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DEFENSE LOGISTICS AGENCY
DEFENSE DISTRIBUTION DEPOT SAN JOAQUIN CALIFORNIA
LATHROP, CALIFORNIA

DDJC-SHARPE
FIVE-YEAR REVIEW REPORT

FINAL

Prepared for:

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January 12, 2004

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Re: Final Five-Year Review Report of the Defense Distribution Depot San Joaquin (DDJC), Sharpe Site, Lathrop, California, October 2003

Dear Colonel Visker:

The U.S. Environmental Protection Agency (EPA) Region 9 has received the Final Five-Year Review Report of the Defense Distribution Depot San Joaquin (DDJC), Sharpe Site, Lathrop, California, dated October 2003. This document addresses completed and ongoing remedial actions taken pursuant to the DDJC-Sharpe Record of Decision. EPA agrees with the findings, conclusions, and recommendations provided in the Report, and concurs with the Defense Logistics Agency that the remedies for groundwater and soil remain protective of human health and the environmental under the current land use at DDJC-Sharpe.

Enclosed is the signature page for the Final Five-Year Review report. If you have any questions, please contact Xuan-Mai Tran, Remedial-Project Manager, at (415) 972-3002.

Sincerely,

Joel Jones
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cc: (See Distribution List)

Enclosure

PROTECTIVENESS DETERMINATION

The actions taken pursuant to the DDJC-Sharpe Record of Decision to address contamination identified in soils and groundwater at DDJC-Sharpe have addressed or are addressing the threats of contaminant exposure to human health and the environment and are protective. This protectiveness determination is made for the DDJC-Sharpe Five-Year Review. The following statements address the protectiveness of the remova1 and remedia1 actions taken at DDJC-Sharpe.

OU 1 Protectiveness

The actions taken for Operable Unit (OU) 1 (groundwater) have been protective in the first five years of operation. However, evidence of incomplete capture of contaminant plumes indicates that extraction well systems are not operating as intended. Because of this, the OU 1 actions may not be protective into the future. To assure protectiveness, the recommendations and follow-up actions presented in Section 9 must be implemented.

OU 2 Protectiveness

The actions taken for OU 2 (soil) are not fully protective because soil at Site S-26 contains lead concentrations that do not allow unrestricted use. Therefore, land use controls are necessary to assure that use of the area of contamination remains industrial unless additional excavation occurs. Furthermore, if a higher inhalation toxicity value (0.4 per mg/kg-day) is accepted for trichloroethene (TCE), the concentrations of TCE that were left in the soil in 2001 after soil vapor extraction (SVE) remedial actions ceased could pose a risk to occupants of residences constructed at the SVE sites. However, there are no residences or occupied structures of any kind on those sites. The actions for volatile organic compounds (VOCs) are protective under current land use and are likely to be protective in the future because the VOC concentrations will be reduced naturally with time. The next five-year review will be a statutory review and TC concentrations in soil are not protective for unrestricted land use.

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DDJC-Sharpe Five-Year Review

Protectiveness Statements Regulatory Concurrence

This report has been prepared in accordance with U.S. EPA OSWER Directive 9355.7-03B-P.

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TABLE OF CONTENTS

		Page
ES.0	EXECUTIVE SUMMARY	ES-1
1.0	INTRODUCTION	1-1
2.0	CHRONOLOGY	2-1
3.0	BACKGROUND	3-1
3.1	Physical Characteristics	3-1
3.2	Land and Resource Use	3-2
3.3	History of Contamination	3-4
3.4	Initial Response	3-4
3.5	Basis for Taking Action	3-6
4.0	REMEDIAL ACTIONS	4-1
4.1	Groundwater Remedy	4-1
4.1.1	Remedy Selection	4-1
4.1.2	Remedy Implementation	4-3
4.2	Groundwater Treatment System Operations and Maintenance	4-9
4.2.1	General	4-9
4.2.2	Groundwater Treatment System Operation	4-9
4.2.3	Routine Maintenance	4-13
4.2.4	O&M Costs	4-15
4.3	Soil Remedy	4-15
4.3.1	Remedy Selection	4-15
4.3.2	Volatile Organic Compounds	4-21
4.3.3	Metals	4-27
4.3.4	Pesticides	4-31
4.4	Institutional Control Sites	4-32
5.0	PROGRESS SINCE LAST REVIEW	5-1
6.0	FIVE-YEAR REVIEW PROCESS	6-1
6.1	Administrative Components	6-1
6.2	Community Involvement and Notifications	6-1
6.3	Document Review	6-2
6.4	Data Review	6-4
6.4.1	Hydraulic Data Summary	6-4
6.4.2	Analytical Data Summary	6-4
6.4.3	Sampling Program Recommendations	6-7
6.5	Site Inspection	6-7
6.6	Interviews	6-7
7.0	TECHNICAL ASSESSMENT	7- 1
7.1	Operable Unit 1 – Groundwater Remedy	7- 1
7.1.1	Operations	7- 2
7.1.2	Plume Capture Analysis	7- 6

TABLE OF CONTENTS (Continued)

			Page
	7.1.3	Protectiveness	7-9
	7.1.4	New Protectiveness Concerns	7-10
7.2	Operable Unit 2 – Soil Remedy		7-10
	7.2.1	OU 2 Soil Remedial Actions (VOCs)	7-10
	7.2.2	OU 2 Soil Remedial Action (Metals)	7-12
	7.2.3	OU 2 Soil Remedial Action (Pesticides)	7-13
	7.2.4	Institutional Control Sites	7-13
	7.2.5	Validity of Remedial Action Objectives	7-14
8.0	ISSUES		8-1
8.1	Operable Unit 1 Remedy Issues		8-1
	8.1.1	Increasing Trends in Groundwater Below Extraction Well Depths	8-1
	8.1.2	Less than Complete Capture in the C Zone	8-1
	8.1.3	Predicted Cleanup Times	8-1
	8.1.4	Hexavalent Chromium	8-2
	8.1.5	Arsenic	8-2
	8.1.6	Optimization Initiatives for the Remedy	8-2
	8.1.7	Potential VOC Inhalation Pathway	8-3
8.2	Operable Unit 2 Remedy Issues		8-4
9.0	RECOMMENDATIONS AND FOLLOW-UP ACTIONS		9-1
9.1	Operable Unit 1		9-1
9.2	Operable Unit 2		9-2
10.0	PROTECTIVENESS STATEMENT		10-1
10.1	OU 1 Protectiveness		10-1
10.2	OU 2 Protectiveness		10-1
11.0	NEXT FIVE-YEAR REVIEW		11-1
12.0	REFERENCES		12-1

ATTACHMENT 1: Summary of Treatment System Construction and Performance References, OU 1, DDJC-Sharpe
ATTACHMENT 2: Exceedances of NPDES Requirements/WDRs
ATTAHCMENT 3: Summary of Treatment System Construction and Performance References, OU 2, DDJC-Sharpe
ATTACHMENT 4: Site Inspection Checklist
ATTACHMENT 5: Photograph Log
ATTACHMENT 6: Interviews
ATTACHMENT 7: WES Groundwater Model Presentation
ATTACHMENT 8: Indoor Inhalation Model Results

LIST OF TABLES

		Page
2-1	Chronology of Site Events, DDJC-Sharpe	2-1
4-1	Remedial Actions at DDJC-Sharpe	4-2
4-2	Remedial Performance Standards – Aquifer Cleanup Levels, DDJC-Sharpe	4-4
4-3	Effluent Discharge Standards, DDJC-Sharpe	4-5
4-4	OU 1 Remediation Systems, DDJC-Sharpe	4-7
4-5	Groundwater Treatment System Improvements and Major Repairs, DDJC-Sharpe	4-16
4-6	Annual Operation and Maintenance Costs for the Three Groundwater Treatment Plans, DDJC-Sharpe	4-21
4-7	Sites Selected for No Further Action after Characterization, DDJC-Sharpe	4-22
4-8	OU 2 Remedial Actions, DDJC- Sharpe	4-26
4-9	Final Remediation Goals for Soils in the Pesticides Mix Area, DDJC-Sharpe	4-31
6-1	Five-Year Review Schedule, DDJC-Sharpe	6-2
6-2	Number of Well Samples Collected, 1998-2002, DDJC-Sharpe	6-8
7-1	Extraction Well Operational Data, 2002, DDJC-Sharpe	7-4

LIST OF FIGURES

		Page
3-1	DDJC-Sharpe Location Map – Local Area	3-3
3-2	Current Installation Restoration Program Project Sites at DDJC- Sharpe	3-5
4-1	Operable Unit 1 Remedial Actions, Groundwater Extraction and Treatment, DDJC-Sharpe	4-6
4-2	Flow Schematic and Discharge Sampling Locations for Groundwater Treatment Plants, DDJC-Sharpe	4-10
4-3	Operable Unit 2 Remedial Actions, Solid Waste Management Units and Other Areas of Soil Contamination, DDJC-Sharpe	4-28
6-1	Well Locations, DDJC-Sharpe	6-10
6-2	Piezometer Locations, GMS Boundary Survey, DDJC-Sharpe	6-11
6-3	Groundwater Level Contours in the A Zone, First Quarter 2003, DDJC-Sharpe	6-12
6-4	Groundwater Level Contours in the B Zone, First Quarter 2003, DDJC-Sharpe	6-13
6-5	Groundwater Level Contours in the C Zone, First Quarter 2003, DDJC-Sharpe	6-14
6-6	Maximum TCE Concentrations in Groundwater, North Balloon, A, B, and C Zones, Third Quarter 2002, DDJC-Sharpe	6-15
6-7	Maximum TCE Concentrations in Groundwater, South Balloon and Central Area, A, B, and C Zones, Third Quarter 2002, DDJC-Sharpe	6-16
6-8	TCE Concentrations in Groundwater in the D Zone and Potable Water Wells, Fourth Quarter 2001 through Third Quarter 2002, DDJC-Sharpe	6-17
6-9	Geologic Cross-Section Locations, DDJC-Sharpe	6-18
6-10	TCE Vertical Isoconcentration Profile, Geologic Cross- Section A-A', North Balloon, Third Quarter 2002, DDJC-Sharpe	6-19

LIST OF FIGURES (Continued)

		Page
6-11	TCE Vertical Isoconcentration Profile, Geologic Cross-Section B-B', Central Area, Third Quarter 2002, DDJC-Sharpe	6-20
6-12	TCE Vertical Isoconcentration Profile, Geologic Cross- Section C-C', South Balloon, Third Quarter 2002, DDJC-Sharpe	6-21
6-13	Maximum PCE Concentrations in Groundwater, North Balloon, A, B, and C Zones, Third Quarter 2002, DDJC-Sharpe	6-22
6-14	Maximum PCE Concentrations in Groundwater, South Balloon and Central Areas, A, B, and C Zones, Third Quarter 2002, DDJC-Sharpe	6-23
6-15	PCE Concentrations in Groundwater in the D Zone and Potable Water Wells, Fourth Quarter 2001 through Third Quarter 2002, DDJC-Sharpe	6-24
6-16	Non-TCE and Non-PCE Volatile Organic Concentrations Greater than Aquifer Cleanup Levels Reported in Monitoring Well Samples, Fourth Quarter 2001 through Third Quarter 2002, DDJC-Sharpe	6-25
6-17	Bromacil Concentrations in Well Samples, Fourth Quarter 2001 through Third Quarter 2002, DDJC-Sharpe	6-26
6-18	Total Chromium and Hexavalent Chromium Concentrations Reported in Well Samples, Fourth Quarter 2001 through Third Quarter 2002, DDJC-Sharpe	6-27
6-19	Wells with Arsenic Concentrations, Fourth Quarter 2001 through Third Quarter 2002, DDJC-Sharpe	6-28
6- 20	TPH and BTEX Concentrations Reported in Monitoring Well Samples, Fourth Quarter 2001 through 2002, DDJC-Sharpe.	6-29
7-1	TCE Comparison Map, 1998-2002, DDJC-Sharpe	7-15
7-2	PCE Comparison Map, 1998-2002, DDJC-Sharpe	7-16
7-3	Estimated Extraction Well Capture Zone in the A Zone, Third Quarter 2002, DDJC-Sharpe	7-17
7-4	Groundwater Level Contours in the A Zone, First Quarter 2003, DDJC- Sharpe	7-18
7-5	Estimated Extraction Well Capture Zone in the B Zone, Third Quarter 2002, DDJC-Sharpe	7-19
7-6	Groundwater Level Contours in the B Zone, First Quarter 2003, DDJC- Sharpe	7-20
7-7	Estimated Extraction Well Capture Zone in the C Zone, Third Quarter 2002, DDJC-Sharpe	7-21
7-8	Groundwater Level Contours in the C Zone, First Quarter 2003, DDJC- Sharpe	7-22
7-9a	Result of Model Simulation of TCE Plumes in the A Zone After 30 Years of Extraction with 45 Wells Operating	7-23
7-9b	Result of Model Simulation of TCE Plumes in the A Zone After 30 Years of Extraction with 35 Wells Operating	7-23
7-10a	Result of Model Simulation of TCE Plumes in the B Zone After 30 Years of Extraction with 45 Wells Operating	7-24
7-10b	Results of Model Simulation of TCE Plumes in the B Zone After 30 Years of Extraction with 35 Wells Operating	7-24
7-11a	Results of Model Simulation of TCE Plumes in the C Zone After 20 Years of Extraction with 45 Wells Operating	7-25
7-11b	Results of Model Simulation of TCE Plumes in the C Zone After 20 Years of Extraction with 35 Wells Operating	7-25
7-12a	Results of Model Simulation of TCE Plumes in the C Zone After 30 Years of Extraction with 45 Wells Operating	7-26
7-12b	Results of Model Simulation of TCE Plumes in the C Zone After 30 Years of Extraction with 35 Wells Operating	7-26
9-1	Proposed Locations for Recommendations and Follow-up Actions, OU 1 and OU 2, DDJC-Sharpe	9- 3

LIST OF ACRONYMS

ACL	aquifer cleanup level
AR	U.S. Army Regulation
ARAR	applicable or relevant and appropriate requirement
bgs	below ground surface
BTEX	benzene, toluene, ethylbenzene, and xylenes
Cal/EPA	California Environmental Protection Agency
CEHNC	Engineering and Support Center, Huntsville
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
DCPA	dichloropropane
DDD	1,1-dichloro-2,2-bis(p-chlorophenyl) ethane
DDE	1,1-dichloro-2,2-bis(p-chlorophenyl) ethylene
DDJC	Defense Distribution Depot San Joaquin California
DDRW	Defense Distribution Region West
DDT	1,1,1-trichloro-2,2-bis(p-chlorophenyl) ethane
DHS	Department of Health Services
DI-WET	deionized water waste extraction testing
DLA	Defense Logistics Agency
DoD	U.S. Department of Defense
DTSC	California Department of Toxic Substances Control
ESE	Environmental Science and Engineering, Inc.
ETM	engineering technical memorandum
EW	extraction well
FFA	federal facilities agreement
FRG	final remediation goal
FS	feasibility study
GAC	granular activated carbon
gpd	gallons per day
gpm	gallons per minute
GWTP	groundwater treatment plant
IGIS	integrated geographical information system
IRP	Installation Restoration Program
ISV	in-situ volatilization
LTM	long-term monitoring
LTO	long-term operation
LUC	land use control
MCL	maximum contaminant level
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
msl	mean sea level
MW	monitoring well
NFA	no further action
NPDES	National Pollutant Discharge Elimination System

LIST OF ACRONYMS (Continued)

O&M	operations and maintenance
OEHHA	California Office of Environmental Health Hazard Assessment
OU	operable unit
PCE	tetrachloroethene
PCOR	Preliminary Close Out Report
PHG	public health goal
PLC	programmable logic controller
ppmv	parts per million by volume
PRG	preliminary remediation goal
QA	quality assurance
QAPP	quality assurance project plan
RAO	remedial action objective
RI	remedial investigation
ROD	record of decision
RPM	remedial project manager
RTU	remote transmission unit
RWQCB	California Regional Water Quality Control Board
SCADA	Supervisory Control and Data Acquisition
SSJIDC	South San Joaquin Irrigation District Canal
SVE	soil vapor extraction
SVOC	semivolatile organic compound
SWMU	solid waste management unit
TCE	trichloroethene
TCLP	toxicity characteristic leachate procedure
TPH	total petroleum hydrocarbons
TPHD	total petroleum hydrocarbons as diesel
TPHG	total petroleum hydrocarbons as gasoline
TRC	technical review committee
USACE	U.S. Army Corps of Engineers
U.S. EPA	U.S. Environmental Protection Agency
USATHAMA	U.S. Army Toxics and Hazardous Materials Agency
UST	underground storage tank
VOC	volatile organic compound
WDR	waste discharge requirements
WES	Waterways Experiment Station
1Q03	first quarter 2003 (quarter, year)

ES. 0 EXECUTIVE SUMMARY

ES.1 This five-year review of remedial actions at the Defense Distribution Depot San Joaquin California, Sharpe Site (DDJC-Sharpe) in Lathrop, California, is required by the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). The purpose of the five- year review is to evaluate the implementation and performance of the selected remedies and determine whether remedial response actions at the facility are protective of human health and the environment. A five- year review also recommends ways to attain or maintain that protection.

ES.2 The remedies for environmental contamination at DDJC-Sharpe include groundwater extraction and treatment, soil gas extraction, soil removal, and institutional land use controls. *The Installation-Wide Preliminary Close Out Report* (PCOR) (URS, 2002a) documents the status of remedial and removal action progress relative to the requirements of the Operable Unit (OU) 1 (groundwater) Record of Decision (ROD) (Environmental Science and Engineering, Inc. [ESE], 1993) and the OU 2 (vadose zone) ROD (ESE, 1996) for DDJC-Sharpe. Specifically, the PCOR documents the completion of the construction of remedial actions, which is an intermediate step between the beginning of construction and the final close out report. As stated in the PCOR, a former toxic waste release site meets the criteria for "construction completion" designation by completing the physical construction of all cleanup actions, addressing all immediate threats, and bringing all long-term threats under control. Through a series of removal actions and remedial actions, DDJC- Sharpe has met the criteria for construction completion, even though all actions are not complete. All remedies have been implemented in accordance with removal or remedial design plans and specifications. The trigger for this five-year review was construction completion of the groundwater remedy as specified in the OU 1 ROD. This was signified by the beginning of groundwater extraction from extraction well (EW) EWCC3 to the Central Area Groundwater Treatment Plant (GWTP) in 1998 (i.e., the third of the three GWTPs at DDJC-Sharpe).

ES.3 For OU 1 (groundwater), extraction systems and treatment systems are in place and operating. In its presentation of groundwater remedial alternatives, the OU 1 ROD states that "time to achieve cleanup goals has been estimated as 16 years" (ESE, 1993). However, changes in the concentrations and extents of the plumes in the five years since the Central Area extraction wells and treatment plant were brought on line suggest that cleanup goals will not be achieved in the next 11 years. The U.S. Army Corps of Engineers, Waterways Experiment Station (WES) groundwater model provided a revised estimate of the cleanup time (greater than 30 years). The extraction systems are expected to continue operation until 2014 or longer to assure aquifer cleanup levels (ACLs) are attained. Future adjustments to groundwater extraction and treatment systems are expected to include well replacements or shutdowns to optimize the operation of the extraction systems as the volatile organic compound (VOC) plumes in groundwater are reduced in size.

ES.4 For OU 2 (vadose zone), all construction and remedial actions have been completed; continuing activities include monitoring contaminant concentrations in wells down-gradient from remedial action sites and maintaining institutional controls. Although the OU 2 remedial actions are complete, the final close out report will be written as an installation-wide document, including groundwater and soil remedial actions; therefore, the projected completion of the final close out report for OU 2 will be delayed until the OU 1 actions are completed. The soil vapor extraction (SVE) remedial action is documented in the Operable Unit 2 Soil Vapor Extraction Remedial Action Report, DDJC-Sharpe (URS, 2002b), which recommends discontinuing SVE and decommissioning the system. The U.S. Environmental Protection Agency (U.S. EPA), California Department of Toxic Substances Control (DTSC), and State of California Central Valley Regional Water Quality Control Board (RWQCB) agreed with this recommendation, and SVE systems at DDJC-Sharpe have been decommissioned.

ES.5 Actions taken as part of soil excavation efforts at Sites S-3 and S-26 are documented in the *Operable Unit 2 Metals Remedial Action Report, Sites S-3 and S-26* (Radian International, 2000a). Several other areas of the depot where soil was found to be contaminated with metals were recommended for no further action (NFA). The affected areas, and the supporting data and reasons for these recommendations, are provided in the Operable Unit 2 No Further Action Remedial Action Report (Radian International, 2000b). The recommendations for NFA have been approved by the overseeing regulatory agencies (U.S. EPA, DTSC, and Central Valley RWQCB).

ES.6 An institutional control remedy was selected for two DDJC-Sharpe sites (S-33/29) identified for remediation because of risks to human health from chromium and/or lead concentrations in soil. The remedial activities associated with the implementation of institutional controls include land use controls (LUCs) for DDJC-Sharpe property south of South Crane Way.

ES.7 This five-year review for DDJC-Sharpe is a statutory review. A statutory review is warranted because the completed OU 2 remedial actions have left hazardous substances, pollutants, or contaminants on site above concentrations that allow for unlimited use and unrestricted exposure, in conformance with the OU 2 ROD. The groundwater remedy at DDJC-Sharpe is not functioning as designed, and although there is no immediate threat, the remedy is unlikely to achieve cleanup goals within the time period indicated in the OU 1 ROD. VOC plumes in the C Zone are not fully captured at the installation boundary.

ES.8 The remedy for groundwater selected in the OU 1 ROD consists of extraction well fields and associated piping to remove groundwater from the contaminated aquifer zones, and air stripping systems designed to remove VOC contamination from groundwater. The remedy for soils selected in the OU 2 ROD consists of SVE for VOC- contaminated soils and excavation and off-site disposal for soils contaminated with lead and chromium. OU 2 remedial actions are complete at DDJC-Sharpe.

ES.9 The actions taken for OU 1 have been protective in the first five years of operation. However, evidence of incomplete capture of contaminant plumes indicates that extraction well systems are not operating as intended. Because of this, the OU 1 actions may not be protective into the future. To assure protectiveness, the recommendations and follow-up actions presented in Section 9.0 must be implemented. The actions taken for OU 2 are protective because they are operating as intended; however, lead concentrations left beneath railroad ballast on Site S-26 would not be protective if land use changed and the soil disturbed. To assure that the contaminated soil would not pose a risk if residences were built at the site, proposed follow-up action for OU 2 is a control that assures continued industrial land use.

ES.10 Recommendations presented in this five-year review report to address the effectiveness of the groundwater OU 1 remedy include (1) optimization of flow rates at operating extraction wells in order to increase capture and (2) installation of additional monitoring wells to verify plume capture. For the OU 2 soil remedy, an institutional land use control is proposed. Follow-up actions documented in remedial action reports include ensuring that institutional controls in the South Balloon Area are enforced and that groundwater monitoring downgradient of Sites S-33/29 continues.

1.0 INTRODUCTION

1.1 This five-year review summarizes the status of actions taken pursuant to the OU 1 and OU 2 RODs for DDJC-Sharpe (ESE, 1993 and 1996, respectively). This is the first five-year review of remedial actions at DDJC-Sharpe and is required under CERCLA. The purpose of the review is to determine whether remedial response actions are protective of human health and the environment and to recommend ways to attain or maintain that protection. An additional objective of the review under U.S. Army guidance is to make recommendations for optimizing long-term monitoring (LTM) and long- term operations (LTO) of remedial actions to ensure that the ongoing operations are cost effective.

1.2 This review was conducted by the U.S Army Corps of Engineers (USACE), Engineering and Support Center, Huntsville (CEHNC), under Executive Order 12580, which delegates review responsibility to federal facilities that control the sole source of the release. This five-year review is a combination of Type 1 and Type 1a reviews. Type 1 reviews are performed for facilities where the remedial action has been completed, while the abbreviated Type 1a reviews are performed for facilities where remedial actions are ongoing, as described in the *Comprehensive Five-Year Review Guidance* (U.S. EPA, 2001). Both ongoing and completed remedial actions are being or have been conducted at the DDJC-Sharpe facility.

1.3 This review is required by the OU 1 and OU 2 RODs, which were signed by the U.S. EPA, DTSC, and Central Valley RWQCB in 1993 and 1996, respectively. The planned submittal date for this review (March 2003) is five years after the construction completion of the groundwater remedy as specified in the OU 1 ROD. Completion was signified by the beginning of groundwater extraction from EWCC3 for conveyance to the Central Area GWTP in 1998. This five- year review was conducted by evaluating the site conditions and the status and performance of remedial actions taken to date and by determining whether those actions meet or demonstrate progress toward the specific goals and objectives stated in the RODs.

1.4 Past investigations and remedial activities at underground storage tank (UST) sites at DDJC-Sharpe have been overseen by San Joaquin County Health Division or the Central Valley RWQCB. The DDJC-Sharpe UST Program includes 92 sites; some of the sites have sumps or vaults instead of underground tanks. All USTs have been removed. Of the 92 UST Program sites, 6 sites remain active, 2 sites are in the closure process under DDJC oversight, 59 sites have been approved for closure, and 25 sites are in the closure process under Central Valley RWQCB oversight. Past investigations, field work, and pilot-scale studies at DDJC-Sharpe UST Program sites currently in the closure process are summarized in the DDJC-Sharpe Preferred Alternatives Report: *UST Sites 5, 12, 15, 17, 18, 21, 34, 55, and 73, Sites 146 and 147, Building 271, Building 669 Sump, Building 186 Sump, Building 404 Sump, Former Fueling Station, and Building 199* (URS, 2002c). USTs are exempt from the CERCLA process and are not discussed further in this five-year review.

2.0 CHRONOLOGY

Significant events and dates related to the initial discovery of the problem and implementation of the selected remedies at DDJC-Sharpe are listed in Table 2-1.

Table 2-1. Chronology of Site Events, DDJC- Sharpe

Event	Date
Initial discovery of soil and groundwater contamination	1980
Initial remedial investigation began	1982
Remediation plan developed for groundwater contamination	1985
Pilot-scale demonstration conducted for South Balloon groundwater treatment	1985
Installation added to NPL	1987
South Balloon GWTP began operation	March 1987
Initial NPDES waste discharge permit issued	1988
North Balloon GWTP design developed	1988
FFA signed	March 1989
TRC charter created; first TRC meeting conducted	June 1990
North Balloon GWTP began operation	October 1990
Basewide remedial investigation completed	June 1991
OU 2 SVE pilot-scale testing conducted in South Balloon and Central Area	July 1991
Groundwater feasibility study completed	November 1991
OU 1 RI/FS report and proposed plan released to the public	February 1992
Substantive Waste Discharge Requirements permit issued	November 1992
North Balloon petroleum-contaminated soils excavation completed (3,000 cu. yd.)	December 1992
OU 2 SVE pilot-scale testing conducted in North Balloon and South Balloon	December 1992
OU 1 ROD signed	January 1993
Central Area GWTP design completed	March 1993
North Balloon Pesticide Mix Area EE/CA completed	October 1993
OU 2 soils feasibility study completed	December 1994
North Balloon pesticide-contaminated soils excavation completed (480 cu. yd.)	December 1994
OU 2 proposed plan released to the public	February 1995
OU 2 RI/FS report and basewide proposed plan released to the public	February 1995
Additional North Balloon pesticide-contaminated soils excavation completed (4 cu. yd.)	March 1995

Table 2-1. Chronology of Site Events, DDJC- Sharpe

Event	Date
Central Area GWTP began operation	May 1995
OU 2 SVE pilot-scale testing conducted in North Balloon	October 1995
Renewed NPDES waste discharge permit adopted	December 1995
Basewide OU 2 ROD signed	February 1996
OU 2 SVE remedial design completed	May 1996
OU 2 SVE pilot-scale testing conducted at OU 2 ROD sites	August 1996
Additional North Balloon pesticide-contaminated soils excavation completed (19 cu. yd.)	October 1996
OU 2 metals-contaminated soils excavation remedial design completed (Sites S-3 and S-26)	August 1997
OU 2 SVE 100% design completed	August 1997
OU 2 SVE system construction completed	July 1998
OU 2 metals-contaminated soils excavation completed (total of 941 cu. yd.) (Sites S-3 and S-26)	July 1998
OU 2 SVE Phase 1 operation began	October 1998
Water management report completed	October 1999
OU 2 metals RAR completed (Sites S-3 and S-26)	September 2000
OU 2 NFA RAR completed	December 2000
Initial OU 2 soil gas closure/confirmation sampling conducted	December 2000
OU 1 interim RAR completed	June 2001
OU 2 SVE operations completed installation-wide	December 2001
Additional OU 2 soil gas closure/confirmation sampling conducted following Phase 4	January 2002
OU 2 SVE RAR completed	May 2002
South Balloon institutional controls implemented (land use controls) with RAR	June 2002
Installation-wide preliminary close out report completed	September 2002
Initial five-year review completed	March 2003
Final close out report completed	TBD
Removal of installation from NPL	TBD

cu. yd. = cubic yards
DDJC = Defense Distribution San Joaquin California
EE/CA = engineering evaluation/cost analysis
FFA = Federal Facilities Agreement
GWTP = groundwater treatment plant
NFA = no further action
NPDES = National Pollutant Discharge Elimination System
NPL = National Priorities List
OU = operable unit
RAR = remedial action report
RI/FS = remedial investigation/feasibility study
ROD = record of decision
SVE = soil vapor extraction
TBD = to be determined
TRC = technical review committee

3.0 BACKGROUND

DDJC-Sharpe is a distribution depot operated by the Defense Logistics Agency (DLA) to supply all military services with the equipment needed to fulfill their missions. DLA is responsible for managing regional and local environmental programs at DDJC, including the Installation Restoration Program (IRP). The IRP at the DDJC- Sharpe site is managed in accordance with the Federal Facility Agreement (FFA) developed specifically for the DDJC-Sharpe site. As described in the FFA, authority for IRP decision making rests with a team of Remedial Project Managers (RPMs) from the California Environmental Protection Agency (Cal/EPA), including DTSC and Central Valley RWQCB, from the U.S. EPA Region 9, and from DDJC. DLA is the lead agency responsible for funding and implementing remedial actions. The U.S. EPA provides final approval for decisions regarding remedial actions taken at DDJC-Sharpe.

3.1 Physical Characteristics

3.1.1 DDJC-Sharpe is located in California's primarily agricultural Central Valley region. The installation lies within the northeastern boundaries of the City of Lathrop, a small community that was incorporated in 1989 (Figure 3-1). The unincorporated community of French Camp borders Lathrop to the northwest, and the City of Manteca borders Lathrop to the east. Large nearby communities include the City of Stockton, approximately 7 miles to the north, and the City of Modesto, approximately 20 miles south of the depot.

3.1.2 Roth Road borders the northern boundary of the depot, Lathrop Road borders the southern boundary, and the Union Pacific Railroad runs parallel and next to the installation's west and east boundaries (Figure 3-1). The South San Joaquin Irrigation District Canal (SSJIDC) also parallels the eastern boundary, and the Union Pacific Inter- Modal Facility borders the installation to the northeast (Figure 3-1).

3.1.3 The installation is generally rectangular in shape. Slightly more than 0.5 miles wide and almost 2 miles long, it covers 724 acres of land. Land surrounding the depot is used for a variety of purposes, including agricultural, residential, and light industrial uses. Agricultural lands lie to the east of the Union Pacific Inter-Modal Facility. Mixed light industrial areas lie to the north, northwest, and south of the depot, and new residential developments lie to the west. A large residential development borders the depot's immediate southwestern boundary. Additional residential developments are found south of the installation, across Lathrop Road.

3.1.4 Surface Water Hydrology. Surface water runoff from the western portion of the installation is collected in stormwater drains and dry wells at the western boundary of the installation. However, most surface water runoff is collected by the stormwater drainage system that discharges to the SSJIDC, which parallels the eastern boundary of the installation. In addition to the stormwater, the irrigation canal also receives treated water from the groundwater treatment systems and treated sanitary sewer water from a publicly owned treatment works discharge line. The irrigation canal drains to the north into French Camp Slough, which is a tributary of the San Joaquin River.

3.1.5 Geology. Surface soils consist of loam to sandy loam that has been disturbed by agricultural and then industrial development. Beneath the soils, to approximately 60 feet below ground surface (bgs), subsurface deposits consist of unconsolidated and discontinuous layers and lenses of gravel, sand, silt, and clay. These sediments originated from the erosion of the Sierra Nevada Mountains to the east and were deposited as an alluvial fan. Some of the alluvial fan and interfan deposits were cut by recent stream channels that were later

filled with sand and gravel. The deposits between 60 and 300 feet bgs are similar in lithology to the deposits found between the surface and 60 feet bgs, but the deeper deposits are semi-consolidated and have more fine-grained material than the shallower deposits. In the depth interval between 220 and 280 feet bgs, there is a clay layer greater than 20 feet thick as well as thinner sand and clay layers. The clay layer may be geologically equivalent to, but thinner and less continuous than, the Corcoran Clay that occurs throughout the San Joaquin Valley (Page, 1986).

3.1.6 Groundwater Hydrology. Groundwater at DDJC- Sharpe is encountered at depths ranging from 9 to 12 feet bgs at the southeastern corner and from 18 to 26 feet bgs at the north-western corner. There is one complex and heterogeneous aquifer in which four principal stratigraphic zones have been identified between 14 and 270 feet bgs. The zones include saturated, transmissive layers (sands) 5 to 12 feet thick in the following depth intervals:

- A Zone— water table to 40 feet bgs;
- B Zone— 40 to 90 feet bgs;
- C Zone— 90 to 170 feet bgs; and
- D Zone— 170 to 270 feet bgs.

3.1.7 Groundwater extraction and seasonal precipitation and infiltration changes cause groundwater fluctuations at DDJC-Sharpe. Groundwater extraction from the North Balloon, Central Area, and South Balloon locally affect groundwater flow beneath the installation and adjacent off-installation areas to the west. In any 12-month period, peak water level elevations occur approximately three months (one quarter) after the peak precipitation months of December, January, and February. When monthly precipitation decreases to zero, generally beginning in June, groundwater elevations fall to their lowest value of the year approximately five to six months later (October or November). Groundwater elevations are consistently highest in the South Balloon monitoring wells and show less fluctuation in the South Balloon and Central Area monitoring wells than in the North Balloon monitoring wells. The difference in water levels from south to north across DDJC- Sharpe may be caused by a greater number of active water supply wells near the northwest corner of the installation than along the south, east, or west boundaries.

3.1.8 Groundwater in all stratigraphic intervals flows from southeast to northwest. In the zones with less sand, the velocity of groundwater movement is less than in zones with more sand.

3.2 Land and Resource Use

3.2.1 The distribution depot known as DDJC-Sharpe opened in 1941. The construction of major facilities at DDJC-Sharpe began during World War II and continued into the post-war period. Additional historic facilities were constructed during the Korean and Vietnam conflicts. Two large warehouse facilities and various improvements have been constructed during the current decade. For most of its existence, the installation carried both supply and maintenance missions. The supply mission remains active today; it includes storage, handling, preservation, packaging, and shipment of general supplies and equipment. The maintenance mission included the repair and reconditioning of heavy equipment and aircraft; its major waste-generating activities

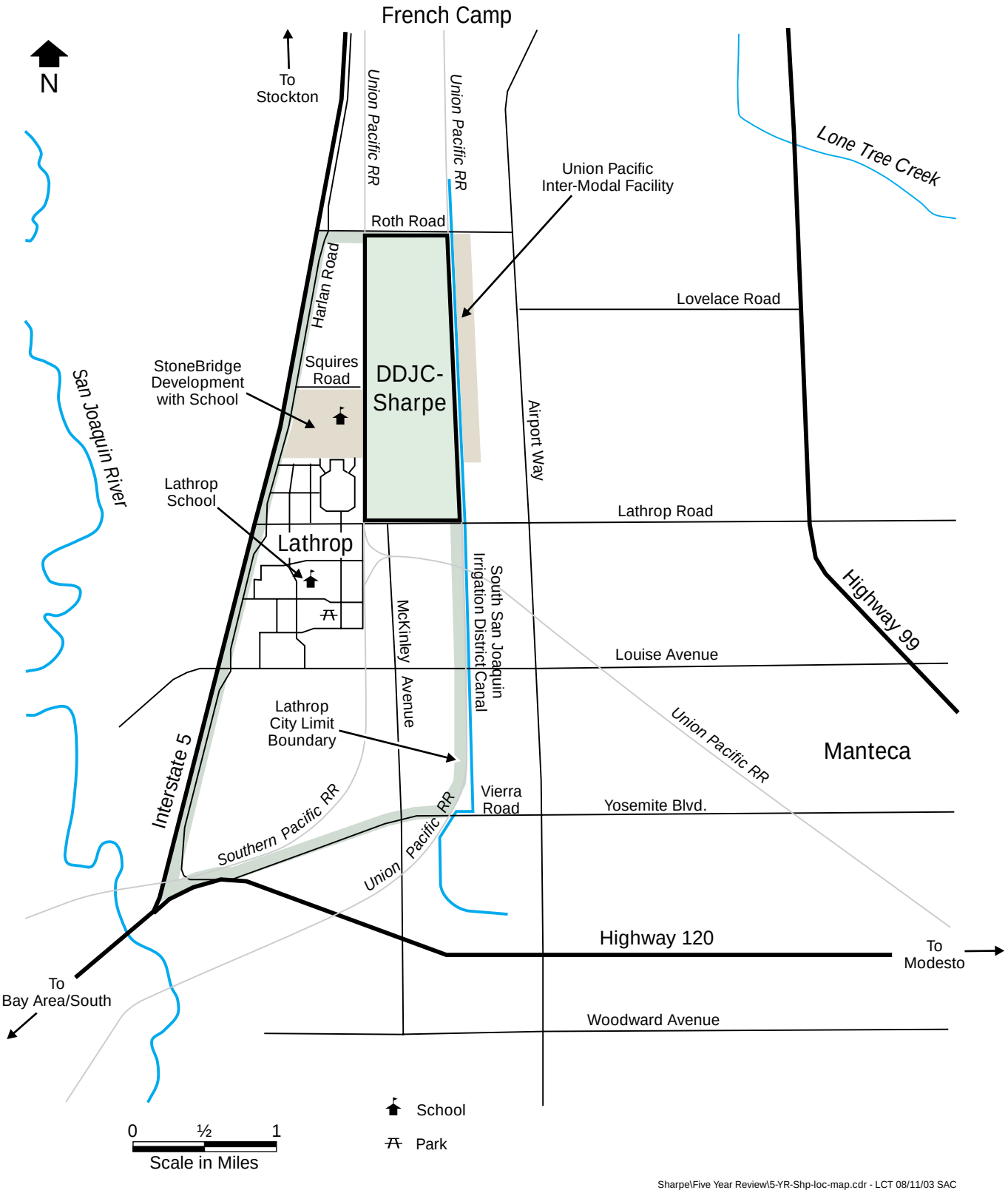


Figure 3-1. DDJC-Sharpe Location Map - Local Area

were paint stripping, metal finishing, and painting. After 1976, the maintenance mission was reduced to the maintenance of installation facilities and vehicles used in performing the supply mission.

3.2.2 The baseline risk assessment and the OU 2 ROD for DDJC-Sharpe were based on the assumption that industrial land use would continue in remedial action areas. The remedies selected in the OU 2 ROD do not allow for any change in the existing land use across the depot. Any change in the land use of depot property requires a site characterization and, at a mini-mum, an environmental assessment. These procedures are required by U.S. Army Regulations (Rs) 200-2, AR 200-1, and AR 415-15.

3.2.3 There are four active drinking water wells at DDJC-Sharpe: PW038 (Sharpe No.1), PW039 (Sharpe No.3), PW040 (Sharpe No.5), and PW041 (Sharpe No.6). These wells are screened at intervals ranging from 138 to 435 feet bgs.

3.3 History of Contamination

3.3.1 Wastes generated at DDJC- Sharpe were primarily a result of former maintenance operations such as paint stripping, metal finishing, and painting. Other waste-generating activities included engine overhauls, hydraulic and electrical repairs, airframe and bodywork, and component repair and reconditioning.

3.3.2 Environmental studies have indicated that groundwater contamination is concentrated in three areas at DDJC-Sharpe: the North Balloon, South Balloon and the Central Area (Figure 3-2). The North and South Balloons are named after the shapes of areas enclosed by railroad tracks, which look like hot-air balloons in map views. Migration of VOCs in the groundwater appears to have originated from soil and soil gas that were contaminated primarily from cleaning solvents used in industrial and vehicle maintenance activities. Metals (lead and total chromium) contamination of soils at DDJC-Sharpe occurred as a result of various activities, including the disposal of paints, paint solvents, and sandblasting wastes. Total petroleum hydrocarbon (TPH) contamination of soils occurred as a result of leaking USTs. In addition, five pesticides were detected in surface soil in the Pesticide Mix Area, where pesticide mixing and container rinsing operations were conducted (ESE, 1996). Metals (arsenic, selenium, total chromium, and lead), the herbicide bromacil, nitrate, and TPH have also been detected in groundwater samples. Among the contaminants frequently detected in groundwater, only the VOCs, bromacil, TPH, and total chromium may have originated at source areas on DDJC- Sharpe (Radian International, 1999a). Lead has been detected infrequently in groundwater. If lead has not migrated to groundwater in sufficient mass to be consistently detected, as have chromium and VOCs, in the period since release to the soil, it is likely that the lead species in the soil is more strongly attracted to soil particles than to percolating water. Therefore, lead is unlikely to be detected in groundwater at concentrations of concern, and is not considered a groundwater contaminant from DDJC-Sharpe.

3.4 Initial Response

3.4.1 The IRP was established by the U.S. Department of Defense (DoD) in approximately 1979. The U.S. Army Toxics and Hazardous Materials Agency (USATHAMA) and its contractors conducted installation assessments at DDJC-Sharpe during that year. During the course of investigations conducted under the IRP and CERCLA, DDJC-Sharpe has been divided into OUs 1 and 2. OU 1 consists solely of contaminated groundwater; OU 2 consists of 18 solid waste management units (SWMUs). Groundwater contamination was first detected at DDJC-Sharpe in 1980. Investigations in 1981 revealed off-depot migration of VOCs in groundwater. Arsenic, selenium, and bromacil were detected sporadically in groundwater samples. As a result

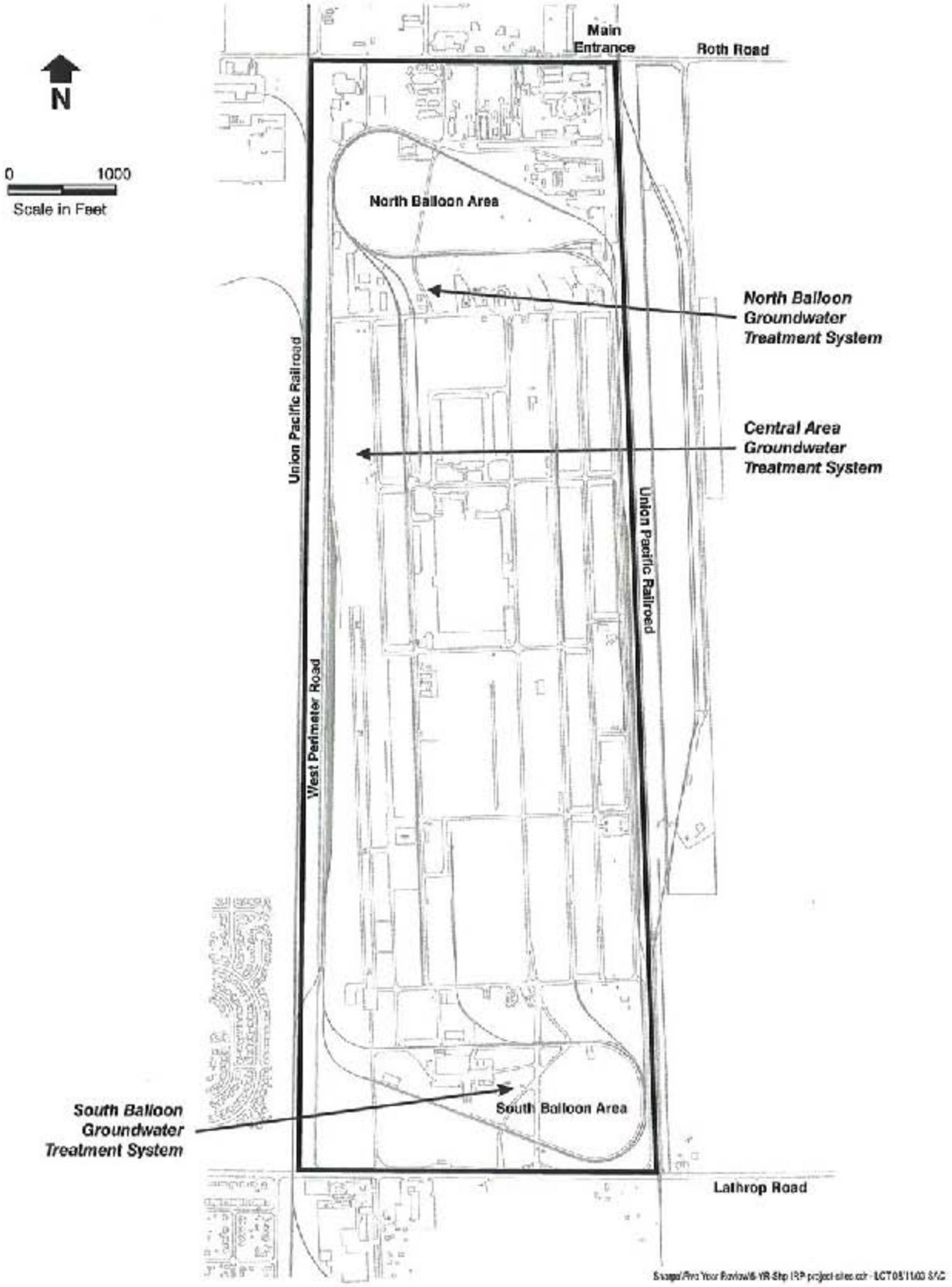


Figure 3-2. Current Installation Restoration Program Project Sites at DDJC-Sharpe

of these investigations, an interim groundwater extraction and treatment system was put into operation in March 1987 to control migration of contaminated groundwater from the South Balloon. Separate investigations were conducted to identify and evaluate interim remedial action alternatives in the North Balloon. These investigations resulted in the design and placement of a second interim groundwater extraction and treatment system, which began operation in October 1990.

3.4.2 After completion of the remedial investigation (RI) for groundwater in June 1991, USATHAMA began evaluating the alternatives for remediating the VOC-contaminated ground-water. The evaluation was documented in a feasibility study (FS) report published in November 1991. The proposed plan for the remediation of groundwater, which presents DDJC-Sharpe's and the agencies' preferred remedial alternative to the community for comment, followed. A public meeting on the proposed plan was held 27 February 1992.

3.4.3 The proposed plan for groundwater was followed by the OU 1 ROD, which outlines the selected remedial alternative. The OU 1 ROD, completed in January 1993, addresses VOC contamination in groundwater through use of extraction and treatment (ESE, 1993). Construction of the third and last groundwater treatment plant, located in the Central Area, was completed and operation began in May 1995. The groundwater treatment system began full operation in March 1998 with the startup of the final extraction well (EWCC3). Groundwater treatment and post-treatment disposal in all three areas— the North Balloon, South Balloon, and Central Area— is conducted in accordance with the OU 1 ROD and is discussed in Section 4.1.2.

3.4.4 Soil in some areas of DDJC-Sharpe was found to be contaminated with trichloroethene (TCE), lead, and total chromium. The FS for soil was completed in December 1994, followed by the proposed plan for the remediation of soil in February 1995 and a public meeting on 1 March 1995. In February 1996, the OU 2 ROD was signed, designating 111 sites for NFA (these included UST sites that are not under CERCLA), 14 sites for further action as a result of VOC contamination (primarily by TCE), and 14 other sites for further action as a result of metals contamination (specifically, lead and total chromium).

3.4.5 Prior to the signing of the OU 2 ROD in 1996, in situ volatilization (ISV) via vacuum extraction to remove VOCs was conducted in pilot- scale studies in the South Balloon (Site P-1A) and Central Area (Site P-6A) in 1991 (ESE, 1992); the South Balloon (Site P-1A) and the North Balloon (Site P-8A) in 1992 (ESE, 1994b); and the North Balloon (Site P-8A) in 1995 (Radian Corporation, 1996a). Operation of the pilot-scale ISV system remediated the vadose zone contamination to concentrations below the decision level at Site P-8A in the North Balloon; consequently, Site P-8A was designated a no further action site in 2000 (Radian International, 2000b). Another soil cleanup action, completed in March 1995, was the excavation and off-site disposal of pesticide-contaminated soils from the former Pesticide Mix Area in the North Balloon.

3.5 Basis for Taking Action

3.5.1 The OU 2 ROD identifies cleanup standards for soils containing TCE, lead, and chromium. The lead cleanup standard of 1,000 milligrams per kilogram (mg/kg) is considered protective of an industrial adult worker based on results from DTSC's Lead Spreadsheet Model default exposure scenarios (ESE, 1996). The cleanup standard for chromium was established as 300 mg/kg at the request of the RWQCB (ESE, 1996). The board considered this value more conservative and protective of groundwater than the dermatitis toxicity value (500 mg/kg) for trivalent chromium that was being considered. Although the 500-mg/kg level accounts for both sensitization and elicitation for the dermatitis reaction, it is not protective of 10% of the population considered hypersensitive (ESE, 1996). The TCE soil gas cleanup standard of 0.35 parts per million by volume (ppmv) was

selected to be protective of the beneficial use of groundwater as a potential drinking water supply, assuming a maximum contaminant level (MCL) of 5 micrograms per liter (µg/L) is protective (ESE, 1996).

3.5.2 Risk assessments indicated that the lead-and chromium-contaminated soil sites required remediation to reduce the potential threat to groundwater and to human health and the environment (ESE, 1996). TCE in soil was determined not to represent a potential threat to human health or the environment based on the relevant exposure scenarios evaluated in the risk assessment; however, TCE-contaminated soils represented a continuing threat to groundwater quality through leaching pathways (ESE, 1996).

3.5.3 Contaminant concentrations in ground-water beneath DDJC- Sharpe exceeded contaminant-specific applicable or relevant and appropriate requirements (ARARs) for TCE, tetrachloroethene (PCE), arsenic, selenium, and nitrate. The health risks posed by TCE and other VOCs in domestic water supplies prompted the remedial actions identified in the OU 1 ROD (ESE, 1993). Remedial actions for arsenic, selenium, and nitrate were not included in the OU 1 ROD because their presence could not be positively attributed to activities at DDJC-Sharpe.

4.0 REMEDIAL ACTIONS

This section describes the remedial actions taken at DDJC-Sharpe under the OU 1 ROD (ground-water) and the OU 2 ROD (vadose zone or soil). For each, the objectives of the ROD are defined, the selected remedy and its implementation are described, and the operation and maintenance (groundwater) or institutional controls (soil) are outlined. Table 4-1 summarizes the remedial action history for DDJC-Sharpe.

4.1 Groundwater Remedy

The primary objectives of the remedial action for groundwater at DDJC-Sharpe are to prevent migration of contaminated groundwater and to capture the contaminant plumes, protect human health and the environment, and restore ground-water to its beneficial use as a potential drinking water source (ESE, 1996). Based on information obtained during the RI and on a careful analysis of all remedial alternatives, DDJC, U.S. EPA, and the State of California thought that the selected remedies would achieve these objectives.

4.1.1 Remedy Selection

4.1.1.1 OU 1 was addressed in three actions that began in 1987 with groundwater treatment and extraction in the South Balloon and continued with groundwater extraction and treatment in the North Balloon in 1990 and in the Central Area in 1995. Actions taken in the South Balloon and North Balloon were undertaken as non-time critical removal actions (ESE, 1985; ESE, 1988). The actions were taken because groundwater was contaminated with TCE and other VOCs at concentrations exceeding MCLs for drinking water. The health risks posed by TCE and other VOCs in domestic water supplies were the cause of remedial actions identified in the OU 1 ROD (ESE, 1996). The selected groundwater remedy described in the OU 1 ROD is groundwater extraction and air stripping to meet the ACLs (i.e., the concentrations of contaminants to which the aquifer must be restored through remediation) and effluent discharge standards specified in Tables 4-2 and 4-3, respectively.

Both state and federal ARARs were evaluated for the selection of the ACLs. Additionally, the health risk assessment was used to develop cleanup levels.

4.1.1.2 Benzene, toluene, ethylbenzene, and xylenes (BTEX) and bromacil have been detected in groundwater beneath DDJC-Sharpe. These constituents are not CERCLA hazardous substances; therefore, cleanup levels were not developed for them in the OU 1 ROD. The OU 2 ROD for DDJC-Sharpe states that remediation of chromium and lead concentrations in ground-water must be considered if concentrations of those metals exceed baseline values and have an increasing statistical concentration trend in groundwater (ESE, 1996). Representatives of DDJC-Sharpe, U.S. EPA, DTSC, and Central Valley RWQCB have not determined a need for a remedial action for chromium in groundwater; therefore, in accordance with the OU 1 ROD, no remedial action is required.

4.1.1.3 The groundwater extraction and air stripping remedy chosen requires treatment of groundwater beneath the North Balloon, Central Area, and South Balloon. The following components were specified for each treatment system:

- Extraction wellhead and associated piping network to remove groundwater from the contaminated aquifer zones;

- Equalization tank designed to stabilize groundwater flow and influent VOC concentrations;

- Air stripping system consisting of counter-current packed towers (including carbon adsorption of air stripper exhaust in the Central Area); and

- Reuse or discharge of treated effluent to surface water, evaporation ponds, or injection wells.

4.1.1.4 The goals of the remedial action are to prevent migration of contaminated groundwater and to capture the contaminant plumes, protect human health and the environment, and restore groundwater to its beneficial use. The selected remedy documented in the OU 1 ROD refers to an operational period of 16 years. The remedy specifies performance monitoring with optimization efforts including:

- Discontinuing operation of extraction wells in areas where cleanup levels have been attained;

- Alternating pumping of extraction wells to eliminate stagnation points; and

- Pulse pumping to allow aquifer equilibration and encourage adsorbed contaminants to partition into the groundwater.

Table 4-1. Remedial Actions at DDJC-Sharpe

Operable Unit	Type of Action	Year Started	Nature of Action	Status
1	Groundwater Treatment	1987	Groundwater extraction and treatment in South Balloon Area	Operating
	Groundwater Treatment	1990	Groundwater extraction and treatment in North Balloon Area	Operating
	Groundwater Treatment	1995	Groundwater extraction and treatment in Central Area	Operating
2	Soil Removal	1994	Removal of soil in Pesticide Mix Area	Completed
	Soil Vapor Extraction	1998	Soil vapor extraction at Sites P-1A, P-1B, P-1C, P-1E, and P-6A	Completed
	Soil Removal	1998	Removal of soil at Sites S-3 and S-26	Completed
	Institutional Controls	2001	Land use controls at South Balloon Area south of South Crane Way	Implemented

DDJC = Defense Distribution Depot San Joaquin California

4.1.1.5 The OU 1 ROD requires maintenance of the groundwater treatment systems, including replacement of pumps, periodic cleaning and acid washing of valves and pumps, replacement and adjustment of telemetry equipment, and other maintenance as needed. Furthermore, the OU 1 ROD specifies weekly analysis of influent and effluent samples. Section 4.2 describes the implementation of the groundwater remedy, including operation and maintenance of the treatment system and effluent disposal requirements.

4.1.2 Remedy Implementation

4.1.2.1 Three GWTPs known as the North Balloon treatment plant, the South Balloon treatment plant, and the Central Area treatment plant, were constructed at DDJC- Sharpe to address the contaminants, primarily TCE and PCE, identified in the OU 1 ROD. These treatment plants, with their associated extraction wells and discharge facilities, were constructed in accordance with the requirements of the selected remedy as documented in the OU 1 ROD (see Figure 4-1). The three GWTPs are currently operational. Groundwater extraction from the South Balloon began in 1987; ground-water extraction from North Balloon began in 1990; and groundwater extraction from the Central Area began in 1995. Table 4-4 describes the remediation systems for OU 1 and their current status. The three groundwater extraction and treatment systems and their operations are described in Section 4.2.2. Documents related to treatment system construction and performance are listed in Attachment 1.

4.1.2.2 Effluent Disposal. During the period of this five-year review, the discharge of treated water was governed by the Substantive Waste Discharge Requirements (WDRs) for Land Disposal in the 1992 OU 1 ROD addendum and the National Pollutant Discharge Elimination System (NPDES) Permit No. CA0081931, Order No. 95-258, adopted by the Central Valley RWQCB on 8 December 1995 (Central Valley RWQCB, 1992 and 1995) (Table 4-3). Beginning in February 2003, the discharge of treated water is governed by the requirements of the renewed NPDES Permit No. CA0081931, Central Valley RWQCB Order No. R5-2002-0213 adopted 6 December 2002, effective 10 January 2003. The renewed permit and subsequent updates will govern the discharge of treated water during the next five-year review period.

4.1.2.3 Treated groundwater from the North and South Balloon and Central Area B/C Zone systems is discharged via the storm drain system to the SSJIDC that flows into French Camp Slough. A portion of the treated groundwater is diverted for use by a neighboring electricity co-generation power plant, El Paso Energy®. El Paso Energy® can use up to 500,000 gallons per day (gpd) of DDJC-Sharpe effluent water. The El Paso Energy® holding tank is at the south end of DDJC-Sharpe. The effluent from the North Balloon and the South Balloon systems commingle at the El Paso Energy® holding tank. Treated water that is not used by El Paso Energy® overflows into the storm drainage system and mixes with the sanitary sewer treated water discharge prior to flowing into the canal.

4.1.2.4 Although discharge of treated water to percolation ponds and injection wells was a component of the selected remedy for the Central Area in the OU 1 ROD, treated water is not currently discharged to the percolation ponds or the injection wells. The discharge to the percolation ponds negatively affected plume capture. The mounding caused by the release and infiltration of water at the percolation ponds is a concern because it creates artificially steep gradients that could adversely affect the capture zones of EWCB3 and EWCB4 in the Central Area (Radian International, 2000c). The flux of treated water may also cause dilution of concentrations at EWCB3 and EWCB4 and spreading of the TCE plume to the west, away from the extraction wells (Radian International, 2000c). To minimize discharge to the percolation ponds and improve groundwater plume capture, a connection from the Central Area B/C train to the storm drain was installed in October 1998 to allow Central Area B/C Zone effluent to discharge directly to the storm drain. As a result of this change in discharge configuration, Central Area B/C Zone effluent was subject to NPDES permit limitations as well as WDRs because the effluent was discharging directly to surface waters.

Table 4-2. Remedial Performance Standards – Aquifer Cleanup Levels, DDJC-Sharpe

Constituent	Aquifer Cleanup Level (µg/L)	Basis
Bromodichloromethane	0.5	HRA
Bromoform	0.5	HRA
Carbon tetrachloride	0.5	HRA
Chloroform	0.5	HRA
Dibromochloromethane	0.5	HRA
ortho-Dichlorobenzene	10	California DHS Action Level
para-Dichlorobenzene	5	California Primary MCL
1,2-Dichloroethane	0.5	HRA
1,1-Dichloroethene	0.5	HRA
cis-1,2-Dichloroethene	6	California Primary MCL
trans-1,2-Dichloroethene	10	California Primary MCL
1,1-Dichloroethane	5	California Primary MCL
1,2-Dichloropropane	0.5	HRA
1,3-Dichloropropene	0.5	HRA
Methylene chloride	0.5	HRA
1,1,1-Trichloroethane	200	California Primary MCL
1,1,2-Trichloroethane	0.5	HRA
1,1,2,2-Tetrachloroethane	0.5	HRA
Tetrachloroethene	0.5	HRA
Trichloroethene	5	U.S. EPA and California Primary MCL
Vinyl chloride	0.5	HRA

DDJC = Defense Distribution Depot San Joaquin California
DHS = Department of Health Services
HRA = human health risk assessment
MCL = maximum contaminant level
U.S. EPA = United States Environmental Protection Agency
µg/L = micrograms per liter

Source: Environmental Science and Engineering, Inc., 1993.

Table 4-3. Effluent Discharge Standards, DDJC-Sharpe

Constituent	Daily Maximum Concentration (µg/L)	Weekly Average Concentration (µg/L)	Monthly Median Concentration (µg/L)
NPDES Effluent Limits for Discharge to South San Joaquin Irrigation District Canal[a]			
Arsenic	50	NA	40
Chromium	NA	NA	11
Lead	NA	3.2	5.3[b]/3.2[c]
Mercury	2.4	NA	0.012
Total volatile organic compounds[d]	1	NA	<0.5
Total petroleum hydrocarbons[e]	100	NA	<50
6.5 < pH < 8.5			
Average discharge flow <1.152 million gallons per day			
Survival of test fish in 96-hour bioassays of undiluted waste:			
Minimum for any one bioassay 70%			
Median for any three consecutive bioassays 90%			
Turbidity not to increase more than 20% over background levels			
Substantive Waste Discharge Requirements for Discharge of Effluent to Land[f]			
Arsenic	279[g]/57[h]	NA	NA
Nitrate	24.4[g]/7.6[h]	NA	NA
Selenium	20.9[g]/3.9[h]	NA	NA
Benzene	1	NA	NA
Total BTEX	5	NA	0.5
Bromacil	90	NA	90
Tetrachloroethene[i]	1	NA	0.5
Trichloroethene[i]	1	NA	0.5
Total VOCs	5	NA	1
6.5 < pH < 8.5			

a NPDES Permit No. CA0081931, Order No. 95- 258.
b This number is a 4-day average based on hardness of 200 milligrams calcium carbonate per liter.
c This number is a 4-day average based on hardness of 100 milligrams calcium carbonate per liter.
d Method SW8021.
e Method Modified SW8015.
f Substantive Waste Discharge Requirements for Land Disposal (Addendum to the Record of Decision, Attachment 2).
g Background concentrations for A Zone.
h Background concentrations for B/ C Zone.
i Based on U.S. EPA Methods 601 and 602 using U.S. EPA minimum detection limits.

BTEX = benzene, toluene, ethylbenzene, and xylenes
DDJC = Defense Distribution Depot San Joaquin California
NA = not available NPDES = National Pollutant Discharge Elimination System
VOC = volatile organic compound
U.S. EPA = United States Environmental Protection Agency
µg/L = micrograms per liter

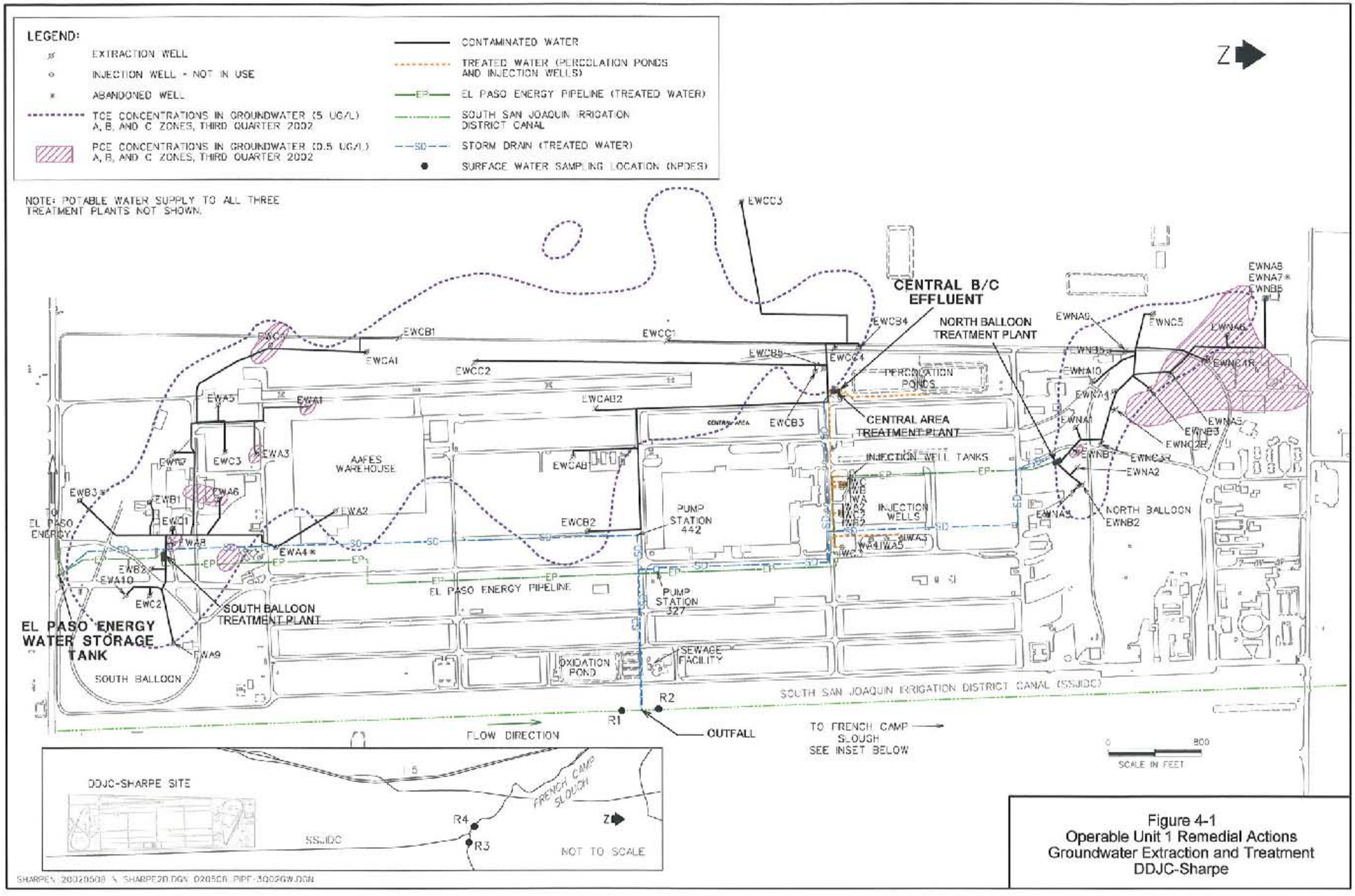


Figure 4-1
Operable Unit 1 Remedial Actions
Groundwater Extraction and Treatment
DDJC-Sharpe

Table 4-4. OU 1 Remediation Systems, DDJC-Sharpe

System	System Description	Status
North Balloon Groundwater Extraction/Treatment System	Designed to treat 500 gpm; the actual flow is 250 to 300 gpm. The system has 18 extraction wells; one well was shutdown and another was added in 1996. One new off-site extraction well was constructed in 2000 and became operational in 2002.	System operational since 1990.
Central Area Groundwater Extraction/Treatment System	Designed to treat 575 gpm; the actual flow is 290 to 400 gpm. The system has 10 extraction wells, 10 injection wells, and two percolation ponds. One new on-site extraction well was constructed in 2000 and became operational in 2001. Injection wells and percolation ponds are not in use.	System operational since October 1995. A Zone treatment system shut down in December 2001. A Zone water now treated by B/C Zone system.
South Balloon Groundwater Extraction/Treatment System	Designed to treat 300 gpm; the actual treatment flow is 79 gpm to 250 gpm. The system has 17 extraction wells, but was originally designed with 14; four extraction wells were added after startup in March 1987 to meet performance requirements of the 1993 OU 1 ROD. Two wells have been shut down, and one new well began extraction in 2001.	System operational since 1987.

DDJC = Defense Distribution Depot San Joaquin California
gpm = gallons per minute
OU = operable unit
ROD = record of decision

4.1.2.5 The injection wells were the preferred discharge option for the Central Area B/C Zone system because the wells provide recharge of the aquifer and thereby help preserve the ground-water for its designated uses (Radian International, 1999b). However, the injection wells are only able to accept approximately 10% of the water treated by the B/C Zone system.

Flow has not been recorded at the injection wells since October 2000, after which treated ground-water from the Central Area facility has been discharged to the SSJIDC through the storm drain. Treated water from the Central Area treatment plant can also be diverted to the El Paso Energy® pipeline or to the percolation ponds, if necessary.

4.1.2.6 The Central Area A Zone treatment plant was taken off line on 19 December 2001 because it was the only effluent being discharged to the percolation ponds that was negatively affecting plume capture. The decision to take the Central Area A Zone treatment plant off line was also based on recommendations presented in the DDJC-Sharpe Air Stripper Data Evaluation Technical Memorandum (URS, 2001a), which indicated that t

the Central Area B/C Zone treatment plant can effectively treat groundwater from the A Zone extraction wells. All influent flow from the Central Area A Zone is now treated by the Central Area B/ C Zone treatment train.

4.1.2.7 Compliance with Effluent and Receiving Water Limitations. Weekly and monthly compliance sampling is performed at the point of compliance for each treatment plant. The compliance points include a sampling location at each treatment plant and the overflow from the El Paso Energy® holding tank in the South Balloon. Separate samples were collected from the Central Area A Zone and B/C Zone treatment trains until the Central Area A Zone treatment system was shut down in December 2001. The compliance point can change depending on the selected discharge strategy being used at the time of sampling. For instance, if the North and South Balloon treatment plants are both discharging to the El Paso Energy® holding tank, then sampling of the holding tank overflow is required, but individual sampling at each plant is not required. Analyses of samples from the SSJIDC upstream of DDJC-Sharpe discharge (R1) and downstream of DDJC-Sharpe discharge (R2) provide measures of water quality compliance in receiving waters (Figure 4-1). French Camp Slough, the receiving water body, is monitored upstream (R3) and downstream (R4) of the confluence with the SSJIDC (Figure 4-1). Tables 1 through 15 in Attachment 2 summarize treatment plant effluent discharge limit exceedances and compliance with receiving water limitations from September 1997 through September 2002.

4.1.2.8 Current Status. To aid in containment of the VOC plumes, three extraction wells were constructed in 2000; all have been connected to the treatment systems and are operating. However, modeling results indicate that, even with the addition of the wells, a minimum of 30 years of pumping must occur before ACLs will be attained in all VOC plume areas beneath DDJC-Sharpe. The well arrays have been modified to capture contaminated groundwater as it migrates within the depot boundaries as well as capturing plumes beyond the boundaries. Optimization of the operation of the extraction wells and treatment plants is an ongoing procedure. However, even with the possible addition of extraction wells and optimization efforts, the time and expenditure to achieve cleanup is expected to be much longer and more expensive than that considered at the time of the FS and ROD.

4.1.2.9 The OU 1 ROD states, “The remedy will include groundwater extraction for a period of 16 years” (ESE, 1993). Based on achievement of full operation in 1998, with certified operation of the Central Area groundwater treatment system, 2014 is the target year to achieve remedial action cleanup levels, based on the OU 1 ROD. However, the systems are expected to require operation beyond 2014 to assure ACLs are attained. The WES groundwater model may to provide a more realistic estimate of the cleanup time. The WES model estimates a 30-year cleanup period. All groundwater remedial actions have been constructed, and a PCOR was finalized in September 2002. After groundwater cleanup levels have been met, a final close out report will be issued.

4.1.2.10 Optimization. In addition to the optimization efforts specified in the OU 1 ROD (see paragraph 4.1.1.4), other ongoing optimization efforts include adjustment of well controls, shut down of extraction wells that do not contribute to plume containment, installation of new extraction wells to enhance plume containment and remediation, addition of chemical sequestrants to control inorganic scale, preventive maintenance of groundwater extraction and treatment systems, development of a groundwater model, and evaluation of potential primary or supplemental alternative technologies.

4.1.2.11 DDJC proposed the shutdown of 10 extraction wells in the *Evaluation of Proposed Extraction Well Shutdown Technical Memorandum* submitted for review and comment in July 2002 (URS, 2002d). A decision was reached among DDJC, U.S. EPA, and DTSC project managers in June 2002 to shut down the wells in a

temporary test of plume containment while reducing the volume of treated groundwater discharged to the SSJIDC because treated effluent discharges exceeded the NPDES-permitted total discharge limit in May and June 2002. Extraction wells EWNA1, EWNA3, EWNA5, EWNB1, EWNB3, and EWNC3R in the North Balloon, EWCAB1 in the Central Area, and EWA9, EWB2, and EWC1 in the South Balloon were shut down on 9 July 2002. The temporary shutdown test period was first set at 60 days (ending 7 September 2002) and was then extended 90 additional days (ending 5 December) to determine if there were any negative impacts from the shutdown. Because the WES modeling results predicted extended cleanup time of the TCE plume in the eastern Central Area, extraction well EWCAB1 in the Central Area was restarted in February 2003. However, the other nine extraction wells will remain shut down.

4.2 Groundwater Treatment System Operation and Maintenance

4.2.1 General

4.2.1.1 The DDJC-Sharpe Operation and Maintenance Manual for the Groundwater Treatment Systems (O&M Manual) (URS, 2001b) describes procedures to operate and maintain the three OU 1 groundwater treatment systems at DDJC-Sharpe. The manual was written to comply with the requirements given in Remedial Design/ Remedial Action Handbook (RD/RA Handbook) (U.S. EPA, 1995). Plant-specific O&M manuals for the North Balloon, Central Area, and South Balloon treatment systems provide more detailed information than the comprehensive O&M Manual (URS, 2001c, 2001d, and 2001e, respectively). The three systems operate independently of each other. However, discharge of treated water from the systems is interconnected.

4.2.1.2 Periodic modifications to the ground-water treatment systems, such as the installation of new extraction wells for refinement of plume control, are planned and implemented independently of the groundwater treatment system O&M. Accordingly, the decision- making criteria and guidance for long- term management of the groundwater treatment systems, including evaluation of system effectiveness at meeting groundwater remedial action objectives (RAOs) and modification of the systems needed to achieve RAOs, are not addressed in the O&M manuals.

4.2.2 Groundwater Treatment System Operation

4.2.2.1 Figure 4-1 shows a piping schematic for the three DDJC-Sharpe systems, including the locations of the groundwater treatment systems, extraction wells, contaminated and treated water piping, and current discharge options (storm drains, percolation ponds, injection wells, and off-depot). Figure 4-2 presents a flow schematic of the piping connections of the three plants. The three groundwater treatment systems are described in the following paragraphs.

4.2.2.2 North Balloon System. The North Balloon groundwater treatment system consists of 18 extraction wells, associated conveyance piping, an air stripping plant, a chemical sequestration system, a control building, and the El Paso Energy® (formerly Dynegy®) discharge pump. Although the treatment plant is designed to treat a maximum of 500 gpm, the ground-water extraction and treatment rate at the North Balloon system averages 250 to 300 gpm.

4.2.2.3 Groundwater is extracted from wells completed in the A Zone (nine wells), B Zone (five wells), and C Zone (four wells). An A Zone well was disconnected from the system and replaced with a B Zone well to improve plume capture. The newest well, EWNC5, was constructed in 2000 to improve capture of the northern

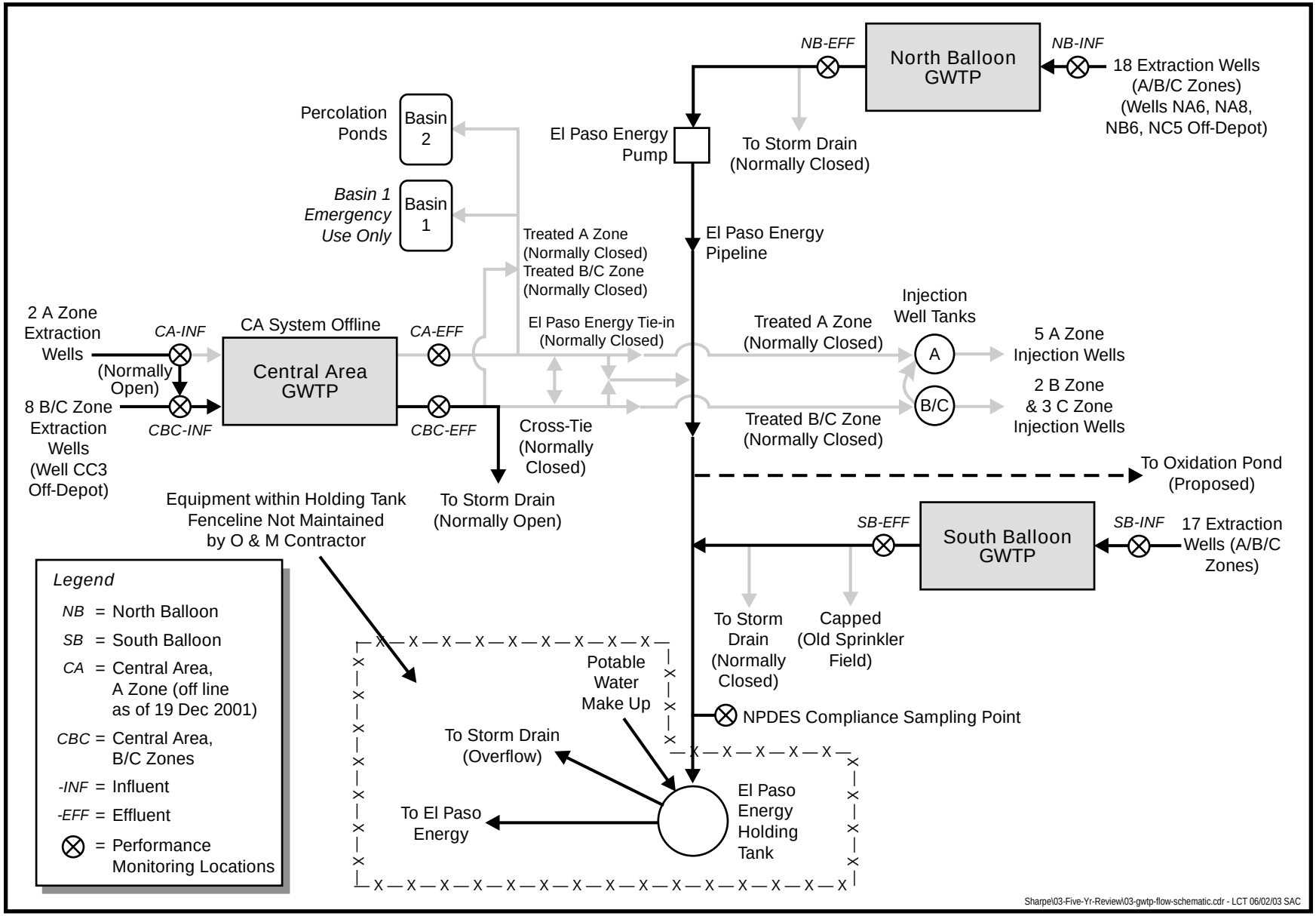


Figure 4-2.
Flow Schematic and Discharge Sampling Locations for Groundwater Treatment Plants, DDJC-Sharpe

C Zone TCE plume, and began operating in September 2002. The extraction wells are connected to the air stripping plant via two primary pipelines and wellhead feeder pipes. The extraction pipelines vary in size from 1 to 6 inches in diameter. The pipeline trenches also contain conduits that provide power, control, and signal wiring to each well. Each well has an associated magnetic flow meter, level sensor, and pressure switch that allow remote monitoring and control of the well. All extraction well pumps are submersible pumps. A Zone wells are completed at depths of approximately 20 to 65 feet bgs; B Zone wells are completed at approximately 60 to 120 feet bgs; and C Zone wells are completed at approximately 90 to 130 feet bgs.

4.2.2.4 Extracted water is pumped to the air stripping plant where VOCs are removed from the water. The North Balloon system uses two 5-foot diameter, 24-foot tall air stripping towers to remove VOCs. The air strippers are packed towers that contain polypropylene media, and are operated in series and under slight pressure. Air is blown into the towers by an upstream air blower. The treatment plant includes a transfer pump mounted between the towers, which is controlled by an actuated valve and level sensors in the "A" tower (primary tower) wet well. Additional controls include an influent flow meter, pressure switch, and a high- level sensor in the "B" tower. Chemical sequestrants are added to the influent water at the treatment pad to minimize scale buildup within the air strippers.

4.2.2.5 As shown on Figures 4-1 and 4-2, treated groundwater can be discharged by gravity to the DDJC-Sharpe storm drain system or discharged by the El Paso Energy® effluent pump to the El Paso Energy® holding tank at the southern boundary of DDJC-Sharpe via a 6-inch diameter pipeline (El Paso Energy® pipeline). The El Paso Energy® effluent pump is controlled by an actuated valve and level sensors in the "B" tower wet well. El Paso Energy® reuses the effluent water in an off-depot cogeneration plant.

4.2.2.6 The control building houses the primary control system/programmable logic controller (PLC), power breakers, and system computer. The PLC receives and evaluates data transmitted from the extraction wells and treatment plant flow meters and level switches. Based on the data evaluation, the PLC transmits control signals to valve actuators and motor starters for automatic operation of the plant.

4.2.2.7 Central Area System. The Central Area groundwater treatment system is the newest of the three DDJC- Sharpe systems. The Central Area system consists of 10 extraction wells, associated conveyance piping, two air stripping treatment trains, two chemical sequestration systems, a control building, two percolation ponds (Basins 1 and 2), 10 injection wells, and a connection to the El Paso Energy® pipeline. The treatment trains are designed to treat a maximum of 75 gpm from the A Zone wells and a maximum of 500 gpm from the B/C Zone wells. Initial operating conditions required that A Zone effluent be discharged to the A Zone aquifer due to a unique mineral content in A Zone groundwater. The A Zone train was taken off line on 19 December 2001, because mass removal rates at the A Zone treatment train had reached asymptotic levels. Additionally, a review of the 2001 water quality data indicated that the mineral content of the A Zone wells had become comparable to that at the other treatment plants. The water from the A Zone was diverted to the B/C Zone system, which is capable of handling the contaminant and hydraulic loads from all Central Area wells. The groundwater extraction and treatment rate at the Central Area system averages 290 to 400 gpm.

4.2.2.8 Groundwater is extracted from wells completed in the A Zone (two wells), B Zone (four wells), and C Zone (four wells). The newest well, EWCB5, was constructed in 2000 to improve capture of the B Zone TCE plume, and began operating in May 2002. These wells are connected to the air stripping plant via four primary pipelines and wellhead feed pipes. The extraction pipelines vary in size from 2 to 6 inches in diameter. Separate pipelines deliver groundwater extracted from the A Zone and the B/C Zone. The pipeline trenches also contain

conduits that provide power, control, and signal wiring to each well. Each well has an associated remote transmission unit (RTU), magnetic flow meter, level sensor, and a pressure switch that allow remote monitoring and control of the well. All extraction well pumps are submersible pumps. A Zone wells are completed at depths of approximately 40 to 60 feet bgs; B Zone wells are completed at approximately 50 to 90 feet bgs; and C Zone wells are completed at approximately 110 to 145 feet bgs.

4.2.2.9 Extracted water is pumped to the Central Area plant where VOCs are removed by air stripping. The Central Area system contains separate treatment trains for the A Zone and B/C Zone groundwater, although all Central Area influent currently is diverted to the B/C Zone treatment train. Both treatment trains include influent holding tanks, influent pumps, and chemical sequestrant feed systems (to prevent scaling) before the air stripping towers. The A Zone treatment train includes two 2-foot diameter, 30-foot tall air stripping towers, while the B/C Zone treatment train consists of two 5-foot diameter, 35-foot tall air stripping towers. The air strippers are packed towers that contain polypropylene media, and are operated in series and under slight vacuum. Air is withdrawn from the towers by a common downstream blower. The treatment trains include transfer pumps mounted between the towers in each treatment train and effluent pumps and filters. All pumps are controlled by actuated valves and level sensors in the tower wet wells. The treatment system also includes a water knockout pot before the blower and air-phase carbon absorbers downstream of the blower. However, the carbon has been removed from the carbon canisters, and the associated pre- heater has been turned off because the treatment of vapor-phase exhaust is no longer required by the Air Pollution Control District (emissions are de minimus per San Joaquin Valley Air District requirements). Additional controls include influent flow meters, pressure switches, and high-level sensors.

4.2.2.10 As shown on Figures 4-1 and 4-2, treated groundwater can be discharged to the storm drain, percolation ponds, injection wells (via holding tanks), or to the El Paso Energy® pipeline leading from the North Balloon system to the El Paso Energy® holding tank at the southern boundary of DDJC-Sharpe. Separate effluent pipes deliver A Zone and B/C Zone water to the injection well holding tanks and El Paso Energy® pipeline connection; a single effluent pipe delivers both A Zone and B/C Zone water to the percolation ponds. Under current normal operating conditions, all effluent water is discharged to the storm drain, and if needed, to the El Paso Energy® pipeline or percolation ponds.

4.2.2.11 The injection well system consists of A Zone and B/C Zone holding tanks, five A Zone wells, two B Zone wells, and three C Zone wells. A cross-tie installed between the holding tanks allows B/C Zone water to be delivered to all 10 injection wells; however, a backflow preventer in the cross-tie prevents delivery of A Zone water to B/C Zone wells. After October 2000, treated water was no longer injected, and there are no plans to inject treated water in the future (see paragraph 4.1.2.4).

4.2.2.12 The control building houses the PLC, power breakers, and system computer. The PLC receives and evaluates data transmitted from the extraction well and treatment plant flow meters and level switches. Based on the data evaluation, the PLC transmits control signals to valve actuators and motor starters for automatic operation of the plant.

4.2.2.13 South Balloon System. The South Balloon groundwater treatment system is the oldest of the three DDJC- Sharpe systems. The South Balloon system consists of 17 extraction wells, associated conveyance piping, an air stripper plant, a chemical sequestration system, a control building, and an El Paso Energy® pipeline connection. Although the treatment plant is designed to treat a maximum of 300 gpm, the current groundwater extraction and treatment rate at the South Balloon system is typically 79 to 250 gpm.

4.2.2.14 Groundwater has been extracted from wells completed in the A Zone (10 wells), B Zone (3 wells), and C Zone (4 wells). An eleventh A Zone and a fourth B Zone well were taken off line because they were no longer within the contaminant plume or needed for plume control. The newest well, EWC4, was constructed in 2000 to improve capture of the southern C Zone TCE plume, and began operating in May 2002. The wells are connected to the air stripping plant via two primary pipelines and wellhead feeder pipes. The extraction pipelines vary in size from 1 ¼ to 6 inches in diameter. The pipeline trenches also contain conduit providing power, control, and signal wiring to each well. Each well has an associated magnetic flow meter, level sensor, and a pressure switch that allow remote monitoring and control of the well. All extraction well pumps are submersible pumps. A Zone wells are completed at depths of approximately 30 to 40 feet bgs, B Zone wells are completed at approximately 50 to 80 feet bgs, and C Zone wells are completed at approximately 90 to 140 feet bgs.

4.2.2.15 Extracted water is pumped to the South Balloon plant where VOCs are removed by air stripping. The South Balloon system uses two 4-foot diameter, 25-foot tall air stripping towers to remove VOCs. The air strippers are packed towers that contain polypropylene media, and operate in series. An air blower is located in the duct between the air stripping towers such that the "A" tower (primary tower) operates under slight pressure, while the "B" tower operates under a slight vacuum. The treatment plant includes a transfer pump mounted between the towers, which is controlled by an actuated valve and level sensors located in the "A" tower wet well. Similarly, the effluent pump is controlled by an actuated valve and level sensors in the "B" tower wet well. Additional controls include influent and effluent flow meters and pressure switches. Chemical sequestrants are added to the influent water at the treatment pad to minimize scale buildup within the air stripping towers.

4.2.2.16 As shown on Figures 4-1 and 4-2, treated groundwater can be discharged to the DDJC- Sharpe storm drain system or to the El Paso Energy® pipeline and holding tank. The El Paso Energy® pipeline from the North Balloon treatment system (6-inch diameter) connects to the South Balloon effluent pipe, from which an 8-inch diameter pipeline leads to the El Paso Energy® holding tank at the southern DDJC-Sharpe boundary.

4.2.2.17 The control building houses the PLC, breakers, and system computer. The PLC receives and evaluates data transmitted from the extraction wells and treatment plant flow meters and level switches. Based on the data evaluation, the PLC transmits control signals to valve actuators and motor starters for automatic operation of the plant.

4.2.2.18 El Paso Energy® Treated Water Supply System. In its cogeneration process, El Paso Energy® uses a portion of the treated groundwater. The water is eventually discharged in accordance with El Paso Energy's® NPDES permit. Water is supplied from each treatment system through a common pipeline running from the North Balloon treatment plant to a holding tank located at the southern facility boundary. The El Paso Energy® system includes an effluent pump at the North Balloon treatment plant, a cross-tie at the Central Area treatment plant, a connection at the South Balloon treatment plant, the holding tank, and pumps at the holding tank. El Paso Energy® performs routine maintenance of this system.

4.2.3 Routine Maintenance

4.2.3.1 O&M activities include weekly O&M inspections, monthly O&M service and calibration, and scheduled and unscheduled remedial maintenance shutdowns.

4.2.3.2 Weekly O&M inspections include the following:

- Visual inspection of all equipment at three groundwater treatment systems. Components inspected include fans, motors, drivers, couplings, pumps, valves, piping, control sensors and transmitters, blowers, wiring and connections, submersible pumps, and Supervisory Control and Data Acquisition (SCADA) system.

- Visual inspection of all extraction and injection wells.

- Repair of minor deficiencies, such as replacing lights and filters, lubrication of pump motors, etc. (supply of spare parts for repair of minor deficiencies is maintained on site).

- Preparation of a deficiencies report listing items requiring maintenance, including estimates of labor and materials costs.

- Participation in bi-weekly O&M conference calls with DDJC-Sharpe and CEHNC staff to discuss O&M status and deficiencies and to set maintenance priorities.

4.2.3.3 Monthly preventative maintenance service includes:

- Cleaning all equipment and piping at the extraction and injection wells, including vacuuming of control cabinets and removal of cobwebs, debris, and standing water from well vaults.

- Trash removal, erosion and rodent damage repair, and weed removal within 10 feet of extraction and injection wellheads.

- Cleaning air stripping towers and associated piping and appurtenances.

- Mechanical inspection for water- and air-tightness of all connections, exercise and lubrication of valves, and condensate draining from air compressors and regulators.

- Electronic systems operation check including chart recorders for paper and pen supply/function.

- Calibration check of reported or monitored points collected for transfer to the Integrated Geographical Information System (IGIS).

- Data logging and SCADA system function check.

4.2.3.4 Troubleshooting services to identify and make repairs, system modifications for optimization, and calibration activities are performed as needed to keep the systems operating.

4.2.3.5 Contractor and DDJC-Sharpe staff provide first response to unscheduled system shutdowns, both during normal work hours and non-work hours. Staff are notified of system shutdowns by system alarms or notification by facility security.

4.2.3.6 Other specialized maintenance activities may be required in response to deficiencies identified during weekly inspections and monthly service, or by other environmental program activities, such as groundwater monitoring or treatment plant optimization tasks.

These maintenance activities are likely to require the use of subcontractors and, as such, will usually be performed as scheduled maintenance. The most likely type of activities include:

- Replacement of submersible pumps;
- Redevelopment of extraction wells;
- Inspection and/or replacement of air stripping tower media; and
- Cleaning of pipelines (typically acid washing of the piping).

4.2.3.7 Numerous maintenance activities and system improvements have been implemented since the treatment plants have been put into operation. Table 4-5 lists system improvements for the each treatment plant since 1996.

4.2.4 O&M Costs

O&M costs include groundwater treatment system operation support, operation cost, electrical power, maintenance, performance monitoring, regulatory reporting, and government oversight. Table 4-6 lists the annual system operations/O&M costs for the North Balloon, Central Area, and South Balloon groundwater treatment systems. Costs in 2000 were higher than the previous two years because the South Balloon treatment plant was rewired. In 2001 and 2002, costs were higher due to repairs to flow meters and other treatment plant equipment, extraction well installations, and constructing the bypass from the Central Area A Zone influent train to the Central Area B/C Zone influent train. Current estimated annual costs are approximately $715,000.

4.3 Soil Remedy

This section identifies the objectives of the OU 2 ROD for soils, followed by a description of the remedies and implementation of the actions for VOC-contaminated soil, metals-contaminated soil, and pesticide-contaminated soil. Institutional controls related to soil sites are discussed in Section 4.4.

4.3.1 Remedy Selection

4.3.1.1 The primary objectives of the remedial action for soil at DDJC-Sharpe are to be protective of human health and the environment and not cause or threaten to cause contaminant concentrations in the groundwater to exceed the ACLs (ESE, 1996). The remedial action objective for OU 2 soil VOC contamination is to remove TCE in soil vapor to a concentration of 0.35 ppmv or less. The OU 2 ROD specifies soil cleanup standards of 1,000 and 300 mg/kg for lead and chromium, respectively. Based on information obtained during the RI and on a careful analysis of all remedial alternatives, DDJC, U.S. EPA, and the State of California believed that the selected remedies would achieve these objectives.

