROs through MNA. Environmental sampling and groundwater modeling will be used to monitor that the ROs are being met.

6.3 Achievement of Remedial Action Criteria

A.R.S. § 49-282.06 requires that remedial actions shall:

- Assure the protection of public health and welfare and the environment.
- To the extent practicable, provide for the control, management, or cleanup of the hazardous substances to allow the maximum beneficial use of the waters of the state.
- Be reasonable, necessary, cost-effective, and technically feasible.

As demonstrated in this PRAP, the proposed remedies and contingencies for the Site meet the requirements of A.R.S. §49-282.06. The Proposed Remedy are protective of human health and the environment, compliant with applicable laws, and allow for the maximum beneficial use of the waters of the state with the lowest cost. The Proposed Remedy is the best combination of practicability, risk, cost, and benefit to achieve the ROs.

6.4 Consistency with Water Management Plans

The Proposed Remedy and contingencies are consistent with the water management plans of local water providers and will protect water quality. The Proposed Remedy will allow for the maximum beneficial use of the waters of the state, protect the groundwater supply for future use, and monitor that wider areas are not impacted for future water development options.

6.5 Consistency with General Land Use Planning

The Proposed Remedy and contingencies are consistent with the current land use and are not anticipated to negatively impact current or future land use at the Site.

6.6 Lead Agency Statement for Proposed Remedy

Based on the information currently available, ADEQ believes the proposed remedies and contingencies provide the best balance of tradeoffs among the other alternatives with respect to the comparison criteria. ADEQ expects the proposed remedies and contingencies will satisfy the remedial action criteria pursuant to A.R.S. § 49-282.06 and the ROs.

6.7 Uncertainties

Uncertainties associated with the proposed remedies at the Site include the following:

- **The duration of time required to remediate the groundwater at the Site.** 30 years is an industry standard assumption for cost estimating purposes when a project duration is

understood to be long-term but is not accurately known. Whereas MNA is expected to achieve the ROs for the Site, modeling has not yet been performed to estimate the time that would be needed to achieve the AWQSs for the plumes. Modeling will be performed as part of MNA implementation.

6.8 Public Comment Period

The PRAP will be issued for a 90-day public comment period. A Community Advisory Board (CAB) meeting may be held during the public comment period. ADEQ will accept written comments on this PRAP that are postmarked within the comment period and submitted to:

Arizona Department of Environmental Quality
Attention: Eric Mannlein, Project Manager
1110 West Washington Street
Phoenix, Arizona 85007
Email: Mannlein.Eric@azdeq.gov

7.0 REFERENCES

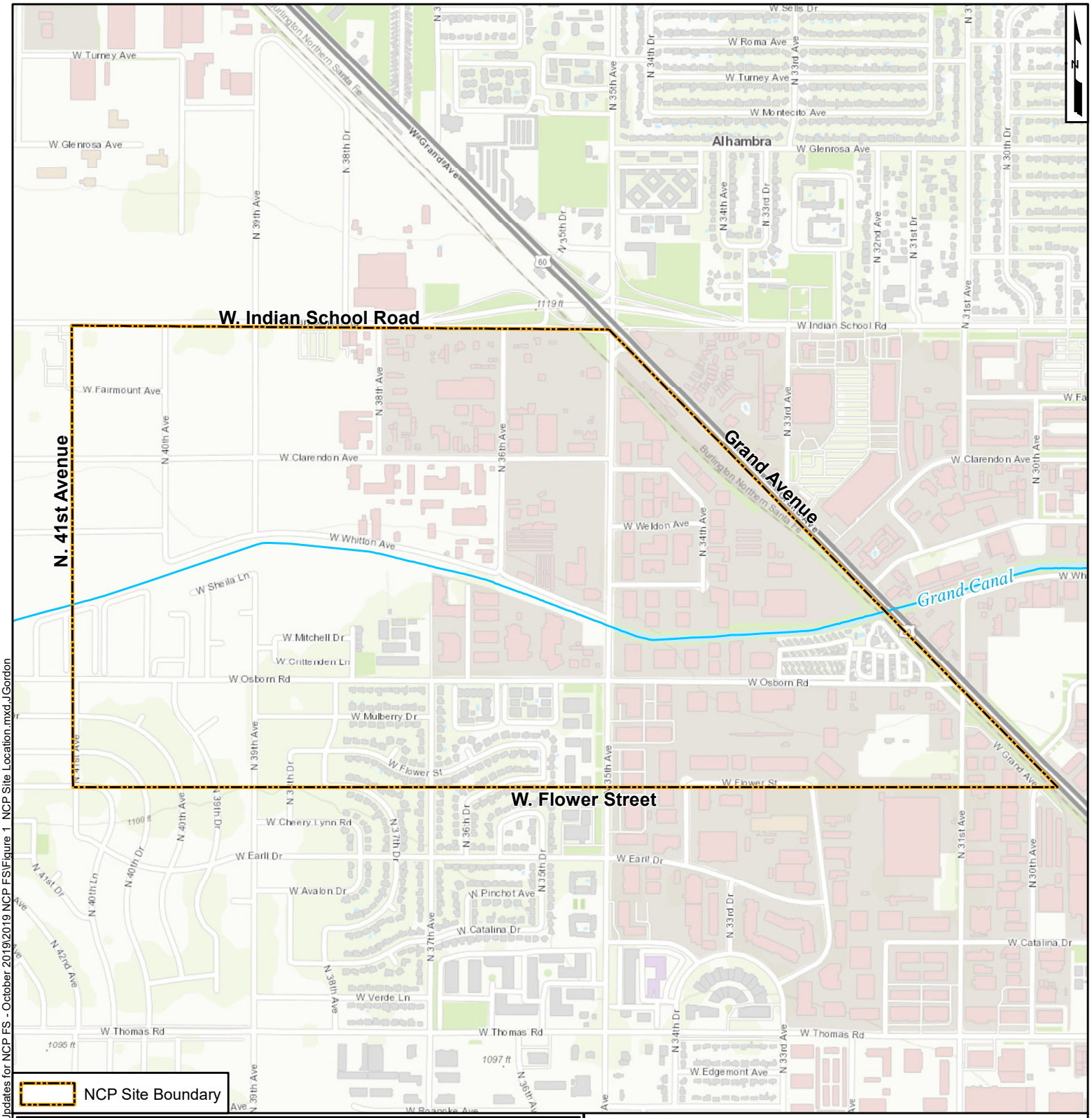
HGC, 2017. Remedial Investigation Report, West Central Phoenix, North Canal Plume WQARF Site, Phoenix, Arizona, 13 March.

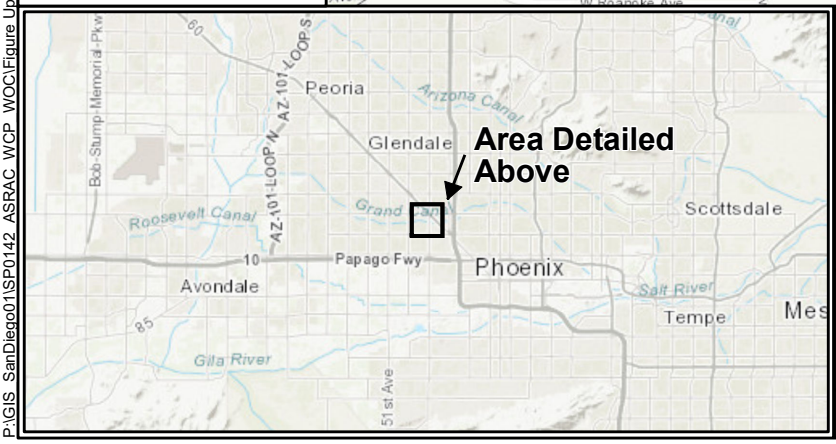
Geosyntec, 2018. Vapor Intrusion Evaluation Technical Memorandum, North Canal Plume WQARF Site, Phoenix, Arizona, December 17.

