PROPOSED REMEDIAL ACTION PLAN

EAST CENTRAL PHOENIX – 32ND STREET AND INDIAN SCHOOL ROAD
WATER QUALITY ASSURANCE REVOLVING FUND SITE

PHOENIX, ARIZONA

August 27, 2020

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Acronyms

A.A.C.	Arizona Administrative Code
ADEQ	Arizona Department of Environmental Quality
A.R.S.	Arizona Revised Statute
AS	Air Sparge
AWQS	Aquifer Water Quality Standard
COC	Contaminant(s) of Concern
COP	City of Phoenix
DHC	Dehalococcoides
ERA	Early Response Action(s)
ECP	East Central Phoenix
ERD	Enhanced Reductive Dechlorination
FASA	Fairmount Avenue Study Area
FS	Feasibility Study
GETS	Groundwater Extraction and Treatment System
GPL	Groundwater Protection Level
GPM	Gallons per Minute
ISCO	In Situ Chemical Oxidation
MNA	Monitored Natural Attenuation
PCE	Tetrachloroethene
PRAP	Proposed Remedial Action Plan
RI	Remedial Investigation
RO	Remedial Objective(s)
ROD	Record of Decision
RSRL	Residential Soil Remediation Level
SRP	Salt River Project
SSVISL	Site-Specific Vapor Intrusion Screening Level
SVE	Soil Vapor Extraction
TCE	Trichloroethene
VC	Vinyl Chloride
VOC	Volatile Organic Compound(s)
WQARF	Water Quality Assurance Revolving Fund
cis-1,2-DCE	cis-1,2-Dichloroethene
trans-1,2-DCE	trans-1,2-dichloroethene
µg/L	Micrograms per Liter
µg/m^3	Micrograms per Cubic Meter

1.0 INTRODUCTION

The Arizona Department of Environmental Quality (ADEQ) prepared this Proposed Remedial Action Plan (PRAP) for the East Central Phoenix (ECP) 32nd Street and Indian School Water Quality Assurance Revolving Fund (WQARF) Site (Site) located in the City of Phoenix (COP), 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, East Central Phoenix 32nd Street and Indian School Road Water Quality Assurance Revolving Fund Site, Phoenix, Arizona (Geosyntec, 2019a)*
>
> *Feasibility Study, East Central Phoenix 32nd Street and Indian School Road Water Quality Assurance Revolving Fund Site, Phoenix, Arizona (Geosyntec, 2019b)*

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 on 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 where 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.
- 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 bound by East Indian School Road to north, East McDowell Road to the south, North 32nd Street to the east, and North 12th Street to the west (Figure 1). The Site includes the area that encompasses the current groundwater plume impacted with volatile organic compounds (VOCs) above Arizona Aquifer Water Quality Standards (AWQS).

3.0 REMEDIAL INVESTIGATION RESULTS

This section presents a summary of the RI conducted at the Site as presented in the following document:

> *Remedial Investigation Report, East Central Phoenix 32nd Street and Indian School Road Water Quality Assurance Revolving Fund Site, Phoenix, Arizona (Geosyntec, 2019a)*

3.1 Site History and Description

The Site is located in an area of mixed commercial and residential development. The Site has historically contained dry-cleaning and automobile service station facilities since the early 1960s. After several years of investigations, tetrachloroethene (PCE) source areas that resulted in chlorinated VOC impacts to soil and groundwater were determined to be located at two dry-cleaning facilities (the Former Maroney's Cleaners & Laundry [Former Maroney's] and the Former Viking Cleaners). These facilities historically operated at locations near the intersection of 32nd Street and Indian School Road (Figure 1).

3.2 Source of Contamination

Data collected during the RI indicate that contaminant releases occurred in soil and groundwater at the site. These data identified the likely sources of contamination as the Former Maroney's, and the Former Viking Cleaners.

3.3 Contaminants of Concern

The contaminants of concern (COCs) include PCE and PCE daughter products trichloroethene (TCE), cis-1,2-dichloroethene (cis-1,2-DCE), trans-1,2-dichloroethene (trans-1,2-DCE), and vinyl chloride [VC]). Site COCs were identified due to the nature of the potential releases from the two dry-cleaning establishments, their historical presence, and/or their potential to be generated through biological transformations.

3.3.1 Soil and Soil Vapor

The COCs in soil at the Site include PCE and TCE. PCE has been detected in soil samples above the Arizona Residential Soil Remediation Levels (RSRLs) and Groundwater Protection Levels (GPLs). TCE was not detected in soil samples above applicable RSRLs or GPLs; however, TCE was included as a COC due to the presence of the constituent in soil vapor samples collected at the Site.

Soil vapor concentrations at the Site were compared to site-specific vapor intrusion screening levels (SSVISLs), which were developed as part of a risk assessment that included scenarios for both residential and commercial/industrial use. These SSVISLs were referred to as Health Protective Concentrations in the FS Report. With the absence of regulatory cleanup standards for soil vapor contamination, the SSVISLs are considered cleanup goals for soil vapor contamination at the Site. Concentrations of PCE and TCE detected in soil vapor samples collected at the Site have exceeded the SSVISLs.

Soil Vapor Extraction (SVE) activities were performed at both the Former Maroney's and Former Viking Cleaner's facilities to treat COC concentrations in soil and soil vapor. Soil vapor rebound analysis conducted following cessation of SVE treatment activities at each facility indicted the following: 1) soil vapor concentrations for PCE and TCE were below their respective RSRL and GPL soil vapor equivalent concentrations at both the Former Maroney's and Former Viking Cleaners, 2) soil vapor PCE and TCE concentrations at the Former Viking Cleaners were below residential and industrial SSVISLs, and 3) soil vapor PCE concentrations in the shallow vadose zone at the Former Maroney's rebounded to concentrations above residential SSVISLs within localized areas at the property (Geosyntec, 2019b).

3.3.2 Groundwater

The COCs in the groundwater at the Site include PCE, TCE, cis-1,2-DCE, trans-1,2-DCE, and VC. Of these COCs, PCE, TCE, and cis-1,2-DCE have been detected in groundwater above their respective AWQS. The other COCs were identified due to their potential to be generated through biological transformations.

3.4 Nature and Extent of Contamination

Several investigative activities were conducted as part of the RI to determine the nature and extent of contamination at the Site. The nature and extent of contamination at the Site is primarily defined by the COC impacts in soil and groundwater, which is discussed in more detail below.

3.4.1 Vadose Zone

Soil and soil vapor COC impacts, primarily from PCE, have been observed throughout the vadose zone at both the Former Maroney's and Former Viking Cleaner's. Several years of SVE operation have reduced these impacts to below RSRLs, GPLs, and SSVISLs. Soil vapor rebound monitoring was conducted following cessation of SVE activities. Monitoring conducted at the Former Maroney's in April and June 2019 indicated that PCE and TCE concentrations had rebounded

above Site clean-up goals (residential scenario SSVISLs) in localized areas within the shallow vadose zone (Geosyntec, 2019c). PCE soil vapor concentrations exceeding the SSVISL of 11,000 micrograms per cubic meter (µg/m^3) ranged from 12,300 µg/m^3 to 43,500 µg/m^3. TCE soil vapor concentrations exceeding the SSVISL of 601 µg/m^3 ranged from 596 µg/m^3 to 1,150 µg/m^3. Figure 2 presents the localized areas where exceedances were observed during the 2019 soil vapor rebound evaluation. No soil vapor exceedances were observed during rebound monitoring at the Former Viking Cleaners.

3.4.2 Groundwater

The predominant COC impacting groundwater at the Site is PCE. The lateral distribution of the PCE in groundwater defines the extent of VOC contamination at the Site. As reported in the 2019 Geosyntec RI Report, there is an overlap of the PCE plume attributed to the Site (32nd and Indian School Road WQARF site), and the PCE plume associated with the ECP 24th Street and Grand Canal WQARF site. The two plumes, however, were identified to be largely discrete, separate plumes, travelling at different vertical elevations in the areas where overlapping is apparent. In these areas, the PCE impacts associated with the Site are deeper than those attributed to the 24th Street and Grand Canal WQARF site.

The estimated extent of PCE in groundwater at concentrations exceeding the AWQS (5 micrograms per liter [µg/L]) is presented on Figure 3. Groundwater monitoring conducted in April 2020 (post-RI Report) indicated the presence of PCE at concentrations ranging from 3.28 µg/L to 57.8 µg/L (Geosyntec, 2020). No other COCs are present in groundwater at concentrations exceeding the AWQS.

While impacts from the Former Maroney's and Former Viking Cleaners and the 24th Street and Grand Canal WQARF site are thought to remain discrete and separated along the majority of their downgradient flow path, recent data from a newly installed monitoring well (24MW-21) suggests that it is possible, that near the distal extent of both plumes, there may be some degree of comingling occurring as the groundwater impacts continue to naturally disperse along their vertically descending flowpath.

3.5 Early Response Action

The following ERAs were performed at the Site to remove contamination at the Site and/or to mitigate the exposure of the contamination to potential receptors (Geosyntec, 2019a):

- **Former Viking Cleaners - 2004 to 2008**: From 2004 to 2007, an air sparge (AS)/SVE system was operational at the Former Viking Cleaners to reduce VOC concentrations in soil vapor.

Approximately 3,000 pounds of PCE were estimated to have been removed from the subsurface between 2004 and 2007. The AS/SVE system was removed from the property in 2008.

- **Former Viking Cleaners - 2011 to 2018**: In 2011, an SVE pilot study was conducted. A new system was installed in 2014. The SVE system operated intermittently between 2014 and 2018 with approximately 182 pounds of VOCs having been removed from the subsurface. The SVE system was removed from the Former Viking's Cleaner in 2018; however, the system infrastructure (i.e. conveyance piping, power supply, etc.) remained in place.

