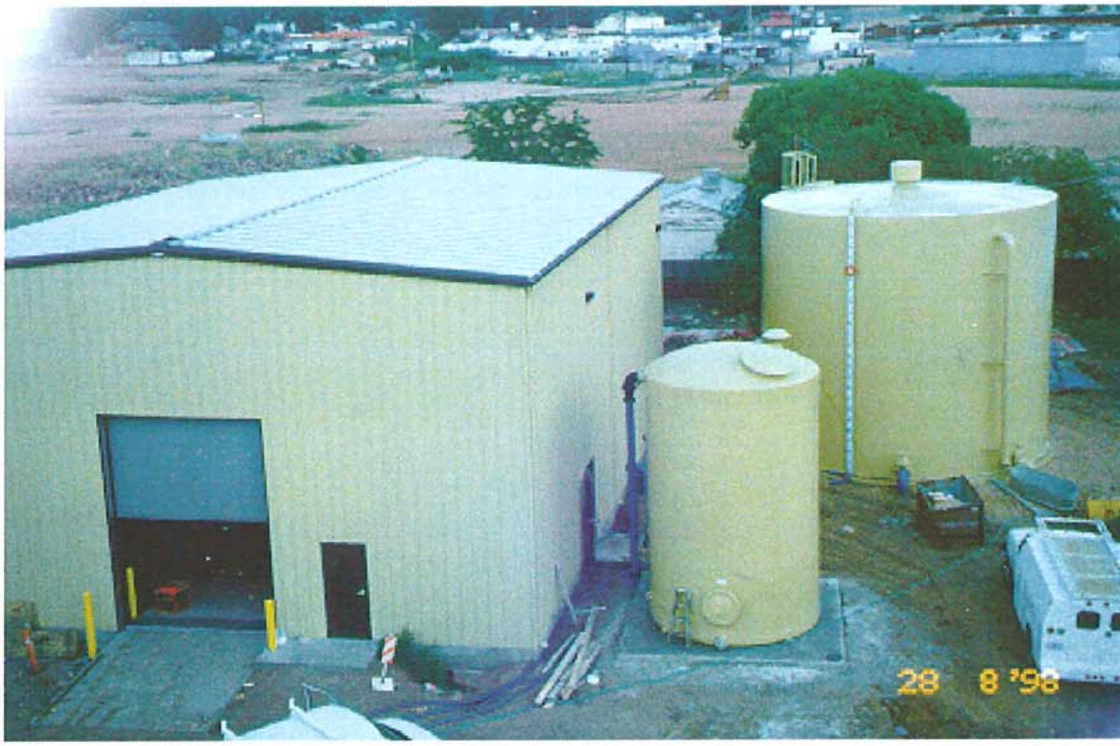
Feasibility Study Report
Payson PCE WQARF Site
Payson, Arizona



Prepared for:

Arizona Department of Environmental Quality
Phoenix, Arizona

May 2003

GeoTrans, Inc.
4665 South Ash Avenue Suite G-1
Tempe, Arizona 85282
(480) 839-2800

Feasibility Study Report

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FEASIBILITY STUDY REPORT
PAYSON PCE WQARF SITE
PAYSON, ARIZONA

Prepared for
Arizona Department of Environmental Quality
1110 West Washington Street
Phoenix, AZ 85007

Submitted by
GeoTrans, Inc.
4665 South Ash Avenue, Suite G-1
Tempe, Arizona 85282
(480) 839-2800

May 29, 2003

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Feasibility Study Report
Payson, Arizona

The material and data in this Feasibility Study Report was prepared under the supervision and direction of the undersigned.

REGISTERED GEOLOGIST
CERTIFICATE NO.
29376
PAUL R.
PLATO
Date Signed 5/30/03
ARIZONA U.S.A.

Paul R. Plato, R.G.
Senior Hydrogeologist

Jeffrey W. Rackow, P.E.
Senior Engineer

REGISTERED GEOLOGIST CERTIFICATE NO. 28376 PAUL R. PLATO Date Signed 5/30/04 ARIZONA, U.S.A.

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REGISTERED GEOLOGIST CERTIFICATE NO. 29376 PAUL R. PLATO Date Signed 5/30/03 ARIZONA

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REGISTERED GEOLOGIST CERTIFICATE NO. 29376 PAUL R. PLATO Date Signed 5/30/07 ARIZONA U.S.A.

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1.0 INTRODUCTION

1.1 PURPOSE AND SCOPE OF THE FS REPORT

This Feasibility Study (FS) report, prepared by GeoTrans, Inc. (GeoTrans) relies upon the data and findings of the Remedial Investigation (RI) activities that have been conducted by the Arizona Department of Environmental Quality (ADEQ) from 1993 through the present at the Payson PCE Water Quality Assurance Revolving Fund (WQARF) Site (the Site) (Figure 1-1). The FS is a process to identify a reference remedy and alternative remedies that appear to be capable of achieving defined Remedial Objectives (ROs) (Appendix E of the RI report, GeoTrans, 2002) and to evaluate the remedies based on prescribed comparison criteria to select a remedy that complies with Arizona Revised Statues (ARS) §49-282.06 Remedial Action Criteria; Rules. The FS has evaluated and selected a preferred remedy from among the proposed remedies which: 1) assures the protection of public health, welfare and the environment; 2) to the extent practicable, provides for the control, management, or cleanup of hazardous substances so as to allow for the maximum beneficial use of waters of the state; 3) is reasonable, necessary, cost-effective and technically feasible; and, 4) addresses any well that either supplies water for municipal, domestic, industrial, irrigation or agricultural uses or is a part of a public water supply system, if the well would now or in the foreseeable future produce water that would not be fit for its current or reasonably foreseeable end use without treatment.

The purpose of the report is to present and evaluate the proposed remedies, strategies and measures and select a proposed remedy that satisfies the criteria presented above. The FS has been conducted in accordance with the ADEQ Remedy Selection Rule (the Rule) as presented in Title 18. Environmental Quality, Chapter 16. Department of Environmental Quality Water Quality Assurance Revolving Fund Program, Article 4. Remedy Selection, R18-16-407 Feasibility Study.

1.2 REPORT ORGANIZATION

The remaining portions of the FS report have been organized into the following sections:

- Section 2.0 SITE BACKGROUND - This section presents a summary of the site description, physiographic setting, nature and extent of contamination and a risk evaluation.

- Section 3.0 FEASIBILITY STUDY SCOPING - This section presents the regulatory requirements presented in statue and rule, delineates the remediation areas and present the ROs identified in the RI.

- Section 4.0 EARLY RESPONSE ACTIONS - The Early Response Actions (ERAs) that have been undertaken at the Site are discussed.

- Section 5.0 IDENTIFICATION and SCREENING OF REMEDIATION TECHNOLOGIES- This section presents the evaluation and screening of various remediation technologies related to contamination in groundwater and lists the technologies that have been retained for inclusion into the reference and alternative remedies.

- Section 6.0 DEVELOPMENT OF REFERENCE REMEDY and ALTERNATIVE REMEDIES - This section presents the selected reference remedy, a more aggressive remedy and a less aggressive remedy. With each is a discussion of the associated strategy and measures.

- Section 7.0 DETAILED COMPARISON OF THE REFERENCE REMEDY and THE ALTERNATIVE REMEDIES - The three remedies are compared to each other based on the comparison criteria of practicability, cost, risk and benefit. Uncertainties, if identified, associated with each remedy or comparison criteria are discussed.

- Section 8.0 PROPOSED REMEDY - This section presents the proposed remedy and discusses how it will achieve the ROs, how the comparison criteria were considered and how the proposed remedy will meet the remedial action criteria as presented in ARS §49-282.06.

2.0 SITE BACKGROUND

The following description of the Site Background is taken from the *Remedial Investigation Report, Payson PCE WQARF Site, Payson, Arizona* (RI Report) (GeoTrans, 2002). The reader is directed to that report for a more detailed description of the Site.

2.1 SITE DESCRIPTION

The Site is approximately 110 acres in area and is located in the southern portion of the Town of Payson (TOP), bounded approximately by Frontier Street on the north, Beeline Highway on the east, Cedar Street on the south and McLane Road on the west (Figure 2-1). The Site was originally characterized by the presence of high levels of tetrachloroethene (PCE) and trichloroethene (TCE) in groundwater associated with the former Old Payson Dry Cleaners (OPDC; the source) located north of the intersection of the South Beeline Highway and West Nugget Street.

2.2 PAYSON PCE WQARF REGISTRY SITE

Contamination at the Site was initially identified by the Town of Payson during their routine groundwater sampling in May 1990. The sampling was conducted for source water approval of four wells that were completed as future Town of Payson water supply wells (Wells TOP-4, -5, -19 and -20). The analytical testing of groundwater identified PCE in concentrations of 13,600 micrograms per liter (µg/L) and 542 µg/L in Well TOP -4 and, -5, respectively (Earth Technology Corporation [Earth Tech], 1992). The United States Environmental Protection Agency (EPA) Maximum Contaminant Level (MCL) for both PCE and TCE is 5 µg/L, which is equivalent to the Arizona Aquifer Water Quality Standard (AWQS) for PCE and TCE.

The Site was identified as a potential WQARF Site in 1990 and, in response, a comprehensive groundwater monitoring program was initiated by the ADEQ that involved the sampling of additional wells in the area. The monitoring indicated detectable concentrations of PCE in eight wells (Earth Tech, 1992).

In 1993, the initial investigation for the ADEQ was conducted by the Preliminary Assessment/Site Inspection Unit (PASI Unit), which identified the OPDC as a possible source of PCE contamination. The OPDC reportedly has historically operated at 904-906 South Beeline Highway and 908-910 South Beeline Highway (Figure 2-2). The Site was added to the WQARF Priority List in December 1993. The Site was incorporated into the newly created WQARF Registry List in April 28, 1998, due to the presence of PCE and TCE in groundwater and the fact that the Town of Payson is wholly dependent on groundwater for their water supply.

2.3 SOURCE AREA DEFINITION

The PASI unit of ADEQ identified two properties which were investigated to determine the source of contamination at the Site: the 904 and 906 South Beeline Highway property, which was the last known location for the OPDC; and the 908 and 910 South Beeline Highway location, which currently is occupied by a Texaco Star Mart gasoline station and historically was occupied by the OPDC on the 908 S. Beeline parcel (ADEQ, 1993). The WQARF site boundaries have then been defined based on the extent of PCE contamination, which extended approximately from South Beeline Highway to South McLane Road, between West Main Street and West Aero Drive (Figure 2-3).

2.4 CHRONOLOGY OF SITE ACTIVITIES

To assist in reviewing the various investigation activities, GeoTrans has compiled this chronology of major investigative activities at the Site. The following outlines many of the events and investigative milestones for the project:

April 1990:	Town of Payson sampling finds PCE and TCE in groundwater collected from Wells TOP-4 and TOP-5 and reports results to ADEQ.
May 1990:	ADEQ identifies the Site as a WQARF Site and conducts initial groundwater sampling event.
December 1990:	Earth Tech, for ADEQ, re-samples wells TOP-4, -5, -19 and Worden.
February 1991:	Earth Tech, for ADEQ, presents workplan for hydrogeologic investigation.
April 1992:	Well elevation and locations surveyed by Yost and Gardner for ADEQ.
November 1992:	ADEQ identifies potential source area (OPDC).
February 1993:	ADEQ conducts Preliminary Assessment (PA) of OPDC.
March 1993:	Earth Tech, for ADEQ, samples wells near Site and prepares plume map.
March 1993:	Earth Tech, for ADEQ, conducts hydrophysical logging of TOP-4 and TOP-5.
April 1993:	ADEQ conducts Site Inspection (SI), including GeoProbe™ groundwater, soil vapor and soil sampling in source area..
December 1993:	Payson WQARF Site placed on the WQARF Site Priorities List.
February 1994:	ADEQ conducts additional Site investigation activities, including the drilling of monitor wells PP-01 (became EW-3), PP-02 and HydroPunch® sampling along four profiles at and near source area (OPDC).
February 1994:	ADEQ begins intermittent groundwater monitoring and sampling of wells near the Site, based on availability of funding.
June 1994:	ADEQ completes monitor well PP-01 (EW-3). Aquifer testing was subsequently conducted in December 1994.
January 1995:	ADEQ conducts an Expanded Site Inspection (ESI) investigation, including soil vapor and soil sampling and sampling of the suspected source area (septic tank).

June 1995:	Growth Environmental (Growth), for ADEQ, removes septic tank system at OPDC as an ERA under WQARF, identifies cesspool and collects confirmation samples beneath septic tank.
Jan-Mar 1996:	ADEQ drills five additional soil borings (including coring) on the Texaco and Rundle properties (B-1 through B-5); collects discrete groundwater samples using HydroPunch® from B-1, B-2 and B-5. Borings B-3 and B-4 completed as monitor wells PP-03 and PP-04 (Rundle 2-Inch and Rundle North). ADEQ installs extraction wells EW-1 and EW-2.
September 1996:	Dames and Moore contracted by ADEQ to construct Interim Groundwater Extraction System (IGTS) as an ERA under WQARF.
Oct-Nov 1996:	ADEQ installs 4 monitor wells downgradient of the source area (DG-1, DG-2, DG-4A and DG-5) and three additional borings DG-3, DG-4 and DG-6. Depth specific water sampling was conducted prior to well installation.
November 1996:	ADEQ conducts sampling of the OPDC cesspool.
Feb-Oct 1997:	Dames and Moore designs and builds IGTS.
Mar-Apr 1997:	Cesspool contents sampled, cesspool removed, with confirmation sampling, as an ERA under WQARF.
August 1997:	EMCON contracted, for ADEQ, to develop Hydrogeologic Conceptual Model (HCM) and groundwater flow model and to evaluate, design and build Expanded Groundwater Treatment System (EGTS) as an ERA under WQARF.
Aug-Oct 1997:	ADEQ installs well sets WS-1, WS-2 and WS-3.
December 1997:	HSI GeoTrans, for ADEQ, conducts aquifer testing on TOP-4, TOP-5, TOP-19, TOP-20, WS-1, WS-2, WS-3 and TOP-Skinner.
December 1997:	Dames and Moore takes over quarterly groundwater sampling at the Site and creates a database for sampling data.
Jan-Dec 1998:	ADEQ and EMCON formulate HCM as part of the development and construction of the groundwater flow model for the site.
January 1998:	IGTS performance tested for 90 days.
March 1998:	Wellhead remediation system installed at the TOP-Skinner by Levine-Fricke-Recon (LFR) for ADEQ.
Apr 98-Apr 99:	TOP-Skinner wellhead treatment system operational.
Apr-Oct 1998:	EMCON designs and builds EGTS.
July 1998:	EMCON contracted to conduct monitor well installation and aquifer testing.
July-Dec 1998:	EMCON installs, samples and conducts aquifer tests at 32 monitor wells to define the plume and provide additional hydrogeologic data.
October 1998:	IGTS and EGTS become fully operational and begin treating and delivering water to Town of Payson.
November 1998:	ADEQ and EMCON begin monitoring water levels in wells at the Site, with continuous monthly measurements by EMCON beginning in April 1999.

December 1998:	Extraction well EW-4 drilled, groundwater flow model report completed and delivered by EMCON.
April 1999:	Extraction well EW-4 connected to the IGTS and EW-1 and EW-2 disconnected due to declining water levels.
April 1999:	Geotechnical and Environmental Consultants, Inc. (GEC) contracted by ADEQ to perform quarterly groundwater monitoring field activities and Dames and Moore continues to prepare quarterly reports and to maintain database.
June 1999:	TOP-Skinner wellhead treatment system removed and the well connected to the EGTS.
September 1999:	Environmental Science and Engineering, Inc. (ESE) contracted by ADEQ to oversee removal of building and 3 USTs (which were previously abandoned) from Rundle property. USTs, the building/slab, underground utilities and contaminated soil were removed by ASL, who was retained by Kaibab Industries, purchaser of the Rundle property.
September 1999:	ESE conducts soil and soil vapor sampling and installs three sets of three nested vapor monitoring wells to evaluate the Rundle property.
September 1999:	IT (after acquiring EMCON in 1999) contracts HSI GeoTrans to measure groundwater levels and complete groundwater model update.
November 1999:	ESE collects soil vapor samples from 11 soil borings and discrete groundwater sample from 3 continuous core borings using HydroPunch® and installs 3 sets of discreet zone vapor sampling wells.
June 2000:	IT completes monthly water level monitoring activities and GEC takes over water level monitoring on a quarterly basis in conjunction with sampling.
July 2000:	HSI GeoTrans contracted by ADEQ to complete RI, drill additional extraction wells and complete investigation activities at the Site.
August 2000:	HSI GeoTrans completes vapor sampling of 14 wells (including vapor monitoring wells) at the Texaco and Rundle properties.
November 2000:	HSI GeoTrans conducts pilot soil vapor extraction (SVE) pilot test at Texaco and Rundle properties.
May 2001:	GeoTrans (formerly HSI GeoTrans) completes ADEQ Approved Draft RI Report, presents information to CAB.
July 2001:	New extraction wells (EX -1 and EX - 2) online, providing water to EGTS.
July 2001:	GeoTrans and ADEQ present RI report to public for comment at meeting in Payson.
July 2001:	Town of Payson provides comments for RI report, identifies additional wells which have detections of PCE below AWQS.
August 2001:	GeoTrans completes construction of the SVE system and starts up the system extracting soil vapor from extraction wells EW-1 and EW-4.

August 2001:	ADEQ and GeoTrans met with Town of Payson to discuss newly disclosed well impacts at Rodeo Grounds, Woodland Meadows No. 2 and McKamey wells.
Oct -Nov 2001:	GeoTrans completes geophysical logging and depth specific groundwater sampling of 3 Town of Payson production wells.
Oct -Nov 2001:	GeoTrans completes six sentinel monitor wells at EGTS to monitor MTBE impacts.
January 2002:	GeoTrans presented a report to ADEQ and the Town of Payson outlining the results of investigation of additional PCE contaminated wells, which will be included as an Appendix to the RI report.
June 2002:	GeoTrans presented the Final RI Report to ADEQ and the Town of Payson.
August 2002:	GeoTrans discontinues SVE system, due to a less than 1 pound per day removal rate.
September 2002:	GeoTrans conducts soil sampling to confirm SVE effectiveness. Samples were all non-detect for VOCs using EPA Method 8260B.
December 2002:	GeoTrans removes SVE system from Site.
January 2003:	IGTS shutdown, pumping rate was down to 15 gallons per minute (gpm). GeoTrans abandoned former extraction wells EW-1, EW-2 and EW-3, and vapor monitoring wells CC-B1, CC-B2 and CC-B3. GeoTrans also abandoned monitor well Rundle 2-Inch and domestic well Rundle.

2.5 RISK EVALUATION FROM RI REPORT

As part of the RI Report, an evaluation of current risks was completed to determine the potential for impacts to public health, welfare and the environment. This evaluation is included as a background for the completion of the FS Report. In order to evaluate risks at the site, the Arizona Department of Health Services (ADHS) completed the *Statement of Risk, Payson WQARF Site, Payson, Arizona*, (ADHS, 1994). This document discusses the risks associated with the contamination at the site. A summary of this report is presented in the following sections.

2.5.1 Chemicals of Concern

ADHS reviewed the water quality data collected during the sampling event of February, 1994 to evaluate potential chemicals of concern (COCs). Based on the data presented, the following chemicals were identified:

- Benzene;
- Chloroform;
- 1,2-Dichloroethane;
- Tetrachloroethene; and,
- Trichloroethene.

These five chemicals were the focus of the risk evaluation process, based on the exceedences of MCLs and Arizona Health Based Guidance Level (HBGL) and the listing of the chemical as a possible, probable or known human carcinogen.

2.5.2 Exposure Assessment

ADHS evaluated exposures to COCs using the following approach:

- Exposure Setting Characterization;
- Exposed Population;
- Exposure Pathway Identification;
- Quantification of Exposure; and,
- Uncertainties in Exposure Assessment.

The report evaluated known hydrologic and geologic data and assessed exposure pathways due to fate and transport of contamination. The exposure assessment identified potential exposures in each of the following pathways:

- Groundwater; and,
- Air.

ADHS considered soil pathway as a potential route of exposure, but no soils data were available at the time of the evaluation. Subsequent soil sampling has not identified samples that exceed relevant residential soil remediation level (R-SRL) or non-residential soil remediation level (NR-SRL). For this reason, the presumed excess cancer risk is probably less than 1 in 1,000,000, which is the basis of the R-SRL. Table 2-1 illustrates the exposure path evaluation conducted:

Table 2-1 Exposure Path Summary

Potential Exposed Population	Exposure Point	Exposure Route	Path Evaluated	Path Selected	Exposure Type	Rationale
Groundwater						
Residents / Occupational	Ingestion of groundwater from private and semi-public wells, swimming pool	Ingestion Inhalation Dermal	Yes Yes Yes	Yes Yes Yes	Actual	Wells have been impacted
Occupational	Truck washing	Inhalation	Yes	Yes	Actual	Contaminated water used for washing trucks
Soil Gas						
Occupational / Trespassers	Vapors outdoors from contaminated groundwater	Inhalation	Yes	Yes	Potential	Potential for human exposure

Soil						
Occupational / Trespassers	Direct contact with soil at site	Ingestion Inhalation Dermal	Yes Yes Yes	No No No	Intermittent	Insufficient data for analysis
Occupational / Trespassers	Fugitive dust	Ingestion Inhalation Dermal	Yes Yes Yes	No No No	Intermittent	Insufficient data for analysis

2.5.3 Groundwater Exposure

ADHS evaluated nine private wells that were known to be contaminated: First Baptist (BAPTIST CHURCH), Aero Drilling (AERO), B & B Auto, Chapman, Payson Auto (AUTO CLINIC), Paysonglo Lodge (PAYSONGLO-S), U-Haul, Wilson and Worden. These wells are shown on Figure 2-4. Each well was evaluated for ingestion, inhalation and dermal contact through standard methodologies established by the EPA. The U-Haul well was also evaluated for inhalation exposure due to washing of trucks. Exposure was evaluated as average exposure and reasonable maximum exposure. The Hazard Index was also calculated for each exposure type, which is a measure of non-cancer adverse health impacts.

ADEQ has collected samples from additional private groundwater wells since the initial samples used in the risk analysis. Table A2 in Appendix A of the RI Report (GeoTrans, 2002) lists 40 private wells that have been sampled or for which information has been gathered during the RI sampling activities. Based on the information gathered during the investigation, the wells listed would represent the extent of wells which may have potential or actual exposure risks. Wells in which PCE was detected are noted, which includes 15 private wells. Table 2-2 lists nine wells that have exceeded relevant AWQS during the course of the investigation. Several of these wells have gone dry or are known to be non-operational, based on recent sampling activities[1].

[1] GeoTrans contacted Steve Kaminski of GEC, Inc. to identify wells which are dry or are presumed to be unused.

Table 2-2 - Threatened Domestic Wells Near Payson PCE WQARF Site

Well Name	ADEQ No.	Currently Operational	Known to be Dry	Impacted Historically	Threatened Domestic Wells
404WMAIN	56741		X		
AERO	002163		X	X	
AUTOCLINIC	002161		X	X	
B&B AUTO	46016		X	X	
BAPTISTCHURCH	46015		X	X	
BMRENTALS	56742	X			X
BUSE	56743		X		
CHAPMAN	002158		X		
GASKILL	56603		X	X	
HARRISON-A	57552	X		X	X
HILLSIDE	57699				
KACHINA	002159		X	X	
KACHINANEW	56602	X		X	X
MORGAN-HANDDUG	46025		X	X	
PAYSONGLO-S	46026	X		X	X
RAYAUTO	56747		X	X	
RICHARDSON-2	56748	X		X	X
ROGERS	56749	X		X	X
SHEEHAN	56604		X	X	
TOP-MORGAN	002160	X		X	X
UHAUL	002157		X	X	
WORDEN	46017		X	X	

2.5.4 Soil Gas Exposure

ADHS evaluated the potential flux of vapors which would be released due to partitioning of contaminants from groundwater to soil vapors. ADHS utilized standard partitioning and vapor flux models to define the outside air concentrations. These data were incorporated into the exposure assessment for each of the private wells, as an additional source of exposure.

2.5.5 Conclusions

Although the evaluation was based on a single round of sampling, the risk evaluation provided some guidance for estimating potential risks posed by the contamination at the site. The evaluation concluded that only the U-Haul well exceeded the EPA guidelines for excess lifetime cancer risk for average exposure. Additionally, the Hazard Index exceeded 1, which indicates that sensitive members of the population may have adverse non-cancer health impacts. This evaluation assumed that the U-Haul well was used for domestic purposes, which the owner did not indicate was currently a use for this well. The report concluded that the U-Haul and the Aero wells exceeded MCLs and therefore should not be used for domestic purposes.

Based on this study, ADEQ has provided bottled water to impacted Town of Payson residents for use as drinking water. The removal of ingestion as a route of exposure substantially lowers the risk, so providing drinking water has been implemented as an interim remedy. Further details can be found in the *Statement of Risk, Payson WQARF Site, Payson, Arizona*, (ADHS, 1994).

3.0 FEASIBILITY STUDY SCOPING

3.1 REGULATORY REQUIREMENTS

ARS §49-282.06. Remedial Action Criteria; Rules B states the Director shall adopt rules necessary to implement the criteria for selection of a remedial action at a WQARF site. The rules required by this Article and in selecting remedial actions must consider the following factors:

- Population, environmental and welfare concerns at risk;
- Routes of exposure;
- Amount, concentration, hazardous properties, environmental fate, such as the ability to bio-accumulate, persistence and probability of reaching the waters of the state and the form of the substance present;
- Physical factors affecting and environmental exposure such as hydrogeology, climate and the extent of previous and expected migration;
- The extent to which the amount of water available for beneficial use will be preserved by a particular type of remedial action;
- The technical practicality and cost-effectiveness of alternative remedial actions applicable to a site; and,
- The availability of other appropriate federal or state remedial action and enforcement mechanisms, including, to the extent consistent with this article, funding sources established under CERCLA, to respond to the release.

The remedial actions required by this Article should be consistent with the requirements of Title 45, Chapter 2, the Groundwater Code, except as provided in amendments.

The Remedy Selection Rules (Article 4, R-18-16) have been developed to address implementation of the Remedial Action Selection. The Remedy Selection Rule ®-18-16-407 - Feasibility Study) states that an FS is a process to identify a reference remedy and alternative remedies that appear to be capable of achieving ROs and to evaluate the remedies based on the comparison criteria to select a remedy that complies with ARS §49-282.06.

This FS has been conducted in accordance with the Remedy Selection Rule R18-16-407, Sections A, B, E, F, G, H and I.

3.2 DELINEATION OF REMEDIATION AREAS

For the purpose of the FS, GeoTrans has assumed that the extent of contamination is defined by the individual samples with detectable concentrations of VOCs above the relevant MCLs for groundwater. For this reason, only compounds whose groundwater concentrations have historically exceeded MCLs were considered for the determination of the extent of contamination in groundwater.

Table 3-1 - Groundwater Sample Results that Exceeded Aquifer Water Quality Standards

Compound Name	Count of Samples with Exceedences
1,2-Dichloroethane	18
Benzene	28
Bis (2-Ethylhexyl) Phthalate	10
cis-1,2-Dichloroethene	14
Ethylbenzene	2
Tetrachloroethene	418
Toluene	3
Trichloroethene	46

Total samples in database for evaluation = 81,014

Based on GeoTrans review of the data in Table 3-1 and other available data, PCE, TCE and cis-1,2-DCE are the primary COCs. AWQS exceedences of 1,2-DCA, benzene, toluene and ethylbenzene have been noted in samples from wells near the Site, but these compounds are generally associated with leaks from gasoline USTs. 1,2-DCA is a common additive to gasoline and each of the wells with exceedences appear to be associated with the UST sites in the area (Texaco and Whiting).

Exceedences of bis (2-ethylhexyl) phthalate were also noted in samples from the Site. This compound is generally assumed to be released during decomposition of plastics, including PVC used for well casing and screen. It is commonly associated with landfills which contain decomposing plastics. GeoTrans assumes that the detection of this compound is associated with the PVC casing for the monitor wells and is not related to general contamination in the aquifer.

None of the primary COCs listed appear in samples separately from PCE[2], and for this reason, the RI for the Site focused the on identifying the extent of PCE in groundwater to define the extent of contamination at the Site. The FS considers whether the proposed remedy will address the other compounds noted above, although the sources of non-primary compounds appear to be unrelated to the contamination mechanism outlined in the RI Report.

Other Areas of Concern

MTBE has recently become a significant concern for groundwater contamination in many areas due to its common use in gasoline as an oxygenating compound to improve air quality. MTBE does not currently have an established AWQS, but it is likely that a standard may be adopted in the future. MTBE presents some significant challenges to designing and operating a remediation system, due to the difficulty of air stripping or remediating MTBE from groundwater using carbon adsorption techniques. GeoTrans has assumed that MTBE is associated with the LUST sites along the Beeline Highway near the site: the Texaco site (910 S. Beeline), the Whiting site (804 S. Beeline) and a

[2] One sample from DMW-13B collected during the aquifer test in November 1998 had an exceedence of TCE, but not of PCE. PCE was detected at a concentration of 0.8 µg/L.

former Union 76 at 901 S. Beeline. MTBE has been used in gasoline since the mid-1980s and each of the sites listed has been an active gasoline station since that time. MTBE has been detected in soil and groundwater samples from the Whiting station and in soils at the former Unocal station. MTBE has not been noted in samples from the Texaco site, but many sampling events (soil, vapor and water) did not include MTBE analysis.

MTBE is a "mobile" constituent of gasoline, implying that it is transported effectively in groundwater with limited retardation. Due to the difficulties in remediating MTBE using the existing treatment systems at the site, the presence of MTBE causes some significant concerns regarding operation of the treatment system. Based on a review of the groundwater database, 18 samples had MTBE concentrations greater than 30 µg/L, with a maximum detected concentration of 1,500 µg/L at well DMW-11A (September, 2000). This suggests that the Whiting site (804 S Beeline) may represent a source of MTBE which must be considered in an evaluation of the remedy for the Site. MTBE concentrations will continue to be measured at monitor wells near the site to determine whether MTBE is migrating to extraction wells connected to the EGTS and whether system operational changes should be considered. These data will be further considered as part of the upcoming remedial alternatives analysis.

3.2.1 Source Area - Vadose Zone

As part of this FS Report, the following sections are excerpted from the RI Report to summarize the nature of the identified source of contamination at the Site.

Sampling activities in the source area have been performed historically by ADEQ, Texaco, Kaibab and their respective subcontractors and consultants. Evaluation of the data collected through the use of a comprehensive database has aided in delineation of areas with elevated levels of PCE. A correlation was found between elevated levels of PCE detected in vadose zone areas at 906 South Beeline Highway and high concentrations in groundwater at and downgradient of these areas. This correlation is discussed in more detail in the following sections.

To define the extent of contamination in the vadose zone, the soil and soil vapor samples will be separately evaluated to define the extent of matrix contamination as compared with vapor concentrations. Generally, the detected soil concentrations have been less areally extensive than the soil vapor sample results at the Site.

Soil Contamination

<u>**Nature of Contamination in Soils**</u>

Although no definitive records exist to indicate the nature of the wastes discharged into the septic and cesspool systems at the OPDC, the resulting contamination is dominated by PCE concentrations (Table 3-2). For this reason, it is assumed that the original source of the contamination was primarily or exclusively composed of PCE, with TCE and cis-1,2-DCE detected in groundwater as degradation products. Table 3-2 illustrates a composite of soil sample results for the course of the investigation.

Extent of Contamination in Soils

Prior to the removal of identified sources of contamination at the OPDC septic tank and cesspool, the extent of contamination in the vadose zone is generally assumed to extend from the presumed disposal of PCE into the septic and cesspool sources directly to the groundwater, which was historically shallow at the source area. Elevated levels of PCE in soil (Figure 3-1) were originally detected in the areas of the wastewater system consisting of the restrooms, floor drain, septic tank, leach field and the unlined cesspool. This contamination extended through the entire depth of vadose zone, to the groundwater.

Figure 3-2 illustrates the extent of detected PCE contamination in soils categorized by sample depth. The soil samples have been divided into three groups: up to 8 feet, 9 to 20 feet and 21 to 27 feet bgs. Two samples were collected from depths greater than 25 feet[3], which was historically below the water table at the site. This categorization by depth helps to evaluate the vertical distribution of soil contamination. The soil sample results show that concentrations of PCE in soil are present within the upper 20 feet in many locations surrounding the presumed source area. Highest concentrations appear to be associated with the septic system source area, although significant concentrations were detected in samples 3-6 and 2-6 near the intersection of South Beeline and West Nugget Street. Additionally, significant concentrations are found in the West Nugget Street area, including sample 8-1 adjacent to the Texaco property. Near the cesspool and septic tank, the concentrations are highest in samples from 9 to 20 feet bgs, while shallow samples 0 to 8 feet are generally higher for other samples.

Based on the data presented (Table 3-2 and Figure 3-2), the lateral extent of contamination of soils can be defined by soil samples 6-3 on the east, 7-2 on the west, 5-2 on the north and SDS-46 on the south and west. The vertical extent of contamination apparently is defined by the depth of the cesspool, with the samples collected to a depth of 43 feet having concentrations of PCE (the analytical results for these samples were not located by GeoTrans). The approximate dimensions of the area defined by the listed soil samples is 100 feet by 90 feet.

None of the soil sample data reviewed for the development of this report indicated concentrations of PCE greater than the R-SRL, or NR-SRL. The sludge samples collected during the investigation of the cesspool were analyzed for aqueous concentrations and thus cannot be compared with the R-SRL or NR-SRL. None of the soil sample data collected during the RI indicated concentrations of PCE greater than the residential R-SRL (53 mg/kg), or NR-SRL (170 mg/kg).

ADEQ has also established Groundwater Protection Levels (GPLs) for PCE, which has a listed minimum value of 1.3 mg/kg. GPLs can be adjusted to reflect site specific conditions, such as depth to water, depth of incorporation and other site specific conditions through the use of a simple vadose zone leaching model. Alternatively, a set of tables with depths to groundwater is provided to reflect various combinations of input parameters. Because groundwater was historically very shallow and

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[3] One sample was collected during the initial soils investigation and one sample was collected during characterization of the cesspool.

the depth of incorporation was below the water table[4], the minimum GPL value is appropriate. Samples collected during removal of the cesspool and the septic tank had concentrations higher than 1.3 mg/kg, although many samples had detection limits of 50 mg/kg or greater (Growth, 1995 and GRI, 1997).

Soil Vapor Contamination

Nature of Contamination in Soil Vapor

As with the distribution noted in soil samples, soil vapor samples also have shown predominantly PCE contamination, with minor detections of TCE and other VOCs. Table 3-3 shows a composite of results from soil vapor sampling through the course of the investigation, also grouped by depth of sampling. Soil vapor samples have a somewhat wider variety of contaminants, including TCE, BTEX constituents, methyl ethyl ketone (MEK) and possibly methylene chloride. However, PCE is still the predominant constituent and the MTBE and BTEX constituents are likely to be related to the LUST sites near the Site.

Extent of Contamination in Soil Vapor

As with soil samples, soil vapor samples detections are directly associated with the source areas at the Site. Elevated levels of PCE in soil vapor (Figure 3-3) were originally detected in the areas of the OPDC wastewater system consisting of the restrooms, floor drain, septic tank, leach field and the unlined cesspool. The soil vapor samples have a wider extent of detectable concentrations however, which is likely to be a combination of vapor migration and off-gassing from contaminated groundwater at the Site.

Soil vapor samples have also been collected from the formerly saturated zone from 20 feet to 60 feet bgs in order to evaluate the residual vapor concentrations that remain in the vadose zone. Following the source removal actions, vadose zone contamination was noted in soil vapor at the Site, including elevated levels of residual PCE in soil (smear zone), extending from the highest to the lowest water levels recorded during the period from 1976 to present (approximately 15 and 65-70 feet bgs, respectively). Soil vapor sampling conducted by HSI GeoTrans in August 2000 indicates residual concentrations are still present in the vadose zone (Figure 3-4) (GeoTrans, 2001).

Figure 3-3 illustrates the results of the soil vapor samples collected historically. These results show that concentrations of PCE in soil vapor are present throughout the unsaturated zone near the source area. Generally, the highest concentrations are noted in shallow samples (less than 20 feet) from the area of the septic tank and cesspool (2-3, PD5, 3-3). Highest concentrations in deeper samples, including zones which were previously saturated, are noted to the south and east of the septic tank and cesspool. This coincides with high reported groundwater concentrations noted for EW-1 and Cardon MW-6, which are south of the presumed source area. One sample, SSG-4, located on the Texaco site has a soil gas PCE concentration of 2,000 µg/L. This may represent a potential

[4]This presumes that the cesspool removed by Growth Resources, Inc. (GRI) from the Rundle property represented the source of contamination and that the depth of the cesspool was approximately 30 to 40 feet (GRI, 1997). GRI removed soils to a depth of 43 feet (pilot hole to 50 feet). The depth to groundwater was reported as 34 feet during excavation activities (GRI, 1997).

additional source area at the Texaco site, or it may represent high concentrations off gassing from groundwater, or migration of PCE vapor due to former SVE operations at the Texaco Site.

Based on the data presented (Table 3-3 and Figures 3-3 and 3-4), the lateral extent of contamination of soil vapor can be defined by vapor samples PSG-1 on the east, extraction well EW-3 on the west, PSG-9 on the north and extraction well EW-2 on the south. Results of vapor sampling and soil vapor extraction (SVE) pilot testing (conducted in August and November 2000) suggest that PCE concentrations in soil vapor are mobile, with detectable concentrations migrating to the extraction point (GeoTrans, 2001). For this reason, the extent of vapor contamination may be difficult to define, since vapor sampling and SVE pilot test activities may have caused migration of contamination.

Impact of SVE at former Cardon Oil Site

Soil Vapor Extraction was implemented at the Texaco site to remediate gasoline contamination in the soils. GeoTrans reviewed the *First Periodic SVE Report: Former Cardon Store #533, 910 S. Beeline Highway, Payson, Arizona 85541* (EnTech, 1999), and has determined that an SVE system was installed in February 1999 by EnTech Environmental Technology, Inc. (EnTech). Due to difficulties with the catalytic oxidizer unit (catox) that was installed as part of the SVE system, the operation of the SVE system was not started until March 20, 1999.

The initial vapor samples collected on March 30, 1999 indicated concentrations of benzene of 17,000 micrograms per cubic meter ($\mu g/m^3$), and toluene at 19,000 $\mu g/m^3$. Benzene concentrations were highest in the sample collected April 22, 1999, at 92,000 $\mu g/m^3$. Samples were apparently collected in March, April, May and June 1999. As of the last sampling (June 28, 1999), the benzene concentration was 6,700 $\mu g/m^3$. During this sampling event, toluene, PCE, ethylbenzene, m-&p-Xylenes and o-Xylenes were detected at 260,000 $\mu g/m^3$, 3,500 $\mu g/m^3$, 43,000 $\mu g/m^3$, 190,000 $\mu g/m^3$ and 61,000 $\mu g/m^3$, respectively. No further samples were reported by EnTech prior to system shutdown.

According to EnTech, the SVE system was shutdown in August 1999 and removed from the site. The report indicates that Texaco, through its environmental management group, Equiva Services LLC (Equiva) assumed responsibility for the site and replaced the SVE system. Based on reports from Miller Brooks Environmental, Inc. (Miller Brooks, 2000a, 2000b and 2000c) and Northshore Engineering, Inc. (Northshore, 2000), a new SVE system was installed in August 1999.

Samples collected by Miller Brooks and Northshore over the period of operation from August 1999 to August 2000 indicate that concentrations of Total Petroleum Hydrocarbons (TPH), ethylbenzene, toluene and xylenes generally declined over the period of operation. Samples of influent vapor were not analyzed for PCE or MTBE. Based on the *Soil and Groundwater Remediation Quarterly Monitoring Report, Second Quarter 2000* (Northshore, 2000), 4,297 pounds of total hydrocarbons were removed during SVE system operation from August 1999 to August 2000. By contrast, the SVE system operated by EnTech reportedly removed 39,919 pounds of total hydrocarbons while operated from March 1999 through August 1999 (EnTech, 1999). The second SVE system was removed on August 29, 2000 according to *"LUST Site Closure Report for Texaco Station #60-349-0335"* (Northshore, 2000a).

The detection of PCE in soil vapor at the Texaco site indicates that the SVE system may have caused soil vapor PCE to migrate toward the vapor extraction wells used. The SVE system operated at between 150 and 500 standard cubic feet per minute (SCFM) during the period of operation from March 1999 and August 1999, which is similar to the rates employed in the SVE system installed as an ERA at the Payson PCE WQARF Site (EnTech, 1999). The new SVE system was operated at 140 to 250 SCFM over it period of operation from August 1999 to August 2000. For this reason, migration of PCE vapor toward the extraction wells is likely to have occurred during the operation of the SVE system at the Texaco site. The extraction wells were located on the southern portion of the Texaco site, adjacent to the existing canopy and dispenser pumps.

3.2.2 Groundwater

The primary issue of concern at the Site has been the extensive groundwater contamination in the area. Groundwater contamination impacts to public and private wells have been the guiding course of the investigation since the initial discovery of high PCE concentrations in groundwater samples collected at the Town of Payson production wells. For this reason, the evaluation of groundwater concentrations is key to understanding the nature and extent of contamination at the site.

Aquifer Characteristics

Based on the development of the HCM, the aquifer characteristics at the Site can be summarized by the following:

- There is only one aquifer present at the Site, with different interconnected components: the Alluvial Unit (AL Unit), Decomposed/Fractured Granite Unit (DG/FG Unit) and the Fractured/Competent Granite Unit (FG/CG Unit);
- There is a minimal vertical downward gradient in the aquifer, with the AL acting as a source of delayed drainage, discharging to the DG/FG;
- The AL is lower in hydraulic conductivity than the underlying DG/FG, thus implying that the groundwater is moving mainly through the DG/FG; and,
- The FG/CG is connected to the DG/FG, but does not generally act as a horizontally continuous aquifer, with water at each location derived from the nature and orientation of fracture interconnection with the DG/FG.

Groundwater Movement

Groundwater flow has historically been westward, with calculated values of 0.0093 feet per foot (ft/ft) using the October 1998 water level data. However, groundwater pumpage has had a profound impact on local groundwater flow conditions, altering the magnitude and direction of the gradient significantly near pumping wells. The driving forces in groundwater movement at the source area that have significant impacts for contaminant transport can be summarized as follows:

- Regional groundwater flow has historically transported contaminants downgradient (west) from the source area as part of the overall regional groundwater flow;
- Localized groundwater flow conditions caused by pumping of wells which results in significant local drawdown;
- Fluctuations in groundwater levels caused by changes in long term pumpage and recharge have caused either deposition of contamination in the vadose zone when the water levels declined, or dissolution of vadose zone contamination when the water levels have risen; and,
- Current declines in water levels resulted in significant residual contamination in vadose zone; and,
- Short term recharge caused by intermittent flows in the historical drainage canal west of the source:
  - Shifting the groundwater flow temporarily to the east or south, thus spreading contamination into normally cross-gradient or upgradient areas;
  - Increasing the horizontal gradient and causing contamination to move large distances over short time periods; and,
  - Increasing water levels caused vadose zone contaminants to come in direct contact with groundwater and dissolve in the groundwater.

Extent of Contamination

GeoTrans has reviewed the available historical data for groundwater concentrations from wells and has prepared or obtained a series of groundwater plume maps which outline the nature and extent of groundwater contamination at the Site. The earliest plume map was derived from data developed by ADEQ and Earth Technologies, based on the March 1993 sampling of wells and groundwater samples collected by ADEQ using a GeoProbe™ sampler (Figure 3-5). This figure indicates that groundwater contamination has clearly impacted the area west of the source area by 1993.

Figure 3-6 illustrate PCE concentrations in groundwater for December 1998, which is the first quarterly plume map developed following the completion of the preliminary monitor well network in 1998. This map illustrates that the extent of the plume immediately after the startup of the EGTS and IGTS (October 1998). Assuming that the plume was subsequently hydraulically contained by pumpage of the IGTS and EGTS extraction wells, the plume map presented in this figure should represent the approximate maximum extent of contamination.

Figures 3-7a, 3-7b and 3-7c illustrate a comparison of groundwater concentrations from September 2002 and December 1999, with individual maps for each of the three hydrologic layers at the Site. This is the latest available data, and these data are summarized below:

- Groundwater contamination by PCE at concentrations greater than 5 µg/L is defined by the following well locations at the Site: the western extent by monitor well DG-4A, the eastern extent by monitor well DMW-3C, the southern extent by Aero and DMW-12C and the northern extent by wells Rundle-N, DMW-8B, DMW-11A and DMW-11C.

- Downgradient extent of PCE contamination greater than 5 µg/L extends approximately 1,500 feet to the west of the source area, with AWQS exceedences at TOP-Skinner, Sheehan and DG-4A.
- PCE has impacted the lowest hydrologic unit at the Site, FG/CG, with vertical depth of contamination defined by monitor well DMW-1D, which has not indicated detectable concentrations of PCE;
- The greatest extent of contamination is noted in the DG/FG unit, which is believed to be the most productive portion of the aquifer; and,
- The extent of contamination in the FG/CG unit is limited, with contaminants "dragged down" into this unit by past groundwater pumping at wells TOP-4, TOP-5R, TOP-19 and other wells.

A review of historical PCE concentrations from the source area indicates that:

- The highest levels of groundwater contamination with PCE (up to 25,000 µg/L) were detected in wells EW-1 and at a discrete groundwater sample location HP-01-02 (southeast of the septic tank and the cesspool), followed by up to 21,000 µg/L in Cardon MW-6 (see Figure 3-8);
- The highest detected PCE concentrations in groundwater (25,000 µg/L) suggest the possible presence of a phase-separated product (based on the PCE solubility of 125,000 µg/L). However, the results from the 90-Day Startup Testing of the IGTS (URS, 2001) showed that concentrations of PCE declined from 10,200 µg/L initially, to 57 µg/L in December 2000. No subsequent rebound in PCE concentrations has been observed during periods of shutdown and restart for the IGTS. This suggests that no phase-separated product is present at the source area; and,
- PCE concentrations are declining in the source area and in the area downgradient (Figures 3-9 and 3-10), with a peak concentration in downgradient well DG-1 measured immediately prior to the startup of the IGTS and EGTS.

PCE concentrations have presumably peaked and are declining due to the impact of the ERAs. The removal of the source of contamination at the OPDC and the operation of the IGTS and EGTS has clearly caused concentrations of PCE to decline at the source area and downgradient. Additionally, the decline in concentration and lack of any subsequent rebound suggest that the source has been removed and that no dense non-aqueous phase liquids (DNAPLs) are likely to be present at the source area.

Flow and Transport of Contaminants

Since the OPDC former cesspool was at least 40 feet deep, the bottom of the cesspool was located below the level of the groundwater historically. This implies that the cesspool contents were in direct contact with the aquifer at the time of higher water elevations, resulting in direct impact to groundwater. For this reason, contaminant movement was from presumed disposal into the septic tank, through the perforated pipe connecting to the unlined cesspool. In addition to direct transport from disposal into the septic tank, other mechanisms that may have caused VOC movement in the vadose zone probably include:

- Groundwater recharge, which drives infiltration from source areas downward under gravitational forces and horizontally as a result of capillary action;
- Vapor diffusion from source areas; and,
- Upward vapor diffusion from contaminated groundwater.

The discharge of PCE to the septic system would introduce a phase-separated fraction, which is more dense than water. Because of the greater density, PCE tends to sink through the water, which would suggest that PCE collected at the bottom of the OPDC septic tank and cesspool. Since the cesspool was completed within the groundwater, the PCE would sink to the bottom of the cesspool and dissolve into groundwater over time. PCE that collected in the septic tank and cesspool would be a DNAPL, which could enter the aquifer as a separate phase, sinking due to the greater density than water.

The following issues were identified during the data review process, which need to be addressed to understand the nature and extent of contamination at the Site:

- Highest groundwater concentrations for the Site were detected in groundwater samples located southeast of the identified OPDC septic tank cesspool source area;
- Soil samples and soil vapor samples do not exhibit a "bullseye" with the highest concentrations centered at the cesspool/septic tank location; and,
- Downgradient groundwater concentrations have been historically higher to the southwest and south of the area immediately adjacent to the Site, despite persistent evidence of a regional westward groundwater flow in the area.

The highest concentrations of PCE in groundwater were 25,000 µg/L at wells EW-1 and HydroPunch™ sample HP-01-02, which are south and east, respectively, of the identified source area. High values have also been detected at monitor well MW-6 on the Texaco property, which implies that some mechanism must allow for PCE to move as dissolved in groundwater or as a DNAPL to the south. The dissolution of the DNAPL would allow for high concentrations in groundwater in the vicinity of the DNAPL. Regional groundwater flow would then carry dissolved PCE westward and generally the contamination would sink toward the more permeable DG/FG unit. However, no evidence of DNAPLs has been noted, particularly since concentrations have declined significantly at the source area.

A secondary possible cause for the detected contamination may be local groundwater flow historically to the south due to the pumping of the Town of Payson Cedar or Paysonglo Motel wells. The lack of detailed historic water level maps or pumping records cannot confirm this possibility. Modest levels of groundwater pumping simulated in the groundwater flow model have caused extensive drawdown and significant capture zones to develop, suggesting that even limited pumping may have had a significant impact on groundwater flow locally. Historically, the groundwater from the Paysonglo Motel wells was contaminated, then the wells became clean, then they went dry. The Paysonglo did hook up to the Town of Payson municipal water system and curtailed or minimized pumping which may account for the decrease in concentrations.

Recent data suggest that there may a more permeable pathway for groundwater to flow south then west, since MTBE concentrations were initially identified at wells TOP-4 and TOP-5R, while TOP-19 and TOP-20 have only recently had detectable MTBE concentrations. Historic water quality data have always suggested that contamination flows preferentially to the south and then west near the source area, ultimately toward the TOP-4 and TOP-5R extraction wells. Based on a review of data from the Texaco and Whiting stations reports, the presumed source of MTBE is the Whiting Station (located at Beeline Highway and Main Street), since limited MTBE concentrations have been detected in soil or vapor near the Texaco site, near the source area. This suggests that MTBE is being transported in groundwater southwest from the Whiting station, initially causing high concentrations at Well Set 11, and then at EW-4 and then finally at TOP-4 and TOP-5R. This supports the conjecture that groundwater flows preferentially south then west, rather that take a shorter path from Whiting directly to well TOP-19 or TOP-20.

Inorganic water quality differences between wells TOP-4/5R and TOP-19/20 noted in the RI report suggest that the wells have slightly different water sources, which may be explained by a permeable pathway which allows for preferential east/west water flow near TOP-4 and TOP-5R. This would also support the observed high PCE concentrations that were noted historically in wells TOP-4 and TOP-5, where PCE flowed south to the more permeable pathway then east to west downgradient to these wells.

The results from the depth-specific sampling of the DG wells downgradient of the Site tend to agree with the conceptual model of the Site, which presumes that contaminant transport primarily occurs in the DG/FG unit. Groundwater samples from DG-1 show contamination in the DG/FG unit, while the shallow portions of the overlying AL unit did not show detectable concentrations of PCE. At boring DG-3, the concentrations of PCE are noted throughout the extent of the boring, with roughly uniform concentrations throughout. Concentrations range from 5.3 µg/l at 113 feet bgs to 12.2 µg/l at 68 feet bgs. These results suggest that the AL unit may also be a significant transport conduit for PCE where the unit is more permeable.

As part of the FS Report, an evaluation of the impacts to the Tonto Apache Tribe's well located at Beeline Highway and McLane Road (Figure 3-11), was included to determine whether the ERA impacts the well, with regard to water production and future viability. This well is significantly south of the southernmost wells that have detected contamination and no detectable concentrations have been noted historically. The operation of the treatment system is assumed to capture the plume and thus prevent the spread of contamination to this well. For this reason, the focus of the FS evaluation was on water levels and water production from this well.

3.2.3 Areas of Uncertainty

Some uncertainties remain in our current understanding of the Site conditions present in the source area. However, these areas of uncertainty do not preclude the selection of a preferred remedy. As previously discussed, the areas of uncertainty include the following:

- Unknown historic local groundwater flow directions, which are not evident in more recent water level data (eg. Paysonglo wells); and,
- Lack of detailed structural geology/hydrology.

It is likely that each of the concerns indicated helps to define the overall contaminant transport mechanism to some extent, including local groundwater pumping influences. Local geologic and hydrologic features may also play an important role in groundwater flow and flow thru the vadose zone, possibly accounting for the lack of detectable concentrations at the Rundle well and the southward migration of contamination.

3.3 REMEDIAL OBJECTIVES

The ROs for the Site have been developed with input from land owners, local governments, water providers and the public. The ROs for the Site are generally consistent with the Town of Payson Water Management Plan and General Land Use Plan. The ROs were developed based upon the current and reasonably foreseeable uses of land and reasonably foreseeable beneficial uses of water of the states. The ROs were prepared for each listed use in the following terms:

- Protecting against the loss or impairment of each listed use that is threatened to be lost or impaired as a result of a release of a hazardous substances;
- Restoring, replacing, or otherwise providing for each listed use to the extent that it has been or will be lost or impaired as a result of a release of a hazardous substance;
- Time frames when action is needed to protect against or provide for the impairment or loss of the use; and,
- The projected duration of the action needed to protect or provide for the use.

3.3.1 Remedial Objectives for Land Use

The former source area for the Site is located at 904-906 S. Beeline Highway (the Property). The Property was previously a dry cleaning facility and is now a vacant site, owned by Perry Overstreet, (recently purchased fromSawmill Crossing, LLC). According to the current property owners, the Property is being redeveloped for commercial/retail use and preliminary plans for a building pad are available. A Chili's Restaurant has been constructed on a pad immediately north of the Property. The area is zoned C-3 for commercial structures and these plans appear to be consistent with zoning and Town of Payson planning.

Three early removal actions were conducted at the Property to remove underground structures and contaminated soils: 1) a septic tank used for disposal of dry cleaning waste was removed; 2) a cesspool, approximately 40 feet in depth was removed along with some surrounding soils; and 3) three underground storage tanks used for the storage of gasoline and diesel were also removed. Soils impacted by PCE have been removed from the former source area. Because there may have been remaining PCE mass in the soil beneath the former source area, where the water table has been lowered, PCE was removed from these soils through vapor extraction as an ERA. For the purposes of this FS, any remaining residual PCE in soil is assumed to be sufficiently deep that it is unlikely to cause a threat to potential land use at the Property and only presents a potential threat to groundwater quality, if water levels rise and groundwater resaturates the remaining impacted soil.

Land use throughout the Site is generally residential and commercial, with large areas of open space. The Green Valley Redevelopment Plan, established by the Town of Payson to revitalize the Main

Street corridor area will encourage zoning changes and infrastructure improvements to facilitate this development. Based on information from the Payson Roundup and Town of Payson, Payson Regional Housing Development has acquired 3 acres of the former Dannie Garcia property located east of McLane Road, between Main Street and Aero Drive. This low income housing project is currently being constructed, and is scheduled for completion in July 2003. There are additional preliminary development plans under discussion for portions of the Site. ADEQ will work with the Town of Payson and potential site developers to promote a final remedy for groundwater that is compatible with these future land uses.

The redevelopment of the 904-906 S. Beeline Highway property for commercial/retail use is currently proceeding and is reasonably foreseeable. The proposed RO for this use is:

- Protect against possible exposure to hazardous substances in surface and subsurface soils that could occur if the property were developed for commercial/retail use. If additional work at the Property is necessary beyond the previously conducted ERAs (See Section 4 for details), ADEQ will coordinate with the Town of Payson and local property owners and work towards a final remedy that is compatible with these development plans.

3.3.2 Remedial Objectives for Groundwater Use

The Town of Payson businesses and residents are solely dependant upon the groundwater aquifer for their water supply. Groundwater within and near the Site is used by both municipal and private users. The Town of Payson is the primary municipal water provider and is completely dependant upon groundwater to meet their water needs. Additionally, many private well owners are dependent upon their wells for their water supply.

Currently, five of the Town of Payson production wells (TOP-4, TOP-5R, TOP-19, TOP-20 and TOP-Skinner) within the Site have been impacted with PCE above the Aquifer Water Quality Standards (AWQS). Four of the Town of Payson production wells (TOP-4, TOP-5R, TOP-19 and TOP-Skinner) and two recently installed ADEQ extraction wells (EX-1 and EX-2) are used to extract groundwater from the Site. The IGTS, which obtains pumped groundwater from the extraction well EW-4, was recently shutdown (January 2003). This well, EW-4, has delivered water for the Town of Payson municipal supply, and has not been abandoned at this time. The Town of Payson production well New McKamey has detected PCE in the groundwater samples, but the concentrations have never exceeded the AWQS. The Town of Payson operates two groundwater treatment systems (the IGTS and the EGTS), which remediate water to below AWQS and directly deliver treated groundwater to its municipal customers. The Town of Payson is dependant upon the treated groundwater to meet current and future water demand. The groundwater resource within the Site, without treatment, may be considered lost and/or impaired and further impacts to groundwater may be possible if the groundwater contamination plume is not managed. A discussion of which water uses are reasonably foreseeable and the remedial objectives proposed for each use follows.

GeoTrans, at the request of ADEQ, also is considering and evaluating the Tonto Apache Tribe's well which is located at the intersection of Beeline Highway and McLane Road. This well has had a decline in well production which will be evaluated in Section 7 of this report. The Town of Payson has connected their municipal water distribution system to the Tonto Apache Tribe to supply water for the reservation located southeast of the well. (Listed as Payson Indian Reservation - Figure 1-1).

Lost or Impaired Municipal Use of Groundwater

The use of groundwater by the municipal water provider is considered reasonably foreseeable. The RO for this use is:

- To restore, replace, or otherwise provide for the use of groundwater currently lost or impaired by PCE contamination at the Site. Water will be provided to the Town of Payson in continuity with existing water treatment at the Site. The action will continue for as long as the need for the water exists, the resource remains available and PCE concentrations in the water prevent its direct use as a domestic water supply.

Threatened Municipal Use of Groundwater

Groundwater threatened by PCE from the Site will be needed for future use by the Town of Payson. Currently the Town of Payson production well New McKamey has detected PCE in the groundwater samples. It is possible that the detected PCE in this production well is associated with the Site, though the detected PCE concentrations are below the AWQS. If the PCE concentrations in New McKamey exceed the AWQS, ADEQ will evaluate the connection of this well to the EGTS. A preliminary contingency evaluation of the costs and construction requirements for connection of the New McKamey well to the EGTS is included as part of the remedy contingency evaluation in Section 7 of this report. The threatened municipal use of groundwater is considered reasonably foreseeable and the RO for the use is:

- To protect or otherwise provide for the use of groundwater currently threatened by PCE contamination from the Site. The protection of threatened groundwater will occur as soon as possible and continue for as long as the need exists, the resource remains available and PCE contamination threatens municipal use of groundwater.

Threatened Private Groundwater Use

The threatened use of groundwater by the private groundwater user is considered reasonably foreseeable. The RO for this use is:

- To protect or otherwise provide for the use of groundwater currently threatened by PCE contamination from the Site. The remedy will provide protection for individuals owning a threatened well and will be implemented in continuity with existing actions designed to protect and preserve water quality. The action will continue for as long as the need for the water exists, the resource remains available and PCE contamination in the water prevents its direct use.

As illustrated in Table 2-2, seven domestic wells are considered currently threatened due to the historic proximity of the PCE plume. Currently, no private domestic wells have measured PCE concentrations greater than the AWQS of 5 µg/l. Fourteen wells are currently dry, but if water levels rise, they might become impacted in the future.

4.0 EARLY RESPONSE ACTIONS

4.1 INTRODUCTION

Because the Town of Payson is completely dependent upon pumped groundwater to provide municipal water supplies, the aquifer near the Site is important as a water source for the Town of Payson. The Town of Payson reported on this as part of *Long Term Management Program of the Town of Payson's Water Resources* (Southwest Ground-water Consultants, Inc. 1998). This report indicates that the aquifer beneath the Site is expected to supply approximately 35 percent of the Town of Payson's total water demands. Consequently, the Town of Payson has worked with ADEQ to construct an interim groundwater treatment system as an ERA under WQARF. For the purposes of meeting the Town of Payson water demands, the following ERAs were carried out at the Site:

- Removal of actual and potential sources of contamination:
  - Septic system (tank, its contents and leach field) and the associated impacted soil and impacted soil in the vicinity of the historic boiler used in dry cleaning, the restroom and floor drain; and,
  - Cesspool and its contents.
- Installation and operation of the temporary TOP-Skinner wellhead treatment system;
- Construction and operation of two groundwater pump- and-treat systems (IGTS and EGTS); and,
- Pilot testing, construction and operation of the SVE system at the source area.

The following is description of these ERAs, which forms the basis for the evaluation of the feasibility of treatment at the Site.

4.2 SEPTIC SYSTEM REMOVAL

During the initial investigation of the source area at the Rundle Property, a possible source of contamination was identified as an old septic system. In January 1995, ADEQ collected a sample of liquid from the septic tank on the 906 S. Beeline Highway parcel (ADEQ, 1996). The analytical results showed 13,100 µg/L PCE, 10,260 µg/L cis-1,2-DCE, 1,430 µg/L TCE, 250 µg/L chlorobenzene and 103 µg/L 1,1-DCE (ADEQ, 1996). In June 1995, Growth was retained by ADEQ to remove and disposed of the septic tank, its contents and the associated contaminated soil. This required removal of a section of the loading dock that was located directly over the contaminated soil and adjacent to the septic tank and a portion of the west corner of the building and the associated portion of the concrete foundation (8 feet by 10 feet). Soil was also excavated to the north of the septic system (area of a former boiler associated with the dry cleaning process), to the west property boundary and along the southwest wall of the building, extending to the USTs area. The latter excavation was approximately 8 feet deep, 12 feet wide and 60 feet long (see Figure 3-1).

Approximately 400 gallons of sludge and liquid were removed from the septic tank and incinerated at the Chief Supply facility in Haskell, Oklahoma. The concrete debris resulting from demolition of the concrete septic tank (approximately 11 tons) and impacted soils, excavated to a depth of approximately 8 feet bgs from immediately beneath the tank (approximately 7 tons), were disposed of as a hazardous waste at the Resource Conservation and Recovery Act (RCRA) Subtitle C U.S. Ecology landfill in Beatty, Nevada. The remaining construction debris and excavated soil were disposed of as a solid waste (Growth, 1995).

Field screening of soils at the bottom of the excavation (at approximately 25-foot intervals) indicated little or no PCE contamination (Growth, 1995). Confirmatory soil samples were collected at six locations and analyzed using EPA Test Method 8010; only three samples were found to contain detectable levels of PCE (0.058 mg/kg beneath the north end of the tank [OPDCS BST-8 North]; and 1.9 mg/kg and 6.4 mg/kg directly underneath the center of the tank [OPDCS BST-2 and OPDCS BST-1, respectively; see Figure 3-2). The excavation was backfilled with clean soil and compacted to 88 percent relative compaction (Growth, 1995).

4.3 CESSPOOL REMOVAL

During the excavation of the septic tank and the southwest end of the trench in 1995, Growth encountered a 4-inch perforated pipe which was connected to an unlined cesspool, approximately 4 feet diameter and at least 30 feet deep, capped with a concrete pad (Growth, 1995). The cesspool contained standing water and black sludge (total thickness of approximately 5 to 7 feet). The sludge sample was found to contain 5,000 µg/kg of PCE. A soil sample, collected at a depth of 26 to 27 feet bgs, was found to contain 360 µg/kg PCE and 760 µg/kg TCE. A soil sample collected approximately 12 feet away from the center of the cesspool in June 1995 did not contain PCE at a detection limit of 50 µg/kg, thus indicating the radial extent of PCE/TCE-impacted soil of less than approximately 10 feet (Growth, 1995). In November 1996, ADEQ collected additional soil samples beneath the cesspool. Analyses of these samples indicated the presence of PCE and TCE at depths of 26 to 43 feet bgs.

In February 1997, ADEQ retained Growth Resources, Inc. (GRI) to perform the removal of the cesspool sludge and impacted soil. The cesspool and the surrounding soils were removed by GRI in April 1997 using a bucket-augering technique; the excavation was 10 feet in diameter and 43 feet deep (GRI, 1997). Confirmatory soil samples collected at depths of 25, 30 and 35 feet bgs did not show the presence of VOCs using EPA Test Method 8260A (GRI, 1997), thus indicating that the soils remaining near the cesspool were clean (GRI, 1997). The hole was filled with cement, brought to grade with reportedly clean fill and graded to original contours (GRI, 1997).

4.4 TOP-SKINNER WELLHEAD TREATMENT SYSTEM

As an ERA by ADEQ, a temporary wellhead treatment system for the TOP-Skinner Well was designed and installed in March 1998, consisting of two skid-mounted, Calgon granular activated carbon (GAC) vessels connected to the wellhead, capable of supporting the maximum flow rate of 250 gpm and up to 125 pounds per square inch (psi) system pressure. The effluent was discharged into the Town of Payson water distribution system at the TOP-Skinner Well location. At the request of ADEQ, Town of Payson installed a liquid-injection wellhead disinfection system, located on the GAC system effluent pipe prior to the gate valve (Levine-Fricke-Recon, 1997). During a 90-day test period (April 24 to June 24, 1998), 17.6 million gallons of water were treated, resulting in the removal of approximately 1.5 pounds of contaminants; analytical data indicated no detectable levels of VOCs at the connection to the water distribution system. The wellhead treatment system was in full operation from April 1998 to April 1999.

The wellhead treatment system was subsequently removed and the TOP-Skinner well was connected to the EGTS in May 1999 (see below), with startup on June 25, 1999 (Advanced Remediation Technologies, 2000). The TOP-Skinner well is now operated as part of the EGTS.

4.5 GROUNDWATER PUMP AND TREAT SYSTEMS

For the purposes of meeting the Town of Payson water demands, an ERA groundwater pump-and-treat system, the IGTS, was designed and built by Dames & Moore (retained by ADEQ) during the period of February through October 1997 to extract and treat contaminated groundwater that originated near the source area. Wells EW-1 and EW-2 were installed in March 1996 for use as source area groundwater extraction wells. Well PP-01, originally installed in 1994, was connected to the IGTS as an extraction well and was renamed EW-3.

Since contaminated groundwater had migrated downgradient from the source area, a second system, the EGTS, was designed by EMCON (retained by ADEQ) to capture the downgradient plume. This system was designed and built during the period of April through October 1998. Both IGTS and EGTS became fully operational in October 1998.

In April 1999, extraction well EW-4 was connected to the IGTS and wells EW-1 and EW-2 were taken out of service, because groundwater had declined below their respective screen intervals. Well EW-3 remained connected, but low water levels have subsequently caused this well to be disconnected from the IGTS.

The IGTS and EGTS are located on a 3.3-acre site owned by and within the Town of Payson limits, at 204 West Aero Drive. The EGTS is currently operational, and the IGTS has been shutdown as of January 2003. The treated water from the systems is chlorinated by the Town of Payson in a contact chlorination tank and delivered to the Town of Payson's potable water supply system.

4.5.1 IGTS

The IGTS was operated from October 1998 through January 2003, and was shutdown due to low water levels in extraction well EW-4, as water production had dropped to approximately 15 gpm. A major equipment layout plan of the IGTS is included as Figure 4-1. The IGTS utilized a low-profile air stripper, with both off-gas and water effluent GAC polish to remove VOCs from pumped groundwater. The IGTS was designed to operate at a water flow rate of up to 100 gpm, with an influent concentration of up to 30,000 µg/L of PCE. The air stripper was designed to reduce PCE concentrations to less than 100 µg/L. The IGTS was also capable of treating periodic occurrences of gasoline compounds in the influent groundwater, including MTBE. The system can accomplish MTBE reductions of greater than 80 percent in the air stripper and 95 percent overall.