Geosyntec, 2019. Vapor Intrusion Evaluation Technical Memorandum Addendum, North Canal Plume WQARF Site, Phoenix, Arizona, 21 March.

Geosyntec, 2020. Final Feasibility Study, West Central Phoenix North Canal Plume Water Quality Assurance Revolving Fund Site, Phoenix, Arizona. January.

FIGURES





Site Vicinity Map

North Canal Plume WQARF Site
Phoenix, Arizona

Geosyntec consultants

Phoenix, AZ | December 2019

Figure 1

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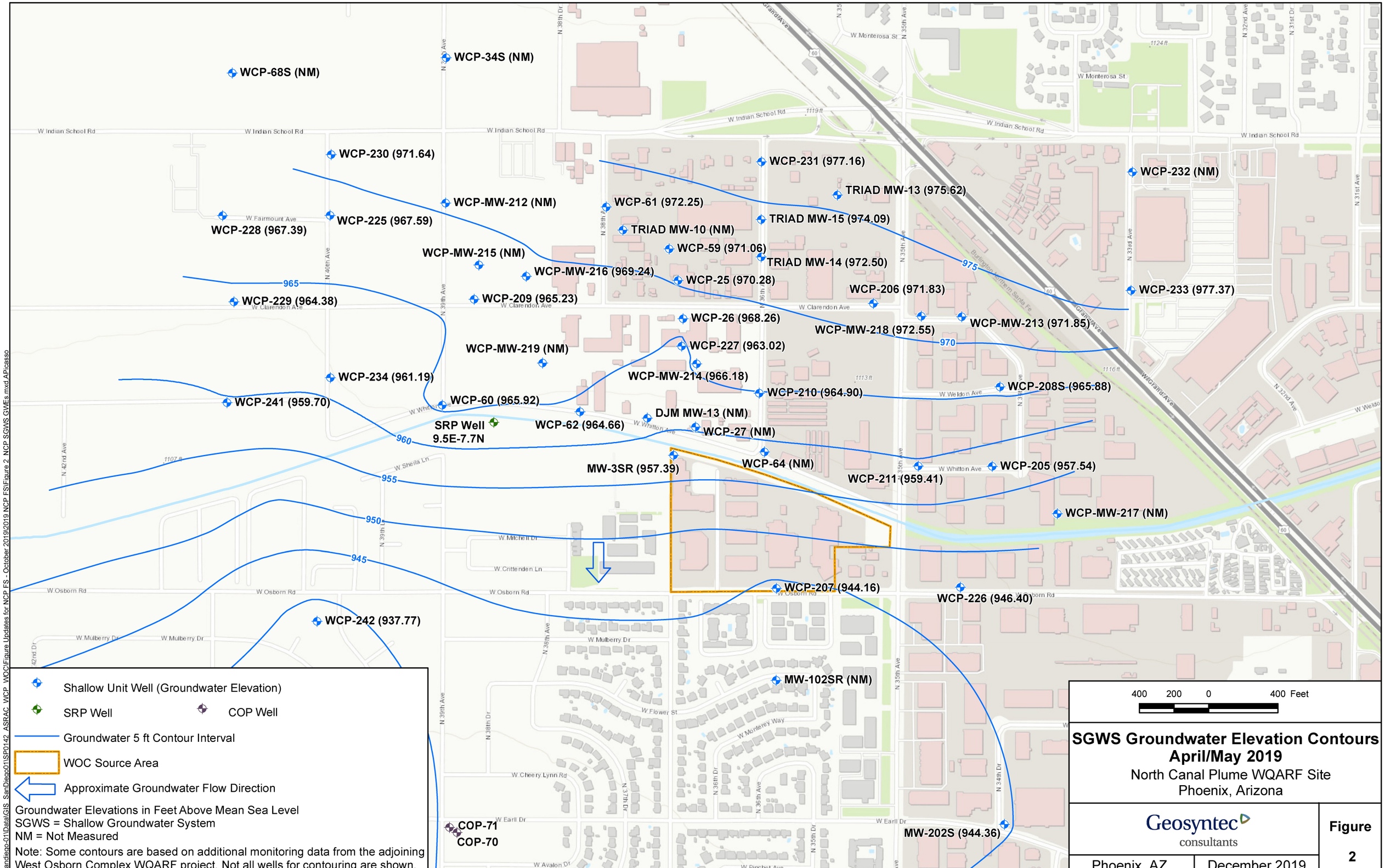
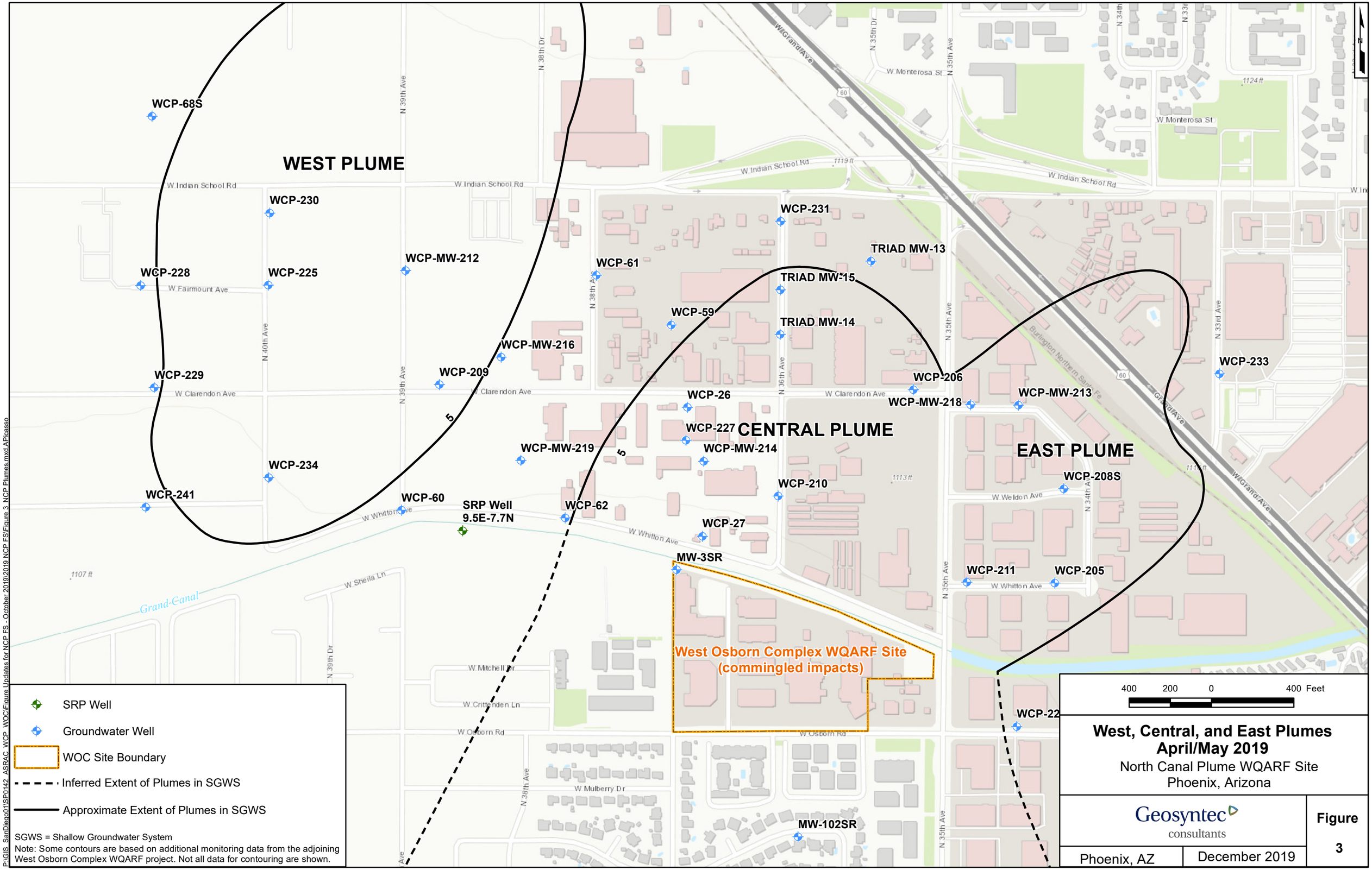