- **Former Maroney's Facility - 2011 to Present**: In 2011, an SVE system was installed and a pilot study was conducted at the Former Maroney's facility. The system was commissioned in June 2013 and operated intermittently between 2013 and 2017. Since start-up, the SVE system removed approximately 115 pounds of VOCs. Based on concentrations observed during rebound sampling, four new SVE wells and three sub-slab soil vapor probes were installed to enhance removal and the SVE system was restarted for a one-month operation period in April 2020.

3.6 Risk Evaluation Summary

Multiple investigations have been conducted at the Site since 1984. The data from these investigations were used to evaluate the risks that the soil, soil vapor, groundwater, and surface water pose to the public and the environment. The risk evaluations indicated there is no current human health risk from groundwater or surface water; however, potential future risks may be associated with exposure to groundwater contamination should the deeper water supply wells present and adjacent to the Site be utilized in the future for water supply.

While the pathway for direct soil contact is incomplete (i.e. no current human health risk from dermal contact or ingestion), the transport of vapor-phase COCs present in soil vapor to indoor air could result in exposure to human health risk via inhalation.

Soil vapor rebound analysis conducted following cessation of SVE treatment activities at the Former Maroney's and Former Viking Cleaner's indicated the following: 1) COC concentrations at the Former Viking Cleaner's remained below SSVISLs. Thus, there is no human health risk from vapor intrusion to indoor air; and 2) COC concentrations in the shallow vadose zone at the Former Maroney's had rebounded to concentrations above the SSVISLs within localized areas at the property (Geosyntec, 2019b).

3.7 Remedial Objectives

The results of the Remedial Investigation, 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, including soil and groundwater (e.g. potable water and irrigation water).

The RO for land use (soil) at the Site is as follows:

> Protect against the loss or impairment of land threatened by contaminants of concern at the 32nd Street and Indian School Road WQARF site and restore land that has been impaired by contaminants of concern at the 32nd Street and Indian School Road WQARF 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 contaminants of concern at the 32nd and Indian School Road WQARF 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 contaminants of the concern at the 32nd and Indian School Road 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 contaminants of concern at the 32nd and Indian School Road WQARF site. Where protection cannot be achieved in a reasonable, necessary, or cost-effective manner; restore, replace, or otherwise provide for potable water that is lost or impaired by contaminants of concern at the 32nd and Indian School Road WQARF 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 use at the Site is irrigation from Salt River Project (SRP) canals. The water in the SRP canals is supplemented with groundwater pumped from SRP wells at the Site. The future use of the surface water in the SRP canals includes irrigation and drinking water. The

current and future source of the water in the SRP canals originating from the Site is groundwater pumped by SRP wells. Thus, ROs for surface water use are not needed because the ROs for groundwater use for the water pumped into the canals are applicable.

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:

> *Feasibility Study, East Central Phoenix, 32nd Street and Indian School Road, Water Quality Assurance Revolving Fund Site, Phoenix Arizona (Geosyntec, 2019b)*

4.1 Identification and Screening of Remedial Technologies

The FS identified several remedial technologies for addressing the soil and groundwater contamination at Site including No Action, Institutional Controls, Groundwater Extraction and Treatment (GETS), *In Situ* Chemical Oxidation (ISCO), *In Situ* Chemical Reduction, Enhanced Reductive Dechlorination (ERD), AS, and 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, constructability, health and safety concerns, flexibility/expandability, operational hazards, and cost-effectiveness. Based on the contaminant treatment screening results ISCO, ERD, MNA, and GETS were retained for consideration as part of the reference remedy and alternative remedies.

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
- 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 (Former Maroney's)** – Resumed operation of the SVE system would provide source control through the removal of VOC mass in the vadose zone at the source area within the Former Maroney's facility. This activity will mitigate the remaining residual VOCs in the vadose zone below the onsite structure, mitigating the potential for vapor intrusion.

- **ISCO (Ozone Sparge)** – ISCO Ozone Sparge would remediate the groundwater contamination present at the Site by treating the highest VOC concentrations in the vicinity of the Fairmount Avenue Study Area (FASA) and along the Grand Canal, cut off the plume, and inhibit migration of PCE further downgradient. The FS outlined a staged approach for implementing the ISCO Ozone Sparge remedy. Stage 1 included ISCO Ozone Sparge within the FASA. Stage 2 included ISCO Ozone Sparge along the Grand Canal.

- **MNA** – MNA would include groundwater monitoring and sampling to monitor the natural degradation of the groundwater contamination at the Site. MNA is appropriate for the peripheral portions of the plume where the COCs are anticipated to be attenuated by natural processes. Five additional performance monitoring wells would be installed to support MNA.

- **SVE (Former Maroney's - Contingency)** – One additional year of SVE operation would be implemented if post-SVE rebound sampling indicated that the Site cleanup goals were not achieved at the Former Maroney's.

- **SVE (FASA - Contingency)** – The ISCO Ozone Sparge may cause elevated ozone concentrations in the vadose zone. If this occurs, SVE would be implemented to remove the elevated ozone concentrations in the vadose zone beneath residences and businesses within the FASA.

- **ISCO (Hydrogen Peroxide - Contingency)** – The simultaneous injection of hydrogen peroxide and ozone into the ozone sparging wells as a mist will be implemented if the removal of COCs from the subsurface needs to be accelerated.

- **ISCO (Ozone Sparge - Contingency)** – If persistent elevated PCE concentrations are measured further downgradient from the FASA area, then ISCO treatment could be implemented in an area between the FASA and Grand Canal.

- **ISCO (Ozone Sparge - Contingency)** – The installation of ozone sparge injection wells and the operation of a mobile ozone sparge system could be implemented in areas surrounding SRP, COP, or other production wells to treat impacted groundwater if PCE concentrations are greater than the AWQS in these areas when the wells are needed to produce drinking water.

- **Wellhead Treatment (Contingency)** - Wellhead treatment could be implemented to treat impacted groundwater that is withdrawn from SRP, COP, or other production wells if COC concentrations exceed the AWQS in these wells when the wells are needed to produce drinking water.

4.2.2 Less Aggressive Remedy

The Less Aggressive Remedy includes the following:

- **MNA** – MNA would include vapor monitoring of the vadose zone and groundwater monitoring of the dissolved groundwater plume. Five additional performance monitoring wells would be installed to support MNA

- **SVE (Former Maroney's - Contingency)** – SVE could be implemented utilizing the existing infrastructure if monitoring conducted during vadose zone MNA indicated that there may be a significant occupancy concern related to indoor air.

- **ISCO (Ozone Sparge - Contingency)** – The installation of ozone sparge injection wells and the operation of a mobile ozone sparge system could be implemented in areas surrounding SRP, COP, or other production wells to treat impacted groundwater if PCE concentrations are greater than the AWQS in these areas when the wells are needed to produce drinking water.

- **Wellhead Treatment (Contingency)** - Wellhead treatment could be implemented to treat impacted groundwater that is withdrawn from SRP, COP, or other production wells if COC concentrations exceed the AWQS in these wells when the wells are needed to produce drinking water.

4.2.3 More Aggressive Remedy

The More Aggressive Remedy includes all the remedial technologies and contingencies proposed for the Reference Remedy along with the installation of two additional SVE wells.

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 Site are presented below in Table 1.

Table 1 - Summary of Remedial Alternatives				
Alternative	**Practicability**	**Risk**	**Cost***	**Benefit**
Reference Remedy	• Highly Feasible • Moderately Reliable • Moderately Effective • Potential Duration of <30 Years	• Moderately Protective from Risk	$9.6M	• Immediate decrease in PCE at the FASA • Dilute downgradient plume • Continued monitoring of the PCE plume
Less Aggressive Remedy	• Highly Feasible • Potentially Reliable • Potentially Effective • Potential Duration of >30 Years	• Likely protective from Risk	$6.1M	• Continued monitoring of the plume
More Aggressive Remedy	• Highly Feasible • Moderately Reliable • Least Implementable • Highly Effective • Potential Duration of <30 Years	• Moderately Protective from Risk.	$9.9M	• Immediate decrease in PCE at the FASA • Dilute downgradient plume • Continued monitoring of the PCE plume • Expected decrease in timing required for remediation
Notes: < - Less Than $ - United States Dollar * - Includes costs associated with the implementation of contingencies.		> - Greater Than M - Million		

4.4 Proposed Remedy

The remedy proposed by the FS for the Site was the Reference Remedy. The Reference Remedy was proposed because it was found to have the best combination of effectiveness, protectiveness, benefits, and cost-effectiveness. Furthermore, the Reference Remedy will achieve the ROs, it meets the remedial action criteria pursuant to A.R.S. §49-282.06, and it is consistent with current and future land and water use.

5.0 PROPOSED REMEDY AND ESTIMATED COST

The Reference Remedy proposed in the FS is the remedial alternative proposed in the PRAP, with the following exceptions: 1) SVE treatment will follow an intermittent operation schedule rather than one full year of operation, 2) ERD technology, rather than ISCO treatment, will be implemented to remediate groundwater in the FASA, 3) ISCO treatment, identified as Phase 2 of the groundwater remedy in the FS, will be carried over as a contingency, and 4) ISCO ozone sparge production well protection was not carried over from the FS as a contingency. This section presents a description of the Proposed Remedy and the associated estimated costs. The following paragraphs discuss the decision to implement ERD as a primary element of the Proposed Remedy, with the subsequent sections providing remedy descriptions (including contingencies) and estimated costs.