The air stripper included a sieve tray aeration unit consisting of a stack of perforated trays and does not contain packing media. Water contaminated with VOCs entered at the top of the stack and flows horizontally across each tray. A blower delivered air at the bottom of the stack and is forced upward through holes in the trays. The effect is a countercurrent flow of water and air, which creates extreme bubbling and turbulence. The turbulence and mixing volatilizes VOCs, transferring them from the liquid phase to the vapor phase. The system was designed with five trays and an air-to-water ratio of 52:1.

The air stream containing VOCs exits at the top of the stripper unit, and passed through the vapor-phase GAC units prior to being discharged into the atmosphere. The vapor-phase GAC was operated such that the discharge to atmosphere contained less than 5 parts per million by volume (ppmv) of PCE and less than 3.0 pounds per day total VOCs.

A transfer pump conveyed water from the air stripper sump through an effluent bag filter to remove particulates, through the liquid-phase GAC units, into the treated water storage tank. From this treated water storage tank, the discharge pump conveyed the treated water directly into the onsite 100,000-gallon Town of Payson drinking water storage tank. Water was chlorinated with a sodium hypochlorite solution prior to entering the storage tank.

The IGTS was controlled by a programmable logic controller (PLC) and has remote monitoring capability through a modem and interface software package. The main control panel is mounted to the air stripper skid located inside the IGTS building.

Construction of the IGTS began in June 1997, and a 90-day Start-up Test was conducted from late October 1997 through January 1998. During start-up testing, extraction wells EW-1, EW-2, and EW-3 were operated with the system. The average IGTS flow rate for the reporting period from Day 71 through Day 90 was 68 gpm. Total influent concentrations of PCE decreased significantly from 10,200 µg/L on Day 1 to 1,500 µg/L on Day 90. Over the same time period, TCE and TPH concentrations decreased from 36 µg/L to < 20 µg/L TCE, and 310 µg/L to < 50 µg/L TPH, respectively. MTBE was not detected in the IGTS influent, however, it was reported that low concentrations of MTBE may have been masked during the first several weeks of Start-up because the analytical reporting limit for EPA Method 624 was elevated at 100 µg/L. The documented total mass of PCE removed during the 90-day start-up test was 110.8 pounds (Dames & Moore, April 1998).

The IGTS has recently been shutdown in January 2003, and had been extracting groundwater only from well EW-4, which was operating at an average flow rate of 21 gpm for the period from April through June 2002 (URS Corp., August 2002). Due to the significant decline in influent VOC concentrations over time, the air stripper system was shut off in April 2001 to reduce costs for operation and maintenance (O&M). Groundwater was treated only by two 5,000-pound liquid-phase GAC vessels configured in series. The GAC treatment was attaining non-detect concentrations of VOCs in the treated effluent, without appreciable mass contaminant loading to the GAC. The flow rate had declined to 15 gpm prior to shutdown.

Well EW-4 was equipped to serve as a dual-phase extraction (DPE) well, for it could simultaneously pump groundwater from the saturated zone and extract soil vapor from the de-watered and vadose zones. Wells EW-1, EW-2, and EW-3, that were previously used for groundwater extraction, are no longer operative with the IGTS, as water levels have declined below the screen intervals for these wells. These wells were abandoned in January 2003, in accordance with ADWR rules. However, former groundwater extraction well EW-1 was being utilized to extract soil vapor from the vadose zone, prior to the shutdown of the SVE system. Wells EW-1 and EW-4 were connected to SVE system that was designed and installed as an enhancement to the IGTS for residual mass removal of VOCs from the affected source area (Section 4.6).

The IGTS received the highest influent concentrations of MTBE (240 µg/L) in August 2000 (URS Corp., October 2001). More recent reported influent concentrations of MTBE were 4.4 µg/L in well EW-4, the only remaining pumping well on the system (URS Corp., August 2002). The source of MTBE is likely associated with a LUST release in the area near the Site. Although MTBE is not the focus of the WQARF investigation, MTBE contamination is a significant issue with regard to operation of the IGTS and EGTS systems, since MTBE is not readily treated with a GAC system, such as the EGTS. Water quality sampling in September 2000 at monitor well DMW-11A showed concentrations of MTBE as high as 1,500 µg/L. Because the IGTS included an air stripping system which can be operated when necessary for more effective removal of MTBE than solely GAC, the IGTS was operated as long as practical to contain MTBE contaminated groundwater. MTBE currently has no established AWQS or MCL, but the system has historically been managed to achieve less than 17 µg/L in the treated effluent, which is the limit specified in the agreement between the Town of Payson and ADEQ. During the period from April through June 2002, neither PCE nor MTBE was detected in the primary GAC vessel effluent from the IGTS (URS Corp., August 2002).

4.5.2 EGTS

The EGTS was designed to treat up to 500 gpm and an average influent concentration of 2,000 µg/L of PCE to concentrations not exceeding half of the federal MCL for PCE (5 µg/L). The constructed system has generally operated at approximately 200 gpm and has not had detectable concentrations of PCE in the effluent. The EGTS has recently been operating at approximately 300 gpm due to increased water demand. The EGTS consists of two 20,000-pound GAC units connected in series which currently receive contaminated groundwater from up to six extraction wells, EX-1, EX-2, TOP-4, TOP-5R, TOP-19 and TOP-Skinner (Figure 4-2). The water flows through a bag-filter and enters the carbon units, exiting to a storage tank at the Site. The system includes variable frequency drive pumps, which can be set pump at the desired pumping rate for each well individually. The EGTS is equipped with piping and inlet works for connecting up to four additional groundwater extraction wells or well sets. ADEQ has installed two additional groundwater extraction wells downgradient of the source area (EX-1 and EX-2), which have been connected to the EGTS as of August 2001.

The GAC vessels and other components of the treatment system are housed in a 3,000-square-foot manufactured steel building. The carbon is periodically backflushed or replaced, based on results of water sampling. The treated water is chlorinated by the Town of Payson in a contact chlorination tank located adjacent to the EGTS building and delivered to the Town of Payson's potable water supply system through an on-site inter-connect.

The EGTS is controlled by means of a PLC and a personal computer (PC). The PC functions as the data storage device and is the means by which changes in operations parameters (setpoints) can be input to the PLC. The PLC is programmed to automatically dial a list of personnel should the system go off-line. Figure 4-2 shows the completed EGTS.

4.6 SOIL VAPOR EXTRACTION SYSTEM

A series of pilot tests examining the effectiveness of SVE and dual phase extraction (DPE) on select wells near the source area (i.e. former OPDC Facility) was conducted by GeoTrans in October and early November, 2000. The design for these tests was provided in a 100 percent (%) design report (GeoTrans, Oct. 2000) and the results were presented in a pilot test results report (GeoTrans, April 2001). The decline in groundwater elevation at the Site had made it possible to more productively remove remaining residual VOC mass present above the current water table via SVE. Therefore, on behalf of ADEQ, GeoTrans completed installation of a full-scale ERA SVE system in August 2001 at the Site. The system was installed to serve as a remedial enhancement to the active IGTS.

Major components of the SVE system included: a skid-mounted nominal 300 standard cubic feet per minute (scfm) capacity SVE blower; a vapor/liquid separator and an air cooled after-cooler for the SVE blower; two (2) 1,000-pound GAC treatment vessels for emissions abatement; a plumbing manifold to facilitate both vapor monitoring and change-out of the GAC vessels; and a fenced equipment compound to house and secure the SVE mechanical and electrical control equipment. The fenced equipment compound was located behind the Texaco Star Mart building at 910 South Beeline Highway. The SVE system incorporated liquid condensate collection sumps and flow control valves for two independent SVE conveyance lines that were connected to extraction well EW-1 and DPE well EW-4 in Nugget Street. Above ground conveyance plumbing in the equipment compound was equipped with multiple vapor monitoring ports, gauges and sampling valves for collection of pertinent SVE operating data. The flow control valves for the SVE conveyance lines were manual 4-inch butterfly valves with fixed setting positions that could be measured and controlled.

SVE well EW-1 formerly was used as a groundwater extraction well which pumped contaminated groundwater to the IGTS. Due to a decline in groundwater elevation at the Site, extraction well EW-1 went dry and the submersible pump was removed in August 2000 to facilitate use of this well for the SVE pilot test. Extraction well EW-1 is 4 inches in diameter and is screened from 45 to 65 feet bgs. Extraction well EW-4 is a DPE well; designed to serve as both an active groundwater extraction well connected to the IGTS and as a vapor extraction well for the SVE system. Extraction well EW-4 is 8 inches in diameter and is screened from 70 to 109 feet bgs. In November 2002, the Town of Payson Water Department reportedly was pumping groundwater at a rate of approximately 20 gpm from extraction well EW-4.

The ERA SVE system was active at the Site from August 15, 2001 through September 18, 2002. During this period and including the pilot tests, the calculated mass of total VOCs removed from the remediation zone using SVE was 66 pounds. Assuming a density of 13.5 pounds per gallon, this amount represents approximately 4.9 gallons of released PCE solvent that has been remediated at the Site. Performance data from the last several months of SVE operations indicated that little contaminant mass remained present in the source zone that could be further remediated via SVE, or that is susceptible to remobilization to groundwater by infiltration, a rising water table, or via soil gas. Therefore, the ERA SVE system was decommissioned in December 2002.

4.7 SUMMARY OF ERAS

Because an FS for a WQARF site would normally propose and evaluate potential remedies, the existence of the ERAs for the Site provides practical results for the further evaluation of the potential remedies. Groundwater pumping is a presumptive remedy for identified groundwater contamination, thus the type and nature of treatment is the focus of the FS. The construction of groundwater treatment and SVE systems to remediate the known contamination changed the focus of the FS to an evaluation of cost and practicality of operation rather than implementation. For example, the feasibility of the existing SVE system was demonstrated through the completion of the pilot test and thus the need to justify the system was not necessary in the FS, particularly since the system was recently shutdown.

5.0 IDENTIFICATION AND SCREENING OF REMEDIATION TECHNOLOGIES

This section defines screening assumptions and describes treatment technologies considered for the FS for the Site. The list of potential alternatives was developed from treatment technologies that are commonly used for treating extracted groundwater impacted by VOCs in environmental and domestic water supply applications. The screening process assumed that the overall remedy is pump-and-treat, as this has been the approach taken for the EGTS and IGTS and treatment technologies were limited to those for above ground treatment of extracted groundwater. Since impacted soil have previously been addressed by the septic tank and cesspool removal actions and the SVE ERA (refer to Section 4.0), no evaluation of technologies was conducted for soils.

There are two groundwater treatment systems that have been operational at the Site: the IGTS and EGTS, and only the EGTS is operating at this time. Ninety day start-up testing for the IGTS occurred from October 1997 to January 1998. Formal full operation of the IGTS began in October 1998. Testing of the EGTS occurred in September 1998, with formal full operation beginning in October 1998. The two constructed systems are meeting the ROs described in Section 3.3. Since the IGTS was decommissioned in January 2003, the IGTS design considerations were not thoroughly evaluated as part of this report other than how the collected operational data helped to determine or evaluate the design for the EGTS.

5.1 SCREENING ASSUMPTIONS AND EVALUATION CRITERIA

The following site assumptions and system requirements were derived from information provided by the ADEQ. The original design was based on these data, although this report also focuses on actual experience from the operation of the system. The screening was initially conducted as part of the *Remedial Technology Evaluation and Life-Cycle Cost Analysis, Payson WQARF Site, Payson, Arizona* (EMCON, 1997). This report was used as the basis for the decisions regarding the design of the EGTS, prior to construction. The contents of this report have been included as part of this section, and specific changes were included where the subsequently available data conflicted with the assumptions in that report. However, the general conclusions of the screening analysis are deemed to be valid, and the overall selection of the technology for the EGTS appears to have been appropriate.

Flow Rate

The potential minimum groundwater extraction rate is estimated to be 100 gpm.[5] This flow rate assumes groundwater extraction and treatment from one or more of the production wells TOP-4, -5, -19, -20, Skinner and extraction wells EX-1 and EX-2. The Town of Payson's New McKamey production well may also be included as part of the remedial action if PCE is detected above AWQS's for more than 3 consecutive quarterly sampling periods. The decision to add the New McKamey well will be made at a later date, if needed.

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[5]These estimates were provided by Mr. Lance Downs, of Advance Remediation Technologies, Inc. (ART) who is the EGTS designer. ART estimated that a safe low end rate would be 100 gpm, which would be adequate to keep the existing pumps operational and high enough such that the GAC would be effective in treatment.

The maximum flow rate was assumed to be approximately 300 to 400 gpm when the systems were originally designed, which assumed 50 to 100 gpm for the IGTS and 200 to 300 gpm for the EGTS. The pumpage rates for the systems have generally been lower than originally designed, with an average of 186 gpm for the combined rates from the EGTS and IGTS. This average includes shutdown periods, so the operational pumping rates are somewhat higher: 200 to 250 gpm for the EGTS and 20 to 40 gpm for the IGTS.

Contaminants

Treatment options were originally screened and evaluated on the basis of an originally estimated average influent concentration of 2,000 µg/L of PCE as part of the *Remedial Technology Evaluation and Life-Cycle Cost Analysis, Payson WQARF Site, Payson Arizona* (EMCON, 1997). Concentrations have subsequently been significantly lower than that, with recently measured (November 2002) influent concentrations of 30 µg/L. The calculated flow-weighted average influent concentration from wells that was used in the original remedial design was 1,600 µg/L. Influent concentrations have generally been much lower than this figure since system startup, although the conclusions of this analysis should not be affected. Based on observed system performance, carbon change-outs have been dictated by biological fouling rather than contaminant loading.

The treatment options were screened on the basis of PCE removal efficiency. However, other chemicals could also be present in groundwater to be treated. TCE has been detected at low concentrations in TOP-4, -5, -19 and -20. The highest detected TCE concentration was 28 µg/L at well TOP-5 in December 1996. TCE was not detected in the most recent available sampling data from TOP-20 (March 2001). BTEX constituents have also been detected in wells TOP-4, TOP-5 and TOP-20. However, BTEX has not been detected since September 1998.

Groundwater has been analyzed for the gasoline additive MTBE since March 1997 at wells TOP-4, TOP-5, TOP-19 and TOP-20 and MTBE had not been detected until late 2002 in influent to the EGTS. The latest available data for extraction wells indicates that MTBE was detected at concentrations of 3.1 and 0.5 µg/L in wells TOP-5R and TOP-19, respectively[6]. Well TOP-4 did not have detectable MTBE in January or February 2003. Currently, EGTS effluent has had detectable MTBE concentrations of approximately 1 µg/L in Janauary and February 2003. ADEQ and the Town of Payson will monitor the concentrations regularly to determine whether MTBE concentrations will necessitate a changeout of GAC at the EGTS.

MTBE was detected in March 1997 in groundwater samples from the IGTS extraction wells EW-2 and EW-3 at concentrations of 10 and 59 µg/L, respectively. The highest detected concentration for MTBE was 1,500 µg/L, at monitor well DMW-11A in September, 2000. GeoTrans installed sentinel wells at the EGTS site to monitor for MTBE in November 2001 (Figure 5-1). MTBE has been detected in monitor wells SW-2B, SW-3A and SW-3B. The highest concentration detected was 13 µg/L in December 2001 at SW-3B. Generally, MTBE concentrations have declined at each of these wells over the three quarterly sampling events conducted to date, although the changes are

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[6]MTBE concentration data were provided by Ms. Karen Probert, Town of Payson in a personal communication on March 24, 2003.

Table 5-1 - Maximum MTBE Concentrations for Each Year (µg/L)

Well	Year 1997	Year 1998	Year 1999	Year 2000	Year 2001	Year 2002
Texaco MW-2	260	-	-	-	-	-
Texaco MW-4	74	-	-	-	-	-
DMW-11A	-		7.4	1500	370	130
DMW-11B	-	87	270	310	34	ND
DMW-11C	-	ND	130	35	11	2.9
DMW-1B	ND	ND	ND	ND	ND	13
DMW-2A	ND	ND	36	ND	ND	ND
DMW-3B	ND	ND	4.8	ND	4.5	ND
DMW-3C	ND	ND	ND	ND	5.4	3.8
EW-3	59	-	-	-	-	-
EW-4	-	21	-	-	-	-
PP-02	54	-	19	-	-	-
SW-2B	-	-	-	-		2.2
SW-3A	-	-	-	-	10	9.6
SW-3B	-	-	-	-	13	11
TC-1	-	-	-	-	1.4	1.5
TC-2	-	-	-	-	1.4	0.97
TC-3	-	-	-	-	1.8	1.3
TC-4	-	-	-	-	2.3	2.0
TOP-5 or 5R	-	-	-	-	-	2.3
WILSON	-	-	10	-	-	-

Note:

ND = Not Detected
- = Not Sampled or Data Not Available

minimal and may not represent a long term trend. Table 5-1 illustrates the highest annual MTBE concentrations for wells with measurable concentrations over the period from 1997 through 2002.

The possible presence of MTBE was considered when screening treatment alternatives. The design of the IGTS incorporated air stripping to treat MTBE in conjunction with GAC at concentration levels that were originally expected to be less than a few hundred micrograms per liter in the IGTS influent. The EGTS was designed without air stripping for MTBE, because it was believed that MTBE was an isolated problem that could be controlled solely by the IGTS. As monitoring progressed and more MTBE concentration data became available, treatment alternatives for MTBE were re-evaluated for the ADEQ by URS (URS Corp., August 22, 2000). This re-evaluation was conducted in response to rising MTBE concentrations that had been measured in the IGTS influent from September 1999 through August 2000 and the potential threat of MTBE impact to the EGTS. Further discussion of MTBE concentrations for operating the EGTS will be presented as part of the Proposed Remedial Action Plan (PRAP).

Compared with other VOCs, MTBE is not as readily or efficiently treated using conventional groundwater treatment technologies (i.e., air stripping and GAC). Air stripping is, however, the most commonly used technology for removing MTBE from groundwater. Typically, high air-to-water rations are required for air stripping as an MTBE pre-treatment step, and GAC is used to polish the remaining MTBE residual A substantial increase in MTBE influent concentrations could influence the existing IGTS and EGTS system operation. More specifically, retro-fitting the IGTS system with larger capacity air stripping and/or adding an air stripping process to the EGTS may be warranted for controlling GAC usage costs, which could skyrocket if MTBE was to increase by an order of magnitude above the historical high observed concentration level[7]. URS Corporation recently completed an analysis of MTBE with regard to carbon usage, based upon assumed possible maximum concentrations at wells TOP-4 and TOP-5R. This analysis is included as Appendix A to this report. The most current data shows that MTBE is apparently present in TOP-4 and TOP-5R, and is not present in TOP-19, EX-1, EX-2 or in the Skinner wells. The conclusions from this analysis suggest that:

- Concentrations of MTBE entering the EGTS may rise if the recently restarted well TOP-4 draws more MTBE contaminated water to this, or other wells;
- MTBE has been detected in wells TOP-4 and TOP-5R;
- An increase in combined MTBE concentrations in wells TOP-4 and TOP-5 to 300 µg/L will cause EGTS influent concentrations to reach 50 µg/L; and,
- An MTBE concentration of 50 µg/L in influent water to the EGTS will substantially increase the carbon changeout frequency for the EGTS and may require an evaluation of supplemental treatment technologies.

Continued review and monitoring of MTBE will be necessary to properly operate the EGTS and meet operating guidelines regarding MTBE concentrations in the effluent[8].

Removal Efficiency

The selected treatment technology, or technology combination, must achieve drinking water standards, MCLs and AWQS for identified chlorinated and petroleum hydrocarbon contaminants. Based upon the original design criteria for the EGTS, the system must produce water with a concentration of PCE less than 2.5 µg/L. To date, no detectable concentrations of PCE have been noted in the effluent.

End-Use

The end-use of the treated groundwater has been domestic consumption from the Town of Payson municipal water supply system. The selected technology and system design must comply with all applicable federal, state and local requirements, including ADEQ Drinking Water Section Bulletins 8 and 10.

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[7]The highest measured concentration of MTBE in the IGTS influent was 260 µg/L in August 2000. The last reported MTBE concentrations in the IGTS influent were < 5.0 µg/L. It is GeoTrans' understanding that as of the date of this report, there have been detections of MTBE in the influent to the EGTS, and the assumed source is wells TOP-4 and TOP-5, which have detectable MTBE concentrations.

[8]The Governmental Agreement between ADEQ and Town of Payson specifies that if effluent from the lead vessel of the EGTS exceeds a concentration of 17.5 µg/L for MTBE, carbon will be changed in the GAC units. As of the date of this report, MTBE has recently been detected in the effluent from the EGTS at about 1 µg/L.

Pretreatment

Removal of hardness (carbonates-$CaCO_3$) is not a treatment objective specified by the ADEQ. Hardness control was considered only in the context of treatment system O&M. Review of the data and discussions with TOP personnel suggest that hardness could cause scaling problems with pipes and equipment. Scaling is not a problem in the TOP northern production areas, where total $CaCO_3$ hardness is reportedly less than 100 milligrams per liter (mg/L). However, hardness is higher in the southern productions areas near the Payson WQARF Site and scaling problems have been reported by Town of Payson personnel. Hardness in the extraction wells (sampled March 1997) ranges from approximately 160 mg/L (hard) in TOP-20 to nearly 200 mg/L (very hard) in TOP-4. For this reason, scaling was thought to potentially cause problems for remediation equipment by fouling pipes and reducing treatment efficiency.

5.2 TREATMENT TECHNOLOGIES

The common water treatment technologies that were screened are described below. The treatment mechanism and typical water treatment applications are mentioned and the suitability and limitations of the technology for the Site are discussed. The reasons a technology was retained for further evaluation or eliminated from consideration are also discussed. The technology screening is summarized in Table 5-1. This screening demonstrates the practicality and utility of the selected technology for the ERA completed for the Site, which includes air-stripping and GAC polish for the IGTS and GAC for the EGTS. This evaluation however assumes that other possible technologies may be employed or added to the existing system, and it is based upon the previously completed *Remedial Technology Evaluation and Life-Cycle Cost Analysis, Payson WQARF Site, Payson Arizona* (EMCON, 1997).

5.2.1 Air Stripping

Air stripping removes VOCs from a waste stream by transferring the compounds from the aqueous phase to the vapor phase. Air stripping is commonly used in water treatment to remove carbon dioxide, hydrogen sulfide, other taste- and odor-causing compounds and VOCs. Air strippers can achieve a high removal efficiency of VOCs. In environmental treatment applications, an air-stripping system typically consists of a packed tower, a cascading tray, or a diffused aeration tank. Residual contamination not removed by the stripper can be treated by carbon adsorption.

Air-stripping systems are simple, relatively inexpensive and reliable. Prepackaged systems are available from numerous manufacturers and installation of modular components is relatively quick and easy. Electrical power consumption is a function of the air-to-water ratio required for treatment and the system groundwater flow rate. O&M includes periodic inspections and servicing of the aeration blower. Depending on water characteristics, such as iron content and hardness, the air-stripper packing might require periodic replacement. To prevent fouling of the packing, pretreatment for hardness removal might be required at the site. Air stripping is commonly followed by carbon adsorption to remove residual contaminants from water. Treatment of air-stripper off-gas could also be required. Air stripping was retained as a treatment alternative for the Site, and has been shown to be effective in the IGTS.

5.2.2 Adsorption

Some chlorinated and most petroleum hydrocarbon contaminants can be removed from water by adsorption to powdered activated carbon or GAC. Carbon adsorption is commonly used in domestic water treatment, as the primary treatment mechanism or in combination with other treatment methods. Carbon-use rates are a function of the contaminant properties and contaminant loading rate.

Carbon adsorption is a low-cost, low-maintenance and reliable alternative for treating non-polar organic contaminants that adsorb well to the carbon. Prepackaged systems are available from numerous manufacturers and installation of modular components is relatively quick and easy. Carbon-use rates are a function of the influent concentration and the adsorptive capacity of the carbon for the contaminants. Pretreatment by air stripping or advanced oxidation can reduce carbon use. System maintenance consists of periodic removal and replacement of the carbon when its adsorption capacity is reached or when pressure through the canisters is lost because of entrapped sediment. Pretreatment for hardness and sediment removal can minimize the fouling of carbon vessels. Carbon adsorption was retained as a treatment alternative for the Site, and has been demonstrated as effective for the IGTS and EGTS.

5.2.3 Chemical Oxidation

Chemical oxidation is used in water treatment to remove iron and manganese, control biological growth and remove color, tastes and odor. Chemical oxidants react with organic contaminants and oxidize the chemicals to harmless end-products. Chemical oxidation can improve flocculation and filtration processes. Strong chemical oxidants can also oxidize some organic chemicals. However, chemical oxidants are often highly selective, reaction rates are often slow and competing reactions can reduce the effectiveness of oxidants for treating organic chemical contaminants. Therefore, use of common chemical oxidants is usually not cost-effective.

Treatability testing would be required before chemical oxidation could be applied with confidence at the Site. Chemical oxidation was not retained as a treatment option because the treatability of target contaminants by chemical oxidation is uncertain and treatment requires the use of hazardous chemicals (oxidants).

5.2.4 UV Oxidation

Advanced oxidation, such as photo-oxidation, is becoming more common in water treatment. Photo-oxidation uses high-intensity ultraviolet (UV) light to generate hydroxyl radicals from an oxidant, such as hydrogen peroxide. The hydroxyl radicals induce a chain of oxidation reactions that mineralize organic pollutants to bicarbonate, or ultimately to carbon dioxide. A potential advantage of UV oxidation is that contaminants are transformed into harmless end-products, eliminating the need for air emission treatment or disposal of sorbed contaminants. UV oxidation is effective in treating a broad range of organic contaminants.

UV/peroxide treatment is becoming more common for treating organic contaminants in water and packaged systems are available from several manufacturers. Considerations for application include maintenance requirements, required pre- and post-treatment and overall cost. Regular maintenance of UV systems is required to sustain transmittance and treatment efficiency. Pretreatment for hardness removal can be required to minimize interference by carbonates and maintain light transmittance. Post-treatment by carbon is often used to minimize UV system requirements and to remove residual hydrogen peroxide and untreated contaminants. UV oxidation was retained as a treatment option for the Site, and was subsequently evaluated as a possible response to increased MTBE concentrations, particularly for the EGTS.

5.2.5 Ion Exchange

Ion exchange removes ionic contaminants from a waste stream by chemically adsorbing them to a synthetic medium. Target ions are adsorbed onto the medium in exchange for an exchangeable ion. Ion exchange is most commonly used in water treatment for water softening. Ion exchange is not suitable for treating the nonionic VOC contaminants at the site and was not retained as a treatment option. Ion exchange was considered, however, as a pretreatment alternative for hardness removal.

5.2.6 Membrane Filtration

Membrane processes include several different technologies, such as reverse osmosis, electro-dialysis and ultra-filtration. In domestic water treatment, membrane processes are most commonly used in desalinization and for removing ions that are otherwise difficult to displace. Reverse osmosis and ultra-filtration can remove some dissolved organic compounds. However, membrane processes are generally not effective at removing low molecular weight compounds, such those at the site. Membrane processes are generally expensive and maintenance-intensive. Membrane processes were not retained as treatment alternatives for the Site.

5.2.7 Biological

Biological treatment can mineralize dissolved contaminants to the harmless end-products of carbon dioxide and water. Chlorinated hydrocarbons have been successfully treated by aerobic biodegradation. However, aerobic biodegradation of chlorinated hydrocarbons typically requires a co-substrate, such as methanol or phenol. Biological process are typically not used for treating drinking water because of concerns about transmitting microorganisms into the drinking water supply. Therefore, biological treatment was not retained as a treatment alternative for the Site.

5.2.8 Air Sparging/Soil Vapor Extraction

In addition to the techniques for remediating groundwater via extraction, GeoTrans also evaluated the possibility of adding a combination Air Sparging/Soil Vapor Extraction (AS/SVE) system as an in-situ treatment technology to complement the groundwater pump and treat remediation. Air sparging is a technique involving injecting air into a well or wells such that oxygen dissolves into the groundwater to accelerate aerobic degradation of contaminants. Additionally, the air sparging would drive contaminants into the vapor phase as part of the bubbling or injection of air. Once in the vapor phase, SVE can be used to remove PCE contaminated vapors from vapor extraction wells. The system would accelerate groundwater cleanup by removing PCE and volatile organic compounds from groundwater by transferring contaminants to the vapor phase and extracting the vapor for treatment. This system would be in addition to groundwater treatment via pumping, and it will be evaluated to determine whether accelerated cleanup could be a more cost effective approach.

5.3 RETAINED TECHNOLOGIES

The treatment technologies retained for further evaluation are air stripping, carbon adsorption and UV oxidation. Treatment alternatives which were evaluated are as follows:

- Alternative 1: Air stripping only;
- Alternative 2: Carbon adsorption only;
- Alternative 3: UV oxidation only;
- Alternative 4: Air stripping with carbon adsorption; and,
- Alternative 5: UV with carbon adsorption.

GeoTrans also retained the AS/SVE technology as an add on to the selected remedy for evaluation of a more aggressive remedy. This choice was made based upon the observed decline rates in water levels which suggest that additional pumping as a more aggressive approach is not sustainable.

5.4 DETAILED EVALUATION OF TREATMENT TECHNOLOGIES

The retained treatment technologies are all compatible with drinking water treatment and can treat the target contaminants. The detailed analysis below evaluates the five treatment alternatives with respect to contaminant treatment efficiency and O&M requirements. The recommended treatment technology and wellhead completion are discussed in Section 5.4.7.

5.4.1 Air Stripping Only

ADEQ mandated that off-gas from the use of air striping would require treatment because moderate contaminant vapor concentrations would be expected and wind could disperse off-gas vapors to nearby residential areas. The IGTS currently includes a GAC vapor treatment system consisting of a vapor-phase carbon vessel sized to accommodate the vapor flow and mass loading rates, which were required to meet Maricopa County air emission standards specified as a design criteria by ADEQ for constructed treatment systems at the Site.

Pretreatment for hardness removal was also implemented at the IGTS and EGTS. The high carbonate concentrations in site water could form carbonate scale and ultimately foul the carbon or air-stripper packing and reduce treatment efficiency. Hardness treatment alternatives are discussed in Section 5.5.

Treatment Efficiency

The estimated PCE treatment efficiency for air stripping is greater than 99 percent. Although a stripper alone could achieve a high removal efficiency, carbon polish treatment is an option to be considered. Air strippers are designed to achieve the air-to-water ratio required to attain the target removal efficiency. However, stripper size and power consumption must increase to achieve a higher removal efficiency. Therefore, air strippers are generally designed to meet minimum design requirements. Liquid carbon polish treatment is often installed to treat residual contamination that could pass through the stripper when unexpectedly high-concentration influent is encountered, or when unexpected concentrations of less-volatile contaminants exceed the stripper's capacity. Carbon polish is also recommended to protect the receiving water if the air stripper's aeration blower fails, without requiring system shutdown.

O&M

Air strippers typically have low maintenance requirements and are reliable. Periodic inspections (monthly) are recommended to confirm proper operation. Routine maintenance would include servicing the aeration blower and checking ancillary equipment and controls. O&M of the off-gas treatment unit would include monitoring off-gas concentrations and replacing the spent carbon. System operation would be monitored at the main control center using process sensors, a programmable logic controller (PLC) and a modem. The PLC would notify operators and shut down the system under predetermined alarm conditions.

5.4.2 Carbon Adsorption Only

There are several options for the design of the carbon-only system. As part of the *Remedial Technology Evaluation and Life-Cycle Cost Analysis, Payson WQARF Site, Payson Arizona* (EMCON, 1997), two options that were analyzed are as follows:

- Alternative 2 - One central treatment system with a design flow capacity of up to 1,500 gpm (a standard model for the manufacturer). The design capacity would accommodate the flow rate from the six TOP wells (TOP-4, TOP-5R, TOP-19, EX-1, EX-2 and TOP-Skinner) and the maximum probable flow if other wells were added later. The treatment system would be installed at a central location near the IGTS. The treatment equipment would consist of a dual-vessel system with a 20,000-pound carbon capacity. One advantage of a single high-flow-capacity system is that it could accommodate an expanded flow rate without modifying the treatment system. A primary disadvantage is limited flexibility (e.g., splitting the influent from different wells).

- Alternative 2a - Two separate treatment systems with a design capacity of up to 1,000 gpm. One treatment system would serve extraction wells TOP-4 and TOP-5R and the second system would serve extraction wells TOP-19, EX-1 and EX-2. The two systems would be identical and each system would have a hydraulic capacity of 500 gpm and a carbon capacity of approximately 10,000 pounds (total system flow capacity of 1,000 gpm and total carbon capacity of 20,000 pounds). The treatment system could be located at the respective wellheads or at a centrally located treatment area. The potential advantages of two smaller systems include a lower carbon-use rate and increased operational flexibility.

The EGTS system that was constructed was designed to operate at up to 500 gpm (EMCON, 1998).

Subsequent operation of the EGTS indicates well performance and demand by the Town of Payson have lead to an operational pumping rate of 200 to 300 gpm.

Auxiliary system requirements would include a fresh water supply (treated water; 700 gpm at 30 pounds per square inch [psi]) and optional utility air supply (100 cubic feet per minute [cfm] at 30 psi) for back washing and carbon transfer. A sedimentation tank and solids-handling system would be required to remove backflushed sediment and dispose of or recycle back flush water.

Pretreatment for hardness removal would be recommended. The high carbonate concentrations in site water could form carbonate scale and ultimately foul the carbon vessel and ancillary piping. Hardness treatment alternatives are described in Section 5.5.

Treatment Efficiency

A carbon-only treatment system could reliably achieve high removal efficiency. Dissolved organic contaminants that pass through a carbon vessel are completely removed until the contaminant breaks through, first at low concentrations. If the carbon were not replaced, effluent concentrations would increase until the effluent concentration equaled the influent concentration. Before breakthrough, the effluent concentration is generally zero and the treatment efficiency is 100 percent.

The adsorption capacity of carbon for a particular contaminant is characterized by an empirical adsorption isotherm. The isotherm is described by an equation that defines the capacity of the carbon for the sorbed contaminant and the strength of the attraction. For a given carbon vessel, the isotherm is used to estimate the time to breakthrough for a specific contaminant and mass loading rate, allowing the carbon-use rate to be calculated.

O&M

Carbon adsorption systems are reliable and typically require little routine maintenance. Routine operation consists of periodic checks of pressure drop across the carbon vessels and monitoring for contaminant breakthrough in the vessel effluent. Increased pressure could result from sediment accumulation. If pressure buildup occurs, the carbon vessels are backwashed to remove sediment and restore the carbon's permeability. It is estimated that the carbon would be backflushed once per quarter. The backwashed water would contain sorbed contaminant and sediment, which would collected in a sedimentation tank. Supernatant water would be pumped through the treatment system and collected solids would be characterized and treated off site. Once the carbon capacity is reached and contaminant breakthrough occurs in the first vessel, the spent carbon needs to be replaced. The carbon in the first vessel is replaced and, by changing valve positions, the second vessel becomes the first in the series. If contaminant and hydraulic load were added from other extraction wells, carbon-use rates would change. Virgin carbon is installed in the vessels, and no on-site management of spent carbon is employed.

The process piping is configured to allow independent operation of each leg of the parallel system. This configuration allows an individual system to be isolated for backwash or carbon exchange with minimal disruption of groundwater pumping.

5.4.3 UV Oxidation Only

The conceptual design of the UV-only system includes modular treatment equipment consisting of high-powered UV lamps and a hydrogen-peroxide-dosing unit. The peroxide is metered into the influent water and hydroxyl radicals are formed by irradiating the water with UV light.

The peroxide-dosing system at the site would consist of a holding tank, a metering pump, flow meters and controls. The peroxide-dosing rate would be adjusted to optimize contaminant destruction and minimize oxidant consumption. Pretreatment for hardness removal would be recommended. The high carbonate concentrations in site water could interfere with UV transmittance and foul process components. Hardness treatment alternatives are discussed in Section 5.5.

Treatment Efficiency

UV oxidation could achieve a high removal efficiency of PCE and petroleum hydrocarbons. Removal efficiency is a function of the energy input per unit volume of water, or UV dose. Contaminant destruction generally follows a first-order relationship, where the energy requirement is proportional to the required UV dose and the log of the required removal efficiency. Therefore, higher removal efficiency requires more electricity. Adding carbon polish treatment after UV oxidation (alternative 5) could lower the energy requirements of a UV system and hence lower the overall operating cost.

NOTE: UV oxidation is the only retained technology that can efficiently treat MTBE. However, site data for MTBE concentrations and IGTS/EGTS system operational data indicate that MTBE concentrations in the influent to the EGTS will not exceed the current capability of the IGTS and EGTS to effectively treat the groundwater[9]. Six additional monitor wells have been installed (in 2001) to monitor for MTBE impacted groundwater which may cause operational changes in the EGTS. However, MTBE was not considered as a screening criterion for selecting an appropriate treatment technology.

O&M

The UV oxidation system would be automated for low-maintenance operation. System operation would be monitored at a main control center using process sensors, a PLC and a modem. The PLC would notify operators and shut down the system under predetermined alarm conditions.

Routine operation would consist of making weekly system checks to confirm system integrity and maintaining the peroxide-feed system and ancillary equipment. Periodic delivery of peroxide would be coordinated by the plant operator. Use of peroxide would require properly trained personnel who are aware of the health and safety hazards of strong oxidants. The UV reactor would be automatically monitored. If transmittance decreased significantly or if the lamps failed, replacement lamps and associated components would be ordered and installed by the plant operator.

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[9] As noted previously, MTBE has been detected in groundwater from wells TOP-4 and TOP-5R, although the concentrations are still well below the levels which would impact system operation.

5.4.4 UV with Carbon

Carbon polish treatment is recommended with UV oxidation, for three reasons. First, electrical power and oxidant requirements can be reduced. For an optimized system, the carbon costs can be offset by lower electricity and oxidant requirements. Second, carbon can remove residual hydrogen peroxide that is undesirable in drinking water. Third, if the UV system fails or requires a brief shutdown for maintenance, the system could be bypassed while groundwater treatment is maintained.

Pretreatment for hardness removal would be recommended. The high carbonate concentrations in site water could form carbonate scale and ultimately reduce treatment efficiency. Hardness treatment alternatives are discussed in Section 5.5.

Treatment Efficiency

A UV-with-carbon system could reliably achieve a high removal efficiency. Most contamination would be removed by the UV system, with the residual contamination removed by the carbon. Before a breakthrough, the effluent concentration generally equals zero and the treatment efficiency is 100 percent. The final system design would balance the UV system specifications and power requirements with carbon-use rates, resulting in the lowest possible operating cost for the alternative.

O&M

O&M tasks would be similar to those for the UV- and carbon-only alternatives. Carbon-use rates could be significantly lower than for the carbon-only alternative because of lower contaminant concentrations in the influent and carbon replacement would be limited by the carbon's physical characteristics (permeability).

5.4.5 Additional Considerations for Technology Selection

Additional considerations that could affect technology selection are discussed below. The issues include uncertainty of influent concentrations, aqueous-phase carbon polish for air-stripper discharge and vapor-phase carbon for treating the air stripper off-gas.

Influent Concentrations

Operation of the EGTS has provided data which needs to be considered as part of the evaluation for the FS:

- Increased MTBE influent concentrations may cause changes in scheduled change-out intervals for aqueous phase carbon to achieve effective MTBE removal. ADEQ and Town of Payson have established an action level of 17.5 µg/L for MTBE concentrations sampled between the two vessels of the EGTS as part of the Governmental Agreement (GA) between Town of Payson and ADEQ. Appendix A documents an evaluation of possible future MTBE concentrations which may cause changes in system operation.

- Influent concentrations have decreased during the operation of the IGTS and EGTS systems (now approximately 30 µg/L for the EGTS). The cost evaluation assumed that carbon-use rates were constant over the 30-year period considered. Generally, this suggests that carbon treatment technology has become significantly more cost-effective than air stripping since the system began operating. For this reason, the air stripping portion of the IGTS was shut down to minimize O&M costs during the last year of operation of the system.

Polish Treatment by Aqueous-Phase Carbon.

If air stripping is the primary treatment, aqueous phase carbon polish is an option for air stripper discharge. This option was selected by the ADEQ, and was implemented for the IGTS. If carbon-only treatment is selected, there could be cost advantages to installing treatment systems at individual wells:

- The conceptual stripper design is conservative and carbon polish might not be necessary. A safety factor was applied to estimates of flow rates and concentrations provided by the ADEQ. Furthermore, influent concentrations will decrease over the long term, (although it is possible that concentrations could be higher if contamination is drawn from the source area). The modeled stripper efficiency (by Carbonair) for the design loading (1,000 gpm and 2,000 µg/L PCE) is 99 percent. The modeled effluent concentration would be 3.5 µg/L (the MCL for PCE is 5 µg/L). Given the conservative design assumptions, it is probable that no contamination would be detected in the stripper effluent. However, carbon polish is suggested as an option to minimize the possibility that low contaminant concentrations would be detected in the treated water.
- Adding carbon polish approximately doubles the capital cost (equipment and installation) of the air stripper system from $397,000 to $860,000 (assuming no off-gas treatment). The 20-year net present value (NPV) would approximately double, from $821,000 to $1,857,000.
- Carbon polish equipment could be included as a backup system and not used unless required. Or, if needed initially, carbon polishing could be discontinued if the stripper consistently met discharge limits.

Off-Gas Treatment

If air stripping is the primary treatment, vapor-phase carbon off-gas treatment is an option to be selected by the ADEQ. The need for off-gas treatment will be assessed on the basis of a risk analysis and the Arizona regulations. If a risk analysis is not done, it will be assumed that off-gas treatment is required. Cost considerations of off-gas treatment could affect the choice of treatment technology:

- Air dispersion and risk analysis modeling would be based on the estimated stripper emissions, typical atmospheric conditions, proximity of receptors and the acceptable risk level. If the risk analysis demonstrated the absence of risk in accordance with applicable regulations, then off-gas treatment would not be required; and,
- Inclusion of off-gas treatment changes the cost comparison of treatment alternatives.
  - Air stripping alone is the least-expensive option. Adding off-gas treatment increases

the estimated installation cost by about 25 percent ($397,000 to $497,000). Off-gas treatment doubles the 20-year cost (NPV from $821,000 to $1,706,000); and,

- The estimated cost of air stripping with off-gas treatment is higher than the cost of carbon alone. The 20-year total cost of air stripping with off-gas treatment is approximately $1,706,000 and the total cost of carbon-only alternatives is approximately $1,397,000 for the central system option and $1,204,000 for the two-system option (see Section 5.4.2). If air stripping requires both vapor-phase and aqueous-phase carbon, then the air stripping cost ($2,807,000) is significantly higher than that of carbon alone.

5.4.6 Recommended Treatment Alternative

The selected treatment technology was carbon adsorption. Carbon adsorption was selected because it is a proven and reliable treatment technology and is less expensive than the acceptable alternatives. The ADEQ determined that air stripper off-gas would require treatment, making air stripping-only (the least expensive system) an unacceptable alternative. The annual O&M costs and the 20-year NPV of the two-carbon-system alternative are also the lowest of the acceptable alternatives. Carbon adsorption systems are relatively easy to install and easy to operate and maintain. Low-cost turnkey carbon replacement services can be contracted from a local service provider. Carbon adsorption does not require off-gas treatment and the required residuals management (e.g., handling of back flush water during carbon replacement) is minimal.

Two independent carbon systems were selected over one single system to increase operational flexibility. The estimated capital and installation costs for two systems are not significantly greater than for a single system and the O&M costs are lower because of lower estimated carbon-use rates. The constructed EGTS was originally designed to allow for construction of two independent systems within the building based on the influent concentrations and assumed pumping rates. The completed system was ultimately capable of handling the entire volume of water produced, so the second, "low concentration" system was never constructed, and all the wells were connected to the EGTS. This results from the overall lower pumping rates and lower influent PCE concentrations for groundwater treated at the EGTS than initially anticipated.

5.5 SCREENING AND SELECTION OF PRETREATMENT TECHNOLOGIES

Hardness pretreatment was implemented to prevent hardness scaling. Hardness scaling could foul treatment equipment and process piping and could reduce treatment efficiency. Water from EGTS pumping wells is classified as either hard or very hard. Hardness is less than 100 mg/L in Town of Payson northern production areas and the Town of Payson (Southwest Ground-water, Inc., 1998) reported no problems with scaling. Hardness is significantly higher in the south (WQARF site, Indian properties, Green Valley Park) and scaling problems have been reported. The hardness ranges from about 160 to 200 mg/L in the TOP EGTS wells.

The cost of hardness pretreatment must be considered with respect to the costs of rehabilitating equipment if it became scaled. For example, experience at similar sites indicates that an air stripper could become fouled several times during the expected project life if hardness treatment were not implemented. The estimated cost of replacing the air stripper packing one time is $35,000 for the packing and $10,000 for materials and labor. The five hardness treatment options that were screened are discussed below and summarized in Table 5-2. Table 5-2 includes cost estimates for three options.

5.5.1 Ion Exchange

Ion exchange removes hardness-causing ions from water by chemically adsorbing them to a synthetic medium. Target ions are adsorbed onto the medium in exchange for an exchangeable ion. Ion exchange is a common method for small-flow water softening because of lower capital costs and ease of automation. The operation of ion exchange systems requires periodic regeneration of the resin bed to displace the hardness ions and resaturate the resin bed with the exchangeable ion. The regeneration process requires using up to 10 percent of the treated water to backwash the resin bed. The backwash water is wasted and must be disposed of along with the displaced hardness salts. The use rate of the exchangeable salt is proportional to the flow rate and the water hardness. Ion exchange is not a suitable hardness treatment method at this site because of the amount of water that would be consumed to backwash the resin bed, the problem of disposing of the large volume of backwash water and the cost of the exchangeable salt.

5.5.2 Membrane Filtration

Membrane processes include several different technologies, such as reverse osmosis, electro dialysis and ultra filtration. In domestic water treatment, membrane processes are most commonly used in desalinization applications and to remove ions that are otherwise difficult to displace. Membrane processes are generally expensive and maintenance-intensive. Membrane filtration is not a suitable hardness treatment method at this site because of the high capital cost, the complex nature of the process and the high O&M requirements of the system.

5.5.3 Lime Softening

Lime softening is a chemical precipitation process commonly used for domestic water treatment. Lime is mixed with raw water in a reaction tank to induce precipitation, flocculation and settling of carbonates. Because softened water has a high scaling potential, carbon dioxide is commonly added to reduce the pH and prevent further precipitation of carbonates. The lime-softening process produces a sludge of carbonate salts ($CaCO_3$ and $MgCO_3$) that must be dewatered and disposed. The process is sensitive to process conditions and requires careful monitoring of the plant operations. The capital costs of the lime-softening system are relatively high and significant effort is required to size and construct the treatment plant. Lime softening was not selected for hardness treatment because of the high capital costs, the complex nature of the process, the significant sludge disposal problem and the high O&M requirements.

5.5.4 Chemical Sequestering

Hardness can be chemically sequestered by adding a chelating agent to the raw water to prevent hardness cations from precipitating and forming scale. This treatment technology does not remove hardness from the water, but the negative effects of hardness scaling are prevented. The process produces no precipitates or sludges. Phosphate-based chelating agents (e.g., sodium hexametaphosphate) are commonly used to prevent scaling in industrial process and drinking water systems. The phosphate solution is metered at a rate proportional to the raw water flow rate and the water hardness. The cost of chemical sequestering is lower than that of lime softening. Although the Town of Payson did not reject using phosphate chelating agents for treating hardness, a Town of Payson water resources specialist was concerned about possible phosphate loading to the Green Valley Park groundwater recharge area. Chemical sequestering was not selected for hardness treatment because of the Town of Payson's concern about phosphate loading and because the cost was higher than that of the selected alternative.

5.5.5 Epitaxial Nucleation

The term epitaxial nucleation describes the formation of microscopic carbonate crystals on the surface of a metal catalyst. Carbonate scaling can be prevented by passing hard water through a treatment vessel that has a catalyst core of heavy metals, including copper, zinc and nickel. The structure of the treatment unit's core (Fre-Flo™) induces the formation of carbonate crystals on the core's surface. After the crystals grow to sufficient size, they are sheared off and carried with the water. Although only a small percentage of the carbonate in the raw water produces crystals on the core, the crystals form seed for further crystal growth and prevent scale from accumulating on pipe and equipment surfaces.

The epitaxial nucleation process produces microscopic crystals that are too small to clog treatment equipment, such as filters, and would not accumulate in an air stripper. The process does not generate sludge and the treatment unit core does not lose metals to the water. The treatment unit requires very little maintenance and should not require replacement during the life of the project. The nature of the process limits the flow range of a unit and the treatment units would be sized for the expected minimum and maximum flow rates. If the well flow rate dropped below the minimum required flow rate, then a smaller unit would have to be purchased and installed. If the hydraulic capacity of the unit was unexpectedly exceeded, the pretreatment capacity could be increased by adding a second unit in parallel. Even considering possible replacement, epitaxial nucleation is substantially less expensive that the other treatment alternatives (Table 5-2) and the cost of hardness treatment is considerably lower than the cost of rehabilitating conveyance piping or replacing stripper packing or carbon.

Epitaxial nucleation was selected as the hardness pretreatment alternative for the EGTS because of its low O&M requirement, its low life-cycle cost and its proven record in preventing hardness scaling. Based on the success of the EGTS, it appears to have been an effective choice for preventing scaling problems.

6.0 DEVELOPMENT OF REFERENCE REMEDY AND ALTERNATIVE REMEDIES

6.1 REFERENCE REMEDY-STRATEGY AND MEASURES

Requirements:

- The Reference Remedy must maintain a minimum supply of water to the Town of Payson at a rate of 150 gpm as long as the resource can support the pumping rate; and,
- The Reference Remedy must be capable of achieving all of the ROs for the Site.

Remedial Strategy: The remedial strategy for the Reference Remedy will be plume remediation to achieve AWQS for the COCs in the groundwater within the Site.

Remedial Measures: The remedial measures for the Reference Remedy will be to pump groundwater from existing (TOP-Skinner, TOP-4, TOP-5R and TOP-19) and new production wells (EX-1 and EX-2), treatment of COCs in the extracted groundwater by GAC at the EGTS and delivery of the treated water to the Town of Payson. The Town of Payson will utilize the water as part of their municipal supply, with delivery to residential customers.

Source Control: Source control must be considered as an element of the Reference Remedy and all alternative remedies. Source control for the Site has been achieved through the implementation of the ERA SVE and IGTS systems at the source area. Therefore source control has been achieved and will not be included in the Reference Remedy.

Uncertainties and Contingencies: MTBE is the primary uncertainty related to groundwater contamination treatment. The Reference Remedy will include contingency treatment alternatives or revised pumping schemes if MTBE becomes an issue. Sentinel monitor wells have been installed to identify MTBE contamination before it reaches the EGTS production wells. This may require more frequent carbon change-outs, although based on operational history, mass loading has not been the driving factor for carbon change-out. Biofouling of the carbon has been the primary driving factor for carbon change-out[10].

If the New McKamey well becomes impacted with PCE above AWQSs for three consecutive quarterly sampling events, the well will be evaluated for connection to the EGTS. An analysis of this contingency has been completed. This analysis evaluates whether to connect this well to the EGTS or install a wellhead treatment system, and will be presented later in this report.

Hydraulic capture is assumed to be effective at the pumping rates specified as part of this remedy, based on direct observation of the groundwater gradients between monitor wells and groundwater modeling simulations. Due to the observed declines in water levels at the Site, pumping rates for the wells currently connected to the EGTS may not remain at or higher than 150 gpm as water

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[10]Based on observation of Peter Storch, P.E. of URS, Inc. URS is contracted by ADEQ and Town of Payson to provide operation and maintenance services for the IGTS and EGTS.

levels fall due to low recharge rates. For this reason, it may be necessary to consider lowered pumping rates for each of the wells to maintain capture of the plume. GeoTrans assumes that capture can be maintained if the water levels remain depressed relative to the surrounding areas, such that an inward hydraulic gradient is maintained. Steady continuous declines in water levels will require a re-evaluation of this assumption.

Proposed Remedy to Evaluate: The remedial strategy for the Reference Remedy will be pump and treat plume remediation using the EGTS at an operational pumping rate of 200 gpm. This pumping rate represents the approximate current operational rate for the EGTS. Appendix B discusses the evaluation of this remedy using the groundwater flow model developed during the RI. This remedy assumes that the existing IGTS has been decommissioned during 2003 and the following pumping rates will be employed (which are similar to current production rates at the EGTS):

Table 6-1
Pumping Rates for Reference Remedy

Well	Rate	
EX-1	25	gpm
EX-2	30	gpm
TOP-4	40	gpm
TOP-5R	40	gpm
TOP-19	40	gpm
Skinner	25	gpm
Total	200	gpm

6.2 MORE AGGRESSIVE ALTERNATIVE REMEDY-STRATEGY AND MEASURES

Requirements:

- The More Aggressive Remedy must maintain a minimum supply of water to the Town of Payson at a rate of 150 gpm as long as the resource can support the pumping rate; and,
- The More Aggressive Remedy must be capable of achieving all of the ROs for the Site.

Remedial Strategy: The remedial strategy for the More Aggressive Remedy will be plume remediation to achieve AWQS for the COCs in the groundwater within the Site. The remediation will be accelerated by inclusion of a separate, in-situ remediation system including air sparging and soil vapor extraction in areas of the plume with the greatest PCE concentrations.

Remedial Measures: The remedial measures for the More Aggressive Remedy will be hydraulic capture of the plume by pumping groundwater from existing (TOP-Skinner, TOP-4, TOP-5R and TOP-19) and new EX-1 and EX-2 production wells, treatment of COCs in the extracted groundwater by GAC at the EGTS and delivery of the treated water to the Town of Payson. The Town of Payson will utilize the water as part of their municipal supply, with delivery to residential customers.

GeoTrans believes that a more aggressive pumping strategy (i.e., greater rates) would accelerate the observed water level declines and may not be effective in achieving cleanup. For this reason, a different approach was selected to determine whether an accelerated cleanup strategy could be effective.

Source Control: Source control must be considered as an element of the Reference Remedy and all alternative remedies. Source control for the Site has been achieved through the implementation of the ERA SVE system at the source area. Therefore, source control has been achieved and will not be included in the More Aggressive Remedy.

Uncertainties and Contingencies: MTBE is the primary uncertainty related to groundwater contamination treatment. The Less Aggressive Remedy will also include contingency treatment alternatives or revised pumping schemes if MTBE becomes an issue.

Also, if the New McKamey well becomes impacted with PCE above AWQSs for three consecutive quarterly sampling events, the well will be evaluated for connection to the EGTS. As noted previously, an analysis of this contingency has been completed as Appendix C, which evaluates whether to connect this well to the EGTS or install a wellhead treatment system.

Hydraulic capture is also assumed to be effective at the pumping rates specified as part of this remedy, based the information previously discussed. As with the reference remedy, declines in water levels at the Site may lead to lower pumping rates as water levels fall due to low recharge rates. For this reason, it may be necessary to consider lowered pumping rates for each of the wells to maintain capture of the plume. GeoTrans assumes that capture can be maintained if the water levels remain relatively depressed relative to the surrounding areas, such that an inward hydraulic gradient is maintained. Steady continuous declines in water levels will require a re-evaluation of this assumption.

Proposed Remedy to Evaluate: The remedial strategy for the More Aggressive Remedy will be pump and treat plume remediation using the EGTS at an operational pumping rate of 200 gpm, with the rates specified in Table 6-1, with supplemental air sparging and concurrent soil vapor extraction. This pumping rate represents the approximate current operational rate for the EGTS. This remedy assumes that the existing IGTS was decommissioned during 2003.

6.3 LESS AGGRESSIVE ALTERNATIVE REMEDY-STRATEGY AND MEASURES

Requirements:

- The Less Aggressive Remedy must contain or capture the plume and supply of water to the Town of Payson at the minimum effective operational pumping rate of 100 gpm as long as the resource can support the pumping rate; and,
- The Less Aggressive Remedy must be capable of achieving all of the ROs for the Site.

Remedial Strategy: The remedial strategy for the Less Aggressive Remedy will be controlled migration to control the direction or rate of migration but not necessarily to contain migration of contaminants in the groundwater within the Site.

Remedial Measures: The remedial measures for the Less Aggressive Remedy will be controlled migration of the plume (PCE concentrations greater than 20 micrograms per liter [ug/L]) by pumping groundwater from the new production wells (EX-1 and EX-2), treatment of COCs in the extracted groundwater by GAC at the EGTS and delivery of the treated water to the Town of Payson. The Town of Payson will utilize the water as part of their municipal supply, with delivery to residential customers. The plume will be allowed to achieve AWQS through natural attenuation.

Source Control: Source control must be considered as an element of the Reference Remedy and all alternative remedies. Source control for the Site has been achieved through the implementation of the Early Response Action (ERA) Soil Vapor Extraction (SVE) system at the source area. Therefore source control has been achieved and will not be included in the Less Aggressive Remedy.

Uncertainties and Contingencies: MTBE is the primary uncertainty related to groundwater contamination treatment. The Less Aggressive Remedy will include contingency treatment alternatives or revised pumping schemes if MTBE becomes an issue.

Hydraulic capture is not assumed at the pumping rates specified as part of this remedy, although groundwater modeling simulations suggest that capture may be maintained at this lower pumping rate. At a minimum the system should guarantee containment or controlled migration of the plume, which seems likely based on the results of the modeling (Appendix B). Due to the observed declines in water levels at the Site, pumping rates may fall to 100 gpm despite the desire to maintain 150 gpm.

Table 6-2
Pumping Rates for Less Aggressive Remedy

Well	Rate	
EX-1	20	gpm
EX-2	20	gpm
TOP-4	15	gpm
TOP-5R	15	gpm
TOP-19	15	gpm
Skinner	15	gpm
Total	100	gpm

Proposed Remedy to Evaluate: The remedial strategy for the Less Aggressive Remedy will be pump and treat plume remediation using the EGTS at a minimal operational pumping rate of 100 gpm, with the rates specified in table 6-2. This pumping rate represents the minimum operational rate for the EGTS, based on current system design. Limits are derived from estimates of pumping rates that will maintain a minimum flow rate of at least 80 gpm through the GAC to prevent channelization and valve and variable frequency drive (VFD) settings which would not damage the pumps. The evaluation of this remedy using the groundwater flow model is discussed in Appendix B. It is assumed that this pumping rate may not maintain containment of the plume and nor maintain capture. This remedy also assumes that the existing IGTS has been decommissioned during 2003.

7.0 DETAILED COMPARISON OF THE REFERENCE REMEDY AND ALTERNATIVE REMEDIES IDENTIFICATION AND SCREENING OF REMEDIATION TECHNOLOGIES

7.1 COMPARISON CRITERIA: PRACTICABILITY, COST, RISK AND BENEFIT

In accordance with the Remedy Selection Rule ®-18-16-407 - Feasibility Study), this FS was completed to identify a reference remedy and alternative remedies that appear to be capable of achieving ROs and to evaluate the remedies based on the comparison criteria to select a remedy that complies with ARS §49-282.06. The Remedy Selection Rules specify that practicality, costs, risks and benefits are the primary basis for which to evaluate remedies.

The existence and clearly effective operation of the EGTS treatment system since October 1998 alters the normal evaluation process for an FS at a WQARF site, since an existing system is in place, is operational, and is meeting the remedial objectives. For this reason, the FS report will focus on the relative effectiveness of the system as constructed and contrasting relative cost differentials that would accrue through changes in operational parameters, such as decreased operational time frames due to differences in remedy effectiveness. Clearly the existing system is practical, and since risks were evaluated as part of the design process, the risk associated with delivering treated groundwater which meets all standards is considered as well defined and acceptable.

7.2 DETAILED EVALUATION OF REMEDIES

7.2.1 Reference Remedy

GeoTrans completed a model simulation for the pumping rates specified in Table 6-1, to evaluate the effectiveness of the reference remedy for the Site. Appendix B discusses the results of this modeling simulation. The results of this model simulation suggest that the groundwater system will achieve an equilibrium situation within 10 years at a water level depth of 80 to 100 feet bgs. This assumes "normal" recharge conditions from average rainfall rates over the historic period of record. Figure 7-1 illustrates a hydrograph from TOP-20, located near the EGTS. As is evident from the figure, water levels decline until stability is reached within about 10 years. Observed water level data suggest that greater depth to water will be reached prior to attaining an equilibrium value, based on the concerns presented in Appendix B.

The results of the simulation clearly show that groundwater gradients will reverse such that flow is from west to east (Figure 7-2). For this reason, the plume is clearly controlled and captured and will eventually reach AWQS cleanup levels as the system continues to operate. Unfortunately, the time frame for cleanup is not possible to estimate due to the uncertainties of the flow simulation. However, the projected remedy appears to be effective and is clearly feasible since it is currently operational and effective.

Based on the latest reported groundwater pumping and influent concentrations, the current system configuration is extracting approximately 6 pounds of PCE per quarter for a cumulative total of 450 pounds of PCE removed (as of November 2002). A review of the decline in influent concentrations, including a "best fit" trend line suggests that the influent concentrations will drop to 5 µg/L within 10 years (Figure 7-3). Realistically, the system will probably operate for at least the next 30 years since individual wells may remain above 5 µg/L well into the future and the exponential decline "best fit" line would not account for the effect of sorbed residual mass.

The following is a summary of the Reference Remedy:

1. Practicality - This remedy is practical, since the EGTS has been constructed, is operational and has proven to be effective.
2. Cost - The cost of the system is fixed as the current O&M cost of $300,000 per year, since the system is in place[11]. Table 7-1 further breaks down the assumptions and estimates used to derive this value for EGTS O&M. Cost comparisons for the FS will involve potential savings through accelerated cleanup or lowered operational costs per year with other remedies.
3. Risk - The EGTS produces water which meets ADEQ and EPA drinking water standards, thus the risk is considered negligible.
4. Benefit - The Town of Payson can use the treated water as much needed municipal supply in conformance with the Town of Payson's water management planning. The risk to human health is lowered due to improved groundwater quality (which impacts private well owners). Groundwater contamination is reduced, with an ultimate goal of achieving water which meets all state and federal standards, which protects future use of the groundwater.

Analysis of Results

A review of Appendix B results indicates that the decision to include the deepened New McKamey well as part of a deepened groundwater flow model was not a successful choice. The groundwater flow model results indicate that the system will reach stability in water levels (and therefore sustainable pumping rates) in the near term, which does not appear to represent the observed conditions accurately. This result was surprising, since the groundwater flow model had previously been very successful in simulating hydraulic conditions in the area near the Payson PCE WQARF Site.

GeoTrans postulates that the deepening of the model to encompass a greater thickness of fractured granite (FG/CG Unit) lead to a breakdown of the porous media assumption such that the model was no longer a usable tool. The McKamey Well is primarily screened in the FG/CG Unit, which is clearly a fracture-dominated hydrologic unit and the majority of the increased pumpage for this well is derived from the deepened section below 500 feet bgs, which was the original depth of the groundwater flow model. For this reason and in agreement with the ADEQ Project Manager, an attempt to deepen the model was completed to account for the greater depth of the McKamey Well.

[11]Based on conversations with David Haag, the ADEQ Project Manager. Current O&M is running $329,000 per year, and future O&M is expected to be approximately $300,000, assuming savings due to system modifications (additional lightning protection). Sampling frequency has remained similar to previous frequency due to additional MTBE evaluation despite IGTS shutdown.

The new model layers added were completely dominated by fracture flow, which is contrary to the porous media assumptions inherent in MODFLOW. Development of a new fracture flow model was not considered reasonable, given the lack of data to characterize the fractures throughout the model domain and specifically for the portion of the model deeper than 500 feet.

However, some useful conclusions were drawn from the model simulations performed for the FS evaluation, particularly that the McKamey Well would already have induced groundwater flow from the Site if the aquifer were fully connected between the WQARF Site and the McKamey Well location. The model clearly indicated that groundwater gradients would already have reversed toward the McKamey Well by this time if the location has a substantial hydraulic connection to the Site. Since this has not occurred, the model strongly suggests:

- That there is a hydraulic barrier such as a bedrock ridge between the Site and the McKamey Well; and/or,
- The McKamey Well obtains production from fractures which are not strongly connected to those in the Site.

The 100-year projections completed to satisfy the requirement of the ARS §49-282.06. Remedial Action Criteria; Rules, therefore, are not particularly valid, since the conditions for conducting a valid MODFLOW groundwater flow simulation are not met as water levels decline below the AL and DG/FG Units. Based on the available data, a full fracture flow model is not possible to complete at this time due to lack of usable information to construct such a model. For this reason, GeoTrans completed an evaluation of measured PCE concentration trends and water levels trends using the monitor well network at the Site. These data were used to evaluate time frames for cleanup, which are addressed in Section 7.3 of this report.

Benefits

This remedy clearly lowers risk to human health and the environment, since groundwater contaminants are removed, although this impact is currently only directly impacting private well owners near the Site. The remedy seeks to provide, protect and preserve current and future groundwater uses in the Town of Payson, with currently contaminated groundwater being made usable to the Town of Payson municipal supply system.

7.2.2 Less Aggressive Remedy

GeoTrans completed a model simulation for the pumping rates specified in Table 6-2, to evaluate the effectiveness of the Less Aggressive Remedy for the Site. Appendix B discusses the modeling results for this simulation. The results of this model simulation suggest that the groundwater system will achieve an equilibrium situation within 10 years at a water level depth of 50 to 60 feet bgs. This assumes "normal" recharge conditions from average rainfall rates over the historic period of record. Figure 7-4 illustrates a hydrograph from TOP-20, located near the EGTS for this simulation. As is evident from the figure, water levels decline until stability is reached within about 10 years. Observed water level data suggest a deeper equilibrium value for depth to water may be reached, based on the concerns presented in Appendix B.

The results of the simulation suggest that groundwater gradients will not reverse, with overall groundwater flow continuing from east to west (Figure 7-5). For this reason, the plume may not be controlled and captured at this pumping rate. This suggests that this pumping rate is inadequate for plume containment and capture and that the current operational pumping rates are more reasonable.

GeoTrans met with Mr. Peter Storch of URS Corporation, which provides services for operation and maintenance of the EGTS. These discussions included a discussion of the replacement life-cycle period experienced for the GAC at the Site. Generally, the currently estimated replacement cycle will be about two years. This period is more a function of biological fouling of the GAC, rather than loading of the carbon with PCE. For this reason, a lowered extraction rate may not affect the replacement period for the GAC significantly. This suggests that this less aggressive remedy may not represent significant cost savings over the reference remedy.

The Less Aggressive Remedy can be summarized as follows:

- Practicality - The remedy is practical, since the system has been constructed and is operational.
- Cost - The costs may be lower than the Reference Remedy if carbon utilization is lessened. GeoTrans and URS Corp. do not believe that carbon utilization will decrease with lowered pumpage, however, since it is believed that organic fouling is the primary cause for carbon replacement. Monitoring and sampling costs are assumed to be the same for this remedy as the Reference Remedy. Some of the O&M costs would also be lower, including electricity, filters and other components whose costs are determined with relation to volume of water flow.
- Risk - The EGTS produces water which meets EPA and ADEQ drinking water standards, thus the risk is negligible.
- Benefit - This remedy also lowers risk to human health and the environment since groundwater contaminants are removed, although the lowered pumping rates may prolong the cleanup and may not completely capture the contaminated groundwater at the Site. This remedy seeks to provide, protect and preserve current and future groundwater uses in the Town of Payson, with currently contaminated groundwater being made usable to the Town of Payson municipal supply system. However, the lower water production rates would imply the higher pumpage rates be employed at other wells in the Town of Payson supply, which might also cause loss of plume control and capture.

7.2.3 More Aggressive Remedy

GeoTrans presented the results of the model simulation for the pumping rates specified in Table 6-1, to evaluate the effectiveness of the reference remedy for the Site. Appendix B discusses the results of this modeling simulation. Since this remedy uses the same rates specified in the reference remedy, the same model results will be assumed. The primary difference in this remedy is that it would represent an add-on to the existing system. Appendix D outlines the approximate costs and design considerations for such a system.