WCP-68S (NM)
WCP-34S (NM)
WCP-230 (971.64)
WCP-231 (977.16)
WCP-232 (NM)
TRIAD MW-13 (975.62)
WCP-MW-212 (NM)
WCP-61 (972.25)
WCP-225 (967.59)
WCP-228 (967.39)
TRIAD MW-15 (974.09)
TRIAD MW-10 (NM)
WCP-59 (971.06)
WCP-MW-215 (NM)
TRIAD MW-14 (972.50)
WCP-MW-216 (969.24)
WCP-25 (970.28)
WCP-206 (971.83)
WCP-233 (977.37)
WCP-229 (964.38)
WCP-209 (965.23)
WCP-26 (968.26)
WCP-MW-218 (972.55)
WCP-MW-213 (971.85)
WCP-MW-219 (NM)
WCP-227 (963.02)
WCP-234 (961.19)
WCP-MW-214 (966.18)
WCP-210 (964.90)
WCP-208S (965.88)
WCP-241 (959.70)
WCP-60 (965.92)
DJM MW-13 (NM)
SRP Well
9.5E-7.7N
WCP-62 (964.66)
WCP-27 (NM)
MW-3SR (957.39)
WCP-64 (NM)
WCP-211 (959.41)
WCP-205 (957.54)
WCP-MW-217 (NM)
WCP-207 (944.16)
WCP-226 (946.40)
WCP-242 (937.77)
MW-102SR (NM)
COP-71
COP-70
MW-202S (944.36)
975
970
965
960
955
950
945
W Indian School Rd
W Monterosa St
W Fairmount Ave
W Clarendon Ave
W Whitton Ave
W Weldon Ave
W Sheila Ln
W Mitchell Dr
W Crittenden Ln
W Osborn Rd
W Mulberry Dr
W Flower St
W Monterey Way
W Cheery Lynn Rd
W Earll Dr
W Avalon Dr
W Pinchot Ave
N 38th Dr
N 39th Ave
N 40th Ave
N 35th Ave
N 33rd Ave
N 32nd Ave
N 31st Ave
N 31st Dr
N 42nd Ave
N 36th Ave
N 36th Dr
N 34th Dr
N 37th Dr
Grand Ave
Burlington Northern Santa Fe
Shallow Unit Well (Groundwater Elevation)
SRP Well
COP Well
Groundwater 5 ft Contour Interval
WOC Source Area
Approximate Groundwater Flow Direction
Groundwater Elevations in Feet Above Mean Sea Level
SGWS = Shallow Groundwater System
NM = Not Measured
Note: Some contours are based on additional monitoring data from the adjoining West Osborn Complex WQARF project. Not all wells for contouring are shown.
400 200 0 400 Feet
SGWS Groundwater Elevation Contours
April/May 2019
North Canal Plume WQARF Site
Phoenix, Arizona
Geosyntec consultants
Figure
2
Phoenix, AZ
December 2019
\\sandiego-01\Data\GIS_SanDiego01\SP0142_ASRAC_WCP_WOC\Figure Updates for NCP FS - October 2019\2019 NCP FS\Figure 2_NCP SGWS GWEs.mxd APicasso


WEST PLUME
CENTRAL PLUME
EAST PLUME
WCP-68S
WCP-230
WCP-228
WCP-225
WCP-MW-212
WCP-229
WCP-209
WCP-MW-216
WCP-234
WCP-241
WCP-60
SRP Well
9.5E-7.7N
WCP-62
WCP-MW-219
WCP-61
WCP-231
TRIAD MW-13
TRIAD MW-15
TRIAD MW-14
WCP-59
WCP-26
WCP-227
WCP-MW-214
WCP-210
WCP-27
MW-3SR
WCP-206
WCP-MW-218
WCP-MW-213
WCP-233
WCP-208S
WCP-211
WCP-205
WCP-22
MW-102SR
West Osborn Complex WQARF Site
(commingled impacts)
5
W Indian School Rd
W Fairmount Ave
W Clarendon Ave
W Whitton Ave
W Sheila Ln
W Mitchell Dr
W Crittenden Ln
W Osborn Rd
W Mulberry Dr
W Monterosa St
W Weldon Ave
W Grand Ave
N 39th Ave
N 40th Ave
N 38th Dr
N 38th Ave
N 36th Ave
N 35th Dr
N 35th Ave
N 34th Ave
N 33rd Ave
N 39th Dr
Grand Canal
Burlington Northern Sant Fe
1124 ft
1119 ft
1113 ft
1107 ft
SRP Well
Groundwater Well
WOC Site Boundary
Inferred Extent of Plumes in SGWS
Approximate Extent of Plumes in SGWS
SGWS = Shallow Groundwater System
Note: Some contours are based on additional monitoring data from the adjoining West Osborn Complex WQARF project. Not all data for contouring are shown.
400 200 0 400 Feet
West, Central, and East Plumes
April/May 2019
North Canal Plume WQARF Site
Phoenix, Arizona
Geosyntec consultants
Phoenix, AZ
December 2019
Figure
3
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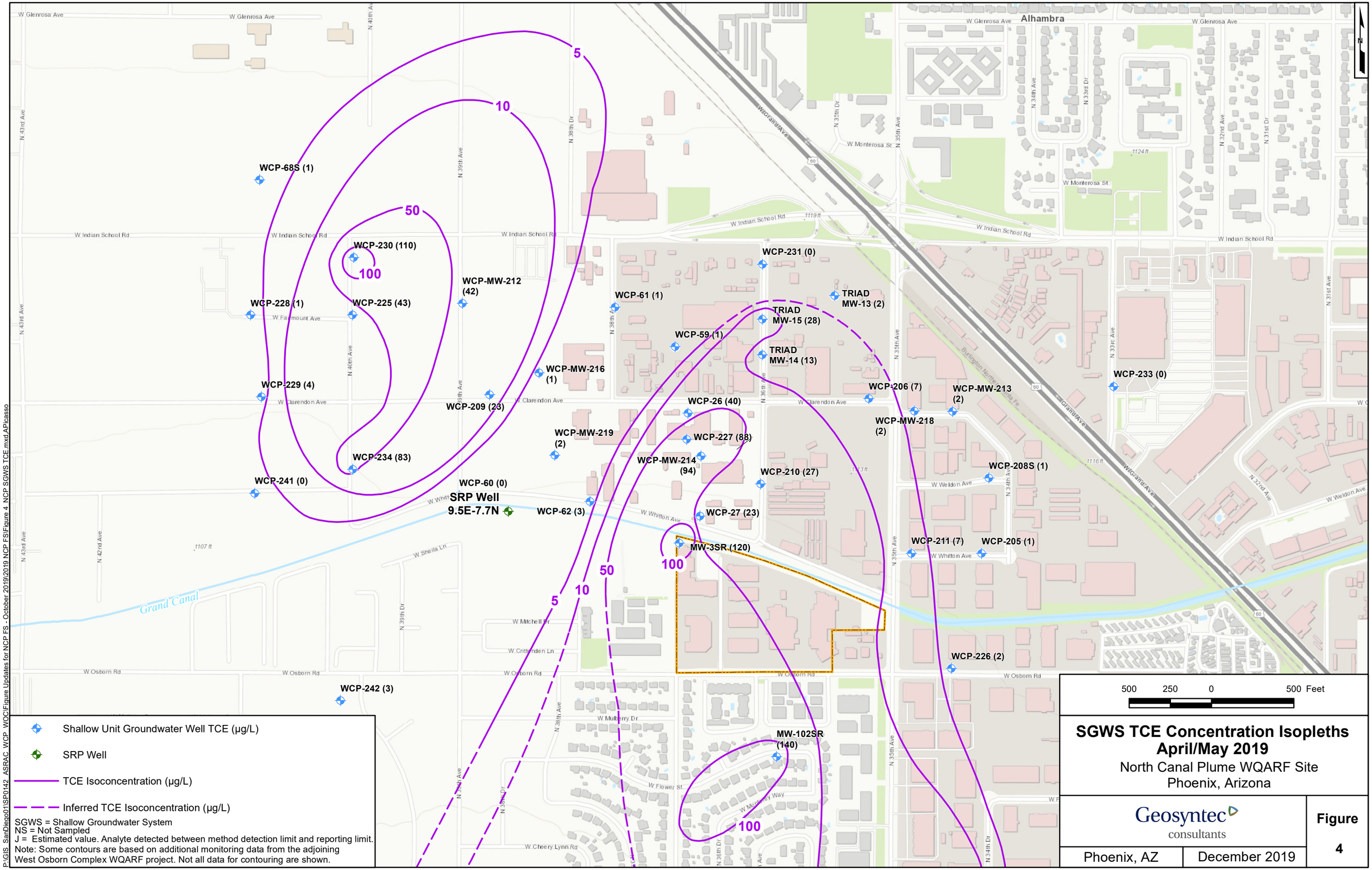