ERD technology was screened and retained as a remedial alternative in the FS; however, the technology was not included as a component to the proposed remedial alternatives (Reference, Less Aggressive, or More Aggressive Remedy). ERD was identified in the FS as a remedial technology capable of achieving the ROs and effective for targeted treatment in areas of high concentration, which is the objective of implementation in the FASA. The decision to propose ERD as a primary component in the Proposed Remedy, as opposed to the ISCO technology proposed in the FS, was based on the equipment and infrastructure required for the Ozone Sparge systems. ERD technology is more readily implemented as the available space for equipment in the FASA is limited and ERD technology requires minimal infrastructure.

An ERD pilot study is currently being performed within the FASA. Five new injections wells and one performance monitoring well were installed as part of the pilot study. This infrastructure is currently believed to be sufficient for ERD application as part of the Proposed Remedy at the Site (i.e. additional injection wells will not be required). The pilot study design parameters for biostimulation and bioaugmentation were to inject a mass of soluble substrate, estimated at 10,000 pounds, and approximately 38 liters of microbial culture (dehalococcoides [DHC] with an initial census count of 10^{11} DHC bacteria/L). Biostimulation and bioaugmentaion were performed in April and May 2020, respectively, and are described further in Section 5.1.2. While the pilot study is early in the treatment process, reduction in COCs have been observed. Routine groundwater sampling will assist with identifying optimization measures to accelerate dechlorination reactions. Figure 5 presents the Proposed Remedy layout for ERD application in the FASA. While ERD was not proposed in the FS as a component to the Reference Remedy or alternative remedies, the technology is a proven technology and capable of meeting the requirements of A.R.S. §49-282.06.

5.1 Remedy Description

The Proposed Remedy includes a combination of remedial technologies for remediating the soil and groundwater at the Site. Each of these remedial technologies is described in the following subsections.

5.1.1 Proposed Remedial Action - Soil

SVE

Resumed operation of the SVE system will remediate the remaining residual levels of PCE and TCE in the shallow vadose zone below the Former Maroney's structure. SVE treatment will follow an intermittent operation schedule for a duration of one year. It is assumed that one year will be sufficient to achieve the SSVISLs based on observations from historical SVE operations and results from recent soil vapor monitoring, while also considering that additional SVE infrastructure (four new SVE wells) were recently installed, which should further enhance removal of residual VOC mass from the subsurface. Soil vapor sampling from select onsite soil vapor probes and SVE wells will be conducted following shutdown of SVE operation to assess the residual presence of COCs in localized areas. Sampling will be conducted at the time of system shutdown, then again after 90 days and 180 days to assess rebound. Should concentrations remain below the residential SSVISLs (11,000 $\mu g/m^3$), remedial efforts will be considered complete and SVE operation will be terminated. If concentrations rebound above the SSVISLs during either the 90-day or 180-day sampling events, the system will be restarted for an intermittent operation period. This general protocol will be continued until COCs remain below the SSVISL as demonstrated by the rebound assessment. The use of the SSVISL developed for the residential scenario as the clean-up goal is protective of future property use. Figure 4 presents the layout of the SVE infrastructure at the Former Maroney's.

5.1.2 Proposed Remedial Action - Groundwater

ERD

ERD involves stimulation or augmentation of naturally occurring microbial populations to expedite the anaerobic biodegradation (reductive dechlorination) of VOCs through injections of electron donors (e.g., sodium lactate, corn syrup, molasses, or emulsified vegetable oil). In the presence of sufficient electron donors, natural microbial activity will produce the required anaerobic conditions conducive to reductive dechlorination. The complete reductive dechlorination process follows the sequential pathway listed below:

PCE → TCE → 1,2-DCE → VC → Ethene → Ethane

The ERD process is implemented in two stages to create the required conditions for reductive dechlorination. The two stages of ERD implementation are as follows: 1) injection of substrate (carbon source) for biostimulation to drive the redox conditions lower and to supply a fermentation source to create dissolved hydrogen, and 2) injection of a specific microbial mixture (dechlorinating bacteria) into the groundwater to aid in the dechlorination processes.

Different compounds are available as a biostimulation amendment for ERD application. Based on the existing site conditions and characteristics, it is expected that a soluble substrate will initially be preferred as it will spread a greater distance and dissolve rapidly, allowing for quicker fermentation reactions. More rapid fermentation reactions are necessary to overcome background reactants such dissolved oxygen, sulfate, and nitrate prior to the start of dechlorination. This biostimulation amendment will be evaluated over the life-cycle of the remedy and may be changed based on performance needs. Biostimulation (substrate injection) would be implemented on a frequency estimated at three times a year (approximately every four months) to maintain the proper reducing conditions and provide excess substrate for fermentation.

Bio-augmentation is required when the native population of microbial cultures is not sufficient to complete the dechlorination process, which is evidenced at the Site by the aerobic conditions of groundwater and the lack of observed degradation daughter products. Bio-augmentation (dechlorinating bacteria injection) will be implemented using a commercial microbial culture once reducing conditions have been achieved through biostimulation. It is assumed that bio-augmentation will be required once per year during ERD implementation. The frequency of bio-augmentation will be evaluated over the life-cycle of the remedy and may be changed based on performance needs.

ERD is scheduled to be conducted at the Site for a period of up to four years. The proposed duration for ERD is based upon the site conditions and experience implementing ERD in other similar areas with similar groundwater conditions (e.g. pH, DO, ORP). Typical ERD treatment may take 6 months to 1 year to establish reducing conditions where reductive dechlorination can occur. For this Site, in particular, it has been estimated that three to fours years of treatment will substantially reduce the PCE flux in the area where ERD is implemented. The ERD performance objective is to control or eliminate the VOC flux in the plume area treated. When COC concentrations in all wells in the nearby area (downgradient areas) have been below the AWQS for one to two years the performance objective for ERD treatment will have been achieved.

The effectiveness of the ERD treatment will be monitored in several ways. Routine groundwater will be conducted at the new injection and performance wells on a quarterly basis (initially) to

assess if dechlorination is occuring. Fix-based laboratory analysis will include VOC analysis for all samples. In addition, fix-based laboratory analysis of natural attenuation indicators such as inorganics (sulfite/sulfate, nitrite/nitrate, and chloride), dissolved gases, and total organic carbon will be performed at up to three wells (two injection wells and the performance well). The monitoring will also include bacterial census counts for specific dechlorinating bacteria. In general, the effectiveness will be determined by reduction of COCs and a thriving dechlorination bacteria population. ERD effectiveness will also take into account the results of MNA efforts. Monitoring may be shifted to semiannual monitoring if conditions warrant.

MNA

MNA is a remedial measure that involves routine groundwater sampling and analysis to monitor the results of one or more naturally occurring physical, chemical, or biological 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, adsorption, volatilization, precipitation, and biological degradation of the contaminants in the groundwater.

MNA will consist of routine groundwater monitoring and sampling to monitor groundwater contamination at the Site. The program will include semi-annual groundwater monitoring of 27 existing monitor wells and semi-annual reporting. Groundwater samples will be monitored in the field for water quality parameters temperature, conductivity, dissolved oxygen, pH, oxidative reduction potential, and turbidity. Fix-based laboratory analysis will include VOC analysis for all samples. In addition, fix-based laboratory analysis of natural attenuation indicators such as inorganics (sulfite/sulfate, nitrite/nitrate, and chloride), dissolved gases, and total organic carbon will be performed at up to three wells during each monitoring event to further evaluate the effectiveness of MNA. Up to four additional performance monitor wells will be installed and subsequently sampled as part of the MNA program. Concentration trends will also be evaluated on an annual basis at select wells using Mann-Kendall (or similar) to aid in decision making regarding MNA optimization. The groundwater monitoring data will be used to evaluate plume migration, plume stability, and natural attenuation of the plume. The data will also be used to trigger appropriate contingency actions to manage risk associated with the groundwater plume migration (e.g. ozone sparge treatment along the Grand Canal).

The MNA program will be conducted at the Site for a period of at least 10 years (four years simultaneous to the ERD and six years post-ERD). The ERD remedy, noted above, is intended to treat plume areas with PCE concentration at 20 ug/L and higher. Natural biodegradation (MNA) will be implemented to treat the larger plume area (at a slower rate) with concentrations less

than 20 ug/L. This corresponds with a 75% reduction in PCE concentrations through MNA over a 10 year period which is equivalent to a degradation half-life (T ½) of just under 5 year. This proposed duration for MNA implementation is based upon other WQARF sites in the Phoenix area where a degradation half-life (solely through MNA) have been estimated at under 5 years.

The actual duration will be based on the achievement of the RO for groundwater (i.e. reduction of COC concentrations to below the respective AWQS). The number of wells to be monitored and the frequency of monitoring will be adjusted over time in response to changing groundwater conditions. MNA will be terminated based upon results of groundwater monitoring. One year of quarterly monitoring with COCs remaining below the respective AWQS will support the conclusion of MNA activities.

5.1.3 Proposed Contingencies

SVE – Continued Operation

If COC concentrations continue to exceed the SSVISL at the Site following one year of operation, then the SVE system operation could be extended for up to one additional year. The duration of the SVE operation period will be determined based on the results of the rebound assessment.

ISCO – Ozone Sparge Along Grand Canal

The ISCO ozone treatment system along the Grand Canal, which was included as part of the reference remedy in the FS, will be carried over as a contingency to the Proposed Remedy presented in the PRAP. Should data indicate that ISCO Ozone Sparge in this area is warranted, an ozone treatment system can be installed to accelerate remediation. The ozone sparge system will be configured to provide groundwater treatment to a series of 11 injection wells, as described in the FS and shown on Figure 6. This contingency will be considered if after three years of MNA, the concentrations in this vicinity do not show a downward trend per the Mann-Kendall analysis. The Ozone Sparge system would be operated for up to three years.

ISCO – Hydrogen Peroxide Injection Along Grand Canal

Hydrogen peroxide can be introduced simultaneously to ozone during the implementation of ISCO Ozone Sparge along the Grand Canal if the removal of COCs from the subsurface needs to be accelerated. This technology is contingent upon the implementation of ozone sparge treatment along the Grand Canal. Hydrogen peroxide injections would be implemented for up to one year during ozone sparge activities.