4.3.1.2 In February 1996, officials from the DLA, the U.S. EPA, DTSC, and the Central Valley RWQCB signed a ROD designating 111 sites for NFA status (these included UST sites that are not under CERCLA), 14 sites for further action as a result of VOC contamination (primarily TCE), and 14 other sites for further action as a result of metals contamination (specifically lead and chromium). In the OU 2 NFA remedial action report, 14 of the 28 action sites were designated NFA (Radian International, 2000b). Of the 14 newly designated NFA

Table 4-5. Groundwater Treatment System Improvements and Major Repairs, DDJC-Sharpe

Activity	Purpose	Completed
NORTH BALLOON		
Replaced wiring from control building to all extraction wells.	Improved system reliability and operation control. Repaired numerous shorts in system.	April 1997
Added flow control valve to discharge pump configuration.	Improved system operation by eliminating cycling on North Balloon discharge pump and stabilizing discharge flow rate from North Balloon plant to DESTEC® pipeline (now referred to as El Paso Energy® pipeline). Allows for simultaneous discharge of North Balloon treated water and a portion of the Central Area treated water to the DESTEC® holding tank. Previous configuration produced pressure surges that caused shutdown of the Central Area plant.	April 1997
Replaced computer system and PLC.	Improved system operability, reliability, and operations data collection.	April 1997
Installed isolation valves in extraction well piping.	Improved system reliability by allowing for maintenance on portions of extraction system without requiring shutdown of entire system.	May 1997
Extended (raised) vaults on extraction well electrical system and installed traffic bollards.	Improved system reliability by preventing rainwater from entering vaults and causing further damage to electrical system. Prevents damage from truck traffic.	May 1997
Acid washed extraction well piping.	Improved system operability by removing scale from piping operability.	August 1997
Redeveloped all extraction wells and replaced pumps on selected wells.	Increased extraction rates for several wells and provided measurement of attainable flow rates (production rates) for all extraction wells. Replaced pumps in several wells to more closely match available production rate.	September 1997
Installed extraction well NB6 and disconnected extraction well NA7.	Improved groundwater plume capture by replacing low production rate A Zone well NA7 with high production rate B Zone well NB6. A Zone plume still captured by companion extraction well NA8.	September 1997
Replaced bubble-style level measurement systems in wells with pressure transducers.	Improved reliability of level measurements and reduced system maintenance cost.	October 1997
Upgraded software and computer hardware.	Improved data collection from the treatment plants. Ensured Year 2000 compliance for the computer and PLCs.	September 1999
Generated GWTP-specific O&M manual.	Generated to conform with U.S. EPA RA/RD 1995 guidance.	July 2001
Installed EWNC5 in September 2000. Installed conveyance line and hookup system in 2001. Connected to treatment plant 25 September 2002.	Improved groundwater plume capture.	September 2002

Table 4-5. (Continued)

Activity	Purpose	Completed
NORTH BALLOON (cont'd)		
Upgraded software and computer hardware. Upgraded autodialer hardware.	Improved data collection from the treatment plant and remote (off-site) communication with the SCADA computer.	October 2002
Replaced mechanical flow meters with magnetic flow meters.	Improved reliability of flow measurements and reduced maintenance cost and failures of meters.	Ongoing as existing meters fail
CENTRAL AREA		
Redeveloped injection wells.	Increased injection rate (aquifer recharge) of wells.	April 1996
Re-plumbed chemical injection points on A and B/C sides.	Improved chemical sequestration effectiveness by increasing chemical contact time prior to air stripping.	November 1996
Extended (raised) vaults at percolation ponds and installed traffic bollards.	Improved system reliability by preventing inflow of rainwater into vaults to protect flow control equipment. Repaired damage caused by truck traffic.	January 1997
Interconnected injection well holding tanks.	Increased injection (aquifer recharge) flow rate by allowing discharge of B/C Zone treated water to A Zone injection wells.	February 1997
Removed air-phase carbon used to treat air exhaust from system.	Improved system reliability and lowered operations costs for power (pre-heater) and carbon regeneration. Carbon no longer required due to low air concentrations; approved by AQMD.	May 1997
Started operation of extraction well CC3.	Improved groundwater plume capture by providing an additional extraction well to capture leading edge of plume.	August 1997
Increased size of concrete pad for treatment system.	Improved system operations and delivery of chemical sequestrants and equipment by providing all weather work area.	December 1997
Enlarged size of concrete pad at treatment plant and installed additional gates.	Improved system operability and access by providing a weatherproof working surface at plant. Gates provide improved access for equipment maintenance and chemical delivery.	January 1998
Replaced chemical sequestrant feed tanks with feed tanks provided by chemical vendor.	Improved system operability by installing tanks that can be directly serviced by vendor and by providing automated paging system to notify when tank levels are low.	January 1998

Table 4-5. (Continued)

Activity	Purpose	Completed
CENTRAL AREA (cont'd)		
Installed sampling port at extraction well CC3 outside of well vault.	Improved performance of groundwater monitoring by providing an accessible sampling port for the extraction well.	March 1998
Installed potable water line isolation valve.	Improved system operability by providing a shut off for the potable water line when repairs to the line are required. Alternate shut off locations required shutting off water to nearby warehouses.	March 1998
Repaired damaged piping, conduit, wiring, and fiber optics to extraction well CC3.	Repaired damage caused by off-site contractor. Improved system safety by registering system with USA and installing warning signs.	April 1998
Installed storm drain connection.	Improved groundwater plume capture by minimizing discharge to percolation ponds.	October 1998
Upgraded software and computer hardware. Upgraded autodialer hardware.	Improved data collection from the treatment plants. Ensured Year 2000 compliance for the computers, autodialers, and PLCs.	September 1999
Generated GWTP-specific O&M manual.	Generated to conform with U.S. EPA RA/RD 1995 guidance.	July 2001
Central Area A-Train treatment plant taken off line.	Influent flow to the A Zone influent flow was directed to the B/C treatment train.	December 2001
Installed EWCB5 in July 2000. Installed conveyance line and hookup system in 2001. Connected to treatment plant in May 2002.	Improved groundwater plume capture.	May 2002
Upgraded software and computer hardware.	Improved data collection from the treatment plant and remove (off-site) communication with the treatment plant.	October 2002
SOUTH BALLOON		
Replaced computer system and PLC.	Improved system operability, reliability, and operations data collection.	December 1996
Replaced mechanical flow meters on all wells with magnetic flow meters.	Improved reliability of flow measurements and reduced maintenance cost and failures of meters.	March 1997
Replaced mechanical flow meters on plant influent line with magnetic flow meter.	Improved reliability of flow measurements and reduced maintenance cost and failures of meter.	June 1997

Table 4-5. (Continued)

Activity	Purpose	Completed
SOUTH BALLOON (cont'd)		
Redeveloped selected extraction wells and replaced pumps on selected wells. Re-screened selected wells.	Increased extraction rates for several wells; provided measurement of attainable flow rates (production rates). Replaced pumps in several wells to more closely match available production rate. Improved reliability and long-term operability of selected wells that indicated damage to screens and loss of sand pack by re-screening the wells with an internal screen and sand pack.	August 1997
Installed purge water system for treatment of purge water from groundwater monitoring wells.	Improved system reliability by allowing purge water to be metered into system at low flow rate, thereby maintaining a higher air-to-water ratio during treatment of purge water.	September 1997
Installed isolation valve on pipeline south of South Balloon plant tie-in.	Improved system operability by allowing system to remain in operation during high stormwater flows by redirecting South Balloon discharge to percolation ponds or oxidation pond (future) in case high storm flows prevent discharge to storm drain.	September 1997
Replaced bubble-style level measurement systems with pressure transducers on all extraction wells.	Improved reliability of level measurements and reduced system maintenance cost.	September 1997
Purchased back-up blower.	Improved system reliability by providing critical spare part, which will significantly reduce system down time (from months to days) when aging blower fails.	January 1998
Upgraded software and computer and PLC hardware.	Improved data collection from the treatment plants. Ensured Year 2000 compliance for the computer, PLCs, and autodialer.	September 1999
Replaced wiring from control building to all South Balloon extraction wells.	Improved system communications/reliability and operational control.	January 2001
Acid washed entire extraction South Balloon well pipelines.	Improved system operability by removing scaling from piping.	March 2001
Generated GWTP-specific O&M manual.	Generated to conform with U.S. EPA RA/RD 1995 guidance.	August 2001
Installed EWC4 in July 2000. Installed conveyance line and hookup system in 2001. Connected to treatment plant in November 2002.	Improved groundwater plume capture.	Fourth Quarter 2001

Table 4-5. (Continued)

Activity	Purpose	Completed
SOUTH BALLOON (cont'd)		
Redeveloped selected extraction wells and replaced pumps on selected wells. Re-screened selected wells.	Increased extraction rates for several wells; provided measurement of attainable flow rates (production rates). Replaced pump in several wells to more closely match available production rate. Improve reliability and long-term operability of selected wells that indicated damage to screens and loss of sand pack by re-screening the wells with an internal screen and sand pack.	February 2002
Upgraded software and computer hardware.	Improved data collection from the treatment plant and remote (off-site) communication with the treatment plant.	October 2002
SOUTH/NORTH BALLOONS/ CENTRAL AREA		
Upgraded WonderWare™ at North Balloon, Central Area, and South Balloon. Upgraded PLCs at South Balloon.	Improved data collection from the treatment plants. Ensured Year 2000 compliance for all computer controlled equipment.	September 1999
Generated comprehensive O&M manual.	Generated to conform with U.S. EPA RA/RD 1995 guidance.	June 2001
Conducted extraction rate optimization testing.	Determine the maximum rate that 21 extraction wells can pump with their existing pumps and without reverting to a frequent on-off cycling. Recommended because extraction well flow rates had not been checked and flow rates had not been adjusted for optimization for several years. The testing provided data that were used to develop optimal flow rate recommendations.	February 2003
EL PASO ENERGY® PIPELINE		
Installed clean-outs in pipeline.	Improved system maintenance by allowing for inspection of pipeline to identify areas with clogs or excessive scale formation. Allows for acid washing selected portions of pipeline.	March 1997
Acid washed entire pipeline from North Balloon plant to holding tank at South Balloon.	Improved system operability and reliability by removing scale in piping. Removed clog that prevented discharge of North Balloon water to holding tank.	December 1997

AQMD = Air Quality Management District
DDJC = Defense Distribution Depot San Joaquin California
GWTP = groundwater treatment plant
O&M = operation and maintenance
PLC = programmable logic controller
RA/RD = remedial action/remedial design
SCADA = supervisory control and data acquisition
USA = Underground Services Alert
U.S. EPA = United States Environmental Protection Agency

Note: El Paso Energy® was formerly called DESTEC.

sites, 11 are VOC-contaminated sites and 3 are metals-contaminated sites. See Table 4-7 for a summary of NFA sites. Sites with contaminated soils are shown on Figure 4-3. The OU 2 ROD also addresses the comprehensive cleanup of the vadose zone.

4.3.1.3 The cleanup methods specified in the OU 2 ROD include the excavation and off-site disposal of soils contaminated with lead and chromium and the use of SVE for soils contaminated with VOCs. A removal action was taken in 1995, before the OU 2 ROD was signed, for pesticide- contaminated soils in the Pesticide Mix Area because of the risk to workers posed by the concentrations in the soil. Table 4- 8 summarizes the remedial actions at OU 2. The implementation of cleanup methods for VOCs, metals, and pesticides in soils is discussed in the following sections.

Table 4-6. Annual Operation and Maintenance Costs for the Three Groundwater Treatment Plants, DDJC-Sharpe

Dates		Total Cost Rounded to Nearest $1,000
From	To	
1998	1999	$573,000
1999	2000	$667,000
2000	2001	$966,000
2001	2002	$794,000
2002	2003	$903,000

DDJC = Defense Distribution Depot San Joaquin California

4.3.2 Volatile Organic Compounds

4.3.2.1 OU 2 Soil Remedial Actions (VOCs). The OU 2 ROD identified seven sites at which VOCs may have been degrading groundwater. Seven additional sites were identified as requiring further characterization to determine whether they were causing groundwater degradation. Two additional sites, P-2B and P-4C, which were not included in the OU 2 ROD, were added to the characterization effort after a data review indicated that they might be degrading groundwater (Radian Corporation, 1996b). The OU 2 ROD identifies TCE as the principal VOC of concern in soil and identifies a cleanup standard for TCE of 0.35 ppmv in the soil gas. The soil gas cleanup level was selected to be protective of beneficial uses of ground-water. When achieved, the cleanup level is expected to reduce the mass of TCE that reaches groundwater and to decrease the aquifer cleanup time.

4.3.2.2 The remedial design and project specifications implemented for VOCs in soil were based on the preferred remedial action alterna-tives and ARARs presented in the OU 2 ROD.

4.3.2.3 As required in Section 9.2 of the OU 2 ROD, ISV, herein referred to as SVE, was the selected remedy for soils contaminated with VOCs, primarily TCE. The remedy requires treatment of VOC-contaminated soil with soil gas concentrations above the cleanup standard. This remedy is required by the OU 2 ROD “as a source control effort to prevent further degradation of the groundwater and minimize the aquifer cleanup time.” The following requirements are specified:

Table 4-7. Sites Selected for No Further Action after Characterization, DDJC-Sharpe

Site No.	Site Background	Impact to Groundwater	NFA Rationale
P-ID	Maximum RI/FS ROD TCE concentration in soil gas: 40.5 ppmv	Monitoring data indicate that TCE has not been detected in groundwater beneath this site since 1996.	1999 field investigation results indicate TCE concentrations in soil gas do not exceed the 0.350 ppmv decision level.
	OU 2 ROD designation: "Design"	There is no TCE groundwater plume beneath the site.	
	Maximum post-ROD TCE concentration in soil gas: 0.21 ppmv		Future impact to groundwater is insignificant to non-existent.
P-IF	Maximum TCE in soil gas: 3.930 ppmv, measured during the 1987 RI/FS	Groundwater monitoring data suggest that VOC contamination in the vadose zone has not significantly affected the A Zone aquifer in the past six years.	No future impact to groundwater is expected.
	OU 2 ROD designation: "Further Characterization"		1996, 1997, and 1999 field investigation results indicate TCE concentrations in soil gas do not exceed the 0.350 ppmv decision level.
P-IG	Maximum TCE in soil gas: 2.929 ppmv, measured during the 1987 RI/FS	Vadose zone modeling shows no impact to total time of groundwater remediation.	Future impact to groundwater is expected to be minimal.
	OU 2 ROD designation: "Further Characterization"	Groundwater monitoring data suggest that much of the vadose zone TCE mass has already migrated into the A Zone aquifer.	
			Results of a technical and economic feasibility analysis indicate implementation of an SVE system is not economically feasible.
P-2A	Maximum TCE in soil gas: 1.4 ppmv, measured during the 1987 RI/FS	Vadose zone modeling shows no impact to total time of groundwater remediation.	Future impact to groundwater is expected to be minimal.
	OU 2 ROD designation: "Further Characterization"	Groundwater monitoring data for the period 1994 to 2002 indicate that the site is not a source of groundwater contamination.	Results of a technical and economic feasibility analysis indicate implementation of an SVE system is not economically feasible.

Table 4-7. (Continued)

Site No.	Site Background	Impact to Groundwater	NFA Rationale
P-2B	Maximum TCE in soil gas: 1.00 ppmv, measured during the 1996 field investigation	Vadose zone modeling shows no impact to total time of groundwater remediation.	Future impact to groundwater is expected to be minimal.
	OU 2 ROD designation: "Further Characterization"	Groundwater monitoring data suggest that VOC contamination in the vadose zone has not significantly affected the A Zone aquifer in the past six years.	
			Results of a technical and economic feasibility analysis indicate implementation of an SVE system is not economically feasible.
P-3A	Maximum TCE in soil gas: 1.546 ppmv, measured during the 1987 RI/FS	Vadose zone modeling shows no impact to total time of groundwater remediation.	Future impact to groundwater is expected to be minimal.
	OU 2 ROD designation: "Further Characterization"	Groundwater monitoring data suggest that much of the vadose zone TCE mass has already migrated into the A Zone aquifer.	
			Results of a technical and economic feasibility analysis indicate implementation of an SVE system is not economically feasible.
P-4A	Maximum TCE in soil gas: 3.191 ppmv, measured during the 1987 RI/FS	Groundwater monitoring data suggest that much of the vadose zone TCE mass has already migrated into the A Zone aquifer.	No further impact to groundwater is expected.
	OU 2 ROD designation: "Further Characterization"		1996, 1997, and 1999 field investigation results indicate TCE concentrations in soil gas do not exceed the 0.350 ppmv decision level.
P-4B	Maximum TCE in soil gas: 1.18 ppmv, measured during the 1987 RI/FS	Vadose zone modeling shows no impact to total time of groundwater remediation.	Future impact to groundwater is expected to be minimal.
	OU 2 ROD designation "Further Characterization"	Groundwater monitoring data suggest that the vadose zone TCE mass has already migrated into the A Zone aquifer.	
			Results of a technical and economic feasibility analysis indicate implementation of an SVE system is not economically feasible.

Table 4-7. (Continued)

Site No.	Site Background	Impact to Groundwater	NFA Rationale
P-4C	Maximum TCE in soil gas: 1.609 ppmv, measured during the 1987 RI/FS	Groundwater monitoring data suggest that the vadose zone TCE mass has already migrated into the A Zone aquifer.	No further impact to groundwater is expected.
	OU 2 ROD designation: "Further Characterization"		1996, 1997, and 1999 field investigation results indicate TCE concentrations in soil gas do not exceed the 0.350 ppmv decision level.
P-5A	Maximum TCE in soil gas: 22.5 ppmv, measured during the 1987 RI/FS	Analysis of the groundwater monitoring data for the period 1994 to 1999 indicate that site is not a source of groundwater contamination.	Future impact to groundwater is expected to be minimal.
	OU 2 ROD designation: "Implement SVE"		Results of additional investigations conducted in 1996, 1997, and 1999 indicate soil gas TCE concentrations below the decision level of 0.350 ppmv.
	Operable Unit 2 Pre-Design Technical Summary site designation: "No Further Action Site."		
P-8A	TCE in soil gas: 4.120 ppmv, measured during the 1987 RI/FS	Vadose zone modeling shows no impact to total time of groundwater remediation.	Future impact to groundwater is expected to be minimal.
	OU 2 ROD designation: "Design"	Water levels have risen at the site, from a depth of 22 feet bgs to 18 feet bgs.	Operation of SVE system has remediated most of the vadose zone contamination.
	Location of an SVE pilot-scale study		1999 field investigation results indicate TCE concentrations in soil gas do not exceed the 0.350 ppmv decision level.
			The area of the 0.35 ppmv TCE contour in soil gas has been submerged by the rising aquifer levels.
			Results of a technical and economic feasibility analysis indicate operation of the existing SVE system is not economically feasible.

Table 4-7. (Continued)

Site No.	Site Background	Impact to Groundwater	NFA Rationale
S-30	Maximum RI/FS ROD lead and chromium concentrations in soil: 27,500 and 171 mg/kg, respectively	Groundwater monitoring data indicate that the site is not a source of metals contamination.	1999 field investigation results indicated lead and chromium concentrations in soil do not exceed cleanup standards.
	OU 2 ROD designation: "Excavation/Off-Site Disposal"		Future impact to groundwater is non-existent.
	Maximum post-ROD lead and chromium concentrations in soil: 240 and 130 mg/kg, respectively		
S-33/29	Maximum RI/FS ROD lead and chromium concentrations in soil: 1,542 and 329 mg/kg, respectively	Groundwater monitoring data indicate that the site is probably an insignificant source of metals contamination.	1999 field investigation results indicated lead and chromium concentrations in soil do not exceed cleanup standards.
	OU 2 ROD designation: "Excavation/Off-Site Disposal"	Groundwater in selected wells will continue to be monitored quarterly for lead and chromium.	Future impact to groundwater is minimal.
	Maximum post-ROD lead and chromium concentrations in soil: 670 and 32 mg/kg, respectively		
S-36	Maximum RI/FS ROD lead and chromium concentrations in soil: 3,990 and 722 mg/kg, respectively	Groundwater monitoring data indicate that the site is probably an insignificant source of metals contamination.	1999 field investigation results indicated lead and chromium concentrations in soil do not exceed cleanup standards.
	OU 2 ROD designation: "Excavation/Off-Site Disposal"	Groundwater in selected wells will continue to be monitored quarterly for lead and chromium.	Future impact to groundwater is minimal.
	Maximum post-ROD lead and chromium concentrations in soil: 370 and 110 mg/kg, respectively		

bgs = below ground surface
DDJC = Defense Distribution Depot San Joaquin California
mg/kg = milligrams per kilogram
NFA = no further action
OU = operable unit
ppmv = parts per million by volume
RI/FS = remedial investigation/feasibility study
ROD = record of decision
SVE = soil vapor extraction
TCE = trichloroethene
VOC = volatile organic compound

- Delineate areas suspected of being sources of groundwater contamination using soil gas data;
- Install vapor extraction wells, a positive displacement blower, a condensate separator, and aboveground piping to extract air flow from subsurface soils;
- Transmit SVE off gas from the vapor extraction wells to a vapor-phase carbon system for treatment of soil vapor prior to discharge to the atmosphere;
- Construct separate SVE systems that can operate independently to remediate separate areas of contamination; and
- Install soil gas monitoring wells to monitor the progress of remediation.

Table 4-8. OU 2 Remedial Actions, DDJC-Sharpe

Site/Action	System/Action Description	Status
P-1A, P-1B, P-1C, P-1E, and P-6A: Soil vapor extraction systems	Soil vapor extraction wells installed	Completed in 2001
S-3 and S-26: Excavation and off-site disposal of lead- and chromium-contaminated soil.	Soil removal design and excavation	Completed 1998
Pesticide Mix Area: Excavation and off-site disposal of pesticide-contaminated soil	Soils were excavated and disposed of at landfill	Completed in 1996

DDJC = Defense Distribution Depot San Joaquin California
OU = operable unit

4.3.2.4 The selected remedy documented in the OU 2 ROD includes an operational period of 24 months. The ROD specifies performance monitoring with optimization efforts, including:

- Collecting soil gas monitoring data and tracking the cumulative mass of VOCs removed.
- Alternating extraction operations with rebound periods; during extraction periods, operating until asymptotic conditions have been reached.
- Discontinuing the operation of extraction wells in areas where cleanup standard levels have been attained.
- Modeling to assess the affects of the remaining VOCs on groundwater.

4.3.2.5 The OU 2 ROD requires DDJC-Sharpe to design, construct, operate, and, if necessary, modify the SVE systems to achieve the 0.35 ppmv cleanup standard. SVE is a proven technology. A vacuum blower is

connected to one or more extraction wells that are screened at soil intervals expected to contain the VOCs. The induced air flow from the subsurface soils removes volatile compounds and induces a negative pressure in the subsurface to enhance vapor extraction from the soil matrix. The off gases are then treated with granular activated carbon (GAC) to mitigate impacts to air quality and minimize health risks.

4.3.2.6 OU 2 Remedy Implementation (VOCs). The ROD identifies seven possible remedial action sites, specifying that further characterization was needed for seven additional sites. Further field characterization was completed, and it was concluded that only five sites at DDJC- Sharpe actually required SVE remediation: P-1A, P-1B, P-1C, P-1E, and P-6A (Radian International, 1997a). SVE systems were constructed for these five sites in the first two quarters of 1998, and started up and proven out during the third quarter of 1998. The SVE extraction and monitoring wells and the vapor conveyance, piping, and SVE treatment systems were constructed in accordance with the remedial design as documented in the design and approved by the U.S. EPA, DTSC, and Central Valley RWQCB. The SVE systems constructed at the five sites operated for two to four phases (depending on the site), beginning in the fourth quarter of 1998. The OU 2 ROD estimated an operation period of 24 months for remediation of the soils using SVE. The SVE systems operated in four phases of extraction and rebound periods from July 1998 through December 2001, an actual operational period of approximately 42 months (3.5 years). The VOC contaminants identified in the ROD were successfully extracted as documented in the final Operable Unit 2 Soil Vapor Extraction Remedial Action Report approved on 21 May 2002 (URS, 2002b). The documents associated with the completion of the elements of the selected remedy are listed in Attachment 3.

4.3.3 Metals

4.3.3.1 OU 2 Soil Remedial Action (Metals). The OU 2 ROD identifies five SWMUs as exceeding the soil cleanup standard of 1,000 mg/kg for total lead and/or 300 mg/kg for total chromium. Metals contamination of soils at the DDJC-Sharpe facility occurred as a result of various activities, including the disposal of paints, paint solvents, and sandblasting wastes. The remedial action specified in the ROD for soils with metals concentrations exceeding cleanup standards is excavation and off-site disposal.

4.3.3.2 For lead- and chromium-contaminated soils, the OU 2 ROD specifies the collection of additional samples to delineate soils with metals concentrations above cleanup levels. The remedy also specifies the following activities.

- Remove existing pavement, concrete, and light brush at locations with soils contami-nated with lead and chromium at levels exceeding cleanup standards.
- Excavate soils with metals concentrations exceeding cleanup standards.
- Analyze the toxicity characteristics of excavated soils to determine whether any soils are hazardous and determine disposal requirements.
- If any portion of soils is determined to be hazardous by toxicity characteristics, trans-port those soils to an appropriately permitted Class I landfill. Soils not found to be hazardous will be disposed of as construction debris in an appropriately permitted Class II landfill.

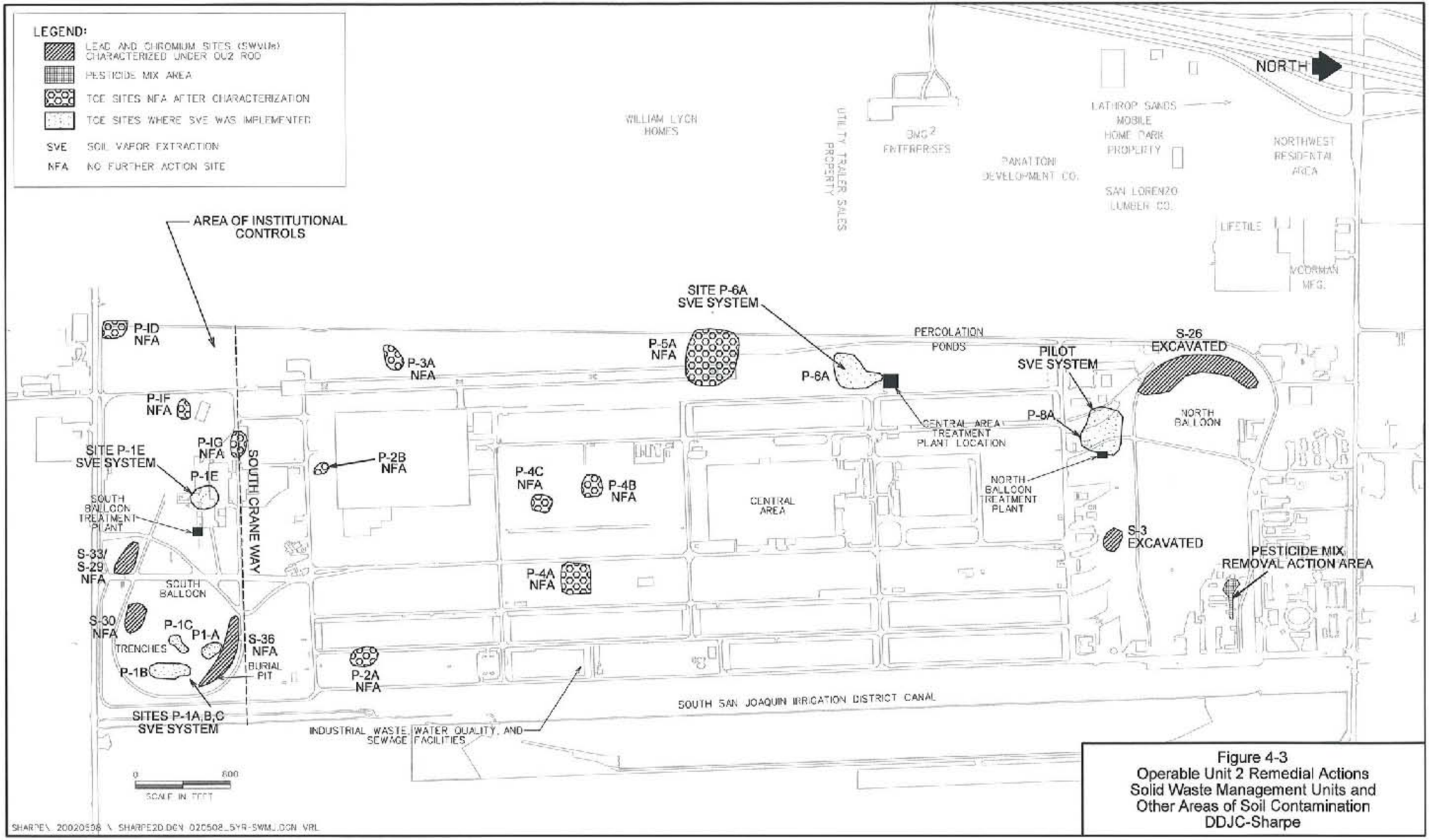


Figure 4-3
Operable Unit 2 Remedial Actions
Solid Waste Management Units and
Other Areas of Soil Contamination
DDJC-Sharpe

- Complete confirmation sampling, including deionized water waste extraction testing (DI-WET), to ensure that soils with lead and chromium concentrations exceeding cleanup standards have been removed within 2 feet of the existing ground surface and to evaluate the potential impact to groundwater from residual contamination in remaining soils.

- Return the site to the existing grade by backfilling the excavation with clean fill.

4.3.3.3 OU 2 Remedy Implementation (Metals). A sampling effort to further define the excavation area and volume of soils contaminated with lead and chromium was completed in July 1996, as described in the Operable Unit 2 Pre-Design Technical Summary (Radian International, 1997a). This sampling revealed that three of the five originally identified SWMUs did not require excavation based on the cleanup standards outlined in the OU 2 ROD. The need for excavation to remove metals-contaminated soils with concentrations above the cleanup standards was confirmed at Sites S-3 and S-26 in the North Balloon Area.

4.3.3.4 The remedial actions implemented at Sites S-3 and S-26 were conducted in accordance with the remedial design specifications (Radian International, 1997b and 1997c) and the Project Work Plans (CKY, Inc., 1998). The U.S. EPA, DTSC, and Central Valley RWQCB reviewed and commented on the construction design. These actions were documented in the project close out report (CKY, Inc., and Radian International, 1998). The reporting and construction activities associated with the remedial actions conducted at Sites S-3 and S-26 included the following:

- Preparation of project work plans;

- Initial site survey and geophysical clearance;

- Soil sample collection and analyses;

- Profiling of soil contamination;

- Construction/demolition:

- Surveying of additional excavation limits;

- Demolition of concrete pad at Site S-3;

- Soil excavation, transportation, and disposal;

- Topographical survey of open excavations;

- Additional soil excavation, transportation, and disposal;

- Final topographic survey of open excavations;

- Backfill and compaction; and

- Final site inspections.

4.3.3.5 Metals contamination at Site S-3 most likely occurred as the result of historical paint spraying activities at Building 119. Total lead concentrations exceeding the cleanup standard of 1,000 mg/kg were detected in surface scrape samples collected at the site. The results from additional soil sampling conducted in 1996 were used in conjunction with historical results to delineate areas exceeding cleanup standards. Based on the soil sample results, the design estimate for the excavation area was approximately 9,530 square feet. The design estimate for the excavation volume was 177 cubic yards, based on an excavation depth of 6 inches.

4.3.3.6 The results from pre-construction soil sampling and profiling at Site S-3 confirmed that the required depth of excavation (6 inches bgs) and the lateral extent of excavation were the same as the depth and extent indicated in the remedial design. This soil profiling was also used to identify soil disposal requirements (i.e., disposal at a Class I or Class II landfill).

4.3.3.7 Construction activities commenced on 22 June 1998 and were completed by 8 July 1998. During construction, an existing concrete pad was demolished and removed, in addition to the contaminated soil. A total of 183 cubic yards of soil were excavated from Site S-3. Thirty-five cubic yards of soil were transported and disposed of at a Class I landfill, and 148 cubic yards were disposed of at a Class II landfill. In addition, 94 cubic yards of concrete were removed from the site and disposed of at a Class II facility. A total of 290 cubic yards of clean fill material were used to backfill the excavated area. This quantity equaled the quantity of soil and concrete removed from the site plus an additional 17 cubic yards of soil required to backfill the volume occupied by a sump in the middle of the concrete pad.

4.3.3.8 Metals contamination at Site S-26 in the North Balloon area resulted from the dumping of sandblasting wastes. Total lead and chromium concentrations in soil exceeding the cleanup standards of 1,000 mg/kg and 300 mg/kg, respectively, were detected in surface scrape samples collected at the site. The results from additional soil sampling conducted in 1996 were used, in conjunction with historical results, to delineate areas exceeding cleanup standards. Based on the soil sample results, the design estimate for the excavation area was approximately 27,429 square feet. The design estimate for the excavation volume was 509 cubic yards, based on an excavation depth of 6 inches. Although six areas at S-26 were reported to have lead concentrations in soil exceeding cleanup standards, the sixth area had railroad tracks present within the excavation limits. As described in the 100% design analysis report (Radian International, 1997d), this area was not excavated for the following reasons:

- The impact to human health was minimal due to the presence of a ballast over the contaminated area that acted as a cover, preventing wind erosion;

- No threat of impact to groundwater exists from soluble lead or chromium based on a DI-WET performed on sample SS0016; and

- The cost to remove and replace the railroad tracks results in a cost per unit soil removed in this area of approximately three times the cost per unit soil removed from other excavation areas at the site.

4.3.3.9 The results from pre-construction soil sampling and profiling at Site S-26 indicated that excavation beyond the designed lateral limits and deeper than the design depth of 6 inches was required to meet ROD requirements. This soil profiling also was used to identify soil disposal requirements (i.e., disposal at a Class I or Class II landfill).

4.3.3.10 Construction activities at Site S-26 commenced on 22 June 1998 and were completed by 8 July 1998. A total of 758 cubic yards of soil were excavated from Site S-26. Of the soil excavated, 680 cubic yards were transported and disposed of at a Class I landfill, and 78 cubic yards were disposed of at a Class II landfill. A total of 758 cubic yards of backfill material were used to backfill the excavated area.

4.3.4 Pesticides

4.3.4.1 Pesticide mixing and container rinsing operations were conducted at Buildings T-40, T-47, and T-67 in the area designated the Pesticide Mix Area in the eastern portion of the North Balloon Area of DDJC-Sharpe (Figure 4-3). Five pesticides were detected frequently in surface soil samples from the Pesticide Mix Area (chlordane, 1,1-dichloro-2,2-bis[p-chloro-phenyl] ethane [DDD], 1,1-dichloro-2,2-bis(p-chlorophenyl] ethylene [DDE], 1,1,1-trichloro-2,2-bis[p-chlorophenyl] ethane [DDT], and dieldrin). Concentrations in the soils exceeded preliminary remediation goals (PRGs) calculated by the U.S. EPA (U.S. EPA, 1991).

4.3.4.2 Results of a risk assessment for pesticides in surface soils at DDJC-Sharpe were used to determine that soils in the Pesticide Mix Area required remediation to prevent the migration of contaminants, eliminate potential sources of contamination, eliminate the potential for receptor exposure, and facilitate a final cleanup of the site (ESE, 1994a). Excavation of soils in the Pesticide Mix Area was based on the action levels for chlordane, DDE, DDD, DDT, and dieldrin. To protect site workers and the public from health risks posed by the pesticides that exceeded PRGs, final remediation goals (FRGs) derived from PRGs were the action levels for excavation. Table 4-9 lists the FRGs applied to surface soils in the Pesticide Mix Area. The removal action and excavation and disposal plans are documented in the removal action memorandum signed in October 1994 (ESE, 1994a). The soil volume excavated in December 1994 was 480 cubic yards; of this amount, 378 cubic yards were disposed of at a Class II landfill, and 102 cubic yards were disposed of at a Class I landfill. Confirmation sampling was performed in December 1994 and February 1995. Additional soil volumes (4 cubic yards in April 1995 and 19 cubic yards in October 1996) were excavated and disposed of at a Class II landfill to remove small pockets of contaminated soils identified in confirmation sampling. The excavation areas were backfilled with clean aggregate base material and were compacted (CKY, Inc., 1995, 1996).

Table 4-9. Final Remediation Goals for Soils in the Pesticide Mix Area, DDCJ-Sharpe

Pesticide Compound	Final Remediation Goal (mg/kg)
Chlordane	1
DDE	2
DDD	3
DDT	2
Dieldrin	0.04

DDD = 1,1-dichloro-2,2-bis(p-chlorophenyl) ethane
DDE = 1,1-dichloro-2,2-bis(p-chlorophenyl) ethylene
DDJC = Defense Distribution Depot San Joaquin California
DDT = 1,1,1-trichloro-2,2-bis(p-chlorophenyl) ethane
mg/kg = milligrams per kilogram

4.4 Institutional Control Sites

4.4.1 An institutional control remedy was selected for two sites at DDJC-Sharpe (S-33/29) identified for remediation because of risks from chromium and/or lead concentrations in soil.

4.4.2 Institutional controls were implemented at the South Balloon Area in response to a comment made by the DTSC during review of the *Engineering Technical Memorandum, Site S-33/29 Metals Investigation* (ETM) (Radian International, 1999c). As part of its concurrence with the NFA recommendation for Sites S-29 and S-33, the DTSC required that institutional controls be implemented, stating that "implementation of institutional controls are necessary to ensure that the proper precautions are taken during future disturbances of the surface soils and/or for further remediation in the event land use is changed" (DTSC, 1999). Subsequently, the RPMs agreed to implement institutional controls in the form of land use controls (LUCs) for the South Balloon Area (URS, 2002e). The DDJC Environmental Management Chief, Environmental Program Manager, and DDJC Facility Engineer each have distinct responsibilities to ensure the success of the institutional control program at DDJC-Sharpe.

4.4.3 The remedial activities associated with the implementation of institutional controls include LUCs for DDJC-Sharpe property south of South Crane Way (Figure 4-3). LUCs are documented at active DoD installations through the master planning process. Consequently, a final *Addendum to the Installation Master Plan* has been prepared as the response action to the DTSC comment (URS, 2002e). The South Balloon Area includes the site that was the subject of the ETM (Radian International, 1999c) and other sites addressed under the Operable Unit 2 No Further Action Remedial Action Report (Radian International, 2000a) and the SVE program. All sites in the South Balloon Area are being addressed under at least one of the FFA documents listed below.

Site	FFA Document
S-33/29	*Remedial Action Report for Institutional Controls at the South Balloon Area, DDJC-Sharpe* (URS, 2002f)
S-30, S-36, P-ID, P-IF, P-IG	*DDJC-Sharpe OU 2 No Further Action Remedial Action Report* (Radian International, 2000b)
P-1A, P-1B, P-1C, P-1E	*OU 2 Soil Vapor Extraction Remedial Action Report* (URS, 2002b)

4.4.4 No institutional controls or LUC requirements were previously identified for sites in the OU 2 NFA remedial action report or under the SVE program. LUCs have been identified only in response to the ETM addressing S-33/29. However, as agreed by the RPMs, LUCs will be implemented for the entire DDJC- Sharpe South Balloon Area south of South Crane Way (URS, 2002e).

4.4.5 The *Addendum to the Installation Master Plan* describes the requirements of restricted land use as enforced by institutional controls at these sites (URS, 2002e). The implementation of institutional controls proposed in the addendum is consistent with the DoD Policy on Land Use Controls Associated with Environmental Restoration Activities (DoD, 2001).

4.4.6 The DDJC Environmental Program Manager and DDJC Facility Engineer will refer to the *Addendum to the Installation Master Plan* to review any change in land use or planned construction, demolition, or excavation projects that affect the area south of South Crane Way at DDJC-Sharpe. The DDJC Environmental Program Manager is responsible for notifying the signatory parties to the FFA at least 90 days before the commencement of any planned change in land use or demolition or construction activities that could expose potentially contaminated soil. The DDJC Environmental Program Manager is also responsible for coordinating with the DDJC Facilities Supervisor to ensure that emergency response personnel are aware of the environmental issues at institutional control sites and are trained accordingly before they may be required to respond to emergencies (e.g., a water main break). The DDJC Environ-mental Program Manager will notify the FFA signatories after emergency repairs are complete.

4.4.7 The DDJC Environmental Program Manager is responsible for conducting an annual inspection of the institutional control sites. The annual inspection will be documented in a report submitted to the signatories of the ROD. The inspection will ensure that the land use and pavement, surface soil, buildings, and other structures are maintained to prevent uncontrolled exposure to subsurface soil. The DDJC Environmental Program Manager is also responsible for preparation of a five-year review report such as this one.

4.4.8 If ownership of the installation is transferred to private or nonfederal entities in the future, restrictive covenants will be written into the land property deed to prevent schools, playgrounds, hospitals, or housing from being built at the sites until the contaminants are below levels of concern. Cooperation between the DLA, USACE, San Joaquin County, and the signatories to the FFA will be required to enact the restrictions on access and land use (URS, 2002f). Full remediation of institutional control sites to bring the contaminants below levels of concern is always an option to release the site from restricted land use (URS, 2002f).

5.0 PROGRESS SINCE LAST REVIEW

This is the first five-year review for the DDJC-Sharpe site.

6.0 FIVE-YEAR REVIEW PROCESS

This section describes the activities performed during the DDJC- Sharpe five-year review process, including identification of the five-year review team, notification of the local community, review of relevant documents and data, inspection of current site conditions, and performance of interviews to assist in determining site status.

6.1 Administrative Components

The DDJC-Sharpe Five-Year Review Team is composed of the RPMs: Michael Work, U.S. EPA (Region 9); Marcus Pierce, Central Valley RWQCB; Peter MacNicholl, DTSC; and Maurice Benson, DDJC-Sharpe. Members of the community surrounding DDJC-Sharpe will be notified of the initiation of the five-year review in accordance with the schedule developed during the February 2003 RPM meeting. Official notification of the local community will be through distribution of the Environmental Update fact sheet. The schedule for the five-year review report was developed in the FFA schedule and is presented in Table 6-1.

6.2 Community Involvement and Notifications

6.2.1 The DDJC-Sharpe Environmental Office has maintained an active community involvement program since the mid-1980s. The key components of this program include:

- Providing general information updates to the community through the distribution of the depot's Environmental Update fact sheets to a list of interested parties (approximately 300 addresses) and to all mailing addresses located within the postal zones surrounding the depot (more than 3,300 addresses).

- Notifying the community of program milestones and opportunities for public review and comment through public notices placed in local newspapers, as required by EPA guidance.

- Holding public meetings to present milestone documents and solicit public review and comment, as required.

- Informal program updates presented to interested community members through the Technical Review Committee (TRC) or, more recently, through the depot's Community Update Forum. Membership in the Community Update Forum includes City of Lathrop representatives, regulatory agency representatives, and interested residents. A Restoration Advisory Board has not been established at DDJC-Sharpe due to the absence of sustained community interest.

6.2.2 In accordance with U.S. EPA guidance, the community will be notified of DDJC-Sharpe's 2003 five-year review at both the beginning and the conclusion of the process (U.S. EPA, 2001).

6.2.3 The community was first informed of DDJC-Sharpe's plans to initiate the review at a TRC meeting on 10 September 2002. At this meeting, the TRC members asked to be briefed on the report's outcome when the report is finalized in late summer 2003.

6.2.4 The greater community will be notified of DDJC-Sharpe's intent to conduct the five-year review in August 2003, when an Environmental Update fact sheet is distributed to the depot's 300- name community contacts mailing list and to all addresses (approximately 3,300) surrounding the depot. This fact sheet will provide general information about the depot, its environmental review program, issues to be considered during

the five-year review process, and the review process schedule; solicit community input to the process; and list points of contact for community members who have questions or concerns. The fact sheet will also invite community members to attend a presentation on the report at an upcoming meeting of DDJC-Sharpe's Community Update Forum.

Table 6- 1. Five-Year Review Schedule, DDJC-Sharpe

Document Title	Document Status	Draft			Draft Final			Finalization Date
		Submission Date	Review Period	Comments Due Date	Submission Date	Review Period	Comments Due Date	
Five-Year Review Report	Primary	15-Mar-03	60 days	14-May-03	14-Aug-03	30 days	15-Sept-03	15-Sept-03

DDJC = Defense Distribution Depot San Joaquin California

6.2.5 At the next meeting of DDJC-Sharpe's Community Update Forum, preliminary findings from the five-year review report will be summarized and community members will have an opportunity to ask questions and comment on the review process.

6.2.6 A public notice will be published in the Stockton Record and Modesto Bee to notify the community of the completion of the review process and finalization of the five-year review report. This notice will briefly summarize the review, note how and where the public can view the report, and list points of contact for community members who have questions or concerns.

6.2.7 The 2003 DDJC-Sharpe five-year review report will be available for viewing by the public at the installation's information repository and administrative record, located at the DDJC-Tracy site.

6.3 Document Review

This five-year review consisted of a review of relevant documents, including but not limited to, the O&M manuals, remedial action reports, removal action memoranda, data and effectiveness evaluations in annual groundwater reports (FFA Annual Progress Reports), and close out reports (see list below). Applicable groundwater and vadose zone cleanup standards as listed in the OU 1 and OU 2 RODs, respectively, were also reviewed. Other documents relevant to the construction and performance of the groundwater and vadose zone remedies are summarized in Attachments 1 and 3.

- Substantive Waste Discharge Requirements for Land Disposal, Defense Distribution Region West (DDRW)-Sharpe (Addendum to the ROD, Attachment 2) (Central Valley RWQCB, 1992).

- Order No. 95-258, NPDES No. CA0081931, Waste Discharge Requirements for DDRW-Sharpe (Central Valley RWQCB, 1995).

- *Remedial Investigation/Feasibility Study at DDRW-Sharpe Site Record of Decision, Operable Unit 1* (ESE, 1993).

- *Final Removal Action Memorandum for Pesticide Mix Area, North Balloon Area, Lathrop, California* (ESE, 1994a).
- *Final Contaminated Soil Removal at Pesticide Mix Area, Sharpe Facility, Lathrop, California* (CKY, Inc., 1995).
- *Addendum to Final Contaminated Soil Removal at Pesticide Mix Area, Sharpe Facility, Lathrop, California* (CKY, Inc., 1996).
- *Final Record of Decision, Basewide Remedy for DDRW-Sharpe Site* (ESE, 1996).
- *Draft Project Close Out Report for Operable Unit 2 Soil Excavation for Sites S-3 and S-26 Defense Distribution Depot San Joaquin – Sharpe Site, Lathrop, California* (CKY, Inc., and Radian International, 1998).
- *Final Engineering Technical Memorandum, Site 33/29 Metals Investigation, DDJC-Sharpe* (Radian International, 1999c).
- *Final Water Management Report, DDJC-Sharpe Site* (Radian International, 1999b).
- *Final Operable Unit 2 Metals Remedial Action Report, Sites S-3 and S-26, DDJC-Sharpe* (Radian International, 2000a).
- *Final Operable Unit 2 No Further Action Remedial Action Report, DDJC-Sharpe* (Radian International, 2000b).
- *Final Operable Unit 1 Interim Remedial Action Report, DDJC-Sharpe* (URS, 2001g)
- *Final Operation and Maintenance Manual for the Groundwater Treatment Systems, DDJC-Sharpe* (URS, 2001b).
- *Addendum to the Installation Master Plan, Defense Distribution Depot San Joaquin California, Sharpe Site, Lathrop, California* (URS, 2002e).
- *Final Operable Unit 2 Soil Vapor Extraction Remedial Action Report, DDJC-Sharpe* (URS, 2002b).
- *Final Remedial Action Report for Institutional Controls at the South Balloon Area, DDJC-Sharpe* (URS, 2002f).
- *Evaluation of Proposed Well Shutdown Technical Memorandum, DDJC-Sharpe* (URS, 2002d).
- *Final Installation-Wide Preliminary Close Out Report, DDJC-Sharpe* (URS, 2002a).
- TCE Plume Capture and Containment Issues, Appendix D of Development of a Comprehensive Groundwater Model of the DDJC-Sharpe Site Lathrop, California. (WES, 2002).
- *Review Final Community Relations Plan, DDJC-Sharpe* (URS, 2003b).

- *Comprehensive Five-Year Review Guidance*, OSWER Directive No. 9355.7-03B-P (U.S. EPA, 2001).

6.4 Data Review

6.4.0.1 To evaluate the effectiveness of the groundwater extraction and treatment remedy, a Well Monitoring Program was established at DDJC-Sharpe. The purpose of the DDJC-Sharpe Well Monitoring Program is to provide a complete and current set of groundwater data from wells located on the installation and on private properties adjacent to the installation. Groundwater monitoring data are collected periodically at DDJC-Sharpe, and monitoring results are presented quarterly. Interpretation of the data— through evaluation of groundwater level changes, gradients, flow directions, capture zones, and groundwater quality— is performed and reported annually in the FFA Annual Progress Report.

6.4.0.2 Figure 6-1[1] shows locations of DDJC-Sharpe groundwater monitoring wells, extraction wells, injection wells, piezometers, observation wells, and potable water wells. Figure 6-2 shows the locations of the groundwater monitoring system boundary piezometers. There are 307 wells at DDJC-Sharpe: 212 monitoring wells (DWs or MWs), 45 extraction wells, 10 injection wells, 6 injection observation wells, and 34 piezometers. There are 51 potable water supply wells on installation and off installation within approximately 1,500 feet to the west. Only 38 of these potable water supply wells are currently sampled as part of the Well Monitoring Program.

6.4.1 Hydraulic Data Summary

Depths to water are measured quarterly in monitoring wells and piezometers screened within the A, B, C, and D Zones. Water levels measured quarterly are used to develop potentiometric surface maps for use in determining groundwater flow directions and to determine vertical and horizontal groundwater gradients. Figures 6-3, 6-4, and 6-5 present the groundwater elevation contour maps for the A, B, and C Zones drawn with data from the first quarter of 2003 (1Q03). Water level contour maps are not developed for the D Zone wells because monitoring wells screened in this zone are too widely spaced to construct meaningful contours. Water levels are evaluated to determine the following: seasonal fluctuations; percolation pond and extraction well influences; estimated capture zones; and any differences or similarities in hydraulic gradients between the A, B, and C Zones. Groundwater extraction from the North Balloon, South Balloon, and Central Area locally affect groundwater flow beneath the installation and adjacent off-installation areas to the west.

6.4.2 Analytical Data Summary

6.4.2.1 VOCs are the most widespread contaminants reported in groundwater beneath DDJC- Sharpe and off-installation areas. The most commonly detected VOC is TCE. During the past five years, sampling for other contaminants in groundwater has included or currently includes bromacil, lead, total chromium, hexavalent chromium, arsenic, selenium, nitrate, and TPH/ BTEX.

6.4.2.2 TCE. Figures 6-6 and 6-7 show the TCE results for A, B, and C Zone wells sampled in 3Q02 in the North Balloon and the South Balloon and Central Area, respectively (URS, 2003a). If a well was not sampled during 3Q02 as recommended, the most recent sampling event result between 3Q01 and 2Q02 was used with the model to draw the plume. The highest concentration of TCE at each well or well cluster reported during the 3Q02 annual sampling event was used to create the plumes that show the estimated horizontal and vertical

1 For continuity of text, all figures are provided at the end of the section.

extent of TCE in groundwater on and off the installation. A well may be shown within an area assigned a higher TCE concentration than the concentration reported for that well because EarthVision . uses the highest TCE value within a volume to model the plume. In the D Zone, TCE was detected below the MCL of 5 µg/L at three wells in 2002 (Figure 6-8).

6.4.2.3 Vertical Extent of TCE Contamination. Figure 6-9 shows the locations of monitor-ing wells, extraction wells, and the lines of three geologic cross-sections. Figure 6-10 is a vertical profile of TCE concentrations reported in 3Q02 along the geological cross-section A to A', which passes through the North Balloon. This cross-section is approximately parallel to the groundwater flow direction in the North Balloon. The TCE plume extends to a depth of 150 feet bgs. Figure 6-11 is a vertical profile of TCE concentrations reported in 3Q02 along the geological cross- section B-B', which passes through the Central Area. The TCE plume extends to a depth of 155 feet bgs. Figure 6-12 is a vertical profile of TCE concentrations reported in 3Q02 along the geological cross-section C-C', which passes through the South Balloon. The TCE plume extends to a depth of 138 feet bgs.

6.4.2.4 PCE. Figures 6-13 and 6-14 show the PCE results for A, B, and C Zone wells sampled in 3Q02 in the North Balloon and the South Balloon and Central Area, respectively (URS, 2003a). The results shown on the figures are for wells that were sampled in 3Q02 or the most recent sample collected. The PCE plumes were drawn manually using the highest concentration of PCE reported at a well or well cluster. PCE was not reported in any samples collected from D Zone monitoring wells during the 2002 monitoring period (Figure 6-15).

6.4.2.5 TCE and PCE in Potable Water Wells. Figure 6-1 shows the locations of the potable water wells. TCE and PCE were detected in potable wells off the installation in the North Balloon Area during the 2002 sampling event (URS, 2003a). Concentrations of TCE in PW020 and PW006 were detected below the MCL of 5 µg/L (Figure 6-8). PCE was detected in PW021 at 0.6 µg/L, which is above the ACL of 0.5 µg/L, during both 2Q02 and 3Q02 (Figure 6-15).

6.4.2.6 Other VOC Contamination. Figure 6-16 shows the location of monitoring wells with concentrations of VOCs other than TCE and PCE (referred to as other VOCs) that exceeded the ACLs in well samples collected during the 2002 sampling event (URS, 2003a). Results for BTEX compounds are shown on Figure 6-20.

6.4.2.7 Bromacil. Figure 6-17 shows the locations of wells where bromacil concentrations were reported in 2002 (URS, 2003a). Of the 24 monitoring wells sampled for bromacil during the 2002 sampling event, two wells had bromacil concentrations greater than the discharge criterion of 90 µg/L established by the RWQCB in the WDRs (Central Valley RWQCB, 1992). Bromacil concentrations did not exceed 90 µg/L in any off-installation wells.

6.4.2.8 Lead. Lead has been detected only rarely in groundwater samples. Lead has not been reported in any groundwater samples collected since 1997. Samples for lead analysis were not collected in 2002 (URS, 2002f).

6.4.2.9 Chromium. In accordance with the OU 2 ROD, baseline chromium concentrations in groundwater were established as the concentration for each well at the time the ROD was signed in 1Q96. For wells not sampled in 1Q96, baseline chromium concentrations are those measured in the next quarter that a sample was collected. See Table 4.5-1 in the *DDJC-Sharpe FFA Annual Progress Report: October 2001 through September 2002* (URS, 2003a) for the baseline concentrations for chromium for each monitoring well sampled for metals. Figure 6-18 shows the locations of wells where total chromium and hexavalent chromium concentrations were

reported in 2002 (URS, 2003a). Two wells had total chromium concentrations greater than or equal to baseline concentrations in at least one sample. During the 2002 sampling event, no well samples had total chromium concentrations exceeding the MCL of 0.05 mg/L. Hexavalent chromium was reported in 17 of the 37 samples collected during the 2002 sampling event. Neither an MCL nor an ACL has been established for hexavalent chromium. Neither total chromium nor hexavalent chromium was detected in monitoring wells or extraction well samples collected beyond DDJC-Sharpe boundaries.

6.4.2.10 Background Metals Concentrations. Background levels were established for arsenic, selenium, and nitrate, identified as inorganic species of concern because historical data indicate widespread occurrence at concentrations greater than the MCLs (arsenic) or because the WDRs required that background levels (selenium and nitrate) for DDJC-Sharpe be established (Radian International, 2000c). Other inorganic species occur naturally in groundwater, but because they have not been identified as potential contaminants, background concentrations were not established; when reported, the concentrations are compared to MCLs. The following table lists the background levels for arsenic, selenium, and nitrate (Radian International, 2000c).

Location	Arsenic (mg/L)	Selenium (mg/L)	Nitrate (mg/L)
A Zone	0.279	0.0244	20.8
B Zone	0.057	0.0076	3.9
C Zone	0.0255	0.0076	3.8

mg/ L = milligrams per liter

6.4.2.11 Arsenic. Figure 6-19 shows the locations of all the wells sampled for arsenic between 4Q01 and 3Q02 (URS, 2003a). Six monitoring wells and one extraction well had arsenic concentrations exceeding the established background levels. Because of the decrease in the MCL value for arsenic to 0.01 mg/L in 4Q01, 40 of the wells sampled at least once for arsenic analysis in 2002 had an average concentration greater than the MCL.

6.4.2.12 Selenium. Three monitoring wells and two extraction wells were sampled for selenium analysis in 3Q02. Two monitoring wells (MW438A and MW420B) had selenium concentrations exceeding the established background levels (URS, 2003a). The concentration of selenium at MW438A also exceeded the MCL of 0.05 mg/L.

6.4.2.13 Nitrate. No samples were collected in 2002 for nitrate analysis. Nitrate was reported at a concentration greater than background in only one sample, MW440A, collected in 2Q99. This was a sample collected as part of the background study for the WDRs. No further sampling for nitrate will be conducted.

6.4.2.14 Petroleum Hydrocarbons. Figure 6-20 shows the locations of the monitoring wells sampled and summarizes the total petroleum hydrocarbons as diesel (TPHD), total petroleum hydrocarbons as gasoline (TPHG), and BTEX results from 4Q01 through 3Q02 (URS, 2003a). UST locations related to the petroleum hydrocarbon contamination in groundwater on the installation are also shown on Figure 6- 20. Three wells had concentrations of petroleum hydrocarbons greater than the reporting limit, and three wells had concentrations of petroleum hydrocarbons and BTEX compounds greater than the reporting limit. Five wells had TPHD reported above the California taste and odor threshold value of 100 µg/L, and four wells had TPHG reported above the California taste and odor threshold value of 5 µg/L during the 2002 sampling event. Three wells had benzene reported above the MCL of 1 µg/L, and one well had xylene reported above the MCL of 1,750 µg/L.

6.4.3 Sampling Program Recommendations

The effort to reduce the number of wells sampled per year and the types of analyses performed has been continuous during the five years of the review period. Table 6-2 lists the actual number of samples collected from wells and the analyses performed during each of the sampling events since 1998. In 2002, the sampling decision flow chart used to determine sampling frequencies was modified to allow for input from spatial statistical evaluation of VOC concentrations. It was decided that three-dimensional spatial evaluation would be used to decide between yearly and every other year sampling frequencies. With the flow chart, resources are focused on the effectiveness and efficiency of remediation. Sampling frequencies are reduced to every other year or to no sampling at well locations that do not provide data essential to the remediation of contaminants or plume definition from DDJC-Sharpe that are in groundwater. With the intent of focusing limited resources on areas that require actions, reductions in the frequency of sampling at some wells are proposed.

6.5 Site Inspection

6.5.1 URS conducted additional site inspec-tions at the DDJC-Sharpe OU 1 and OU 2 remedial action sites on 3 July 2003. Site inspection checklists are provided in Attachment 4.

6.5.2 The photographs in Attachment 5 show current site conditions at DDJC-Sharpe. The purpose of the photograph log is to document existing site conditions, including examining the condition of restored soil sites, examining the fencing that restricts access to the three GWTP facilities, and evaluating the maintenance upkeep and security restrictions at extraction wells and control panels (i.e., locks).

6.5.3 URS personnel visited each of the GWTPs and associated extraction systems (OU 1 remedial sites) on 3 July 2003. No anomalies were observed with respect to the operation of the treatment plants or extraction wells. Site inspection checklists indicate the extraction and treatment systems are functioning properly. Photographs 1 through 8 in Attachment 5 show the groundwater treatment systems at DDJC-Sharpe.

6.5.4 Locations where OU 2 remedies were implemented were also inspected on 3 July 2003. All OU 2 remedial actions at DDJC-Sharpe are now complete. Site inspections at OU 2 remedial action areas primarily consist of photograph documentation of existing site conditions. Vegetation has grown over the sites where asphalt does not exist. Evidence of abandoned wells can be seen at the SVE sites as a result of decommissioning activities conducted in 2002. Photographs 9 through 15 in Attachment 5 show the existing conditions at the former OU 2 remedial action sites.

6.5.5 The institutional controls currently in place include land use controls in the area south of South Crane Way in the South Balloon. The land use controls are in place to ensure that the land use and pavement, surface soil, buildings, and other structures are maintained to prevent uncontrolled exposure to potentially contaminated subsurface soil. The southern portion of the institutional controls area is shown in Photograph 16 in Attachment 5.

6.6 Interviews

Interview results are included as Attachment 6.

Table 6-2. Number of Well Samples Collected, 1998–2002, DDJC-Sharpe

Analyte Suite	Quarterly	Twice Yearly	Yearly
1998[a]			
VOCs	152	36	91
Arsenic	41	4	12
Chromium	41	4	12
Lead	41	4	12
Metals (full suite)	2	0	0
Pesticides	0	5	2
Bromacil	9	4	1
TPH (gasoline and diesel)	2	11	3
SVOCs	0	2	1
Nitrate	11	0	0
Hexavalent chromium	0	0	49
1999[b]			
VOCs	89	72	118
Arsenic	14	23	21
Chromium	21	10	15
Lead	21	10	15
Selenium	11	0	0
Pesticides	0	0	2
Bromacil	6	12	0
PCBs	0	3	3
TPH (gasoline and diesel)	0	14	3
SVOCs	0	1	2
Nitrate	11	0	0
Hexavalent chromium	0	1	11
2000[c]			
VOCs	77	24	76
Arsenic	0	18	36
Chromium	1	12	26
Lead	0	0	1
Bromacil	0	13	12
TPH (gasoline and diesel)	0	0	9
SVOCs	0	1	0
Nitrate	0	0	9
Hexavalent chromium	0	0	11
2001[d]			
VOCs	74	7	150
Arsenic	1	1	54
Chromium	2	1	30
Selenium	0	2	3
Bromacil	0	5	28
TPH (gasoline and diesel)	0	8	34
SVOCs	0	1	2
Hexavalent chromium	0	1	12
2002[e]			
VOCs	85	12	71
Arsenic	10	2	31
Chromium	11	1	16
Selenium	0	0	5

Table 6-2. (Continued)

Analyte Suite	Quarterly	Twice Yearly	Yearly
2002[e] (cont'd)			
Bromacil	0	14	12
TPH (gasoline and diesel)	0	4	10
SVOCs	0	0	1
Hexavalent chromium	0	1	26

[a] Source: *DDJC-Sharpe, FFA Annual Progress Report: October 1997 through September 1998* (Radian International, 1999a).
[b] Source: *DDJC-Sharpe, FFA Annual Progress Report: October 1998 through September 1999* (Radian International, 2000c).
[c] Source: *DDJC-Sharpe, FFA Annual Progress Report: October 1999 through September 2000* (URS, 2001f).
[d] Source: *DDJC-Sharpe, FFA Annual Progress Report: October 2000 through September 2001* (URS, 2002f).
[e] Source: *DDJC-Sharpe, FFA Annual Progress Report: October 2001 through September 2002* (URS, 2003a).

DDJC = Defense Distribution Depot San Joaquin California
PCB = polychlorinated biphenyls
SVOC = semivolatile organic compound
TPH = total petroleum hydrocarbons
VOC = volatile organic compound

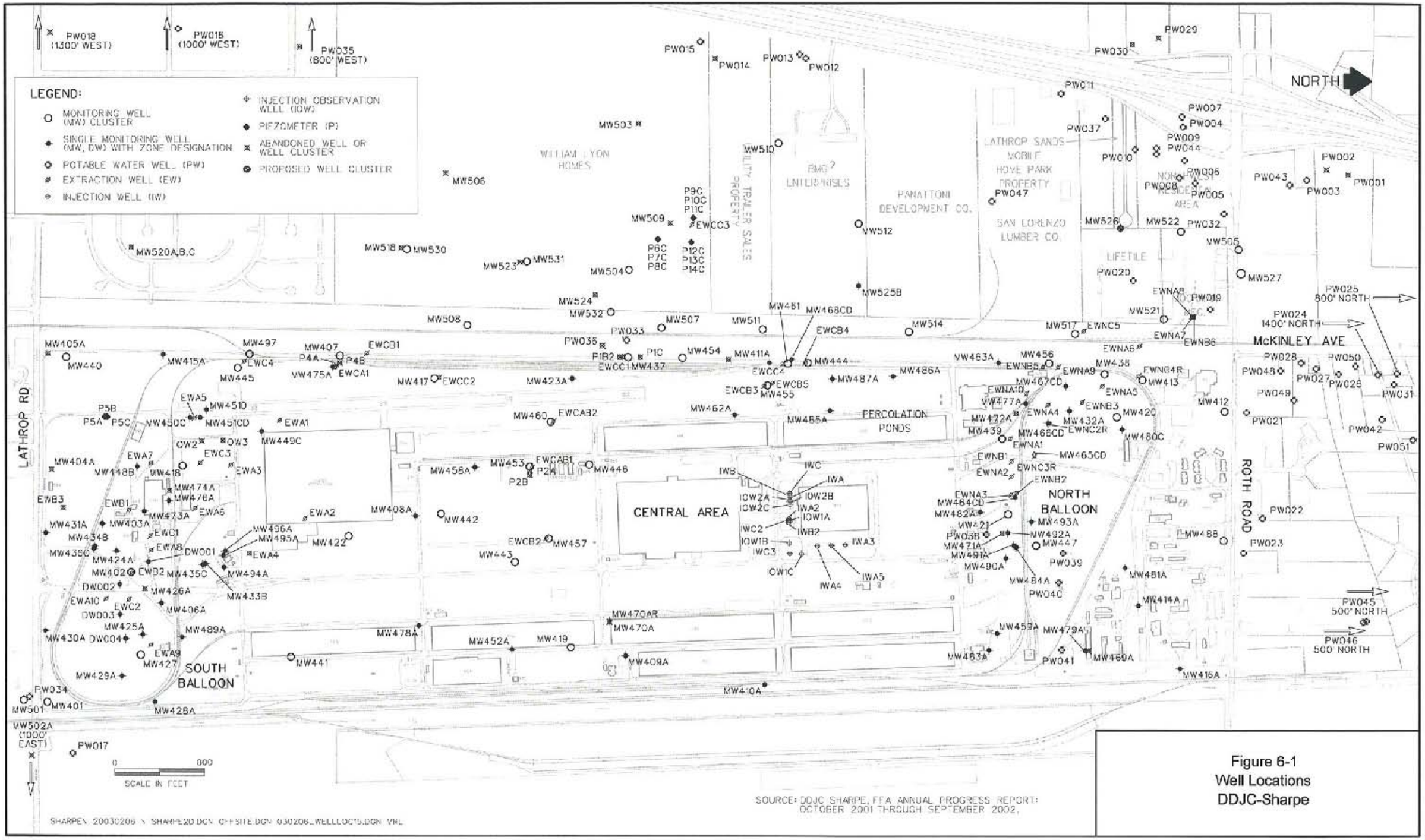


Figure 6-1
Well Locations
DDJC-Sharpe

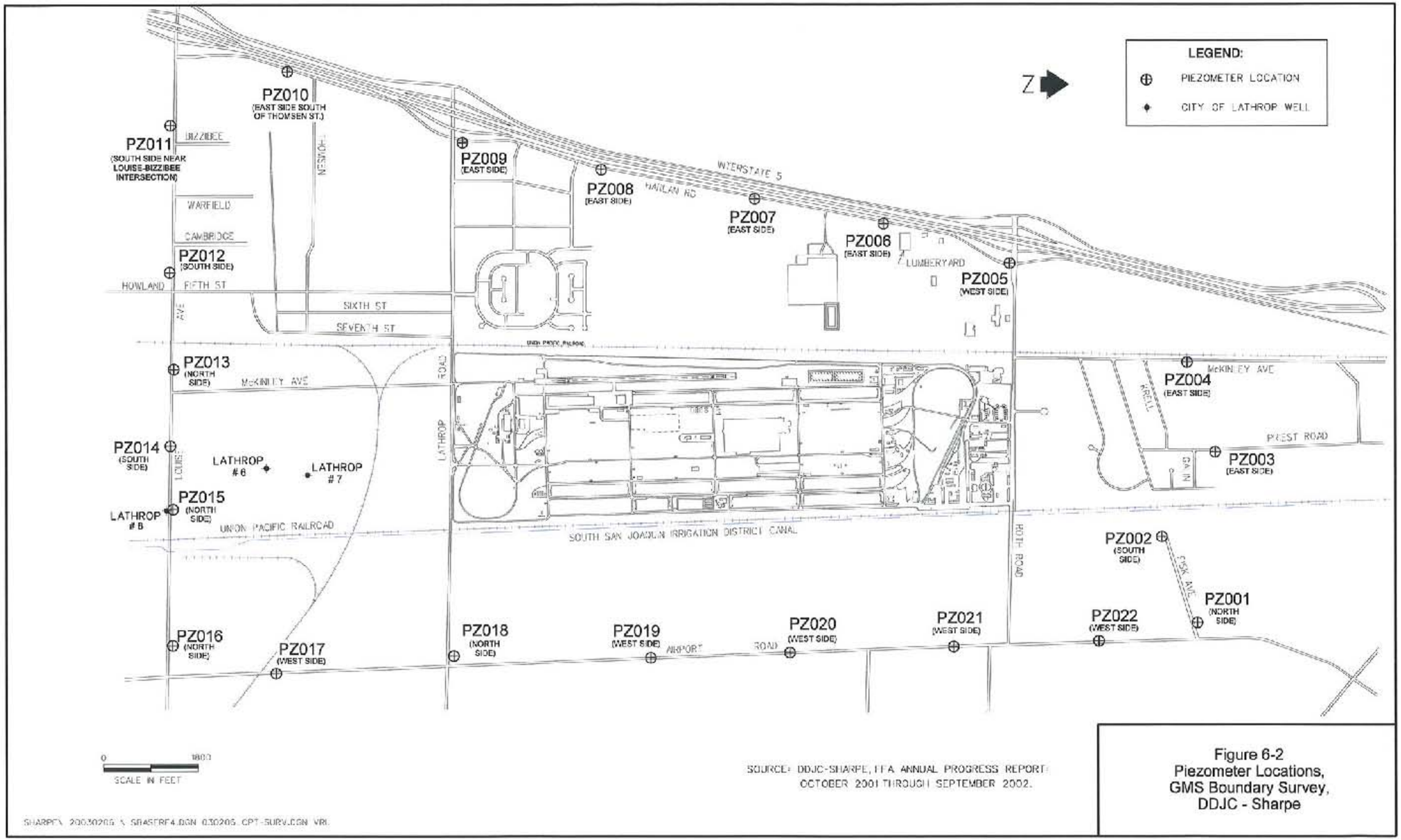


Figure 6-2
Piezometer Locations,
GMS Boundary Survey,
DDJC - Sharpe

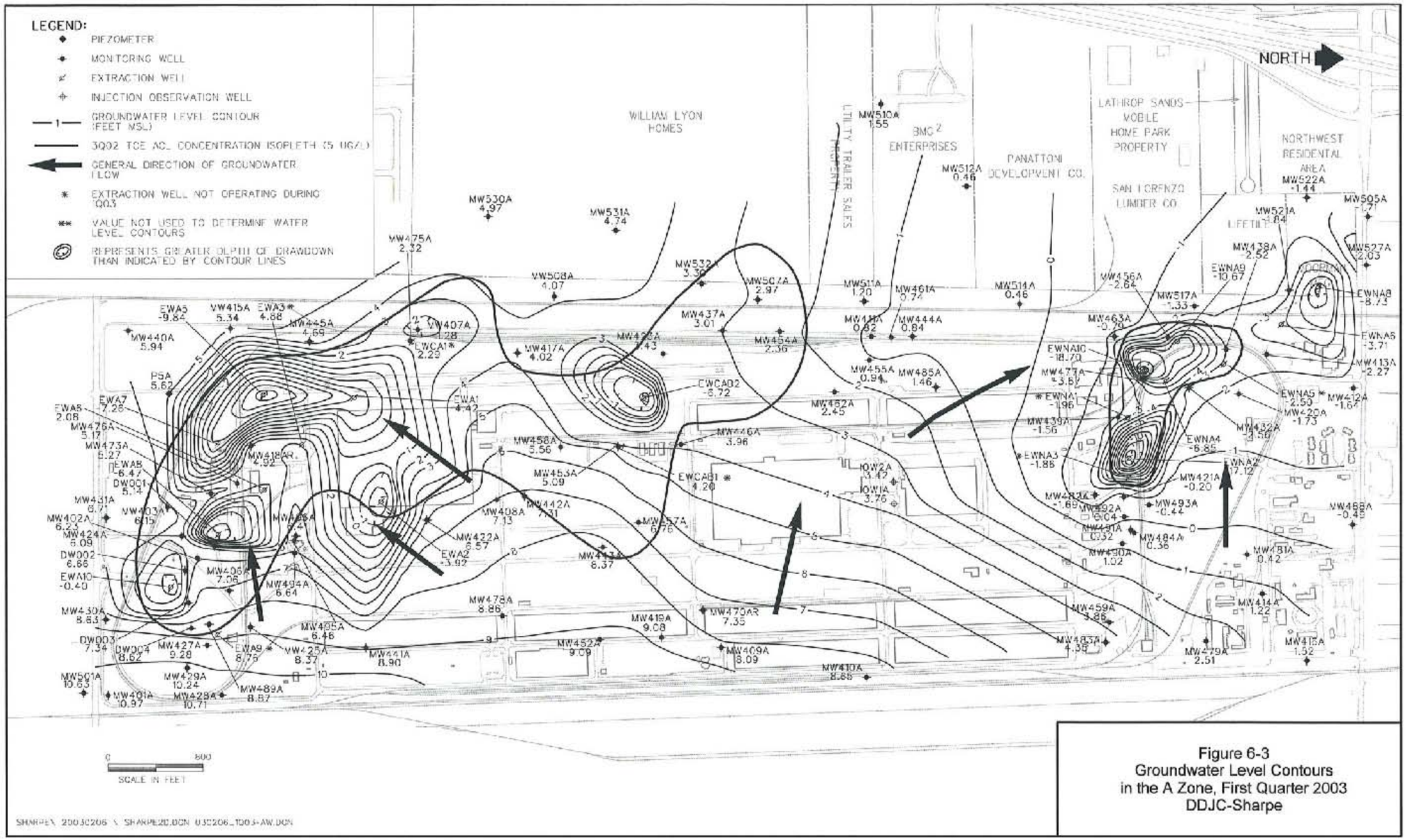


Figure 6-3
Groundwater Level Contours
in the A Zone, First Quarter 2003
DDJC-Sharpe

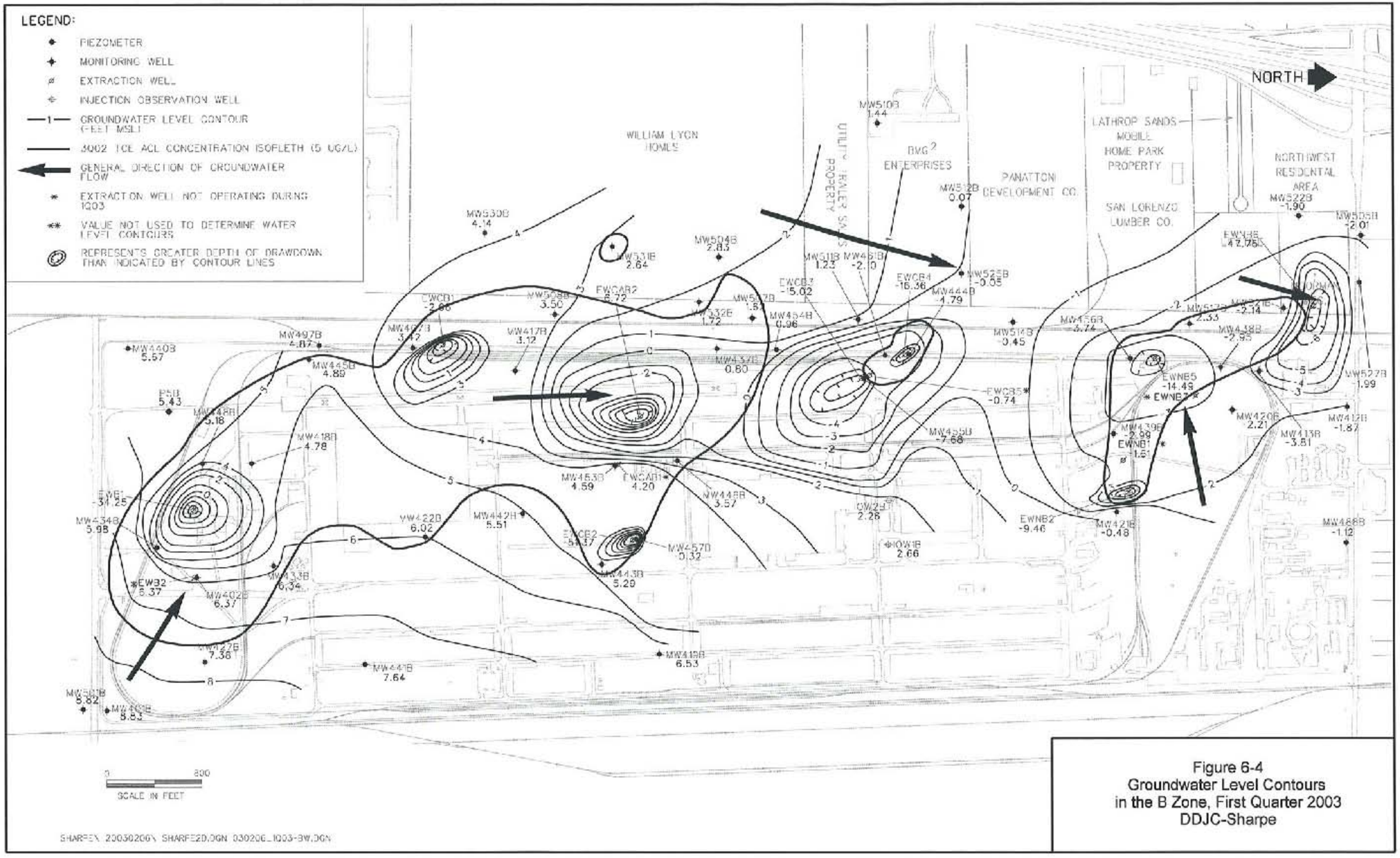


Figure 6-4
Groundwater Level Contours
in the B Zone, First Quarter 2003
DDJC-Sharpe

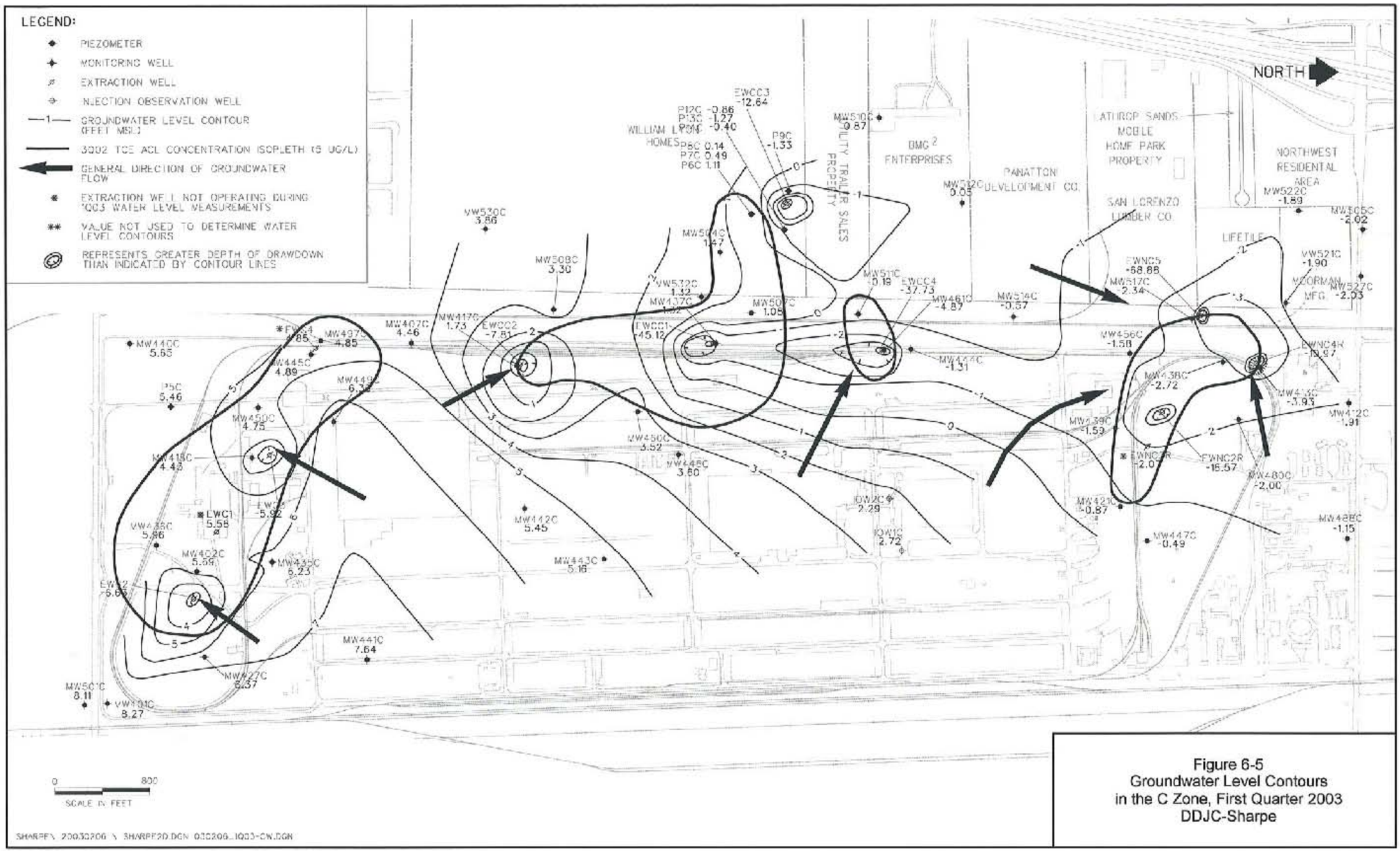
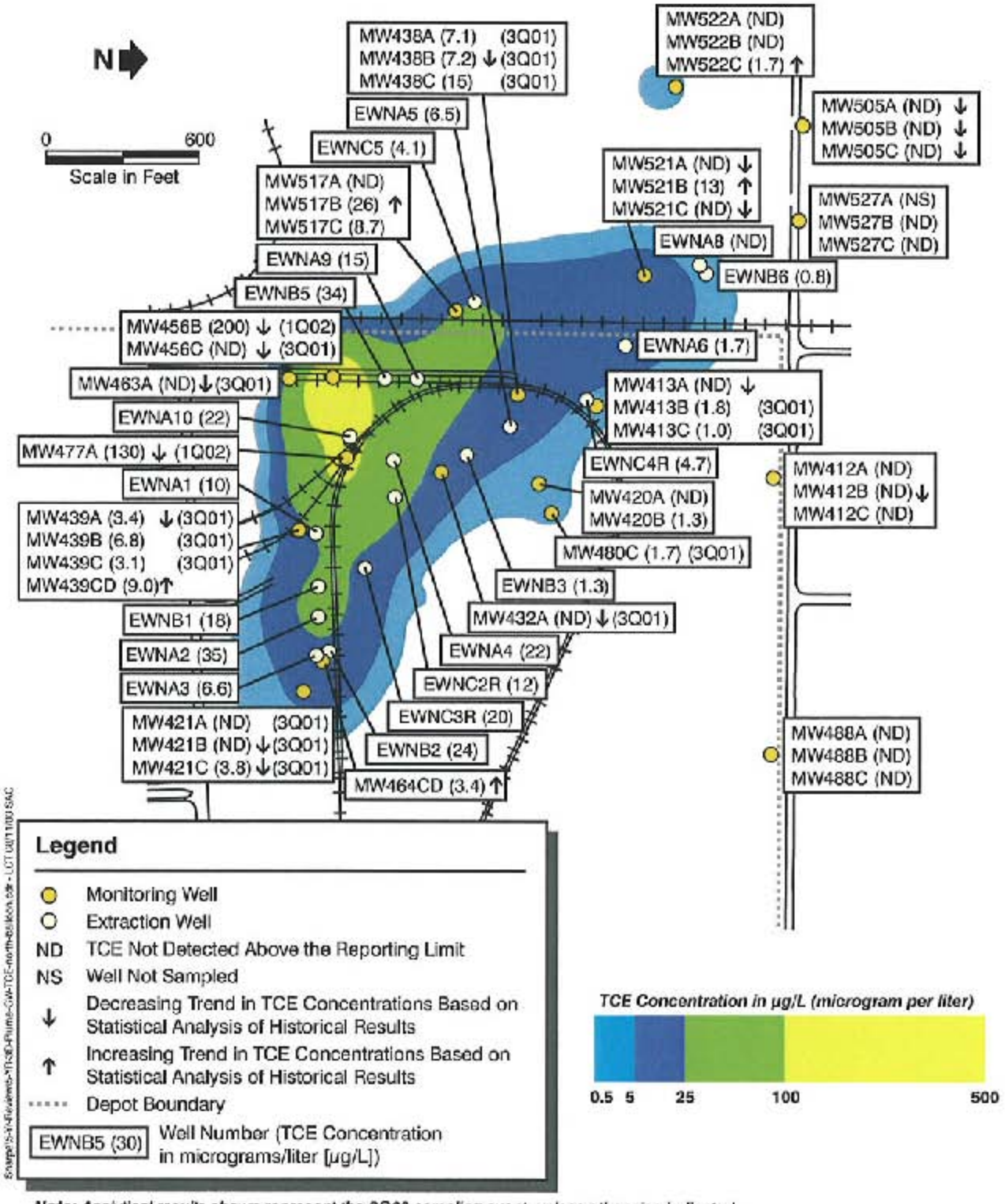


Figure 6-5
Groundwater Level Contours
in the C Zone, First Quarter 2003
DDJC-Sharpe



Note: *Analytical results shown represent the 3Q02 sampling event, unless otherwise indicated.*
SOURCE: DDJC-Sharpe FFA Annual Progress Report: October 2001 through September 2002.

Figure 6-6. Maximum TCE Concentrations in Groundwater North Balloon, A, B, and C Zones, Third Quarter 2002, DDJC-Sharpe

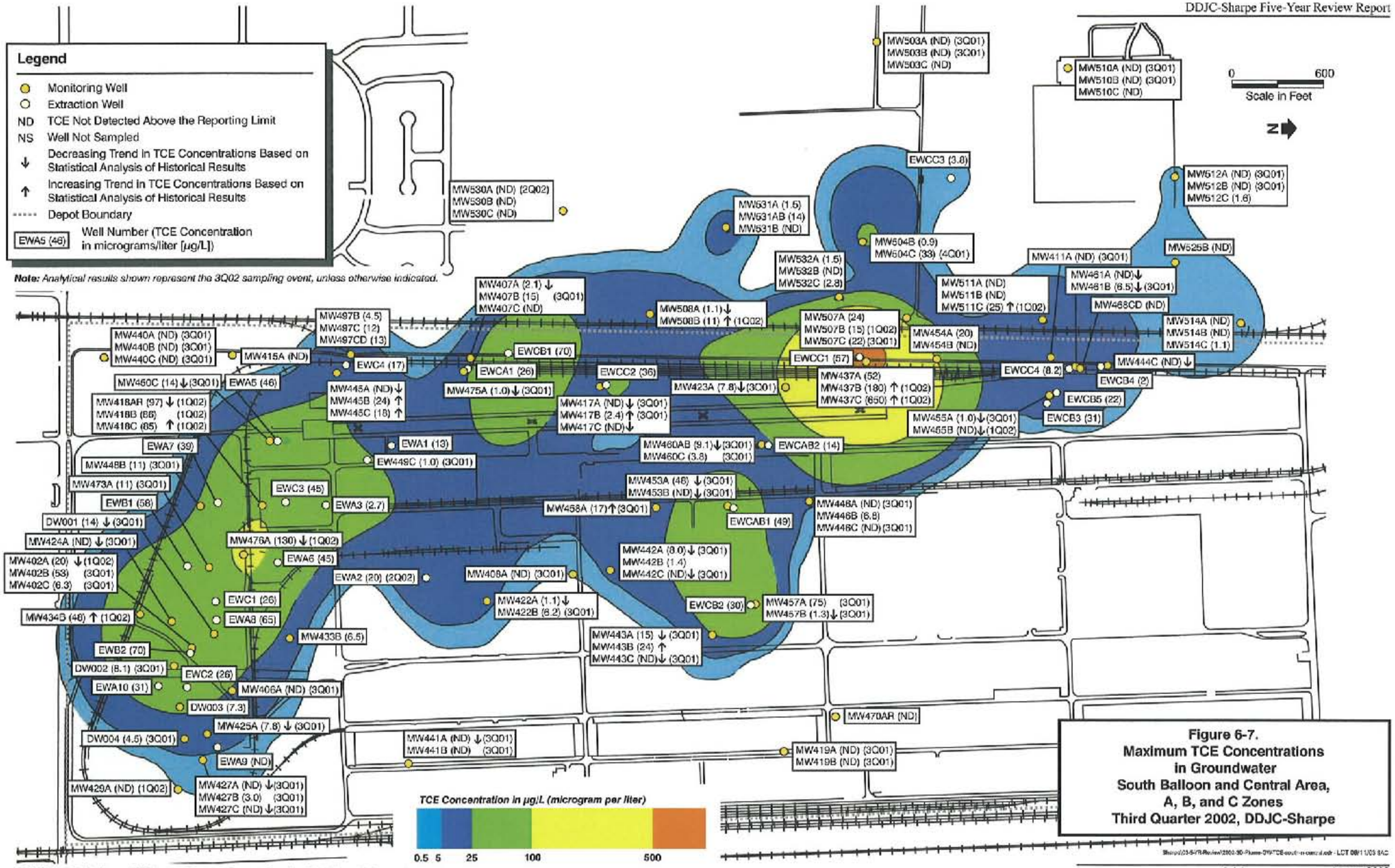


Figure 6-7.
Maximum TCE Concentrations in Groundwater
South Balloon and Central Area, A, B, and C Zones
Third Quarter 2002, DDJC-Sharpe

SOURCE: DDJC-Sharpe FFA Annual Progress Report: October 2001 through September 2002.