SGWS = Shallow Groundwater System
NS = Not Sampled
J = Estimated value. Analyte detected between method detection limit and reporting limit.
Note: Some contours are based on additional monitoring data from the adjoining West Osborn Complex WQARF project. Not all data for contouring are shown.

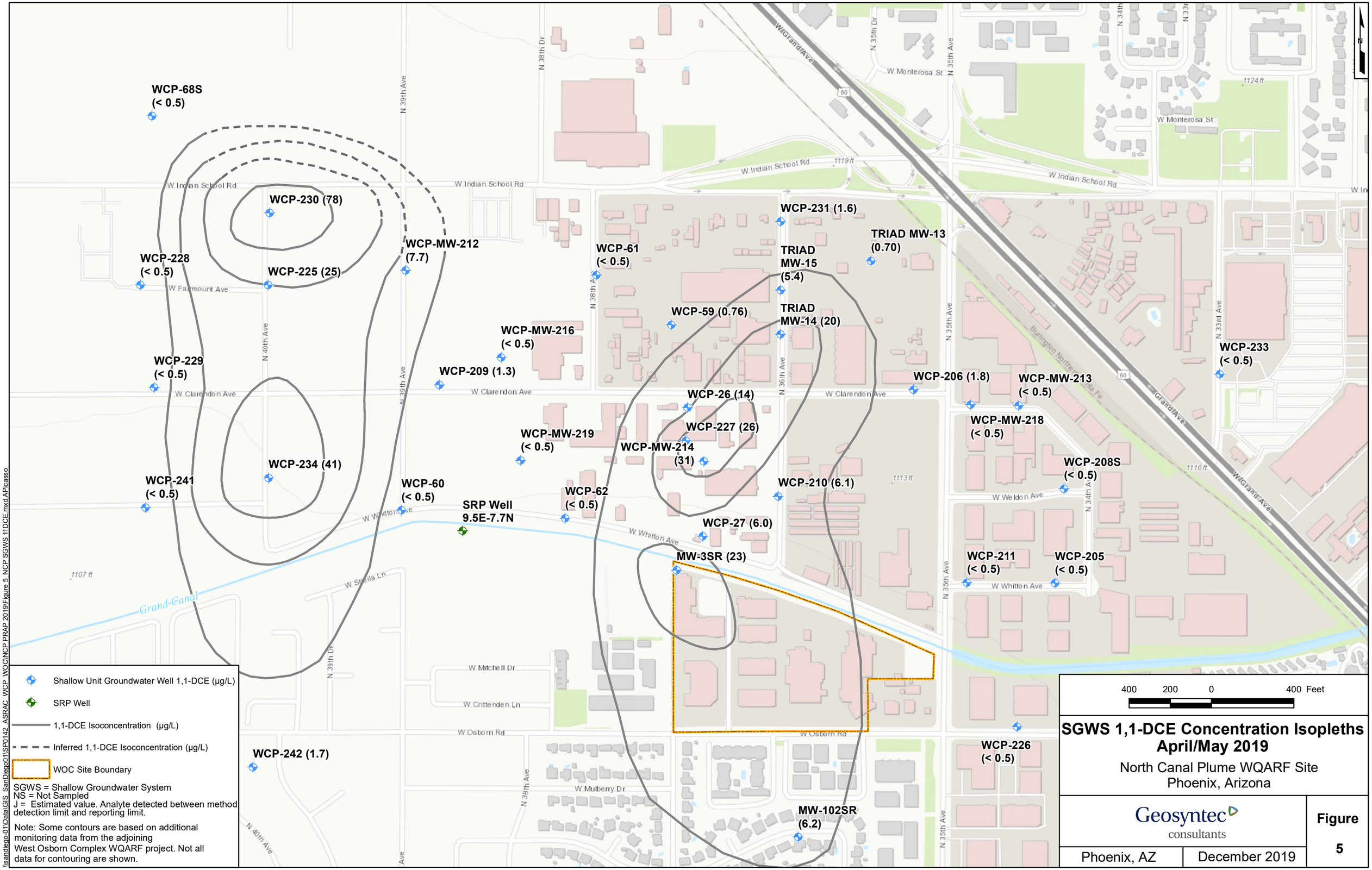
SGWS TCE Concentration Isopleths
April/May 2019
North Canal Plume WQARF Site
Phoenix, Arizona

Geosyntec consultants

Phoenix, AZ | December 2019

Figure 4

P:\GIS_SanDiego01\SP0142_ASRAC_WCP_WOC\Figure Updates for NCP FS - October 2019\2019 NCP FS\Figure 4_NCP SGWS TCE.mxd APicasso