MNA – Continued Monitoring

If COC concentrations continue to exceed the AWQS at the Site following 10 years of monitoring, then the MNA program could be extended for up to 10 additional years (total of up to 20 years of MNA). The duration of the MNA program will be determined based on results of periodic site reviews.

SRP Wellhead Treatment

Wellhead treatment will be implemented if SRP well 17E-8N is impacted with groundwater contamination associated with the Site. Wellhead treatment will consist of adding LGAC treatment to a production well when COC concentrations extracted from the well exceed the AWQS and the groundwater pumped from the well will be used for drinking water. The cost of installing wellhead treatment at a production well is well specific and would be variable depending on the well location, well production rate, and the timing of bringing the well online. This contingency assumes that one production well pumping at a production rate of 2,000 gallons per minute (gpm) will need wellhead treatment for a period of up to 10 years. Multiple factors, which include, but are not limited, to groundwater conditions, production capacity, and wellhead treatment design will be discussed with with SRP prior to implementing this contingency.

COP Wellhead Treatment

Wellhead treatment will be implemented if the COP Coronado Park well is impacted with groundwater contamination associated with the Site. Wellhead treatment will consist of adding LGAC treatment to a production well when COC concentrations extracted from the well exceed the AWQS and the groundwater pumped from the well will be used for drinking water. The cost of installing wellhead treatment at a production well is well specific and would be variable depending on the well location, well production rate, and the timing of bringing the well online. This contingency assumes that one production well pumping at a production rate of 2,000 gpm will need wellhead treatment for a period of up to 10 years. Multiple factors, which include, but are not limited, to groundwater conditions, production capacity, and wellhead treatment design will be discussed with with COP prior to implementing this contingency.

ISCO – Ozone Sparge Production Well Protection

This contingency was proposed in the FS; however, was not carried over as a contingency in the PRAP.

5.1.4 Performance Monitoring, and Periodic Reviews

Performance monitoring and periodic reviews will be used to judge the effectiveness and adequacy of the implemented remedies. Monitoring will include the following:

- **Vadose Zone Monitoring** – Soil vapor monitoring will be conducted to assess the residual levels of COCs present in the vadose zone following shutdown of the SVE system. Soil vapor samples will be collected from four SVE wells, five soil vapor probes, and three sub-slab soil vapor probes at the Former Maroney's facility. Sampling will be collected immediately following shut-down and again at 90-days and 180 days. Should COC concentrations remain below the residential SSVISLs (11,000 $\mu g/m^3$) after both the 90-day and 180-day evaluation periods, SVE operation will be complete.

- **Groundwater Performance Monitoring** – Groundwater monitoring will be conducted to evaluate the remedial effectiveness of ERD and MNA. The performance monitoring will be conducted on a semi-annual frequency for up to 10 years (four years simultaneous to the ERD and six years post-ERD) at up to 31 wells (27 existing wells and up to 4 performance monitoring wells) during the implementation of the remedy.

- **Periodic Reviews** - Periodic reviews of remedial progress will be conducted as necessary to determine the effectiveness of the remedy in achieving the ROs. These reviews will be conducted, at a minimum, every five years. The first review will occur after the first three years of remedy implementation.

5.2 Estimated Cost

The estimated cost of the Proposed Remedy, without contingencies, is $2.9 million. The estimated cost with contingencies is $15.3 million. A summary of the costs associated with the remedy is presented in Table 2 below.

Table 2 - Summary of Costs for Proposed Remedy		
Remedial Technology	**Appendix A**	**Cost**
Proposed Remedy		
SVE	Table A1	$269,000
ERD	Table A2	$608,000
MNA	Table A3	$2,070,000
	SUBTOTAL	**$2,947,000**
Contingencies		
SVE - Extended Treatment (Additional year)	Table A4	$64,000
MNA – Extended Monitoring (Additional 10 years)	Table A5	$1,672,000
ISCO Ozone Sparge Along Grand Canal	Table A6	$2,876,000
ISCO Hydrogen Peroxide Injection Along Grand Canal	Table A7	$166,000
Wellhead Treatment – SRP Well 17E-8N	Table A8	$3,799,000
Wellhead Treatment – COP Coronado Park Well	Table A9	$3,799,000
	SUBTOTAL	**$12,376,000**
	TOTAL	**$15,323,000**
Notes: Costs assume 3% annual inflation rate		

Detailed cost breakdowns are presented in Tables A1 through A9 of Appendix A.

5.3 Duration

The overall duration of the Proposed Remedy is up to 10 years. The duration is the estimated number of years required for the primary elements of the Proposed Remedy to achieve the ROs. If periodic Site reviews indicate additional time is be needed to achieve the ROs, contingencies for the Proposed Remedy could be implemented.

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 Remedy includes 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 are currently no unmitigated human health risks associated with the contamination at the Site and the components of the Proposed Remedy will be protective of the public health and the environment.

Each component of the Proposed Remedy and contingencies 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 this remedy is low and all known exposure pathways have been addressed. Over time, the remedial actions will reduce the concentrations and the volume of contaminated soil and groundwater at the Site. Environmental sampling and groundwater monitoring are included to verify that the remedy is protective of public health and the environment during and after remedy implementation. The combined components of the Proposed Remedy are consistent and compatible with current and anticipated future land and resource use. Upon implementation, this remedy is considered to have a positive impact in terms of enhancement of future land uses and impacts on the local economy.

6.2 Achievement of Remedial Objectives

Per A.C.C. R18-16-408(B)(3), the Proposed Remedy must achieve each of the ROs established by ADEQ for the Site as presented in this PRAP.

The Proposed Remedy for groundwater will achieve ROs for groundwater use by treating the source of contamination with ERD and MNA to remediate the groundwater plume. The Proposed Remedy will clean up the groundwater to levels that are less than the AWQS. Environmental and performance monitoring will be used to confirm the groundwater ROs are being met.

The Proposed Remedy for soil will achieve ROs for land use by treating the remaining residual VOCs present in the shallow vadoze zone to concentrations below applicable remediation and screening levels.

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 Remedy and contingencies for the Site meet the requirements of A.R.S. §49-282.06. The Proposed Remedy is 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 remedies will allow for the maximum beneficial use of the waters of the State, protect the groundwater supply for future use, and ensure 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 Remedy and contingencies provide the best balance of tradeoffs among the other alternatives with respect to the comparison criteria. ADEQ expects the Proposed Remedy 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 Remedy at the Site include the following:

- **The duration of time required to remediate the groundwater at the Site.** The estimated duration for remedial efforts to achieve ROs is based on professional judgement and data available at the time of the PRAP.

6.8 Public Comment Period

The PRAP will be issued for a 90-day public comment period. A Community Advisory Board 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: Mikel Morales, Project Manager
1110 West Washington Street
Phoenix, Arizona 85007
Email: Morales.Mikel@azdeq.gov

7.0 REFERENCES

Geosyntec, 2017. Technical Memorandum: Additional Soil Vapor Extraction Well Installation, Maroney's Cleaners Facility, Phoenix, Arizona, June 28

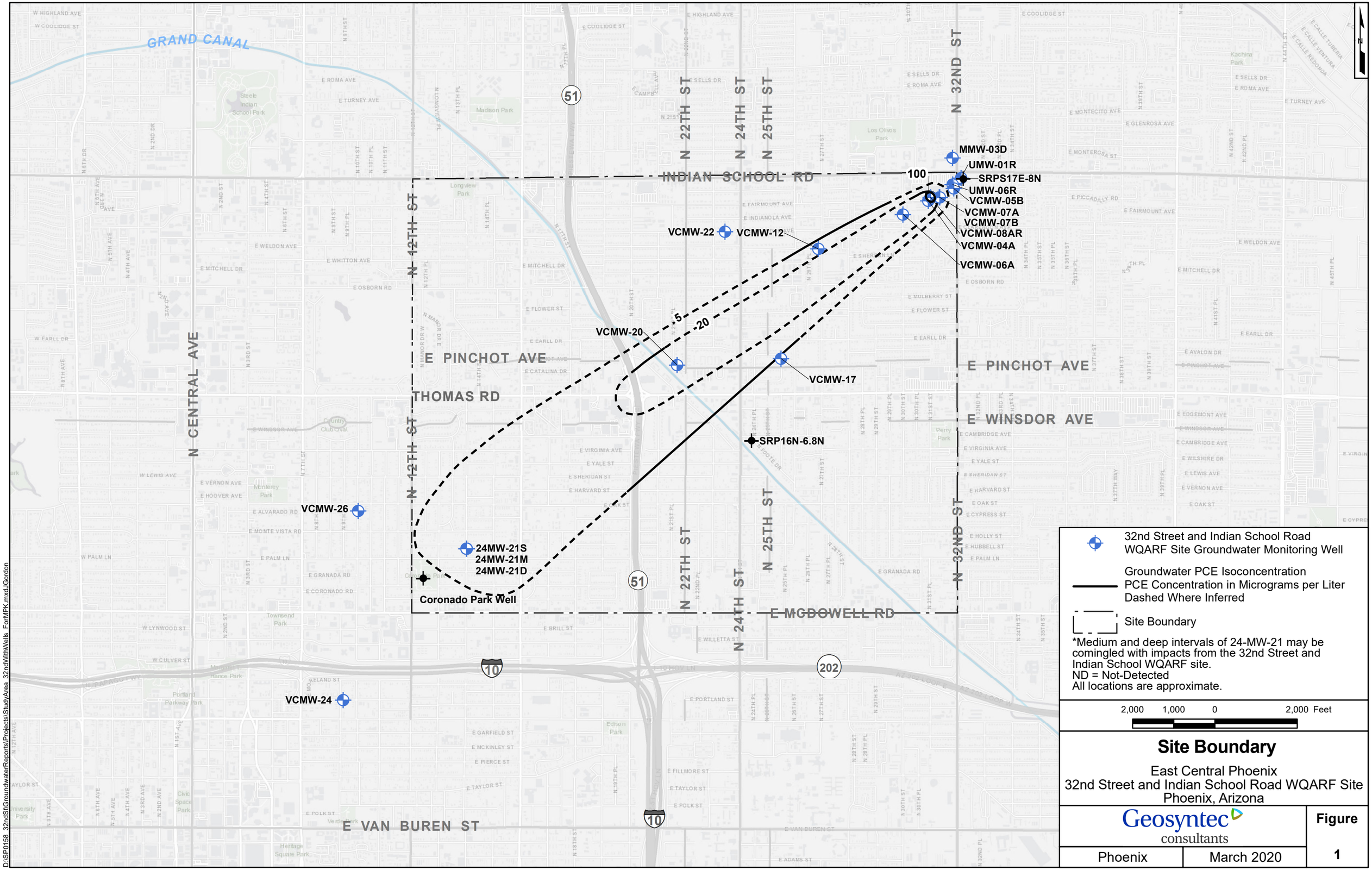
Geosyntec, 2019a. Remedial Investigation Report, ECP 32nd Street and Indian School Road WQARF Site, Phoenix, Arizona. June.