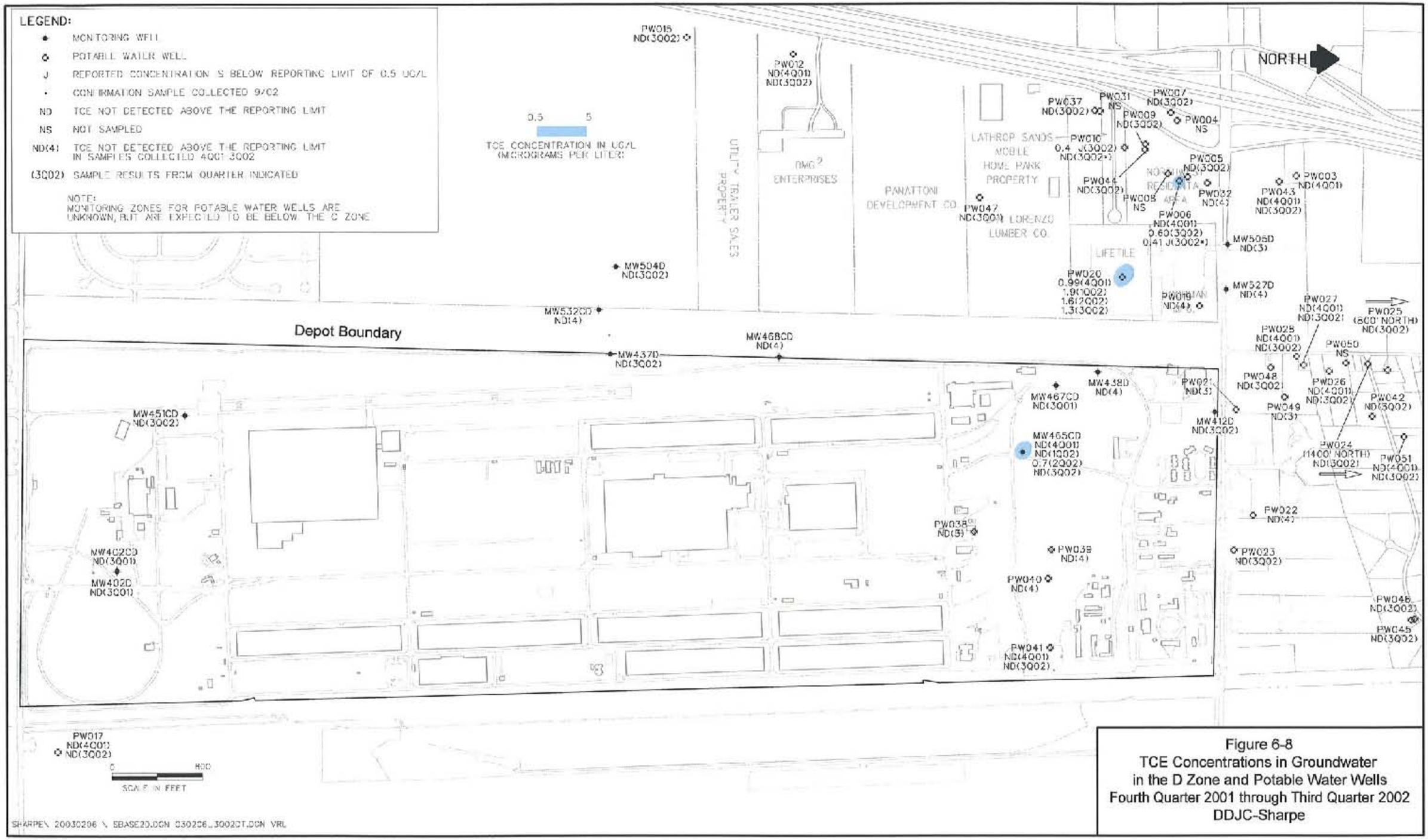


Figure 6-8
TCE Concentrations in Groundwater
in the D Zone and Potable Water Wells
Fourth Quarter 2001 through Third Quarter 2002
DDJC-Sharpe

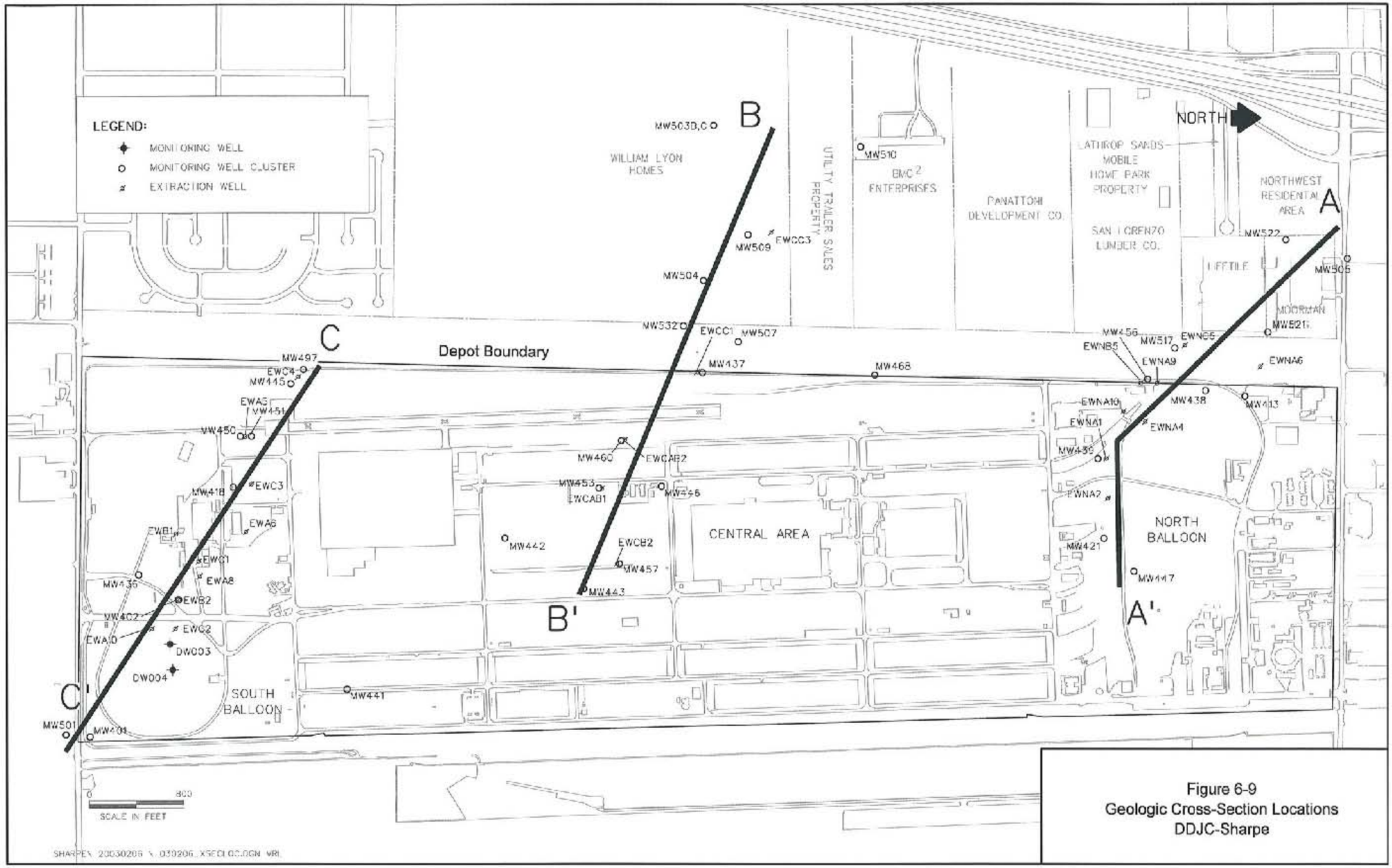


Figure 6-9
Geologic Cross-Section Locations
DDJC-Sharpe

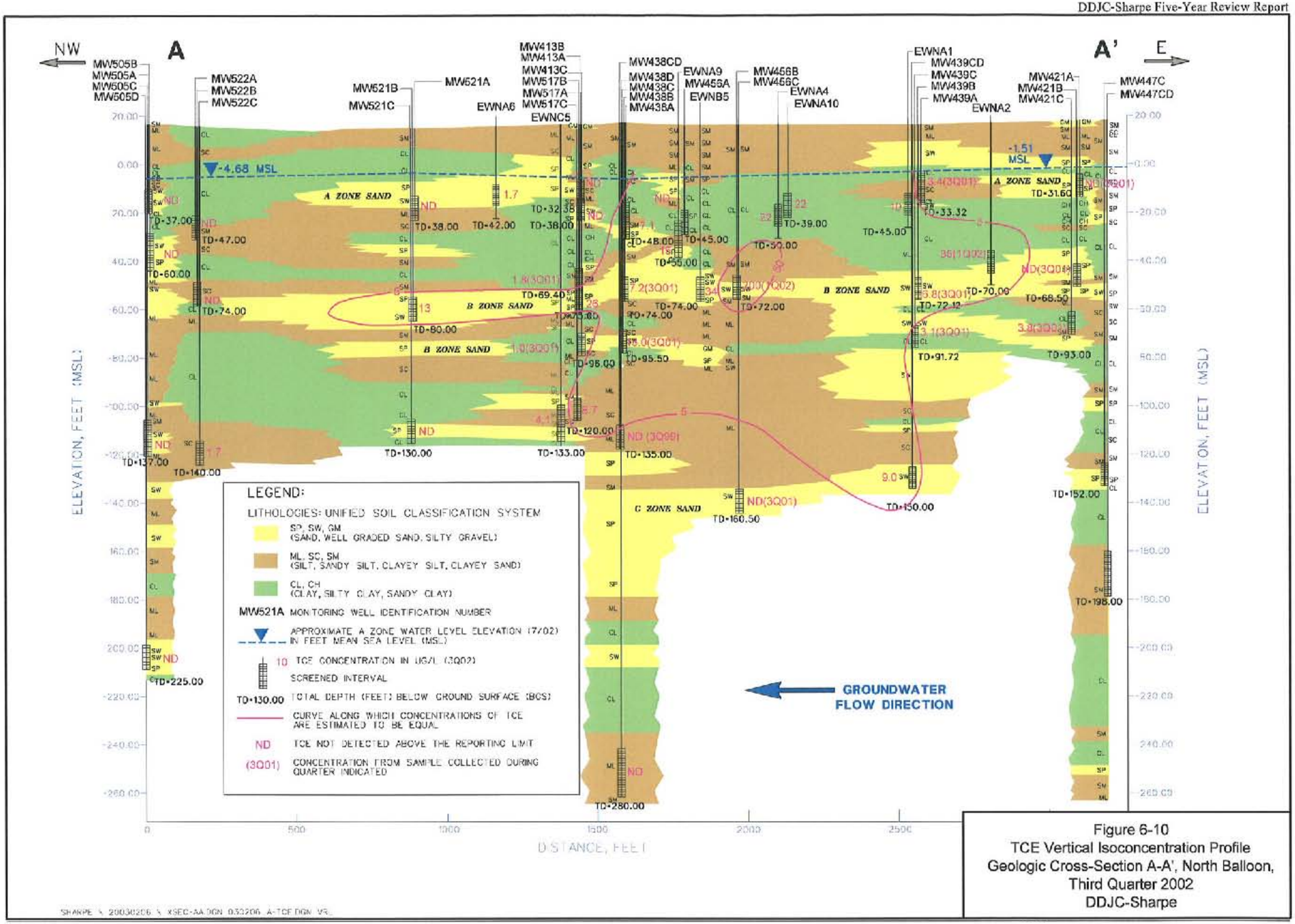


Figure 6-10
TCE Vertical Isoconcentration Profile
Geologic Cross-Section A-A', North Balloon,
Third Quarter 2002
DDJC-Sharpe

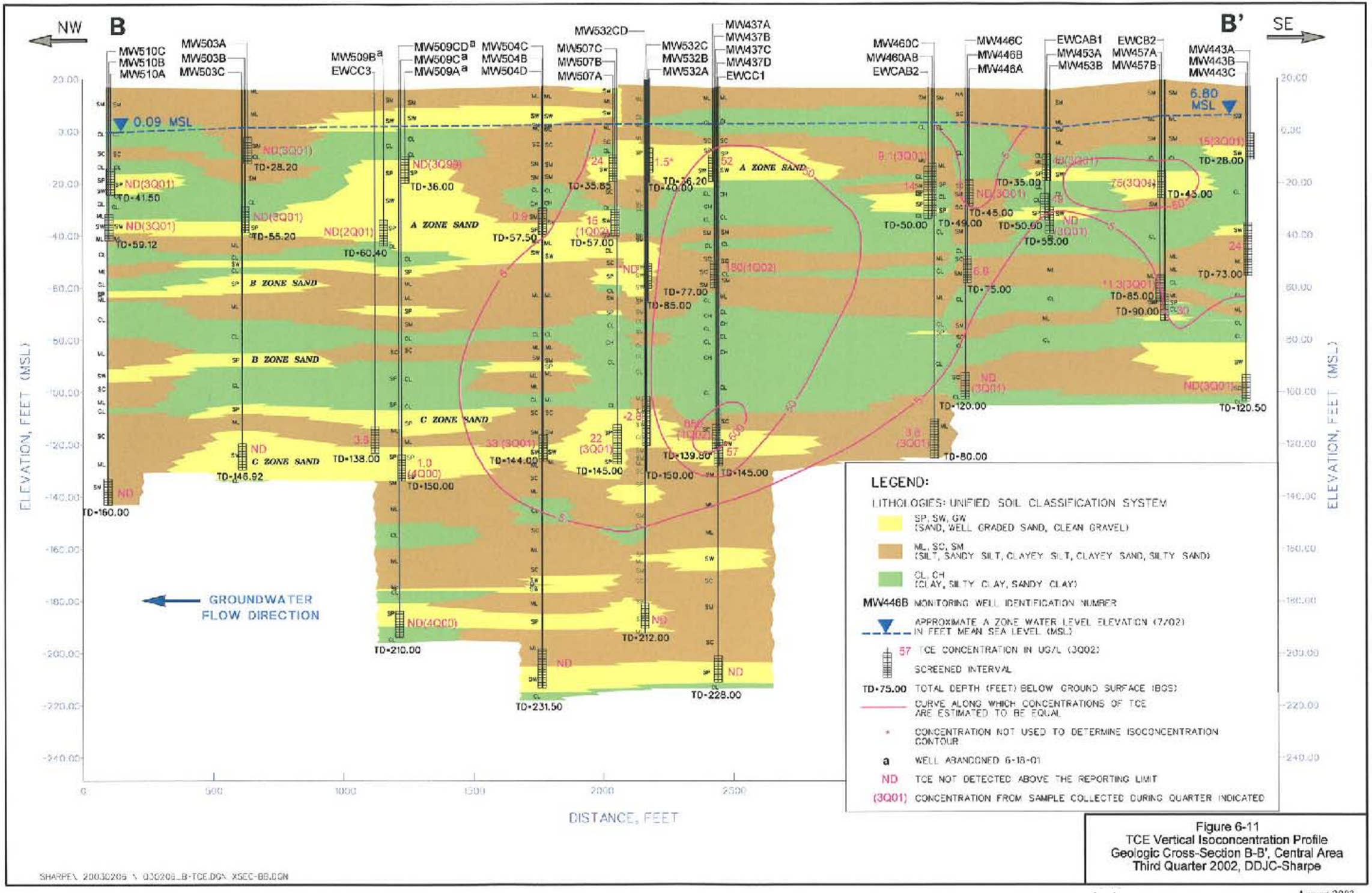


Figure 6-11
TCE Vertical Isoconcentration Profile
Geologic Cross-Section B-B', Central Area
Third Quarter 2002, DDJC-Sharpe

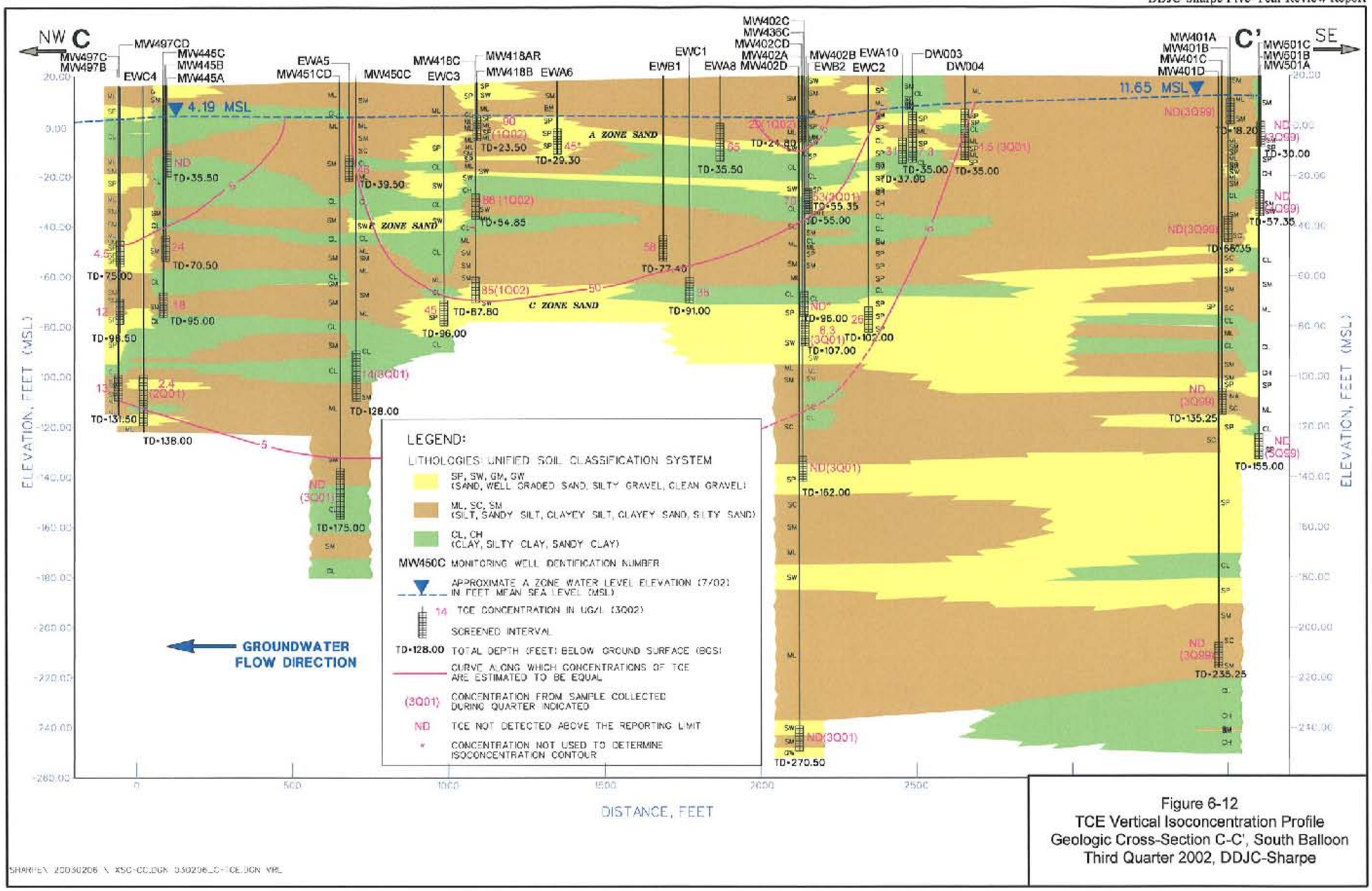


Figure 6-12
TCE Vertical Isoconcentration Profile
Geologic Cross-Section C-C', South Balloon
Third Quarter 2002, DDJC-Sharpe

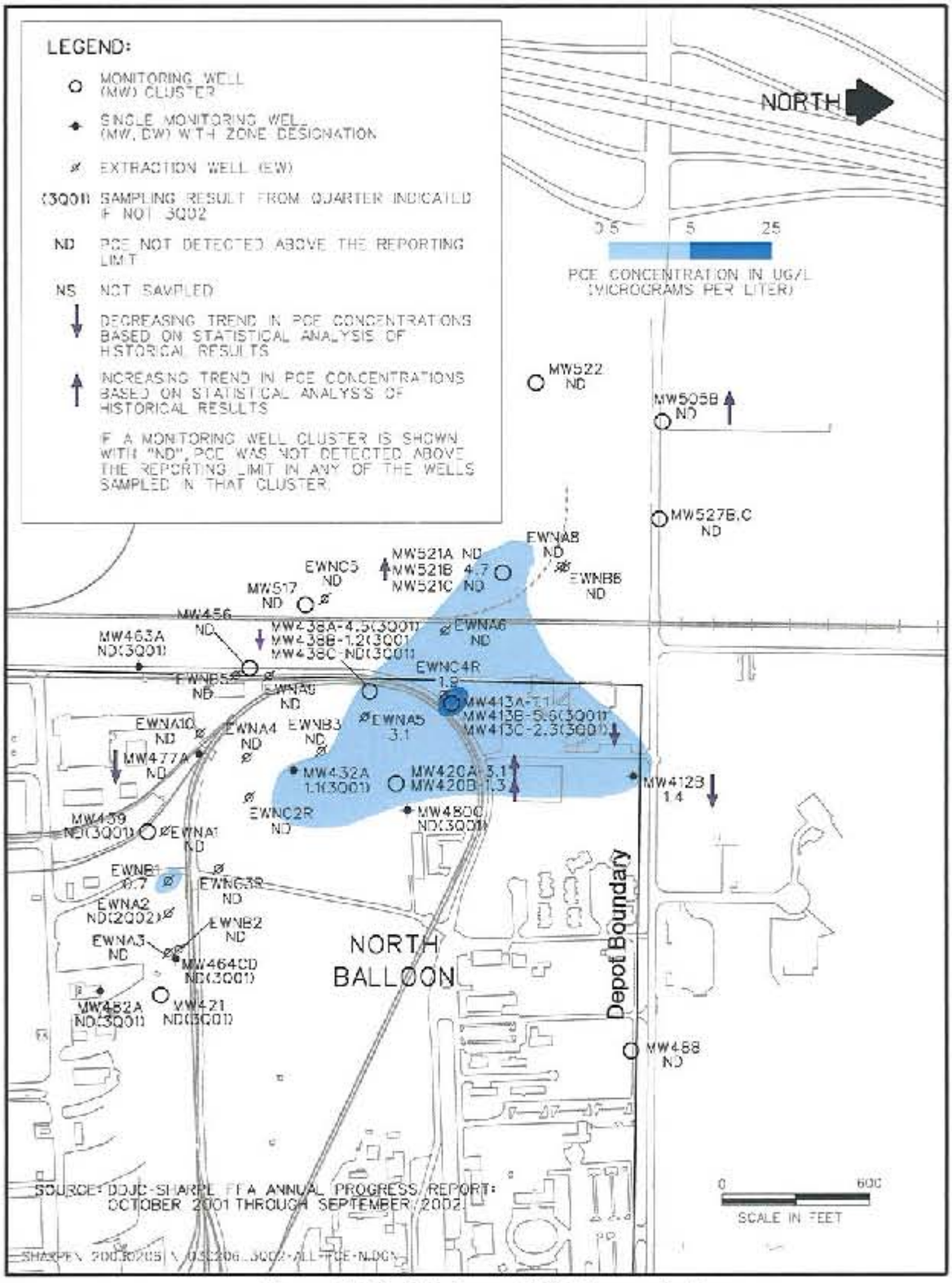


Figure 6-13. Maximum PCE Concentrations in Groundwater, North Balloon, A, B, and C Zones, Third Quarter 2002, DDJC-Sharpe

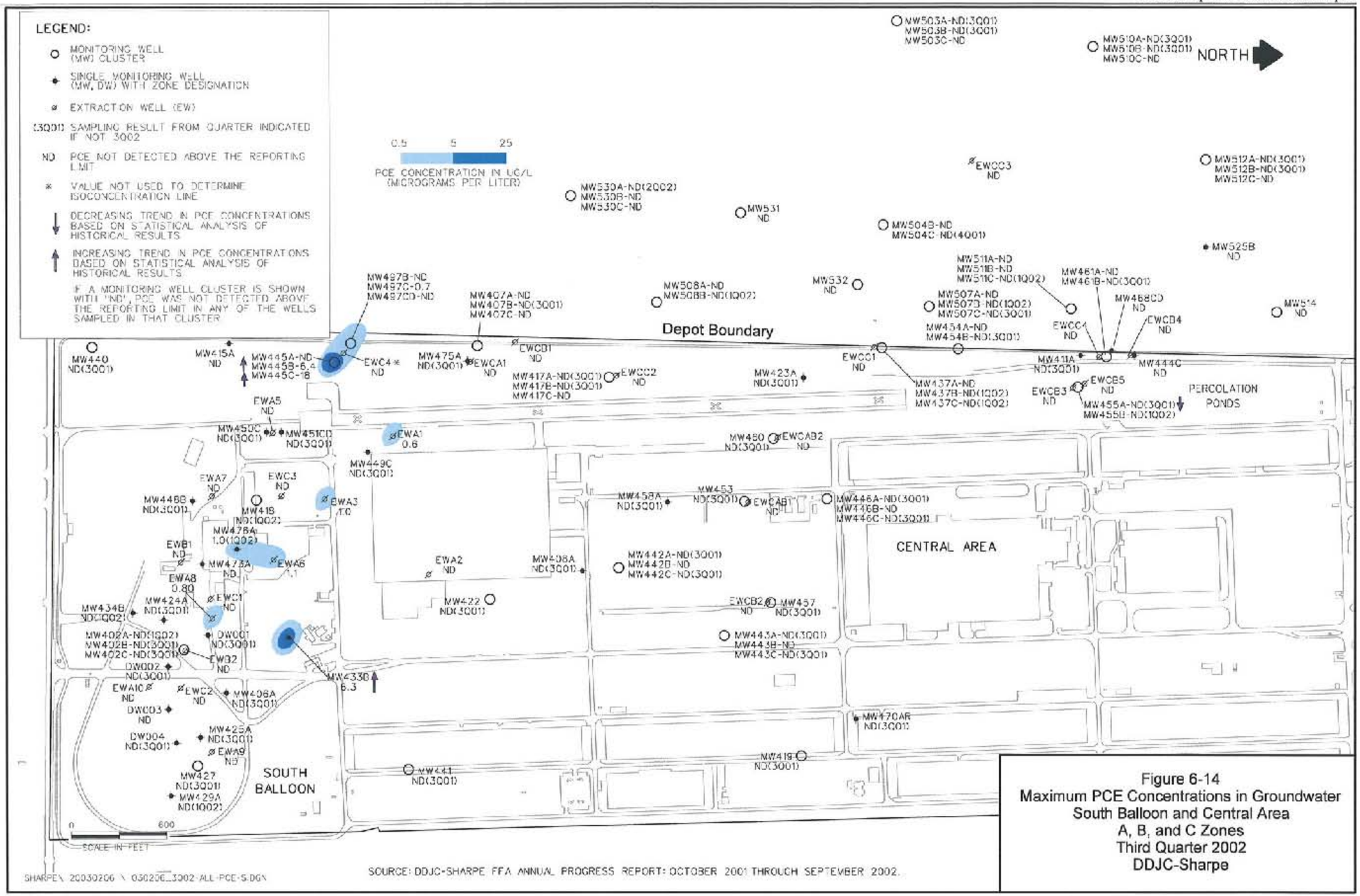


Figure 6-14
Maximum PCE Concentrations in Groundwater
South Balloon and Central Area
A, B, and C Zones
Third Quarter 2002
DDJC-Sharpe

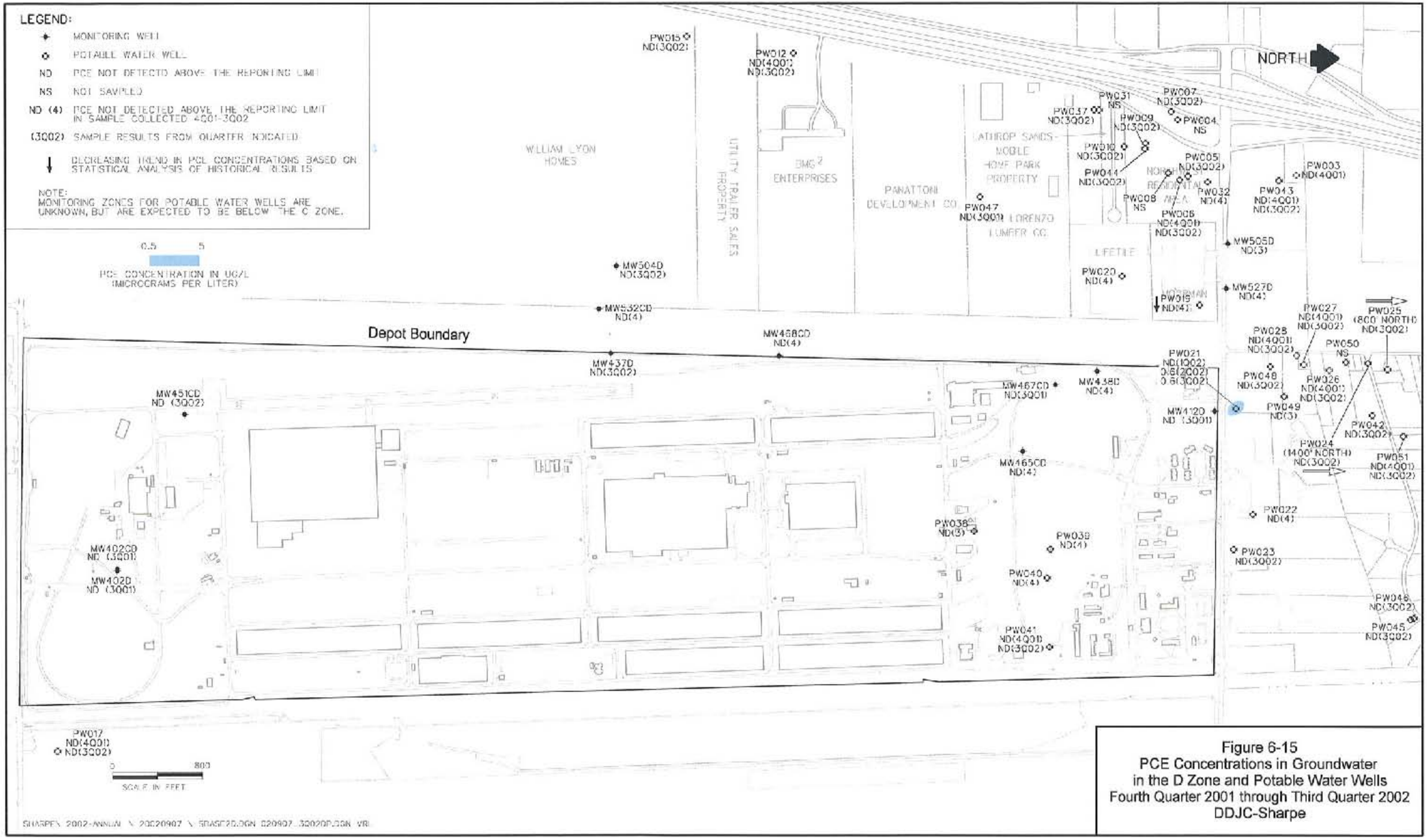


Figure 6-15
PCE Concentrations in Groundwater
in the D Zone and Potable Water Wells
Fourth Quarter 2001 through Third Quarter 2002
DDJC-Sharpe

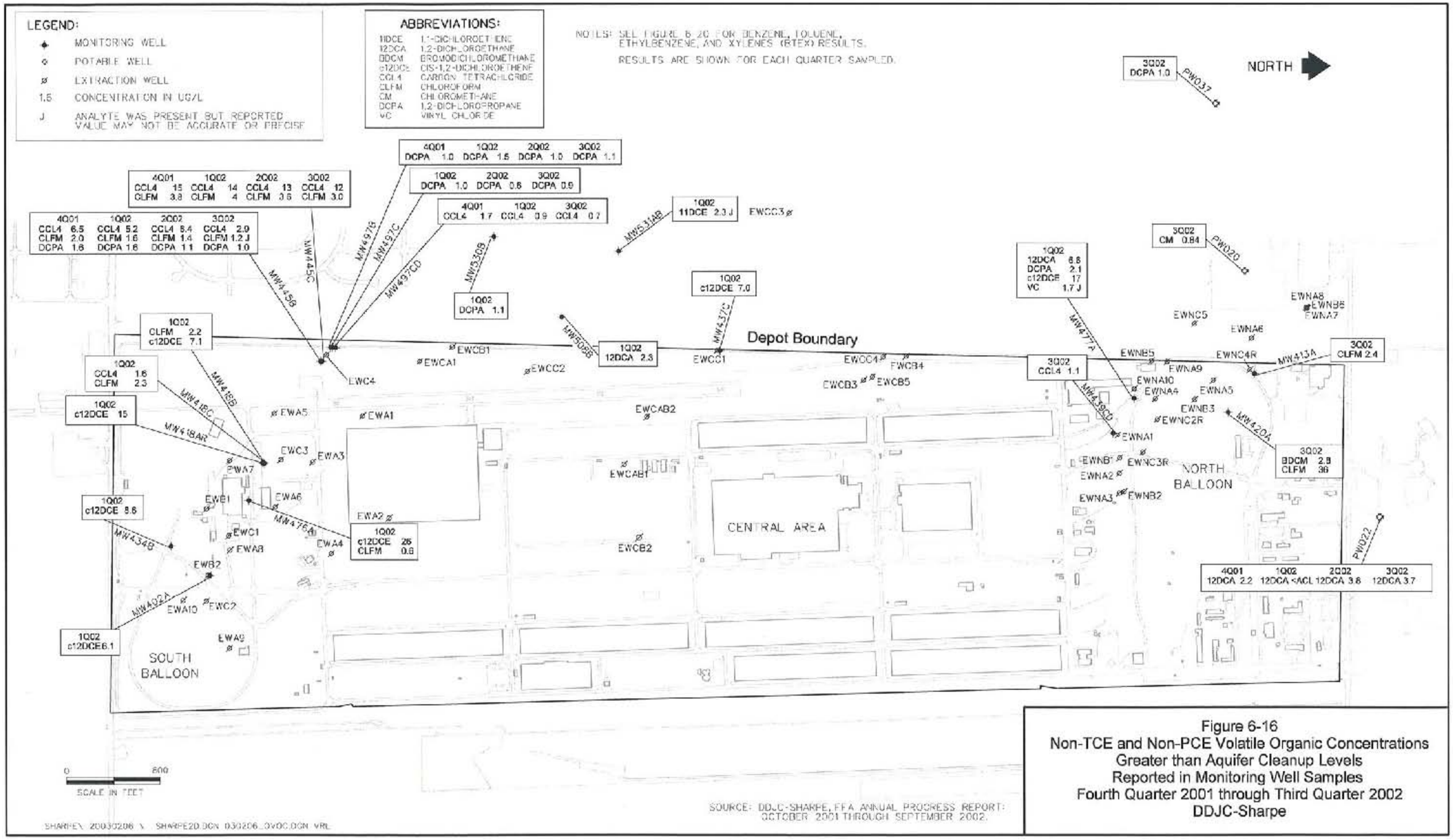
LEGEND:
- ◆ MONITORING WELL
- ◇ POTABLE WELL
- ⌀ EXTRACTION WELL
- 1.5 CONCENTRATION IN UG/L
- J ANALYTE WAS PRESENT BUT REPORTED VALUE MAY NOT BE ACCURATE OR PRECISE

ABBREVIATIONS:

11DCE	1,1-DICHLOROETHENE
12DCA	1,2-DICHLOROETHANE
BDCM	BROMODICHLOROMETHANE
c12DCE	CIS-1,2-DICHLOROETHENE
CCL4	CARBON TETRACHLORIDE
CLFM	CHLOROFORM
CM	CHLOROMETHANE
DCPA	1,2-DICHLOROPROPANE
VC	VINYL CHLORIDE

NOTES: SEE FIGURE 6-20 FOR BENZENE, TOLUENE, ETHYLBENZENE, AND XYLENES (BTEX) RESULTS.

RESULTS ARE SHOWN FOR EACH QUARTER SAMPLED.



SOURCE: DDJC-SHARPE, FFA ANNUAL PROGRESS REPORT: OCTOBER 2001 THROUGH SEPTEMBER 2002.

Figure 6-16
Non-TCE and Non-PCE Volatile Organic Concentrations
Greater than Aquifer Cleanup Levels
Reported in Monitoring Well Samples
Fourth Quarter 2001 through Third Quarter 2002
DDJC-Sharpe

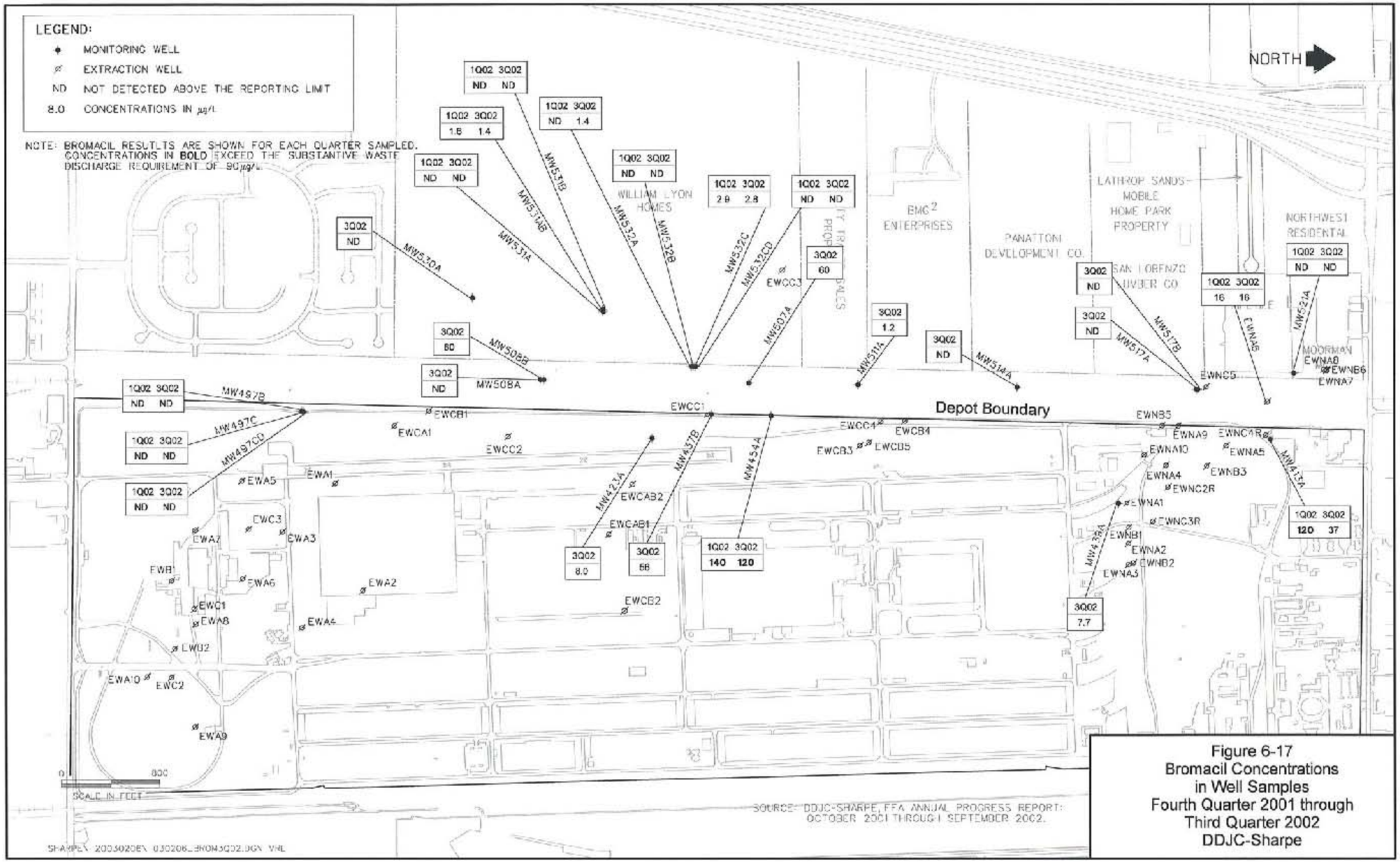


Figure 6-17
Bromacil Concentrations
in Well Samples
Fourth Quarter 2001 through
Third Quarter 2002
DDJC-Sharpe

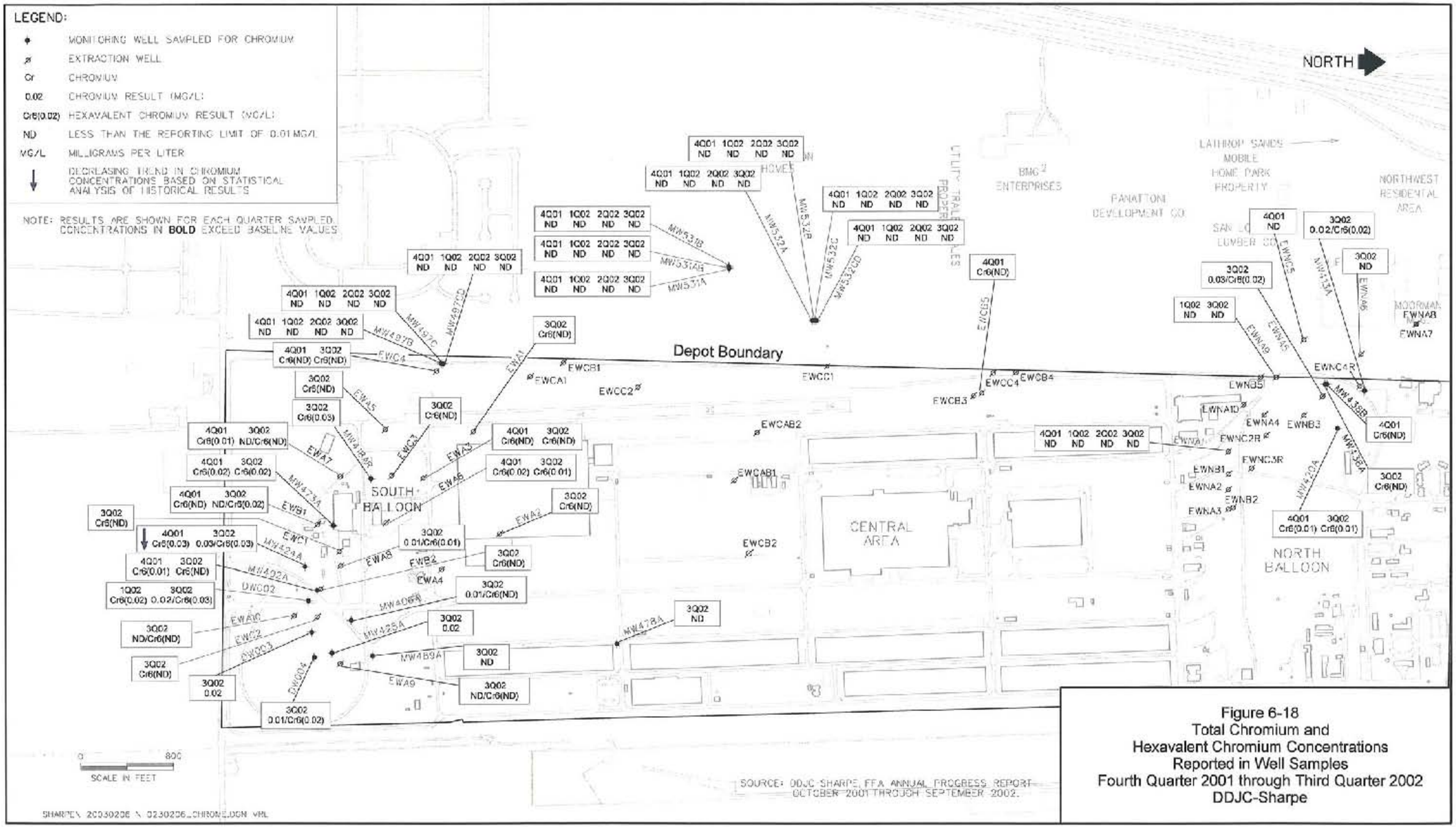


Figure 6-18
Total Chromium and
Hexavalent Chromium Concentrations
Reported in Well Samples
Fourth Quarter 2001 through Third Quarter 2002
DDJC-Sharpe

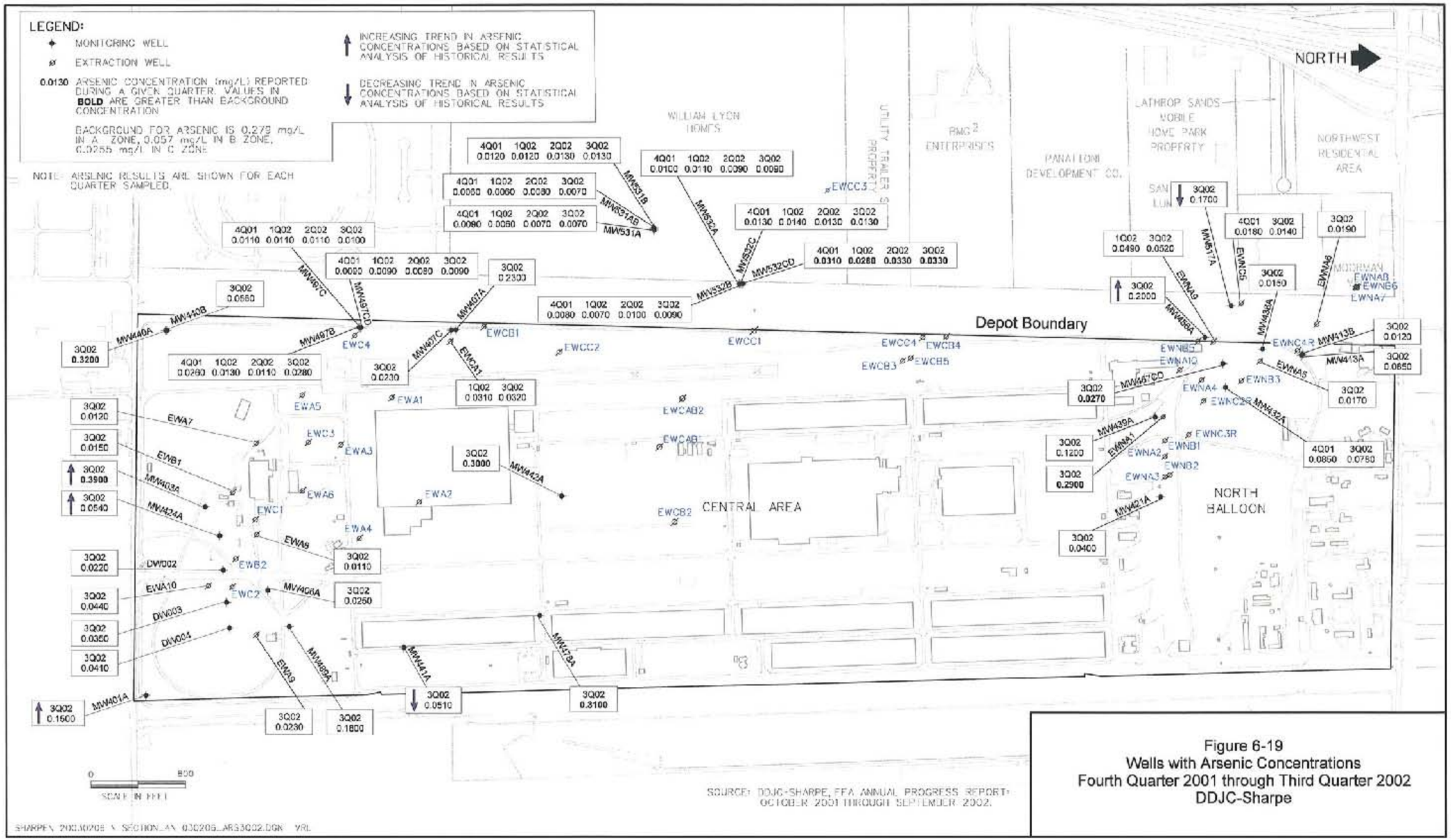


Figure 6-19
Wells with Arsenic Concentrations
Fourth Quarter 2001 through Third Quarter 2002
DDJC-Sharpe

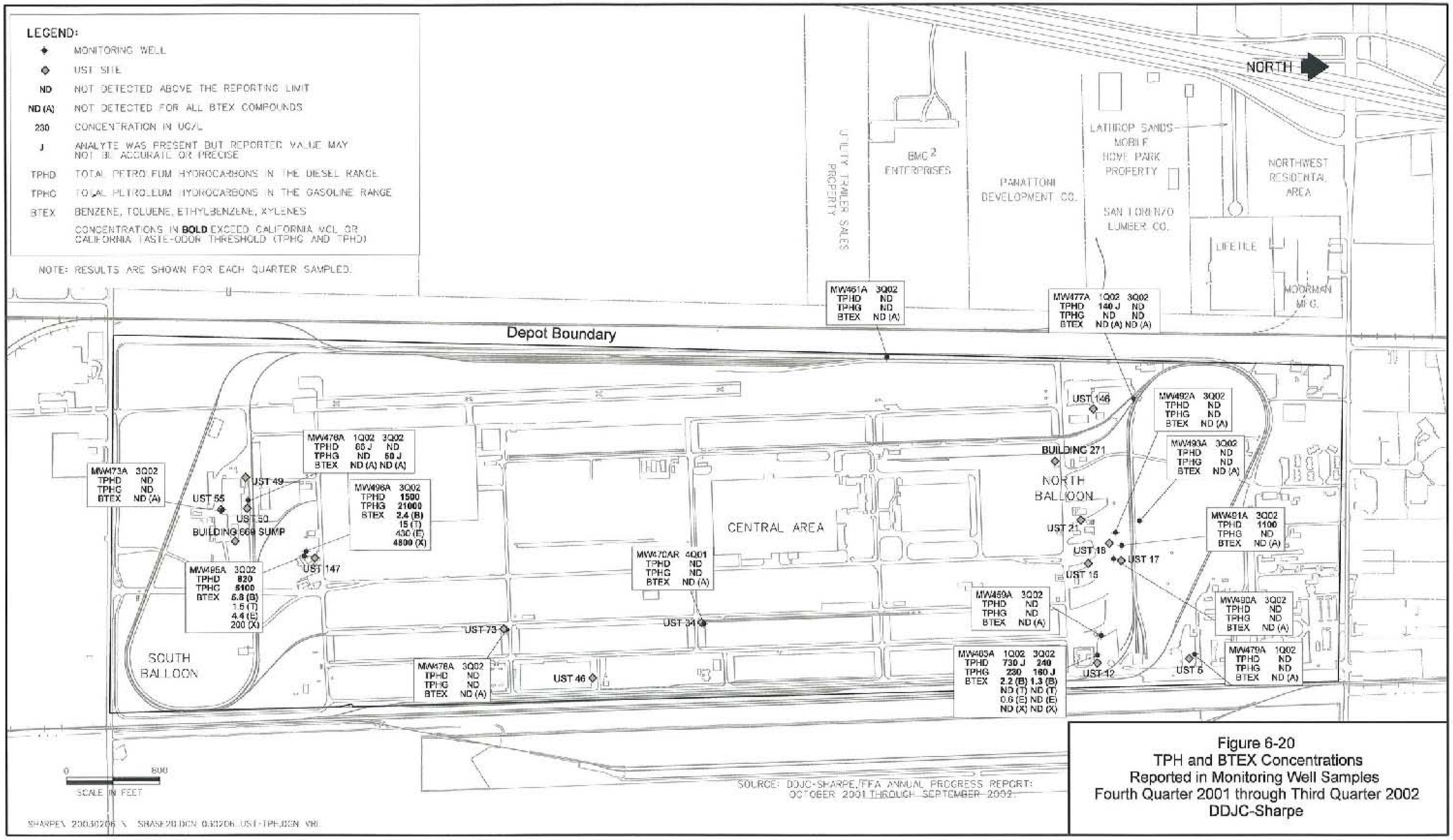


Figure 6-20
TPH and BTEX Concentrations
Reported in Monitoring Well Samples
Fourth Quarter 2001 through Third Quarter 2002
DDJC-Sharpe

7.0 TECHNICAL ASSESSMENT

7.0.1 The technical assessment for remedial and removal actions at DDJC-Sharpe consists of determining if those actions are continuing to be protective of human health and the environment. To reach the determination, U.S. EPA guidance recommends that the following three questions be addressed for each action (U.S. EPA, 2001):

- Question A— Is the remedy functioning as intended by the decision documents?
- Question B— Are the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of the remedy selection still valid?
- Question C— Has any other information come to light that could call into question the protectiveness of the remedy?

7.0.2 To respond to Question A, the operating conditions of the remedy are compared to criteria to evaluate performance of the remedies. To address Questions B and C, a review of any changes in assumptions or RAOs or new information is presented.

7.0.3 The following sections address the questions for the remedies implemented in OU 1 and OU 2.

7.1 Operable Unit 1 – Groundwater Remedy

7.1.0.1 The remedy for groundwater selected in the OU 1 ROD (ESE, 1993) consists of the following components:

- Extraction well field and associated piping to remove groundwater from the contaminated aquifer zones.
- Equalization tank designed to stabilize groundwater flow and VOC concentrations in the influent (applies to Central Area only).
- Air stripping systems consisting of counter-current packed towers designed to remove VOC contamination from groundwater. (This component also included treatment of air stripper off gases with carbon adsorption in the Central Area; however, the requirement for this treatment was alleviated by San Joaquin Air District policies in 1996.)
- Treated water discharge via surface water discharge, water reuse, and evaporation ponds with connector/ injection wells.

7.1.0.2 The goal of the groundwater remedial action stated in the OU 1 ROD is to restore groundwater to its beneficial use as a potential drinking water source; to meet that goal, groundwater extraction was expected to continue for 16 years after all components of the groundwater remedy were operating (ESE, 1993). The criteria for restoring the beneficial use are ACLs for VOCs; if the VOC concentrations are reduced below ACLs by remedial action, the beneficial use may be restored. The ACLs for groundwater are determined by potential cancer risks if the groundwater is used as drinking water (see Table 4-2).

7.1.0.3 In the OU 2 ROD for DDJC-Sharpe, additional mandatory evaluations were added for groundwater to address the potential for impacts to water quality from lead and chromium concentrations in soil (ESE, 1996). No specific remedial actions were identified; however, it was determined that,

> "If an Annual Statistical Analysis identifies a statistically significant impact to water quality above the conditions that exist at the time of the signature of this ROD, then DDJC-Sharpe, U.S. EPA, DTSC, and RWQCB will determine the need for any additional action (may include continued monitoring, groundwater data trend analysis, soil sampling, or additional remedial action) and modify this ROD, if necessary."

7.1.0.4 Although concentrations of total chromium in samples from several monitoring wells have exceeded the baseline concentrations that existed at the time the ROD was signed, no actions, other than continued monitoring have been decided upon. The OU 2 ROD has not been modified.

7.1.1 Operations

7.1.1.1 Performance Criteria. Neither the OU 1 nor the OU 2 ROD specifies performance criteria, with the exception of the goal of restoring groundwater to its beneficial use that was expected to take at least 16 years. The OU 1 ROD specifies the locations of 15 extraction wells in the Central Area to be added to the 16 in the North Balloon and the 15 in the South Balloon and an estimated total flow rate of 570 gpm from the wells to the Central Area treatment system; however, the design flow rate of each extraction well on DDJC-Sharpe was to be determined from simulation results of three-dimensional groundwater flow and transport modeling that had not been performed at the time the ROD was signed. The design flow rates from modeling for all wells are shown in Table 7-1 with actual flow rates for the extraction wells. However, these are not specific performance criteria. Furthermore, the Central Area equalization tank, the countercurrent, packed stripping towers, and treated water discharge to surface water, to percolation ponds, or to reuse are operations as mentioned in the ROD. Three wells identified in the ROD have been shut down because of poor performance or concentrations less than ACLs. However, four new wells (EWNB6, EWCB5, EWC4, and EWNC5) have been added to capture plumes that were not being captured. For this five- year review, the performance assessment of the OU 1 remedial action is based on the progress toward reduction of VOC concentrations to less than ACLs and capture of plumes that exceed ACLs.

7.1.1.2 Progress Toward ACLs. Concentrations of TCE, the most widespread VOC in groundwater, and PCE have decreased since 1998 when all ROD-identified extraction wells first operated; however, the total plume area exceeding the ACL has remained almost the same. Figures 7-1 and 7-2 are TCE and PCE plume maps, respectively, for the DDJC-Sharpe site. [2] The 3Q02 TCE and PCE plumes have been compared to the 3Q98, 3Q99, 3Q00, and 3Q01 plumes to evaluate changes in TCE and PCE concentrations and extent over the past five years.

7.1.1.3 Plume Illustration. The graphical plumes were generated using Earth Vision™ , a three-dimensional, geological modeling program. The results shown are for samples from wells screened at depths from the water table to 160 feet bgs. The Earth Vision™ model uses the highest TCE value within a volume (three-dimensional search) to interpret the plume configuration illustrated in Figures 7-1 and 7-2. A range of colors shows variations in TCE concentrations in groundwater across the installation (Figures 7-1 and 7-2). The colors represent the following ranges in TCE concentrations:

2 For continuity of text, all figures are provided at the end of the section.

- Light blue— TCE detected between the reporting limit of 0.5 µg/L and the ACL of 5.0;
- Dark blue— TCE detected between 5.1 µg/L and 25.0 µg/L;
- Green— TCE detected between 25.1 µg/L and 100;
- Yellow— TCE detected between 100.1 and 500 µg/L; and
- Orange— TCE detected between 500.1 and l, 000 µg/L.

7.1.1.4 TCE in the North Balloon. In the North Balloon, remedial actions have decreased concentrations in the plume and have contained most of the plume on the installation. Comparison of the TCE plumes from 3Q98 through 3Q02 in Figure 7-1 shows that the areal extent of the 2002 TCE plume exceeding the ACL of 5.0 µg/L was similar to the 2001 plume, but smaller than the plume in the 1998 through 2000 period. The areal extent of TCE concentrations greater than 25.0 µg/L (green area) increased in 2002 compared to 2001 and 2000; however, the 2002 extent was less than in 1998 and 1999. Increased TCE concentrations in wells MW456B and MW477A in 2002, compared with their respective 2001 concentrations, have contributed to the increased area of TCE above 25 µg/L and the return of an area of the plume exceeding 100 µg/L (yellow color). A yellow-colored plume area was last observed in 3Q00, when TCE was detected above 100 µg/L in monitoring wells in the North Balloon area. Also, the TCE concentration has increased in samples from well MW517B, off the installation to the west, from 2001 to 2002; the green area has been extended to include the MW517 cluster. Under statistical analysis, most wells have either no trend or have downward trends in concentration; however, MW517B, MW521B, and MW522C that are west of the installation boundary have significantly increasing concentrations of TCE (URS, 2003a). Although less than the ACL, concentrations exceeding the detection limit detected at MW522C and at PW06 are greater than 600 feet west of the installation boundary. The North Balloon area on the installation and the off-installation area west of the North Balloon are the only locations were TCE has been consistently detected in monitoring wells below the C Zone. Concentrations of TCE in samples from two wells (MW439CD and MW464CD) screened below the C Zone depth interval have significantly increasing trends. Increasing trends downgradient from extraction wells may indicate that the VOC plume has not been contained horizontally or vertically in the C Zone.

7.1.1.5 TCE in the South Balloon. Remedial actions in the South Balloon have reduced the highest concentration areas and have not allowed the plume to expand. Changes in the concentrations of TCE in groundwater in the South Balloon are evident on Figure 7-1. The disappearance of concentrations exceeding 500 µg/ L (orange and red areas) and the shrinkage of the plume areas exceeding 100 µg/L (yellow area) illustrates the effects of the remedial action. The highest TCE concentration reported in the South Balloon was 130 µg/ L. The areal extent of contamination greater than 100 µg/ L is smaller than in any year since 1998. The area of groundwater exceeding 25 µg/L was slightly larger in 2002 than in 2001, but not as great as it had previously been. The total areal extent of concentrations exceeding the ACL was slightly larger in 2002 than in 2001; however, there is no clear trend of expansion. Results of statistical analyses indicate that most wells in the South Balloon produce samples with no significant TCE trends or significant downward trend; the only wells with significant increasing trends are MW418C, MW445B, and MW445C. Extraction wells EWC3 and EWC4 are down-gradient from the locations of these increasing trends.

7.1.1.6 TCE in the Central Area. Remedial actions in the Central Area have caused a general decrease in concentrations; however, the total extent of the plume exceeding 5 µg/L may be increasing in extent. In Figure 7-1, the effects of the remedial action on concentrations are evident in the Central Area. Areas of concentrations exceeding 100 µg/L had been decreasing in number and size from 1998 through 2001. The large area of concentrations exceeding 25 µg/L in 3Q99, 3Q00, and 3Q01 has been drawn as four separate areas in 3Q02 and seems to be “breaking up.” However, because of the increase in TCE at one well (MW437C) from 300 µg/L in 3Q01 to 650 µg/L in 3Q02, the area of orange (500 µg/L to 1,000 µg/L) evident on the 2002 map had not been

Table 7-1. Extraction Well Operational Data, 2002, DDJC-Sharpe

Well Number	Monitoring Zone	Design Maximum Discharge (gpm)	Proposed[a] Discharge (gpm)	Estimated Flow Rates (gpm)[b]	Estimated Percent Uptime[c]
North Balloon					
EWNA1[d]	A	10	NM	1	NA
EWNA2	A	30	NM	19	NA
EWNA3[d]	A	20	NM	15	NA
EWNA4	A	30	NM	8	NA
EWNA5[c]	A	10	NM	NA	NA
EWNA6	A	10	NM	3	NA
EWNA8	A	10	NM	2	NA
EWNA9	A	40	NM	7	NA
EWNA10	A	40	NM	4	NA
EWNB1[d]	B	10	NM	3	NA
EWNB2	B	8	NM	10	NA
EWNB3[d]	B	10	NM	10	NA
EWNB5	B	40	NM	38	NA
EWNB6	B	19	NM	17	NA
EWNC2R	C	40	NM	48	NA
EWNC3R[d]	C	40	NM	18	NA
EWNC4R	C	40	NM	48	NA
EWNC5	C	65	NM	16[e]	NA
Central Area					
EWCAB1[d]	AB	41	NM	14	NA
EWCAB2	AB	30	NM	8	NA
EWCB2	B	30	NM	37	NA
EWCB3	B	24	NM	19	NA
EWCB4	B	25	NM	19	NA
EWCB5	B	30	NM	7[f]	NA
EWCC1	C	60	NM	37	NA
EWCC2	C	30	NM	14	NA
EWCC3	C	60	NM	3	NA
EWCC4	C	55	NM	31	NA
South Balloon					
EWA1	A	10	9	1	NA
EWA2	A	10	10	4	NA
EWA3	A	10	14	2	NA
EWA5	A	10	4	5	NA
EWA6	A	10	21	3	NA
EWA7	A	10	15	2	NA
EWA8	A	10	10	8	NA
EWA9[d]	A	10	16	9	NA
EWA10	A	10	10	11	NA
EWB1	B	20	28	9	NA
EWB2[d]	B	20	16	5	NA
EWC1[d]	C	20	24	4	NA
EWC2	C	20	32	26	NA
EWC3	C	20	30	26	NA
EWC4	C	35	NM	10	NA

Table 7-1. (Continued)

Well Number	Monitoring Zone	Design Maximum Discharge (gpm)	Proposed[a] Discharge (gpm)	Estimated Flow Rates (gpm)[b]	Estimated Percent Uptime[c]
South Balloon (cont'd)					
EWCA1	A	50	NM	10	NA
EWCB1	B	50	NM	10	NA

[a] Proposed discharge rate in 3-D model (Engineering Technologies Associates, Inc., 1992).
[b] Based on the average volume from the *Groundwater Treatment Plant Monthly Performance Monitoring Reports* reporting periods October 2001 through September 2002. Estimated flow rates are calculated using the following method: (sum of monthly average flow) gallons per day/12 months/1,440 minutes per day.
[c] Estimated percent uptime data were only available for the reporting periods of August 2002 and September 2002. Refer to the *Groundwater Treatment Plant Monthly Reports* for estimated percent uptime data for individual wells.
[d] Extraction well shut down on 9 July 2002 for 150 days.
[e] EWNC5 was brought on line in September 2002. Estimated flow rate is based on one month of data.
[f] EWCB5 was brought on line 20 May 2002. Estimated flow rate for EWCB5 is based on five months of available data.

DDJC = Defense Distribution Depot San Joaquin California
gpm = gallons per minute
NA = not available
NM = not modeled

seen since 1998. MW437B and MW437C have statistically significant increasing trends for TCE; they are within 50 feet of extraction well EWCC1. The increasing concentrations suggest that more concentrated portions of the plume are being hydraulically drawn toward the extraction well. The extent of the plume with a concentration less than 5 µg/L was drawn further north in 2002 than in previous years. In 3Q02, because of TCE concentrations reported in MW512C (1.6 µg/L) and MW514C (1.1 µg/L), the plume was extended further north to include those two wells. Although the general decrease in concentrations across the Central Area suggested by the breakup of the areas with concentrations exceeding 25 µg/L, the expansion to the west and north since 2000 of concentrations between 0.5 µg/L and 25 µg/L (light blue and dark blue on figures) may indicate continuing migration of the TCE plume. Results of statistical trend analyses indicate that most wells' sample results have no significant trend or have a significant downward trend in TCE concentration; however, MW417B, MW443B, MW437C, MW508B, and MW511C sample results show significant increasing trends. MW417B, MW437B, and MW443B are upgradient from or within capture zones of extraction wells; however, MW508C and MW511C may not be in capture zones.

7.1.1.7 PCE in the North Balloon. Remedial actions have been effective in reducing concentrations and limiting off- installation migration of PCE. In the North Balloon, comparison of the PCE plume from 3Q98 through 3Q02 indicates that the plume has changed shape and is smaller in areal extent (Figure 7-2). Concentrations of PCE in groundwater have generally decreased over the past five years. Concentrations of PCE at MW505B, which is the well farthest down-gradient with detectable PCE, increased between 3Q97 and 3Q99 but decreased from 3Q00 to 3Q02. Results from statistical analyses indicate the only wells with significantly increasing PCE trends are MW420A, MW420B, and MW521B. The PCE plume is within or upgradient from capture zones of extraction wells.

7.1.1.8 PCE in the South Balloon and Central Area. Remedial actions are containing the extent of PCE in the South Balloon. All but one of the detected concentrations of PCE in 2001 and 2002 came from samples collected at extraction wells. The estimated areal extent of PCE contamination in the South Balloon and Central Area has fluctuated since 1998 (Figure 7-2). The largest plume has been centered on MW445B, MW445C, and MW497C, near the installation boundary. The areal extent of this plume increased between 3Q98 and 3Q99, but decreased slightly between 2000 and 2002. EWC4, installed to capture VOCs in the area of MW497, began

operating in 2001. In 3Q01, plumes were identified at EWA1, EWA3, and EWA8 and are still present in 2002 with similar estimated areal extents. Results from statistical trend analyses indicate that samples from only one well, MW433B, in the South Balloon indicate an increasing trend in concentration. PCE plumes in the South Balloon are upgradient of operating extraction wells. A PCE plume is not present in the Central Area.

7.1.2 Plume Capture Analysis

7.1.2.1 Groundwater level data were used to estimate the areas of hydraulic influence of extraction wells. Figures 7-3, 7-5, and 7-7 show the 3Q02 estimated capture zones for TCE from extraction wells in the A, B, and C Zones, respectively, when 44 extraction wells (of a possible 45) were operating. After the water levels were measured for the 3Q02 quarterly measurement, 10 extraction wells (EWA9, EWB2, EWC1, EWCAB1, EWNA1, EWNA3, EWNA5, EWNB1, EWNB3, and EWNC3R) were shut down to reduce flows to the SSJIDC, which exceeded NPDES off-site discharge limits in May and June 2002, and to optimize the extraction and treatment systems (URS, 2002d). Water levels measured in wells in the 4Q02 quarterly measurement show the changes in water level contours resulting from the shutdown of the wells. The 1Q03 water level contours are shown in Figures 7-4, 7-6, and 7-8 for the A, B, and C Zones, respectively. Unfortunately, EWCC3, an important extraction well in the C Zone interval, was not operating on the days water levels were measured in 3Q02 because the pressure transducer was not operating correctly, which caused the pump in the well to shut down. The pump was not restarted until the problem was observed by the O&M contractor. The operation of the well was changed from automatic mode to manual mode to prevent the shutdown of the pump. The transducer was replaced on 18 October 2002, and the well was operating when 1Q03 water levels were measured. Therefore, water level contours did not indicate the presence of a capture zone in 3Q02.

7.1.2.2 Capture zones for extraction wells are estimated from the hydraulic gradients indicated by water elevation contours. The downgradient extent to which a single well or group of wells had hydraulic influence was estimated from potential flow lines on a contour map for one zone. An upgradient curvature in several contour lines was considered an indication that one well or a group of closely spaced wells screened within the same zone were creating a depression on the potentiometric surface. The surface depression causes the sketched flow lines to point toward an extraction well location. In the downgradient direction from every extraction well or group of wells, there is a series of points at which a groundwater molecule could travel to the extraction well or could be carried down-gradient and away from the extraction well(s). At those points, flow lines could point back toward the wells or away from the wells. Capture zone curves drawn on Figures 7-3 to 7-8 are the curves that represent the series of points where groundwater would be drawn back into the extraction well depression. All capture zone curves are dashed because they are estimated. The extents of the contaminant plumes that are intended to be captured are shown as solid- line isopleths with 3Q02 TCE concentrations greater than 5 µg/L on each capture zone map.

7.1.2.3 A Zone Contaminant Capture. In the North Balloon during 3Q02, the A Zone extraction wells fully captured the TCE plume (Figure 7-3). Full capture of the TCE plume in the North Balloon was also obtained during 1Q03 even though three extraction wells were shut down (Figure 7-4). In the North Balloon, approximately 100% of the PCE plume was captured in both quarters. In the Central Area, the A Zone extraction wells were capturing approximately 54% of the Central Area TCE plume in 3Q02 and approximately 56% in 1Q03 when one well was shut down. Incomplete capture of the Central Area plume is attributed to the absence of an extraction well downgradient from EWCAB2. However, VOCs in the A Zone may now migrate north toward the North Balloon extraction wells because the mound created by the Central Area percolation ponds has not been observed since December 2001. There were no A Zone PCE plumes identified in the Central Area. In the South Balloon during 3Q02, the A Zone extraction wells fully captured the TCE plume. The South

Balloon extraction wells in the A Zone captured all of the TCE plume during 1Q03 although one well had been shut down. The four small PCE plumes in the South Balloon, identified by PCE in extraction wells EWA1, EWA3, EWA6, and EWA8, were 100% captured in both 3Q02 and 1Q03. The percentage of a plume that is within a capture zone and considered captured by a well or group of wells has been estimated by calculating the percentage of the total area of a plume that is upgradient of a capture zone on a map figure. For the plume capture percentage estimates, it was assumed that the capture zone extended through the entire thickness of the contaminated groundwater in the zone for which the estimate was made.

7.1.2.4 B Zone Contaminant Capture. In the North Balloon during 3Q02, the B Zone extraction wells fully captured the TCE plume (Figure 7-5). Approximately 100% of the North Balloon TCE plume was also being captured during 1Q03 when two B Zone wells were shut down. PCE plumes identified in the North Balloon B Zone were also 100% captured in 3Q02 and 1Q03. In the Central Area, the extraction wells captured 71% of the TCE plume in 3Q02; however, the entire plume was being captured in 1Q03 (Figure 7-6). In the South Balloon during 3Q02 and 1Q03, a large portion of the TCE plume was not captured. However, the uncaptured portion of the TCE plume was migrating toward operating extraction wells in the Central Area. The PCE plumes identified in the South Balloon were 100% captured in both 3Q02 and 1Q03.

7.1.2.5 C Zone Contaminant Capture. Approximately 90% of the C Zone TCE plume in the North Balloon was being captured during 3Q02 (Figure 7-7). The entire plume seemed to be in capture zones in 1Q03, even though one extraction well had been shut down (Figure 7-8). PCE in the C Zone of the North Balloon was fully captured in 3Q02 and 1Q03. In the Central Area, approximately 85% of the TCE plume was being captured during 3Q02 and approximately 95% was being captured in 1Q03. EWCC3 was not operating when water levels were measured in 3Q02, but it was operating in 1Q03. The South Balloon extraction wells captured approximately 94% of the C Zone TCE plume during 3Q02; approximately 85% of the TCE plume was being captured in 1Q03. The decrease in estimated capture is attributable to the temporary non- operation of EWC4. The PCE plume in the South Balloon was 100% captured. PCE plumes were not identified in the C Zone of the Central Area.

7.1.2.6 Groundwater Model Application. A groundwater flow model has been developed for DDJC-Sharpe by personnel of U.S. Army Engineer Research and Development Center of WES. In 2002, the model was modified to allow for simulation of contaminant transport with time; details of the model and simulation results are provided in Attachment 7. The purposes of the model are to:

- Help manage the remediation activities at DDJC- Sharpe.
- Develop a “living” model that can address a range of hydrologic needs, for example:
  - Siting of new municipal water wells;
  - Placement of stormwater detention ponds; and
  - Testing of the effectiveness of pump-and-treat systems.
- Forecast plume migration and capture.

7.1.2.7 The model was used to simulate the migration of TCE for 10-year periods beginning with the "initial condition" concentrations from sampling in 3Q02 (see Figure 7-1). Two hydraulic conditions were defined for simulation: one simulated the operation of 45 extraction wells, pumping at "typical rates" for the year prior to June 2002 and the second with only 35 extraction wells, pumping at typical rates. Simulations of 10, 20, and 30 years of extraction and migration under the two conditions were performed to determine if the permanent shutdown of the 10 wells would diminish the capture of the TCE plumes or lengthen the time necessary to clean up groundwater.

7.1.2.8 Model Results. Simulations of TCE transport over 10-year, 20-year, and 30-year intervals indicated that for most areas and depth intervals at DDJC-Sharpe, the shutdown of 10 extraction wells will not decrease capture of VOC plumes and will not lengthen the time to clean up TCE. None of the 10 wells that were shut down in July 2002 were at the leading edges of VOC plumes; therefore, their shutdown was unlikely to decrease plume capture. In most areas of the North Balloon, Central Area, and South Balloon upgradient from the leading edges, the model results predict that the shutdown of the 10 wells will not lengthen the time of operation except in the eastern Central Area at EWCAB1 and in the eastern South Balloon where only a B zone well, EWB2, was shut down. However, the model results indicate that the TCE plume in the C Zone is not being captured whether the 10 wells are operating or shut down.

7.1.2.9 A Zone Prediction. The model indicates that if EWCAB1 were not returned to operation and no extraction occurred in the A and B Zones in the eastern part of the Central Area, extraction for approximately 20 years longer (year 10 to year 30 of the simulation) would be required. The differing conditions of the TCE plume in the A Zone after 30 years of simulated operation are contrasted in Figures 7-9a and 7-9b. In Figure 7-9b, a plume of TCE exceeding 5 µg/L exists in the eastern Central Area an additional 20+ years after the plume is predicted to disappear in the simulation with 45 wells operating, as shown in Figure 7-9a. The difference between the two model simulations is the operation versus the non-operation of EWCAB1. TCE plumes in other DDJC-Sharpe plume areas would shrink or persist over the present- to- 30- year time period whether 45 extraction wells or 35 extraction wells were operating.

7.1.2.10 B Zone Prediction. A plume in the eastern Central Area, albeit in the B Zone, is also predicted to remain for an additional 20 years (year 10 to year 30 in the simulation) because EWCAB1 is shut down in the 35- extraction well simulation (Figures 7-10a and 7-10b). EWCAB1 has screens in both A and B Zones and is given equal hydraulic influence for both zones in the model. Model results for the time intervals present-to-10-years and 10-years-to-20 years indicate a small TCE plume in the B Zone within the easternmost part of the South Balloon would require 10 more years of extraction if EWB2, the only B Zone well shut down in the South Balloon, is not returned to operation. TCE plumes in other DDJC-Sharpe plume areas would shrink or persist over the present-to-30-year time period whether 45 extraction wells or 35 extraction wells were operating. Figures illustrating the simulations for all time intervals and all zones are provided in Attachment 7.

7.1.2.11 C Zone Prediction. In the simulation of plume behavior of the C Zone, there is no evidence that the shutdown of two C Zone extraction wells (EWC1 and EWNC3R) will decrease the capture of plumes or increase the time to clean up groundwater (Figures 7-11a and 7-11b showing 20-year results). However, the model simulations suggest that the TCE plume at the DDJC- Sharpe boundary is not being captured and will continue to migrate to the northwest (Figures 7-12a and 7-12b showing 30-year results).

7.1.2.12 Baseline Metals. A two-part approach to evaluating metals concentrations in ground-water was established in the OU 2 ROD signed in 1996. The first part is to determine if concentrations of lead, chromium, and other metals in groundwater have increased to levels exceeding background or MCLs. The second part is to

monitor concentrations of metals relative to those that existed at the time the OU 2 ROD was signed (i.e., baseline conditions) and determine if changes are statistically significant (ESE, 1996). The following section identifies the baseline metals and provides results of the baseline study performed to identify significant trends.

7.1.2.13 Potential Lead Contamination. In accordance with the OU 2 ROD, baseline metals concentrations were established as the concentration for each well at the time the ROD was signed in 1Q96. For wells not sampled in 1Q96, baseline concentrations are those measured in the next quarter that a sample was collected. Because lead was not reported in any groundwater samples collected in 1998 or 1999 and only eight results were reported in monitoring well samples collected in 1996 and 1997, potential contamination of groundwater by lead from soil is considered improbable. Lead at a concentration of 0.00322 mg/L was reported in only the 4Q99 sample collected from EWNA1 and in no samples following that one. Lead was not reported in the only sample collected for lead analysis during the 2001 sampling event. Therefore, no samples for lead were collected in 2002. Lead is not considered a contaminant of concern in groundwater.

7.1.2.14 Potential Chromium Contamination. For total chromium analyses performed in 2002, sample results from 2 of 24 monitoring wells sampled were greater than or equal to baseline concentrations in at least one sample (see Figure 7-12). For most of the wells sampled in both the 2001 and 2002 sampling events, concentrations of total chromium were lower in 2001. In the North Balloon, the total chromium concentration from only one well sample (MW413A— 0.02 mg/L) exceeded its baseline value in 2002. In the South Balloon, the sample collected in 3Q02 from one well (DW002— 0.020 mg/L) had a total chromium concentration greater than its baseline. One well (MW424A) in the South Balloon produced samples that had detectable levels of hexavalent chromium and total chromium (less than baseline); this well has a significant decreasing trend for total chromium. No wells sampled for total chromium in the Central Area had concentrations exceeding baseline. Monitoring continues because results for total chromium do not suggest the presence of a plume of chromium contamination or a threat to receptors. The potential for the presence of hexavalent chromium in a "total chromium" analysis has caused the California Department of Health Services (DHS) to consider a public health goal (PHG) of 0.0025 mg/L for total chromium.

7.1.2.15 Hexavalent Chromium. No cleanup level for hexavalent chromium has been established for DDJC-Sharpe. During the 2002 monitoring period, hexavalent chromium was reported in 17 of the 37 samples collected at concentrations ranging from 0.01 mg/L to 0.03 mg/L. During the 2001 monitoring period, hexavalent chromium concentrations ranged from 0.01 to 0.05 mg/L.

7.1.3 Protectiveness

7.1.3.1 The groundwater remedy described in the OU 1 ROD was considered protective because:

- Groundwater having VOC concentrations exceeding the ACLs (see Table 4-2) would not reach receptors through drinking water wells;

- The air stripping systems installed and operating in the North Balloon, South Balloon, and the Central Area would remove VOC contamination from groundwater prior to discharge of the water to a surface water body (SSJIDC) or to the subsurface by injection or percolation;

- Gases released from the air stripper were to be treated with carbon adsorption in the Central Area to prevent migration of VOCs to receptors through the atmosphere (however, the requirement for this treatment was alleviated by San Joaquin County Air District policies in 1996); and

- Chromium and lead concentrations exceeding baseline levels would not reach receptors because a remedial action would be considered if concentrations in groundwater were significantly greater than baseline values.

7.1.3.2 Assumptions at the time of this five-year review regarding exposure and remedial action objectives are the same as when the ROD was signed. The presence of hexavalent chromium in samples with total chromium has raised health concerns because hexavalent chromium is a suspected human carcinogen by oral ingestion. The remedy for groundwater has remained at the same level of protectiveness of human health and the environment it held at the time the OU 1 ROD was signed. The only exceptions to maintenance of the level of protectiveness are temporary exceedances of levels established in the NPDES permit for groundwater discharge from DDJC-Sharpe (for example, see URS, 2003a). However, the incomplete capture of VOC plumes by the Central Area extraction system raises concerns that protectiveness may not be maintained by the OU 1 groundwater remedy.

7.1.4 New Protectiveness Concerns

New protectiveness concerns regarding the OU 1 remedy are:

- Potential increased health risks to groundwater users downgradient from DDJC-Sharpe plumes in the C Zone because the VOC plume is not fully captured at the installation boundary;

- Potential increased health risks to groundwater users downgradient or surface water beneficial uses because of concentrations of hexavalent chromium exceeding the PHG by a factor of 100;

- Potential increased health risks to surface water beneficial uses because of arsenic concentrations exceeding the revised primary drinking water MCL of 0.010 mg/L in the effluent from groundwater treatment plants.

7.2 Operable Unit 2 – Soil Remedy

The OU 2 ROD specifies the remedies for contaminated soils at DDJC- Sharpe. The selected remedies for OU 2 are SVE for VOC-contaminated soils and excavation and off-site disposal for soils contaminated with lead and chromium. OU 2 remedial actions are complete at DDJC- Sharpe. Further description of the OU 2 remedies and information supporting the performance of the OU 2 remedial actions are provided in the following paragraphs.

7.2.1 OU 2 Soil Remedial Actions (VOCs)

7.2.1.1 SVE treatment systems were constructed in accordance with the requirements of the selected remedy, as documented in the OU 2 ROD, and have been confirmed to be effective. Concentrations of VOCs in soil gas are less than detection limits or have reached levels that will not significantly impact groundwater. Modeling of the remaining mass at specific circuits with reportable concentrations indicates that the impact to groundwater will be below the ACL (URS, 2002b). Modeling assumptions, methods, and results were reviewed by regulatory agencies in prior documents (Radian International, 1997a). Based on all known criteria, the remedial action is considered complete.

7.2.1.2 The OU 2 ROD specifies 0.35 ppmv as the cleanup standard for TCE contamination in soil gas. This value was first suggested in the *Remedial Investigation/Feasibility Study at DDRW-Sharpe Site: Soils*

Feasibility Study Report (ESE, 1994b). The ROD requires the remedial action to continue until asymptotic VOC concentrations were reached. Asymptotic VOC concentrations were reached for all SVE sites in approximately 42 months of operation. The ROD also requires monitoring of the mass extracted from the site and modeling to deter-mine possible impacts to groundwater. Results of 2000, 2001, and 2002 confirmation sampling and modeling indicated no further impacts to groundwater (URS, 2002b).

7.2.1.3 The mass of TCE extracted was monitored during weekly compliance monitoring of the SVE system. Weekly monitoring of the SVE system and sampling of soil gas in extraction and monitoring wells and of soil during closure/confirmation sampling activities were performed according to the guidelines of the *DDJC-Sharpe/Tracy Comprehensive Field Work Plan* (URS, 2001h) and the *Soil Vapor Extraction Implementation Work Plan* (Radian International, 1998). Results met quality assurance project plan (QAPP) criteria.

7.2.1.4 The results of the SVE monitoring program were provided in quarterly monitoring reports and the FFA Annual Progress Reports. The U.S. EPA, DTSC, and Central Valley RWQCB reviewed the FFA Annual Progress Reports.

7.2.1.5 The closure/confirmation sampling conducted after Phase 4 in January 2002 showed that the lateral and vertical extent of TCE contamination in the soil gas has been greatly reduced and that the TCE concentrations in most areas meet the cleanup standard of 0.35 ppmv for TCE. Modeling results showed that the residual mass of TCE in the vadose zone would not cause leachate to raise groundwater concentrations above drinking water standards. Based on these results, the *Operable Unit 2 Soil Vapor Extraction Remedial Action Report, DDJC-Sharpe* (URS, 2002b) recommended discontinuation of SVE system operation.

7.2.1.6 Recommendations for discontinuing SVE operations were reviewed and approved by the U.S. EPA, DTSC, and the Central Valley RWQCB during the summer of 2002. The DDJC-Sharpe SVE systems were decommissioned during November and December 2002 according to the procedures defined in the *DDJC-Sharpe Soil Vapor Extraction System Decommissioning Work Plan* (URS, 2002h).

7.2.1.7 Several other areas of the depot that were found to have soil contaminated with VOCs were recommended for NFA. The affected areas, and the supporting data and reasons for these recommendations, are provided in the *Operable Unit 2 No Further Action Remedial Action Report* (Radian International, 2000b). All field sampling activities in support of the NFA recommendation were performed in accordance with the *DDJC-Sharpe/Tracy Comprehensive Field Work Plan* (URS, 2001h). All sampling results were assessed and validated according to the QAPP guidelines. The recommendations for the NFA sites have been approved by the overseeing regulatory agencies (U.S. EPA, DTSC, and Central Valley RWQCB).

7.2.1.8 New Protectiveness Concerns for VOCs in Soil. The cleanup standard for soil gas was 0.350 ppmv of TCE, which was based on maintaining groundwater at concentrations less than ACLs if VOCs migrated to groundwater. Other potential routes of exposure to VOCs were not important because the VOCs were below ground surface and no structures were built over soils contaminated with VOCs. However, awareness of the potential for health risks from inhalation of VOCs and changes in inhalation slope factors have heightened concerns about risks to occupants of buildings constructed atop contaminated soil and groundwater. A comparison of the VOC cleanup goals in the ROD with 2002 PRGs suggests that 8 of the 14 VOCs with risk-based cleanup levels, including TCE, are considered more toxic today than in 1993, two are less toxic, and four are about as toxic as they were in 1993. In 1993, the inhalation cancer slope factor for TCE was 1.7E-02 per mg/ kg-day. U.S. EPA is currently evaluating a pro-posed cancer slope factor of 0.4 per mg/kg-day, which

indicates that the cancer-producing potency of TCE may be 23 times greater than formerly estimated. To date, neither U.S. EPA nor Cal/EPA has officially adopted the new slope factor. The pathways of exposure through which VOCs may cause risks are inhalation of VOC vapors rising from the aquifer and VOC vapors rising from volumes of soil/soil gas into occupied buildings. Vapors entering the air outside buildings generally do not present a risk because they are rapidly diluted by air movement. However, because air circulation and exchange in buildings is much less than outdoors, air vapors entering buildings through the floor can build to levels high enough to present a significant risk.

7.2.1.9 In addition to migration to the upper groundwater surface, VOC vapor in porous soil, such as loam, may migrate vertically towards the surface. Therefore, buildings located above contaminated groundwater plumes are more likely to be affected than those located elsewhere. The Johnson and Ettinger model (1991), as adapted by the U.S. EPA for risk estimation of indoor air contaminants originating in soil or groundwater, was applied in the screening mode, which has conservative health-protective assumptions. Detectable VOC concentrations, principally TCE, that were left in the soil gas after several phases of SVE ranged from 0.35 ppmv to 4.2 ppmv. The potential lifetime incremental cancer risk posed by TCE in indoor air to a hypothetical, on-site resident was estimated and ranged from 3.1E-08 to 3.7E-07 using the toxicity value previously accepted by U.S. EPA and from 9.3E-06 to 1.1E-03 using the increased toxicity value currently being evaluated by U.S. EPA. If the higher toxicity value for inhalation risk is approved, the calculations indicate the potential that concentrations of VOCs remaining in soil gas could also create an incremental cancer risk to occupants of a building built in an area where soil gas contamination had been present; however, no occupied structures are located over those areas at DDJC-Sharpe.

7.2.2 OU 2 Soil Remedial Action (Metals)

7.2.2.1 The OU 2 ROD cleanup standards for Sites S-3 and S-26 were achieved as a result of the remedial actions performed, including sampling, waste profiling, excavation, transportation, disposal, and backfilling of soil areas contaminated with lead and chromium.

7.2.2.2 Federal agency involvement in this project included participation in a series of remedial project management meetings. The U.S. EPA Region 9, DTSC, and Central Valley RWQCB also were involved in reviewing and commenting on the construction design.

7.2.2.3 The ROD specifies that DI-WET testing be performed on soils that remain in place in the excavation areas to evaluate the remaining concentrations of soluble metals. These tasks were specified in the ROD to evaluate the impact or threat of impact to groundwater from residual lead and chromium in the vadose zone. Analyses of DI- WET extracts were performed on post- excavation samples collected at Sites S-3 and S-26. The results for soluble lead and chromium were below detection limits; therefore, an attenuation or follow-up study was not required.

7.2.2.4 All of the samples collected for the excavation field effort were assessed and validated according to the guidance set forth in the DDRW *Comprehensive Field Work Plan, Volume 2 of 2 – Quality Assurance Project Plan* (Radian Corporation, 1996b). Over half of the soil samples were leached using DI-WET; a subset of samples was leached using the toxicity characteristic leachate procedure (TCLP) and analyzed for lead and chromium by Method SW6010A. Quality assurance (QA) split samples were collected and analyzed for lead and chromium using Method SW6010; the sampling was evaluated by the U.S. Army Corps of Engineers, HTRW Support Laboratory, Missouri River Laboratory, Omaha.

7.2.2.5 Actions taken as part of the excavation effort at Sites S-3 and S-26 are documented in the DDJC-Sharpe Site Operable Unit 2 Metals Remedial Action Report, Sites S-3 and S-26 (Radian International, 2000a). Although there is minimal risk from lead concentrations in soil beneath the railroad ballast at Site S-26, the concentrations would exceed risk-based cleanup levels if the railroad ballast were removed and the site adapted for non- industrial uses. Therefore, controls will be put in place by DDJC to assure that only industrial land use could occur in the area of contaminated soil.

7.2.2.6 Several other areas of the depot that were found to have soil contaminated with metals were recommended for NFA. The affected areas, and the supporting data and reasons for these recommendations, are provided in the *Operable Unit 2 No Further Action Remedial Action Report* (Radian International, 2000b). All field sampling activities in support of the NFA recommendation were performed in accordance with the *DDJC-Sharpe/Tracy Comprehensive Field Work Plan* (URS, 2001h). All sampling results were assessed and validated according to the QAPP guidelines. The recommendations for the NFA sites have been approved by the overseeing regulatory agencies (U.S. EPA, DTSC, and Central Valley RWQCB).

7.2.2.7 A final site inspection was conducted by DDJC on 9 July 1998. Minor cleanup at the site was completed, and no other deficient items were noted at the site. The OU 2 ROD-specified remedial activities at Sites S-3 and S-26 have been completed, and each site has been closed with regulatory acceptance of the final OU 2 Metals RAR.

7.2.3 OU 2 Soil Remedial Action (Pesticides)

7.2.3.1 A removal action was taken in 1995, before the OU 2 ROD was signed, for pesticide-contaminated soils in the Pesticide Mix Area because of the risk to workers posed by the concentrations in the soil. The removal action and excavation and disposal plans are documented in the removal action memorandum that was signed in October 1994 (ESE, 1994a). The soil volume excavated in December 1994 was 480 cubic yards; of this amount, 378 cubic yards were disposed of at a Class II landfill, and 102 cubic yards were disposed of at a Class I landfill. Confirmation sampling was performed in December 1994 and February 1995. Additional soil volumes (4 cubic yards in April 1995 and 19 cubic yards in October 1996) were excavated and disposed of at a Class II landfill to remove small pockets of contaminated soils identified in confirmatory sampling. The excavation areas were backfilled with clean aggregate base material and were compacted (CKY, Inc., 1995, 1996).

7.2.3.2 New Protectiveness Concerns for Pesticides in Soil. For this report, changes in PRGs from 1991 to 2002 were reviewed to assure the level of protectiveness in the Pesticide Mix Area had not diminished. The toxicity criteria for dieldrin, DDD, DDE, and DDT have not changed since the ROD was published, and the 2002 PRGs are very similar to the removal-action-specified cleanup levels. Although the cancer slope factor for chlordane has increased from 1.3 to 3.5 per mg/kg-day, and the standard soil ingestion rate for industrial workers has doubled, the current PRG for chlordane is 60% higher (1.6 mg/kg) than the removal-action-specified cleanup level (1.0 mg/kg). The removal-action-specified cleanup levels for the four pesticides will remain protective whether the pesticide-contaminated area of DDJC-Sharpe remains industrial or is redeveloped for residential use. The residual concentrations of pesticides in soils at the Pesticide Mix Area do not exceed current PRGs.

7.2.4 Institutional Control Sites

7.2.4.1 Implementation of institutional controls at the DDJC-Sharpe South Balloon began in June 2002 with the submission of the *Addendum to the Installation Master Plan* (URS, 2002e). Institutional controls have been implemented in the form of LUCs restricting the land use in the area to industrial activities that do not disturb subsurface soil. DDJC-FA staff is responsible for implementing institutional controls at the DDJC-Sharpe South Balloon.

7.2.4.2 The first annual inspection of the institutional control sites will be performed by the DDJC-FA Environmental Program Manager in 2003. DDJC-FA staff will perform the inspection using the annual inspection form and procedures identified in the *Addendum to the Installation Master Plan* (URS, 2002e). A report summarizing the annual inspection will be provided to the signatories of the FFA. Results from annual inspection reports will be used in the institutional controls evaluations of subsequent five-year reviews.

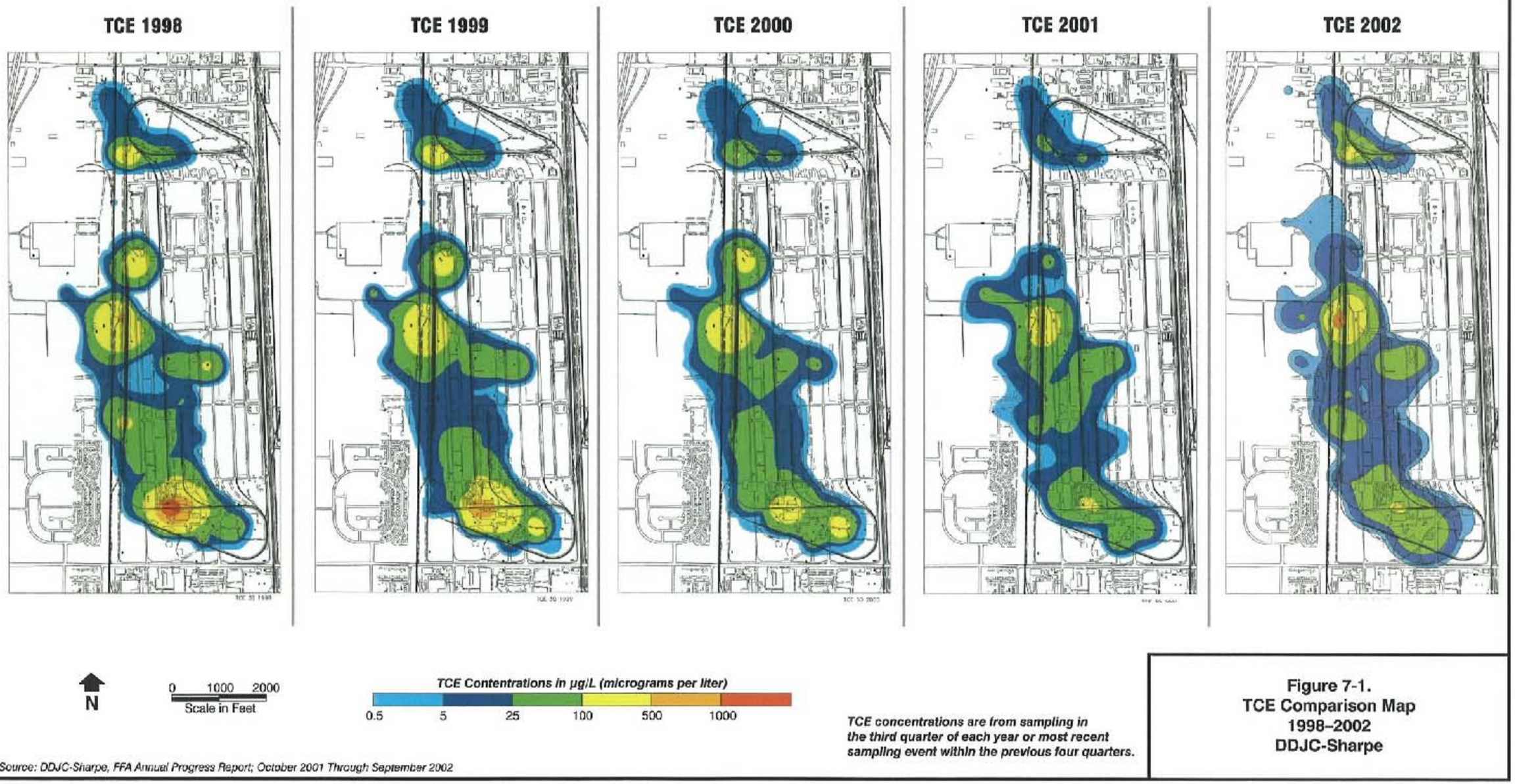
7.2.4.3 Many of the responsibilities for institutional controls relate to change in land use. For example, an upcoming land disposal discharge of groundwater evaluation in the area near Sites P-1D, S-37, and S-38 will require an active implementation of the institutional control requirements. Procedures outlined in the *Addendum to the Installation Master Plan* will be followed prior to the commencement of the treated groundwater land disposal discharge evaluation.

7.2.4.4 Institutional controls implemented as LUCs at the South Balloon are operating as intended. Initial responsibilities of the DDJC Environmental Management Chief, Environ-mental Program Manager, and DDJC Facility Engineer are being carried out according to the *Addendum to the Installation Master Plan* (URS, 2002e). The institutional control area is maintained as an industrial land use area. No construction activities have occurred to change the land use classification of the institutional control area. Uncontrolled exposure to subsurface soil has not occurred since the initiation of LUCs at the South Balloon.

7.2.4.5 Results of groundwater samples collected in the institutional control area show isolated levels of chromium above baseline levels. However, contaminant levels above the baseline are not consistent and a chromium plume cannot be identified. There is no indication that residual contamination in the soil is affecting the groundwater and no further remedial action is warranted. The institutional controls in the South Balloon area appear to be adequately protecting human health and the environment.

7.2.5 Validity of Remedial Action Objectives

Remedial action objectives identified in the OU 2 ROD for the DDJC-Sharpe site are still considered valid. The remedial actions have not been altered in any documents submitted since the ROD was signed in 1996. Remedial actions for VOCs, metals, and pesticides have been completed and the sites are closed. Remedial action objectives for the institutional controls area are also considered valid. There is no evidence through groundwater monitoring that groundwater contamination is increasing from soil contamination in the institutional controls area.



TCE concentrations are from sampling in the third quarter of each year or most recent sampling event within the previous four quarters.