WCP-68S
(< 0.5)
WCP-230 (78)
WCP-228
(< 0.5)
WCP-225 (25)
WCP-MW-212
(7.7)
WCP-229
(< 0.5)
WCP-234 (41)
WCP-241
(< 0.5)
WCP-60
(< 0.5)
SRP Well
9.5E-7.7N
WCP-61
(< 0.5)
WCP-231 (1.6)
TRIAD MW-13
(0.70)
TRIAD
MW-15
(5.4)
WCP-59 (0.76)
TRIAD
MW-14 (20)
WCP-MW-216
(< 0.5)
WCP-209 (1.3)
WCP-26 (14)
WCP-227 (26)
WCP-MW-219
(< 0.5)
WCP-MW-214
(31)
WCP-62
(< 0.5)
WCP-210 (6.1)
WCP-27 (6.0)
MW-3SR (23)
WCP-206 (1.8)
WCP-MW-213
(< 0.5)
WCP-MW-218
(< 0.5)
WCP-208S
(< 0.5)
WCP-211
(< 0.5)
WCP-205
(< 0.5)
WCP-233
(< 0.5)
WCP-226
(< 0.5)
WCP-242 (1.7)
MW-102SR
(6.2)
W Indian School Rd
W Fairmount Ave
W Clarendon Ave
W Whitton Ave
W Sheila Ln
W Mitchell Dr
W Crittenden Ln
W Osborn Rd
W Mulberry Dr
W Monterosa St
W Weldon Ave
N 39th Ave
N 40th Ave
N 38th Dr
N 38th Ave
N 36th Ave
N 35th Dr
N 35th Ave
N 34th Ave
N 33rd Ave
W Grand Ave
Burlington Northern Santa Fe
Grand Canal
1124 ft
1119 ft
1116 ft
1113 ft
1107 ft
Shallow Unit Groundwater Well 1,1-DCE (µg/L)
SRP Well
1,1-DCE Isoconcentration (µg/L)
Inferred 1,1-DCE Isoconcentration (µg/L)
WOC Site Boundary
SGWS = Shallow Groundwater System
NS = Not Sampled
J = Estimated value. Analyte detected between method detection limit and reporting limit.
Note: Some contours are based on additional monitoring data from the adjoining West Osborn Complex WQARF project. Not all data for contouring are shown.
400 200 0 400 Feet
SGWS 1,1-DCE Concentration Isopleths
April/May 2019
North Canal Plume WQARF Site
Phoenix, Arizona
Geosyntec consultants
Figure
5
Phoenix, AZ
December 2019
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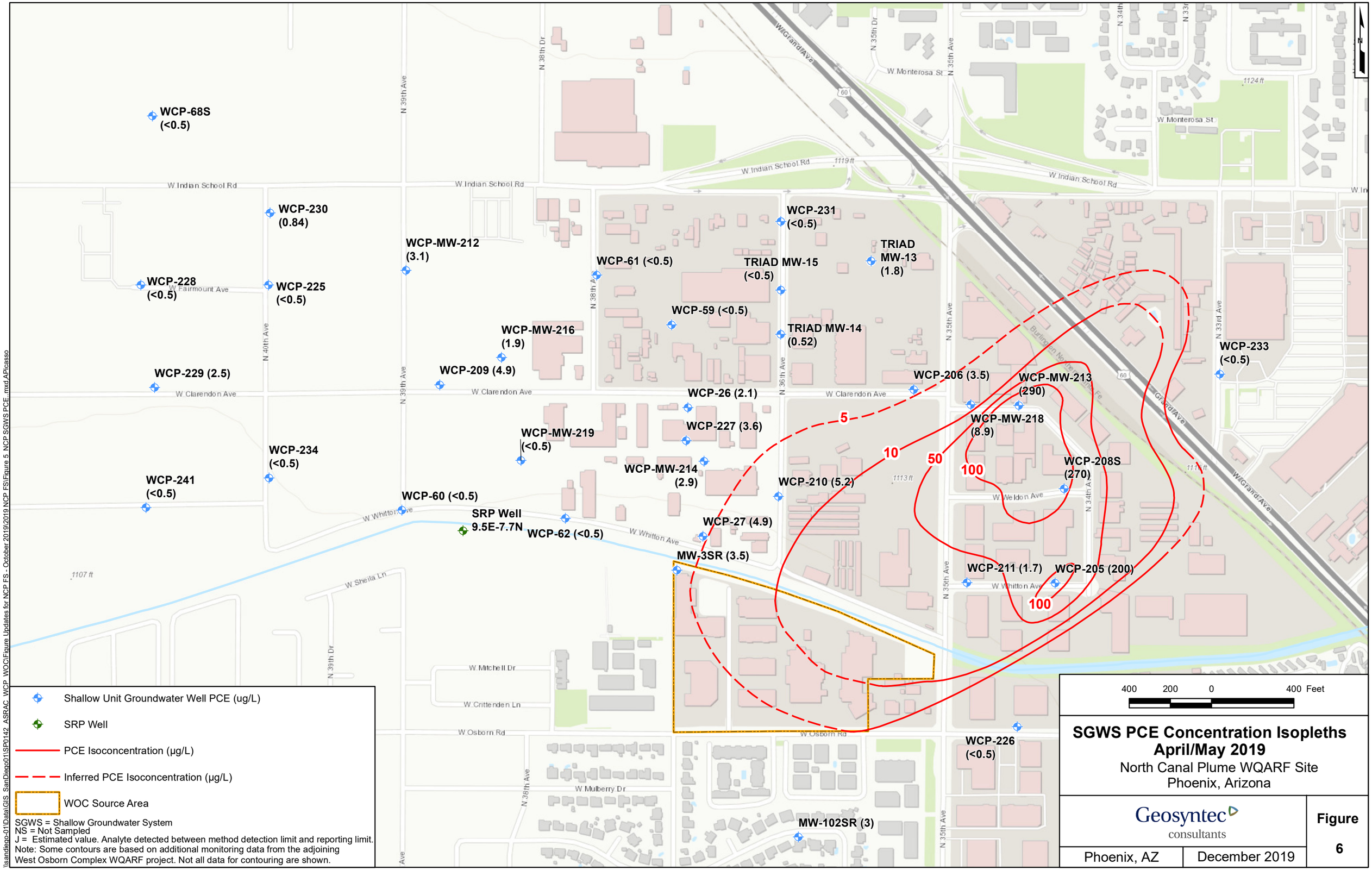


SGWS = Shallow Groundwater System
NS = Not Sampled
J = Estimated value. Analyte detected between method detection limit and reporting limit.
Note: Some contours are based on additional monitoring data from the adjoining West Osborn Complex WQARF project. Not all data for contouring are shown.

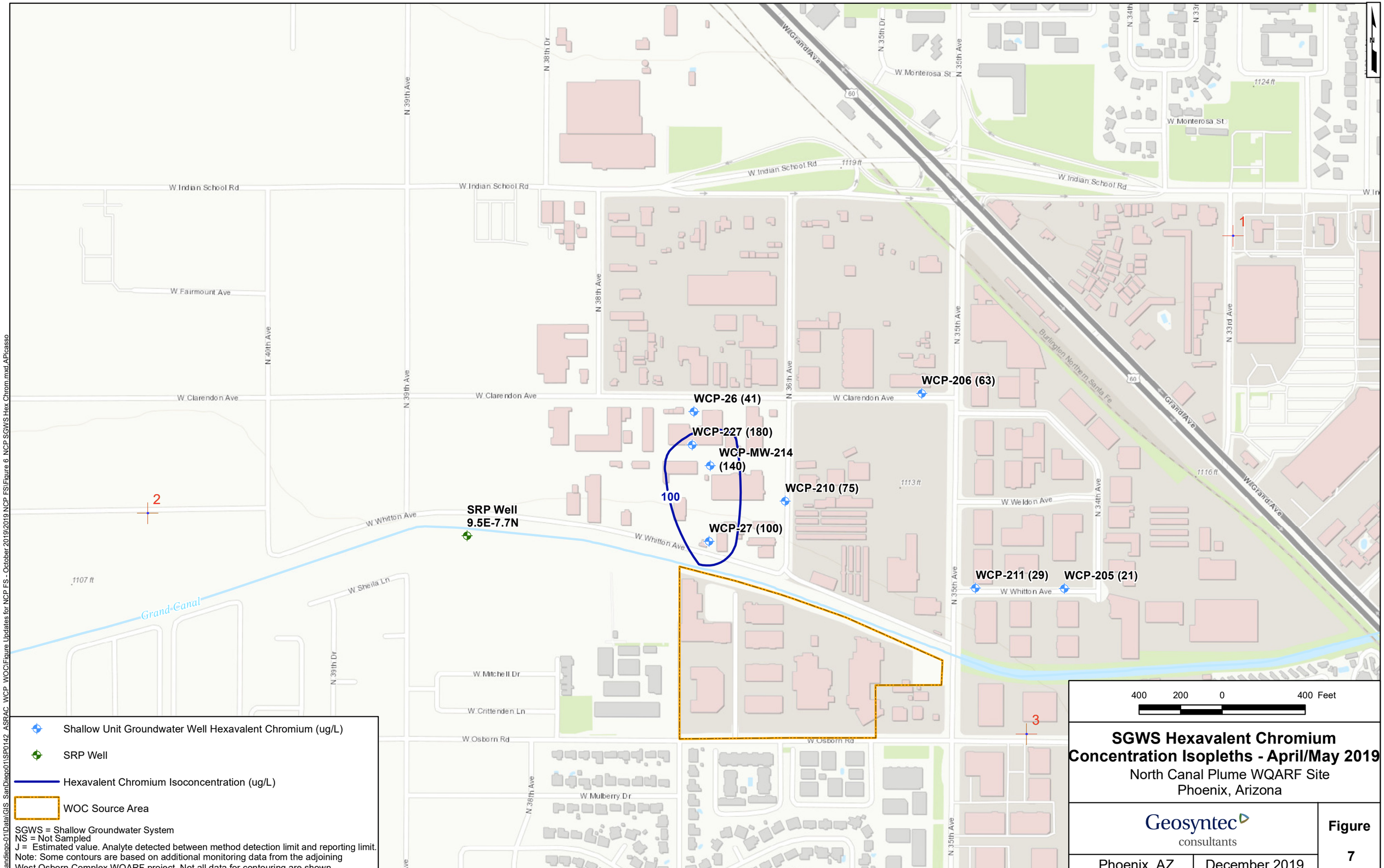
SGWS PCE Concentration Isopleths
April/May 2019
North Canal Plume WQARF Site
Phoenix, Arizona

