W O R K   P L A N

FEASIBILITY STUDY AND ASSOCIATED ACTIVITIES

PARK-EUCLID WQARF SITE TUCSON, ARIZONA

Prepared for

Park-Euclid Responsible Parties

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List of Acronyms

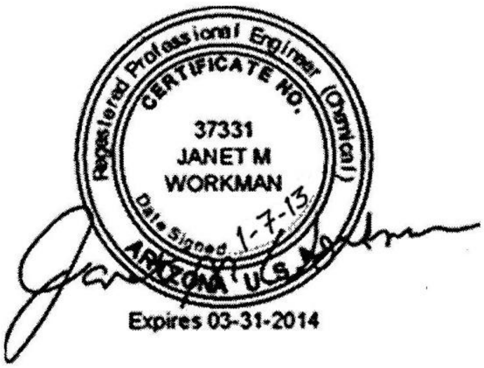
AAC	Arizona Administrative Code
AC	average concentration
ADEQ	Arizona Department of Environmental Quality
ATSDR	Agency for Toxic Substances and Disease Registry
bgs	below ground surface
CAB	Community Advisory Board
CalEPA	California Environmental Protection Agency
CIP	Community Involvement Plan
COC	contaminant of concern
COPC	chemical of potential concern
CR	carcinogenic risk
CVOC	chlorinated volatile organic compounds
DCE	dichloroethene
EPC	exposure point concentration
FS	Feasibility Study
HHRA	Human Health Risk Assessment
HI	hazard index
J&E	Johnson & Ettinger
LVZ	Lower Vadose Zone
MPE	multi-phase extraction
NCP	National Contingency Plan
NISTIR	National Institute of Standards and Technology Interagency Report
PCE	tetrachloroethene
PDEQ	Pima County Department of Environmental Quality
PID	photoionization detector
PPRTV	Provisional Peer-Reviewed Toxicity Values
RO	Remedial Objective
RI	Remedial Investigation
RP	Responsible Party
RSL	Regional Screening Level
SOP	Standard Operating Procedure
SVE	soil vapor extraction
TCE	trichloroethene

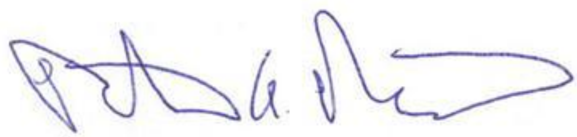
List of Acronyms

TDSGC	Target Deep Soil Gas Concentration
TTG	Tetra Tech GEO
UA	University of Arizona
USEPA	United States Environmental Protection Agency
UVZ	Upper Vadose Zone
VC	vinyl chloride
VOC	volatile organic compound
WQARF	Water Quality Assurance Revolving Fund

Certification Page

This Feasibility Study Work Plan for the Park – Euclid WQARF site in Tucson, Arizona was prepared by URS Corporation on behalf of the Park – Euclid Responsible Parties for the Arizona Department of Environmental Quality. The work plan has been prepared under the supervision and technical direction of the undersigned and is consistent with the usual thoroughness and competence of the environmental profession. Plans and specifications are in accordance with generally accepted engineering principles and practices. No other warranty is expressed or implied.





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This Work Plan describes the overall scope of work to conduct a Feasibility Study (FS) and associated activities for the Park-Euclid Water Quality Assurance Revolving Fund (WQARF) Site (the Site) in Tucson, Arizona (Figure 1) and was developed in accordance with the requirements of the Arizona Administrative Code (AAC) Title 18, Chapter 16, Section 407. This work is being performed by URS Corporation (URS) on behalf of the Park – Euclid Responsible Parties (the RPs) under an Agreement to Conduct Work between the RPs and the Arizona Department of Environmental Quality (ADEQ) dated July 16, 2010.

The Site is located east of downtown Tucson, Arizona and is bounded approximately by 7th Street on the north, Cherry Avenue on the east, 14th Street on the south, and Tyndall Avenue on the west. The Site encompasses soil and groundwater that have been impacted by chlorinated volatile organic compounds (CVOCs). The contaminants of concern (COCs) related to the Site are the dry cleaning chemical tetrachloroethene (PCE) and its biological breakdown products trichloroethene (TCE), dichloroethene (1,1-DCE, cis-1,2-DCE, trans-1,2-DCE), and vinyl chloride (VC). Well locations within the Site and in the area of the Mission Linen Supply (Mission) Plant at 301 South Park Avenue (Mission Plant) are depicted in Figures 2 and 3, respectively.

1.1 WORK PLAN TASKS

This Work Plan will:

- Identify data gaps and recommend activities to address the data gaps to support the FS (Section 3.0)
- Present activities required to develop a groundwater model to support the FS (Section 4.1)
- Present activities required to conduct a soil vapor extraction pilot test in the Lower Vadose Zone to support the FS (Section 4.2)
- Present activities to evaluate the potential for risk to human health as a result of vapor intrusion to indoor air (Section 4.3); and
- Present activities required to conduct the FS and prepare an FS report pursuant to AAC Title 18, Chapter 16, Section 407 (Section 4.4). These activities will include development of alternatives and recommendation of a final remedy for the Regional Aquifer.

In addition, community involvement activities required by AAC R18-16-404 and the Park-Euclid Community Involvement Plan are described in Section 5.0. The proposed schedule for implementation of the Work Plan is presented in Section 6.0.

1.2 REMEDIAL OBJECTIVES

The Arizona Department of Environmental Quality (ADEQ) prepared a Remedial Objectives (RO) Report in 2008. The ROs as stated in the Final Remedial Investigation (RI) Report (Tetra Tech GEO [TTG], 2011), for land and groundwater use at the Park-Euclid WQARF Site are:

> "To restore soil conditions to the remediation standards for non-residential use specified in A.A.C. R18-7-203 (specifically background remediation standards prescribed in R18-7-204, predetermined remediation standards prescribed by

R18-7-205, or site-specific remediation standards prescribed by R18-7-206 that are applicable to the hazardous substances identified (tetrachloroethene (PCE), trichloroethene (TCE), cis-1,2-dichloroethene (cis-1,2-DCE) and trans-1,2-dichloroethene (trans-1,2-DCE), and vinyl chloride)."

"To protect for the use of the groundwater supply by the University of Arizona (UA) near the Park-Euclid WQARF site from contamination from the site. This action is needed for the present time and for as long as the UA wells are used for potable purposes, the resource remains available, and their use is threatened as a result of contamination from the Park-Euclid WQARF site. This action is also needed to protect potential future use of the groundwater supply for the City of Tucson, which is not expected within the next five to ten years."

The above ROs will be used as basis in the performance of the FS.

This section provides a discussion of the history of facility operations at the Mission Plant and provides a brief discussion of the history of the various environmental investigations that have been performed at the Site. For more detail on these activities, see the Final Remedial Investigation (RI) Report (TTG, 2011).

2.1 MISSION PLANT HISTORY

The 301 South Park Avenue Mission Linen Supply (Mission) facility (Mission Plant) [Figure 3], is currently owned and operated by Mission and provides industrial laundry and linen supply services to the Tucson area, primarily for restaurants, service stations, hotels, and janitorial services. Products cleaned include uniforms, bed linens, towels, industrial shop rags, dust mops, and dust mats. Mission's current operations do not include dry cleaning or the use of any chlorinated solvents in their industrial laundry process.

The 299 South Park Avenue property to the north of the Mission Plant is also owned by Mission but is partially leased to tenants. This facility was originally owned and operated by Cascade Linen. The first listing in the City of Tucson Business Directory for the property was in 1949, under the ownership of Cascade Linen. Haskell Linen reportedly purchased the facility at 299 South Park Avenue from Cascade in the mid-1960s. According to interviews conducted by Earth Tech (Earth Tech, 1991), dry cleaning was conducted at 299 South Park Avenue until approximately 1971. At that time, Haskell Linen moved the dry cleaning equipment to the 301 South Park Avenue facility.

The address of the Mission Plant was listed in the City of Tucson Business Directory in 1938, under ownership by Haskell Linen. Haskell Linen performed dry cleaning at this facility using the equipment from Cascade Linen from approximately 1971 until January 1973 when Haskell purchased higher capacity equipment and sold the previously used equipment. Haskell continued to conduct dry cleaning at this property with the new equipment using tetrachloroethene (PCE) until 1983.

Mission purchased the properties located at 301 and 299 South Park Avenue from Haskell Linen on February 16, 1983 and continued to perform dry cleaning until this operation was discontinued on June 11, 1985. At that time, the dry cleaning equipment consisted of two large dry cleaning machines and one 2,000-gallon aboveground PCE storage tank with aboveground piping. The machines and the storage tank were removed in 1985. Employee interviews that were conducted by Earth Tech (Earth Tech, 1991) indicated that spills occurred in the former dry cleaning area of the Mission Plant. These spills may have moved through joints and cracks in the floor of the building to underlying soils and may also have reached sewer lines through floor drains and sumps. Releases reportedly included accidental overfills of PCE tanks and accidental spills from the dry cleaning machines.

2.2 SITE INVESTIGATION HISTORY

ADEQ contracted Earth Tech in 1991 to perform a Preliminary Site Characterization of 299 and 301 South Park Avenue. The activities were performed under the WQARF program. Field activities were performed in 1991 and reported in a Preliminary Site Characterization report (Earth Tech, 1991). Field activities included:

- A limited soil gas survey,

- Limited discrete soil sampling and analysis,
- Installation of three Regional Aquifer monitoring wells (MLR-1, MLR-2, and MLR-3),
- Geophysical and video logging of two inactive onsite water production wells (Old Well and MP-1), and
- Depth-specific sampling of the Old Well and MP-1.

Diesel and PCE were detected in the Old Well and MP-1. PCE was also detected in two of the three Regional Aquifer-monitoring wells (MLR-1 and MLR-3). At the time of the Preliminary Site Characterization, only one aquifer, the Regional Aquifer, was identified beneath the Mission Plant with an average potentiometric surface of 188 feet below ground surface (bgs). In addition to being present in groundwater beneath the Mission Plant, PCE was detected in shallow soil vapors.

On behalf of Mission, EMCON prepared a Remedial Action Workplan and performed the Phase 1 of the RI in the fall of 1992. The Phase 1 RI consisted of:

- A shallow soil gas survey,
- Geophysical logging of the Old Well,
- Abandoning the Old Well,
- Bailing product from Well MP-1,
- Measuring product and water levels in Well MP-1,
- Performing depth-specific water quality sampling in Well MP-1, and
- Sampling groundwater in the Regional Aquifer monitoring wells MLR-1, MLR-2, and MLR 3.

During the Phase 1 RI, elevated concentrations of PCE were observed in shallow soil vapors beneath the Mission Plant. The highest concentrations were located in the former dry cleaning area. In addition, petroleum product containing PCE was confirmed in both the Old Well and MP-1. No chlorinated organic compounds were detected in samples collected from the Regional Aquifer monitoring wells during the Phase 1 investigation.

The Phase 2 RI was performed by EMCON in 1993 (EMCON, 1995). The Perched Aquifer was identified beneath the Mission Plant during this phase. Phase 2 investigations consisted of:

- Installing three Perched Aquifer monitoring wells (MLS-4, MLS-5, and MLS-6),
- Installing four Soil Vapor Extraction (SVE) wells (SVE-101, SVE-102, SVE-103, and SVE-104),
- Performing a short-term SVE test, and
- Collecting product and groundwater samples.

During these investigations, elevated concentrations of vapor-phase PCE were observed in the Vadose Zone. A diesel product layer was found on the Perched Aquifer at a depth of approximately 90 feet bgs that contained dissolved PCE and limited PCE degradation products (trichloroethene [TCE] and *cis*-1,2-dichloroethene [*cis*-1,2-DCE]) (EMCON, 1995).

The Phase 3 RI was performed by EMCON in 1994. Phase 3 consisted of:

- Groundwater monitoring and sampling,
- Installation and sampling of a new Regional Aquifer monitoring well, MLR-7,
- Performing an aquifer test to assess the character of the Regional Aquifer,
- Performing video and geophysical logging in MP-1 to assess the need for abandonment,
- Collecting product and sediment samples from MP-1,
- Abandoning well MP-1,
- Collecting a product sample from the Perched Aquifer to compare results to product in MP-1, and
- Monitoring monthly water and product levels in all wells.

During Phase 3 investigations, the top of the Regional Aquifer was identified at an approximate depth of 220 feet bgs, and MLR-7 was completed in the uppermost part of the aquifer. This investigation suggested that the Regional Aquifer is confined beneath the Mission Plant. MLR-7 was found to contain PCE at a concentration of 630 micrograms per liter (µg/L) and limited concentrations of several PCE degradation products. In addition, EMCON reported evidence of diesel (and possibly solvents) in soil at a depth of 185 to 185.5 feet bgs. EMCON postulated that this was a smear zone from the former top of the aquifer. The product sample collected in the Perched Aquifer well was found to consist of diesel fuel oil containing alkylated poly-nuclear aromatics.

URS, formerly Dames & Moore, was retained by Mission in early 1998 to continue the assessment of subsurface contamination at the Mission Plant and to design and implement Early Response Actions for shallow soil, as appropriate. During 1998 and 1999, URS performed a Phase 4 investigation including:

- A three-dimensional soil gas survey to characterize the distribution of chlorinated solvents in Vadose Zone soil gas beneath the Mission Plant,
- A soil gas investigation targeted at the sanitary sewer beneath the Mission Plant,
- Single-well testing to evaluate the hydraulic properties of the Perched Aquifer,
- Four quarterly sampling events of the Perched and Regional Aquifer groundwater monitoring wells at the Site and in the surrounding area.

Results of the Phase 4 investigation were documented in the Phase 4 Investigation Report dated February 17, 2000 (Dames & Moore, 2000). The report documented that an extensive PCE vapor plume existed beneath the Mission Plant that was sourced from residual soil contamination and potentially the sanitary sewer crossing the Mission Plant. It was concluded that the product plume and chlorinated solvent concentrations in the Perched Aquifer were relatively stable, and the plume did not extend beyond the Arroyo Chico Wash. It was also noted that PCE concentrations in the Regional Aquifer were generally decreasing, likely a result of abandonment of the Old Well and MP-1 that had been interpreted as the source of PCE in the Regional Aquifer.

After Mission completed the Phase 4 investigation, ADEQ assumed the lead role in the RI for the Site under the WQARF program. A variety of activities were performed by consultants for ADEQ during the RI field investigations including sanitary sewer investigations, a lower vadose zone investigation, Perched and Regional groundwater monitoring well installation and sampling, and aquifer testing. ADEQ investigated the integrity of sanitary sewer/wastewater collection lines beneath the Mission Plant to evaluate the potential for leakage of solvents from the wastewater lines to the subsurface. The lower vadose zone investigation included installation and sampling of three vapor monitor wells. ADEQ installed three "sentinel" Regional Aquifer monitor wells between the Park Euclid Site and the University of Arizona (UA) water supply wells in January 2000 to provide early warning of potential chlorinated solvent migration toward the UA production wells. From 2000 to 2003, ADEQ installed and sampled nine Perched Aquifer and eight Regional Aquifer monitor wells. These activities led up to the Draft RI Report that was issued by ADEQ in June 2004 (Miller Brooks Environmental (MBE), 2004). The Draft RI Report was followed with a Proposed Remedial Objectives Report in June of 2006 (MBE, 2006). After the Draft RI was issued, ADEQ performed semi-annual groundwater monitoring at the Site through November 2008. Groundwater monitoring at the Site was temporarily suspended following November 2008. The RI Report was finalized by Tetra Tech GEO in 2011 (TTG, 2011).

In 2010, the responsible parties at the Park-Euclid site signed an agreement to form the Park-Euclid (P-E) Group that will manage and fund remediation activities at the Site. Work plans were prepared and reviewed for groundwater monitoring and for operating a multi-phase extraction (MPE) system. Long term monitoring at the site resumed in June-August 2011. Work Plan activities associated with MPE system operation began in August 2011 (see Section 2.5 for additional background on the MPE system).

2.3 SITE SPECIFIC GEOLOGY AND HYDROGEOLOGY

The Park-Euclid Site is located within the western portion of the Tucson Basin. The Tucson Basin is an approximately 1,000-square mile region located with the upper Santa Cruz River drainage basin (Davidson 1973). The Tucson Basin is drained by the Santa Cruz River, located west of the Site, and several smaller tributaries. The Arroyo Chico crosses the northern area of the Site from east to west. Topographically, the Tucson Basin is a broad plain, sloping gently to the northwest. Groundwater enters the basin from infiltration associated with precipitation events and recharge from streams discharging from the surrounding mountains. Groundwater flow direction in the Regional Aquifer prior to urban development and groundwater withdrawals, was generally parallel to the ground surface, and flowed northwest, parallel to the Santa Cruz River, toward the outlet of the Tucson Basin (Davidson 1973). Groundwater flow directions in the Regional Aquifer have been altered since the early 1940s as a result of municipal pumping.

Of interest beneath the Site are sedimentary units comprising the Perched Aquifer (depths to approximately 100 feet below ground surface) and upper portions of the Regional Aquifer (depths from approximately 200 to 700 feet).

With respect to environmental investigations, the subsurface beneath the Site has been divided into five hydrostratigraphic zones (GeoTrans 2008). All of these zones are comprised of interbedded sands and clays. The sediments are largely unconsolidated, although thin intervals of partially indurated sediments are encountered during drilling. From shallowest to deepest, they are the:

- Upper Vadose Zone (UVZ) (0 to 85 feet below ground surface)
- Perched Aquifer (85 to 95 feet)
- Upper Aquitard (90 to 110 feet)
- Lower Vadose Zone (LVZ) (110 to 200 feet)
- Regional Aquifer (200 feet to undetermined depth)

The Regional Aquifer is a thick sequence (greater than 1,000 feet) of interbedded sands and clays, and serves as the principal aquifer of the Tucson Basin (Davidson, 1973). Locally, this aquifer produces most of the drinking water for the UA. UA potable water supply wells (Huachuca, Martin, and Aggie) are approximately 4,000 to 4,500 feet downgradient of the Mission Plant and UA sentinel/monitoring well (UAM-2) is located approximately 2,500 feet hydraulically downgradient (north-northeast) of the Mission Plant. The majority of Regional Aquifer monitoring wells at the Site are screened in the upper portion of the aquifer. However, UA production wells extend into deeper portions of the Regional Aquifer (400 to 680 feet bgs).

2.4 CURRENT SITE CONDITIONS

The monitoring network (see Figures 2 and 3) contains 19 Perched Aquifer monitoring wells, 6 Perched Aquifer MPE Wells, 20 Regional Aquifer monitoring wells, five UA production wells screened deeper in the Regional Aquifer, and seven vapor monitoring wells (each screened at four depths in the upper vadose zone). Maps depicting product thickness and distribution in the Perched Aquifer, relative CVOC concentrations in the Perched Aquifer, and groundwater potentiometric surfaces and dissolved CVOC concentrations in groundwater for both the Perched and Regional Aquifers are presented in Appendix A for the period June-August 2011. Maps depicting the distribution of PCE in soil vapor within the UVZ during the same time frame are also presented in Appendix A. These data are discussed in the Baseline Monitoring Report (URS, 2011c).

2.5 SUMMARY OF EARLY RESPONSE ACTIONS

As summarized in the Work Plan for Multi-Phase Extraction System Early Response Action (URS, 2011b), several Early Response Actions have been implemented at the Site. These include:

- Abandonment of "Old Well;"
- Abandonment of Well MP-1;
- Soil Vapor Extraction (SVE) system installation and operation; and
- Multi-Phase Extraction (MPE) system installation and operation.

The SVE and MPE activities are described in additional detail below.

Using the results of the Phase 4 soil gas characterization, URS performed an Engineering Evaluation/Cost Analyses (EE/CA) in accordance with the United States Environmental Protection Agency's (USEPA's) Non-Time Critical Removal Action guidance. The final EE/CA report (Dames & Moore, 1999) provided the results of evaluation of a number of options for removal of soil contamination beneath the Mission Plant and recommended SVE as the preferred alternative. Design and construction of the SVE system was performed during the summer and fall of 1999.

The first phase of SVE operation was from June 2000 through July 2002. During this period, approximately 6,000 pounds of PCE and other volatile organic compounds (VOCs) were removed from the vadose zone by the SVE system. Following this phase of operation, URS prepared a work plan to perform a confirmation study to evaluate the effectiveness of the SVE system (URS, 2002).

Concurrently, ADEQ and URS began evaluating options for remediation of the free-product layer containing diesel and PCE at the top of the Perched Aquifer that had been identified during previous investigations. Based on observations of more than 2 feet of diesel free product in the Perched Aquifer wells approximately 500 feet upgradient from the Mission Plant, the diesel plume source is recognized to be from off-site petroleum release(s) to the south. However, spills from dry cleaning equipment at the Mission Plant are thought to have resulted in the downward migration of PCE through the Vadose Zone and into the diesel product layer at the surface of the Perched Aquifer. Because PCE is very soluble in diesel, most of this PCE dissolved in the diesel layer where it remains today. As stated in the Draft RI (MBE, 2004), "the large mass of chlorinated hydrocarbons in the floating diesel free product makes it an important component of remediation."

ADEQ conducted free product bail-down tests in February 2001 followed by a pilot test at two SVE wells using product-only pumps. The pilot tests were conducted in cooperation with Mission. Following a period of intermittent operation, the pilot test was discontinued due to poor performance of the pumps, low product recovery volumes, and high water recovery volumes (MBE, 2004).

Based on discussions with ADEQ and research by ADEQ's and Mission Linen's respective consultants, multi-phase extraction (MPE) was considered as an alternative to product skimming for the removal of the diesel/VOC product mixture. A short-term pilot test of MPE technology at the Mission Plant was designed and presented for ADEQ review and approval in the confirmation study work plan (URS, 2002).

Following ADEQ approval of this work plan, the confirmation study to evaluate SVE system performance and the MPE pilot test were performed in 2003. These activities were documented in separate reports dated August 7 and November 26, 2003 (URS, 2003a and 2003b), respectively. From the confirmation study, URS concluded that concentrations of PCE in the vadose zone had been reduced by approximately 90 percent but recommended additional SVE operation focused primarily on the source area and that soil vapor concentrations in the vicinity of the Mission Plant be monitored during operation. A series of seven multi-depth soil vapor monitoring well clusters were installed by URS and ADEQ during the confirmation study to better evaluate changes in VOC concentrations in soil gas over time in response to future SVE operation.

URS conducted MPE pilot testing during September 2003. Prior to testing, a pilot test well, MPE-1, and a monitoring well, MPM-1, were installed at locations expected to exhibit free product (the diesel/VOC mixture) accumulation within the wells. The testing consisted of MPE extraction at MPE-1. The extraction test was performed with a small trailer-mounted temporary extraction system. The extraction test occurred between September 10 and September 16, 2003.

Following completion of the pilot test, URS prepared a Multi-Phase Extraction Pilot Test Report, dated November 26, 2003 (URS 2003b).