A summary of the More Aggressive Remedy can be summarized as follows:

- Practicality - The groundwater treatment component, EGTS, is clearly practical, but the AS/SVE system may be impractical, due to potential difficulties in obtaining land for construction of AS/SVE wells and complications due to the declining water levels at the Site. In general, the system is practical, but issues will arise with regard to construction and future operation of the system.
- Cost - The cost represents the existing O&M costs, plus capital construction costs and O&M for the AS/SVE system. The costs appear to be significantly higher than is justified considering the uncertainty in cleanup timeframes.
- Risk - The EGTS produces water which meets EPA and ADEQ drinking water standards; the supplemental AS/SVE remediation should accelerate cleanup, generally lowering risk beyond that provided in the Reference Remedy.
- Benefit - The accelerated cleanup may return the aquifer to an uncontaminated condition faster than the Reference Remedy. The quantity of water produced is the same as the Reference Remedy, with the Town of Payson receiving the treated water for municipal supply. This remedy also seeks to provide, protect and preserve current and future groundwater uses in the Town of Payson, with currently contaminated groundwater being made usable to the Town of Payson municipal supply system.

7.3 COMPARISON OF REMEDIES

Comparison of the remedies with each other is required under the Remedy Selection Rule, R-18-16-407 - Feasibility Study. For this reason, a comparison of the remedies indicates that:

Practicality:

- Each of the selected remedies is practical, but the More Aggressive Remedy may encounter construction, operational and land acquisition difficulties which would limit the practicality of the system; and,
- The Less Aggressive Remedy may not achieve plume capture or containment, and thus contamination may spread beyond the currently impacted areas, thus limiting the practicality of the system, either due to loss of plume capture or changes in pumping outside of the Site area, which would, in turn, alter regional groundwater flow and cause loss of plume capture.

Cost:

- The least costly remedy is the Less Aggressive Remedy. However, the Reference Remedy may be very similar in cost, due to the carbon changeout frequency being unrelated to contaminant loading rates. Thus limited cost savings can be realized in the Less Aggressive Remedy. The More Aggressive Remedy is clearly the most costly remedy evaluated.

Risk:

- The risks associated with each remedy are approximately equivalent, since groundwater will meet all applicable standards prior to delivery to Town of Payson customers. The Less Aggressive Remedy may have increased risks associated with possible loss of plume capture and containment. The More Aggressive Remedy may have a slightly lower risk since it is assumed cleanup would proceed more rapidly.

Benefit:

- The benefits of the remedial measures for the Reference Remedy and the More Aggressive Remedy are more in agreement with the Town of Payson's requirements for groundwater production in the area. The Less Aggressive Remedy's lower pumping is less satisfactory with regard to Town of Payson municipal water demands.

Appendix D outlines the costs and design considerations for a supplemental AS/SVE system for the More Aggressive Remedy. The basic conclusion is that the More Aggressive Remedy may be practical, but is not clearly a cost effective approach due to the added cost and uncertainty in the time frames for cleanup. Additionally, the uncertainty with regard to declining water levels and land availability for construction of the AS/SVE system suggest that this remedy may not be practical or may be difficult to implement, with possible land acquisition costs which have not been accounted for in this analysis. These factors appear to outweigh the accelerated cleanup time frame and lowered risks. For these reasons, this remedy does not appear to be a better choice than the Reference Remedy.

Because the Less Aggressive Remedy may not assure plume capture and containment, this remedy does not necessarily lower risks or fully protect the regional aquifer from possible further spread of contamination, and may not meet the ROs for the Site. Additionally, the lower pumping does not fully provide for current and future water supplies for the Town of Payson. Also, the lack of clear cost savings, and minimal potential nature of these savings, suggest that the Less Aggressive Remedy does not appear to be a better choice than the Reference Remedy.

In general, the Reference Remedy appears to represent the best choice for groundwater remediation at the Site. The costs, practicality and benefits are well known from successful system operation since 1998 and appear to represent the best choice to satisfy the ROs for the Site. The ROs require that the Town of Payson groundwater supply be provided for as part of the remedy, so a scenario which included any substantially less aggressive remedy, such as monitored natural attenuation, could not be implemented. Additionally, operational results since 1998 for the existing IGTS and EGTS suggest that additional higher pumping rates were not feasible, so a more aggressive remedy could not include significantly higher pumping rates to accelerate cleanup. Based on these results, the Reference Remedy appears to be the best choice for remediation at the Site.

7.4 UNCERTAINTIES

The key concerns which may impact the nature of the evaluation of the feasibility for the remedy selected is whether the pumping can be maintained into the future and whether the New McKamey well will ultimately influence the groundwater flow at the Site. If the pumping from the New McKamey well ultimately impacts the Site, then the contingency item for connection of the New McKamey well to the EGTS becomes a significant concern and the long term viability of the system may be in question. Unfortunately, the data to adequately evaluate this condition are not available at this time, since the groundwater model has not been successful in simulating a connection between the area near the Site and the New McKamey well.

Additionally, the hydrographs for measured water levels in monitor wells suggest that water levels may decline significantly unless recharge returns to normal rates. Figures 7-6 and Figure 7-7 illustrate hydrographs for Well Set 4 and wells SW-1A, SW-1B and TOP-20, respectively. These figures illustrate the aquifer zones as compared with the water levels at each location. As is evident from these data, water levels at the Site could decline to the FG/CG interface by as early as 2005 at well SW-1A, B. GeoTrans assumes that water production rates may fall dramatically if the water levels decline into the hard granite (FG/CG) at the Site. This discrepancy is a significant concern which must be further evaluated as the water levels decline at the Site.

GeoTrans, at the request of ADEQ, also evaluated the Tonto Apache Tribe's well which is located at the intersection of Beeline Highway and McLane Road (Figure 3-11). Figure 7-8 presents a hydrograph of the limited available data for the Tonto Apache well with data from B & B Auto well, monitor well DMW-12B and TOP-20 at the site. The data presented suggest that the water level at this well was declining prior to the startup of the IGTS/EGTS in October 1998. Water levels began declining in 1997, as illustrated by well B & B Auto. These data suggest that well performance is a function of prior declines in water levels and that lack of recharge is the primary factor in why this well has recently gone "dry". Additionally, this well was declining at a rate greater than the regional rates prior to the 1998 EGTS startup, suggesting that the well could not support the production rates employed. The reported production rate in March 1998 was 7 gpm[12], which is prior to the startup of the EGTS. This well was reported to produce up to 60 gpm in May 1997.

[12]Data were provided by telephone conversation with Mr. Farrell Hoosava on August 15, 2002, with reported water levels and well pumpage rates for 1997 through 1999.

8.1 PROCESS AND REASON FOR SELECTION

Because an operational treatment system (EGTS) is currently in place and operating effectively, the focus of the FS has been to determine whether conditions may arise that would mandate a change in operation, or whether supplemental remedial actions may accelerate cleanup to make the system more effective in terms of costs or benefits. The remedies considered included an evaluation of the current operation of the system as the Reference Remedy, a lowered pumping scheme as a Less Aggressive Remedy and a supplemental AS/SVE system to augment remedial actions in addition to pumping as a More Aggressive Remedy. The FS considered the effectiveness of the remedy and whether additional remedial actions are warranted.

8.2 COMPARISON CRITERIA

The basic criteria for treatment effectiveness is whether the goals of the ROs are met, whether the system is effective in containing and capturing the plume and whether the system is constructable and practical. Since the system is already in operation, its clearly is constructable and unless a more aggressive approach could significantly limit the time frames for operation, it is technically a feasible option.

8.3 ACHIEVEMENT OF REMEDIAL OBJECTIVES

The remedial objective of containment and capture of the PCE plume is demonstrated for the Reference Remedy and the More Aggressive Remedy. The Less Aggressive Remedy does not assure capture of the plume, although a carefully constructed remedial pumping scheme may be effective in containing the downgradient spread of contamination. The conclusion of the evaluation is that the Reference Remedy is capable of meeting the objective of capturing and containing the plume. This is based on the model results which show that the gradient will reverse toward the site, with complete capture conditions. Additionally, the gradient analysis completed by URS Corp. as part of the RI report indicate that inward horizontal flow gradients are present throughout the Site (GeoTrans, 2002).

The Less Aggressive Remedy does not guarantee capture and containment and thus does not necessarily fulfill the ROs for this Site. This remedy may become a factor however as water levels continue to decline and pumping rates for the operational EGTS system cannot be maintained.

The More Aggressive Remedy will be effective in capturing and containing the plume and it will accelerate the clean up at the Site. However, the difficulties in constructing the remedy, including obtaining land from Sawmill Crossing and the costs for installing and maintaining an AS/SVE System may make this remedy impractical. The potential for declining water levels to limit the period of effective operation of the proposed system suggests that the remedy may be impractical. The cost for installation and O&M for this system is approximately $1,000,000 for an estimated life of 9 years. Because the remedy may not be operable over that period, this remedy is not clearly feasible, and thus the costs may not be justifiable.

8.4 ACHIEVEMENT OF REMEDIAL ACTION CRITERIA PURSUANT TO ARS §49-282.06

It is recommended that the Reference Remedy be selected as the Final Remedy for the Site. Based on a comparison with the Less Aggressive and More Aggressive Remedies, the Reference Remedy appears to:

- best assure, the protection of public health and welfare and the environment;
- to the extent practicable, provides for the control, management and cleanup of the PCE contamination, maximizing beneficial use of the groundwater in Payson; and,
- is reasonable, necessary, cost-effective and technically feasible.

Because the EGTS is currently operational and appears to contain, capture and remediate the plume, this remedy is clearly the best choice. The results of model simulations and review of operational data suggest that the system is reasonably efficient and that no significant changes are warranted.

Although the groundwater flow modeling was not conclusive regarding time-frames to complete the cleanup of the Site, GeoTrans completed an analysis of the current trends in the measured PCE concentrations for a variety of monitor wells and currently used extraction wells at the Site. These trends were evaluated by fitting exponential decline curves (linear fits on logarithmic concentration scale). Figure 8-1 illustrates the current concentration trends for the influent water to the EGTS. This graph suggests that based on current trends, the influent PCE concentration will reach the AWQS of 5 µg/L by 2004. This actual date may be optimistic since it doesn't account for potential sorbed mass acting to delay the date somewhat, but the trend suggests that the operational time-frame for the EGTS will probably be less than the 30 years used in the analysis of life-cycle costs and possibly as little as 10 years.

Individual extraction wells also exhibit declining concentration trends, as evident for extraction wells EW-4, TOP-5R and TOP-19 (Figure 8-2). These trends reach the AWQS by 2005 for EW-4, which may actually go dry by that time due to declining water levels[13]. TOP-5R and TOP-19 each show declines to AWQS by 2004 and 2008, respectively. This suggests that the EGTS is effectively cleaning up the aquifer, and the time frames indicated above are relevant to the individual wells.

Concentration trends have been reviewed for each of the monitor wells where concentrations have been above AWQS. Figures 8-3, 8-4, 8-5 and 8-6 display PCE concentration graphs for Well Sets 1, 2 and 4 and DG-1. The trends projected for each of these wells is declining, although well monitor well DMW-4C does not intercept the AWQS until approximately 2048 (Figure 8-5). Other monitor wells reach AWQS by 2015 at the latest. However, these data must be considered as "optimistic" since release of sorbed PCE mass will tend to stretch out the projected time frames.

[13] As previously noted, the IGTS, to which EW-4 is connected, has been decommissioned as of January 2003.

However, experience with the SVE system suggests that significant residual mass does not appear to be present, even at the source area.

The data presented in these figures suggest that the EGTS will achieve the ROs, presuming that water level declines do not cause significant changes in the operation of the EGTS. Projections illustrated in Figures 7-6 and 7-7 suggest that water level declines may begin to limit well production rates within the next 5 years, which would affect the time-frames estimated for cleanup. Additionally, the possible future declines in water levels may cause changes in plume capture and containment, which currently appears to be attained. For these reasons, the 30-year life-cycle estimates are reasonable to account for uncertainty in time frames for remediation. These considerations should be further evaluated as part of the PRAP.

8.5 CONSISTENCY WITH WATER MANAGEMENT PLANS

The water management plans presented by the Town of Payson all require the pumping of the impacted wells connected to the EGTS as an integral portion of the available supply (projected as 35% of available supply - Southwest Ground-water Consultants, 1998). For this reason, the pumping of these wells in accordance with the Reference Remedy rates specified is fully consistent with the water management plan for the Town of Payson. The Town of Payson is currently operating the EGTS through a Governmental Agreement with ADEQ.

8.6 CONSISTENCY WITH GENERAL LAND USE PLANNING

The Town of Payson has provided land for use of the EGTS and IGTS treatment systems which currently occupy Town of Payson land that is zoned as commercial and residential. The Site is located in a mixed commercial/industrial/residential area of the Town of Payson and the site construction has conformed with Town of Payson requirements. For this reason, the Site and current well locations and piping are consistent with the existing land use planning for the Town of Payson.

8.7 CONTINGENCIES

A contingency evaluation was completed for the connection of the Town of Payson's New McKamey production well to the EGTS as a contingency, which can be implemented if this well becomes contaminated above 5 µg/L. This analysis is presented in Appendix C. This analysis indicates that the New McKamey well can be connected to the EGTS if needed, although the costs will be significant.

The results of the FS modeling are not strongly supported by observed conditions at the Site, however, the various analyses suggest that capture and containment is currently effective at the Site. The key concern will be whether the water levels continue to decline at the Site. If water levels decline into the FG/CG and aquifer recharge rates stay low, then a re-evaluation of the operation of the EGTS will be needed to determine appropriate pumping rates which will continue operation of the EGTS, as indicated above.

9.0 REFERENCES

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Table 2-2
Private Wells with Exceedences of AWQS
Payson PCE WQARF Site

Well Name	Sample Type	Compound Exceeds AWQS	Dry?	Operational?
AERO	VOC	Tetrachloroethene	Yes	No
AUTOCLINIC	VOC	Tetrachloroethene		No
CHAPMAN	VOC	Tetrachloroethene		
GASKILL	VOC	Tetrachloroethene	Yes	No
KACHINANEW	VOC	Tetrachloroethene		
ROGERS	VOC	1,2-Dichloroethane		
SHEEHAN	VOC	Tetrachloroethene	No	Yes*
UHAUL	VOC	Tetrachloroethene		
WORDEN	VOC	Tetrachloroethene, Trichloroethene	Yes	No

* Receiving bottled water or hooked to Town of Payson water supply

TABLE 3-2
CONCENTRATIONS OF PCE DETECTED IN SOURCE AREA SOIL SAMPLES

Sample Location	PCE (μg/kg)
0 to 8 ft bgs	
SDS-4	4B
1-1	16
1-2	5.1
1-3	15
1-4	34
2-1	25
2-3	210 E; 47 D
2-4	340 E; 60 E; 13 D
2-5	14
2-6	116 E
3-2	210 E; 11
3-3	234 E; 109 D
3-4	199 E; 25 D
3-5	15
3-6	245 E; 44 DE
4-3	39 B
5-2	5.4
5-3	9.8
5-4	31
6-3	7.7
7-2	4.6
7-3	228 E
7-4	101 E; 21 D
8-1	193 E; 37 D; 202 E; 21 D

TABLE 3-2 CONCENTRATIONS OF PCE DETECTED IN SOURCE AREA SOIL SAMPLES	
Sample Location	**PCE (μg/kg)**
9 to 20 ft bgs	
1-1	7.4; 63
1-2	220
1-3	5.4; 24; 6.5; 4.6
1-4	11; 4.1; 6.2
2-1	6.2
2-2	5.8; 300 E; 14 D; 7.1
2-3	19
2-4	16; 105 E; 7.9 D; 3.8
2-5	376 E; 22 D; 313 E; 23 D; 11; 18
2-6	8.3; 4.1; 5.5
3-2	11; 6.3; 13
3-3	12
3-4	26
3-5	52
3-6	115 E; 28 DE 4.1; 7.8
4-1	7.4
4-3	5.9 B; 4.4 B;
5-4	6.9; 12; 9
6-3	7.3 B; 4.3 B; 5.5 B
7-1	10
7-2	5.2
7-3	7.8; 5.6
7-4	4.2; 7.1; 8.8
8-1	149 E; 3 5D
PD1	120*

TABLE 3-2 CONCENTRATIONS OF PCE DETECTED IN SOURCE AREA SOIL SAMPLES	
Sample Location	**PCE (µg/kg)**
PD3	130
PD5	<50**
21 to 27 ft bgs	
5-4	12
Cesspool	360#

* = Contained 240 µg/kg methylene chloride
** = Contained 120 µg/kg trichloroethane
# = Contained 760 µg/kg trichloroethene
PCE = Tetrachloroethene
ft = Feet
bgs = below ground surface
B = Result falls below the Contract Required Quantitation Limit. Result is estimated and is considered qualitatively acceptable but quantitatively unreliable due to uncertainties in the analytical precision near the limit of detection.
D = Analyte is quantified from a secondary dilution of the sample or sample extract.
E = Result is estimated because the value exceeds the upper limit of the calibration curve and may have exceeded the instrument's linear range. The reported concentration may be somewhat larger.
µG/kg = Micrograms per kilograms
< = Less than listed detection limit

TABLE 3-3
SUMMARY OF COMPOUNDS DETECTED IN SOIL VAPOR IN THE SOURCE AREA

Sample	PCE (μg/l)	Other Detected VOCs (μg/l)
0 to 8 ft bgs		
PSG-1	6.7	
PSG-3	50 B	Benzene = 0.57 Toluene = 0.63 B TCE = 0.5
PSG-4	1B	Benzene = 0.20 Toluene =0.40B
PSG-5	3.2 B	Benzene = 0.190 Toluene =0.48 B
PSG-6	1.8 B	Toluene = 0.40 B
PSG-7	46 B	Benzene = 0.28 Toluene = 0.47 B TCE = 0.54
PSG-8	8.4 B	Benzene = 0.28 Toluene =0.50 B
PSG-9	11 B	Benzene = 1.4 Toluene =1.8 B
PD-1SG	0.27	
PD-5SG	510	
SSG-1	59; 71	
SSG-2	77; 170	Benzene = 9.0 Toluene =1.8
SSG-4	550 E; 430 E; 2000	
SSG-6	2.4; 0.23	Toluene = 0.44; 0.16 1,2-DCE = 4 MEK = 7
SSG-7	3.1; 2.9	
SSG-8	2.6; 5.5	Toluene = 0.30
SSG-9	2.1; 0.43	Toluene = 0.38 TCA = 0.05

TABLE 3-3
SUMMARY OF COMPOUNDS DETECTED IN SOIL VAPOR IN THE SOURCE AREA

Sample	PCE (µg/l)	Other Detected VOCs (µg/l)
9 to 20 ft bgs		
2-2	1207 EJA	
2-3	3221 E	
2-5	336	
2-6	1586 E	
3-2	680 E	
3-3	2498 E	
3-4	4.2	
3-5	824 E; 864 E	
SW-B2-12.5'SV	31	
SW-B2-20.5'SV	290	
CCB1VP	7	
CCB3VP	12	TCE = 0.41
21 to 40 ft bgs		
CON-B1-21' SV	27	
CON-B1-31' SV	71	
CON-B2-21' SV	11	
CON-B3-31' SV	29	
CON-B3-41' SV	75	
UST-B1-21' SV		MC = 52 J
UST-B1-31' SV		MC = 58 J
UST-B1-41' SV		MC = 61 J
UST-B2-21' SV	120	
UST-B2-31' SV	1500	MC = 96 J
UST-B3-21' SV	<2	MC = 70 J
UST-B3-40' SV	<2	MC = 78 J
UST-B4-21' SV	<2	MC = 67 J

TABLE 3-3
SUMMARY OF COMPOUNDS DETECTED IN SOIL VAPOR IN THE SOURCE AREA

Sample	PCE (µg/l)	Other Detected VOCs (µg/l)
UST B4-31' SV	<2	MC = 58 J; 66 J
UST-B5-21' SV	23	MC = 42 J
UST-B5-31' SV	19	
SW-B1-21' SV	<2	MC = 69 J
CCB1VP	9.2	
CCB2VP	15	
CCB3VP	57	
41to 69 ft bgs		
CON-B2-41'SV	8.9	
CON-B3-41'SV	75	
SW-B1-41'SV	350	
SW-B2-41'SV	390	
UST-B2-41' SV	210	
UST-B5-41' SV	630	
CCB2VP	0.390	
CCB3VP	3.7	
70 to 109 ft bgs		
EW-4	0.470	Benzene = 0.01 Toluene = 0.01 MTBE = 0.027

PCE = Tetrachloroethene
TCE = Trichloroethene
MC = Methylene chloride
MTBE = Methyl tertiary butyl ether
µg/l = Micrograms per liter
ft bgs = Feet below ground surface
B = Analyte was detected in the associated laboratory blank
E = Result is estimated because the value exceeds the upper limit of the calibration curve and may have exceeded the instrument's linear range. The reported concentration may be somewhat larger
E = Calculated concentration exceeds the linear calibration range, possibly resulting in an artificially low result
J = Potential invalid sample
JA = Estimated value; analyte in the audit cylinder exceeds the percent recovery of 50% to 150%.
< = Less than detection limit

Table 7-1
Estimated Operation and Maintenance Costs for the EGTS
Payson PCE WQARF Site

ADEQ's Estimated Annual Power Savings After IGTS Shutdown [B]

	Equipment Description	HP	Amps	Volts	Days/Yr	kWh/Yr
1	Primary Blower--Not currently used	40	39	480	0	0
2	Booster Blower--Not currently used	30	30	480	0	0
3	Transfer Pump	3	5	480	330	27984
4	KO Pot Pump--Not currently used	2	3.4	480		0
5	Acid Pump	0.75	1.6	480	25	678
6	Air Duct Heater--Not currently used (inoperative)	20 kW	0	480	0	0
7	Misc. lights, ventilation fans, outlets, etc. (estimated)	--	5	120	365	7738
	Total Estimated kWh/Yr					36,401
	Total Annual Utility Costs @ $0.11/ kWh Rate					**$4,004**

Power Calculation:

$P = V*I*(3)^{0.5}*(0.85)$; where 0.85 is assumed power factor

[B] = These costs do not include the Town of Payson's charges for operating the 15 HP finished water discharge pump.

Note: Based on the Town of Payson's records, the average monthly utility cost was $316.75 for the period of July 2001 - July 2002. Total costs over this time period were $3,801.09.

ADEQ's Estimated Annual IGTS Analytical Testing Savings After IGTS Shut-Down

Total Annual Cost IGTS + EGTS compliance and performance testing, July 2001 - July 2002	$19,260
Estimated Cost After IGTS Shut-Down, Assume a 42% Reduction (K. Probert, Town of Payson Water)	$11,264
Estimated Annual IGTS Analytical Savings After IGTS Shut-down	**$7,996**

ADEQ's Estimated Annual Consulting Savings After IGTS Shutdown

URS's Total Annual Consulting Costs IGTS + EGTS, July 2001 - July 2002[C]	$132,000
Estimated Annual Consulting Cost After IGTS Shut-Down, Assumes a 25% Reduction	$99,000
Estimated Annual Consulting Savings After IGTS Shut-down	**$33,000**

[C] = These costs include $93,000 directly paid by ADEQ, and $39,000 paid by ADEQ through the Town of Payson IGA.

Table 7-1
Estimated Operation and Maintenance Costs for the EGTS
Payson PCE WQARF Site

Summary, ADEQ's Estimated Annual Savings After IGTS Shutdown	
IGTS Electric Utility Fees	$4,004
IGTS Analytical Testing	$7,996
IGTS Consulting	$33,000
Subtotal, Excluding Additional Monitoring Costs for MTBE	**$45,000**
Projected Annual Increase: Groundwater Monitoring for MTBE	$16,000
Estimated Net Annual Cost Savings After IGTS Shutdown	**$29,000**

Summary, ADEQ's Estimated Total Annual Costs: EGTS O&M, Consulting, and Groundwater Monitoring		
July 2001 to July 2002 Total Annual Costs	$329,000	
Net Annual Savings From IGTS Shutdown	$29,000	
ADEQ's Total Estimated Annual Costs After IGTS Shutdown	**$300,000**	**per year**

Present Value of $300,000 Annual Costs Through Calendar Year 2030 Assuming 6% Annual Interest (See attached Calculations)	**$ 4,021,800**

Operation and Maintenance Notes and Analysis:

---ADEQ's July 2001 - July 2002 costs for O&M, performance monitoring, and groundwater monitoring at the Payson PCE WQARF Site for the IGTS and EGTS totaled approximately $329,000/yr. This included approximately $125,000/yr to the Town of Payson for O&M with limited consulting engineering; $ 93,000/yr to URS Corp. for environmental engineering/consulting and reporting; and $111,000/yr to GEC for groundwater monitoring/sampling and reporting. This information was furnished to GeoTrans by Mr. David Haag, ADEQ Project Manager, for the Payson PCE WQARF Site.

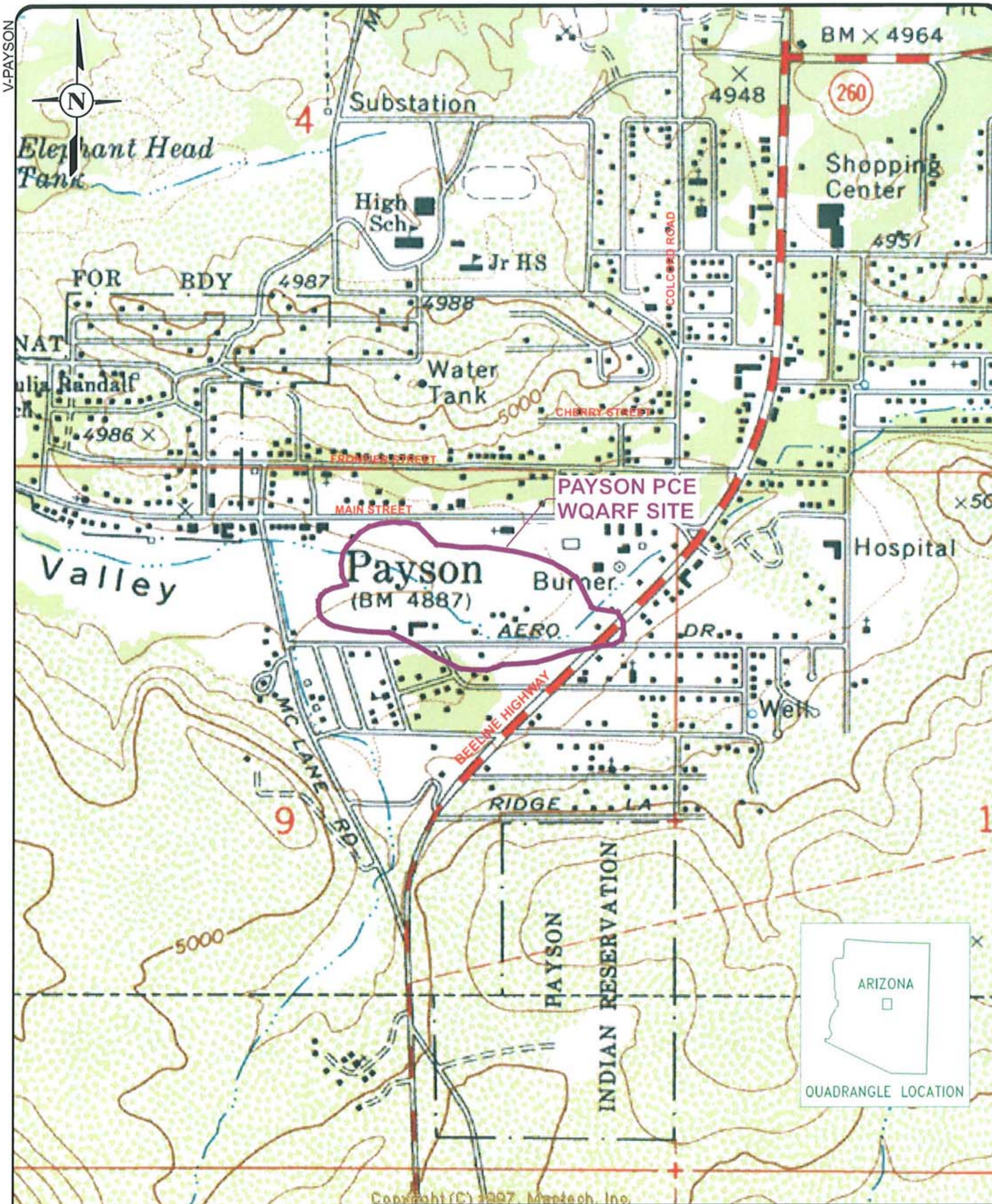
---During the period from July 2001 - July 2002, the IGTS primary power consuming equipment (40 hp and 30 hp primary and booster blowers) did not operate because the air stripping process was not needed to achieve required treatment.

---By January 2003, the IGTS had been permananetly shut down. The projected annual savings from shut-down of the IGTS is estimated to be approximately $45,000 for O&M and consulting; however, costs for groundwater monitoring have increased due to MTBE at the site. Therefore, ADEQ's net annual savings after IGTS shut-down is estimated to be only $29,000/yr. Going forward, this results in an annual estimated cost of $300,000/yr for EGTS O&M, performance testing, consulting engineering/reporting, and groundwater monitoring at the Payson PCE WQARF Site.

---Performance monitoring/sampling has shown that the controlling factor for GAC usage at the EGTS has been the gradual fouling of the GAC media (i.e. biological, iron, and/or other fouling) which clearly supercedes the VOC mass loading. This occurs about every two years for the primary GAC vessel (per P. Storch, URS).

---The total present value of costs for continued EGTS O&M, Consulting, and Groundwater Monitoring, projected through calendar year 2030, has been calculated to be $ 4,021,800. This is based on a 6% annual interest rate and a period of 28 years remaining to a 30-year projected system life-cycle (see attached Present Value Calculation).

V-PAYSON



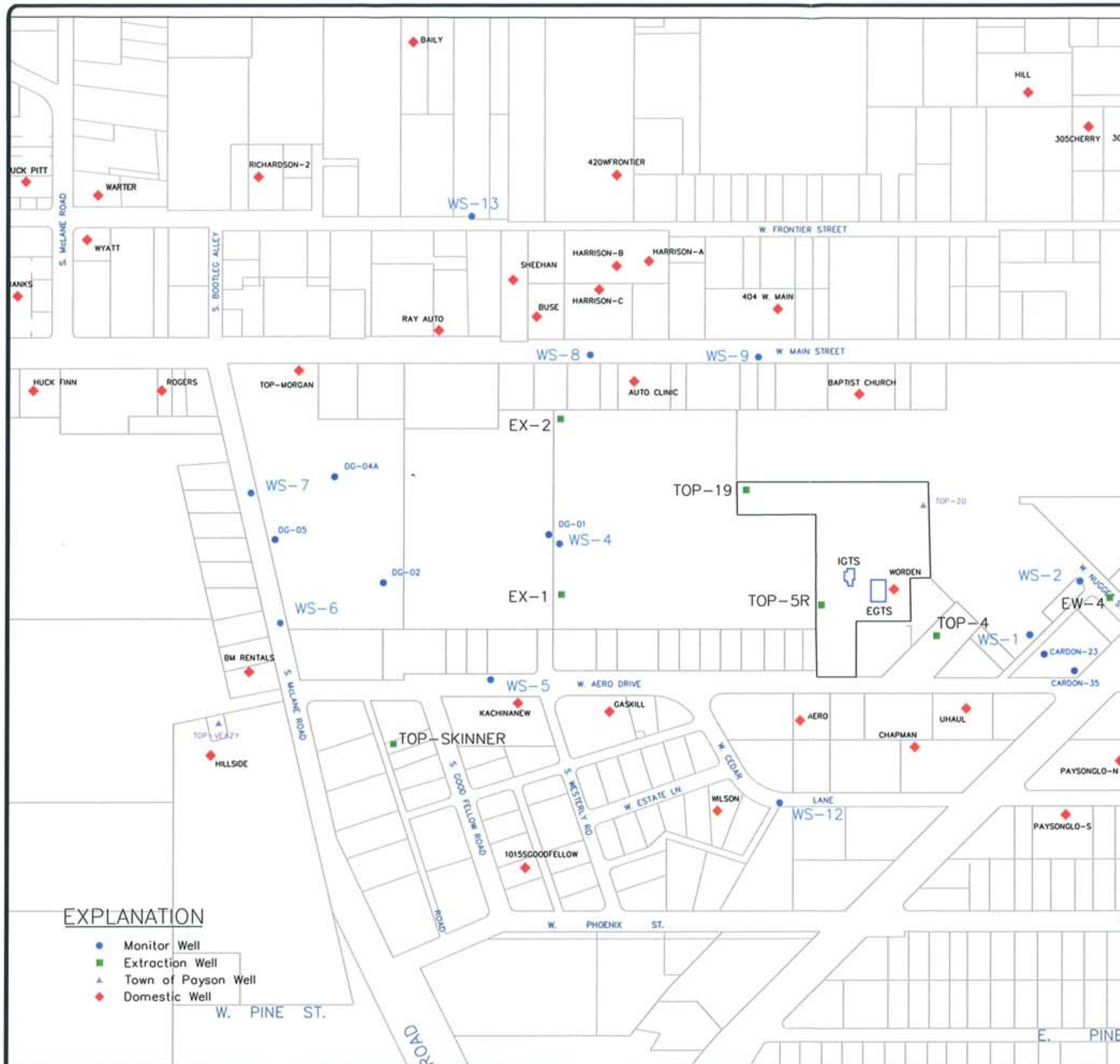
0 500 1000

APPROXIMATE SCALE IN FEET

TITLE	VICINITY MAP ARIZONA DEPARTMENT OF ENVIRONMENTAL QUALITY
LOCATION	PAYSON PCE WQARF SITE

GeoTrans, Inc. A TETRA TECH COMPANY

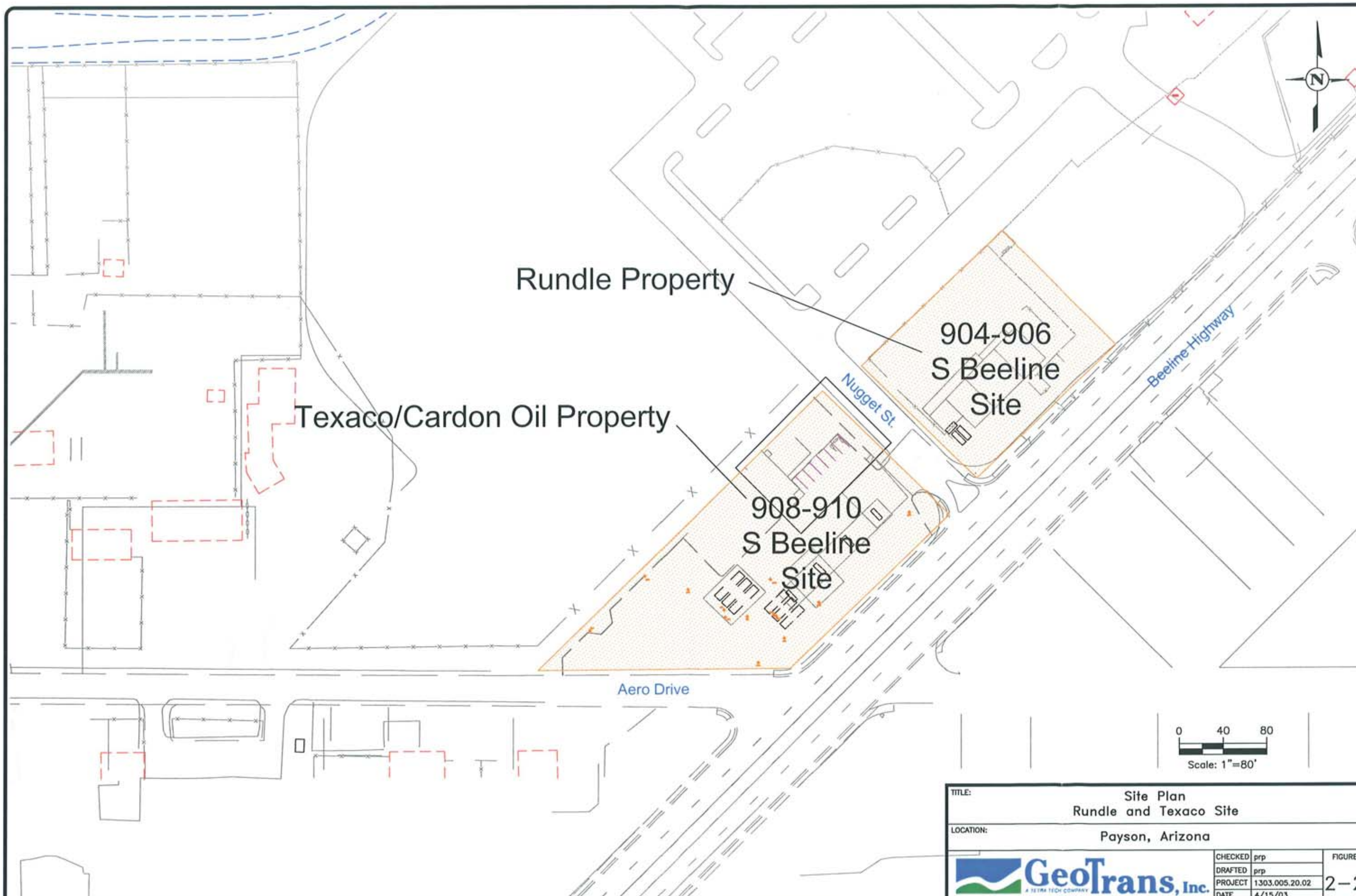
CHECKED	PRP	FIGURE
DRAFTED	DBS	1-1
PROJECT	F144-I50	
DATE	9/4/02	



TITLE:	Site Plan Payson PCE WQARF Site
LOCATION:	Payson, Arizona

GeoTrans, Inc. A TETRA TECH COMPANY

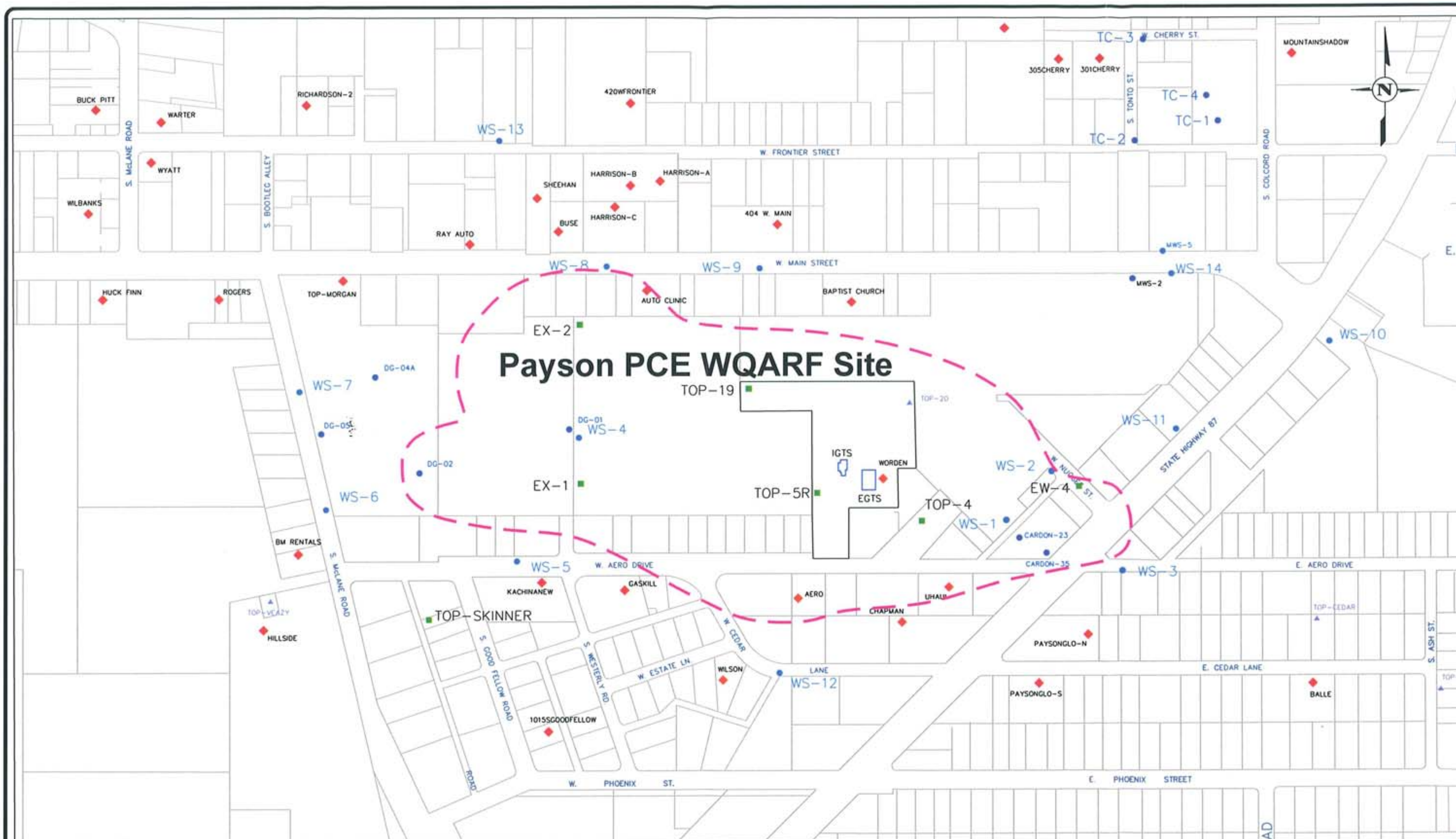
CHECKED	PRP	FIGURE:
DRAFTED	PRP	2-1
PROJECT	1303.005.20.02	
DATE	4/15/03	



TITLE:	Site Plan Rundle and Texaco Site
LOCATION:	Payson, Arizona

GeoTrans, Inc. A TETRA TECH COMPANY

CHECKED	prp	FIGURE:
DRAFTED	prp	2−2
PROJECT	1303.005.20.02	
DATE	4/15/03	



EXPLANATION

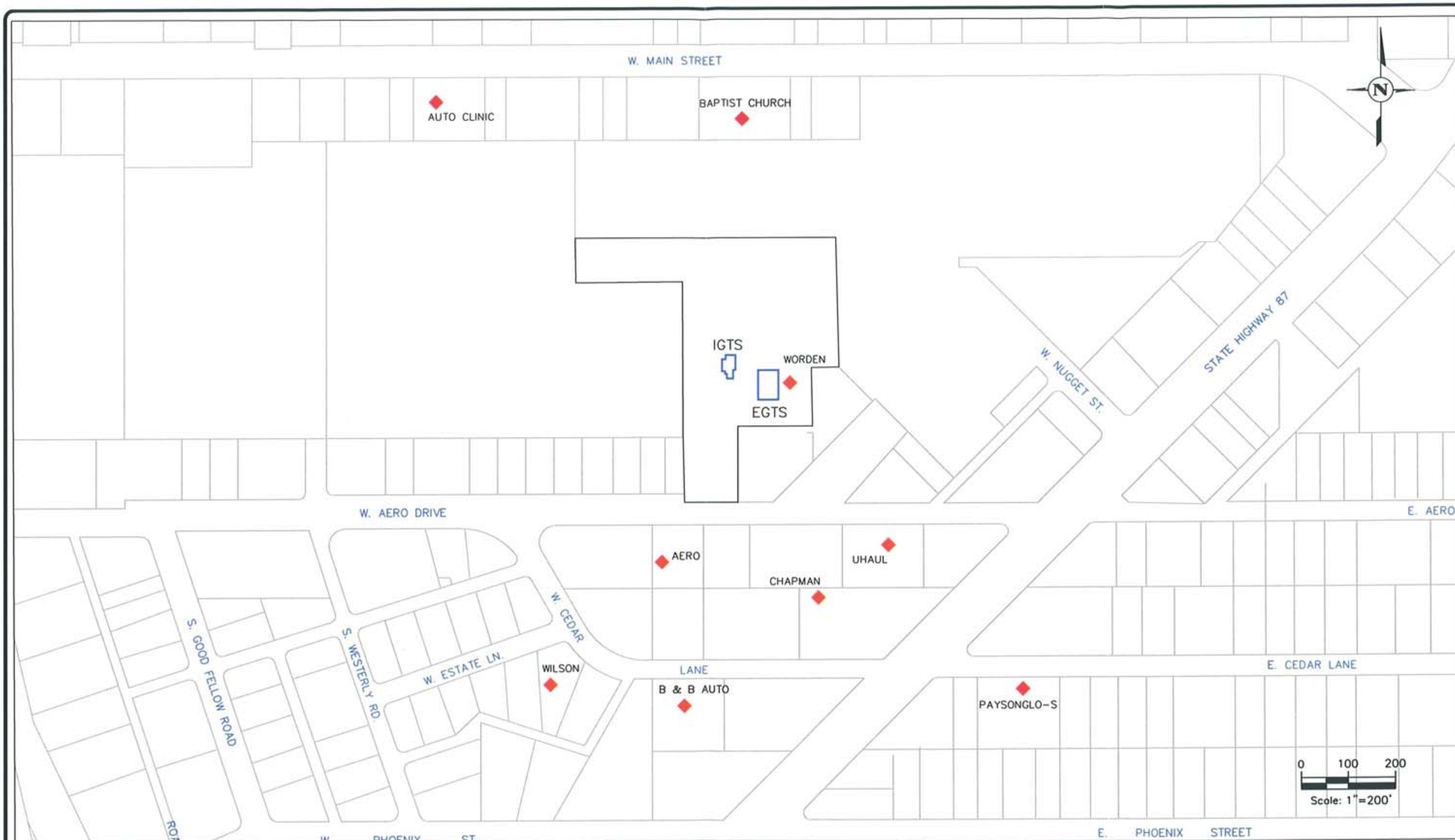
- ● Monitor Well
- ■ Extraction Well
- ▲ Town of Payson Well
- ◆ Domestic Well
- - - - Approximate WQARF Site Boundary

0 150 300 600
APPROXIMATE SCALE IN FEET

TITLE:	SITE BOUNDARIES PAYSON PCE WQARF SITE
LOCATION:	PAYSON, ARIZONA

GeoTrans, Inc. A TETRA TECH COMPANY

CHECKED	PP	FIGURE
DRAFTED	DBS	2-3
PROJECT	1303.005.20.02	
DATE	4/15/03	



EXPLANATION

◆ Domestic Well

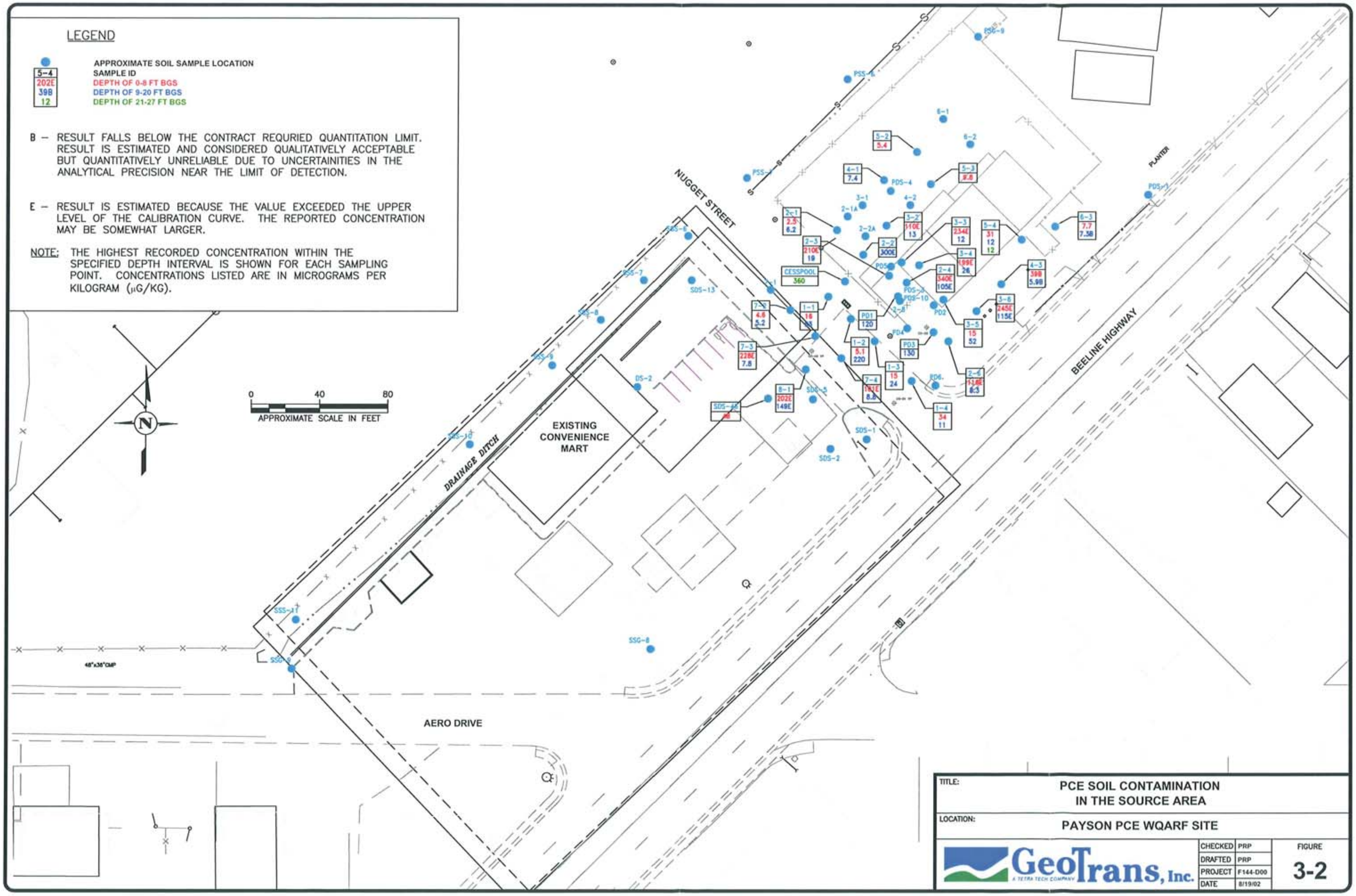
TITLE: PRIVATE WELLS SAMPLED BY ADHS
PAYSON PCE WQARF SITE

LOCATION: PAYSON, ARIZONA

GeoTrans, Inc. A TETRA TECH COMPANY

CHECKED	PRP
DRAFTED	PRP
PROJECT	1303.005.20.02
DATE	4/15/03

FIGURE: 2-4



LEGEND

- APPROXIMATE SOIL SAMPLE LOCATION
- SAMPLE ID
- DEPTH OF 0-8 FT BGS
- DEPTH OF 9-20 FT BGS
- DEPTH OF 21-27 FT BGS

(Example: 5-4 / 202E / 39B / 12)

B – RESULT FALLS BELOW THE CONTRACT REQURIED QUANTITATION LIMIT. RESULT IS ESTIMATED AND CONSIDERED QUALITATIVELY ACCEPTABLE BUT QUANTITATIVELY UNRELIABLE DUE TO UNCERTAINITIES IN THE ANALYTICAL PRECISION NEAR THE LIMIT OF DETECTION.

E – RESULT IS ESTIMATED BECAUSE THE VALUE EXCEEDED THE UPPER LEVEL OF THE CALIBRATION CURVE. THE REPORTED CONCENTRATION MAY BE SOMEWHAT LARGER.

NOTE: THE HIGHEST RECORDED CONCENTRATION WITHIN THE SPECIFIED DEPTH INTERVAL IS SHOWN FOR EACH SAMPLING POINT. CONCENTRATIONS LISTED ARE IN MICROGRAMS PER KILOGRAM (μG/KG).

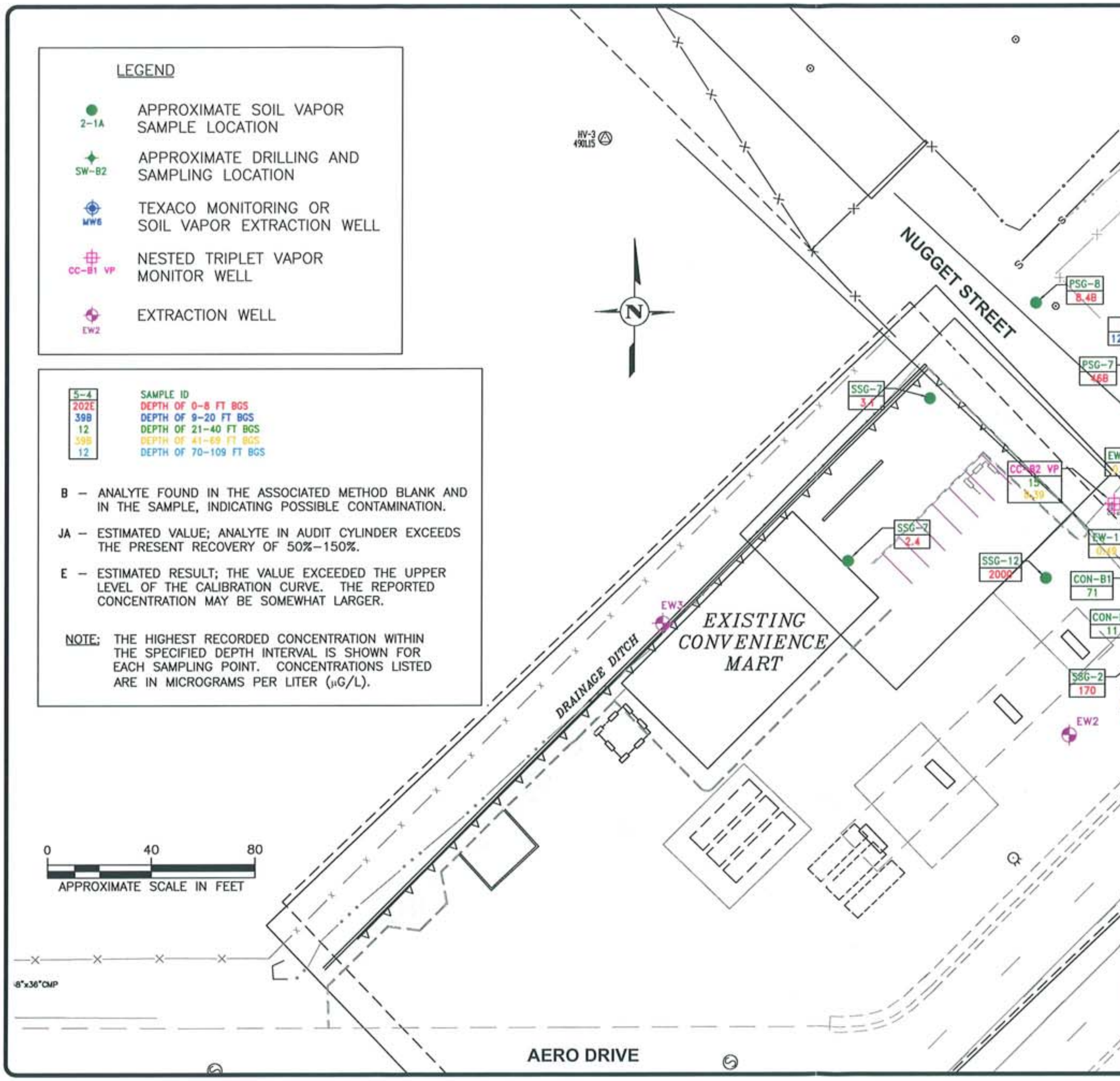
TITLE: PCE SOIL CONTAMINATION IN THE SOURCE AREA

LOCATION: PAYSON PCE WQARF SITE

GeoTrans, Inc. A TETRA TECH COMPANY

CHECKED	PRP
DRAFTED	PRP
PROJECT	F144-D00
DATE	8/19/02

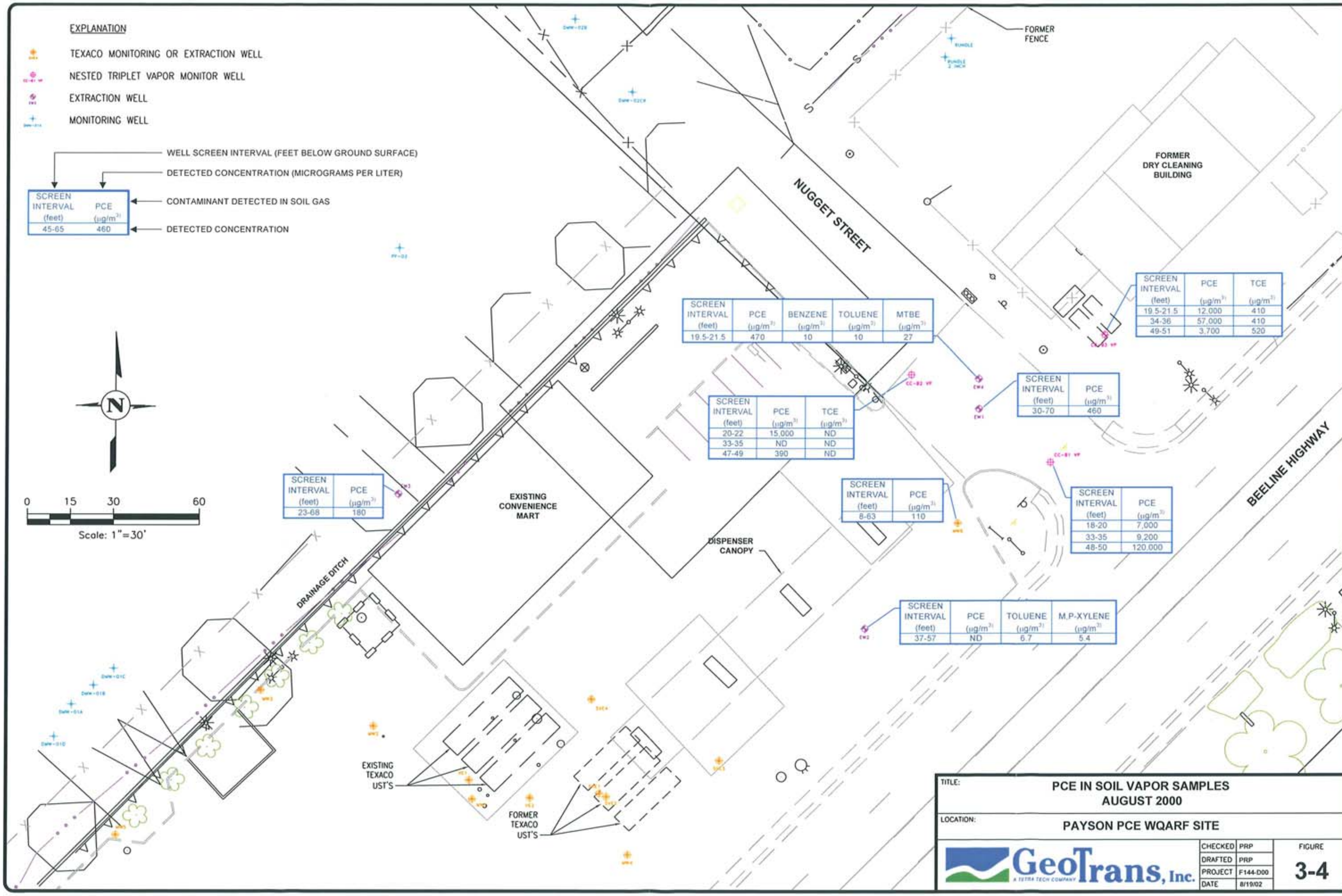
FIGURE 3-2



TITLE:	EXTENT OF SOURCE AREA SOIL VAPOR PCE CONTAMINATION
LOCATION:	PAYSON PCE WQARF SITE

GeoTrans, Inc. A TETRA TECH COMPANY

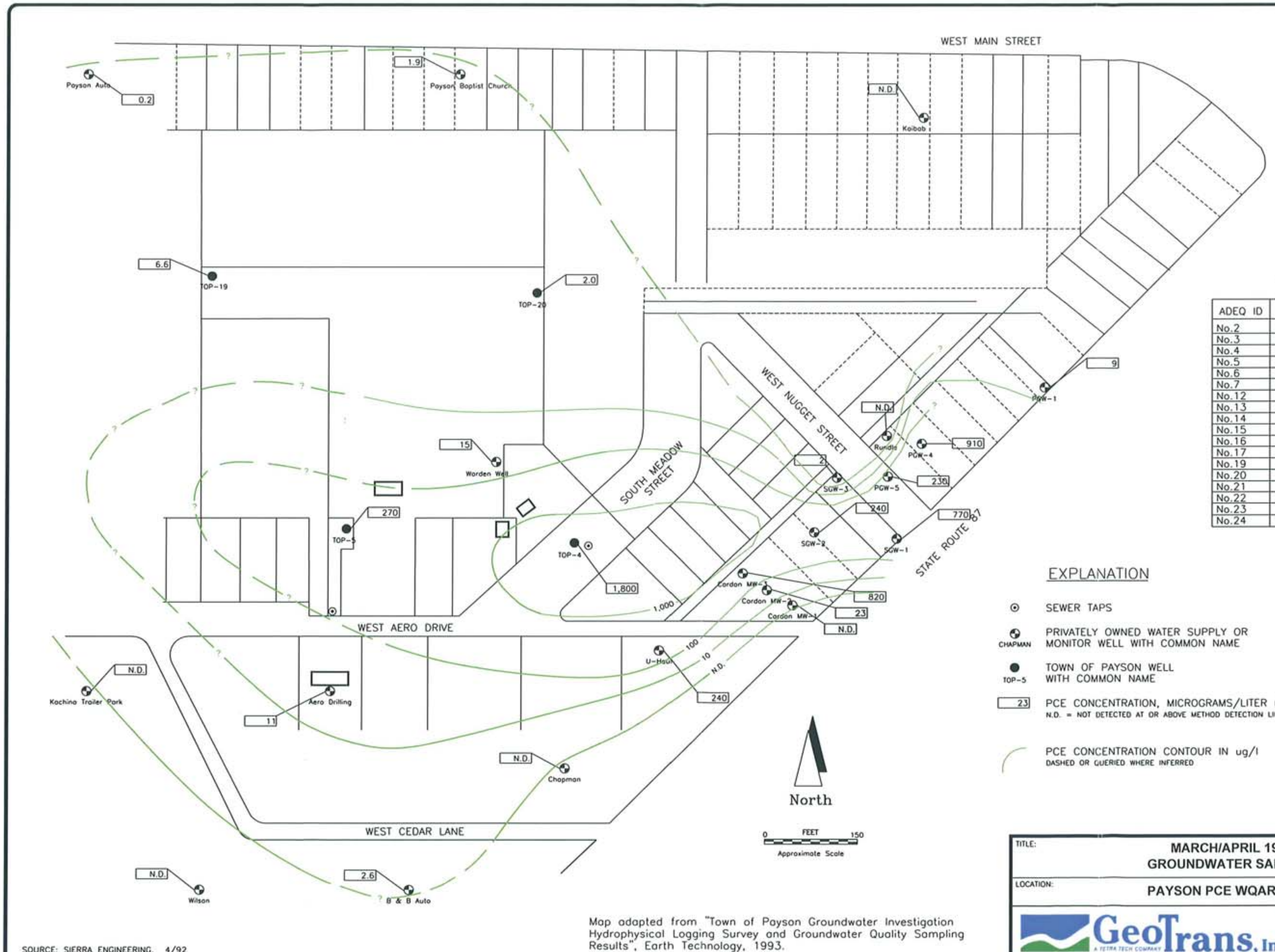
CHECKED	PRP	FIGURE
DRAFTED	PRP	3-3
PROJECT	F144-D00	
DATE	8/19/02	



TITLE:	PCE IN SOIL VAPOR SAMPLES AUGUST 2000
LOCATION:	PAYSON PCE WQARF SITE

GeoTrans, Inc. A TETRA TECH COMPANY

CHECKED	PRP	FIGURE
DRAFTED	PRP	3-4
PROJECT	F144-D00	
DATE	8/19/02	



WELL KEY

ADEQ ID	WELL NAME/LOCATION
No.2	PAYSON AUTO
No.3	TRAILER COURT
No.4	TOP-4
No.5	TOP-5
No.6	CHAPMAN
No.7	U-HAUL
No.12	KAIBAB
No.13	BAPTIST CHURCH
No.14	AERO DRILLING
No.15	RUNDLE
No.16	WILSON
No.17	B & B AUTO
No.19	TOP-19
No.20	TOP-20
No.21	WORDEN
No.22	CARDON MW-3
No.23	CARDON MW-2
No.24	CARDON MW-1

EXPLANATION

⊙ SEWER TAPS

CHAPMAN — PRIVATELY OWNED WATER SUPPLY OR MONITOR WELL WITH COMMON NAME

TOP-5 — TOWN OF PAYSON WELL WITH COMMON NAME

23 — PCE CONCENTRATION, MICROGRAMS/LITER (ug/l)
N.D. = NOT DETECTED AT OR ABOVE METHOD DETECTION LIMIT

PCE CONCENTRATION CONTOUR IN ug/l
DASHED OR QUERIED WHERE INFERRED

Map adapted from "Town of Payson Groundwater Investigation Hydrophysical Logging Survey and Groundwater Quality Sampling Results", Earth Technology, 1993.