Geosyntec, 2019b. Feasibility Study, ECP 32nd Street and Indian School Road WQARF Site, Phoenix, Arizona. September.

Geosyntec, 2019c, Results of Soil Vapor Rebound Evaluation, Former Maroney's Cleaners Facility, ECP 32nd Street and Indian School Road WQARF Site, Phoenix, Arizona. June.

Geosyntec, 2020. Groundwater Monitoring Report First 2020 Second Groundwater Sampling Event East Central Phoenix 32nd Street and Indian School Road WQARF Site Phoenix, Arizona. May 2020.

FIGURES



32nd Street and Indian School Road WQARF Site Groundwater Monitoring Well

Groundwater PCE Isoconcentration
PCE Concentration in Micrograms per Liter
Dashed Where Inferred

Site Boundary

*Medium and deep intervals of 24-MW-21 may be comingled with impacts from the 32nd Street and Indian School WQARF site.
ND = Not-Detected
All locations are approximate.

2,000 1,000 0 2,000 Feet

Site Boundary

East Central Phoenix
32nd Street and Indian School Road WQARF Site
Phoenix, Arizona

Geosyntec consultants

Phoenix | March 2020 | Figure 1

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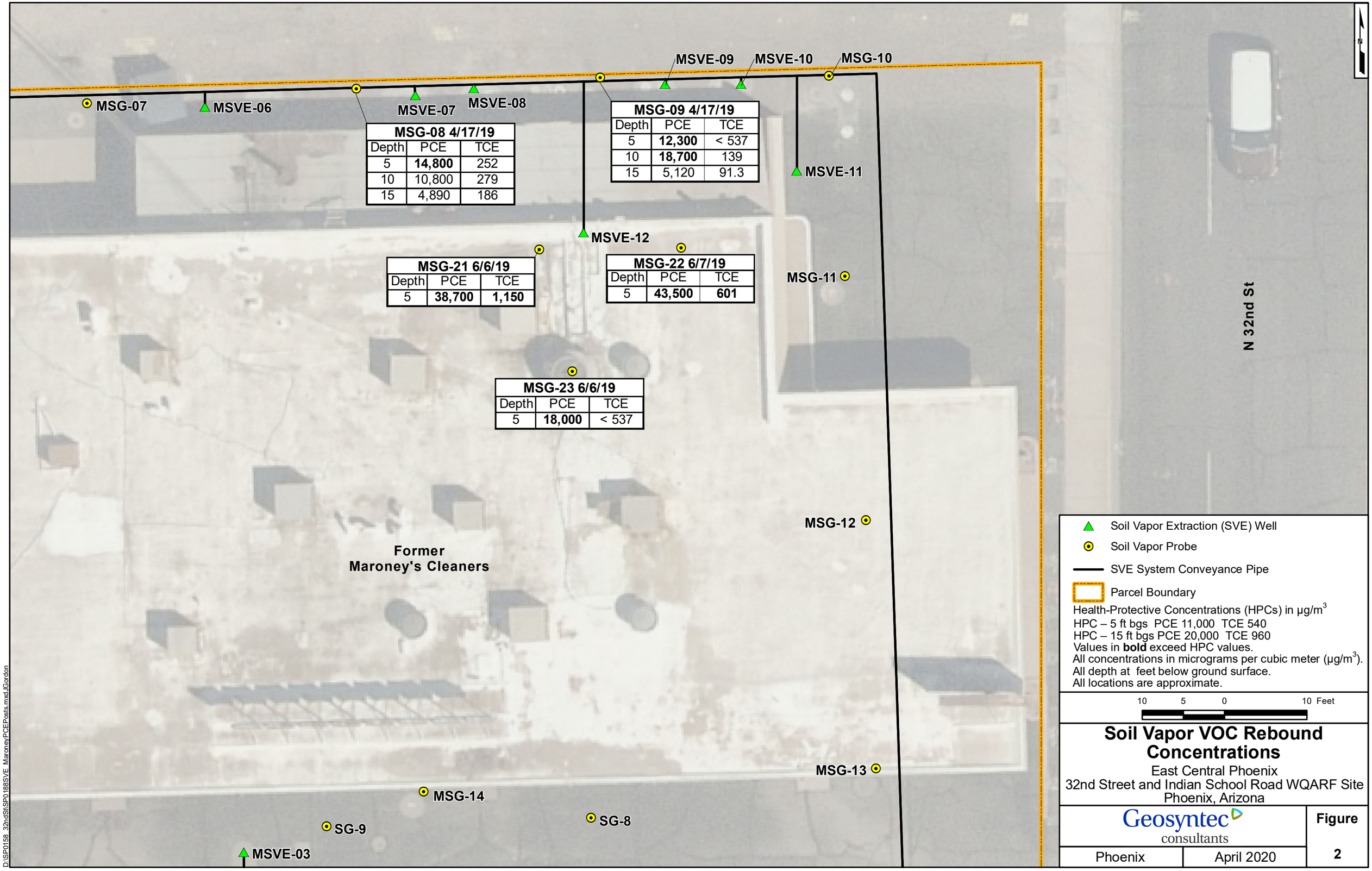

MSG-08 4/17/19

Depth	PCE	TCE
5	**14,800**	252
10	10,800	279
15	4,890	186

MSG-09 4/17/19

Depth	PCE	TCE
5	**12,300**	< 537
10	**18,700**	139
15	5,120	91.3

MSG-21 6/6/19

Depth	PCE	TCE
5	**38,700**	**1,150**

MSG-22 6/7/19

Depth	PCE	TCE
5	**43,500**	**601**

MSG-23 6/6/19

Depth	PCE	TCE
5	**18,000**	< 537

Soil Vapor Extraction (SVE) Well

Soil Vapor Probe

SVE System Conveyance Pipe

Parcel Boundary

Health-Protective Concentrations (HPCs) in µg/m^3
HPC – 5 ft bgs PCE 11,000 TCE 540
HPC – 15 ft bgs PCE 20,000 TCE 960
Values in **bold** exceed HPC values.
All concentrations in micrograms per cubic meter (µg/m^3).
All depth at feet below ground surface.
All locations are approximate.

10 5 0 10 Feet

Soil Vapor VOC Rebound Concentrations

East Central Phoenix
32nd Street and Indian School Road WQARF Site
Phoenix, Arizona

Geosyntec consultants

Phoenix | April 2020

Figure 2

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MMW-03D (<1.00)
UMW-01R (<25.0)**
SRP 17.0E-8.0N
UMW-06R (3.28)
VCMW-05B (<1.00)
VCMW-07A (9.93)
VCMW-07B (<1.00)
VCMW-08AR (57.8)
VCMW-04A (NS)
VCMW-06A (16.1)
VCMW-22 (<1.00)
VCMW-12 (6.24)
5
20
VCMW-20 (26.6)
VCMW-17 (NS)
SRP 16.0E-06.8N
VCMW-26 (<1.00)
24MW-21S (4.62)
24MW-21M (9.15)*
24MW-21D (10.3)*
VCMW-24 (<1.00)

INDIAN SCHOOL RD
E MCDOWELL RD
E PINCHOT AVE
E PINCHOT AVE
N 12TH ST
N 22TH ST
N 24TH ST
N 25TH ST
N 32ND ST

51
10
202

32nd Street and Indian School Road WQARF Site Groundwater Monitoring Well

Salt River Project Well

Groundwater PCE Isoconcentration
PCE Concentration in Micrograms per Liter
Dashed Where Inferred

Site Boundary

PCE concentrations in micrograms per liter.
*Medium and deep intervals of 24-MW-21 may be comingled with impacts from the 24th Street and Grand Canal WQARF Site.
**Elevated method detection limit due to dilution required.
NS = Not Sampled, well not accessible.
All locations are approximate.