Source: DDJC-Sharpe, FFA Annual Progress Report; October 2001 Through September 2002

Figure 7-1.
TCE Comparison Map
1998–2002
DDJC-Sharpe

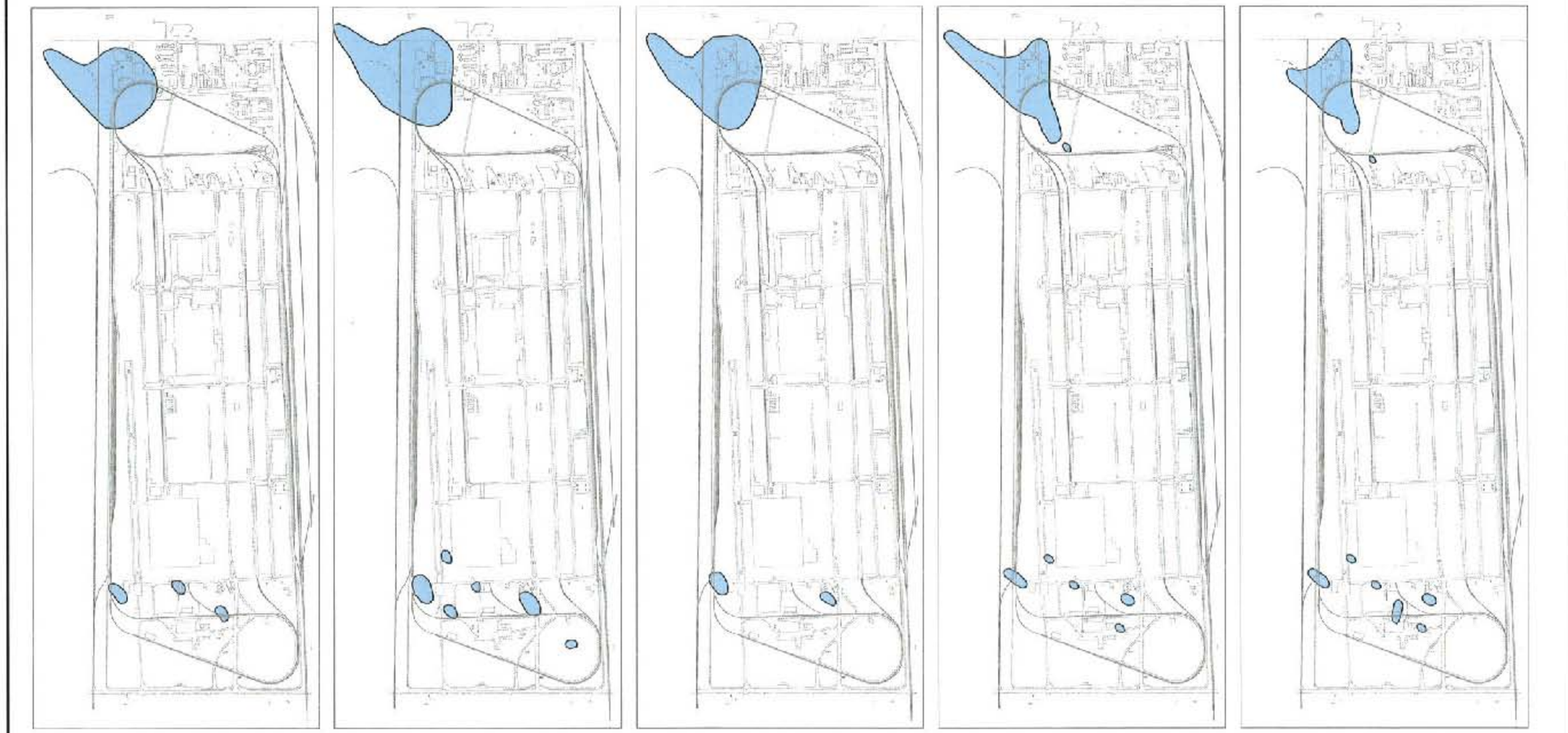


Figure 7-2
PCE Comparison Map
1998 - 2002
DDJC-Sharpe

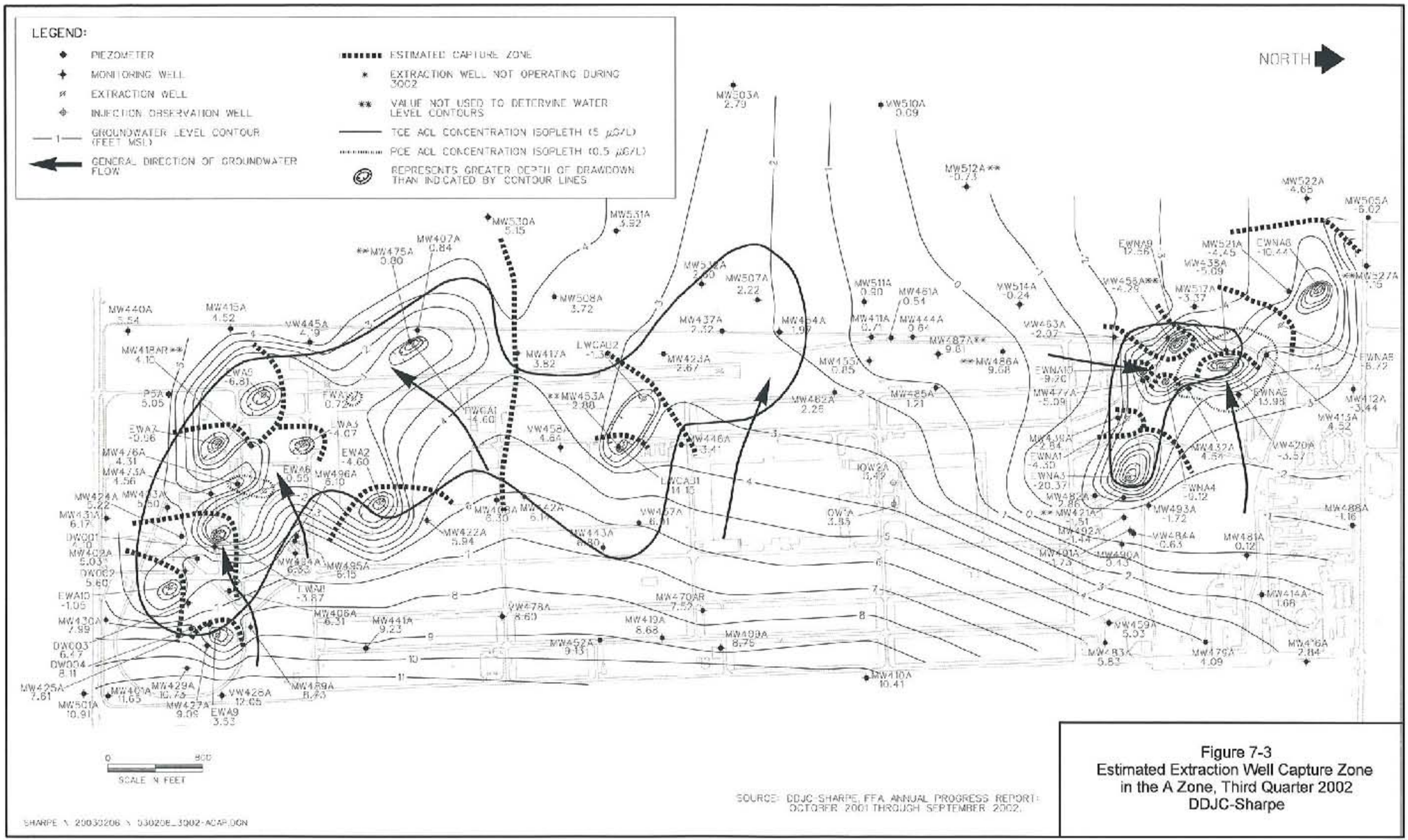


Figure 7-3
Estimated Extraction Well Capture Zone
in the A Zone, Third Quarter 2002
DDJC-Sharpe

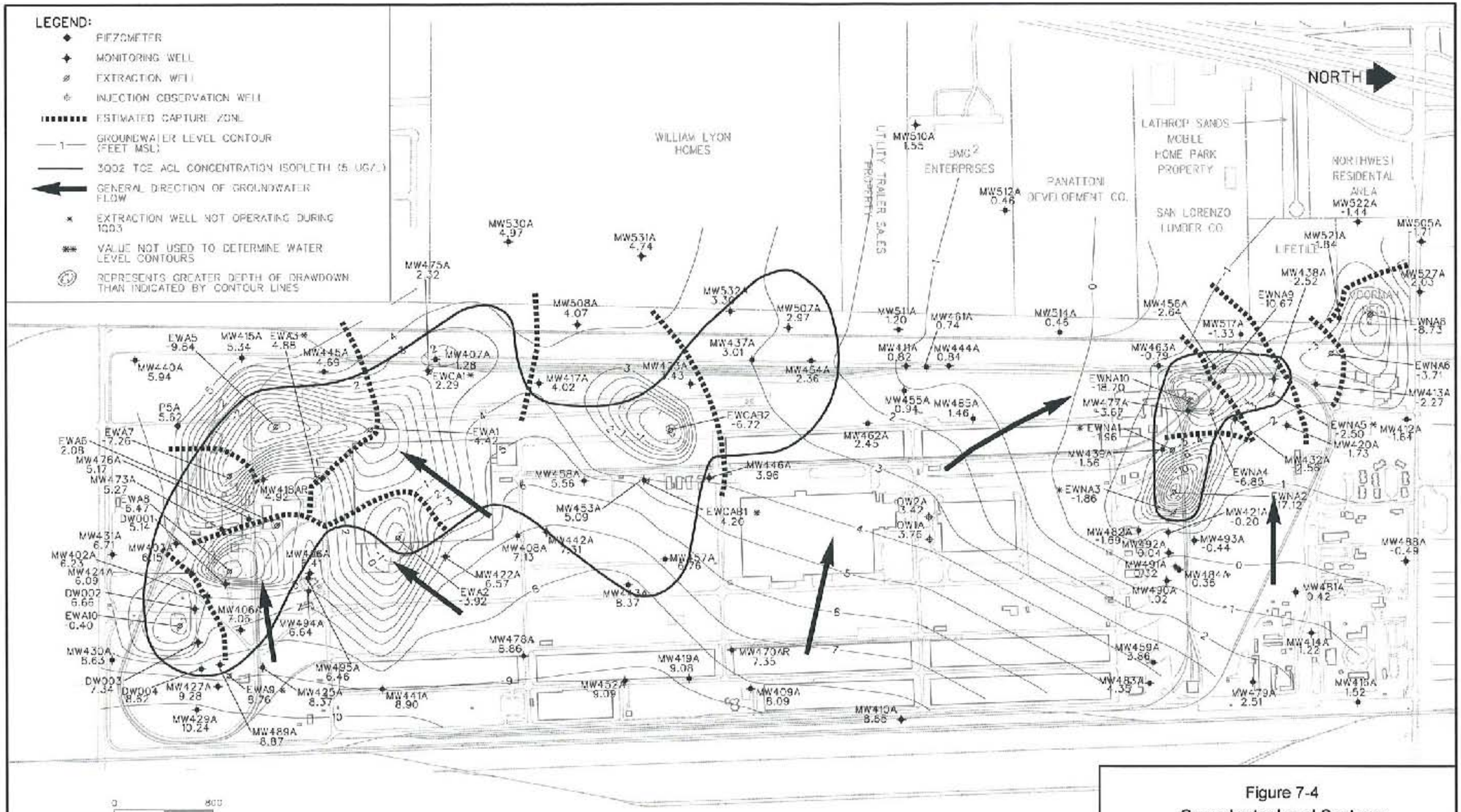


Figure 7-4
Groundwater Level Contours
in the A Zone, First Quarter 2003
DDJC-Sharpe

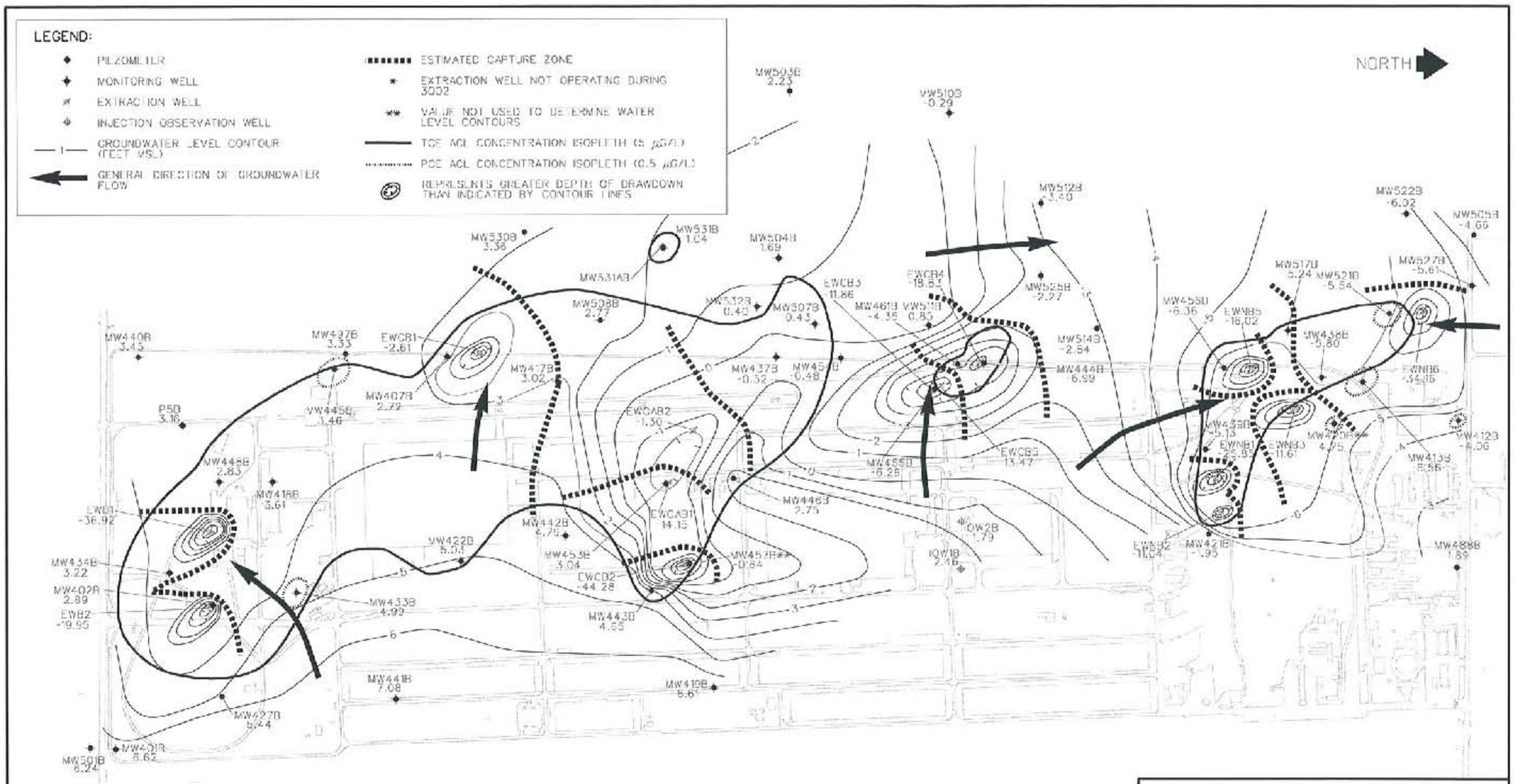


Figure 7-5
Estimated Extraction Well Capture Zone
in the B Zone, Third Quarter 2002
DDJC-Sharpe

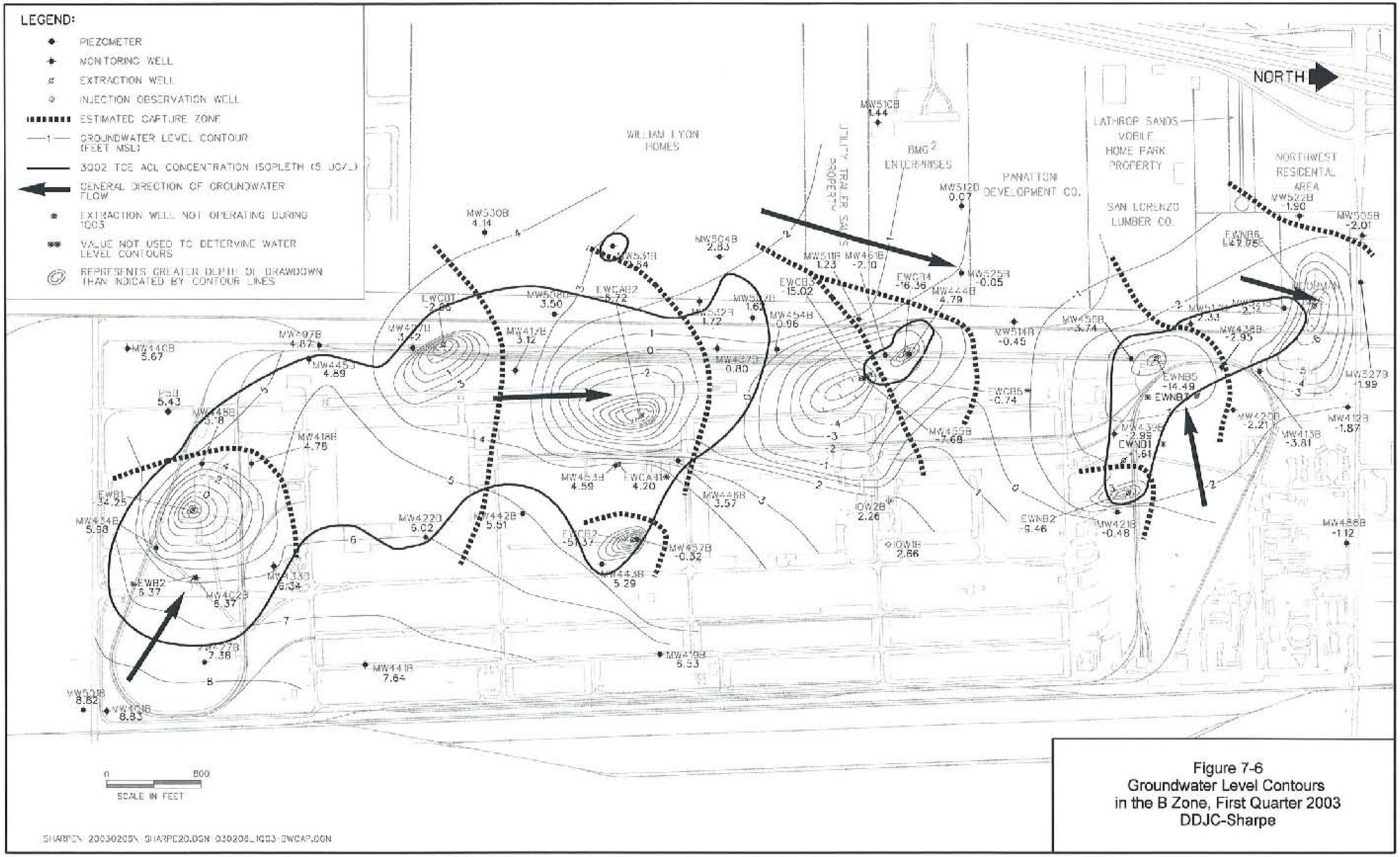


Figure 7-6
Groundwater Level Contours
in the B Zone, First Quarter 2003
DDJC-Sharpe

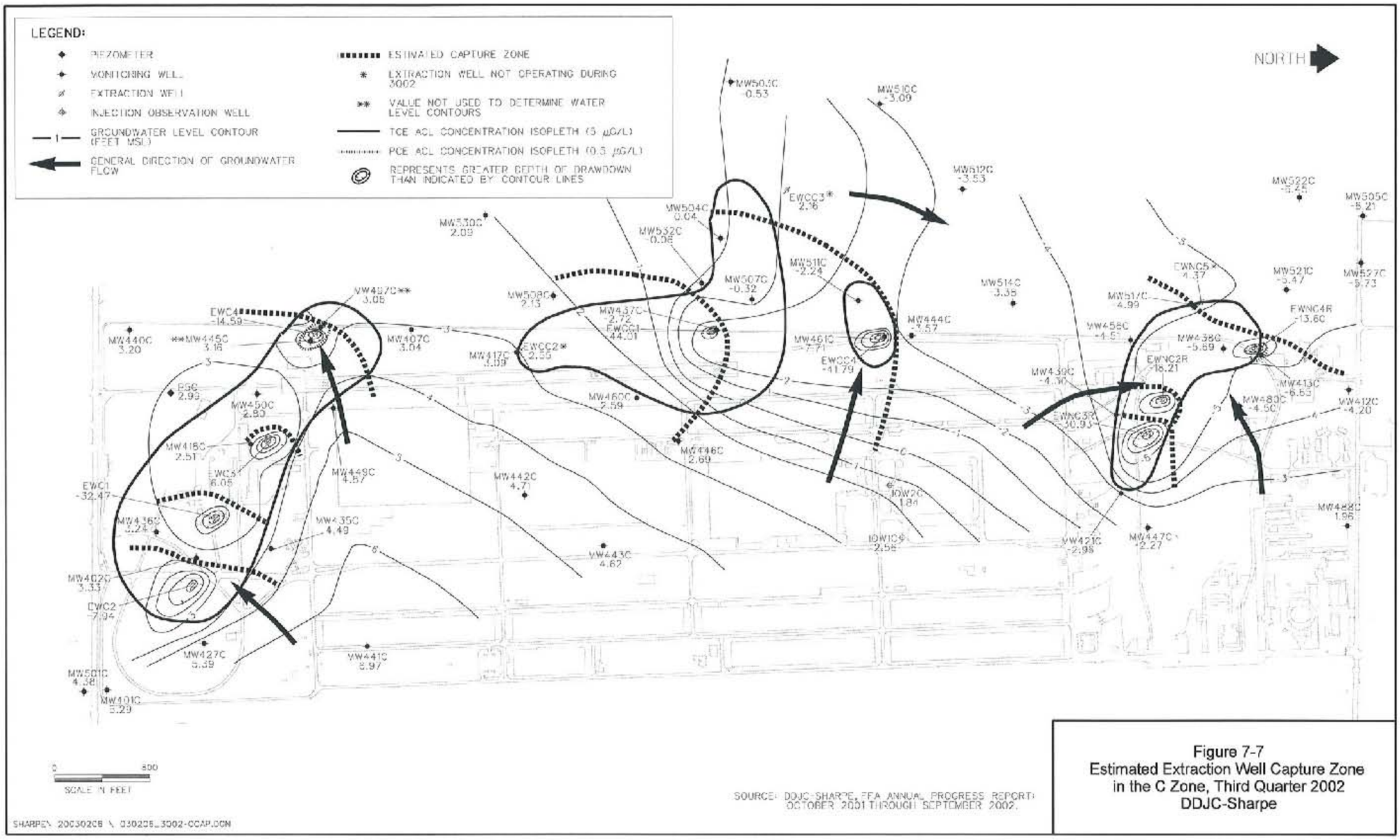


Figure 7-7
Estimated Extraction Well Capture Zone
in the C Zone, Third Quarter 2002
DDJC-Sharpe

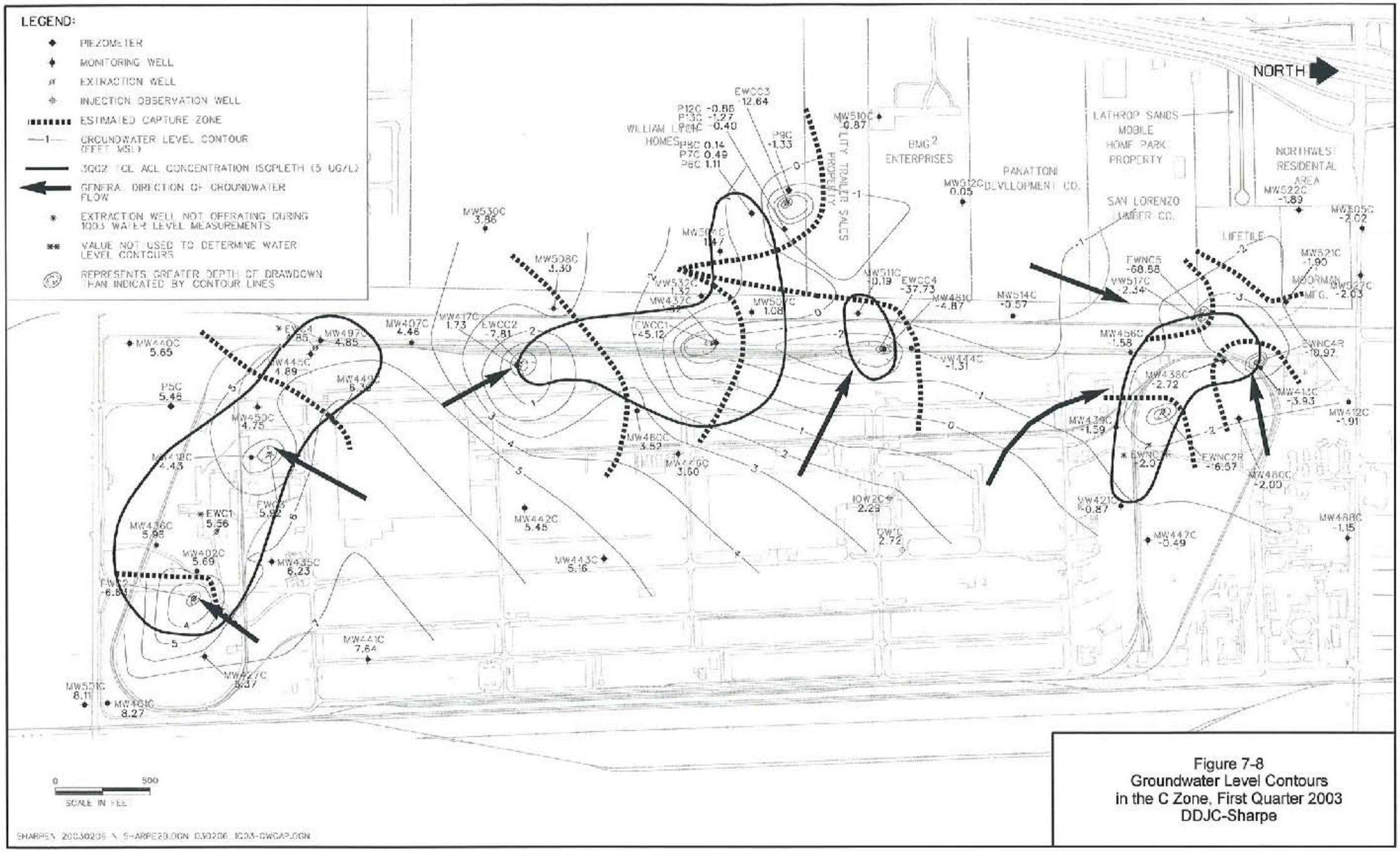


Figure 7-8
Groundwater Level Contours
in the C Zone, First Quarter 2003
DDJC-Sharpe

Figure 7-9a. Result of Model Simulation of TCE Plumes in the A Zone After 30 Years of Extraction with 45 Wells Operating

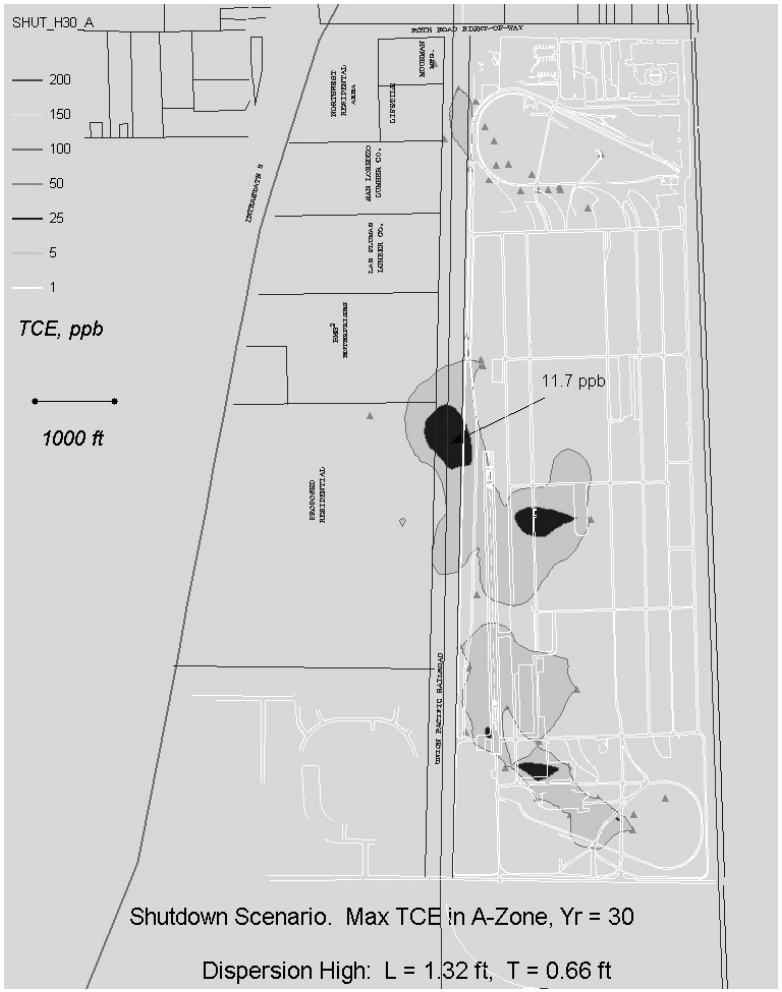


Figure 7-9b. Result of Model Simulation of TCE Plumes in the A Zone After 30 Years of Extraction with 35 Wells Operating

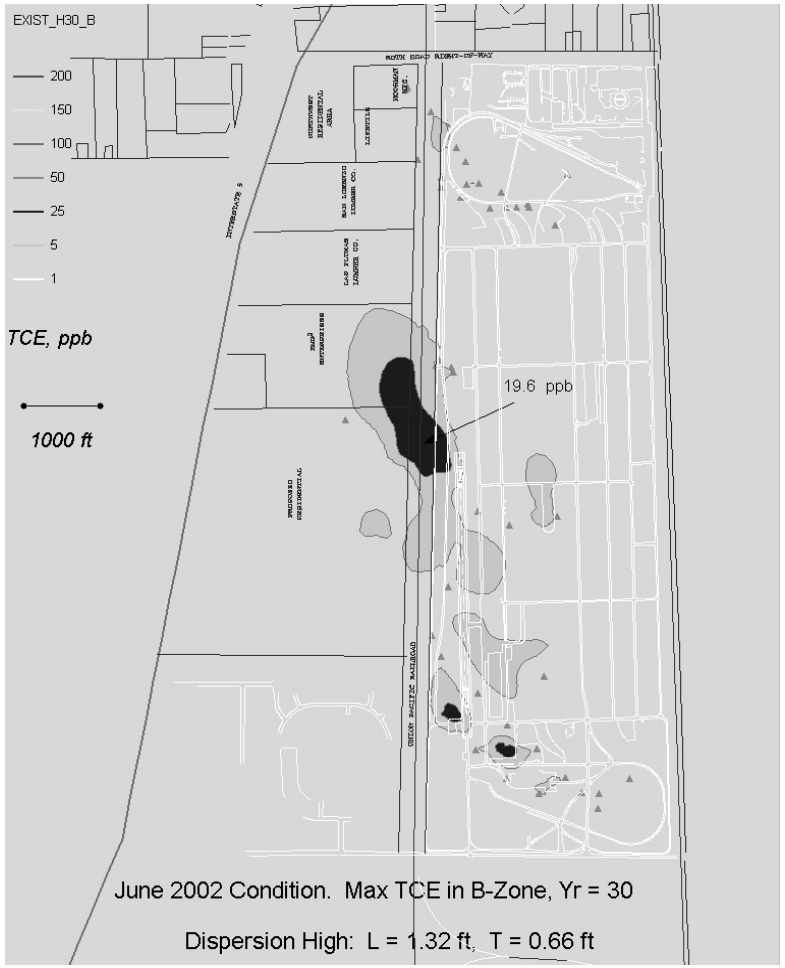


Figure 7-10a. Result of Model Simulation of TCE Plumes in the B Zone After 30 Years of Extraction with 45 Wells Operating

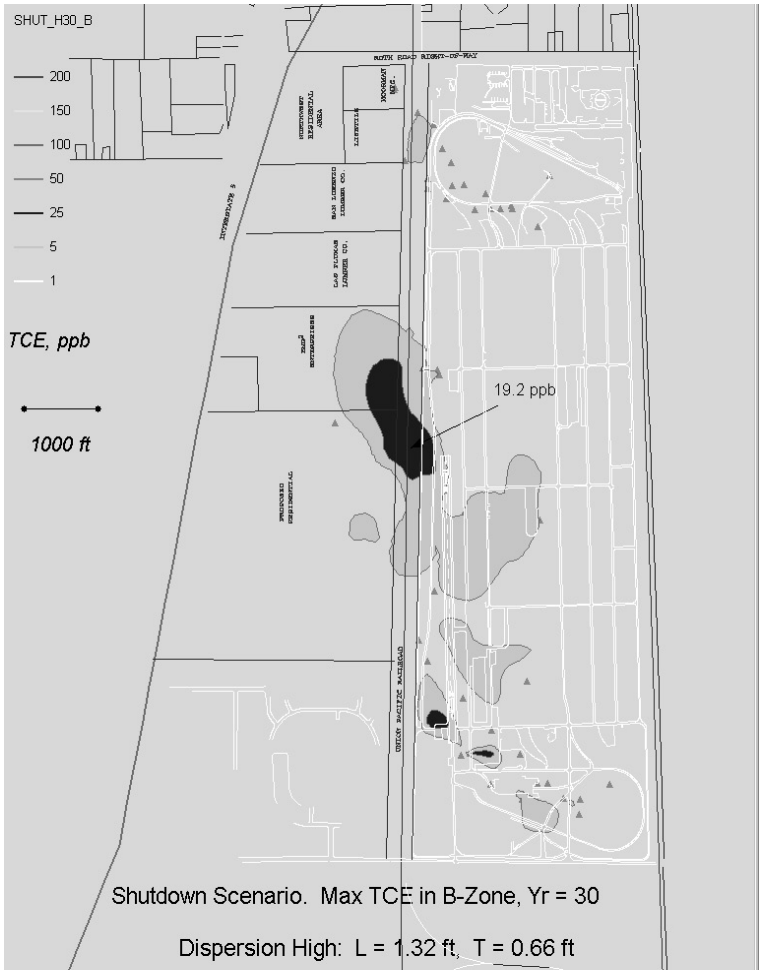


Figure 7-10b. Results of Model Simulation of TCE Plumes in the B Zone After 30 Years of Extraction with 35 Wells Operating

Figure 7-11a. Results of Model Simulation of TCE Plumes in the C Zone After 20 Years of Extraction with 45 Wells Operating

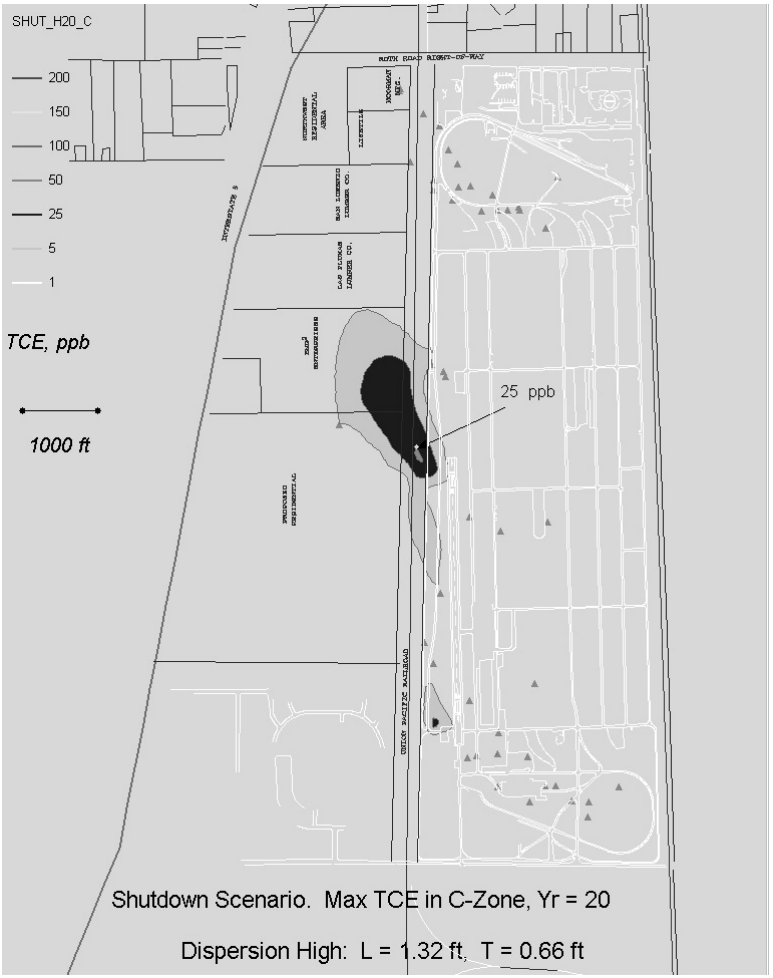


Figure 7-11b. Results of Model Simulation of TCE Plumes in the C Zone After 20 Years of Extraction with 35 Wells Operating

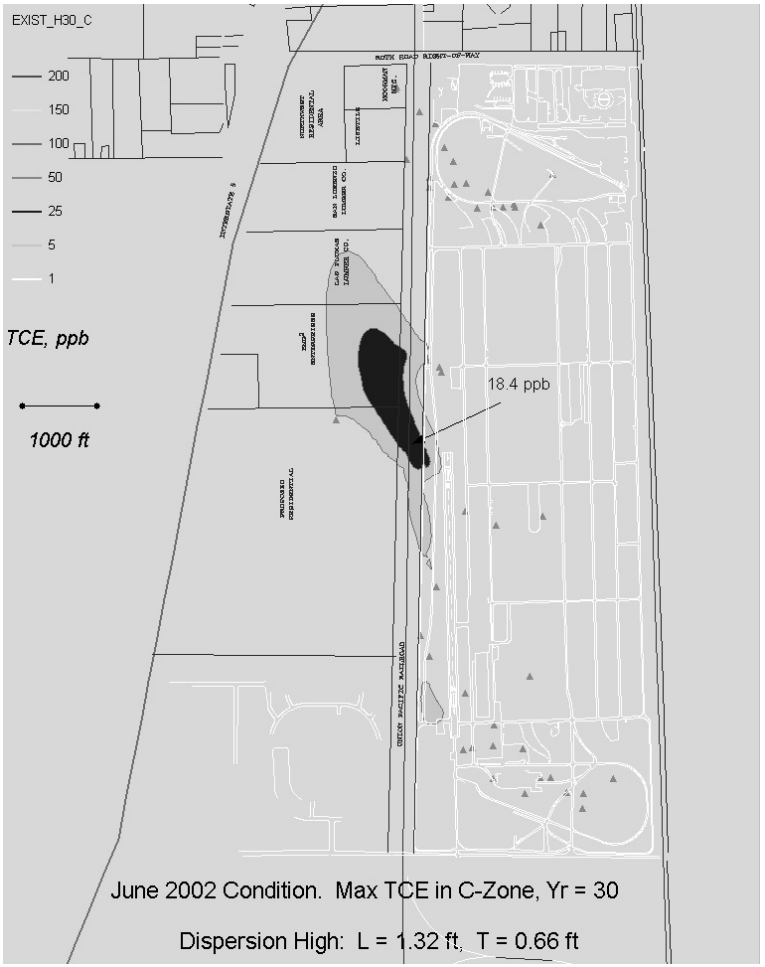


Figure 7-12a. Results of Model Simulation of TCE Plumes in the C Zone After 30 Years of Extraction with 45 Wells Operating

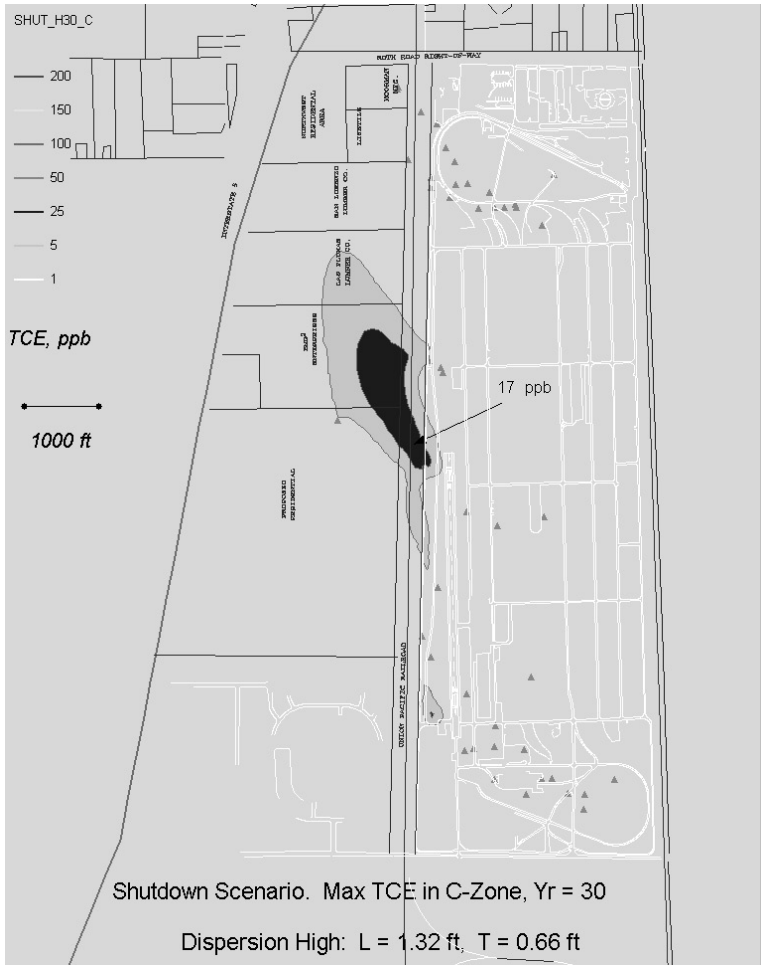


Figure 7-12b. Results of Model Simulation of TCE Plumes in the C Zone After 30 years of Extraction with 35 Wells Operating

8.0 ISSUES

Issues arise if remedies selected in DDJC-Sharpe RODs are not operating as intended after five years. This section summarizes issues that arose because of the technical assessment of remedies or because of concerns raised by regulatory agency personnel.

8.1 Operable Unit 1 Remedy Issues

Several problem areas regarding the operation of the OU 1 remedy were identified in the technical assessment. These have raised the concerns of regulatory agency personnel from the U.S. EPA, DTSC, and the RWQCB. The issues relating to the problems and concerns of regulatory personnel are described in the following paragraphs.

8.1.1 Increasing Trends in Groundwater Below Extraction Well Depths

VOC results from samples collected at two monitoring wells in the North Balloon suggest increasing concentration trends at depths greater than the screens of operating extraction wells; one of the wells has a concentration exceeding the ACL for TCE. MW439CD (screen interval: -121.3 to -131.3 mean sea level [msl]) and MW464CD (screen interval: -117.9 to -127.9 msl) are deeper than the screens (elevation range: -70.5 to -112.5 msl) of all extraction wells (operating or shut down) in the North Balloon. This absence of well screens in the groundwater at the depths of the two wells raises the issue that the plumes may continue migration off of the installation beneath the “capture depth” of the existing extraction wells.

8.1.2 Less than Complete Capture in the C Zone

Data compiled and interpreted for the FFA Annual Progress Report for DDJC-Sharpe (URS, 2003a) indicate that VOC contaminant plumes in the C Zone are not completely captured by the extraction well systems. Incomplete capture in the C Zone interval (-70 to -140 msl) may be allowing TCE plumes to migrate beyond extraction wells (EWCC3 and EWCC4) in the Central Area. The hypothetical “escape” of VOC plumes in the C Zone interval from the Central Area indicated in routine analyses (URS, 2003a) was supported by contaminant transport modeling simulations (WES, 2002). The occurrence of TCE at C Zone or deeper levels 600 to 800 feet west of the installation boundary in the North Balloon raises the issue of incomplete capture and migration toward potable supply wells that may be screened in C, D, or below D Zone depth intervals.

8.1.3 Predicted Cleanup Times

8.1.3.1 Results of numerical modeling of TCE transport in groundwater indicated that remediation of groundwater to ACLs established in the OU 1 ROD would not be complete within 16 years and that shutdown of 10 wells would not increase the total cleanup time.

8.1.3.2 The contaminant transport model simulations indicated that the shutdown of 10 extraction wells would not extend the total time interval for restoring the aquifer to beneficial uses. However, the model results led to the prediction that the shutdown of EWCAB1 (having screens in the A and B Zones) would extend the cleanup time of the TCE plume in the eastern Central Area by approximately 20 years and that the shutdown of EWB2 would extend the cleanup time of the TCE plume in the eastern South Balloon by approximately 10 years.

Therefore, the only issues regarding shutdown of extraction wells is whether EWCAB1 and EWB2 should be restarted.

8.1.3.3 The groundwater transport model results also indicated that more than 30 years of extraction well operation will be required to achieve the RAO of restoring groundwater to its beneficial use as a potential drinking water source with all 45 wells operating or the 35 wells currently operating. The cost of the OU 1 remedial action has already exceeded the estimated total cost of remediation, $4.1 million, by 300 percent. The total length of operation and the potential total cost of remediation exceeding $28 million (two times the costs incurred between 1987 through 2002) is an issue for DLA And DDJC because of the consumption of resources for operation and monitoring for 30 or more years. It has already been demonstrated that the groundwater extraction, treatment, and discharge systems have not achieved the RAO within the expenditures specified in the ROD. Furthermore, data analysis and modeling results indicate that the systems will require at least 200% more time to achieve the RAO.

8.1.3.4 The groundwater model results indicated that a new C Zone extraction well located west of the Central Area would increase plume capture and shorten the time to cleanup. However, water level elevation contours from the first quarter of 2003 suggested that increasing flow rates of existing C Zone wells, EWCC1 and EWCC3, would increase capture of the plume without adding a new well.

8.1.4 Hexavalent Chromium

Hexavalent chromium in groundwater has raised an issue with regulatory agency personnel because of the potential that oral ingestion poses an increased cancer risk for receptors. Although hexavalent chromium was not addressed in the OU 1 or OU 2 RODs (ESE, 1993 and 1996), that species raises greater concern because concentrations exceeding 0.2 mg/L have been detected in DDJC-Sharpe groundwater. Hexavalent chromium is potentially a naturally occurring constituent in groundwater; therefore, an assessment of background concentrations is necessary to establish background concentrations and, if needed, to evaluate if activities at DDJC- Sharpe have affected hexavalent chromium concentrations. Groundwater containing hexavalent chromium is not migrating off installation to potable supply wells; however, the species is migrating into extraction wells and the groundwater treatment systems do not remove it. The presence of hexavalent chromium in groundwater raises an issue of its potential impact on treated waters discharged to surface water bodies. At this time, monitoring for hexavalent chromium is performed monthly on the effluent from each groundwater treatment plant.

8.1.5 Arsenic

Dissolved arsenic species represent a new protectiveness concern because of the discharge of treated groundwater to the SSJIDC, which empties into French Camp Slough. The mitigation of the concentrations of arsenic in groundwater were not addressed in the OU 1 remedy, although they are greater than previous (0.050 mg/L) or current (0.010 mg/L) MCLs for drinking water, because the concentrations are considered background and not caused by DDJC-Sharpe historical activities. However, there are potential increased health risks and diminishment of surface water beneficial uses because of arsenic concentrations that may pass through the groundwater treatment systems and enter the SSJIDC and French Camp Slough, which have a default municipal/domestic beneficial use designation (Central Valley RWQCB, 2003).

8.1.6 Optimization Initiatives for the Remedy

Optimization of the OU 1 remedy will be an issue continued forward until the next five-year review is prepared. It is in the interest of DDJC and all federal and state government regulatory personnel to enhance the effectiveness and the efficiency of the OU 1 remedy through optimization initiatives that will save resources concurrent with maintaining protectiveness of human health and the environment. Optimization initiatives that have been considered and evaluated for their feasibility of application for DDJC-Sharpe groundwater are as follows: aggressive extraction in areas of highest concentrations (greater than 300 µg/L of TCE); establishment of a containment zone for the VOC plumes; discharge of all treated ground-water on site; adoption of natural attenuation as a part of the remedy; point-of-use treatment of groundwater; and potential modifications of any of the groundwater treatment plants to increase efficiency or effectiveness. There will also be a continuation of efforts begun in 1998 to reduce resources expended on long-term monitoring.

8.1.7 Potential VOC Inhalation Pathway

8.1.7.1 Since the OU 1 ROD was written and approved, the protectiveness of the ACLs has become questionable because of changes in toxicity criteria (cancer slope factors and reference doses) routinely used to estimate potential risk and develop health- protective cleanup levels and because the risk assessment did not account for the indoor air exposure pathway. A comparison of the cleanup goals with PRGs suggests that 8 of the 14 VOCs with risk-based cleanup levels, including TCE, are considered more toxic today than in 1993, two are less toxic, and four are about as toxic as they were in 1993. In 1993, the inhalation cancer slope factor for TCE was 1.7E-02 per mg/kg-day. U.S. EPA is currently evaluating a pro-posed cancer slope factor of 0.4 per mg/kg-day, which indicates that the cancer-producing potency of TCE may be 23 times greater than formerly estimated. To date, neither U.S. EPA nor the California Office of Environmental Health Hazard Assessment (OEHHA) has officially adopted the new slope factor. Calculations of carcinogenic risk potential with currently accepted parameters and models indicate human health risks posed by indoor inhalation of VOCs emanating from the water table are less than 1 x 10- 6 under current land use.

8.1.7.2 Although this analysis indicates that the ROD-specified cleanup levels for the eight VOCs with increased toxicity are inadequate for human health protection, direct human exposure to groundwater contaminants is not occurring because contaminated groundwater at the DDJC-Sharpe facility is not being used for any benefi-cial purpose and the contaminated aquifers are not accessible to the general public. The contaminated aquifers are more than 50 feet bgs and the water table of a shallow aquifer is at least 10 feet bgs. Without exposure, there is no risk. However, an additional potential pathway of exposure associated with VOCs in the A Zone at DDJC-Sharpe is inhalation of VOC vapors rising from the upper groundwater surface and entering the atmosphere above ground surface. Vapors entering the air outside of buildings generally do not present a significant risk because they are rapidly diluted by air movement. However, because air circulation and exchange in buildings are much less than outdoors, air vapors entering buildings through the floor can build to concentrations high enough to present a significant risk. Because of the potential for movement of VOC vapors in porous soil, such as loam, upwards toward the surface, buildings located over VOC-contaminated groundwater in the A Zone are more likely to be affected than those located elsewhere. Some of the on-site buildings in which DDJC-Sharpe personnel work are located over some of the plumes of contaminated groundwater. Thus, there is a possibility that people in those buildings are being exposed to VOCs in indoor air. Furthermore, the VOC plume has migrated beyond the depot boundary to the west and beneath homes in that area. The potential lifetime incremental cancer risk posed by TCE in indoor air to on-site personnel and off-site residents was estimated and found to be less than the highest acceptable level of risk (1×10^{-6}) established by the National Oil and Hazardous Substances Contingency Plan (Federal Register, Part 300) for CERCLA sites. To estimate the potential risk to residents living or working over a VOC plume, the DTSC/ Human and Ecological Risk Division's Version 3, Mod 1 of Version 3.0 of the Johnson and Ettinger (1991) vapor intrusion model was

used to calculate potential health risk for seven locations where industrial buildings (for example, Buildings 649 and 655 in the South Balloon, the AAFES building north of the South Balloon, Buildings 462, 464, and 684 in the Central Area) or homes (Stonegate Development) stand over A Zone groundwater that contains TCE or PCE concentrations. The soil parameters used in calculations of risk from soil vapor intrusion are an average of soil parameters measured in 1996 sampling at DDJC-Sharpe. For its calculations, DDJC-Sharpe evaluated the soil types from the surface to the top of the A Zone and used those soil types in the calculations. Only concentrations of TCE or PCE measured in A Zone samples in the third quarter of 2003 were used in the calculations. The GW Screen Microsoft Excel workbook was used for most calculations. However, concentrations of TCE and PCE in the A Zone beneath the AAFES building and Buildings 649 and 655 were subjected to GW Screen and GW-ADV calculations. The GW-ADV workbook allows for changing the dimensions of a home or residence. Risk probabilities for both an industrial setting and a residential setting were calculated for the six locations on DDJC-Sharpe. In the GW Screen calculations, risk in an industrial scenario was estimated by changing the exposure duration to 25 years and the exposure frequency to 250 days per year. Inhalation results and soil parameters used in calculations are provided in Attachment 8.

8.1.7.3 DDJC-Sharpe calculation results for carcinogenic risks at the seven locations varied from 3.8×10^{-6} to 9.4×10^{-10}. The concentration of TCE equal to 44 µg/L (from MW476A samples) in an A Zone plume at the water table may pose a carcinogenic risk exceeding 1×10^{-6} if a residence stood in the location of Buildings 649 and 655 in the South Balloon. Although the estimated TCE inhalation risk at the location of the two buildings from the GW Screen calculation is greater than 1×10^{-6}, the estimated carcinogenic risk to industrial workers in the buildings was less than 1×10^{-6}. Therefore, use of the buildings for industrial purposes is acceptable. However, if the area of these two buildings were considered for residential use, if the depot were closed, the risk resulting from inhalation may be unacceptable if the groundwater concentration remained the same.

8.1.7.4 With the exception of the Building 649 and 655 location, all calculated carcinogenic risks were less that 4×10^{-7} for either TCE or PCE. The concentrations used in the calculations for the AAFES building are as follows: TCE = 14 µg/ L from EWA2, and 1.1 µg/L from EWA1. For all calculations, only the currently accepted U.S. EPA and OEHHA unit risk factors for TCE and PCE were used. Other details of the calculations are provided in Attachment 8.

8.2 Operable Unit 2 Remedy Issues

No issues were identified during the technical assessment of the OU 2 remedies for VOCs and pesticides at DDJC-Sharpe. Remedial actions are complete and the sites are closed. Remedial actions for metals at Sites S-3 and S-26 are also complete; the sites have been closed. Institutional controls implemented as LUCs at the South Balloon are currently operating as intended and groundwater sampling for analysis of chromium and lead continues at monitoring wells downgradient of Site S-33/29.

9.0 RECOMMENDATIONS AND FOLLOW-UP ACTIONS

This section provides recommendations and follow-up actions to address issues identified in the technical assessment.

9.1 Operable Unit 1

9.1.1 The following are recommendations and follow-up actions for the OU 1 groundwater remedy.

9.1.2 To address incomplete capture, increase the pumping rate of EWCC1 and EWCC3 to capture the plume that could migrate off installation in the C Zone interval.

9.1.3 To address incomplete capture, install at least one monitoring well cluster in the elevation interval -117 to -140 msl west (off installation) of the Central Area to monitor migration down-gradient from the operating extraction wells and the proposed new extraction well (Figure 9-1). The cluster should have at least two wells to allow determination of gradients in the interval.

9.1.4 To address increasing VOC concentrations at depth beneath existing extraction well screens, install at least two monitoring well clusters in the elevation interval -117 to -140 msl of the North Balloon to evaluate the cause and extent of migration beneath the operating extraction wells (Figure 9-1). Each cluster should have at least two wells to allow for determination of gradients in the interval.

9.1.5 To address concerns raised by VOC concentrations in the proposed North Balloon monitoring well clusters and contingent upon the results of samples and gradient calculations for the new well clusters (see paragraph 9.1.4) determine if TCE is migrating into the screens of private water supply wells.

9.1.6 To address the lengthening of A and B Zone cleanup times in eastern Central Area TCE plumes, EWCAB1 was returned to operation in February 2003. Its flow will be optimized to increase capture of TCE plumes in the A Zone and B Zone of the Central Area.

9.1.7 To address the lengthening of B Zone cleanup times in the eastern South Balloon and address concentrations of TCE 3 to 14 times greater than the ACL in groundwater, EWB2 will be returned to operation. The well's flow rate (maximum of approximately 8 gpm) will be optimized for capture.

9.1.8 To address concerns regarding the potential health risks caused by intrusion of VOC vapors into workplaces, DDJC will conduct sampling and analysis of soil gas within 10 feet of the ground surface and adjacent to the foundations of a few frequently occupied buildings that stand over groundwater plumes. Lithologic and VOC concentration data will be used in soil vapor intrusion models to estimate the potential health risks to workers in those buildings.

9.1.9 To address concerns regarding hexavalent chromium migration in groundwater or in surface waters, continue to sample monitoring wells, extraction wells, and treatment effluent for hexavalent chromium concentrations that may migrate to human or ecological receptors. If discharge of effluent from treatment plants to surface water bodies is stopped, monitoring of effluent may be discontinued. In conjunction with efforts to address dissolved arsenic species that may be discharged to surface water, the potential risk of hexavalent

chromium release to surface water must be addressed through the construction of percolation ponds that will allow discharge of all treated groundwater within DDJC-Sharpe boundaries.

9.1.10 To address the protection of surface waters (SSJIDC and French Camp Slough) with a beneficial use category of municipal/domestic water supply from arsenic concentrations exceeding the MCL, complete the evaluations of on-site locations where percolation ponds can effectively be constructed. The percolation ponds must be designed to accept the full discharge of treated groundwater from the DDJC-Sharpe treatment plants. Siting of the ponds will fully account for the potential effects of the discharges on plume migration and extraction well capture. Evaluations of locations for ponds northeast and southwest of the South Balloon were conducted in February and March 2003. Percolation ponds located north of the eastern South Balloon or south of the western South Balloon will not cause hydraulic interference with VOC plume migration or extraction well operation. After construction, these ponds would also address concerns regarding hexavalent chromium concentrations in treated groundwater (see paragraph 9.1.8).

9.1.11 DLA and DDJC are concerned that the remedy identified in the OU 1 ROD cannot achieve the RAO within a reasonable timeframe or within reasonable costs. Therefore, an exit strategy document will be prepared. The exit strategy will re-evaluate the RAO, the remedy selected, and alternative approaches that have greater potential for being protective of human health and the environment and with reasonable expenditures of time and resources. The following are potential approaches to be considered in the exit strategy:

- Establish a containment zone, or zones, for DDJC- Sharpe groundwater;
- Allow off-installation stabilization and natural attenuation to control plume concentration and extent;
- Evaluate the use of point-of-exposure controls (for example, point-of-use treatment) to ensure protection of human health at any downgradient supply wells that may be affected by migration of VOCs from DDJC-Sharpe; and
- Replace the existing ACLs with more realistic and cost-effective cleanup objectives.

9.1.12 As the recommendations and follow- up actions are implemented, the results of monitoring or changes in capture should be evaluated and reported annually in the FFA Annual Progress Report.

9.2 Operable Unit 2

9.2.1 No recommendations are proposed for the OU 2 remedy. Follow-up actions are to ensure that institutional controls in the South Balloon are enforced and that groundwater monitoring downgradient of Site S-33/29 continues according to the proposed schedule. Institutional controls to ensure only industrial land use will occur in the area of Site S-26 include annual inspections and inspection report submittal to the signatories of the FFA by the DDJC-FA Environmental Program Manager, in addition to implementation of procedures outlined in the Addendum to the Installation Master Plan (URS, 2002e).

9.2.2 In the North Balloon, lead concentrations would exceed risk-based cleanup levels if the railroad ballast were removed and Site S-26 adapted for non-industrial uses. Therefore, controls will be put in place by DDJC to assure that only industrial land use could occur in the area of contaminated soil.

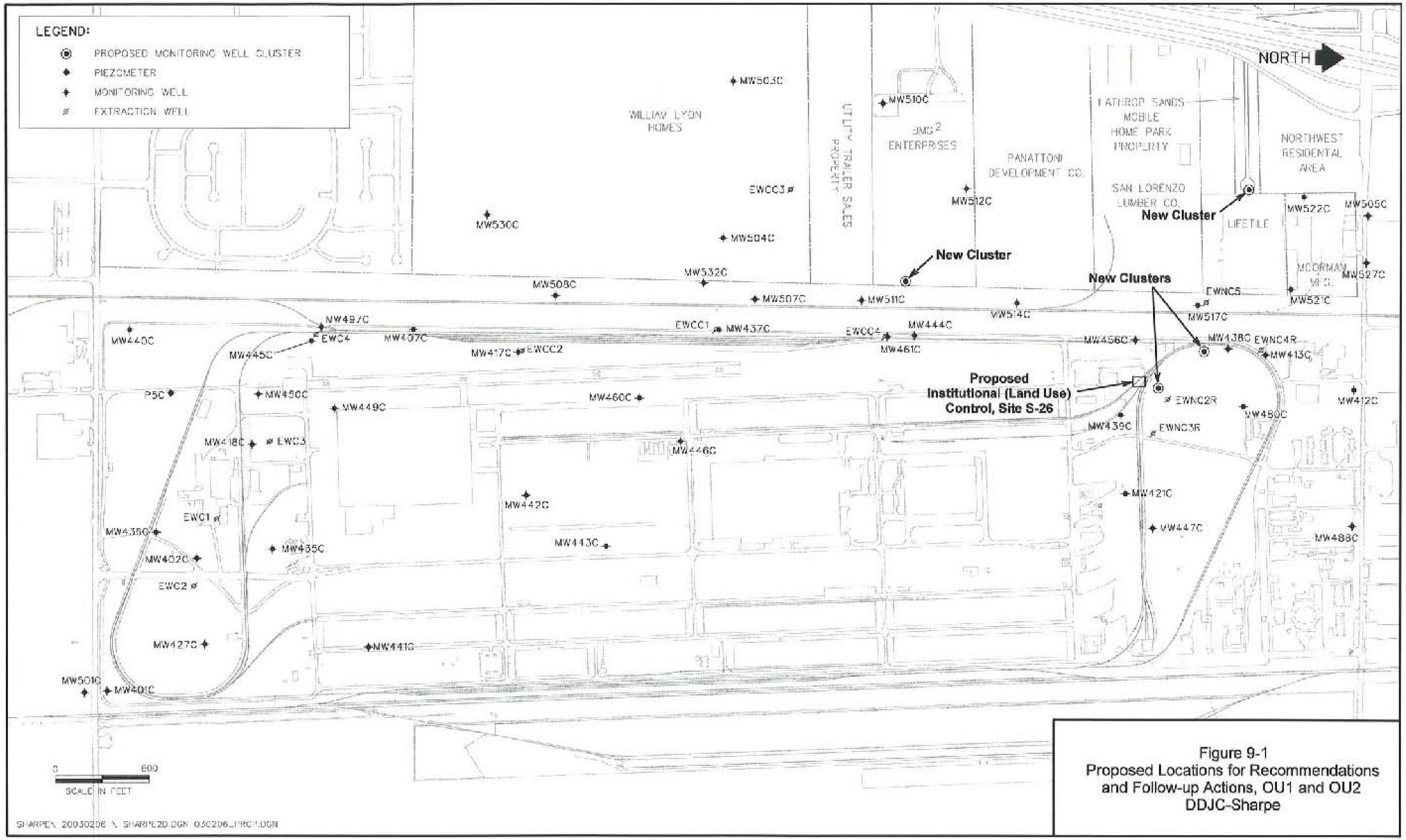


Figure 9-1
Proposed Locations for Recommendations and Follow-up Actions, OU1 and OU2
DDJC-Sharpe

10.0 PROTECTIVENESS STATEMENT

The following statements address the protectiveness of the removal and remedial actions taken at DDJC-Sharpe site.

10.1 OU 1 Protectiveness

The actions taken for OU 1 have been protective in the first five years of operation. However, evidence of incomplete capture of contaminant plumes indicates that extraction well systems are not operating as intended. Because of this, the OU 1 actions may not be protective into the future. To assure protectiveness, the recommendations and follow-up actions presented in Section 9 must be implemented.

10.2 OU 2 Protectiveness

The actions taken for OU 2 are not fully protective because soil at Site S-26 contains lead concentrations that do not allow unrestricted use. Therefore, land use controls are necessary to assure that use of the area of contamination remains industrial unless additional excavation occurs. Furthermore, if a higher inhalation toxicity value (0.4 per mg/kg-day) is accepted for TCE, the concentrations of TCE that were left in the soil in 2001 after SVE remedial actions ceased could pose a risk to occupants of residences constructed at the SVE sites. However, there are no residences or occupied structures of any kind on those sites. The actions for VOCs are protective under current land use and are likely to be protective in the future because the VOC concentrations will be reduced naturally with time. The next five- year review will be a statutory review because lead and TCE concentrations in soil are not protective for unrestricted land use.

11.0 NEXT FIVE-YEAR REVIEW

The next five-year review for the DDJC-Sharpe site is required by 15 March 2008, five years from the date of this review.

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ATTACHMENT 1

Summary of Treatment System Construction and Performance References, OU 1, DDJC-Sharpe (Source: DDJC-Sharpe FFA Annual Progress Report: October 2001 – September 2002)

Table 1. Summary of Treatment System Construction and Performance References, OU 1, DDJC-Sharpe

Year	Topic	Associated Reference
1985	Pilot Demonstration for South Balloon	ESE, 1985; Pilot Demonstration of Air Stripping Technology for the Treatment of Groundwater Contaminated with Volatile Organic Compounds at Sharpe Army Depot. April.
1985	Remediation Plan for South Balloon	ESE, 1985; Draft Groundwater Remediation Plan for the South Balloon Area at Sharpe Army Depot. July.
1985	Pump Test for South Balloon	ESE, 1985. Final Pump Test Report at Sharpe Army Depot.
1988	NPDES Discharge Permit	Sharpe Army Depot (SHAD), 1988; NPDES Discharge Permit No. CA0081931, Annual Report for the Period of March 3, 1987 through December 31, 1987. January.
1988	North Balloon Conceptual Design	ESE, 1988. Conceptual Design for the Interim Groundwater Remediation System for the North Balloon Area at Sharpe Army Depot. Draft Report.
1990	North Balloon Extraction Well Evaluation	ESE, 1990. North Balloon Pumping Tests Extraction Well Evaluation.
1990	South Balloon Extraction Well Evaluation	ESE, 1990. Sharpe Army Depot South Balloon C-Zone Extraction Well C-3 Pumping Test and Modeling.
1991	Central Area Feasibility Study	ESE, 1991. Remedial Investigation/Feasibility Study at Sharpe Site, Groundwater Feasibility Study Report.
1992–94	Installation Restoration Quarterly Progress Report	Defense Distribution Region West - Sharpe, 1992. Installation Restoration Quarterly Progress Report, Period: April 1, 1992 to June 30, 1992. July 24.
1992	Well-Field Design (3-D Model)	Engineering Technologies Associates, Inc., 1992. Draft Final Remedial Well-Field Design Using Three-Dimensional Ground Water Flow and Transport Modeling, Defense Distribution Region West - Sharpe, Lathrop, California.
1993	Central Area Design Work Plan	James M. Montgomery, Inc., 1993. Final Remedial Design Work Plan for Central Area Groundwater Treatment System, Defense Distribution Region West-Sharpe, Lathrop, California. March 5.
1993	Central Area Pre-Design Technical Summary	James M. Montgomery, Inc., 1993. Final Pre-Design Technical Summary Report, DDRW-Sharpe, Lathrop, California, March 5.
1994	Central Area Operation and Maintenance Plan	Montgomery-Watson, 1994. Final Operation and Maintenance Plan, DDRW-Sharpe, Lathrop, California. February 28.
1994	Central Area Remedial Action Work Plan	Montgomery-Watson, 1994. Final Remedial Action Work Plan, DDRW-Sharpe, Lathrop, California. February 28.
1994	Central Area Technical Specifications	Montgomery-Watson, 1994. Technical Specifications, DDRW-Sharpe, Lathrop, California. February 28.
1995	Central Area Treatment Plant Start-up	ESE, 1995. Commissioning/Potable Water Start-up Report. June.
1995	Central Area Treatment Plant Testing	ESE, 1995. Prove-out Phase Report. June.

Table 1. (Continued)

Year	Topic	Associated Reference
1995-96	Central Area Treatment Plant Operation	ESE, 1995. Full Scale Operation Weekly Reports, May 30 through December 31.
		ESE, 1996. Central Area, Operable Unit 1, Quarterly Operations and Monitoring Report, June-August 1995. February.
		ESE, 1996. Central Area, Operable Unit 1, Quarterly Operations and Monitoring Report, September-November 1995. March.
		ESE, 1996. Central Area, Operable Unit 1, Quarterly Operations and Monitoring Report, December 1995-February 1996. April.
1996	Central Area Operations and Maintenance	ESE, 1996. DDRW-Sharpe Central Area Quarterly Operations and Monitoring Report, Period: June - August 1995. February 1.
1996	Impacts on Receiving Water	Radian Corporation, 1996. DDRW-Sharpe Groundwater Treatment Plant Effluent Impacts on Receiving Water Study Field Work Plan. Final Report. May 29.
1996	Scale Study	Radian Corporation, 1996. DDRW-Sharpe Scale Study Work Plan. Final Report. May 30.
		Radian Corporation, 1996. DDRW-Sharpe Scale Study Report. Final Report. December.
1996	Groundwater Extraction System and Treatment System Repairs and Modifications	Radian Corporation, 1996. DDRW-Sharpe/Tracy OU 1 Design Support - OU 1 Repairs and Enhancements Work Plan. Final Report. August 30.
		Radian Corporation, 1996. Delivery Order 3, Modification 2, OU 1 Repairs and Enhancements PLC I/O Point Data Sheet Lists. October 7.
1996	Well Installation	Radian Corporation, 1996. DDRW-Sharpe Well Installation Work Plan. Final Report. November.
1996-2002	Well Monitoring Program	Radian Corporation, 1996. FFA Annual Progress Report, January through December 1995. Final Report. October.
		Radian Corporation, 1996. DDRW-Sharpe Well Monitoring Program Quarterly Monitoring Report 1Q, 2Q, 3Q , 4Q96 Sampling Rounds. June 3, July 22, October 31, April 1997.
		Radian International, 1997. FFA Annual Progress Report, October 1996 through September 1997. Final. December.
		Radian International, 1997. DDJC-Sharpe Well Monitoring Program Quarterly Monitoring Report 1Q97 June 1997, 2Q97 July 1997, 3Q97 May 1998. Final.
		Radian International, 1998. DDJC-Sharpe Well Monitoring Program Quarterly Monitoring Report 4Q97, 1Q98, 2Q98. Final. January, April, July.

Table 1. (Continued)

Year	Topic	Associated Reference
1996-2002 (cont'd)	Well Monitoring Program (cont'd)	Radian International, 1999. DDJC-Sharpe Well Monitoring Program Quarterly Monitoring Report 4Q98, 1Q99, 2Q99. Final. January, April, July. Radian International, 1999. FFA Annual Progress Report, October 1997 through September 1998. Final. May. Radian International, 2000. DDJC-Sharpe Well Monitoring Program Quarterly Monitoring Report 4Q99, 1Q00, 2Q00. Final. January, April, July. Radian International, 2000. FFA Annual Progress Report, October 1998 through September 1999. Final. May. URS, 2001. DDJC-Sharpe Well Monitoring Program Quarterly Monitoring Report 4Q00, 1Q01, 2Q01. Final. January, April, July. URS, 2001. DDJC-Sharpe FFA Annual Progress Report, October 1999 through September 2000. Final. May. URS, 2002. DDJC-Sharpe FFA Annual Progress Report, October 2000 through September 2001. Final. May. URS, 2002. DDJC-Sharpe Well Monitoring Program Quarterly Monitoring Reports 4Q01, 1Q02, 2Q02. Final. January, May, July. URS, 2002. DDJC-Sharpe FFA Annual Progress Report, October 2001 through September 2002. Draft. November.
1996-2002	Treatment Plant Performance	Radian Corporation, 1996. DDRW-Sharpe Groundwater Treatment Plant Monthly Performance Monitoring Reports, Periods January through December. Radian International, 1997. DDRW-Sharpe Groundwater Treatment Plant Monthly Performance Monitoring Reports, Periods January through December. Radian International, 1998. DDJC-Sharpe Groundwater Treatment Plant Monthly Performance Monitoring Reports, Periods January through September. Radian International, 1999. DDJC-Sharpe Groundwater Treatment Plant Monthly Performance Monitoring Reports, Periods January through December. Radian International, 2000. DDJC-Sharpe Groundwater Treatment Plant Monthly Performance Monitoring Reports, periods January through September. URS, 2000. DDJC-Sharpe Groundwater Treatment Plant Monthly Performance Reports. January through December. URS, 2001. DDJC-Sharpe Groundwater Treatment Plant Monthly Performance Reports. January through December.

Table 1. (Continued)

Year	Topic	Associated Reference
1996-2002 (cont'd)	Treatment Plant Performance (cont'd)	URS, 2002. DDJC-Sharpe Groundwater Treatment Plant Monthly Performance Reports. January through September.
1998	Effluent Impacts on Receiving Water	Radian International, 1998. DDRW-Sharpe Groundwater Treatment Plant Effluent Impacts on Receiving Water Report. Final. February.
1996-2002	Operations and Maintenance Reports	Radian Corporation, 1996. DDRW-Sharpe Monthly Maintenance and Operations Reports. September through December 1996.
		Radian International, 1997. DDJC-Sharpe Monthly Maintenance and Operations Reports. January through December 1997.
		Radian International, 1998. DDJC-Sharpe Monthly Maintenance and Operations Reports. January through June 1998.
		Tetra Tech, 1998. DDJC-Sharpe Monthly Maintenance and Operations Reports. July through September 1998.
		Radian International, 1999. DDJC-Sharpe/Tracy Operations and Maintenance Data Needs Analysis. Draft Final. September.
		Tetra Tech, 1999. DDJC-Sharpe Monthly Maintenance and Operations Reports. January through December 1999.
		Radian International, 1999. DDJC-Sharpe and DDJC-Tracy Groundwater Treatment Facilities Year 2000 Contingency Plan. Final. October.
		Tetra Tech, 2000. DDJC-Sharpe Monthly Maintenance and Operations Reports. January through September 2000.
		Tetra Tech, 2001. DDJC-Sharpe Monthly Maintenance and Operations Reports. January through December 2001.
		Tetra Tech, 2002. DDJC-Sharpe Monthly Maintenance and Operations Reports. January through August.
		URS, 2001. DDJC-Sharpe Operation and Maintenance Manual for the Groundwater Treatment Systems. Final. June.
		URS, 2001. DDJC-Sharpe Operation and Maintenance Manual for the South Balloon Groundwater Treatment System. Final. July.
		URS, 2001. DDJC-Sharpe Operation and Maintenance Manual for the Central Area Groundwater Treatment System. Final. August.
		URS, 2001. DDJC-Sharpe Operation and Maintenance Manual for the North Balloon Groundwater Treatment System. Final. August.
1998	Groundwater Treatment System Optimization	Radian International, 1998. DDRW-Sharpe/Tracy Groundwater Treatment System Optimization Engineering Technical Memorandum. Final. July. Revised 24 August 1999.

Table 1. (Continued)

Year	Topic	Associated Reference
		URS, 2001. Groundwater Treatment System Optimization Technical Memorandum. Draft. September 2000.
1998-1999	Well Management	Radian International, 1998. DDJC-Sharpe Well Management Task Engineering Technical Memorandum. Final. July.
		Radian International, 1999. DDJC-Sharpe Water Management Report, Version 1.0. Final. October.

DDJC = Defense Distribution Depot San Joaquin California
DDRW = Defense Distribution Region West
ESE = Environmental Science and Engineering, Inc.
FFA = Federal Facilities Agreement
NPDES = National Pollutant Discharge Elimination System
OU = operable unit

ATTACHMENT 2

Exceedances of NPDES Requirements/WDRs
(Sources: DDJC-Sharpe FFA Annual Progress Reports from 1998, 1999, 2000, 2001, and 2002)

Table 1. NPDES Exceedances for Treatment Plant Effluent in October 1997 through September 1998, DDJC-Sharpe

Constituent	Daily Max Criteria	Monthly Median Criteria	North Balloon	Central Area B/C Zone	South Balloon	Dynegy®	Effluent Monthly Median
Arsenic, µg/L	50	40	NE	NE	NE	NE	NE
Chromium VI, µg/L	—	11	NE	NE	NE	NE	NE
Lead, µg/L	—	5.3[a]/3.2[b]	NE	NE	NE	NE	NE
Mercury, µg/L	2.4	0.012	NE	NE	NE	NE	NE
Volatile organic compounds, µg/L	1.0	<0.5	NE	NE	NE	NE	NE
Total petroleum hydrocarbons, µg/L	100	<50	4-7-98 (220)	NE	NE	4-7-98 (210)	3-3-98, Dynegy® (70) 4-7-98, Dynegy® (210) 4-7-98, North Balloon (220) 8-4-98, Dynegy® (50)
pH	6.5 - 8.5	—	NE	NE	NE	NE	NE
Fish bioassay, % survival	70[c]	—	NE	NE	NE	NE	NE
Specific conductance, µmhos/cm	—	—	NE	NE	NE	NE	NE

[a] This number is a 4-day average based on hardness of 200 mg $CaCO_3$/L.
[b] This number is a 4-day average based on hardness of 100 mg $CaCO_3$/L.
[c] 70% for any single bioassay, 90% for the median of three consecutive bioassays.

Exceedance values are indicated in parentheses.

DDJC = Defense Distribution Depot San Joaquin California
NE = no exceedances
NPDES = National Pollutant Discharge Elimination System
µg/L = micrograms per liter
µmhos/cm = micromhos per centimeter

Table 2. WDR Exceedances for Treatment Plant Effluent in October 1997 through September 1998, DDJC-Sharpe

Constituent	Daily Max Criteria	Monthly Median Criteria	Central Area A Zone	Central Area B/C Zone
cis-1,2-Dichloroethene, µg/L	—	—	NE	NE
TCE, µg/L	1	0.5	NE	NE
PCE, µg/L	1	0.5	NE	NE
Total VOC[a], µg/L	5	1	NE	NE
Arsenic, µg/L	42 or background[b]	—	NE	NE
Selenium, µg/L	5 or background[b]	—	NE	NE
Nitrate, µg/L	10 or background[b]	—	NE	NE
Bromacil, µg/L	90	90	NE	NE
Benzene, µg/L	1	0.5	5-19-98 (2.0)	NE
BTEX, µg/L	5	0.5	5-19-98 (2.0)[c]	NE
pH	6.5 - 8.5	—	11-5-97 (8.6) 1-7-98 (8.6) 7-7-98 (8.6) 7-21-98 (8.6)	NE
Specific conductance, µmhos/cm	—	—	NE	NE

[a] Total VOCs is the sum of all halogenated compounds including TCE and PCE.

[b] Background concentrations for arsenic, selenium, and nitrate have not been determined.

[c] The 2.0 µg/L BTEX value is below the daily maximum criterion of 5 µg/L. However, the monthly median value of 1.12 µg/L exceeds the monthly median criterion of 0.5 µg/L.

Exceedance values are indicated in parentheses.

BTEX = benzene, toluene, ethylbenzene, and xylenes
DDJC = Defense Distribution Depot San Joaquin California
NE = no exceedances
PCE = tetrachloroethene
TCE = trichloroethene
VOC = volatile organic compound
WDR = waste discharge requirement
µg/L = micrograms per liter
µmhos/cm = micromhos per centimeter

Table 3. R1, R2, R3, and R4 Compliance Monitoring October 1997 through September 1998, DDJC-Sharpe

Constituent	Criteria	R1	R2	R3	R4
Arsenic, µg/L	<10	NE	NE	NE	NE
Volatile organic compounds, µg/L	—	NE	NE	NE	NE
pH	6.5-8.5/Δ0.5	NE	NE	NE	NE
Temperature, °F	Δ5° F	NE	12-2-97 (59) 1-6-98 (59)	NE	1-6-98 (50)
Specific conductance, µmhos/cm	—	NE	NE	NE	NE

Exceedance values are indicated in parentheses.

DDJC = Defense Distribution Depot San Joaquin California
NE = no exceedances
R1 = SSJIDC sample location, 100 feet upstream
R2 = SSJIDC sample location, 100 feet downstream
R3 = French Camp Slough sample location, 100 feet upstream of confluence at SSJIDC
R4 = French Camp Slough sample location, 100 feet downstream of confluence at SSJIDC
SSJIDC = South San Joaquin Irrigation District Canal
µg/L = micrograms per liter
µmhos/cm = micromhos per centimeter
°F = degrees Fahrenheit

Table 4. NPDES Exceedances for Treatment Plant Effluent in October 1998 through September 1999, DDJC-Sharpe

Constituent	Daily Max Criteria	Monthly Median Criteria	North Balloon	Central Area B/C Zone	South Balloon	Dynegy®	Effluent Monthly Median
Arsenic, µg/L	50	40	NE	NE	NE	NE	NE
Chromium VI, µg/L	—	11	NE	NE	NE	NE	NE
Lead, µg/L	—	5.3[a]/3.2[b]	NE	NE	NE	NE	NE
Mercury, µg/L	2.4	0.012	NE	NE	6-3-99 (0.01)	9-8-99 (0.01)	7-13-99, South Balloon (0.01) 5-4-99, Central Area-B/C Zone (0.01) 8-3-99, Dynegy® (0.01)
Volatile organic compounds, µg/L	1.0	<0.5	NE	5-12-99 (4.7)	NE	NE	NE
Total petroleum hydrocarbons, µg/L	100	<50	NE	7-13-99 (130)	7-13-99 (340)	NE	7-13-99, Central Area BC Zone (77.5) 7-13-99, South Balloon (182.5)
pH	6.5 - 8.5	—	1-5-99 (8.6) 1-26-99 (8.6) 2-25-99 (8.8) 6-22-99 (8.6) 6-30-99 (8.6)		2-25-99 (8.7) 4-6-99 (8.7)	10-21-99 (8.6) 10-27-99 (8.7) 11-3-99 (8.6) 3-9-99 (8.8) 3-30-99 (8.6) 4-6-99 (8.6)	NE
Fish bioassay, % survival	70[c]	—	NE	NE	NE	NE	NE
Specific conductance, µmhos/cm	—	—	NE	NE	NE	NE	NE

[a] This number is a 4-day average based on hardness of 200 mg $CaCO_3$/L.
[b] This number is a 4-day average based on hardness of 100 mg $CaCO_3$/L.
[c] 70% for any single bioassay, 90% for the median of three consecutive bioassays.

Exceedance values are indicated in parentheses.

DDJC = Defense Distribution Depot San Joaquin California
NE = no exceedances
NPDES = National Pollutant Discharge Elimination System
µg/L = micrograms per liter
µmhos/cm = micromhos per centimeter

Table 5. WDR Exceedances for Treatment Plant Effluent in October 1998 through September 1999, DDJC-Sharpe

Constituent	Daily Max Criteria	Monthly Median Criteria	Central Area A Zone	Central Area B/C Zone
cis-1,2-Dichloroethene, µg/L	—	—	NE	NE
TCE, µg/L	1	0.5	NE	NE
PCE, µg/L	1	0.5	NE	NE
Total VOC[a], µg/L	5	1	NE	NE
Arsenic, µg/L	279[b]/57[c]	—	NE	NE
Selenium, µg/L	24.4[b]/7.6[c]	—	NE	NE
Nitrate, µg/L	20.9[b]/3.9[c]	—	NE	NE
Bromacil, µg/L	90	90	NE	NE
Benzene, µg/L	1	0.5	5-4-99 (1.5)	NE
BTEX, µg/L	5	0.5	NE	NE
pH	6.5 - 8.5	—	3-4-99 (8.6) 3-16-99 (8.7) 3-23-99 (8.7) 3-30-99 (8.6) 4-20-99 (8.6) 6-8-99 (8.6) 6-15-99 (8.6) 6-22-99 (8.6) 8-3-99 (8.6)	NE
Specific conductance, µmhos/cm	—	—	NE	NE

[a] Total VOCs is the sum of all halogenated compounds including TCE and PCE.
[b] Background concentrations for A Zone.
[c] Background concentrations for B/C Zone.

Exceedance values are indicated in parentheses.

BTEX = benzene, toluene, ethylbenzene, and xylenes
DDJC = Defense Distribution Depot San Joaquin California
NE = no exceedances
PCE = tetrachloroethene
TCE = trichloroethene
VOC = volatile organic compound
µg/L = micrograms per liter
µmhos/cm = micromhos per centimeter

Table 6. R1, R2, R3, and R4 Compliance Monitoring October 1998 through September 1999, DDJC-Sharpe

Constituent	Criteria	R1	R2	R3	R4
Arsenic, µg/L	<10	NE	NE	NE	NE
Volatile organic compounds, µg/L	—	NE	NE	NE	NE
pH	6.5-8.5/Δ0.5	4-20-99 (8.9) 4-28-99 (8.6) 8-3-99 (9.3)	3-30-99 (9.0) 4-6-99 (9.0) 4-20-99 (8.9) 4-28-99 (9.0) 8-3-99 (8.6)	4-20-99 (8.8)	7-13-99 (7.1) 8-3-99 (7.8)
Temperature, °F	Δ5° F	NE	12-9-98 (64.4)	NE	NE
Specific conductance, µmhos/cm	—	NE	NE	NE	NE
Turbidity, NTU	Δ<+20%	NE	5-4-99 (35.2)	NE	NE
Dissolved oxygen, mg/L	>7 mg/L	NE	NE	8-3-99 (6.80)	NE

Exceedance values are indicated in parentheses.

DDJC = Defense Distribution Depot San Joaquin California
NE = no exceedances
NTU = nephelometric turbidity units
R1 = SSJIDC sample location, 100 feet upstream
R2 = SSJIDC sample location, 100 feet downstream
R3 = French Camp Slough sample location, 100 feet upstream of confluence at SSJIDC
R4 = French Camp Slough sample location, 100 feet downstream of confluence at SSJIDC
SSJIDC = South San Joaquin Irrigation District Canal
µg/L = micrograms per liter
µmhos/cm = micromhos per centimeter
°F = degrees Fahrenheit

Table 7. NPDES Exceedances for Treatment Plant Effluent in October 1999 through September 2000, DDJC-Sharpe

Constituent	Daily Max Criteria	Monthly Median Criteria	North Balloon	Central Area B/C Zone	South Balloon	El Paso Energy®	Effluent Monthly Median
Arsenic, µg/L	50	40	NE	NE	NE	NE	NE
Chromium VI, µg/L	—	11	NE	NE	NE	NE	NE
Lead, µg/L	—	5.3[a]/3.2[b]	NE	NE	NE	8-1-00 (12) 8-2-00 (16)	8-1-00, El Paso Energy® (12) 8-2-00 El Paso Energy® (16)
Mercury, µg/L	2.4	0.012	10-5-99 (0.01) 1-4-00 (0.02) 2-1-00 (0.01) 3-1-00 (0.02)	10-5-99 (0.01) 12-8-99 (0.01) 1-19-00 (1.6)	2-17-00 (0.05) 4-4-00 (0.01)	10-5-99 (0.02) 12-8-99 (0.01) 2-1-00 (0.01) 4-4-00 (0.01)	10-5-99, El Paso Energy® (0.02) 10-5-99, Central Area B/C (0.01) 10-5-99, North Balloon (0.01) 12-8-99, El Paso Energy® (0.01) 12-8-99, Central Area B/C (0.01) 1-4-00, North Balloon (0.02) 2-1-00, North Balloon (0.01) 2-1-00, El Paso Energy® (0.01) 2-17-00, South Balloon (0.05) 3-1-00, North Balloon (0.02) 4-4-00, South Balloon (0.01) 4-4-00, El Paso Energy® (0.01)
Volatile organic compounds, µg/L	1.0	<0.5	NE	3-7-00 (2.0)	NE	NE	NE
Total petroleum hydrocarbons, µg/L	100	<50	NE	NE	NE	NE	NE
pH	6.5 - 8.5	—	9-19-00 (8.6) 7-18-00 (8.7) 11-2-99 (8.6)	9-19-00 (9.0)	2-1-00 (8.8) 7-11-00 (8.7) 7-18-00 (8.6) 9-19-00 (8.7) 9-16-00 (8.6)	12-8-99 (8.6) 9-12-00 (8.6) 9-19-00 (8.7)	NE
Fish bioassay, % survival	70[c]	—	NE	NE	NE	NE	NE
Specific conductance, µmhos/cm	—	—	NE	NE	NE	NE	NE

[a] This number is a 4-day average based on hardness of 200 mg $CaCO_3$/L.
[b] This number is a 4-day average based on hardness of 100 mg $CaCO_3$/L.
[c] 70% for any single bioassay, 90% for the median of three consecutive bioassays.

Exceedance values are indicated in parentheses.

DDJC = Defense Distribution Depot San Joaquin California
NE = no exceedances
NPDES = National Pollutant Discharge Elimination System
µg/L = micrograms per liter
µmhos/cm = micromhos per centimeter

Table 8. WDR Exceedances for Treatment Plant Effluent in October 1999 through September 2000, DDJC-Sharpe

Constituent	Daily Max Criteria	Monthly Median Criteria	Central Area A Zone	Central Area B/C Zone
cis-1,2-Dichloroethene, µg/L	—	—	NE	NE
TCE, µg/L	1	0.5	NE	NE
PCE, µg/L	1	0.5	NE	NE
Total VOC[a], µg/L	5	1	NE	NE
Arsenic, µg/L	279[b]/57[c]	—	NE	NE
Selenium, µg/L	24.4[b]/7.6[c]	—	NE	NE
Nitrate, mg/L	20.9[b]/3.9[c]	—	NE	11-10-99 (9.0) 12-8-99 (8.4) 7-11-00 (8.6) 8-8-00 (15)
Bromacil, µg/L	90	90	NE	NE
Benzene, µg/L	1	0.5	NE	NE
BTEX, µg/L	5	0.5	NE	NE
pH	6.5 - 8.5	—	10-5-99 (8.6) 1-19-00 (8.6) 8-22-00 (8.6) 9-6-00 (8.6) 9-19-00 (8.7)	9-6-00 (8l6) 9-19-00 (9.0)
Specific conductance, µmhos/cm	—	—	NE	NE

[a] Total VOCs is the sum of all halogenated compounds including TCE and PCE.
[b] Background concentrations for A Zone.
[c] Background concentrations for B/C Zone.

Exceedance values are indicated in parentheses.

BTEX = benzene, toluene, ethylbenzene, and xylenes
DDJC = Defense Distribution Depot San Joaquin California
NE = no exceedances
PCE = tetrachloroethene
TCE = trichloroethene
VOC = volatile organic compound
WDR = waste discharge requirement
µg/L = micrograms per liter
µmhos/cm = micromhos per centimeter

Table 9. R1, R2, R3, and R4 Compliance Monitoring October 1999 through September 2000, DDJC-Sharpe

Constituent	Criteria	R1	R2	R3	R4
Arsenic, µg/L	<10	NE	11-10-99 (21) 1-28-00 (13) 2-1-00 (16)	NE	12-8-99 (11)
Volatile organic compounds, µg/L	—	10-5-99 (9.2)	10-5-99 (8.7)	NE	NE
pH	6.5-8.5/Δ0.5	1-28-00 (9.6) 2-1-00 (8.8) 6-6-00 (8.9) 7-11-00 (8.9) 9-19-00 (9.5)	1-28-00 (7.4) 3-1-00 (6.7) 11-10-99 (8.2) 4-4-00 (7.7) 5-2-00 (8.9) 7-11-00 (8.8) 8-8-00 (7.6) 9-19-00 (9.0)	11-10-99 (9.1) 1-28-00 (8.9) 12-8-99 (9.2) 9-19-00 (8.8)	11-10-99 (8.5) 12-8-99 (8.8) 1-28-00 (8.8) 2-1-00 (7.7) 9-19-00 (10)
Temperature, °F	Δ5° F	NE	NE	NE	NE
Specific conductance, µmhos/cm	—	NE	NE	NE	NE
Turbidity, NTU	Δ<+20%	NE	11-10-99 (48.7) 1-28-00 (18.4)	NE	12-8-99 (4.81)
Dissolved oxygen, mg/L	>7 mg/L	10-5-99 (6.41) 11-10-99 (2.06) 1-28-00 (6.5) 3-1-00 (5.5) 5-2-00 (6.44)	10-5-99 (6.1) 3-1-00 (5.04) 5-2-00 (5.52)	10-5-99 (4.9) 2-1-00 (6.16) 3-1-00 (5.55) 5-2-00 (5.25)	10-5-99 (4.98) 11-10-99 (6.60) 5-2-00 (5.61)

Exceedance values are indicated in parentheses.

DDJC = Defense Distribution Depot San Joaquin California
NE = no exceedances
R1 = SSJIDC sample location, 100 feet upstream
R2 = SSJIDC sample location, 100 feet downstream
R3 = French Camp Slough sample location, 100 feet upstream of confluence at SSJIDC
R4 = French Camp Slough sample location, 100 feet downstream of confluence at SSJIDC
SSJIDC = South San Joaquin Irrigation District Canal
µg/L = micrograms per liter
µmhos/cm = micromhos per centimeter
°F = degrees Fahrenheit

Table 10. NPDES Exceedances for Treatment Plant Effluent in October 2000 through September 2001, DDJC-Sharpe

Constituent	Daily Max Criteria	Monthly Median Criteria	North Balloon	Central Area B/C Zone	South Balloon	El Paso Energy®	Effluent Monthly Median
Arsenic, µg/L	50	40	NE	NE	NE	NE	NE
Chromium VI, µg/L	—	11	NE	NE	NE	NE	NE
Lead, µg/L	—	5.3[a]/3.2[b]	NE	NE	NE	11-7-00 (7)	11-7-00, El Paso Energy® (7)
Mercury, µg/L	2.4	0.012	NE	NE	NE	NE	NE
Volatile organic compounds, µg/L	1.0	<0.5	NE	NE	NE	NE	NE
TPH, µg/L	100	<50	NE	NE	NE	NE	NE
pH	6.5 - 8.5	—	10-10-00 (9.2) 1-30-01 (8.6) 3-9-01 (9.3)	10-10-00 (9.0) 1-10-01 (8.6) 3-9-01 (8.7) 4-17-01 (8.6) 4-24-01 (8.6) 5-1-01 (8.6) 9-18-01 (8.6)	10-10-00 (8.7) 4-3-01 (8.8) 4-10-01 (8.6) 4-24-01 (8.7) 5-1-01 (8.6) 5-15-01 (8.6) 6-13-01 (8.6) 7-25-01 (8.6)	10-19-00 (8.6) 10-24-00 (8.7) 11-21-00 (8.7) 1-10-01 (8.7) 1-16-01 (8.6) 4-3-01 (8.7) 4-10-01 (8.6) 5-1-01 (8.8) 5-9-01 (8.6) 8-7-01 (8.6) 8-21-01 (8.7) 8-28-01 (8.7) 9-5-01 (8.7) 9-18-01 (8.6)	NE
Fish bioassay, % survival	70[c]	—	NE	NE	NE	NE	NE
Specific conductance, µmhos/cm	—	—	NE	NE	NE	NE	NE

[a] This number is a 4-day average based on hardness of 200 mg $CaCO_3$/L.
[b] This number is a 4-day average based on hardness of 100 mg $CaCO_3$/L.
[c] 70% for any single bioassay, 90% for the median of three consecutive bioassays.

Exceedance values are indicated in parentheses.

DDJC = Defense Distribution Depot San Joaquin California
NE = no exceedances
NPDES = National Pollutant Discharge Elimination System
TPH = total petroleum hydrocarbon
µg/L = micrograms per liter
µmhos/cm = micromhos per centimeter

Table 11. WDR Exceedances for Treatment Plant Effluent in October 2000 through September 2001, DDJC-Sharpe

Constituent	Daily Max Criteria	Monthly Median Criteria	Central Area A Zone	Central Area B/C Zone
cis-1,2-Dichloroethene, µg/L	—	—	NE	NE
TCE, µg/L	1	0.5	NE	NE
PCE, µg/L	1	0.5	NE	NE
Total VOC[a], µg/L	5	1	NE	NE
Arsenic, µg/L	279[b]/57[c]	—	NE	NE
Selenium, µg/L	24.4[b]/7.6[c]	—	NE	NE
Nitrate, mg/L	20.9[b]/3.9[c]	—	NE	NE
Bromacil, µg/L	90	90	NE	NE
Benzene, µg/L	1	0.5	NE	NE
BTEX, µg/L	5	0.5	NE	NE
pH	6.5 – 8.5	—	10-10-00 (8.7) 12-5-00 (8.6) 12-19-00 (8.7) 4-3-01 (8.7) 4-17-01 (8.6) 7-25-01 (8.6)	10-10-00 (9.0) 1-10-01 (8.6) 3-9-01 (8.7) 4-17-01 (8.6) 4-24-01 (8.6) 5-1-01 (8.6) 9-18-01 (8.6)
Specific conductance, µmhos/cm	—	—	NE	NE

[a] Total VOCs is the sum of all halogenated compounds including TCE and PCE.
[b] Background concentrations for A Zone.
[c] Background concentrations for B/C Zone.

Exceedance values are indicated in parentheses.

BTEX = benzene, toluene, ethylbenzene, and xylenes
DDJC = Defense Distribution Depot San Joaquin California
NE = no exceedances
PCE = tetrachloroethene
TCE = trichloroethene
VOC = volatile organic compound
WDR = waste discharge requirement
µg/L = micrograms per liter
µmhos/cm = micromhos per centimeter

Table 12. R1, R2, R3, and R4 Compliance Monitoring October 2000 through September 2001, DDJC-Sharpe

Constituent	Criteria	R1	R2	R3	R4
Arsenic, µg/L	<10	12-19-00 (12) 2-6-01 (15) 3-13-01 (1)	12-19-00 (13) 2-6-01 (16) 3-13-01 (12)	NE	NE
Volatile organic compounds, µg/L	—	NE	NE	NE	NE
pH	6.5-8.5/Δ0.5	10-24-00 (8.6) 11-7-00 (9.1) 12-19-00 (9.2) 1-9-01 (9.3) 1-16-01 (8.9) 2-6-01 (8.6) 3-13-01 (9.0) 4-3-01 (9.0) 5-9-01 (9.2) 6-5-01 (8.8) 8-7-01 (8.8) 9-18-01 (8.8)	10-24-00 (8.9) 12-19-00 (9.0) 1-9-01 (8.9) 3-13-01 (8.8) 6-5-01 (8.6)	10-10-00 (9.7) 12-19-00 (9.0) 1-9-01 (8.9) 3-13-01 (8.8) 6-5-01 (8.6)	10-10-00 (9.0) 11-7-00 (8.6) 1-9-01 (8.7) 2-6-01 (8.6) 3-13-01 (8.8) 4-3-01 (8.7) 6-5-01 (8.9)
Temperature, °F	Δ5° F	NE	1-23-01 (62.9) 2-6-01 (59)	NE	NE
Specific conductance, µmhos/cm	—	NE	NE	NE	NE
Turbidity, NTU	Δ<+20%	NE	11-7-00 (9.0)	NE	12-19-00 (6.40) 9-18-01 (36.3)
Dissolved oxygen, mg/L	>7 mg/L	NE	NE	8-7-01 (6.5)	8-7-01 (6.6)

Exceedance values are indicated in parentheses.

DDJC = Defense Distribution Depot San Joaquin California
NE = no exceedances
R1 = SSJIDC sample location, 100 feet upstream
R2 = SSJIDC sample location, 100 feet downstream
R3 = French Camp Slough sample location, 100 feet upstream of confluence at SSJIDC
R4 = French Camp Slough sample location, 100 feet downstream of confluence at SSJIDC
SSJIDC = South San Joaquin Irrigation District Canal
µg/L = micrograms per liter
µmhos/cm = micromhos per centimeter
°F = degrees Fahrenheit

Table 13. NPDES Exceedances for Treatment Plant Effluent in October 2001 through September 2002, DDJC-Sharpe

Constituent	Daily Max Criteria	Monthly Median Criteria	North Balloon	Central Area B/C Zone	South Balloon	El Paso Energy®	Effluent Monthly Median
Arsenic, µg/L	50	40	NE	NE	NE	NE	NE
Chromium VI, µg/L	—	11	NE	NE	NE	NE	NE
Lead, µg/L	—	5.3[a]/3.2[b]	NE	NE	NE	NE	NE
Mercury, µg/L	2.4	0.012	NE	NE	NE	NE	NE
Volatile organic compounds, µg/L	1.0	<0.5	NE	NE	9-17-02 (2.0)	NE	NE
TPH, µg/L	100	<50	NE	NE	NE	NE	NE
pH	6.5 - 8.5	—	12-27-01 (8.6)	12-19-02 (8.8) 1-3-02 (8.6) 6-18-02 (8.6)	10-3-01 (8.7) 2-13-02 (8.7) 4-17-02 (8.6)	10-3-01 (8.7) 10-17-02 (8.6) 10-24-01 (8.7) 11-27-01 (8.7) 12-5-01 (8.6) 12-12-01 (8.7) 12-19-01 (9.1) 12-27-01 (8.8) 3-12-02 (8.6) 5-14-02 (8.6) 5-20-02 (8.6) 6-10-02 (8.6)	
Fish bioassay, % survival	70[c]	—	NE	NE	NE	NE	NE
Specific conductance, µmhos/cm	—	—	NE	NE	NE	NE	NE

[a] This number is a 4-day average based on hardness of 200 mg $CaCO_3$/L.
[b] This number is a 4-day average based on hardness of 100 mg $CaCO_3$/L.
[c] 70% for any single bioassay, 90% for the median of three consecutive bioassays.

Exceedance values are indicated in parentheses.

DDJC = Defense Distribution Depot San Joaquin California+
NE = no exceedances
NPDES = National Pollutant Discharge Elimination System
TPH = total petroleum hydrocarbon
µg/L = micrograms per liter
µmhos/cm = micromhos per centimeter

Table 14. WDR Exceedances for Treatment Plant Effluent in October 2001 through September 2002, DDJC-Sharpe

Constituent	Daily Max Criteria	Monthly Median Criteria	Central Area A Zone	Central Area B/C Zone
cis-1,2-Dichloroethene, µg/L	—	—	NE	NE
TCE, µg/L	1	0.5	NE	NE
PCE, µg/L	1	0.5	NE	NE
Total VOC[a], µg/L	5	1	NE	NE
Arsenic, µg/L	279[b]/57[c]	—	NE	NE
Selenium, µg/L	24.4[b]/7.6[c]	—	NE	NE
Nitrate, mg/L	20.9[b]/3.9[c]	—	NE	NE
Bromacil, µg/L	90	90	NE	NE
Benzene, µg/L	1	0.5	NE	NE
BTEX, µg/L	5	0.5	NE	NE
pH	6.5 – 8.5	—	NE	12-19-01 (8.8)
Specific conductance, µmhos/cm	—	—	NE	NE

[a] Total VOCs is the sum of all halogenated compounds including TCE and PCE.
[b] Background concentrations for A Zone.
[c] Background concentrations for B/C Zone.

Exceedance values are indicated in parentheses.

BTEX = benzene, toluene, ethylbenzene, and xylenes
DDJC = Defense Distribution depot San Joaquin California
NE = no exceedances
PCE = tetrachloroethene
TCE = trichloroethene
VOC = volatile organic compound
WDR = waste discharge requirement
µg/L = micrograms per liter
µmhos/cm = micromhos per centimeter

Table 15. R1, R2, R3, and R4 Compliance Monitoring October 2001 through September 2002, DDJC-Sharpe

Constituent	Criteria	R1	R2	R3	R4
Arsenic, µg/L	<10	11-14-01 (13) 12-4-01 (17) 1-9-02 (11) 2-5-02 (18) 5-8-02 (33)	11-14-01 (17) 12-4-01 (18) 1-9-02 (13) 2-5-02 (17) 5-8-02 (32)	NE	NE
Volatile organic compounds, µg/L	—	NE	NE	NE	NE
pH	6.5-8.5/Δ0.5	12-4-01 (8.6) 6-4-02 (9.0)	6-4-02 (9.0)	2-5-02 (9.0)	12-4-01 (8.7) 2-5-02 (8.4) 6-4-02 (8.6)
Temperature, °F	Δ5° F	NE	NE	NE	NE
Specific conductance, µmhos/cm	—	NE	NE	NE	NE
Turbidity, NTU	Δ<+20%	NE	1-9-02 (7.35)	NE	NE
Dissolved oxygen, mg/L	>7 mg/L	NE	NE	NE	NE

Exceedance values are indicated in parentheses.