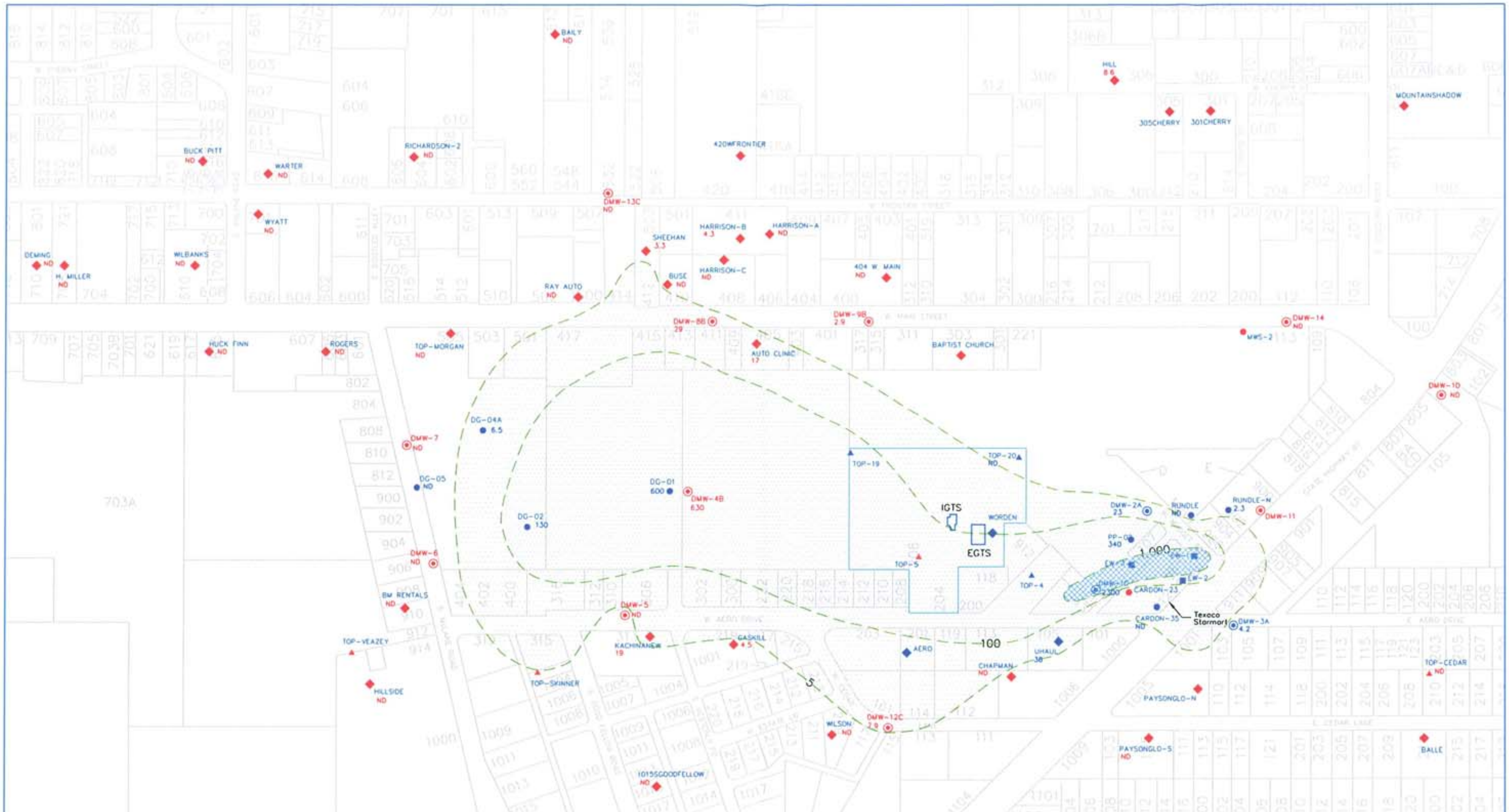
SOURCE: SIERRA ENGINEERING, 4/92

TITLE: MARCH/APRIL 1993 GROUNDWATER SAMPLES

LOCATION: PAYSON PCE WQARF SITE

GeoTrans, Inc. A TETRA TECH COMPANY

CHECKED	PRP	FIGURE
DRAFTED	PRP	3-5
PROJECT	F144-D00	
DATE	8/19/02	



LEGEND:

PCE CONCENTRATIONS	SURVEYED WELL LOCATIONS	ESTIMATED WELL LOCATIONS
>1,000 ug/L PCE Concentration	Monitoring Well	Monitoring Well
100 - 999 ug/L PCE Conc.	Extraction Well	Extraction Well
5 - 99 ug/L PCE Conc.	Town of Payson Well	Town of Payson Well
PCE Contour Inferred	Domestic Well	Domestic Well
	Monitor Well Set	Monitor Well Set

NOTES

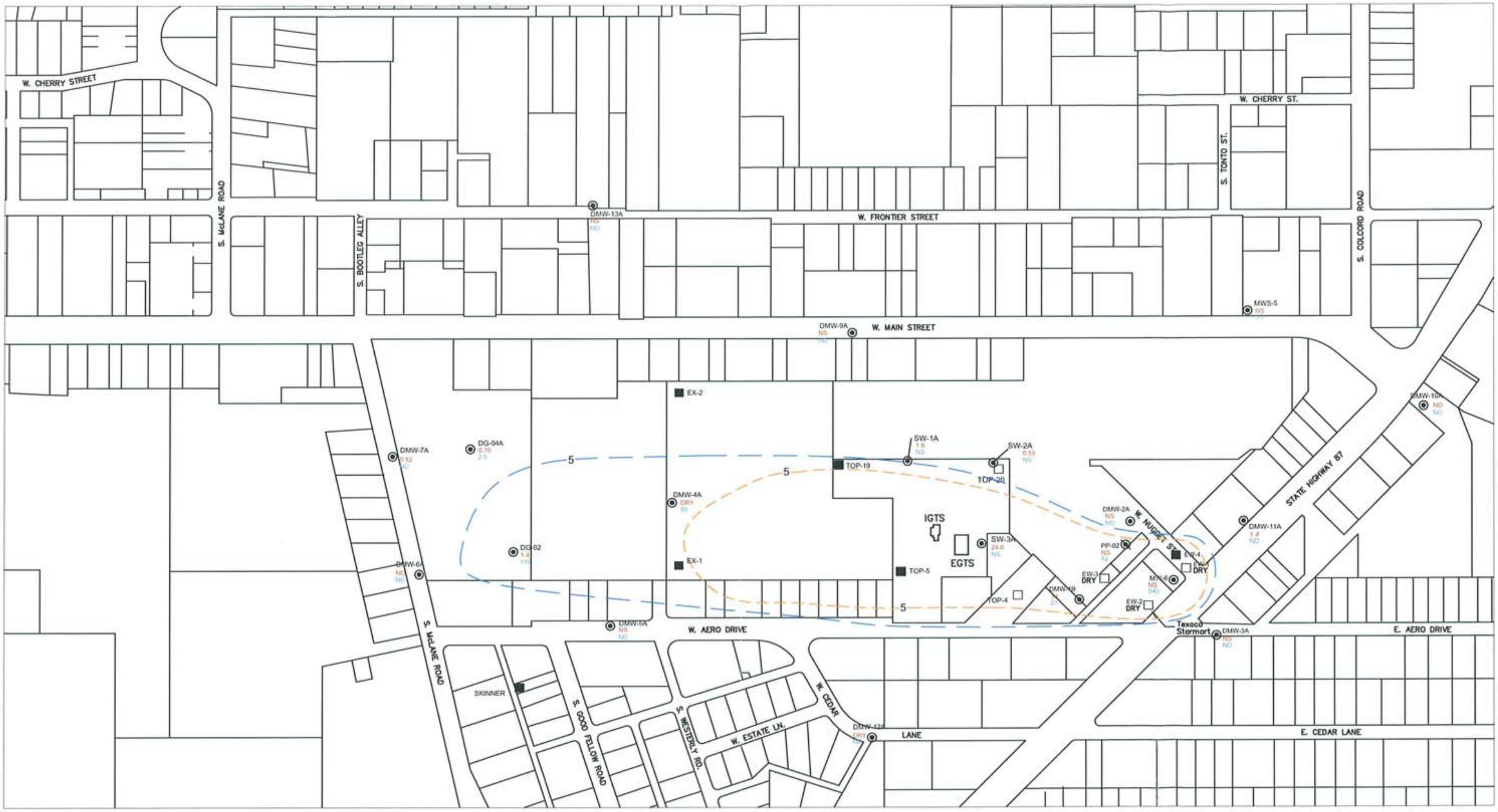
1. The Highest PCE Concentration From Each Well Set Is Used To Construct The PCE Contours.
2. PCE Concentrations From Extraction Wells EW-1, EW-2, EW-3, TOP-4, TOP-5, and TOP-19 Were Not Included On This Contour Map.
3. The PCE Reporting Limit For CARDON-35 Is 100/ug/L.

0 300 600
SCALE IN FEET

Figure 3-6
PCE Concentration Contours
December 1998
Payson WQARF Site

DAMES & MOORE
A DAMES & MOORE GROUP COMPANY
27674-037-022

A12170.03-17-99



LEGEND:

PCE CONCENTRATIONS

- September 2002 5ppb PCE Contour (inferred)
- December 1999 5ppb PCE Contour (inferred)

ND Not Detected

NS Not Sampled

WELL LOCATIONS

- Extraction Well - Operating
- Extraction Well - Not Operating
- Monitor Well
- PCE Concentration (September 2002)
- PCE Concentration (December 1999)
- Abandoned Well

NOTES

1. Method Detection Limit (MDL) for ND wells is <0.5 µg/l.
2. All concentrations are µg/l.

0 300 600

SCALE IN FEET

URS

PCE Concentration Contours

AL Unit

Comparison of September 2002 and December 1999 Data

Payson WQARF Site

Figure 3-7a

O:\AutoCAD\Old D&M022\1WORLD\23442636\A15858.DWG 4-8-03 XREF:PAYSON1.DWG

LEGEND:

PCE CONCENTRATIONS

- September 2002 5ppb PCE Contour (inferred)
- December 1999 5ppb PCE Contour (inferred)
- ND Not Detected
- NS Not Sampled

WELL LOCATIONS

- Extraction Well - Operating
- Extraction Well - Not Operating
- Monitor Well
  - PCE Concentration (September 2002)
  - PCE Concentration (December 1999)
- Abandoned Well

NOTES

1. Method Detection Limit (MDL) for ND wells is <0.5 µg/l.
2. All concentrations are µg/l.

0 300 600

SCALE IN FEET

URS

PCE Concentration Contours

DG/FG Unit

Comparison of September 2002 and December 1999 Data

Payson WQARF Site

Figure 3-7b

O:\AutoCAD\Old D&M022\1WORLD\23442636\A15857.DWG 4-8-03 XREF:PAYSON1.DWG

LEGEND:

PCE CONCENTRATIONS

- September 2002 5ppb PCE Contour (inferred)
- December 1999 5ppb PCE Contour (inferred)
- ND Not Detected
- NS Not Sampled

WELL LOCATIONS

- Extraction Well - Operating
- Extraction Well - Not Operating
- Monitor Well
  - PCE Concentration (September 2002)
  - PCE Concentration (December 1999)
- Abandoned Well

NOTES

1. Method Detection Limit (MDL) for ND wells is <0.5 µg/l.
2. All concentrations are µg/l.

0 300 600

SCALE IN FEET

URS

PCE Concentration Contours

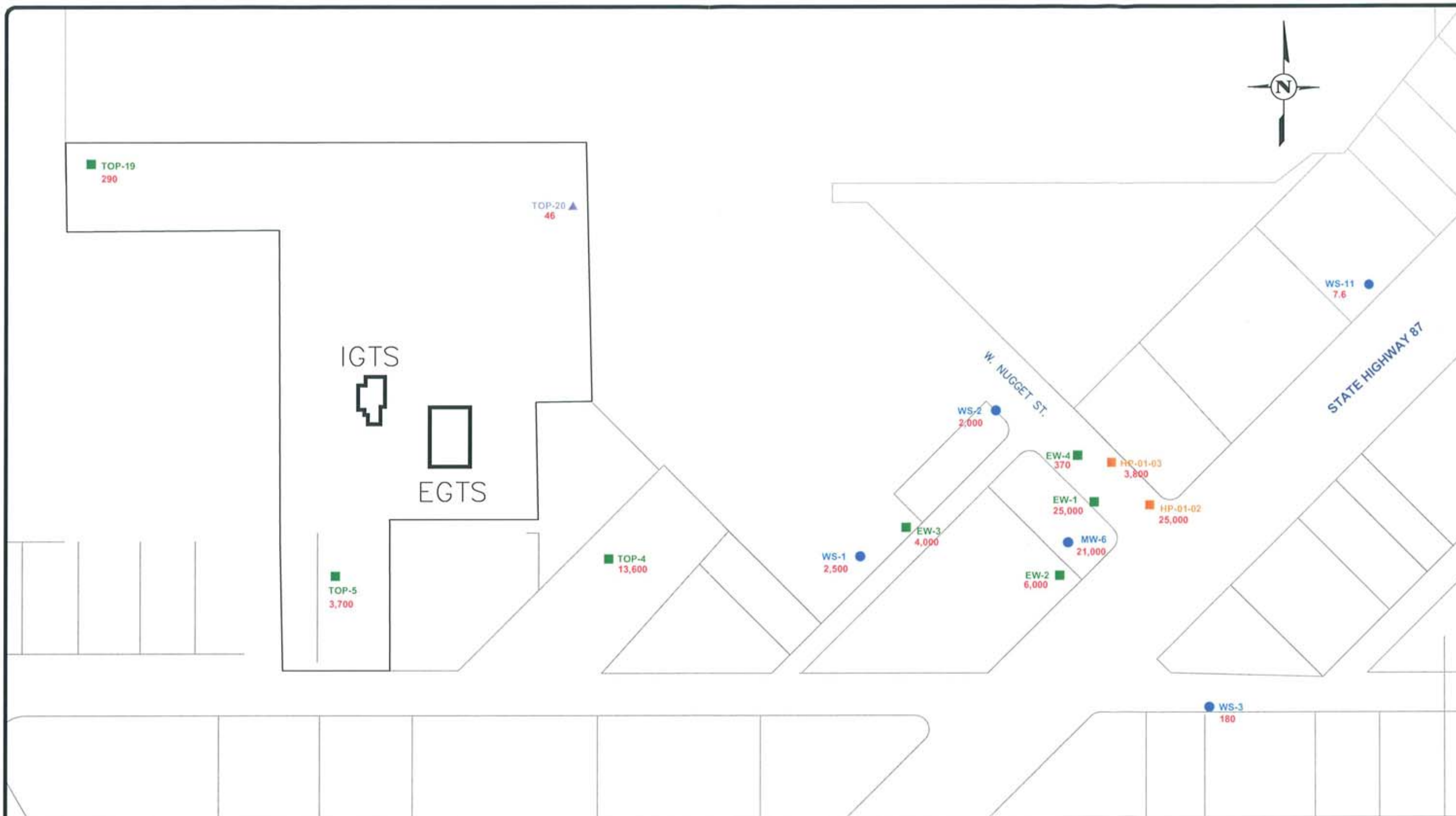
FG/CG Unit

Comparison of September 2002 and December 1999 Data

Payson WQARF Site

Figure 3-7c

O:\AutoCAD\Old D&M022\1WORLD\23442636\A15854.DWG 4-8-03 XREF:PAYSON1.DWG



EXPLANATION

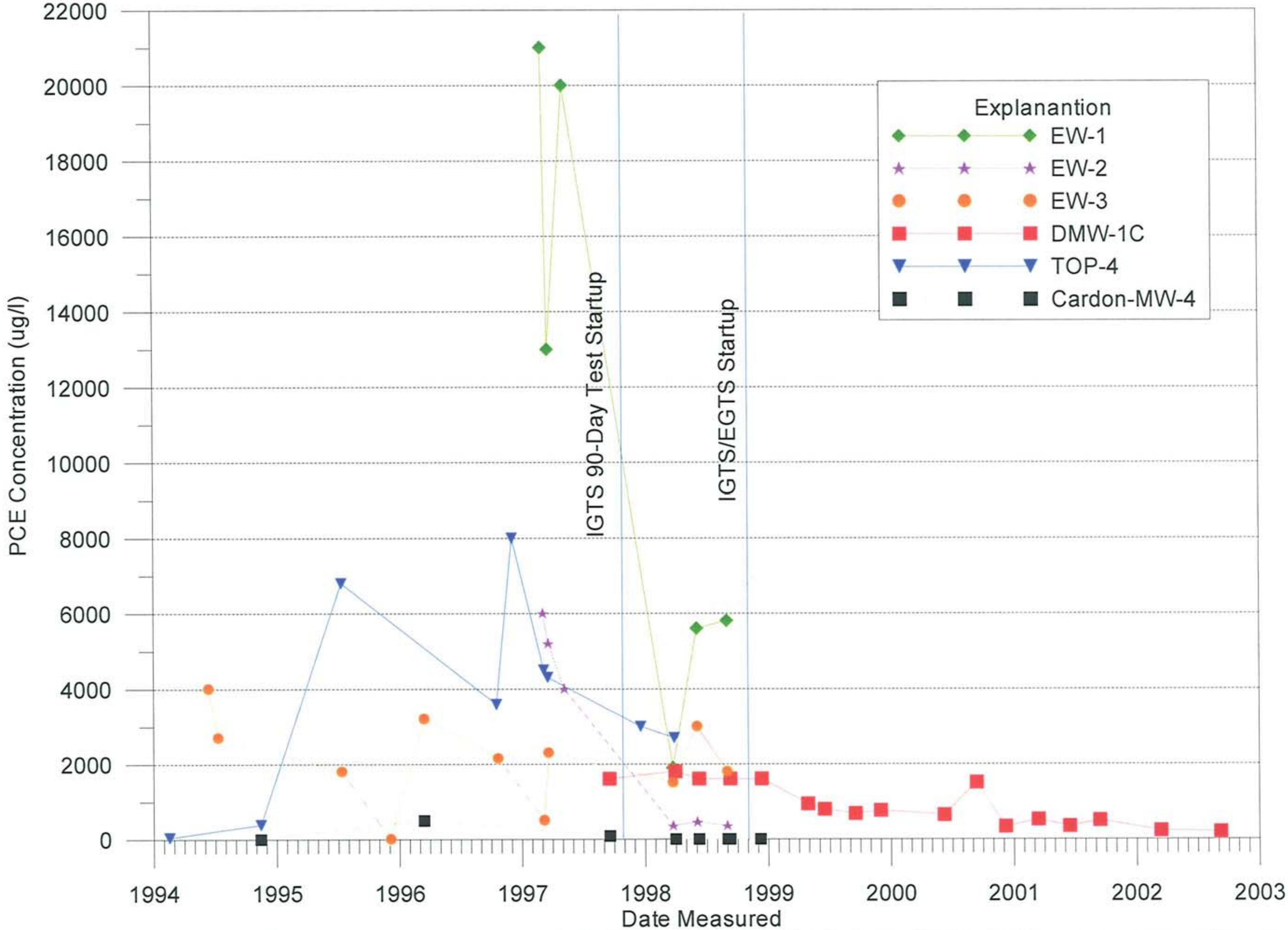
- Monitor Well
- Extraction Well
- Town of Payson Well
- HydroPunch Sample Location
- 2,600 Maximum Historic PCE Concentration at Well or Well Set (ug/l)

Note: Samples presented were collected from 1990 to 1999

TITLE:	HIGHEST PCE CONCENTRATIONS FOR GROUNDWATER SAMPLES
LOCATION:	PAYSON PCE WQARF SITE

GeoTrans, Inc. A TETRA TECH COMPANY

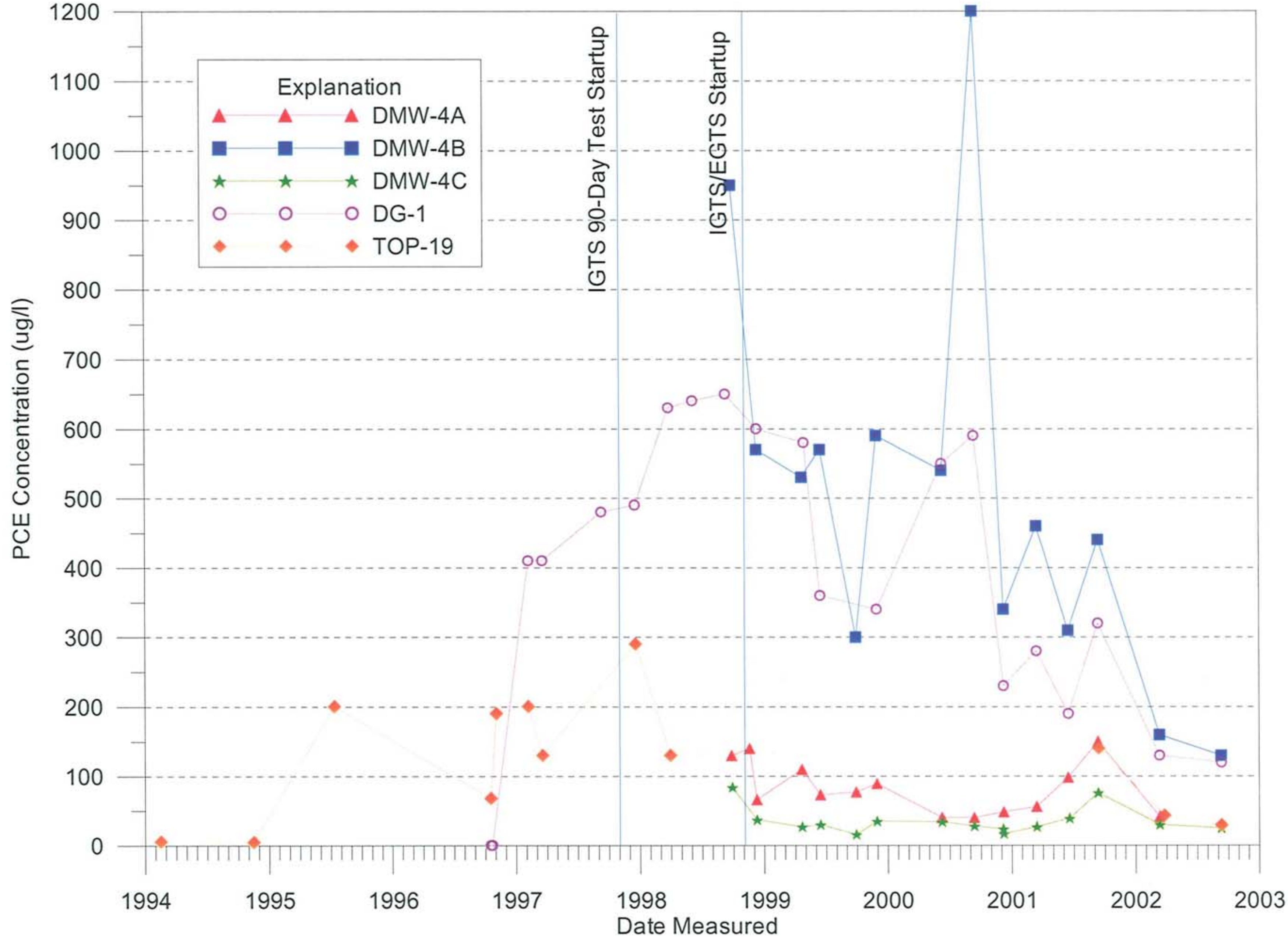
CHECKED	PRP	FIGURE
DRAFTED	PRP	3-8
PROJECT	F144-D00	
DATE	8/19/02	



GeoTrans, Inc.

PCE Concentrations near Source Area
Payson PCE WQARF Site - Feasibility Study
Arizona Department of Environmental Quality

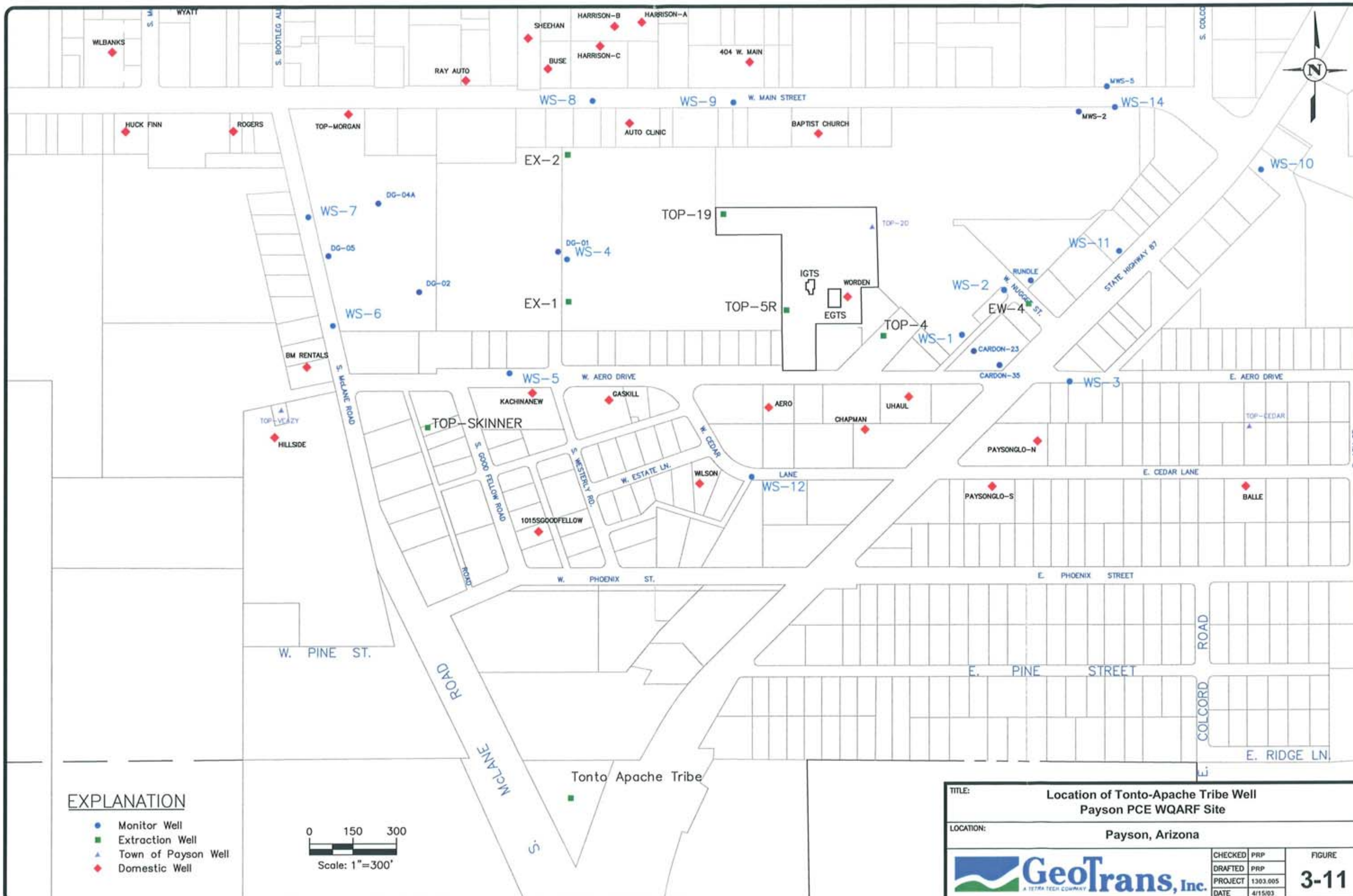
FIGURE
3-9



GeoTrans, Inc.

PCE Concentrations Downgradient of Source Area
Payson PCE WQARF Site - Feasibility Study
Arizona Department of Environmental Quality

FIGURE 3-10

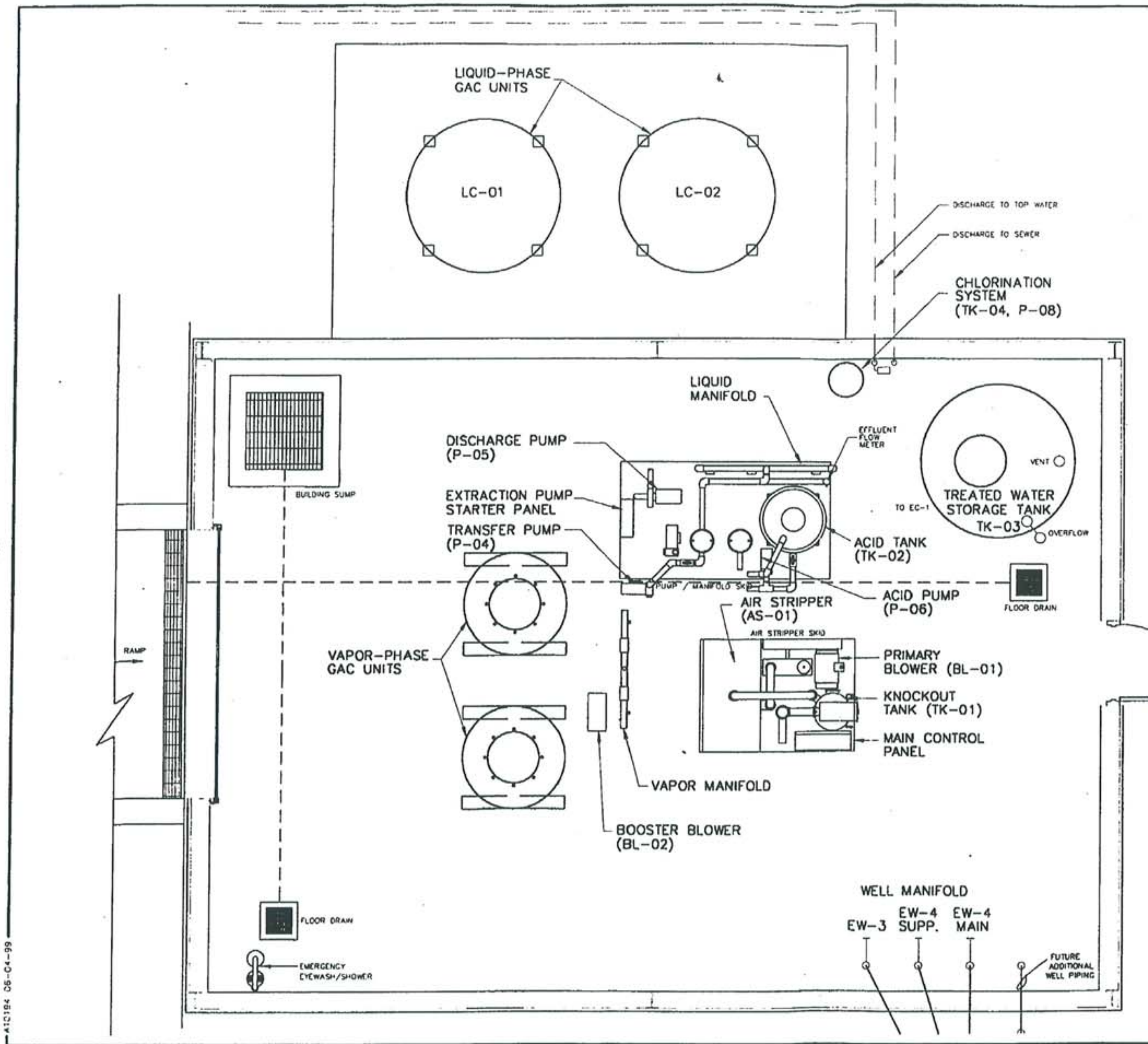


TITLE: Location of Tonto-Apache Tribe Well
Payson PCE WQARF Site

LOCATION: Payson, Arizona

GeoTrans, Inc.
A TETRA TECH COMPANY

CHECKED	PRP	FIGURE
DRAFTED	PRP	
PROJECT	1303.005	3-11
DATE	4/15/03	



SCALE

0 4 8

SCALE IN FEET

MAJOR EQUIPMENT LAYOUT PLAN

INTERM GROUNDWATER TREATMENT SYSTEM

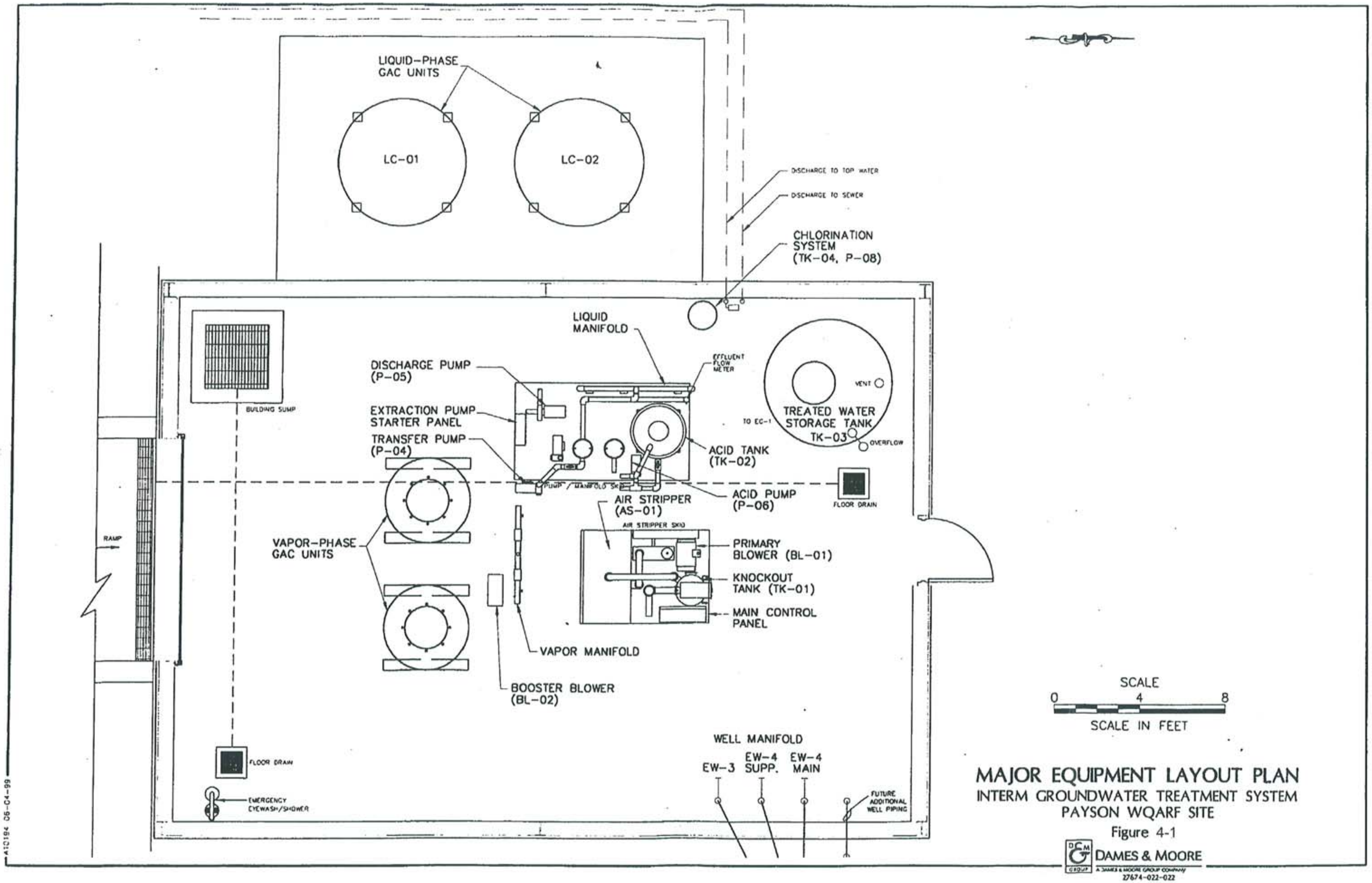
PAYSON WQARF SITE

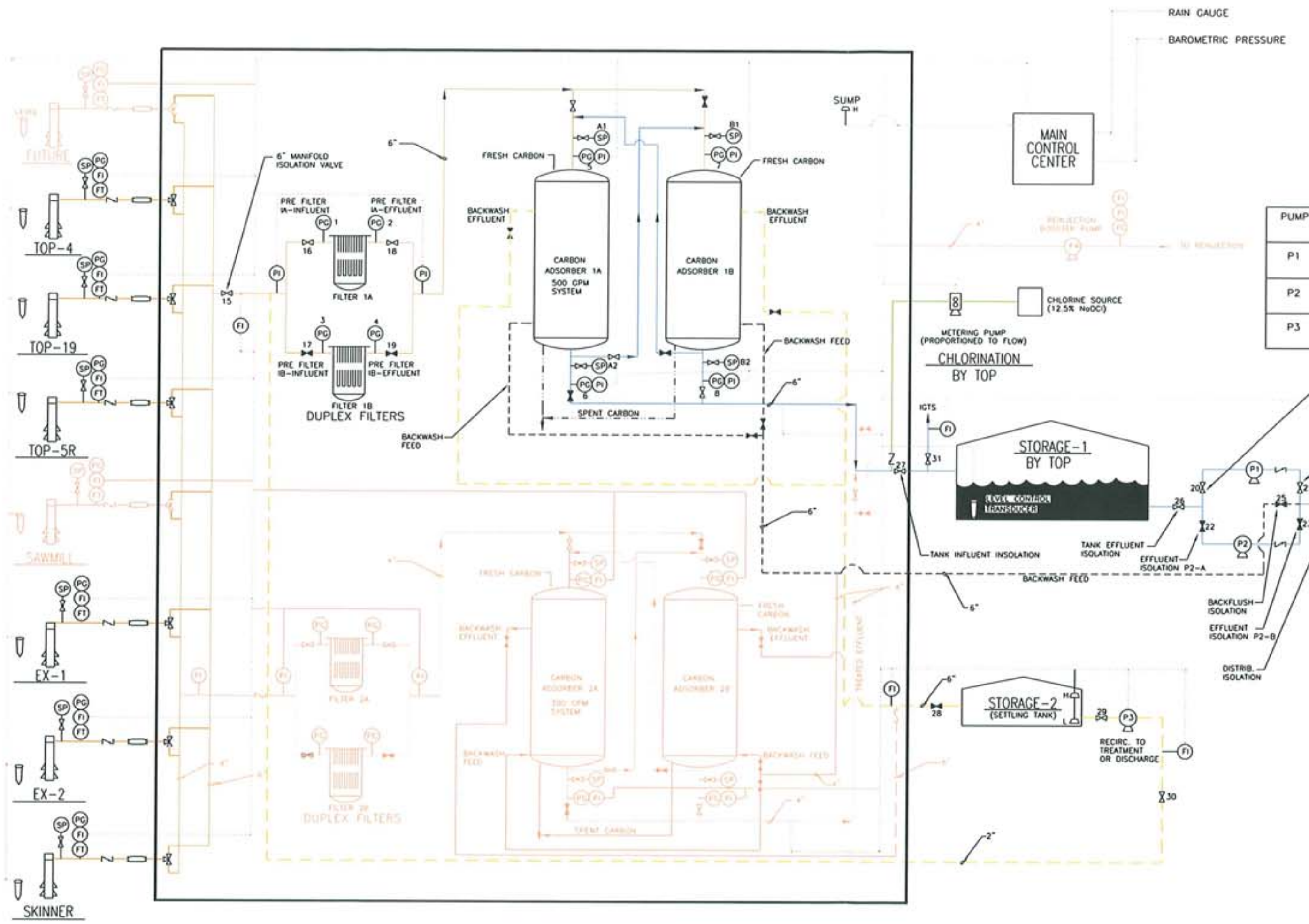
Figure 4-1

DAMES & MOORE

A DAMES & MOORE GROUP COMPANY

27674-022-022


LIQUID-PHASE GAC UNITS
LC-01
LC-02
DISCHARGE TO TOP WATER
DISCHARGE TO SEWER
CHLORINATION SYSTEM (TK-04, P-08)
LIQUID MANIFOLD
EFFLUENT FLOW METER
DISCHARGE PUMP (P-05)
EXTRACTION PUMP STARTER PANEL
TRANSFER PUMP (P-04)
BUILDING SUMP
TO EC-1
VENT
TREATED WATER STORAGE TANK TK-03
OVERFLOW
ACID TANK (TK-02)
ACID PUMP (P-06)
FLOOR DRAIN
PUMP / MANIFOLD SKID
AIR STRIPPER (AS-01)
AIR STRIPPER SKID
PRIMARY BLOWER (BL-01)
KNOCKOUT TANK (TK-01)
MAIN CONTROL PANEL
VAPOR-PHASE GAC UNITS
VAPOR MANIFOLD
BOOSTER BLOWER (BL-02)
RAMP
FLOOR DRAIN
EMERGENCY EYEWASH/SHOWER
WELL MANIFOLD
EW-3
EW-4 SUPP.
EW-4 MAIN
FUTURE ADDITIONAL WELL PIPING
SCALE
0
4
8
SCALE IN FEET
MAJOR EQUIPMENT LAYOUT PLAN
INTERM GROUNDWATER TREATMENT SYSTEM
PAYSON WQARF SITE
Figure 4-1
DAMES & MOORE
A DAMES & MOORE GROUP COMPANY
27674-022-022
A10184 06-04-99



NOTES

1. EACH CARBON ADSORBTION VESSEL TO BE FACTORY PLUMBED WITH CARBON FILL PIPE ON TOP, AND CARBON EMPTY PIPE ON BOTTOM.

2. CARBON REPLACEMENT WILL BE THROUGH FILL AND EMPTY PIPE IN A SLURRY FORM.

3. SETTLING TANK IS CONSTRUCTED OF REINFORCED FIBERGLASS. INFLUENT TO TANK IS PIPED TO THE TOP OF THE TANK WITH DIRECT DISCHARGE AT THE TOP.

PUMP SCHEDULE

PUMP	EST. RATE	RECOMMENDED MODEL	HORSE-POWER
P1	300-800 GPM	PACO 3095-5	60
P2	300-800 GPM	PACO 3095-5	60
P3	45-63 GPM	GOULD NPE 1 x 1-1/4 - 5	2.0

LEGEND

- SINGLE CONTROL LINE
- BUNDLED CONTROL LINE
- BACKWASH EFFLUENT
- BACKWASH FEED
- FRESH & SPENT CARBON
- CHLORINATION FEED LINE
- PRESSURE TRANSDUCER
- PRESSURE GAGE No. 7
- PRESSURE INDICATOR
- FLOW TOTALIZER
- FLOW INDICATOR
- OPEN VALVE No. 7
- CLOSED VALVE No. 8
- CHECK VALVE
- SAMPLE PORT
- TANK LEVEL FLOATS
- ELECTRIC SUBMERSIBLE PUMP
- HARDNESS PRETREATMENT DEVICE

THESE RECORD DRAWINGS HAVE BEEN PREPARED BASED ON INFORMATION PROVIDED BY OTHERS. ADVANCED REMEDIATION TECHNOLOGIES, INC. HAS NOT VERIFIED THE ACCURACY AND/OR COMPLETENESS OF THIS INFORMATION AND SHALL NOT BE RESPONSIBLE FOR ANY ERRORS OR OMISSIONS WHICH MAY BE INCORPORATED HEREIN AS A RESULT.

REVISION INFORMATION		
MILESTONE	DATE	REVIEWING AGENCY
RECORD DRAWING	03/11/02	ARIZONA DEQ

"PARTNERS IN SERVICE"

Advanced Remediation Technologies Co.

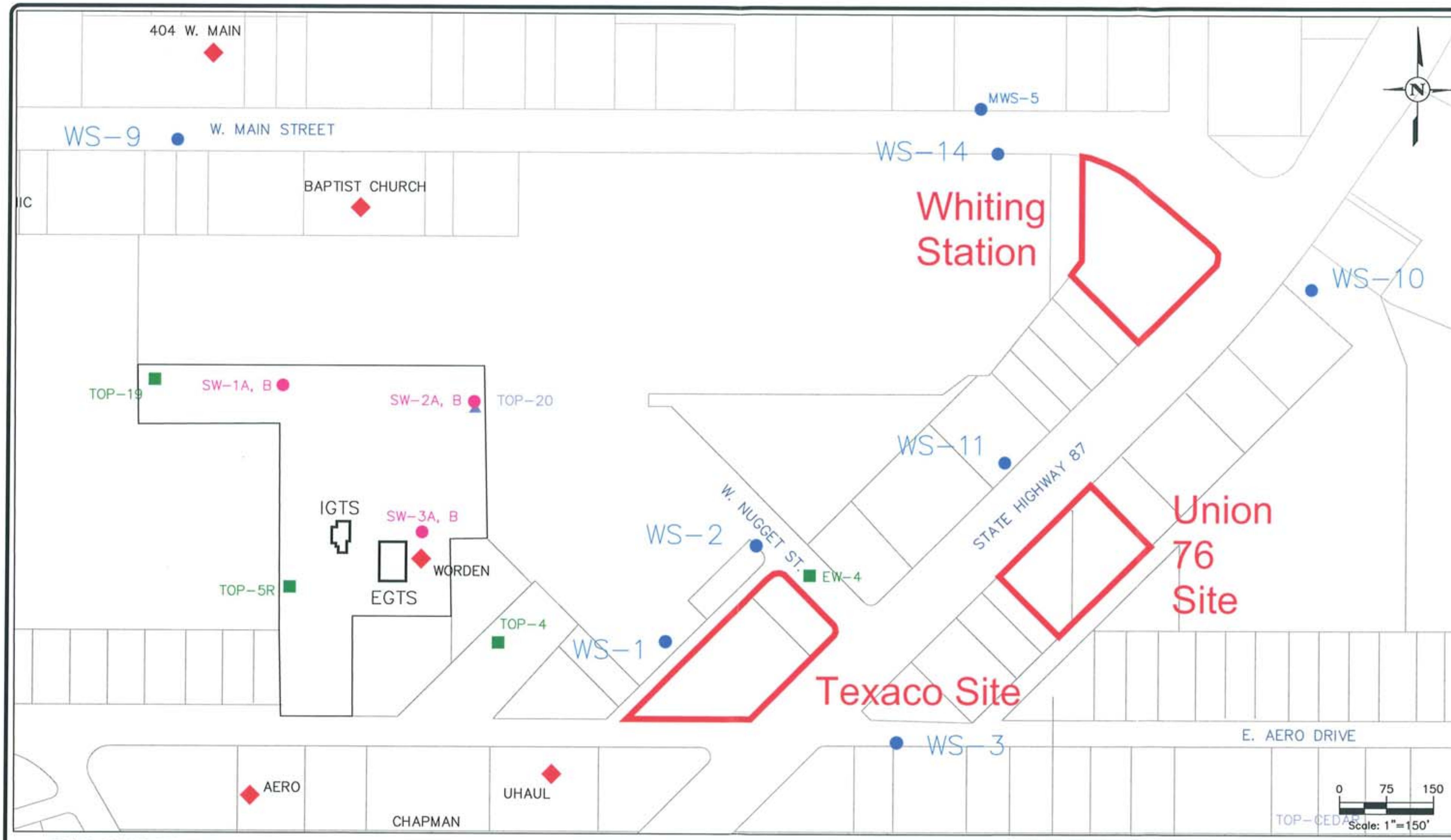
119 NW 4TH AVE CANBY, OREGON 97013
PHONE: (503) 266-2122 fax: (503) 266-4724

ARIZONA DEQ
TOWN OF PAYSON - WQARF
PAYSON, ARIZONA

PROCESS & INSTRUMENTATION DIAGRAM

DATE	03/11/02
DRAWN	LAD
DESIGN	LAD
CHECK	
SCALE	NTS
P&ID	

SHEET **4-2** OF



EXPLANATION

- ● Monitor Well
- ■ Extraction Well
- ▲ Town of Payson Well
- ◆ Domestic Well
- Site Boundaries
- ● MTBE Sentinel Monitor Well

NOTE: Monitor wells DMW-1A, DMW-2A, DMW-3A, Worden and MWS-5 and former extraction wells EW-1, EW-2 and EW-3 are currently dry

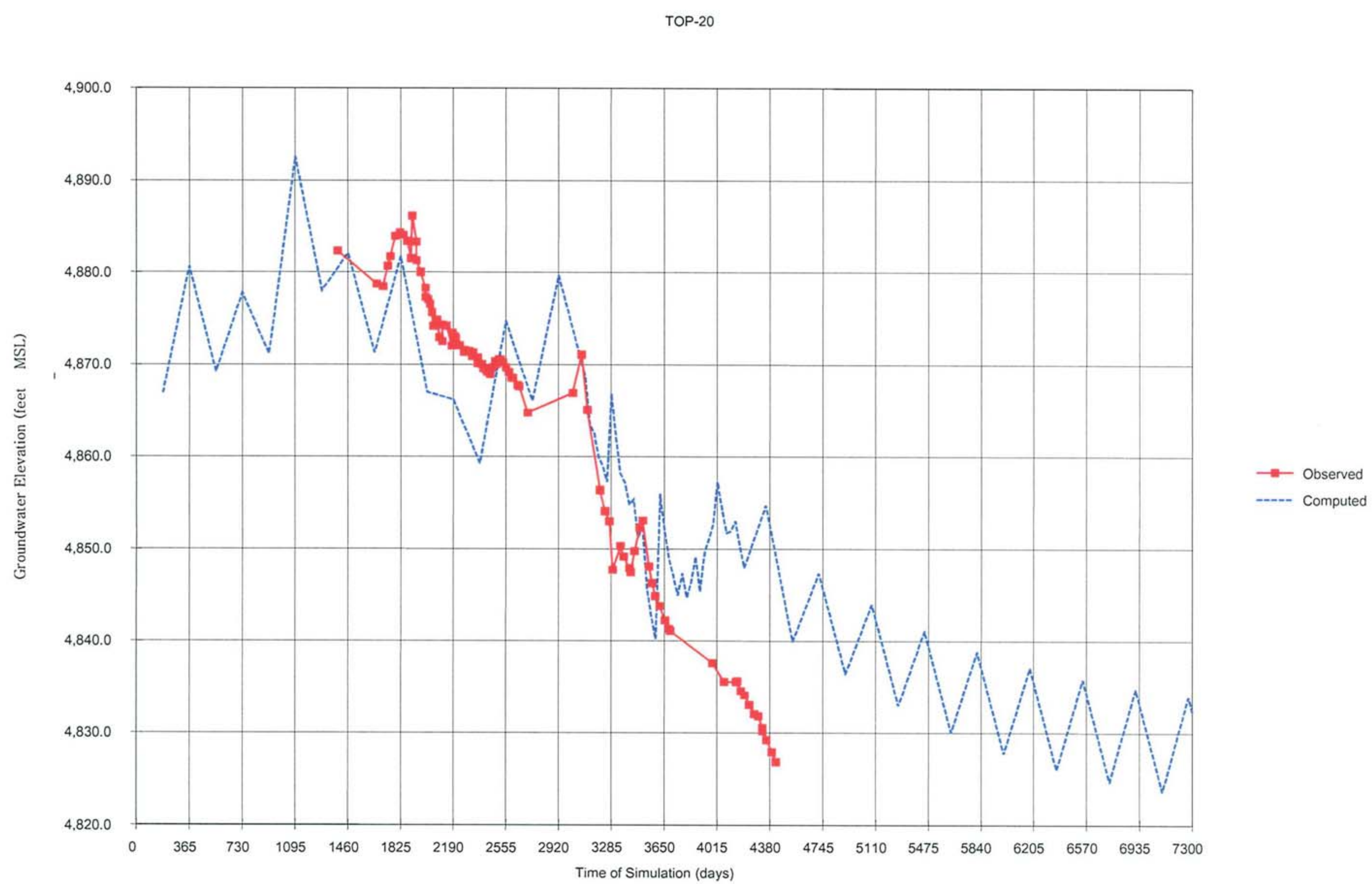
TITLE: Onsite MTBE Sentinel Monitor Wells
Payson PCE WQARF Site

LOCATION: Payson, Arizona

GeoTrans, Inc.
A TETRA TECH COMPANY

CHECKED	prp
DRAFTED	prp
PROJECT	F144
DATE	09/30/02

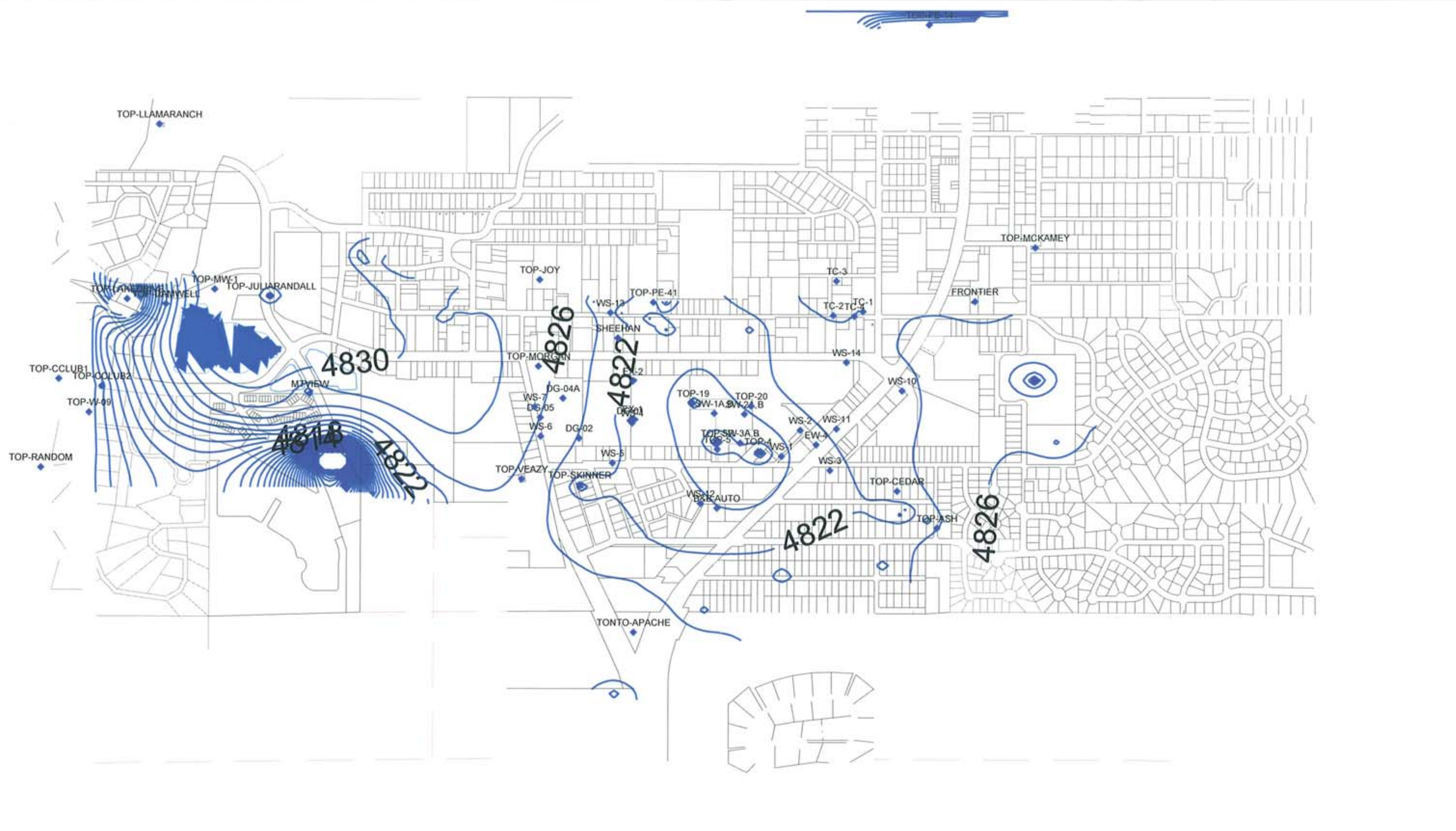
FIGURE: 5-1



GeoTrans, Inc.

Reference Remedy
Model Simulated Hydrograph for TOP-20
Payson PCE WQARF Site
Arizona Department of Environmental Quality

FIGURE
7-1



GeoTrans, Inc.

Payson PCE WQARF Site
Arizona Department of Environmental Quality

Reference Remedy
Simulated Water Level Elevations
October 2102
(Feet-MSL)

FIGURE
7-2

EGTS Mass Removal Summary for PCE

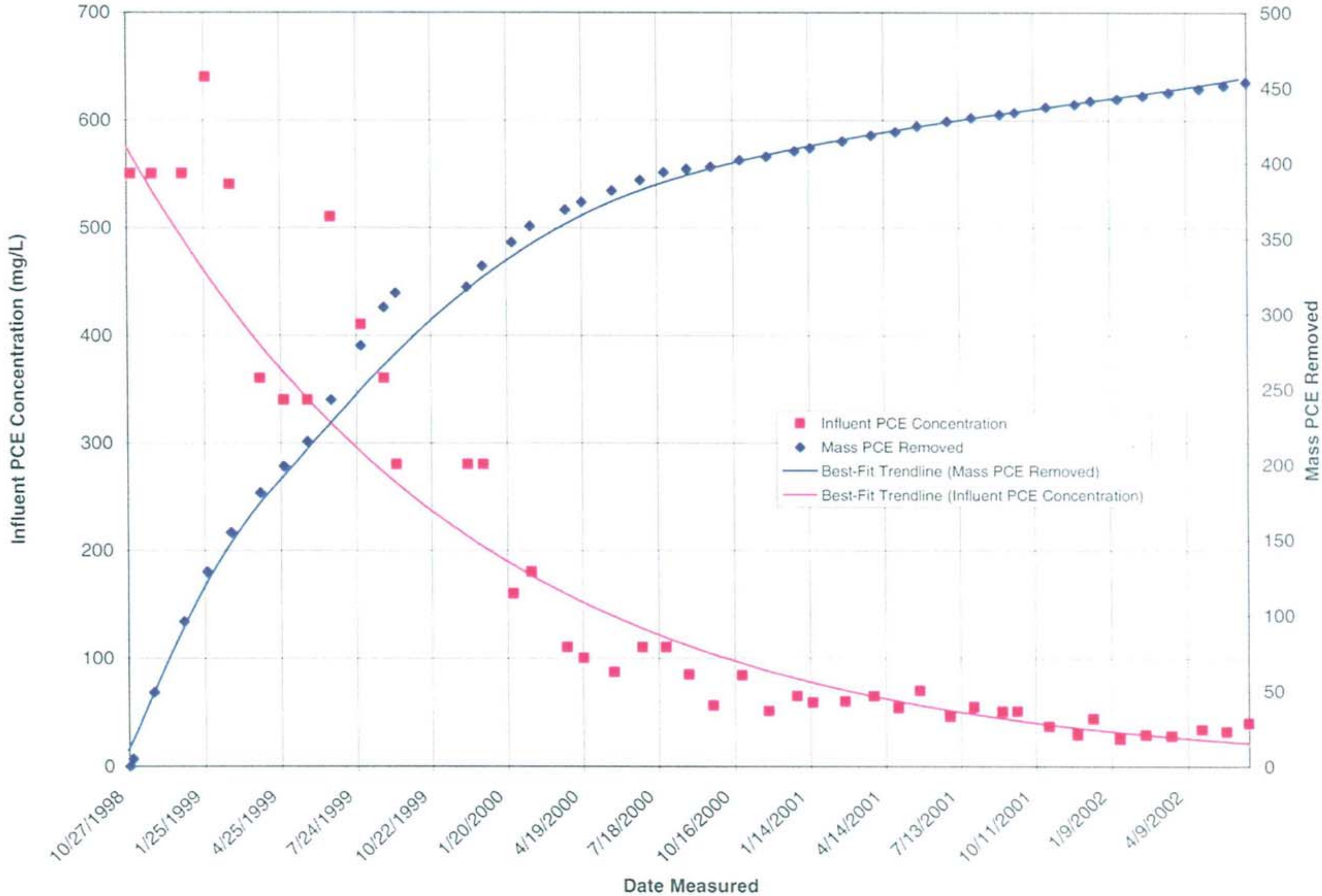
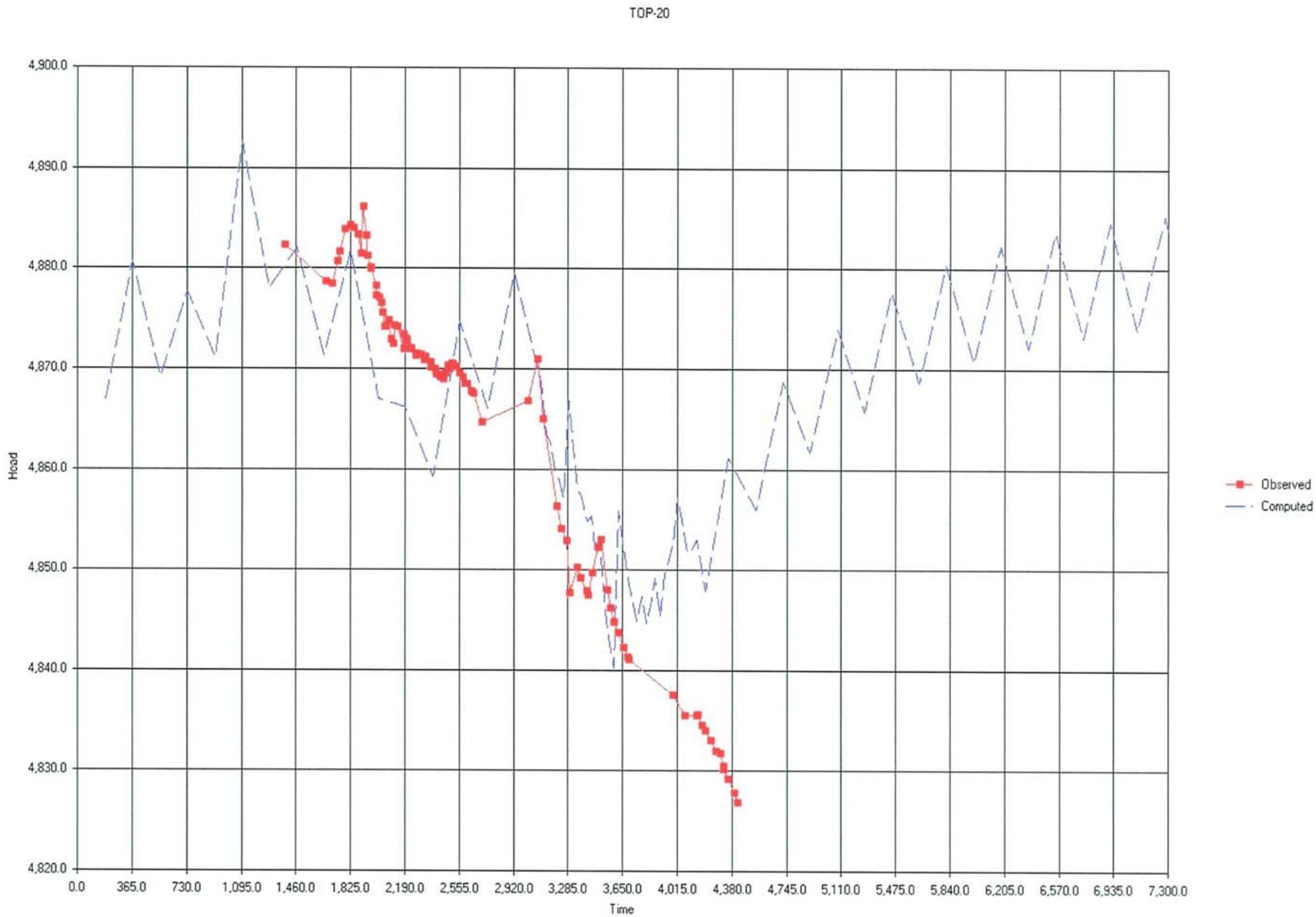


Figure taken from *Payson WQARF Site Groundwater Treatment Systems Performance Review*, URS Corp., 2002.

GeoTrans, Inc.

EGTS System Performance
Payson PCE WQARF Site
Arizona Department of Environmental Quality

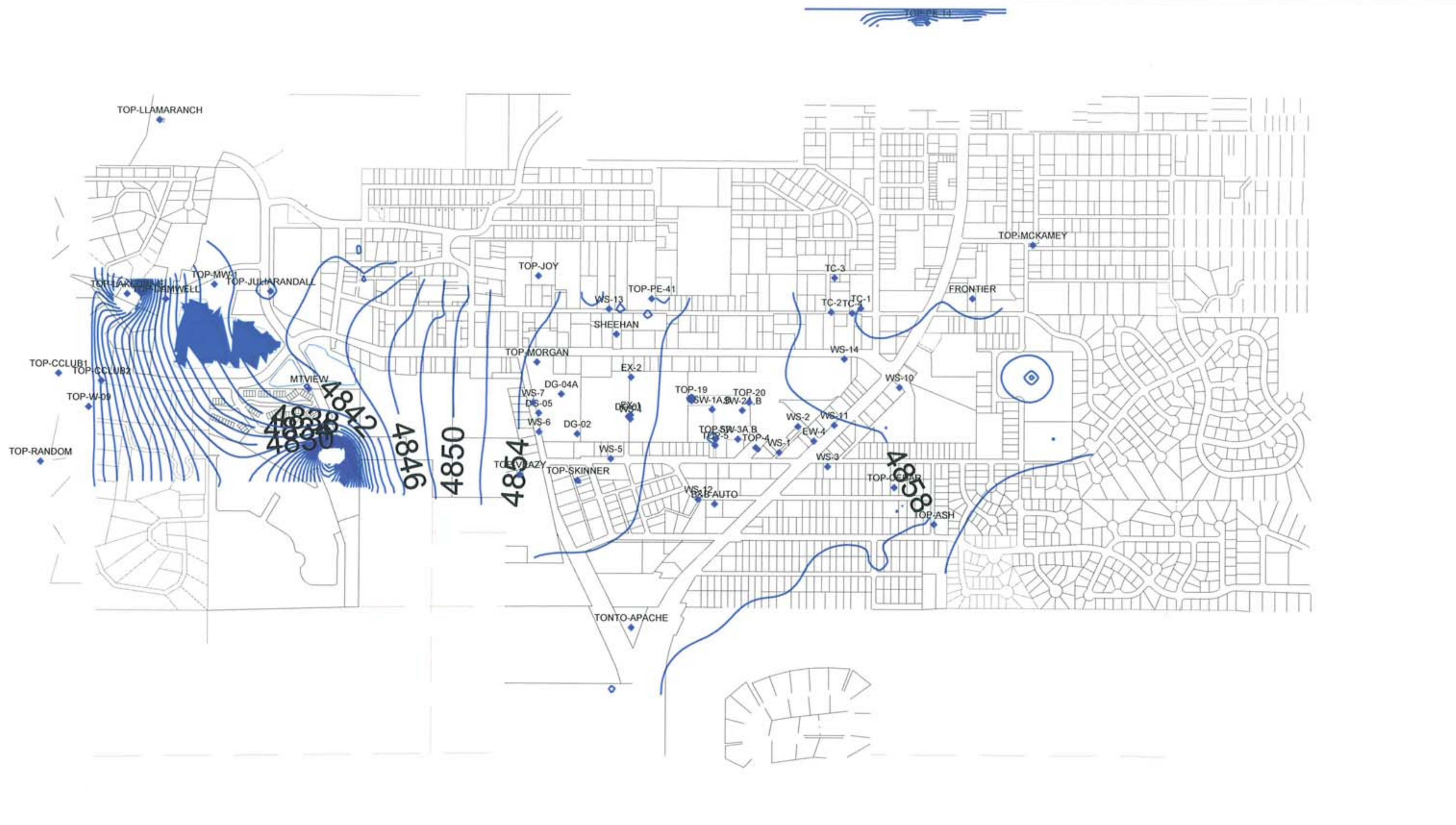
FIGURE
7-3



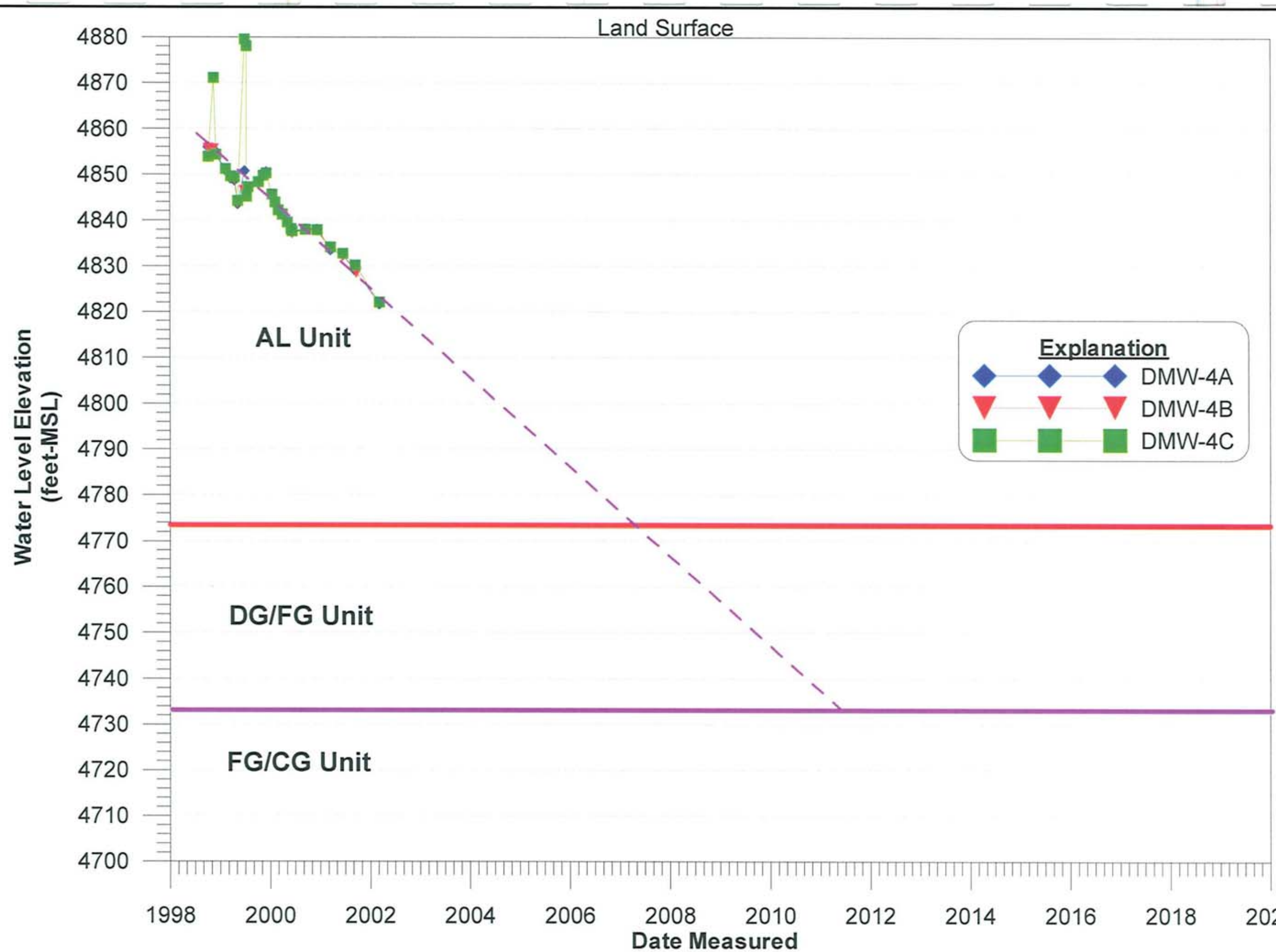
GeoTrans, Inc.