1,500 750 0 1,500 Feet

PCE Groundwater Isoconcentration Map April 2020

East Central Phoenix
32nd Street and Indian School Road WQARF Site
Phoenix, Arizona

Geosyntec consultants

Phoenix	May 2020	Figure 3

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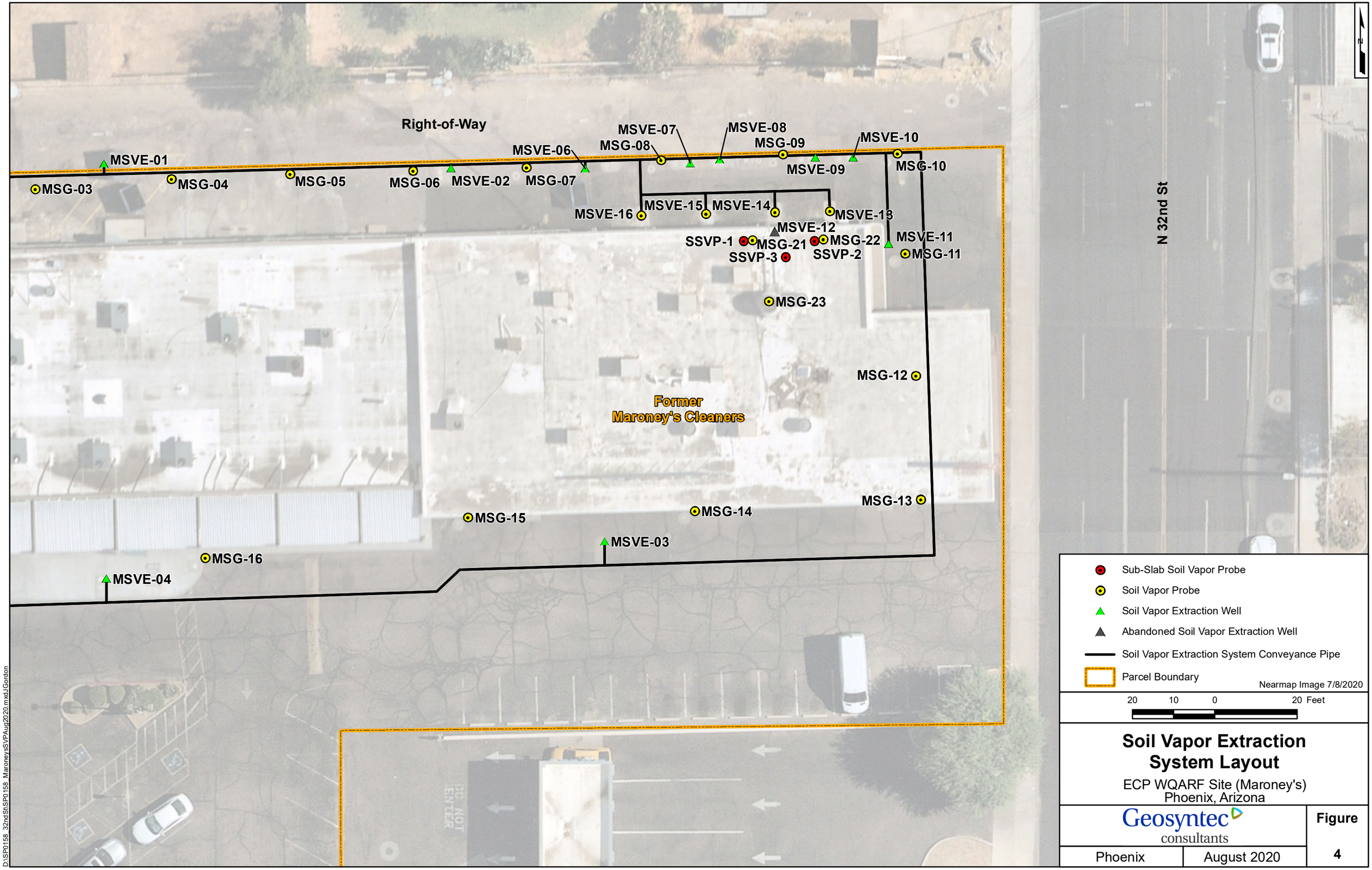

Sub-Slab Soil Vapor Probe

Soil Vapor Probe

Soil Vapor Extraction Well

Abandoned Soil Vapor Extraction Well

Soil Vapor Extraction System Conveyance Pipe

Parcel Boundary

Nearmap Image 7/8/2020

20 10 0 20 Feet

Soil Vapor Extraction System Layout

ECP WQARF Site (Maroney's)
Phoenix, Arizona

Geosyntec consultants

Phoenix	August 2020	Figure 4

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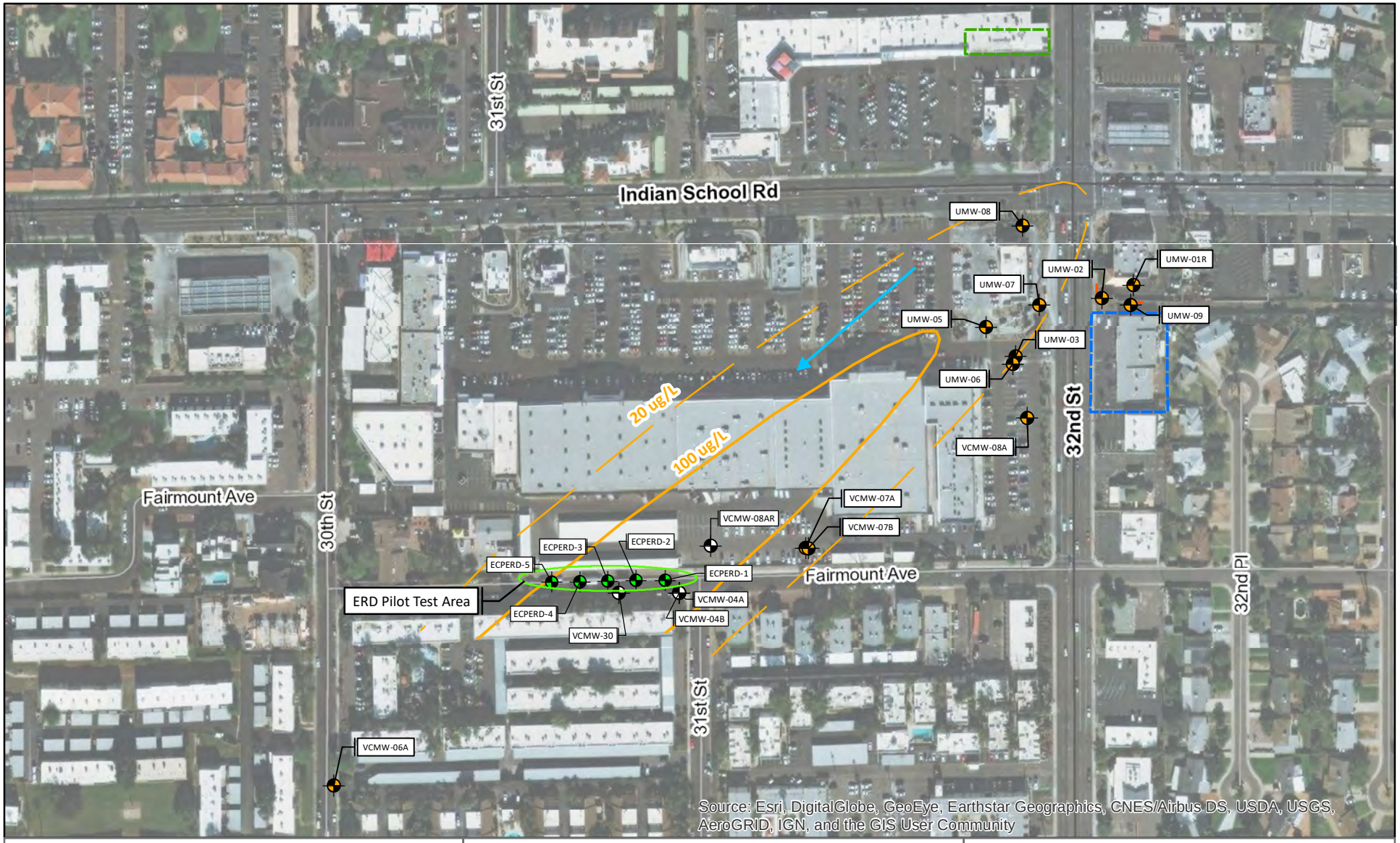