DDJC = Defense Distribution Depot San Joaquin California
NE = no exceedances
R1 = SSJIDC sample location, 100 feet upstream
R2 = SSJIDC sample location, 100 feet downstream
R3 = French Camp Slough sample location, 100 feet upstream of confluence at SSJIDC
R4 = French Camp Slough sample location, 100 feet downstream of confluence at SSJIDC
SSJIDC = South San Joaquin Irrigation District Canal
µg/L = micrograms per liter
µmhos/cm = micromhos per centimeter
°F = degrees Fahrenheit

ATTACHMENT 3

Summary of Treatment System Construction and Performance References, OU 2, DDJC-Sharpe

(Source: DDJC-Sharpe OU 2 Soil Vapor Extraction Remedial Action Report)

Table 1. Summary of Treatment System Construction and Performance References, OU 2, DDJC-Sharpe

Year	Topic	Associated Reference
1996	OU 2 Record of Decision identifies ISV as the remediation technology for VOC-contaminated soil and identifies a cleanup standard of 0.35 ppmv for TCE.	Environmental Science and Engineering, Inc., 1996. *Record of Decision Basewide Remedy for DDRW-Sharpe Site*. Final. February.
1996	The Remedial Design Work Plan is submitted to further characterize the VOCs in soil and to collect enough information to conduct modeling and to develop plans, specifications cost estimates, and remedial design documents.	Radian Corporation, 1996. *DDRW-Sharpe, Operable Unit 2 Remedial Design Work Plan*. Final. Prepared for U.S. Army Corps of Engineers, Huntsville. May.
1996	August 1996. Implement Remedial Design Work Plan. Collect samples to further delineate the extent of TCE in soil and to characterize the five sites. Includes collection of SVE information (e.g., soil lithology, soil vapor, and groundwater samples).	Radian Corporation, 1997. *DDRW-Sharpe Operable Unit 2 Pre-Design Technical Summary*. Final. January. Radian Corporation, 1996. *DDRW-Sharpe/Tracy Comprehensive Field Work Plan, Volume 2 of 2.*
1996	August 1996. Implement Remedial Design Work Plan. SVE pilot tests conducted to determine design parameters (air permeability values and radius of influence for SVE wells).	Radian International, 1997. *DDRW-Sharpe Operable Unit 2 Pre-Design Technical Summary*. Final. January. Radian International, 1997. *DDRW-Sharpe Addendum to Operable Unit 2 Pre-Design Technical Summary*. Final. September.
1997	Design is submitted for construction of the trailer-mounted unit, the conveyance piping, the extraction wells, the monitoring wells, and the electrical components at the five sites. Design documents include the Design Analysis Report and the Design Specifications.	Radian International, 1997. *DDRW-Sharpe Operable Unit 2 Soil Vapor Extraction Systems for Sites P-1A, P-1B, P-1C, P-1E, and P-6A. Design Analysis Report. 100% Design*. July. Radian International, 1997. *DDRW-Sharpe Operable Unit 2 Soil Vapor Extraction Systems for Sites P-1A, P-1B, P-1C, P-1E, and P-6A. Specifications. 100% Design*. July.
1998	Work Plan for implementation of the Design Analysis Report.	Radian International, 1998. *Soil Vapor Extraction Implementation Work Plan*. Final. April. Radian International, 1998. *DDJC-Sharpe/Tracy Comprehensive Field Work Plan*. Version 2.0. Final. October.
1998	Contractor (RUST) develops work plan for installation of soil vapor extraction wells and soil vapor monitoring wells.	RUST, 1998. *Soil Vapor Extraction Well Installation Work Plan Addendum, DDJC-Sharpe Site.* September.
1998	1Q98 and 2Q98. SVE system construction.	Radian International, 1998. *DDJC-Sharpe Final Engineering Technical Memorandum, Well Management Task*. July.

Table 1. (Continued)

Year	Topic	Associated Reference
1998	July – October 1998. Startup and proveout phase. Each of the seven SVE circuits was started up and operated for about one week. The startup and proveout activities were documented in a series of proveout letter reports written for each circuit.	Radian International, 1998. DDJC-Sharpe Soil Vapor Extraction System Proveout Letter Reports (Separate letters written for Circuits P-1A1, P-1A2, P-1B, P-1C, P-1E, P-6A1, P-6A2). Draft. August through November. Radian International, 2000. *FFA Annual Progress Report October 1998 – September 1999*. Final. May.
1998	October 1998. Start of Phase 1 operations at each circuit.	Radian International, 2000. *FFA Annual Progress Report October 1998 – September 1999*. Final. May.
1998 – 2001	October 1998 – December 2001. Operation phases 1, 2, 3, and 4 conducted at the five sites. Performance and operations and maintenance are documented in quarterly performance reports, annual progress reports, and quarterly Well Monitoring Program Reports.	Radian International, 1999. *DDJC-Sharpe Soil Vapor Extraction Quarterly Performance Reports* (1Q99, 2Q99). Radian International, 1999-2001. DDJC- Sharpe FFA Annual Progress Reports (October 1998 through September 1999; October 1999 through September 2000; October 2000 through September 2001). Well Monitoring Program Quarterly Monitoring Reports (4Q01).
2000	Work plan to summarize the installation and operation activities for the SVE system and lay out the steps to optimize SVE operations using the SVE Termination or Optimization Process (STOP) protocol and an exit strategy.	Radian International. 2000. *DDJC-Sharpe Soil Vapor Extraction Optimization Work Plan*. Final. October.
2000	"Remedial Process Optimization Work Plan for DDJC-Sharpe" issued under AFCEE contract.	Parsons Engineering Science, Inc., 2000. *Remedial Process Optimization Work Plan for the Sharpe Defense Distribution Depot San Joaquin California.* Issued under AFCEE contract. July.
2000	3Q00 to February 2001. SVE wells were opened to the atmosphere for passive venting when not actively operating.	
2000	December 2000. First soil gas closure/ confirmation sampling event. Included collection of soil gas samples at each circuit to evaluate the need for further SVE operations.	Radian International, 2000. *Soil Gas Closure/Confirmation Sampling (Sites P-1A, P-1B, P-1C, P-1E, and P-6A) Work Plan*. Final. December.
2001	Decision to discontinue operations at P-1E and P-6A1, based on the December 2000 closure/confirmation sampling results.	URS, 2001. Optimization Summary, Internal Email. 3 August.
2001	February – December 2001. Phase 3 and Phase 4 operations conducted, where each circuit was operated in two 2-week cycles per phase.	Quarterly and annual reports.

Table 1. (Continued)

Year	Topic	Associated Reference
2002	Second soil gas closure/confirmation sampling event. January 2002. Included collection of soil gas samples at each circuit to evaluate the need for further SVE operations.	URS, 2002. *Second Round Soil Gas Closure Confirmation Sampling (Sites P-1A, P-1B, P-1C, P-1E, and P-6A) Work Plan*. Final. January.
2002	After Phase 4 operations, the SVE wells were opened to the atmosphere for passive venting.	
2002	Recommendation to discontinue SVE system operations. SVE systems have been constructed and confirmed to be effective. Soil cleanup activities at the five VOC soil remediation system sites completed.	URS, 2002. *DDJC-Sharpe OU 2 Soil Vapor Extraction Remedial Action Report*. Final. May.
2002	SVE system decommissioning of five sites and seven SVE circuits in December 2002. Activities included removal and disposal of all above- and below-ground SV conveyance piping and electrical conduit; abandonment of 30 SVE wells and 28 soil vapor monitoring wells; removal and disposal of concrete pads and piping manifolds.	URS, 2002. *DDJC-Sharpe Soil Vapor Extraction Decommissioning Work Plan*. Final. November.

AFCEE = Air Force Center for Environmental Excellence
DDJC = Defense Distribution Depot San Joaquin California
DDRW = Defense Distribution Region West
FFA = Federal Facilities Agreement
ISV = in situ volatilization
OU = Operable Unit
ppmv = parts per million by volume
Q = quarter
ROI = radius of influence
SV = soil vapor
SVE = soil vapor extraction
TCE = trichloroethene
VOC = volatile organic compound

ATTACHMENT 4

Site Inspection Checklist

Please note that "O&M" is referred to throughout this checklist. At sites where Long-Term Response Actions are in progress, O&M activities may be referred to as "system operations" since these sites are not considered to be in the O&M phase while being remediated under the Superfund program.

Five-Year Review Site Inspection Checklist (Template)

(Working document for site inspection. Information may be completed by hand and attached to the Five-Year Review report as supporting documentation of site status. "N/A" refers to "not applicable.")

I. SITE INFORMATION

Site name: North Billerica GWTP	**Date of inspection:** 7/8/03
Location and Region: DOT - Shaw	**EPA ID:**
Agency, office, or company leading the five-year review: USD	**Weather/temperature:** Clear 80°

Remedy includes: (Check all that apply)

- Landfill cover/containment
- Access controls
- Institutional controls
- (Groundwater pump and treatment)
- Surface water collection and treatment
- Other _____

- Monitored natural attenuation
- Groundwater containment
- Vertical barrier walls

Attachments: Inspection team roster attached Site map attached

II. INTERVIEWS (Check all that apply)

1. **O&M site manager** _____ _____ _____
   Name Title Date
   Interviewed at site at office by phone Phone no. _____
   Problems, suggestions: Report attached _____

2. **O&M staff** _____ _____ _____
   Name Title Date
   Interviewed at site at office by phone Phone no. _____
   Problems, suggestions: Report attached _____

3. **Local regulatory authorities and response agencies** (i.e., State and Tribal offices, emergency response office, police department, office of public health or environmental health, zoning office, recorder of deeds, or other city and county offices, etc.) Fill in all that apply.

Agency _____
Contact _____ _____ _____ _____
Name Title Date Phone no.
Problems; suggestions; Report attached _____

Agency _____
Contact _____ _____ _____ _____
Name Title Date Phone no.
Problems; suggestions; Report attached _____

Agency _____
Contact _____ _____ _____ _____
Name Title Date Phone no.
Problems; suggestions; Report attached _____

Agency _____
Contact _____ _____ _____ _____
Name Title Date Phone no.
Problems; suggestions; Report attached _____

4. **Other interviews** (optional) Report attached.

III. ON-SITE DOCUMENTS & RECORDS VERIFIED (Check all that apply)

1. **O&M Documents**
   - O&M manual — Readily available — Up to date — N/A
   - As-built drawings — Readily available — Up to date — N/A
   - Maintenance logs — Readily available — Up to date — N/A

   Remarks _____

2. **Site-Specific Health and Safety Plan** — Readily available — Up to date — N/A
   - Contingency plan/emergency response plan — Readily available — Up to date — N/A

   Remarks _____

3. **O&M and OSHA Training Records** — Readily available — Up to date — N/A

   Remarks _____

4. **Permits and Service Agreements**
   - Air discharge permit — Readily available — Up to date — N/A
   - Effluent discharge — Readily available — Up to date — N/A
   - Waste disposal, POTW — Readily available — Up to date — N/A
   - Other permits _____ — Readily available — Up to date — N/A

   Remarks _____

5. **Gas Generation Records** — Readily available — Up to date — N/A

   Remarks _____

6. **Settlement Monument Records** — Readily available — Up to date — N/A

   Remarks _____

7. **Groundwater Monitoring Records** — Readily available — Up to date — N/A

   Remarks _____

8. **Leachate Extraction Records** — Readily available — Up to date — N/A

   Remarks _____

9. **Discharge Compliance Records**
   - Air — Readily available — Up to date — N/A
   - Water (effluent) — Readily available — Up to date — N/A

   Remarks _____

10. **Daily Access/Security Logs** — Readily available — Up to date — N/A

    Remarks _____

IV. O&M COSTS

1. **O&M Organization**

State in-house — Contractor for State
PRP in-house — Contractor for PRP
Federal Facility in-house — Contractor for Federal Facility
Other_____

2. **O&M Cost Records**

Readily available — Up to date
Funding mechanism/agreement in place
Original O&M cost estimate_____ Breakdown attached

Total annual cost by year for review period if available

From_____ To_____ _____ Breakdown attached
Date Date Total cost

From_____ To_____ _____ Breakdown attached
Date Date Total cost

From_____ To_____ _____ Breakdown attached
Date Date Total cost

From_____ To_____ _____ Breakdown attached
Date Date Total cost

From_____ To_____ _____ Breakdown attached
Date Date Total cost

3. **Unanticipated or Unusually High O&M Costs During Review Period**

Describe costs and reasons: _____

V. ACCESS AND INSTITUTIONAL CONTROLS — Applicable — N/A

A. Fencing

1. **Fencing damaged** — Location shown on site map — Gates secured — N/A

Remarks_____

B. Other Access Restrictions

1. **Signs and other security measures** — Location shown on site map — N/A

Remarks_____

C. Institutional Controls (ICs)

1. **Implementation and enforcement**

Site conditions imply ICs not properly implemented — Yes No N/A
Site conditions imply ICs not being fully enforced — Yes No N/A

Type of monitoring (e.g., self-reporting, drive by) _____
Frequency _____
Responsible party/agency _____
Contact _____ _____ _____ _____
Name Title Date Phone no.

Reporting is up-to-date — Yes No N/A
Reports are verified by the lead agency — Yes No N/A

Specific requirements in deed or decision documents have been met — Yes No N/A
Violations have been reported — Yes No N/A
Other problems or suggestions: Report attached

_____
_____
_____
_____

2. **Adequacy** ICs are adequate ICs are inadequate N/A
Remarks_____
_____
_____

D. General

1. **Vandalism/trespassing** Location shown on site map No vandalism evident
Remarks_____
_____

2. **Land use changes on site** N/A
Remarks_____
_____

3. **Land use changes off site** N/A
Remarks_____
_____

VI. GENERAL SITE CONDITIONS

A. Roads Applicable N/A

1. **Roads damaged** Location shown on site map (Roads adequate) N/A
Remarks_____
_____

B. Other Site Conditions

Remarks_____

_____

_____

_____

_____

_____

VII. LANDFILL COVERS Applicable N/A

A. Landfill Surface

1. **Settlement** (Low spots) Location shown on site map Settlement not evident
   Areal extent_____ Depth_____
   Remarks_____
   _____

2. **Cracks** Location shown on site map Cracking not evident
   Lengths_____ Widths_____ Depths_____
   Remarks_____
   _____

3. **Erosion** Location shown on site map Erosion not evident
   Areal extent _____ Depth_____
   Remarks_____
   _____

4. **Holes** Location shown on site map **Holes not evident**
   Areal extent _____ **Depth**_____
   Remarks_____
   _____

5. **Vegetative Cover** Grass Cover properly established No signs of stress
   Trees/Shrubs (indicate size and locations on a diagram)
   Remarks _____
   _____

6. **Alternative Cover (armored rock, concrete, etc.)** N/A
   Remarks_____
   _____

7. **Bulges** Location shown on site map Bulges not evident
   Areal extent_____ Height_____
   Remarks _____
   _____

8. **Wet Areas/Water Damage** Wet areas/water damage not evident
   - Wet areas — Location shown on site map — Areal extent_____
   - Ponding — Location shown on site map — Areal extent_____
   - Seeps — Location shown on site map — Areal extent_____
   - Soft subgrade — Location shown on site map — Areal extent_____

   Remarks_____

9. **Slope Instability** Slides — Location shown on site map — No evidence of slope instability
   Areal extent_____
   Remarks_____

B. Benches Applicable N/A

(Horizontally constructed mounds of earth placed across a steep landfill side slope to interrupt the slope in order to slow down the velocity of surface runoff and intercept and convey the runoff to a lined channel.)

1. **Flows Bypass Bench** Location shown on site map N/A or okay
   Remarks_____

2. **Bench Breached** Location shown on site map N/A or okay
   Remarks_____

3. **Bench Overtopped** Location shown on site map N/A or okay
   Remarks_____

C. Letdown Channels Applicable N/A

(Channel lined with erosion control mats, riprap, grout bags, or gabions that descend down the steep side slope of the cover and will allow the runoff water collected by the benches to move off of the landfill cover without creating erosion gullies.)

1. **Settlement** Location shown on site map No evidence of settlement
   Areal extent_____ Depth_____
   Remarks_____

2. **Material Degradation** Location shown on site map No evidence of degradation
   Material type_____ Areal extent_____
   Remarks_____

3. **Erosion** Location shown on site map No evidence of erosion
   Areal extent_____ Depth _____
   Remarks_____

4. **Undercutting** Location shown on site map No evidence of undercutting
Areal extent_____ Depth_____
Remarks_____

5. **Obstructions** Type_____ No obstructions
Location shown on site map Areal extent_____
Size_____
Remarks_____

6. **Excessive Vegetative Growth** Type_____
No evidence of excessive growth
Vegetation in channels does not obstruct flow
Location shown on site map Areal extent_____
Remarks_____

D. Cover Penetrations Applicable N/A

1. **Gas Vents** Active Passive
Properly secured/locked Functioning Routinely sampled Good condition
Evidence of leakage at penetration Needs Maintenance
N/A
Remarks_____

2. **Gas Monitoring Probes**
Properly secured/locked Functioning Routinely sampled Good condition
Evidence of leakage at penetration Needs Maintenance N/A
Remarks_____

3. **Monitoring Wells** (within surface area of landfill)
Properly secured/locked Functioning Routinely sampled Good condition
Evidence of leakage at penetration Needs Maintenance N/A
Remarks_____

4. **Leachate Extraction Wells**
Properly secured/locked Functioning Routinely sampled Good condition
Evidence of leakage at penetration Needs Maintenance N/A
Remarks_____

5. **Settlement Monuments** Located Routinely surveyed N/A
Remarks_____

E. Gas Collection and Treatment	Applicable	N/A

1. **Gas Treatment Facilities**
   Flaring Thermal destruction Collection for reuse
   Good condition Needs Maintenance
   Remarks_____

2. **Gas Collection Wells, Manifolds and Piping**
   Good condition Needs Maintenance
   Remarks_____

3. **Gas Monitoring Facilities** (e.g., gas monitoring of adjacent homes or buildings)
   Good condition Needs Maintenance N/A
   Remarks_____

F. Cover Drainage Layer	Applicable	N/A

1. **Outlet Pipes Inspected** Functioning N/A
   Remarks_____

2. **Outlet Rock Inspected** Functioning N/A
   Remarks_____

G. Detention/Sedimentation Ponds	Applicable	N/A

1. **Siltation** Areal extent_____ Depth_____ N/A
   Siltation not evident
   Remarks_____

2. **Erosion** Areal extent_____ Depth_____
   Erosion not evident
   Remarks_____

3. **Outlet Works** Functioning N/A
   Remarks_____

4. **Dam** Functioning N/A
   Remarks_____

II. Retaining Walls Applicable N/A

1. **Deformations** Location shown on site map Deformation not evident
   Horizontal displacement_____ Vertical displacement_____
   Rotational displacement_____
   Remarks_____

2. **Degradation** Location shown on site map Degradation not evident
   Remarks_____

I. Perimeter Ditches/Off-Site Discharge Applicable N/A

1. **Siltation** Location shown on site map Siltation not evident
   Areal extent _____ Depth _____
   Remarks_____

2. **Vegetative Growth** Location shown on site map N/A
   Vegetation does not impede flow
   Areal extent _____ Type_____
   Remarks_____

3. **Erosion** Location shown on site map Erosion not evident
   Areal extent _____ Depth_____
   Remarks_____

4. **Discharge Structure** Functioning N/A
   Remarks_____

VIII. VERTICAL BARRIER WALLS Applicable N/A

1. **Settlement** Location shown on site map Settlement not evident
   Areal extent_____ Depth_____
   Remarks_____

2. **Performance Monitoring** Type of monitoring_____
   Performance not monitored
   Frequency_____ Evidence of breaching
   Head differential_____
   Remarks_____

IX. GROUNDWATER/SURFACE WATER REMEDIES — Applicable / N/A

A. Groundwater Extraction Wells, Pumps, and Pipelines — Applicable / N/A

1. **Pumps, Wellhead Plumbing, and Electrical**
   (Good condition) All required wells properly operating / Needs Maintenance / N/A
   Remarks _____

2. **Extraction System Pipelines, Valves, Valve Boxes, and Other Appurtenances**
   (Good condition) / Needs Maintenance
   Remarks _____

3. **Spare Parts and Equipment**
   Readily available / Good condition / Requires upgrade / Needs to be provided
   Remarks Not onsite

B. Surface Water Collection Structures, Pumps, and Pipelines — Applicable / (N/A)

1. **Collection Structures, Pumps, and Electrical**
   ~~(Good condition)~~ / Needs Maintenance
   Remarks _____

2. **Surface Water Collection System Pipelines, Valves, Valve Boxes, and Other Appurtenances**
   Good condition / Needs Maintenance
   Remarks _____

3. **Spare Parts and Equipment**
   Readily available / Good condition / Requires upgrade / Needs to be provided
   Remarks _____

C. Treatment System Applicable N/A

1. **Treatment Train** (Check components that apply)
   - Metals removal
   - Oil/water separation
   - Bioremediation
   - Air stripping
   - Carbon adsorbers
   - Filters_____
   - Additive (e.g., chelation agent, flocculent)_____
   - Others_____
   - Good condition
   - Needs Maintenance
   - Sampling ports properly marked and functional
   - Sampling/maintenance log displayed and up to date
   - Equipment properly identified
   - Quantity of groundwater treated annually_____
   - Quantity of surface water treated annually_____

   Remarks_____

2. **Electrical Enclosures and Panels** (properly rated and functional)
   - N/A
   - Good condition
   - Needs Maintenance

   Remarks_____

3. **Tanks, Vaults, Storage Vessels**
   - N/A
   - Good condition
   - Proper secondary containment
   - Needs Maintenance

   Remarks_____

4. **Discharge Structure and Appurtenances**
   - N/A
   - Good condition
   - Needs Maintenance

   Remarks_____

5. **Treatment Building(s)**
   - N/A
   - Good condition (esp. roof and doorways)
   - Needs repair
   - Chemicals and equipment properly stored

   Remarks_____

6. **Monitoring Wells** (pump and treatment remedy)
   - Properly secured/locked
   - Functioning
   - Routinely sampled
   - Good condition
   - All required wells located
   - Needs Maintenance
   - N/A

   Remarks_____

D. Monitoring Data

1. Monitoring Data
   - Is routinely submitted on time
   - Is of acceptable quality

2. Monitoring data suggests:
   - Groundwater plume is effectively contained
   - Contaminant concentrations are declining

D. Monitored Natural Attenuation

1. **Monitoring Wells** (natural attenuation remedy)
   Properly secured/locked Functioning Routinely sampled Good condition
   All required wells located Needs Maintenance N/A
   Remarks_____

X. OTHER REMEDIES

If there are remedies applied at the site which are not covered above, attach an inspection sheet describing the physical nature and condition of any facility associated with the remedy. An example would be soil vapor extraction.

XI. OVERALL OBSERVATIONS

A. Implementation of the Remedy

Describe issues and observations relating to whether the remedy is effective and functioning as designed. Begin with a brief statement of what the remedy is to accomplish (i.e., to contain contaminant plume, minimize infiltration and gas emission, etc.).

B. Adequacy of O&M

Describe issues and observations related to the implementation and scope of O&M procedures. In particular, discuss their relationship to the current and long-term protectiveness of the remedy.

C.	Early Indicators of Potential Remedy Problems
	Describe issues and observations such as unexpected changes in the cost or scope of O&M or a high frequency of unscheduled repairs, that suggest that the protectiveness of the remedy may be compromised in the future.

D.	Opportunities for Optimization
	Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy.

Please note that "O&M" is referred to throughout this checklist. At sites where Long-Term Response Actions are in progress, O&M activities may be referred to as "system operations" since these sites are not considered to be in the O&M phase while being remediated under the Superfund program.

Five-Year Review Site Inspection Checklist (Template)

(Working document for site inspection. Information may be completed by hand and attached to the Five-Year Review report as supporting documentation of site status. "N/A" refers to "not applicable.")

I. SITE INFORMATION

Site name: Central Avs WTP	**Date of inspection:** 7/5/12
Location and Region: DOJC - Shimpa	**EPA ID:**
Agency, office, or company leading the five-year review: USN	**Weather/temperature:** clear 90°

Remedy Includes: (Check all that apply)

- Landfill cover/containment
- Access controls
- Institutional controls
- (Groundwater pump and treatment)
- Surface water collection and treatment
- Other _____

- Monitored natural attenuation
- Groundwater containment
- Vertical barrier walls

Attachments: Inspection team roster attached. Site map attached

II. INTERVIEWS Check all that apply)

1. **O&M site manager** _____ _____ _____
   Name Title Date
   Interviewed at site at office by phone Phone no. _____
   Problems, suggestions: Report attached _____

2. **O&M staff** _____ _____ _____
   Name Title Date
   Interviewed at site at office by phone Phone no. _____
   Problems, suggestions: Report attached _____

3. **Local regulatory authorities and response agencies** (i.e., State and Tribal offices, emergency response office, police department, office of public health or environmental health, zoning office, recorder of deeds, or other city and county offices, etc.) Fill in all that apply.

Agency _____
Contact _____ _____ _____ _____
Name Title Date Phone no.
Problems; suggestions; Report attached _____

Agency _____
Contact _____ _____ _____ _____
Name Title Date Phone no.
Problems; suggestions; Report attached _____

Agency _____
Contact _____ _____ _____ _____
Name Title Date Phone no.
Problems; suggestions; Report attached _____

Agency _____
Contact _____ _____ _____ _____
Name Title Date Phone no.
Problems; suggestions; Report attached _____

4. **Other interviews** (optional) Report attached.

III. ON-SITE DOCUMENTS & RECORDS VERIFIED (Check all that apply)

1. **O&M Documents**

O&M manual	Readily available	Up to date	N/A
As built drawings	Readily available	Up to date	N/A
Maintenance logs	Readily available	Up to date	N/A

Remarks_____

2. **Site-Specific Health and Safety Plan** Readily available Up to date N/A
   Contingency plan/emergency response plan Readily available Up to date N/A
   Remarks_____

3. **O&M and OSHA Training Records** Readily available Up to date N/A
   Remarks_____

4. **Permits and Service Agreements**

Air discharge permit	Readily available	Up to date	N/A
Effluent discharge	Readily available	Up to date	N/A
Waste disposal, POTW	Readily available	Up to date	N/A
Other permits_____	Readily available	Up to date	N/A

Remarks_____

5. **Gas Generation Records** Readily available Up to date N/A
   Remarks_____

6. **Settlement Monument Records** Readily available Up to date N/A
   Remarks_____

7. **Groundwater Monitoring Records** Readily available Up to date N/A
   Remarks_____

8. **Leachate Extraction Records** Readily available Up to date N/A
   Remarks_____

9. **Discharge Compliance Records**

Air	Readily available	Up to date	N/A
Water (effluent)	Readily available	Up to date	N/A

Remarks_____

10. **Daily Access/Security Logs** Readily available Up to date N/A
    Remarks_____

IV. O&M COSTS

1. **O&M Organization**

State in-house — Contractor for State
PRP in-house — Contractor for PRP
Federal Facility in-house — Contractor for Federal Facility
Other_____

2. **O&M Cost Records**

Readily available — Up to date
Funding mechanism/agreement in place
Original O&M cost estimate_____ Breakdown attached

Total annual cost by year for review period if available

From_____ To_____ _____ Breakdown attached
Date Date Total cost
From_____ To_____ _____ Breakdown attached
Date Date Total cost
From_____ To_____ _____ Breakdown attached
Date Date Total cost
From_____ To_____ _____ Breakdown attached
Date Date Total cost
From_____ To_____ _____ Breakdown attached
Date Date Total cost

3. **Unanticipated or Unusually High O&M Costs During Review Period**

Describe costs and reasons: _____

V. ACCESS AND INSTITUTIONAL CONTROLS — Applicable — N/A

A. Fencing

1. **Fencing damaged** — Location shown on site map — Gates secured — N/A
Remarks_____

B. Other Access Restrictions

1. **Signs and other security measures** — Location shown on site map — N/A
Remarks_____

C. Institutional Controls (ICs)

1. **Implementation and enforcement**

Site conditions imply ICs not properly implemented — Yes / No / N/A
Site conditions imply ICs not being fully enforced — Yes / No / N/A

Type of monitoring (*e.g.*, self-reporting, drive by) _____
Frequency _____
Responsible party/agency _____
Contact _____ _____ _____ _____
Name / Title / Date / Phone no.

Reporting is up-to-date — Yes / No / N/A
Reports are verified by the lead agency — Yes / No / N/A

Specific requirements in deed or decision documents have been met — Yes / No / N/A
Violations have been reported — Yes / No / N/A
Other problems or suggestions: Report attached

_____
_____
_____
_____

2. **Adequacy** ICs are adequate ICs are inadequate N/A
Remarks _____
_____
_____

D. General

1. **Vandalism/trespassing** Location shown on site map (No vandalism evident)
Remarks _____
_____

2. **Land use changes on site** N/A
Remarks _____
_____

3. **Land use changes off site** N/A
Remarks _____
_____

VI. GENERAL SITE CONDITIONS

A. Roads Applicable N/A

1. **Roads damaged** Location shown on site map (Roads adequate) N/A
Remarks _____
_____

B. Other Site Conditions

Remarks_____

VII. LANDFILL COVERS Applicable N/A

A. Landfill Surface

1. **Settlement** (Low spots) Location shown on site map Settlement not evident
   Areal extent_____ Depth_____
   Remarks_____

2. **Cracks** Location shown on site map Cracking not evident
   Lengths_____ Widths_____ Depths_____
   Remarks_____

3. **Erosion** Location shown on site map Erosion not evident
   Areal extent_____ Depth_____
   Remarks_____

4. **Holes** Location shown on site map Holes not evident
   Areal extent_____ Depth_____
   Remarks_____

5. **Vegetative Cover** Grass Cover properly established No signs of stress
   Trees/Shrubs (indicate size and locations on a diagram)
   Remarks_____

6. **Alternative Cover (armored rock, concrete, etc.)** N/A
   Remarks_____

7. **Bulges** Location shown on site map Bulges not evident
   Areal extent_____ Height_____
   Remarks_____

8. **Wet Areas/Water Damage** — Wet areas/water damage not evident
   - Wet areas — Location shown on site map — Areal extent_____
   - Ponding — Location shown on site map — Areal extent_____
   - Seeps — Location shown on site map — Areal extent_____
   - Soft subgrade — Location shown on site map — Areal extent_____

   Remarks_____

9. **Slope Instability** — Slides — Location shown on site map — No evidence of slope instability
   Areal extent_____
   Remarks_____

B. Benches — Applicable — N/A

(Horizontally constructed mounds of earth placed across a steep landfill side slope to interrupt the slope in order to slow down the velocity of surface runoff and intercept and convey the runoff to a lined channel.)

1. **Flows Bypass Bench** — Location shown on site map — N/A or okay
   Remarks_____

2. **Bench Breached** — Location shown on site map — N/A or okay
   Remarks_____

3. **Bench Overtopped** — Location shown on site map — N/A or okay
   Remarks_____

C. Letdown Channels — Applicable — N/A

(Channel lined with erosion control mats, riprap, grout bags, or gabions that descend down the steep side slope of the cover and will allow the runoff water collected by the benches to move off of the landfill cover without creating erosion gullies.)

1. **Settlement** — Location shown on site map — No evidence of settlement
   Areal extent_____ Depth_____
   Remarks_____

2. **Material Degradation** — Location shown on site map — No evidence of degradation
   Material type_____ Areal extent_____
   Remarks_____

3. **Erosion** — Location shown on site map — No evidence of erosion
   Areal extent_____ Depth_____
   Remarks_____

4. **Undercutting** Location shown on site map No evidence of undercutting
Areal extent_____ Depth_____
Remarks_____

5. **Obstructions** Type_____ No obstructions
Location shown on site map Areal extent_____
Size_____
Remarks_____

6. **Excessive Vegetative Growth** Type_____
No evidence of excessive growth
Vegetation in channels does not obstruct flow.
Location shown on site map Areal extent_____
Remarks_____

D. Cover Penetrations Applicable N/A

1. **Gas Vents** Active Passive
Properly secured/locked Functioning Routinely sampled Good condition
Evidence of leakage at penetration Needs Maintenance
N/A
Remarks_____

2. **Gas Monitoring Probes**
Properly secured/locked Functioning Routinely sampled Good condition
Evidence of leakage at penetration Needs Maintenance N/A
Remarks_____

3. **Monitoring Wells** (within surface area of landfill)
Properly secured/locked Functioning Routinely sampled Good condition
Evidence of leakage at penetration Needs Maintenance N/A
Remarks_____

4. **Leachate Extraction Wells**
Properly secured/locked Functioning Routinely sampled Good condition
Evidence of leakage at penetration Needs Maintenance N/A
Remarks_____

5. **Settlement Monuments** Located Routinely surveyed N/A
Remarks_____

E. Gas Collection and Treatment	Applicable	N/A
1. **Gas Treatment Facilities** Flaring Thermal destruction Collection for reuse Good condition Needs Maintenance Remarks_____		
2. **Gas Collection Wells, Manifolds and Piping** Good condition Needs Maintenance Remarks_____		
3. **Gas Monitoring Facilities** (*e.g.*, gas monitoring of adjacent homes or buildings) Good condition Needs Maintenance N/A Remarks_____		
F. Cover Drainage Layer	Applicable	N/A
1. **Outlet Pipes Inspected** Functioning N/A Remarks_____		
2. **Outlet Rock Inspected** Functioning N/A Remarks_____		
G. Detention/Sedimentation Ponds	Applicable	N/A
1. **Siltation** Areal extent_____ Depth_____ N/A Siltation not evident Remarks_____		
2. **Erosion** Areal extent_____ Depth_____ Erosion not evident Remarks_____		
3. **Outlet Works** Functioning N/A Remarks_____		
4. **Dam** Functioning N/A Remarks_____		

H. Retaining Walls Applicable N/A

1. **Deformations** Location shown on site map Deformation not evident
   Horizontal displacement_____ Vertical displacement_____
   Rotational displacement_____
   Remarks_____

2. **Degradation** Location shown on site map Degradation not evident
   Remarks_____

I. Perimeter Ditches/Off-Site Discharge Applicable N/A

1. **Siltation** Location shown on site map Siltation not evident
   Areal extent_____ Depth_____
   Remarks_____

2. **Vegetative Growth** Location shown on site map N/A
   Vegetation does not impede flow
   Areal extent_____ Type_____
   Remarks_____

3. **Erosion** Location shown on site map Erosion not evident
   Areal extent_____ Depth_____
   Remarks_____

4. **Discharge Structure** Functioning N/A
   Remarks_____

VIII. VERTICAL BARRIER WALLS Applicable N/A

1. **Settlement** Location shown on site map Settlement not evident
   Areal extent_____ Depth_____
   Remarks_____

2. **Performance Monitoring** Type of monitoring_____
   Performance not monitored
   Frequency_____ Evidence of breaching
   Head differential_____
   Remarks_____

IX. GROUNDWATER/SURFACE WATER REMEDIES — Applicable / N/A

A. Groundwater Extraction Wells, Pumps, and Pipelines — Applicable / N/A

1. **Pumps, Wellhead Plumbing, and Electrical**
   Good condition ~~All required wells properly operating~~ Needs Maintenance N/A
   Remarks

2. **Extraction System Pipelines, Valves, Valve Boxes, and Other Appurtenances**
   Good condition Needs Maintenance
   Remarks

3. **Spare Parts and Equipment**
   Readily available Good condition Requires upgrade Needs to be provided
   Remarks not applicable

B. Surface Water Collection Structures, Pumps, and Pipelines — Applicable / N/A

1. **Collection Structures, Pumps, and Electrical**
   Good condition Needs Maintenance
   Remarks

2. **Surface Water Collection System Pipelines, Valves, Valve Boxes, and Other Appurtenances**
   Good condition Needs Maintenance
   Remarks

3. **Spare Parts and Equipment**
   Readily available Good condition Requires upgrade Needs to be provided
   Remarks

C. Treatment System Applicable N/A

1. **Treatment Train** (Check components that apply)
   Metals removal Oil/water separation Bioremediation
   Air stripping Carbon adsorbers
   Filters
   Additive (e.g., chelation agent, flocculent)
   Others
   Good condition Needs Maintenance
   Sampling ports properly marked and functional
   Sampling/maintenance log displayed and up to date
   Equipment properly identified
   Quantity of groundwater treated annually
   Quantity of surface water treated annually
   Remarks

2. **Electrical Enclosures and Panels** (properly rated and functional)
   N/A Good condition Needs Maintenance
   Remarks

3. **Tanks, Vaults, Storage Vessels**
   N/A Good condition Proper secondary containment Needs Maintenance
   Remarks

4. **Discharge Structure and Appurtenances**
   N/A Good condition Needs Maintenance
   Remarks

5. **Treatment Building(s)**
   N/A Good condition (esp. roof and doorways) Needs repair
   Chemicals and equipment properly stored
   Remarks

6. **Monitoring Wells** (pump and treatment remedy)
   Properly secured/locked Functioning Routinely sampled Good condition
   All required wells located Needs Maintenance N/A
   Remarks

D. Monitoring Data

1. Monitoring Data
   Is routinely submitted on time Is of acceptable quality

2. Monitoring data suggests:
   Groundwater plume is effectively contained Contaminant concentrations are declining

D. Monitored Natural Attenuation

1. **Monitoring Wells** (natural attenuation remedy)
Properly secured/locked Functioning Routinely sampled Good condition
All required wells located Needs Maintenance N/A
Remarks

X. OTHER REMEDIES

If there are remedies applied at the site which are not covered above, attach an inspection sheet describing the physical nature and condition of any facility associated with the remedy. An example would be soil vapor extraction.

XI. OVERALL OBSERVATIONS

A. Implementation of the Remedy

Describe issues and observations relating to whether the remedy is effective and functioning as designed. Begin with a brief statement of what the remedy is to accomplish (i.e., to contain contaminant plume, minimize infiltration and gas emission, etc.).

B. Adequacy of O&M

Describe issues and observations related to the implementation and scope of O&M procedures. In particular, discuss their relationship to the current and long-term protectiveness of the remedy.

C.	Early Indicators of Potential Remedy Problems
	Describe issues and observations such as unexpected changes in the cost or scope of O&M or a high frequency of unscheduled repairs, that suggest that the protectiveness of the remedy may be compromised in the future.

D.	Opportunities for Optimization
	Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy.

Please note that "O&M" is referred to throughout this checklist. At sites where Long-Term Response Actions are in progress, O&M activities may be referred to as "system operations" since these sites are not considered to be in the O&M phase while being remediated under the Superfund program.

Five-Year Review Site Inspection Checklist (Template)

(Working document for site inspection. Information may be completed by hand and attached to the Five-Year Review report as supporting documentation of site status. "N/A" refers to "not applicable.")

I. SITE INFORMATION

Site name: South Ballcon GWTP	**Date of inspection:** 7/3/03
Location and Region: DDJC - Shaw	**EPA ID:**
Agency, office, or company leading the five-year review: USN	**Weather/temperature:** 70° clear

Remedy Includes: (Check all that apply)

- Landfill cover/containment
- Access controls
- Institutional controls
- (Groundwater pump and treatment)
- Surface water collection and treatment
- Other _____

- Monitored natural attenuation
- Groundwater containment
- Vertical barrier walls

Attachments: Inspection team roster attached Site map attached

II. INTERVIEWS (Check all that apply)

1. **O&M site manager** _____ _____ _____
   Name Title Date
   Interviewed at site at office by phone Phone no. _____
   Problems, suggestions: Report attached _____

2. **O&M staff** _____ _____ _____
   Name Title Date
   Interviewed at site at office by phone Phone no. _____
   Problems, suggestions: Report attached _____

3. **Local regulatory authorities and response agencies** (i.e., State and Tribal offices, emergency response office, police department, office of public health or environmental health, zoning office, recorder of deeds, or other city and county offices, etc.) Fill in all that apply.

Agency _____
Contact _____ _____ _____ _____
Name Title Date Phone no.
Problems; suggestions; Report attached _____

Agency _____
Contact _____ _____ _____ _____
Name Title Date Phone no.
Problems; suggestions; Report attached _____

Agency _____
Contact _____ _____ _____ _____
Name Title Date Phone no.
Problems; suggestions; Report attached _____

Agency _____
Contact _____ _____ _____
Name Title Date Phone no.
Problems; suggestions; Report attached _____

4. **Other interviews** (optional) Report attached.

III. ON-SITE DOCUMENTS & RECORDS VERIFIED (Check all that apply)

1.	**O&M Documents**			
	O&M manual	Readily available	Up to date	N/A
	As-built drawings	Readily available	Up to date	N/A
	Maintenance logs	Readily available	Up to date	N/A
	Remarks			
2.	**Site-Specific Health and Safety Plan**	Readily available	Up to date	N/A
	Contingency plan/emergency response plan	Readily available	Up to date	N/A
	Remarks			
3.	**O&M and OSHA Training Records**	Readily available	Up to date	N/A
	Remarks			
4.	**Permits and Service Agreements**			
	Air discharge permit	Readily available	Up to date	N/A
	Effluent discharge	Readily available	Up to date	N/A
	Waste disposal, POTW	Readily available	Up to date	N/A
	Other permits	Readily available	Up to date	N/A
	Remarks			
5.	**Gas Generation Records**	Readily available	Up to date	N/A
	Remarks			
6.	**Settlement Monument Records**	Readily available	Up to date	N/A
	Remarks			
7.	**Groundwater Monitoring Records**	Readily available	Up to date	N/A
	Remarks			
8.	**Leachate Extraction Records**	Readily available	Up to date	N/A
	Remarks			
9.	**Discharge Compliance Records**			
	Air	Readily available	Up to date	N/A
	Water (effluent)	Readily available	Up to date	N/A
	Remarks			
10.	**Daily Access/Security Logs**	Readily available	Up to date	N/A
	Remarks			

IV. O&M COSTS

1. **O&M Organization**

State in-house — Contractor for State
PRP in-house — Contractor for PRP
Federal Facility in-house — Contractor for Federal Facility
Other_____

2. **O&M Cost Records**

Readily available — Up to date
Funding mechanism/agreement in place
Original O&M cost estimate_____ _____ Breakdown attached

Total annual cost by year for review period if available

From_____ To_____ _____ Breakdown attached
Date — Date — Total cost

From_____ To_____ _____ Breakdown attached
Date — Date — Total cost

From_____ To_____ _____ Breakdown attached
Date — Date — Total cost

From_____ To_____ _____ Breakdown attached
Date — Date — Total cost

From_____ To_____ _____ Breakdown attached
Date — Date — Total cost

3. **Unanticipated or Unusually High O&M Costs During Review Period**

Describe costs and reasons: _____

V. ACCESS AND INSTITUTIONAL CONTROLS — Applicable — N/A

A. Fencing

1. **Fencing damaged** — Location shown on site map — (Gates secured) — N/A
Remarks _____

B. Other Access Restrictions

1. **Signs and other security measures** — Location shown on site map — N/A
Remarks _____

C. Institutional Controls (ICs)

1. **Implementation and enforcement**

Site conditions imply ICs not properly implemented — Yes / No / N/A
Site conditions imply ICs not being fully enforced — Yes / No / N/A

Type of monitoring (*e.g.*, self-reporting, drive by) _____
Frequency _____
Responsible party/agency _____
Contact _____
Name / Title / Date / Phone no.

Reporting is up-to-date — Yes / No / N/A
Reports are verified by the lead agency — Yes / No / N/A

Specific requirements in deed or decision documents have been met — Yes / No / N/A
Violations have been reported — Yes / No / N/A
Other problems or suggestions: Report attached

_____

2. **Adequacy** ICs are adequate / ICs are inadequate / N/A
Remarks _____

D. General

1. **Vandalism/trespassing** Location shown on site map (No vandalism evident)
Remarks _____

2. **Land use changes on site** (N/A)
Remarks _____

3. **Land use changes off site** (N/A)
Remarks _____

VI. GENERAL SITE CONDITIONS

A. Roads Applicable / N/A

1. **Roads damaged** Location shown on site map (Roads adequate) N/A
Remarks _____

B. Other Site Conditions

Remarks Treatment system, pad, and extraction wells in satisfactory condition.

VII. LANDFILL COVERS Applicable (N/A)

A. Landfill Surface

1. **Settlement** (Low spots) Location shown on site map Settlement not evident
   Areal extent_____ Depth_____
   Remarks_____

2. **Cracks** Location shown on site map Cracking not evident
   Lengths_____ Widths_____ Depths_____
   Remarks_____

3. Erosion Location shown on site map Erosion not evident
   Areal extent_____ Depth_____
   Remarks_____

4. **Holes** Location shown on site map Holes not evident
   Areal extent_____ Depth_____
   Remarks_____

5. **Vegetative Cover** Grass Cover properly established No signs of stress
   Trees/Shrubs (indicate size and locations on a diagram)
   Remarks_____

6. **Alternative Cover (armored rock, concrete, etc.)** N/A
   Remarks_____

7. Bulges Location shown on site map Bulges not evident
   Areal extent_____ Height_____
   Remarks_____

8. **Wet Areas/Water Damage** — Wet areas/water damage not evident
   - Wet areas — Location shown on site map — Areal extent_____
   - Ponding — Location shown on site map — Areal extent_____
   - Seeps — Location shown on site map — Areal extent_____
   - Soft subgrade — Location shown on site map — Areal extent_____

   Remarks_____

9. **Slope Instability** — Slides — Location shown on site map — No evidence of slope instability
   Areal extent_____
   Remarks_____

B. Benches — Applicable — N/A

(Horizontally constructed mounds of earth placed across a steep landfill side slope to interrupt the slope in order to slow down the velocity of surface runoff and intercept and convey the runoff to a lined channel.)

1. **Flows Bypass Bench** — Location shown on site map — N/A or okay
   Remarks_____

2. **Bench Breached** — Location shown on site map — N/A or okay
   Remarks_____

3. **Bench Overtopped** — Location shown on site map — N/A or okay
   Remarks_____

C. Letdown Channels — Applicable — N/A

(Channel lined with erosion control mats, riprap, grout bags, or gabions that descend down the steep side slope of the cover and will allow the runoff water collected by the benches to move off of the landfill cover without creating erosion gullies.)

1. **Settlement** — Location shown on site map — No evidence of settlement
   Areal extent_____ Depth_____
   Remarks_____

2. **Material Degradation** — Location shown on site map — No evidence of degradation
   Material type_____ Areal extent_____
   Remarks_____

3. **Erosion** — Location shown on site map — No evidence of erosion
   Areal extent_____ Depth_____
   Remarks_____

4. **Undercutting** Location shown on site map No evidence of undercutting
Areal extent_____ Depth_____
Remarks_____

5. **Obstructions** Type_____ No obstructions
Location shown on site map Areal extent_____
Size_____
Remarks_____

6. **Excessive Vegetative Growth** Type_____
No evidence of excessive growth
Vegetation in channels does not obstruct flow
Location shown on site map Areal extent_____
Remarks_____

D. Cover Penetrations Applicable N/A

1. **Gas Vents** Active Passive
Properly secured/locked Functioning Routinely sampled Good condition
Evidence of leakage at penetration Needs Maintenance
N/A
Remarks_____

2 **Gas Monitoring Probes**
Properly secured/locked Functioning Routinely sampled Good condition
Evidence of leakage at penetration Needs Maintenance N/A
Remarks_____

3. **Monitoring Wells** (within surface area of landfill)
Properly secured/locked Functioning Routinely sampled Good condition
Evidence of leakage at penetration Needs Maintenance N/A
Remarks_____

4. **Leachate Extraction Wells**
Properly secured/locked Functioning Routinely sampled Good condition
Evidence of leakage at penetration Needs Maintenance N/A
Remarks_____

5. **Settlement Monuments** Located Routinely surveyed N/A
Remarks_____

E. Gas Collection and Treatment Applicable N/A

1. **Gas Treatment Facilities**
   Flaring Thermal destruction Collection for reuse
   Good condition Needs Maintenance
   Remarks_____

2. **Gas Collection Wells, Manifolds and Piping**
   Good condition Needs Maintenance
   Remarks_____

3. **Gas Monitoring Facilities** (*e.g.*, gas monitoring of adjacent homes or buildings)
   Good condition Needs Maintenance N/A
   Remarks_____

F. Cover Drainage Layer Applicable N/A

1. **Outlet Pipes Inspected** Functioning N/A
   Remarks_____

2. **Outlet Rock Inspected** Functioning N/A
   Remarks_____

G. Detention/Sedimentation Ponds Applicable N/A

1. **Siltation** Areal extent_____ Depth_____ N/A
   Siltation not evident
   Remarks_____

2. **Erosion** Areal extent_____ Depth_____
   Erosion not evident
   Remarks_____

3. **Outlet Works** Functioning N/A
   Remarks_____

4. **Dam** Functioning N/A
   Remarks_____

H. Retaining Walls Applicable N/A

1. **Deformations** Location shown on site map Deformation not evident
   Horizontal displacement_____ Vertical displacement_____
   Rotational displacement_____
   Remarks_____

2. **Degradation** Location shown on site map Degradation not evident
   Remarks_____

I. Perimeter Ditches/Off-Site Discharge Applicable N/A

1. **Siltation** Location shown on site map Siltation not evident
   Areal extent_____ Depth_____
   Remarks_____

2. **Vegetative Growth** Location shown on site map N/A
   Vegetation does not impede flow
   Areal extent_____ Type_____
   Remarks_____

3. **Erosion** Location shown on site map Erosion not evident
   Areal extent_____ Depth_____
   Remarks_____

4. **Discharge Structure** Functioning N/A
   Remarks_____

VIII. VERTICAL BARRIER WALLS Applicable N/A

1. **Settlement** Location shown on site map Settlement not evident
   Areal extent_____ Depth_____
   Remarks_____

2. **Performance Monitoring** Type of monitoring_____
   Performance not monitored
   Frequency_____ Evidence of breaching
   Head differential_____
   Remarks_____

IX. GROUNDWATER/SURFACE WATER REMEDIES — Applicable / N/A

A. Groundwater Extraction Wells, Pumps, and Pipelines — (Applicable) / N/A

1. **Pumps, ~~Wellhead Plumbing~~, and Electrical**
   (Good condition) All required wells properly operating Needs Maintenance N/A
   Remarks _____

2. **Extraction System Pipelines, Valves, Valve Boxes, and Other Appurtenances**
   (Good condition) Needs Maintenance
   Remarks _____

3. **Spare Parts and Equipment**
   Readily available Good condition Requires upgrade Needs to be provided
   Remarks not available

B. Surface Water Collection Structures, Pumps, and Pipelines — Applicable / (N/A)

1. **Collection Structures, Pumps, and Electrical**
   Good condition Needs Maintenance
   Remarks _____

2. **Surface Water Collection System Pipelines, Valves, Valve Boxes, and Other Appurtenances**
   Good condition Needs Maintenance
   Remarks _____

3. **Spare Parts and Equipment**
   Readily available Good condition Requires upgrade Needs to be provided
   Remarks _____

C. Treatment System Applicable N/A

1. **Treatment Train** (Check components that apply)
   - Metals removal
   - Oil/water separation
   - Bioremediation
   - Air stripping
   - Carbon adsorbers
   - Filters_____
   - Additive (e.g., chelation agent, flocculent)_____
   - Others_____
   - Good condition
   - Needs Maintenance
   - Sampling ports properly marked and functional
   - Sampling/maintenance log displayed and up to date
   - Equipment properly identified
   - Quantity of groundwater treated annually_____
   - Quantity of surface water treated annually_____
   - Remarks_____

2. **Electrical Enclosures and Panels** (properly rated and functional)
   - N/A
   - Good condition
   - Needs Maintenance
   - Remarks_____

3. **Tanks, Vaults, Storage Vessels**
   - N/A
   - Good condition
   - Proper secondary containment
   - Needs Maintenance
   - Remarks_____

4. **Discharge Structure and Appurtenances**
   - N/A
   - Good condition
   - Needs Maintenance
   - Remarks_____

5. **Treatment Building(s)**
   - N/A
   - Good condition (esp. roof and doorways)
   - Needs repair
   - Chemicals and equipment properly stored
   - Remarks_____

6. **Monitoring Wells** (pump and treatment remedy)
   - Properly secured/locked
   - Functioning
   - Routinely sampled
   - Good condition
   - All required wells located
   - Needs Maintenance
   - N/A
   - Remarks_____

D. Monitoring Data

1. Monitoring Data
   - Is routinely submitted on time
   - Is of acceptable quality

2. Monitoring data suggests:
   - Groundwater plume is effectively contained
   - Contaminant concentrations are declining

D. Monitored Natural Attenuation

1. **Monitoring Wells** (natural attenuation remedy)

Properly secured/locked Functioning Routinely sampled Good condition
All required wells located Needs Maintenance N/A

Remarks_____

X. OTHER REMEDIES

If there are remedies applied at the site which are not covered above, attach an inspection sheet describing the physical nature and condition of any facility associated with the remedy. An example would be soil vapor extraction.

XI. OVERALL OBSERVATIONS

A. Implementation of the Remedy

Describe issues and observations relating to whether the remedy is effective and functioning as designed. Begin with a brief statement of what the remedy is to accomplish (i.e., to contain contaminant plume, minimize infiltration and gas emission, etc.).

B. Adequacy of O&M

Describe issues and observations related to the implementation and scope of O&M procedures. In particular, discuss their relationship to the current and long-term protectiveness of the remedy.

C.	Early Indicators of Potential Remedy Problems
	Describe issues and observations such as unexpected changes in the cost or scope of O&M or a high frequency of unscheduled repairs, that suggest that the protectiveness of the remedy may be compromised in the future.

D.	Opportunities for Optimization
	Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy.

Please note that "O&M" is referred to throughout this checklist. At sites where Long-Term Response Actions are in progress, O&M activities may be referred to as "system operations" since these sites are not considered to be in the O&M phase while being remediated under the Superfund program.

Five-Year Review Site Inspection Checklist (Template)

(Working document for site inspection. Information may be completed by hand and attached to the Five-Year Review report as supporting documentation of site status. "N/A" refers to "not applicable.")

I. SITE INFORMATION

Site name: P-1A, B, C	**Date of inspection:** 7/3/03
Location and Region: DOE Slope	**EPA ID:**
Agency, office, or company leading the five-year review: URS	**Weather/temperature:** Clear 80°

Remedy Includes: (Check all that apply)

- Landfill cover/containment
- Access controls
- Institutional controls
- Groundwater pump and treatment
- Surface water collection and treatment
- Other SVE system - Decommissioned 2002
- Monitored natural attenuation
- Groundwater containment
- Vertical barrier walls

Attachments: Inspection team roster attached Site map attached

II. INTERVIEWS (Check all that apply)

1. **O&M site manager** N/A — Name — Title — Date
   Interviewed at site at office by phone Phone no.
   Problems, suggestions: Report attached

2. **O&M staff** — Name — Title — Date
   Interviewed at site at office by phone Phone no.
   Problems, suggestions: Report attached

3. **Local regulatory authorities and response agencies** (i.e., State and Tribal offices, emergency response office, police department, office of public health or environmental health, zoning office, recorder of deeds, or other city and county offices, etc.) Fill in all that apply.

Agency _____
Contact _____ _____ _____ _____
Name Title Date Phone no.
Problems; suggestions; Report attached _____

Agency _____
Contact _____ _____ _____ _____
Name Title Date Phone no.
Problems; suggestions; Report attached _____

Agency _____
Contact _____ _____ _____ _____
Name Title Date Phone no.
Problems; suggestions; Report attached _____

Agency _____
Contact _____ _____ _____ _____
Name Title Date Phone no.
Problems; suggestions; Report attached _____

4. **Other interviews** (optional) Report attached.

III. ON-SITE DOCUMENTS & RECORDS VERIFIED (Check all that apply)

1.	**O&M Documents**			
	O&M manual	Readily available	Up to date	N/A
	As-built drawings	Readily available	Up to date	N/A
	Maintenance logs	Readily available	Up to date	N/A
	Remarks			
2.	**Site-Specific Health and Safety Plan**	Readily available	Up to date	N/A
	Contingency plan/emergency response plan	Readily available	Up to date	N/A
	Remarks			
3.	**O&M and OSHA Training Records**	Readily available	Up to date	N/A
	Remarks			
4.	**Permits and Service Agreements**			
	Air discharge permit	Readily available	Up to date	N/A
	Effluent discharge	Readily available	Up to date	N/A
	Waste disposal, POTW	Readily available	Up to date	N/A
	Other permits	Readily available	Up to date	N/A
	Remarks			
5.	**Gas Generation Records**	Readily available	Up to date	N/A
	Remarks			
6.	**Settlement Monument Records**	Readily available	Up to date	N/A
	Remarks			
7.	**Groundwater Monitoring Records**	Readily available	Up to date	N/A
	Remarks			
8.	**Leachate Extraction Records**	Readily available	Up to date	N/A
	Remarks			
9.	**Discharge Compliance Records**			
	Air	Readily available	Up to date	N/A
	Water (effluent)	Readily available	Up to date	N/A
	Remarks			
10.	**Daily Access/Security Logs**	Readily available	Up to date	N/A
	Remarks			

IV. O&M COSTS

1. **O&M Organization**

State in-house — Contractor for State
PRP in-house — Contractor for PRP
Federal Facility in-house — Contractor for Federal Facility
Other_____

2. **O&M Cost Records**

Readily available — Up to date
Funding mechanism/agreement in place
Original O&M cost estimate_____ Breakdown attached

Total annual cost by year for review period if available

From _____ To_____ _____ Breakdown attached
Date — Date — Total cost

From _____ To_____ _____ Breakdown attached
Date — Date — Total cost

From _____ To_____ _____ Breakdown attached
Date — Date — Total cost

From _____ To_____ _____ Breakdown attached
Date — Date — Total cost

From _____ To_____ _____ Breakdown attached
Date — Date — Total cost

3. **Unanticipated or Unusually High O&M Costs During Review Period**

Describe costs and reasons: _____

V. ACCESS AND INSTITUTIONAL CONTROLS — Applicable — N/A

A. Fencing

1. **Fencing damaged** — Location shown on site map — Gates secured — N/A

Remarks_____

B. Other Access Restrictions

1. **Signs and other security measures** — Location shown on site map — N/A

Remarks "No Dumping Signs" only.

C. Institutional Controls (ICs)

1. **Implementation and enforcement**

Site conditions imply ICs not properly implemented — Yes / No / N/A
Site conditions imply ICs not being fully enforced — Yes / No / N/A

Type of monitoring (e.g., self-reporting, drive by) _____
Frequency _____
Responsible party/agency _____
Contact _____ _____ _____ _____
Name Title Date Phone no.

Reporting is up-to-date — Yes / No / N/A
Reports are verified by the lead agency — Yes / No / N/A

Specific requirements in deed or decision documents have been met — Yes / No / N/A
Violations have been reported — Yes / No / N/A
Other problems or suggestions: Report attached

_____
_____
_____
_____

2. **Adequacy** ICs are adequate ICs are inadequate N/A
Remarks _____
_____
_____

D. General

1. **Vandalism/trespassing** Location shown on site map (No vandalism evident)
Remarks _____
_____

2. **Land use changes on site** (N/A)
Remarks _____
_____

3. **Land use changes off site** (N/A)
Remarks _____
_____

VI. GENERAL SITE CONDITIONS

A. Roads Applicable N/A

1. **Roads damaged** Location shown on site map Roads adequate (N/A)
Remarks _____
_____

B. Other Site Conditions

Remarks SVE system decommissioned, Area covered with natural vegetation.

VII. LANDFILL COVERS Applicable N/A

A. Landfill Surface

1. **Settlement** (Low spots) Location shown on site map Settlement not evident
   Areal extent_____ Depth_____
   Remarks_____

2. **Cracks** Location shown on site map Cracking not evident
   Lengths_____ Widths_____ Depths_____
   Remarks_____

3. **Erosion** Location shown on site map Erosion not evident
   Areal extent_____ Depth_____
   Remarks_____

4. **Holes** Location shown on site map Holes not evident
   Areal extent_____ Depth_____
   Remarks_____

5. **Vegetative Cover** Grass Cover properly established No signs of stress
   Trees/Shrubs (indicate size and locations on a diagram)
   Remarks_____

6. **Alternative Cover** (armored rock, concrete, etc.) N/A
   Remarks_____

7. **Bulges** Location shown on site map Bulges not evident
   Areal extent_____ Height_____
   Remarks_____

8. **Wet Areas/Water Damage** — Wet areas/water damage not evident
   - Wet areas — Location shown on site map — Areal extent_____
   - Ponding — Location shown on site map — Areal extent_____
   - Seeps — Location shown on site map — Areal extent_____
   - Soft subgrade — Location shown on site map — Areal extent_____

   Remarks_____

9. **Slope Instability** — Slides — Location shown on site map — No evidence of slope instability
   Areal extent_____
   Remarks_____

B. Benches — Applicable — N/A

(Horizontally constructed mounds of earth placed across a steep landfill side slope to interrupt the slope in order to slow down the velocity of surface runoff and intercept and convey the runoff to a lined channel.)

1. **Flows Bypass Bench** — Location shown on site map — N/A or okay
   Remarks_____

2. **Bench Breached** — Location shown on site map — N/A or okay
   Remarks_____

3. **Bench Overtopped** — Location shown on site map — N/A or okay
   Remarks_____

C. Letdown Channels — Applicable — N/A

(Channel lined with erosion control mats, riprap, grout bags, or gabions that descend down the steep side slope of the cover and will allow the runoff water collected by the benches to move off of the landfill cover without creating erosion gullies.)

1. **Settlement** — Location shown on site map — No evidence of settlement
   Areal extent _____ Depth_____
   Remarks_____

2. **Material Degradation** — Location shown on site map — No evidence of degradation
   Material type_____ Areal extent_____
   Remarks_____

3. **Erosion** — Location shown on site map — No evidence of erosion
   Areal extent_____ Depth_____
   Remarks_____

4. **Undercutting** Location shown on site map No evidence of undercutting
Areal extent_____ Depth_____
Remarks_____

5. **Obstructions** Type_____ No obstructions
Location shown on site map Areal extent_____
Size_____
Remarks_____

6. **Excessive Vegetative Growth** Type_____
No evidence of excessive growth
Vegetation in channels does not obstruct flow
Location shown on site map Areal extent_____
Remarks_____

D. Cover Penetrations Applicable (N/A)

1. **Gas Vents** Active Passive
Properly secured/locked Functioning Routinely sampled Good condition
Evidence of leakage at penetration Needs Maintenance
N/A
Remarks SVE wells decommissioned 2002

2. **Gas Monitoring Probes**
Properly secured/locked Functioning Routinely sampled Good condition
Evidence of leakage at penetration Needs Maintenance N/A
Remarks_____

3. **Monitoring Wells** (within surface area of landfill)
Properly secured/locked Functioning Routinely sampled Good condition
Evidence of leakage at penetration Needs Maintenance N/A
Remarks_____

4. **Leachate Extraction Wells**
Properly secured/locked Functioning Routinely sampled Good condition
Evidence of leakage at penetration Needs Maintenance N/A
Remarks_____

5. **Settlement Monuments** Located Routinely surveyed N/A
Remarks_____

E. Gas Collection and Treatment Applicable N/A

1. **Gas Treatment Facilities**
   Flaring Thermal destruction Collection for reuse
   Good condition Needs Maintenance
   Remarks_____

2. **Gas Collection Wells, Manifolds and Piping**
   Good condition Needs Maintenance
   Remarks_____

3. **Gas Monitoring Facilities** (*e.g.*, gas monitoring of adjacent homes or buildings)
   Good condition Needs Maintenance N/A
   Remarks_____

F. Cover Drainage Layer Applicable N/A

1. **Outlet Pipes Inspected** Functioning N/A
   Remarks _____

2. **Outlet Rock Inspected** Functioning N/A
   Remarks_____

G. Detention/Sedimentation Ponds Applicable N/A

1. **Siltation** Areal extent_____ Depth_____ N/A
   Siltation not evident
   Remarks_____

2. **Erosion** Areal extent _____ Depth_____
   Erosion not evident
   Remarks_____

3. **Outlet Works** Functioning N/A
   Remarks _____

4. **Dam** Functioning N/A
   Remarks_____

H. Retaining Walls Applicable (N/A)

1. **Deformations** Location shown on site map Deformation not evident
   Horizontal displacement_____ Vertical displacement_____
   Rotational displacement_____
   Remarks_____

2. **Degradation** Location shown on site map Degradation not evident
   Remarks_____

I. Perimeter Ditches/Off-Site Discharge Applicable (N/A)

1. **Siltation** Location shown on site map Siltation not evident
   Areal extent_____ Depth_____
   Remarks_____

2. **Vegetative Growth** Location shown on site map N/A
   Vegetation does not impede flow
   Areal extent_____ Type_____
   Remarks_____

3. **Erosion** Location shown on site map Erosion not evident
   Areal extent_____ Depth_____
   Remarks_____

4. **Discharge Structure** Functioning N/A
   Remarks_____

VIII. VERTICAL BARRIER WALLS Applicable (N/A)

1. **Settlement** Location shown on site map Settlement not evident
   Areal extent_____ Depth_____
   Remarks_____

2. **Performance Monitoring** Type of monitoring_____
   Performance not monitored
   Frequency_____ Evidence of breaching
   Head differential_____
   Remarks_____

IX. GROUNDWATER/SURFACE WATER REMEDIES — Applicable (N/A)

A. Groundwater Extraction Wells, Pumps, and Pipelines — Applicable N/A

1. **Pumps, Wellhead Plumbing, and Electrical**
   Good condition All required wells properly operating Needs Maintenance N/A
   Remarks_____

2. **Extraction System Pipelines, Valves, Valve Boxes, and Other Appurtenances**
   Good condition Needs Maintenance
   Remarks_____

3. **Spare Parts and Equipment**
   Readily available Good condition Requires upgrade Needs to be provided
   Remarks_____

B. Surface Water Collection Structures, Pumps, and Pipelines — Applicable N/A

1. **Collection Structures, Pumps, and Electrical**
   Good condition Needs Maintenance
   Remarks_____

2. **Surface Water Collection System Pipelines, Valves, Valve Boxes, and Other Appurtenances**
   Good condition Needs Maintenance
   Remarks_____

3. **Spare Parts and Equipment**
   Readily available Good condition Requires upgrade Needs to be provided
   Remarks_____

C. Treatment System Applicable (N/A)

1. **Treatment Train** (Check components that apply)
   - Metals removal — Oil/water separation — Bioremediation
   - Air stripping — Carbon adsorbers
   - Filters _____
   - Additive (*e.g.*, chelation agent, flocculent) _____
   - Others _____
   - Good condition — Needs Maintenance
   - Sampling ports properly marked and functional
   - Sampling/maintenance log displayed and up to date
   - Equipment properly identified
   - Quantity of groundwater treated annually _____
   - Quantity of surface water treated annually _____

   Remarks Site System decommissioned 2002

2. **Electrical Enclosures and Panels** (properly rated and functional)
   N/A — Good condition — Needs Maintenance
   Remarks _____

3. **Tanks, Vaults, Storage Vessels**
   N/A — Good condition — Proper secondary containment — Needs Maintenance
   Remarks _____

4. **Discharge Structure and Appurtenances**
   N/A — Good condition — Needs Maintenance
   Remarks _____

5. **Treatment Building(s)**
   N/A — Good condition (esp. roof and doorways) — Needs repair
   Chemicals and equipment properly stored
   Remarks _____

6. **Monitoring Wells** (pump and treatment remedy)
   Properly secured/locked — Functioning — Routinely sampled — Good condition
   All required wells located — Needs Maintenance — N/A
   Remarks _____

D. Monitoring Data

1. Monitoring Data
   Is routinely submitted on time — Is of acceptable quality

2. Monitoring data suggests:
   Groundwater plume is effectively contained — Contaminant concentrations are declining

D. Monitored Natural Attenuation

1. **Monitoring Wells** (natural attenuation remedy)
   Properly secured/locked Functioning Routinely sampled Good condition
   All required wells located Needs Maintenance N/A
   Remarks_____

X. OTHER REMEDIES

If there are remedies applied at the site which are not covered above, attach an inspection sheet describing the physical nature and condition of any facility associated with the remedy. An example would be soil vapor extraction.

XI. OVERALL OBSERVATIONS

A. Implementation of the Remedy

Describe issues and observations relating to whether the remedy is effective and functioning as designed. Begin with a brief statement of what the remedy is to accomplish (i.e., to contain contaminant plume, minimize infiltration and gas emission, etc.).

B. Adequacy of O&M

Describe issues and observations related to the implementation and scope of O&M procedures. In particular, discuss their relationship to the current and long-term protectiveness of the remedy.

C.	Early Indicators of Potential Remedy Problems
	Describe issues and observations such as unexpected changes in the cost or scope of O&M or a high frequency of unscheduled repairs, that suggest that the protectiveness of the remedy may be compromised in the future.

D.	Opportunities for Optimization
	Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy.

Please note that "O&M" is referred to throughout this checklist. At sites where Long-Term Response Actions are in progress, O&M activities may be referred to as "system operations" since these sites are not considered to be in the O&M phase while being remediated under the Superfund program.

Five-Year Review Site Inspection Checklist (Template)

(Working document for site inspection. Information may be completed by hand and attached to the Five-Year Review report as supporting documentation of site status. "N/A" refers to "not applicable.")

I. SITE INFORMATION	
Site name: PJ-E	**Date of inspection:** 7/3/03
Location and Region: 9032 Shasta	**EPA ID:**
Agency, office, or company leading the five-year review: URS	**Weather/temperature:** clear 80°

Remedy Includes: (Check all that apply)

Landfill cover/containment	Monitored natural attenuation
Access controls	Groundwater containment
Institutional controls	Vertical barrier walls
Groundwater pump and treatment	
Surface water collection and treatment	

Other Soil extraction

Attachments: Inspection team roster attached Site map attached

II. INTERVIEWS (Check all that apply)

1. **O&M site manager** NA _____ _____ _____
   Name Title Date
   Interviewed at site at office by phone Phone no. _____
   Problems, suggestions; Report attached _____

2. **O&M staff** NA _____ _____ _____
   Name Title Date
   Interviewed at site at office by phone Phone no. _____
   Problems, suggestions: Report attached _____

3. **Local regulatory authorities and response agencies** (i.e., State and Tribal offices, emergency response office, police department, office of public health or environmental health, zoning office, recorder of deeds, or other city and county offices, etc.) Fill in all that apply.

Agency _____
Contact _____ _____ _____ _____
Name Title Date Phone no.
Problems; suggestions; Report attached _____

Agency _____
Contact _____ _____ _____ _____
Name Title Date Phone no.
Problems; suggestions; Report attached _____

Agency _____
Contact _____ _____ _____ _____
Name Title Date Phone no.
Problems; suggestions; Report attached _____

Agency _____
Contact _____ _____ _____ _____
Name Title Date Phone no.
Problems; suggestions; Report attached _____

4. **Other interviews** (optional) Report attached.

III. ON-SITE DOCUMENTS & RECORDS VERIFIED (Check all that apply)

1.	**O&M Documents**			
	O&M manual	Readily available	Up to date	N/A
	As-built drawings	Readily available	Up to date	N/A
	Maintenance logs	Readily available	Up to date	N/A
	Remarks			
2.	**Site-Specific Health and Safety Plan**	Readily available	Up to date	N/A
	Contingency plan/emergency response plan	Readily available	Up to date	N/A
	Remarks			
3.	**O&M and OSHA Training Records**	Readily available	Up to date	N/A
	Remarks			
4.	**Permits and Service Agreements**			
	Air discharge permit	Readily available	Up to date	N/A
	Effluent discharge	Readily available	Up to date	N/A
	Waste disposal, POTW	Readily available	Up to date	N/A
	Other permits	Readily available	Up to date	N/A
	Remarks			
5.	**Gas Generation Records**	Readily available	Up to date	N/A
	Remarks			
6.	**Settlement Monument Records**	Readily available	Up to date	N/A
	Remarks			
7.	**Groundwater Monitoring Records**	Readily available	Up to date	N/A
	Remarks			
8.	**Leachate Extraction Records**	Readily available	Up to date	N/A
	Remarks			
9.	**Discharge Compliance Records**			
	Air	Readily available	Up to date	N/A
	Water (effluent)	Readily available	Up to date	N/A
	Remarks			
10.	**Daily Access/Security Logs**	Readily available	Up to date	N/A
	Remarks			

IV. O&M COSTS

1. **O&M Organization**

State in-house — Contractor for State
PRP in-house — Contractor for PRP
Federal Facility in-house — Contractor for Federal Facility
Other_____

2. **O&M Cost Records**

Readily available — Up to date
Funding mechanism/agreement in place
Original O&M cost estimate — Breakdown attached

Total annual cost by year for review period if available

From_____ To_____ _____ Breakdown attached
Date Date Total cost
From_____ To_____ _____ Breakdown attached
Date Date Total cost
From_____ To_____ _____ Breakdown attached
Date Date Total cost
From_____ To_____ _____ Breakdown attached
Date Date Total cost
From_____ To_____ _____ Breakdown attached
Date Date Total cost

3. **Unanticipated or Unusually High O&M Costs During Review Period**

Describe costs and reasons: _____

V. ACCESS AND INSTITUTIONAL CONTROLS — Applicable — N/A

A. Fencing

1. **Fencing damaged** — Location shown on site map — Gates secured — N/A

Remarks_____

B. Other Access Restrictions

1. **Signs and other security measures** — Location shown on site map — N/A

Remarks N/A

C. Institutional Controls (ICs)

1. **Implementation and enforcement**

Site conditions imply ICs not properly implemented — Yes No N/A
Site conditions imply ICs not being fully enforced — Yes No N/A

Type of monitoring (*e.g.*, self-reporting, drive by) _____
Frequency _____
Responsible party/agency _____
Contact _____ _____ _____ _____
Name Title Date Phone no.

Reporting is up-to-date — Yes No N/A
Reports are verified by the lead agency — Yes No N/A

Specific requirements in deed or decision documents have been met — Yes No N/A
Violations have been reported — Yes No N/A
Other problems or suggestions: Report attached

_____
_____
_____
_____

2. **Adequacy** ICs are adequate ICs are inadequate N/A
Remarks _____
_____

D. General

1. **Vandalism/trespassing** Location shown on site map (No vandalism evident)
Remarks _____
_____

2. **Land use changes on site** N/A
Remarks _____
_____

3. **Land use changes off site** N/A
Remarks _____
_____

VI. GENERAL SITE CONDITIONS

A. Roads Applicable N/A

1. **Roads damaged** Location shown on site map (Roads adequate) N/A
Remarks _____
_____

B. Other Site Conditions

Remarks Asphalt pavement in good condition. All SVE activities have been completed and decommissioned.

VII. LANDFILL COVERS Applicable (N/A)

A. Landfill Surface

1. **Settlement** (Low spots) Location shown on site map Settlement not evident
   Areal extent_____ Depth_____
   Remarks_____

2. **Cracks** Location shown on site map Cracking not evident
   Lengths_____ Widths_____ Depths_____
   Remarks_____

3. **Erosion** Location shown on site map Erosion not evident
   Areal extent_____ Depth_____
   Remarks_____

4. **Holes** Location shown on site map Holes not evident
   Areal extent_____ Depth_____
   Remarks_____

5. **Vegetative Cover** Grass Cover properly established No signs of stress
   Trees/Shrubs (indicate size and locations on a diagram)
   Remarks_____

6. **Alternative Cover (armored rock, concrete, etc.)** N/A
   Remarks_____

7. **Bulges** Location shown on site map Bulges not evident
   Areal extent_____ Height_____
   Remarks_____

8. **Wet Areas/Water Damage** — Wet areas/water damage not evident
   - Wet areas — Location shown on site map — Areal extent_____
   - Ponding — Location shown on site map — Areal extent_____
   - Seeps — Location shown on site map — Areal extent_____
   - Soft subgrade — Location shown on site map — Areal extent_____

   Remarks_____

9. **Slope Instability** — Slides — Location shown on site map — No evidence of slope instability
   Areal extent
   Remarks_____

B. Benches — Applicable — N/A

(Horizontally constructed mounds of earth placed across a steep landfill side slope to interrupt the slope in order to slow down the velocity of surface runoff and intercept and convey the runoff to a lined channel.)

1. **Flows Bypass Bench** — Location shown on site map — N/A or okay
   Remarks_____

2. **Bench Breached** — Location shown on site map — N/A or okay
   Remarks_____

3. **Bench Overtopped** — Location shown on site map — N/A or okay
   Remarks_____

C. Letdown Channels — Applicable — N/A

(Channel lined with erosion control mats, riprap, grout bags, or gabions that descend down the steep side slope of the cover and will allow the runoff water collected by the benches to move off of the landfill cover without creating erosion gullies.)

1. **Settlement** — Location shown on site map — No evidence of settlement
   Areal extent_____ Depth_____
   Remarks_____

2. **Material Degradation** — Location shown on site map — No evidence of degradation
   Material type_____ Areal extent_____
   Remarks_____

3. **Erosion** — Location shown on site map — No evidence of erosion
   Areal extent_____ Depth_____
   Remarks_____

4. **Undercutting** Location shown on site map No evidence of undercutting
Areal extent_____ Depth_____
Remarks_____

5. **Obstructions** Type_____ No obstructions
Location shown on site map Areal extent_____
Size_____
Remarks_____

6. **Excessive Vegetative Growth** Type_____
No evidence of excessive growth
Vegetation in channels does not obstruct flow
Location shown on site map Areal extent_____
Remarks_____

D. Cover Penetrations Applicable N/A

1. **Gas Vents** Active Passive
Properly secured/locked Functioning Routinely sampled Good condition
Evidence of leakage at penetration Needs Maintenance
N/A
Remarks_____

2. **Gas Monitoring Probes**
Properly secured/locked Functioning Routinely sampled Good condition
Evidence of leakage at penetration Needs Maintenance N/A
Remarks_____

3. **Monitoring Wells** (within surface area of landfill)
Properly secured/locked Functioning Routinely sampled Good condition
Evidence of leakage at penetration Needs Maintenance N/A
Remarks_____

4. **Leachate Extraction Wells**
Properly secured/locked Functioning Routinely sampled Good condition
Evidence of leakage at penetration Needs Maintenance N/A
Remarks_____

5. **Settlement Monuments** Located Routinely surveyed N/A
Remarks_____

E. Gas Collection and Treatment Applicable (N/A)

1. **Gas Treatment Facilities**
   Flaring Thermal destruction Collection for reuse
   Good condition Needs Maintenance
   Remarks De commissioned.

2. **Gas Collection Wells, Manifolds and Piping**
   Good condition Needs Maintenance
   Remarks_____

3. **Gas Monitoring Facilities** (e.g., gas monitoring of adjacent homes or buildings)
   Good condition Needs Maintenance N/A
   Remarks_____

F. Cover Drainage Layer Applicable N/A

1. **Outlet Pipes Inspected** Functioning N/A
   Remarks_____

2. **Outlet Rock Inspected** Functioning N/A
   Remarks_____

G. Detention/Sedimentation Ponds Applicable (N/A)

1. **Siltation** Areal extent_____ Depth_____ N/A
   Siltation not evident
   Remarks_____

2. **Erosion** Areal extent_____ Depth_____
   Erosion not evident
   Remarks_____

3. **Outlet Works** Functioning N/A
   Remarks_____

4. **Dam** Functioning N/A
   Remarks_____

H. Retaining Walls Applicable N/A

1. **Deformations** Location shown on site map Deformation not evident
   Horizontal displacement_____ Vertical displacement_____
   Rotational displacement_____
   Remarks_____

2. **Degradation** Location shown on site map Degradation not evident
   Remarks_____

I. Perimeter Ditches/Off-Site Discharge Applicable N/A

1. **Siltation** Location shown on site map Siltation not evident
   Areal extent_____ Depth_____
   Remarks_____

2. **Vegetative Growth** Location shown on site map N/A
   Vegetation does not impede flow
   Areal extent_____ Type_____
   Remarks_____

3. **Erosion** Location shown on site map Erosion not evident
   Areal extent Depth
   Remarks_____

4. **Discharge Structure** Functioning N/A
   Remarks_____

VIII. VERTICAL BARRIER WALLS Applicable N/A

1. **Settlement** Location shown on site map Settlement not evident
   Areal extent_____ Depth_____
   Remarks_____

2. **Performance Monitoring** Type of monitoring_____
   Performance not monitored
   Frequency_____ Evidence of breaching
   Head differential_____
   Remarks_____

IX. GROUNDWATER/SURFACE WATER REMEDIES

Applicable ~~N/A~~

A. Groundwater Extraction Wells, Pumps, and Pipelines

Applicable N/A

1. **Pumps, Wellhead Plumbing, and Electrical**
   Good condition All required wells properly operating Needs Maintenance N/A
   Remarks_____

2. **Extraction System Pipelines, Valves, Valve Boxes, and Other Appurtenances**
   Good condition Needs Maintenance
   Remarks_____

3. **Spare Parts and Equipment**
   Readily available Good condition Requires upgrade Needs to be provided
   Remarks_____

B. Surface Water Collection Structures, Pumps, and Pipelines

Applicable N/A

1. **Collection Structures, Pumps, and Electrical**
   Good condition Needs Maintenance
   Remarks_____

2. **Surface Water Collection System Pipelines, Valves, Valve Boxes, and Other Appurtenances**
   Good condition Needs Maintenance
   Remarks_____

3. **Spare Parts and Equipment**
   Readily available Good condition Requires upgrade Needs to be provided
   Remarks_____

C. Treatment System Applicable (N/A)

1. **Treatment Train** (Check components that apply)
   - Metals removal
   - Oil/water separation
   - Bioremediation
   - Air stripping
   - Carbon adsorbers
   - Filters_____
   - Additive (e.g., chelation agent, flocculent)_____
   - Others_____
   - Good condition
   - Needs Maintenance
   - Sampling ports properly marked and functional
   - Sampling/maintenance log displayed and up to date
   - Equipment properly identified
   - Quantity of groundwater treated annually_____
   - Quantity of surface water treated annually_____

   Remarks_____

2. **Electrical Enclosures and Panels** (properly rated and functional)
   N/A Good condition Needs Maintenance
   Remarks_____

3. **Tanks, Vaults, Storage Vessels**
   N/A Good condition Proper secondary containment Needs Maintenance
   Remarks_____

4. **Discharge Structure and Appurtenances**
   N/A Good condition Needs Maintenance
   Remarks_____

5. **Treatment Building(s)**
   N/A Good condition (esp. roof and doorways) Needs repair
   Chemicals and equipment properly stored
   Remarks_____

6. **Monitoring Wells** (pump and treatment remedy)
   Properly secured/locked Functioning Routinely sampled Good condition
   All required wells located Needs Maintenance N/A
   Remarks_____

D. Monitoring Data

1. Monitoring Data
   Is routinely submitted on time Is of acceptable quality

2. Monitoring data suggests:
   Groundwater plume is effectively contained Contaminant concentrations are declining

D. Monitored Natural Attenuation

1. **Monitoring Wells** (natural attenuation remedy)
   Properly secured/locked Functioning Routinely sampled Good condition
   All required wells located Needs Maintenance N/A
   Remarks

X. OTHER REMEDIES

If there are remedies applied at the site which are not covered above, attach an inspection sheet describing the physical nature and condition of any facility associated with the remedy. An example would be soil vapor extraction.

XI. OVERALL OBSERVATIONS

A. Implementation of the Remedy

Describe issues and observations relating to whether the remedy is effective and functioning as designed. Begin with a brief statement of what the remedy is to accomplish (i.e., to contain contaminant plume, minimize infiltration and gas emission, etc.).

SVE system decommissioned in 2002. No further actions planned.

B. Adequacy of O&M

Describe issues and observations related to the implementation and scope of O&M procedures. In particular, discuss their relationship to the current and long-term protectiveness of the remedy.

C.	**Early Indicators of Potential Remedy Problems**
	Describe issues and observations such as unexpected changes in the cost or scope of O&M or a high frequency of unscheduled repairs, that suggest that the protectiveness of the remedy may be compromised in the future.

D.	**Opportunities for Optimization**
	Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy.

Please note that "O&M" is referred to throughout this checklist. At sites where Long-Term Response Actions are in progress, O&M activities may be referred to as "system operations" since these sites are not considered to be in the O&M phase while being remediated under the Superfund program.

Five-Year Review Site Inspection Checklist (Template)

(Working document for site inspection. Information may be completed by hand and attached to the Five-Year Review report as supporting documentation of site status. "N/A" refers to "not applicable.")

I. SITE INFORMATION	
Site name: P6A	**Date of inspection:** 7/3/03
Location and Region: DOE - Sharpe	**EPA ID:**
Agency, office, or company leading the five-year review: DOE	**Weather/temperature:** Clear. 80°

Remedy Includes: (Check all that apply)

- Landfill cover/containment
- Access controls
- Institutional controls
- Groundwater pump and treatment
- Surface water collection and treatment
- Other _____
- Monitored natural attenuation
- Groundwater containment
- Vertical barrier walls

Attachments: Inspection team roster attached Site map attached

II. INTERVIEWS (Check all that apply)

1. **O&M site manager** _____ _____ _____
   Name Title Date
   Interviewed at site at office by phone Phone no. _____
   Problems, suggestions; Report attached _____

2. **O&M staff** _____ _____ _____
   Name Title Date
   Interviewed at site at office by phone Phone no _____
   Problems, suggestions; Report attached _____

3. **Local regulatory authorities and response agencies** (i.e., State and Tribal offices, emergency response office, police department, office of public health or environmental health, zoning office, recorder of deeds, or other city and county offices, etc.) Fill in all that apply.

Agency _____
Contact _____ _____ _____ _____
Name Title Date Phone no.
Problems; suggestions; Report attached _____

Agency _____
Contact _____ _____ _____ _____
Name Title Date Phone no.
Problems; suggestions; Report attached _____

Agency _____
Contact _____ _____ _____ _____
Name Title Date Phone no.
Problems; suggestions; Report attached _____

Agency _____
Contact _____ _____ _____ _____
Name Title Date Phone no.
Problems; suggestions; Report attached _____

4. **Other interviews** (optional) Report attached.

III. ON-SITE DOCUMENTS & RECORDS VERIFIED (Check all that apply)

1.	**O&M Documents**			
	O&M manual	Readily available	Up to date	N/A
	As-built drawings	Readily available	Up to date	N/A
	Maintenance logs	Readily available	Up to date	N/A
	Remarks			
2.	**Site-Specific Health and Safety Plan**	Readily available	Up to date	N/A
	Contingency plan/emergency response plan	Readily available	Up to date	N/A
	Remarks			
3.	**O&M and OSHA Training Records**	Readily available	Up to date	N/A
	Remarks			
4.	**Permits and Service Agreements**			
	Air discharge permit	Readily available	Up to date	N/A
	Effluent discharge	Readily available	Up to date	N/A
	Waste disposal, POTW	Readily available	Up to date	N/A
	Other permits	Readily available	Up to date	N/A
	Remarks			
5.	**Gas Generation Records**	Readily available	Up to date	N/A
	Remarks			
6.	**Settlement Monument Records**	Readily available	Up to date	N/A
	Remarks			
7.	**Groundwater Monitoring Records**	Readily available	Up to date	N/A
	Remarks			
8.	**Leachate Extraction Records**	Readily available	Up to date	N/A
	Remarks			
9.	**Discharge Compliance Records**			
	Air	Readily available	Up to date	N/A
	Water (effluent)	Readily available	Up to date	N/A
	Remarks			
10.	**Daily Access/Security Logs**	Readily available	Up to date	N/A
	Remarks			

IV. O&M COSTS

1. **O&M Organization**

State in-house | Contractor for State
PRP in-house | Contractor for PRP
Federal Facility in-house | Contractor for Federal Facility
Other_____

2. **O&M Cost Records**

Readily available | Up to date
Funding mechanism/agreement in place
Original O&M cost estimate_____ | Breakdown attached

Total annual cost by year for review period if available

From_____ To_____ _____ Breakdown attached
Date Date Total cost

From_____ To_____ _____ Breakdown attached
Date Date Total cost

From_____ To_____ _____ Breakdown attached
Date Date Total cost

From_____ To_____ _____ Breakdown attached
Date Date Total cost

From_____ To_____ _____ Breakdown attached
Date Date Total cost

3. **Unanticipated or Unusually High O&M Costs During Review Period**

Describe costs and reasons: _____

V. ACCESS AND INSTITUTIONAL CONTROLS | Applicable | N/A

A. Fencing

1. **Fencing damaged** | Location shown on site map | Gates secured | N/A

Remarks_____

B. Other Access Restrictions

1. **Signs and other security measures** | Location shown on site map | N/A

Remarks_____

C. Institutional Controls (ICs)

1. **Implementation and enforcement**

Site conditions imply ICs not properly implemented — Yes / No / N/A
Site conditions imply ICs not being fully enforced — Yes / No / N/A

Type of monitoring (*e.g.*, self-reporting, drive by) _____
Frequency _____
Responsible party/agency _____
Contact _____ _____ _____ _____ _____
Name / Title / Date / Phone no.

Reporting is up-to-date — Yes / No / N/A
Reports are verified by the lead agency — Yes / No / N/A

Specific requirements in deed or decision documents have been met — Yes / No / N/A
Violations have been reported — Yes / No / N/A
Other problems or suggestions: Report attached

_____
_____
_____
_____

2. **Adequacy** ICs are adequate ICs are inadequate N/A
Remarks _____
_____
_____

D. General

1. **Vandalism/trespassing** Location shown on site map No vandalism evident
Remarks _____
_____

2. **Land use changes on site** N/A
Remarks _____
_____

3. **Land use changes off site** N/A
Remarks _____
_____

VI. GENERAL SITE CONDITIONS

A. Roads Applicable N/A

1. **Roads damaged** Location shown on site map Roads adequate N/A
Remarks _____
_____

B. Other Site Conditions

Remarks_____

VII. LANDFILL COVERS Applicable N/A

A. Landfill Surface

1. **Settlement** (Low spots) Location shown on site map Settlement not evident
   Areal extent_____ Depth_____
   Remarks_____

2. **Cracks** Location shown on site map Cracking not evident
   Lengths_____ Widths_____ Depths_____
   Remarks_____

3. **Erosion** Location shown on site map Erosion not evident
   Areal extent_____ Depth_____
   Remarks_____

4. **Holes** Location shown on site map Holes not evident
   Areal extent_____ Depth_____
   Remarks_____

5. **Vegetative Cover** Grass Cover properly established No signs of stress
   Trees/Shrubs (indicate size and locations on a diagram)
   Remarks_____

6. **Alternative Cover (armored rock, concrete, etc.)** N/A
   Remarks_____

7. **Bulges** Location shown on site map Bulges not evident
   Areal extent_____ Height_____
   Remarks_____

8. **Wet Areas/Water Damage** — Wet areas/water damage not evident
   - Wet areas — Location shown on site map — Areal extent_____
   - Ponding — Location shown on site map — Areal extent_____
   - Seeps — Location shown on site map — Areal extent_____
   - Soft subgrade — Location shown on site map — Areal extent_____

   Remarks_____

9. **Slope Instability** — Slides — Location shown on site map — No evidence of slope instability
   Areal extent _____
   Remarks_____

B. Benches — Applicable — N/A

(Horizontally constructed mounds of earth placed across a steep landfill side slope to interrupt the slope in order to slow down the velocity of surface runoff and intercept and convey the runoff to a lined channel.)

1. **Flows Bypass Bench** — Location shown on site map — N/A or okay
   Remarks_____

2. **Bench Breached** — Location shown on site map — N/A or okay
   Remarks_____

3. **Bench Overtopped** — Location shown on site map — N/A or okay
   Remarks_____

C. Letdown Channels — Applicable — N/A

(Channel lined with erosion control mats, riprap, grout bags, or gabions that descend down the steep side slope of the cover and will allow the runoff water collected by the benches to move off of the landfill cover without creating erosion gullies.)

1. **Settlement** — Location shown on site map — No evidence of settlement
   Areal extent_____ Depth_____
   Remarks_____

2. **Material Degradation** — Location shown on site map — No evidence of degradation
   Material type_____ Areal extent_____
   Remarks_____

3. **Erosion** — Location shown on site map — No evidence of erosion
   Areal extent_____ Depth _____
   Remarks_____

4. **Undercutting** Location shown on site map No evidence of undercutting
Areal extent _____ Depth_____
Remarks_____

5. **Obstructions** Type_____ No obstructions
Location shown on site map Areal extent_____
Size_____
Remarks_____

6. **Excessive Vegetative Growth** Type_____
No evidence of excessive growth
Vegetation in channels does not obstruct flow
Location shown on site map Areal extent_____
Remarks_____

D. Cover Penetrations Applicable N/A

1. **Gas Vents** Active Passive
Properly secured/locked Functioning Routinely sampled Good condition
Evidence of leakage at penetration Needs Maintenance
N/A
Remarks_____

2. **Gas Monitoring Probes**
Properly secured/locked Functioning Routinely sampled Good condition
Evidence of leakage at penetration Needs Maintenance N/A
Remarks_____

3. **Monitoring Wells** (within surface area of landfill)
Properly secured/locked Functioning Routinely sampled Good condition
Evidence of leakage at penetration Needs Maintenance N/A
Remarks_____

4. **Leachate Extraction Wells**
Properly secured/locked Functioning Routinely sampled Good condition
Evidence of leakage at penetration Needs Maintenance N/A
Remarks_____

5. **Settlement Monuments** Located Routinely surveyed N/A
Remarks_____

E. Gas Collection and Treatment	Applicable	N/A

1. **Gas Treatment Facilities**
   Flaring Thermal destruction Collection for reuse
   Good condition Needs Maintenance
   Remarks_____

2. **Gas Collection Wells, Manifolds and Piping**
   Good condition Needs Maintenance
   Remarks_____

3. **Gas Monitoring Facilities** (*e.g.*, gas monitoring of adjacent homes or buildings)
   Good condition Needs Maintenance N/A
   Remarks_____

F. Cover Drainage Layer	Applicable	N/A

1. **Outlet Pipes Inspected** Functioning N/A
   Remarks_____

2. **Outlet Rock Inspected** Functioning N/A
   Remarks_____

G. Detention/Sedimentation Ponds	Applicable	N/A

1. **Siltation** Areal extent_____ Depth_____ N/A
   Siltation not evident
   Remarks_____

2. **Erosion** Areal extent_____ Depth_____
   Erosion not evident
   Remarks_____

3. **Outlet Works** Functioning N/A
   Remarks_____

4. **Dam** Functioning N/A
   Remarks_____

II. Retaining Walls Applicable N/A

1. **Deformations** Location shown on site map Deformation not evident
   Horizontal displacement_____ Vertical displacement_____
   Rotational displacement_____
   Remarks_____

2. **Degradation** Location shown on site map Degradation not evident
   Remarks_____

I. Perimeter Ditches/Off-Site Discharge Applicable N/A

1. **Siltation** Location shown on site map Siltation not evident
   Areal extent_____ Depth_____
   Remarks_____

2. **Vegetative Growth** Location shown on site map N/A
   Vegetation does not impede flow
   Areal extent_____ Type_____
   Remarks_____

3. **Erosion** Location shown on site map Erosion not evident
   Areal extent_____ Depth_____
   Remarks_____

4. **Discharge Structure** Functioning N/A
   Remarks_____

VIII. VERTICAL BARRIER WALLS Applicable N/A

1. **Settlement** Location shown on site map Settlement not evident
   Areal extent_____ Depth_____
   Remarks_____

2. **Performance Monitoring** Type of monitoring_____
   Performance not monitored
   Frequency_____ Evidence of breaching
   Head differential_____
   Remarks_____

IX. GROUNDWATER/SURFACE WATER REMEDIES Applicable N/A

A. Groundwater Extraction Wells, Pumps, and Pipelines Applicable N/A

1. **Pumps, Wellhead Plumbing, and Electrical**
   Good condition All required wells properly operating Needs Maintenance N/A
   Remarks_____

2. **Extraction System Pipelines, Valves, Valve Boxes, and Other Appurtenances**
   Good condition Needs Maintenance
   Remarks_____

3. **Spare Parts and Equipment**
   Readily available Good condition Requires upgrade Needs to be provided
   Remarks_____

B. Surface Water Collection Structures, Pumps, and Pipelines Applicable N/A

1. **Collection Structures, Pumps, and Electrical**
   Good condition Needs Maintenance
   Remarks_____

2. **Surface Water Collection System Pipelines, Valves, Valve Boxes, and Other Appurtenances**
   Good condition Needs Maintenance
   Remarks_____

3. **Spare Parts and Equipment**
   Readily available Good condition Requires upgrade Needs to be provided
   Remarks_____

C. Treatment System Applicable N/A

1. **Treatment Train** (Check components that apply)
   - Metals removal
   - Oil/water separation
   - Bioremediation
   - Air stripping
   - Carbon adsorbers
   - Filters_____
   - Additive (*e.g.*, chelation agent, flocculent)_____
   - Others_____
   - Good condition
   - Needs Maintenance
   - Sampling ports properly marked and functional
   - Sampling/maintenance log displayed and up to date
   - Equipment properly identified
   - Quantity of groundwater treated annually_____
   - Quantity of surface water treated annually_____

   Remarks_____

2. **Electrical Enclosures and Panels** (properly rated and functional)
   - N/A
   - Good condition
   - Needs Maintenance

   Remarks_____

3. **Tanks, Vaults, Storage Vessels**
   - N/A
   - Good condition
   - Proper secondary containment
   - Needs Maintenance

   Remarks_____

4. **Discharge Structure and Appurtenances**
   - N/A
   - Good condition
   - Needs Maintenance

   Remarks_____

5. **Treatment Building(s)**
   - N/A
   - Good condition (esp. roof and doorways)
   - Needs repair
   - Chemicals and equipment properly stored

   Remarks_____

6. **Monitoring Wells** (pump and treatment remedy)
   - Properly secured/locked
   - Functioning
   - Routinely sampled
   - Good condition
   - All required wells located
   - Needs Maintenance
   - N/A

   Remarks_____

D. Monitoring Data

1. Monitoring Data
   - Is routinely submitted on time
   - Is of acceptable quality

2. Monitoring data suggests:
   - Groundwater plume is effectively contained
   - Contaminant concentrations are declining

D. Monitored Natural Attenuation

1. **Monitoring Wells** (natural attenuation remedy)
   Properly secured/locked Functioning Routinely sampled Good condition
   All required wells located Needs Maintenance N/A
   Remarks_____

X. OTHER REMEDIES

If there are remedies applied at the site which are not covered above, attach an inspection sheet describing the physical nature and condition of any facility associated with the remedy. An example would be soil vapor extraction.

XI. OVERALL OBSERVATIONS

A. Implementation of the Remedy

Describe issues and observations relating to whether the remedy is effective and functioning as designed. Begin with a brief statement of what the remedy is to accomplish (i.e., to contain contaminant plume, minimize infiltration and gas emission, etc.).