Less Aggressive Remedy
Model Simulated Hydrograph for TOP-20
Payson PCE WQARF Site
Arizona Department of Environmental Quality

FIGURE
7-4



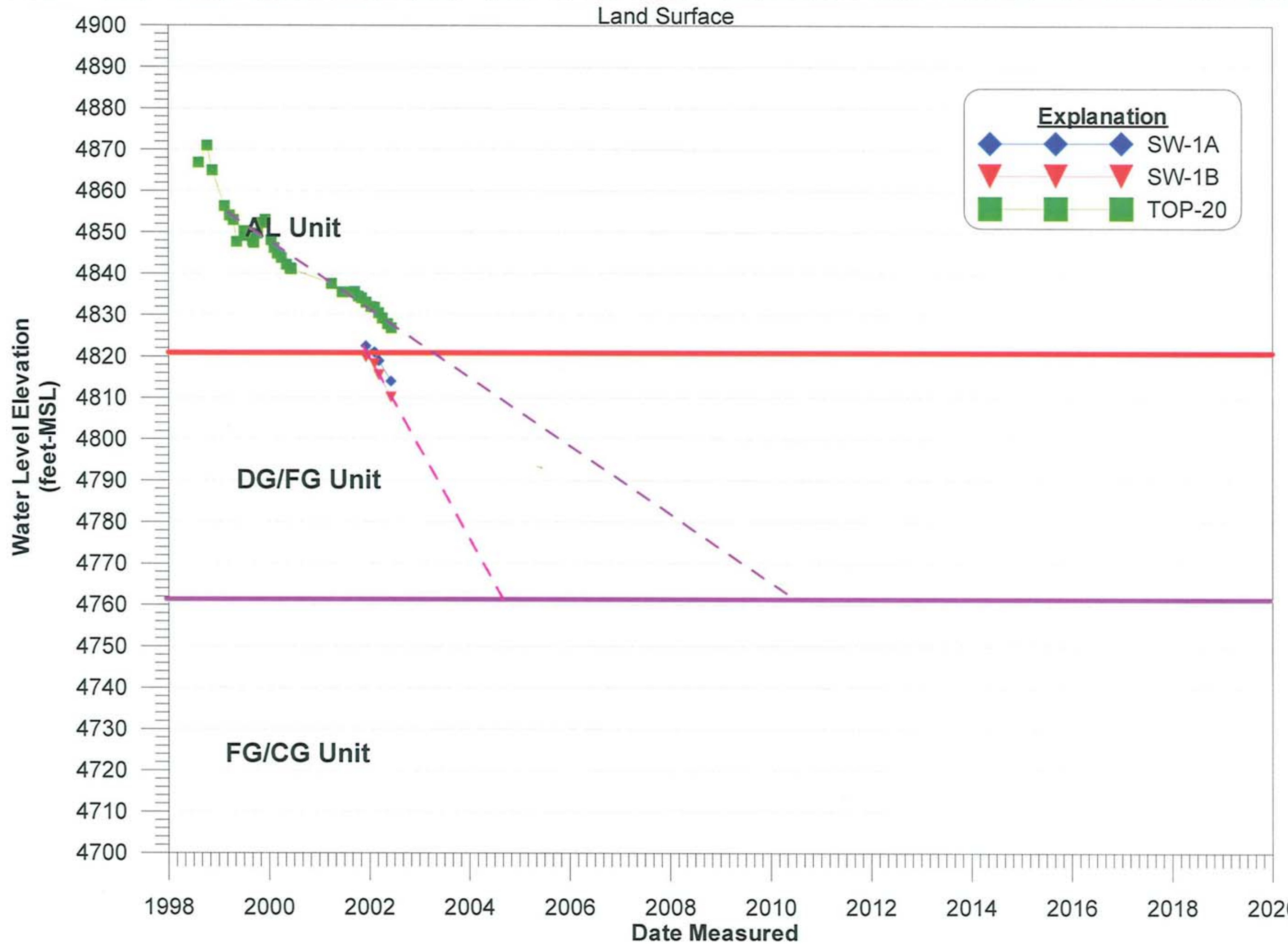
GeoTrans, Inc.	Payson PCE WQARF Site Arizona Department of Environmental Quality	Less Aggressive Remedy Simulated Water Level Elevations October 2102 (Feet-MSL)	FIGURE 7-5



GeoTrans, Inc.

Projected Water Levels Based on Current Trends
Payson PCE WQARF Site
Arizona Department of Environmental Quality

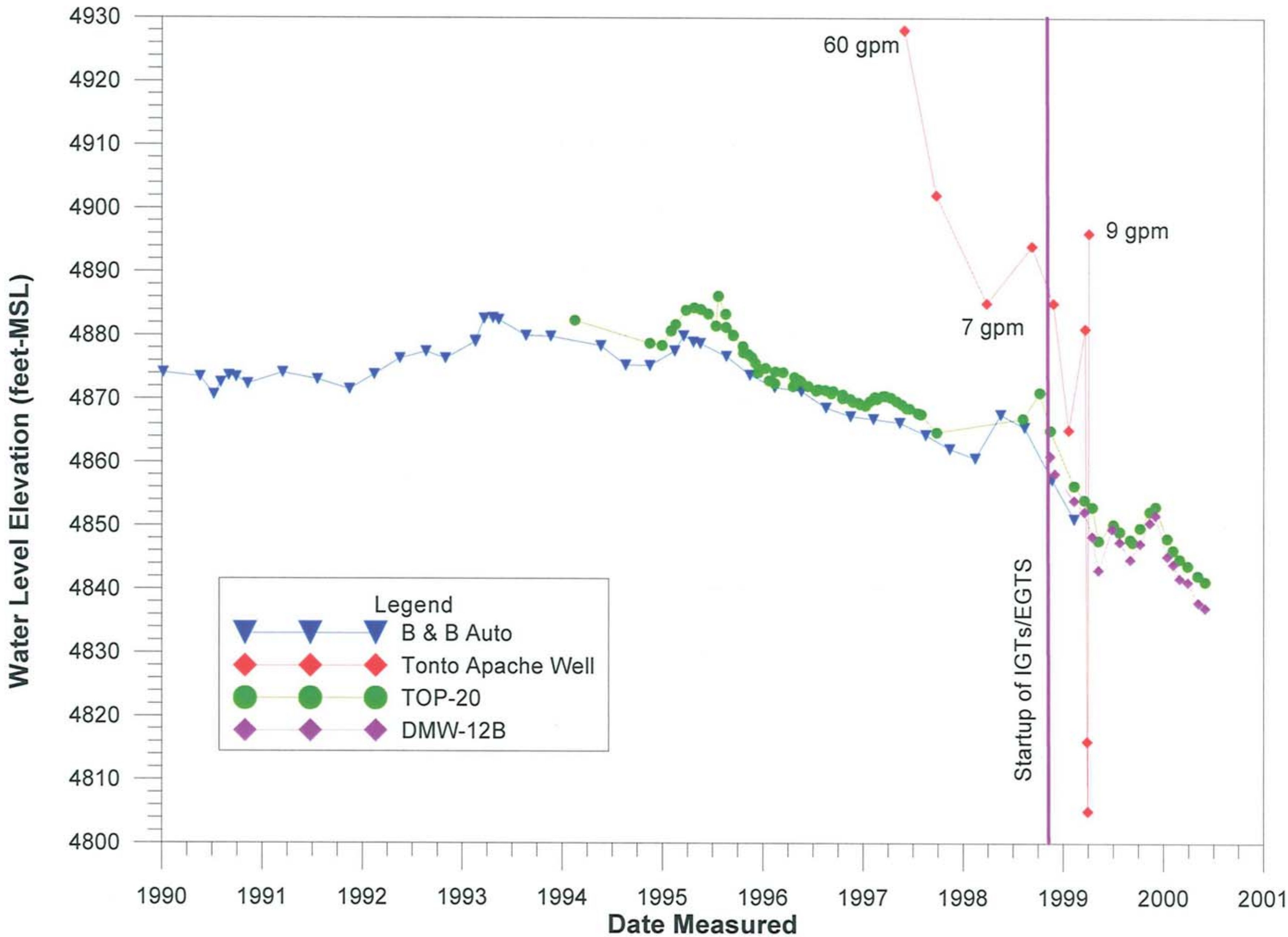
FIGURE 7-6



GeoTrans, Inc.

Projected Water Level Declines Based on Current Trends
Payson PCE WQARF Site
Arizona Department of Environmental Quality

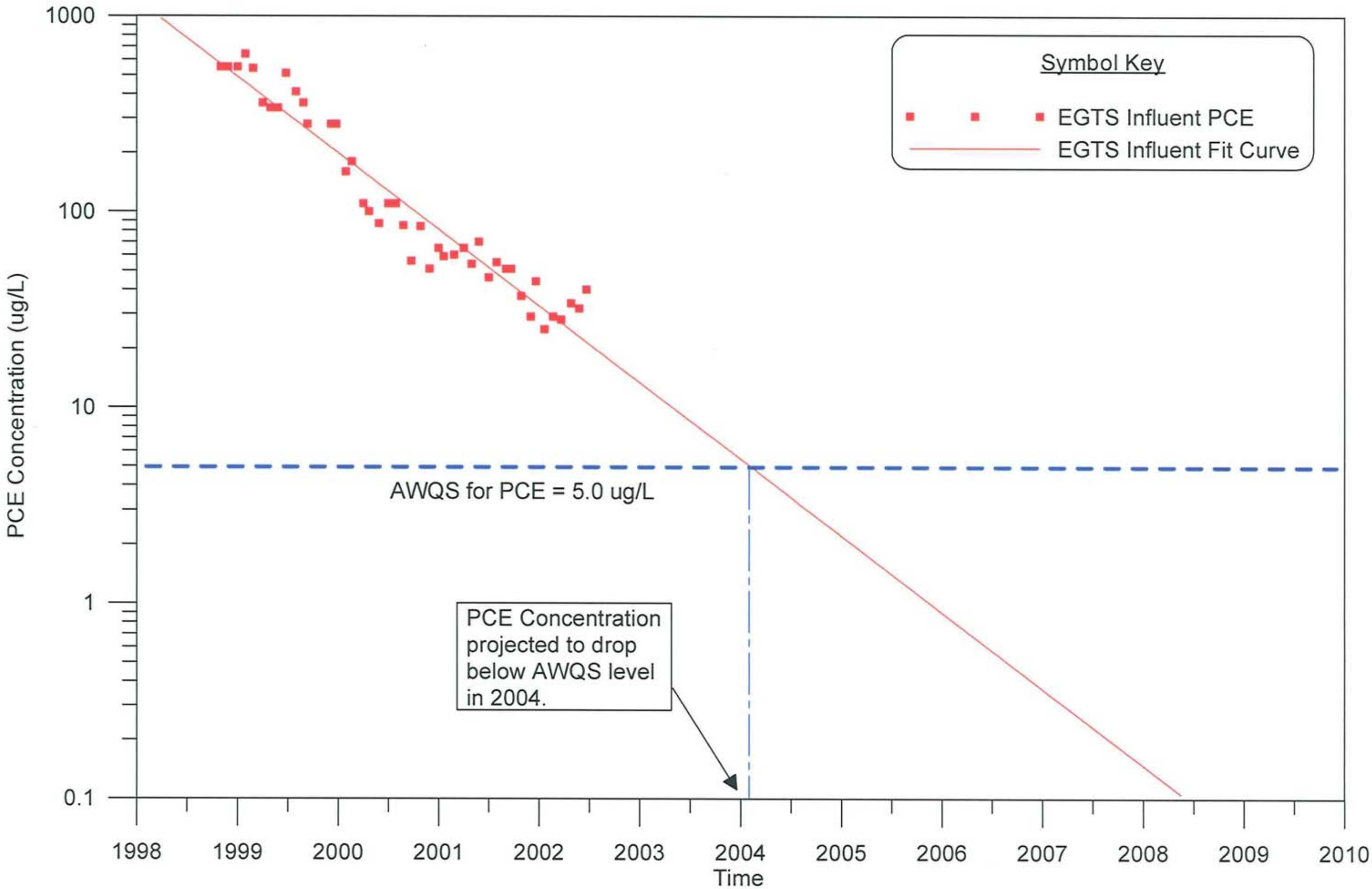
FIGURE 7-7



GeoTrans, Inc.

Comparison of Tonto Apache Well to Site Water Levels
Payson PCE WQARF Site
Arizona Department of Environmental Quality
Payson, Arizona

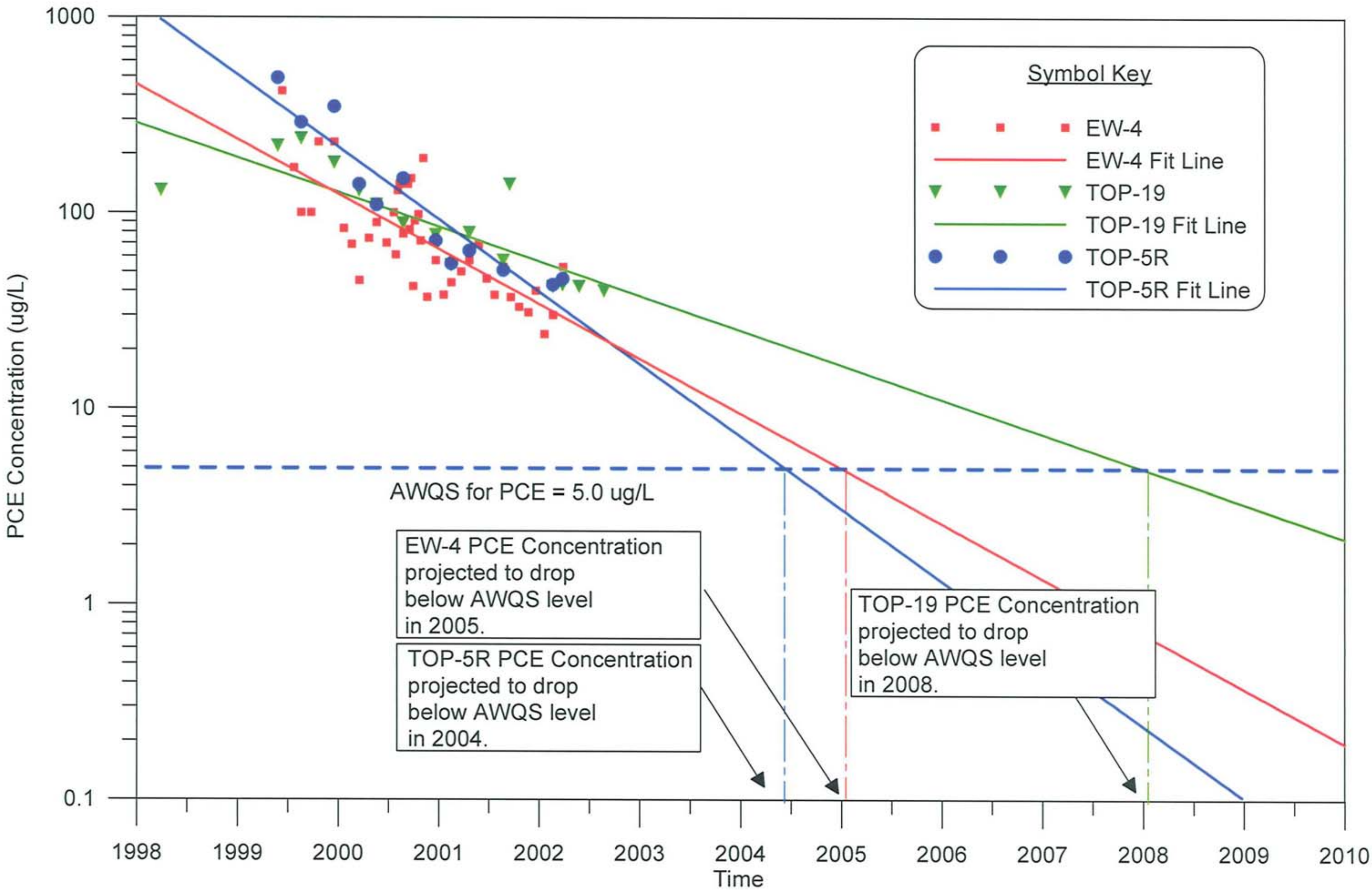
FIGURE
7-8



GeoTrans, Inc.

EGTS System Performance Projection
Payson PCE WQARF Site
Arizona Department of Environmental Quality

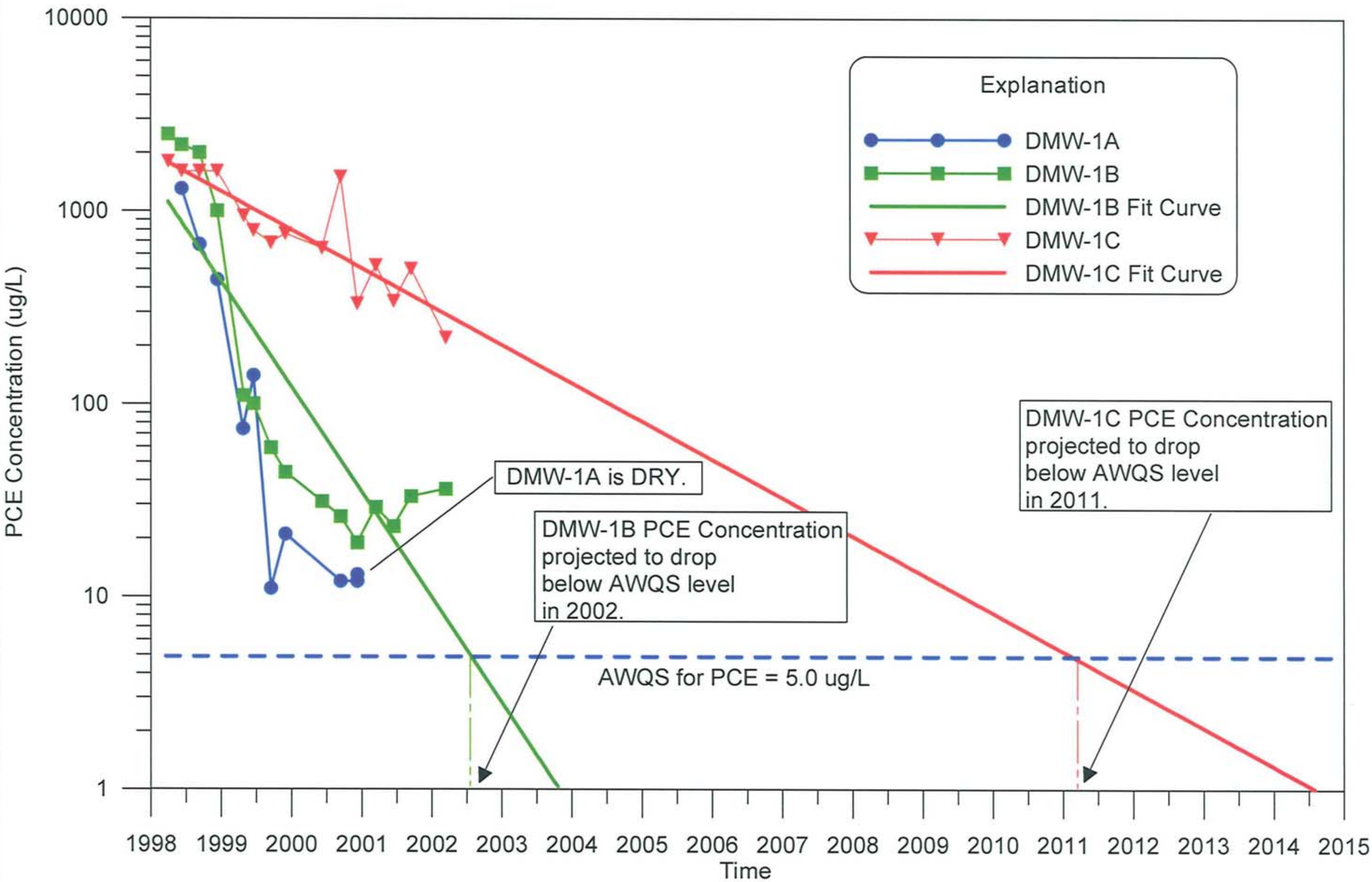
FIGURE **8-1**



GeoTrans, Inc.

IGTS / EGTS System Performance
Payson PCE WQARF Site
Arizona Department of Environmental Quality

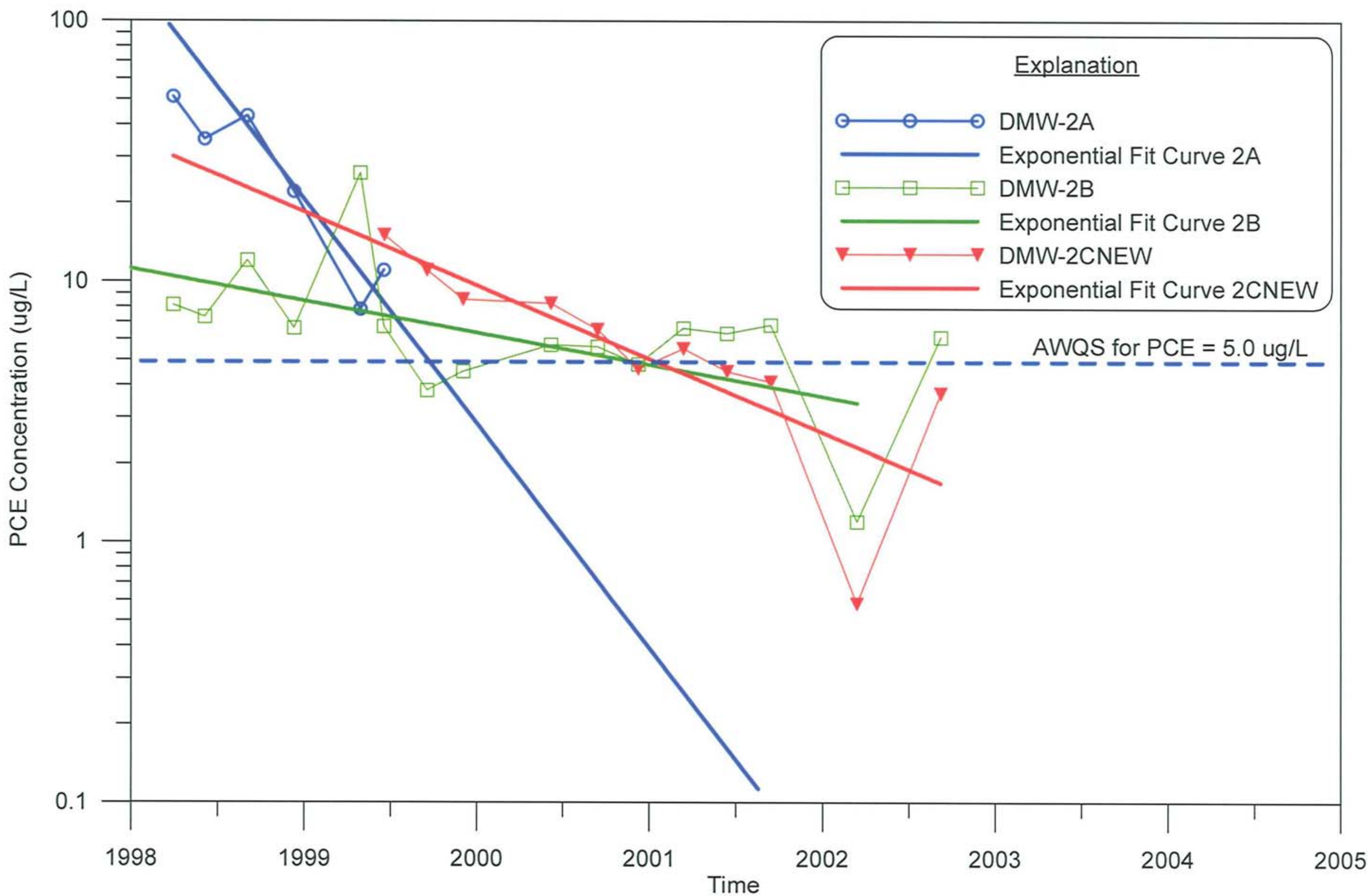
FIGURE
8-2



GeoTrans, Inc.

PCE Concentrations - Well Set 1
Payson PCE WQARF Site
Arizona Department of Environmental Quality

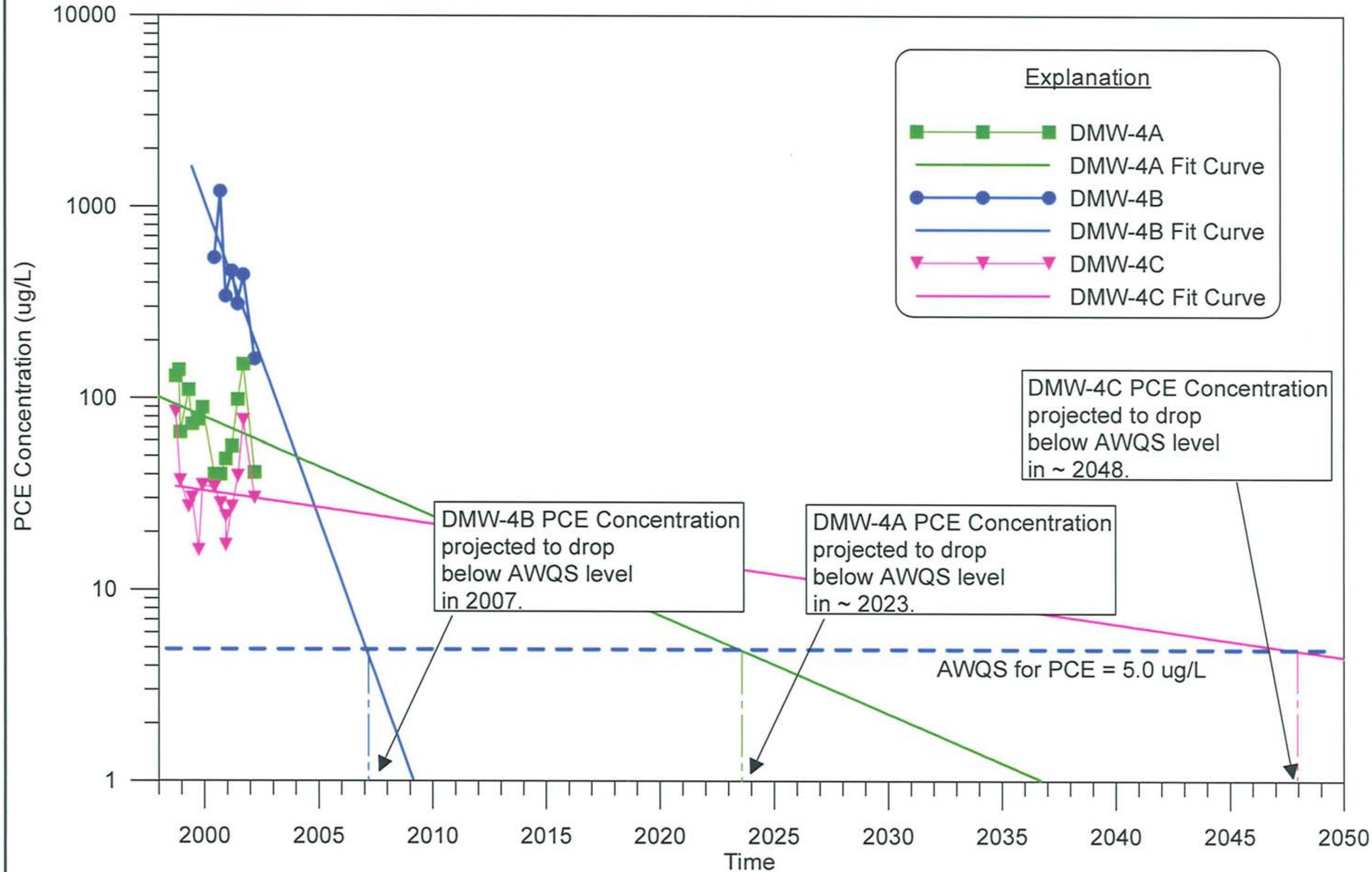
FIGURE **8-3**



GeoTrans, Inc.

PCE Concentrations - Well Set 2
Payson PCE WQARF Site
Arizona Department of Environmental Quality

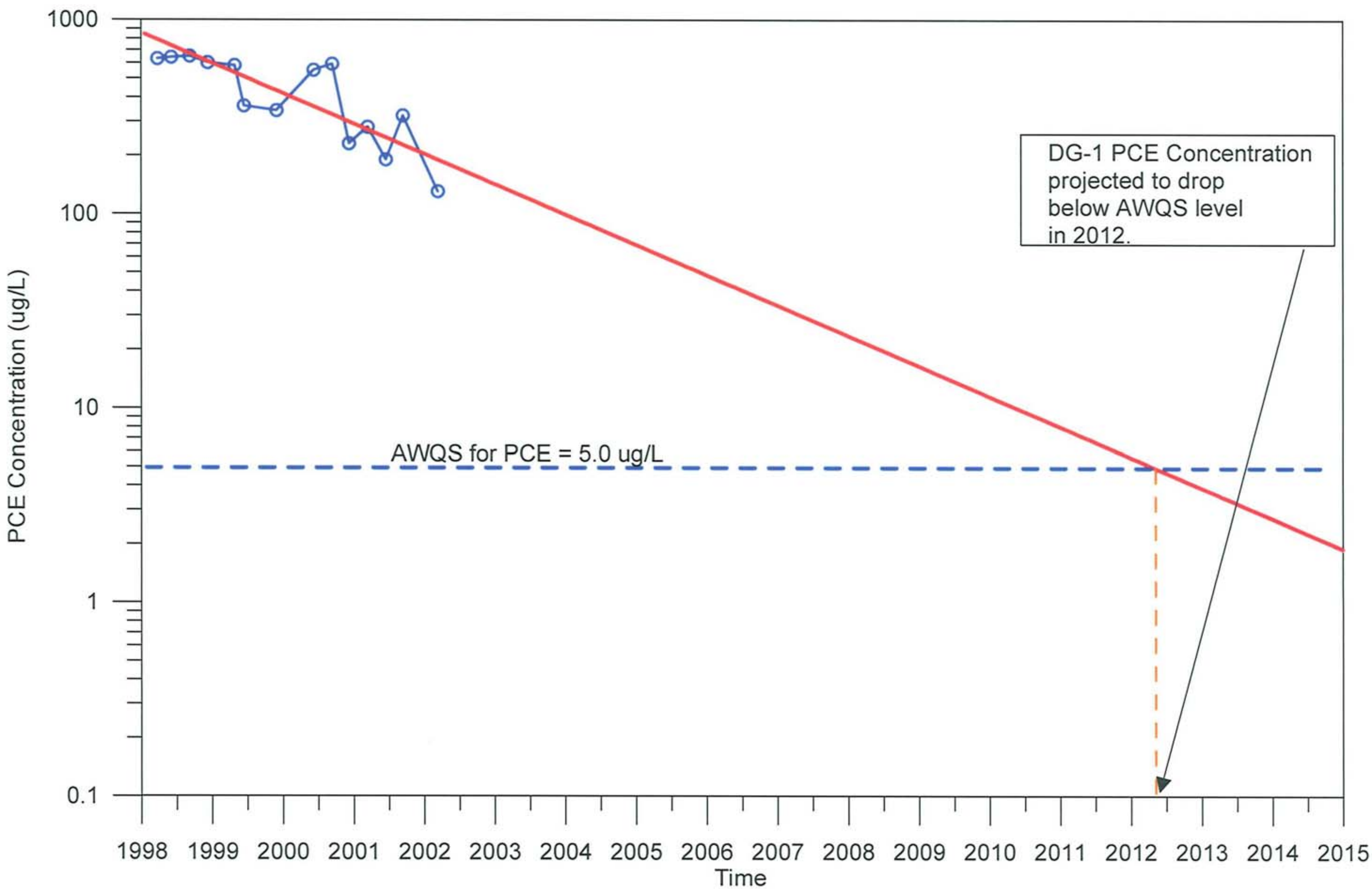
FIGURE **8-4**



GeoTrans, Inc.

PCE Concentrations - Well Set 4
Payson PCE WQARF Site
Arizona Department of Environmental Quality

FIGURE
8-5



GeoTrans, Inc.

PCE Concentrations - DG-1
Payson PCE WQARF Site
Arizona Department of Environmental Quality

FIGURE
8-6

APPENDIX A

MTBE Dilution Evaluation for EGTS

URS **TRANSMITTAL SHEET**

7720 NORTH 16th STREET, SUITE 100, PHOENIX, ARIZONA 85020, TEL 602.371.1100, FAX 602.371.1615

To: ADEQ
1110 West Washington Street
Phoenix, AZ 85007

Date January 13, 2003

Your Order No.

Our Job No. 23442636

Attention: Mr. David Haag
Remedial Projects Section

Subject: MTBE Dilution Evaluation for EGTS

We are sending you via First Class Mail

the following MTBE Dilution Evaluation for EGTS.

This is for Your Review

These are

No. of copies submitted: 1

Copies to:

URS

By Kacy Vance
Kacy Vance

DOCUMENT7

URS

January 13, 2003

Mr. David Haag
Remedial Projects Section
Arizona Department of Environmental Quality
1110 West Washington Street
Phoenix, Arizona 85007

Re: MTBE Dilution Evaluation for EGTS
Payson WQARF Site
URS Job No. 23442636

Dear Mr. Haag:

URS has evaluated the possible methyl-tert-butyl-ether (MTBE) concentrations in wells TOP-4 and TOP-5 necessary to reach total influent MTBE concentrations of 2.5 micrograms per liter (µg/L), 33 µg/L, and 50 µg/L, which are the laboratory detection limit, the HBGL limit, and the critical cost limits, respectively. This evaluation was initiated due to the recent detection of MTBE during the disinfection and restart of well TOP-4 as well as recent MTBE detections in TOP-5.

Mass balance calculations to determine the combined concentration of TOP-4 and TOP-5 necessary to reach the total influent MTBE concentrations listed above are included with this letter. A calculation to determine the probable MTBE concentration at TOP-4 during the December 2002 monthly sampling event, and a calculation of total influent concentration at the EGTS if the MTBE concentration at TOP-4 were to reach the maximum observed concentration of 1,500 mg/L, are attached and are discussed in detail below.

Additionally, a discussion of GAC usage and cost data is presented below and illustrated in Figures 1, 2, and 3 for a range of MTBE concentrations and flow rates.

Mass Balance Calculations

Mass balance calculations were performed to determine the combined concentration of TOP-4 and TOP-5 necessary to reach a total influent MTBE concentration of 2.5 µg/L, 33 µg/L, and 50 µg/L, which are the laboratory detection limit, the HBGL limit, and the critical cost limits, respectively. The MTBE concentration of 50 µg/L was selected as the critical cost limit since this is the point at which GAS use costs begin to increase at a significant rate. Because recent individual well data in not available to establish a relationship between MTBE concentrations in TOP-4 and TOP-5, a total concentration for the two wells was calculated.. The flow rates for

URS Corporation
7720 North 16th Street, Suite 100
Phoenix, AZ 85020
Tel: 602.371.1100
Fax: 602.371.1615

TOP-4 and TOP-5 are usually within one or two gallons per minute (GPM) of each other, and were assumed to be equal for this calculation. The assumptions, mass balance equations, and an example calculation are attached.

Using EGTS flow data from January 3, 2003, a combined concentration of 17 µg/L is required to reach the laboratory detection limit of 2.5 µg/L at the EGTS influent. Similarly, combined MTBE concentrations of 220 µg/L and 330 µg/L at TOP-4 and TOP-5 were required to reach total influent concentrations of 33 µg/L and 50 µg/L, respectively at the EGTS influent.

Flow and sample data from the December 18, 2002 monthly compliance sample was used to calculate the maximum TOP-4 concentration for a non-detect MTBE concentration at the EGTS influent. Because the MTBE concentration at TOP-5 was 3.20 µg/L in August 2002 and 4.30 µg/L in November 2002, it was assumed to be 4 µg/L to simplify the calculation. Because the monthly compliance sample collected on December 18, 2002 was non-detect for MTBE and both TOP-4 and TOP-5 were operating, the highest likely MTBE concentration at TOP-4 is 12 µg/L (when a TOP-5 concentration of 4 µg/L) is assumed. Therefore, it is likely that the MTBE concentration at TOP-4 had dropped from 18 µg/L when the well was restarted on December 3, 2002 to 12 µg/L or less on December 18, 2002.

A calculation to determine the theoretical maximum influent concentration to the EGTS was performed if the maximum observed MTBE concentration for the site of 1,500 µg/L was encountered in TOP-4. If TOP-5 is assumed to remain at 4 µg/L, the influent concentration at the EGTS would be approximately 235 µg/L.

EGTS Carbon Usage

EGTS carbon usage in pounds per day for a range of MTBE influent concentrations and flow rates of 150 and 200 gpm are presented in Figure 1. For the current EGTS flow rate of 200 gpm, PCE concentration of 60 µg/L, and the critical cost influent conditions of 50 µg/L MTBE the carbon usage rate is approximately 250 pounds per day. For these same conditions, the days between changeout is approximately 80 and the GAC daily cost is approximately $700 per day.

Conclusions

Based on URS calculations, the total MTBE concentration at TOP-4 and TOP-5 would have to reach a concentration of 17 µg/L to exceed the laboratory detection limit of 2.5 µg/L. The total TOP-4 and TOP-5 MTBE concentration would need to be greater than 200 µg/L and greater than 300 µg/L to exceed the HBGL and the critical cost limit, respectively.

At the site's maximum observed MTBE concentration of 1,500 µg/L in TOP-4 the total influent concentration at the EGTS would be 236 µg/L, which is significantly higher than the 50 µg/L concentration estimated to significantly impact GAC usage costs.

There is no current well sample data for TOP-4 and TOP-5 MTBE concentrations. It is not known at this time if the restart of TOP-4 will begin to pull in additional MTBE in the vicinity of the well and increase MTBE concentrations. It is also not known if MTBE concentrations at TOP-4 and TOP-5 will increase or decrease at a similar rate. Additional data from these wells is needed to better estimate future MTBE concentrations at the EGTS and extraction wells.

If an increasing trend in MTBE concentrations is observed in EGTS wells that will result in a total influent concentration of greater than 50 µg/L, an engineering evaluation of treatment alternatives is recommended to determine the most cost-effective solution.

URS

Please contact me if you have questions concerning this evaluation and the recommendations presented here. I can be reached at 602-861-7422.

Sincerely,

URS Corporation

Kathleen Vance

Kathleen Vance, E.I.T.
Assistant Engineer

Peter J. Storch

Peter J. Storch, P.E.
Project Manager

PJS/kcv
cc: File
Enclosures: MTBE Dilution Calculation
Figure 1 – EGTS Carbon Usage
Figure 2 – EGTS Days Between Carbon Changeout
Figure 3 – EGTS GAC Daily Cost

MTBE Dilution Calculation
EGTS - Payson WQARF Site

Prepared by Peter Storch and Kacy Vance
URS Corporation
9-Jan-03

A mass balance on the influent streams of the EGTS was performed to establish the possible concentrations of MTBE in wells TOP-4 and TOP-5 for the influent to reach the following levels: 1) the detection limit of 2.5 ug/L, 2) the HBGL limit of 33 ug/L, and 3) a critical cost limit of 50 ug/L.

1. Assumptions:

a. Well TOP-5 has had detections of MTBE of 3.2 ug/L in Aug 02 and 4.3 ug/L in Nov 02.

b. Well TOP-4 was re-activated in Dec 02 with an initial detection of MTBE at 18 ug/L.

c. Since data is unavailable to establish a relationship between MTBE concentrations in TOP-4 and TOP-5, we have calculated a total concentration $C_{TOP4} + C_{TOP5}$.

d. The flow rates for TOP-4 and TOP-5 are assumed to be the same.

2. MTBE Mass Balance:

a. Q represents the flowrate (in gallons per minute) of the well denoted by the subscript.

b. C represents the concentration (in µg/L) of MTBE in the well denoted by the subscript.

c. Q_{TOTAL} is the total of the well flows into the EGTS in gallons per minute.

d. C_{TOTAL} is the total influent MTBE concentration into the EGTS in µg/L.

$$Q_{TOTAL}C_{TOTAL} = Q_{TOP4}C_{TOP4} + Q_{TOP5}C_{TOP5} + Q_{EX1}C_{EX1} + Q_{EX2}C_{EX2} + Q_{TOP19}C_{TOP19} + Q_{Skinner}C_{Skinner}$$

$$Q_{TOTAL} = Q_{TOP4} + Q_{TOP5} + Q_{EX1} + Q_{EX2} + Q_{TOP19} + Q_{Skinner}$$

$$C_{TOTAL} = \frac{Q_{TOP4}C_{TOP4} + Q_{TOP5}C_{TOP5}}{Q_{TOTAL}}$$

where $Q_{TOP5} = Q_{TOP4}$

$$C_{TOTAL} = \frac{Q_{TOP4}(C_{TOP4} + C_{TOP5})}{Q_{TOTAL}}$$

$$\frac{C_{TOTAL}Q_{TOTAL}}{Q_{TOP4}} = C_{TOP4} + C_{TOP5}$$

3. Example Calculation:

Using January 3, 2003 flow data:

$C_{out} = 2.5\mu g/L$, $Q_{out} = 213gpm$, $Q_{TOP4} = 32gpm$

$$C_{TOP4} + C_{TOP5} = \frac{C_{out}\,Q_{out}}{Q_{TOP4}}$$

$$C_{TOP4} + C_{TOP5} = \frac{(2.5\mu g/L)(213gpm)}{(32gpm)}$$

$$C_{TOP4} + C_{TOP5} = 16.64\ \mu g/L$$

4. Summary of Results:

TOP-4/TOP-5 concentrations have been calculated for influent MTBE concentrations of 2.5, 33, and 50 µg/L using January 3, 2003 flow data. Flow and MTBE concentration data from the December 2002 sampling event has been included to show that the TOP-4 MTBE concentration was likely under 12 µg/L since the MTBE concentration in the influent was non-detect (in this case, the TOP-5 concentration was assumed to be 4 µg/L - MTBE concentrations for TOP-5 were 3.20 and 4.30 µg/L in August and November of 2002, respectively). A caluclation using a maximum MTBE concentration of 1500 µg/L (the highest observed at the WQARF site) in well TOP-4 was included to show the highest MTBE influent concentration possible at the EGTS.

	Flowrate (gpm)	MTBE Concentration (µg/L)
TOP 4	31	16.64
TOP 5	33	
EX-1	28	0
EX-2	24	0
TOP 19	56	0
Skinner	41	0
Influent	**213**	**2.5**

	Flowrate (gpm)	MTBE Concentration (µg/L)
TOP 4	31	219.66
TOP 5	33	
EX-1	28	0
EX-2	24	0
TOP 19	56	0
Skinner	41	0
Influent	**213**	**33**

	Flowrate (gpm)	MTBE Concentration (µg/L)
TOP 4	31	332.81
TOP 5	33	
EX-1	28	0
EX-2	24	0
TOP 19	56	0
Skinner	41	0
Influent	**213**	**50**

Maximum MTBE Well Conc. For Non-detect Influent

	Flowrate (gpm)	MTBE Concentration (µg/L)
TOP 4	35	**12**
TOP 5	34	4
EX-1	26	0
EX-2	24	0
TOP 19	63	0
Skinner	41	0
Influent	**223**	**2.49**

Maximum MTBE Conc. Observed

	Flowrate (gpm)	MTBE Concentration (µg/L)
TOP 4	35	**1500**
TOP 5	34	4
EX-1	26	0
EX-2	24	0
TOP 19	63	0
Skinner	41	0
Influent	**223**	**236.04**

5. Conclusions:

1. There is no current well sample data for TOP-4 and TOP-5 MTBE concentrations. TOP-5 MTBE concentrations have been in the vicinity of 4 µg/L since August of 2002. It is not known at this time if the restart of TOP-4 will pull in additional MTBE in the vicinity of the well and if concentrations will increase in TOP-4, and consequently at the EGTS, or if MTBE concentrations at TOP-4 and TOP-5 will increase or decrease at a similar rate. More current data form these wells is required to predict individual concentrations for the various influent MTBE concentrations.

2. Based on the calculation above, the total MTBE concentration at TOP-4 and TOP-5 would have to reach a concentration of 16 µg/L to exceed the detection limit in the EGTS influent, more than 200 µg/L to exceed the HBGL, and a concentration of more than 300 µg/L to significantly impact GAC usage costs.

3. At a maximum MTBE concentration of 1500 µg/L in well TOP-4, the total influent concentration at the EGTS would be 236 µg/L, which is significantly higher than the concentration of 50 µg/L estimated to significantly impact GAC usage costs.

Figure 1. EGTS Carbon Usage (lbs/day)

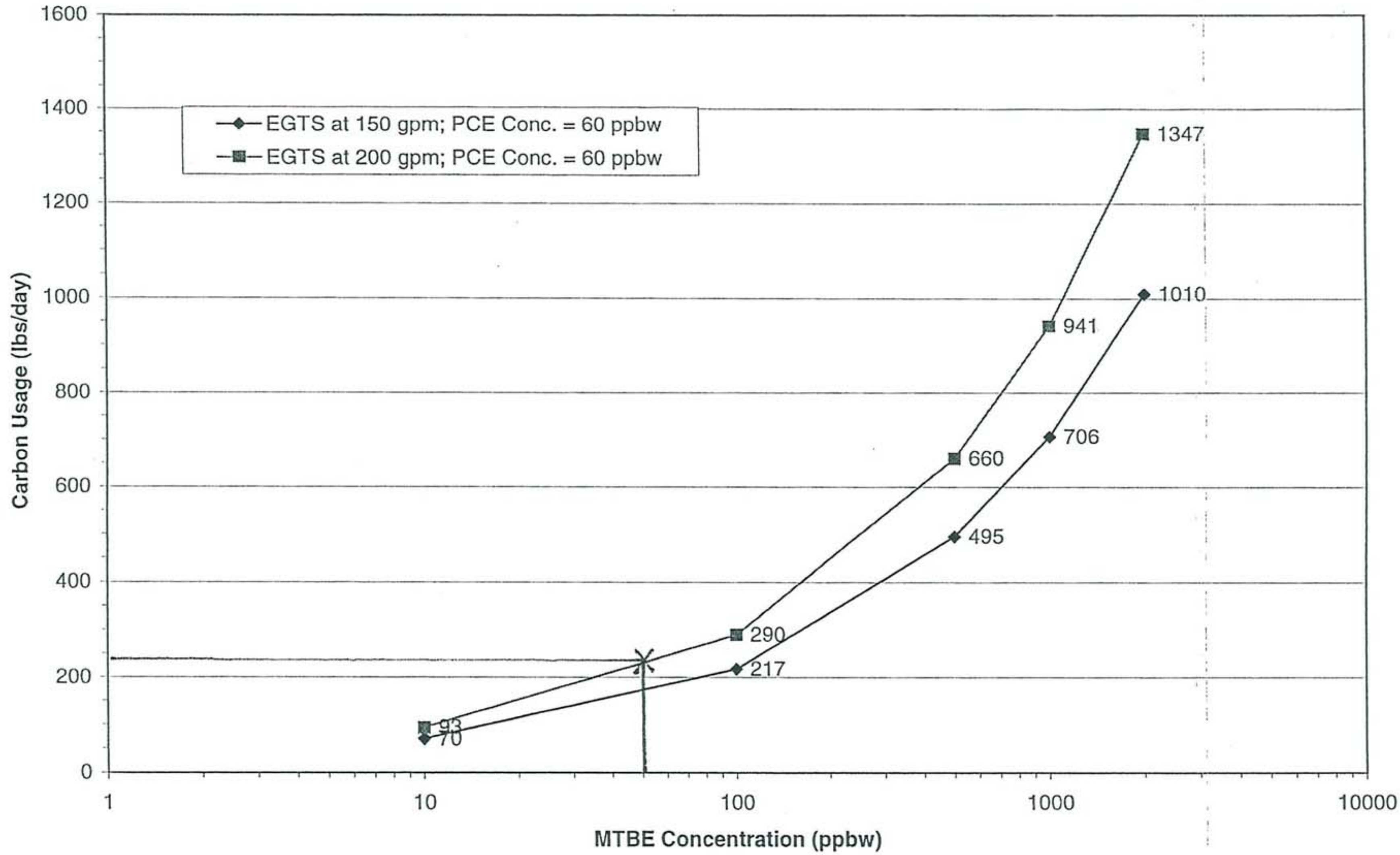


Figure 2. EGTS Days Between GAC Changeout

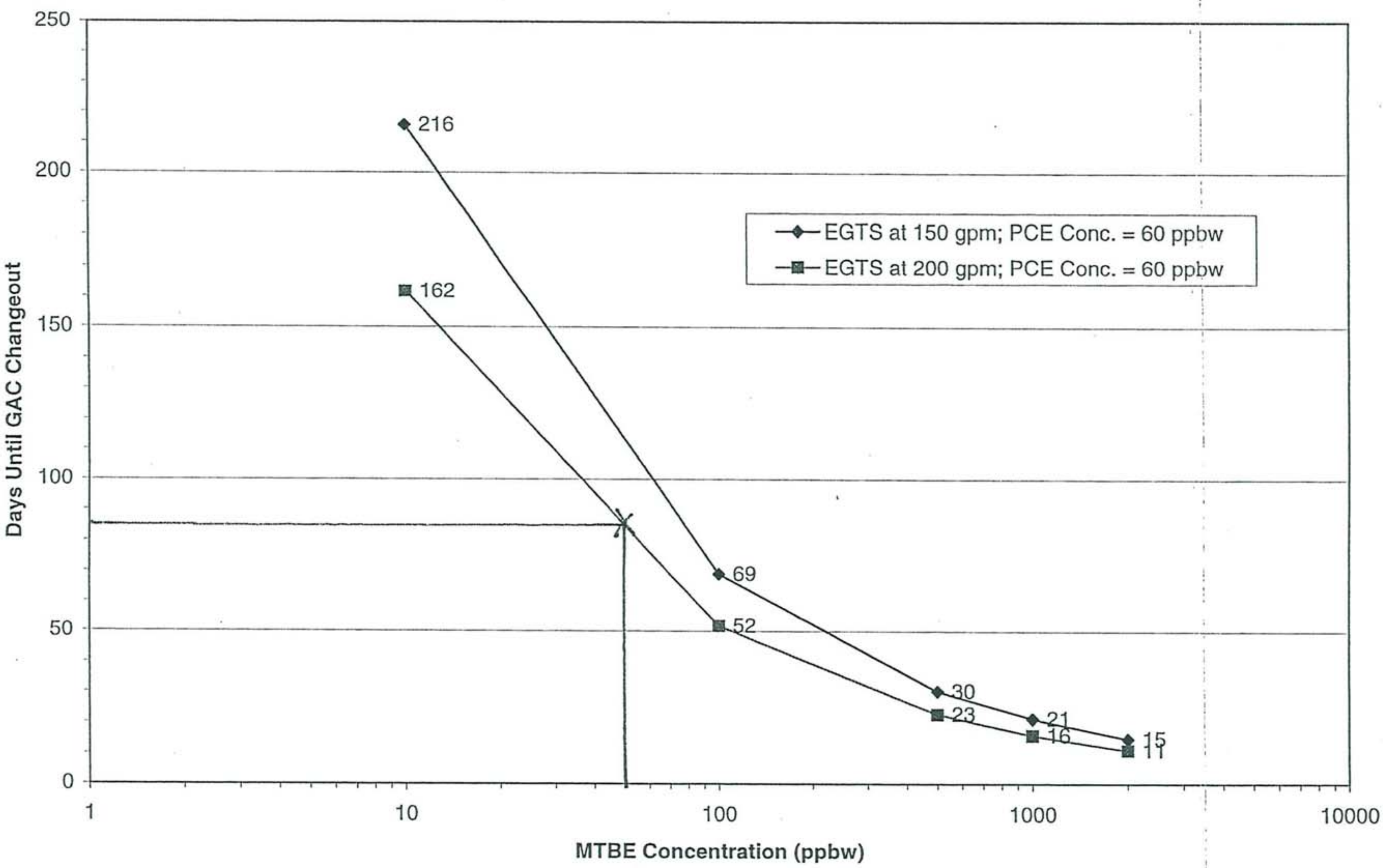
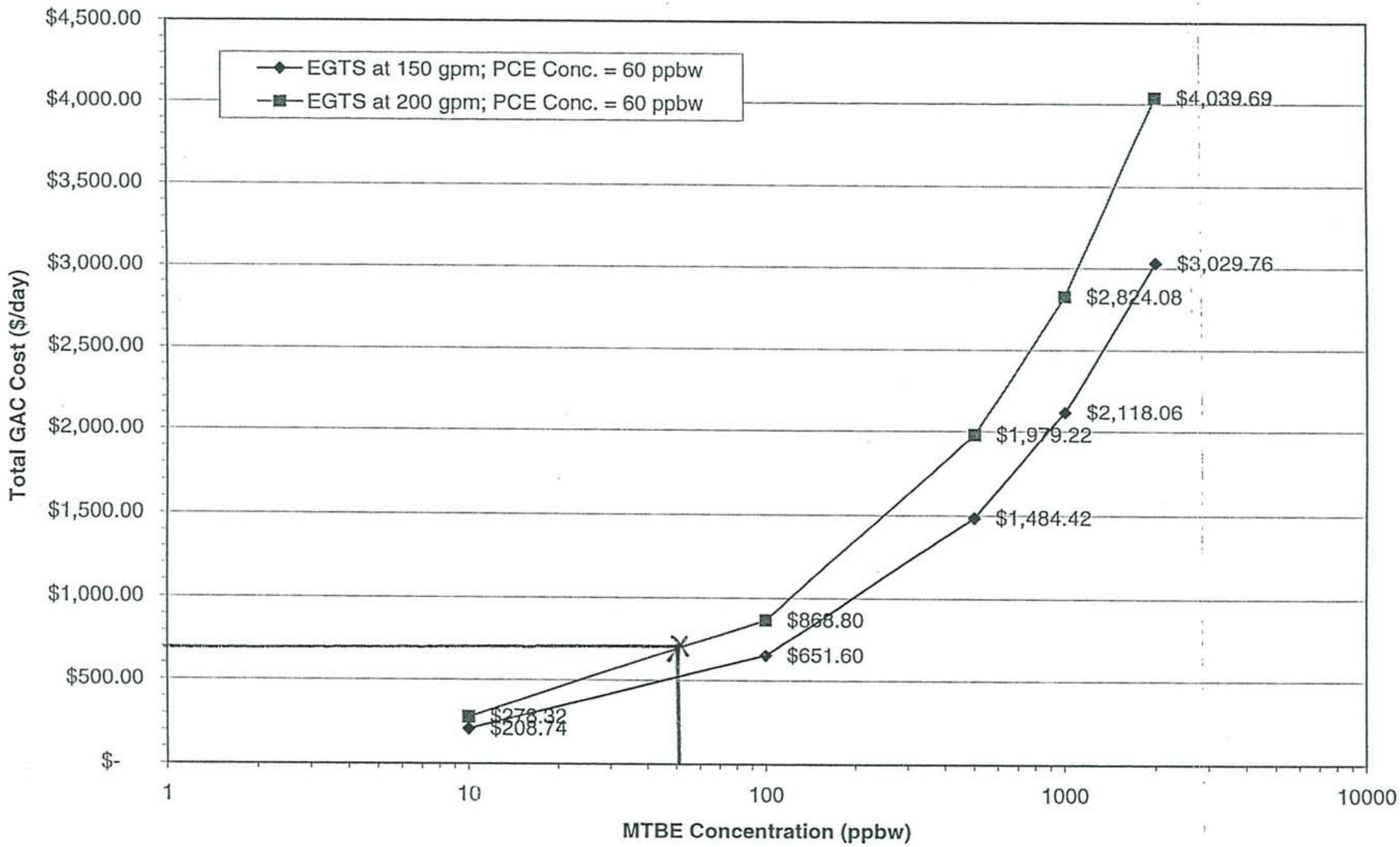


Figure 3. EGTS GAC Daily Cost



APPENDIX B

FS Groundwater Model Simulation Memorandum

GeoTrans, Inc.
A TETRA TECH COMPANY
4665 S. Ash Avenue
Suite G-1
Tempe, AZ 85282
www.geotransinc.com
480-839-2800 FAX 480-839-2828

January 22, 2003 E-5490.5.6

David Haag
Arizona Department of Environmental Quality
1110 West Washington
Phoenix, Arizona 85007

Appendix B: FS Modeling Findings

To complete the evaluation of the FS for the Payson PCE WQARF Site, GeoTrans utilized the Payson groundwater flow model to determine whether the remedial objectives would be met for the selected remedy. Generally, the model was updated through the latest available rainfall data, allowing for consistent semi-annual stress periods with the original model, which were set as November through April and May through October. For this reason, the model was updated through October 2001 (from September 1999 in previous update) with added monthly stress periods extended from the previous model update. The following discusses the general outcome of this modeling effort and the issues and problems identified.

Model Setup

In order to evaluate remedies under the WQARF remedy selection rules (Arizona Revised Statues (ARS) §49-282.06 Remedial Action Criteria; Rules), a 100-year period must be evaluated to determine the effectiveness of the selected remedy. For this reason, GeoTrans constructed a model run which simulated the period from November 1998 through October 2001, then a 100-year projection using average stress rates. To complete this run, the final version of the Payson Model Update was executed and head files were saved after model stress period 17 (September 1998) which would serve as starting heads for the simulation. This starting period would allow for the introduction of particles to determine capture zones and initial concentrations to complete a simulated contaminant transport simulation. This process failed due to model instabilities did not produce stable simulation results. To correct this problem, it was decided to utilize the original May

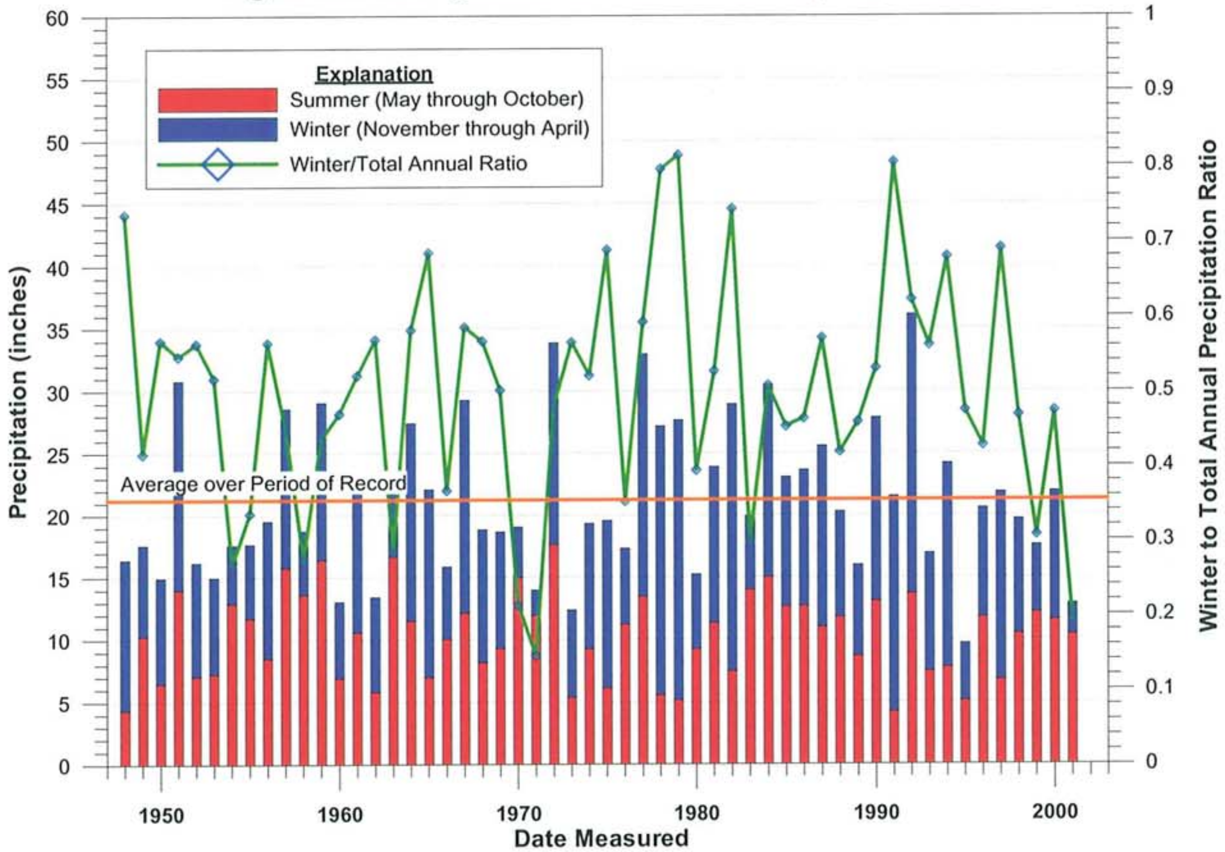
1990 starting point as the original model[1]. Additionally, due to the observed declines in water levels, GeoTrans decided to complete a water supply simulation with 5 year stress periods which attempted to evaluate the possibility that water level declines would cause the aquifer to become "dry", with water levels declining below the current depth of the extraction wells. This would determine whether a more detailed projection would be possible, or whether the aquifer would dry up, preventing any meaningful simulations.

Update of Stress Rates

Recharge

The initial tasks were to collect the updated rainfall data which were available through March 2002 from the Western Regional Climate data. These data were entered into the previous spreadsheets

Figure B1: Precipitation Breakdown for Payson, Arizona



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[1]The cause of these instabilities was never completely determined, but it has been theorized that the use of Surfer™ output head files as starting heads for 1998 caused subtle errors which were magnified by the previously noted (see the original model reports for details) instability of the model. Because any modification to the model would require re-executing the initial 17 stress periods to create a revised starting head array, it was decided to use a simulation which started in May 1990. This eliminated the iterative process that would be needed to account for any changes in the model and it also eliminated the possibility of transport modeling, since the transport model proposed for use (MT3D) can only be executed for the identical period.

used for recharge estimates to update the rates applied for the period of October 1999 through October 2001. The methodology for estimating rates was the same process as used in the previous modeling which has been documented as part of the previous modeling reports (*Payson PCE WQARF site Groundwater Model Update Addendum Report*, HSI GeoTrans 2000a and *Groundwater Flow Modeling Report - Town of Payson PCE WQARF site*, EMCON 1998b). Two sets of rates were generated with one set starting in November 1998 and one set starting in May 1990. The reason for this was a shift in model simulation period from November 1998 start date to May 1990 start, as noted previously. This was due to difficulties in getting a reasonable starting head array for the November 1998 starting point and model instability and limits on modifications.

In general, recharge rates for the updated groundwater flow model were lower than historic norms for the period. The above figure illustrates the breakdown of winter and summer precipitation, which shows lower winter rainfall rates, which represent a majority of the recharge applied to the moidel. For this reason, overall aquifer recharge has been lower than normal. Table B-1 lists the recharge rates used for the FS model simulations.

Pumpage

GeoTrans requested pumpage data from Mr. Mike Ploughe at the Town of Payson to update the stress rates for municipal supply wells from 1999 through recent data. Mr. Ploughe provided monthly totalizer flow readings for wells through at least September 2001 (some data were current through December 2001). These stress rates were converted from gallons to cubic feet per day by dividing by the number of days for each month. The rate at New McKamey well was significantly increased in April 2001 due to deepening of the well, so the average pumping rates were significantly higher. GeoTrans used the data from 2001 to estimate a winter/summer average rate based on the reported pumpage for the well to use for projections. Other Town of Payson production wells were similarly estimated with winter/summer stress period average rates. The proposed stress rates for the reference remedy (Table 6-1 in the FS Report) were used for future projections. Table B-2 lists the reported pumpage data used for developing the model simulations, as provided by Mr. Mike Ploughe of the Town of Payson.

Water Supply Simulation

GeoTrans completed a water supply simulation using the updated model (through October 2001) with 21, 5-year stress periods added to project 100 years into the future employing average pumping rates through October 2106 (Total of 74 stress period from May 1990 through October 2106). This model run indicated significant declines in water levels (up to 500 feet) in the area near the site after 100 years (Figure B2). This simulation implied that the water levels would decline such that the existing EGTS system would be unusable after 5 to 10 years, with significant declines in production over that period. Additionally, the gradient near the Site was noted to reverse toward the New McKamey well (Figure B3) by the October 2001 stress period, which has not been observed in the field data collected. This simulation used the well deepening package which allowed the wells to continue pumping from deeper model layers as the simulation continued, thus simulating the production as far into the future as possible.

Base Projection Run

GeoTrans proceeded with a base projection run to determine whether the model would require dramatic changes to be usable. GeoTrans completed a test transport run using the base projection run and decided that transport modeling was not practical using the model as constructed, due to the difficulty in accurately simulating the flow system and the need to alter the starting point to May 1990. Because of the gradient reversals and poor match with observed data for the updated period (October 1999 through October 2001), contaminant transport modeling was determined to be unreliable. Figure B4 illustrates model simulated heads for model layer 3, September 2001. As is evident, increased pumping at the New McKamey well has reversed the westward gradient in the vicinity of Beeline Road and Main Street causing northeastward flow. This is not evident in observed data. The observed water level data do suggest that the water levels will decline such that layers 1 and 2 (representing the AL and DG/FG units) are likely to become dry within 5 to 10 years, as the water supply model simulations indicated. But no gradient reversal has been observed as of the first quarter of 2002 (URS, 2002). For this reason, GeoTrans decided that a revised flow model would be necessary to complete an evaluation of the system.

Meeting with Town of Payson

GeoTrans, ADEQ and Town of Payson met on July 23, 2002 to discuss these preliminary model simulation outcomes and the implications of the findings. A preliminary memorandum was prepared for Mr. David Haag, ADEQ Project Manager, which is included as an attachment. The general conclusion was that the New McKamey well was not impacting the area near the site as evident from observed water level data, but that the model simulations suggested it would. Figures B5a, B5b and B5c illustrate the latest available water level elevation maps for September 2002 (URS, 2002). These maps indicate a westward groundwater gradient from Well Set 10 toward the EGTS in each of the three aquifer zones. Since the model suggests that a strong gradient would already have developed toward the New McKamey well due to increased pumpage, it was determined that:

1. The New McKamey well is either partially, or significantly hydraulically isolated by a bedrock ridge or low conductivity zone from the Payson PCE WQARF Site;
2. The New McKamey well draws from fractures that are hydraulically isolated from the Payson PCE WQARF Site; and/or,
3. The New McKamey well is deriving a substantial portion of its water production from deeper than 500 feet, which is below the model bottom.