The second phase of SVE operation began in September 2004 and continued until February 2006. A total of five quarterly soil vapor monitoring events were performed by URS during the second phase of SVE operation, and quarterly monitoring reports were prepared to document the results of these events. The reports showed that average concentrations (ACs) of VOCs decreased dramatically in nearly all wells and depths during the monitoring period. At the conclusion of the operational period, URS calculated that approximately 2,000 additional pounds of VOCs were removed from the vadose zone during the second phase of SVE operation.

Based on the successful results from the short-term MPE pilot test described above, Mission proposed a more extensive series of MPE wells and construction of an MPE treatment system at the Mission Plant. The design included a series of six MPE wells in and around the Mission Plant. This system was constructed between December 2007 and April 11, 2008. An initial "pilot phase" of operation of the MPE system was completed using six new MPE wells between April 2008 and June 2009 to better evaluate the long term response of the Perched Aquifer, product layer thickness, and PCE concentrations in the product to MPE operation. As documented in the system operations summary report (URS, 2009), the MPE system was effective in reducing product thickness and in reducing VOC concentrations in both the diesel product and in Perched Aquifer groundwater. Monitoring performed during pilot phase operations also confirmed that reductive dechlorination of VOCs is occurring in both Perched Aquifer groundwater and in the diesel product. Confirmation of the reductive dechlorination process is supported by academic studies conducted by UA graduate students and faculty using site-specific data (Carreón-Diazconti, et. al., 2009).

URS prepared an Early Response Action Work Plan for operation of the MPE system in January 2011 (URS, 2011b). Intermittent operation of the system began in August 2011 and has continued to date.

As a component of development of this work plan, URS has performed a review of existing Site data to identify potential gaps in the characterization of the Site. Addressing the data gaps is considered essential for completing a WQARF-compliant FS. This included a review of the Final Remedial Investigation Report (TTG, 2011) as well as other historical documents prepared by consultants for ADEQ and Mission. The data gaps evaluation also incorporates data that have been collected by URS as part of monitoring activities performed on behalf of the RPs as a component of the MPE system performance evaluation and the long term groundwater monitoring program. A detailed description of the various data gaps for each hydrogeologic unit is provided in the following Sections 3.1 through 3.4. For quick reference a general listing of the data gaps is listed below:

- Upper Vadose Zone: Assess vapor intrusion risk
- Perched Aquifer: Long term impact of existing remedies on the Aquifer
- Lower Vadose Zone: Impact of contamination in this zone on the Regional Aquifer
- Lower Vadose Zone: Evaluation of this zone to assess the need for an active remedy
- Regional Aquifer: Cause and mechanism for increasing VOC concentrations in PER-14A
- Regional Aquifer: Refine downgradient plume definition

3.1 UPPER VADOSE ZONE DATA GAPS

The UVZ beneath the Mission Plant and the immediate vicinity has been adequately characterized during activities leading up to and including the Remedial Investigation (TTG, 2011). Further, the ongoing monitoring program (URS, 2010) includes quarterly monitoring of seven soil vapor monitoring well clusters (each screened at four depths within the UVZ) to evaluate the distribution of vapor phase VOCs in the UVZ over time. However, outside of the immediate vicinity of the Mission Plant, the distribution of VOC vapors is not well defined. It is unlikely that these vapors could contribute significantly to contamination of Regional Aquifer groundwater. However, it is important to have an understanding of the distribution of VOC vapors in the area surrounding the Mission Plant as these vapors could present a vapor intrusion risk at residences and commercial properties surrounding the plant.

A preliminary investigation of potential vapor intrusion risk at the Mission Plant and surrounding areas is recommended as a component of pre-FS activities including field soil gas sampling and risk assessment as described in Section 4.3. The results of this investigation and follow-on activities, if necessary, will be used in the FS to evaluate whether vapor mitigation measures are needed.

3.2 PERCHED AQUIFER DATA GAPS

Monitoring of the MPE system that is currently in operation at the Mission Plant to remove diesel product (including dissolved VOCs) as well as VOC contaminated soil vapor and groundwater will provide useful information with respect to contaminant mass remaining in the Perched Aquifer. At the conclusion of the first year of operation of the MPE system, an evaluation of existing monitoring data will be performed, and a recommendation will be made regarding continued operation and monitoring of this system. This information will also provide input to the alternatives analysis to be performed in the feasibility study.

The hydrogeology of the Perched Aquifer was described in Section 3.5.1.2 of the Remedial Investigation Report (TTG, 2011). In the immediate vicinity of the Mission Plant, the top of the Perched Aquifer normally ranges from 85 to 96 feet bgs (TTG, 2011). TTG (2011) described the aquitard at the base of the Perched Aquifer as a sequence of clays and cohesive, clay-rich sands ranging from 10 to 30 feet in thickness. At PER-14 immediately adjacent to the Mission Plant to the north (Figure 3), a 10-foot coarse gradation of the aquitard (clayey sand) is present from approximately 90 feet to 100 feet bgs and is underlain by an approximate 18-foot thick clay layer (TTG, 2011). The groundwater flow direction in the Perched Aquifer is highly variable, but the VOC plume is generally aligned along a southeast to northwest trending axis (URS, 2011b). Wells on the perimeter of the plume are either non-detect or contain low concentrations of PCE and TCE. During ADEQ's final site-wide monitoring event in November 2008 (TTG, 2009), concentrations of cis-1,2-DCE and vinyl chloride appeared to peak in the most downgradient monitoring well in this zone (PEP-10). However, since that time a decreasing trend in the concentration of both parameters has been observed (Figure 4). At this time, no additional monitoring wells are recommended in the Perched Aquifer. VOC concentrations will continue to be evaluated during the routine monitoring program, and should the VOC concentrations in PEP-10 or other perimeter wells demonstrate an increasing concentration trend, then additional measures may be proposed to further characterize the extent of the VOC plume in this zone.

3.3 LOWER VADOSE ZONE DATA GAPS

The LVZ was characterized by ADEQ and its consultants as reported in the RI Report (TTG, 2011). Three soil vapor wells, VML-1, VML-2, and VEL-3 have been completed in this zone in the immediate vicinity of the Mission Plant. Discrete soil samples were collected from the LVZ for laboratory analysis in VML-1 and VML-2 and from Regional Aquifer monitoring wells PER-14 and WR-347B during drilling. Soil vapor samples were collected from VML-1, VML-2, and VEL-3 for laboratory analysis. From these analyses, the RI documented significant petroleum hydrocarbons and VOCs in the LVZ above the Regional Aquifer in the immediate vicinity of the Mission Plant, particularly in the interval from 165 to 190 feet below ground surface.

To evaluate current VOC concentrations in LVZ soil gas and changes in concentration over time, we recommend collecting soil gas samples, initially on a quarterly basis, from the three LVZ wells and from the upper 30 to 35 feet of onsite groundwater monitoring well PER-14A that is above the water table. Additionally, we recommend that a short term pilot test of soil vapor extraction be performed in the LVZ to evaluate the potential for this technology to remove documented soil contamination in this interval that may be acting as a source of contamination to the Regional Aquifer. The proposed pilot test is described in Section 4.2.

3.4 REGIONAL AQUIFER DATA GAPS

The current monitoring well network in the Regional Aquifer as described in the Remedial Investigation (TTG, 2011) and updated in the baseline monitoring report (URS, 2011) adequately defines the extent of the COC plume in this zone (Figure 5). However, within the plume, there are two specific areas of concern based on the latest monitoring data.

3.4.1 Increasing VOC Concentrations in PER-14A

In samples from onsite well PER-14A (Figure 5), COC concentrations have increased substantially since the well was installed in October 2008. Figure 6 displays the concentration of key VOCs in samples collected from PER-14A over time. In particular, PCE and cis-1,2-DCE increased in concentration from 2.1 and less than 1.0 µg/L, respectively when the well was initially installed to 400 and 2,000 µg/L, respectively during the February 2012 monitoring event. Since February 2012, concentrations of PCE and cis-1,2-DCE in samples from this well have decreased to 190 and 770 µg/L, respectively. The fact that significant concentrations of PCE degradation products such as TCE and cis-1,2-DCE are present suggests the source of the contamination is likely elevated VOC and petroleum hydrocarbon concentrations in the LVZ as described in Section 3.3. Petroleum hydrocarbons in the presence of chlorinated solvents tend to increase the natural biodegradation of the solvents as the petroleum provides a carbon source to enhance this process. However, groundwater samples from Regional Aquifer monitoring wells have historically contained minimal concentrations of these degradation products.

Continued monitoring of VOCs in this well and regional wells immediately downgradient (MLR-3 and MLR-7) is recommended to evaluate Regional Aquifer VOC concentration trends in the immediate vicinity of the Mission Plant. Should the results of this monitoring suggest that concentrations of VOCs are increasing in the Regional Aquifer at and immediately downgradient from PER-14A, recommendations for additional investigation/remedial activities will be made, as appropriate.

3.4.2 Refining of Downgradient Plume Definition

University of Arizona sentinel well UAM-2 is the most downgradient monitoring well in the Regional Aquifer along the axis of the plume. This well provides a limit to the lateral extent of PCE exceeding the AWQS of 5 µg/L (3.7 µg/L, February 2012). However, the downgradient extent of PCE exceeding the AWQS is not well defined at this time. An additional well in the Regional Aquifer located downgradient of Well PER-26 and upgradient of UAM-2 is recommended. With the exception of the anomalous result at PER-14A described above, the core of the PCE plume has shifted downgradient, and is centered at PER-26 (130 µg/L, July 2012). There are currently no wells between PER-26 and the UA sentinel well UAM-2. An additional Regional Aquifer well would allow the tracking of contaminant distribution downgradient from PER-26 and aid in the alternatives analysis to be performed in the FS. A recommended location is along East 9th Street near the intersection of North Santa Rita Avenue is shown on Figure 5. The recommended screen interval for this well is from 240 to 290 feet bgs to monitor the same interval as PER-26.

4.1 REGIONAL GROUNDWATER MODEL DEVELOPMENT

Groundwater modeling is proposed to support FS remedial alternative evaluation.

4.1.1 Rationale for Groundwater Model Development

Groundwater modeling is a process that integrates various geologic, hydraulic, and chemical data to support the understanding of Site hydrogeologic conditions and CVOC plume fate and transport behavior. The numerical model may then be used as an effective tool to predict system behavior and to quantitatively evaluate remedial alternatives. For this Site, groundwater modeling is proposed to support the FS in the evaluation of potential remedies for the Regional Aquifer.

4.1.2 Previous Groundwater Modeling Efforts

Groundwater modeling was conducted by Malcolm Pirnie in 2007 and by GeoTrans in 2008. The regional groundwater modeling report by GeoTrans (2008), prepared for ADEQ, thoroughly discussed the conceptual model of the Regional Aquifer, model design and construction, and model calibration approach and results. The steady state model was conducted for average groundwater conditions in two representative time periods. The model was also calibrated through transient simulations to the two major pumping tests in the Regional Aquifer. The calibrated model was then used to evaluate four pump-and-treat (P&T) remedial alternatives with assumed variable conditions. A fate and transport model was also developed and calibrated through simulating historical plume migration. The calibrated models were then used to predict potential future plume fate and transport conditions based on assumed non-pumping or P&T conditions.

4.1.3 Conceptual Model Update

The Conceptual Site Model will be updated for groundwater flow and contaminant conditions at this site, based on:

- The evaluation of historical data by URS;
- Recent data collected by URS as part of the long term monitoring program;
- Review of available regional groundwater studies by others, including GeoTrans (2008).

The updated Conceptual Site Model will be used to develop reasonable assumptions and calibration targets for the numerical groundwater modeling.

4.1.4 Development of Groundwater Flow Model

If the electronic version of the groundwater numerical model by GeoTrans is available, the development of this model will be based on modification of the GeoTrans model. If the files of the GeoTrans model are not available or are not suitable for use, the numerical model will be developed as described below.

A three-dimensional numerical groundwater flow model will be developed using MODFLOW (McDonald and Harbaugh, 1988) for the regional aquifer beneath the site. The model will cover an area that is large enough to allow simulations of various potential remedial alternatives without model boundary effect. The numerical model will be calibrated to available groundwater elevations, aquifer hydraulic properties, and groundwater extractions. The feedback of transport modeling results will also be used to revise model calibration. Particle tracking simulation using MODPATH (Pollock, 1989) will be conducted to compare simulated groundwater flow pathways to the conceptual understanding of the Site.

4.1.5 Development of Fate and Transport Model

A groundwater contaminant fate and transport model will be developed using MT3DMS (Zheng and Wang, 1998). The groundwater PCE plume will be simulated as a representative plume. The likely history of the groundwater PCE plume growth and migration will be approximately simulated to evaluate reasonableness of the groundwater flow model and to estimate fate and transport parameters.

4.1.6 Model Prediction to Support FS Alternatives Analysis

The developed groundwater flow and transport models will be used to simulate potential remedial strategies or remedial measures for the Regional Aquifer where the remedial strategy and/or remedial measure is intended to protect the use of groundwater for the UA in accordance with the RO. Remedial strategies to be considered may include, but not be limited to:

- Monitored natural attenuation (MNA);
- Active remediation through groundwater extraction and treatment;
- Containment of the plume;
- Controlled migration; and
- Wellhead protection at existing production wells.

Uncertainty evaluation will be conducted for predicted results using sensitivity analyses.

4.1.7 Groundwater Modeling Report

A groundwater modeling report will be prepared to document the results of the modeling. The report will include:

- The updated Conceptual Site Model, which includes the regional and site hydrogeological and groundwater contamination conditions for both Perched and Regional Aquifers as well as the vadose zones (UVZ and LVZ);
- Numerical groundwater flow and transport model development, including model assumptions and calibration results;
- Model prediction results with uncertainty analyses for potential remedial strategies and/or remedial measures; and
- Model limitations and uncertainties.

The groundwater model report will be included as an appendix to the FS Report (Section 4.4.5).

4.2 SVE PILOT TESTING

4.2.1 SVE Pilot Testing Rationale

The rationale for conducting an SVE pilot test is: 1) to provide data that is useful in remedy development for the FS; and 2) to evaluate the possible source of increasing VOCs within PER-14A.

4.2.2 Pilot Test Objectives and Summary of Activities

An SVE test on the LVZ will have the following test objectives:

- To evaluate the applicability of SVE to the LVZ (to support the FS);
- To confirm the presence and magnitude of volatile organic compound (VOC) concentrations in soil vapor from the LVZ in the vicinity of VEL-3 and PER-14A;
- To evaluate vertical air permeability, and soil vapor concentration profiles along the screened interval of PER-14A and VEL-3 using PneuLog® equipment provided and operated by Praxis Environmental Technologies, Inc. (Praxis);
- To evaluate the rate of decline, if any, in extracted VOC concentrations from VEL-3 over a period of 4 to 5 days;
- To evaluate contaminant rebound as it relates to the mass estimate for the site and the performance of full-scale SVE in the LVZ; and
- To evaluate air flow versus vacuum relationship, as well as the area/zone of effective vacuum influence for VEL-3.

Activities associated with the pilot test will consist of:

- Pre-test coordination and permitting;
- Baseline sampling;
- PneuLog® testing;
- SVE testing;
- Rebound testing; and
- Data analysis.

These activities are described in additional detail in Sections 4.2.3 through 4.2.10.

4.2.3 Pre-Test Coordination and Permitting

On behalf of the RPs, Praxis will be contracted to perform PneuLog® and SVE testing at PER-14A and VEL-3. A 1.5 hp blower will be connected to each of the wells in turn for extraction and will be powered using a portable generator. URS will coordinate with a fuel supplier for delivery of fuel throughout the duration of the pilot test. Praxis will supply the PneuLog® testing equipment.

Prior to delivery of the equipment to the site, URS will coordinate with the Pima County Department of Environmental Quality (PDEQ) Air Quality Program to obtain permission to use the MPE system vapor abatement equipment (i.e., three 2,000-pound granular activated carbon [GAC] vessels and single vessel containing 500 pounds of permanganate-impregnated zeolite beads [PIZB]) to temporarily treat extracted vapors from the SVE pilot test. The MPE system will be temporarily shut down during the SVE pilot test. URS anticipates that such a change may be made as a “Facility Change Without Permit Revision” and will require only a seven-day advance notice to the PDEQ. Following the pilot test, the MPE system will be re-connected to the vapor abatement equipment. Note that all existing permit conditions will apply to the SVE test including flow rate restrictions (150 standard cubic feet per minute) and emission concentration limits.

URS and Praxis will coordinate in the development of field data sheets to be used to collect data during the PneuLog® and SVE testing.

URS will work with the ADEQ to notify the Community Advisory Board (CAB) and Mission Plant neighbors of the plans for LVZ SVE pilot testing including the schedule and 24-hour operation of the equipment.

4.2.4 Baseline Sampling

Prior to start of the pilot test, baseline soil vapor samples will be collected from VEL-3, PER-14A, and each of the four depth-specific sampling intervals in VML-1 and VML-2. The samples will be collected in Tedlar bags or Summa canisters in accordance with the soil vapor sampling standard operating procedure (SOP) as provided in Appendix B. The majority of samples will be collected in Tedlar bags and shipped to Praxis’ office for analysis of VOCs by GC (i.e., modified U.S. EPA Method 18). Split samples will be collected for confirmation of the GC analyses at a rate of ten percent. In the case of the PneuLog® testing, a split sample will be collected at each sampling location. The split sample will be collected within a laboratory-supplied Summa canister and submitted to an Arizona-licensed laboratory for analysis of VOCs by U.S. EPA Method TO-15.

4.2.5 PneuLog® Testing

Following the conclusion of baseline testing, PneuLog® testing will commence in well PER-14A, followed by PneuLog® testing in VEL-3. The testing will be conducted and vapor samples will be conducted in accordance with the SOP provided in Appendix C.

4.2.6 SVE Testing

SVE testing will be performed at VEL-3 following conclusion of the PneuLog® testing. A step-down test will be conducted to evaluate the air flow rate versus vacuum relationship. A dilution air valve on the vacuum side of the blower will be used to vary the vacuum applied to the VEL-3 wellhead. A digital manometer or a magnehelic gauge will be used to measure the applied vacuum at the wellhead. A thermal anemometer will be used to measure the air flow from the well at each of the applied vacuums. Wellhead vacuum and associated air flow rates will be recorded on field data sheets.

Following the step-down test, a 3-day extraction test will be conducted at VEL-3. VEL-3 has a screened interval from 160 to 190 feet bgs. Flow rate, wellhead vacuum, blower vacuum, and observation well vacuum, and vapor concentrations (as measured with a photoionization detector [PID]) will be measured and recorded at regular intervals throughout the test. Vacuums at selected observation wells will also be recorded throughout the test to evaluate the vacuum radius of influence. Observation points will consist of each of the four screened intervals in VML-1 and VML-2 (screened intervals of 125-130 feet bgs, 145-150 feet bgs, 165-170 feet bgs, and 185-190 feet bgs), PER-14A (screened interval of 178-248 feet bgs), WR-347B (screened interval of 180-235 feet bgs), and MLR-7 (screened interval of 210-280 feet bgs). Samples of extracted vapor will be collected at 8-hour intervals throughout the 3-day test. In addition, soil vapor samples will be collected from each of the four screened intervals within VML-2 at 8-hour intervals. The samples will be collected in Tedlar bags and shipped to Praxis' facility in California for analysis of VOCs by GC. Split samples will be collected in laboratory-supplied Summa canisters and shipped to an Arizona-licensed laboratory for analysis of VOCs using U.S. EPA Method TO-15. Split samples will be collected at a frequency of one sample for every 10 samples analyzed with the field GC.

During testing, the performance of the vapor abatement system (GAC and permanganate) will be monitored using a hand-held PID (10.6 eV lamp, calibrated with isopropylene). A single influent sample and a single effluent sample will be collected using Summa canisters and analyzed for VOCs using U.S. EPA Method TO-15 in order to demonstrate the removal efficiency of the vapor abatement system.

4.2.7 Rebound Sampling

At the conclusion of the 3-day SVE test, the system will be shut down and removed from site. The day following the conclusion of the SVE test, soil vapor samples will be collected from VEL-3, PER-14A, and each of the four depth-specific sampling intervals in VML-1 and VML-2. The samples will be collected in Tedlar bags or Summa canisters in accordance with the soil vapor sampling standard operating procedure (SOP) as provided in Appendix B. The majority of samples will be collected in Tedlar bags and shipped to Praxis' office for analysis of VOCs by GC (i.e., modified U.S. EPA Method 18). Split samples will be collected for confirmation of the GC analyses at a rate of ten percent. The split sample will be collected within a laboratory-supplied Summa canister and submitted to an Arizona-licensed laboratory for analysis of VOCs by U.S. EPA Method TO-15.

Additional post-SVE-test samples will be collected from the same wells 14 and 30 days following the conclusion of the SVE test and analyzed as described above.

4.2.8 Quality Control Sampling

Field duplicate samples will be collected at a frequency of one per every 10 field original samples collected. Ambient air blanks and equipment blank samples will also be collected at a frequency of ten percent or at a minimum of one per day.

4.2.9 Summary of Soil Vapor Sampling

The table below summarizes the total number of soil vapor and quality control samples to be collected during the PneuLog® testing and SVE pilot test.

	Number of Samples					
	Tedlar Bag Field Originals for GC Analysis	Tedlar Bag Field Duplicates for GC Analysis	Summa Canister Field Originals for TO-15 Analysis	Summa Canister Field Duplicates for TO-15 Analysis	Equipment Blanks	Ambient Blanks
Baseline Sampling	10	1	1	-	1	1
PneuLog® Testing	6	1	6	1	1	1
SVE Testing	45	5	5	1	5	5
Rebound Testing	30	3	3	-	3	3
Total	91	10	15	2	9	9

4.2.10 Data Analysis and Reporting

The data collected during the PneuLog® and SVE pilot testing will be tabulated and summarized in a technical memorandum. The memorandum will include conclusions regarding the feasibility of SVE within the LVZ. The memorandum will be included in the Feasibility Study Report (Section 4.4.5) as an appendix.

4.3 VAPOR INTRUSION RISK ASSESSMENT

4.3.1 Rationale for Vapor Intrusion Risk Assessment

A human health risk assessment (HHRA) will be performed to evaluate current or potential future threats to human health from VOCs in soil and groundwater at the Site under existing or anticipated future conditions. The HHRA will be limited to evaluating potential exposure of residents and commercial/industrial workers to VOCs in indoor air via vapor intrusion from soil and groundwater. Soil gas concentrations will be used with USEPA's (2004a) SG-ADV-Feb 04 Johnson and Ettinger model to predict indoor air concentrations in residences and industrial buildings.

4.3.2 Soil Vapor Sampling Plan

Two types of data will be used to evaluate the potential for vapor intrusion to indoor air and the potential risk to human health:

a) Soil vapor data collected from permanent soil vapor monitoring points VW-1 through VW-7. These data are currently being collected on a quarterly basis under the long-term monitoring program for the Site.

b) Soil vapor data collected from six proposed shallow probes. The tentative proposed locations for the six proposed vapor probes are presented in Figure 7.