ADEQ Arizona Department of Environmental Quality

CALIBRE

Matrix ENVIRONMENTAL

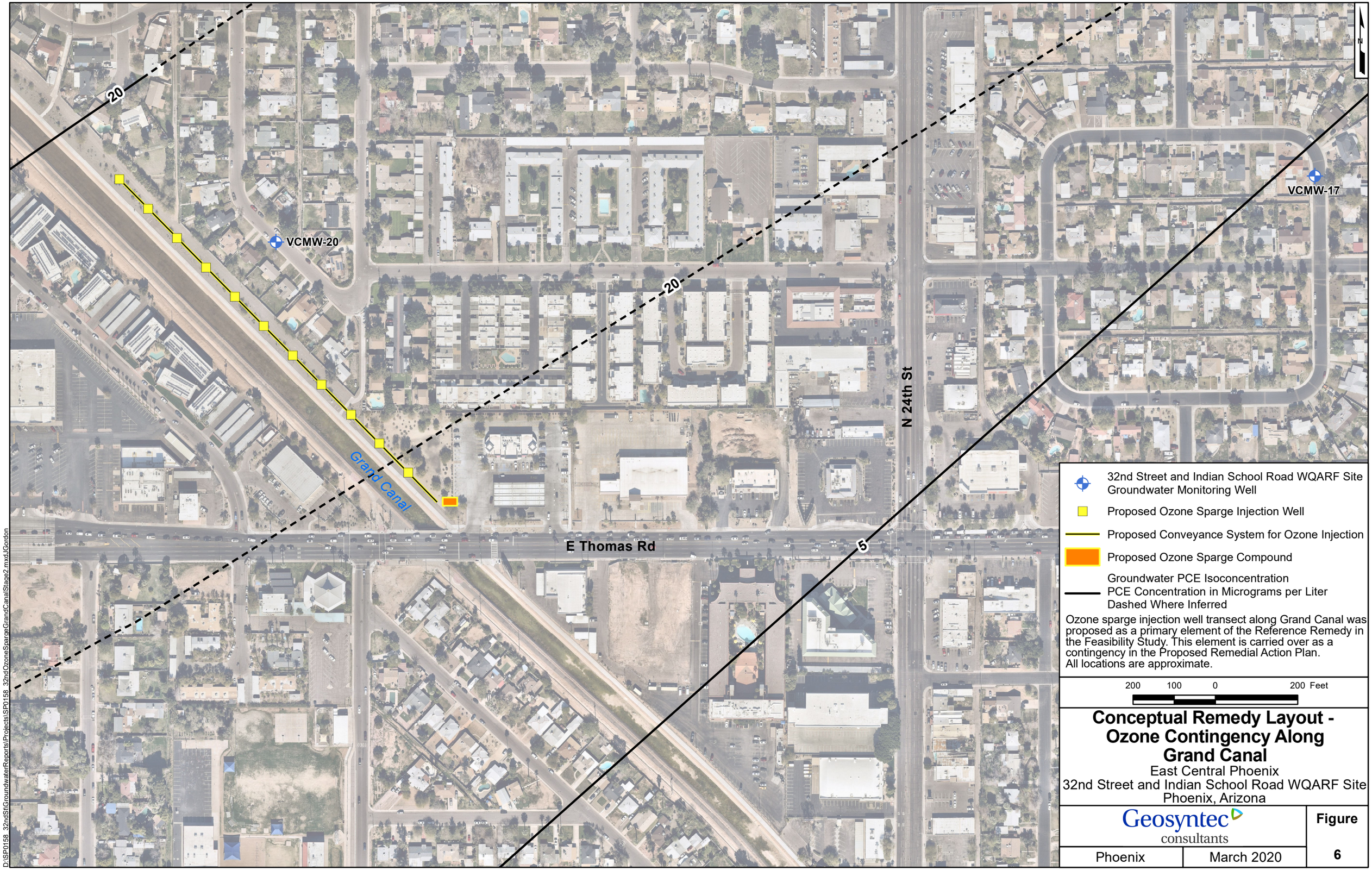
Legend

- Injection Well
- Monitoring Well
- Other Relevant MW
- Approximate Plume Contour from 2019 RI
- Former Maroney's Cleaners
- Former Viking Cleaners
- Groundwater Flow Direction

0 125 250 500 Feet

N

Figure 5 - Proposed Remedy Layout - ERD
32nd Street and Indian School Road
WQARF Site



32nd Street and Indian School Road WQARF Site Groundwater Monitoring Well

Proposed Ozone Sparge Injection Well

Proposed Conveyance System for Ozone Injection

Proposed Ozone Sparge Compound

Groundwater PCE Isoconcentration
PCE Concentration in Micrograms per Liter
Dashed Where Inferred

Ozone sparge injection well transect along Grand Canal was proposed as a primary element of the Reference Remedy in the Feasibility Study. This element is carried over as a contingency in the Proposed Remedial Action Plan.
All locations are approximate.

200 100 0 200 Feet

Conceptual Remedy Layout - Ozone Contingency Along Grand Canal

East Central Phoenix
32nd Street and Indian School Road WQARF Site
Phoenix, Arizona

Geosyntec consultants

Phoenix | March 2020

Figure 6

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APPENDIX A – Detailed Cost Summary

Table A1
Soil Vapor Extraction Cost Summary
Proposed Remedial Action Plan
East Central Phoenix - 32nd Street and Indian School Road WQARF Site
Phoenix, Arizona
March 2020

Description	Quantity	Unit	Unit Cost	Subtotal
SVE Annual OMM Costs - Year 1				
Routine Monitoring, Sampling, & Reporting	1	LS	$30,000	$30,000
Equipment Repairs & Maintenance (As Needed)	1	LS	$7,000	$7,000
Utilities (Electric)	12	MO	$200	$2,400
VGAC Changout	1	YR	$5,000	$5,000
Miscellaneous Field Supplies	1	LS	$6,000	$6,000
Capital Project Oversight	-	-	15%	$7,600
Annual OMM Subtotal (Pre-Inflation)				***$58,000***
Site Decommissioning and Project Closeout - Year 1				
Decommissioning of SVE System and Associated Infrastructure - Former Vikings Cleaners	1	LS	$100,000	$100,000
Annual Subtotal (Pre-Inflation)				***$100,000***
Site Decommissioning and Project Closeout - Year 2				
Decommissioning of SVE System and Associated Infrastructure - Former Maroney's	1	LS	$100,000	$100,000
Annual Subtotal (Pre-Inflation)				***$100,000***
Total Annual Cost (With 3% Inflation per Year)				**Subtotal**
Year 1				$163,000
Year 2				$106,100
Total 1 Year SVE Costs (With 3% Inflation per Year)				***$269,000***

Notes and Assumptions:

WQARF - Water Quality Assurance Revolving Fund
SVE - Soil vapor extraction
OMM - Operation, maintenance, and monitoring
VGAC - Vapor-phase granular activated carbon
LS - Lump Sum
MO - Monty
YR - Year
Costs assume there are no capital costs due to the resumed operation of an existing SVE system.

Table A2
Enhanced Reductive Dechlorination Cost Summary
Proposed Remedial Action Plan
East Central Phoenix - 32nd Street and Indian School Road WQARF Site
Phoenix, Arizona
March 2020

Description	Quantity	Unit	Unit Cost	Total
ERD Capital Costs - Year 1				
Injection Well Installation*				
ERD system design layout/access/permitting	0	LS	$40,000	$0
ERD Injection Well Installations in FASA	0	EA	$45,000	$0
Survey, Permitting, Waste Profile, IDW Disposal	0	EA	$1,500	$0
Capital Costs Subtotal				**$0**
Estimated ERD Injection Annual Costs - Year 1 through 4				
ERD Injections**	3	EA	$40,000	$120,000
Field Supplies	1	YR	$6,000	$6,000
Annual Reporting	1	EA	$15,000	$15,000
Annual Costs for ERD OMM Subtotal				**$141,000**
Total Annual Cost (With 3% Inflation per Year)				**Subtotal**
Year 1				$145,200
Year 2				$149,600
Year 3				$154,100
Year 4				$158,700
Total 4 Year ERD Treatment Costs (With 3% Inflation per Year)				**$608,000**

Notes and Assumptions:
* - Infrastructure installed during Pilot Study conducted in March 2020
** - Biostimulation performed three times per year. Bioaugmentation performed during one of the biostimulation events.
WQARF - Water Quality Assurance Revolving Fund
ERD - Enhanced Reductive Dechlorination
FASA - Fairmount Avenue Study Area
IDW - Investigation derived waste
OMM - Operation, maintenance, and monitoring
LS - Lump sum
EA - Each
YR - Year
Inflation Rate = 3% per year

Table A3
Monitored Natural Attenuation Cost Summary
Proposed Remedial Action Plan
East Central Phoenix - 32nd Street and Indian School Road WQARF Site
Phoenix, Arizona
March 2020

Description	Quantity	Unit	Unit Cost	Total
Performance Monitoring Well Installation Year 1				
Design layout/access/permitting	1	LS	$25,000	$25,000
Monitor Well Installation and Oversight	5	LS	$100,000	$500,000
Survey, Permitting, Waste Profile, IDW Disposal	5	LS	$2,500	$12,500
Project Management/Administration	15%	n/a	n/a	$81,000
Capital Costs Subtotal				**$618,500**
Estimated GW MNA Annual Costs - Year 1 through 10				
Semiannual GW Monitoring/Reporting	2	EA	$40,000	$80,000
Field Sampling Supplies	1	EA	$6,000	$6,000
Annual Reporting	1	EA	$15,000	$15,000
Annual MNA OMM Subtotal				**$101,000**
Site Decommissioning and Project Closeout - Year 10				
Decommissioning of Monitoring Well Network	1	LS	$150,000	$150,000

Total Annual Cost (With 3% Inflation per Year)	**Subtotal**
Year 1	$741,100
Year 2	$107,200
Year 3	$110,400
Year 4	$113,700
Year 5	$124,000
Year 6	$127,800
Year 7	$131,600
Year 8	$135,500
Year 9	$139,600
Year 10	$339,500
Total 10 Year ERD Treatment and MNA Costs (With 3% Inflation per Year)	**$2,070,000**

Notes and Assumptions:
* - Infrastructure installed during Pilot Study conducted in March 2020
** - Biostimulation performed twice per year. Bioaugmentation performed during one of the biostimulation events.
WQARF - Water Quality Assurance Revolving Fund
FASA - Fairmount Avenue Study Area
IDW - Investigation derived waste
MNA - Monitored natural attenuation
GW - Groundwater
OMM - Operation, maintenance, and monitoring
LS - Lump sum
EA - Each
YR - Year
Inflation Rate = 3% per year

Table A4
Extended Soil Vapor Extraction Contingency Cost Summary
Proposed Remedial Action Plan
East Central Phoenix - 32nd Street and Indian School Road WQARF Site
Phoenix, Arizona
March 2020

Description	Quantity	Unit	Unit Cost	Subtotal
Conitngency SVE OMM Costs - Year 2				
Routine Operation, Monitoring & Maintenance	6	MO	$10,000	$60,000
Annual OMM Subtotal (Pre-Inflation)				***$60,000***
Total Annual Cost (With 3% Inflation per Year)				**Subtotal**
Year 1				$0
Year 2				$63,700
Total 1 Year Extended SVE Costs (With 3% Inflation per Year)				***$64,000***

Notes and Assumptions:

MO - Month
OMM - Operation, maintenance, and monitoring
SVE - Soil vapor extraction
WQARF - Water Quality Assurance Revolving Fund
Costs are contingent on the Proposed Remedy of 12 months of SVE OMM. This implies the additional six months of SVE OMM would occur in the second year; Inflation costs are calculated accordingly.