B. Adequacy of O&M

Describe issues and observations related to the implementation and scope of O&M procedures. In particular, discuss their relationship to the current and long-term protectiveness of the remedy.

C.	**Early Indicators of Potential Remedy Problems**
	Describe issues and observations such as unexpected changes in the cost or scope of O&M or a high frequency of unscheduled repairs, that suggest that the protectiveness of the remedy may be compromised in the future.

D.	**Opportunities for Optimization**
	Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy.

Please note that "O&M" is referred to throughout this checklist. At sites where Long-Term Response Actions are in progress, O&M activities may be referred to as "system operations" since these sites are not considered to be in the O&M phase while being remediated under the Superfund program.

Five-Year Review Site Inspection Checklist (Template)

(Working document for site inspection. Information may be completed by hand and attached to the Five-Year Review report as supporting documentation of site status. "N/A" refers to "not applicable.")

I. SITE INFORMATION

Site name: PB-A	**Date of inspection:** 7/3/03
Location and Region: DDJC - Sharpe	**EPA ID:**
Agency, office, or company leading the five-year review: USN	**Weather/temperature:** Clear 90°

Remedy Includes: (Check all that apply)

- Landfill cover/containment
- Access controls
- Institutional controls
- Groundwater pump and treatment
- Surface water collection and treatment
- Other Pilot Site
- Monitored natural attenuation
- Groundwater containment
- Vertical barrier walls

Attachments: Inspection team roster attached Site map attached

II. INTERVIEWS (Check all that apply)

1. O&M site manager ___ NA ___ ___ ___
   Name Title Date
   Interviewed at site at office by phone Phone no. ___
   Problems, suggestions: Report attached ___

2. O&M staff ___ ___ ___
   Name Title Date
   Interviewed at site at office by phone Phone no. ___
   Problems, suggestions: Report attached ___

3. **Local regulatory authorities and response agencies** (i.e., State and Tribal offices, emergency response office, police department, office of public health or environmental health, zoning office, recorder of deeds, or other city and county offices, etc.) Fill in all that apply.

Agency _____
Contact _____ _____ _____ _____
Name Title Date Phone no.
Problems; suggestions; Report attached _____

Agency _____
Contact _____ _____ _____ _____
Name Title Date Phone no.
Problems; suggestions; Report attached _____

Agency _____
Contact _____ _____ _____ _____
Name Title Date Phone no.
Problems; suggestions; Report attached _____

Agency _____
Contact _____ _____ _____
Name Title Date Phone no.
Problems; suggestions; Report attached _____

4. **Other interviews** (optional) Report attached.

III. ON-SITE DOCUMENTS & RECORDS VERIFIED (Check all that apply)

1. **O&M Documents**
   - O&M manual — Readily available — Up to date — N/A
   - As-built drawings — Readily available — Up to date — N/A
   - Maintenance logs — Readily available — Up to date — N/A

   Remarks _____

2. **Site-Specific Health and Safety Plan** — Readily available — Up to date — N/A
   - Contingency plan/emergency response plan — Readily available — Up to date — N/A

   Remarks _____

3. **O&M and OSHA Training Records** — Readily available — Up to date — N/A

   Remarks _____

4. **Permits and Service Agreements**
   - Air discharge permit — Readily available — Up to date — N/A
   - Effluent discharge — Readily available — Up to date — N/A
   - Waste disposal, POTW — Readily available — Up to date — N/A
   - Other permits _____ — Readily available — Up to date — N/A

   Remarks _____

5. **Gas Generation Records** — Readily available — Up to date — N/A

   Remarks _____

6. **Settlement Monument Records** — Readily available — Up to date — N/A

   Remarks _____

7. **Groundwater Monitoring Records** — Readily available — Up to date — N/A

   Remarks _____

8. **Leachate Extraction Records** — Readily available — Up to date — N/A

   Remarks _____

9. **Discharge Compliance Records**
   - Air — Readily available — Up to date — N/A
   - Water (effluent) — Readily available — Up to date — N/A

   Remarks _____

10. **Daily Access/Security Logs** — Readily available — Up to date — N/A

    Remarks _____

IV. O&M COSTS

1. **O&M Organization**

State in-house — Contractor for State
PRP in-house — Contractor for PRP
Federal Facility in-house — Contractor for Federal Facility
Other_____

2. **O&M Cost Records**

Readily available — Up to date
Funding mechanism/agreement in place
Original O&M cost estimate_____ Breakdown attached

Total annual cost by year for review period if available

From_____ To_____ _____ Breakdown attached
Date Date Total cost
From_____ To_____ _____ Breakdown attached
Date Date Total cost
From_____ To_____ _____ Breakdown attached
Date Date Total cost
From_____ To_____ _____ Breakdown attached
Date Date Total cost
From_____ To_____ _____ Breakdown attached
Date Date Total cost

3. **Unanticipated or Unusually High O&M Costs During Review Period**

Describe costs and reasons: _____

V. ACCESS AND INSTITUTIONAL CONTROLS

Applicable (N/A)

A. Fencing

1. **Fencing damaged** — Location shown on site map — Gates secured — N/A
Remarks_____

B. Other Access Restrictions

1. **Signs and other security measures** — Location shown on site map — N/A
Remarks_____

C. Institutional Controls (ICs)

1. Implementation and enforcement

Site conditions imply ICs not properly implemented — Yes / No / N/A
Site conditions imply ICs not being fully enforced — Yes / No / N/A

Type of monitoring (*e.g.*, self-reporting, drive by) _____
Frequency _____
Responsible party/agency _____
Contact _____

Name	Title	Date	Phone no.

Reporting is up-to-date — Yes / No / N/A
Reports are verified by the lead agency — Yes / No / N/A

Specific requirements in deed or decision documents have been met — Yes / No / N/A
Violations have been reported — Yes / No / N/A
Other problems or suggestions: Report attached

_____

2. Adequacy ICs are adequate ICs are inadequate N/A
Remarks_____

D. General

1. Vandalism/trespassing Location shown on site map (No vandalism evident)
Remarks_____

2. Land use changes on site N/A
Remarks_____

3. Land use changes off site N/A
Remarks_____

VI. GENERAL SITE CONDITIONS

A. Roads Applicable N/A

1. Roads damaged Location shown on site map (Roads adequate) N/A
Remarks _____

B. Other Site Conditions

Remarks Site generally covered w/ asphalt in fair condition. Pilot DUE has been decommissioned

VII. LANDFILL COVERS Applicable N/A

A. Landfill Surface

1. **Settlement** (Low spots) Location shown on site map Settlement not evident
Areal extent_____ Depth_____
Remarks_____

2. **Cracks** Location shown on site map Cracking not evident
Lengths_____ Widths_____ Depths_____
Remarks_____

3. **Erosion** Location shown on site map Erosion not evident
Areal extent_____ Depth_____
Remarks_____

4. **Holes** Location shown on site map Holes not evident
Areal extent_____ Depth_____
Remarks_____

5. **Vegetative Cover** Grass Cover properly established No signs of stress
Trees/Shrubs (indicate size and locations on a diagram)
Remarks_____

6. **Alternative Cover (armored rock, concrete, etc.)** N/A
Remarks_____

7. **Bulges** Location shown on site map Bulges not evident
Areal extent_____ Height_____
Remarks_____

8. **Wet Areas/Water Damage** Wet areas/water damage not evident
   - Wet areas — Location shown on site map — Areal extent_____
   - Ponding — Location shown on site map — Areal extent_____
   - Seeps — Location shown on site map — Areal extent_____
   - Soft subgrade — Location shown on site map — Areal extent_____

   Remarks_____

9. **Slope Instability** Slides — Location shown on site map — No evidence of slope instability
   Areal extent_____
   Remarks_____

B. Benches Applicable N/A

(Horizontally constructed mounds of earth placed across a steep landfill side slope to interrupt the slope in order to slow down the velocity of surface runoff and intercept and convey the runoff to a lined channel.)

1. **Flows Bypass Bench** Location shown on site map N/A or okay
   Remarks_____

2. **Bench Breached** Location shown on site map N/A or okay
   Remarks_____

3. **Bench Overtopped** Location shown on site map N/A or okay
   Remarks_____

C. Letdown Channels Applicable N/A

(Channel lined with erosion control mats, riprap, grout bags, or gabions that descend down the steep side slope of the cover and will allow the runoff water collected by the benches to move off of the landfill cover without creating erosion gullies.)

1. **Settlement** Location shown on site map No evidence of settlement
   Areal extent_____ Depth_____
   Remarks_____

2. **Material Degradation** Location shown on site map No evidence of degradation
   Material type_____ Areal extent_____
   Remarks_____

3. **Erosion** Location shown on site map No evidence of erosion
   Areal extent_____ Depth_____
   Remarks_____

4. **Undercutting** Location shown on site map No evidence of undercutting
Areal extent_____ Depth_____
Remarks_____

5. **Obstructions** Type_____ No obstructions
Location shown on site map Areal extent_____
Size_____
Remarks_____

6. **Excessive Vegetative Growth** Type_____
No evidence of excessive growth
Vegetation in channels does not obstruct flow
Location shown on site map Areal extent_____
Remarks_____

D. Cover Penetrations Applicable N/A

1. **Gas Vents** Active Passive
Properly secured/locked Functioning Routinely sampled Good condition
Evidence of leakage at penetration Needs Maintenance
N/A
Remarks_____

2. **Gas Monitoring Probes**
Properly secured/locked Functioning Routinely sampled Good condition
Evidence of leakage at penetration Needs Maintenance N/A
Remarks_____

3. **Monitoring Wells** (within surface area of landfill)
Properly secured/locked Functioning Routinely sampled Good condition
Evidence of leakage at penetration Needs Maintenance N/A
Remarks_____

4. **Leachate Extraction Wells**
Properly secured/locked Functioning Routinely sampled Good condition
Evidence of leakage at penetration Needs Maintenance N/A
Remarks_____

5. **Settlement Monuments** Located Routinely surveyed N/A
Remarks_____

E. Gas Collection and Treatment	Applicable	N/A

1. **Gas Treatment Facilities**
   Flaring Thermal destruction Collection for reuse
   Good condition Needs Maintenance
   Remarks_____

2. **Gas Collection Wells, Manifolds and Piping**
   Good condition Needs Maintenance
   Remarks_____

3. **Gas Monitoring Facilities** (*e.g.*, gas monitoring of adjacent homes or buildings)
   Good condition Needs Maintenance N/A
   Remarks_____

F. Cover Drainage Layer	Applicable	N/A

1. **Outlet Pipes Inspected** Functioning N/A
   Remarks_____

2. **Outlet Rock Inspected** Functioning N/A
   Remarks_____

G. Detention/Sedimentation Ponds	Applicable	N/A

1. **Siltation** Areal extent_____ Depth_____ N/A
   Siltation not evident
   Remarks_____

2. **Erosion** Areal extent_____ Depth_____
   Erosion not evident
   Remarks_____

3. **Outlet Works** Functioning N/A
   Remarks_____

4. **Dam** Functioning N/A
   Remarks_____

H. Retaining Walls Applicable N/A

1. **Deformations** Location shown on site map Deformation not evident
   Horizontal displacement_____ Vertical displacement_____
   Rotational displacement_____
   Remarks_____

2. **Degradation** Location shown on site map Degradation not evident
   Remarks_____

I. Perimeter Ditches/Off-Site Discharge Applicable N/A

1. **Siltation** Location shown on site map Siltation not evident
   Areal extent_____ Depth_____
   Remarks_____

2. **Vegetative Growth** Location shown on site map N/A
   Vegetation does not impede flow
   Areal extent_____ Type_____
   Remarks_____

3. **Erosion** Location shown on site map Erosion not evident
   Areal extent_____ Depth_____
   Remarks_____

4. **Discharge Structure** Functioning N/A
   Remarks_____

VIII. VERTICAL BARRIER WALLS Applicable N/A

1. **Settlement** Location shown on site map Settlement not evident
   Areal extent_____ Depth_____
   Remarks_____

2. **Performance Monitoring** Type of monitoring_____
   Performance not monitored
   Frequency_____ Evidence of breaching
   Head differential_____
   Remarks_____

IX. GROUNDWATER/SURFACE WATER REMEDIES	Applicable	N/A

A. Groundwater Extraction Wells, Pumps, and Pipelines Applicable N/A

1. **Pumps, Wellhead Plumbing, and Electrical**
   Good condition All required wells properly operating Needs Maintenance N/A
   Remarks _____

2. **Extraction System Pipelines, Valves, Valve Boxes, and Other Appurtenances**
   Good condition Needs Maintenance
   Remarks _____

3. **Spare Parts and Equipment**
   Readily available Good condition Requires upgrade Needs to be provided
   Remarks _____

B. Surface Water Collection Structures, Pumps, and Pipelines Applicable N/A

1. **Collection Structures, Pumps, and Electrical**
   Good condition Needs Maintenance
   Remarks _____

2. **Surface Water Collection System Pipelines, Valves, Valve Boxes, and Other Appurtenances**
   Good condition Needs Maintenance
   Remarks _____

3. **Spare Parts and Equipment**
   Readily available Good condition Requires upgrade Needs to be provided
   Remarks _____

C. Treatment System Applicable N/A

1. **Treatment Train** (Check components that apply)
   - Metals removal
   - Oil/water separation
   - Bioremediation
   - Air stripping
   - Carbon adsorbers
   - Filters_____
   - Additive (*e.g.*, chelation agent, flocculent)_____
   - Others_____
   - Good condition
   - Needs Maintenance
   - Sampling ports properly marked and functional
   - Sampling/maintenance log displayed and up to date
   - Equipment properly identified
   - Quantity of groundwater treated annually_____
   - Quantity of surface water treated annually_____

   Remarks_____

2. **Electrical Enclosures and Panels** (properly rated and functional)
   N/A Good condition Needs Maintenance
   Remarks_____

3. **Tanks, Vaults, Storage Vessels**
   N/A Good condition Proper secondary containment Needs Maintenance
   Remarks_____

4. **Discharge Structure and Appurtenances**
   N/A Good condition Needs Maintenance
   Remarks_____

5. **Treatment Building(s)**
   N/A Good condition (esp. roof and doorways) Needs repair
   Chemicals and equipment properly stored
   Remarks_____

6. **Monitoring Wells** (pump and treatment remedy)
   Properly secured/locked Functioning Routinely sampled Good condition
   All required wells located Needs Maintenance N/A
   Remarks_____

D. Monitoring Data

1. Monitoring Data
   Is routinely submitted on time Is of acceptable quality

2. Monitoring data suggests:
   Groundwater plume is effectively contained Contaminant concentrations are declining

D. Monitored Natural Attenuation

1. **Monitoring Wells** (natural attenuation remedy)
   Properly secured/locked Functioning Routinely sampled Good condition
   All required wells located Needs Maintenance N/A
   Remarks _____

X. OTHER REMEDIES

If there are remedies applied at the site which are not covered above, attach an inspection sheet describing the physical nature and condition of any facility associated with the remedy. An example would be soil vapor extraction.

XI. OVERALL OBSERVATIONS

A. Implementation of the Remedy

Describe issues and observations relating to whether the remedy is effective and functioning as designed. Begin with a brief statement of what the remedy is to accomplish (i.e., to contain contaminant plume, minimize infiltration and gas emission, etc.).

Site system decommissioned.

B. Adequacy of O&M

Describe issues and observations related to the implementation and scope of O&M procedures. In particular, discuss their relationship to the current and long-term protectiveness of the remedy.

C.	Early Indicators of Potential Remedy Problems
	Describe issues and observations such as unexpected changes in the cost or scope of O&M or a high frequency of unscheduled repairs, that suggest that the protectiveness of the remedy may be compromised in the future.
D.	Opportunities for Optimization
	Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy.

Please note that "O&M" is referred to throughout this checklist. At sites where Long-Term Response Actions are in progress, O&M activities may be referred to as "system operations" since these sites are not considered to be in the O&M phase while being remediated under the Superfund program.

Five-Year Review Site Inspection Checklist (Template)

(Working document for site inspection. Information may be completed by hand and attached to the Five-Year Review report as supporting documentation of site status. "N/A" refers to "not applicable.")

I. SITE INFORMATION

Site name: S-3	**Date of inspection:** 7/3/03
Location and Region: DOE - Shoup	**EPA ID:**
Agency, office, or company leading the five-year review: USA	**Weather/temperature:** clear 80°

Remedy Includes: (Check all that apply)

- ☐ Landfill cover/containment
- ☐ Access controls
- ☐ Institutional controls
- ☐ Groundwater pump and treatment
- ☐ Surface water collection and treatment
- ☐ Other excavation
- ☐ Monitored natural attenuation
- ☐ Groundwater containment
- ☐ Vertical barrier walls

Attachments: ☐ Inspection team roster attached ☐ Site map attached

II. INTERVIEWS Check all that apply!

1. **O&M site manager** _____ _____ _____
   Name Title Date
   Interviewed ☐ at site ☐ at office ☐ by phone Phone no. _____
   Problems, suggestions: Report attached _____

2. **O&M staff** _____ _____ _____
   Name Title Date
   Interviewed ☐ at site ☐ at office ☐ by phone Phone no. _____
   Problems, suggestions: Report attached _____

3. **Local regulatory authorities and response agencies** (i.e., State and Tribal offices, emergency response office, police department, office of public health or environmental health, zoning office, recorder of deeds, or other city and county offices, etc.) Fill in all that apply.

Agency _____
Contact _____ _____ _____ _____
Name Title Date Phone no.
Problems; suggestions; Report attached _____

Agency _____
Contact _____ _____ _____ _____
Name Title Date Phone no.
Problems; suggestions; Report attached _____

Agency _____
Contact _____ _____ _____ _____
Name Title Date Phone no.
Problems; suggestions; Report attached _____

Agency _____
Contact _____ _____ _____ _____
Name Title Date Phone no.
Problems; suggestions; Report attached _____

4. **Other interviews** (optional) Report attached.

III. ON-SITE DOCUMENTS & RECORDS VERIFIED (Check all that apply)

1.	**O&M Documents**			
	O&M manual	Readily available	Up to date	N/A
	As-built drawings	Readily available	Up to date	N/A
	Maintenance logs	Readily available	Up to date	N/A
	Remarks			
2.	**Site-Specific Health and Safety Plan**	Readily available	Up to date	N/A
	Contingency plan/emergency response plan	Readily available	Up to date	N/A
	Remarks			
3.	**O&M and OSHA Training Records**	Readily available	Up to date	N/A
	Remarks			
4.	**Permits and Service Agreements**			
	Air discharge permit	Readily available	Up to date	N/A
	Effluent discharge	Readily available	Up to date	N/A
	Waste disposal, POTW	Readily available	Up to date	N/A
	Other permits	Readily available	Up to date	N/A
	Remarks			
5.	**Gas Generation Records**	Readily available	Up to date	N/A
	Remarks			
6.	**Settlement Monument Records**	Readily available	Up to date	N/A
	Remarks			
7.	**Groundwater Monitoring Records**	Readily available	Up to date	N/A
	Remarks			
8.	**Leachate Extraction Records**	Readily available	Up to date	N/A
	Remarks			
9.	**Discharge Compliance Records**			
	Air	Readily available	Up to date	N/A
	Water (effluent)	Readily available	Up to date	N/A
	Remarks			
10.	**Daily Access/Security Logs**	Readily available	Up to date	N/A
	Remarks			

IV. O&M COSTS

1. **O&M Organization**

State in-house — Contractor for State
PRP in-house — Contractor for PRP
Federal Facility in-house — Contractor for Federal Facility
Other_____

2. **O&M Cost Records**

Readily available — Up to date
Funding mechanism/agreement in place
Original O&M cost estimate_____ _____ Breakdown attached

Total annual cost by year for review period if available

From_____ To_____ _____ Breakdown attached
Date Date Total cost

From_____ To_____ _____ Breakdown attached
Date Date Total cost

From_____ To_____ _____ Breakdown attached
Date Date Total cost

From_____ To_____ _____ Breakdown attached
Date Date Total cost

From_____ To_____ _____ Breakdown attached
Date Date Total cost

3. **Unanticipated or Unusually High O&M Costs During Review Period**

Describe costs and reasons: _____

V. ACCESS AND INSTITUTIONAL CONTROLS — Applicable — N/A

A. Fencing

1. **Fencing damaged** — Location shown on site map — Gates secured — N/A

Remarks_____

B. Other Access Restrictions

1. **Signs and other security measures** — Location shown on site map — N/A

Remarks_____

C. Institutional Controls (ICs)

1. **Implementation and enforcement**

Site conditions imply ICs not properly implemented — Yes / No / N/A
Site conditions imply ICs not being fully enforced — Yes / No / N/A

Type of monitoring (*e.g.*, self-reporting, drive by) _____
Frequency _____
Responsible party/agency _____
Contact _____
Name _____ Title _____ Date _____ Phone no. _____

Reporting is up-to-date — Yes / No / N/A
Reports are verified by the lead agency — Yes / No / N/A

Specific requirements in deed or decision documents have been met — Yes / No / N/A
Violations have been reported — Yes / No / N/A
Other problems or suggestions: Report attached

_____

2. **Adequacy** ICs are adequate ICs are inadequate N/A
Remarks _____

D. General

1. **Vandalism/trespassing** Location shown on site map No vandalism evident
Remarks _____

2. **Land use changes on site** N/A
Remarks _____

3. **Land use changes off site** N/A
Remarks _____

VI. GENERAL SITE CONDITIONS

A. Roads Applicable N/A

1. **Roads damaged** Location shown on site map (Roads adequate) N/A
Remarks _____

B. Other Site Conditions

Remarks site covered in ground/asphalt pavement, and vegetation.

VII. LANDFILL COVERS Applicable N/A

A. Landfill Surface

1. **Settlement** (Low spots) Location shown on site map Settlement not evident
   Areal extent_____ Depth_____
   Remarks_____

2. **Cracks** Location shown on site map Cracking not evident
   Lengths_____ Widths_____ Depths_____
   Remarks_____

3. **Erosion** Location shown on site map Erosion not evident
   Areal extent_____ Depth_____
   Remarks_____

4. **Holes** Location shown on site map Holes not evident
   Areal extent_____ Depth_____
   Remarks_____

5. **Vegetative Cover** Grass Cover properly established No signs of stress
   Trees/Shrubs (indicate size and locations on a diagram)
   Remarks_____

6. **Alternative Cover (armored rock, concrete, etc.)** N/A
   Remarks_____

7. **Bulges** Location shown on site map Bulges not evident
   Areal extent_____ Height_____
   Remarks_____

8. **Wet Areas/Water Damage** — Wet areas/water damage not evident
   - Wet areas — Location shown on site map — Areal extent_____
   - Ponding — Location shown on site map — Areal extent_____
   - Seeps — Location shown on site map — Areal extent_____
   - Soft subgrade — Location shown on site map — Areal extent_____

   Remarks_____

9. **Slope Instability** — Slides — Location shown on site map — No evidence of slope instability
   Areal extent_____
   Remarks_____

B. Benches — Applicable — N/A

(Horizontally constructed mounds of earth placed across a steep landfill side slope to interrupt the slope in order to slow down the velocity of surface runoff and intercept and convey the runoff to a lined channel.)

1. **Flows Bypass Bench** — Location shown on site map — N/A or okay
   Remarks_____

2. **Bench Breached** — Location shown on site map — N/A or okay
   Remarks_____

3. **Bench Overtopped** — Location shown on site map — N/A or okay
   Remarks_____

C. Letdown Channels — Applicable — N/A

(Channel lined with erosion control mats, riprap, grout bags, or gabions that descend down the steep side slope of the cover and will allow the runoff water collected by the benches to move off of the landfill cover without creating erosion gullies.)

1. **Settlement** — Location shown on site map — No evidence of settlement
   Areal extent_____ Depth_____
   Remarks_____

2. **Material Degradation** — Location shown on site map — No evidence of degradation
   Material type_____ Areal extent_____
   Remarks_____

3. **Erosion** — Location shown on site map — No evidence of erosion
   Areal extent_____ Depth_____
   Remarks_____

4. **Undercutting** Location shown on site map No evidence of undercutting
Areal extent_____ Depth_____
Remarks_____

5. **Obstructions** Type_____ No obstructions
Location shown on site map Areal extent_____
Size_____
Remarks_____

6. **Excessive Vegetative Growth** Type_____
No evidence of excessive growth
Vegetation in channels does not obstruct flow
Location shown on site map Areal extent_____
Remarks_____

D. Cover Penetrations Applicable N/A

1. **Gas Vents** Active Passive
Properly secured/locked Functioning Routinely sampled Good condition
Evidence of leakage at penetration Needs Maintenance
N/A
Remarks_____

2. **Gas Monitoring Probes**
Properly secured/locked Functioning Routinely sampled Good condition
Evidence of leakage at penetration Needs Maintenance N/A
Remarks_____

3. **Monitoring Wells** (within surface area of landfill)
Properly secured/locked Functioning Routinely sampled Good condition
Evidence of leakage at penetration Needs Maintenance N/A
Remarks_____

4. **Leachate Extraction Wells**
Properly secured/locked Functioning Routinely sampled Good condition
Evidence of leakage at penetration Needs Maintenance N/A
Remarks_____

5. **Settlement Monuments** Located Routinely surveyed N/A
Remarks_____

E. Gas Collection and Treatment Applicable N/A

1. **Gas Treatment Facilities**
   Flaring Thermal destruction Collection for reuse
   Good condition Needs Maintenance
   Remarks_____

2. **Gas Collection Wells, Manifolds and Piping**
   Good condition Needs Maintenance
   Remarks_____

3. **Gas Monitoring Facilities** (e.g., gas monitoring of adjacent homes or buildings)
   Good condition Needs Maintenance N/A
   Remarks_____

F. Cover Drainage Layer Applicable N/A

1. **Outlet Pipes Inspected** Functioning N/A
   Remarks_____

2. **Outlet Rock Inspected** Functioning N/A
   Remarks_____

G. Detention/Sedimentation Ponds Applicable N/A

1. **Siltation** Areal extent_____ Depth_____ N/A
   Siltation not evident
   Remarks_____

2. **Erosion** Areal extent_____ Depth_____
   Erosion not evident
   Remarks_____

3. **Outlet Works** Functioning N/A
   Remarks_____

4. **Dam** Functioning N/A
   Remarks_____

H. Retaining Walls Applicable N/A

1. **Deformations** Location shown on site map Deformation not evident
   Horizontal displacement_____ Vertical displacement_____
   Rotational displacement_____
   Remarks_____

2. **Degradation** Location shown on site map Degradation not evident
   Remarks_____

I. Perimeter Ditches/Off-Site Discharge Applicable N/A

1. **Siltation** Location shown on site map Siltation not evident
   Areal extent_____ Depth_____
   Remarks_____

2. **Vegetative Growth** Location shown on site map N/A
   Vegetation does not impede flow
   Areal extent_____ Type_____
   Remarks_____

3. **Erosion** Location shown on site map Erosion not evident
   Areal extent_____ Depth_____
   Remarks_____

4. **Discharge Structure** Functioning N/A
   Remarks_____

VIII. VERTICAL BARRIER WALLS Applicable N/A

1. **Settlement** Location shown on site map Settlement not evident
   Areal extent_____ Depth_____
   Remarks_____

2. **Performance Monitoring** Type of monitoring_____
   Performance not monitored
   Frequency_____ Evidence of breaching
   Head differential_____
   Remarks_____

IX. GROUNDWATER/SURFACE WATER REMEDIES	Applicable	N/A

A. Groundwater Extraction Wells, Pumps, and Pipelines Applicable N/A

1. **Pumps, Wellhead Plumbing, and Electrical**
   Good condition All required wells properly operating Needs Maintenance N/A
   Remarks_____

2. **Extraction System Pipelines, Valves, Valve Boxes, and Other Appurtenances**
   Good condition Needs Maintenance
   Remarks_____

3. **Spare Parts and Equipment**
   Readily available Good condition Requires upgrade Needs to be provided
   Remarks_____

B. Surface Water Collection Structures, Pumps, and Pipelines Applicable N/A

1. **Collection Structures, Pumps, and Electrical**
   Good condition Needs Maintenance
   Remarks_____

2. **Surface Water Collection System Pipelines, Valves, Valve Boxes, and Other Appurtenances**
   Good condition Needs Maintenance
   Remarks_____

3. **Spare Parts and Equipment**
   Readily available Good condition Requires upgrade Needs to be provided
   Remarks_____

C. Treatment System Applicable N/A

1. **Treatment Train** (Check components that apply)
   - Metals removal
   - Oil/water separation
   - Bioremediation
   - Air stripping
   - Carbon adsorbers
   - Filters_____
   - Additive (*e.g.*, chelation agent, flocculent)_____
   - Others_____
   - Good condition
   - Needs Maintenance
   - Sampling ports properly marked and functional
   - Sampling/maintenance log displayed and up to date
   - Equipment properly identified
   - Quantity of groundwater treated annually_____
   - Quantity of surface water treated annually_____

   Remarks_____

2. **Electrical Enclosures and Panels** (properly rated and functional)
   - N/A
   - Good condition
   - Needs Maintenance

   Remarks_____

3. **Tanks, Vaults, Storage Vessels**
   - N/A
   - Good condition
   - Proper secondary containment
   - Needs Maintenance

   Remarks_____

4. **Discharge Structure and Appurtenances**
   - N/A
   - Good condition
   - Needs Maintenance

   Remarks_____

5. **Treatment Building(s)**
   - N/A
   - Good condition (esp. roof and doorways)
   - Needs repair
   - Chemicals and equipment properly stored

   Remarks_____

6. **Monitoring Wells** (pump and treatment remedy)
   - Properly secured/locked
   - Functioning
   - Routinely sampled
   - Good condition
   - All required wells located
   - Needs Maintenance
   - N/A

   Remarks_____

D. Monitoring Data

1. Monitoring Data
   - Is routinely submitted on time
   - Is of acceptable quality

2. Monitoring data suggests:
   - Groundwater plume is effectively contained
   - Contaminant concentrations are declining

D. Monitored Natural Attenuation

1. **Monitoring Wells** (natural attenuation remedy)
   Properly secured/locked Functioning Routinely sampled Good condition
   All required wells located Needs Maintenance N/A
   Remarks_____

X. OTHER REMEDIES

If there are remedies applied at the site which are not covered above, attach an inspection sheet describing the physical nature and condition of any facility associated with the remedy. An example would be soil vapor extraction.

XI. OVERALL OBSERVATIONS

A. Implementation of the Remedy

Describe issues and observations relating to whether the remedy is effective and functioning as designed. Begin with a brief statement of what the remedy is to accomplish (i.e., to contain contaminant plume, minimize infiltration and gas emission, etc.).

B. Adequacy of O&M

Describe issues and observations related to the implementation and scope of O&M procedures. In particular, discuss their relationship to the current and long-term protectiveness of the remedy

C.	**Early Indicators of Potential Remedy Problems**
	Describe issues and observations such as unexpected changes in the cost or scope of O&M or a high frequency of unscheduled repairs, that suggest that the protectiveness of the remedy may be compromised in the future.

D.	**Opportunities for Optimization**
	Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy.

Please note that "O&M" is referred to throughout this checklist. At sites where Long-Term Response Actions are in progress, O&M activities may be referred to as "system operations" since these sites are not considered to be in the O&M phase while being remediated under the Superfund program.

Five-Year Review Site Inspection Checklist (Template)

(Working document for site inspection. Information may be completed by hand and attached to the Five-Year Review report as supporting documentation of site status. "N/A" refers to "not applicable.")

I. SITE INFORMATION

Site name: S-26	**Date of inspection:** 7/3/03
Location and Region: ODJC - Klapa	**EPA ID:**
Agency, office, or company leading the five-year review: USD	**Weather/temperature:** Clear 80°

Remedy Includes: (Check all that apply)

- Landfill cover/containment
- Access controls
- Institutional controls
- Groundwater pump and treatment
- Surface water collection and treatment
- Other Excavation
- Monitored natural attenuation
- Groundwater containment
- Vertical barrier walls

Attachments: Inspection team roster attached Site map attached

II. INTERVIEWS (Check all that apply)

1. **O&M site manager** _____ _____ _____
   Name Title Date
   Interviewed at site at office by phone Phone no. _____
   Problems, suggestions; Report attached _____

2. **O&M staff** _____ _____ _____
   Name Title Date
   Interviewed at site at office by phone Phone no. _____
   Problems, suggestions; Report attached _____

3. **Local regulatory authorities and response agencies** (i.e., State and Tribal offices, emergency response office, police department, office of public health or environmental health, zoning office, recorder of deeds, or other city and county offices, etc.) Fill in all that apply.

Agency _____
Contact _____ _____ _____ _____
Name Title Date Phone no.
Problems; suggestions; Report attached _____
_____

Agency _____
Contact _____ _____ _____ _____
Name Title Date Phone no.
Problems; suggestions; Report attached _____
_____

Agency _____
Contact _____ _____ _____ _____
Name Title Date Phone no.
Problems; suggestions; Report attached _____
_____

Agency _____
Contact _____ _____ _____ _____
Name Title Date Phone no.
Problems; suggestions; Report attached _____
_____

4. **Other interviews** (optional) Report attached.

III. ON-SITE DOCUMENTS & RECORDS VERIFIED (Check all that apply)

1.	**O&M Documents**			
	O&M manual	Readily available	Up to date	N/A
	As-built drawings	Readily available	Up to date	N/A
	Maintenance logs	Readily available	Up to date	N/A
	Remarks			
2.	**Site-Specific Health and Safety Plan**	Readily available	Up to date	N/A
	Contingency plan/emergency response plan	Readily available	Up to date	N/A
	Remarks			
3.	**O&M and OSHA Training Records**	Readily available	Up to date	N/A
	Remarks			
4.	**Permits and Service Agreements**			
	Air discharge permit	Readily available	Up to date	N/A
	Effluent discharge	Readily available	Up to date	N/A
	Waste disposal, POTW	Readily available	Up to date	N/A
	Other permits	Readily available	Up to date	N/A
	Remarks			
5.	**Gas Generation Records**	Readily available	Up to date	N/A
	Remarks			
6.	**Settlement Monument Records**	Readily available	Up to date	N/A
	Remarks			
7.	**Groundwater Monitoring Records**	Readily available	Up to date	N/A
	Remarks			
8.	**Leachate Extraction Records**	Readily available	Up to date	N/A
	Remarks			
9.	**Discharge Compliance Records**			
	Air	Readily available	Up to date	N/A
	Water (effluent)	Readily available	Up to date	N/A
	Remarks			
10.	**Daily Access/Security Logs**	Readily available	Up to date	N/A
	Remarks			

IV. O&M COSTS

1. **O&M Organization**

State in-house — Contractor for State
PRP in-house — Contractor for PRP
Federal Facility in-house — Contractor for Federal Facility
Other_____

2. **O&M Cost Records**

Readily available — Up to date
Funding mechanism/agreement in place
Original O&M cost estimate_____ Breakdown attached

Total annual cost by year for review period if available

From_____ To_____ _____ Breakdown attached
Date Date Total cost

From_____ To_____ _____ Breakdown attached
Date Date Total cost

From_____ To_____ _____ Breakdown attached
Date Date Total cost

From_____ To_____ _____ Breakdown attached
Date Date Total cost

From_____ To_____ _____ Breakdown attached
Date Date Total cost

3. **Unanticipated or Unusually High O&M Costs During Review Period**

Describe costs and reasons: _____

V. ACCESS AND INSTITUTIONAL CONTROLS

Applicable N/A

A. Fencing

1. **Fencing damaged** — Location shown on site map — Gates secured — N/A

Remarks_____

B. Other Access Restrictions

1. **Signs and other security measures** — Location shown on site map — N/A

Remarks_____

C. Institutional Controls (ICs)

1. **Implementation and enforcement**

Site conditions imply ICs not properly implemented — Yes No N/A
Site conditions imply ICs not being fully enforced — Yes No N/A

Type of monitoring (e.g., self-reporting, drive by) _____
Frequency _____
Responsible party/agency _____
Contact _____ _____ _____ _____
Name Title Date Phone no.

Reporting is up-to-date — Yes No N/A
Reports are verified by the lead agency — Yes No N/A

Specific requirements in deed or decision documents have been met — Yes No N/A
Violations have been reported — Yes No N/A
Other problems or suggestions: Report attached

_____
_____
_____
_____

2. **Adequacy** ICs are adequate ICs are inadequate N/A
Remarks_____
_____
_____

D. General

1. **Vandalism/trespassing** Location shown on site map No vandalism evident
Remarks_____
_____

2. **Land use changes on site** N/A
Remarks_____
_____

3. **Land use changes off site** N/A
Remarks_____
_____

VI. GENERAL SITE CONDITIONS

A. Roads Applicable N/A

1. **Roads damaged** Location shown on site map (Roads adequate) N/A
Remarks_____
_____

B. Other Site Conditions

Remarks Site is covered w/ native vegetation. Groundwater extraction wells located at site.

VII. LANDFILL COVERS Applicable N/A

A. Landfill Surface

1. **Settlement** (Low spots) Location shown on site map Settlement not evident
   Areal extent____ Depth____
   Remarks____

2. **Cracks** Location shown on site map Cracking not evident
   Lengths____ Widths____ Depths____
   Remarks____

3. **Erosion** Location shown on site map Erosion not evident
   Areal extent____ Depth____
   Remarks____

4. **Holes** Location shown on site map Holes not evident
   Areal extent____ Depth____
   Remarks____

5. **Vegetative Cover** Grass Cover properly established No signs of stress
   Trees/Shrubs (indicate size and locations on a diagram)
   Remarks____

6. **Alternative Cover (armored rock, concrete, etc.)** N/A
   Remarks____

7. **Bulges** Location shown on site map Bulges not evident
   Areal extent____ Height____
   Remarks____

8. **Wet Areas/Water Damage** — Wet areas/water damage not evident
   - Wet areas — Location shown on site map — Areal extent_____
   - Ponding — Location shown on site map — Areal extent_____
   - Seeps — Location shown on site map — Areal extent_____
   - Soft subgrade — Location shown on site map — Areal extent_____

   Remarks_____

9. **Slope Instability** — Slides — Location shown on site map — No evidence of slope instability
   Areal extent_____
   Remarks_____

B. Benches — Applicable — N/A

(Horizontally constructed mounds of earth placed across a steep landfill side slope to interrupt the slope in order to slow down the velocity of surface runoff and intercept and convey the runoff to a lined channel.)

1. **Flows Bypass Bench** — Location shown on site map — N/A or okay
   Remarks_____

2. **Bench Breached** — Location shown on site map — N/A or okay
   Remarks_____

3. **Bench Overtopped** — Location shown on site map — N/A or okay
   Remarks_____

C. Letdown Channels — Applicable — N/A

(Channel lined with erosion control mats, riprap, grout bags, or gabions that descend down the steep side slope of the cover and will allow the runoff water collected by the benches to move off of the landfill cover without creating erosion gullies.)

1. **Settlement** — Location shown on site map — No evidence of settlement
   Areal extent_____ Depth_____
   Remarks_____

2. **Material Degradation** — Location shown on site map — No evidence of degradation
   Material type_____ Areal extent_____
   Remarks_____

3. **Erosion** — Location shown on site map — No evidence of erosion
   Areal extent_____ Depth_____
   Remarks_____

4. **Undercutting** Location shown on site map No evidence of undercutting
Areal extent_____ Depth_____
Remarks_____

5. **Obstructions** Type_____ No obstructions
Location shown on site map Areal extent_____
Size_____
Remarks_____

6. **Excessive Vegetative Growth** Type_____
No evidence of excessive growth
Vegetation in channels does not obstruct flow
Location shown on site map Areal extent_____
Remarks_____

D. **Cover Penetrations** Applicable N/A

1. **Gas Vents** Active Passive
Properly secured/locked Functioning Routinely sampled Good condition
Evidence of leakage at penetration Needs Maintenance
N/A
Remarks_____

2. **Gas Monitoring Probes**
Properly secured/locked Functioning Routinely sampled Good condition
Evidence of leakage at penetration Needs Maintenance N/A
Remarks_____

3. **Monitoring Wells** (within surface area of landfill)
Properly secured/locked Functioning Routinely sampled Good condition
Evidence of leakage at penetration Needs Maintenance N/A
Remarks_____

4. **Leachate Extraction Wells**
Properly secured/locked Functioning Routinely sampled Good condition
Evidence of leakage at penetration Needs Maintenance N/A
Remarks_____

5. **Settlement Monuments** Located Routinely surveyed N/A
Remarks_____

E. Gas Collection and Treatment Applicable N/A

1. **Gas Treatment Facilities**
   Flaring Thermal destruction Collection for reuse
   Good condition Needs Maintenance
   Remarks_____

2. **Gas Collection Wells, Manifolds and Piping**
   Good condition Needs Maintenance
   Remarks_____

3. **Gas Monitoring Facilities** (*e.g.*, gas monitoring of adjacent homes or buildings)
   Good condition Needs Maintenance N/A
   Remarks_____

F. Cover Drainage Layer Applicable N/A

1. **Outlet Pipes Inspected** Functioning N/A
   Remarks _____

2. **Outlet Rock Inspected** Functioning N/A
   Remarks_____

G. Detention/Sedimentation Ponds Applicable N/A

1. **Siltation** Areal extent_____ Depth_____ N/A
   Siltation not evident
   Remarks_____

2. **Erosion** Areal extent_____ Depth_____
   Erosion not evident
   Remarks_____

3. **Outlet Works** Functioning N/A
   Remarks _____

4. **Dam** Functioning N/A
   Remarks_____

H. Retaining Walls Applicable N/A

1. **Deformations** Location shown on site map Deformation not evident
   Horizontal displacement_____ Vertical displacement_____
   Rotational displacement_____
   Remarks_____

2. **Degradation** Location shown on site map Degradation not evident
   Remarks_____

I. Perimeter Ditches/Off-Site Discharge Applicable N/A

1. **Siltation** Location shown on site map Siltation not evident
   Areal extent_____ Depth_____
   Remarks_____

2. **Vegetative Growth** Location shown on site map N/A
   Vegetation does not impede flow
   Areal extent_____ Type_____
   Remarks_____

3. **Erosion** Location shown on site map Erosion not evident
   Areal extent_____ Depth_____
   Remarks_____

4. **Discharge Structure** Functioning N/A
   Remarks_____

VIII. VERTICAL BARRIER WALLS Applicable N/A

1. **Settlement** Location shown on site map Settlement not evident
   Areal extent_____ Depth_____
   Remarks_____

2. **Performance Monitoring** Type of monitoring_____
   Performance not monitored
   Frequency_____ Evidence of breaching
   Head differential_____
   Remarks_____

IX. GROUNDWATER/SURFACE WATER REMEDIES (Applicable) N/A

A. Groundwater Extraction Wells, Pumps, and Pipelines — Applicable N/A

1. **Pumps, Wellhead Plumbing, and Electrical**
   (Good condition) All required wells properly operating Needs Maintenance N/A
   Remarks _____

2. **Extraction System Pipelines, Valves, Valve Boxes, and Other Appurtenances**
   (Good condition) Needs Maintenance
   Remarks _____

3. **Spare Parts and Equipment**
   Readily available Good condition Requires upgrade Needs to be provided
   Remarks none onsite

B. Surface Water Collection Structures, Pumps, and Pipelines — Applicable N/A

1. **Collection Structures, Pumps, and Electrical**
   Good condition Needs Maintenance
   Remarks _____

2. **Surface Water Collection System Pipelines, Valves, Valve Boxes, and Other Appurtenances**
   Good condition Needs Maintenance
   Remarks _____

3. **Spare Parts and Equipment**
   Readily available Good condition Requires upgrade Needs to be provided
   Remarks _____

C. Treatment System Applicable N/A

1. **Treatment Train** (Check components that apply)
   - Metals removal
   - Oil/water separation
   - Bioremediation
   - Air stripping
   - Carbon adsorbers
   - Filters_____
   - Additive (e.g., chelation agent, flocculent)_____
   - Others_____
   - Good condition
   - Needs Maintenance
   - Sampling ports properly marked and functional
   - Sampling/maintenance log displayed and up to date
   - Equipment properly identified
   - Quantity of groundwater treated annually_____
   - Quantity of surface water treated annually_____

   Remarks groundwater pumped to air stripper GWTP.

2. **Electrical Enclosures and Panels** (properly rated and functional)
   - N/A
   - Good condition
   - Needs Maintenance

   Remarks_____

3. **Tanks, Vaults, Storage Vessels**
   - N/A
   - Good condition
   - Proper secondary containment
   - Needs Maintenance

   Remarks_____

4. **Discharge Structure and Appurtenances**
   - N/A
   - Good condition
   - Needs Maintenance

   Remarks_____

5. **Treatment Building(s)**
   - N/A
   - Good condition (esp. roof and doorways)
   - Needs repair
   - Chemicals and equipment properly stored

   Remarks_____

6. **Monitoring Wells** (pump and treatment remedy)
   - Properly secured/locked
   - Functioning
   - Routinely sampled
   - Good condition
   - All required wells located
   - Needs Maintenance
   - N/A

   Remarks_____

D. Monitoring Data

1. Monitoring Data
   - Is routinely submitted on time
   - Is of acceptable quality

2. Monitoring data suggests:
   - Groundwater plume is effectively contained
   - Contaminant concentrations are declining

D. Monitored Natural Attenuation

1. **Monitoring Wells** (natural attenuation remedy)
Properly secured/locked Functioning Routinely sampled Good condition
All required wells located Needs Maintenance N/A
Remarks _____

X. OTHER REMEDIES

If there are remedies applied at the site which are not covered above, attach an inspection sheet describing the physical nature and condition of any facility associated with the remedy. An example would be soil vapor extraction.

XI. OVERALL OBSERVATIONS

A. Implementation of the Remedy

Describe issues and observations relating to whether the remedy is effective and functioning as designed. Begin with a brief statement of what the remedy is to accomplish (i.e., to contain contaminant plume, minimize infiltration and gas emission, etc.).

_____

B. Adequacy of O&M

Describe issues and observations related to the implementation and scope of O&M procedures. In particular, discuss their relationship to the current and long-term protectiveness of the remedy.

_____

C.	Early Indicators of Potential Remedy Problems
	Describe issues and observations such as unexpected changes in the cost or scope of O&M or a high frequency of unscheduled repairs, that suggest that the protectiveness of the remedy may be compromised in the future.

D.	Opportunities for Optimization
	Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy.

Please note that "O&M" is referred to throughout this checklist. At sites where Long-Term Response Actions are in progress, O&M activities may be referred to as "system operations" since these sites are not considered to be in the O&M phase while being remediated under the Superfund program.

Five-Year Review Site Inspection Checklist (Template)

(Working document for site inspection. Information may be completed by hand and attached to the Five-Year Review report as supporting documentation of site status. "N/A" refers to "not applicable.")

I. SITE INFORMATION

Site name: Pesticide Mix Removal Action Area	**Date of inspection:** 7/3/03
Location and Region: DDJC - Skimpe	**EPA ID:**
Agency, office, or company leading the five-year review: GAS	**Weather/temperature:** Clear 80°

Remedy Includes: (Check all that apply)

- Landfill cover/containment
- Access controls
- Institutional controls
- Groundwater pump and treatment
- Surface water collection and treatment
- Other Excavation

- Monitored natural attenuation
- Groundwater containment
- Vertical barrier walls

Attachments: Inspection team roster attached Site map attached

II. INTERVIEWS (Check all that apply)

1. **O&M site manager** _____ _____ _____
   Name Title Date
   Interviewed at site at office by phone Phone no. _____
   Problems, suggestions: Report attached _____

2. **O&M staff** _____ _____ _____
   Name Title Date
   Interviewed at site at office by phone Phone no. _____
   Problems, suggestions: Report attached _____

3. **Local regulatory authorities and response agencies** (i.e., State and Tribal offices, emergency response office, police department, office of public health or environmental health, zoning office, recorder of deeds, or other city and county offices, etc.). Fill in all that apply.

Agency _____
Contact _____ _____ _____ _____
Name Title Date Phone no.
Problems; suggestions; Report attached _____

Agency _____
Contact _____ _____ _____ _____
Name Title Date Phone no.
Problems; suggestions; Report attached _____

Agency _____
Contact _____ _____ _____ _____
Name Title Date Phone no.
Problems; suggestions; Report attached _____

Agency _____
Contact _____ _____ _____ _____
Name Title Date Phone no.
Problems; suggestions; Report attached _____

4. **Other interviews** (optional) Report attached.

III. ON-SITE DOCUMENTS & RECORDS VERIFIED (Check all that apply)

1.	**O&M Documents**			
	O&M manual	Readily available	Up to date	N/A
	As-built drawings	Readily available	Up to date	N/A
	Maintenance logs	Readily available	Up to date	N/A
	Remarks			
2.	**Site-Specific Health and Safety Plan**	Readily available	Up to date	N/A
	Contingency plan/emergency response plan	Readily available	Up to date	N/A
	Remarks			
3.	**O&M and OSHA Training Records**	Readily available	Up to date	N/A
	Remarks			
4.	**Permits and Service Agreements**			
	Air discharge permit	Readily available	Up to date	N/A
	Effluent discharge	Readily available	Up to date	N/A
	Waste disposal, POTW	Readily available	Up to date	N/A
	Other permits	Readily available	Up to date	N/A
	Remarks			
5.	**Gas Generation Records**	Readily available	Up to date	N/A
	Remarks			
6.	**Settlement Monument Records**	Readily available	Up to date	N/A
	Remarks			
7.	**Groundwater Monitoring Records**	Readily available	Up to date	N/A
	Remarks			
8.	**Leachate Extraction Records**	Readily available	Up to date	N/A
	Remarks			
9.	**Discharge Compliance Records**			
	Air	Readily available	Up to date	N/A
	Water (effluent)	Readily available	Up to date	N/A
	Remarks			
10.	**Daily Access/Security Logs**	Readily available	Up to date	N/A
	Remarks			

IV. O&M COSTS

1. **O&M Organization**

State in-house — Contractor for State
PRP in-house — Contractor for PRP
Federal Facility in-house — Contractor for Federal Facility
Other_____

2. **O&M Cost Records**

Readily available — Up to date
Funding mechanism/agreement in place
Original O&M cost estimate_____ _____ Breakdown attached

Total annual cost by year for review period if available

From_____ To_____ _____ Breakdown attached
Date Date Total cost

From_____ To_____ _____ Breakdown attached
Date Date Total cost

From_____ To_____ _____ Breakdown attached
Date Date Total cost

From_____ To_____ _____ Breakdown attached
Date Date Total cost

From_____ To_____ _____ Breakdown attached
Date Date Total cost

3. **Unanticipated or Unusually High O&M Costs During Review Period**

Describe costs and reasons: _____

V. ACCESS AND INSTITUTIONAL CONTROLS — Applicable — N/A

A. Fencing

1. **Fencing damaged** — Location shown on site map — Gates secured — N/A

Remarks Fencing in place, but gates open

B. Other Access Restrictions

1. **Signs and other security measures** — Location shown on site map — N/A

Remarks_____

C. Institutional Controls (ICs)

1. **Implementation and enforcement**

Site conditions imply ICs not properly implemented — Yes — No — N/A
Site conditions imply ICs not being fully enforced — Yes — No — N/A

Type of monitoring (*e.g.*, self-reporting, drive by) _____
Frequency _____
Responsible party/agency _____
Contact _____ _____ _____ _____
Name — Title — Date — Phone no.

Reporting is up-to-date — Yes — No — N/A
Reports are verified by the lead agency — Yes — No — N/A

Specific requirements in deed or decision documents have been met — Yes — No — N/A
Violations have been reported — Yes — No — N/A
Other problems or suggestions: — Report attached

_____
_____
_____
_____

2. **Adequacy** — ICs are adequate — ICs are inadequate — N/A
Remarks _____
_____
_____

D. General

1. **Vandalism/trespassing** — Location shown on site map — No vandalism evident
Remarks _____
_____

2. **Land use changes on site** — N/A
Remarks _____
_____

3. **Land use changes off site** — N/A
Remarks _____
_____

VI. GENERAL SITE CONDITIONS

A. Roads — Applicable — N/A

1. **Roads damaged** — Location shown on site map — Roads adequate — N/A
Remarks _____
_____

B. Other Site Conditions

Remarks Area continues to be used by facility staff. Area is paved with several buildings.

VII. LANDFILL COVERS Applicable N/A

A. Landfill Surface

1. **Settlement** (Low spots) Location shown on site map Settlement not evident
   Areal extent_____ Depth_____
   Remarks_____

2. **Cracks** Location shown on site map Cracking not evident
   Lengths_____ Widths_____ Depths_____
   Remarks_____

3. **Erosion** Location shown on site map Erosion not evident
   Areal extent_____ Depth_____
   Remarks_____

4. **Holes** Location shown on site map Holes not evident
   Areal extent_____ Depth_____
   Remarks_____

5. **Vegetative Cover** Grass Cover properly established No signs of stress
   Trees/Shrubs (indicate size and locations on a diagram)
   Remarks_____

6. **Alternative Cover (armored rock, concrete, etc.)** N/A
   Remarks_____

7. **Bulges** Location shown on site map Bulges not evident
   Areal extent_____ Height_____
   Remarks_____

8. **Wet Areas/Water Damage** — Wet areas/water damage not evident
   - Wet areas — Location shown on site map — Areal extent_____
   - Ponding — Location shown on site map — Areal extent_____
   - Seeps — Location shown on site map — Areal extent_____
   - Soft subgrade — Location shown on site map — Areal extent_____

   Remarks_____

9. **Slope Instability** — Slides — Location shown on site map — No evidence of slope instability
   Areal extent_____
   Remarks_____

B. Benches — Applicable — N/A

(Horizontally constructed mounds of earth placed across a steep landfill side slope to interrupt the slope in order to slow down the velocity of surface runoff and intercept and convey the runoff to a lined channel.)

1. **Flows Bypass Bench** — Location shown on site map — N/A or okay
   Remarks_____

2. **Bench Breached** — Location shown on site map — N/A or okay
   Remarks_____

3. **Bench Overtopped** — Location shown on site map — N/A or okay
   Remarks_____

C. Letdown Channels — Applicable — N/A

(Channel lined with erosion control mats, riprap, grout bags, or gabions that descend down the steep side slope of the cover and will allow the runoff water collected by the benches to move off of the landfill cover without creating erosion gullies.)

1. **Settlement** — Location shown on site map — No evidence of settlement
   Areal extent_____ Depth_____
   Remarks_____

2. **Material Degradation** — Location shown on site map — No evidence of degradation
   Material type_____ Areal extent_____
   Remarks_____

3. **Erosion** — Location shown on site map — No evidence of erosion
   Areal extent_____ Depth_____
   Remarks_____

4. **Undercutting** Location shown on site map No evidence of undercutting
Areal extent_____ Depth_____
Remarks_____

5. **Obstructions** Type_____ No obstructions
Location shown on site map Areal extent_____
Size_____
Remarks_____

6. **Excessive Vegetative Growth** Type_____
No evidence of excessive growth
Vegetation in channels does not obstruct flow
Location shown on site map Areal extent_____
Remarks_____

D. Cover Penetrations Applicable N/A

1. **Gas Vents** Active Passive
Properly secured/locked Functioning Routinely sampled Good condition
Evidence of leakage at penetration Needs Maintenance
N/A
Remarks_____

2. **Gas Monitoring Probes**
Properly secured/locked Functioning Routinely sampled Good condition
Evidence of leakage at penetration Needs Maintenance N/A
Remarks_____

3. **Monitoring Wells** (within surface area of landfill)
Properly secured/locked Functioning Routinely sampled Good condition
Evidence of leakage at penetration Needs Maintenance N/A
Remarks_____

4. **Leachate Extraction Wells**
Properly secured/locked Functioning Routinely sampled Good condition
Evidence of leakage at penetration Needs Maintenance N/A
Remarks_____

5 **Settlement Monuments** Located Routinely surveyed N/A
Remarks_____

E. Gas Collection and Treatment Applicable N/A

1. **Gas Treatment Facilities**
   Flaring Thermal destruction Collection for reuse
   Good condition Needs Maintenance
   Remarks_____

2. **Gas Collection Wells, Manifolds and Piping**
   Good condition Needs Maintenance
   Remarks_____

3. **Gas Monitoring Facilities** (*e.g.*, gas monitoring of adjacent homes or buildings)
   Good condition Needs Maintenance N/A
   Remarks_____

F. Cover Drainage Layer Applicable N/A

1. **Outlet Pipes Inspected** Functioning N/A
   Remarks_____

2. **Outlet Rock Inspected** Functioning N/A
   Remarks_____

G. Detention/Sedimentation Ponds Applicable N/A

1. **Siltation** Areal extent_____ Depth_____ N/A
   Siltation not evident
   Remarks_____

2. **Erosion** Areal extent_____ Depth_____
   Erosion not evident
   Remarks_____

3. **Outlet Works** Functioning N/A
   Remarks_____

4. **Dam** Functioning N/A
   Remarks_____

H. Retaining Walls Applicable N/A

1. **Deformations** Location shown on site map Deformation not evident
   Horizontal displacement_____ Vertical displacement_____
   Rotational displacement_____
   Remarks_____

2. **Degradation** Location shown on site map Degradation not evident
   Remarks_____

I. Perimeter Ditches/Off-Site Discharge Applicable N/A

1. **Siltation** Location shown on site map Siltation not evident
   Areal extent_____ Depth_____
   Remarks_____

2. **Vegetative Growth** Location shown on site map N/A
   Vegetation does not impede flow
   Areal extent_____ Type_____
   Remarks_____

3. **Erosion** Location shown on site map Erosion not evident
   Areal extent_____ Depth_____
   Remarks_____

4. **Discharge Structure** Functioning N/A
   Remarks_____

VIII. VERTICAL BARRIER WALLS Applicable N/A

1. **Settlement** Location shown on site map Settlement not evident
   Areal extent_____ Depth_____
   Remarks_____

2. **Performance Monitoring** Type of monitoring _____
   Performance not monitored
   Frequency_____ Evidence of breaching
   Head differential_____
   Remarks_____

IX. GROUNDWATER/SURFACE WATER REMEDIES

Applicable N/A

A. Groundwater Extraction Wells, Pumps, and Pipelines

Applicable N/A

1. **Pumps, Wellhead Plumbing, and Electrical**
   Good condition All required wells properly operating. Needs Maintenance N/A
   Remarks _____

2. **Extraction System Pipelines, Valves, Valve Boxes, and Other Appurtenances**
   Good condition Needs Maintenance
   Remarks _____

3. **Spare Parts and Equipment**
   Readily available Good condition Requires upgrade Needs to be provided
   Remarks _____

B. Surface Water Collection Structures, Pumps, and Pipelines

Applicable N/A

1. **Collection Structures, Pumps, and Electrical**
   Good condition Needs Maintenance
   Remarks _____

2. **Surface Water Collection System Pipelines, Valves, Valve Boxes, and Other Appurtenances**
   Good condition Needs Maintenance
   Remarks _____

3. **Spare Parts and Equipment**
   Readily available Good condition Requires upgrade Needs to be provided
   Remarks _____

C. Treatment System Applicable N/A

1. **Treatment Train** (Check components that apply)
   - Metals removal
   - Oil/water separation
   - Bioremediation
   - Air stripping
   - Carbon adsorbers
   - Filters_____
   - Additive (e.g., chelation agent, flocculent)_____
   - Others_____
   - Good condition
   - Needs Maintenance
   - Sampling ports properly marked and functional
   - Sampling/maintenance log displayed and up to date
   - Equipment properly identified
   - Quantity of groundwater treated annually_____
   - Quantity of surface water treated annually_____

   Remarks_____

2. **Electrical Enclosures and Panels** (properly rated and functional)
   N/A Good condition Needs Maintenance

   Remarks_____

3. **Tanks, Vaults, Storage Vessels**
   N/A Good condition Proper secondary containment Needs Maintenance

   Remarks_____

4. **Discharge Structure and Appurtenances**
   N/A Good condition Needs Maintenance

   Remarks_____

5. **Treatment Building(s)**
   N/A Good condition (esp. roof and doorways) Needs repair
   Chemicals and equipment properly stored

   Remarks_____

6. **Monitoring Wells** (pump and treatment remedy)
   Properly secured/locked Functioning Routinely sampled Good condition
   All required wells located Needs Maintenance N/A

   Remarks_____

D. Monitoring Data

1. Monitoring Data
   Is routinely submitted on time Is of acceptable quality

2. Monitoring data suggests:
   Groundwater plume is effectively contained Contaminant concentrations are declining

D. Monitored Natural Attenuation

1. **Monitoring Wells** (natural attenuation remedy)
   Properly secured/locked Functioning Routinely sampled Good condition
   All required wells located Needs Maintenance N/A
   Remarks_____

X. OTHER REMEDIES

If there are remedies applied at the site which are not covered above, attach an inspection sheet describing the physical nature and condition of any facility associated with the remedy. An example would be soil vapor extraction.

XI. OVERALL OBSERVATIONS

A. Implementation of the Remedy

Describe issues and observations relating to whether the remedy is effective and functioning as designed. Begin with a brief statement of what the remedy is to accomplish (i.e., to contain contaminant plume, minimize infiltration and gas emission, etc.).

B. Adequacy of O&M

Describe issues and observations related to the implementation and scope of O&M procedures. In particular, discuss their relationship to the current and long-term protectiveness of the remedy.

C.	Early Indicators of Potential Remedy Problems
	Describe issues and observations such as unexpected changes in the cost or scope of O&M or a high frequency of unscheduled repairs, that suggest that the protectiveness of the remedy may be compromised in the future.

D.	Opportunities for Optimization
	Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy.

Please note that "O&M" is referred to throughout this checklist. At sites where Long-Term Response Actions are in progress, O&M activities may be referred to as "system operations" since these sites are not considered to be in the O&M phase while being remediated under the Superfund program.

Five-Year Review Site Inspection Checklist (Template)

(Working document for site inspection. Information may be completed by hand and attached to the Five-Year Review report as supporting documentation of site status. "N/A" refers to "not applicable.")

I. SITE INFORMATION	
Site name: Area of Contaminated Groundwater	**Date of inspection:** 7/3/03
Location and Region: DOE - Skunk	**EPA ID:**
Agency, office, or company leading the five-year review: USGS	**Weather/temperature:** Clear 80°

Remedy Includes: (Check all that apply)

- Landfill cover/containment
- Access controls
- Institutional controls
- Groundwater pump and treatment
- Surface water collection and treatment
- Other _____
- Monitored natural attenuation
- Groundwater containment
- Vertical barrier walls

Attachments: Inspection team roster attached Site map attached

II. INTERVIEWS (Check all that apply)

1. **O&M site manager** _____ _____ _____
   Name Title Date
   Interviewed at site at office by phone Phone no. _____
   Problems, suggestions; Report attached _____

2. **O&M staff** _____ _____ _____
   Name Title Date
   Interviewed at site at office by phone Phone no. _____
   Problems, suggestions; Report attached _____

3. **Local regulatory authorities and response agencies** (i.e., State and Tribal offices, emergency response office, police department, office of public health or environmental health, zoning office, recorder of deeds, or other city and county offices, etc.) Fill in all that apply.

Agency _____
Contact _____ _____ _____ _____
Name Title Date Phone no.
Problems; suggestions; Report attached _____

Agency _____
Contact _____ _____ _____ _____
Name Title Date Phone no.
Problems; suggestions; Report attached _____

Agency _____
Contact _____ _____ _____ _____
Name Title Date Phone no.
Problems; suggestions; Report attached _____

Agency _____
Contact _____ _____ _____ _____
Name Title Date Phone no.
Problems; suggestions; Report attached _____

4. **Other interviews** (optional) Report attached.

III. ON-SITE DOCUMENTS & RECORDS VERIFIED (Check all that apply)

1.	**O&M Documents**			
	O&M manual	Readily available	Up to date	N/A
	As-built drawings	Readily available	Up to date	N/A
	Maintenance logs	Readily available	Up to date	N/A
	Remarks			
2.	**Site-Specific Health and Safety Plan**	Readily available	Up to date	N/A
	Contingency plan/emergency response plan	Readily available	Up to date	N/A
	Remarks			
3.	**O&M and OSHA Training Records**	Readily available	Up to date	N/A
	Remarks			
4.	**Permits and Service Agreements**			
	Air discharge permit	Readily available	Up to date	N/A
	Effluent discharge	Readily available	Up to date	N/A
	Waste disposal, POTW	Readily available	Up to date	N/A
	Other permits	Readily available	Up to date	N/A
	Remarks			
5.	**Gas Generation Records**	Readily available	Up to date	N/A
	Remarks			
6.	**Settlement Monument Records**	Readily available	Up to date	N/A
	Remarks			
7.	**Groundwater Monitoring Records**	Readily available	Up to date	N/A
	Remarks			
8.	**Leachate Extraction Records**	Readily available	Up to date	N/A
	Remarks			
9.	**Discharge Compliance Records**			
	Air	Readily available	Up to date	N/A
	Water (effluent)	Readily available	Up to date	N/A
	Remarks			
10.	**Daily Access/Security Logs**	Readily available	Up to date	N/A
	Remarks			

IV. O&M COSTS

1. **O&M Organization**

State in-house — Contractor for State
PRP in-house — Contractor for PRP
Federal Facility in-house — Contractor for Federal Facility
Other_____

2. **O&M Cost Records**

Readily available — Up to date
Funding mechanism/agreement in place
Original O&M cost estimate_____ Breakdown attached

Total annual cost by year for review period if available

From_____ To_____ _____ Breakdown attached
Date Date Total cost
From_____ To_____ _____ Breakdown attached
Date Date Total cost
From_____ To_____ _____ Breakdown attached
Date Date Total cost
From_____ To_____ _____ Breakdown attached
Date Date Total cost
From_____ To_____ _____ Breakdown attached
Date Date Total cost

3. **Unanticipated or Unusually High O&M Costs During Review Period**

Describe costs and reasons: _____

V. ACCESS AND INSTITUTIONAL CONTROLS (Applicable) N/A

A. Fencing

1. **Fencing damaged** — Location shown on site map — Gates secured — (N/A)

Remarks_____

B. Other Access Restrictions

1. **Signs and other security measures** — Location shown on site map — N/A

Remarks No visible signs in area.

C. Institutional Controls (ICs)

1. **Implementation and enforcement**

Site conditions imply ICs not properly implemented — (Yes) No N/A
Site conditions imply ICs not being fully enforced — (Yes) No N/A

Type of monitoring (*e.g.*, self-reporting, drive by) _____
Frequency _____
Responsible party/agency _____
Contact _____
Name Title Date Phone no.

Reporting is up-to-date — Yes No N/A
Reports are verified by the lead agency — Yes No N/A

Specific requirements in deed or decision documents have been met — Yes No N/A
Violations have been reported — Yes No N/A
Other problems or suggestions: Report attached

Install institutional control signs in area.

2. **Adequacy** ICs are adequate ICs are inadequate N/A
Remarks _____

D. General

1. **Vandalism/trespassing** Location shown on site map (No vandalism evident)
Remarks _____

2. **Land use changes on site** N/A
Remarks _____

3. **Land use changes off site** N/A
Remarks _____

VI. GENERAL SITE CONDITIONS

A. Roads Applicable N/A

1. **Roads damaged** Location shown on site map (Roads adequate) N/A
Remarks _____

B. Other Site Conditions

Remarks Area is mostly covered by vegetation. No signs posted for institutional controls. New road construction along Southeast Perimeter along Inthrop Rd.

VII. LANDFILL COVERS Applicable N/A

A. Landfill Surface

1. **Settlement** (Low spots) Location shown on site map Settlement not evident
   Areal extent_____ Depth _____
   Remarks_____

2. **Cracks** Location shown on site map Cracking not evident
   Lengths_____ Widths_____ Depths_____
   Remarks_____

3. **Erosion** Location shown on site map Erosion not evident
   Areal extent_____ Depth_____
   Remarks_____

4. **Holes** Location shown on site map Holes not evident
   Areal extent_____ Depth_____
   Remarks_____

5. **Vegetative Cover** Grass Cover properly established No signs of stress
   Trees/Shrubs (indicate size and locations on a diagram)
   Remarks_____

6. **Alternative Cover (armored rock, concrete, etc.)** N/A
   Remarks_____

7. **Bulges** Location shown on site map Bulges not evident
   Areal extent_____ Height____
   Remarks_____

8. **Wet Areas/Water Damage** — Wet areas/water damage not evident
   - Wet areas — Location shown on site map — Areal extent_____
   - Ponding — Location shown on site map — Areal extent_____
   - Seeps — Location shown on site map — Areal extent_____
   - Soft subgrade — Location shown on site map — Areal extent_____

   Remarks_____

9. **Slope Instability** — Slides — Location shown on site map — No evidence of slope instability
   Areal extent_____
   Remarks_____

B. Benches — Applicable — N/A

(Horizontally constructed mounds of earth placed across a steep landfill side slope to interrupt the slope in order to slow down the velocity of surface runoff and intercept and convey the runoff to a lined channel.)

1. **Flows Bypass Bench** — Location shown on site map — N/A or okay
   Remarks_____

2. **Bench Breached** — Location shown on site map — N/A or okay
   Remarks_____

3. **Bench Overtopped** — Location shown on site map — N/A or okay
   Remarks_____

C. Letdown Channels — Applicable — N/A

(Channel lined with erosion control mats, riprap, grout bags, or gabions that descend down the steep side slope of the cover and will allow the runoff water collected by the benches to move off of the landfill cover without creating erosion gullies.)

1. **Settlement** — Location shown on site map — No evidence of settlement
   Areal extent_____ Depth_____
   Remarks_____

2. **Material Degradation** — Location shown on site map — No evidence of degradation
   Material type_____ Areal extent_____
   Remarks_____

3. **Erosion** — Location shown on site map — No evidence of erosion
   Areal extent_____ Depth_____
   Remarks_____

4. **Undercutting** Location shown on site map No evidence of undercutting
Areal extent_____ Depth_____
Remarks_____

5. **Obstructions** Type_____ No obstructions
Location shown on site map Areal extent_____
Size_____
Remarks_____

6. **Excessive Vegetative Growth** Type_____
No evidence of excessive growth
Vegetation in channels does not obstruct flow
Location shown on site map Areal extent_____
Remarks_____

D. Cover Penetrations Applicable N/A

1. **Gas Vents** Active Passive
Properly secured/locked Functioning Routinely sampled Good condition
Evidence of leakage at penetration Needs Maintenance
N/A
Remarks_____

2. **Gas Monitoring Probes**
Properly secured/locked Functioning Routinely sampled Good condition
Evidence of leakage at penetration Needs Maintenance N/A
Remarks_____

3. **Monitoring Wells** (within surface area of landfill)
Properly secured/locked Functioning Routinely sampled Good condition
Evidence of leakage at penetration Needs Maintenance N/A
Remarks_____

4. **Leachate Extraction Wells**
Properly secured/locked Functioning Routinely sampled Good condition
Evidence of leakage at penetration Needs Maintenance N/A
Remarks_____

5 **Settlement Monuments** Located Routinely surveyed N/A
Remarks_____

E. Gas Collection and Treatment	Applicable	N/A
1. **Gas Treatment Facilities**		
Flaring	Thermal destruction	Collection for reuse
Good condition	Needs Maintenance	
Remarks_____		
2. **Gas Collection Wells, Manifolds and Piping**		
Good condition	Needs Maintenance	
Remarks_____		
3. **Gas Monitoring Facilities** (*e.g.*, gas monitoring of adjacent homes or buildings)		
Good condition	Needs Maintenance	N/A
Remarks_____		
F. Cover Drainage Layer	Applicable	N/A
1. **Outlet Pipes Inspected**	Functioning	N/A
Remarks_____		
2. **Outlet Rock Inspected**	Functioning	N/A
Remarks_____		
G. Detention/Sedimentation Ponds	Applicable	N/A
1. **Siltation** Areal extent_____	Depth_____	N/A
Siltation not evident		
Remarks_____		
2. **Erosion** Areal extent_____	Depth_____	
Erosion not evident		
Remarks_____		
3. **Outlet Works**	Functioning	N/A
Remarks_____		
4 **Dam**	Functioning	N/A
Remarks_____		

H. Retaining Walls Applicable N/A

1. **Deformations** Location shown on site map Deformation not evident
   Horizontal displacement_____ Vertical displacement_____
   Rotational displacement _____
   Remarks_____

2. **Degradation** Location shown on site map Degradation not evident
   Remarks_____

I. Perimeter Ditches/Off-Site Discharge Applicable N/A

1. **Siltation** Location shown on site map Siltation not evident
   Areal extent_____ Depth_____
   Remarks_____

2. **Vegetative Growth** Location shown on site map N/A
   Vegetation does not impede flow
   Areal extent_____ Type_____
   Remarks_____

3. **Erosion** Location shown on site map Erosion not evident
   Areal extent_____ Depth_____
   Remarks_____

4. **Discharge Structure** Functioning N/A
   Remarks_____

VIII. VERTICAL BARRIER WALLS Applicable N/A

1. **Settlement** Location shown on site map Settlement not evident
   Areal extent_____ Depth_____
   Remarks_____

2. **Performance Monitoring** Type of monitoring_____
   Performance not monitored
   Frequency_____ Evidence of breaching
   Head differential_____
   Remarks_____

IX. GROUNDWATER/SURFACE WATER REMEDIES — Applicable / N/A

A. Groundwater Extraction Wells, Pumps, and Pipelines — (Applicable) / N/A

1. **Pumps, Wellhead Plumbing, and Electrical**
   (Good condition) All required wells properly operating Needs Maintenance N/A
   Remarks

2. **Extraction System Pipelines, Valves, Valve Boxes, and Other Appurtenances**
   (Good condition) Needs Maintenance
   Remarks

3. **Spare Parts and Equipment**
   Readily available Good condition Requires upgrade Needs to be provided
   Remarks not applicable

B. Surface Water Collection Structures, Pumps, and Pipelines — Applicable / (N/A)

1. **Collection Structures, Pumps, and Electrical**
   Good condition Needs Maintenance
   Remarks

2. **Surface Water Collection System Pipelines, Valves, Valve Boxes, and Other Appurtenances**
   Good condition Needs Maintenance
   Remarks

3. **Spare Parts and Equipment**
   Readily available Good condition Requires upgrade Needs to be provided
   Remarks

C. Treatment System Applicable N/A

1. **Treatment Train** (Check components that apply)
   Metals removal Oil/water separation Bioremediation
   Air stripping Carbon adsorbers
   Filters
   Additive (e.g., chelation agent, flocculent)
   Others
   Good condition Needs Maintenance
   Sampling ports properly marked and functional
   Sampling/maintenance log displayed and up to date
   Equipment properly identified
   Quantity of groundwater treated annually
   Quantity of surface water treated annually
   Remarks groundwater pumped to South Dalton GWTP.

2. **Electrical Enclosures and Panels** (properly rated and functional)
   N/A Good condition Needs Maintenance
   Remarks

3. **Tanks, Vaults, Storage Vessels**
   N/A Good condition Proper secondary containment Needs Maintenance
   Remarks

4. **Discharge Structure and Appurtenances**
   N/A Good condition Needs Maintenance
   Remarks

5. **Treatment Building(s)**
   N/A Good condition (esp. roof and doorways) Needs repair
   Chemicals and equipment properly stored
   Remarks

6. **Monitoring Wells** (pump and treatment remedy)
   Properly secured/locked Functioning Routinely sampled Good condition
   All required wells located Needs Maintenance N/A
   Remarks

D. Monitoring Data

1. Monitoring Data
   Is routinely submitted on time Is of acceptable quality

2. Monitoring data suggests:
   Groundwater plume is effectively contained Contaminant concentrations are declining

D. Monitored Natural Attenuation

1. **Monitoring Wells** (natural attenuation remedy)
   Properly secured/locked Functioning Routinely sampled Good condition
   All required wells located Needs Maintenance N/A
   Remarks_____

X. OTHER REMEDIES

If there are remedies applied at the site which are not covered above, attach an inspection sheet describing the physical nature and condition of any facility associated with the remedy. An example would be soil vapor extraction.

XI. OVERALL OBSERVATIONS

A. Implementation of the Remedy

Describe issues and observations relating to whether the remedy is effective and functioning as designed. Begin with a brief statement of what the remedy is to accomplish (i.e., to contain contaminant plume, minimize infiltration and gas emission, etc.).

B. Adequacy of O&M

Describe issues and observations related to the implementation and scope of O&M procedures. In particular, discuss their relationship to the current and long-term protectiveness of the remedy

C.	Early Indicators of Potential Remedy Problems
	Describe issues and observations such as unexpected changes in the cost or scope of O&M or a high frequency of unscheduled repairs, that suggest that the protectiveness of the remedy may be compromised in the future.

D.	Opportunities for Optimization
	Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy.

Please note that "O&M" is referred to throughout this checklist. At sites where Long-Term Response Actions are in progress, O&M activities may be referred to as "system operations" since these sites are not considered to be in the O&M phase while being remediated under the Superfund program.

Five-Year Review Site Inspection Checklist (Template)

(Working document for site inspection. Information may be completed by hand and attached to the Five-Year Review report as supporting documentation of site status. "N/A" refers to "not applicable.")

I. SITE INFORMATION	
Site name: DDK-Sharpe Groundwater Treatment Systems	**Date of inspection:**
Location and Region: California - Central Valley	**EPA ID:**
Agency, office, or company leading the five-year review:	**Weather/temperature:**

Remedy Includes: (Check all that apply)

- Landfill cover/containment
- Access controls
- Institutional controls
- Groundwater pump and treatment ✓
- Surface water collection and treatment
- Other _____
- Monitored natural attenuation
- Groundwater containment ✓
- Vertical barrier walls

Attachments: Inspection team roster attached Site map attached

II. INTERVIEWS (Check all that apply)

1. **O&M site manager** Paul Marsden (Name) O&M Site Manager (Title) 3/13/2003 (Date)
   Interviewed at site at office by phone Phone no. _____
   Problems, suggestions; Report attached See Attachment 5

2. **O&M staff** _____ (Name) _____ (Title) _____ (Date)
   Interviewed at site at office by phone Phone no. _____
   Problems, suggestions; Report attached _____

3. **Local regulatory authorities and response agencies** (i.e., State and Tribal offices, emergency response office, police department, office of public health or environmental health, zoning office, recorder of deeds, or other city and county offices, etc.) Fill in all that apply.

Agency _____
Contact _____ _____ _____ _____
Name Title Date Phone no.
Problems; suggestions; Report attached _____

Agency _____
Contact _____ _____ _____ _____
Name Title Date Phone no.
Problems; suggestions; Report attached _____

Agency _____
Contact _____ _____ _____ _____
Name Title Date Phone no.
Problems; suggestions; Report attached _____

Agency _____
Contact _____ _____ _____ _____
Name Title Date Phone no.
Problems; suggestions; Report attached _____

4. **Other interviews** (optional) Report attached.

III. ON-SITE DOCUMENTS & RECORDS VERIFIED (Check all that apply)

1.	**O&M Documents**			
	O&M manual ✓	Readily available ✓	Up to date 10/03	N/A
	As-built drawings ✓	Readily available ✓	Up to date 7/03	N/A
	Maintenance logs	Readily available	Up to date	N/A
	Remarks			
2.	**Site-Specific Health and Safety Plan**	Readily available ✓	Up to date	N/A
	Contingency plan/emergency response plan	Readily available	Up to date	N/A
	Remarks			
3.	**O&M and OSHA Training Records**	Readily available	Up to date	N/A
	Remarks			
4.	**Permits and Service Agreements**			
	Air discharge permit	Readily available	Up to date	N/A ✓
	Effluent discharge	Readily available	Up to date	N/A
	Waste disposal, POTW	Readily available	Up to date	N/A
	Other permits	Readily available	Up to date	N/A
	Remarks			
5.	**Gas Generation Records**	Readily available	Up to date	N/A ✓
	Remarks			
6.	**Settlement Monument Records**	Readily available	Up to date	N/A ✓
	Remarks			
7.	**Groundwater Monitoring Records**	Readily available ✓	Up to date	N/A
	Remarks			
8.	**Leachate Extraction Records**	Readily available	Up to date	N/A ✓
	Remarks			
9.	**Discharge Compliance Records**			
	Air	Readily available	Up to date	N/A
	Water (effluent)	Readily available ✓	Up to date	N/A
	Remarks			
10.	**Daily Access/Security Logs**	Readily available	Up to date	N/A ✓
	Remarks			

IV. O&M COSTS

1. **O&M Organization**

State in-house — Contractor for State
PRP in-house — Contractor for PRP
Federal Facility in-house — Contractor for Federal Facility ✓
Other_____

2. **O&M Cost Records**

Readily available ✓ Up to date ✓ SEE TABLE 4-6 P. 4-20 OF 5-yr Review Report
Funding mechanism/agreement in place
Original O&M cost estimate_____ _____ Breakdown attached

Total annual cost by year for review period if available

From_____ To_____ _____ Breakdown attached
Date Date Total cost
From_____ To_____ _____ Breakdown attached
Date Date Total cost
From_____ To_____ _____ Breakdown attached
Date Date Total cost
From_____ To_____ _____ Breakdown attached
Date Date Total cost
From_____ To_____ _____ Breakdown attached
Date Date Total cost

3. **Unanticipated or Unusually High O&M Costs During Review Period**

Describe costs and reasons: _____

V. ACCESS AND INSTITUTIONAL CONTROLS Applicable N/A

A. Fencing

1. **Fencing damaged** Location shown on site map Gates secured N/A ✓

Remarks_____

B. Other Access Restrictions

1. **Signs and other security measures** Location shown on site map N/A ✓

Remarks Pass through security to enter facility. No security other than gate - facility-wide patrol.

C. Institutional Controls (ICs)

1. **Implementation and enforcement**

Site conditions imply ICs not properly implemented — Yes / No / N/A
Site conditions imply ICs not being fully enforced — Yes / No / N/A

Type of monitoring (*e.g.*, self-reporting, drive by) _____
Frequency _____
Responsible party/agency _____
Contact _____

Name	Title	Date	Phone no.

Reporting is up-to-date — Yes / No / N/A
Reports are verified by the lead agency — Yes / No / N/A

Specific requirements in deed or decision documents have been met — Yes / No / N/A
Violations have been reported — Yes / No / N/A
Other problems or suggestions: Report attached

_____

2. **Adequacy** ICs are adequate ICs are inadequate N/A ✓
Remarks _____

D. General

1. **Vandalism/trespassing** Location shown on site map No vandalism evident ✓
Remarks _____

2. **Land use changes on site** N/A ✓
Remarks _____

3. **Land use changes off site** N/A ✓
Remarks _____

VI. GENERAL SITE CONDITIONS

A. Roads Applicable N/A

1. **Roads damaged** Location shown on site map Roads adequate ✓ N/A
Remarks _____

B. Other Site Conditions

Remarks Site well maintained in good condition

VII. LANDFILL COVERS Applicable N/A ✓

A. Landfill Surface

1. **Settlement** (Low spots) Location shown on site map Settlement not evident
   Areal extent_____ Depth_____
   Remarks_____

2. **Cracks** Location shown on site map Cracking not evident
   Lengths_____ Widths_____ Depths_____
   Remarks_____

3. **Erosion** Location shown on site map Erosion not evident
   Areal extent_____ Depth _____
   Remarks_____

4. **Holes** Location shown on site map Holes not evident
   Areal extent_____ Depth_____
   Remarks_____

5. **Vegetative Cover** Grass Cover properly established No signs of stress
   Trees/Shrubs (indicate size and locations on a diagram)
   Remarks_____

6. **Alternative Cover (armored rock, concrete, etc.)** N/A
   Remarks_____

7. **Bulges** Location shown on site map Bulges not evident
   Areal extent_____ Height _____
   Remarks_____

8. **Wet Areas/Water Damage** — Wet areas/water damage not evident
   - Wet areas — Location shown on site map — Areal extent_____
   - Ponding — Location shown on site map — Areal extent_____
   - Seeps — Location shown on site map — Areal extent_____
   - Soft subgrade — Location shown on site map — Areal extent_____

   Remarks_____

9. **Slope Instability** — Slides — Location shown on site map — No evidence of slope instability
   Areal extent_____
   Remarks_____

B. Benches — Applicable — N/A

(Horizontally constructed mounds of earth placed across a steep landfill side slope to interrupt the slope in order to slow down the velocity of surface runoff and intercept and convey the runoff to a lined channel.)

1. **Flows Bypass Bench** — Location shown on site map — N/A or okay
   Remarks_____

2. **Bench Breached** — Location shown on site map — N/A or okay
   Remarks_____

3. **Bench Overtopped** — Location shown on site map — N/A or okay
   Remarks_____

C. Letdown Channels — Applicable — N/A

(Channel lined with erosion control mats, riprap, grout bags, or gabions that descend down the steep side slope of the cover and will allow the runoff water collected by the benches to move off of the landfill cover without creating erosion gullies.)

1. **Settlement** — Location shown on site map — No evidence of settlement
   Areal extent_____ Depth_____
   Remarks_____

2. **Material Degradation** — Location shown on site map — No evidence of degradation
   Material type_____ Areal extent_____
   Remarks_____

3. **Erosion** — Location shown on site map — No evidence of erosion
   Areal extent_____ Depth_____
   Remarks_____

4. **Undercutting** Location shown on site map No evidence of undercutting
Areal extent_____ Depth_____
Remarks_____

5. **Obstructions** Type_____ No obstructions
Location shown on site map Areal extent_____
Size_____
Remarks_____

6. **Excessive Vegetative Growth** Type_____
No evidence of excessive growth
Vegetation in channels does not obstruct flow
Location shown on site map Areal extent_____
Remarks_____

D. Cover Penetrations Applicable N/A

1. **Gas Vents** Active Passive
Properly secured/locked Functioning Routinely sampled Good condition
Evidence of leakage at penetration Needs Maintenance
N/A
Remarks_____

2. **Gas Monitoring Probes**
Properly secured/locked Functioning Routinely sampled Good condition
Evidence of leakage at penetration Needs Maintenance N/A
Remarks_____

3. **Monitoring Wells** (within surface area of landfill)
Properly secured/locked Functioning Routinely sampled Good condition
Evidence of leakage at penetration Needs Maintenance N/A
Remarks_____

4. **Leachate Extraction Wells**
Properly secured/locked Functioning Routinely sampled Good condition
Evidence of leakage at penetration Needs Maintenance N/A
Remarks_____

5. **Settlement Monuments** Located Routinely surveyed N/A
Remarks_____

E. Gas Collection and Treatment Applicable N/A

1. **Gas Treatment Facilities**
   Flaring Thermal destruction Collection for reuse
   Good condition Needs Maintenance
   Remarks_____

2. **Gas Collection Wells, Manifolds and Piping**
   Good condition Needs Maintenance
   Remarks_____

3. **Gas Monitoring Facilities** (e.g., gas monitoring of adjacent homes or buildings)
   Good condition Needs Maintenance N/A
   Remarks_____

F. Cover Drainage Layer Applicable N/A

1. **Outlet Pipes Inspected** Functioning N/A
   Remarks_____

2. **Outlet Rock Inspected** Functioning N/A
   Remarks_____

G. Detention/Sedimentation Ponds Applicable N/A

1. **Siltation** Areal extent_____ Depth_____ N/A
   Siltation not evident
   Remarks_____

2. **Erosion** Areal extent_____ Depth_____
   Erosion not evident
   Remarks_____

3. **Outlet Works** Functioning N/A
   Remarks_____

4. **Dam** Functioning N/A
   Remarks_____

H. Retaining Walls Applicable N/A

1. **Deformations** Location shown on site map Deformation not evident
   Horizontal displacement_____ Vertical displacement _____
   Rotational displacement_____
   Remarks_____

2. **Degradation** Location shown on site map Degradation not evident
   Remarks_____

I. Perimeter Ditches/Off-Site Discharge Applicable N/A

1. **Siltation** Location shown on site map Siltation not evident
   Areal extent_____ Depth_____
   Remarks_____

2. **Vegetative Growth** Location shown on site map N/A
   Vegetation does not impede flow
   Areal extent_____ Type_____
   Remarks_____

3. **Erosion** Location shown on site map Erosion not evident
   Areal extent_____ Depth_____
   Remarks_____

4. **Discharge Structure** Functioning N/A
   Remarks_____

VIII. VERTICAL BARRIER WALLS Applicable N/A ✓

1. **Settlement** Location shown on site map Settlement not evident
   Areal extent_____ Depth_____
   Remarks_____

2. **Performance Monitoring** Type of monitoring_____
   Performance not monitored
   Frequency_____ Evidence of breaching
   Head differential_____
   Remarks_____

IX. GROUNDWATER/SURFACE WATER REMEDIES — Applicable ✓ N/A

A. Groundwater Extraction Wells, Pumps, and Pipelines — Applicable N/A

1. **Pumps, Wellhead Plumbing, and Electrical**
   Good condition ✓ All required wells properly operating Needs Maintenance ✓ N/A
   Remarks Most pumps, wellhead, plumbing, etc. in good condition. Ongoing maintenance activities to address issue as they arise

2. **Extraction System Pipelines, Valves, Valve Boxes, and Other Appurtenances**
   Good condition ✓ Needs Maintenance
   Remarks

3. **Spare Parts and Equipment**
   Readily available Good condition Requires upgrade Needs to be provided
   Remarks

B. Surface Water Collection Structures, Pumps, and Pipelines — Applicable N/A ✓

1. **Collection Structures, Pumps, and Electrical**
   Good condition ✓ Needs Maintenance
   Remarks

2. **Surface Water Collection System Pipelines, Valves, Valve Boxes, and Other Appurtenances**
   Good condition Needs Maintenance
   Remarks

3. **Spare Parts and Equipment**
   Readily available Good condition Requires upgrade Needs to be provided
   Remarks

C. Treatment System Applicable N/A

1. **Treatment Train** (Check components that apply)
   - Metals removal
   - Air stripping ✓
   - Oil/water separation
   - Carbon adsorbers
   - Bioremediation
   - Filters
   - Additive (e.g., chelation agent, flocculent) chemical Sequestrant
   - Others
   - Good condition ✓
   - Needs Maintenance
   - Sampling ports properly marked and functional ✓
   - Sampling/maintenance log displayed and up to date ✓
   - Equipment properly identified ✓, generally but needs some more attention
   - Quantity of groundwater treated annually
   - Quantity of surface water treated annually N/A

   Remarks

2. **Electrical Enclosures and Panels** (properly rated and functional)
   - N/A
   - Good condition ✓
   - Needs Maintenance

   Remarks

3. **Tanks, Vaults, Storage Vessels**
   - N/A
   - Good condition ✓
   - Proper secondary containment
   - Needs Maintenance

   Remarks

4. **Discharge Structure and Appurtenances**
   - N/A
   - Good condition ✓
   - Needs Maintenance

   Remarks

5. **Treatment Building(s)**
   - N/A
   - Good condition (esp. roof and doorways) ✓
   - Needs repair
   - Chemicals and equipment properly stored ✓

   Remarks

6. **Monitoring Wells** (pump and treatment remedy)
   - Properly secured/locked
   - Functioning ✓
   - Routinely sampled ✓
   - Good condition ✓
   - All required wells located
   - Needs Maintenance
   - N/A

   Remarks

D. Monitoring Data

1. Monitoring Data
   - Is routinely submitted on time ✓
   - Is of acceptable quality ✓

2. Monitoring data suggests:
   - Groundwater plume is effectively contained
   - Contaminant concentrations are declining ✓

D. Monitored Natural Attenuation

1. **Monitoring Wells** (natural attenuation remedy)
   Properly secured/locked Functioning Routinely sampled Good condition
   All required wells located Needs Maintenance N/A
   Remarks_____

X. OTHER REMEDIES

If there are remedies applied at the site which are not covered above, attach an inspection sheet describing the physical nature and condition of any facility associated with the remedy. An example would be soil vapor extraction.

XI. OVERALL OBSERVATIONS

A. Implementation of the Remedy

Describe issues and observations relating to whether the remedy is effective and functioning as designed. Begin with a brief statement of what the remedy is to accomplish (i.e., to contain contaminant plume, minimize infiltration and gas emission, etc.).

B. Adequacy of O&M

Describe issues and observations related to the implementation and scope of O&M procedures. In particular, discuss their relationship to the current and long-term protectiveness of the remedy.
See O&M interview, Attachment 5

C.	**Early Indicators of Potential Remedy Problems**
	Describe issues and observations such as unexpected changes in the cost or scope of O&M or a high frequency of unscheduled repairs, that suggest that the protectiveness of the remedy may be compromised in the future.
D.	**Opportunities for Optimization**
	Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy.