4.3.2.1 Access Agreements/Right-of-Way Permitting

The temporary locations proposed for soil vapor sampling will be field verified, where possible, based on public access to the location. A decision will be made for each of the soil vapor sampling locations to be located within City right-of-way or on private property. As shown in Figure 7, three of the proposed locations will likely be within the City right-of-way and three locations will likely be on private property. Based on the location, applications will be made to install the sampling point within the public right-of-way or to negotiate an access agreement.

The three proposed locations within the public right-of-way will be surveyed and figures developed to support the permit application and provide utility clearance. The right-of-way permit application will be submitted to the City of Tucson Transportation Department along with applicable fees.

Locations of the three sampling points on private property will be finalized based on negotiation with the respective property owner.

4.3.2.2 Utility Clearance

At least two full business days prior to ground-disturbing activities, Bluestake will be contacted to provide utility clearance of the proposed soil vapor sampling locations. A private locator will be used to verify that the proposed locations do not conflict with on-site underground utilities. Should underground utility conflicts be identified, the sampling point will be shifted to provide clearance.

4.3.2.3 Soil Vapor Sampling Point Installation

A direct push rig will be used to install vapor monitoring points that will be screened from five to six feet below ground surface (bgs) at each of the sampling locations in order to correspond with the five-foot sampling interval of the permanent soil vapor points.

Each boring will be advanced using a 1.5-inch outside-diameter steel rod. Once the desired depth is achieved, the rod will be retracted and the vapor monitoring point constructed as shown in Figure 8. The vapor monitoring point will consist of a 3/8-inch inside diameter by 1-foot-long Geoprobe stainless steel implant (AT9637) placed in 10/20 silica sand at the desired depth. The implant will be connected to the surface using ¼-inch outside diameter Teflon PFA tubing. The tubing will terminate with a brass Swagelok tube fitting and cap. The boring will be sealed from the top of the filter pack to the surface with bentonite. The capped tubing will be protected by a 4-inch wellhead with a concrete skirt.

4.3.2.4 Soil Vapor Sampling

Soil vapor samples will be collected from the newly installed vapor sampling points as close to quarterly soil vapor long-term monitoring at the Mission Plant Site as possible to provide comparable data. Ideally, the sampling points will be allowed to equilibrate for a minimum of one day prior to purging. Sampling points will be purged and soil vapor samples collected in accordance with the soil vapor sampling procedure provided in Appendix B. Summa canisters will be used to collect the soil vapor samples. 20 mL/min flow controllers will be attached to the canister and opened, allowing the soil vapors to be captured in the 1-liter container. Fill times of 50 minutes are anticipated. A leak detection compound will be introduced in the vicinity of the sampling system by saturating a towel with 1,1-diflouroethane (1,1, DFA), and placing it at the surface around the drill rod. This process will be repeated at each sampling location. The compound 1,1-DFA will be added to the TO-15 analyte list as a tentatively identified compound.

Once the soil vapor sample is collected, the canister will be closed, labeled, and prepared for transport to an Arizona-licensed laboratory for analysis of VOC's by US EPA Method TO-15. The sample will be handled under standard chain-of-custody procedures.

A single field duplicate sample and one equipment blank sample will be collected for quality assurance purposes.

Field notes detailing sampling procedures will be completed along with a copy of the Quality Assurance Checklist for Soil Gas Sampling (see Appendix B).

The probes will remain in place in the event that additional shallow soil vapor sampling is required in the future. For the purposes of this Work Plan, however, a single sampling event will occur.

4.3.3 Risk Modeling

4.3.3.1 Screening Level Analysis

Maximum detected concentrations of VOCs in soil gas across the entire site will be multiplied by an attenuation factor of 0.01. The attenuated values will be compared to USEPA Region 9 Regional Screening Levels (RSLs) for residential indoor air (USEPA, 2012). As of the date of this Work Plan, the most recent RSL summary table was updated on May 2012; however, URS will reference the most current RSL summary table at the time the soil gas data are evaluated. Attenuated concentrations of VOCs in soil gas that exceed their respective RSLs will be selected for further evaluation in the risk assessment.

4.3.3.2 Modeling and Analysis

The following site-specific information will be obtained (in some cases, USEPA 2004a default values may be used instead of site-specific values) and entered into the Johnson & Ettinger (J&E) model for both residential and industrial scenarios.

- Soil gas concentration
- Soil gas sampling depth below grade
- Average soil temperature
- Site-specific soil types, thicknesses, dry bulk density, total porosity, and water-filled porosity for up to three soil strata

The following default values will be used for the residential scenario:

- Depth below grade to bottom of enclosed space floor: 15 cm, based on USEPA (2004a) default value for slab-on-grade buildings
- Enclosed space floor thickness: 10 cm, based on USEPA (2004a) default value
- Soil-building pressure differential: 40 grams per centimeter seconds squared (g/cmseconds2), based on USEPA (2004a) default value
- Enclosed space floor length: 1000 cm, based on USEPA (2004a) default value
- Enclosed space floor width: 1000 cm, based on USEPA (2004a) default value

- Enclosed space height: 366 cm, based on USEPA (2004a) default value for residences
- Floor-wall seam crack width: 0.1 cm, based on USEPA (2004a) default value
- Indoor air exchange rate: 0.25 exchange per hour, based on USEPA (2004a) default value for residences
- Average vapor flow rate into building: 5 liters per minute, based on USEPA (2004a) default value

The following default values will be used for the industrial scenario:

- Depth below grade to bottom of enclosed space floor: 15 cm, based on USEPA (2004b) default value for slab-on-grade buildings
- Enclosed space floor thickness: 10 cm, based on USEPA (2004a) default value
- Soil-building pressure differential: 40 grams per centimeter seconds squared (g/cmseconds2), based on USEPA (2004a) default value
- Enclosed space floor length: 1000 cm, based on USEPA (2004a) default value
- Enclosed space floor width: 1000 cm, based on USEPA (2004a) default value
- Enclosed space height: 244 cm, based on USEPA (2004b) default value for commercial/industrial buildings
- Floor-wall seam crack width: 0.1 cm, based on based on USEPA (2004a) default value
- Indoor air exchange rate: 1 exchange per hour, based on USEPA BASE study (NISTIR 2004) for commercial/industrial buildings
- Average vapor flow rate into building: 5 liters per minute, based on USEPA (2004a) default value

4.3.4 Vapor Intrusion Risk Assessment Report

4.3.4.1 Data Evaluation

Analytical data will be evaluated and organized into a form appropriate for baseline risk assessment. A primary purpose of the evaluation of data usability is to select validated analytical results that are of adequate quality for use in quantifying risks.

4.3.4.2 Selection of COPCs

Maximum detected concentrations of VOCs in soil gas that were selected for further evaluation (see Section 4.3.3.1) will be used with the J&E model to predict maximum concentrations of VOCs in residential indoor air across the entire site. These predicted indoor air concentrations will be compared to USEPA (2012) Regional Screening Levels (RSLs) for residential air. VOCs with predicted indoor air concentrations that exceed their respective RSLs for residential air will be selected as chemicals of potential concern (COPCs) for further evaluation in the risk assessment.

4.3.4.3 Exposure Assessment

The exposure assessment will describe the methodology to be used to identify human exposure scenarios; calculate exposure point concentrations (EPCs); identify exposure factors; and calculate intake for each COPC, exposure pathway, and receptor.

Exposure scenarios evaluated in the HHRA will include current and potential future residential and commercial/industrial worker scenarios. The exposure pathway evaluated in the HHRA will be inhalation of VOCs in indoor air. USEPA standard default exposure factor values for the RME condition will be used for evaluating commercial/industrial workers and residents.

At each sampling location that has one or more COPC, concentrations of COPCs in soil gas will be used with the J&E model to predict indoor air concentrations for residents and commercial/industrial workers. The predicted indoor air concentrations will be the EPCs used in the risk assessment.

The USEPA recently updated their methods for evaluating inhaled chemicals (USEPA 2009). Previous methods utilized equations that used inhalation rates and body weights of typical receptors to derive an inhaled dose (mass) of chemical. Current methods recognize that the exposure concentration, the pattern of exposure (e.g., intermittent versus continuous), and the ultimate organ or organ system that is affected by a chemical, all interact to affect the response in an exposed receptor. USEPA (2009) methodology will be used to calculate ACs for non-carcinogens or lifetime average concentrations (LAC) for carcinogens.

4.3.4.4 Toxicity Assessment

Inhalation toxicity values used for COPCs will be selected in accordance with USEPA (2003) as outlined below:

- Tier 1 – Integrated Risk Information System (IRIS), available on-line (USEPA 2011)
- Tier 2 – USEPA’s Provisional Peer-Reviewed Toxicity Values (PPRTVs)
- Tier 3 - other provisional toxicity values (e.g., from the California Environmental Protection Agency [CalEPA] (CalEPA 2011), Agency for Toxic Substances and Disease Registry (ATSDR 2010), and USEPA’s Health Effects Assessment Summary Tables [USEPA 1997]) obtained from USEPA RSL tables (USEPA 2012)

4.3.4.5 Risk Characterization

The risk characterization step will apply the toxicity factors in conjunction with intake of COPCs to estimate the noncarcinogenic hazard index (HI) and carcinogenic risk (CR). HI and CR for residents and commercial/industrial workers will be calculated for each soil gas sampling location.

The National Contingency Plan (NCP) (USEPA 1990) must be considered to interpret the significance of HI and CR estimates for individuals. CRs at or below USEPA’s point of departure of 1E-06 (1 in a million risk) and HIs at or below 1 are considered acceptable. The NCP also states that: “For known or suspected carcinogens, acceptable exposure levels are generally concentration levels that represent an excess upper bound lifetime CR to an individual of between 10^{-4} [1E-04] and 10^{-6} [1E-06].” Unacceptable risk may be associated with an HI greater than 1 or CR greater than 1E-04.

Uncertainties are inherent in the risk assessment process because of the numerous assumptions that are made in estimating exposure, toxicity, and potential risk. Per USEPA guidance (USEPA, 1989), conservative assumptions are made throughout the risk assessment process so as not to underestimate potential risk. On the other hand, some uncertainties may contribute to underestimating exposure and risk. The HHRA will include an evaluation of uncertainties related to the risk assessment in order to place the risk estimates in perspective and to assist in risk-based decision-making.

4.4 FEASIBILITY STUDY

Based on the updated Conceptual Site Model as developed from the RI Report (TTG, 2011) and recent data (e.g., URS, 2011c), an FS will be performed with the purpose of developing a reference remedy and two alternative remedies for: a) the UVZ; b) the Perched Aquifer; c) the LVZ; and, d) the Regional Aquifer combined. Each remedy will consist of a combination of a remedial strategy or strategies and remedial measures that will achieve the ROs for the Site.

The FS will be conducted in accordance with the Arizona Administrative Code (A.A.C.) R18-16-407.

4.4.1 Remedy Development

In developing the reference remedy and two alternative remedies, the remedial strategies itemized in AAC R18-16-407(F) and remedial measures presented in AAC R18-16-407(F) will be considered. Each of these alternatives will consist of multiple components, as necessary, to address the various hydrogeologic units (i.e., UVZ, Perched Aquifer, LVZ, and Regional Aquifer).

As stipulated by AAC R18-16-407(F), the following strategies will be considered in development of the reference remedy and alternative remedies:

- Plume remediation to achieve water quality standards for COCs throughout the Site;
- Containment within specific boundaries;
- Controlled migration;
- Source control (must be an element each of the developed remedies);
- Monitoring; and
- No action.

For a remedial strategy involving plume remediation, various remedial technologies will be screened to determine whether such technologies are applicable to the Site and should be retained for further consideration. If necessary, a pilot test may be proposed to evaluate a specific technology.

As stipulated in AAC R18-16-407(F), should a remedial measure such as well replacement, well modifications, wellhead treatment, or replacement of water supplies be proposed as part of the considered remedy, such measures will be developed in consultation with the UA and City of Tucson.

For each remedy, supporting documentation will be prepared to show that the remedy will meet the ROs, that the remedy is consistent with water management plans for the UA and the City of Tucson, and that the remedy is consistent with general land use plans of the City of Tucson.

4.4.2 Remedy Comparison

The practicability, protectiveness, and cost considerations of each remedy will be evaluated as required by AAC R18-16-407(H). Where appropriate the groundwater model will be used to support such evaluation. Detailed cost estimates will be developed for each remedy to evaluate the cost considerations. Supporting documentation for the evaluation will be included in the Feasibility Study Report (Section 4.4.5). Criteria will be developed for the comparison of the remedies.

4.4.3 Proposed Remedy

Based on the comparison of the reference and alternative remedies, a remedy will be proposed and the reasons for the selection will be documented.

4.4.4 Pilot Testing

If, based on the development of a remedial strategy and evaluation of remedial technologies, additional bench scale testing or pilot testing is deemed necessary, the plan for such pilot testing will be developed and submitted for ADEQ approval.

4.4.5 Feasibility Study Report

An FS Report documenting the development and comparison of a minimum of three remedies will be prepared The FS Report will present the proposed remedy and the reasons for selecting the remedy. Associated activities, such as groundwater modeling and the vapor intrusion risk assessment, will be presented as appendices to the report.

The FS Report will be presented as a Draft document to ADEQ to allow ADEQ to review and comment. Upon receipt of comments from ADEQ, a Final Draft will be prepared for community review and comment prior to submittal of a Final FS Report.

ADEQ prepared a Community Involvement Plan (CIP) for the Site in accordance with the AAC R18-16-404 and A.R.S §49-287.03. The CIP was originally published September 2004 and was prepared by ADEQ and LL Decker & Associates (ADEQ, 2004). At this time, it is recommended that ADEQ retain responsibility for leading community involvement activities with support from the RPs.

Community involvement activities by the RPs for the FS will include a short presentation at an ADEQ-led Community Advisory Board (CAB) meeting to summarize plans for groundwater modeling, the vapor intrusion evaluation, the SVE pilot test, and the draft FS. Following completion of these activities, another presentation will be prepared to present the results of the FS and associated activities to the CAB. Regular community correspondence provided by ADEQ will include any applicable information on the FS activities deemed appropriate by ADEQ.

The proposed schedule for the activities described in this Work Plan is presented in Figure 9.

Agency for Toxic Substances and Disease Registry (ATSDR). 2010. Minimum Risk Levels (MRLs) for Hazardous Substances. December. Online at: http://www.atsdr.cdc.gov/ mrls/index.asp.

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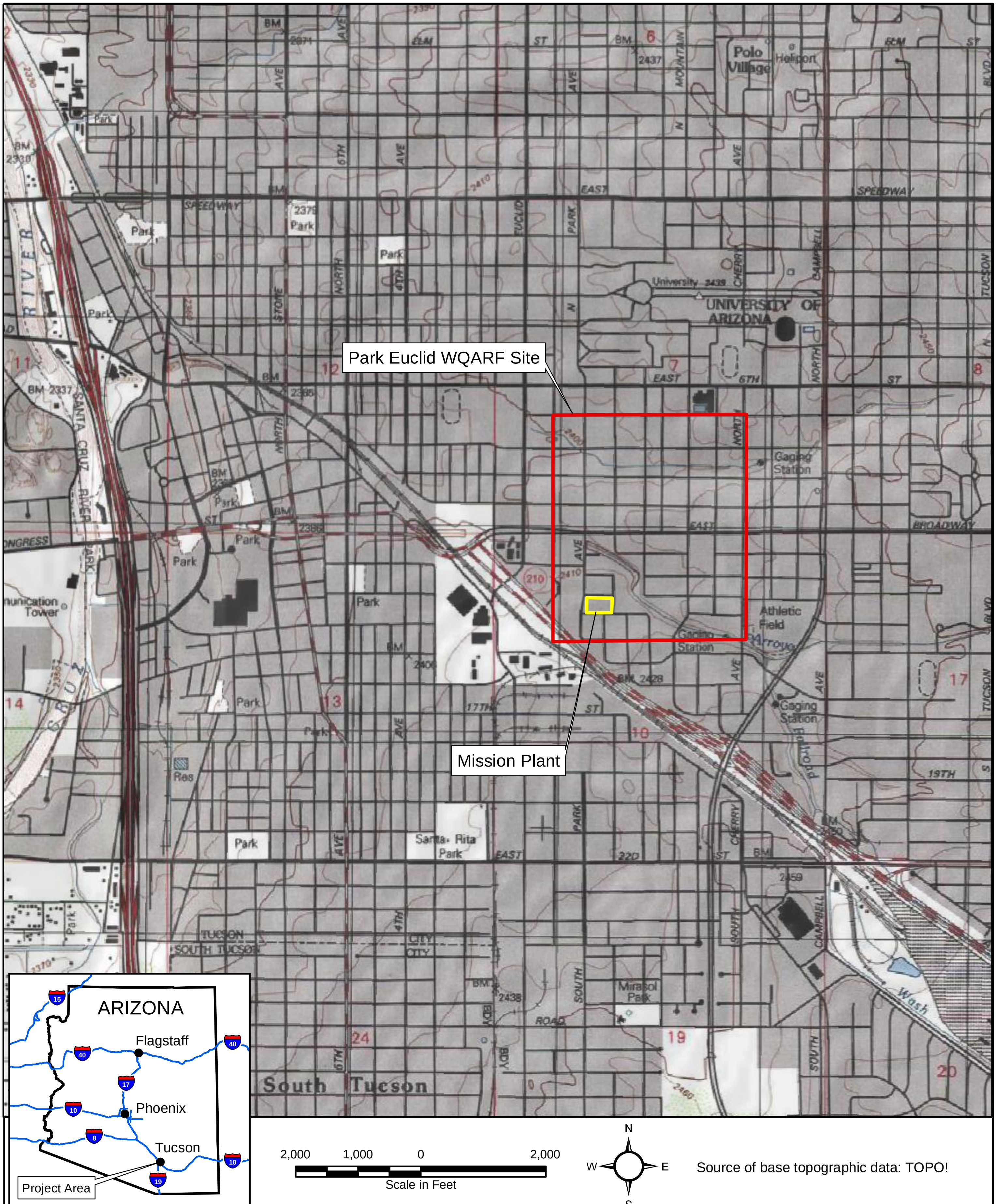


URS

Project Name: Park-Euclid WQARF Site

Job No: 22241866

Date: January 2013

SITE LOCATION
PARK-EUCLID WQARF SITE
301 SOUTH PARK AVENUE
TUCSON, ARIZONA

Y:/GIS/Projects/Mission/Park_Euclid/Proj13/FS_Final/Fig1_SiteLocation.mxd

Figure 1

Source: Bing Maps aerial imagery web mapping service, (c) 2009 Microsoft Corporation and its data suppliers.

URS

Project Name: Park-Euclid WQARF Site

Job No: 22241866

Date: January 2013

WELL LOCATIONS
PARK-EUCLID WQARF SITE
301 SOUTH PARK AVENUE
TUCSON, ARIZONA

Y:/GIS/Projects/Mission/Park_Euclid/Proj13/FS_Final/Fig2_Wells.mxd

Figure 2

Aerial Photography Source: Pima County, Arizona GIS 2010

URS

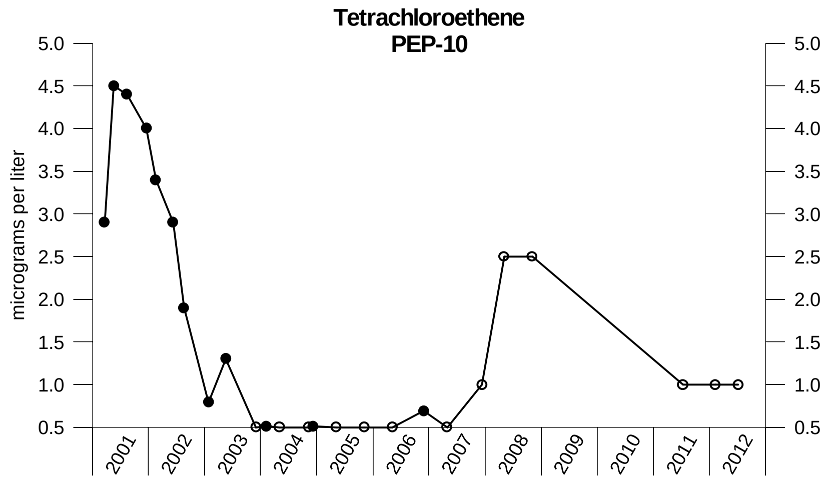
Project Name: Park-Euclid WQARF Site

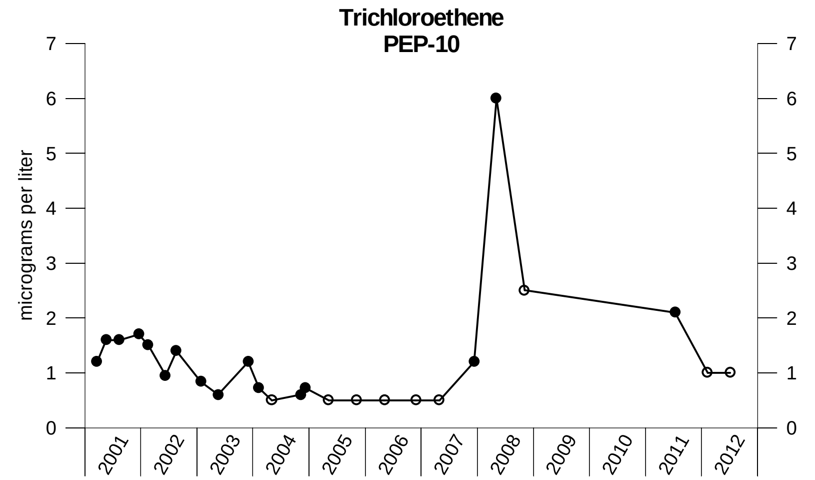
Job No: 22241866 | Date: January 2013

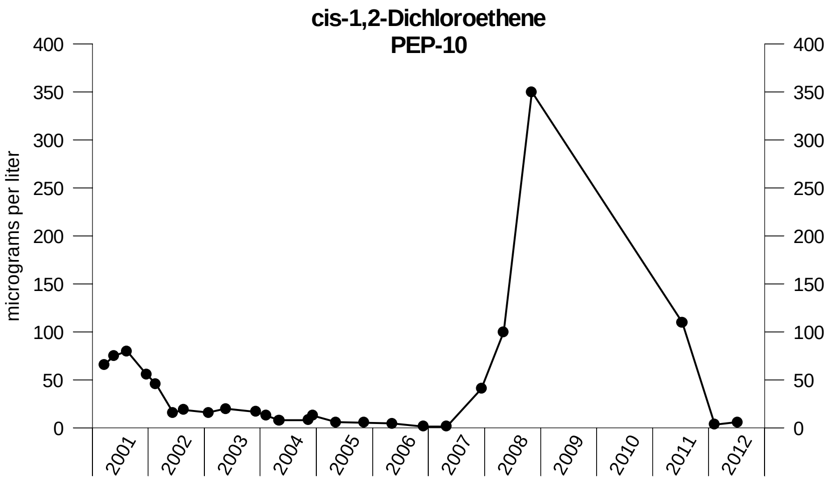
WELL LOCATIONS AT MISSION PLANT AREA
PARK-EUCLID WQARF SITE
301 SOUTH PARK AVENUE
TUCSON, ARIZONA

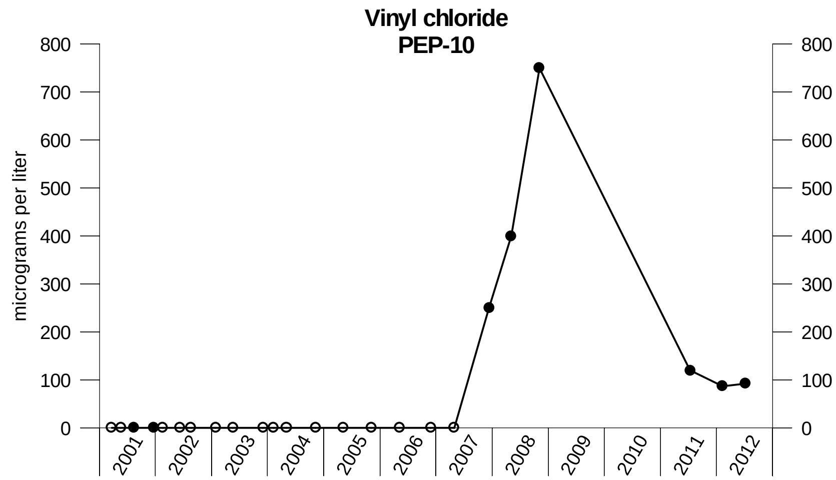
Proj/Mission.../Park_Euclid/Proj13/FS_Final/Fig3_Plant_Wells.mxd

Figure 3









EXPLANATION

- ● - Detected Concentration
- ○ - Not Detected (Shown as RL)

URS

Project Name: Park - Euclid WQARF Site

Job No: 22241866 | Date: January 2013

VOC Concentration Versus Time
Perched Aquifer Monitoring Well PEP-10
Park - Euclid WQARF Site
Tucson, Arizona

Figure 4

Note:
NS - Not Sampled, WR-345B could not be accessed due to nearby construction activities.