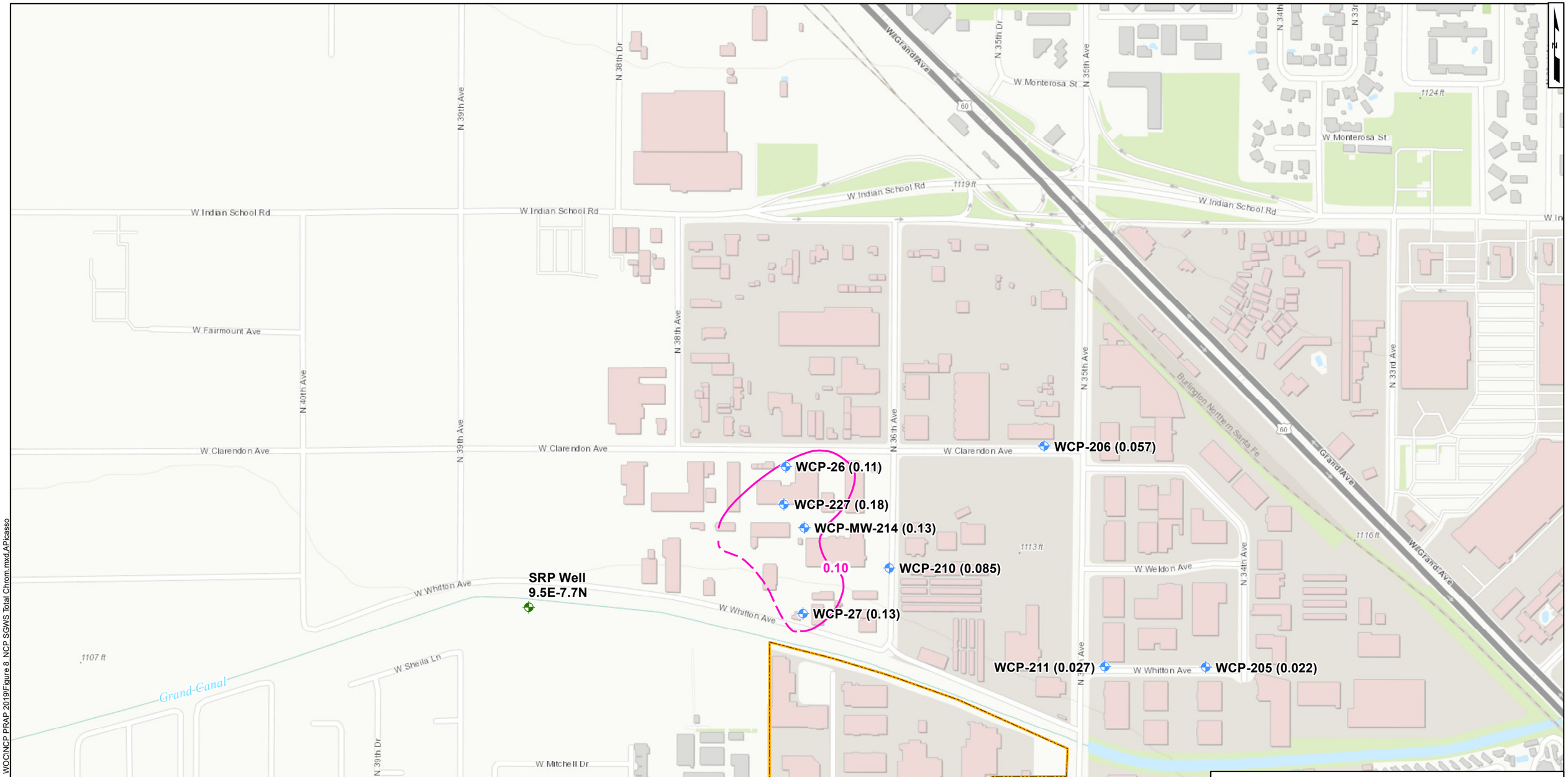
Geosyntec consultants

Phoenix, AZ | December 2019

Figure 6

\\sandiego-01\Data\GIS_SanDiego01\SP0142_ASRAC_WCP_WOC\Figure Updates for NCP FS - October 2019\2019 NCP FS\Figure 5_NCP SGWS PCE_.mxd APicasso


W Indian School Rd
W Fairmount Ave
W Clarendon Ave
W Whitton Ave
W Sheila Ln
W Mitchell Dr
W Crittenden Ln
W Osborn Rd
W Mulberry Dr
W Monterosa St
W Weldon Ave
N 39th Ave
N 40th Ave
N 38th Dr
N 38th Ave
N 36th Ave
N 35th Dr
N 35th Ave
N 34th Ave
N 33rd Ave
N 39th Dr
W Grand Ave
Burlington Northern Santa Fe
Grand Canal
1119 ft
1124 ft
1113 ft
1116 ft
1107 ft
WCP-26 (41)
WCP-227 (180)
WCP-MW-214 (140)
WCP-210 (75)
WCP-27 (100)
WCP-206 (63)
WCP-211 (29)
WCP-205 (21)
SRP Well 9.5E-7.7N
100
1
2
3
Shallow Unit Groundwater Well Hexavalent Chromium (ug/L)
SRP Well
Hexavalent Chromium Isoconcentration (ug/L)
WOC Source Area
SGWS = Shallow Groundwater System
NS = Not Sampled
J = Estimated value. Analyte detected between method detection limit and reporting limit.
Note: Some contours are based on additional monitoring data from the adjoining West Osborn Complex WQARF project. Not all data for contouring are shown.
400 200 0 400 Feet
SGWS Hexavalent Chromium Concentration Isopleths - April/May 2019
North Canal Plume WQARF Site
Phoenix, Arizona
Geosyntec consultants
Phoenix, AZ
December 2019
Figure 7
\\sandiego-01\Data\GIS_SanDiego\011SP0142_ASRAC_WCP_WOC\Figure Updates for NCP FS - October 2019\2019 NCP FS\Figure 6_NCP SGWS Hex Chrom.mxd APicasso



Shallow Unit Groundwater Well Chromium (mg/L)

SRP Well

Chromium Isoconcentration (mg/L)

Inferred Chromium Isoconcentration (mg/L)

WOC Source Area

SGWS = Shallow Groundwater System
NS = Not Sampled
J = Estimated value. Analyte detected between method detection limit and reporting limit.
Note: Some contours are based on additional monitoring data from the adjoining West Osborn Complex WQARF project. Not all data for contouring are shown.