Because the groundwater model was designed to simulate the deepest wells at the time of its original construction, a depth of 500 feet was selected as the bottom of the model, representing the deepest wells in the model domain at the time. The New McKamey well was deepened from 400 feet to 900 feet in April 2001, and pump testing indicated a significant increase in production rates (Ploughe, 2001) from 135 gpm to 350 to 400 gpm. GeoTrans also evaluated a video log for this well and conducted depth-specific sampling and geophysical logging as part of Appendix D to the RI Report, which indicated a number of potential water producing zones below 500 feet. Since this additional production must come from the area below 500 feet, it is likely that the model is not simulating the pumping accurately. Additionally, a review of well logs from monitor wells drilled at the Tonto & Cherry WQARF Site indicates shallow bedrock at Frontier Street and Colcord Road. Bedrock also outcrops at Frontier Street and Ponderosa Street (direct observation by ADEQ PM and GeoTrans PM), suggesting that a bedrock ridge may exist near the Frontier/Beeline Road area. Based on these data, ADEQ and GeoTrans agreed that:

- The model should be deepened to account for the New McKamey well by the addition of a new model layer;
- New well log info should be incorporated into the model to address new information that is available, including shallow bedrock near Frontier and Beeline; and,
- Model layers 1 and 2 should be adjusted to address premature dewatering of the layers (dry as of September 2001).

Model Update

In order to address the issues identified in the meeting with Town of Payson, a revised groundwater flow model was constructed, with the addition of a sixth layer. The original model update (HSI GeoTrans 2000a) had broken the FG/CG Unit into 3 layers to improve numerical stability, with the upper 2 layers representing the AL and DG/FG Units respectively. The bottom of layer 5 was set as 500 feet below land surface at this time. GeoTrans altered the model such that the bottom of the added layer 6 was set as 820 feet below the elevation of the New McKamey well (4100 feet above mean sea level[MSL]), which is the current depth of the well after development and pump installation. This layer is flat throughout the model domain. The bottom of layer 5 was reset as 4420 feet MSL (500 feet) throughout the model domain and the bottom of layer 4 was reset as 4,570 feet MSL (350 feet). These depths were chosen to distinguish between the production wells which are deeper than 350 feet (Mountain View, Country Club #1 and #2...etc) and wells such as TOP-19 which are less than 350 feet.

Base Model Simulation

Based on revised depth of these layers, pumping stresses were re-allocated to the appropriate layers and a new model run was initiated. The base model run begins in May 1990 and includes 17 semi-annual stress periods through October 1998, 36 monthly stress periods through October 2001 and 202 semi-annual projection stress periods through October 2102. This initial run used the existing hydraulic conductivity and storage parameter arrays which were documented in the previous modeling reports. The following sections discuss the results and changes in the model design which were implemented to improve the match in heads and hydrographs.

Model Simulation Results

The initial result of the modeling run was that water levels did not rise to match hydrograph data for the early stages of the model, particularly the 1992 through 1993 period. Subsequently water levels fell at a rate consistent with the observed data, but remained approximately 20 feet lower than the observed data. This result of this was to reevaluate the bedrock (no-flow) cells per the observed information regarding bedrock data and reload the layer thickness information from an updated layer depth spreadsheet.

The next run utilized a modified no-flow cell configuration (Figure B6), and a lowered hydraulic conductivity for layers 1 and 2 between the added no-flow cells, assuming a bedrock ridge is present. This limited transmissivity between the New McKamey well and the Payson PCE WQARF Site, but still allowed groundwater flow between the site and the New McKamey well. This configuration improved results, but not significantly.

Generally, the model was not retaining water during higher recharge periods early in the simulation, so experimental runs were conducted using lowered hydraulic conductivities for each of the model layers, including lowered vertical conductivity. These results improved the match with observed data, but the values which produced reasonable results were much lower than observed hydraulic conductivities from aquifer testing. For this reason, a no-flow bedrock ridge was introduced between the New McKamey well and the Payson PCE WQARF Site as an experiment, based on the observations noted. This dramatically improved the match with observed data, and allowed for increased hydraulic conductivity, which is more representative of observed data.

Model Update Results

Figure B7 illustrates the model no-flow cell configuration used to simulate the no-flow bedrock ridge. Ths effectively cuts off the northeast portion of the model, with New McKamey well no longer having an impact on the system. Hydraulic conductivity (horizontal and vertical) and storage parameter values were lowered for layers 1 and 2. Figures B8 through B11 illustrate horizontal hydraulic conductivity and specific yield used. Vertical hydraulic conductivity was lowered from 10% of horizontal conductivity to 2.5% of horizontal. This did not cause a significant change in simulated heads, as was expected from the sensitivity analysis completed for the original modeling work.

Figure B12 illustrates the hydrograph for well TOP-20, which illustrates projected water levels over the 100 year future projection. This hydrograph clearly indicates that water levels in this well will stabilize at a level slightly lower than the current water levels at the site, presuming "normal" recharge from "normal" levels of precipitation. The match with measured heads begins to deviate during the last few measurements, with measured heads showing a steep decline. The reason for this stable head configuration can be illustrated in Figure B13, which shows simulated heads for October 2102. This figure illustrates that groundwater flow reverses from westward to eastward, with the Green Valley Park recharge lakes supplying water to the area of the site. This situation suggests that given a normal period of recharge, the model simulation suggests that the flow system will eventually stabilize.

Lowered Recharge

Because the model simulations indicated that water levels would eventually stabilize, at levels slightly lower than currently observed, and that current well hydrographs do not tend to support this conclusion, GeoTrans conducted a simulation using a 15% recharge rate (15% of rainfall recharges instead of 20%). As evident in Figure B14, the water levels will also stabilize at a lower level than the 20% recharge rate simulation, with depths to water of about 130 feet at TOP-20. This conclusion also depends upon the eastward gradient from the Green Valley Lakes.

Less Aggressive Remedy Pumping

GeoTrans completed a model simulation using the pumping rates for the less aggressive remedy. These rates were presented in Table 6-2. Figure B15 illustrates the hydrograph for well TOP-20, which illustrates projected water levels over the 100 year future projection. This hydrograph clearly indicates that water levels in this well will stabilize at a level slightly higher than the current water levels at the site, presuming "normal" recharge from "normal" levels of precipitation. The match with measured heads also begins to deviate during the last few measurements, with measured heads showing a steep decline. The reason for this stable head configuration can be illustrated in Figure B16, which shows simulated heads for October 2102. This figure illustrates that groundwater flow does not reverse from westward to eastward, as in the reference remedy rates. This situation suggests that given a normal period of recharge, the model simulation suggests that the flow system will eventually stabilize and that the 100 gpm rate is not adequate to contain and capture the plume.

These results suggest the current operation of the system is the preferred remedy since it captures and contains the plume and the water is needed for the Town of Payson municipal supply. These results suggest that the system should be operated at the current rate as long as feasible.

Conclusions and Possible Concerns

The model results suggest a stable groundwater flow system can develop for the pumping rates simulated for the reference remedy based on the model design. However the following factors may effect this conclusion:

- New McKamey well is hydraulically isolated from the Payson PCE WQARF Site;
- Groundwater can flow eastward from the Green Valley Lakes;
- Recharge conditions representative of the current average precipitation rates continue into the future; and,
- No significant additional pumping occurs near the Site.

The complete hydraulic isolation of the New McKamey well from the Payson PCE WQARF Site is not likely to be an accurate approximation of flow conditions in the area. As has been noted previously, the groundwater flow model is constructed with the assumption that porous media flow assumptions are reasonable. This assumption is likely to break down if water levels decline into the FG/CG layer, where fracture flow conditions are dominant. For this reason, the validity of the flow simulation is likely to break down as longer term projections are applied. The recently increased stresses at the New McKamey well have exposed a weakness in the model simulation for which insufficient data are available to adequately evaluate the conditions. It is unknown if the New McKamey well is connected in some way to the Payson PCE WQARF Site, although clearly it cannot be a strong connection. Since the majority of the data for hydraulic conductivity of the

FG/CG are limited to short, screened- interval aquifer tests which are dependent upon the specific fractures encountered, the variations in hydraulic conductivity for the FG/CG Unit is not known throughout the model domain. These variations may play a critical factor in long term estimates of the regional impacts of pumpage at the Payson PCE WQARF Site.

Based on the observed conditions, the aquifer in the Payson area is probably connected through fractures in a limited way throughout the region. On a small scale, local stresses are critical to defining the flow field, but over the entire area, pumpage stresses will slowly equilibrate such that the total pumpage in the area must be balanced against the total available storage and long term aquifer recharge. These evaluations must be conducted on a regional basis, such as a water balance estimate. This is beyond the scope of the modeling completed. This would explain the steeply declining water levels which cannot be accounted for in the current model simulation, ie., that the New McKamey well and other Town of Payson production wells are drawing the regional water levels down over long time periods, but is not locally influencing the flow field over short time intervals.

Sincerely,

For GeoTrans, Inc.

Paul R. Plato, R.G.
Senior Hydrogeologist

GeoTrans, Inc.
A TETRA TECH COMPANY

4665 S. Ash Avenue
Suite G-1
Tempe, AZ 85282

www.geotransinc.com

480-839-2800 FAX 480-839-2828

July 8, 2002

E-5490.5.6

David Haag
Arizona Department of Environmental Quality
3033 North Central Avenue
Phoenix, Arizona 85012

Comments regarding FS Modeling Preliminary Findings

Dear Dave:

GeoTrans, Inc. (GeoTrans) has completed preliminary modeling for the Payson WQARF Site FS and must evaluate how to proceed in order to complete the FS. The modeling consists of an update of the previous flow model (1990-1999 simulation period) through September 2001, then a 100 year projection through 2102. The model update includes actual pumping from EGTS/IGTS extraction wells near the site and also includes TOP production wells. The update includes higher production rates from TOP-New New McKamey well, which went from an average rate of 35 gpm to 135 gpm (long term average including periods when off). The typical pumping rate of this well is reported as about 300 gpm, and this would imply that over a year it runs about 1/3 of the time.

The model simulations show dewatering of layers 1 and 2 (AL and DG/FG) in the northern portion of the site (along Main St), along with dewatering at wells TOP-19 and TOP-5R by Sept 2001. The model simulations utilized the well deepening package, which allows pumpage to be continually reassigned to lower layers as they dewater. This assumption may not be realistic since we are unlikely to deepen the wells. But this insures that the pumpage is simulated and not lost. The model has identified potentially significant new information which could not have been seen before the pumpage was raised at these wells.

The following has been noted:

1. New McKamey is now 875 feet deep, and the model is 500 feet thick at that location (was 450 feet deep);
2. According to the model, gradients at the Payson WQARF Site should have reversed in the upper layers 1,2 (by Sept 2001) because the dewatering of the EGTS wells causes New McKamey to capture the site (which clearly hasn't happened) as of the Sept 2001 stress period;
3. Shallow bedrock was identified during drilling at T&C in Fall 2000;

4. Shallow bedrock was identified at Frontier and Ponderosa by Dave Haag during completion of the RI Responsiveness summary;
5. Well Set 10 hydrographs do not indicate a significant impact from New McKamey (whereas the model suggests it should); and,
6. Gradients at T&C are not indicative of New McKamey capturing flow from the area.

GeoTrans believes that either one of two things (or a combination) could explain these results:

- A bedrock high exists which hydraulically isolates New McKamey from the Payson WQARF Site; and,
- New McKamey derives production from deeper than the model simulates, thus we are simulating an overproducing well.

The bedrock high would probably not isolate the site completely due to likely fractures, but may strongly impede flow to the northeast from the site. This could be a critical issue with regard to the need for the installation of any system at the New McKamey well.

The dewatering of the upper layers is a fact evident in measured water level data, which implies that the projections will predominantly model fracture dominated flows in the FG/CG, which limits the value of transport modeling. This may make projections very speculative, even if a recalibration is undertaken.

For this reason the FS modeling is temporarily on hold pending a decision on possible approaches to take. GeoTrans needs to review individual well production rates to make sure that we are simulating the wells production rather than it getting "lost " due to dewatering.

GeoTrans will request water level data from Mike Ploughe for wells TOP-PE-14, Ash, Cedar and Old New McKamey to compare with WS-10. Additionally, we will obtain Stevens chart recorder info from the Frontier well to determine how New McKamey has impacted the area. A review of this information will assist us in determining if an additional geologic feature needs to be simulated in the model to correctly simulate the impact of the New McKamey well at the site.

GeoTrans will be happy to provide additional information, if you require it. If you have any questions, please contact GeoTrans Project Manager, Paul Plato at 480-839-2800.

Sincerely,

For GeoTrans, Inc.

Paul R. Plato, R.G.
Senior Hydrogeologist

TABLE B-1
FINAL CALIBRATED RECHARGE RATES APPLIED
PAYSON PCE WQARF SITE GROUNDWATER FLOW MODEL - FS MODEL SIMULATIONS

Stress Period	Period	Precipitation for Stress Period (inches)	Precipitation for Stress Period (Feet)	Total Volume Applied to Surface Watershed (ft3)	Total Annual Applied to Surface Watershed (ft3)	Total Annual Recharge (ft3)	Winter/Summer Volumes (75%/25% Split) (ft3)	Days of Stress Period (days)	Summer Rate for Zone 2 (ft3/day)	75 % Winter Rate (Zones 2/4) (ft3/day)	25 % Winter Rate (Zone 1) (ft3/day)	Rate for Recharge Lakes (Zone 4) (ft3/day)	Notes
1	May 90-Oct 90	13.07	1.09	82207768.10			8742830.7	184	0.0165				
2	Nov 90-Apr 91	14.73	1.23	92648846.53	174856614.63	34971322.93	26228492.2	181		0.0377	0.0012		
3	May 91-Oct 91	4.21	0.35	26480084.45			6764686.7	184	0.0127				
4	Nov 91-Apr 92	17.30	1.44	108813648.67	135293733.12	27058746.62	20294060.0	182		0.0290	0.0009		
5	May 92-Oct 92	13.66	1.14	85918753.81			11343665.6	184	0.0214				
6	Nov 92-Apr 93	22.41	1.87	140954558.77	226873312.58	45374662.52	34030996.9	181		0.0489	0.0016		
7	May 93-Oct 93	7.42	0.62	46670362.61			5311741.4	184	0.0100				
8	Nov 93-Apr 94	9.47	0.79	59564465.49	106234828.10	21246965.62	15935224.2	181		0.0229	0.0007		
9	May 94-Oct 94	7.76	0.65	48808896.75			7591796.2	184	0.0143				
10	Nov 94-Apr 95	16.38	1.37	103027026.89	151835923.64	30367184.73	22775388.5	181		0.0327	0.0010		
11	May 95-Oct 95	5.08	0.42	31952215.91			3034831.5	184	0.0057				
12	Nov 95-Apr 96	4.57	0.38	28744414.71	60696630.62	12139326.12	9104494.6	182		0.0130	0.0004		
13	May 96-Oct 96	11.77	0.98	74031019.94			6456486.1	184	0.0148			0.0904	Recharge Project Online
14	Nov 96-Apr 97	8.76	0.73	55098703.03	129129722.96	25825944.59	19369458.4	181		0.0339	0.0009	0.0904	Recharge Project Online
15	May 97-Oct 97	6.77	0.56	42581988.53			6865323.6	184	0.0158			0.0904	Recharge Project Online
16	Nov 97-Apr 98	15.06	1.26	94724482.60	137306471.13	27461294.23	20595970.7	181		0.0360	0.0009	0.0904	Recharge Project Online
17	May 98-Oct 98	10.46	0.87	65791373.71			6176589.8	184	0.0142			0.0904	Recharge Project Online
18	Nov-98	1.50	0.13	9434709.42			3027740.1	30		0.0320	0.0008	0.0904	Recharge Project Online
19	Dec-98	1.27	0.11	7988053.98			2563486.6	31		0.0262	0.0007	0.0904	Recharge Project Online
20	Jan-99	0.05	0.00	314490.31			100924.7	31		0.0010	0.0000	0.0904	Recharge Project Online
21	Feb-99	0.75	0.06	4717354.71			1513870.0	28		0.0171	0.0004	0.0904	Recharge Project Online
22	Mar-99	0.67	0.06	4214170.21			1352390.6	31		0.0138	0.0004	0.0904	Recharge Project Online
23	Apr-99	4.94	0.41	31071643.03	123531795.37	24706359.07	9971357.3	30		0.1053	0.0027	0.0904	Recharge Project Online
24	May-99	0.00	0.00	0.00			0.0	31	0.0000			0.0904	Recharge Project Online
25	Jun-99	0.04	0.00	251592.25			22060.8	30	0.0003			0.0904	Recharge Project Online
26	Jul-99	6.54	0.55	41135333.08			3606940.5	31	0.0491			0.0904	Recharge Project Online
27	Aug-99	1.69	0.14	10629772.62			932068.7	31	0.0127			0.0904	Recharge Project Online
28	Sep-99	3.91	0.33	24593142.56			2156443.0	30	0.0304			0.0904	Recharge Project Online
29	Oct-99	0.00	0.00	0.00	134350262.18	26870052.44	0.0	31	0.0000			0.0904	Recharge Project Online
30	Nov-99	0.00	0.00	0.00			0.0	30		0.0000	0.0000	0.0904	Recharge Project Online
31	Dec-99	0.00	0.00	0.00			0.0	31		0.0000	0.0000	0.0904	Recharge Project Online
32	Jan-00	0.41	0.03	2578820.58			1262567.5	31		0.0129	0.0003	0.0904	Recharge Project Online
33	Feb-00	0.33	0.03	2075636.07			1016212.9	29		0.0111	0.0003	0.0904	Recharge Project Online
34	Mar-00	4.25	0.35	26731676.70			13087590.4	31		0.1337	0.0035	0.0904	Recharge Project Online
35	Apr-00	0.39	0.03	2453024.45	110448998.31	22089799.66	1200978.9	30		0.0127	0.0003	0.0904	Recharge Project Online
36	May-00	0.00	0.00	0.00			0.0	31	0.0000			0.0904	Recharge Project Online
37	Jun-00	0.89	0.07	5597927.59			410385.3	30	0.0058			0.0904	Recharge Project Online
38	Jul-00	0.22	0.02	1383757.38			101443.6	31	0.0014			0.0904	Recharge Project Online
39	Aug-00	4.24	0.35	26668778.63			1955094.2	31	0.0266			0.0904	Recharge Project Online
40	Sep-00	0.10	0.01	628980.63			46110.7	30	0.0006			0.0904	Recharge Project Online
41	Oct-00	6.09	0.51	38304920.26	106423522.29	21284704.46	2808142.3	31	0.0383			0.0904	Recharge Project Online
42	Nov-00	1.94	0.16	12202224.19			3869141.5	30		0.0409	0.0011	0.0904	Recharge Project Online
43	Dec-00	0.06	0.01	377388.38			119664.2	31		0.0012	0.0000	0.0904	Recharge Project Online
44	Jan-01	2.69	0.22	16919578.90			5364943.7	31		0.0548	0.0014	0.0904	Recharge Project Online
45	Feb-01	1.55	0.13	9749199.74			3091324.4	28		0.0350	0.0009	0.0904	Recharge Project Online
46	Mar-01	1.65	0.14	10378180.36			3290764.7	31		0.0336	0.0009	0.0904	Recharge Project Online
47	Apr-01	2.47	0.21	15535821.52	137746757.57	27549351.51	4926175.1	30		0.0520	0.0014	0.0904	Recharge Project Online
48	May-01	1.48	0.12	9308913.30			929994.5	31	0.0127			0.0904	Recharge Project Online
49	Jun-01	0.68	0.06	4277068.27			427294.8	30	0.0060			0.0904	Recharge Project Online

NOTES:
Volumes listed are cubic-feet (ft3)
Rates listed are cubic-feet per day (ft3/day)
FS Recharge Rates Update.XLS

TABLE B-1
FINAL CALIBRATED RECHARGE RATES APPLIED
PAYSON PCE WQARF SITE GROUNDWATER FLOW MODEL - FS MODEL SIMULATIONS

50	Jul-01	2.67	0.22	16793782.77			1677760.4	31	0.0229			0.0904	Recharge Project Online
51	Aug-01	4.01	0.33	25222123.19			2519782.4	31	0.0343			0.0904	Recharge Project Online
52	Sep-01	0.59	0.05	3710985.71			370741.1	30	0.0052			0.0904	Recharge Project Online
53	Oct-01	0.95	0.08	5975315.97	130450582.28	26090116.46	596955.9	31	0.0081			0.0904	Recharge Project Online
54	Nov 01 - Apr 02						20372110.7	181		0.0357	0.0008	0.0904	Recharge Project Online
55	May 02 - Oct 02	21.59	1.80	135814071.64	135814071.64	27162814.33	6790703.6	184	0.0156			0.0904	Recharge Project Online
56	Nov 02 - Apr 03						20372110.7	181		0.0357	0.0008	0.0904	Recharge Project Online
57	May 03 - Oct 03	21.59	1.80	135814071.64	135814071.64	27162814.33	6790703.6	184	0.0156			0.0904	Recharge Project Online
58	Nov 03 - Apr 04						20372110.7	182		0.0355	0.0008	0.0904	Recharge Project Online
59	May 04 - Oct 04	21.59	1.80	135814071.64	135814071.64	27162814.33	6790703.6	184	0.0156			0.0904	Recharge Project Online

NOTE: Stress periods through October 2101 alternate rates using those from SP 58 and 59

Zone	Area (ft2)	
Surface Watershed Area	75,477,675.38	
Active Model Domain	38,010,000.00	
Zone 1	30,247,500.00	Main body of model
Zone 2	2,367,500.00	Green Valley Drainage
Zone 3	4,877,500.00	Mountain Front Zone
Zone 4	517,500.00	Green Valley Recharge Project Lakes

Zone	Active Cells
Zone 1	12099
Zone 2	947
Zone 3	1951
Zone 4	207
All	15204

NOTES:
Volumes listed are cubic-feet (ft3)
Rates listed are cubic-feet per day (ft3/day)
FS Recharge Rates Update.XLS

Table B-2
Reported Pumpage Rates for Wells in Payson, Arizona
Payson PCE WQARF Site Groundwater Flow Model

Time Period		Meter Reading (gallons)				Pumping Rate			Est. GPM	Comments	Month	Model Pump Rate	Days
Start	End	Start	End	Days	Gallons	gpm	gpd	ft3/day					
New Develop-1													
Time Period		METER READING (gallons)					Pumping Rate		Est. GPM	Comments			
Start	End	START	END	Total Days	Total Gallons	gal/min	gal/day	ft3/day					
2003	2102					35	50,400	6,738					
New Develop-2													
Time Period		METER READING (gallons)					Pumping Rate		Est. GPM	Comments			
Start	End	START	END	Total Days	Total Gallons	gal/min	gal/day	ft3/day					
2003	2102					35	50,400	6,738					
EX-1													
Time Period		METER READING (gallons)					Pumping Rate		Est. GPM	Comments			
Start	End	START	END	Total Days	Total Gallons	gal/min	gal/day	ft3/day					
10/05/2001	10/12/2001	1,646,200	1,967,100	7	320,900	32	45,752	6,117					
10/12/2001	10/18/2001	1,967,100	2,168,100	6	201,000	23	32,595	4,358			Oct-01	4,637.65	31
10/18/2001	10/26/2001	2,168,100	2,496,100	8	328,000	29	41,891	5,600					
10/26/2001	11/09/2001	2,496,100	2,557,500	14	61,400	3	4,335	580					
11/09/2001	11/21/2001	2,557,500	2,557,500	12	-	-	-	-					
11/21/2001	11/29/2001	2,557,500	3,033,700	8	476,200	42	60,470	8,084					
11/29/2001	12/06/2001	3,033,700	3,303,700	7	270,000	26	37,674	5,037					
12/06/2001	12/14/2001	3,303,700	3,558,600	8	254,900	23	33,098	4,425					
12/14/2001	12/18/2001	3,558,600	3,714,400	4	155,800	25	36,599	4,893					
EX-2													
Time Period		METER READING (gallons)					Pumping Rate		Est. GPM	Comments			
Start	End	START	END	Total Days	Total Gallons	gal/min	gal/day	ft3/day					
10/05/2001	10/12/2001	1,679,350	2,149,100	7	469,750	47	66,974	8,954					
10/12/2001	10/18/2001	2,149,100	2,373,300	6	224,200	25	36,357	4,861			Oct-01	5,817.62	31
10/18/2001	10/26/2001	2,373,300	2,746,600	8	373,300	33	47,676	6,374					
10/26/2001	11/09/2001	2,746,600	2,819,700	14	73,100	4	5,161	690					
11/09/2001	11/21/2001	2,819,700	3,483,700	12	664,000	38	55,094	7,366					
11/21/2001	11/29/2001	3,483,700	3,950,200	8	466,500	41	59,238	7,920					
11/29/2001	12/06/2001	3,950,200	4,377,700	7	427,500	41	59,651	7,975					
12/06/2001	12/14/2001	4,377,700	4,783,800	8	406,100	37	52,731	7,050					
12/14/2001	12/18/2001	4,783,800	5,033,600	4	249,800	41	58,681	7,845					
EW-4													
Time Period		METER READING (gallons)					Pumping Rate		Est. GPM	Comments			
Start	End	START	END	Total Days	Total Gallons	gal/min	gal/day	ft3/day					
08/05/1999	08/08/1999	4,240,359	4,325,079	3	84,720	21	30,499	4,077					
08/08/1999	08/08/1999	4,325,079	4,326,263	0	1,184	8	11,366	1,520					
08/08/1999	08/11/1999	4,326,263	4,419,335	3	93,072	23	33,051	4,419					
08/11/1999	08/14/1999	4,419,335	4,495,384	3	76,049	18	25,950	3,469					
08/14/1999	08/16/1999	4,495,384	4,556,476	2	61,092	21	29,521	3,947					
08/16/1999	08/18/1999	4,556,476	4,625,086	2	68,610	22	31,020	4,147					
08/18/1999	08/26/1999	4,625,086	4,904,046	8	278,960	25	35,691	4,772					
08/26/1999	09/01/1999	4,904,046	5,258,265	6	354,219	40	57,312	7,662					
09/01/1999	09/02/1999	5,258,265	5,330,849	1	72,584	66	95,019	12,703					
09/02/1999	09/03/1999	5,330,849	5,428,272	1	97,423	67	96,751	12,935					
09/03/1999	09/23/1999	5,428,272	5,436,968	20	8,696	0	433	58					

Table B-2
Reported Pumpage Rates for Wells in Payson, Arizona
Payson PCE WQARF Site Groundwater Flow Model

Time Period		Meter Reading (gallons)				Pumping Rate			Est. GPM	Comments	Month	Model Pump Rate	Days
Start	End	Start	End	Days	Gallons	gpm	gpd	ft3/day					
09/23/1999	10/20/1999	5,436,968	5,439,816	27	2,848	0	104	14					
10/20/1999	11/17/1999	5,439,816	5,445,386	28	5,570	0	202	27					
11/17/1999	11/18/1999	5,445,386	5,450,413	1	5,027	3	4,022	538					
11/18/1999	12/03/1999	5,450,413	5,526,903	15	76,490	4	5,160	690					
12/03/1999	12/08/1999	5,526,903	5,591,084	5	64,181	9	12,917	1,727					
12/08/1999	12/16/1999	5,591,084	6,365,246	8	774,162	67	96,103	12,848					
12/16/1999	12/22/1999	6,365,246	7,010,757	6	645,511	77	110,265	14,741					
12/22/1999	12/22/1999	7,010,757	7,011,280	0	523	2	2,248	301					
12/22/1999	01/05/2000	7,011,280	8,536,195	14	1,524,915	75	108,305	14,479					
01/05/2000	01/14/2000	8,536,195	9,425,988	9	889,793	69	99,985	13,367					
01/14/2000	01/26/2000	9,425,988	10,460,965	12	1,034,977	61	88,240	11,797					
01/26/2000	01/26/2000	10,460,965	10,461,693	0	728	49	69,888	9,343					
01/26/2000	02/02/2000	10,461,693	10,767,750	7	306,057	30	42,582	5,693					
02/02/2000	02/10/2000	10,767,750	11,375,260	8	607,510	53	76,370	10,210					
02/10/2000	02/17/2000	11,375,260	11,931,702	7	556,442	53	76,421	10,217					
02/17/2000	03/01/2000	11,931,702	12,906,921	13	975,219	53	75,684	10,118					
03/01/2000	03/09/2000	12,906,921	13,414,172	8	507,251	46	65,687	8,782					
03/09/2000	03/15/2000	13,414,172	13,661,076	6	246,904	27	38,333	5,125					
03/15/2000	03/23/2000	13,661,076	14,014,903	8	353,827	32	46,616	6,232					
03/23/2000	03/30/2000	14,014,903	14,578,222	7	563,319	55	79,124	10,578					
03/30/2000	03/30/2000	14,578,222	14,581,470	0	3,248	11	15,185	2,030					
03/30/2000	04/19/2000	14,581,470	16,139,690	20	1,558,220	54	77,938	10,420					
04/19/2000	05/05/2000	16,139,690	17,106,452	16	966,762	42	60,779	8,126					
05/05/2000	05/12/2000	17,106,452	17,278,454	7	172,002	18	25,574	3,419					
05/12/2000	05/12/2000	17,278,454	17,278,908	0	454	1	1,676	224					
05/12/2000	05/17/2000	17,278,908	17,613,760	5	334,852	46	66,144	8,843					
05/17/2000	05/25/2000	17,613,760	18,165,152	8	551,392	50	71,791	9,598					
05/25/2000	05/25/2000	18,165,152	18,167,692	0	2,540	11	16,256	2,173					
05/25/2000	05/26/2000	18,167,692	18,248,462	1	80,770	50	71,796	9,598					
05/26/2000	05/30/2000	18,248,462	18,380,868	4	132,406	25	35,374	4,729					
05/30/2000	06/07/2000	18,380,868	18,975,172	8	594,304	50	71,287	9,530					
06/07/2000	06/15/2000	18,975,172	19,538,188	8	563,016	50	71,494	9,558					
06/15/2000	06/20/2000	19,538,188	19,695,084	5	156,896	23	33,031	4,416					
06/20/2000	06/23/2000	19,695,084	19,760,718	3	65,634	16	22,503	3,008					
06/23/2000	06/28/2000	19,760,718	20,068,208	5	307,490	42	60,822	8,131					
06/28/2000	07/01/2000	20,068,208	20,196,764	3	128,556	30	43,354	5,796					
07/01/2000	07/03/2000	20,196,764	20,377,226	3	180,462	49	70,424	9,415					
07/03/2000	07/06/2000	20,377,226	20,494,548	3	117,322	29	41,870	5,598					
07/06/2000	07/12/2000	20,494,548	20,873,952	6	379,404	45	65,041	8,695					
07/12/2000	07/18/2000	20,873,952	21,265,838	6	391,886	45	64,939	8,682					
07/18/2000	07/25/2000	21,265,838	21,373,520	7	107,682	11	15,232	2,036					
07/25/2000	07/26/2000	21,373,520	21,433,824	1	60,304	52	74,220	9,923					
07/26/2000	07/27/2000	21,433,824	21,514,928	1	81,104	51	73,684	9,851					
07/27/2000	07/27/2000	21,514,928	21,515,236	0	308	3	4,032	539					
07/27/2000	07/28/2000	21,515,236	21,516,106	1	870	1	1,101	147					
07/28/2000	08/02/2000	21,516,106	21,828,716	5	312,610	41	58,813	7,863					
08/02/2000	08/09/2000	21,828,716	22,317,344	7	488,628	49	70,341	9,404					
08/09/2000	08/22/2000	22,317,344	22,320,864	13	3,520	0	277	37					
08/22/2000	08/24/2000	22,320,864	22,382,652	2	61,788	21	29,658	3,965					
08/24/2000	08/25/2000	22,382,652	22,382,996	1	344	0	381	51					
08/25/2000	09/14/2000	22,382,996	22,858,376	20	475,380	16	23,501	3,142					
09/14/2000	09/20/2000	22,858,376	23,278,392	6	420,016	50	72,590	9,705					

Table B-2
Reported Pumpage Rates for Wells in Payson, Arizona
Payson PCE WQARF Site Groundwater Flow Model

Time Period		Meter Reading (gallons)				Pumping Rate			Est. GPM	Comments	Month	Model Pump Rate	Days
Start	End	Start	End	Days	Gallons	gpm	gpd	ft3/day					
09/20/2000	09/27/2000	23,278,392	23,794,486	7	516,094	49	70,914	9,480					
09/27/2000	10/03/2000	23,794,486	24,130,236	6	335,750	41	58,675	7,844					
10/03/2000	10/13/2000	24,130,236	24,810,066	10	679,830	47	67,875	9,074					
10/13/2000	10/16/2000	24,810,066	25,037,080	3	227,014	47	68,005	9,092					
10/16/2000	10/24/2000	25,037,080	25,533,702	8	496,622	45	64,660	8,644					
10/24/2000	11/08/2000	25,533,702	26,511,108	15	977,406	45	65,145	8,709					
11/08/2000	11/08/2000	26,511,108	26,512,400	0	1,292	8	10,944	1,463					
11/08/2000	11/16/2000	26,512,400	27,000,476	8	488,076	43	62,474	8,352					
11/16/2000	11/17/2000	27,000,476	27,002,646	1	2,170	1	1,741	233					
11/17/2000	11/22/2000	27,002,646	27,322,624	5	319,978	47	67,364	9,006					
11/22/2000	11/22/2000	27,322,624	27,328,640	0	6,016	21	29,873	3,994					
11/22/2000	11/29/2000	27,328,640	27,748,598	7	419,958	43	61,645	8,241					
11/29/2000	12/06/2000	27,748,598	27,775,308	7	26,710	3	3,808	509					
12/06/2000	12/07/2000	27,775,308	27,843,168	1	67,860	48	69,304	9,265					
12/07/2000	12/07/2000	27,843,168	27,843,636	0	468	1	1,846	247					
12/07/2000	12/14/2000	27,843,636	28,302,970	7	459,334	47	67,528	9,028					
12/14/2000	12/18/2000	28,302,970	28,582,652	4	279,682	46	66,186	8,848					
12/18/2000	12/28/2000	28,582,652	29,208,660	10	626,008	44	63,910	8,544					
12/28/2000	01/04/2001	29,208,660	29,637,136	7	428,476	43	61,608	8,236					
01/04/2001	01/11/2001	29,637,136	30,040,172	7	403,036	38	55,353	7,400					
01/11/2001	01/16/2001	30,040,172	30,308,756	5	268,584	38	54,130	7,237					
01/16/2001	01/30/2001	30,308,756	31,010,784	14	702,028	35	50,407	6,739					
01/30/2001	02/02/2001	31,010,784	31,161,000	3	150,216	35	50,777	6,788					
02/02/2001	02/04/2001	31,161,000	31,262,192	2	101,192	33	47,776	6,387					
02/04/2001	02/13/2001	31,262,192	31,342,618	9	80,426	6	8,974	1,200					
02/13/2001	02/23/2001	31,342,618	31,680,732	10	338,114	23	33,636	4,497					
02/23/2001	02/27/2001	31,680,732	31,920,850	4	240,118	43	62,470	8,352					
02/27/2001	03/01/2001	31,920,850	32,060,712	2	139,862	46	66,360	8,872					
03/01/2001	03/09/2001	32,060,712	32,226,220	8	165,508	14	20,370	2,723					
03/09/2001	03/16/2001	32,226,220	32,411,308	7	185,088	19	26,868	3,592					
03/16/2001	03/21/2001	32,411,308	32,421,088	5	9,780	1	1,943	260					
03/21/2001	03/30/2001	32,421,088	33,006,044	9	584,956	45	64,820	8,666					
03/30/2001	04/06/2001	33,006,044	33,335,352	7	329,308	34	48,837	6,529					
04/06/2001	04/19/2001	33,335,352	33,657,184	13	321,832	17	24,334	3,253					
04/19/2001	04/28/2001	33,657,184	34,175,216	9	518,032	40	56,901	7,607					
04/28/2001	05/04/2001	34,175,216	34,497,940	6	322,724	40	57,765	7,723					
05/04/2001	05/10/2001	34,497,940	34,829,356	6	331,416	36	52,473	7,015					
05/10/2001	05/18/2001	34,829,356	35,260,780	8	431,424	39	55,818	7,462			Month	Model Pump Rate	Days
05/18/2001	05/24/2001	35,260,780	35,621,156	6	360,376	42	59,959	8,016			Sep-99	800.06	30
05/24/2001	06/01/2001	35,621,156	35,930,536	8	309,380	27	38,192	5,106			Oct-99	18.54	31
06/01/2001	06/06/2001	35,930,536	36,206,872	5	276,336	39	55,927	7,477			Nov-99	313.66	30
06/06/2001	06/22/2001	36,206,872	37,029,832	16	822,960	36	51,257	6,853			Dec-99	13,618.68	31
06/22/2001	06/29/2001	37,029,832	37,366,060	7	336,228	34	48,320	6,460			Jan-00	14,055.03	31
06/29/2001	07/06/2001	37,366,060	37,705,700	7	339,640	34	48,376	6,467			Feb-00	9,961.14	29
07/06/2001	07/13/2001	37,705,700	37,976,952	7	271,252	27	38,750	5,181			Mar-00	7,609.21	31
07/13/2001	07/21/2001	37,976,952	38,290,960	8	314,008	26	38,094	5,093			Apr-00	9,578.38	30
07/21/2001	07/28/2001	38,290,960	38,600,740	7	309,780	32	46,613	6,232			May-00	7,447.16	31
07/28/2001	08/08/2001	38,600,740	39,091,468	11	490,728	31	44,262	5,917			Jun-00	7,481.07	30
08/08/2001	08/16/2001	39,091,468	39,490,260	8	398,792	33	48,225	6,447			Jul-00	6,194.11	31
08/16/2001	08/22/2001	39,490,260	39,566,832	6	76,572	9	12,722	1,701			Aug-00	3,505.92	31
08/22/2001	08/31/2001	39,566,832	39,968,352	9	401,520	31	45,030	6,020			Sep-00	6,422.25	30
08/31/2001	09/07/2001	39,968,352	40,270,656	7	302,304	30	43,729	5,846			Oct-00	8,778.28	31

Table B-2
Reported Pumpage Rates for Wells in Payson, Arizona
Payson PCE WQARF Site Groundwater Flow Model

Time Period		Meter Reading (gallons)				Pumping Rate			Est. GPM	Comments	Month	Model Pump Rate	Days
Start	End	Start	End	Days	Gallons	gpm	gpd	ft3/day					
09/07/2001	09/11/2001	40,270,656	40,432,884	4	162,228	30	42,590	5,694			Nov-00	8,001.52	30
09/11/2001	09/18/2001	40,432,884	40,628,232	7	195,348	19	27,404	3,664			Dec-00	7,089.22	31
09/18/2001	10/05/2001	40,628,232	41,178,584	17	550,352	23	32,460	4,340			Jan-01	7,205.70	31
10/05/2001	10/12/2001	41,178,584	41,425,976	7	247,392	25	35,289	4,718			Feb-01	4,429.74	28
10/12/2001	10/18/2001	41,425,976	41,664,316	6	238,340	27	38,507	5,148			Mar-01	4,287.43	31
10/18/2001	10/26/2001	41,664,316	41,977,728	8	313,412	28	40,145	5,367			Apr-01	5,305.92	30
10/26/2001	11/02/2001	41,977,728	42,256,680	7	278,952	27	39,056	5,221			May-01	6,984.36	31
11/02/2001	11/09/2001	42,256,680	42,512,372	7	255,692	25	36,655	4,900			Jun-01	6,612.75	30
11/09/2001	11/21/2001	42,512,372	42,960,960	12	448,588	26	36,870	4,929			Jul-01	5,684.33	31
11/21/2001	11/29/2001	42,960,960	43,228,576	8	267,616	24	35,033	4,684			Aug-01	5,308.71	31
11/29/2001	12/06/2001	43,228,576	43,389,688	7	161,112	15	21,980	2,939			Sep-01	4,693.38	30
12/06/2001	12/14/2001	43,389,688	43,671,532	8	281,844	26	36,729	4,910			Oct-01	4,820.02	31
12/14/2001	12/18/2001	43,671,532	43,829,108	4	157,576	25	36,569	4,889			Nov-01		30
12/18/2001	01/04/2002	43,829,108	44,463,944	17	634,836	26	37,558	5,021			Dec-01		31
												6,125.10	

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Time Period		METER READING (gallons)				Pumping Rate			Est. GPM	Comments	Month	Model Pump Rate	Days
Start	End	START	END	Total Days	Total Gallons	gal/min	gal/day	ft3/day					
11/05/1998	12/03/1998	902,400	4,041,200	28	3,138,800	78	112,100	14,987					
12/03/1998	12/04/1998	4,041,200	4,118,400	1	77,200	54	77,200	10,321					
12/4/98 - 6/29/99	System off	NM		#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!					
06/29/1999	07/20/1999	4,118,400	7,035,100	21	2,916,700	96	138,890	18,568					
07/20/1999	09/14/1999	7,035,100	11749500	56	4,714,400	58	84,186	11,255			Sep-99	6,012.40	30
09/14/1999	10/28/1999	11749500	12,218,600	44	469,100	7	10,661	1,425			Oct-99	1,310.02	31
10/28/1999	12/01/1999	12,218,600	12,278,100	34	59,500	1	1,750	234	0		Nov-99	8,335.33	30
12/01/1999	01/14/2000	12,278,100	15,559,400	44	3,281,300	52	74,575	9,970	46				
01/14/2000	02/22/2000	15,559,400	18,564,000	39	3,004,600	54	77,041	10,300	55				
02/22/2000	03/29/2000	18,564,000	20,235,240	36	1,671,240	32	46,423	6,206	50				
03/29/2000	04/27/2000	20,235,240	22,448,200	29	2,212,960	53	76,309	10,202	58				
04/27/2000	05/26/2000	22,448,200	23,788,500	29	1,340,300	32	46,217	6,179		off because IGTS off			
05/26/2000	06/27/2000	23,788,500	23,788,500	32	-	-	-	-		off - IGTS			
06/27/2000	07/26/2000	23,788,500	23,788,500	29	-	-	-	-	0	off until IGTS repaired			
07/26/2000	08/29/2000	23,788,500	23,788,500	34	-	-	-	-	0	down			
08/29/2000	09/26/2000	23,788,500	23,788,500	28	-	-	-	-	0	off since May 28(due to influence on EW-4)			
09/26/2000	10/30/2000	23,788,500	NM	34	-	-	-	-					
10/30/2000	11/27/2000	NM	NM	28	-	-	-	-					
11/27/2000	12/21/2000	NM	NM	24	-	-	-	-					
12/21/2000	02/26/2001	NM	NM	67	-	-	-	-					
02/26/2001	03/28/2001	NM	NM	30	-	-	-	-					
03/28/2001	04/25/2001	NM	NM	28	-	-	-	-					
04/25/2001	05/30/2001	NM	NM	35	-	-	-	-					
05/30/2001	06/26/2001	NM	NM	27	-	-	-	-					
06/26/2001	08/27/2001	NM	NM	62	-	-	-	-					
08/27/2001	09/26/2001	NM	NM	30	-	-	-	-					
09/26/2001	10/26/2001	NM	NM	30	-	-	-	-		Karen gets results every week; get future data from her			
10/26/2001	11/28/2001	NM	NM	33	-	-	-	-					
11/28/2001	12/27/2001	NM	NM	29	-	-	-	-					
12/27/2001	02/28/2002	NM	NM	63	-	-	-	-					

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Time Period		METER READING (gallons)				Pumping Rate			Est. GPM	Comments
Start	End	START	END	Total Days	Total Gallons	gal/min	gal/day	ft3/day		

Table B-2
Reported Pumpage Rates for Wells in Payson, Arizona
Payson PCE WQARF Site Groundwater Flow Model

Time Period		Meter Reading (gallons)				Pumping Rate			Est. GPM	Comments	Month	Model Pump Rate	Days
Start	End	Start	End	Days	Gallons	gpm	gpd	ft3/day					
11/05/1998	12/03/1998	2,608,800	3,637,700	28	1,028,900	26	36,746	4,913					
12/03/1998	01/11/1999	3,637,700	7,663,900	39	4,026,200	72	103,236	13,802					
01/11/1999	01/28/1999	7,663,900	8,893,900	17	1,230,000	31	72,353	9,673					
01/28/1999	02/10/1999	8,893,900	10,006,000	13	1,112,100	59	85,546	11,437					
02/10/1999	03/15/1999	10,006,000	12,831,300	33	2,825,300	70	85,615	11,446					
03/15/1999	04/20/1999	12,831,300	15,852,000	36	3,020,700	58	83,908	11,218					
04/20/1999	05/06/1999	15,852,000	17,166,000	16	1,314,000	33	82,125	10,979					
05/06/1999	05/13/1999	17,166,000	17,740,800	7	574,800	57	82,114	10,978					
05/13/1999	05/27/1999	17,740,800	18,816,800	14	1,076,000	27	76,857	10,275					
05/27/1999	06/15/1999	18,816,800	20,296,600	19	1,479,800	54	77,884	10,412					
06/15/1999	07/01/1999	20,296,600	20,773,200	16	476,600	12	29,788	3,982					
07/01/1999	07/20/1999	20,773,200	22,377,400	19	1,604,200	59	84,432	11,288					
07/20/1999	09/14/1999	22,377,400	NR	56	#VALUE!	#VALUE!	#VALUE!	#VALUE!					
09/14/1999	System down	NR	26,525,500	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!					
09/14/1999	10/28/1999	26,525,500	26,933,900	44	408,400	6	9,282	1,241			Month	Model Pump Rate	Days
10/28/1999	12/01/1999	26,933,900	26,989,600	34	55,700	1	1,638	219	0		Nov-99	219.02	
12/01/1999	01/12/2000	26,989,600	29,901,000	42	2,911,400	48	69,319	9,267	48		Dec-99	9,267.25	
01/12/2000	02/22/2000	29,901,000	32,474,200	41	2,573,200	44	62,761	8,391	48		Jan-00	8,459.23	31
02/22/2000	03/29/2000	32,474,200	34,682,100	36	2,207,900	43	61,331	8,199	60		Feb-00	8,344.35	29
03/29/2000	04/27/2000	34,682,100	36,562,800	29	1,880,700	45	64,852	8,670	34		Mar-00	8,229.64	31
04/27/2000	05/25/2000	36,562,800	38,468,100	28	1,905,300	47	68,046	9,097	52		Apr-00	8,712.73	30
05/25/2000	06/27/2000	38,468,100	40,614,000	33	2,145,900	45	65,027	8,693	50		May-00	9,018.99	31
06/27/2000	07/26/2000	40,614,000	42,401,300	29	1,787,300	43	61,631	8,239	40		Jun-00	8,648.08	30
07/26/2000	08/29/2000	42,401,300	43,521,600	34	1,120,300	23	32,950	4,405	0	Down	Jul-00	7,621.00	31
08/29/2000	09/26/2000	43,521,600	44,966,700	28	1,445,100	36	51,611	6,900	50		Aug-00	4,566.03	31
09/26/2000	10/30/2000	44,966,700	47,424,000	34	2,457,300	50	72,274	9,662	50		Sep-00	7,268.15	30
10/30/2000	11/27/2000	47,424,000	49,444,400	28	2,020,400	50	72,157	9,647	50		Oct-00	9,661.73	31
11/27/2000	12/21/2000	49,444,400	50,897,700	24	1,453,300	42	60,554	8,095	49		Nov-00	9,491.56	30
12/21/2000	02/05/2001	50,897,700	53,978,100	46	3,080,400	47	66,965	8,953	50		Dec-00	8,371.96	31
02/05/2001	02/26/2001	53,978,100	55,310,200	21	1,332,100	44	63,433	8,480	48		Jan-01	8,952.57	
02/26/2001	03/28/2001	55,310,200	57,204,200	30	1,894,000	44	63,133	8,440	30		Feb-01	8,447.45	
03/28/2001	04/25/2001	57,204,200	58,482,300	28	1,278,100	32	45,646	6,102	34		Mar-01	8,214.04	
04/25/2001	05/30/2001	58,482,300	60,657,200	35	2,174,900	43	62,140	8,307	40		Apr-01	6,469.97	
05/30/2001	06/26/2001	60,657,200	62,229,400	27	1,572,200	40	58,230	7,785	40		May-01	8,290.62	
06/26/2001	08/27/2001	62,229,400	65,082,200	62	2,852,800	32	46,013	6,151	44		Jun-01	7,566.94	
08/27/2001	09/26/2001	65,082,200	66,784,100	30	1,701,900	39	56,730	7,584	40		Jul-01	6,336.33	
09/26/2001	10/26/2001	66,784,100	68,393,700	30	1,609,600	37	53,653	7,173	28		Aug-01	7,517.88	
10/26/2001	11/29/2001	68,393,700	69,486,300	35	1,092,600	22	31,663	4,233			Sep-01	7,529.38	30
11/29/2001	12/18/2001	69,486,300	70,301,100	19	814,800	30	42,604	5,696			Oct-01	6,698.73	31

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Time Period		METER READING (gallons)				Pumping Rate			Est. GPM	Comments
Start	End	START	END	Total Days	Total Gallons	gal/min	gal/day	ft3/day		
11/05/1998	12/03/1998	1,352,800	5,958,500	28	4,605,700	114	164,489	21,991		
12/03/1998	01/11/1999	5,958,500	12,436,900	39	6,478,400	115	166,113	22,208		
01/11/1999	01/28/1999	12,436,900	14,407,300	17	1,970,400	49	115,906	15,495		
01/28/1999	02/10/1999	14,407,300	15,671,400	13	1,264,100	68	97,238	13,000		
02/10/1999	03/15/1999	15,671,400	20,194,200	33	4,522,800	112	137,055	18,323		
03/15/1999	04/20/1999	20,194,200	25,014,500	36	4,820,300	93	133,897	17,901		
04/20/1999	05/06/1999	25,014,500	27,086,800	16	2,072,300	51	129,519	17,315		
05/06/1999	05/13/1999	27,086,800	27,988,200	7	901,400	89	128,771	17,215		
05/13/1999	05/27/1999	27,988,200	29,811,300	14	1,823,100	45	130,221	17,409		

Table B-2
Reported Pumpage Rates for Wells in Payson, Arizona
Payson PCE WQARF Site Groundwater Flow Model

Time Period		Meter Reading (gallons)				Pumping Rate			Est. GPM	Comments	Month	Model Pump Rate	Days	
Start	End	Start	End	Days	Gallons	gpm	gpd	ft3/day						
05/27/1999	06/15/1999	29,811,300	31,957,800	19	2,146,500	78	112,974	15,103						
06/15/1999	07/01/1999	31,957,800	33,686,800	16	1,729,000	43	108,063	14,447						
07/01/1999	07/20/1999	33,686,800	35,967,900	19	2,281,100	83	120,058	16,051						
07/20/1999	09/14/1999	35,967,900	NR	56	#VALUE!	#VALUE!	#VALUE!	#VALUE!						
09/14/1999	System down	NR		#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!						
914/99	10/28/1999	NR	42,460,900	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!			Month	Model Pump Rate	Days	Jan0101
10/28/1999	12/01/1999	42,460,900	42,541,400	34	80,500	2	2,368	317	0		Nov-99	316.53		Feb0101
12/01/1999	01/14/2000	42,541,400	47,036,200	44	4,494,800	71	102,155	13,657	76		Dec-99	13,657.02		Mar0101
01/14/2000	02/22/2000	47,036,200	50,822,700	39	3,786,500	67	97,090	12,980	0		Jan-00	13,285.71	31	Apr0101
02/22/2000	03/29/2000	50,822,700	53,793,500	36	2,970,800	57	82,522	11,032	64		Feb-00	12,509.82	29	May0101
03/29/2000	04/27/2000	53,793,500	56,303,700	29	2,510,200	60	86,559	11,572	56		Mar-00	11,067.20	31	Jun0101
04/27/2000	05/26/2000	56,303,700	58,661,200	29	2,357,500	56	81,293	10,868	58		Apr-00	11,501.61	30	Jul0101
05/26/2000	06/27/2000	58,661,200	60,985,800	32	2,324,600	50	72,644	9,712	50		May-00	10,681.56	31	Aug0101
06/27/2000	07/26/2000	60,985,800	62,819,400	29	1,833,600	44	63,228	8,453	46		Jun-00	9,585.85	30	Sep-01
07/26/2000	08/29/2000	62,819,400	63,679,800	34	860,400	18	25,306	3,383	0	down	Jul-00	7,635.18	31	Oct-01
08/29/2000	09/26/2000	63,679,800	64,580,700	28	900,900	22	32,175	4,301	24		Aug-00	3,442.39	31	
09/26/2000	10/30/2000	64,580,700	65,354,300	34	773,600	16	22,753	3,042	10		Sep-00	4,133.52	30	
10/30/2000	11/27/2000	65,354,300	65,553,900	28	199,600	5	7,129	953	0	off?	Oct-00	2,974.46	31	
11/27/2000	12/21/2000	65,553,900	67,147,700	24	1,593,800	46	66,408	8,878	74		Nov-00	1,745.53	30	
12/21/2000	03/26/2001	67,147,700	76,025,900	95	8,878,200	65	93,455	12,494	49		Dec-00	10,044.52	31	
03/26/2001	04/25/2001	76,025,900	78,656,300	30	2,630,400	61	87,680	11,722	74		Jan-01			
04/25/2001	05/30/2001	78,656,300	82,298,500	35	3,642,200	72	104,063	13,912	70		Feb-01			
05/30/2001	06/26/2001	82,298,500	85,109,700	27	2,811,200	72	104,119	13,920	76		Mar-01			
06/26/2001	07/28/2001	85,109,700	87,805,400	32	2,695,700	59	84,241	11,262	70	Karen gets results ev	Apr-01			
07/28/2001	08/31/2001	87,805,400	90,606,000	35	2,800,600	56	80,957	10,823	70		May-01			
08/31/2001	09/26/2001	90,606,000	93,226,400	25	2,620,400	72	103,140	13,789	70		Jun-01			
09/26/2001	10/26/2001	93,226,400	96,138,100	30	2,911,700	66	95,727	12,798	70		Jul-01			
10/26/2001	11/29/2001	96,138,100	99,169,000	34	3,030,900	62	88,908	11,886	70		Aug-01			
11/29/2001	12/18/2001	99,169,000	101,490,600	19	2,321,600	84	121,391	16,229	70		Sep-01			

SKINNER

Time Period		METER READING (gallons)				Pumping Rate			Est. GPM	Comments
Start	End	START	END	Total Days	Total Gallons	gal/min	gal/day	ft3/day		
04/30/1998	05/15/1998	1,298,499	2,923,099	15	1,624,600	75.21	108,307	14,480		
05/15/1998	05/21/1998	2,923,099	4,217,283	6	1,294,184	149.79	215,697	28,837		
05/21/1998	05/29/1998	4,217,283	5,841,289	8	1,624,006	140.97	203,001	27,139		
05/29/1998	06/04/1998	5,841,289	7,101,140	6	1,259,851	145.82	209,975	28,072		
06/04/1998	06/11/1998	7,101,140	8,552,380	7	1,451,240	143.97	207,320	27,717		
06/11/1998	06/18/1998	8,552,380	9,985,677	7	1,433,297	142.19	204,757	27,374		
06/18/1998	06/26/1998	9,985,677	11,567,888	8	1,582,211	137.34	197,776	26,441		
06/26/1998	07/02/1998	11,567,888	12,770,795	6	1,202,907	139.23	200,485	26,803		
07/02/1998	07/09/1998	12,770,795	14,146,499	7	1,375,704	136.48	196,529	26,274		
07/09/1998	07/16/1998	14,146,499	15,479,342	7	1,332,843	132.23	190,406	25,455		
07/23/1998	07/30/1998	347,099	1,651,420	7	1,304,321	129.40	186,332	24,911		
07/30/1998	08/07/1998	1,651,420	3,120,618	8	1,469,198	127.53	183,650	24,552		
08/07/1998	08/13/1998	3,120,618	4,240,185	6	1,119,567	129.58	186,595	24,946		

Table B-2
Reported Pumpage Rates for Wells in Payson, Arizona
Payson PCE WQARF Site Groundwater Flow Model

Time Period		Meter Reading (gallons)				Pumping Rate			Est. GPM	Comments	Month	Model Pump Rate	Days	
Start	End	Start	End	Days	Gallons	gpm	gpd	ft3/day						
08/13/1998	08/21/1998	4,240,185	4,617,753	8	377,568	32.78	47,196	6,310						
08/21/1998	09/03/1998	4,617,753	1,039,057	13	(3,578,696)	flow meter malfunctioning								
09/03/1998	System shut down untill connected to EGTS													
				106	18,451,497									
04/30/1998	08/07/1998	79,581,000	90,171,000	99	10,590,000									
06/11/1999	Start pumping													
06/15/1999	07/01/1999	469,900	1,778,300	16	1,308,400	56.79	81,775	10,932						
07/01/1999	07/20/1999	1,778,300	2,270,100	19	491,800	17.98	25,884	3,460						
08/22/1999	09/14/1999	System off line			#VALUE!	#VALUE!	#VALUE!	#VALUE!						
09/14/1999	10/28/1999	2,270,100	2,274,300	44	4,200	0.07	95	13			Month	Model Pump Rate	Days	
10/28/1999	12/01/1999	2,274,300	2,274,300	34	-	-	-	-	0		Nov-99	-		
12/01/1999	01/12/2000	2,274,300	4,656,700	42	2,382,400	39.39	56,724	7,583	72		Dec-99	7,583.40		
01/12/2000	02/22/2000	4,656,700	8,219,700	41	3,563,000	60.35	86,902	11,618	69		Jan-00	10,056.20	31	
02/22/2000	03/29/2000	8,219,700	11,226,600	36	3,006,900	58.00	83,525	11,166	60		Feb-00	11,508.98	29	
03/29/2000	04/27/2000	11,226,600	13,680,900	29	2,454,300	58.77	84,631	11,314	68		Mar-00	11,175.98	31	
04/27/2000	05/25/2000	13,680,900	16,168,500	28	2,487,600	61.70	88,843	11,877	68		Apr-00	11,370.62	30	
05/25/2000	06/27/2000	16,168,500	19,041,500	33	2,873,000	60.46	87,061	11,639	68		May-00	11,831.27	31	
06/27/2000	07/26/2000	19,041,500	21,381,200	29	2,339,700	56.03	80,679	10,786	58		Jun-00	11,553.81	30	
07/26/2000	08/29/2000	21,381,200	22,745,000	34	1,363,800	27.86	40,112	5,363	0	Down	Jul-00	9,911.25	31	
08/29/2000	09/26/2000	22,745,000	24,478,600	28	1,733,600	43.00	61,914	8,277	68		Aug-00	5,550.59	31	
09/26/2000	10/30/2000	24,478,600	27,362,300	34	2,883,700	58.90	84,815	11,339	60		Sep-00	8,685.52	30	
10/30/2000	11/27/2000	27,362,300	29,673,700	28	2,311,400	57.33	82,550	11,036	60		Oct-00	11,329.10	31	
11/27/2000	12/21/2000	29,673,700	31,332,000	24	1,658,300	47.98	69,096	9,237	50		Nov-00	10,856.23	30	
12/21/2000	02/26/2001	31,332,000	36,249,000	67	4,917,000	50.96	73,388	9,811	50		Dec-00	9,422.52	31	
02/26/2001	03/28/2001	36,249,000	38,056,500	30	1,807,500	41.84	60,250	8,055	49		Jan0101	9,811.24		
03/28/2001	04/25/2001	38,056,500	39,130,000	28	1,073,500	26.62	38,339	5,126	50		Feb0101	9,685.78		
04/25/2001	05/30/2001	39,130,000	41,965,400	35	2,835,400	56.26	81,011	10,830	60		Mar0101	7,771.34		
05/30/2001	06/26/2001	41,965,400	43,857,200	27	1,891,800	48.66	70,067	9,367	52		Apr0101	6,076.38		
06/26/2001	08/27/2001	43,857,200	46,698,100	62	2,840,900	31.82	45,821	6,126	0		May0101	10,783.20		
08/27/2001	09/26/2001	46,698,100	46,698,100	30	-	-	-	-			Jun0101	8,935.01		
09/26/2001	10/12/2001	46,698,100	46,698,100	16	-	-	-	-			Jul0101	6,125.80		
10/12/2001	10/26/2001	46,698,100	47,401,700	14	703,600	35.98	51,812	6,927			Aug0101	5,335		8,776.56
10/26/2001	11/29/2001	47,401,700	49,067,700	35	1,666,000	33.53	48,280	6,455			Sep-01	-		7,850.85
11/29/2001	12/18/2001	49,067,700	50,426,200	19	1,358,500	49.33	71,033	9,496			Oct-01	4,169.26		
	12/18/2001	50426200												

McKamey, W-27

Time Period		METER READING (gallons)					Pumping Rate		Est. GPM	Comments
Start	End	START	END	Total Days	Total Gallons	gal/min	gal/day	ft3/day		
11/05/1998	12/03/1998	53,621,000	53,908,800	28	287,800	7.14	10,279	1,374		
12/03/1998	01/11/1999	53,908,800	55,561,700	39	1,652,900	29.43	42,382	5,666		
01/11/1999	02/10/1999	55,561,700	56,871,900	30	1,310,200	30.33	43,673	5,839		
02/10/1999	03/02/1999	56,871,900	57,801,200	20	929,300	32.27	46,465	6,212		
03/02/1999	03/15/1999	57,801,200	58,540,400	13	739,200	39.49	56,862	7,602		
03/15/1999	04/20/1999	58,540,400	60,009,600	36	1,469,200	28.34	40,811	5,456		
04/20/1999	05/06/1999	60,009,600	60,975,400	16	965,800	41.92	60,363	8,070		
05/06/1999	05/13/1999	60,975,400	61,565,300	7	589,900	58.52	84,271	11,266		
05/13/1999	05/27/1999	61,565,300	62,973,200	14	1,407,900	69.84	100,564	13,444		
05/27/1999	06/15/1999	62,973,200	64,995,800	19	2,022,600	73.93	106,453	14,232		

Table B-2
Reported Pumpage Rates for Wells in Payson, Arizona
Payson PCE WQARF Site Groundwater Flow Model

Time Period		Meter Reading (gallons)				Pumping Rate			Est. GPM	Comments	Month	Model Pump Rate	Days	
Start	End	Start	End	Days	Gallons	gpm	gpd	ft3/day						
06/15/1999	07/01/1999	64,995,800	66,735,200	16	1,739,400	75.49	108,713	14,534						
07/01/1999	07/20/1999	66,735,200	67,193,200	19	458,000	16.74	24,105	3,223						
07/20/1999	08/17/1999	67,193,200	68,582,200	28	1,389,000	34.45	49,607	6,632						
08/17/1999	09/23/1999	68,582,200	71,926,800	37	3,344,600	62.77	90,395	12,085	130					
09/23/1999	10/28/1999	71,926,800	74,921,200	35	2,994,400	59.41	85,554	11,438	135		Month	Model Pump Rate	Days	
10/28/1999	12/01/1999	74,921,200	77,538,800	34	2,617,600	53.46	76,988	10,293	137		Nov-99	10,292.54		
12/01/1999	01/12/2000	77,538,800	78,881,600	42	1,342,800	22.20	31,971	4,274	0		Dec-99	4,274.26		
01/12/2000	02/22/2000	78,881,600	80,396,600	41	1,515,000	25.66	36,951	4,940	0		Jan-00	4,682.29	31	
02/22/2000	03/29/2000	80,396,600	81,638,600	36	1,242,000	23.96	34,500	4,612	150		Feb-00	4,860.90	29	
03/29/2000	04/27/2000	81,638,600	83,413,100	29	1,774,500	42.49	61,190	8,180			Mar-00	4,842.50	31	
04/27/2000	05/25/2000	83,413,100	85,897,200	28	2,484,100	61.61	88,718	11,861	138		Apr-00	8,548.46	30	
05/25/2000	06/27/2000	85,897,200	89,061,100	33	3,163,900	66.58	95,876	12,818	138		May-00	12,045.89	31	
06/27/2000	07/26/2000	89,061,100	91,329,800	29	2,268,700	54.33	78,231	10,459	135		Jun-00	12,581.72	30	
07/26/2000	08/29/2000	91,329,800	94,377,700	34	3,047,900	62.25	89,644	11,985	0		Jul-00	10,704.79	31	
08/29/2000	09/26/2000	94,387,700	96,042,100	28	1,654,400	41.03	59,086	7,899	0		Aug-00	11,720.94	31	
09/26/2000	10/30/2000	96,042,100	96,856,300	34	814,200	16.63	23,947	3,201	0		Sep-00	7,272.80	30	9,587.12
10/30/2000	11/27/2000	96,856,300	97,495,000	28	638,700	15.84	22,811	3,050			Oct-00	3,196.58	31	5,994.77
11/27/2000	12/21/2000	97,495,000	98,753,700	24	1,258,700	36.42	52,446	7,011	0	Rising well just off	Nov-00	3,445.75	30	
12/21/2000	01/26/2001	98,753,700	NM	36	-	-	-	-	0	down for rehab	Dec-00	7,011.48	31	
01/26/2001	02/27/2001	NM	NM	32	-	-	-	-		down for redevelop	Jan-01	-		
02/27/2001	03/30/2001	0	2,682,600	31	2,682,600	60.09	86,535	11,569	380	reset to 0 CG	Feb-01	-		
03/30/2001	04/25/2001	2,682,600	6,869,500	26	4,186,900	111.83	161,035	21,529	0		Mar-01	11,890.20		
04/25/2001	05/30/2001	6,869,500	16,115,900	35	9,246,400	183.46	264,183	35,319	375		Apr-01	22,649.72		
05/30/2001	06/26/2001	16,115,900	23,852,000	27	7,736,100	198.97	286,522	38,305	0		May-01	35,414.90		
06/26/2001	07/30/2001	23,852,000	29,692,000	34	5,840,000	119.28	171,765	22,963	380		Jun-01	36,259.52		
07/30/2001	08/27/2001	29,692,000	34,262,200	28	4,570,200	113.35	163,221	21,821	380		Jul-01	22,926.35		
08/27/2001	09/26/2001	34,262,200	39,741,600	30	5,479,400	126.84	182,647	24,418	380		Aug-01	22,156.14		
09/26/2001	10/26/2001	39,741,600	44,074,900	30	4,333,300	100.31	144,443	19,311	370		Sep-01	23,737.02		26,430.06
10/26/2001	11/28/2001	44,074,900	46,968,000	33	2,893,100	60.88	87,670	11,721	0		Oct-01	18,086.40		11,487.16
11/28/2001	12/27/2001	46,968,000	49,229,700	29	2,261,700	54.16	77,990	10,426	0		Nov-01	11,634.27		
12/27/2001	01/28/2002	49,229,700	52,672,500	32	3,442,800	74.71	107,588	14,383	0		Dec-01	10,937.00		
01/28/2002	02/28/2002	52,672,500	56,561,700	31	3,889,200	87.12	125,458	16,772	0		Jan-02			

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Time Period		METER READING (gallons)					Pumping Rate		Est. GPM	Comments
Start	End	START	END	Total Days	Total Gallons	gal/min	gal/day	ft3/day		
11/05/1998	12/03/1998	45,193,900	48,854,400	28	3,660,500	90.79	130,732	17,478		
12/03/1998	01/11/1999	48,854,400	55,437,200	39	6,582,800	117.22	168,790	22,565		
01/11/1999	01/28/1999	55,437,200	58,437,100	17	2,999,900	122.54	176,465	23,592		
01/28/1999	02/10/1999	58,437,100	60,981,400	13	2,544,300	135.91	195,715	26,165		
02/10/1999	03/02/1999	60,981,400	64,298,800	20	3,317,400	115.19	165,870	22,175		
03/02/1999	03/15/1999	64,298,800	66,574,300	13	2,275,500	121.55	175,038	23,401		
03/15/1999	04/19/1999	66,574,300	71,977,100	35	5,402,800	107.20	154,366	20,637		
04/19/1999	05/06/1999	71,977,100	73,174,300	17	1,197,200	48.91	70,424	9,415		
05/06/1999	05/13/1999	73,174,300	73,662,700	7	488,400	48.45	69,771	9,328		
05/13/1999	05/27/1999	73,662,700	76,105,300	14	2,442,600	121.16	174,471	23,325		
05/27/1999	06/15/1999	76,105,300	79,543,400	19	3,438,100	125.66	180,953	24,192		
06/15/1999	07/01/1999	79,543,400	82,047,400	16	2,504,000	108.68	156,500	20,922		
07/01/1999	07/20/1999	82,047,400	83,700,000	19	1,652,600	60.40	86,979	11,628		
07/20/1999	08/17/1999	83,700,000	84,807,400	28	1,107,400	27.47	39,550	5,287		
08/17/1999	09/23/1999	84,807,400	87,167,900	37	2,360,500	44.30	63,797	8,529	0	