Aerial Imagery Source: Orthophoto provided by Pima Association of Governments, Pima County, Arizona, 2010

URS

Project Name: Park-Euclid WQARF Site

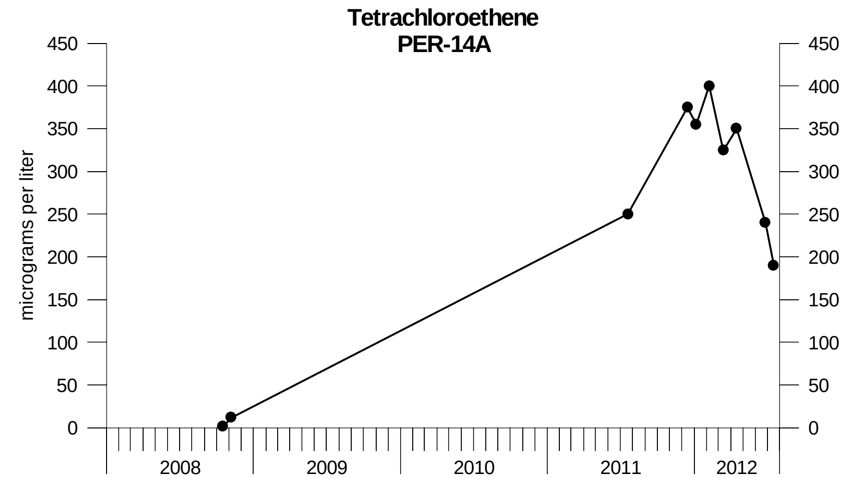
Job No: 22241866

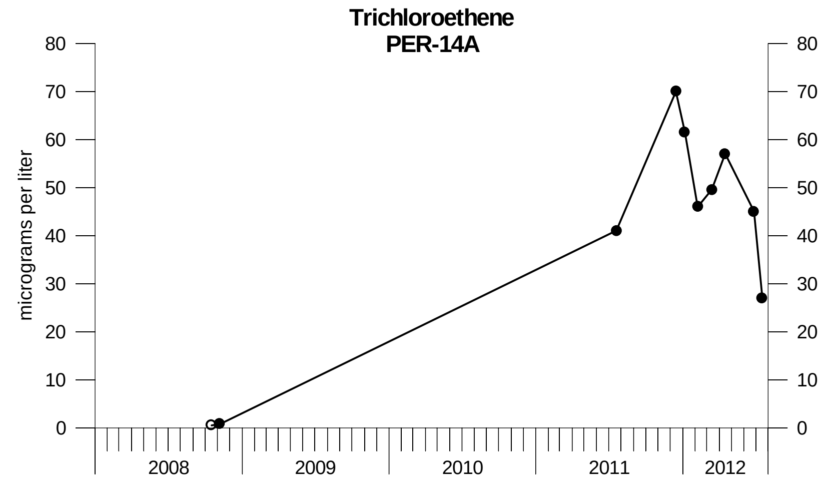
Date: January 2013

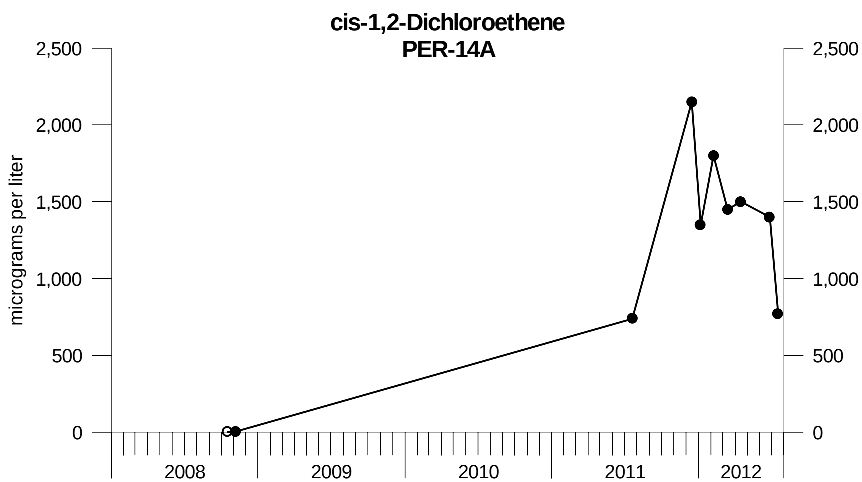
PCE DISTRIBUTION IN REGIONAL GROUNDWATER, JULY 2012
PARK-EUCLID WQARF SITE
TUCSON, ARIZONA

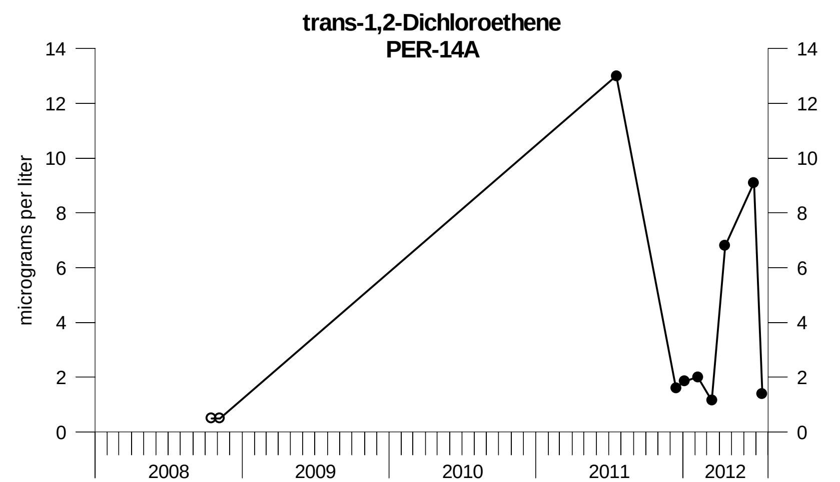
Mission.../P-E/Proj13/FS_Final/Fig5_RA_PCE_July2012.mxd

Figure 5









EXPLANATION

- ● - Detected Concentration
- ○ - Not Detected (Shown as RL)

URS

Project Name: Park - Euclid WQARF Site

Job No: 22241866 | Date: January 2013

VOC Concentration Versus Time
Regional Aquifer Monitoring Well PER-14A
Park - Euclid WQARF Site
Tucson, Arizona

Figure 6

Note:

Aerial Imagery Source: Orthophoto provided by Pima Association of Governments, Pima County, Arizona, 2010

URS

Project Name: Park-Euclid WQARF Site

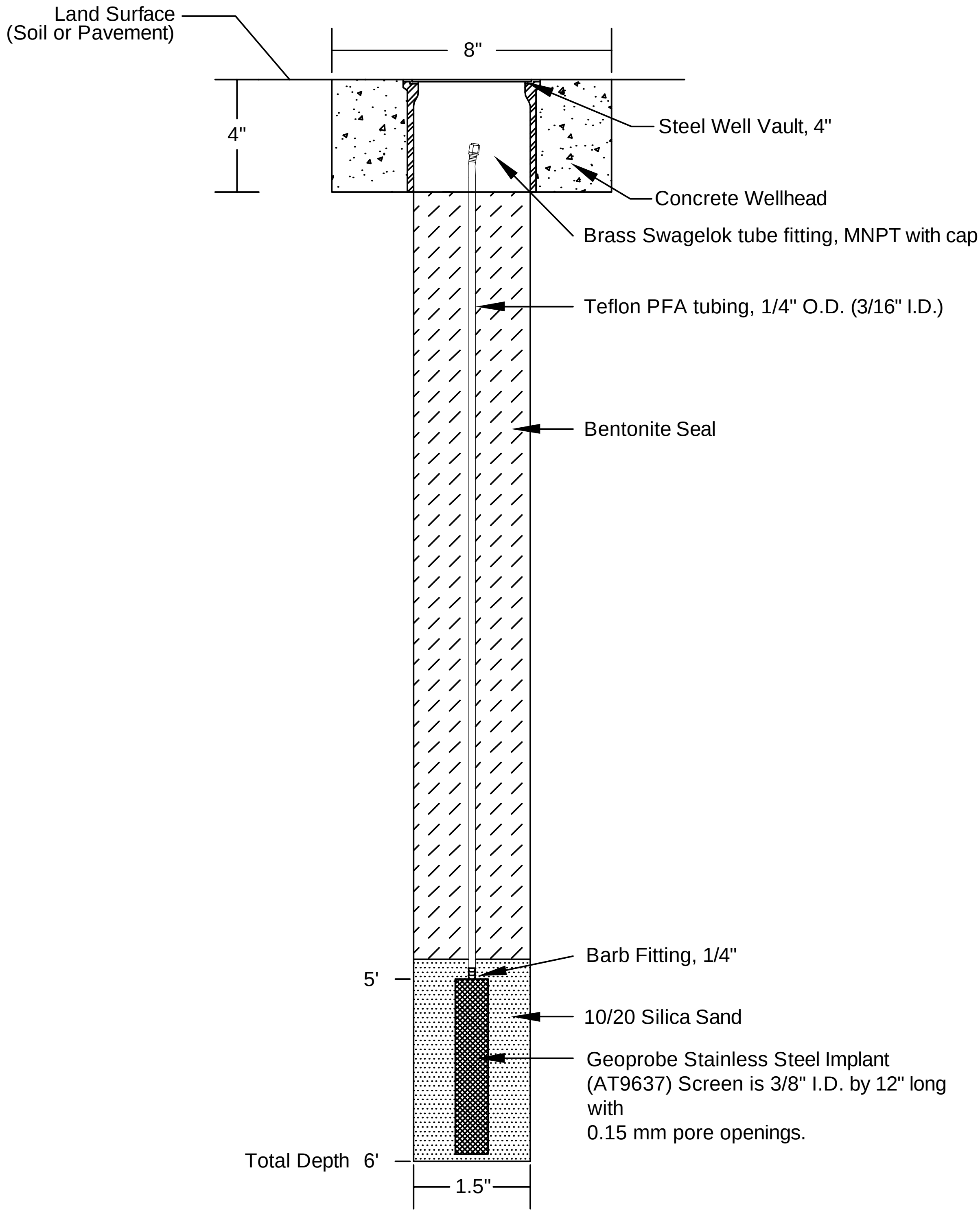
Job No: 22241866

Date: January 2013

PROPOSED SOIL GAS MONITORING POINTS
VAPOR INTRUSION INVESTIGATION
PARK-EUCLID WQARF SITE
TUCSON, ARIZONA

P-E/Proj13/FS_Final/Fig_prop_SG_pnts_SV_PCE_5ft_July2012.mxd

Figure 7



DRAWING NOT TO SCALE

:\GIS\Projects\Mission_Linen\Park_Euclid\Projects13\FS_Final\ Fig8_OVP-1_Well Construction.dwg

URS

Project Name: Park-Euclid WQARF Site

Job No: 22241866 | Date: January 2013

PROPOSED CONSTRUCTION
FOR SOIL VAPOR SAMPLING POINT
(TYPICAL)

PARK-EUCLID WQARF SITE
TUCSON, ARIZONA

Figure 8

ID	Task Name	Duration	Start	Finish
1	Work Plan Submittal	1 day	Mon 1/7/13	Mon 1/7/13
2	ADEQ Review of Work Plan	3 wks	Tue 1/8/13	Mon 1/28/13
3	Opportunity for Public Comment	1 mon	Tue 1/29/13	Mon 2/25/13
4	Response to Comments	2.5 wks	Tue 2/26/13	Thu 3/14/13
5	Work Plan Approval	1 day	Thu 3/14/13	Fri 3/15/13
6	**CAB Meetings**	**387.5 days**	**Wed 1/16/13**	**Fri 7/11/14**
7	Presentation of FS Work Plan	1 day	Wed 1/16/13	Wed 1/16/13
8	Presentation of Intermediate Results	1 day	Thu 10/31/13	Fri 11/1/13
9	Presentation of FS Report	1 day	Thu 7/10/14	Fri 7/11/14
10	**Regional GW Monitoring Well Installation**	**154 days**	**Fri 3/15/13**	**Thu 10/17/13**
11	Well Installation Work Plan Preparation	3 wks	Fri 3/15/13	Fri 4/5/13
12	Submit Well Installation Work Plan	1 day	Fri 4/5/13	Mon 4/8/13
13	ADEQ Review of Well Install Work Plan	3 wks	Mon 4/8/13	Mon 4/29/13
14	ADEQ Well Install Work Plan Approval	1 day	Mon 4/29/13	Tue 4/30/13
15	Negotiate Access Agreement/ROW Permit	6 mons	Fri 3/15/13	Fri 8/30/13
16	Receive Signed Agreement/Permit	1 day	Fri 8/30/13	Mon 9/2/13
17	Utility Clearance	1 day	Mon 9/16/13	Tue 9/17/13
18	Well Installation and Development	1 wk	Tue 9/17/13	Tue 9/24/13
19	Initial Well Sampling	1 day	Tue 10/1/13	Wed 10/2/13
20	Receive Laboratory Results	1 day	Wed 10/16/13	Thu 10/17/13
21	**Groundwater Modeling**	**264 days**	**Fri 5/10/13**	**Thu 5/15/14**
22	Compile and Review Existing Data	4 wks	Fri 5/10/13	Fri 6/7/13
23	Conceptual Model Update	2 wks	Fri 6/7/13	Fri 6/21/13
24	Develop Groundwater Flow Model	3 wks	Fri 6/21/13	Fri 7/12/13
25	Develop Fate and Transport Model	2 wks	Thu 10/17/13	Thu 10/31/13
26	Model FS Alternatives	6 mons	Wed 10/16/13	Wed 4/2/14
27	Groundwater Modeling Report	6 wks	Wed 4/2/14	Wed 5/14/14
28	Report Finalized	1 day	Wed 5/14/14	Thu 5/15/14
29	**Pilot Testing**	**98 days**	**Thu 4/11/13**	**Tue 8/27/13**
30	Coordination and Permitting	8 wks	Thu 4/11/13	Thu 6/6/13
31	Baseline Sampling	1 day	Thu 6/6/13	Fri 6/7/13
32	Pneulog Testing	1 day	Fri 6/7/13	Mon 6/10/13
33	SVE Testing	3 days	Mon 6/10/13	Thu 6/13/13
34	Rebound Sampling	22 days	Thu 6/13/13	Mon 7/15/13
35	Data Analysis and Reporting	6 wks	Mon 7/15/13	Mon 8/26/13
36	Technical Memorandum	1 day	Mon 8/26/13	Tue 8/27/13
37	**Vapor Intrusion Risk Assessment**	**162 days**	**Fri 3/15/13**	**Tue 10/29/13**
38	Negotiate Access Agreements/ROW Permits	6 mons	Fri 3/15/13	Fri 8/30/13
39	Receive Signed Agreements/ROW Permits	1 day	Fri 8/30/13	Mon 9/2/13
40	Utility Clearance	48 hrs	Mon 9/16/13	Tue 9/24/13
41	Vapor Sampling Point Installation	2 days	Tue 9/24/13	Thu 9/26/13
42	Soil Vapor Sampling	2 days	Thu 9/26/13	Mon 9/30/13
43	Data Evaluation and Risk Analysis	4 wks	Mon 9/30/13	Mon 10/28/13
44	Technical Memorandum	1 day	Mon 10/28/13	Tue 10/29/13
45	**Feasibility Study**	**406 days**	**Fri 3/15/13**	**Mon 10/6/14**
46	Technology/Measure Screening	4 wks	Fri 3/15/13	Fri 4/12/13
47	Develop and Evaluate Alternatives	8 mons	Wed 10/16/13	Wed 5/28/14
48	FS Report Preparation	6 wks	Wed 5/28/14	Wed 7/9/14
49	Submit Report	1 day	Wed 7/9/14	Thu 7/10/14
50	ADEQ Review of FS Report	6 wks	Thu 7/10/14	Thu 8/21/14
51	Receive ADEQ Comments	1 day	Thu 8/21/14	Fri 8/22/14
52	Address ADEQ Comments and Finalizes FS I	6 wks	Fri 8/22/14	Fri 10/3/14
53	Submit Final FS Report	1 day	Fri 10/3/14	Mon 10/6/14

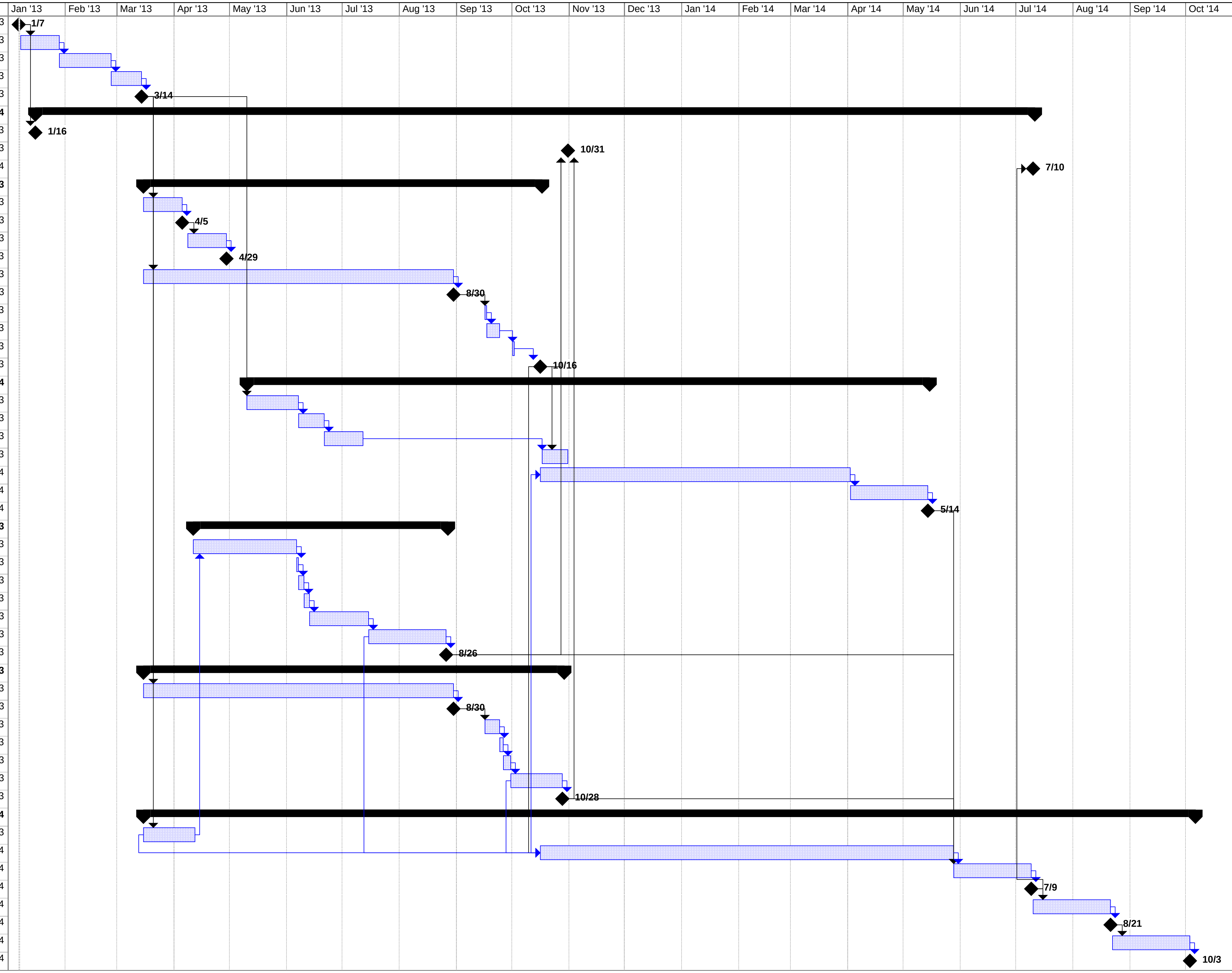


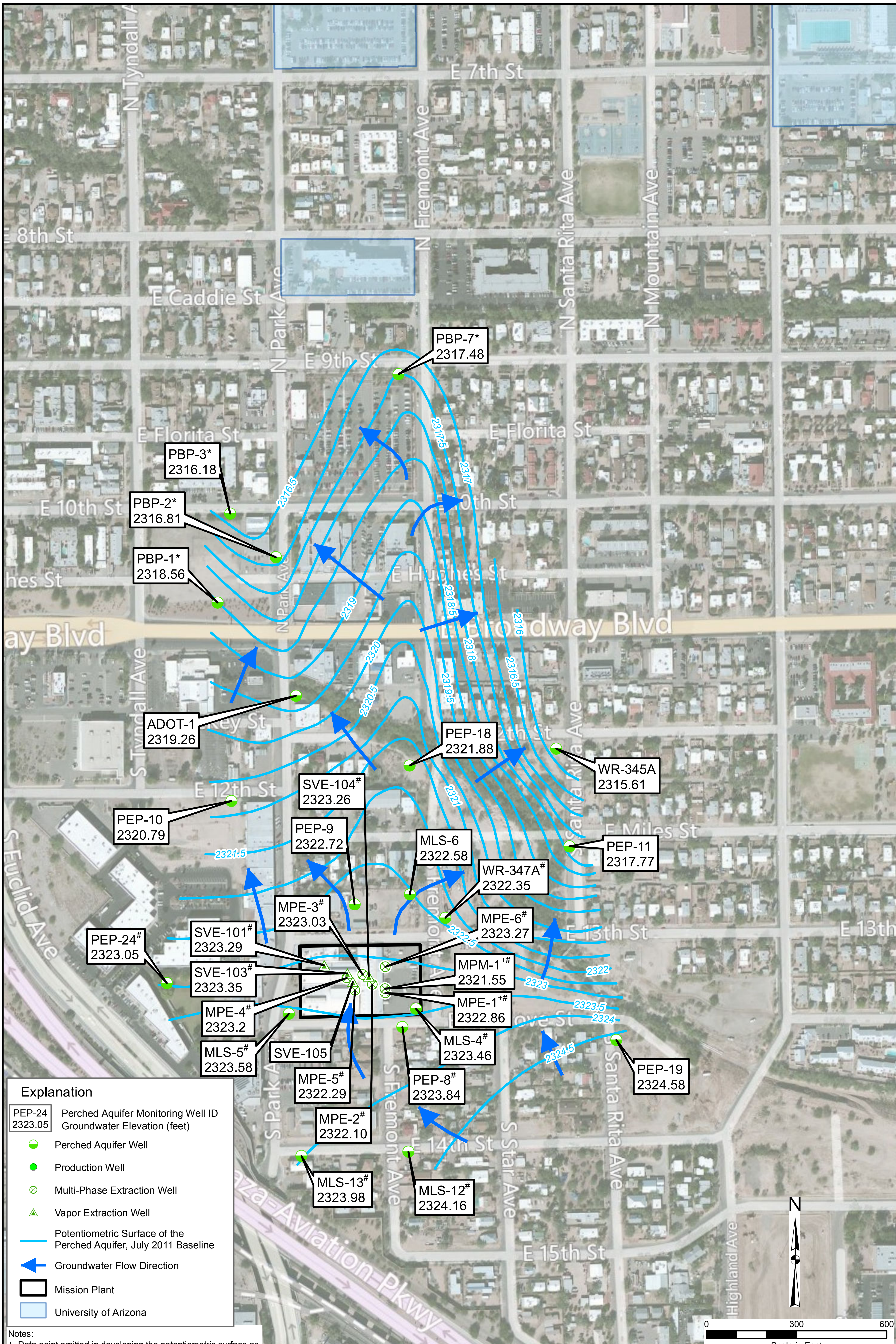
Figure 9
Park Euclid Feasibility Study Schedule
Date: Mon 1/7/13