400 200 0 400 Feet

SGWS Total Chromium Concentration Isopleths - April/May 2019

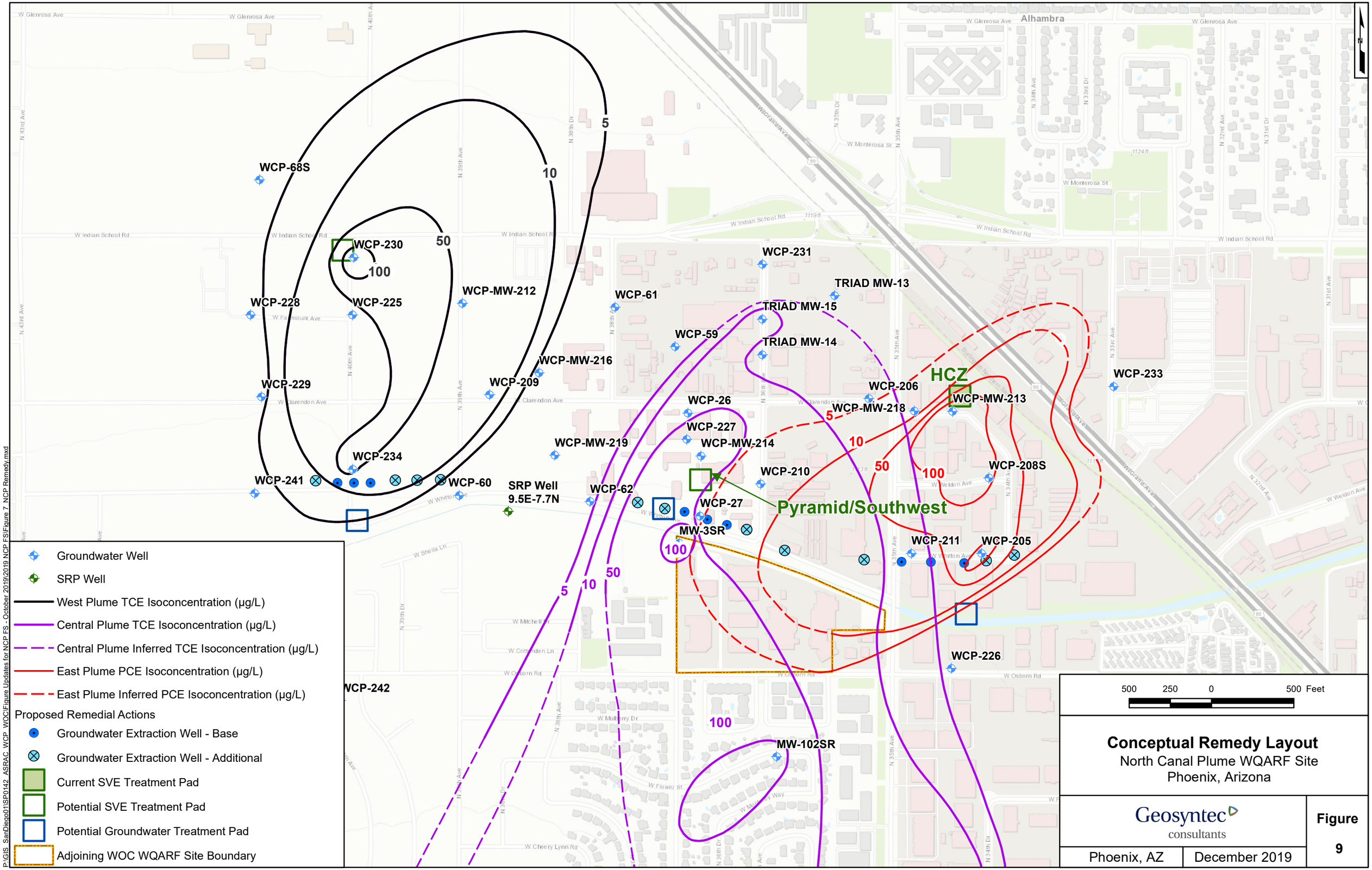
North Canal Plume WQARF Site
Phoenix, Arizona

Geosyntec consultants

Phoenix, AZ | December 2019

Figure 8

\\sandiego-01\Data\GIS_SanDiego01\SP0142_ASRAC_WCP_WOC\NCP PRAP 2019\Figure 8_NCP SGWS Total Chrom.mxd APicasso


Alhambra
WCP-68S
WCP-230
WCP-228
WCP-225
WCP-229
WCP-234
WCP-241
WCP-60
WCP-242
WCP-MW-212
WCP-61
WCP-231
TRIAD MW-13
TRIAD MW-15
TRIAD MW-14
WCP-59
WCP-MW-216
WCP-209
WCP-26
WCP-227
WCP-MW-214
WCP-MW-219
WCP-62
SRP Well
9.5E-7.7N
WCP-27
MW-3SR
WCP-210
Pyramid/Southwest
HCZ
WCP-206
WCP-MW-218
WCP-MW-213
WCP-233
WCP-208S
WCP-211
WCP-205
WCP-226
MW-102SR
5
10
50
100
Groundwater Well
SRP Well
West Plume TCE Isoconcentration (µg/L)
Central Plume TCE Isoconcentration (µg/L)
Central Plume Inferred TCE Isoconcentration (µg/L)
East Plume PCE Isoconcentration (µg/L)
East Plume Inferred PCE Isoconcentration (µg/L)
Proposed Remedial Actions
Groundwater Extraction Well - Base
Groundwater Extraction Well - Additional
Current SVE Treatment Pad
Potential SVE Treatment Pad
Potential Groundwater Treatment Pad
Adjoining WOC WQARF Site Boundary
500 250 0 500 Feet
Conceptual Remedy Layout
North Canal Plume WQARF Site
Phoenix, Arizona
Geosyntec consultants
Figure
9
Phoenix, AZ
December 2019
P:\GIS_SanDiego01\SP0142_ASRAC_WCP_WOC\Figure Updates for NCP FS - October 2019\2019 NCP FS\Figure 7_NCP Remedy.mxd

APPENDIX A – Detailed Cost Summary

Table A1
Soil Vapor Extraction Operation and Maintenance Cost Summary
Vadose Zone Proposed Remedial Action Plan
North Canal Plume WQARF Site
Phoenix, Arizona
August 2020

Description	Quantity	Unit	Unit Cost	Subtotal
SVE Treatment System Capital Costs				
Soil vapor extraction wells	33	Each	$30,000	$990,000
VGAC system (two vessels, hoses)	3	Each	$20,000	$60,000
Treatment compound (foundation, fence, power drop, controls)	3	Each	$50,000	$150,000
Conveyance piping (trenchwork, piping)	300	Linear Feet	$100	$30,000
Professional services (design, engineering, permitting, etc.)	-	-	25%	$307,500
Capital Costs Subtotal (Pre-Inflation)				***$1,538,000***
SVE System Annual Operation and Maintenance				
Treatment system operation and maintenance labor	750	Hour	$100	$75,000
Electric power (three 10-hp blowers)	264,000	kW-hr	$0.17	$44,900
VGAC media exchange (per vessel)	6	Each	$10,000	$60,000
Annual O&M Subtotal (Pre-Inflation)				***$180,000***
Total Annual Cost (With 3% Inflation per Year)				**Subtotal**
Year 1				$1,769,500
Year 2				$191,000
Year 3				$196,700
Year 4				$202,600
Year 5				$208,700
Total 5-Year SVE Costs (With 3% Inflation per Year)				***$2,569,000***

Notes and Assumptions:

VGAC is vapor-phase granular activated carbon
hp is horsepower
kW-hr is kilowatt-hour
O&M is operation and maintenance
Inflation Rate = 3% per year

Table A2
Monitored Natural Attenuation Cost Summary
Groundwater Proposed Remedial Action Plan
North Canal Plume WQARF Site
Phoenix, Arizona
December 2020

Groundwater MNA Monitoring (34 wells) and MNA Reporting	Subtotal
Year 1	$121,300
Year 2	$125,000
Year 3	$128,700
Year 4	$132,600
Year 5	$136,600
Year 6	$60,700
Year 7	$62,500
Year 8	$64,400
Year 9	$66,300
Year 10	$68,300
Year 11	$70,300
Year 12	$72,400
Year 13	$74,600
Year 14	$76,900
Year 15	$79,200
Year 16	$81,500
Year 17	$84,000
Year 18	$86,500
Year 19	$89,100
Year 20	$91,800
Year 21	$94,500
Year 22	$97,400
Year 23	$100,300
Year 24	$103,300
Year 25	$106,400
Year 26	$109,600
Year 27	$112,900
Year 28	$116,200
Year 29	$119,700
Year 30	$123,300
Total 30 Year MNA Costs (With 3% Inflation per Year)	***$2,856,000***