Table B-2
Reported Pumpage Rates for Wells in Payson, Arizona
Payson PCE WQARF Site Groundwater Flow Model

Time Period		Meter Reading (gallons)				Pumping Rate			Est. GPM	Comments	Month	Model Pump Rate	Days	
Start	End	Start	End	Days	Gallons	gpm	gpd	ft3/day						
09/23/1999	10/28/1999	87,167,900	91,700,800	35	4,532,900	89.94	129,511	17,314	0		Month	Model Pump Rate	Days	
10/28/1999	12/02/1999	91,700,800	94,618,500	35	2,917,700	57.89	83,363	11,145			Nov-99	11,144.77		
12/02/1999	01/12/2000	94,618,500	96,090,400	41	1,471,900	24.93	35,900	4,799	0		Dec-99	5,208.84		
01/12/2000	02/22/2000	96,090,400	97,799,700	41	1,709,300	28.95	41,690	5,574	0		Jan-00	5,273.91	31	
02/22/2000	03/29/2000	97,799,700	100,099,982	36	2,300,282	44.37	63,897	8,542	160		Feb-00	6,290.16	29	
03/29/2000	04/27/2000	99,982	1,987,300	29	1,887,318	45.19	65,080	8,701	0		Mar-00	8,552.55	31	
04/27/2000	05/25/2000	1,387,300	4,792,700	28	3,405,400	84.46	121,621	16,260	150		Apr-00	9,456.43	30	
05/25/2000	06/27/2000	4,792,700	8,279,000	33	3,486,300	73.36	105,645	14,124	0		May-00	15,846.16	31	
06/27/2000	07/26/2000	8,279,000	10,777,900	29	2,498,900	59.84	86,169	11,520	150		Jun-00	13,863.34	30	
07/26/2000	08/29/2000	10,777,900	14,691,000	34	3,913,100	79.92	115,091	15,387	160		Jul-00	12,143.56	31	
08/29/2000	09/26/2000	14,691,000	17,270,000	28	2,579,000	63.96	92,107	12,314	160		Aug-00	15,188.28	31	
09/26/2000	10/30/2000	17,270,000	20,118,300	34	2,848,300	58.18	83,774	11,200			Sep-00	12,165.24	30	
10/30/2000	11/27/2000	20,118,300	20,939,000	28	820,700	20.35	29,311	3,919	0		Oct-00	10,964.79	31	
11/27/2000	12/21/2000	20,939,000	22,517,200	24	1,578,200	45.67	65,758	8,791	170		Nov-00	4,405.81	30	
12/21/2000	02/05/2001	22,517,200	26,016,900	46	3,499,700	52.83	76,080	10,171	0		Dec-00	9,236.37	31	
02/05/2001	02/27/2001	26,016,900	27,190,000	22	1,173,100	37.03	53,323	7,129	0	down for service	Jan-01	10,171.18		
02/27/2001	03/26/2001	27,190,000	28,058,100	27	868,100	22.33	32,152	4,298			Feb-01	7,570.92		
03/26/2001	04/25/2001	28,058,100	31,021,300	30	2,963,200	68.59	98,773	13,205	160		Mar-01	5,734.93		
04/25/2001	05/29/2001	31,021,300	34,786,700	34	3,765,400	76.91	110,747	14,806	160		Apr-01	13,471.79		
05/29/2001	06/26/2001	34,786,700	39,683,700	28	4,897,000	121.45	174,893	23,381	160		May-01	13,850.55		
06/26/2001	08/27/2001	39,683,700	47,621,000	62	7,937,300	88.90	128,021	17,115			Jun-01	22,545.89		
08/27/2001	09/26/2001	47,621,000	50,381,200	30	2,760,200	63.89	92,007	12,300	0		Jul-01	17,115.10		
09/26/2001	10/26/2001	50,381,200	52,136,600	30	1,755,400	40.63	58,513	7,823	160		Aug-01	14,906.70		
10/26/2001	11/28/2001	52,136,600	54,235,000	33	2,098,400	44.16	63,588	8,501	0		Sep-01	10,681.64		13,933.61
11/28/2001	12/27/2001	54,235,000	55,514,000	29	1,279,000	30.63	44,103	5,896	0		Oct-01	7932.06		7907.37
12/27/2001	01/28/2002	55,514,000	57,000,300	32	1,486,300	32.25	46,447	6,209	160		Nov-01	8248.97		
01/28/2002	02/28/2002	57,000,300	58,688,200	31	1,687,900	37.81	54,448	7,279	0		Dec-01	5936.61		

Julia Randall

Time Period		METER READING (gallons)				Pumping Rate			Est. GPM	Comments
Start	End	START	END	Total Days	Total Gallons	gal/min	gal/day	ft3/day		
06/26/1998	07/02/1998	10,190	271,970	6	261,780	30.30	43,630	5,833		
07/02/1998	07/09/1998	271,970	799,860	7	527,890	52.37	75,413	10,082		
07/09/1998	07/16/1998	799,860	1,281,550	7	481,690	47.79	68,813	9,200		
07/16/1998	07/23/1998	1,281,550	1,795,440	7	513,890	50.98	73,413	9,815		
07/23/1998	08/07/1998	1,795,440	2,802,980	15	1,007,540	46.65	67,169	8,980		
08/07/1998	08/13/1998	2,802,980	2,910,620	6	107,640	12.46	17,940	2,398		
08/13/1998	09/03/1998	2,910,620	3,694,160	21	783,540	25.91	37,311	4,988		
09/03/1998	09/17/1998	3,694,160	4,346,830	14	652,670	32.37	46,619	6,233		
09/17/1998	10/02/1998	4,346,830	5,109,370	15	762,540	35.30	50,836	6,796		
10/02/1998	10/21/1998	5,109,370	6,354,640	19	1,245,270	45.51	65,541	8,762		
10/21/1998	12/03/1998	6,354,640	8,765,590	43	2,410,950	38.94	56,069	7,496		
12/03/1998	01/11/1999	8,765,590	10,942,550	39	2,176,960	38.76	55,819	7,462		
01/11/1999	01/28/1999	10,942,550	11,557,260	17	614,710	25.11	36,159	4,834		
01/28/1999	02/10/1999	11,557,260	11,573,380	13	16,120	0.86	1,240	166		
02/10/1999	05/06/1999	11,573,380	13,834,400	85	2,261,020	18.47	26,600	3,556		
05/06/1999	06/15/1999	13,834,400	14,577,200	40	742,800	12.90	18,570	2,483		
06/15/1999	07/01/1999	14,577,200	15,279,000	16	701,800	30.46	43,863	5,864		

Mt. View, PE 24, WS-28

Time Period	METER READING (gallons)	Pumping Rate	Est. GPM	Comments

Table B-2
Reported Pumpage Rates for Wells in Payson, Arizona
Payson PCE WQARF Site Groundwater Flow Model

Time Period		Meter Reading (gallons)				Pumping Rate			Est. GPM	Comments	Month	Model Pump Rate	Days
Start	End	Start	End	Days	Gallons	gpm	gpd	ft3/day					
Start	End	START	END	Total Days	Total Gallons	gal/min	gal/day	ft3/day					
01/08/1998	01/22/1998	2,542,800	5,561,600	14	3,018,800	149.74	215,629	28,827					
01/22/1998	02/05/1998	5,561,600	8,489,000	14	2,927,400	145.21	209,100	27,955					
02/05/1998	02/19/1998	8,489,000	10,122,900	14	1,633,900	81.05	116,707	15,603					
02/19/1998	04/03/1998	10,122,900	10,122,900	43	-	-	-	-					
04/03/1998	04/16/1998	10,122,900	11,320,800	13	1,197,900	63.99	92,146	12,319					
04/16/1998	04/30/1998	11,320,800	13,475,100	14	2,154,300	106.86	153,879	20,572					
04/30/1998	05/15/1998	13,475,100	15,587,700	15	2,112,600	97.81	140,840	18,829					
05/15/1998	05/21/1998	15,587,700	16,736,600	6	1,148,900	132.97	191,483	25,599					
05/21/1998	05/29/1998	16,736,600	18,180,500	8	1,443,900	125.34	180,488	24,129					
05/29/1998	06/04/1998	18,180,500	19,345,000	6	1,164,500	134.78	194,083	25,947					
06/04/1998	06/11/1998	19,345,000	20,581,100	7	1,236,100	122.63	176,586	23,608					
06/11/1998	06/18/1998	20,581,100	21,756,600	7	1,175,500	116.62	167,929	22,450					
06/18/1998	06/26/1998	21,756,600	23,484,800	8	1,728,200	150.02	216,025	28,880					
06/26/1998	07/02/1998	23,484,800	24,815,600	6	1,330,800	154.03	221,800	29,652					
07/02/1998	07/09/1998	24,815,600	26,358,300	7	1,542,700	153.05	220,386	29,463					
07/09/1998	07/16/1998	26,358,300	27,780,700	7	1,422,400	141.11	203,200	27,166					
07/16/1998	07/23/1998	27,780,700	28,896,600	7	1,115,900	110.70	159,414	21,312					
07/23/1998	07/30/1998	28,896,600	29,832,700	7	936,100	92.87	133,729	17,878					
07/30/1998	08/13/1998	29,832,700	31,891,600	14	2,058,900	102.13	147,064	19,661					
08/13/1998	08/21/1998	31,891,600	32,639,400	8	747,800	64.91	93,475	12,497					
08/21/1998	09/03/1998	32,639,400	33,968,800	13	1,329,400	71.01	102,262	13,671					
09/03/1998	09/17/1998	33,968,800	36,689,500	14	2,720,700	134.96	194,336	25,981					
09/17/1998	10/02/1998	36,689,500	39,051,000	15	2,361,500	109.33	157,433	21,047					
10/02/1998	10/21/1998	39,051,000	42,790,200	19	3,739,200	136.67	196,800	26,310					
10/21/1998	11/05/1998	42,790,200	45,193,900	15	2,403,700	111.28	160,247	21,423					
11/05/1998	11/23/1998	45,193,900	47,368,300	18	2,174,400	83.89	120,800	16,150					
11/23/1998	12/03/1998	47,368,300	48,854,400	10	1,486,100	103.20	148,610	19,868					
12/03/1998	12/18/1998	48,854,400	51,534,700	15	2,680,300	124.09	178,687	23,889					
12/18/1998	01/11/1999	51,534,700	55,437,200	24	3,902,500	112.92	162,604	21,739					
01/11/1999	01/28/1999	55,437,200	58,437,100	17	2,999,900	122.54	176,465	23,592					
01/28/1999	02/10/1999	58,437,100	60,981,400	13	2,544,300	135.91	195,715	26,165					
02/10/1999	03/02/1999	60,981,400	64,298,800	20	3,317,400	115.19	165,870	22,175					
03/02/1999	03/15/1999	64,298,800	66,574,300	13	2,275,500	121.55	175,038	23,401					
03/15/1999	04/19/1999	66,574,300	71,977,100	35	5,402,800	107.20	154,366	20,637					
04/19/1999	05/06/1999	71,977,100	73,174,300	17	1,197,200	48.91	70,424	9,415					
05/06/1999	05/13/1999	73,174,300	73,662,700	7	488,400	48.45	69,771	9,328					
05/13/1999	05/27/1999	73,662,700	76,105,300	14	2,442,600	121.16	174,471	23,325					
05/27/1999	06/15/1999	76,105,300	79,543,400	19	3,438,100	125.66	180,953	24,192					
06/15/1999	07/01/1999	79,543,400	82,047,400	16	2,504,000	108.68	156,500	20,922					
07/01/1999	07/20/1999	82,047,400	83,700,000	19	1,652,600	60.40	86,979	11,628					
07/20/1999	08/17/1999	83,700,000	84,807,400	28	1,107,400	27.47	39,550	5,287					
08/17/1999	09/23/1999	84,807,400	87,167,900	37	2,360,500	44.30	63,797	8,529	0				
09/23/1999	10/28/1999	87,167,900	91,700,800	35	4,532,900	89.94	129,511	17,314	0				
10/28/1999	12/02/1999	91,700,800	94,618,500	35	2,917,700	57.89	83,363	11,145					
12/02/1999	01/12/2000	94,618,500	96,090,400	41	1,471,900	24.93	35,900	4,799	0				
01/12/2000	02/22/2000	96,090,400	97,799,700	41	1,709,300	28.95	41,690	5,574	0				
02/22/2000	03/29/2000	97,799,700	100,099,982	36	2,300,282	44.37	63,897	8,542	160				
03/29/2000	04/27/2000	99,982	1,987,300	29	1,887,318	45.19	65,080	8,701	0				
04/27/2000	05/25/2000	1,987,300	4,792,700	28	2,805,400	69.58	100,193	13,395	150				
05/25/2000	06/27/2000	4,792,700	8,279,000	33	3,486,300	73.36	105,645	14,124	0				

Table B-2
Reported Pumpage Rates for Wells in Payson, Arizona
Payson PCE WQARF Site Groundwater Flow Model

Time Period		Meter Reading (gallons)				Pumping Rate			Est. GPM	Comments	Month	Model Pump Rate	Days
Start	End	Start	End	Days	Gallons	gpm	gpd	ft3/day					
06/27/2000	07/26/2000	8,279,000	10,777,900	29	2,498,900	59.84	86,169	11,520	150				
07/26/2000	08/29/2000	10,777,900	14,691,000	34	3,913,100	79.92	115,091	15,387	160				
08/29/2000	09/26/2000	14,691,000	17,270,000	28	2,579,000	63.96	92,107	12,314	160				
09/26/2000	10/30/2000	17,270,000	20,118,300	34	2,848,300	58.18	83,774	11,200					
10/30/2000	11/27/2000	20,118,300	20,939,000	28	820,700	20.35	29,311	3,919	0				
11/27/2000	12/21/2000	20,939,000	22,517,200	24	1,578,200	45.67	65,758	8,791	170				
12/21/2000	02/05/2001	22,517,200	26,016,900	46	3,499,700	52.83	76,080	10,171	0				
02/05/2001	02/27/2001	26,016,900	27,190,000	22	1,173,100	37.03	53,323	7,129	0	down for service			
02/27/2001	03/26/2001	27,190,000	28,058,100	27	868,100	22.33	32,152	4,298					
03/26/2001	04/25/2001	28,058,100	31,021,300	30	2,963,200	68.59	98,773	13,205	160				
04/25/2001	05/29/2001	31,021,300	34,786,700	34	3,765,400	76.91	110,747	14,806	160				
05/29/2001	06/26/2001	34,786,700	39,683,700	28	4,897,000	121.45	174,893	23,381	160				
06/26/2001	08/27/2001	39,683,700	47,621,000	62	7,937,300	88.90	128,021	17,115					
08/27/2001	09/26/2001	47,621,000	50,381,200	30	2,760,200	63.89	92,007	12,300	0				
09/26/2001	10/26/2001	50,381,200	52,136,600	30	1,755,400	40.63	58,513	7,823	160				
10/26/2001	11/28/2001	52,136,600	54,235,000	33	2,098,400	44.16	63,588	8,501	0				
11/28/2001	12/27/2001	54,235,000	55,514,000	29	1,279,000	30.63	44,103	5,896	0				
12/27/2001	01/28/2002	55,514,000	57,000,300	32	1,486,300	32.25	46,447	6,209	160				
01/28/2002	02/28/2002	57,000,300	58,688,200	31	1,687,900	37.81	54,448	7,279	0				

Lake Drive, W-38

Time Period		METER READING (gallons)				Pumping Rate			Est. GPM	Comments
Start	End	START	END	Total Days	Total Gallons	gal/min	gal/day	ft3/day		
08/29/1997	09/12/1997	14,576,600	16676000	14	2,099,400	104.14	149,957	20,048		
09/12/1997	04/30/1998	16,676,000	49327300	230	32,651,300	98.58	141,962	18,979		
01/08/1998	01/22/1998	33,399,500	33,687,500	14	288,000	14.29	20,571	2,750		
01/22/1998	02/05/1998	33,687,500	34,215,300	14	527,800	26.18	37,700	5,040		
02/05/1998	02/19/1998	34,215,300	36,652,500	14	2,437,200	120.89	174,086	23,273		
02/19/1998	03/05/1998	36,652,500	38,907,200	14	2,254,700	111.84	161,050	21,531		
03/05/1998	03/19/1998	38,907,200	41,422,600	14	2,515,400	124.77	179,671	24,020		
03/19/1998	04/03/1998	41,422,600	43,907,500	15	2,484,900	115.04	165,660	22,147		
04/03/1998	04/16/1998	43,907,500	45,611,300	13	1,703,800	91.01	131,062	17,522		
04/16/1998	04/30/1998	45,611,300	47,853,900	14	2,242,600	111.24	160,186	21,415		
04/30/1998	05/15/1998	45,611,300	49,327,300	15	3,716,000	172.04	247,733	33,119		
05/15/1998	05/21/1998	49,327,300	49,327,300	6	-	-	-	-		
05/21/1998	05/29/1998	49,327,300	49,330,000	8	2,700	0.23	338	45		
05/29/1998	06/04/1998	49,330,000	49,330,000	6	-	-	-	-		
06/04/1998	06/11/1998	49,330,000	50,168,600	7	838,600	83.19	119,800	16,016		
06/11/1998	06/18/1998	50,168,600	51,158,000	7	989,400	98.15	141,343	18,896		
06/18/1998	06/26/1998	51,158,000	52,317,800	8	1,159,800	100.68	144,975	19,382		
06/26/1998	07/02/1998	52,317,800	52,896,200	6	578,400	66.94	96,400	12,888		
07/02/1998	07/16/1998	52,896,200	54,357,700	14	1,461,500	72.50	104,393	13,956		
07/16/1998	07/23/1998	54,357,700	55,253,500	7	895,800	88.87	127,971	17,108		
07/23/1998	07/30/1998	55,253,500	56,113,100	7	859,600	85.28	122,800	16,417		
07/30/1998	08/07/1998	56,113,100	57,004,500	8	891,400	77.38	111,425	14,896		
08/07/1998	08/13/1998	57,004,500	57,683,600	6	679,100	78.60	113,183	15,131		
08/13/1998	08/21/1998	57,683,600	58,290,700	8	607,100	52.70	75,888	10,145		
08/21/1998	09/03/1998	58,290,700	59,425,600	13	1,134,900	60.63	87,300	11,671		
09/03/1998	09/17/1998	59,425,600	60,727,800	14	1,302,200	64.59	93,014	12,435		
09/17/1998	10/02/1998	60,727,800	62,710,900	15	1,983,100	91.81	132,207	17,675		
10/02/1998	10/21/1998	62,710,900	65,618,200	19	2,907,300	106.26	153,016	20,457		

Table B-2
Reported Pumpage Rates for Wells in Payson, Arizona
Payson PCE WQARF Site Groundwater Flow Model

Time Period		Meter Reading (gallons)				Pumping Rate			Est. GPM	Comments	Month	Model Pump Rate	Days	
Start	End	Start	End	Days	Gallons	gpm	gpd	ft3/day						
10/21/1998	11/05/1998	65,618,200	67,185,500	15	1,567,300	72.56	104,487	13,969						
11/05/1998	11/23/1998	67,185,500	68,976,800	18	1,791,300	69.11	99,517	13,304						
11/23/1998	12/03/1998	68,976,800	70,183,600	10	1,206,800	83.81	120,680	16,134						
12/03/1998	12/18/1998	70,183,600	70,409,900	15	226,300	10.48	15,087	2,017						
12/18/1998	01/11/1999	70,409,900	73,344,600	24	2,934,700	84.92	122,279	16,347						
01/11/1999	01/28/1999	73,344,600	75,863,000	17	2,518,400	102.88	148,141	19,805						
01/28/1999	02/10/1999	75,863,000	77,640,700	13	1,777,700	94.96	136,746	18,282						
02/10/1999	03/02/1999	77,640,700	80,490,900	20	2,850,200	98.97	142,510	19,052						
03/02/1999	03/15/1999	80,490,900	82,458,600	13	1,967,700	105.11	151,362	20,235						
03/15/1999	04/19/1999	82,458,600	87,023,000	35	4,564,400	90.56	130,411	17,435						
04/19/1999	05/06/1999	87,023,000	89,514,200	17	2,491,200	101.76	146,541	19,591						
05/06/1999	05/13/1999	89,514,200	90,514,700	7	1,000,500	99.26	142,929	19,108						
05/13/1999	06/15/1999	90,514,700	95,298,700	33	4,784,000	100.67	144,970	19,381						
06/15/1999	07/01/1999	95,298,700	96,640,200	16	1,341,500	58.22	83,844	11,209						
07/01/1999	07/20/1999	96,640,200	98,146,000	19	1,505,800	55.04	79,253	10,595						
07/20/1999	08/17/1999	98,146,000	99,098,800	28	952,800	23.63	34,029	4,549						
08/17/1999	09/23/1999	99,098,800	101,196,100	37	2,097,300	39.36	56,684	7,578	0					
09/23/1999	10/28/1999	1,196,100	4,338,100	35	3,142,000	62.34	89,771	12,002	0		Month	Model Pump Rate	Days	
10/28/1999	12/01/1999	4,338,100	6,794,800	34	2,456,700	50.18	72,256	9,660	0		Nov-99	9,659.88		
12/01/1999	01/12/2000	6,794,800	8,110,900	42	1,316,100	21.76	31,336	4,189	0		Dec-99	4,189.27		
01/12/2000	02/22/2000	8,110,900	10,214,700	41	2,103,800	35.63	51,312	6,860			Jan-00	5,826.12	31	
02/22/2000	03/29/2000	10,214,700	12,238,692	36	2,023,992	39.04	56,222	7,516	150	* changed from 238	Feb-00	7,018.36	29	
03/29/2000	04/27/2000	12,238,692	14,272,200	29	2,033,508	48.70	70,121	9,374	160	Just on. *	Mar-00	7,636.19	31	
04/27/2000	05/25/2000	14,272,200	16,880,400	28	2,608,200	64.69	93,150	12,453	140		Apr-00	9,682.34	30	
05/25/2000	06/27/2000	16,880,400	20,094,500	33	3,214,100	67.64	97,397	13,021	148	Just on	May-00	12,563.10	31	
06/27/2000	07/26/2000	20,094,500	22,386,700	29	2,292,200	54.89	79,041	10,567	140		Jun-00	12,775.59	30	
07/26/2000	08/29/2000	22,386,700	25,503,500	34	3,116,800	63.66	91,671	12,255	140		Jul-00	10,839.35	31	
08/29/2000	09/26/2000	25,503,500	27,583,000	28	2,079,500	51.57	74,268	9,929	140		Aug-00	12,105.33	31	
09/26/2000	10/30/2000	27,583,000	28,862,000	34	1,279,000	26.12	37,618	5,029	140		Sep-00	9,275.56	30	
10/30/2000	11/27/2000	28,862,000	29,521,300	28	659,300	16.35	23,546	3,148			Oct-00	4,968.41	31	
11/27/2000	12/21/2000	29,521,300	30,793,400	24	1,272,100	36.81	53,004	7,086	140		Nov-00	3,541.74	30	
12/21/2000	01/26/2001	30,793,400	32,945,400	36	2,152,000	41.51	59,778	7,992	140		Dec-00	7,378.24	31	
01/26/2001	02/27/2001	32,945,400	34,781,200	32	1,835,800	39.84	57,369	7,670	142		Jan-01	7939.74		
02/27/2001	03/26/2001	34,781,200	36,493,700	27	1,712,500	44.05	63,426	8,479			Feb-01	7698.54		
03/26/2001	04/25/2001	36,493,700	38,269,600	30	1,775,900	41.11	59,197	7,914	140		Mar-01	8388.21		
04/25/2001	05/29/2001	38,269,600	41,442,700	34	3,173,100	64.81	93,326	12,477	140		Apr-01	8674.46		
05/29/2001	06/26/2001	41,442,700	44,452,700	28	3,010,000	74.65	107,500	14,372	140		May-01	12599.05		
06/26/2001	07/30/2001	44,452,700	46,650,600	34	2,197,900	44.89	64,644	8,642	140		Jun-01	13607.74		
07/30/2001	08/27/2001	46,620,600	48,325,700	28	1,705,100	42.29	60,896	8,141	0		Jul-01	8626.10		
08/27/2001	09/26/2001	48,325,700	50,253,400	30	1,927,700	44.62	64,257	8,590	140		Aug-01	8199.20		7,159.21
09/26/2001	10/26/2001	50,253,400	51,684,300	30	1,430,900	33.12	47,697	6,377	140		Sep-01	8295.28		10,033.26
10/26/2001	11/28/2001	51,684,300	53,515,100	33	1,830,800	38.53	55,479	7,417	0		Oct-01	6544.36		
11/28/2001	12/27/2001	53,515,100	54,673,800	29	1,158,700	27.75	39,955	5,342	0		Nov-01	7216.11		
12/27/2001	01/30/2002	54,673,800	56,107,500	34	1,433,700	29.28	42,168	5,637	140		Dec-01	5379.77		
01/30/2002	02/28/2002	56,107,500	57,544,700	29	1,437,200	34.42	49,559	6,625	0		Jan-02			

Country Club #2

Time Period		METER READING (gallons)				Pumping Rate				
Start	End	START	END	Total Days	Total Gallons	gal/min	gal/day	ft3/day	Est. GPM	Comments
01/08/1998	01/22/1998	21,257,900	21,947,500	14	689,600	34.21	49,257	6,585		
01/22/1998	02/05/1998	21,947,500	22,629,700	14	682,200	33.84	48,729	6,515		

Table B-2
Reported Pumpage Rates for Wells in Payson, Arizona
Payson PCE WQARF Site Groundwater Flow Model

Time Period		Meter Reading (gallons)				Pumping Rate			Est. GPM	Comments	Month	Model Pump Rate	Days
Start	End	Start	End	Days	Gallons	gpm	gpd	ft3/day					
02/05/1998	02/19/1998	22,629,700	23,325,800	14	696,100	34.53	49,721	6,647					
02/19/1998	04/03/1998	23,325,800	24,282,500	43	956,700	15.45	22,249	2,974					
04/03/1998	04/16/1998	24,282,500	24,915,000	13	632,500	33.79	48,654	6,505					
04/16/1998	04/30/1998	24,915,000	25,602,300	14	687,300	34.09	49,093	6,563					
04/30/1998	05/15/1998	25,602,300	26,352,300	15	750,000	34.72	50,000	6,684					
05/15/1998	05/21/1998	26,352,300	26,656,700	6	304,400	35.23	50,733	6,783					
05/21/1998	05/29/1998	26,656,700	27,046,300	8	389,600	33.82	48,700	6,511					
05/29/1998	06/04/1998	27,046,300	27,354,100	6	307,800	35.63	51,300	6,858					
06/04/1998	06/11/1998	27,354,100	27,705,700	7	351,600	34.88	50,229	6,715					
06/11/1998	06/18/1998	27,705,700	28,069,800	7	364,100	36.12	52,014	6,954					
06/18/1998	06/26/1998	28,069,800	28,477,500	8	407,700	35.39	50,963	6,813					
06/26/1998	07/02/1998	28,477,500	28,790,500	6	313,000	36.23	52,167	6,974					
07/02/1998	07/09/1998	28,790,500	29,154,600	7	364,100	36.12	52,014	6,954					
07/09/1998	07/16/1998	29,154,600	29,514,700	7	360,100	35.72	51,443	6,877					
07/16/1998	07/23/1998	29,514,700	29,881,300	7	366,600	36.37	52,371	7,002					
07/23/1998	07/30/1998	29,881,300	30,222,900	7	341,600	33.89	48,800	6,524					
07/30/1998	08/07/1998	30,222,900	30,628,100	8	405,200	35.17	50,650	6,771					
08/07/1998	08/13/1998	30,628,100	30,933,600	6	305,500	35.36	50,917	6,807					
08/13/1998	08/21/1998	30,933,600	31,329,800	8	396,200	34.39	49,525	6,621					
08/21/1998	09/03/1998	31,329,800	31,988,800	13	659,000	35.20	50,692	6,777					
09/03/1998	09/17/1998	31,988,800	32,684,700	14	695,900	34.52	49,707	6,645					
09/17/1998	10/02/1998	32,684,700	33,208,000	15	523,300	24.23	34,887	4,664					
10/02/1998	10/21/1998	33,208,000	33,992,500	19	784,500	28.67	41,289	5,520					
10/21/1998	11/05/1998	33,992,500	34,798,200	15	805,700	37.30	53,713	7,181					
11/05/1998	11/23/1998	34,798,200	35,727,200	18	929,000	35.84	51,611	6,900					
11/23/1998	12/03/1998	35,727,200	36,239,800	10	512,600	35.60	51,260	6,853					
12/03/1998	12/18/1998	36,239,800	36,983,800	15	744,000	34.44	49,600	6,631					
12/18/1998	01/11/1999	36,983,800	38,199,700	24	1,215,900	35.18	50,663	6,773					
01/11/1999	01/28/1999	38,199,700	39,047,400	17	847,700	34.63	49,865	6,666					
01/28/1999	02/10/1999	39,047,400	39,691,200	13	643,800	34.39	49,523	6,621					
02/10/1999	03/02/1999	39,691,200	40,549,900	20	858,700	29.82	42,935	5,740					
03/02/1999	03/15/1999	40,549,900	40,687,600	13	137,700	7.36	10,592	1,416					
03/15/1999	04/19/1999	40,687,600	42,385,100	35	1,697,500	33.68	48,500	6,484					
04/19/1999	05/06/1999	42,385,100	43,227,400	17	842,300	34.41	49,547	6,624					
05/06/1999	05/13/1999	43,227,400	43,567,800	7	340,400	33.77	48,629	6,501					
05/13/1999	05/27/1999	43,567,800	44,254,900	14	687,100	34.08	49,079	6,561					
05/27/1999	06/15/1999	44,254,900	45,169,100	19	914,200	33.41	48,116	6,433					
06/15/1999	07/01/1999	45,169,100	45,934,400	16	765,300	33.22	47,831	6,395					
07/01/1999	07/20/1999	45,934,400	46,830,400	19	896,000	32.75	47,158	6,305					
07/20/1999	08/17/1999	46,830,400	47,127,200	28	296,800	7.36	10,600	1,417					
08/17/1999	09/23/1999	47,127,200	48,597,900	37	1,470,700	27.60	39,749	5,314	35				
09/23/1999	10/28/1999	48,597,900	50,298,300	35	1,700,400	33.74	48,583	6,495	34		Month	Model Pump Rate	Days
10/28/1999	12/02/1999	50,298,300	50,877,100	35	578,800	11.48	16,537	2,211			Nov-99	2,210.85	
12/02/1999	01/12/2000	50,877,100	50,877,100	41	-	-	-	-	~34	meter stuck	Dec-99	6,500.00	
01/12/2000	02/22/2000	50,877,100	50,877,100	41	-	-	-	-	~32	meter stuck	Jan-00	6,500.00	
02/22/2000	03/29/2000	50,877,100	51,241,900	36	364,800	7.04	10,133	1,355	34	meter not working	Feb-00	6,000.00	
03/29/2000	04/27/2000	51,241,900	52,276,900	29	1,035,000	24.78	35,690	4,771	34		Mar-00	6,000.00	
04/27/2000	05/25/2000	52,276,900	53,605,300	28	1,328,400	32.95	47,443	6,343	33		Apr-00	4,928.47	
05/25/2000	06/27/2000	53,605,300	55,168,900	33	1,563,600	32.90	47,382	6,334	34		May-00	6,341.05	
06/27/2000	07/26/2000	55,168,900	56,023,700	29	854,800	20.47	29,476	3,941	34	meter stuck	Jun-00	6,095.08	
07/26/2000	08/29/2000	56,025,100	57,049,400	34	1,024,300	20.92	30,126	4,028	32		Jul-00	6,000.00	
08/29/2000	09/26/2000	57,049,400	57,162,200	28	112,800	2.80	4,029	539	~34	meter stuck	Aug-00	4,028.00	

Table B-2
Reported Pumpage Rates for Wells in Payson, Arizona
Payson PCE WQARF Site Groundwater Flow Model

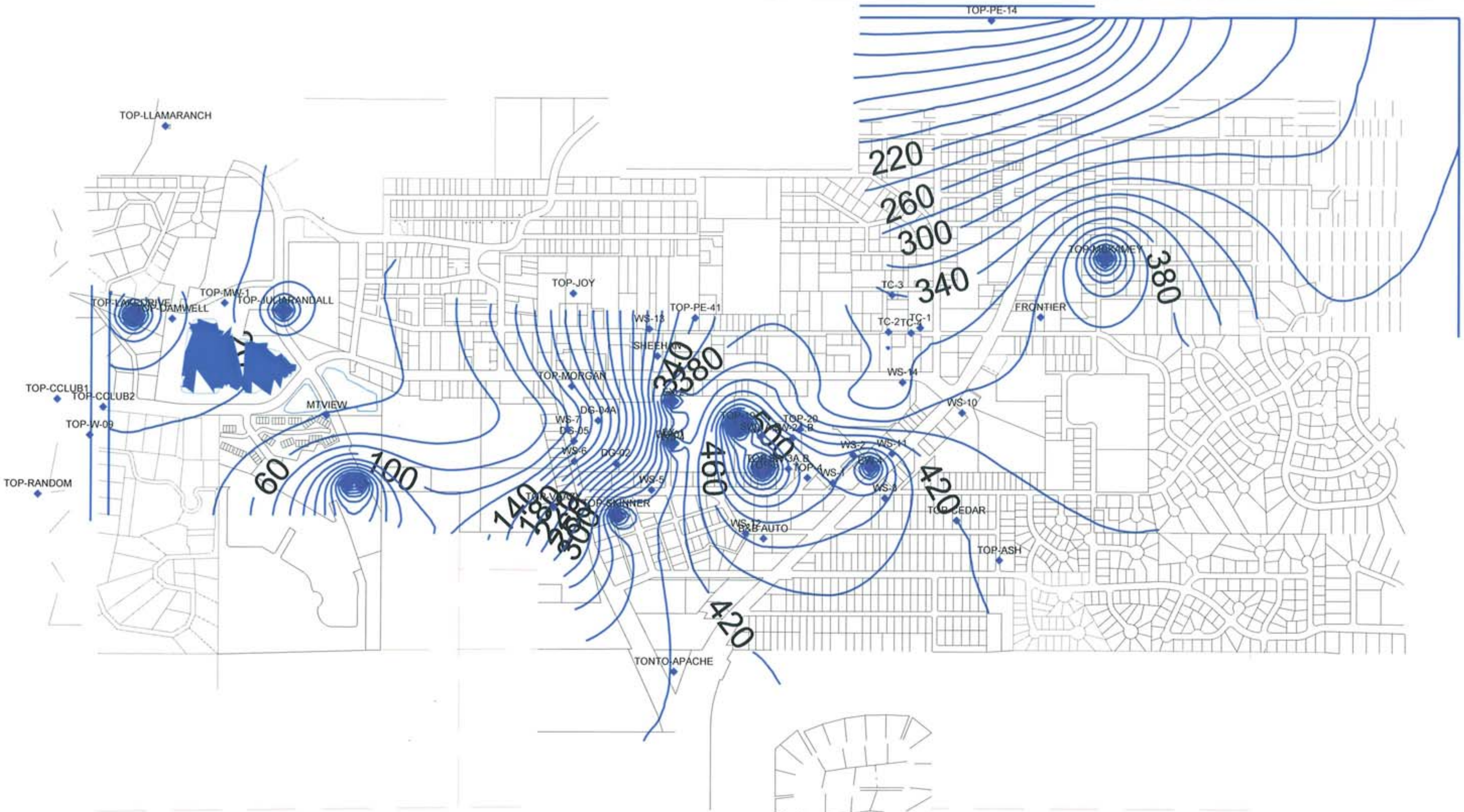
Time Period		Meter Reading (gallons)				Pumping Rate			Est. GPM	Comments	Month	Model Pump Rate	Days	
Start	End	Start	End	Days	Gallons	gpm	gpd	ft3/day						
09/26/2000	10/30/2000	57,162,200	57,673,600	34	511,400	10.45	15,041	2,011	32		Sep-00	5,000.00		
10/30/2000	11/27/2000	57,673,600	58,946,500	28	1,272,900	31.57	45,461	6,078	34		Oct-00	2,011.00		
11/27/2000	12/21/2000	58,946,500	59,248,500	24	302,000	8.74	12,583	1,682	34	meter stuck	Nov-00	5,638.10		
12/21/2000	02/05/2001	59,248,500	60,546,300	46	1,297,800	19.59	28,213	3,772	32		Dec-00	2,356.31		
02/05/2001	02/27/2001	60,546,300	61,559,700	22	1,013,400	31.99	46,064	6,158	32		Jan-01	3,771.80	31	
02/27/2001	03/26/2001	61,559,700	62,827,300	27	1,267,600	32.60	46,948	6,276	32		Feb-01	5,736.31	29	
03/26/2001	04/25/2001	62,827,300	63,902,900	30	1,075,600	24.90	35,853	4,793	32	meter stuck	Mar-01	5,264.15	31	
04/25/2001	05/29/2001	63,902,900	64,129,600	34	226,700	4.63	6,668	891	32		Apr-01	5,000.00	30	
05/29/2001	06/26/2001	64,129,600	65,198,600	28	1,069,000	26.51	38,179	5,104	34		May-01	5,000.00	31	
06/26/2001	07/30/2001	65,198,600	66,349,300	34	1,150,700	23.50	33,844	4,525	32		Jun-01	5,010.62	30	
07/30/2001	08/27/2001	66,349,300	66,889,600	28	540,300	13.40	19,296	2,580	34		Jul-01	4,461.88	31	
08/27/2001	10/04/2001	66,889,600	66,889,600	38	-	-	-	-	34	meter stuck	Aug-01	2,892.03	31	4,921.54
10/04/2001	10/26/2001	66,889,000	NM	22	#VALUE!	#VALUE!	#VALUE!	#VALUE!	34	meter stuck - 7 psi	Sep-01	5,000.00	30	4,736.64
10/26/2001	11/28/2001	NM	NM	33	#VALUE!	#VALUE!	#VALUE!	#VALUE!	34	meter stuck	Oct-01	5,000.00	31	
11/28/2001	12/27/2001	66,889,000	67,695,000	29	806,000	19.30	27,793	3,716	32	start meter assumec	Nov-01	5,000.00	30	
12/27/2001	01/28/2002	67,695,000	69,103,700	32	1,408,700	30.57	44,022	5,885	32		Dec-01	3,995.61	31	
01/28/2002	02/28/2002	69,103,700	70,485,800	31	1,382,100	30.96	44,584	5,960	30					

Country Club #1

Time Period		METER READING (gallons)					Pumping Rate		Est. GPM	Comments			
Start	End	START	END	Total Days	Total Gallons	gal/min	gal/day	ft3/day					
11/05/1998	11/23/1998	4,796,000	5,031,000	18	235,000	9.07	13,056	1,745					
11/23/1998	12/03/1998	5,031,000	5,244,000	10	213,000	14.79	21,300	2,848					
12/03/1998	12/18/1998	5,244,000	6,388,000	15	1,144,000	52.96	76,267	10,196					
12/18/1998	01/11/1999	6,388,000	6,687,000	24	299,000	8.65	12,458	1,666					
01/28/1999	02/10/1999	123,900	530,900	13	407,000	21.74	31,308	4,186					
02/10/1999	03/02/1999	530,900	1,289,300	20	758,400	26.33	37,920	5,070					
03/02/1999	03/15/1999	1,289,300	1,890,600	13	601,300	32.12	46,254	6,184					
03/15/1999	04/19/1999	1,890,600	2,943,200	35	1,052,600	20.88	30,074	4,021					
04/19/1999	05/06/1999	2,943,200	3,790,700	17	847,500	34.62	49,853	6,665					
05/06/1999	05/13/1999	3,790,700	4,272,700	7	482,000	47.82	68,857	9,206					
05/13/1999	05/27/1999	4,272,700	5,410,200	14	1,137,500	56.42	81,250	10,862					
05/27/1999	06/15/1999	5,410,200	6,909,400	19	1,499,200	54.80	78,905	10,549					
06/15/1999	07/01/1999	6,909,400	8,224,100	16	1,314,700	57.06	82,169	10,985					
07/01/1999	07/20/1999	8,224,100	8,548,400	19	324,300	11.85	17,068	2,282					
07/20/1999	08/17/1999	8,548,400	9,726,600	28	1,178,200	29.22	42,079	5,625					
08/17/1999	09/23/1999	9,726,600	11,939,600	37	2,213,000	41.54	59,811	7,996	100				
09/23/1999	10/28/1999	11,939,600	14,239,900	35	2,300,300	45.64	65,723	8,786	100	120 psf	Month	Model Pump Rate	Days
10/28/1999	12/02/1999	14,239,900	16,363,500	35	2,123,600	42.13	60,674	8,112	100		Nov-99	8,111.54	
12/02/1999	01/12/2000	16,363,500	16,995,800	41	632,300	10.71	15,422	2,062	0		Dec-99	2,452.07	
01/12/2000	02/22/2000	16,995,800	17,518,800	41	523,000	8.86	12,756	1,705	120	meter stuck	Jan-00	1,843.32	31
02/22/2000	03/29/2000	17,518,800	17,519,400	36	600	0.01	17	2			Feb-00	1,294.26	29
03/29/2000	04/27/2000	17,519,400	17,519,800	29	400	0.01	14	2	0		Mar-00	4,000.00	31
04/27/2000	05/25/2000	17,519,800	17,520,300	28	500	0.01	18	2	120	meter stuck	Apr-00	4,000.00	30
05/25/2000	06/27/2000	17,520,300	17,521,800	33	1,500	0.03	45	6	0		May-00	4,000.00	31
06/27/2000	07/26/2000	17,521,800	17,523,600	29	1,800	0.04	62	8	110	meter stuck	Jun-00	4,000.00	30
07/26/2000	08/29/2000	17,523,600	17,525,300	34	1,700	0.03	50	7	0		Jul-00	4,000.00	31
08/29/2000	09/26/2000	17,525,300	17,528,500	28	3,200	0.08	114	15	~110	meter stuck	Aug-00	4,000.00	31
09/26/2000	10/30/2000	17,528,500	1,067,770	34	1,067,770	21.81	31,405	4,199	0		Sep-00	4,000.00	30
10/30/2000	11/27/2000	1,067,770	1,640,930	28	573,160	14.22	20,470	2,737		Total reset from 16.4	Oct-00	4,000.00	31
11/27/2000	12/21/2000	1,640,930	2,747,400	24	1,106,470	32.02	46,103	6,163	112	Total reset from 16.4	Nov-00	3,162.97	30

Table B-2
Reported Pumpage Rates for Wells in Payson, Arizona
Payson PCE WQARF Site Groundwater Flow Model

Time Period		Meter Reading (gallons)				Pumping Rate			Est. GPM	Comments	Month	Model Pump Rate	Days	
Start	End	Start	End	Days	Gallons	gpm	gpd	ft3/day						
12/21/2000	02/05/2001	2,747,400	5,216,920	46	2,469,520	37.28	53,685	7,177	0		Dec-00	7,000.00	31	
02/05/2001	02/27/2001	5,216,920	6,214,330	22	997,410	31.48	45,337	6,061	110		Jan-01	7,177.17	31	
02/27/2001	03/26/2001	6,214,330	7,700,140	27	1,485,810	38.22	55,030	7,357		off	Feb-01	6,061.07	29	
03/26/2001	04/25/2001	7,700,140	9,226,910	30	1,526,770	35.34	50,892	6,804	112		Mar-01	6,170.35	31	
04/25/2001	05/29/2001	9,226,910	1,714,810	34	2,487,900	50.81	73,174	9,783	100		Apr-01	7,300.25	30	
05/29/2001	06/26/2001	1,714,810	4,068,120	28	2,353,310	58.37	84,047	11,236	100		May-01	9,876.34	31	
06/26/2001	08/27/2001	4,068,120	7,329,110	62	3,260,990	36.53	52,597	7,032	110		Jun-01	10,675.59	30	
08/27/2001	10/04/2001	7,329,110	9,056,560	38	1,727,450	31.57	45,459	6,077	110		Jul-01	7,031.63	31	
10/04/2001	10/26/2001	9,056,560	426,040	22	1,369,480	43.23	62,249	8,322	110		Aug-01	7,104.56	31	4,964.11
10/26/2001	11/28/2001	426,040	2,005,910	33	1,579,870	33.25	47,875	6,400	0		Sep-01	6,077.43	30	6,064.81
11/28/2001	12/27/2001	2,005,910	3,007,120	29	1,001,210	23.98	34,524	4,616	0		Oct-01	8,012.12	31	
12/27/2001	01/28/2002	3,007,120	4,163,070	32	1,155,950	25.09	36,123	4,829	123		Nov-01	6,281.39	30	

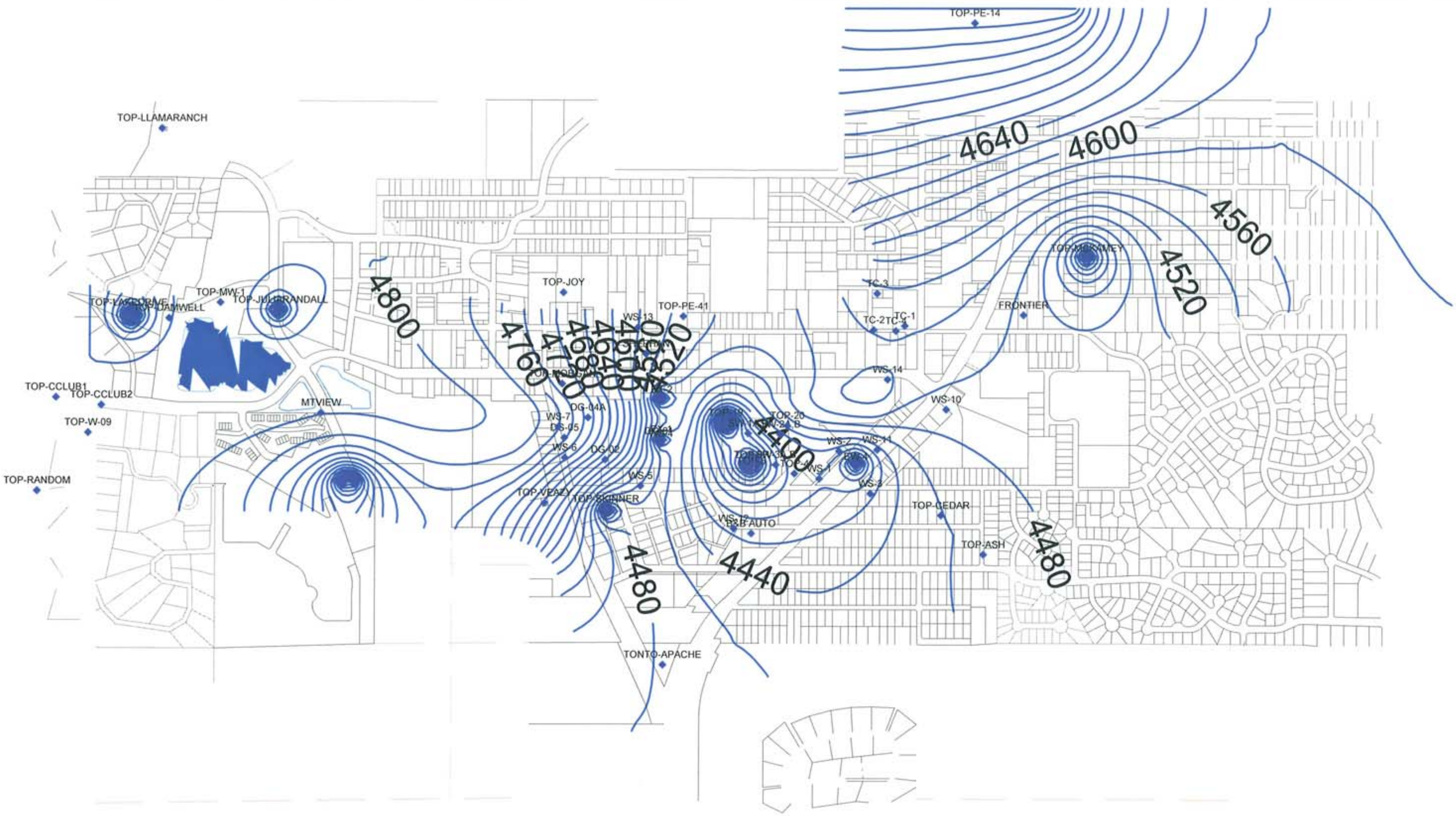


GeoTrans, Inc.

Payson PCE WQARF Site
Arizona Department of Environmental Quality

Simulated Drawdown
FS Water Supply Simulation
October 2106 (Feet)

FIGURE
B2

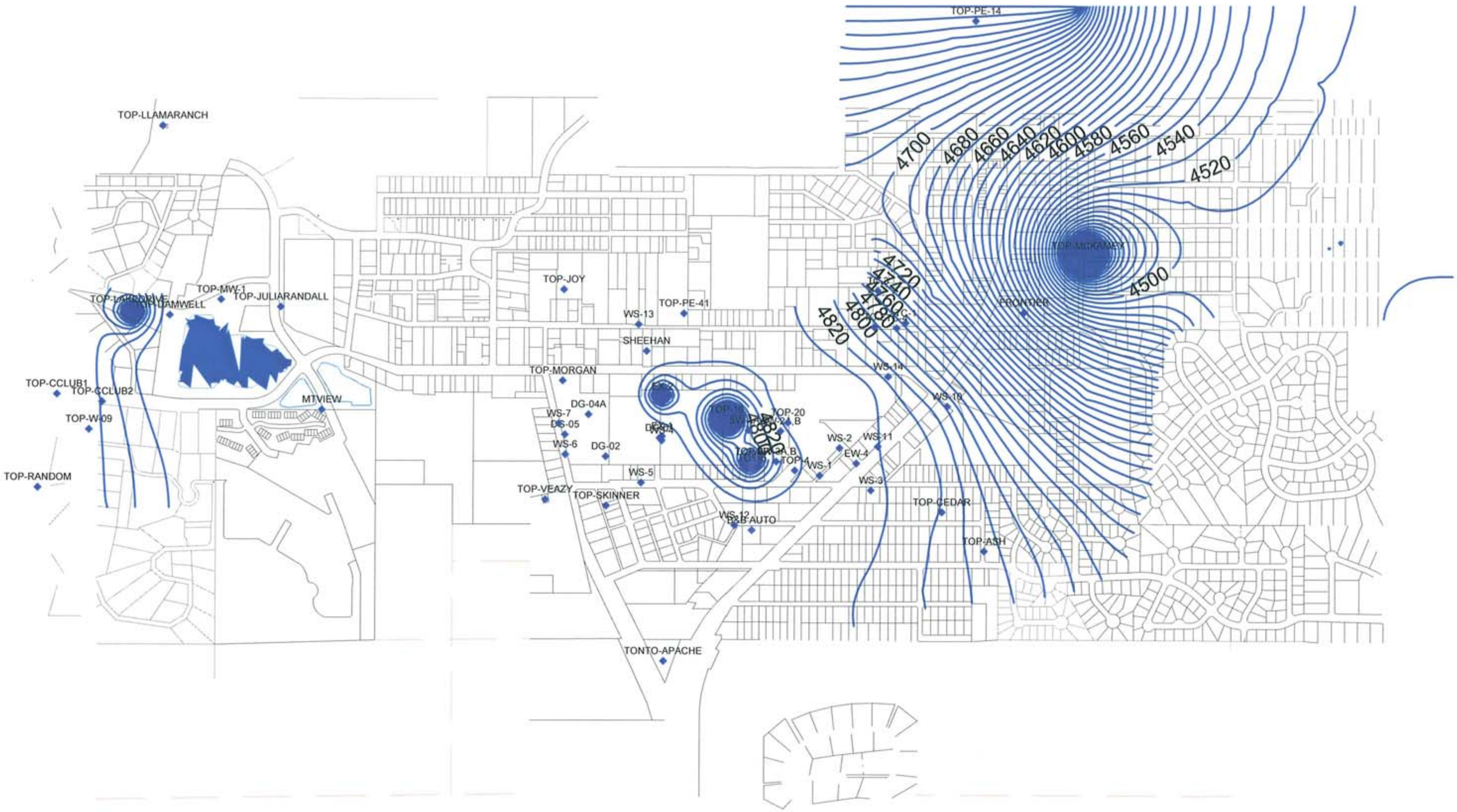


GeoTrans, Inc.

Payson PCE WQARF Site
Arizona Department of Environmental Quality

Simulated Heads
FS Water Supply Simulation
October 2106 (Feet)

FIGURE
B3



GeoTrans, Inc.

Payson PCE WQARF Site
Arizona Department of Environmental Quality

Simulated Heads
FS Base Model Simulation
October 2001 (Feet-MSL)

FIGURE
B4

LEGEND:

- Extraction Well - Operating
- Extraction Well - Not Operating
- Monitor Well
- 4839.90 Water Level Elevation
- NM Not Measured
- Inferred Groundwater Contour
- Abandoned Well

NOTES:

1. Water Level Elevations are in Feet Above Mean Sea Level

0 300 600

SCALE IN FEET

URS

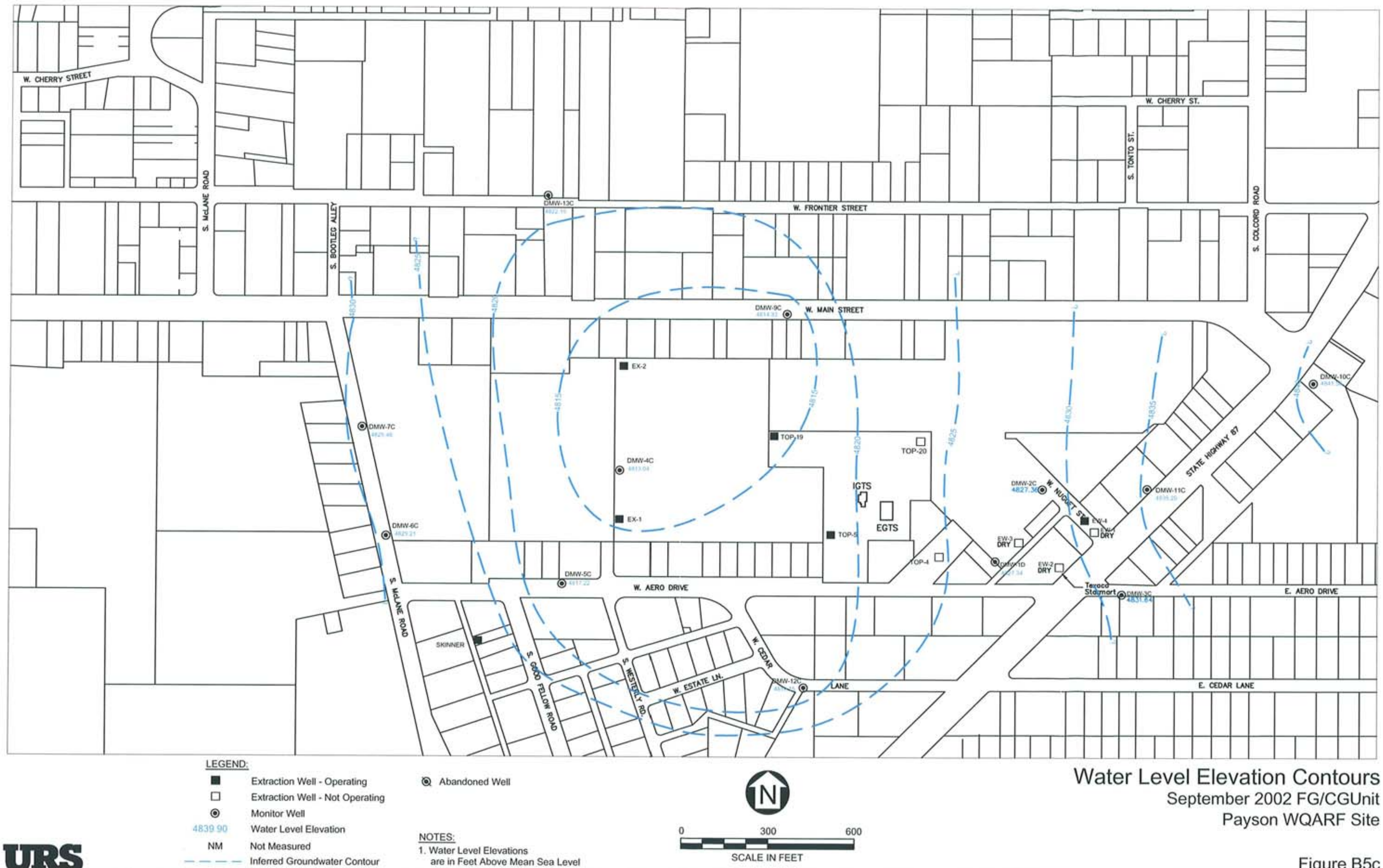
Water Level Elevation Contours

September 2002 DG/FG Unit

Payson WQARF Site

Figure B5b

O:\AutoCAD\Old D&M022\1WORLD\23442636\A15852.DWG 4-8-03 XREF:PAYSON1.DWG



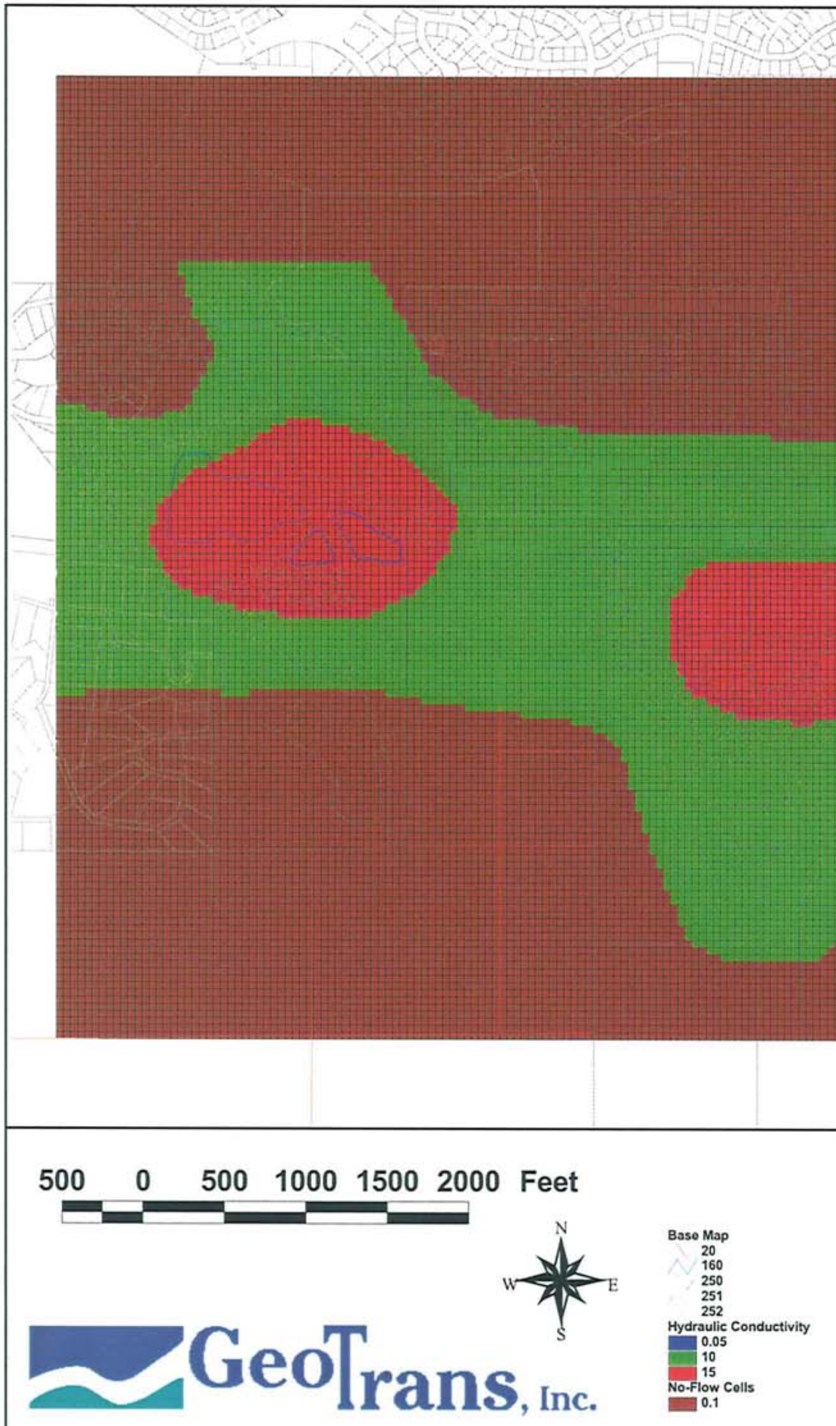
NOTES:
1. Water Level Elevations are in Feet Above Mean Sea Level

URS

Water Level Elevation Contours
September 2002 FG/CGUnit
Payson WQARF Site

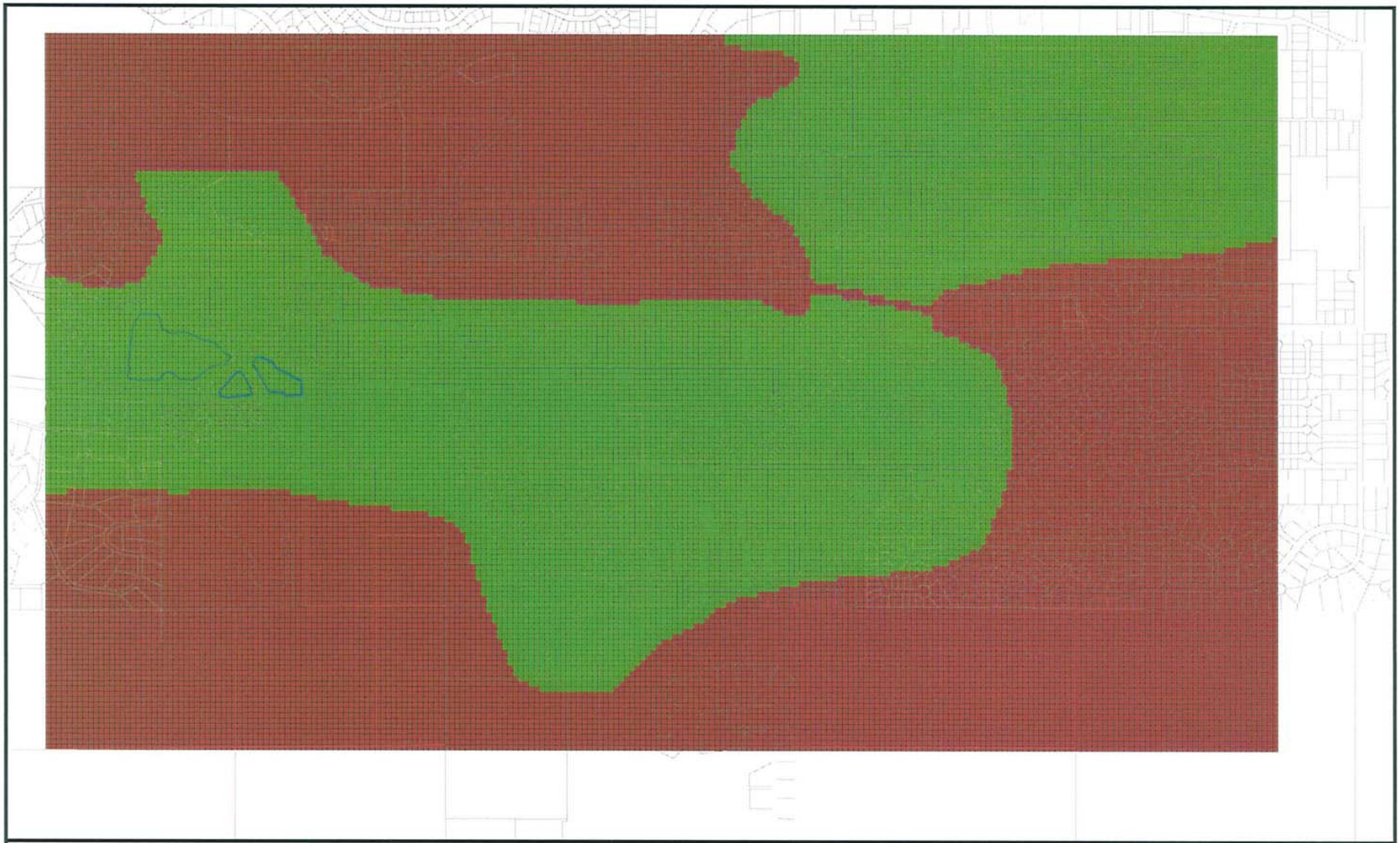
Figure B5c

0:\AutoCAD\Old D&M022\1WORLD\23442636\A15853.DWG 4-8-03 XREF:PAYSON1.DWG



Lower Hydraulic Conductivity
Near McKamey Well
Payson FS Model Update

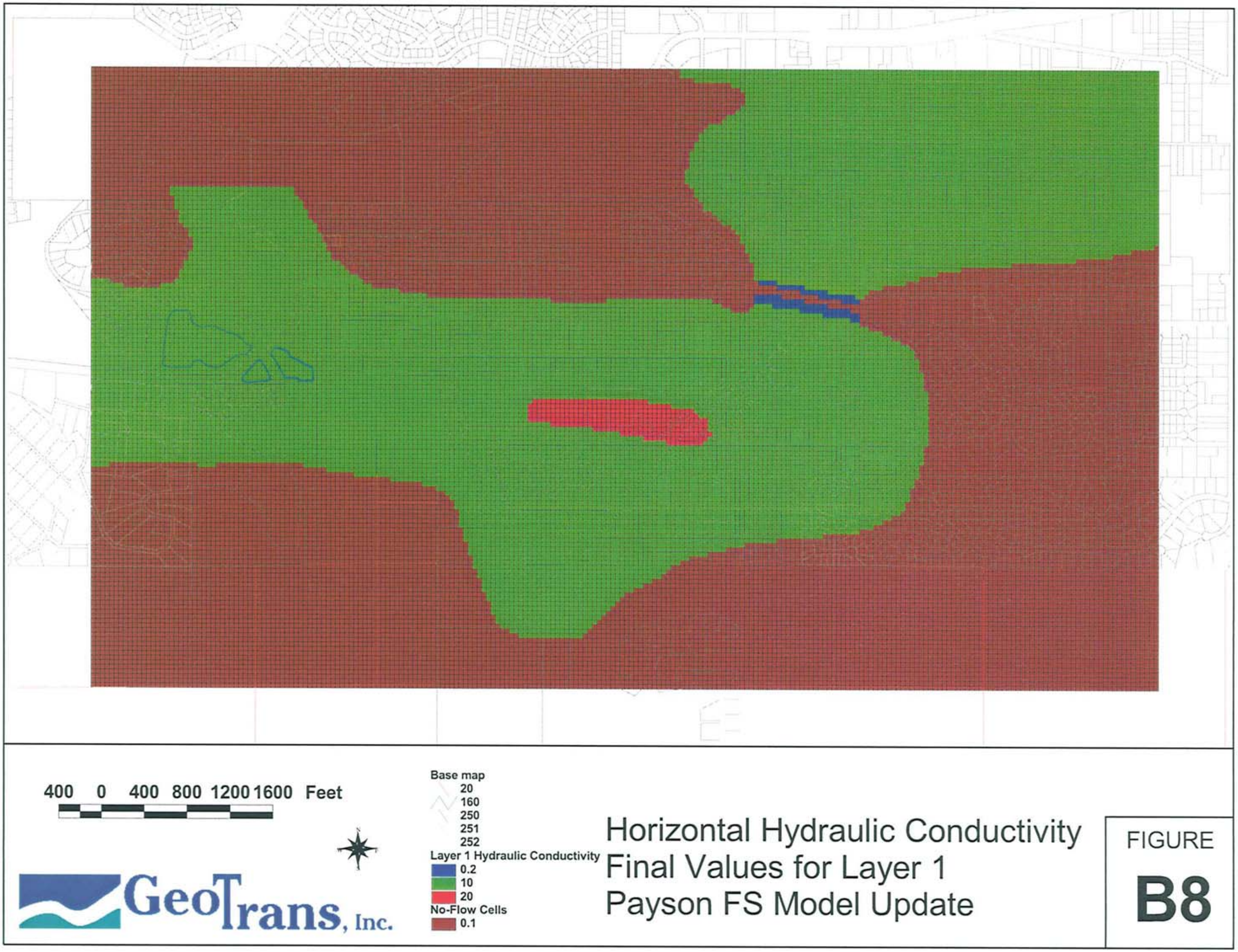
FIGURE
B6



Active Cells
FS Groundwater Flow Model Update
Payson PCE WQARF Site

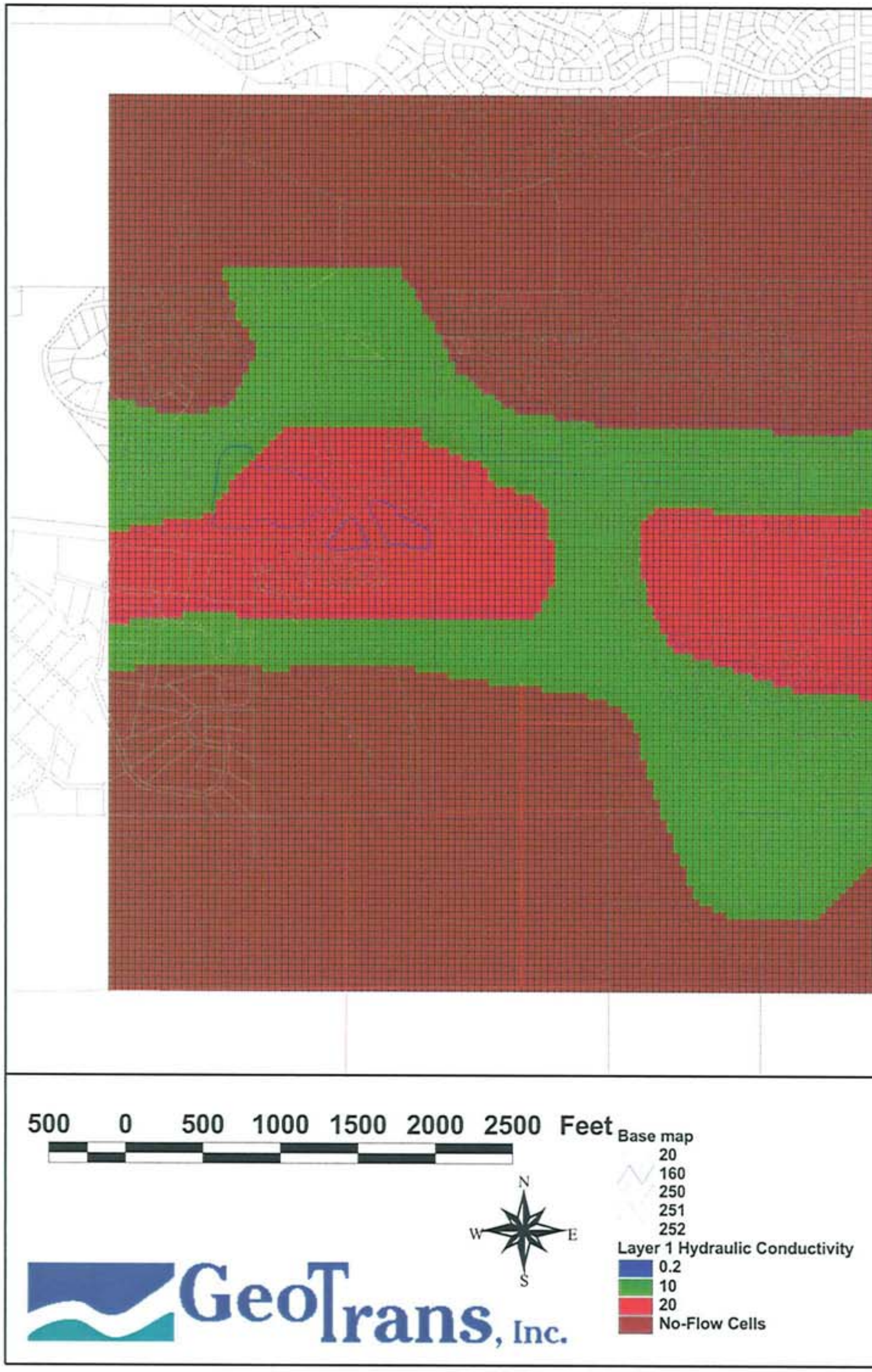
FIGURE
B7

GeoTrans, Inc.