Task	Milestone	Rolled Up Task	Rolled Up Progress	External Tasks	Group By Summary
Progress	Summary	Rolled Up Milestone	Split	Project Summary	

Appendix A

Potentiometric Surface and COC Distribution Maps for 2011 Baseline Monitoring Event

Appendix A
Potentiometric Surface and COC Distribution Maps for 2011 Baseline Monitoring Event



Notes:
+ Data point omitted in developing the potentiometric surface as it is anomalous with nearby wells.
* Data posted for wells PBP-1, PBP-2, PBP-3, and PBP-7 are from June 2011, as they were not measured in July 2011.
# Groundwater elevations at wells containing product reflect corrected elevations accounting for LNAPL thickness and density.

Source: Bing Maps aerial imagery web mapping service, (c) 2009 Microsoft Corporation and its data suppliers.

URS

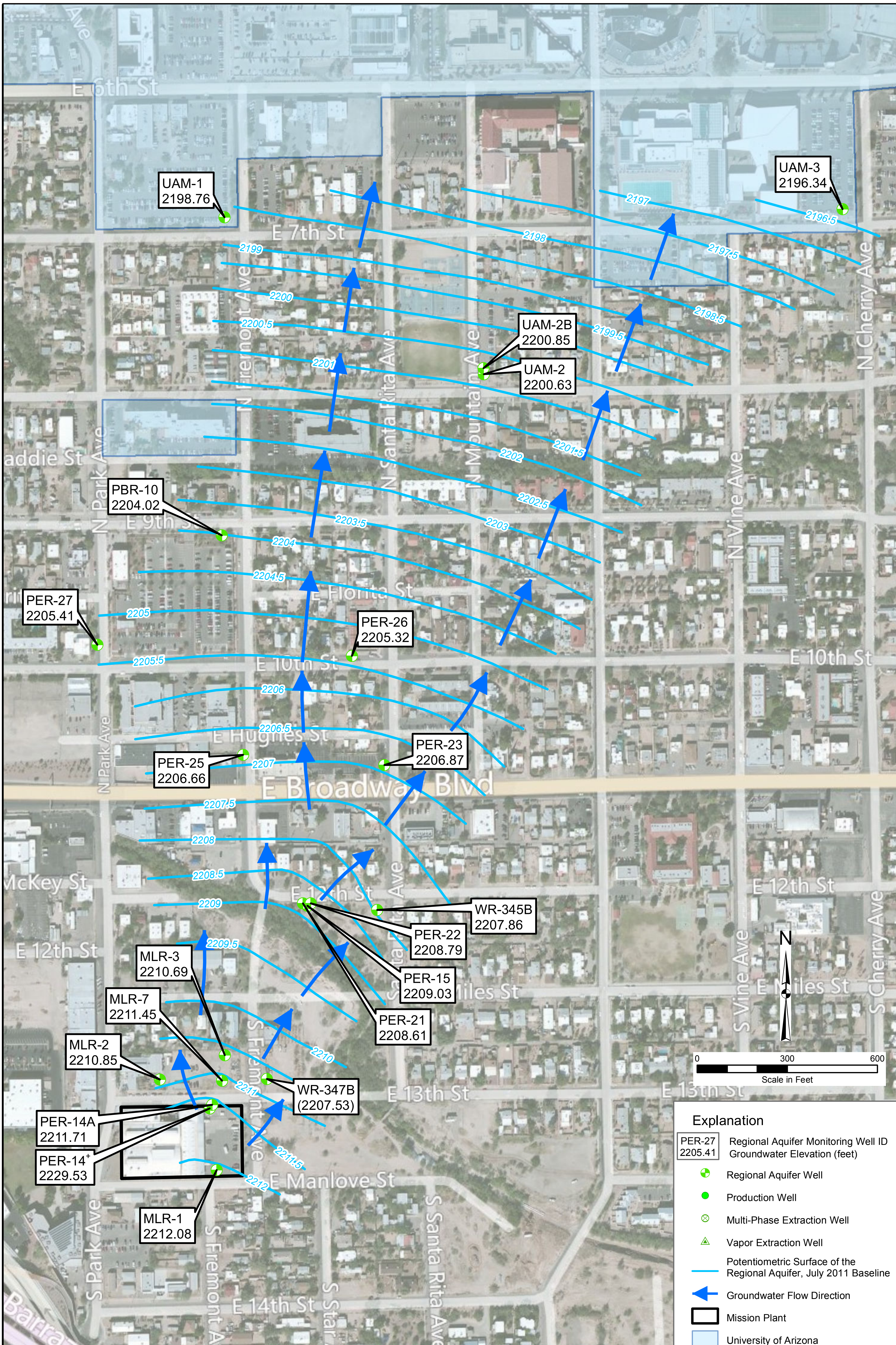
Project Name: Park-Euclid WQARF Site

Job No: 22241866 | Date: April 2012

PERCHED AQUIFER POTENTIOMETRIC MAP, BASELINE (JULY 2011)
PARK-EUCLID WQARF SITE
TUCSON, ARIZONA

Mission.../P-E/Proj12/maps/FS_WP/PA_potentiometric_July2011.mxd

Figure A1



Note:
+ Data point omitted in developing the potentiometric surface as it is anomalous with nearby wells. PER-14 is screened in a deeper zone than surrounding wells.
( ) Data point not used in contouring.

Source: Bing Maps aerial imagery web mapping service, (c) 2009 Microsoft Corporation and its data suppliers.

URS

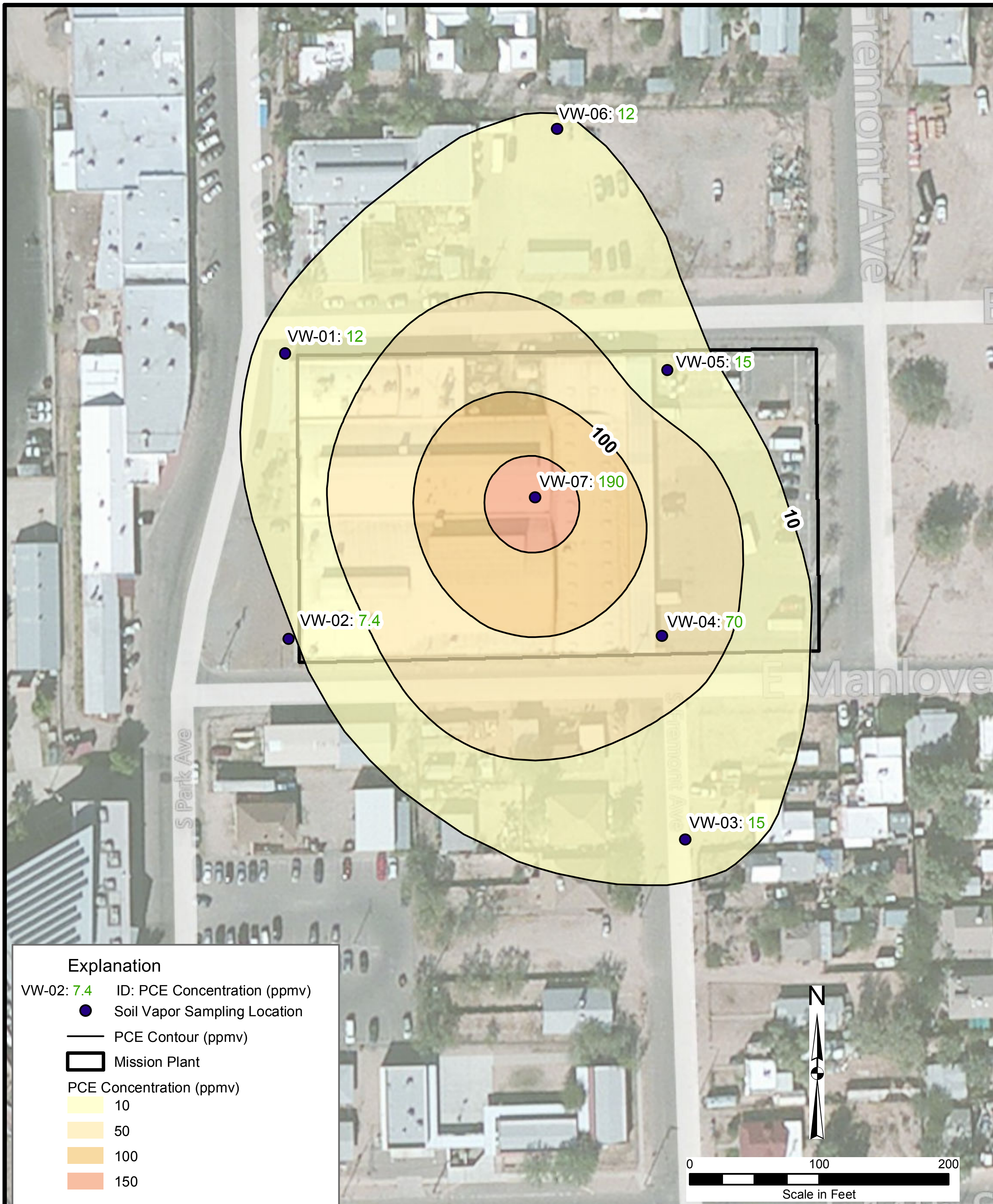
Project Name: Park-Euclid WQARF Site

Job No: 22241866 | Date: April 2012

REGIONAL AQUIFER POTENTIOMETRIC MAP, BASELINE (JULY/AUGUST 2011)
PARK-EUCLID WQARF SITE
TUCSON, ARIZONA

Mission.../P-E/Proj12/maps/FS_WP/RA_potentiometric_July2011.mxd

Figure A2



Note:

Source: Bing Maps aerial imagery web mapping service, (c) 2009 Microsoft Corporation and its data suppliers.

URS

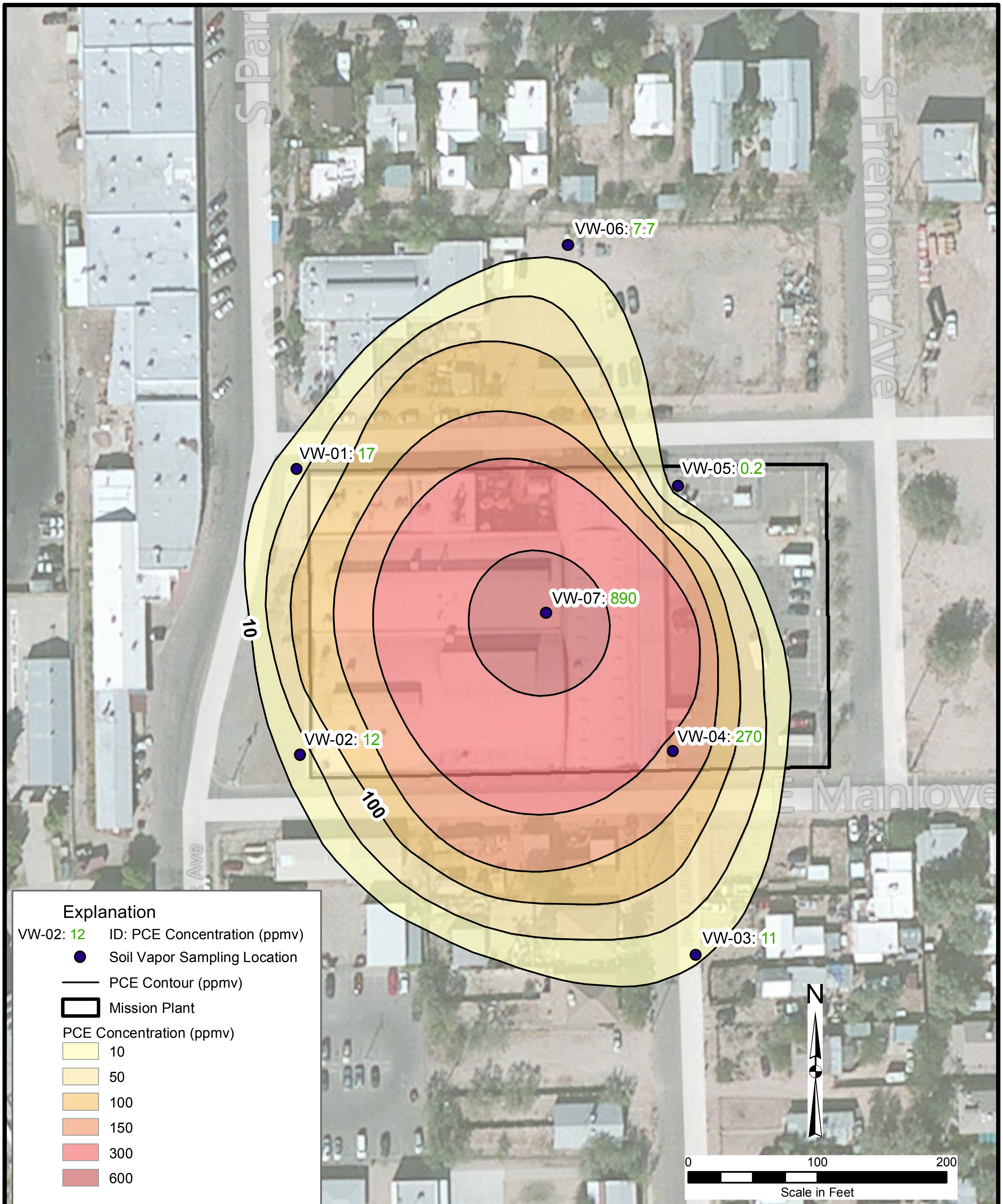
Project Name: Park-Euclid WQARF Site

Job No: 22241866 | Date: April 2012

PCE DISTRIBUTION IN SOIL GAS AT 5 FEET BGS
BASELINE JULY/AUGUST 2011
PARK-EUCLID WQARF SITE
TUCSON, ARIZONA

Mission.../P-E/Proj12/FS_WP/SV_PCE_5ft_Aug2011.mxd

Figure A3



Note:

Source: Bing Maps aerial imagery web mapping service, (c) 2009 Microsoft Corporation and its data suppliers.

URS

Project Name: Park-Euclid WQARF Site

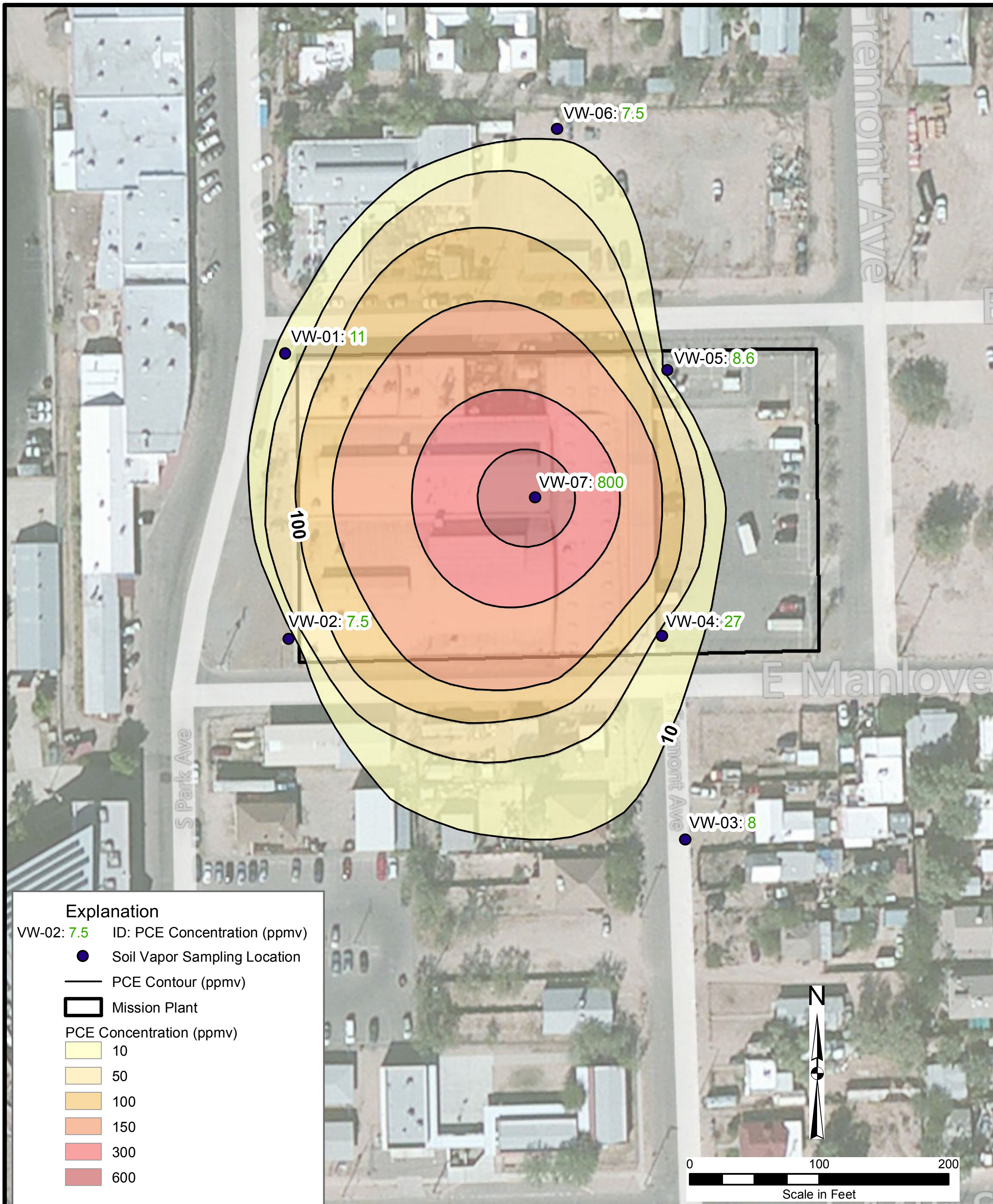
Job No: 22241866

Date: April 2012

PCE DISTRIBUTION IN SOIL GAS AT 30 FT BGS
BASELINE JULY/AUGUST 2011
PARK-EUCLID WQARF SITE
TUCSON, ARIZONA

Mission.../P-E/Proj12/FS_WP/SV_PCE_30ft_Aug2011.mxd

Figure A4



Note:

Source: Bing Maps aerial imagery web mapping service, (c) 2009 Microsoft Corporation and its data suppliers.