ATTACHMENT 5

Photograph Log

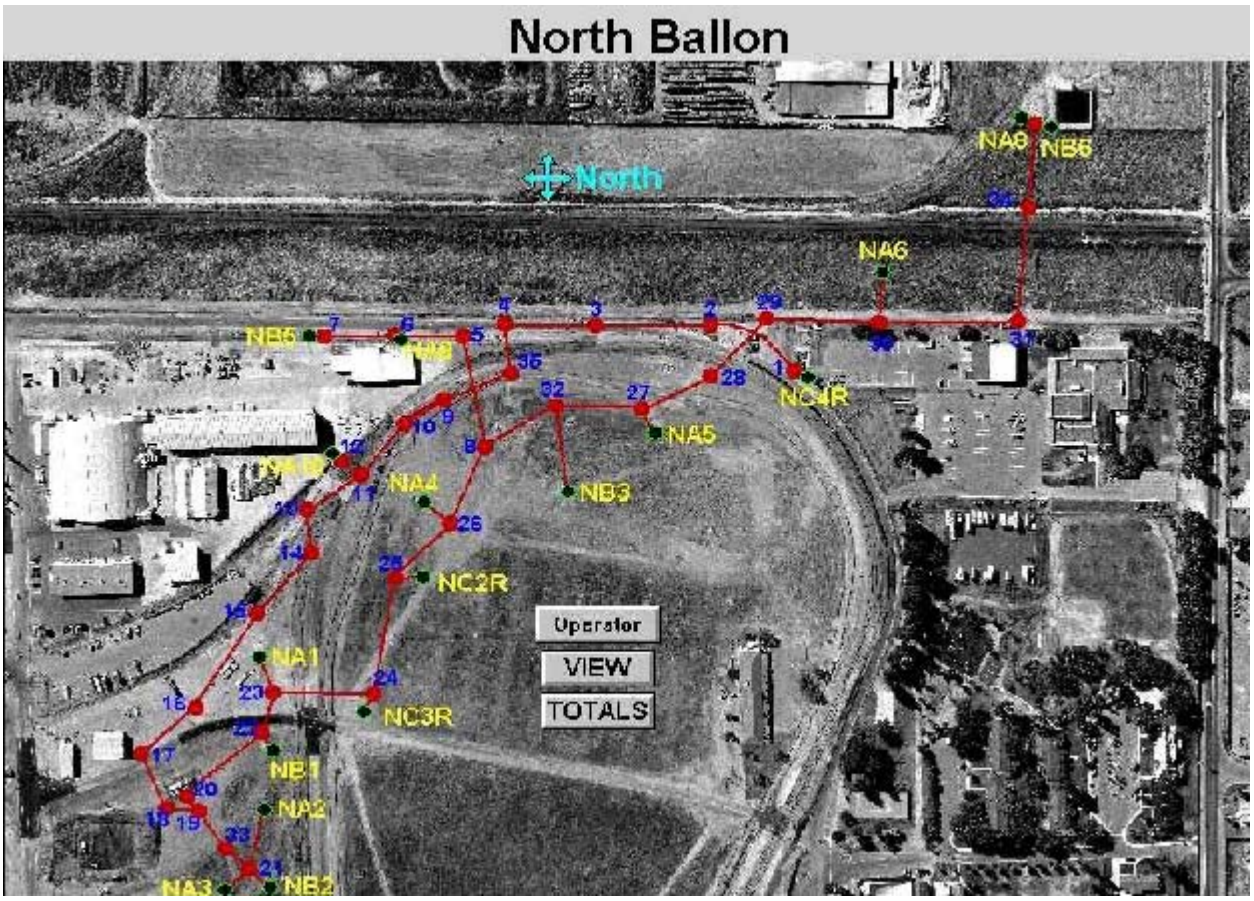

Photo 1. North Balloon Groundwater Treatment System

Photo 2. North Balloon Groundwater Treatment Plant

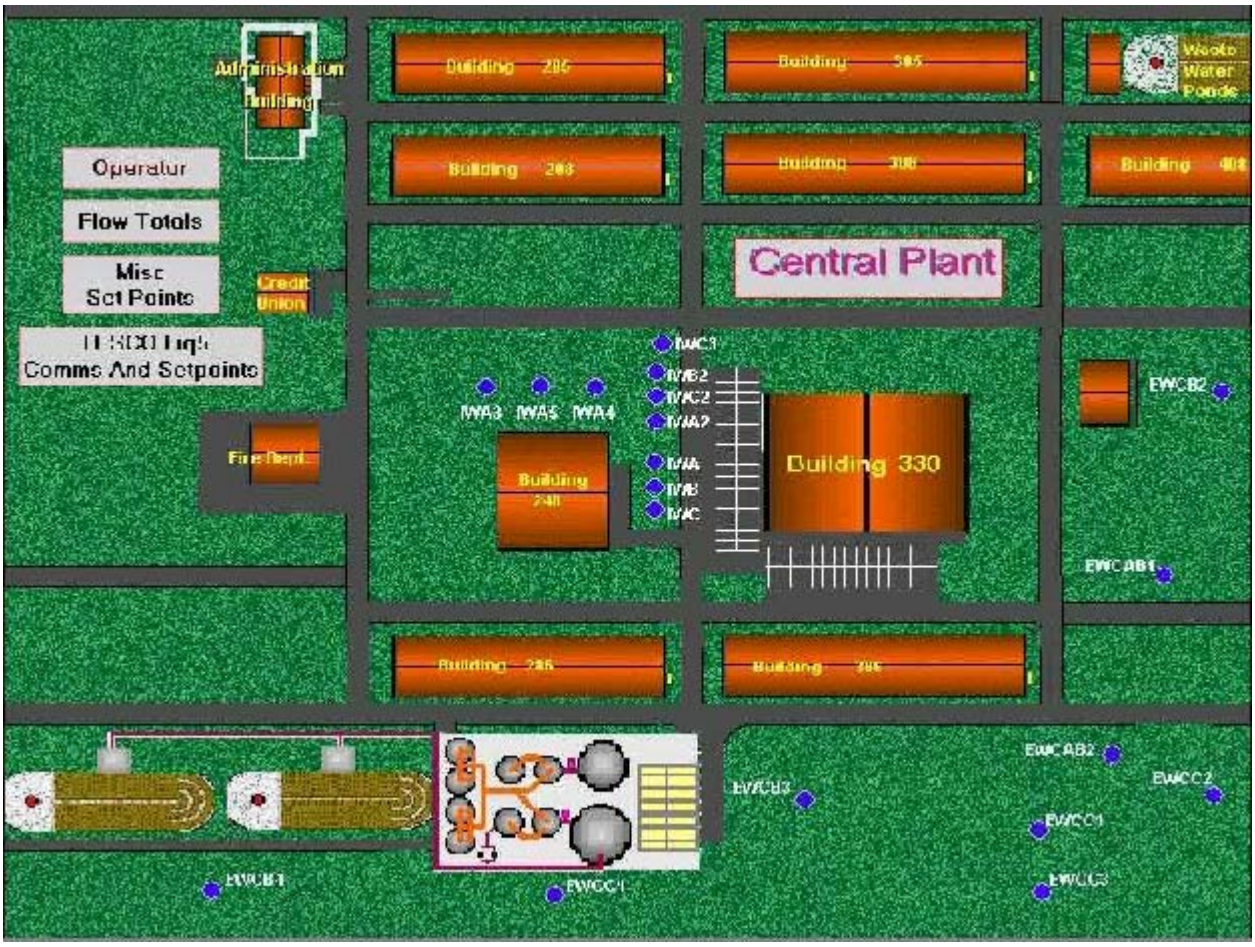

Photo 3. Central Area Groundwater Treatment System

Photo 4. Central Area Groundwater Treatment Plant

Photo 5. Central Area Extraction Wells

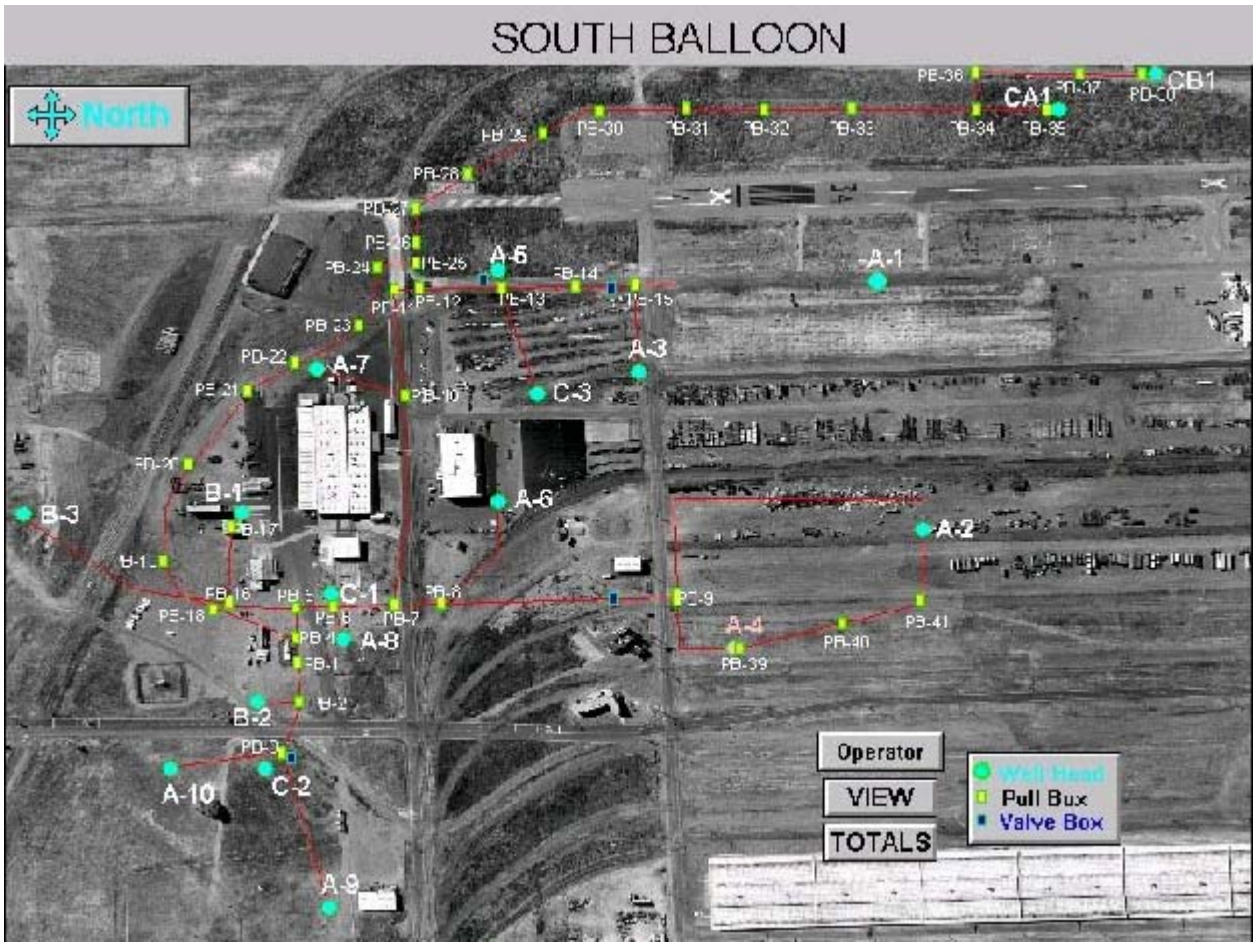

Photo 6. South Balloon Groundwater Treatment System

Photo 7. South Balloon Groundwater Treatment Plant

Photo 8. South Balloon Extraction Well and Monitoring Wells

Photo 9. SVE Sites P-1A, P-1B, and P-1C

Photo 10. SVE Site P-6A

Photo 11. SVE Site P-1E

Photo 12. Metals Excavation Site S-3

Photo 13. Metals Excavation Site S-26

Photo 14. Former Pesticide Mix Area

Photo 15. Former Pesticide Mix Area Facing South

Photo 16. Institutional Controls Area

ATTACHMENT 6

Interviews

Questions for John Guzman and/or Maurice Benson

1. What is your overall impression of the remedies selected for OU 1 and OU 2?

2. Is the OU 1 remedy functioning as expected? Do you have any concerns regarding the function of the remedy?

3. Have there been unexpected O&M difficulties or costs at the site since startup or in the last five years?

4. Have there been significant changes in the O&M requirements, maintenance schedules, or sampling routines since startup or in the last five years? If so, do they affect the protectiveness or effectiveness of the remedy?

5. Do you have any comments, suggestions, or recommendations regarding the implementation of the OU 1 and OU 2 remedies?

6. Do you have any observations on the operation of the OU 1 remedy related to future effectiveness of optimization of operations?

7. What is your single greatest concern regarding the ongoing performance of the OU 1 remedy?

INTERVIEW RECORD

Site Name: DDJC - ~~Jr.~~ SHARPE		**EPA ID No.:** CA8210020832
Subject: DDJC - SHARPE REMEDIAL SYSTEMS	**Time:** 1430	**Date:** 3/5/03
Type: ☐ Telephone ☒ Visit ☐ Other **Location of Visit:** DDJC - TRACY	☐ Incoming ☐ Outgoing	

Contact Made By:

Name: PAUL WADDING	**Title:** ENGINEER	**Organization:** URS

Individual Contacted:

Name: JOHN GUZMAN	**Title:** ENVIRONMENTAL MANAGER	**Organization:** DDJC - FA
Telephone No: 209 - 839 - 4129 **Fax No:** 209 - 839 - 4949 **E-Mail Address:** jguzman@ddc.dla.mil	**Street Address:** **City, State, Zip:**	

Summary Of Conversation

1. Overall OU2 - Good choices for economic reasons. Best choice for expedition of remediation.
   OU1 - Only viable alternative that minimized capital expenditure. Best for guarantee of results. Problems w/ scale → leading to approval for chemical addition
2. OU1 Functioning - Current optimization anticipated as expected. Concern - expense over long run. Will agencies recognize the very last bit of contamination will be big $ to get out.
3. Scaling - ~~the~~ acid washing line. Addition of chemical to clean line, chemical sequesterant.
4. Always adding sampling for potable wells when indications were there.

Page 1 of ____

5. ~~Not~~ Just to implement recommendations from expert analysis. Can we shut down more wells to reduce cost? Explore the possibility of the containment zone policy

6. Keep on top of operations for proper function. What happens when extraction wells become non-detect. If so, analyze and shut down. May not need some and add more
7. ~~If~~ Increased ratio of costs to ~~lbs~~ removed. Benefit - reduced at

at some low value — 10 yr? Approaching clean up level, maybe analyze reduce treatment area, or discontinue because very close to clean up level. Why continue to treat when it will not be economically feasible

5-Year Review Questions

Questions provided to Paul Marsden of Tetra Tech (DDJC-Sharpe groundwater treatment system O&M contractor)

Q1. What is your overall impression of the OU 1 groundwater extraction and treatment systems?

A1. They are old technology but doing a great job.

Q2. Are the OU 1 groundwater treatment systems functioning as expected from an operations and maintenance perspective?

A2. Yes they are working properly, with the exception of Central Plant. Central Plant used to work properly but over the last two too three years the PLC's have begun to have more and more problems.

Q3. Have there been unexpected O&M difficulties or costs at the site since start-up or in the last five years?

A3. Yes, the upgrade of PLC's at Central Plant.

Q4. Have there been significant changes in the O&M requirements, maintenance schedules, or sampling routines since start-up or in the last five years? If so, do they affect the effectiveness of operations?

A4. No, there have been no significant changes in the O&M requirements at any of the three plants out side of updating equipment. "I.E." pumps, PLC's, wiring, ext.

Q5. Is there a need for a continuous on-site O&M presence? If so, describe activities. If not, describe required staff and frequency of site inspections.

A5. Yes. Weekly maintenance and repairs need to be done on daily basses. As well as data and computer maintenance, updating, and testing all of this should be done daily.

Q6. Do you have any comments, suggestions, or recommendations regarding the management or operation of the groundwater treatment systems?

A6. No comments.

5-Year Review Questions

Q7. Do you have any observations on the operation of the OU 1 remedy related to future effectiveness or optimization of operations?

A7. The operator needs to have more input from whom ever has the "Plum Map" for better understanding of how to run the plants / extraction well.

Q8. What is your single greatest concern regarding the on-going performance of the OU 1 groundwater treatment systems?

A8. FUNDING for maintenance and parts needed for repairs.

ATTACHMENT 7

WES Groundwater Model Presentation

Scenario 3: TCE Plume Capture and Containment Issues

Appendix D

Development of a Comprehensive Groundwater Model of the Defense Distribution Depot San Joaquin (DDJC), Sharpe Site Lathrop, California

by

Barbara P. Donnell, Earl V. Edris,
Hsin Chi J. Lin, Hwai-Ping Cheng and Thomas L. McGehee

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Research and Development Center
Waterways Experiment Station, Corps of Engineers
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May 1, 2003

Appendix D: Contents

SCENARIO 3: TCE PLUME CAPTURE AND CONTAINMENT ISSUES 7

Introduction 7

Purpose of Modeling 7

Modeling System 8

Numerical Model Assumptions 8
Datum Reference 8
Extraction wells for 10-12 June 2002 8
Injection wells 10
Head boundary conditions for June 2002 10
Model domain 11
Mesh resolution 12
Computational environment 13
Hydraulic conductivity 14
Unsaturated curves 14
Infiltration rates 14
Percolation ponds 14
TCE Plume description 15
Transport Parameters 17
Types of simulations 18
FEMWATER steady-state flow only simulation 19
FEMWATER transient transport only simulation 19

Flow Verification 2002 19

Transport Verification 21
Flow analysis for “Typical 1998” 22
TCE Initial Condition for Transport Verification 22
TCE Transport Verification (1999-2002) 23
TCE Initial Condition for 30-Year Transport 25
TCE Transport analysis (30 years) for June 2002 Condition 26

Scenario CLEANUP **27**
Flow analysis 27
TCE Transport analysis (30 years) 27

Scenario SHUTDOWN **29**
Flow analysis 29
TCE Transport analysis (30 years) 30

Scenario SHUTDOWN Alternative **31**
Flow analysis 31
TCE Transport analysis (30 years) 31

Scenario Comparisons **32**

Limitations **34**
Stratigraphy conceptualization 34
Transport parameter uncertainty 34
Natural attenuation processes 34

Summary **35**

References **36**

Appendix D: List of Figures

Figure D 1. Site map of study area with existing 10-12 June 2002 extraction well gallery. *37*
Figure D 2. Northern area extraction well names, pumping rates in gpm (where 1 gpm = 8.02 ft^3/hr) *38*
Figure D 3. Southern area extraction well names, pumping rates in gpm (where 1 gpm = 8.02 ft^3/hr) *39*
Figure D 4. Head boundary data for June 2002 obtained from the permanent piezometers installed in May 2002. ..... *40*
Figure D 5. Geostatistical interpolation of observed groundwater levels for 10-12 June 2002. ..... *41*
Figure D 6. FEMWATER 3-D Mesh with 31 Vertical layers *42*
Figure D 7. Plan view of 5 $\mu g / L$ contour for the A-, B, and C-zone TCE plumes (2Q98) *43*
Figure D 8. Plan view of TCE concentrations contours in $\mu g / L$ for the third quarter of 1998, 1999, 2000, 2001 and 2002 TCE plumes. (Figure provided by URS) *44*
Figure D 9. GMS statistical analysis of TCE 1999 third quarter concentration observations *45*
Figure D 10. Selected monitoring stations for examining historical TCE behavior on the Sharpe DDJC site. A –99 concentration indications that there is no data available for that period. *46*
Figure D 11. Total head color contours and GMS statistical analysis of groundwater level model results versus all monitoring locations for the 10-12 June 2002 verification data set. *47*
Figure D 12. (a) Zoom of west-central area. Total head color contours and GMS statistical analysis of groundwater level model results versus all monitoring locations for the 10-12 June 2002 verification data set. *48*
Figure D 13. Individual GMS statistical analysis by zone of groundwater level model results versus monitoring locations for the 10-12 June 2002 verification data set. *49*
Figure D 14. Total head contours and constant length vectors of FEMWATER results of the 10-12 June 2002 verification period for the top of the B-zone, -28 ft elevation. *50*
Figure D 15. Total head contours and constant length vectors of FEMWATER results of the typical pumping condition for 1998. The top of the B-zone, -28 ft elevation, is displayed. Triangles represent B-zone extraction wells. *51*
Figure D 16. Statistical evaluation of the 3Q 1999 TCE concentration initial condition (ppb) *52*
Figure D 17. Examination of plan view TCE plume Iso-surfaces derived from the IDW-3D interpolation of the 3Q 1999 TCE concentration observations. *53*
Figure D 18. Computed versus observation data of TCE 3-year transport (3Q99 – 3Q02) using a high dispersion coefficient. *54*

Figure D 19. Computed versus observation data statistics for TCE 3-year transport (3Q99 – 3Q02) using a high, medium, and zero dispersion coefficients. 55
Figure D 20. Maximum TCE concentrations found within the A, B, C, and D zones for the initial condition (part a), year 0, and after 3-years of TCE plume transport. Parts b through d, compare the effects of varying the dispersion rate after 3-years of simulation. 56
Figure D 21. Initial Condition interpolated from monitoring well data from the third quarter of 2002 TCE concentrations. For each (x,y) nodal location, the maximum TCE concentration found in within the specified vertical dimension is plotted.....57
Figure D 22. Statistical evaluation of the 3Q 2002 TCE concentration initial condition (ppb) 58
Figure D 23. Long-term transport results for 10-12 June 2002 conditions, year 0, year 10, year 20, and year 30. For each (x,y) locations, the maximum concentration found in the vertical (0 < Z < -220 ft) is plotted. 59
Figure D 24. Long-term results for 10-12 June 2002 condition, for years 10 and 20, demonstrating the sensitivity effects of the diffusion coefficient. For each (x,y) locations, the maximum concentration found in the vertical (0< Z < -220 ft) is plotted. 60
Figure D 25. Sharpe DDJC pumping gallery comparisons for the Cleanup versus the Shutdown, and Shutdown alternative ("What If") scenario. 61
Figure D 26. Total head contours and constant length vectors of FEMWATER results of the no pumping condition using the 10-12 June 2002 boundary head conditions. The top of the B-zone, -28 ft elevation, is displayed. 62
Figure D 27. Total head contours and constant length vectors of FEMWATER results of the CLEANUP scenario. The top of the B-zone, -28 ft elevation, is displayed. Triangles represent B-zone extraction wells. 63
Figure D 28. Long-term transport results for CLEANUP scenario, year 0, year 10, year 20, and year 30. For each (x,y) locations, the maximum concentration found in the vertical (0< Z < -220 ft) is plotted. 64
Figure D 29. Total head contours and constant length vectors of FEMWATER results of the SHUTDOWN scenario. The top of the B-zone, -28 ft elevation, is displayed. Triangles represent B-zone extraction wells. 65
Figure D 30. Detail of total head contours constant length velocity vectors for the SHUTDOWN scenario. Experiment to determine the effect of increasing the pumping rate of EWCC3 from 66 to 96 gpm. Part a and b zooms in on the area of interest and isolates the top of the B-Zone (-28 < Z < -48 ft). Part c and d isolates the view for the C-Zone (-70 < Z < -140) horizon. 66
Figure D 31. Long-term transport results for SHUTDOWN scenario, year 0, year 10, year 20, and year 30. For each (x,y) locations, the maximum concentration found in the vertical (0< Z < -220 ft) is plotted. 67
Figure D 32. Total head contours and constant length vectors of FEMWATER results of the SHUTDOWN Alternative scenario ("What if". The top of the B-zone, -28 ft elevation, is displayed. Triangles represent B-zone extraction wells 68
Figure D 33. Detail of total head contours constant length velocity vectors for the SHUTDOWN alternative. Part a zooms in on the area of interest and isolates the top of the B-Zone (-28 < Z < -48 ft). Part b isolates the view for the C-Zone (-70 < Z < -140) horizon. 69

Figure D 34. Long-term transport results for SHUTDOWN alternative scenario ("What If"), year 0, year 10, year 20, and year 30. For each (x,y) locations, the maximum concentration found in the vertical (0< Z < -220 ft) is plotted. 70
Figure D 35. Maximum TCE comparisons within A-Zone for CLEANUP versus SHUTDOWN scenario, for year 10 and year 20.....71
Figure D 36. Maximum TCE comparisons within B-Zone for CLEANUP versus SHUTDOWN scenario, for year 10 and year 20.....72
Figure D 37. Maximum TCE comparisons within C-Zone for CLEANUP versus SHUTDOWN scenario, for year 10 and year 20.....73
Figure D 38. Maximum TCE comparisons within D-Zone for CLEANUP versus SHUTDOWN scenario, year 10 and year 20. 74

Appendix D: List of Tables

Table D 1.....9
Table D 2.....12
Table D 3.....15
Table D 4.....17
Table D 5.....24
Table D 6.....28
Table D 7.....33
Table D 8.....35

Scenario 3: TCE Plume Capture and Containment Issues

Introduction

The U.S. Army Engineer Research and Development Center (ERDC) at the Waterways Experiment Station (WES), under a previous tasking from the Huntsville Engineering and Support Center (CEHNC), developed a three-dimensional groundwater model of the Defense Distribution Depot San Joaquin-Sharpe, in Lathrop, California (DDJC-Sharpe). The purpose of the model was to assist in the groundwater remediation activities at DDJC-Sharpe. This report builds upon the work outlined and described in the main report (Donnell et al., 2000). This appendix specifically addresses several issues. First it addresses the effectiveness of the existing pumping gallery by verifying the flow and transport numerical model to a synoptic data set representing present conditions (June 2002). Next it addresses the effect of modifying the pumping gallery on the long-term plume migration. This appendix will evaluate these scenarios to make recommendations if any potential non-captured areas, and provide time estimates for plume remediation. Figure D 1 shows the study area, installation layout, and sections of the city of Lathrop, California.

At the time of this writing, Dynegy Corporation uses some of the treated groundwater from the depot. The only other water disposal options on site are located in the central area, labeled as basin1 and basin2 in Figure D 1. Since these basins are not lined and are in a precarious location with respect to the existing contaminant plumes, they were completely deactivated in Dec 2001 on the advice of the California Water Board regulators. Given that event, the scenarios tested in this appendix considered both basins empty.

Purpose of Modeling

The purpose of this modeling project was to evaluate existing conditions, a CLEANUP, and a SHUTDOWN pumping configuration. The CLEANUP pumping configurations will test existing pumping well gallery (as of 10-12 June 2002), plus recently installed extraction wells. The SHUTDOWN pumping option will test the effects of turning off a set of 10 extraction wells. In fact, these 10 extraction wells were turned off on 9 July 2002 under temporary permission by the California Water Board regulators. The task is to evaluate each alternative according to its influence on TCE contaminant plumes. The modeling approach uses the previously developed regional scale conceptual model, described in the main report, to address these scenarios. The groundwater model is housed within a graphically driven user environment that allows an array of scenarios to be evaluated.

Modeling System

The modeling system chosen for the DDJC-Sharpe application is the Department of Defense Groundwater Modeling System (GMS). The FEMWATER three dimensional groundwater model documented in the main report, appendix A, (Lin, et al, 1997) is used to simulate the scenarios.

Numerical Model Assumptions

The following assumptions were made for the scenario test addressed in this appendix.

Datum Reference

Former work reported in Appendix B of this series (Donnell et al., 2000) warned of datum uncertainty that the numerical modeling work had revealed. The Huntsville Engineering and Support Center (CEHNC) contracted with URS Corporation (referred to as Radian International in previous reports) in the December 2000 to complete a resurvey of the Sharpe site. The resurvey was conducted to rectify inconsistencies of vertical and horizontal datum references for all of the monitoring and extraction wells. It was revealed that there was indeed a mixture of datum references that was beyond simple explanation. The 2002 survey now references a common datum for all stations. Both the horizontal and vertical datum reference is CA State Plane Zone 403 NAD83.

Extraction wells for 10-12 June 2002

The array of 44 existing extraction wells, 1 Shad extraction well, and 2 municipal pumping wells within the DDJC-Sharpe numerical model domain were assigned pumping rates equivalent to what was observed during the synoptic 10-12 June 2002 data collection exercise. Shad well #3, also known as PW39, was the only one of the 4 shad wells pumping during the synoptic data collection. Otherwise stated; Shad 1, 5, and 6 were not activated. Table D 1 provides the location and 3-day average pumping rates assigned for each of the wells operational during this time period. There are 3 additional extraction wells added since the last modeling simulations: EWC4 in the south balloon, EWCB5 in the central area, and EWNC5 in the north balloon. As noted in Table D 1, some of these new extraction wells (EWCB5, EWNC5) in the process of coming online, but were not operational for the 10-12 June 2002 collection period. Of further note, pumping rate information was not available for EWCC2, EWCC3, and EWNA5 due to electrical malfunctions; therefore a typical pumping rate for these wells was applied.

Typical operations of existing Lathrop municipal wells include a large pumping rate for peak hourly demands of 8-12 hour duration with dormant intervals. Rather than pulsing the production wells on and off at 8 to 12 hour intervals, equivalent 24 hour pumping rates were determined and used in the numerical simulations. This allowed longer numerical time steps and reasonable computer time.

Because the 3D mesh used for these scenarios had a finite number of vertical layers, the z-coordinate assignment for the extraction well screens in the numerical model may be slightly different than the field values. Typically if there were a difference, then the numerical model screen would tend to be slightly deeper than the field data screen. The existing extraction wells locations and their synoptic 3-day average pumping rates as 10-12 June 2002 are shown in Figure D 2 through Figure D 3.

Table D 1
Synoptic extraction rates observed in 10-12 June 2002 (URS, 2002)

Easting Coordinate, ft	Northing Coordinate, ft	Mid-Screen ft bgs, msl*	3-Day Ave Rate gpm	3-Day Ave Rate cu-ft/hr	June 2002 Water Level ft,msl*	STATION
South						
6338689	2126451	-5.3	2.3	18.45	1.0	EWA1
6339560	2126677	-6.0	6.0	48.4	-4.8	EWA2
6339082	2126016	-3.9	2.6	20.6	-2.5	EWA3
6338665	2125690	-14.8	6.5	52.1	Unknown	EWA5
6339464	2125696	-4.6	13.1	105.1	-1.2	EWA6
6339066	2125305	-8.6	2.8	22.5	-5.4	EWA7
6339835	2125307	-3.9	11.7	93.8	-6.4	EWA8
6340674	2125303	-4.4	5.8	46.5	3.7	EWA9
6340271	2124906	-8.2	11.7	93.6	-0.6	EWA10
6339488	2125105	-49.5	26.7	214.1	-36.4	EWB1
6340051	2125117	-27.3	11.2	89.6	-19.5	EWB2
6339711	2125297	-62.3	23.9	192.2	-31.2	EWC1
6340272	2125105	-74.1	46.7	374.5	-6.7	EWC2
6339062	2125744	-72.4	40.7	326.4	-5.1	EWC3
6338167	2126139	-108.1	29.0	232.9	-13.0	EWC4
6338221	2126940	-16.5	27.5	220.8	-3.9	EWCA1
6338098	2127222	-37.8	27.1	217.0	-2.0	EWCB1
Central						
6339105	2128691	(A) -12.6 (B) -29.2	27.1	217.3	-14.2	EWCAB1 (2 screens)
6338697	2128884	-20.9	8.3	66.8	-1.4	EWCAB2
6338096	2127221	-34.8	26.9	215.7	-2.0	EWCB1
6339736	2128815	-64.7	43.8	351.5	-43.6	EWCB2
6338381	2130742	-37.3	11.2	89.8	-4.0	EWCB3
6338178	2131111	-67.9	20.1	161.2	-17.4	EWCB4
6338354	2130814	(A) -47.7 (B) -68.2	0	0	New Install But No Op	EWCB5 (2 screens)
6338128	2129492	-120.8	60.1	482.0	-44.2	EWCC1
6338307	2127864	-84.6	52.4	420.3	3.4	EWCC2 #
6336958	2130112	-118.3	66.1	530.9	-9.7	EWCC3 #
6338188	2130910	-86.5	44.4	356.4	-40.2	EWCC4
North						
6338860	2132942	-15.9	1.5	12.03	-3.1	EWNA1
6339189	2132942	-40.1	0	0	No Op	EWNA2
6339357	2132951	-25.7	28.1	225.1	-19.4	EWNA3
6338554	2133264	-20.6	0	0	No Op	EWNA4
6338412	2133749	-20.9	2.8	22.5	-13.2	EWNA5 #
6338079	2134227	-16.2	5.0	40.1	-5.7	EWNA6
6337768	2134544	-8.1	4.1	32.9	-7.4	EWNA8
6338221	2133360	-28.7	6.8	54.5	-11.7	EWNA9
6338462	2133081	-14.7	4.5	35.8	-16.8	EWNA10
6339069	2132952	-97.6	3.6	28.6	-23.7	EWNB1
6339343	2132989	-90.4	10.3	82.8	-9.5	EWNB2
6338529	2133567	-91.1	12.3	98.4	-10.2	EWNB3
6338217	2133224	-50.3	37.3	299.2	-14.8	EWNB5

6337775	2134560	-48.2	16.7	134.2	-49.7	EWNB6
6338709	2133275	-65.7	49.8	399.7	-16.6	EWNC2R
6338997	2133152	-62.3	46.6	373.5	-29.3	EWNC3R
6338300	2134067	-73.9	48.9	392.2	-12.6	EWNC4R
6337902	2133599	-102.5	0	0	New, No Op	EWNC5
Potable Wells						
6339866	2133399	-138.0	15.3	122.7	N/A	Shad3 (PW39)+
6340189	2120773	-180.0	413.6	2217.4	N/A	Lathrop-PW6
6340315	2121559	-180.0	884.5	7094.4	N/A	Lathrop-PW7

*MSL is a historical on-site elevation reference of unknown datum.
+Extraction rates are estimates of contributions above the D-Zone.
#The well was working but the actual extraction rate of 10-12 June 2002 was not available, a "typical" rate was assigned

Note, there are a scattering of private agricultural wells in the general region west central domain of the model, none of which were included as extraction wells in the numerical simulation because of lack of access to information regarding their pump rates, screen intervals, or mode of operation.

Injection wells

During the June 2002 collection period, all injection wells were off line or determined to be ineffective injectors and therefore were not included in the scenario testing. This is a reasonable assumption since their operation was not consistent and their future use was uncertain.

Head boundary conditions for June 2002

The Huntsville Engineering and Support Center (CEHNC) contracted with URS Corporation to install 22 permanent piezometers in May 2002. The locations and reference number of each of these are shown in Figure D 4. Each piezometer had a 10-ft screen interval that fell between 11 and 33 feet below ground surface. After several weeks passed to allow for equilibrium, a June 2002 data set of groundwater elevations (ft) were recorded, as shown in the figure.

These head boundary conditions (Dirichlet boundary conditions) were obtained from the June 2002 field data collection effort, verified to match the common datum for the Sharpe site, linearly interpolated between piezometers, and applied to the exterior perimeter of the three-dimensional mesh. Figure D 4 shows the nodal locations for head boundary specifications as red circles.

There are several differences of note between the June 2002 the head boundary conditions and those collected in August 1998. First, the 10-12 June 2002 water level readings are on average 2.5 feet lower than those taken in August 1998. Secondly, the June 2002 data is the complete synoptic set of groundwater elevation data with perimeter and all operable monitoring well locations (approximately 287) set to a common datum. In contrast, the August 1998 data is a synoptic subset of groundwater elevation data with the temporary perimeter piezometers and a representative subset of monitoring well locations (approximately 32) set to non-constant unknown datum references. The other interesting comparison is the head gradient. The August 1998 data set had an

18.28 ft gradient from the eastern boundary to the northwestern boundary and 9.4 ft gradient from the San Joaquin Irrigation District Canal at Lathrop road to the northwestern boundary. The June 2002 data set had a 16.8 ft gradient from the eastern boundary to the northwestern boundary and 16.6 ft gradient from the canal at Lathrop road to the northwestern boundary. Admittedly, the San Joaquin Irrigation District Canal elevations were not recorded during either survey and were set based upon groundwater levels sampled at monitoring locations along the western edge of the canal (for example MW401A=12.4 ft in the 2002 survey).

A geostatistical interpolation of the 10-12 June 2002 groundwater level data to a 2D mesh was conducted to estimate the water table surface, as shown in Figure D 5. To increase visibility, the color contours were truncated to display between –5.0 and +15.0 ft. The dark triangles indicate extraction well locations. From examination of the June 2002 groundwater elevation data, the San Joaquin Irrigation District Canal recharge is pronounced for this lower head condition. Recharge from the canal is influencing the local water table up to 3 ft above the regional water table surface. Also there is clear evidence of a dome of water above the regional water table in the vicinity of both storm water Basins (1 and 2). This is more evident under the northern Basin, Basin #2. These Basins have been disconnected from receiving storm water storage since Dec 2001. URS hypothesizes that this is not actually a dome effect from the basins but may be from two “perched” monitoring locations, MW486A and MW487A, biasing the data.

Although there was no cross section measurements, flow, or water level data collected in the irrigation canal (ditch), the June 2002 field data suggested that the canal would have a more influential role for this data set. Head boundary conditions (Dirichlet boundary conditions) were assigned to surface nodes representing the eastern edge, center, and western edge of the canal. These irrigation canal head values ranged from 4.6 on the north edge to 13.1 ft on the southern edge.

Model domain

The model domain (extent), outlined in Figure D 1 is basically the same as that reported in the main report (Donnell et al., 2000). The domain was slightly modified to match the locations of the newly installed permanent perimeter monitoring wells that were installed in May and June 2002 (Figure D 4). More discussion on that field effort will follow.

In this model, the complex geology is represented with the four zone (A, B, C, and D) designation previously adopted by other investigators. Vertical layers in the 3D mesh represent the geologic stratigraphy from the surface to the bottom of the D-Zone. The surface topography of the mesh was defined from ground surface elevations provided by the USGS 7.5 minute quadrangle maps. The horizontal model boundaries stretch from approximately a half-mile north of Roth Road, south to Louise Avenue and from Interstate 5 east to Airport Road (also called Durham Ferry Road). Therefore, the modeling domain is a trapezoidal shaped coverage with an area over 6 square miles. The vertical

extent of the model domain ranges from the ground surface to the average elevation of the top of the Corcoran clay layer. The bottom of the model is treated as an impermeable boundary. The 3D mesh provides the basic geometric input for the FEMWATER numerical model.

Mesh resolution

The verified Sharpe groundwater flow model presented in the main report, consisted of 11 vertical layers ranging from a ground surface elevation of +20 to an elevation of –220 ft. This model, referred to as "the global flow model", consisted of 102,996 nodes, 187,902 elements, 11 vertical layers (3 ft unsaturated resolution), and 8 material types. The 11-layer model resolution was sufficient to address the existing extraction system. The FEMWATER simulations using this mesh ran within 1 gigabyte of memory.

As the scope of the modeling effort became directed toward evaluation of impacts of proposed percolation pond locations on the existing TCE plumes, it became evident that an unsaturated vertical layer resolution of 0.50-1.50 ft was necessary in the vicinity of a test pond to address anticipated gradient changes around ponds. The need for thin unsaturated layers has a ripple effect down the vertical extent of the model. Good mesh construction practices should strive to for each element not to exceed 50% of the volume of neighboring elements. Increasing the vertical resolution was also considered to be vital to address anticipated concentration gradients during the transport simulations. The lateral resolution within the mesh also had to be refined around pond alternative locations to ensure numerical accuracy around zones of high gradient changes. (Another percolation pond test is anticipated and may be reported at a later date.) The 3D mesh that met these constraints resulted in a mesh containing 409,792 nodes, and 790,655 elements, and 8 material types, for a total of 31 vertical layers. As shown in Table D 2 the maximum layer thickness gradually increased with depth. Figure D 6, parts a through d; show excerpts from the 31-layer three-dimensional finite element mesh used for the scenarios reported in this appendix. As shown in part c of this figure, the mesh resolution is highly refined around EWA5 and all extraction wells. Part d of this figure, illustrates how a group of elements around EWA5 were isolated and turned oblique to illustrate that 3 nodes were assigned as pump nodes (triangle symbol) because they fell within the EWA5 screen interval of –9.9 to –19.7 ft msl. This illustrates that the ability to define the appropriate screen elevations in the numerical model is largely a function of the vertical resolution.

The FEMWATER model simulations using the 31-layer mesh ran within 5 gigabytes of memory.

Table D 2
FEMWATER Hydraulic Conductivity assignments by layer

Vertical Layer Description (no. of layers)	Elevation Range, ft	Max Layer Thickness, ft	Horizontal Hydraulic Conductivity ft/hr	Vertical Hydraulic Conductivity ft/hr
Unsaturated Zone (8)	+25 to +10	1.25	0.40	0.04

Unsaturated Zone (6)	+10 to 0	1.67	0.40	0.04
A-Zone, Top (4)	0 to -14	3.50	0.40	0.04
A-Zone, Bottom (3)	-14 to -28	4.70	0.40	0.04
B-Zone, Top (3)	-28 to -48	10.0	0.20	0.02
B-Zone, Bottom (2)	-48 to -70	11.0	0.20	0.02
C-Zone (3)	-70 to -140	23.4	2.00	0.10
D-Zone (2)	-140 to -220	40.0	4.00	0.20

A number of combinations of nodes, elements, and layers could have been used. The mesh design is a balance of horizontal and vertical resolution, expected gradients, convergence, modeling experience, and the computational resources available to address the problem.

Computational environment

FEMWATER (flow mode) was converted to the parallel computational environment in 2000. This provided the production tool to accurately model complex unsaturated groundwater problems such as the percolation pond scenarios. In order to conduct large resolution simulations, a parallel computational environment, such as the Department of Defense (DOD) Cray T3E, was required. This technology provides the capability to divide a large problem into a discrete number of smaller problems that can be simultaneously solved on a set of processors. Quality control measures were conducted to ensure comparability between the serial and the parallel version of FEMWATER (McGehee et al., 1999). The FEMWATER steady state simulations presented herein were partitioned with "METIS", (a recursive partitioning method derived by the University of Minnesota), into 64 processing elements (PE's) and parallel processed on the DOD Cray T3E *('jim')* supercomputer located at WES. After recent system upgrades, the Cray T3E presently has 1,792 processing elements (PE). The majority of these 64-bit processors are 675 Mhz Alpha processors, with 624 Gflops of computational capacity, and 512 Mbytes of memory per PE. Each PE is addressable by high-speed interconnectability. On average, it took approximately 22-minutes of run time for 64-parallel processors to solve the steady state flow simulations described herein.

FEMWATER (transport mode) was converted to the parallel computational environment in 2002. To illustrate the benefit of parallel processing for the long-term transport computations, a serial run (one-CPU) were conducted on-site using a unix Dec-Alpha *('quad')* with a 666 Mhz processor speed and a total of 8 Gbytes of memory. On average, it took an average of .22 CPU hours/simulation year, or 10.8 hours of total computational time to conduct one 50-year transport simulation (advection only). For more complex transport simulations that included longitudinal and transverse dispersion and molecular diffusion, the average computational time on a serial computer increased to 3.7 CPU hour/simulation year, or 185 hours of total computational time to conduct one 50-year transport simulation. The computational turn around time for this same complex transport simulation using 64-processors in parallel on the Cray T3E was 37 hours.

The additional vertical resolution and additional precision of computation make these simulations the most rigorous simulation presented thus far in the Sharpe project.

Hydraulic conductivity

The most important hydrogeologic parameter that is used in the flow simulations is the hydraulic conductivity. Table D 2 shows the assigned values. Although the vertical resolution increased, the assignments and zone demarcations for these parameters remained unchanged from what was described in the main report (Donnell et al., 2000). Refer to Figure D 6, for a visual of the vertical layer descriptions.

Unsaturated curves

The same unsaturated soil property curves defining how the moisture content, relative conductivity, and water capacity vary as a function of the pressure head in the unsaturated zone were used for these simulations as were described in the main report (Donnell et al., 2000).

Infiltration rates

The same method of applying infiltration was used for these scenarios as described in the main report (Donnell et al., 2000). A flux rate is applied on the element face as a Cauchy flux boundary condition. For the verification to the 10-12 June 2002 data set (dry season), a very small infiltration rate of approximately 0.1 *in/yr* (9.58e-7 *ft/hr*) was applied to the surface of the modeling domain. For the SHUTDOWN and CLEANUP scenarios, an average infiltration rate of approximately 1 *in/yr* (9.58e-6 *ft/hr*) was applied to the surface of the modeling domain.

Percolation ponds

The same method of applying recharge from ponded water was used for the percolation pond scenarios as described in the main report (Donnell et al., 2000).

The inclusion of infiltration or percolation ponds provides large head gradients near the ponds. This is a difficult modeling task because the gradients transcend the unsaturated zone. Additional vertical resolution in the mesh, described earlier, was required to achieve numerical convergence and to provide the most reliable results.

URS Corporation, provided a percolation rate of 4.77 gallons/square foot/day (gpsfd) and a typical operation depth of one foot. The percolation rate was

calculated based on the current Central Groundwater Treatment Plant (GWTP) percolation pond operating condition (388,890 gallons/day at 1 foot depth). This value was converted to 0.022532 *ft/hr* and applied as a variable boundary condition flux rate over the surface face of the test pond footprint in the FEMWATER simulation. After discussions with URS, it was determined that a ponding depth of 2 feet would be assigned in the model to simulate an extreme condition. The ponding depth parameter is localized to the pond test location and affects only the pressure head applied to the surface.

TCE Plume description

The primary focus of these tests was the management of the TCE plumes.

In publications of the Quarterly Monitoring Report prior to 2000, the TCE plumes were interpreted and presented as color contours for individual horizons. Publications since have provided a more global interpretation of the plume in plan view. The graphical plan view interpretation of the A-, B-, and C-zone TCE plumes for the second quarter of 1998 (2Q98), were obtained from Figure 3.3-1 through 3.3-3 within the Quarterly Well Monitoring Report provided by Radian International, 1998a. Figure D 7 is a plan view of the 5.0 microgram/liter (5 ppb) contour of the A-, B-, and C-Zone second quarter of 1998 plumes representing the perimeter of the aquifer cleanup level (ACL). The publications since May 2002 of the Quarterly Well Monitoring Report do not attempt to separate the plume by vertical layer. The representations of the TCE plume was obtained from URS Corporation and are provided as Figure D 8. This 5-part figure is a plan view color contour of the TCE concentrations in parts per billion ($\mu g/L$) for the third quarter of years 1998, 1999, 2000, 2001 and 2002. The color contours are derived from the actual field data at each monitoring location if available. If a particular point was omitted from the monitoring rotation, then the most recent available value was substituted. For example, Table D 3 shows a few representative stations. The TCE value of 23 ppb was used as a representative 3Q02 value for MW511C, although the last field data reading for that station was 1Q02. MW437C, represents the highest TCE concentration for 3Q02 plume description, although that data is also several quarters old. Of note is EWCC1, which is also in the C-zone and very close to MW437C has a current TCE reading of 57 ppb. This methodology does introduce some uncertainty in the plots presented in Figure D 8 because the data used to derive these contours was not temporally synoptic and may be misleading. For reference, the shallowest non-zero representative concentration occurs at MW 425A, Z= +6 ft, and the deepest non-zero TCE concentration represented for the 3Q02 data set occurs in the North Balloon, at MW 439CD, Z = -126 ft, TCE=9 ppb.

Table D 3
Historical TCE concentrations (ppb) readings, and representative (Rep) selections for the 3Q02 initial condition.

Station	mids	Rep	3Q02	2Q02	1Q02	4Q01	3Q01	2Q01	1Q01	4q00
MW511C	-119	23	-	-	23	-	8.8	-	-	-
MW507A	-11	24	24	22	2	7.7	1.4	0	0	0

MW507B	-32	15	-	-	15	-	16	-	-	-
MW454C	-16	20	20	19	30	9	4.8	3.8	4.8	3.8
MW425A	+6	7.8	-	-	-	-	7.8	-	-	-
MW423A	-5	7.8	-	-	-	-	7.8	-	-	-
MW439CD	-126	9	9	-	-	-	7.8	-	-	-
MW437C	-115	650	-	-	650	-	300	-	-	-
EWCC1	-118	57	57	59	61	67	-	-	38	40

URS Corporation provided quarterly readings of TCE concentration for 263 potential monitoring locations starting with the first quarter of 1997 to present, third quarter of 2002 or July 2002. Unfortunately the concentration data had missing observations at stations for each monitoring period. The sampling is determined by a set monitoring schedule. For instance the number of actual observations for the quarterly data provided varied between 72 readings and 238 readings. The reporting limit for this data was 0.5 ppb (micrograms per liter), meaning that a zero value could actually have a concentration uncertainty between 0 and 0.5 ppb. This field data was analyzed individually by quarter in GMS to extract statistics, as demonstrated in Figure D 9, and summarized in Table D 4. The last quarter 2002 readings have not yet been conducted. With the exception of 3Q98, there are a more complete number of observations made for the third quarter of each year.

In summary, the highest recorded TCE concentration was 1500 ppb in the third quarter of 1998 at the south balloon station MW418C (X=6339086.7, Y=2125594.1, Z=-62.75 ft tgs). The next highest TCE reading, 1400 ppb, occurs in the first two quarters of 1997 at MW455B (X=6338379.4, Y=2130764.3, Z=-40.2 ft tgs). Five monitoring wells were plotted in Figure D 10 to examine their historical TCE concentration variation with time. In this plot, a –99 value indicates that no observation was made at that station for that time period.

Table D 4
TCE Plume Field Data Summary 1997-2002 (concentration in ppb)

Year | Quarter	TCE Max Concentration	TCE Mean, Concentration	TCE Standard Deviation	Observations Made
1997 | 1Q	1400	39	125	156
1997 | 2Q	1400	42	133	153
1997| 3Q	570	21	66	238
1997| 4Q	580	32	78	155
1998 | 1Q	570	26	71	152
1998 | 2Q	140	16	27	90
1998| 3Q	**1500**	23	114	90
1998| 4Q	88	13	17	84
1999 | 1Q	910	26	98	123
1999 | 2Q	110	13	21	89
1999| 3Q	800	20	71	230
1999| 4Q	100	12	20	90
2000 | 1Q	360	18	44	90
2000 | 2Q	78	13	19	84
2000| 3Q	370	18	45	123
2000| 4Q	100	12	19	73
2001 | 1Q	61	10	15	72
2001 | 2Q	100	11	18	69
2001| 3Q	300	11	29	187
2001| 4Q	83	10	16	74
2002 | 1Q	650	28	73	98
2002 | 2Q	64	15	19	82
2002| 3Q	70	12	17	116
2002| 4Q	N/a	N/a	N/a	N/a

Transport Parameters

FEMWATER has the ability to model transport with a wide range of parameters: molecular diffusion, tortuosity, bulk density, longitudinal and transverse dispersion, distribution coefficient (Kd), and radioactive decay. However, in this study, the field data required to accurately define the necessary parameters for natural attenuation processes were not collected for this site. Therefore, we assumed that neither biodegradation nor sorption occurs during the process of TCE transport. This results in a conservative transport simulation. This decision is believed to result in a simulation that will over estimate the amount of time required for cleanup.

The molecular diffusion coefficient of TCE, 3.87 e-5 ft^2/hr, was adopted from the literature and is basically negligible (Jacobs EM Team, Sept 1998). By definition, the molecular diffusion coefficient is independent of the porous medium. An estimated tortuosity of 3.0 was used (Cussler, 1997). Bulk density is a necessary input parameter if the distribution coefficient (Kd) parameter is non-zero. Bulk density can range as low as 65 lbm/ft^3 for organic and silty clays to 135 lbm/ft^3 for clean gravel-sand mixtures. An estimate of 110 lbm/ft^3 for

bulk density, which is in the descriptive range of sand-silt-mix, was made for the site (Lindeburg, 5th edition).

Under the assumption that the dispersivity is approximately equal to the medium grain diameter of the aquifer solid (Hemond and Fechner-Levy, 2000), which was estimated to be 0.1 – 2.0 mm for the Sharpe site (mixture of sand, silt, and clay), the 2.0 mm was used as the conservation choice. Since the so-called macrodispersion, caused by the heterogeneity of the medium, may appreciably enhance dispersion by two orders of magnitude or more in field studies, we further increased the dispersivity by 100 times (i.e., 200 mm or 0.66 ft). An assumption was made that the longitudinal dispersivity is two times of the transverse dispersivity. A sensitivity analysis was conducted to compare the numerical results at various times throughout the long-term simulation with three sets of longitudinal/transverse dispersivity values: 1.32 ft/0.66ft, 0.66 ft/0.33 ft, and 0.0/0.0 ft. The results indicate that the differences in plume migration are only visible after a decade and then only evident at the higher concentration locations. The differences in the plume migration are more noticeable as the transport simulation progresses with time. This sensitivity brackets the dispersivity effects. These sensitivity results will be addressed later in the report (reference Table D 5, Figure D 19, Figure D 20, and Figure D 24).

Based upon the definition of the distribution coefficient (Kd) as the sorbed concentration divided by the dissolved concentration, it is evident that the magnitude of Kd depends on both the water chemistry and mineral composition of the system. Therefore, it may be concentration dependent and vary from place to place during the transport process (Steefel, 1998) (Fesch, 1998). In fact, it has been realized that using Kd is not an adequate way to simulate retarded transport for many contaminant transport problems in academia. It's ease of use is the major reason why many consultants still use Kd. The Kd values based on field or related laboratory experiments are unavailable in many cases, and certainly were not available for the Sharpe site. All this said, in the testing phase of transport, a range of Kd values were used in a sensitivity analysis: 0.14 ml/g, 0.014 ml/g, and 0 (where 1 ml/g = 0.01602 ft^3/lbm). From the viewpoint of transport, a higher Kd value represents more retardation of the contaminant. Therefore, when Kd=0, the retardation factor is one, representing the case that the contaminant will migrate freely along with groundwater flow. The sensitivity testing revealed that as Kd increased, the comparison of model results deviated more from the observed field data concentrations. Therefore, Kd=0 was used. Without the true Kd values, the numerical simulation is not for TCE but for a synthetic medium.

Types of simulations

Although, the FEMWATER model can be run in either flow and/or transport mode, coupled or uncoupled, it was run uncoupled for these scenarios. First the model was run in flow only mode, the solution examined, then these flow computations became input for the FEMWATER transport only mode. In this investigation, steady-state flow results were used as input to subsequent FEMWATER transient transport simulations.

FEMWATER steady-state flow only simulation

The decision to run the flow simulation in steady state mode for the long-term predictive transport simulations is obvious. The simplest way to measure long-term capture effectiveness for a given pumping array is to hold the flow field constant during the transport simulation.

The FEMWATER flow model requires boundary and initial conditions. The initial condition for pressure head was based upon the same technique described in the main report.

For each of the steady-state flow simulations conducted herein, the extraction wells were assigned the effective pumping rates applicable for each scenario, see Table D 6. A convergence criterion of 0.0005 ft was used for all flow simulations. Once the model had converged to a steady state solution for this condition, the results were analyzed and passed to the transport model.

FEMWATER transient transport only simulation

This is the first set of FEMWATER transport simulations attempted at the Sharpe site. Although the input flow field was steady state, the transport simulation was run transient with a time step that ramped from 2 hours up to and never exceeding 100 hours.

The primary transport variables used for these simulations were: lateral dispersivity (ft), longitudinal dispersivity (ft), and molecular diffusion (ft^2/hr). The molecular diffusion was set to a representative value of 3.87 e-5 ft^2/hr. The dispersion coefficients tested had a high, medium, and zero value. The higher case had longitudinal dispersion of 1.32 ft, and lateral dispersion of 0.66 ft. The medium case had longitudinal dispersion of 0.66 ft, and lateral dispersion of 0.33 ft. The distribution coefficient (K_d), which determines the amount of contaminant adsorbed to the soil, was not used for these simulations.

Flow Verification 2002

A model quality control check is standard procedure whenever a new mesh has been created. To ensure that the 31-layer mesh reproduced the steady state condition recorded in 10-12 June 2002, a verification of these flow conditions was conducted. During this verification period, both “Basin1” and “Basin2” in the central area are off. Figure D 11 shows color contours of total head and observation point statistics for the synoptic 10-12 June 2002 on-site monitoring well data. In this figure, the color coding for the observation points symbols are: dark blue for the A-zone, light blue for B-zone, green for the C-zone, and red for the CD and/or D-zone. The calibration targets (whisker plot) are used to indicate spatial variations in model verification. For these groundwater level model versus field data comparisons, the confidence interval is 2.0 ft. Although calibration targets have been repeatedly used in other appendices of this report, they will be explained again for clarification. The confidence interval of 2.0 ft, means that a “red” whisker plot is shown if the computed data set does not agree with the observed field data of 10-12 Jun 2002 within 2 intervals (4-ft). Orange indicates

agreement within one-interval (2-ft), and green means less than one-interval (< 2-ft) agreement. A whisker plot with no visible color bar means near perfect agreement, and no whisker means that the point was 'not observed'. The up/down direction of the color bar indicates that the numerical results are higher/lower than the field data. The statistics for the verification simulation indicate a mean error (ME) of 1.23 ft; mean absolute error (MAE) of 1.83 ft and a root mean square error (RMS) of 2.3 ft.

Figure D 12 is a zoomed view of Figure D 11 emphasizing the west-central area of the domain. This figure illustrates where the flow verification is the weakest and will be helpful for referencing monitoring locations discussed in the next several paragraphs.

Figure D 13 shows each group of monitoring wells according to aquifer horizon (zone) and includes observation point statistics for zone. The total head values calculated by the numerical model are in reasonable agreement with the field data in the A-zone. For deeper zones, the numerical model generally over predicts the total head value. The potential impacts of over estimating the total head in the deeper zones would be that the numerical model would over estimate the vertical velocity gradient.

Figure D 13 part (a), indicates that there are two primary outliers with a residual error exceeding 8 ft in the A-zone: MW486A west of basin 2, and MW487A west of basin1 in the central area. As mentioned earlier, the numerical model was run with both basins off since both basins were deactivated at the Sharpe site in Dec 2001. At first it was believed that residual effects of their percolation effects remained evident in the field data, but geologists at URS hypothesizes that these two locations (MW486A and MW487A) are monitoring screen intervals no deeper than ~11 feet below ground surface and have probably been above the water table since basin discharges ceased in 4Q01. Therefore readings from MW486A and MW487A are likely from standing water in the bottom of the wells and should be eliminated from the observation set. For example, Figure D 12 highlights MW486A to show the observed total head at MW486A was 9.6 ft, while the numerical model computed 1.3 ft, a residual of –8.3 ft. Similarly the residual for MW487A is –8.1 ft. This explains the discrepancy between model and field observations for these primary outliers. There are two stations which have residual error between 3.1 and 3.5 ft, these are both in the north balloon MW482A and MW527A (near Roth Road). All other A-Zone stations have a residual less than |2.7 ft|. Even with these two outliers included in the statistics, the model compares quite well with the field data as indicated by a ME=-.20 ft, MAE= 1.13 ft, and RMS=1.73 ft.

Examination of Figure D 13 part (b), the B zone, the worst outliers are again clustered around the basins: MW444B with residual = 6.0 ft, MW461B with residual of 4.4 ft, and MW455B with residual of 4.0 ft. Other outliers are located east of the basins near BMG[2] Enterprises: MW 512B with residual of 4.1 ft, and MW525B with residual of 3.0 ft. Three north balloon stations were also outliers: MW439B with residual 3.7 ft and MW 456B with residual of 3.3 ft, and MW413B with a residual of 3.1 ft. All other B-Zone stations have a residual of 3.0 ft or less.

Examination of Figure D 13 part (c), the C-zone, the worst outlier is again clustered around the basins: MW461C with residual =-6.0 ft, and MW511C with residual of 4.1. Other extremities are again near BMG[2] Enterprises: MW510C with residual of 5.1 ft, MW512C with residual of 4.3 ft, and MW503 with residual of 4.1 ft (see Figure D 12 parts b-d, expanded view). The numerical model is over predicting the total head for the deeper horizon, as indicated by the mean error of 2.5 ft.

Examination of Figure D 13 part (d), is a mixture of the CD and D-zone again shows the trend of the numerical model over predicting the total head. The top three worst comparisons are for MW447CD in the north balloon with a residual of 6.8 ft, followed by MW468CD southeast of basin1 with a residual of 3.7 ft, followed by MW401D in the southeast corner of the site with a residual of 3.4 ft.

If the two recommended monitoring locations, MW486A and MW487A, are eliminated from the observation set, the statistical summary improves: ME=1.32 ft, MAE= 1.76 ft, and RMS=2.17 ft. A flow model is considered verified when the mean error is less than 10% of the head gradient across the model domain. For the 10-12 June 2002 data set, the head gradient is 16.8 ft. Using this guideline, the flow verification is acceptable.

Figure D 14 shows the color contours of computed total head in conjunction with constant length velocity vectors for the isolated top of the B-zone, where the top most elevation shown is –28 ft. The purple triangles represent wells extracting from this isolated view.

Transport Verification

For purposes of this appendix, a 3-year TCE transport verification was conducted. The start flow conditions were described above as “Typical 1998” and the TCE initial condition concentration values were derived from the 3Q99 monitoring well data.

The FEMWATER transport TCE verification began at 3Q99 and terminated 3 years later. The computations from the transport simulation were compared with the quarterly monitoring well concentration field data for 3Q2002 (year 3).

Flow analysis for "Typical 1998"

The new 31-layer mesh was used to reproduce the steady state pumping condition described as "typical 1998" in previous appendix C of this report (Donnell et al., 2000).

The head boundary conditions (Dirichlet boundary conditions) were obtained from the August 1998 field data collection effort, adjusted for datum compatibility, and applied to the exterior perimeter of the three-dimensional mesh. Head boundary conditions (Dirichlet boundary conditions) were assigned to surface nodes representing the eastern edge, center, and western edge of the San Joaquin Irrigation District Canal. These "typical 1998" head values for the canal ranged from 1.5 on the north to 6.5 ft on the southern edge of the canal.

The same hydraulic conductivities, infiltration rate of 1.0 in/yr, and procedures were followed as previously described in appendix C. The typical pump rates for the year 1998 were assigned as reported in Table C4 of Appendix C (Donnell et al., 2000) for the 1998 extraction well array. During this time period, "Basin1" was off while the north-most basin, "Basin2", in the central area remained active. Analysis of impacts of "Basin2" indicate that the lateral zone of influence extends over 600 feet and the vertical pressure influences from the basin are evident as deep as –70 ft elevation.

Figure D 15 shows the "typical 1998" color contours of computed total head in conjunction with constant length velocity vectors for the isolated top of the B-zone, the top most elevation is –28 ft. The contour interval was set to show the effect of basin2 activated. Later in this report, EWCC3, located south of BMG2 Enterprises, will be discussed. For the "typical 1998" pumping condition, EWCC3 (z = -188) is pumping 96.1 gpm and the effect of that pump rate is evident on the surrounding velocity vectors.

TCE Initial Condition for Transport Verification

The numerical model requires that every node in the 3D mesh be assigned an initial concentration value. The step of properly interpolating the field data to the 3D mesh is critical. The value and location of the initial TCE is critical because the transport model is being run without a new TCE source other than the initial condition. This was the only viable way to run the transport model because the location and nature of the TCE source in the field is illusive and unknown. Referring back to Table D 4, recall that there are a more complete number of TCE concentration observations made for the third quarter of each year. Therefore, the third quarter 1999 was selected as the initial condition for the 3-year transport verification. Historical data were incorporated into the input of the interpolation data for monitoring stations that were not observed. For instance, if a particular point was omitted from the monitoring rotation, then the most recent historical value available was substituted (see Table D 3).

The GMS has numerous interpolation options available for 3D scatter data sets. For these tasks, the 3D Inverse Distance Weighted (IDW-3D) option was used. The specific GMS settings were: IDW: Constant (a.k.a. Shepard's) methodology, log interpolation, z-scale = 24, truncate interpolated values to the min/max of the scatter data set, set negatives to 1e-6, and compute interpolation weights based on a subset of the nearest 24 points. It is very difficult for this or any interpolation to handle cases where there are spatially close monitoring locations with large discrepancies in concentrations readings. Since the interpolation scheme cannot discern which points are extraction well readings and which are monitoring well readings, there was a need to add some "man-made" interpolation points to aid the interpolation process. In particular, there were two problematic locations. The first such case are central monitoring locations in the C-zone located within 24 feet of each other: EWCC1 with a 3Q99 TCE concentrations of 89 ppb and MW437C with a 3Q99 TCE concentration of 360 ppb. The second case are south balloon monitoring locations in the C-zone located within 153 feet of each other: EWC3 with a 3Q99 TCE concentrations of 38 ppb and MW418C with a 3Q99 TCE concentration of 800 ppb. Using this IDW-3D method of interpolation, an initial condition representative of 3Q99 was obtained.

The statistical comparison of the TCE field observations for 3Q99 with the results from the IDW-3D interpolation is provided in Figure D 16. This data set was used as the initial condition for TCE concentration, and corresponds to Year=0 of the 3-year TCE transport verification. The whisker plots are again used to directly compare observed data to computed data (or interpolated data in this particular example) and are displayed graphically. Following a similar color scheme as before, observation points are black for extraction wells, dark blue for monitoring wells located in the A-zone, light blue for B-zone, green for the C zone, and reddish purple for the CD and red for the D-zone. However, the confidence interval was set to 10 ppb, which seemed an appropriate for the range of concentration values. Figure D 16 shows two extreme outliers: MW437C in the central area has a residual of –91 ppb, and MW418C in the south balloon has a residual of –55 ppb. Given the explanation in the previous paragraph, these two outliers were not a surprise. However the mean error (ME) of –2.9 ppb, mean absolute error (MAE) of 3.5 ppb, and root mean square error or 9.7 ppb is within the tolerance of 10% of the total range (800) of the data set.

Figure D 17 shows the plan view of the interpolation results of the plume for iso-surfaces of: 2, 10, 50, 200, and 600 ppb.

TCE Transport Verification (1999-2002)

To reiterate, Figure D 17 illustrate the data set that became the initial condition for starting the transport verification. The model was run for 3 years and results were saved at year 1 (3Q2000), year 2 (3Q2001), and year 3 (3Q2002).

The FEMWATER transport 3-year verification was conducted to determine sensitivities of longitudinal and lateral (transverse) dispersion. Although dispersion effects are more readily apparent with longer simulations, Table D 5

illustrates the effect of the dispersion coefficient on this 3-year simulation by comparing a few stations. Examination of model results in a tabular manner such as this is difficult and tedious, therefore statistical methods were used.

The comparison of observed versus computed results for year 3 (3Q2002) for the higher dispersion case, is presented in Figure D 18. The high dispersion case had a longitudinal dispersion of 1.32 ft and lateral dispersion of 0.66 ft. The comparison of observed versus computed results for year 3 (3Q2002) for the medium dispersion and zero dispersion case is presented in Figure D 19.

Table D 5
Selected comparisons showing the effect of the Dispersion Coefficient on TCE

Station (mid-Z)	Year	Observed, ppb	High Dispersion	Med Dispersion	Zero Dispersion
EWC3 (-72)	1999	42.8	42.8	42.8	42.8
	2000	119	109.4	80.9	11.7
	2001	92	91.7	67.8	9.7
	2002	69	73.6	53.6	7.2
EWCC1 (-121)	1999	89	88.9	88.9	88.9
	2000	54	148.1	151.9	191.4
	2001	no data	103.2	104.4	133.5
	2002	57	81.4	82.9	111.7
MW418C (-63)	1999	800	745.7	745.7	745.7
	2000	200	672.6	708.0	743.3
	2001	79	562.7	636.1	728.2
	2002	no data	448.2	544.7	694.1
MW437B (-52)	1999	360	357.5	357.5	357.5
	2000	370	350.3	351.3	352.3
	2001	120	326.6	330.1	333.5
	2002	no data	292.4	297.7	303.1
MW455B (-40)	1999	180	168.9	168.9	168.9
	2000	20	73.7	88.5	122.4
	2001	2.4	60.6	73.5	101.3
	2002	no data	52.5	64.0	86.9
MW476A (-7)	1999	190	130.3	130.3	130.3
	2000	no data	120.5	121.3	120.9
	2001	110	109.6	111.8	112.6
	2002	no data	102.8	104.8	105.8

Although the differences are subtle, the higher dispersion value results in a slightly better statistical comparison. As shown in Figure D 19, the high dispersion simulation had a, ME = -4.8, MAE= 11.7, and RMS = 22.6 ppb. For the medium dispersion, ME = -5.0, MAE=11.9, and RMS=22.5 ppb. For the case of zero dispersion, the ME = -5.0, MAE= 13.1, RMS= 25.8 ppb. A transport model is considered verified when the mean error is less than 10% of the concentration gradient within the model domain. Although that the actual TCE data collected for 3Q02 had a min/max value of 0/70 ppb, only 116 observations were conducted. If the other monitoring stations are assigned the most recent historical value, then the highest historical value occurs at MW 437C with 650 ppb. Therefore the range of the data set for 3Q02 was 650 ppb. So the RMS error of 22.6 is within 10% of 650. Using this guideline, the transport verification is acceptable.

Figure D 20 is yet another way of examining the three dimensional model results. Here the concentrations at every node for a given horizontal plane were

examined to determine the maximum TCE value in the vertical, 0 < Z < -220 ft. Part a of this figure represents the maximum TCE concentrations found within the A, B, C, and D zones for the initial condition used for the 3-year verification. Parts b through d of this figure represents the maximum TCE concentration found within the A, B, C, and D zones after 3-years of TCE plume transport. Parts b through d compares the effects of varying the dispersion rate after 3-years of simulation.

TCE Initial Condition for 30-Year Transport

For the long-term transport simulations, the 3Q2002 data set, used as the starting or initial condition, was the most recent data set available. As previously described, historical values were incorporated into the input of the interpolation data for monitoring stations that were not observed. This data had to be interpolated to the 3D mesh to generate an initial condition TCE concentration for all nodes in the mesh. The 3D Inverse Distance Weighted (IDW-3D) interpolation was again used, using the same parameters and methodology as described above in the section entitled "TCE Initial Condition for Transport Verification". Using this IDW-3D method of interpolation, an initial condition representative of 3Q02 was obtained.

This initial condition was sliced by zone and the maximum concentration found within the range of elevation representing the entire mesh is depicted in Figure D 21, part a. Here the concentrations at every node for a given horizontal plane were examined to determine the maximum TCE value in the vertical, 0 < Z < -220 ft. Part b shows the maximum concentration for the initial condition within zone A (0 < Z < -28 ft). Similarly part c and part d, represent the B and C zone concentration initialization.

The statistical comparison of the TCE field observations for 3Q02 with the results from the IDW-3D interpolation is provided in Figure D 22. The whisker plots are again used to directly compare observed data to computed data (or interpolated data in this particular example) and are displayed graphically. Following a similar color scheme as before, observation points are black for extraction wells, dark blue for monitoring wells located in the A-zone, light blue for B-zone, green for the C zone, and reddish purple for the CD and red for the D-zone. The confidence interval was set to 10 ppb for transport. The majority of the sampling points for this quarter were at extraction wells (the black symbols). The most extreme outlier occurs at EWCC1 (see Figure D 22, part b zoom), with an observed value of 57 ppb and a calculated value of 222 ppb. This illustrates the difficulty of incorporating historical values into the initial condition and making comparisons to actual field observations. Essentially the initial condition does not represent a true synoptic snap shot in time. MW437C was not observed in 3Q02, but its most recent historical value of 650 ppb from 1Q02 was taken into consideration to create the interpolated initial condition. Part c of this figure shows the residual versus observed values for 3Q02 if EWCC1 were eliminated from the graphic. The mean error (ME) of –4.4 ppb, mean absolute error (MAE) of 7.42 ppb, and root mean square error of 19.00 ppb is within the tolerance of 10% of the total range (386) of the data set. In general, the initial condition used for the long-term transport simulations over estimates

the TCE concentration at the extraction wells. This may be due to a potential for variation between concentration in samples from extraction wells and neighboring monitoring wells due to the inherit difference between an active pumping and passive flow environment.

TCE Transport analysis (30 years) for June 2002 Condition

Using the 3Q02 initial condition as described above, a 30-year transport simulation was conducted using the flow field representative of the 10-12 June pumping condition.

Figure D 23 presents the long-term transport results for 10-12 June 2002 conditions, year 0, year 10, year 20 and year 30. These results represent the high dispersion coefficient simulation. For each (x,y) locations, the maximum concentration found within the vertical (0< Z < -220 ft) is plotted. The high concentration zones appear to clean up rather rapidly, but there is a capture problem evident at year 10, between EWCC3 and EWCC4, that continues with time.

Figure D 24 compares the year 10 and year 20 results for both the high and zero dispersion coefficient simulation. The capture problem remains regardless of the dispersion coefficient value.

For the scenario testing, only the high dispersion simulations will be presented.

Scenario CLEANUP

The scenario CLEANUP is representative of the pumping gallery at Sharpe working at full potential for present circumstances (year 2002) with the addition of the extraction wells EWB4 (proposed), EWCB5 (new install), and EWNC5 (new install). The pumping rate assignments are provided in Table D 6. In the CLEANUP scenario, both basins are off, an average infiltration rate of approximately 1 *in/yr* (9.58e-6 *ft/hr*) was assigned, and the head boundary conditions obtained from the 10-12 June 2002 were applied.

Figure D 25 compares the Sharpe DDJC pumping gallery as it existing during the 10-12 June 2002 synoptic survey with each of the scenarios presented in this appendix.

Flow analysis

For reference purposes, Figure D 26 illustrates the steady state FEMWATER flow results for the no-pumping condition. The no-pumping condition simply means that the 10-12 June 2002 head boundary conditions were applied in the numerical model, but there were no extraction rates (no-pumping rates) assigned. This data set was used as the initial flow condition for all scenarios reported in this appendix. Figure D 27 illustrates total head color contours with constant length velocity vectors for the CLEANUP scenario are presented for the top of the B-Zone representing –28 ft elevation. The light colored triangles represent the B-zone CLEANUP extraction wells with pumping nodes within the $-28 < Z < -48$ elevation (tgs, ft).

TCE Transport analysis (30 years)

Using the 3Q02 initial condition for concentration as described above, a 30-year transport simulation was conducted using the 10-12 June 2002 head boundary conditions, and the extraction rates for the CLEANUP scenario configuration described in Table D 6.

Figure D 28 presents the long-term transport results for CLEANUP pumping scenario using the 10-12 June 2002 head boundary conditions for year 0, year 10, year 20 and year 30. These results represent the high dispersion coefficient simulation. For each (x,y) locations, the maximum concentration found within the vertical ($0 < Z < -220$ ft) is plotted. The linear contour (light blue) represents the 0.5 ppb edge. The high concentration zones appear to clean up rather rapidly, but there is a capture problem evident at year 10, between EWCC3 and EWCC4, that continues with time.

Table D 6.
Scenario extraction rates (URS, 2002)

Easting Coordinate, ft	Northing Coordinate, ft	Mid-Screen ft bgs, msl*	3-Day Ave June 02 Rate, gpm	CLEANUP Rate, gpm	SHUTDOWN Rate, gpm	STATION
South						
6338689	2126451	-5.3	2.3	√	√	EWA1
6339560	2126677	-6.0	6.0	√	√	EWA2
6339082	2126016	-3.9	2.6	√	√	EWA3
6338665	2125690	-14.8	6.5	√	√	EWA5
6339464	2125696	-4.6	13.1	√	√	EWA6
6339066	2125305	-8.6	2.8	√	√	EWA7
6339835	2125307	-3.9	11.7	√	√	EWA8
6340674	2125303	-4.4	5.8	√	Shutdown	EWA9
6340271	2124906	-8.2	11.7	√	√	EWA10
6339488	2125105	-49.5	26.7	√	√	EWB1
6340051	2125117	-27.3	11.2	√	Shutdown	EWB2
6338784	2125716	-42.0	0	20.0	20.0	Test EWB4
6339711	2125297	-62.3	23.9	√	Shutdown	EWC1
6340272	2125105	-74.1	46.7	√	√	EWC2
6339062	2125744	-72.4	40.7	√	√	EWC3
6338167	2126139	-108.1	29.0	√	√	EWC4
6338221	2126940	-16.5	27.5	√	√	EWCA1
6338098	2127222	-37.8	27.1	√	√	EWCB1
Central						
6339105	2128691	-12.6 -29.2	27.1	√	Shutdown	EWCAB1 (2 screens)
6338697	2128884	-20.9	8.3	√	√	EWCAB2
6338096	2127221	-34.8	26.9	√	√	EWCB1
6339736	2128815	-64.7	43.8	√	√	EWCB2
6338381	2130742	-37.3	11.2	√	√	EWCB3
6338178	2131111	-67.9	20.1	√	√	EWCB4
6338354	2130814	(A) -47.7 (B) -68.2	0	20.0 Total	20.0 Total	New EWCB5 (2 screens)
6338128	2129492	-120.8	60.1	√	√	EWCC1
6338307	2127864	-84.6	52.4 #	√	√	EWCC2
6336958	2130112	-118.3	66.1 #	√	√	EWCC3
6338188	2130910	-86.5	44.4	√	√	EWCC4
North						
6338860	2132942	-15.9	1.5	√	Shutdown	EWNA1
6339189	2132942	-40.1	0	5.0	5.0	EWNA2
6339357	2132951	-25.7	28.1	17.5	Shutdown	EWNA3
6338554	2133264	-20.6	0	12.0	12.0	EWNA4
6338412	2133749	-20.9	2.8 #	√	Shutdown	EWNA5
6338079	2134227	-16.2	5.0	√	√	EWNA6
6337768	2134544	-8.1	4.1	√	√	EWNA8
6338221	2133360	-28.7	6.8	√	√	EWNA9
6338462	2133081	-14.7	4.5	√	√	EWNA10
6339069	2132952	-97.6	3.6	√	Shutdown	EWNB1
6339343	2132989	-90.4	10.3	√	√	EWNB2
6338529	2133567	-91.1	12.3	√	Shutdown	EWNB3
6338217	2133224	-50.3	37.3	√	√	EWNB5
6337775	2134560	-48.2	16.7	√	√	EWNB6
6338709	2133275	-65.7	49.8	√	√	EWNC2R
6338997	2133152	-62.3	46.6	√	Shutdown	EWNC3R
6338300	2134067	-73.9	48.9	√	√	EWNC4R
6337902	2133599	-102.5	0	25.0	25.0	New EWNC5

Easting Coordinate, ft	Northing Coordinate, ft	Mid-Screen ft bgs, msl*	3-Day Ave June 02 Rate, gpm	CLEANUP Rate, gpm	SHUTDOWN Rate, gpm	STATION
Potable Wells						
6339703	2132721	-162.0	0	√	√	Shad1 (PW38)+
6339866	2133399	-138.0	15.3	15.3	15.3	Shad3 (PW39)+
6340127	2133363	-200.0	0	√	√	Shad5 (PW40)+
6340725	2133389	-395.0	0	√	√	Shad6 (PW41)+
6340189	2120773	-180.0	413.6	√	√	Lathrop-PW6
6340315	2121559	-180.0	884.5	√	√	Lathrop-PW7
6342018	2122352	-180.0	0	√	√	Test Muni PW10

*MSL is a historical on-site elevation reference of unknown datum.
+Extraction rates are estimates of contributions above the D-Zone.
#The well was working but the actual extraction rate of 10-12 June 2002 was not available, a "typical" rate was assigned
√ Indicates the same pumping rate was used as listed under the column labeled 3-day average, 10-12 June 2002.

Scenario SHUTDOWN

There was a temporary permission granted by the California Water Board regulates to allow 10 extraction wells to be taken off-line as of July 9, 2002. The purpose of this scenario is to test the effect of permanently taking those extraction wells off line. More specifically, the purpose is to determine if shutdown will impact the estimated clean-up time for the TCE plumes. The list of 10 wells involved in the shutdown is:

North Balloon: EWNA1, EWNA3, EWNA5, EWNB1, EWNB3, EWNC3R
Central Area: EWCAB1
South Balloon: EWC1, EWB2, EWA9

Refer back to Figure D 25 (part b) to get a visual of where these wells are located. The pumping rate assignments are provided in Table D 6. After the 10 extraction wells listed are shutdown and the new extraction wells are added, the net effect is a 125-gpm reduction in the overall pumping at Sharpe DDJC. In the SHUTDOWN scenario, both basins are off, an average infiltration rate of approximately 1 *in/yr* (9.58e-6 *ft/hr*) was assigned, and the head boundary conditions obtained from the 10-12 June 2002 were applied.

Flow analysis

Figure D 29 presents the modeled effect of taking the 10 extraction wells off-line. Total head color contours with constant length velocity vectors for the existing conditions are presented for the top of the B-Zone representing –28 ft elevation. The light colored triangles represent the top of the B-zone SHUTDOWN extraction wells with pumping nodes within the $-28 < Z < -48$ elevation (ft bgs).

It was evident that the capture zone for EWCC3, pumping 66 gpm, was not as large as anticipated for the 10-12 June 2003 head boundary conditions. An experiment was conducted to determine the effect of increasing the pumping rate

from its normal rate of 66 gpm to a near maximum capacity rate of 96 gpm. Figure D 30 illustrates this pump rate experiment by zooming in on this area of interest. Parts a and b of this figure examine the top of the B-zone velocity vectors (-28 < Z < -48 ft bgs). Parts c and d examine the C-zone velocity vectors (-70 < Z < -140 ft bgs). Although the increased pumping rate results in a better drawdown, as indicated by the total head color contours of parts b and d of this figure, the constant length vectors still indicate an escape route between EWCC3 and EWCC4.

TCE Transport analysis (30 years)

Figure D 31 presents the long-term transport results for SHUTDOWN scenario conditions, year 0, year 10, year 20 and year 30. These results represent the high dispersion coefficient simulation, and EWCC3 pumping 66 gpm. For each (x,y) locations, the maximum concentration found within the vertical (0< Z < -220 ft) is plotted. Again the high concentration zones appear to clean up rather rapidly, but there is a capture problem evident at year 10, between EWCC3 and EWCC4, that continues with time.

Scenario SHUTDOWN Alternative

Upon examination of the SHUTDOWN scenario where 10 wells were off-line, it appeared evident that EWCAB1 in the Central area remain active as long as it was contributing to TCE extraction. Otherwise the list of 9 wells to deactivate remains consistent with the original SHUTDOWN scenario:

North Balloon: EWNA1, EWNA3, EWNA5, EWNB1, EWNB3, EWNC3R
South Balloon: EWC1, EWB2, EWA9

It is recommended that a C-zone extraction well be place in the central area in the general area as shown in Figure D 25 (part c). For purposes of testing this "What if" configuration of SHUTDOWN 9 + Add 1, a C-zone extraction well, pumping 60 gpm, was added at these coordinates: X= 6337806., Y=2129996., and mid-screen elevation –116 ft.

Flow analysis

Figure D 32 presents the modeled effect of taking the 9 extraction wells off-line and adding 1 C-zone extraction well in the central area. Total head color contours with constant length velocity vectors for the existing conditions are presented for the top of the B-Zone representing –28 ft elevation. The light colored triangles represent the top of the B-zone for this SHUTDOWN alternative (a.k.a. "What if") extraction wells with pumping nodes within the –28 < Z < -48 elevation (ft bgs).

Figure D 33 zooms in on the area of interest where the new well placement was proposed. For the C-zone examination, Figure D 33 (part b) compares with Figure D 30 (part d). The velocity vectors indicate better capture, but there may be enough margins to experiment with placement testing of the new extraction well and pumping rate. Fortunately, the TCE field data and model test seem to indicate very low TCE concentrations expected on the east side of EWCC3.

TCE Transport analysis (30 years)

Figure D 34 presents the long-term transport results for SHUTDOWN alternative ("What if") conditions, year 0, year 10, year 20 and year 30. These results represent the high dispersion coefficient simulation, and EWCC3 pumping 66 gpm. For each (x,y) locations, the maximum concentration found within the vertical (0< Z < -220 ft) is plotted. By comparing Figure D 31 with Figure D 34 it is evident that the extra C-zone central extraction well seems to have greatly helped the plume escape problem between EWCC3 and EWCC4. Furthermore, leaving EWCAB1 active is beneficial.

Scenario Comparisons

The CLEANUP and SHUTDOWN scenarios are compared side-by-side, zone-by-zone, for years 10 and 20 in Figure D 35 through Figure D 38. This side-by-side comparison was done to provide an easier visual of the effect of taking 10 extraction wells off line. Figure D 35 contours indicates the maximum TCE concentrations are found within the A-zone for the CLEANUP scenario (parts a and c) and for the SHUTDOWN scenario (parts b and d). Figure D 36 displays the B-zone comparison. The primary difference seems to be in the central area, most likely caused by off-lining EWCAB1, which has screen in both the A and B zones (-10.1 to –15.1 ft A-zone screen length, and –26.7 to –31.7 ft B-zone screen length). There is evidence that the TCE plume will begin to escape between EWCC3 and EWCC4 sometime shortly after year10. However, recall that the numerical model is generally over estimating the total head in the deeper zones, thereby over estimating the vertical velocity gradient, and my indicate more plume breakthrough than would actually occur in the field. Figure D 37 displays the C-zone comparison. Figure D 38 displays the D-zone comparison. No visible difference between the scenarios is revealed in either the C or D zones.

Comparisons of the total volume of contaminated soil for specified iso-surfaces are provided in Table D 7. . The listed volumes represent the volumes (cubic feet) between each of the iso-values. Take year 0 for example, the first volume, 4.009 e+10, represents the volume of soil containing less than 0.5 ppb of contaminant. The volume in the second row for year 0, 2.697 e+08, represents the volume between the 0.5 ppb and 5.0 ppb iso-values. This table compares the three scenarios, each with the high dispersion coefficient. For sake of reference, the mesh volume is 4.0503 e+10 cubic feet. This table confirms that there is little short-term consequence between the cleanup and shutting down the 10 proposed extraction wells. However, it appears to be a better choice to shut down only 9 of the 10 extraction wells and add to a central C-zone extraction well as demonstrated by results from the “What If” scenario

Table D 7.
Transport Simulation Comparisons of Iso-Surface volumes

Iso-Surface	Time Year 0 is 1999	CLEANUP Concentration, Volumes cu ft	SHUTDOWN-10 Concentration, Volumes cu ft	SHUTDOWN-9 Plus Add 1 EWell "What If" Concentration, Volumes, cu ft
Iso-Surface less than 0.5 ppb	Year 0	4.009 e+10	4.009 e+10	4.009 e+10
	Year 10	4.001 e+10	3.997 e+10	4.010 e+10
	Year 20	4.001 e+10	3.995 e+10	4.017 e+10
	Year 30	3.998 e+10	3.991 e+10	4.023 e+10
Iso-Surface between 0.5 ppb and 5 ppb	Year 0	2.697 e+08	2.697 e+08	2.697 e+08
	Year 10	4.102 e+08	4.230 e+08	3.416 e+08
	Year 20	3.473 e+08	3.799 e+08	2.933 e+08
	Year 30	3.010 e+08	3.551 e+08	2.488 e+08
Iso-Surface between 5 ppb and 10 ppb	Year 0	7.216 e+07	7.216 e+07	7.216 e+07
	Year 10	4.528 e+07	6.346 e+07	3.543 e+07
	Year 20	4.267 e+07	5.578 e+07	2.386 e+07
	Year 30	4.048 e+07	4.791 e+07	1.834 e+07
Iso-Surface between 10 ppb and 15 ppb	Year 0	1.902 e+07	1.902 e+07	1.902 e+07
	Year 10	2.295 e+07	2.357 e+07	1.622 e+07
	Year 20	2.026 e+07	2.141 e+07	9.256 e+06
	Year 30	9.088 e+06	5.735 e+06	3.436 e+06
Iso-Surface between 15 ppb and 25 ppb	Year 0	2.800 e+07	2.800 e+07	2.800 e+07
	Year 10	1.295 e+07	1.620 e+07	8.668 e+06
	Year 20	6.225 e+06	3.771 e+06	2.741 e+06
	Year 30	1.993 e+06	1.642 e+06	1.528 e+05
Iso-Surface between 25 ppb and 50 ppb	Year 0	1.344 e+07	1.344 e+07	1.344 e+07
	Year 10	6.853 e+06	4.625 e+06	2.908 e+06
	Year 20	3.578 e+05	2.788 e+05	4.283 e+04
	Year 30	0	0	0
Iso-Surface between 50 ppb and 100 ppb	Year 0	3.184 e+06	3.184 e+06	3.184 e+06
	Year 10	2.501 e+03	2.067 e+03	0
	Year 20	0	0	0
	Year 30	0	0	0
Iso-Surface between 100 ppb and Max Concentration, ppb	Year 0	1.041 e+07	8.919 e+06	8.919 e+06
	Year 10	0	0	0
	Year 20	0	0	0
	Year 30	0	0	0
Max Concentration, ppb	Year 0	387	387	387
	Year 10	51	50	46
	Year 20	33	34	26
	Year 30	24	24	17

Limitations

The conceptual model, which is the crux of the groundwater model, will continue to improve through time as additional data or model improvements are added. With these additions, the model accuracy will improve, as will its adaptability and ability to demonstrate remediation effectiveness. The limitations sited are primarily related to the need for more information.

Stratigraphy conceptualization

It is recognized that the conceptual model from which the three dimensional mesh was constructed is a homogenous representation of a complex statigraphy composed of sands, silts, and non-continuous clay lenses. The hydraulic parameters and modeling technique described herein were designed to create a regional model of the site. It is possible that the actual field condition at a given test pond location may reveal clay lenses as indicated by the stratigraphy maps in Section 4 of the Well Monitoring Program Quarterly Monitoring Report, July 1998 by Radian International. The presence of clay lenses in the southern DDJC-Sharpe region may prevent the deep vertical flow due to a pond influence as predicted by the groundwater model. However if this were the case, then the horizontal flow would be even greater than the model predicted and the particle migration would be more expansive than these findings indicate.

Transport parameter uncertainty

The transport simulations are sensitive to certain input parameters such as molecular diffusion, longitudinal and lateral dispersion, bulk density, and decay coefficients. The field data required to define all of the necessary parameters for natural attenuation processes were not available for the site. Field data to define the parameters would be beneficial to future transport modeling efforts.

Natural attenuation processes

Natural attenuation processes at the site could provide a measure of cleanup without active intervention by the installation. Numerical models can estimate the impacts of natural attenuation if appropriate field data are available with which to verify the numerical transport models. To date, this data is not available at Sharpe but could be collected.

Summary

It is our recommendation that only 9 of the original 10 Sharpe DDJC extraction wells should be taken off line at this time. Those 9 extraction wells are listed in Table D 8. If these 9 extraction wells were taken off-line, it would result in saving disposal of 125.2 gpm and well maintenance costs. However, the numerical model transport simulations show a cleanup benefit if EWCAB1 in the Central area remain active for a few more years. EWCAB1 should be monitored and re-evaluated every few years. As the plume remediation continues, other extraction wells will become candidates for shutdown.

It is further recommended that a C-zone extraction well be place in the central area in the general area as shown in Figure D 25 (part c). The model results indicate that a minimum of 60 gpm is required to eliminate plume migration off Sharpe DDJC property.

Table D 8
Recommended Shutdown Extraction Wells

Extraction Well	Location (Mid-Screen, ft bgs)	Cleanup Extraction Rate (gpm)	TCE Concentration For 3Q 2002 (ppb)	PCE Concentration For 3Q 2002 (ppb)
Off-Line				
EWNA1	North Balloon, -16	1.5	10	No data
EWNA3	North Balloon, -26	17.5	6.6	No data
EWNA5	North Balloon, -21	2.8	6.5	3.1
EWNB1	North Balloon, -98	3.6	18	0.7
EWNB3	North Balloon, -91	12.3	1.3	1.3
EWNC3R	North Balloon, -62	46.6	20	No Data
EWC1	South Balloon, -62	23.9	35	No Data
EWB2	South Balloon, -27	11.2	70	No Data
EWA9	South Balloon, -4	5.8	0	No data
On-Line				
EWCAB1	Central Zone, -13 & -29	27.1	49	No data
Additional				
New EWell	Central Area, West DDJC, C-zone	Tested 60	X	X

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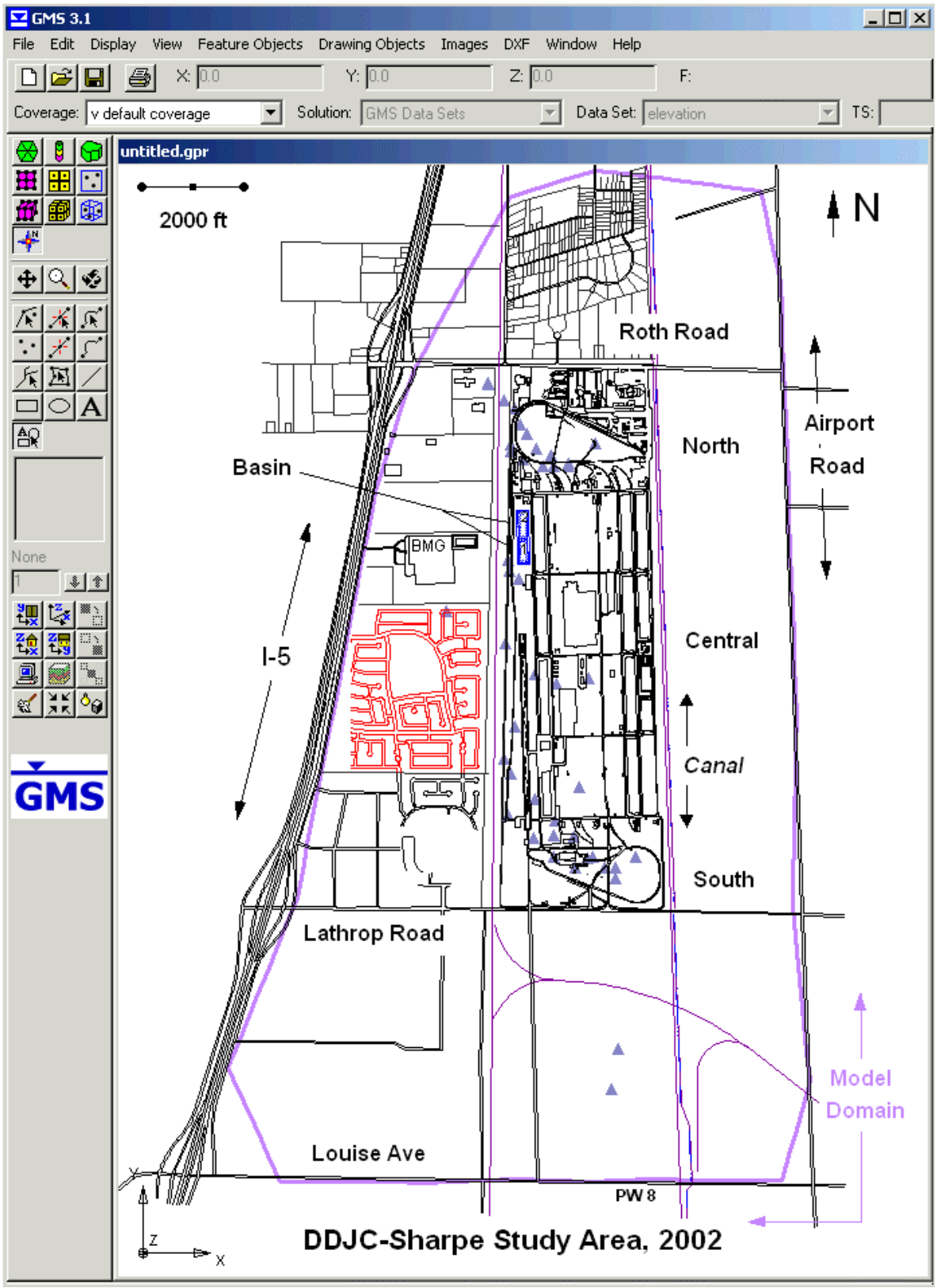


Figure D 1. Site map of study area with existing 10-12 June 2002 extraction well gallery.

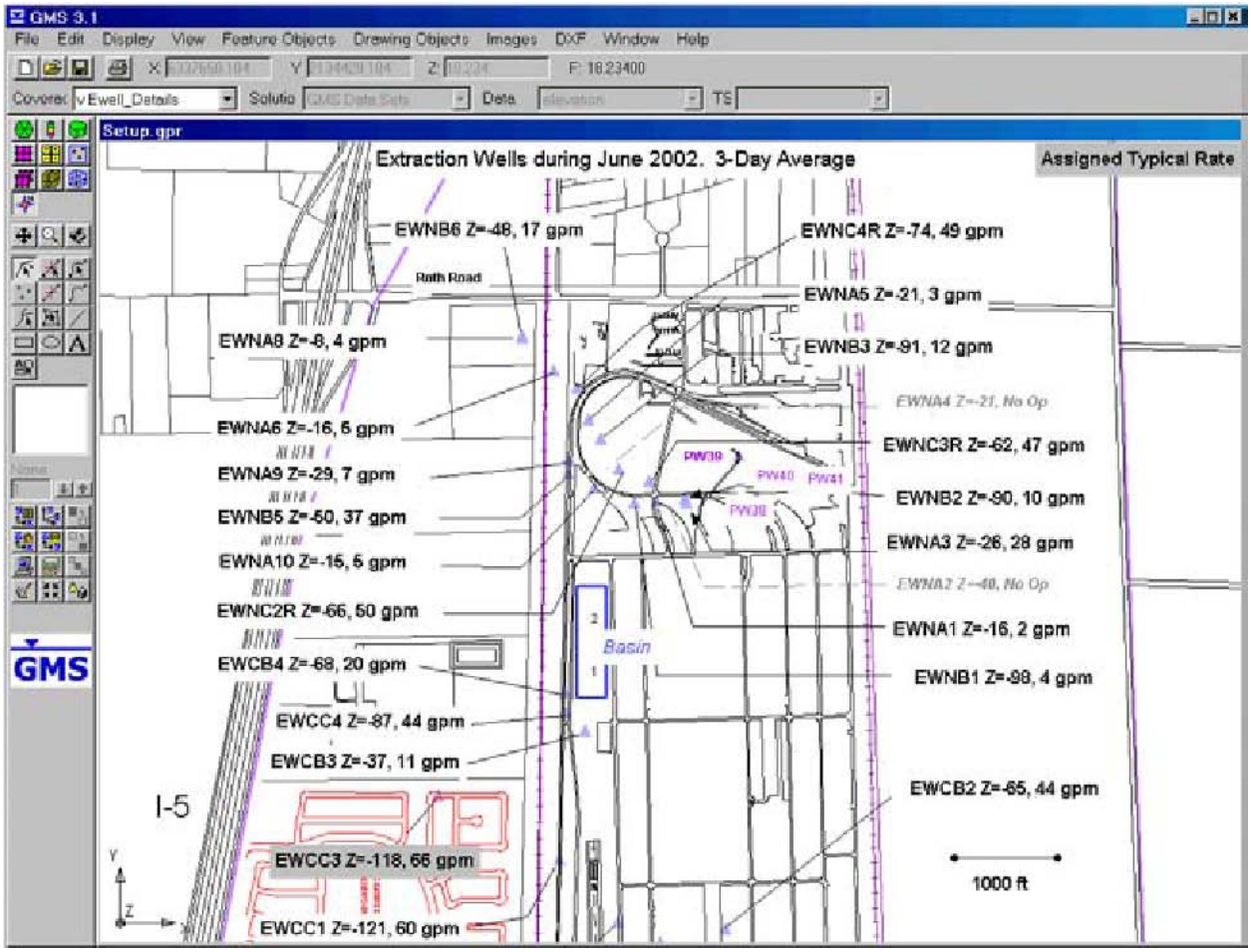


Figure D 2. Northern area extraction well names, pumping rates in gpm (where 1 gpm = 8.02 ft^3/hr)

NOTE: The pumping rates are from the 10-12 June 2002 synoptic data set. Due to communication problems, actual rates were not available for the highlighted wells. They were assigned a typical rate.