Notes and Assumptions:

MNA = Monitored Natural Attenuation
Inflation Rate = 3% per year
MNA Annual Monitoring Cost = $1,700/well (Years 1-5)
MNA Annual Monitoring Cost = $850/well (Years 6-30)
MNA Reporting Cost = $10,000/event

Table A3
Pump and Treat Contingency Cost Summary
Groundwater Proposed Remedial Action Plan
North Canal Plume WQARF Site
Phoenix, Arizona
December 2020

Description	Quantity	Unit	Unit Cost	Subtotal
P&T Treatment System Capital Costs (300 gpm per System)				
Shallow groundwater extraction wells (well & pump)	20	Each	$70,000	$1,400,000
LGAC system (two vessels, bag filter break tank, piping)	3	Lump Sum	$50,000	$150,000
IX system (three vessels, piping)	1	Lump Sum	$150,000	$150,000
Treatment compound no IX (foundation, fence, power drop, controls)	2	Lump Sum	$130,000	$260,000
Treatment compound with IX (foundation, fence, power drop, controls)	1	Lump Sum	$150,000	$150,000
Conveyance piping (trenchwork, piping)	3,000	Lineal Feet	$200	$600,000
Project management (design, engineering, permitting, etc.)	-	-	25%	$677,500
Capital Costs Subtotal (Pre-Inflation)				***$3,388,000***
P&T Treatment System Annual Operation, Maintenance, and Monitoring Costs (300 gpm per System)				
Treatment system operation and maintenance	900	Hour	$100	$90,000
P&T electric power (twenty 2-hp wells, three 1-hp transfer pumps)	562,000	kW-hr	$0.17	$95,500
LGAC media exchange (per vessel)	6	Each	$10,000	$60,000
IX media exchange (per vessel)	1	Each	$20,000	$20,000
Treatment system sampling (VOCs)	1	Lump Sum	$13,000	$13,000
Project management and reporting	1	Lump Sum	$75,000	$75,000
Annual OMM Subtotal (Pre-Inflation)				***$354,000***
Total Annual Cost (With 3% Inflation per Year)				**Subtotal**
Year 1				$3,854,300
Year 2				$375,600
Year 3				$386,800
Year 4				$398,400
Year 5				$410,400
Year 6				$422,700
Year 7				$435,400
Year 8				$448,400
Year 9				$461,900
Year 10				$475,700
Year 11				$490,000
Year 12				$504,700
Year 13				$519,900
Year 14				$535,500
Year 15				$551,500
Year 16				$568,100
Year 17				$585,100
Year 18				$602,700
Year 19				$620,700
Year 20				$639,400
Total 20 Year P&T Treatment Costs (With 3% Inflation per Year)				***$13,287,000***

Notes and Assumptions:

LGAC is liquid-phase granular activated carbon
P&T is pump and treat (i.e., groundwater extraction and treatment)
VOCs is volatile organic compounds
hp is horsepower
kW-hr is kilowatt-hour
OMM is operation, maintenance, and monitoring
IX is ion exchange.
Inflation Rate = 3% per year

Table A4
Wellhead Treatment Contingency Cost Summary
Groundwater Proposed Remedial Action Plan
North Canal Plume WQARF Site
Phoenix, Arizona
December 2020

Description	Quantity	Unit	Unit Cost	Subtotal
Wellhead Treatment Capital Costs				
Design				
COP Well: New well based on COP-157	1	Lump Sum	$113,000	$113,000
SRP Well: 9.5E-7.7N	1	Lump Sum	$760,000	$760,000
Project management (design, engineering, permitting, etc.)	-	-	25%	$220,000
Capital Costs Subtotal (Pre-Inflation)				***$1,093,000***
Wellhead Treatment Annual Operation, Maintenance, and Monitoring Costs				
LGAC Changeouts (one 18,000# vessel per event)				
COP Well: New well based on COP-157	1	Event	$22,000	$22,000
SRP Well: 9.5E-7.7N	1	Event	$66,000	$66,000
Treatment Sytem O&M				
COP Well: New well based on COP-157	1	Lump Sum	$75,000	$75,000
SRP Well: 9.5E-7.7N	1	Lump Sum	$100,000	$100,000
Project Management				
COP Well: New well based on COP-157	1	Year	$10,000	$10,000
SRP Well: 9.5E-7.7N	1	Year	$40,000	$40,000
Annual OMM Costs Subtotal (Pre-Inflation)				***$313,000***
Total Annual Cost (With 3% Inflation per Year)				**Subtotal**
Year 1				$1,448,200
Year 2				$332,100
Year 3				$342,000
Year 4				$352,300
Year 5				$362,900
Year 6				$373,700
Year 7				$385,000
Year 8				$396,500
Year 9				$408,400
Year 10				$420,600
Year 11				$433,300
Year 12				$446,300
Year 13				$459,700
Year 14				$473,400
Year 15				$487,600
Year 16				$502,300
Year 17				$517,300
Year 18				$532,900
Year 19				$548,800
Year 20				$565,300
Total 20 Year Wellhead Treatment Costs (With 3% Inflation per Year)				***$9,789,000***

Notes and Assumptions:

LGAC is liquid-phase granular activated carbon
OMM is operation, maintenance, and monitoring
SRP - Salt River Project
COP - City of Phoenix
Inflation Rate = 3% per year

Table A5
In-Situ Chemical Oxidation Contingency Cost Summary
Groundwater Proposed Remedial Action Plan
North Canal Plume WQARF Site
Phoenix, Arizona
December 2020

Description	Quantity	Unit	Unit Cost	Subtotal
ISCO Capital Costs				
Coordination, Design, and Bench Testing	3	Lump Sum	$60,000	$180,000
Injection and Monitoring Wells Installation	39	Each	$30,000	$1,170,000
Demobilization / Closeout	3	Lump Sum	$45,000	$135,000
Project management (design, engineering, permitting, etc.)	-	-	25%	$370,000
Capital Costs Subtotal (Pre-Inflation)				***$1,855,000***
ISCO Annual Costs (Year 1)				
ISCO Injections	6	Year	$65,000	$390,000
Post-Injection Monitoring	3	Year	$20,000	$60,000
Project Management and Reporting	3	Year	$40,000	$120,000
Annual Costs Subtotal (Pre-Inflation)				***$570,000***
ISCO Annual Costs (Year 2)				
Post-Injection Monitoring	3	Year	$20,000	$60,000
Project Management and Reporting	3	Year	$40,000	$120,000
Annual Costs Subtotal (Pre-Inflation)				***$180,000***
Total Annual Cost (With 3% Inflation per Year)				**Subtotal**
Year 1				$2,497,800
Year 2				$191,000
Total 2-Year ISCO Costs (With 3% Inflation per Year)				***$2,689,000***

Notes and Assumptions:

ISCO is in-situ chemical oxidation
OMM is operation, maintenance, and monitoring
Inflation Rate = 3% per year

Table A6
Groundwater Monitor Well Installation Contingency Cost Summary
Groundwater Proposed Remedial Action Plan
North Canal Plume WQARF Site
Phoenix, Arizona
December 2020

Description	Quantity	Unit	Unit Cost	Subtotal
Groundwater Monitor Well Installation Capital Costs				
Monitor well installation and oversight	3	Each	$40,000	$120,000
Project management (design, engineering, permitting, etc.)	-	-	25%	$30,000
Capital Costs Subtotal (Pre-Inflation)				***$150,000***
Total Annual Cost (With 3% Inflation per Year)				**Subtotal**
Year 1				$154,500
Year 2				$159,100
Year 3				$163,900
Year 4				$168,800
Year 5				$173,900
Total 5 Year Additional Monitor Well Installation Costs (With 3% Inflation per Year)				***$820,000***

Notes and Assumptions:

Inflation Rate = 3% per year