URS

Project Name: Park-Euclid WQARF Site

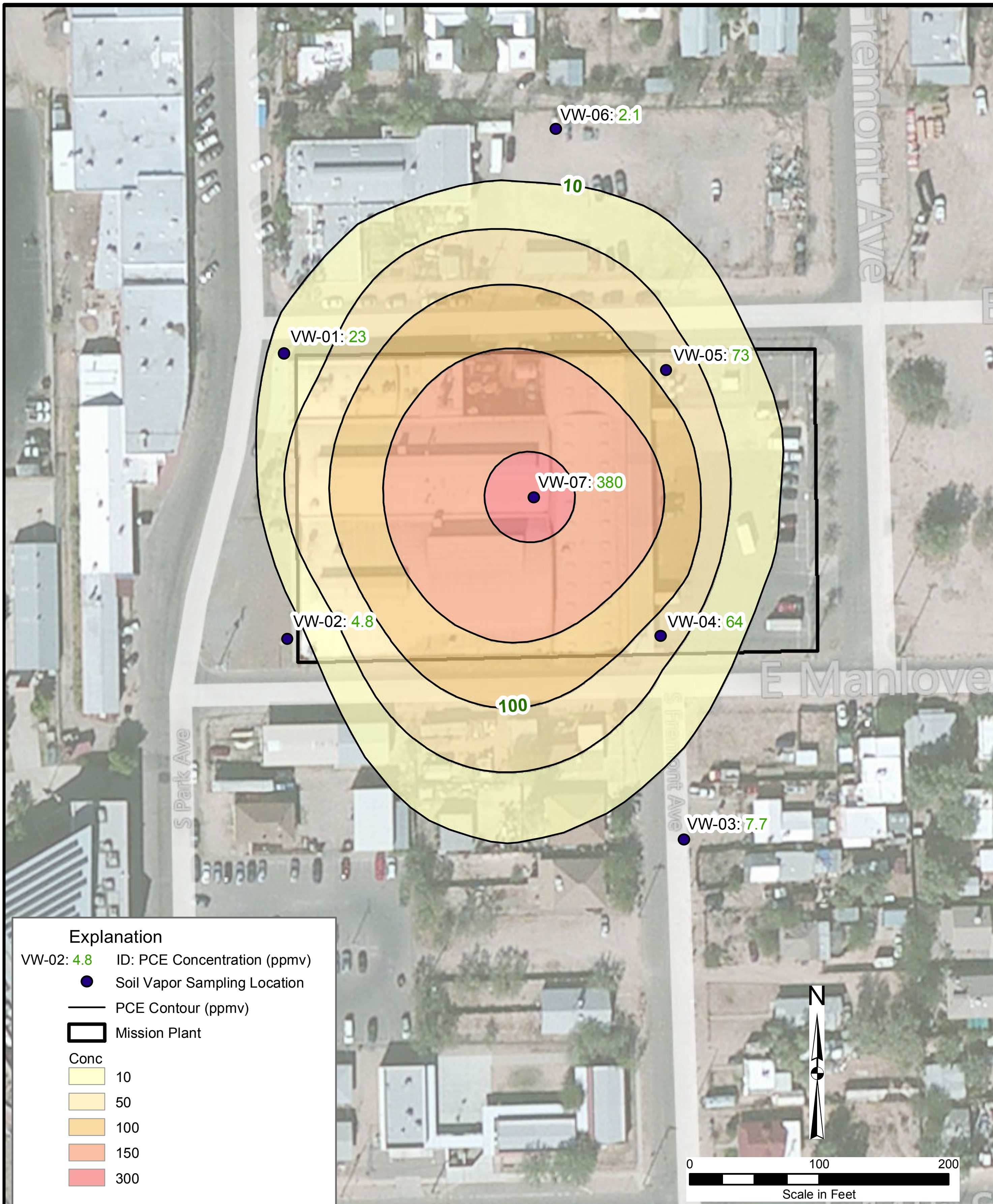
Job No: 22241866

Date: April 2012

PCE DISTRIBUTION IN SOIL GAS AT 55 FT BGS
BASELINE JULY/AUGUST 2011
PARK-EUCLID WQARF SITE
TUCSON, ARIZONA

Mission.../P-E/Proj12/FS_WP/SV_PCE_55ft_Aug2011.mxd

Figure A5



Note:

Source: Bing Maps aerial imagery web mapping service, (c) 2009 Microsoft Corporation and its data suppliers.

URS

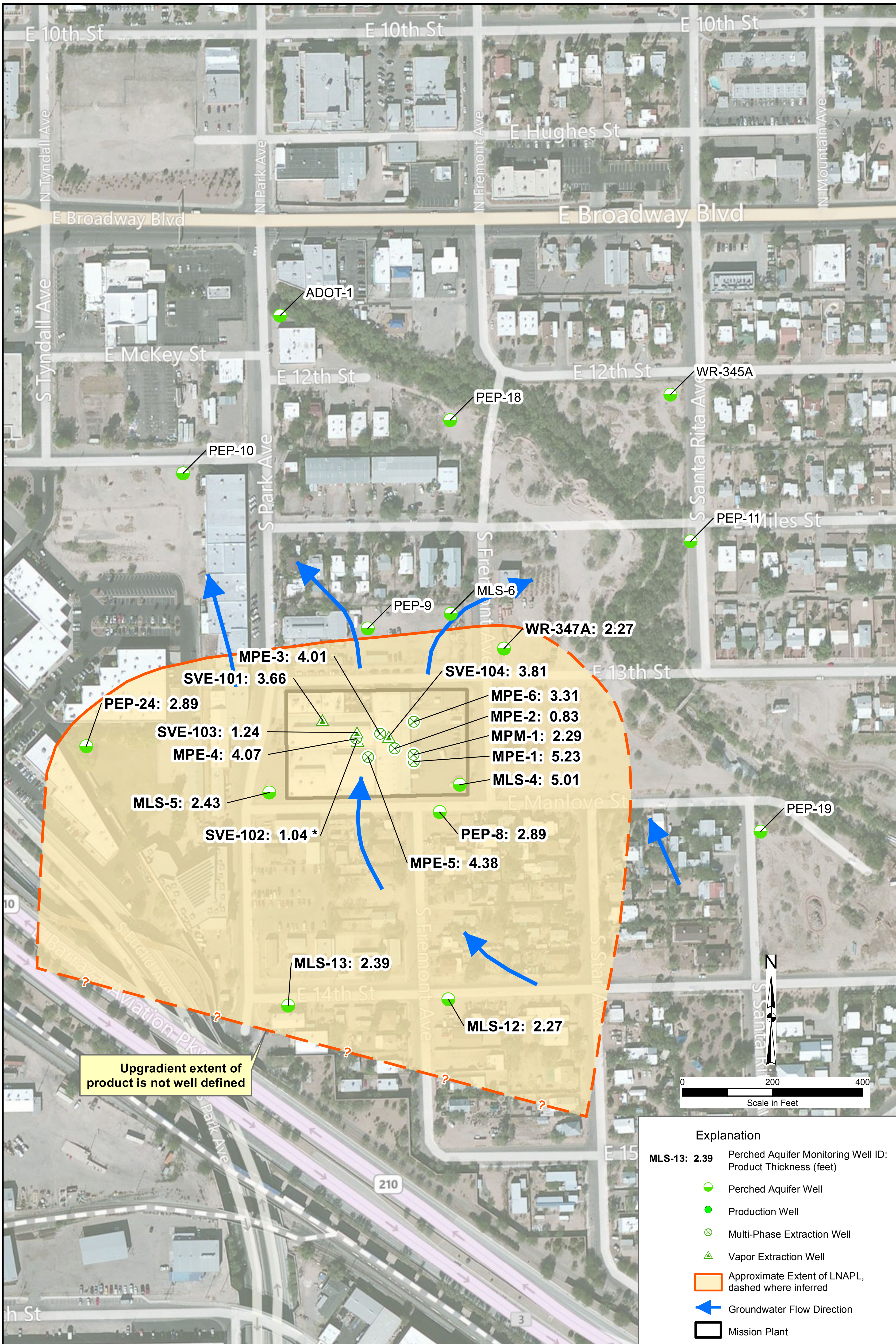
Project Name: Park-Euclid WQARF Site

Job No: 22241866 | Date: April 2012

PCE DISTRIBUTION IN SOIL GAS AT 85 FT BGS
BASELINE JULY/AUGUST 2011
PARK-EUCLID WQARF SITE
TUCSON, ARIZONA

Mission.../P-E/Proj12/FS_WP/SV_PCE_85ft_Aug2011.mxd

Figure A6



Note:
* Product and water levels were not measured in July 2011 at SVE-102. Product thickness was 1.04 feet when last measured on 6/15/11.

Source: Bing Maps aerial imagery web mapping service, (c) 2009 Microsoft Corporation and its data suppliers.

URS

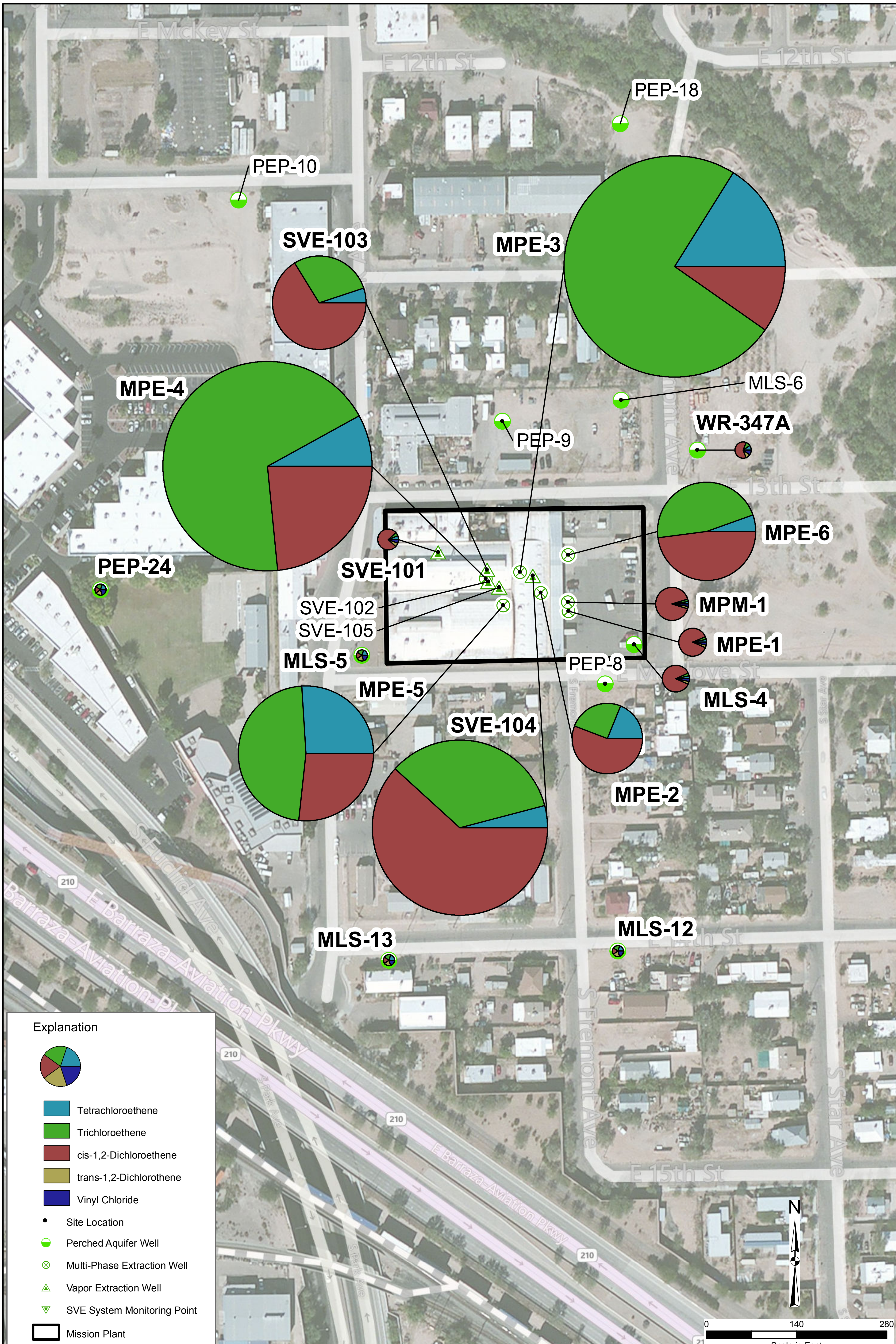
Project Name: Park-Euclid WQARF Site

Job No: 22241866 | Date: April 2012

PRODUCT THICKNESS AND DISTRIBUTION,
BASELINE (JULY 2011)
PARK-EUCLID WQARF SITE
TUCSON, ARIZONA

Mission.../P-E/Proj12/FS_WP/PD_thickness_PA_July2011.mxd

Figure A7



Note: The size of the chart is relatively proportional to the total VOC concentrations. Small equal values were assigned for non-detects, rather than utilizing reporting limits, which varied and falsely portrayed various compositions.

Source: Bing Maps aerial imagery web mapping service, (c) 2009 Microsoft Corporation and its data suppliers.

URS

Project Name: Park-Euclid WQARF Site

Job No: 22241866 | Date: April 2012

PCE AND DEGRADATION COMPONENTS IN PRODUCT BASELINE (JULY 2011)
PARK-EUCLID WQARF SITE
TUCSON, ARIZONA

Mission.../P-E/Proj12/FS_WP/PD_PA_pie_charts_July2011.mxd

Figure A8

Note:
[1] Not reported - groundwater results from SVE-105 were not utilized for interpreting distribution as SVE-105 is not representative of the Perched Aquifer.

Source: Bing Maps aerial imagery web mapping service, (c) 2009 Microsoft Corporation and its data suppliers.

URS

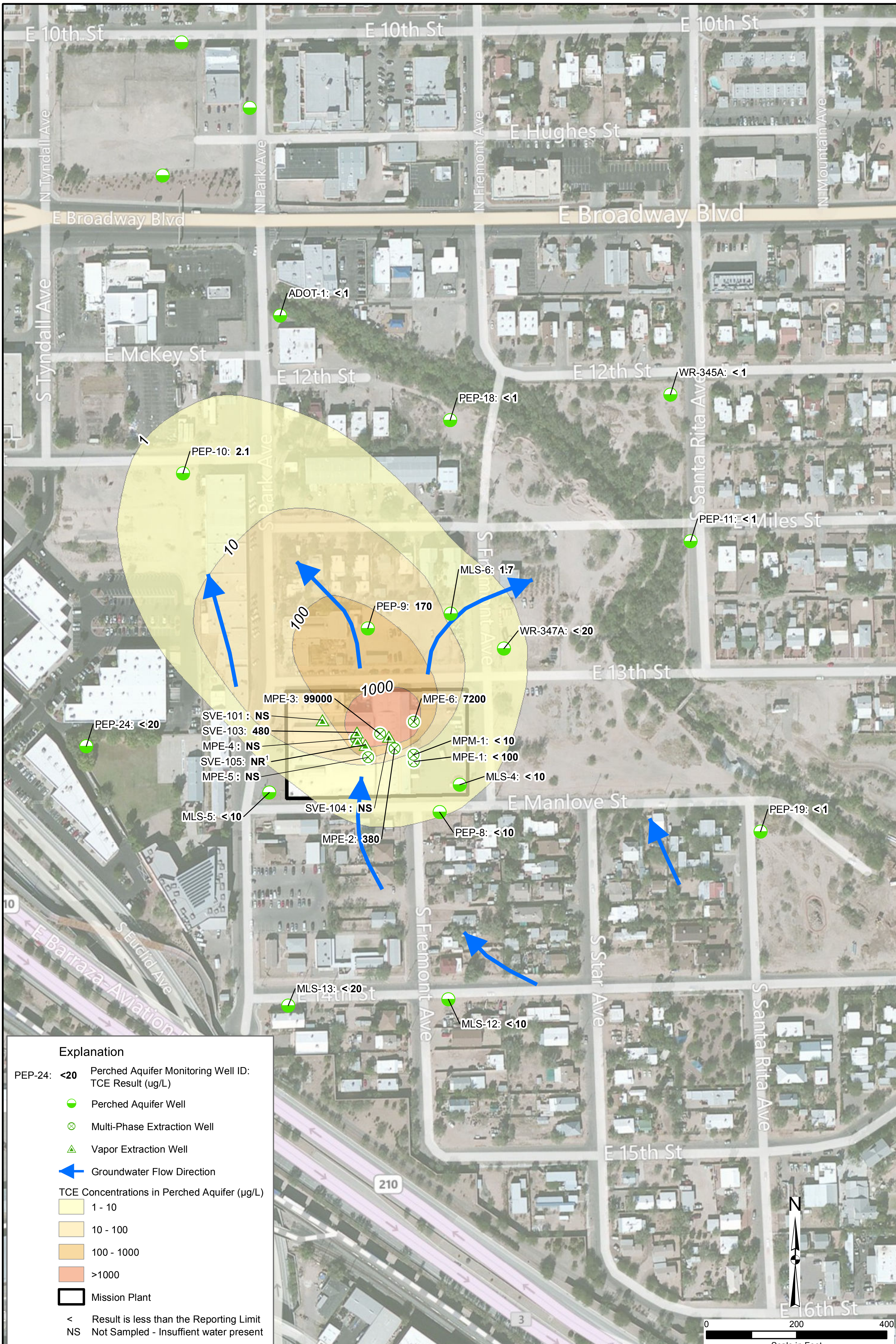
Project Name: Park-Euclid WQARF Site

Job No: 22241866 | Date: April 2012

PCE DISTRIBUTION IN PERCHED GROUNDWATER, BASELINE (JULY 2011)
PARK-EUCLID WQARF SITE
TUCSON, ARIZONA

Mission.../P-E/Proj12/FS_WP/PA_PCE_July2011.mxd

Figure A9



Note:
[1] Not reported - groundwater results from SVE-105 were not utilized for interpreting distribution as SVE-105 is not representative of the Perched Aquifer.

Source: Bing Maps aerial imagery web mapping service, (c) 2009 Microsoft Corporation and its data suppliers.

URS

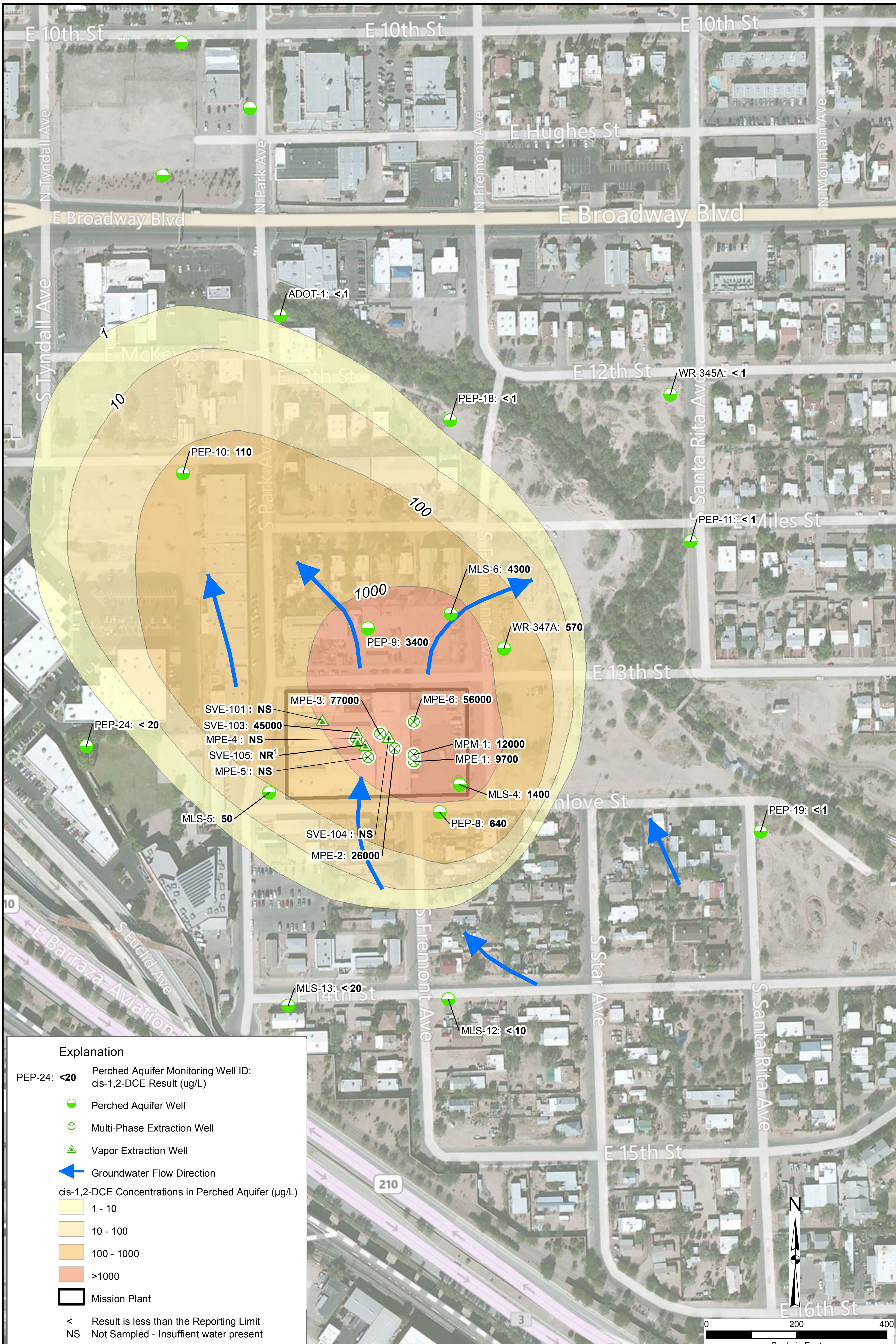
Project Name: Park-Euclid WQARF Site

Job No: 22241866 | Date: April 2012

TCE DISTRIBUTION IN PERCHED GROUNDWATER, BASELINE (JULY 2011)
PARK-EUCLID WQARF SITE
TUCSON, ARIZONA

Mission.../P-E/Proj12/FS_WP/PA_TCE_July2011.mxd

Figure A10



Note:
1 Not reported - groundwater results from SVE-105 were not utilized for interpreting distribution as SVE-105 is not representative of the Perched Aquifer.

Source: Bing Maps aerial imagery web mapping service, (c) 2009 Microsoft Corporation and its data suppliers.

URS

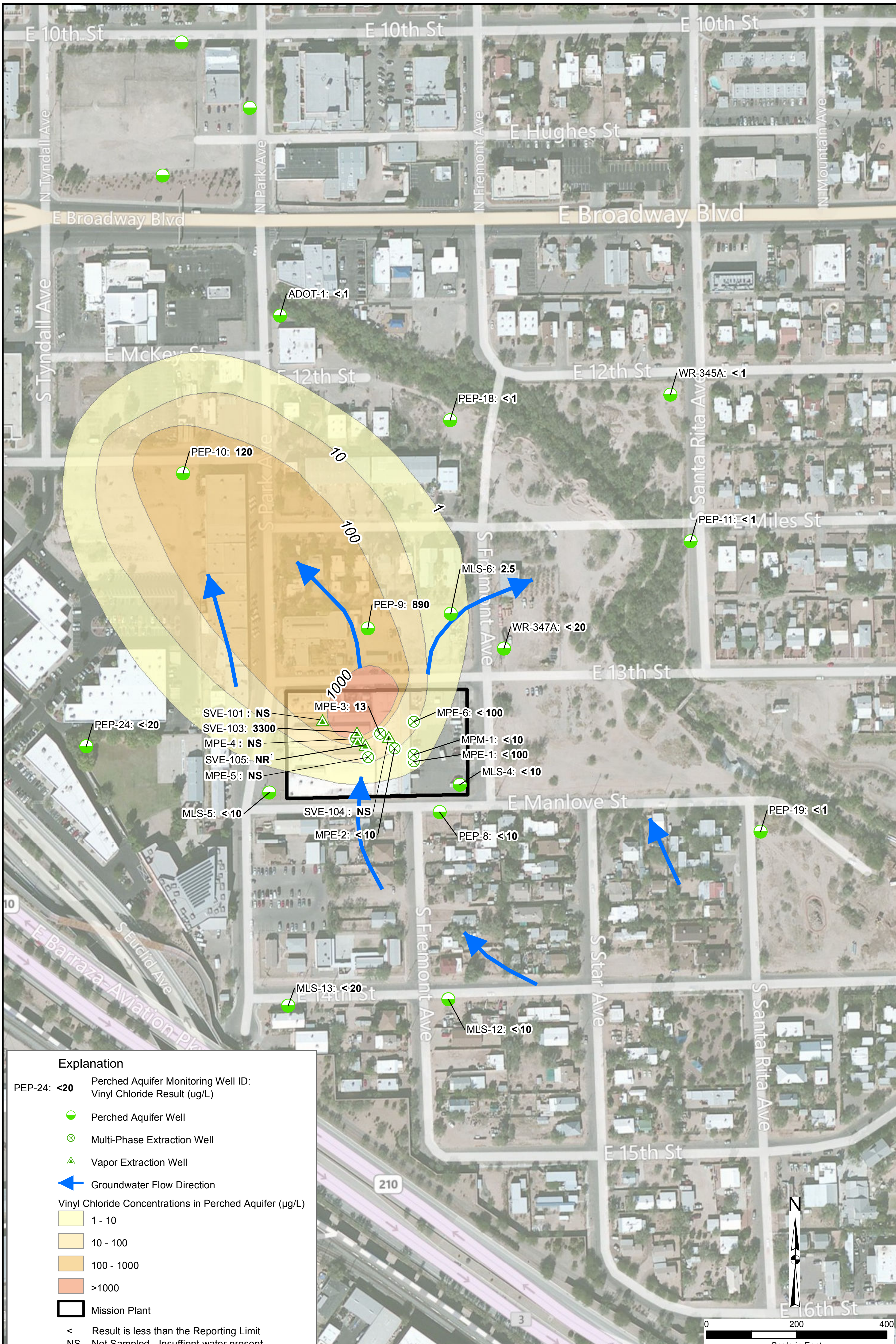
Project Name: Park-Euclid WQARF Site

Job No: 22241866 | Date: April 2012

cis-1,2-DCE DISTRIBUTION IN PERCHED GROUNDWATER, BASELINE (JULY 2011)
PARK-EUCLID WQARF SITE
TUCSON, ARIZONA

Mission.../P-E/Proj12/FS_WP/PA_cis12DCE_July2011.mxd

Figure A11



Note:
[1] Not reported - groundwater results from SVE-105 were not utilized for interpreting distribution as SVE-105 is not representative of the Perched Aquifer.