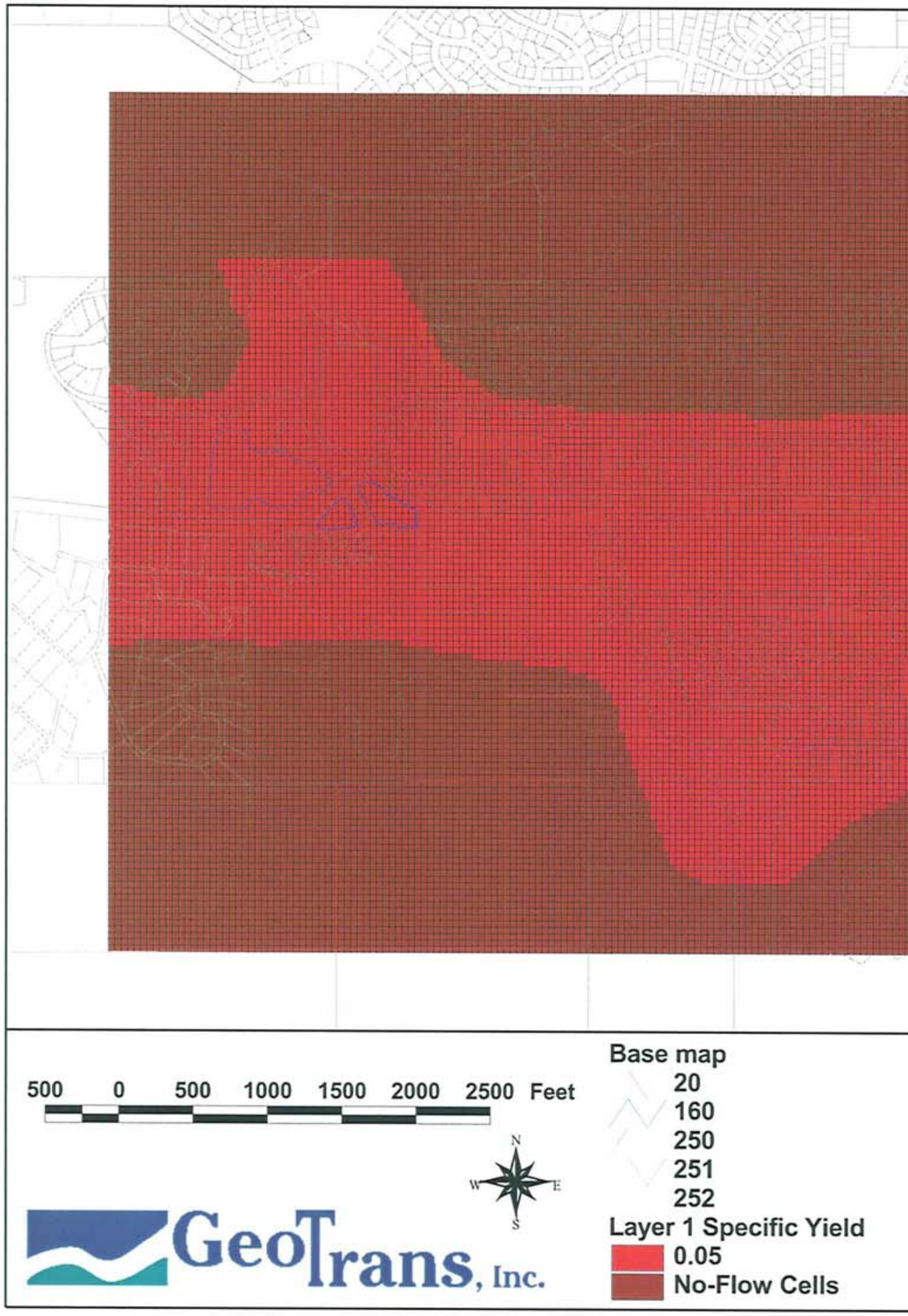
Horizontal Hydraulic Conductivity
Final Values for Layer 1
Payson FS Model Update

FIGURE
B8



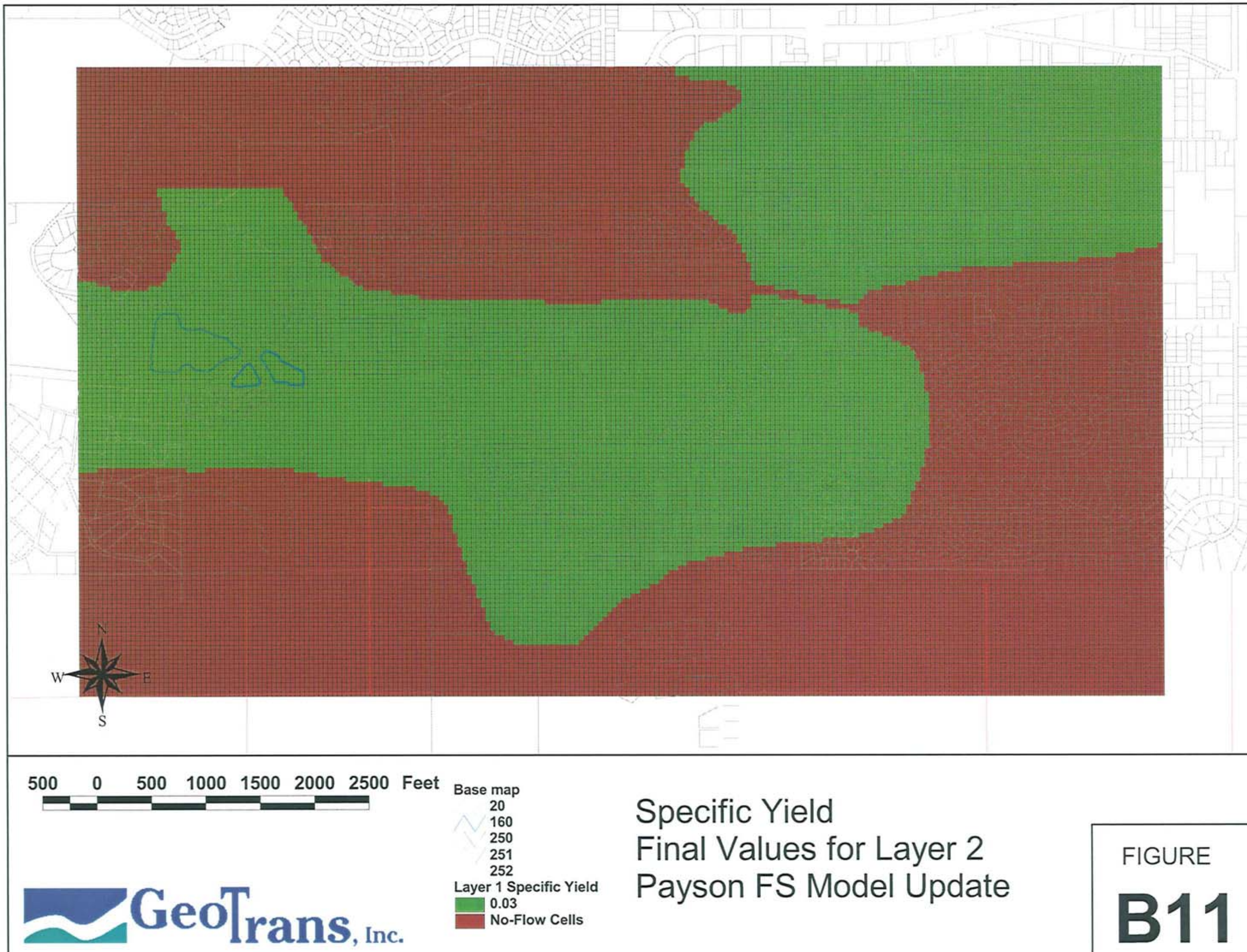
Horizontal Hydraulic Conductivity
Final Values for Layer 2
Payson FS Model Update

FIGURE
B9



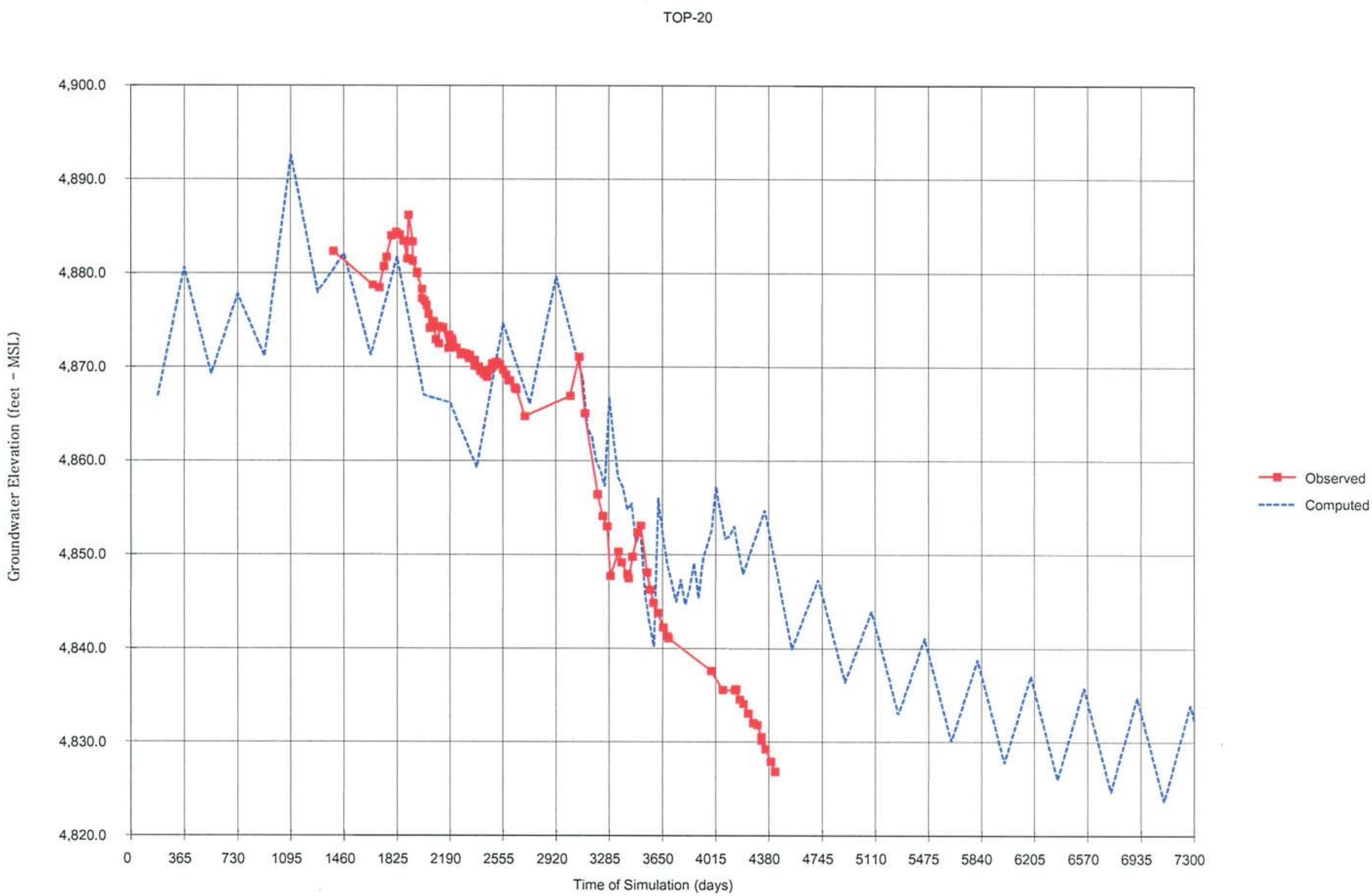
Specific Yield
Final Values for Layer 1
Payson FS Model Update

FIGURE
B10



Specific Yield
Final Values for Layer 2
Payson FS Model Update

FIGURE
B11



GeoTrans, Inc.

Reference Remedy
Model Simulated Hydrograph for TOP-20
Payson PCE WQARF Site
Arizona Department of Environmental Quality

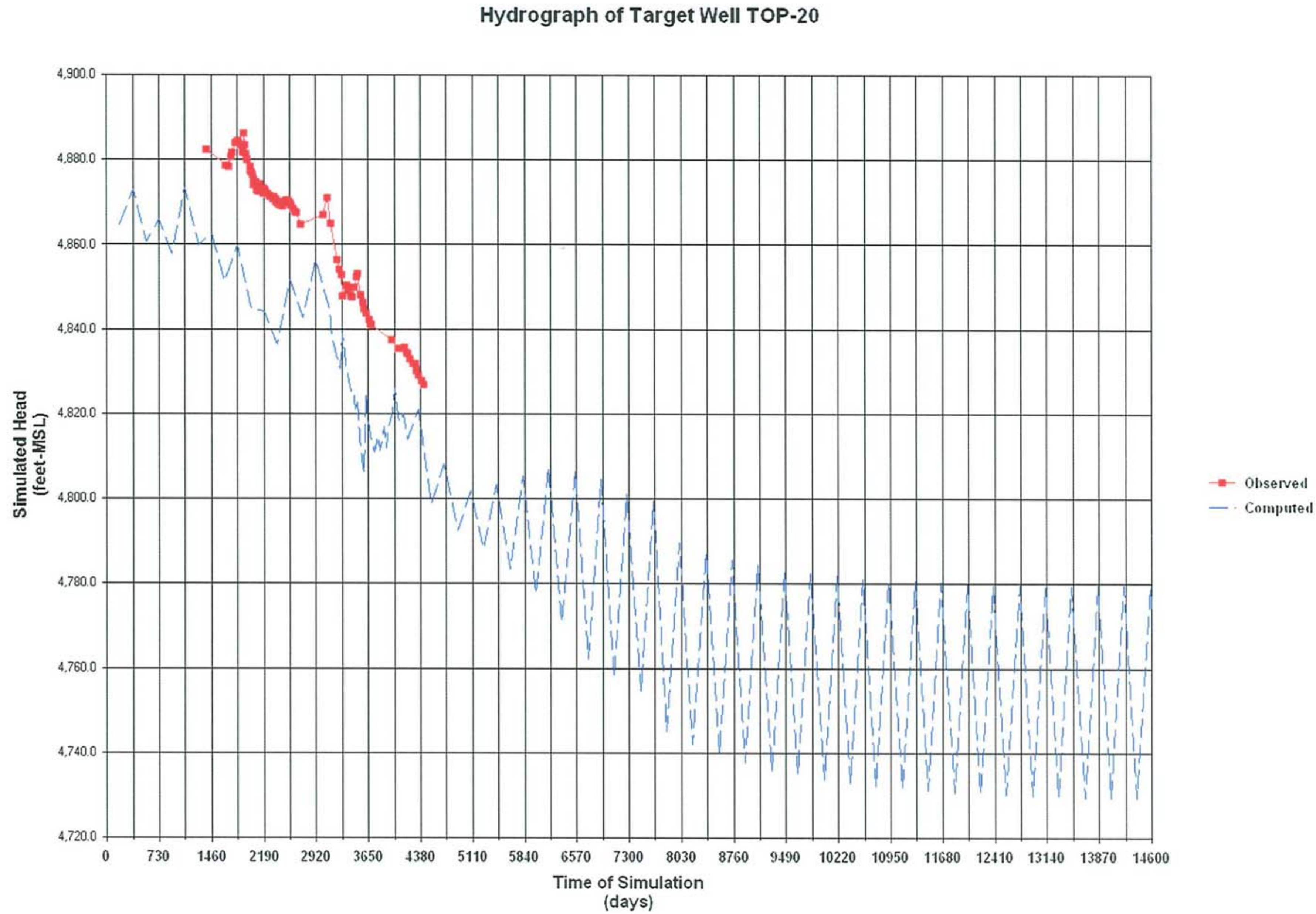
FIGURE
B12

Payson PCE WQARF Site
Arizona Department of Environmental Quality

Reference Remedy
Simulated Water Level Elevations
October 2102
(Feet-MSL)

FIGURE
B13

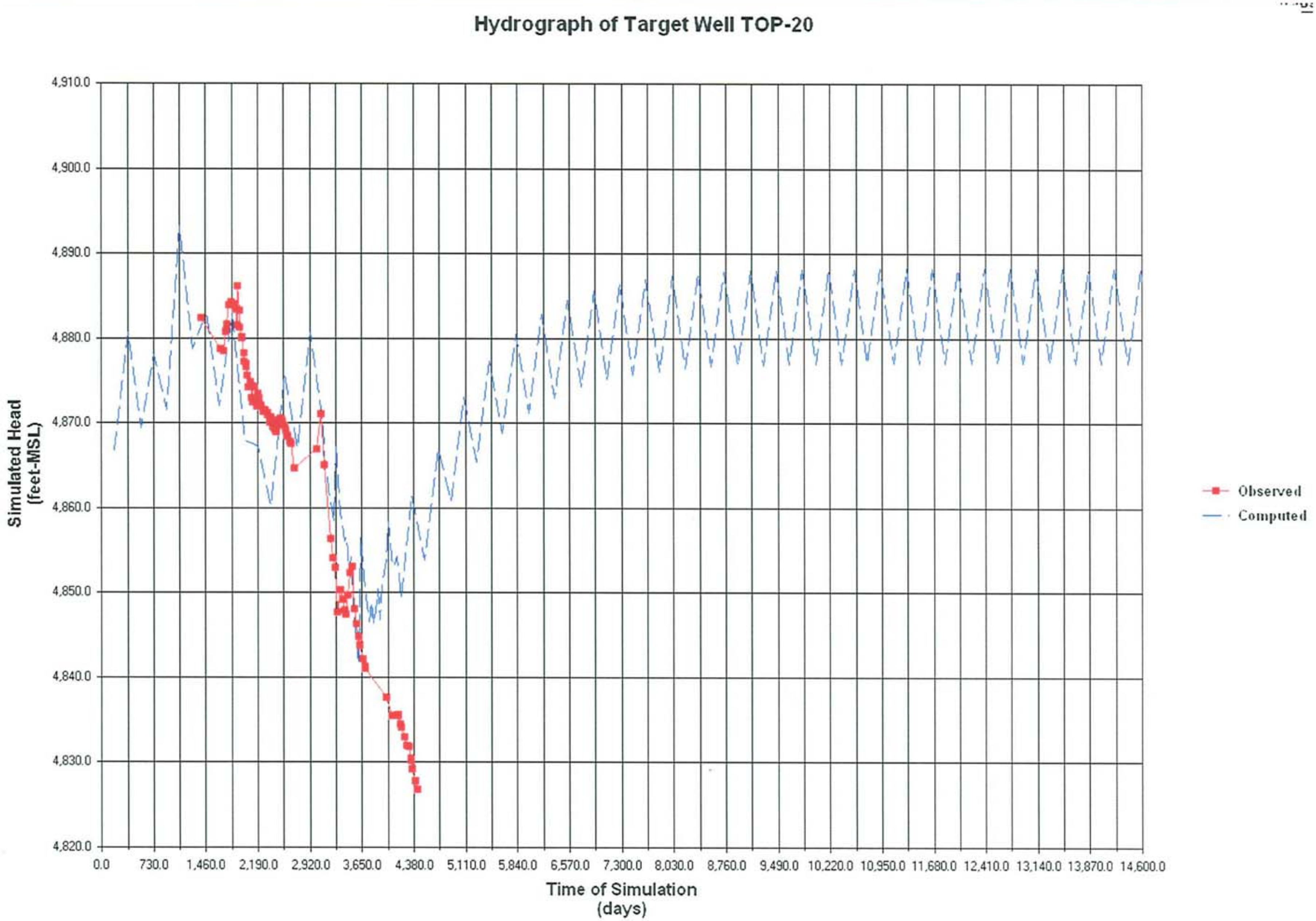
GeoTrans, Inc.



GeoTrans, Inc.

Reference Remedy – Lowered Recharge Rate
Model Simulated Hydrograph for TOP-20
Payson PCE WQARF Site
Arizona Department of Environmental Quality

FIGURE
B14



GeoTrans, Inc.

Less Aggressive Remedy
Model Simulated Hydrograph for TOP-20
Payson PCE WQARF Site
Arizona Department of Environmental Quality

FIGURE
B15

APPENDIX C

Contingency Evaluation for Connecting New McKamey Well to EGTS

Appendix C

CONTINGENCY EVALUATION FOR TREATING CONTAMINATED GROUNDWATER FROM NEW MCKAMEY WELL

If PCE concentrations in groundwater pumped from the Town of Payson (TOP) New McKamey production well increase to 5 μg/L or more, treating for removal of VOCs will be required. Two options exist for treating the contaminated groundwater: connecting the New McKamey production well to the EGTS via a new water conveyance line, or installing an independent wellhead treatment system at the New McKamey well site. The following presents a discussion of the conceptual designs and costs associated with these two contingency options.

Contingency Options Evaluation

New Water Main Connection from New McKamey to the EGTS

This option involves installing a 4-inch HDPE water main to convey up to 350 gallons per minute (gpm) of pumped groundwater from the New McKamey production well to the EGTS. The route for the water main in shown on the attached conceptual layout (Figure C-1). A photographic log is also included that shows the construction route. Installing the new water main is a significant construction effort due to the length of piping (approximately 3,370 lineal feet), and the presence of several challenging construction zones:

- The new water main must cross beneath Highway 87 at the intersection of Frontier Street. Per the requirements of the Arizona Department of Transportation (ADOT), a lateral boring would need to be drilled to complete the construction (i.e., conventional trenching across the highway is not allowed by ADOT). The lateral drilling and jacking equipment would need to be set-up on currently open land at the southwest corner of Highway 87 and Frontier Street. Access to this property and the property across the highway would need to be negotiated and obtained from the respective land owners. The physical construction of the highway crossing is feasible and will cost approximately $35,000.

- According to the TOP Public Works Department, there are significant quantities of underground utilities at and near the intersection of South Colcord Road and West Frontier Street, including a gas main, potable water main, and a fiber optic telecommunications cable. These utilities, along with the typical traffic congestion at the adjacent U.S. Post Office and County Complex, are expected to delay the progress of the construction; and,

- There are several underground storm culverts along the proposed route of construction that the water main would need to pass beneath (see enclosed Photographic Log), resulting in delays and supplemental construction costs.

Construction of the new water main would terminate at the Main Street south right-of-way. At this location, the new main would be connected to the existing 4-inch HDPE water line that had been pre-constructed for connection to a formerly planned extraction well EX-3 (see Figure C-1).

Estimated Costs for New Water Main

The estimated costs for designing, permitting, access, and construction total $453,750 (Table C-1). This cost assumes that the submersible pump currently operating at New McKamey would be replaced with a new pump and control system with full integration to the EGTS. The supplemental O&M costs associated with connecting new McKamey to the EGTS is considered negligible. O&M of the EGTS is occurring anyway, and it is believed that a potential increase of up to 350 gpm flow will not affect the schedule for GAC change-out or represent significant additional costs for treatment chemicals and/or other consumables[1].

New McKamey Wellhead Treatment System

This option involves providing a wellhead treatment system that includes bag filter pre-filtration, GAC treatment, and chlorination disinfection with a pressure/contact tank. The major equipment components would include:

- Two 20,000 pound GAC units, treatment manifold, gauges, and related appurtenances;
- A 12,000 gallon pressure/contact tank for sufficient detention to achieve ADEQ's requirements for 4-log reduction in viruses and a minimum 0.5-hr detention time;
- A storage tank, feed pump, and control system for disinfection using sodium hypochlorite solution; and,
- A new 25' wide x 50' long x 12' high pre-engineered building to house the treatment system, pressure tank, and related pump controls. A new reinforced concrete slab would also be designed and constructed to support the treatment system infrastructure withing the pre-engineered building.

The implementation costs for this option include estimated costs of $55,000 for design engineering, consulting, and permitting, and capital costs of approximately $392,812 to construct the wellhead treatment system. This estimate is detailed in the attached cost table (Table C-2). The estimated annual O&M cost for operating the system is $56,860.

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[1]According to Peter Storch. P.E. URS Corporation, experience has shown that the controlling factor for carbon change-out is fouling of the carbon, not VOC mass loading. It is believed that the current change-out schedule of the primary GAC vessel every two years will remain relatively consistent, regardless of the additional New McKamey throughput. This assumes that ADEQ will continue its policy of changing out the primary 20,000 lb GAC vessel as soon as breakthrough is detected.

Treatment Alternatives Pros and Cons

New Water Main

The primary advantage of the EGTS connection option is that once the water main, pump, and control system are installed and operative, long-term O&M costs independent of the current EGTS O&M costs can be avoided. This includes the anticipated GAC usage (footnote, page 2). Compared with the wellhead treatment alternative, this alternative is believed to be the lower cost option due to significant savings from avoiding supplemental O&M. It is also the preferred alternative of the TOP Payson Public Works Director, Mr. Colin P. ("Buzz") Walker.

Disadvantages to the EGTS connection option include the disruption to the driving public during the projected construction period of 28 days; construction difficulties related to crossing beneath the Beeline Highway, several storm water culverts, and areas with high density underground utilities and automobile traffic; and the uncertainties of gaining land access beyond the highway right-of-way for the lateral bore/jacking construction effort.

Wellhead Treatment System

Primary advantages of this option are that because the TOP owns the land at the well site and the lot is sufficiently large to facilitate construction/expansion, negotiating land access is not required, and disruption to the driving public is greatly minimized. The most significant disadvantage is that it is believed to be the higher cost option. It represents an independent system with potentially long-term O&M and performance monitoring, and thus, would require additional resources from ADEQ and the Town of Payson to operate.

Recommendation

Based on the overall cost savings and to minimize requirements for additional resources, connection of the New McKamey Well to the EGTS via a new 4-inch water main is the recommended alternative for this contingency evaluation. Although the capital costs for the two alternatives are similar, annual O&M savings of approximately $57,000 can be realized by implementing the new water main option.

Table C-1
Cost Estimate for New Water Main Connection from New McKamey Well to the Extended Groundwater Treatment System (EGTS)
Payson PCE WQARF Site, Payson, Arizona

	Topographic Survey, Design Engineering, Access & Permitting					
	Item	Quantity	Unit	Unit Cost		Total Price
1	Registered Land Surveyor's Topographic Survey	1	ls	---	$	3,500
2	Engineering Design & Report: Civil & Electrical	1	ls	---	$	35,000
3	Land Access: Hwy 87 Underground Bore & Jack	1	ls	---	$	10,000
4	Permitting, Town of Payson Coord./Meetings	1	ls	---	$	10,000
	Total				$	58,500

	Capital Equipment, Construction, and Source Water Approval Costs					
	Item	Quantity	Unit	Unit Cost		Total Price
1	Furnish/Install 400 gpm Submersible Pump, Pipe & Seal	1	ls	---	$	9,500
2	PLC Control System to Interface w/ EGTS	1	ls	--	$	15,000
3	Furnish/Install Pressure Gauges at Wellhead	2	ea	$85.00	$	170
4	Furnish/Install Electromagnetic Flow meter	1	ea	$3,800.00	$	3,800
5	Furnish/Install Turbine Flow meter	1	ea	$475.00	$	475
6	Furnish/Install Isolation Butterfly Valve	1	ea	$275.00	$	275
7	Furnish/Install Swing Check Valve	1	ea	$350.00	$	350
8	Air/Vacuum Release Valve & Installation	1	ea	$350.00	$	350
9	In-Line Catalytic Water Conditioner & Installation	1	ea	$4,500.00	$	4,500
10	Install Well Head Control Building	1	ls	--	$	10,500
11	HeatTrace w/Pipe Insulation,Control Thermostat, Switch	1	ls	---	$	2,250
12	APS Construction Costs for Modified Power Supply	1	ls	---	$	1,500
13	Crew Rate for 4" HDPE Water Line Installation[A]	28	day	$7,315.00	$	204,820
14	4" SDR 11 HDPE NSF Pipe; Water Line Conveyance	3370	ea	$3.00	$	10,110
15	4" SDR 11 HDPE NSF Elbow Fittings	10	ea	$175.00	$	1,750
16	4" Cast Iron, Epoxy Coated Gate Valve	6	ea	$275.00	$	1,650
17	Hwy 87 Crossing: Horiz. Bore & Jack, Pipe Installation	1	ls	---	$	35,000
18	Traffic Control/Barricades/Trench Plate	28	day	$325.00	$	9,100
19	Flush, Superchlorinate, Rinse, New Water Main	1	ls	---	$	2,500
20	Consulting: Construction Mgmt; Sr Engineer	45	hr	$95.00	$	4,275
21	Consulting: Construction Oversight; Project Engineer	100	hr	$70.00	$	7,000
22	Source Water Approval Testing	1	ls	$4,500.00	$	4,500
	Sub Total				*$*	*329,375*
	Markup (20%)				*$*	*65,875*
	Total				$	395,250

[A] = The costs presented below were used to develop the daily crew rate for installation of the new 4" HDPE water main. Means Building Construction Cost Data, 8th Annual Western Edition, was used to compute the daily crew rate.

Table C-1
Cost Estimate for New Water Main Connection from New McKamey Well to the Extended Groundwater Treatment System (EGTS)
Payson PCE WQARF Site, Payson, Arizona

Cost Estimate of Daily Crew Rate for Installation of New Water Main							
Item		**Cost/Hr**		**Cost/Day**	**Quantitiy**		**Extension**
Trackhoe			$	1,000	1	$	1,000
End Loader			$	500	1	$	500
Pipe Truck			$	300	1	$	300
Dump Truck			$	300	2	$	600
Compactor			$	150	1	$	150
Fusion Welder			$	200	1	$	200
Pavement Saw			$	100	1	$	100
Pavement Breaker			$	50	1	$	50
Water Truck			$	75	1	$	75
Tamper			$	50	1	$	50
Pickup Truck			$	50	1	$	50
Crew Superintendent	$	50.00	$	400	1	$	400
Equipment Operators	$	40.00	$	320	5	$	1,600
Drivers	$	35.00	$	280	2	$	560
Laborers	$	30.00	$	240	7	$	1,680
Total Cost Per Day						$	7,315

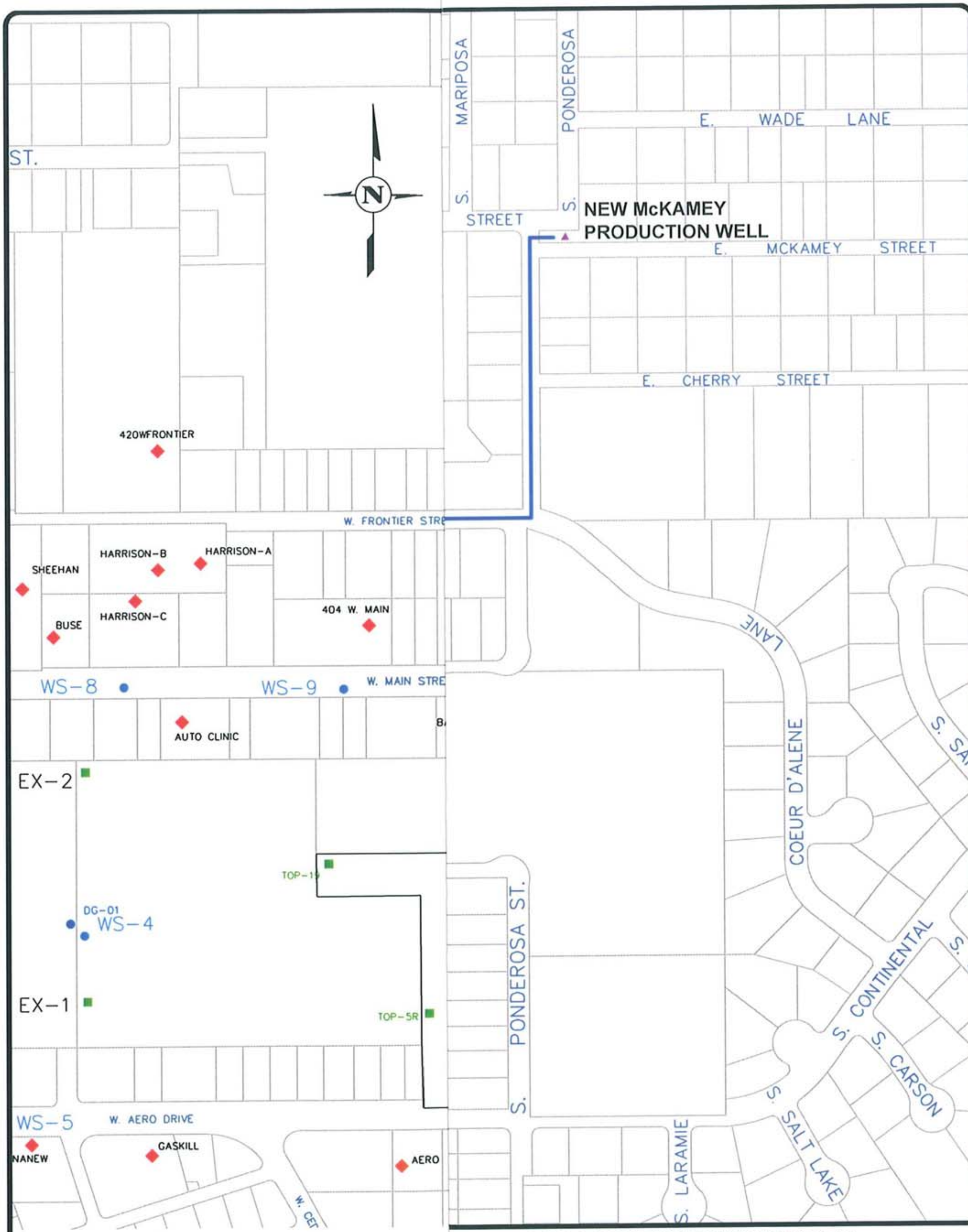
Table C-2
Cost Estimate for New McKamey Wellhead Treatment System: Activated Carbon and Chlorine Disinfection
Payson PCE WQARF Site, Payson Arizona

	Design Engineering				
	Item	Quantity	Unit	Unit Cost	Total Price
1	Engineering Design & Report: Civil & Electrical	1	ls	---	$ 55,000
	Total				$ 55,000

	Capital Equipment, Construction, and Source Source Water Approval Costs				
	Item	Quantity	Unit	Unit Cost	Total Price
1	Furnish/Install 400 gpm Submersible Pump, Pipe & Seal	1	ls	---	$9,500.00
2	Calgon Model 10 GAC Modular Package (Two 20,000 Lb Units)	1	ls	---	$155,000.00
3	Delivery/Freight Fees for GAC Modular Package	1	ls	---	$4,500.00
4	Furnish/Install 400 gpm Prefilters (Parallell Bag Filter Housings)	2	ea	$2,500.00	$5,000.00
5	Pipe Connections To/From Prefilters, Modular GAC, Water Main	1	ls	---	$3,200.00
6	Furnish/Install 12,000 Gal.,125 PSI, Pressure/Contact Tank[A]	1	ls	--	$35,000.00
7	Flush, Superchlorinate, Rinse, Water Main, Tank, Well	1	ls	---	$3,500.00
8	55 Ton Crane Services: Pick/Place GAC Pkg and Contact Tank	2	day	$800.00	$1,600.00
9	Furnish/Install Chemical Feed Pump for NaCLO Solution[A]	1	ea	--	$1,800.00
10	Furnish/Install 200 Gal Poly.Tank, Tank Stand, Mixer[A]	1	ls	---	$2,600.00
11	Furnish/Install, Press/Relief Valves, Damper, Cal.Cylinder[A]	1	ls	---	$2,200.00
12	Prep.Subgrade & Construct 25' x 50' x 8" Reinf.Concrete Slab	1	ls	---	$15,000.00
13	Install Insulated Bldg for Controls, Contact Tank, NaCLO Feed	1	ls	---	$45,000.00
14	Install Electrical Supply/Distribution to New Shop Building	1	ls	---	$10,000.00
15	Heat Tracing w/Pipe Insulation,Control Thermostat/ Switch	1	ls	---	$5,500.00
16	APS's Construct Costs: Power Upgrades to Well Site & Bldg	1	ls	---	$2,500.00
17	Consulting: Construction Mgmt; Sr Engineer	30	hr	$95.00	$2,850.00
18	Consulting: Construction Oversight; Projecct Engineer	50	hr	$80.00	$4,000.00
19	Source Water Approval Testing	1	ls	$5,500.00	$5,500.00
	Sub Total				*$314,250.00*
	Markup (25%)				*$78,562.50*
	Total				**$392,812.50**

[A] = This item is related to chlorine disinfection for the 400 gpm potable water supply utilizing sodium hypochlorite (NaCLO) solution. The chlorination process would attain 4 log reduction in viruses with a 0.5-hr min. contact time. Currently, there is no regulatory requirement to disinfect groundwater pumped from the Town of Payson's New McKamey production well. However, ADEQ has asked GeoTrans to provide costs for disinfection facilities in this FS in anticipation of a future requirement for disinfection.

	Annual Estimate of O&M and Consulting Costs				
	Item	Quantity	Unit	Unit Cost	Total Price
1	GAC Usage (20,000 lb change-out assumed every 2 yrs)	10,000	lb	$1.15	$11,500.00
2	Electrical Power (estimated)	12	mo	$1,400.00	$16,800.00
3	Performance Testing for GAC (VOC analysis)	36	ea	$225.00	$8,100.00
	Sub Total				*$36,400.00*
	Markup (15%)				*$5,460.00*
	Subtotal O&M w/ Mark-up	1	yr	---	*$41,860.00*
4	*Subtotal Consulting: system evals. & reporting (estimated)*	1	yr	---	*$15,000.00*
	Total O&M with Consulting				**$56,860.00**



CONCEPTUAL LAYOUT FOR NEW MCKAMEY WATER LINE CONNECTION TO EGTS

PAYSON PCE WQARF SITE

GeoTrans, Inc.
TETRA TECH COMPANY

CHECKED	JWR	FIGURE
DRAFTED	DBS	
PROJECT	F144-C22	C-1
DATE	8/19/02	

View of New McKamey production well
and associated shed looking east.

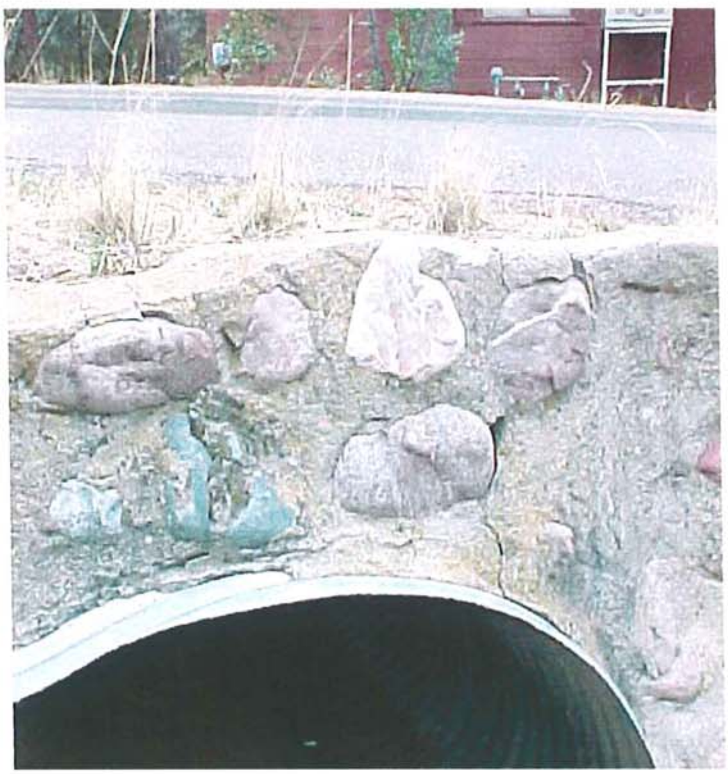
View looking west at predominantly empty lot of
Town of Payson (TOP) New McKamey production
well. Fenced compound of wellhead is shown in background.

Intersection of East McKamey Street and Ponderosa Street
looking southwest from the New McKamey production well lot.

View looking north from Ponderosa Street at intersection with East McKamey Street (Portion of New McKamey fenced compound shown in upper right corner of photograph). Sanitary sewer manholes are shown in foreground. The sewer main is routed north-south along the approximate centerline of Ponderosa Street.

View looking north on Ponderosa Street near intersection with East Cherry Street. Sanitary Sewer Manhole shown in foreground. TOP's underground water main is located along west side of Ponderosa Street, routed north-south.

View of Ponderosa Street looking south from intersection with Cherry Street. TOP's underground water main is routed north-south along the west side of Ponderosa Street.



View looking east of stormwater culvert (4.0-ft CMP) installed beneath Ponderosa Street between East Cherry Street and East Frontier Street. The top of the culvert is only approximately 1.5 -feet below the asphalt street.

View looking north from intersection of Ponderosa Street and East Frontier Street.

View looking west from intersection of East Frontier Street and Ponderosa Street.

View from East Frontier Street looking east towards intersection of East Frontier Street/Coeur D'Alene Lane and Ponderosa Street. Rocky, hard-dig conditions are expected along this segment of the new 4-inch water main route.

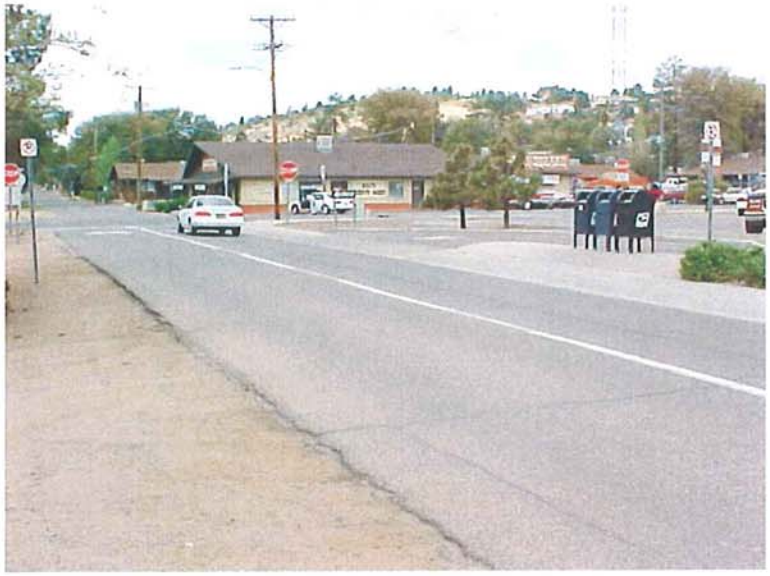
View of stormwater culverts beneath East Frontier Street. These culverts, located between Beeline Highway and Ponderosa Street, represent an obvious obstruction to the new water main installation. View looking southwest and west respectively.

View from East Frontier Street looking west at the intersection of Beeline Highway. Consistent with ADOT's requirements, it is at this intersection where a lateral boring beneath the highway would be required to facilitate installation of the new 4-inch water main.

View looking southwest across the intersection of Beeline Highway and East/West Frontier Street. The U.S. Post Office and Gila County offices are located at the NW and SW corners of the intersection, respectively. Bore and jack equipment to install the new water main would be located on the vacant land at the southwest corner.

View of Beeline Highway looking north near intersection with East Frontier Street.

View looking northwest across Beeline Highway at intersection of West Frontier Street. U.S. Post office located in background.



View looking west/northwest towards intersection
of West Frontier Street and South Colcord Road.

View looking east from intersection of West Frontier Street
and South Colcord Road. Numerous underground utilities
are routed through the intersection (water, sewer, fiber
optic cable, gas, etc.)

View of West Frontier Street looking west near the intersection with Colcord Road. Underground water and telecommunications utilities are marked along north right-of-way.

View from West Frontier Street looking west at intersection of South Tonto Street.

View from East Frontier Street looking east
at Tonto Street intersection.

View from West Frontier Street looking west
near intersection with South Meadow Street.

View looking south down Meadow Street from intersection with West Frontier Street. According to the Town of Payson, this leg of Meadow Street is privately owned and access for installation of a new 4-inch water main may be problematic.

View from Meadow Street looking north towards intersection with West Frontier Street.

View from Meadow Street looking south towards intersection with West Main Street. Sanitary sewer manhole shown in foreground; sawmill crossing property lies across Main Street in background.

View looking south/southwest from intersection of Meadow Street and Main Street. The new 4-inch water main would be connected to the existing, pre-plumbed 4" HDPE water line which terminates underground near the area of the yellow fire hydrant shown in the background.

APPENDIX D

Evaluation of More Aggressive Remedy Costs and Design

Appendix D

EVALUATION OF MORE AGGRESSIVE REMEDY COSTS AND DESIGN

Remediation technologies which actively extract and treat groundwater contaminants are typically the most aggressive remedy for addressing large-scale groundwater contamination by volatile organic contaminants (VOCs). The available technologies include groundwater pump and treat, and air sparging (AS), usually combined with soil vapor extraction (SVE). For source area or hot spot remediation, more aggressive technologies can include physical removal of impacted soil/rock, chemical oxidation, steam injection, and six-phase heating. Source area remediation through physical removal of soils and SVE has been completed at the Site. The remaining contamination is widely dispersed with no obvious or well-defined hot spots identified. However, based on the existing location and density of groundwater monitoring wells, two areas with the highest remaining PCE concentrations have been identified during the course of the Remedial Investigation (RI). These include the area around extraction well EW-4 and the region between extraction wells EX-1 and EX-2. Based on this contaminant distribution, the only potentially practical more aggressive remedy available was the addition of an AS/SVE system at these two locations, operated in conjunction with the existing groundwater pump and treat system.

GeoTrans has evaluated the use of an AS/SVE system as an aggressive remedy enhancement to the existing pump-and-treat EGTS. The conceptual design is presented on Figure D-1, and a cost estimate provided on Table D-1. The general design includes an East System composed of 7 AS wells and 5 SVE wells, and a West System composed of 13 AS and 9 SVE wells. The East System wells are designed along a north-south transect with a total length of approximately 312 feet approximately 25 feet east of the DMW-1 well cluster. This alignment is designed perpendicular to groundwater flow to intersect the greatest volume of impacted groundwater and to address the high PCE concentrations observed in well DMW-1C. The West System has been aligned in an "L" shape with a north-south transect 400 feet long and an east-west transect 200 feet long. The rationale behind this design and placement is that the north-south transect will maximize the intersection with the plume between extraction wells EX-1 and EX-2 while the east-west transect addresses the potential contaminant migration towards Well Set 5. Both systems utilize a 50-foot spacing for the AS wells and an 80-foot spacing for the SVE wells.

Proposed Aggressive Remedy System Evaluation

Figure D-1 illustrates the location of the proposed systems, which would consist of the following features and equipment:

<u>East System</u>

- Seven (7) 1-1/4" dia. steel AS wells constructed to 140 feet in depth; five 4-inch dia. PVC

SVE wells constructed to 110 feet in depth;

- Well spacings of approximately 50 feet for AS wells and 80 feet for SVE wells;
- Nominal 300 cfm capacity rotary-lobe SVE blower package, and two (2) 1,000 GAC units with a treatment manifold for GAC monitoring and emissions abatement;
- Nominal 150 cfm rotary screw AS air compressor package including gauges, after-cooler, flow meters; and controls;
- Adjustable flow meters installed at each AS wellhead; butterfly flow control valves installed at each SVE wellhead; and pre-cast vaults for access and security of each wellhead;
- Approximately 315 lineal feet (lf) of underground (u.g.) 2.5" dia. steel header pipe for air supply to the AS wells; and 315 lf of u.g. 6"PVC header pipe for SVE;
- Fenced equipment compound, approximately 30' x 20' in area, with a 4-inch thick reinforced concrete slab; and,
- 240/480 volt, 3 phase, 200 amp, independently metered electric service to provide power to the remediation equipment.

This system would function to remove dissolved-phase PCE and other trace VOCs from the aquifer. Air injection rates of up to approximately 15 cfm could be balanced among the nine AS wells. SVE rates of up to 50 cfm could be balanced among the six SVE wells. Access for installation of the remediation system would be required with the land owner of the Sawmill Crossing property.

<u>West System</u>

This system would be similar to that which is described for the east system, however; it would incorporate 6 additional AS wells and 4 additional SVE wells. The capacities of the AS compressor and SVE blower packages would be increased to 200 cfm and 400 cfm, respectively.

<u>System Operation</u>

Under the proposed aggressive treatment regime, two lines of alternating air sparge wells and soil vapor extraction wells would be installed. As groundwater flows toward the EGTS due to continued pumping, it would be drawn past these two treatment lines. By stripping the dissolved phase PCE from the groundwater using air sparge wells and removing from the soil vapor using the SVE wells, the groundwater plume would be more rapidly remediated than purely by advective transport to the extraction wells as is currently done.

Assuming a 100 percent stripping efficiency, the operation time for the AS/SVE transect lines would be determined by their duration of effectiveness, or the period of time over which impacted groundwater will intersect their zones of impact. This operation time may be estimated based on the time required for the outer extent of the PCE groundwater plume (based on March 2002 plume designation) to flow back and through the AS/SVE transects. This time can be calculated using the following assumptions:

Assumptions:

- The aquifer is homogeneous and isotropic;
- Existing flow gradient and direction will persist throughout the operating time of interest;
- Sorption of PCE on inorganic clays accounts for an approximate retardation factor of 10;
- Hydraulic conductivity (K) is 20 ft/day;
- Porosity (n) is 0.10; and,
- Bulk density is approximately 2.3 g/cm^3

Average linear pore water velocity may be estimated based on volumetric flux through a cross-sectional area.

$$v = \frac{Q}{nA} = -\frac{K}{n}\frac{\partial h}{\partial l}$$

Retardation Factor Estimate

Calculated

Retardation factors due to sorption are typically determined using the following equation

$$Rf = \frac{v}{v_c} = 1 + \frac{\rho_b}{n} K_d$$

where v is the average linear pore water velocity, and v_c is the velocity of the contaminant. K_d is the distribution coefficient which can be expressed as a ratio of the mass of solute sorbed to the concentration of solute in solution.

A study of Retardation of Volatile Organic Compounds in Groundwater in Low Organic Carbon Sediments by Lawrence Livermore National Laboratories (LLNL, 1995) suggests that a range for the Kd of PCE in a gravel aquifer is 0.4 to 1.16. Since the Payson granite is fracture dominated and undoubtedly contains a substantially lower ratio of void space to surface area, we chose to use the low end of the Kd range of 0.4. This suggests a retardation factor of approximately 10.

Local Estimate

The groundwater gradient in the central Payson valley in 1990 was approximately 0.0071 ft/ft and flowed west down the valley according to depth to water measurements. The PCE contamination in the valley was believed to have occurred sometime around 30 years ago (GeoTrans, 1998). The equation for average pore water velocity above indicates a groundwater flow velocity of 1.41 ft/day over those 30 years. Based on current plume designations the maximum distance traveled by PCE from the source area has been approximately 1850 feet, or 0.169 ft/day. Since the retardation factor is equal to the ratio of the velocity of the groundwater to the velocity of the contaminant, the local estimate for a retardation factor for PCE in the Payson granite is approximately 8.35.

Time for System Operation

Using the above information an approximate time of operation for the Western and Eastern systems can be estimated.

Western Edge of Plume

The flow gradient at the West System transect is approximately 0.011 ft/ft. This means that the average velocity is approximately 2.2 ft/day. If we include the retardation factor of 8.35, the modified velocity is 0.26 ft/day. The distance from the West System AS/SVE line upgradient to where groundwater flow will flow towards the East System instead of the West System is approximately 850 feet. Based on this distance the time required for a molecule of PCE to flow from the furthest extent of the plume to the West System transect of AS/SVE wells is approximately 8.8 years

Eastern Edge of Plume

The flow gradient at the eastern transect is approximately 0.008 ft/ft. This means that the average velocity is approximately 1.6 ft/day. If we assume retention from potential sorption effects to cause the PCE to effectively flow at half of this rate, the modified velocity is 0.19 ft/day. The distance from the East System treatment line to the downgradient location where groundwater flows towards the West System is approximately 450 feet. Using this distance the time required for a molecule of PCE to flow from the furthest extent of the plume to the eastern transect of AS/SVE wells is therefore approximately 6.5 years.

Conclusions

Based on the existing information, the western transect should be effective for 8.8 years. The eastern transect should be effective for 6.5 years. Assuming that no additional slowly desorbing sources of PCE are present that are not intersected by the AS/SVE systems these time frames are also representative of the time for cleanup of the entire groundwater plume utilizing both the EGTS and the AS/SVE systems.

Estimated Costs

A cost estimate for construction and O&M of the AS/SVE aggressive remedy is detailed on the attached cost tables. The capital cost for the system is significant: it is estimated to be approximately $530,900. The greatest percentage of the cost is attributed to remediation well drilling/construction ($233,500 including a 20 % mark-up). Costs for design engineering, permitting, and access would add an estimated additional $40,450 to the system implementation costs. The annual estimate for O&M is approximately $70,400, which includes performance sampling, energy costs, and consulting engineering fees. Assuming a total operation time of 9 years and 6 % annual interest, the total present value costs associated with implementing the more aggressive remedy is estimated to be approximately $ 1.05 million.

Conclusion of Proposed More Aggressive Remedy

Because the rate of decline of water levels is a significant concern for the operation of the EGTS, the installation of air sparging wells or well points is likely to be problematic. If water levels decline below the DG/FG Unit, then air sparging will not be effective in the fractured granite. At the current rate of decline in water levels, (see Figure 7-6 and 7-7 in the report) air sparging wells or points placed at the bottom of the DG/FG Unit may be above the water table within the next 4-8 years. Based on the information presented, approximately 9 years of operation of the proposed AS/SVE system, with concurrent operation of the EGTS, will be required to complete remediation of the PCE plume. For this reason, the points may not be effective over the projected life-span for the proposed aggressive remedy, because the declining water levels will make installation and operation of the system difficult to maintain over the projected period of operation. Due to the significant uncertainty in cleanup time frames noted, it is difficult to justify the additional expense inherent in the more aggressive remedy. The current EGTS appears to be capturing and containing the plume, and the declining PCE concentrations suggest that the current system is effectively remediating the plume at the Payson PCE WQARF Site.

Table D-1
Aggressive Remedy Cost Estimate for AS/SVE Systems (Enhancements for the EGTS)

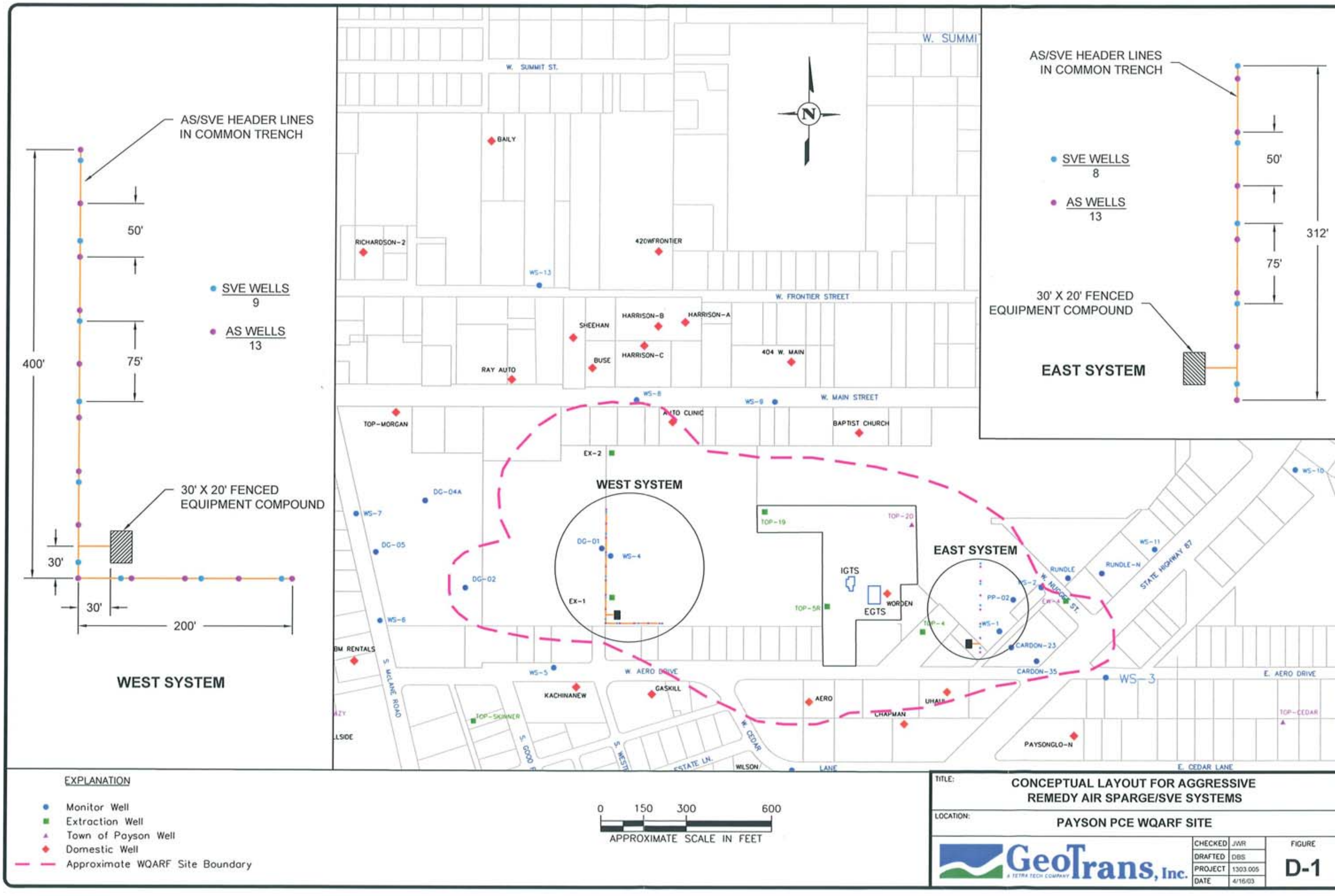
Item No.	Description	Quantity	Unit	Unit Cost	Extended Cost
	AS/SVE System Design, Design Report, Air Quality & Constuction Permitting				
1	Principal Engineer, Civil (P.E.)	10	hr	$ 135.00	$ 1,350
2	Sr. Design Engineer, Civil/Environ (P.E.)	100	hr	$ 105.00	$ 10,500
3	Staff Engineer, Civil/Environ (E.I.T.)	150	hr	$ 70.00	$ 10,500
4	Sr. Design Engineer, Electrical (P.E.)	45	hr	$ 105.00	$ 4,725
5	Site Surveys: Survey Crew and Mapping (R.L.S.)	1	ls	---	$ 2,500
6	CAD Specialists	150	hr	$ 60.00	$ 9,000
7	Administrative/Clerical Support	25	hr	$ 55.00	$ 1,375
8	Town of Payson Fees: Plan Review/Construction Permits	1	ls	---	$ 500
9	Plan Reproduction: Draft & Final Design Drawings	1	ls	---	$ 150
	Subtotal, Engineering Design, Design Report, Permitting				***$ 40,450***
	Remedial Well Construction and Installation of AS/SVE Systems				
1	Air Rotary drill/install 1-1/4" steel air sparge (AS) wells	2940	ft	$ 40	$ 117,600
2	(assumes 21 wells to depth of 140 feet)				
3	Air Rotary drill/install 3" PVC soil vapor extraction wells	1540	ft	$ 50	$ 77,000
4	(assumes 14 wells to depth of 110 feet)				
5	Consultant oversight of drilling/well construction	50	day	$ 650	$ 32,500
6	Mobilize/demobilize backhoe to site	1	ls	$ 350	$ 350
7	Excavate 2' x 3' x 1000' common pipe trenches	222	cy	$ 12.50	$ 2,775
8	Backfill & compact common pipe trenches, 6" lifts	222	cy	$ 8.50	$ 1,887
9	Furnish/install 2.5" steel AS conveyance pipe & fittings	1400	lf	$ 4.00	$ 5,600
10	Furnish/install 6" PVC SVE conveyance pipe & fittings	1400	lf	$ 4.75	$ 6,650
11	Furnish/install access vaults for air sparge wells	21	ea	$ 375	$ 7,875
12	Furnish/install access vaults for SVE wells	14	ea	$ 750	$ 10,500
13	Furnish/install air sparge flow meters (0-20 scfm)	21	ea	$ 225	$ 4,725
14	Air Sparge pressure gages & installation	26	ea	$ 55	$ 1,430
15	SVE vacuum gages & installation	20	ea	$ 70	$ 1,400
16	Furnish/Install flow meters for SVE monitoring	2	ea	$ 250	$ 500
17	Furnish/install 3" butterfly valves (BFVs) @ SVE wells	14	ea	$ 225	$ 3,150
18	Furnish/install 6" BFVs for Header Pipe & GAC Units	6	ea	$ 425	$ 2,550
19	Clear/prepare subgrade for equipment compounds	2	ea	$ 550	$ 1,100

Table D-1
Aggressive Remedy Cost Estimate for AS/SVE Systems (Enhancements for the EGTS)

20	Construct 30' x 20' x 4" thick reinforced concrete slabs	2	ea	$	3,200	$	6,400
21	Furnish/Install security fencing, gates, screening inserts	200	lf	$	16.75	$	3,350
22	Ambient make-up air filters/silencers & installation	2	ea	$	350	$	700
23	Fab & Install 6" GAC Treatment Manifolds	2	ea	$	2,800	$	5,600
24	1/4" NPT labcock valves and installation	25	ea	$	35	$	875
25	Bi-metal thermometers for SVE Hdr & GAC Manifold	8	ea	$	80	$	640
26	Rotary Screw Air Compressor Pkgs, Controls, Installation	2	ea	$	28,000	$	56,000
27	SVE Blower Pkgs, Controls, Installation	2	ea	$	35,000	$	70,000
28	240/480 volt, 3 ph,100 amp power supplies & distribution	2	ea	$	8,500	$	17,000
29	(meter boxes, panels, switches, conduits, outlets, etc.)						
30	Consultant Management of AS/SVE Installations	50	hrs	$	85	$	4,250
	Subtotal						*$442,407.00*
	Markup (20%)						*$88,481.40*
	Total Estimated Costs for AS/SVE System Installations						***$530,888.40***

Estimated Annual O&M and Reporting Costs for AS/SVE Systems

1	Consulting engineering--labor for O&M, monitoring	12	mo	$	1,600	$	19,200
2	Consulting engineering--remedial performance reports	2	ea	$	6,500	$	13,000
3	Analytical testing--EPA Method TO-15 for VOCs	30	ea	$	255	$	7,650
4	Average annual power--Blowers & Compressors	12	mo	$	2,500	$	30,000
5	Manage generated SVE condensate (GAC treatment)	1	ls	$	500	$	500
6	GAC usage attributed to mass VOC loading (negligible)	60	lbs	$	1.10	$	66
	Annual Estimated O&M, Reporting Costs--AS/SVE Systems					**$**	**70,416**



TITLE: CONCEPTUAL LAYOUT FOR AGGRESSIVE REMEDY AIR SPARGE/SVE SYSTEMS

LOCATION: PAYSON PCE WQARF SITE

GeoTrans, Inc. A TETRA TECH COMPANY

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PROJECT	1303.005
DATE	4/16/03

FIGURE D-1

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Jasenka Zbozinek

Jasenka Zbozinek, Ph.D.
Principal Environmental Scientist