Table A5
Extended MNA Contingency Cost Summary
Proposed Remedial Action Plan
East Central Phoenix - 32nd Street and Indian School Road WQARF Site
Phoenix, Arizona
March 2020

Description	Quantity	Unit	Unit Cost	Subtotal
Estimated GW MNA Annual Costs - Year 11 through 20				
Semiannual GW Monitoring/Reporting	2	EA	$40,000	$80,000
Field Sampling Supplies	1	EA	$6,000	$6,000
Annual Reporting	1	EA	$15,000	$15,000
Annual MNA OMM Subtotal				**$101,000**
Site Decommissioning and Project Closeout - Year 20				
Decommissioning of Monitoring Well Network	1	LS	$150,000	$150,000
Annual Subtotal (Pre-Inflation)				***$150,000***
Total Annual Cost (With 3% Inflation per Year)				**Subtotal**
Year 1				$0
Year 2				$0
Year 3				$0
Year 4				$0
Year 5				$0
Year 6				$0
Year 7				$0
Year 8				$0
Year 9				$0
Year 10				$0
Year 11				$139,808
Year 12				$144,002
Year 13				$148,322
Year 14				$152,772
Year 15				$157,355
Year 16				$162,075
Year 17				$166,938
Year 18				$171,946
Year 19				$177,104
Year 20*				$251,746
Total 20 Year Extended Groundwater Monitoring Costs (With 3% Inflation per Year)				***$1,672,000***

Notes and Assumptions:

* - Includes the difference between cost of well decommissioning at Year 10 and Year 20 when a 3% annual inflation rate is applied.

WQARF - Water Quality Assurance Revolving Fund
GW - Groundwater
MNA - Monitored natural attenuation
OMM - Operation, maintenance, and monitoring
EA - Each
LS - Lump sum

Table A6
ISCO Ozone Sparge Along Grand Canal Contingency Cost Summary
Proposed Remedial Action Plan
East Central Phoenix - 32nd Street and Indian School Road WQARF Site
Phoenix, Arizona
March 2020

Description	Quantity	Unit	Unit Cost	Subtotal
ISCO Ozone Sparge Along Grand Canal Capital Costs - Year 3				
Ozone Sparging System Design	1	LS	$100,000	$100,000
Ozone Injection Well Installations at Grand Canal				
Installation & Oversight	11	EA	$70,000	$770,000
Vertical Profiling, Surveying, Permitting, & IDW Disposal	11	EA	$6,000	$66,000
Ozone Sparging System Installations				
Ozone Generator (Including Conex Box & Telemetry)	1	LS	$200,000	$200,000
Earthwork, Trenching, & Pipe Installation	1,400	LF	$50	$70,000
Asphalt Repair	100	LF	$60	$6,000
Related Appurtenances, Equipment, & Repairs	1	LS	$30,000	$30,000
Capital Project Oversight	-	-	15%	$186,300
Capital Costs Subtotal (Pre-Inflation)				***$1,428,000***
ISCO Ozone Sparge Along Grand Canal Annual OMM Costs - Years 3-5				
Ozone Sparging System Operation & Maintenance	1	YR	$100,000	$100,000
Semiannual Groundwater Monitoring & Reporting	2	EA	$40,000	$80,000
Annual Reporting	1	YR	$15,000	$15,000
Sampling & Field Supplies	1	YR	$6,000	$6,000
Equipment Repairs & Maintenance (As Needed)	1	YR	$10,000	$10,000
Annual OMM Subtotal (Pre-Inflation)				***$211,000***
ISCO Ozone Sparge Along Grand Canal Annual Costs - Years 6-8				
Semiannual Groundwater Monitoring & Reporting - Southern Monitoring Network	2	EA	$30,000	$60,000
Annual Reporting	1	YR	$15,000	$15,000
Annual OMM Subtotal (Pre-Inflation)				***$75,000***
Site Decommissioning and Project Closeout - Year 9				
Decommissioning of ISCO System and Associated Infrastructure	1	LS	$250,000	$250,000
Annual Subtotal (Pre-Inflation)				***$250,000***
Total Annual Cost (With 3% Inflation per Year)				**Subtotal**
Year 1				$0
Year 2				$0
Year 3				$1,791,000
Year 4				$237,500
Year 5				$244,600
Year 6				$89,600
Year 7				$92,200
Year 8				$95,000
Year 9				$326,200
Total 9 Year ISCO Ozone Sparge Along Grand Canal Costs (With 3% Inflation per Year)				***$2,876,000***

Notes and Assumptions:

WQARF - Water Quality Assurance Revolving Fund
ISCO - In-situ chemical oxidation
IDW - Investigation derived waste
OMM - Operation, maintenance, and monitoring
LS - Lump sum
EA - Each
LF - Linear feet
YR - Year

Table A7
Hydrogen Peroxide Injection Along Grand Canal Contingency Cost Summary
Proposed Remedial Action Plan
East Central Phoenix - 32nd Street and Indian School Road WQARF Site
Phoenix, Arizona
March 2020

Description	Quantity	Unit	Unit Cost	Subtotal
Hydrogen Peroxide Injection Along Grand Canal Capital Costs				
Hydrogen Peroxide Injection at Grand Canal	1	LS	$140,000	$140,000
Capital Project Oversight	-	-	15%	$21,000
Capital Costs Subtotal (Pre-Inflation)				***$161,000***
Total Annual Cost (With 3% Inflation per Year)				**Subtotal**
Year 1				$165,800
Total Hydrogen Peroxide Along Grand Canal Injection Costs (With 3% Inflation per Year)				***$166,000***

Notes and Assumptions:

WQARF - Water Quality Assurance Revolving Fund

LS - Lump sum

Contingency costs assume the hydrogen peroxide injections will occur simultaneously with the ozone for one year in all ozone sparging wells.

Table A8
Wellhead Treatment (SRP Well) Contingency Cost Summary
Proposed Remedial Action Plan
East Central Phoenix - 32nd Street and Indian School Road WQARF Site
Phoenix, Arizona
March 2020

Description	Quantity	Unit	Unit Cost	Subtotal
Wellhead Treatment Capital Costs				
Treatment Compound Construction - Foundation, Fencing, Controls, Etc.	1	LS	$500,000	$500,000
Treatment System Construction - 2,000 gpm & Two LGAC Vessels	1	LS	$1,000,000	$1,000,000
Conveyance Piping Modifications	1	LS	$30,000	$30,000
System Commissioning & Startup	1	LS	$35,000	$35,000
Capital Project Oversight	-	-	15%	$234,800
Capital Costs Subtotal (Pre-Inflation)				***$1,800,000***
Wellhead Treatment Annual OMM Costs - Years 1-10				
Equipment Repairs & Maintenance (As Needed)	1	YR	$3,300	$3,300
OMM and Carbon Changeouts	1	YR	$150,000	$150,000
Annual OMM Subtotal (Pre-Inflation)				***$153,000***
Site Decommissioning and Project Closeout - Year 11				
Decommissioning of Treatment System and Associated Infrastructure	1	LS	$100,000	$100,000
Annual Subtotal (Pre-Inflation)				***$100,000***
Total Annual Cost (With 3% Inflation per Year)				**Subtotal**
Year 1				$2,011,600
Year 2				$162,000
Year 3				$167,000
Year 4				$172,000
Year 5				$177,000
Year 6				$183,000
Year 7				$188,000
Year 8				$194,000
Year 9				$200,000
Year 10				$206,000
Year 11				$138,000
Total Wellhead Treatment Costs (With 3% Inflation per Year)				***$3,799,000***

Notes and Assumptions:

WQARF - Water Quality Assurance Revolving Fund
LGAC - Liquid-phase granular activated carbon
OMM - Operation, maintenance, and monitoring
LS - Lump sum
YR - Year

Table A9
Wellhead Treatment (Coronado Park Well) Contingency Cost Summary
Proposed Remedial Action Plan
East Central Phoenix - 32nd Street and Indian School Road WQARF Site
Phoenix, Arizona
March 2020

Description	Quantity	Unit	Unit Cost	Subtotal
Wellhead Treatment Capital Costs				
Treatment Compound Construction - Foundation, Fencing, Controls, Etc.	1	LS	$500,000	$500,000
Treatment System Construction - 2,000 gpm & Two LGAC Vessels	1	LS	$1,000,000	$1,000,000
Conveyance Piping Modifications	1	LS	$30,000	$30,000
System Commissioning & Startup	1	LS	$35,000	$35,000
Capital Project Oversight	-	-	15%	$234,800
Capital Costs Subtotal (Pre-Inflation)				***$1,800,000***
Wellhead Treatment Annual OMM Costs - Years 1-10				
Equipment Repairs & Maintenance (As Needed)	1	YR	$3,300	$3,300
OMM and Carbon Changeouts	1	YR	$150,000	$150,000
Annual OMM Subtotal (Pre-Inflation)				***$153,000***
Site Decommissioning and Project Closeout - Year 11				
Decommissioning of Treatment System and Associated Infrastructure	1	LS	$100,000	$100,000
Annual Subtotal (Pre-Inflation)				***$100,000***
Total Annual Cost (With 3% Inflation per Year)				**Subtotal**
Year 1				$2,011,600
Year 2				$162,000
Year 3				$167,000
Year 4				$172,000
Year 5				$177,000
Year 6				$183,000
Year 7				$188,000
Year 8				$194,000
Year 9				$200,000
Year 10				$206,000
Year 11				$138,000
Total Wellhead Treatment Costs (With 3% Inflation per Year)				***$3,799,000***

Notes and Assumptions:

WQARF - Water Quality Assurance Revolving Fund
LGAC - Liquid-phase granular activated carbon
OMM - Operation, maintenance, and monitoring
LS - Lump sum
YR - Year