Source: Bing Maps aerial imagery web mapping service, (c) 2009 Microsoft Corporation and its data suppliers.

URS

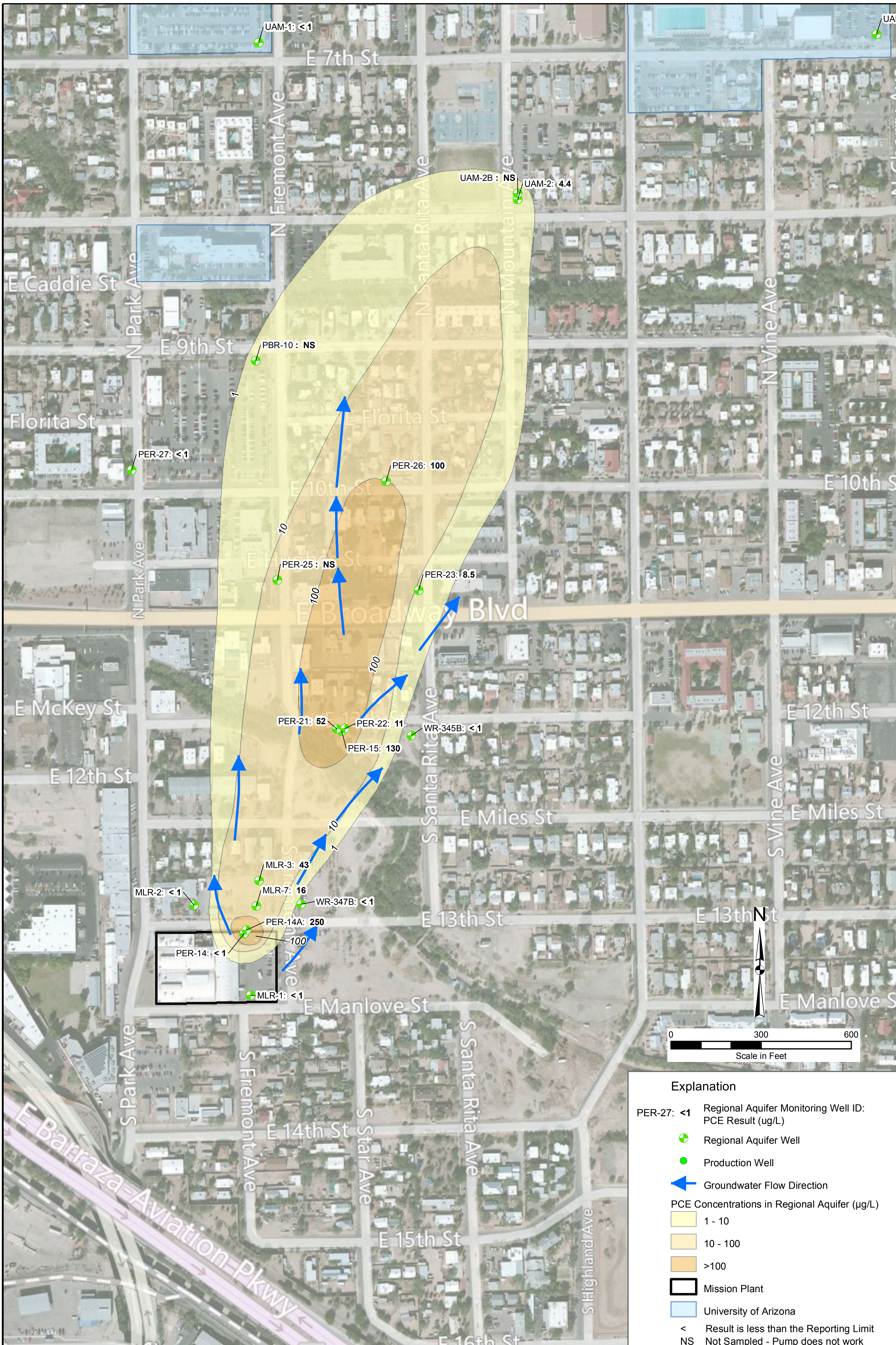
Project Name: Park-Euclid WQARF Site

Job No: 22241866 | Date: April 2012

VC DISTRIBUTION IN PERCHED GROUNDWATER, BASELINE (JULY 2011)
PARK-EUCLID WQARF SITE
TUCSON, ARIZONA

Mission.../P-E/Proj12/FS_WP/PA_VC_July2011.mxd

Figure A12



Note:

Source: Bing Maps aerial imagery web mapping service, (c) 2009 Microsoft Corporation and its data suppliers.

URS

Project Name: Park-Euclid WQARF Site

Job No: 22241866 | Date: April 2012

PCE DISTRIBUTION IN REGIONAL GROUNDWATER, BASELINE (JULY/AUGUST 2011) PARK-EUCLID WQARF SITE TUCSON, ARIZONA

Mission.../P-E/Proj12/FS_WP/RA_PCE_July2011.mxd

Figure A13

Note:

Source: Bing Maps aerial imagery web mapping service, (c) 2009 Microsoft Corporation and its data suppliers.

URS

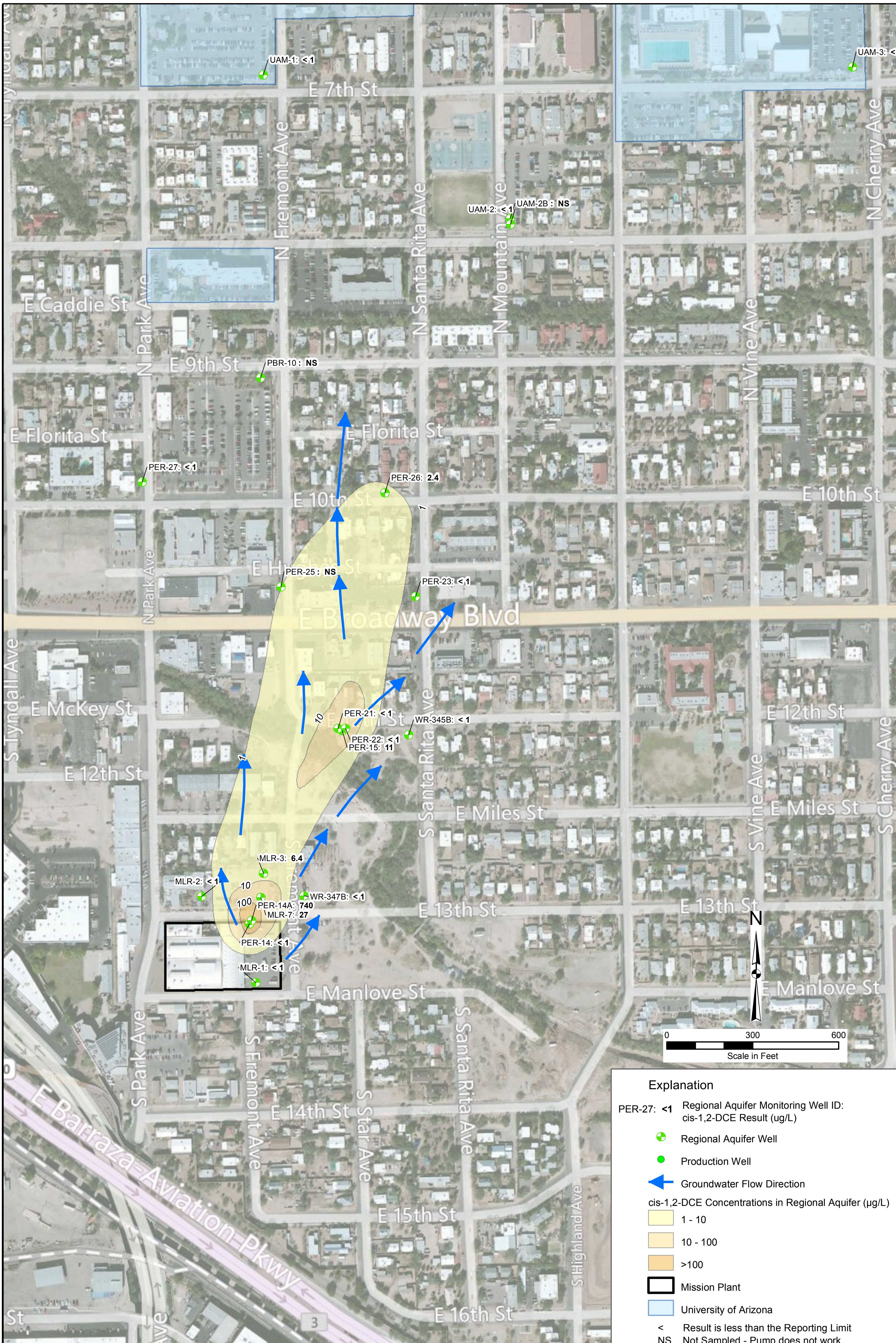
Project Name: Park-Euclid WQARF Site

Job No: 22241866 | Date: April 2012

TCE DISTRIBUTION IN REGIONAL GROUNDWATER, BASELINE (JULY/AUGUST 2011)
PARK-EUCLID WQARF SITE
TUCSON, ARIZONA

Mission.../P-E/Proj12/FS_WP/RA_TCE_July2011.mxd

Figure A14



Note:

Source: Bing Maps aerial imagery web mapping service, (c) 2009 Microsoft Corporation and its data suppliers.

URS

Project Name: Park-Euclid WQARF Site

Job No: 22241866 | Date: April 2012

cDCE DISTRIBUTION IN REGIONAL GROUNDWATER, BASELINE (JULY/AUGUST 2011)
PARK-EUCLID WQARF SITE
TUCSON, ARIZONA

Mission.../P-E/Proj12/FS_WP/RA_cis12DCE_July2011.mxd

Figure A15

Appendix B

SOP for Soil Vapor Sampling

Appendix B - Soil Vapor Sampling Standard Operating Procedure

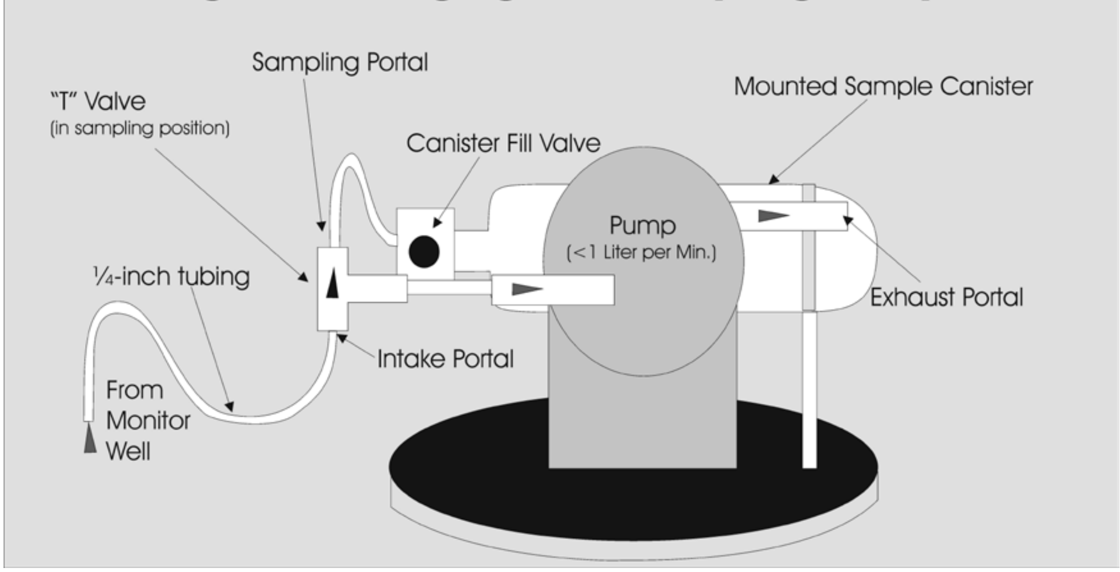
This SOP describes the specific protocols necessary for the collection of representative samples from soil vapor monitor wells. The designs of soil vapor monitoring points vary from site to site. This SOP addresses site specific sampling protocols for simple single-screen vapor monitoring point or nested soil vapor monitor wells constructed of tubing bundles or piping buried inside of sand filter packs, with bentonite seals segregating the sampling intervals.

1.0 Evacuation and Sampling Equipment

This section describes the methods and types of equipment that will be used to evacuate and collect soil vapor samples from typical nested monitoring well systems. The capacity of evacuation system is a function of casing/tubing diameter and depth, type of constituent selected for analysis, and objective of the particular sampling task.

URS typically utilizes a purging and sampling pump to evacuate the casing and tubing, and to collect the sample. The standard purging and sampling pump capacity is approximately 1 liter per minute, and the higher capacity pump can evacuate at a rate of up to 10 liters per minute. For small purge volumes, the pump on field monitoring equipment (such as a PID) may be used to purge the casing and tubing.

Figure 1. Purging and Sampling Pump



The purging and sampling pump is set up to accept a ¼-inch inner diameter tubing, which connects directly to the intake portal. The air flow is then directed through a "T" valve into the pump and exits from the pump at the exhaust portal. The other side of the "T" valve is the sampling portal. A sample canister can be mounted on the side of the pump, and is connected to the sampling portal.

2.0 Sample Collection Procedures

2.1 Planning

Prior to mobilization, sampling personnel should review the site-specific Health and Safety Plan. The laboratory and property owners should also be notified.

2.2 Soil Gas Screening

If the well is constructed with casing larger than ½"inch diameter, then a purge pump should be used to first evacuate the well casing. Once the well casing has been evacuated, a length of tubing that will reach the screened section should then be lowered into the well. This tubing can be dedicated, or disposable, depending on the duration of the sampling program. URS recommends that Teflon®-lined tubing be used if more than three sampling events are needed, the tubing can be dedicated to the individual well if this is the case. Once the well casing is evacuated, the tubing can also be evacuated, using the purging and sampling pump. The purging and sampling pump utilizes quick-connects, or can accept open ended tubing as well.

The intricacies of each of these systems are too great to provide detail in this SOP, and the user should refer to equipment specific procedures prior to using any of these systems. However, the general process for the evacuation and sampling procedure using these systems is summarized as follows:

1. Assess historic data, if available, to ensure the order of sample collection shall be from the least contaminated well to the mot, and from the least contaminated sampling interval to the interval with the highest contamination.
2. Assess the tubing bundles, if applicable, to ensure that individual tubes are correctly labeled according to the interval they are monitoring.
3. Determine the well interval to be sampled, and identify on the field log.
4. Attach the tubing to the purging and sampling pump's intake portal.
5. Ensure that nothing is blocking the exhaust or sampling portals.
6. Remove the red plastic end cap from the Silonite coated sampling canister, and connect the sampler to the Silonite coated sampling canister.
7. Connect the Silonite-coated sampling canister to the sampling portal.
8. Record the serial number for the sample canister on the chain of custody, and on the field record.
9. Turn the "T" valve and open the sampling portal side, then open the sample canister valve and record the pressure in the canister on the chain of custody, on the sample canister tag, and in the field notes

10. Close the sample canister valve.
11. Turn the "T" valve away from the sampling portal and ensure that the valve is open toward the purge pump.
12. Calculate and record the tubing volume based on the inner diameter and total length of the tubing.
13. Determine the total purge volume, and record on field log.
14. Measure and record the flow rate and compare to the purge volume
15. Determine the time required for purging the tubing and record.
16. Start the purging and sampling pump, and record the time.
17. Continue pumping until the tubing is purged, and record the elapsed time.
18. Shut the purging and sampling pump off
19. Turn the "T" valve to divert the airflow to the sampling portal.
20. Open the valve on the sampling canister.
21. After waiting appropriate time (typically two to three minutes, but depends on several factors) shut off the fill valve on the sampling container.
22. Disconnect the sampling container and all hoses and tubing.
23. Disconnect the sampler from the Silonite coated sampling canister, and replace the red plastic end cap onto the canister.
24. Secure well and location.

2.2.1 Soil Vapor Sample Collection, Handling, and Documentation

2.2.1.1 Well Casing and Tubing Evacuation

Purge each well prior to sampling to ensure that stagnant air from within the well/tubing casing has been evacuated and the sample collected is representative of soil gas in the vicinity of the sampling interval. Before beginning evacuation, calculate the volume of air contained in one casing/tubing volume using the following equation:

$$V = (TL)\ \pi\ r^2\ (28.316\ L/ft^3)$$

Where

- V equals one evacuation volume, in liters
- TL is equal to the total length of the tubing or the total depth of the well casing, in feet
- π is equal to 3.14159
- r is equal to the inner casing/tubing diameter, in feet
- 28.316 L/ft^3 is the conversion factor from cubic feet to liters

For standard ¼-inch inner diameter tubing, this simple approximation can be used

$$V = (TL)\ 0.03861\ L/ft^2$$

Where

- V equals one evacuation volume, in liters
- TL is equal to the total length of the tubing or the total depth of the well casing, in feet
- 0.03861 L/ft2 is the approximation of the surface area in Liters per square feet

Evacuate three volumes from casings and/or tubing using the purging and sampling pump. If the casing is greater than ½ inch diameter a higher capacity pump should be used for purging the larger volume. Once the casing has been evacuated use the purging and sampling pump to evacuate the sample tubing.

2.2.1.2 Sample Collection

The sample is collected immediately following purging of the sample tubing (and well casing, if present). Once the tubing is purged, the pump is turned off, and the "T" Valve is opened to the sample portal side. The valve on the sample canister is then opened. After evacuation of the desired volume of air, the gate valve will be closed to prevent the introduction of ambient air to the sample stream. The laboratory-supplied, negative pressure canister labeled with a unique identification number will be opened to allow for the collection of the soil gas sample. Once the vacuum has decreased to approximately (–3) inches of mercury, the valve is closed and the sampling is complete.
For characterization or compliance monitoring, additional quality assurance samples will also be collected. The quality assurance samples may include duplicate/split samples and equipment blanks.

If a Tedlar bag is to be used for sampling, the bag is placed within a commercially available vacuum box. Valving and tubing is to be connected in accordance with the manufacturer's instructions. Once the sampling probe or well is purged, the pump is turned off, and the "T" Valve is opened to the sample portal side. The vacuum box is then turned on and the Tedlar bag filled to approximately three-quarters full. The "T" valve is then closed, the vacuum box turned off and the inlet valve on the vacuum box closed. The box is then opened and the valve on the Tedlar bag is closed.

2.3 Sample Preservation and Handling

The canisters used to collect and store the soil gas sample will depend on the laboratory analyses required for the sample. The analytical laboratory will provide all canisters required for sampling, and all samples will be collected according to the requirements for each analysis.

All samples will be placed in their respective shipping boxes, after ensuring that all data has been recorded on the container tag. A completed chain-of-custody form will accompany the sample containers during transport. Samples will be transported from the field to a central shipping location for shipment to the analytical laboratory.

2.4 Documentation

2.4.1 Soil Gas Monitoring Sample Collection Record

A field record will be completed for each well site and will include, at a minimum, the following information:

- Well ID and/or portal ID
- Sampler's name(s)
- Whether conditions
- Minimum purge volume
- Sample date and time
- Canister serial number (if applicable)
- Flow rate information
- Purge Time in minutes
- Beginning pressure
- Ending pressure
- Sample ID number
- Other significant field observations pertinent to sample collection

2.4.2 Sample Labels

The analytical laboratory will provide Chain-of-Custody seals and sample labels, which are filled out by the field technician. The sample label will include the job number, sample ID (comprised of a six-digit date code and a sequentially numbered, 2-digit sample ID), date and time of sample collection, type of analysis requested and the final pressure in the canister. A Chain-of-Custody seal will be placed over the cap of each sample container, and will include the sample collection date and the signature of the field technician.

2.4.3 Chain of Custody

A laboratory Chain-of-Custody will be completed by the field technician collecting the sample, and will accompany each sample. Whenever a sample is transferred to another responsible party, the receiving party must sign off on the Chain-of-Custody form. Each Chain-of-Custody form will include the following information:

- consultant name, address, phone number
- project manager
- project name and/or number

- sample ID (eight digit code)
- canister ID
- final pressure in canister
- date sample was collected
- time sample was collected
- Size of sampling canister
- analysis to be performed on the sample
- signature of the sampler
- date/time relinquished by sample technician
- signature of sample recipient
- signature of the person at the lab who accepted the samples
- date and time the sample was received by the laboratory
- final remarks about the samples after acceptance by the laboratory

A copy of the Chain-of-Custody records will be submitted to the project office on a daily basis; an additional copy will be included with the analytical results from the laboratory.

3.0 References

ADEQ, 2000; *Arizona Department of Environmental Quality Superfund Program Section Quality Assurance Program Plan*, Arizona Department of Environmental Quality SPS, May 22, 2000.

ASTM Standard Designation D 5466-95; Test Method for Determination of Volatile Organic Chemicals in Atmospheres (Canister Sampling Methodolog).-

US EPA, 1991, *Site Characterization For Subsurface Remediation*, Epa/625/4-91/026; U.S. Environmental Protection Agency, November 1991.

Appendix C

SOP for PneuLog® Testing

Appendix C
SOP for PneuLog® Testing

STANDARD OPERATING PROCEDURE - PNEULOG®

1. INTRODUCTION

This project will utilize a procedure combining site characterization and the collection of soil vapor extraction (SVE) data in vadose zone soils contaminated with volatile organic compounds (VOCs). The procedure developed by PRAXIS Environmental Technologies, Inc. uses pneumatic well logging, known as PneuLog®, to measure the vertical air permeability and contaminant concentration profiles in wells screened for SVE. The field procedures associated with PneuLog® are described in this attachment. All field activities will adhere to the procedures and specifications contained in the project Field Sampling Plan (FSP) and Quality Assurance Project Plan (QAPP) prepared as separate documents.

Pneumatic well logging is used to develop a detailed conceptual site model to aid in the design, optimization, or closure of SVE systems. The following data are collected in addition to lithologic logging and conventional sample analyses to build the conceptual site model:

- Flow and vacuum data from extraction wells,
- Vertical vapor concentration data from extraction wells, and
- Vertical air production profiles from extraction wells.

This attachment describes the PneuLog® technology and the collection of the data listed above.

2. TECHNOLOGY DESCRIPTION

This project will employ an expedited approach to vadose zone characterization with simultaneous collection of data for optimized SVE design and operation. For both vadose zone characterization and remedial design, Praxis has developed, field-tested and commercialized a pneumatic well logging process. Known as PneuLog®, the well logging is performed by simultaneously measuring the cumulative air flow and contaminant vapor concentrations along the depth of an extraction well screen during active SVE. To make these measurements, a flow sensor is moved through the well during vapor extraction and soil gas samples are collected and analyzed continuously. Performing these measurements at a representative number of wells can yield a three-dimensional picture of the extent of soil contamination at a site as well as the soil permeability distribution. These measurements, in conjunction with traditional measurements, yield a thorough site evaluation.

The equipment for the pneumatic logging is illustrated in Figure 1. The Pneulog® instrumentation is attached to a cable, which passes through alignment pulleys and a vacuum-tight fitting at the wellhead. The instrumentation is raised or lowered by a motorized reel around which the cable is wound. The logging proceeds at roughly eight feet per minute along the screen in the SVE well. Sensors in the pulley assembly indicate the depth of the measurement. Electrical leads connect the flow sensor to a data acquisition system located on the motorized reel. A vapor sampling tube connects the sample port on the instrument to a vacuum pump, also on the reel. The sampling pump draws a continuous stream of air through the sampling tube to the surface where it is analyzed for VOCs and other compounds of interest (e.g., oxygen and carbon dioxide). A photoionization detector (PID) is used to provide a continuous reading of total VOC concentration. Canister samples can be collected for off-site gas chromatographic and mass spectrometer analyses to determine compound-specific concentrations at discrete depths and to calibrate the PID readings. Supplemental vapor samples can be collected and analyzed on-site or at Praxis' office with a field gas chromatograph.

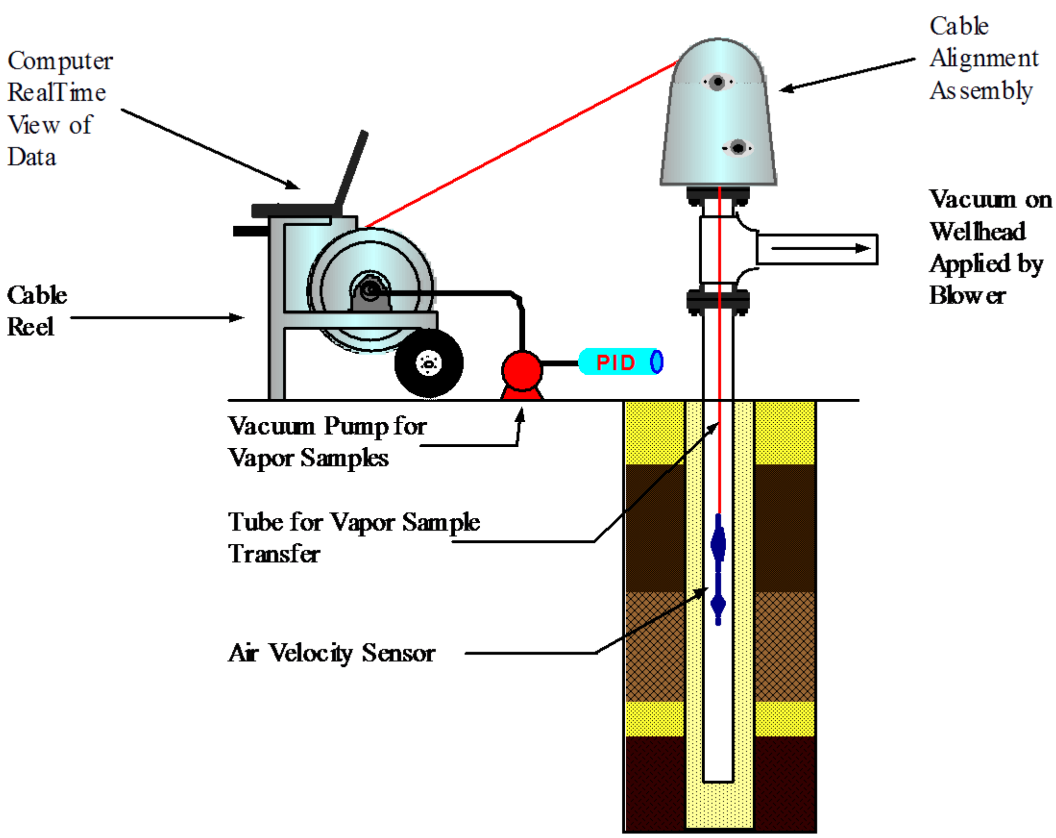


Figure 1. Schematic of Pneumatic Well Logging Equipment

The airflow from each soil layer is related to the cumulative airflow by a simple mass balance. To determine the airflow from a given soil layer, the cumulative airflow measured below the soil layer is subtracted from the cumulative airflow measured above the soil layer. The soil permeability of the interval is then determined from Darcy's law. The data and the analyses appear similar to output from borehole flowmeter testing in water wells (Molz et al., 1989). A typical cumulative airflow measurement from PneuLog® is provided in Figure 2a. In this example, the well is screened from 12 to 32 feet below the ground surface (bgs). The screen interval is indicated by the green (dark) and yellow (light) blocks together. As shown, the airflow from the bottom half of the well is practically zero. The airflow increases steadily from 0 to 28 standard cubic feet per minute (scfm) between 23 and 16.5 feet bgs as the instrument is raised through the screen. The steady flow increase indicates this soil interval has a relatively uniform permeability to air. From 16.5 to 15 feet, only 2.5 scfm of soil gas are added. 15 scfm are then added in the next 1.5-foot interval up to 13.5 feet. The top 1.5 feet of the screen adds only one scfm to the total.

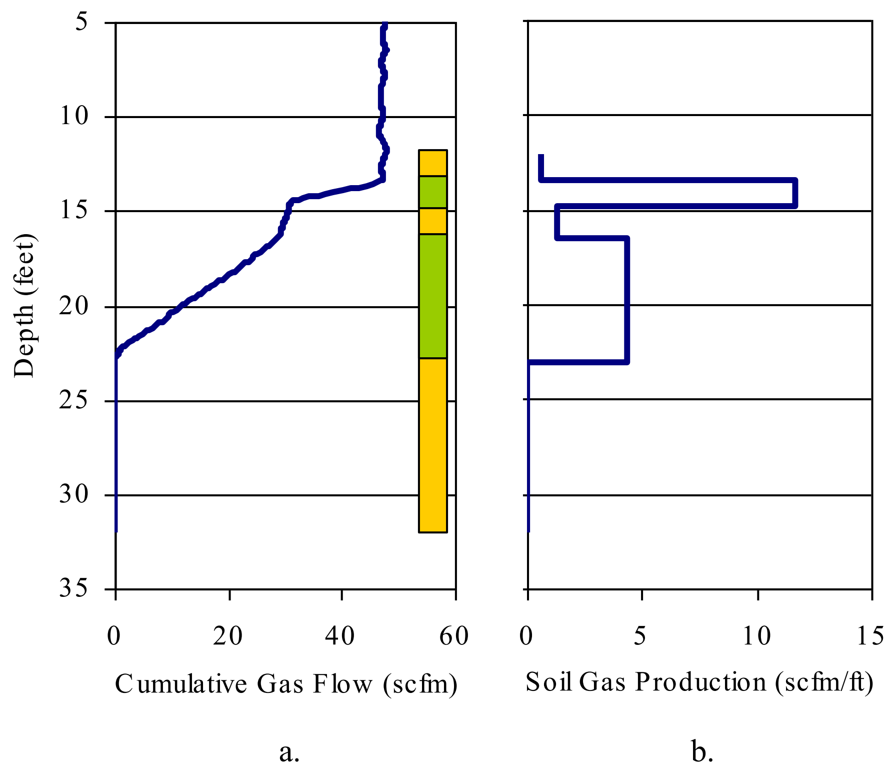


Figure 2. Example Pneumatic Well Logging Results for Soil Permeability to Air

Figure 2b presents an interpretation of the cumulative flow measurements as soil gas production. An effective air permeability profile can be generated using the soil gas production profile with multi-dimensional analytical or numerical airflow models. The permeability of an interval is proportional to the change in flow across the interval, its thickness, its depth below the surface and the well vacuum according to Darcy's law. Figure 2b reveals roughly five soil strata along the screen. The stratum intersected by the bottom half of the screen has a relatively low permeability since no measurable soil gas was produced. The geologist characterized the soils of this interval as silts. The soil intervals from 16.5 to 23 feet and 13.5 to 15 feet have air productions indicative of coarse sands. These two sand intervals are separated by a 1.5-foot-thick silt interval. The soil at the top of the screen would also be characterized as silt. This characterization of the physical properties is superior to a geological log and a typical air permeability test. The PneuLog® results were qualitatively consistent with the geological log; however, the geological log provided little indication of air permeability. Without the pneumatic logging data, the permeability determined by typical testing would be averaged over the screen interval and dominant features of the subsurface flow during SVE would not be quantified.

The characterizations of contaminated zones and soil gas concentrations result from the measurement of VOC concentrations along the well screen. An example concentration log, which was collected simultaneously with the previously discussed air flow log, is presented in Figure 3a. This concentration profile was obtained from a continuous PID reading which was calibrated to trichloroethylene (TCE) concentrations with on-site and off-site gas chromatographic analyses of vapor samples from discrete depths and the wellhead. The measured vapor concentration is lowest near the bottom of the screen and increases slightly up to a depth of about 28 feet. As the instrumentation is raised higher in the well, the concentration increases sharply to a maximum and remains relatively steady into the soil gas production interval starting at 23 feet. The concentration then decreases steadily from 22 to 15 feet bgs. Between 15 feet and the top of the screen, the concentration increases very slightly.

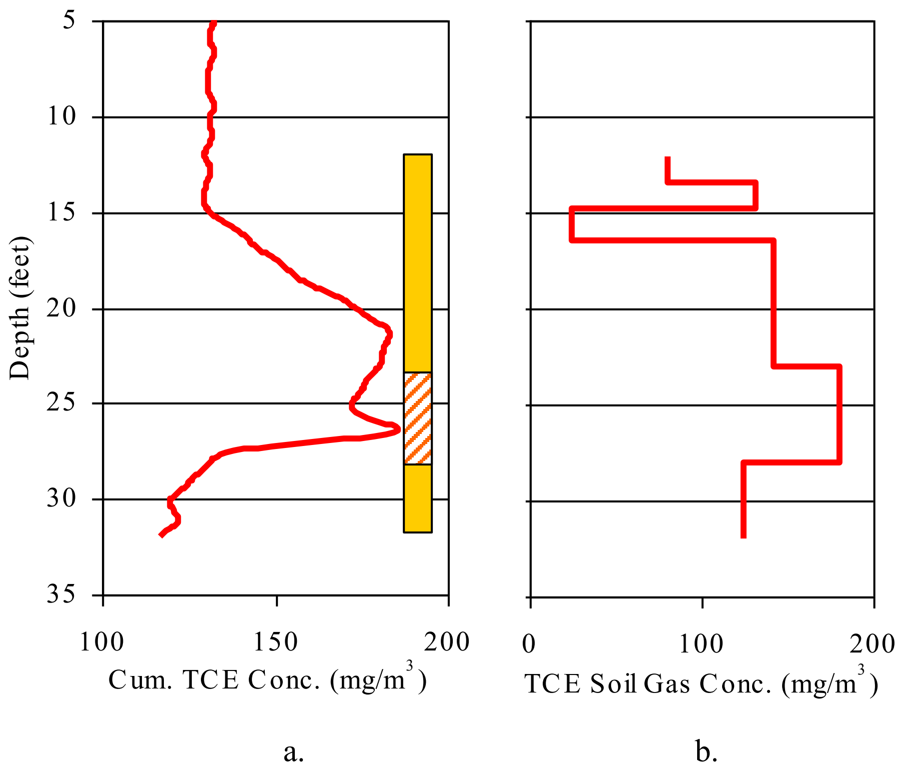


Figure 3. Sample Pneumatic Well Logging Results for Contaminant Production

The observed increases and decreases in concentration can be combined with the depth-specific air production in a mass balance to estimate depth-specific soil gas concentrations. The PneuLog® device simultaneously measures the flow rate and concentration versus depth. The change in the product of these two variables over a specified depth interval divided by the flow change is equal to the contaminant vapor concentration in the soils of that depth interval. Application of this relationship to the data shown in Figures 2a and 3a yields the contaminant vapor concentration profile presented in Figure 3b. The highest concentration occurs in the low permeability material underlying the deep sand interval. This high concentration indicates the low permeability interval creates a mass transfer constraint to SVE. Contaminant must migrate slowly out of this interval into the flow interval above. The silt interval at 15 feet does not appear to be a barrier to contaminant migration between the sands.

As illustrated by this example, pneumatic logging provides a more thorough and appropriate site characterization than traditional methods alone. Repeating the process in a representative number of wells can generate a three-dimensional description of the physical and chemical subsurface by correlating between locations. The technique also provides data to more effectively design and optimize an SVE system. Soil strata near or below cleanup goals are quickly identified and the extraction flow rate can be lowered or terminated from these layers. The operation can then be focused on strata remaining above cleanup goals. This optimization could lead to cost savings by accelerating cleanup and lowering operation & maintenance costs.

3. FIELD TASKS AND PROCEDURES

This section describes the field activities and procedures to collect data for site characterization and SVE design using PneuLog®. The activities adhere to the procedures and specifications contained in the project Field Sampling Plan (FSP) and Quality Assurance Project Plan (QAPP) prepared as separate documents. Site evaluation includes measurements of flow and vacuum in extraction and monitoring wells during pneumatic logging. Concentrations during the tests are monitored with a PID and three samples from each screen interval are collected and analyzed for VOCs. During the testing, vacuum responses are monitored in other available screens to aid in the calculation of permeabilities at the site. Vacuum responses depend on the soil properties and well spacing and may not be measurable in all monitored screen intervals.

The PneuLog® technique was described in detail in Section 2. During the pneumatic logging, a small flow of air is extracted through the Teflon® tubing attached to the flow instrument in the well. The total organic compound concentration in this air flow will be measured with a calibrated photoionization detector (PID) to yield the contaminant concentration in soil gases extracted along the well screen depth. The pneumatic log will then be repeated. A soil gas sample will be collected in a Tedlar bag and in a canister at the bottom of the screened interval (or just above the saturated zone) prior to repeating the pneumatic log. Subsequently, the instrument will be paused at a depth of major change in flow or concentration, generally at the maximum concentration. At this discrete depth, a sample of the soil gas may be collected in a canister and a Tedlar® bag. A third canister and Tedlar® sample will be collected at the top of the screened interval. This sample is considered to be representative of the concentration that would be observed during typical soil vapor extraction operation. Canisters will be packaged and shipped to a state-certified, off-site laboratory for analysis of VOCs by TO-15. The flow data from the pneumatic well log will immediately be analyzed to yield an air production profile along the well screen and the concentration log will be analyzed to indicate the most contaminated intervals. In less contaminated wells, a meaningful maximum concentration along the screen may not be identified. In these screens, a vapor sample will be collected only from the bottom and at the top of the screen.

Any point or non-point discharge to air generally requires review and permission from the local air board. This includes any process that volatilizes materials from the ground (e.g., soil vapor extraction) or uses volatilization as a means of disposal for unwanted materials or constituents. The SVE aspect of this fieldwork will require the extraction of contaminated air from the subsurface. The SVE discharge from each well will be treated with existing vapor abatement equipment on each site.

4. VAPOR SAMPLING AND ANALYSES

This section summarizes the procedures for collecting and analyzing vapor samples during the field tests. The equipment that will be used to collect vapor samples is also described. The sample locations, frequencies, and procedures presented are subject to change based on site-specific conditions.

Vapor concentrations will be monitored continuously during extraction periods with a calibrated PID as described in Section 3. Vapor samples will be collected in Summa® canisters for off-site analysis via method TO-14 (VOCs) or TO-15 (VOCs), and/or method TO-3 (total volatile petroleum hydrocarbons) at a state-certified laboratory or in Tedlar bags for analyses of VOCs using a modified EPA Method 18 (on-site or at Praxis' office). Up to three samples will be collected during the pneumatic log of each screen in each well location. Samples will be collected through the pneumatic logging instrumentation and will provide depth-specific concentrations from inside the extraction wells. One sample will be collected from the bottom of the screened interval, one from above the screened interval and one sample from the depth in the screen yielding the highest concentration or the bottom. Additional samples may be collected based on field observations.

Depth-specific samples will be drawn by a small, oilless diaphragm pump through a Teflon® tube attached to the flow instrumentation for pneumatic logging. The vapor sample will be monitored by a PID on the surface and collected near the discharge of the Teflon® tube in a stainless steel SUMMA® canister or Tedlar® bag. The majority of samples collected in Tedlar bags will be analyzed with a portable GC either on site or at Praxis' California facility. For samples analyzed at Praxis' facility, Tedlar bags will be shipped via overnight express for analysis the following day. Canisters will also be used to directly collect vapor samples at selected locations to validate Praxis' GC analyses. The canisters will be submitted for offsite chemical analysis. Samples will be collected following the guidance offered in EPA's "*Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air*," EPA 4-84-041-April 1984. The specific methods to be used are TO-14, "Determination of Volatile Organic Compounds (VOCs) in Ambient Air Using SUMMA Passivated Canister Sampling and Gas Chromatography Analysis" or TO-15 and/or TO-3 for total volatile petroleum hydrocarbons. The canisters will be used and samples collected in the vacuum mode. The vacuum in the clean canister (near 30 inches Hg) will be sufficient to pull the sample out of the gas line. A slow flow rate into the canister will be controlled manually by slightly cracking open its valve. The rate is checked by monitoring the canister vacuum gauge and comparing the value to the elapsed time and the wellhead vacuum. The final canister vacuum will be approximately equal to the vacuum in the vapor extraction line. The final vacuum will be recorded on the chain-of-custody and then measured at the laboratory after shipment and before analysis. The two recorded vacuums will be approximately equal if the canister has not leaked. Each canister will be cleaned in the laboratory before delivery.

The purpose of a field quality control program is to provide a measure of data quality. QA samples to be collected include field duplicates, equipment blanks, and ambient condition blanks. Collection of the QA samples during the project is described in the project Work Plan. The sample handling, preservation and shipment procedures are described in the Work Plan along with sample custody and decontamination procedures.

5. DATA MANAGEMENT

The data to be collected during PneuLog® include:

- Soil vapor concentrations,
- Extraction air flowrates,
- Wellhead vacuums,
- Vertical air flow profiles, and
- Vertical concentration profiles.

These data can be used to define the vertical and horizontal extent of contamination at the various sites if a sufficient number of representative wells are logged. The data will also yield the disposition of the contamination (e.g., found primarily in low permeability soil, found near the groundwater, suspected non-aqueous phase liquid present, etc.). The pneumatic logging data, combined with historical data can provide information on optimal SVE system operation and possibly the optimal locations for new SVE wells.

A general chronicle of field activities and personnel on site will be recorded daily. The following information shall be recorded for all field activities: (1) location, (2) date and time, and (3) identity of people performing activity. The information shall be recorded in a field notebook or on data logging sheets. These records shall be archived in an easily accessible form and made available to the Air Force upon request.

The collection of soil vapor samples will be documented in a field notebook or on appropriate data logging sheets. These records shall be archived in an easily accessible form and made available to the Air Force or its contractors upon request. The following additional information shall be recorded for all sampling activities: (1) sample type and sampling method, (2) the identity of each sample including location and depth(s), where applicable, from which it was collected, (3) the date and time of collection, (4) the amount of each sample or sample container volume, (5) sample description (e.g., color, odor, clarity), and (6) identification of conditions that might affect the representativeness of a sample (e.g., refueling operations, damaged casing).

Field measurements will be recorded on data sheets specific to each measurement (e.g., air flow rates and wellhead vacuums). For each field instrument the following shall also be recorded: (1) the numerical value and units of each measurement, and (2) calibration results

6. HEALTH AND SAFETY

The health and safety plan for the fieldwork is prepared separately and is adhered to during all field activities.

7. MANAGEMENT AND STAFFING

Key staff from PRAXIS assigned to the project are shown in Table 1 with their responsibilities. Team members include:

Ms. Mary Scarpetti is the President of PRAXIS. She is responsible for the administrative, contractual and fiscal aspects of all PRAXIS projects. All significant changes in scope or cost must have her approval. Ms. Scarpetti received her law degree from the University of San Francisco in 1990 and is a member of the California Bar Association. Ms. Scarpetti has seven years of experience in the operations and financing of small firms and, in particular, government contracting and accounting. She worked in the securities industry prior to law school.

Dr. Lloyd "Bo" Stewart is the Principal Engineer for the pneumatic well logging and a Vice President of PRAXIS. Dr. Stewart has ten years of experience overseeing the development and implementation of innovative technologies for the remediation and characterization of hazardous waste sites. Dr. Stewart also develops and implements computer models for risk assessments and cleanup actions. Remedial technologies under development at Praxis include steam injection combined with vacuum extraction, dual-phase extraction, and hydraulic fracturing. Dr. Stewart received his Ph.D. in Mechanical Engineering from the University of California Berkeley in 1989.

Mr. Mike Chendorain in the Soil Hydrologist for the subsurface investigation, data analysis, and modeling. Mr. Chendorain received an MS in Soil and Environmental Sciences from the University of California at Riverside. He received a BS in Environmental Sciences from Virginia Institute of Technology. He has three years of experience in modeling the fate and transport of contaminants in the subsurface. While working on his MS, he also worked as a teaching assistant and as a research assistant.

Table 1
PRAXIS Project Team Members

Responsibility	Team Member
Program Manager / Contracts	Mary Scarpetti
Project Manager / Principal Engineer	Bo Stewart
Subsurface Modeling/Data Analysis	Mike Chendorain
Equipment Installation & Maintenance	Steven Scarpetti

8. REFERENCES

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