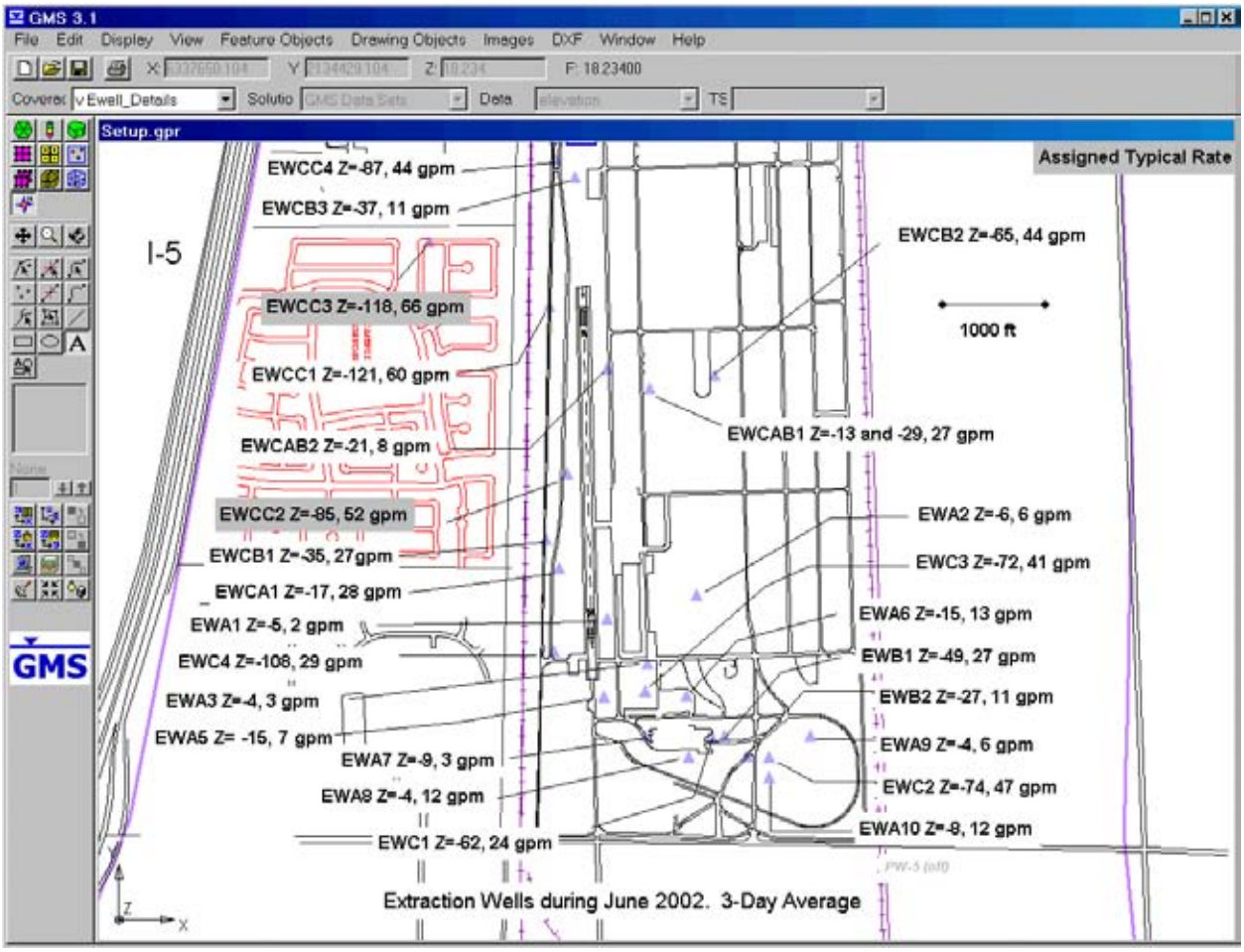


Figure D 3. Southern area extraction well names, pumping rates in gpm (where 1 gpm = 8.02 ft^3/hr)

NOTE: The pumping rates are from the 10-12 June 2002 synoptic data set. Due to communication problems, actual rates were not available for the highlighted wells. They were assigned a typical rate.

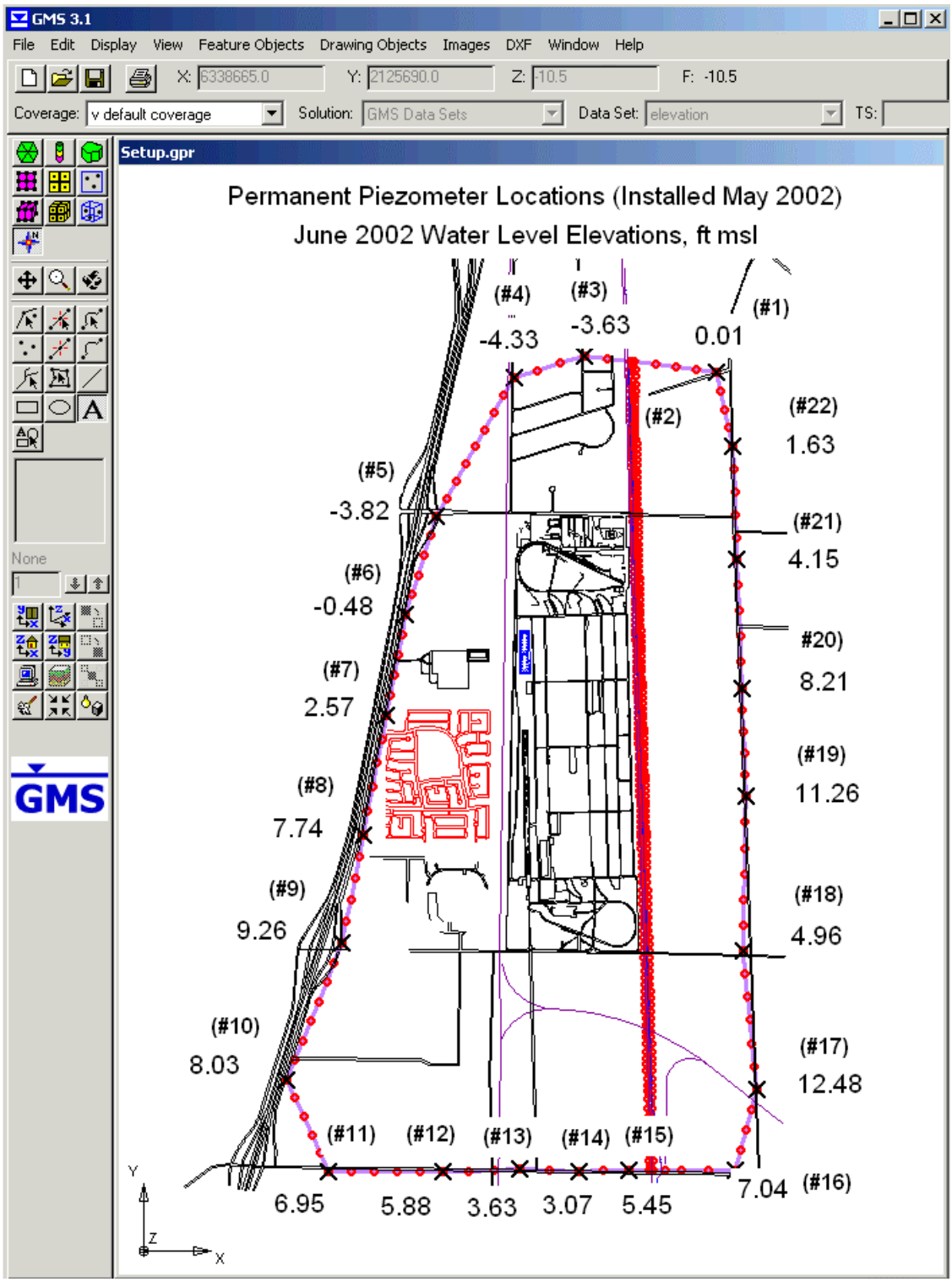


Figure D 4. Head boundary data for June 2002 obtained from the permanent piezometers installed in May 2002.

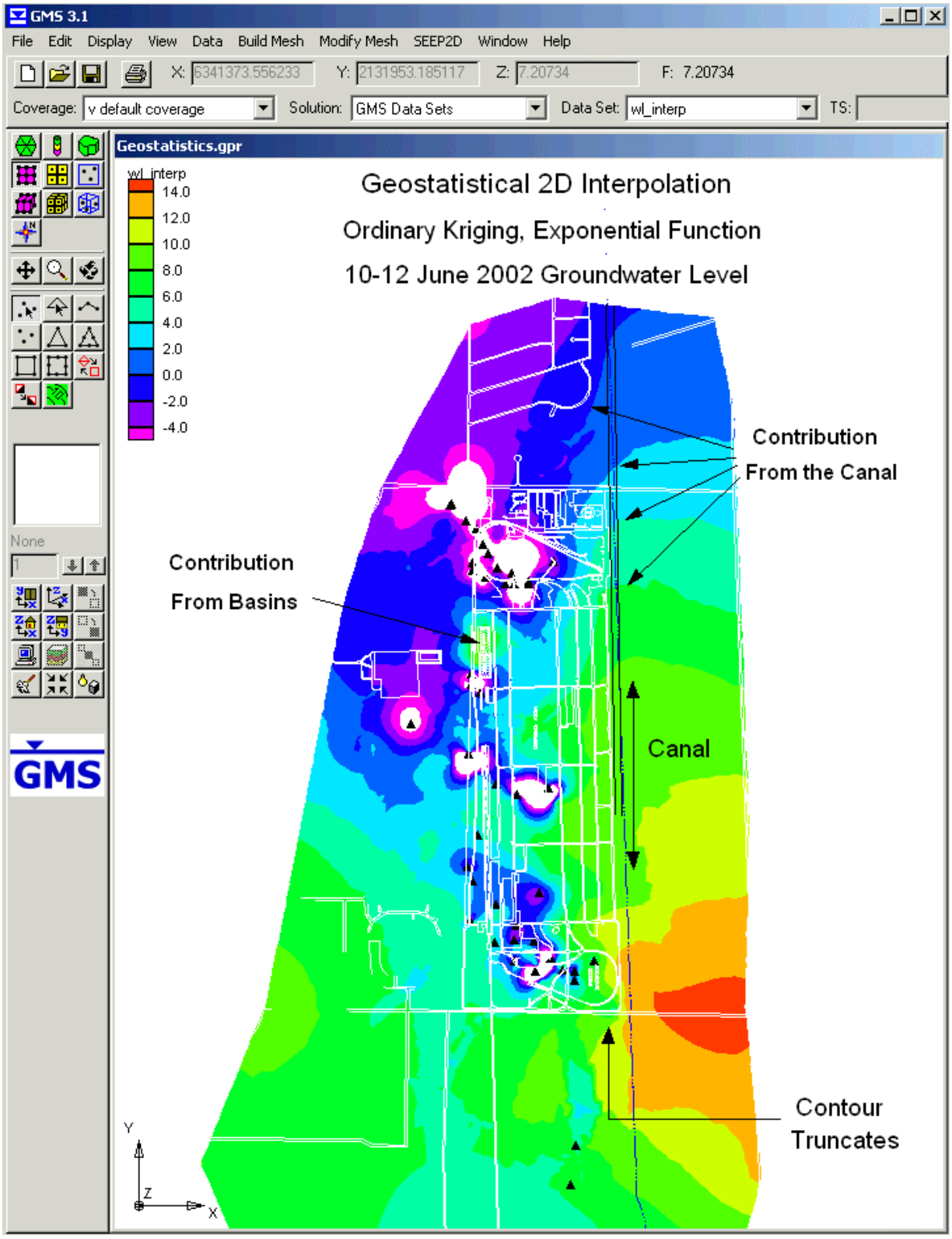
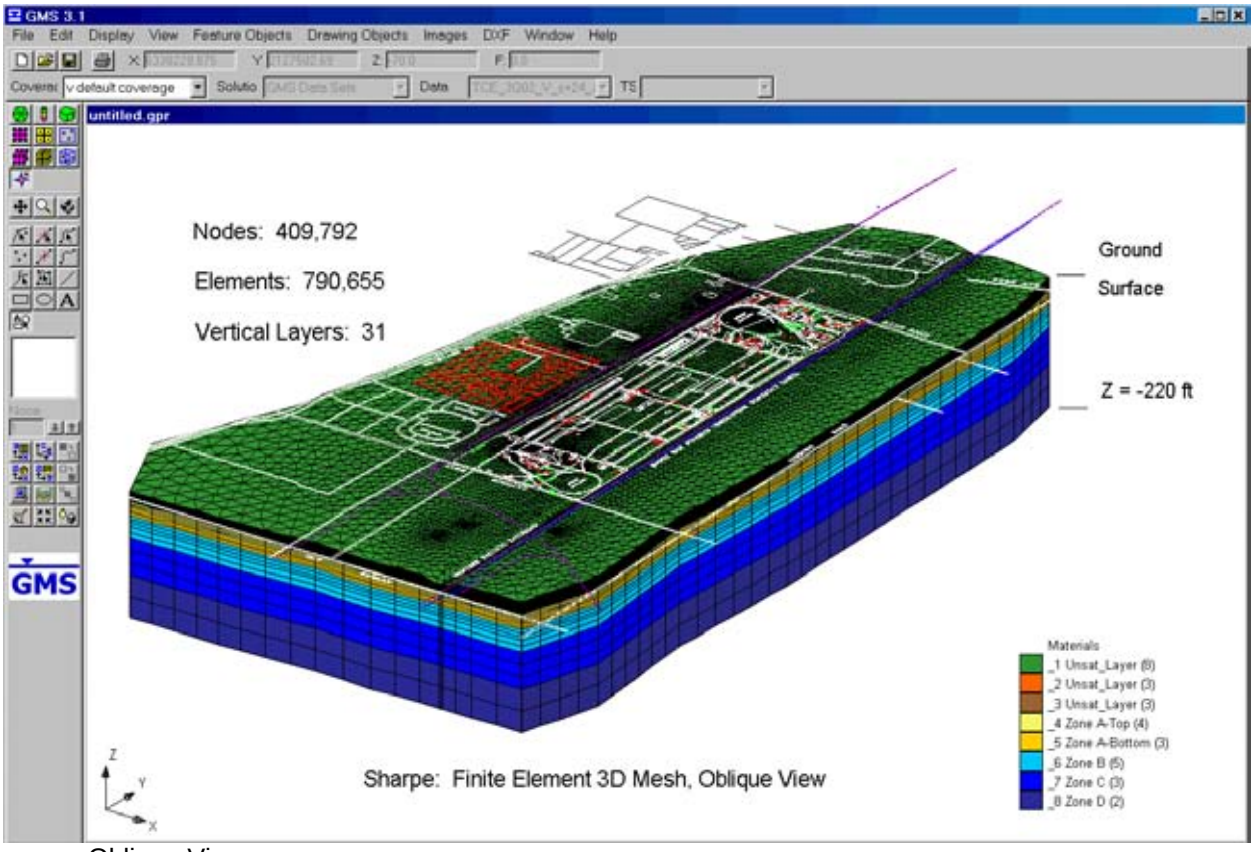
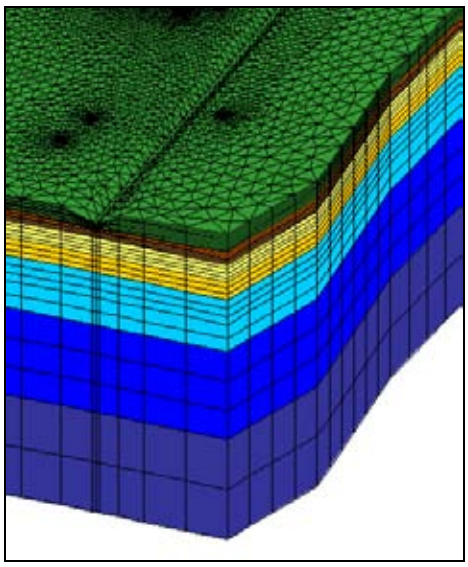


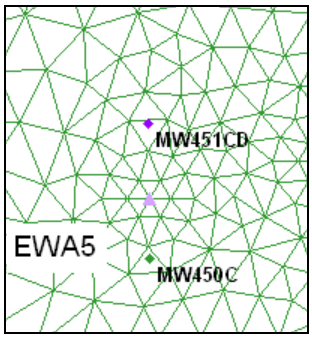
Figure D 5. Geostatistical interpolation of observed groundwater levels for 10-12 June 2002.



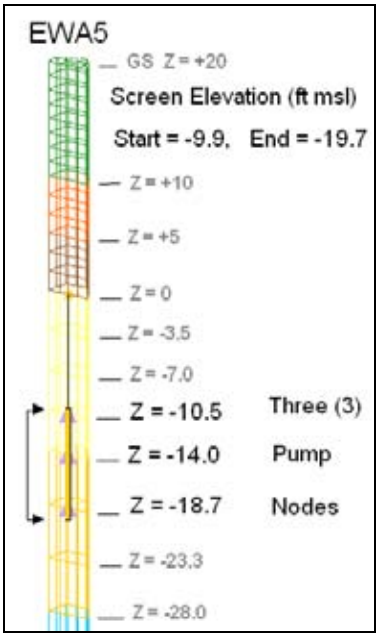
a. Oblique View



b. Oblique View of SE corner.



c. Plan view of EWA5.



d. Vertical view of EWA5.

Figure D 6. FEMWATER 3-D Mesh with 31 Vertical layers

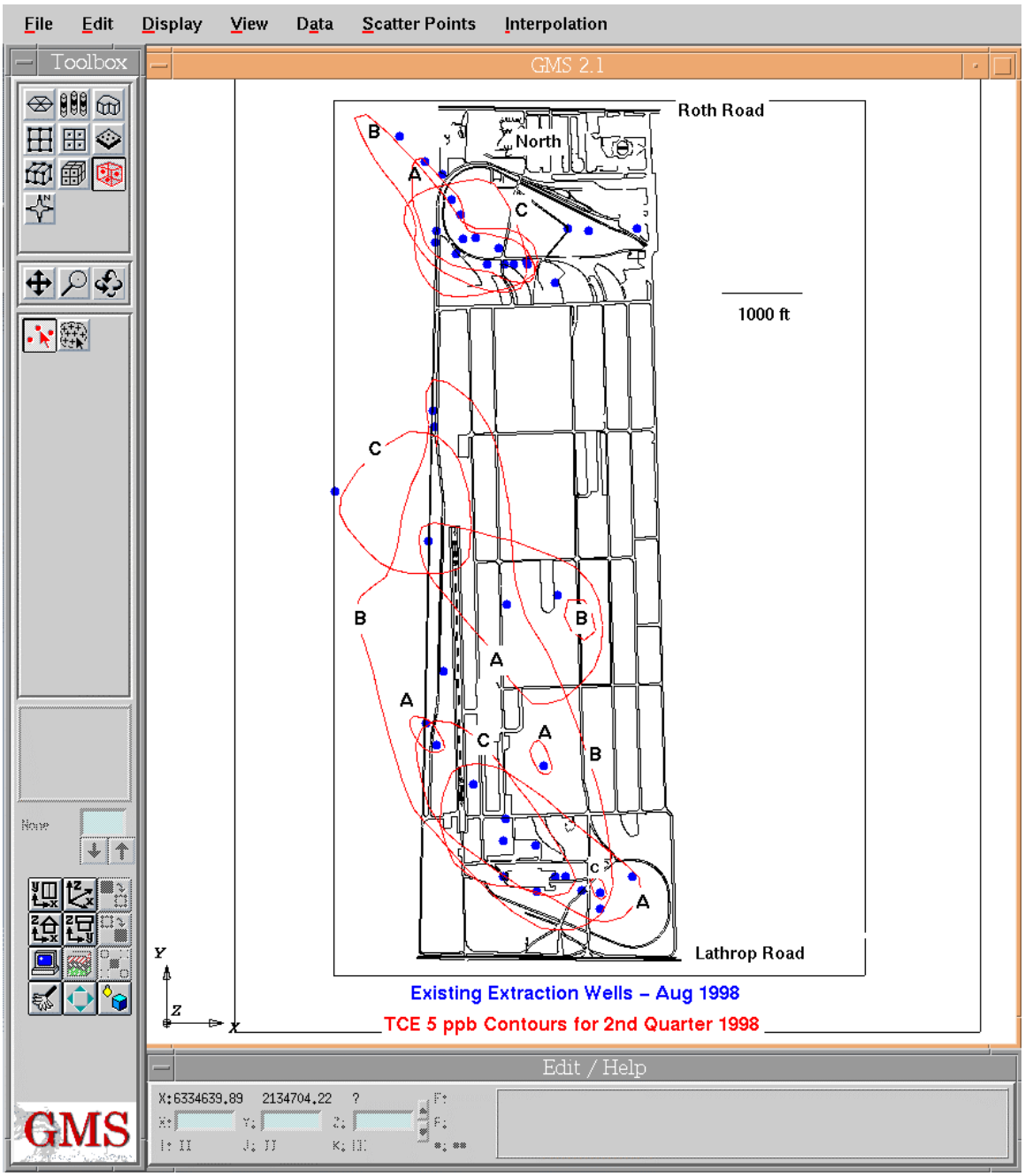


Figure D 7. Plan view of 5 $\mu g / L$ contour for the A-, B, and C-zone TCE plumes (2Q98)

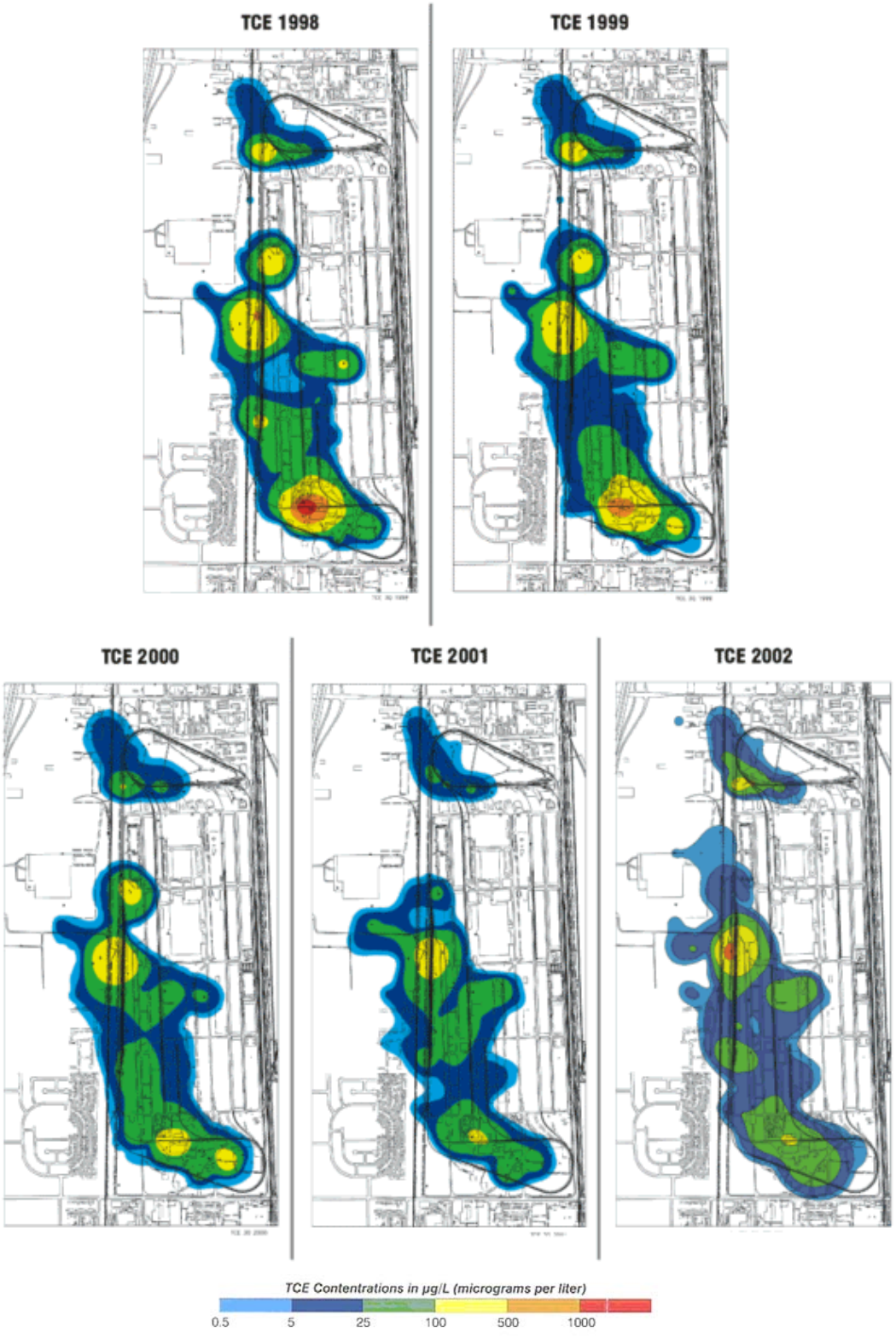


Figure D 8. Plan view of TCE concentrations contours in $\mu g / L$ for the third quarter of 1998, 1999, 2000, 2001 and 2002 TCE plumes. (Figure provided by URS)

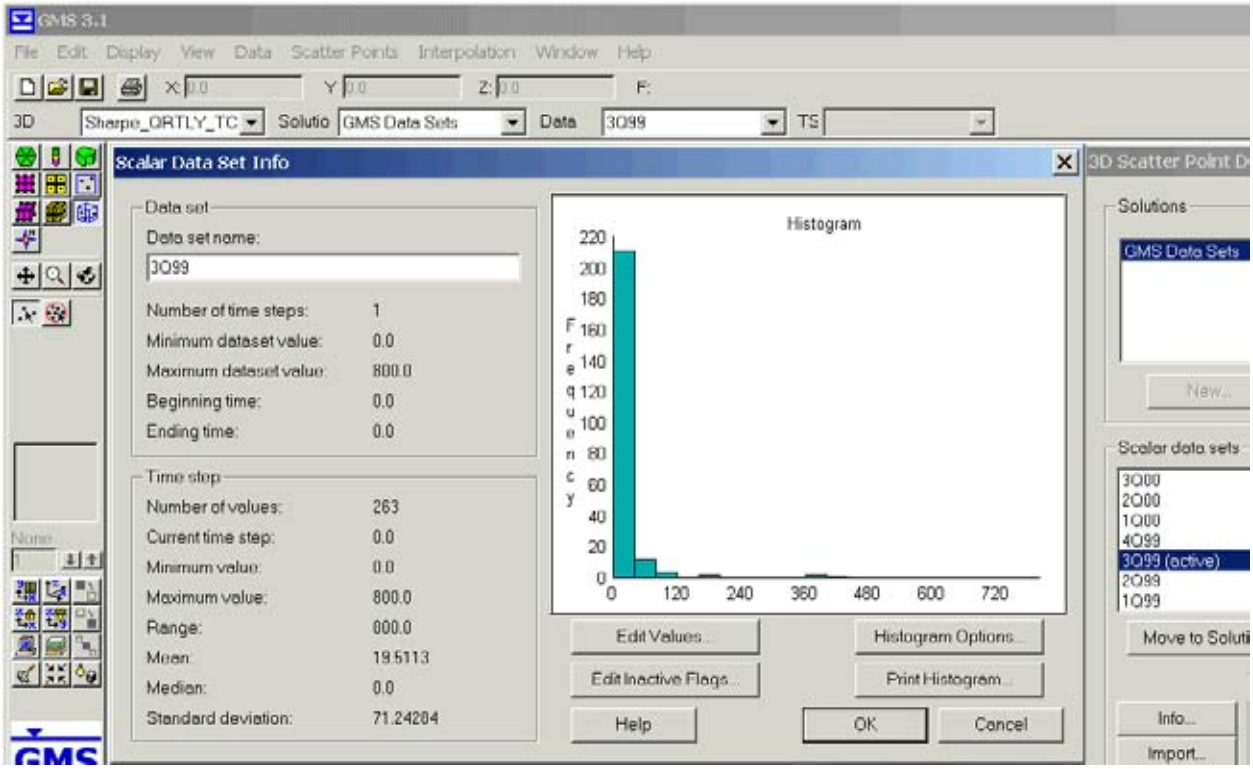
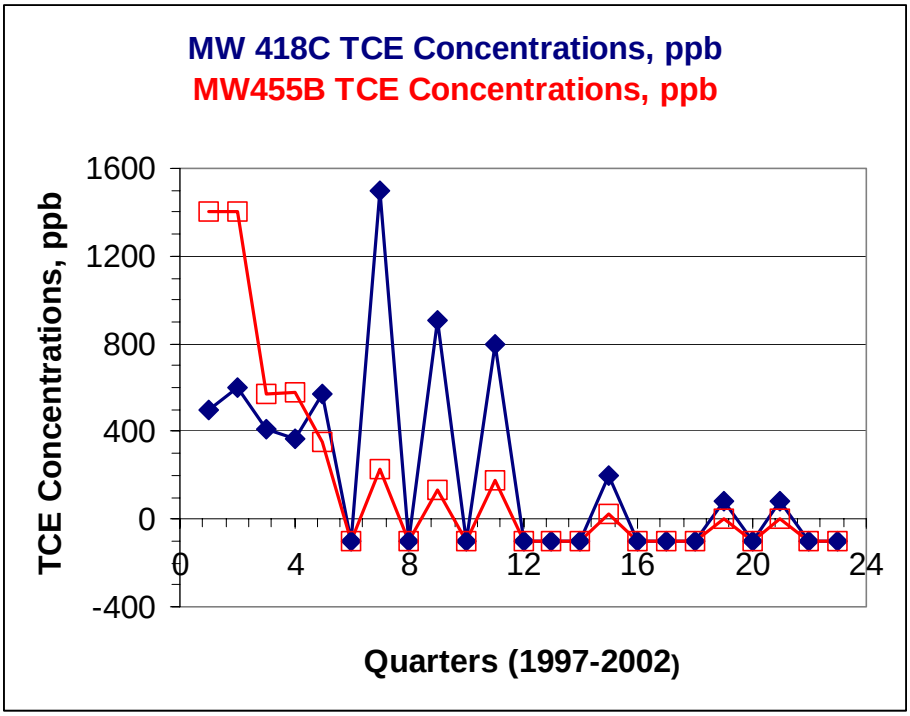
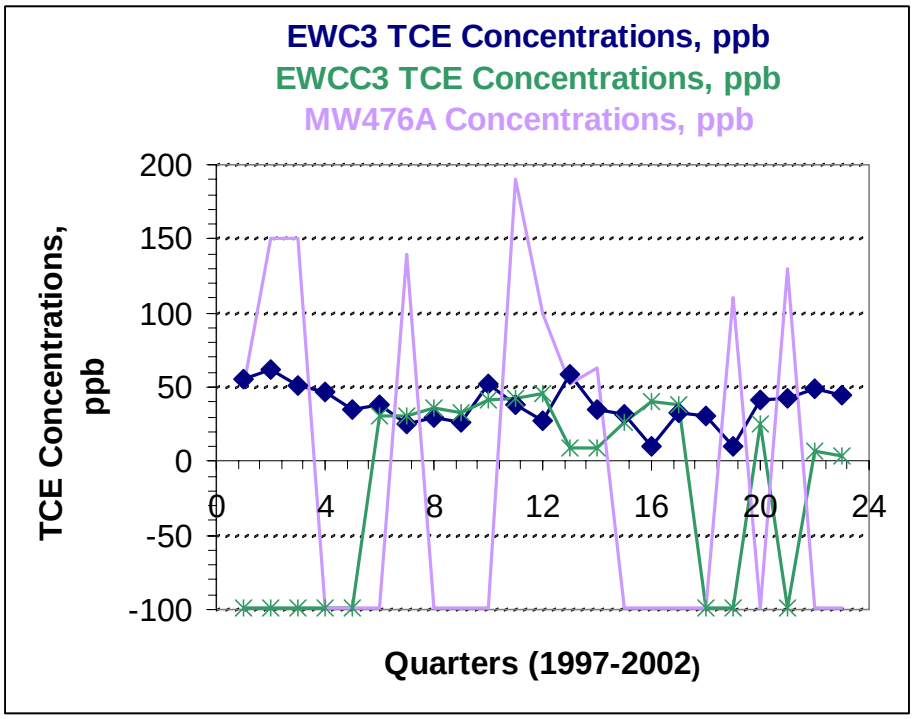


Figure D 9. GMS statistical analysis of TCE 1999 third quarter concentration observations



Part a. Hottest recordings.



Part b. Sample recordings.

Figure D 10. Selected monitoring stations for examining historical TCE behavior on the Sharpe DDJC site. A –99 concentration indications that there is no data available for that period.

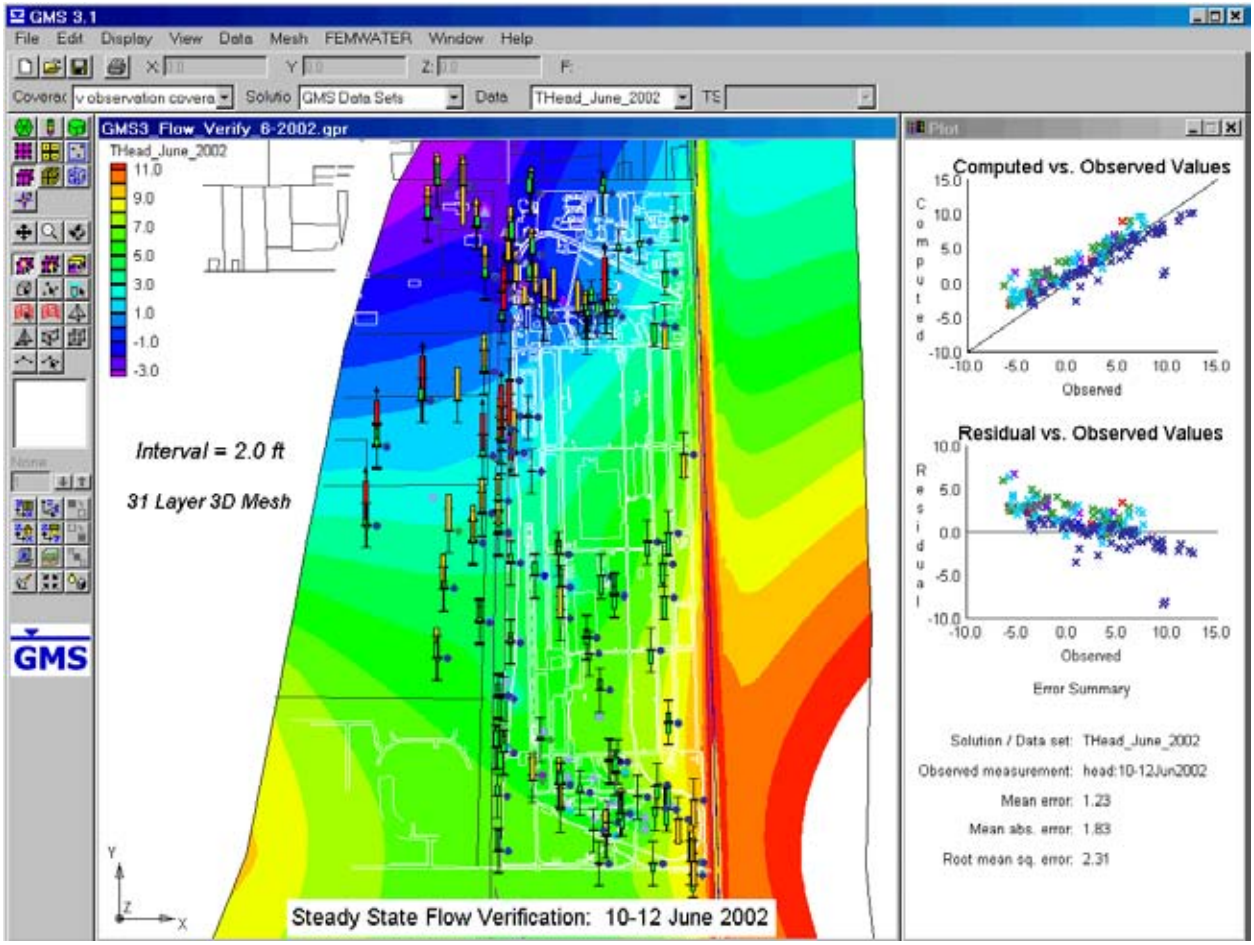


Figure D 11. Total head color contours and GMS statistical analysis of groundwater level model results versus all monitoring locations for the 10-12 June 2002 verification data set.

Where extraction wells are purple triangles and observation points are dark blue if located in the A-zone, light blue for B-zone, green for the C zone, and red for the CD and/or D-zone.

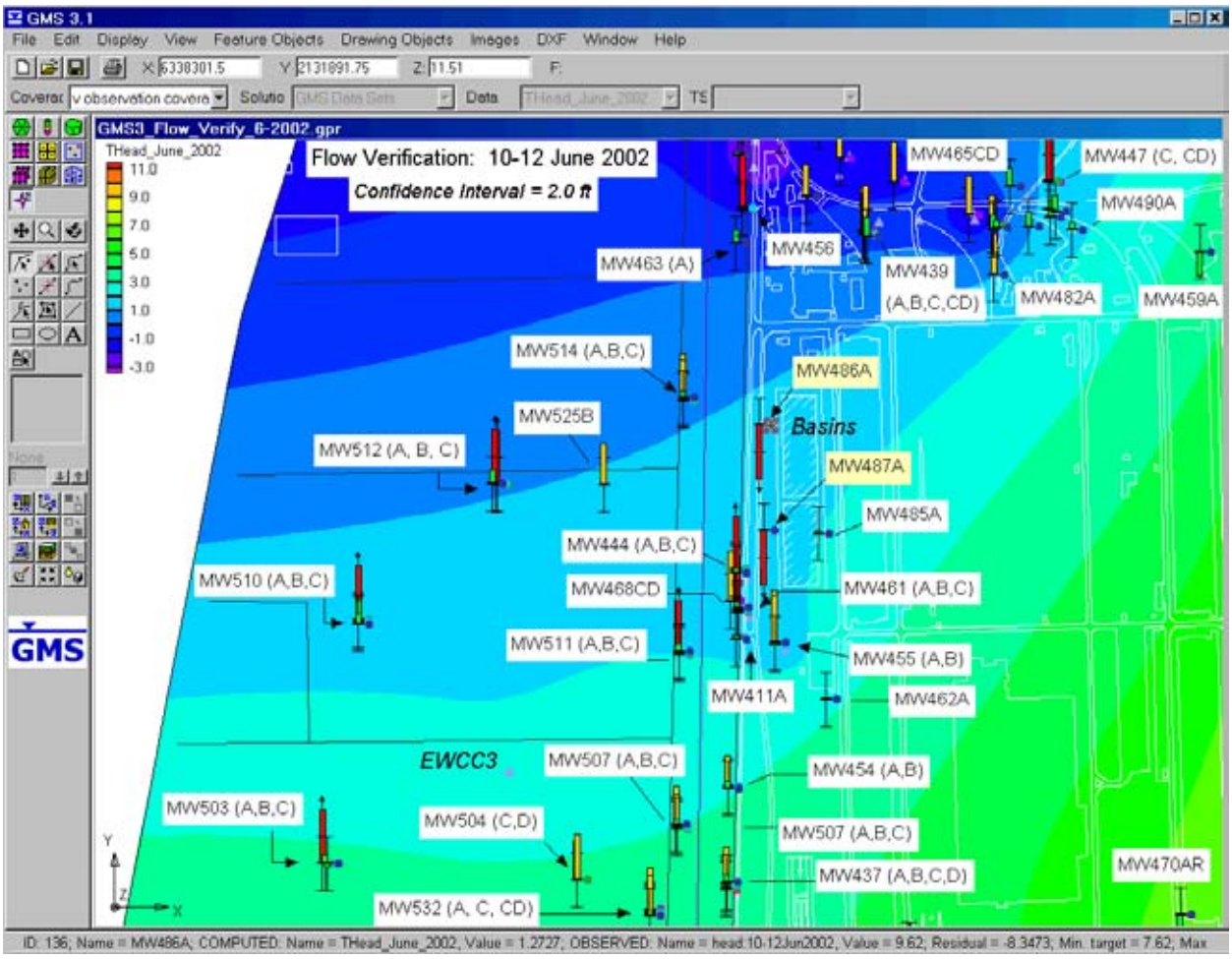
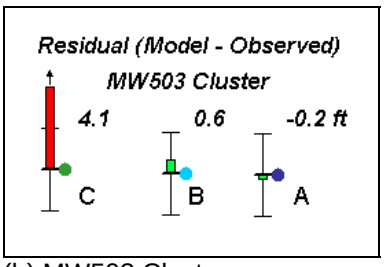
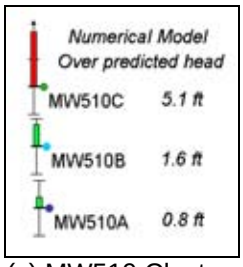


Figure D 12. (a) Zoom of west-central area. Total head color contours and GMS statistical analysis of groundwater level model results versus all monitoring locations for the 10-12 June 2002 verification data set.

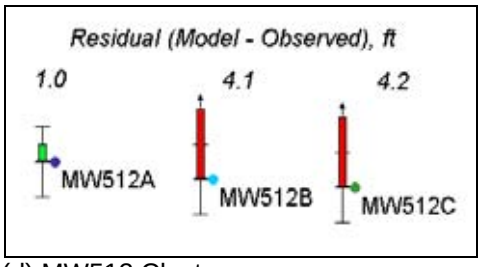
Where extraction wells are purple triangles and observation points are dark blue if located in the A-zone, light blue for B-zone, green for the C zone, and red for the CD and/or D-zone.



(b) MW503 Cluster

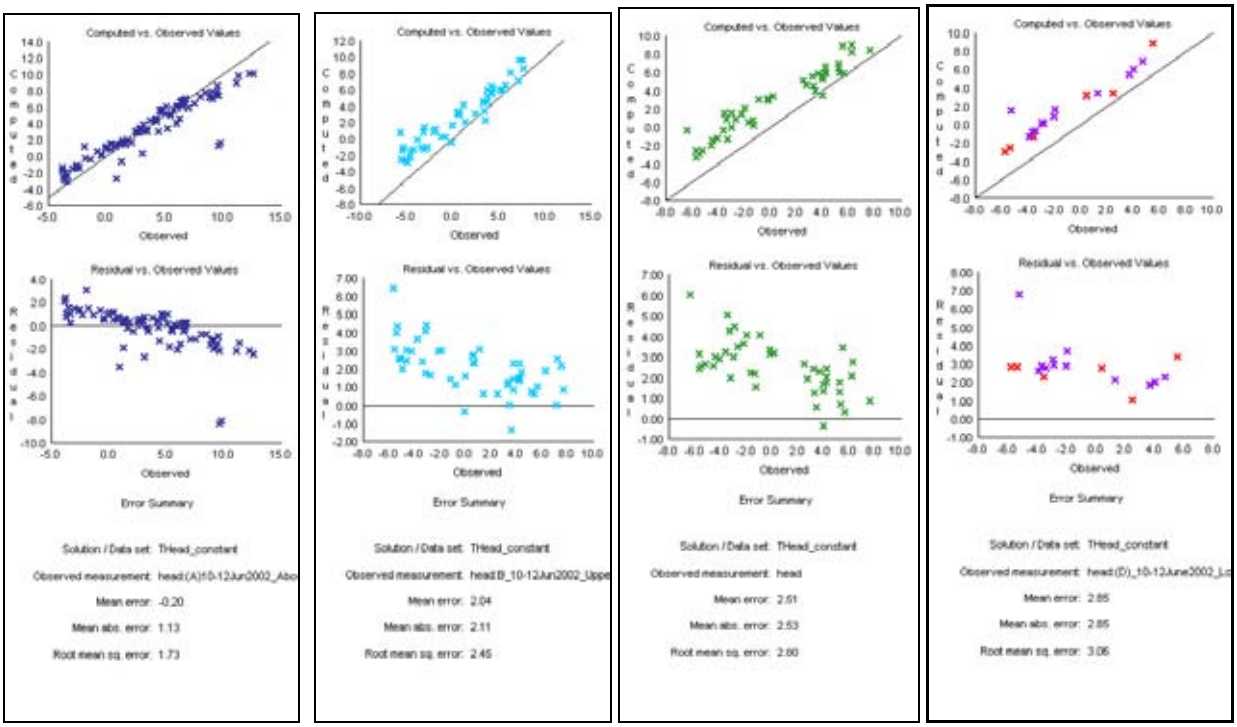


(c) MW510 Cluster



(d) MW512 Cluster

Expanded view of MW503, MW510 and MW512 clusters, illustrates the residual between the numerical model and the observed values for the June 2002 verification data set.



(a) A-Zone (b) B-Zone (c) C-Zone (d) CD- and D-Zone

Figure D 13. Individual GMS statistical analysis by zone of groundwater level model results versus monitoring locations for the 10-12 June 2002 verification data set.

From left to right: dark blue for the A-zone, light blue for B-zone, green for the C zone, and purple for the CD-zone, and red for the D-zone.

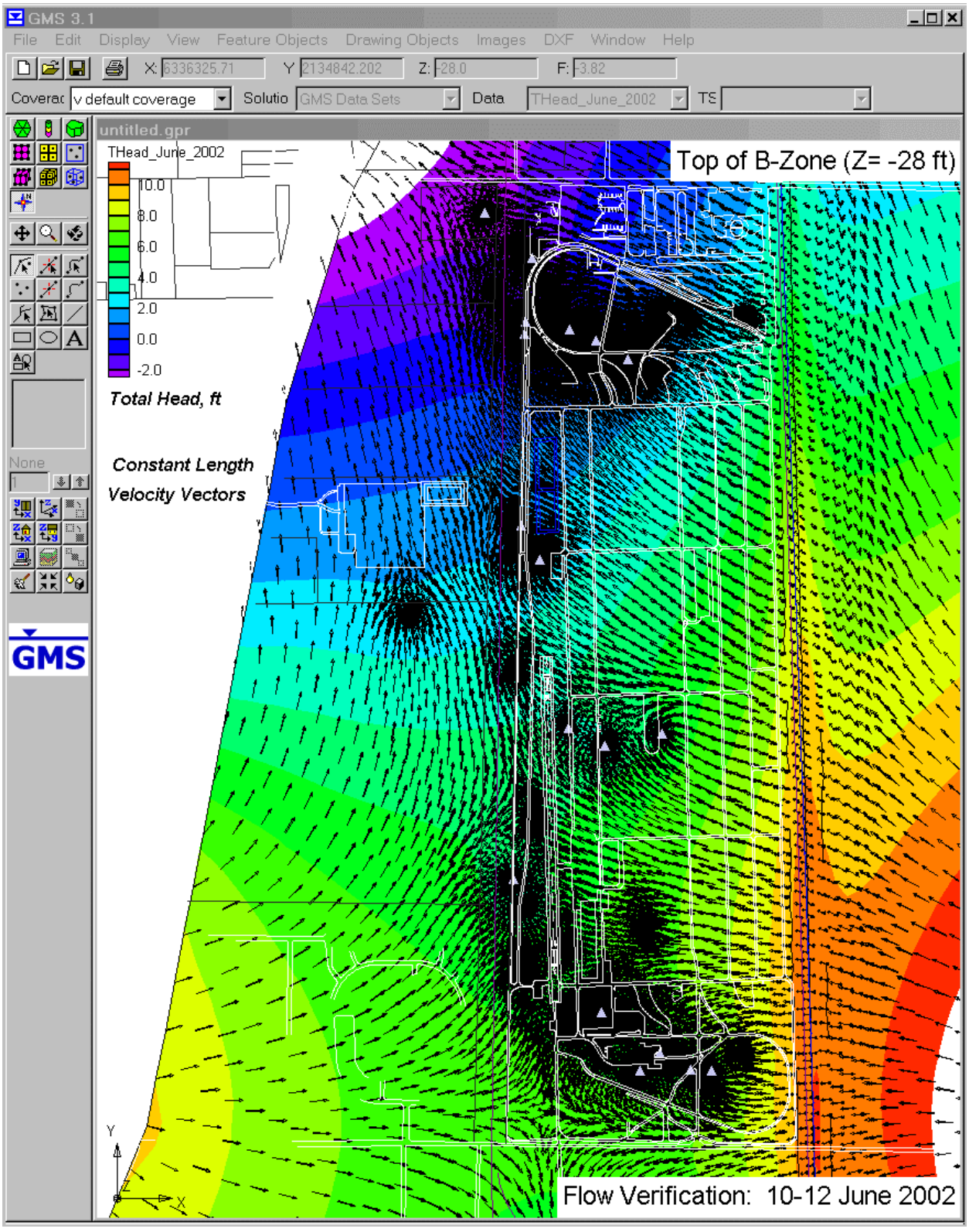


Figure D 14. Total head contours and constant length vectors of FEMWATER results of the 10-12 June 2002 verification period for the top of the B-zone, -28 ft elevation.

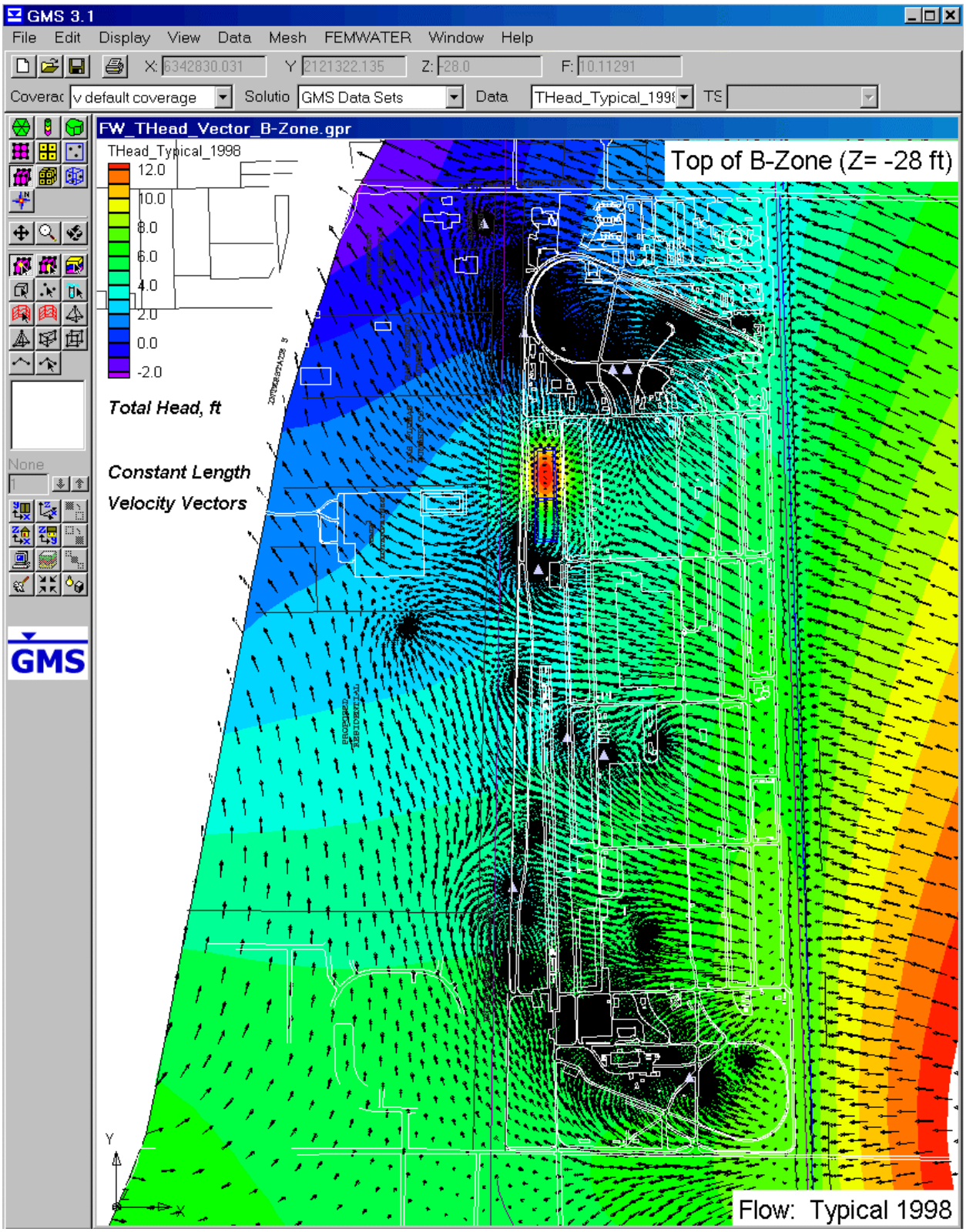


Figure D 15. Total head contours and constant length vectors of FEMWATER results of the typical pumping condition for 1998. The top of the B-zone, -28 ft elevation, is displayed. Triangles represent B-zone extraction wells.

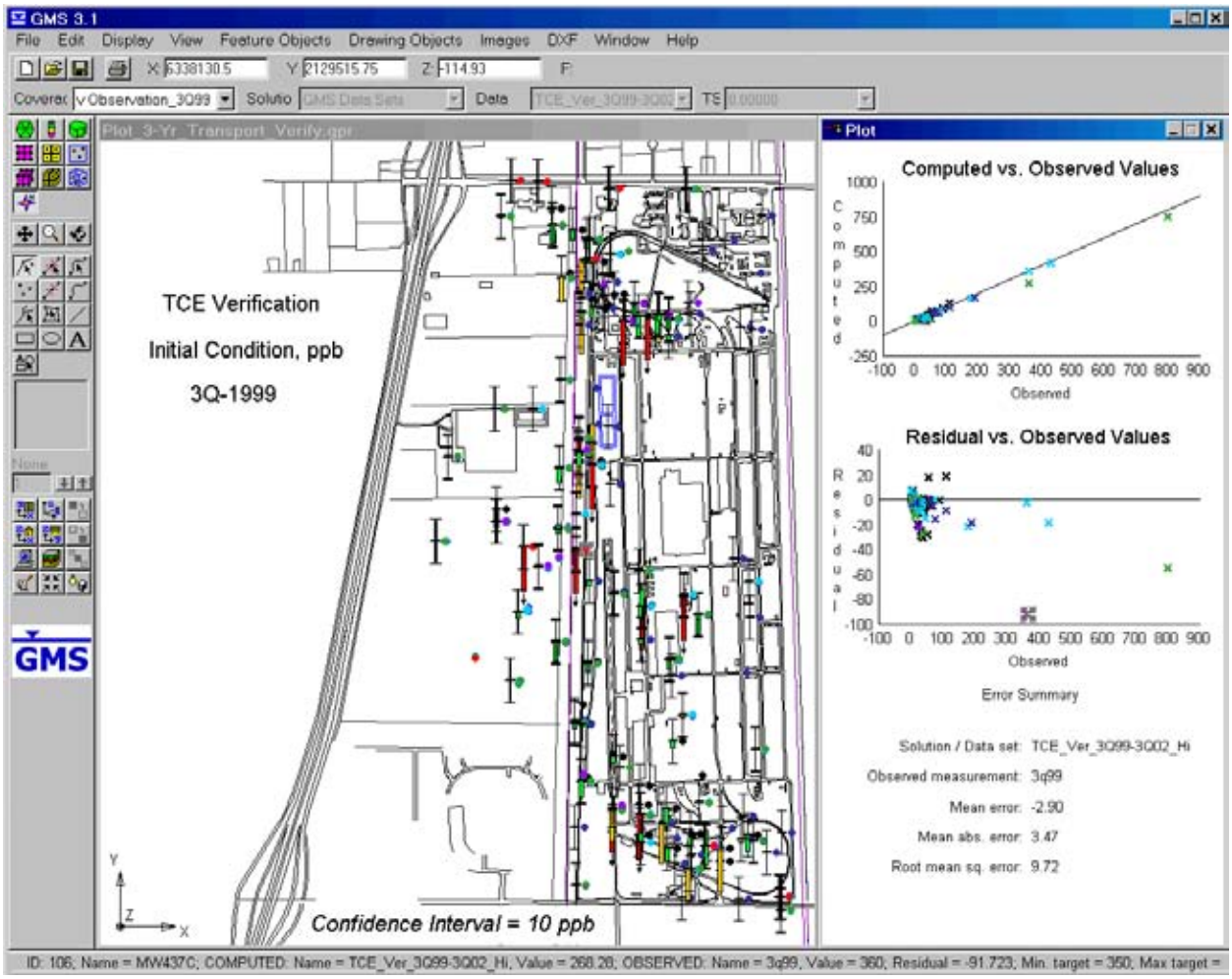


Figure D 16. Statistical evaluation of the 3Q 1999 TCE concentration initial condition (ppb)

Where observation points are black for extraction wells, dark blue for monitoring wells located in the A-zone, light blue for B-zone, green for the C zone, and red for the CD and/or D-zone.

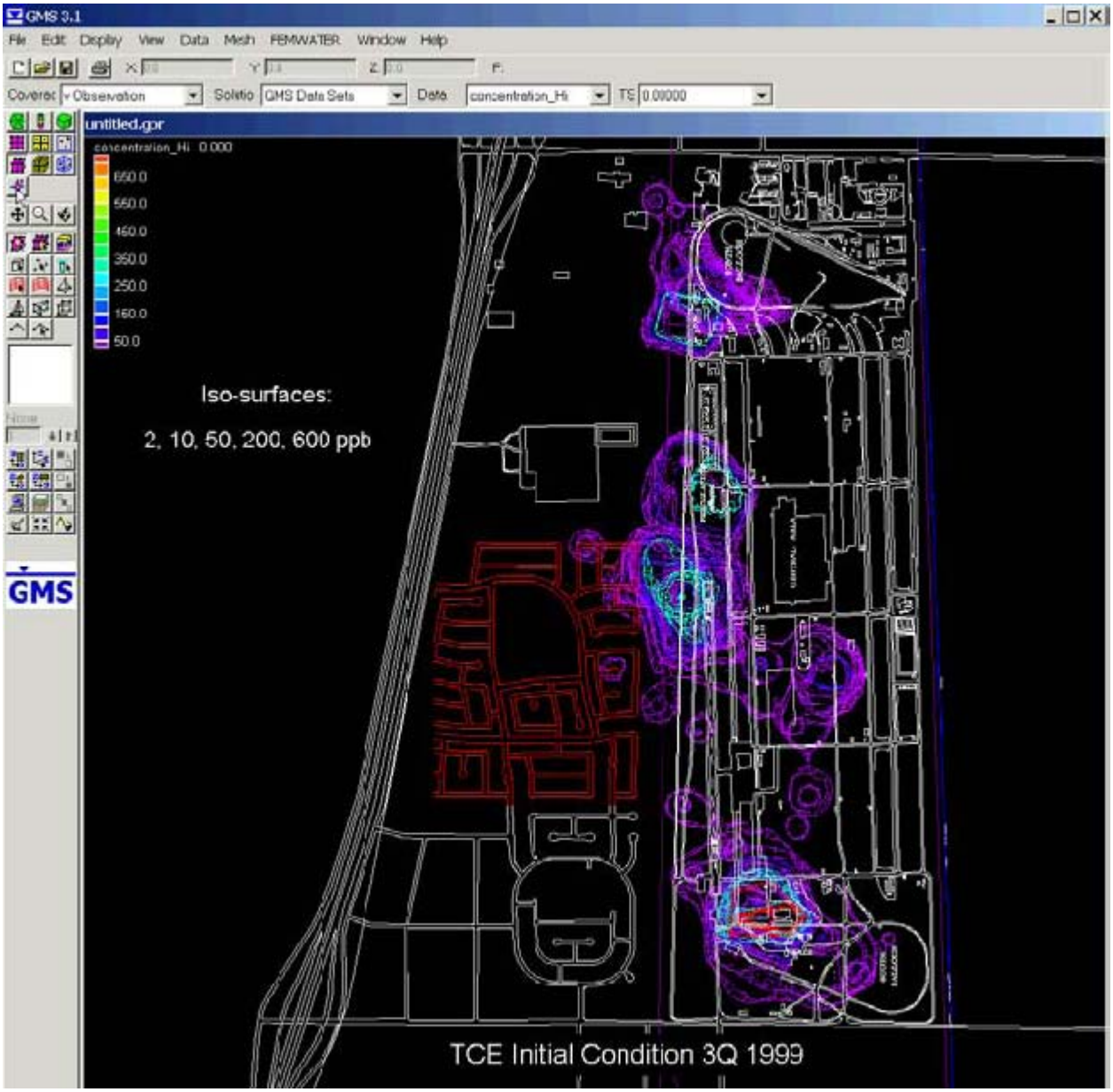


Figure D 17. Examination of plan view TCE plume Iso-surfaces derived from the IDW-3D interpolation of the 3Q 1999 TCE concentration observations.

This data set became the initial condition for TCE 3-year transport verification simulation.

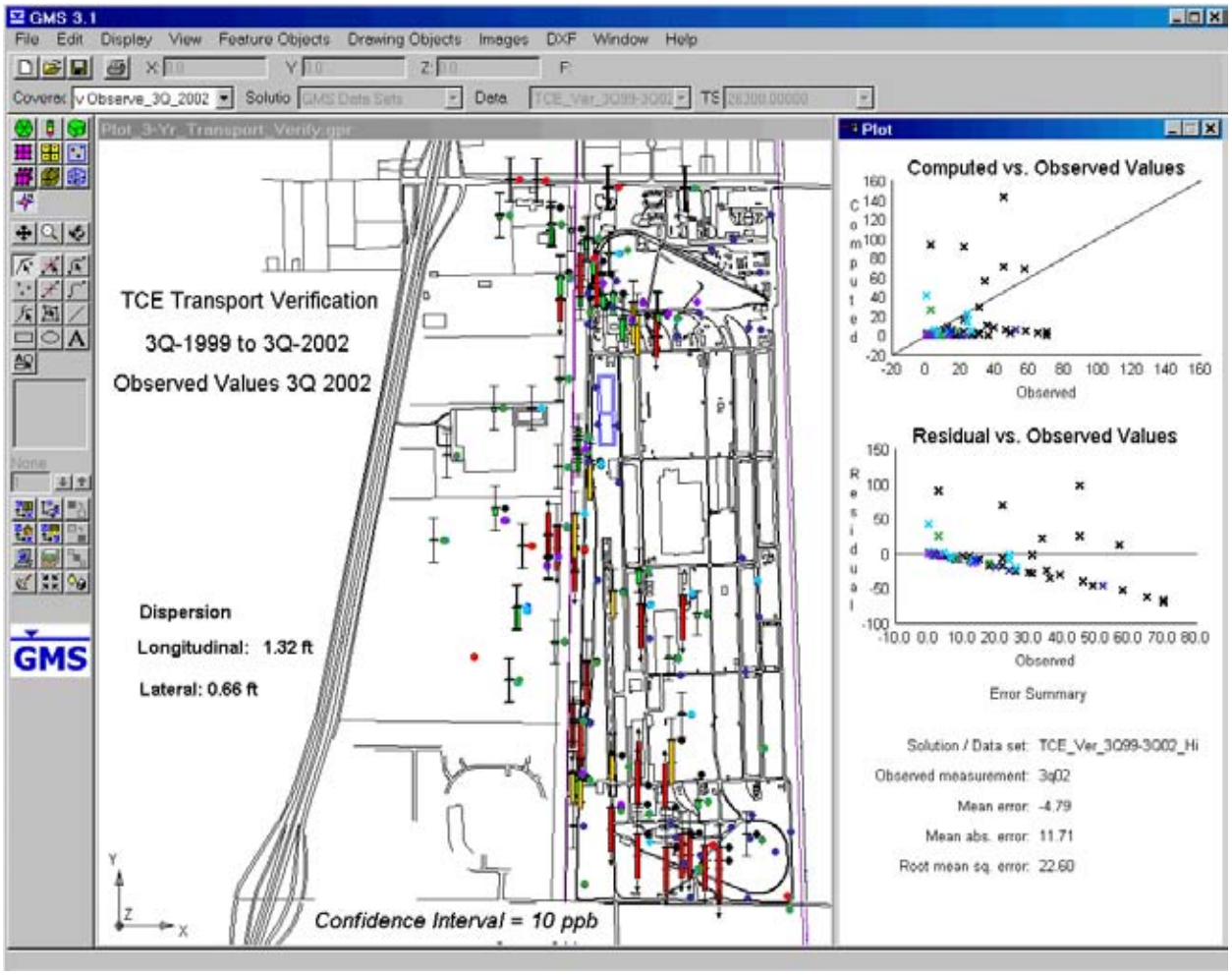
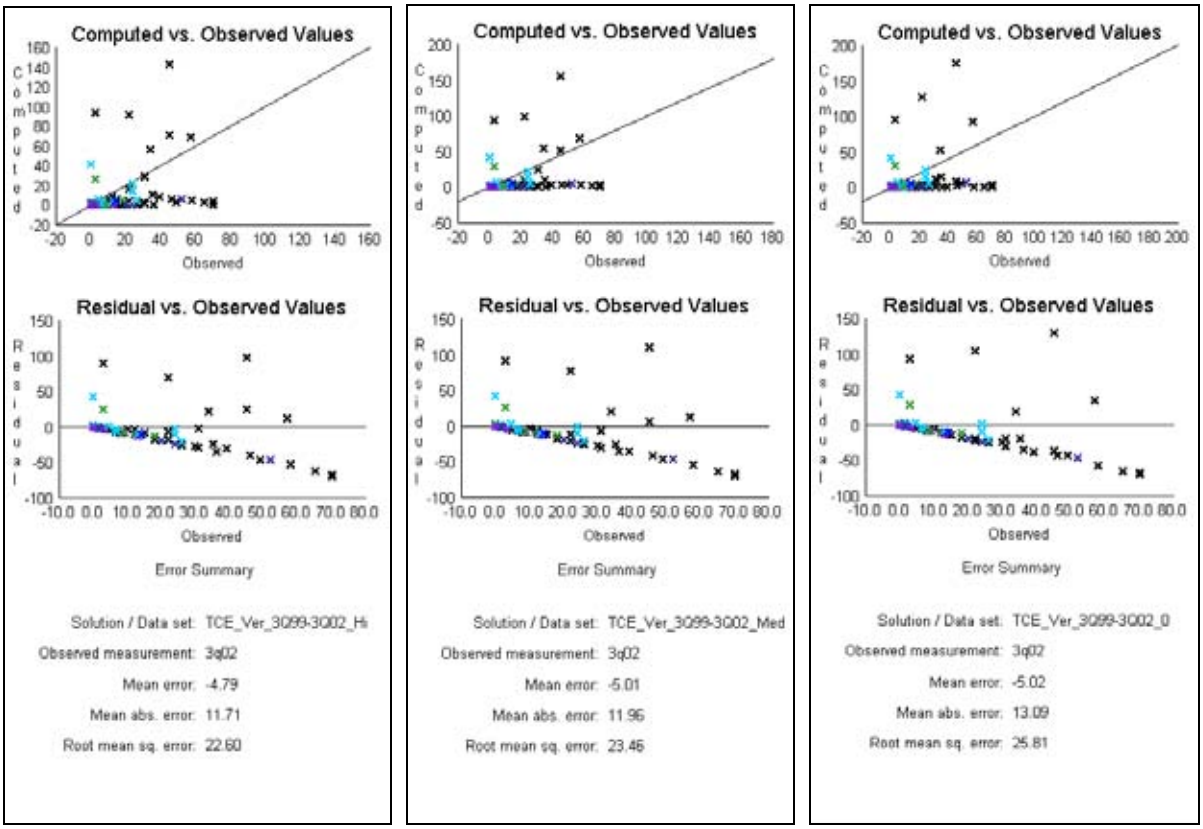


Figure D 18. Computed versus observation data of TCE 3-year transport (3Q99 – 3Q02) using a high dispersion coefficient.

Where observation points are black for extraction wells, dark blue for monitoring wells located in the A-zone, light blue for B-zone, green for the C zone, and red for the CD and/or D-zone.

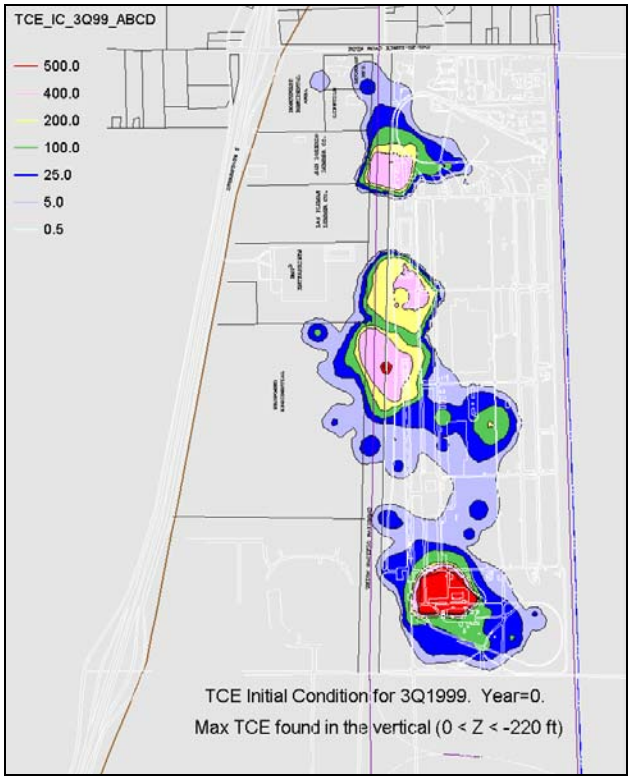


(a) High dispersion. (b) Medium dispersion. (c) Zero dispersion.

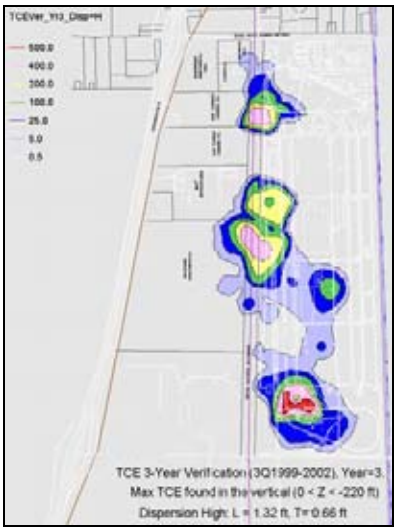
Figure D 19. Computed versus observation data statistics for TCE 3-year transport (3Q99 – 3Q02) using a high, medium, and zero dispersion coefficients.

The high case had longitudinal dispersion of 1.32 ft, and lateral dispersion of 0.66 ft.
The medium case had longitudinal dispersion of 0.66 ft, and lateral dispersion of 0.33 ft.
The zero case set both longitudinal and lateral dispersion to zero.

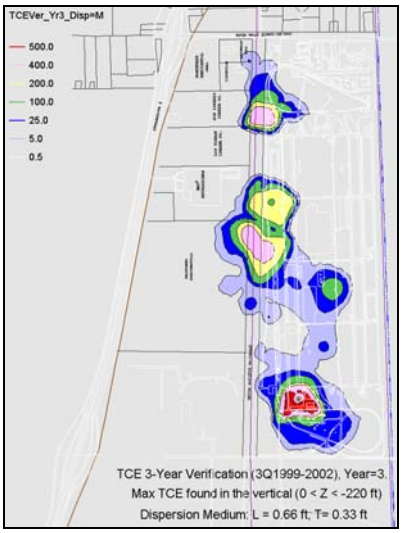
Where observation points are black for extraction wells, dark blue for monitoring wells located in the A-zone, light blue for B-zone, green for the C zone, and red for the CD and/or D-zone.



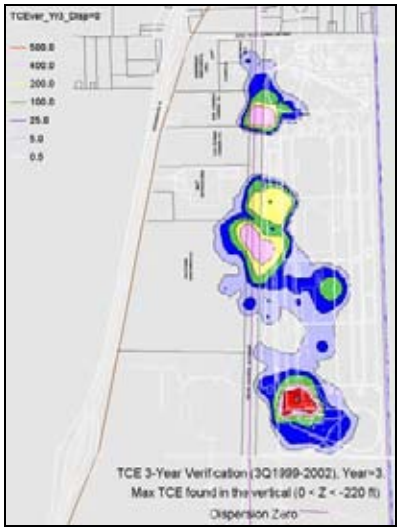
(a) Initial condition for 3Q99



(b) High dispersion



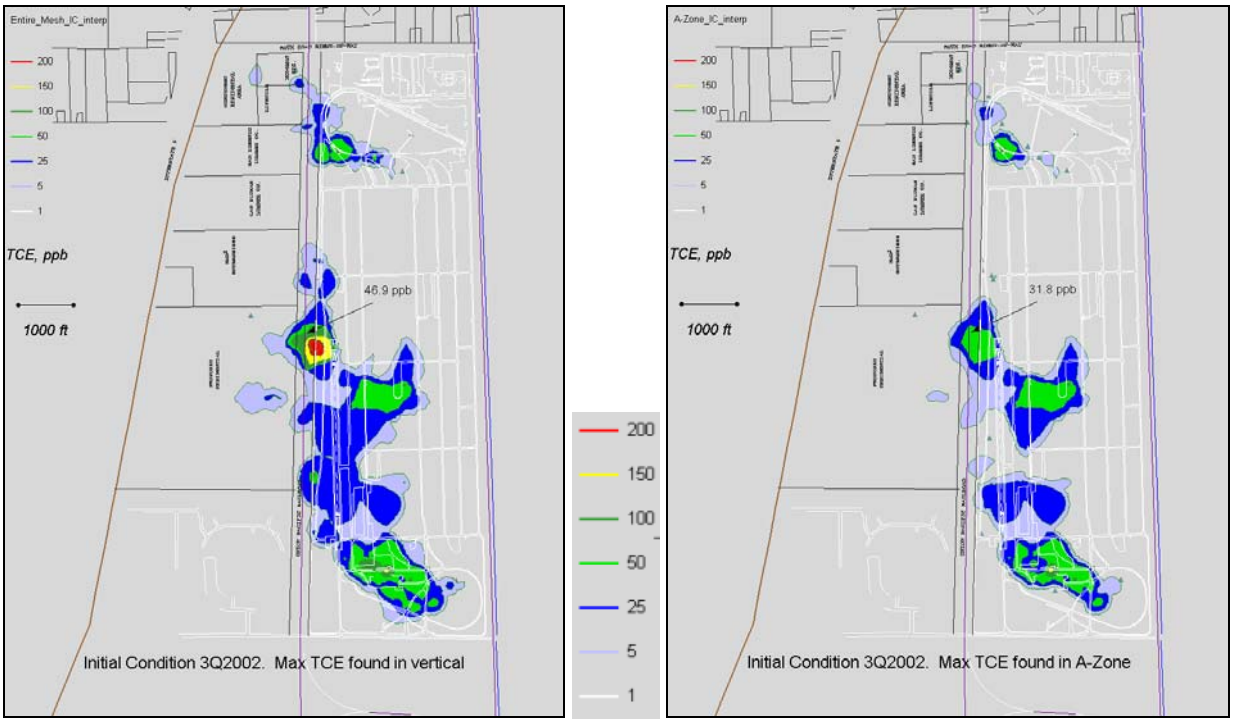
(c) Medium dispersion rate



(d) Zero dispersion rate

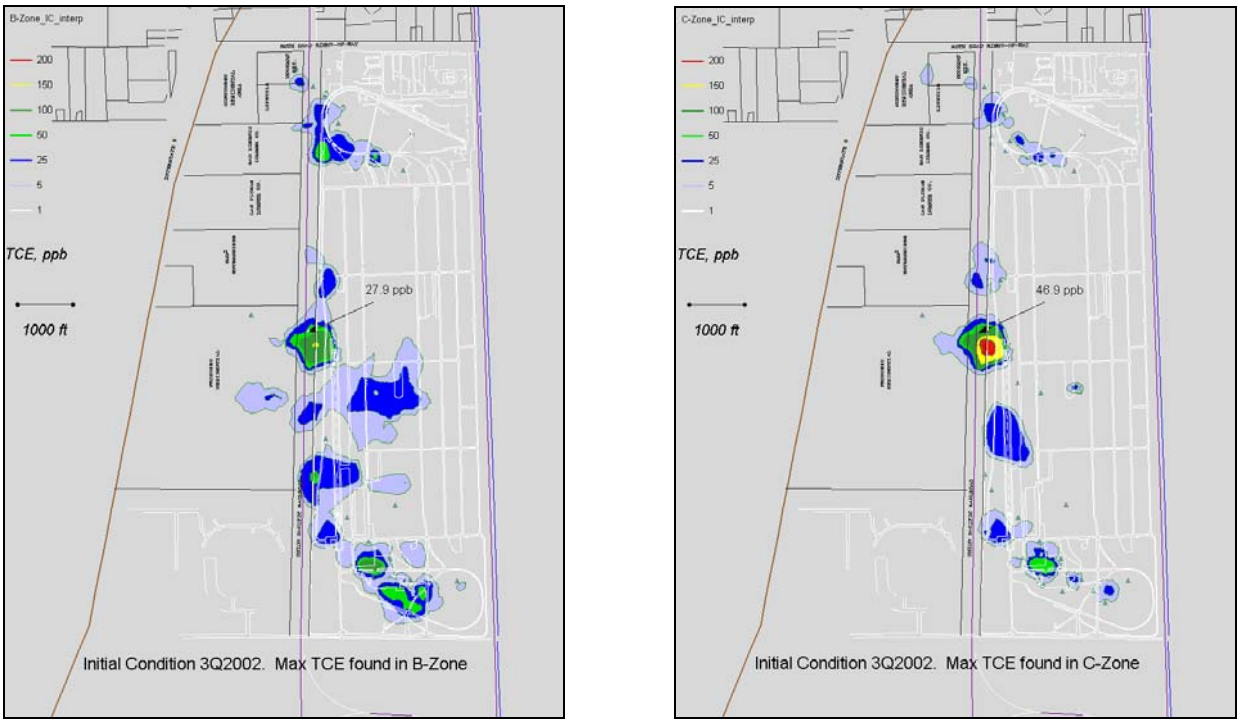
Figure D 20. Maximum TCE concentrations found within the A, B, C, and D zones for the initial condition (part a), year 0, and after 3-years of TCE plume transport. Parts b through d, compare the effects of varying the dispersion rate after 3-years of simulation.

The data set in part (a) became the initial condition for TCE 3-year transport verification simulation.



(a) Max TCE Concentration found in the vertical
Entire domain (+22 < Z < -220)

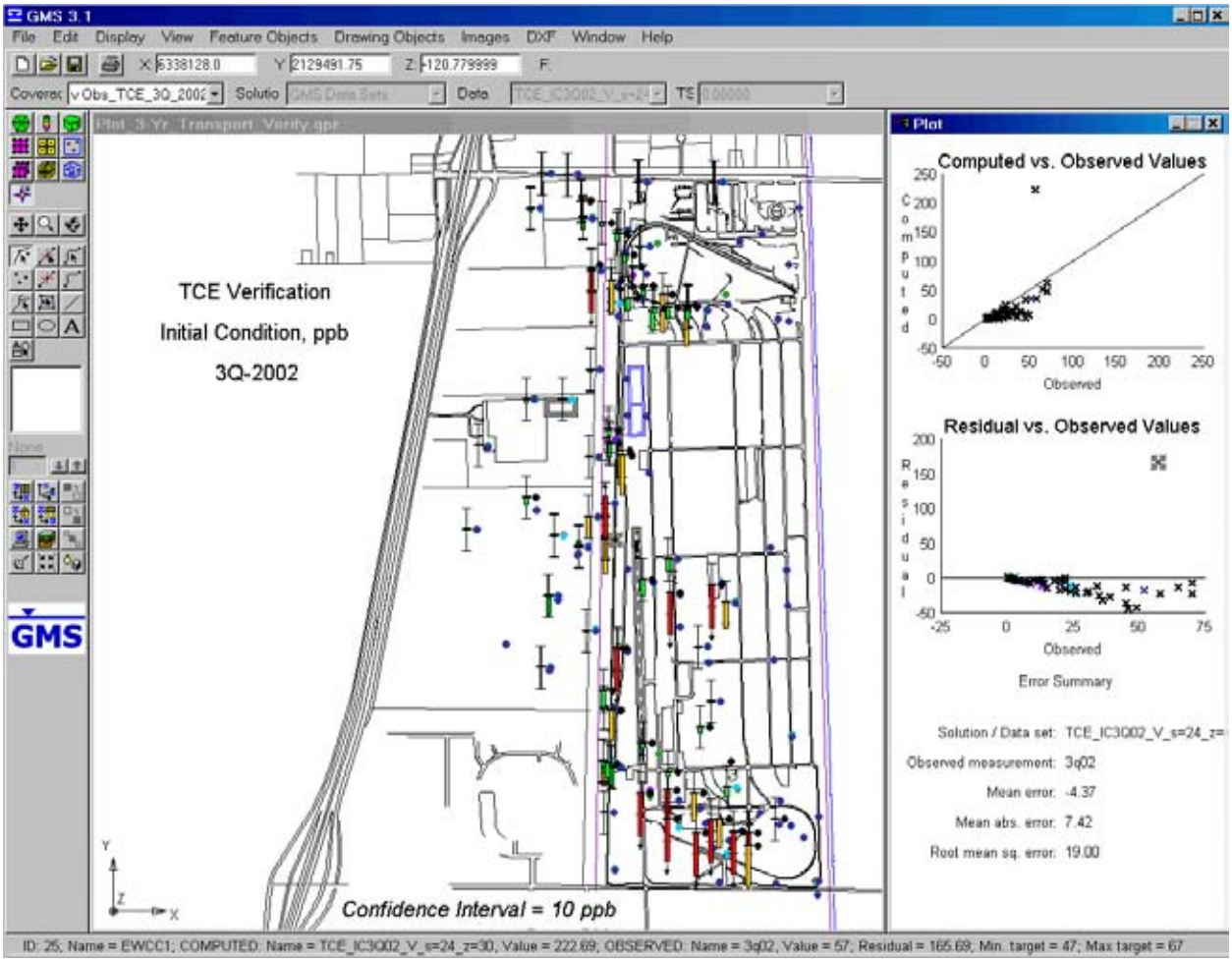
(b) Max TCE Concentration within A-Zone
A-zone (0 < Z < -27.9ft)



(c) Max TCE Concentration within B-Zone
B-Zone (-28 < Z < -69.9 ft)

(d) Max TCE Concentration within C-Zone
C-Zone (-70 < Z < -139.9 ft)

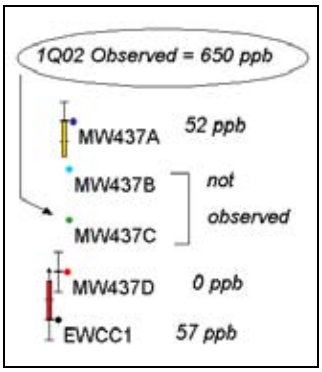
Figure D 21. Initial Condition interpolated from monitoring well data from the third quarter of 2002 TCE concentrations. For each (x,y) nodal location, the maximum TCE concentration found in within the specified vertical dimension is plotted



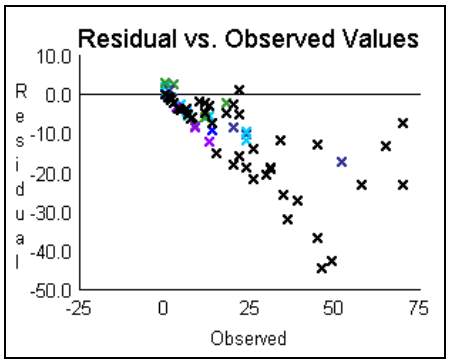
(a) Comparison of the interpolated initial condition with the field observations from the 3Q2002 .

Figure D 22. Statistical evaluation of the 3Q 2002 TCE concentration initial condition (ppb)

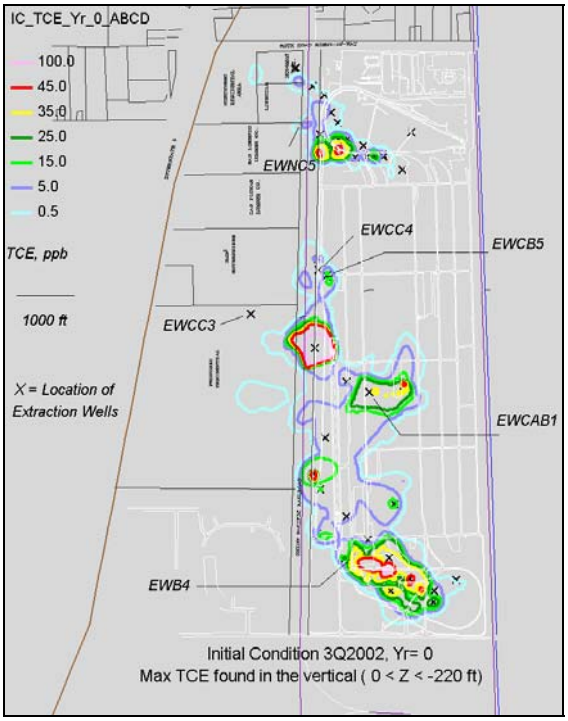
Where observation points are black for extraction wells, dark blue for monitoring wells located in the A-zone, light blue for B-zone, green for the C zone, and red for the CD and/or D-zone.



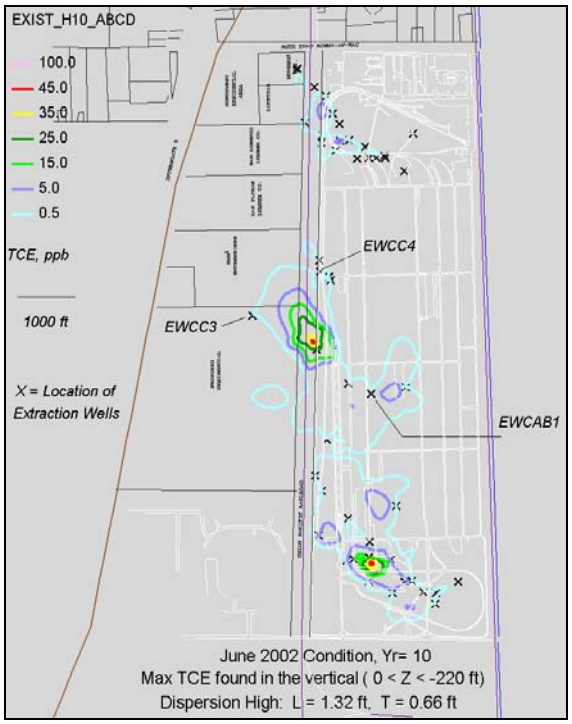
Part b. Zoom of the EWCC1 and MW437 cluster



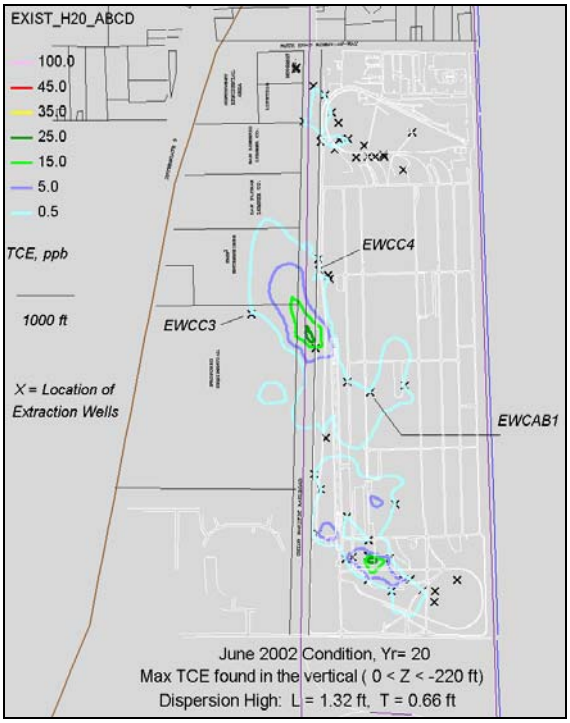
Part c. Residual vs observed, EWCC1 omitted



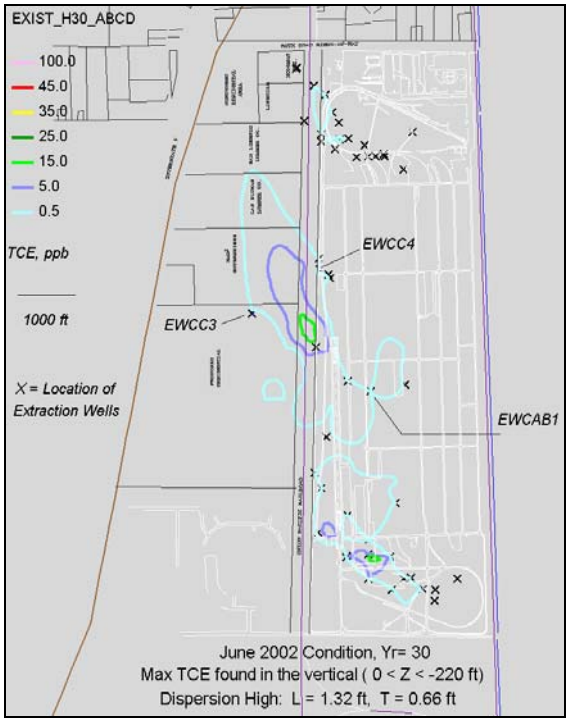
(a) Initial condition for 3Q2002, Year 0



(b) June 2002, Year 10, high dispersion

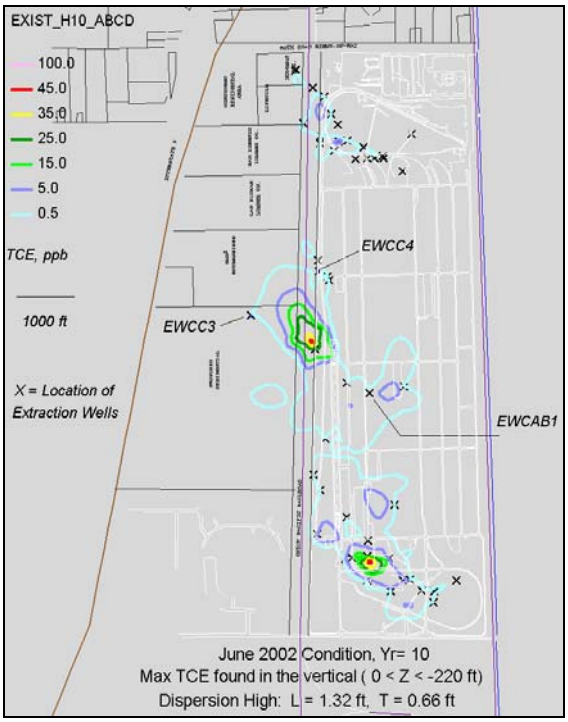


(c) June 2002, Year 20, high dispersion

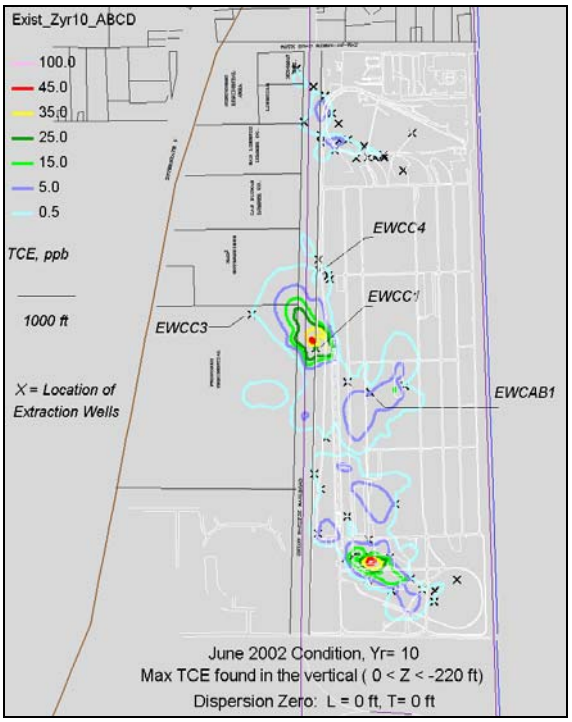


(d) June 2002, Year 30, high dispersion

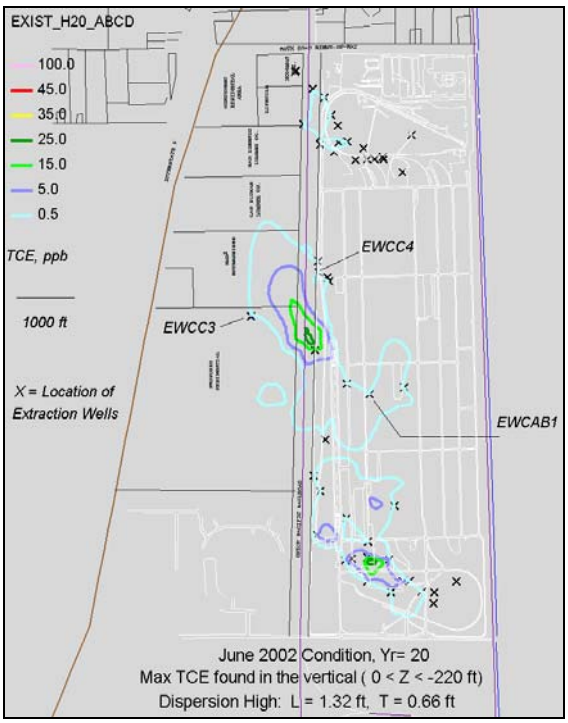
Figure D 23. Long-term transport results for 10-12 June 2002 conditions, year 0, year 10, year 20, and year 30. For each (x,y) locations, the maximum concentration found in the vertical (0 < Z < -220 ft) is plotted.



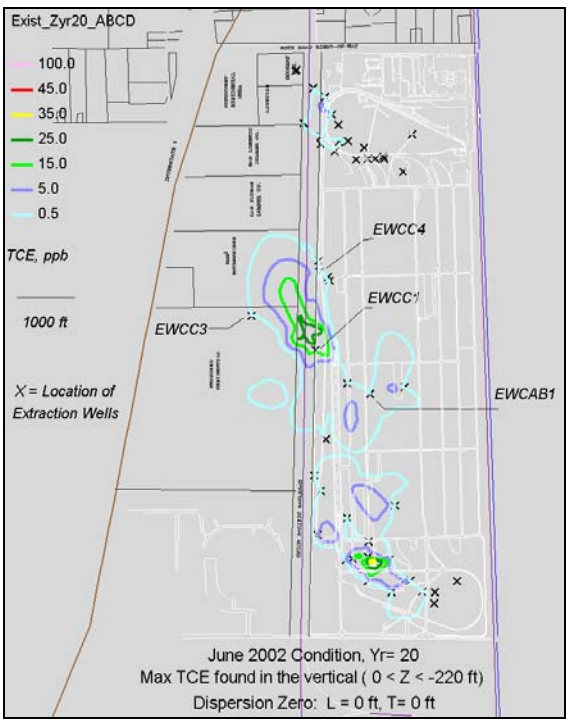
a) June 2002, High dispersion, year 10



(b) June 2002, Zero dispersion, year 10.

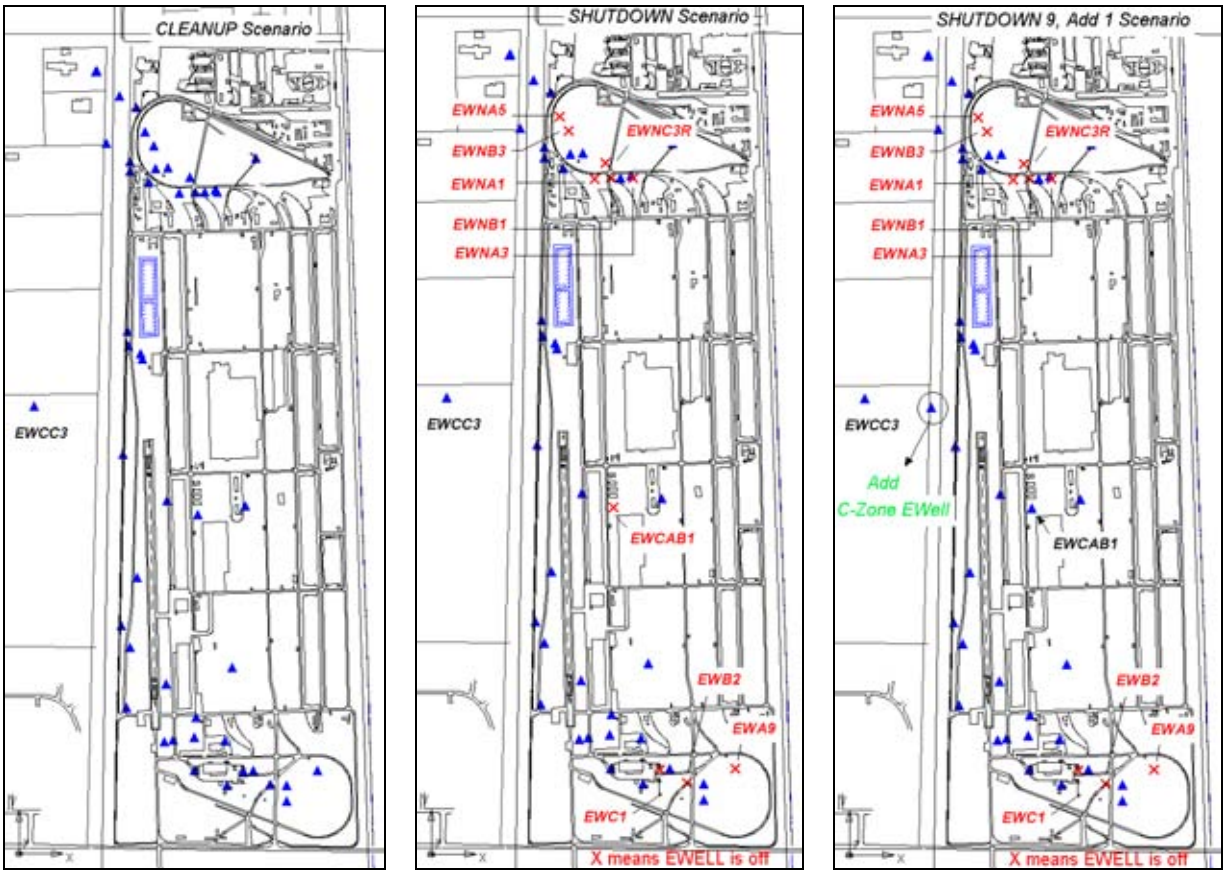


(c) June 2002, High dispersion, year 20



(d) June 2002, Zero dispersion, year 20.

Figure D 24. Long-term results for 10-12 June 2002 condition, for years 10 and 20, demonstrating the sensitivity effects of the diffusion coefficient. For each (x,y) locations, the maximum concentration found in the vertical (0< Z < -220 ft) is plotted.



(a) CLEANUP Extraction Wells (b) SHUTDOWN Extraction wells (c) SHUTDOWN Alternative ("What If")

Figure D 25. Sharpe DDJC pumping gallery comparisons for the Cleanup versus the Shutdown, and Shutdown alternative ("What If") scenario.

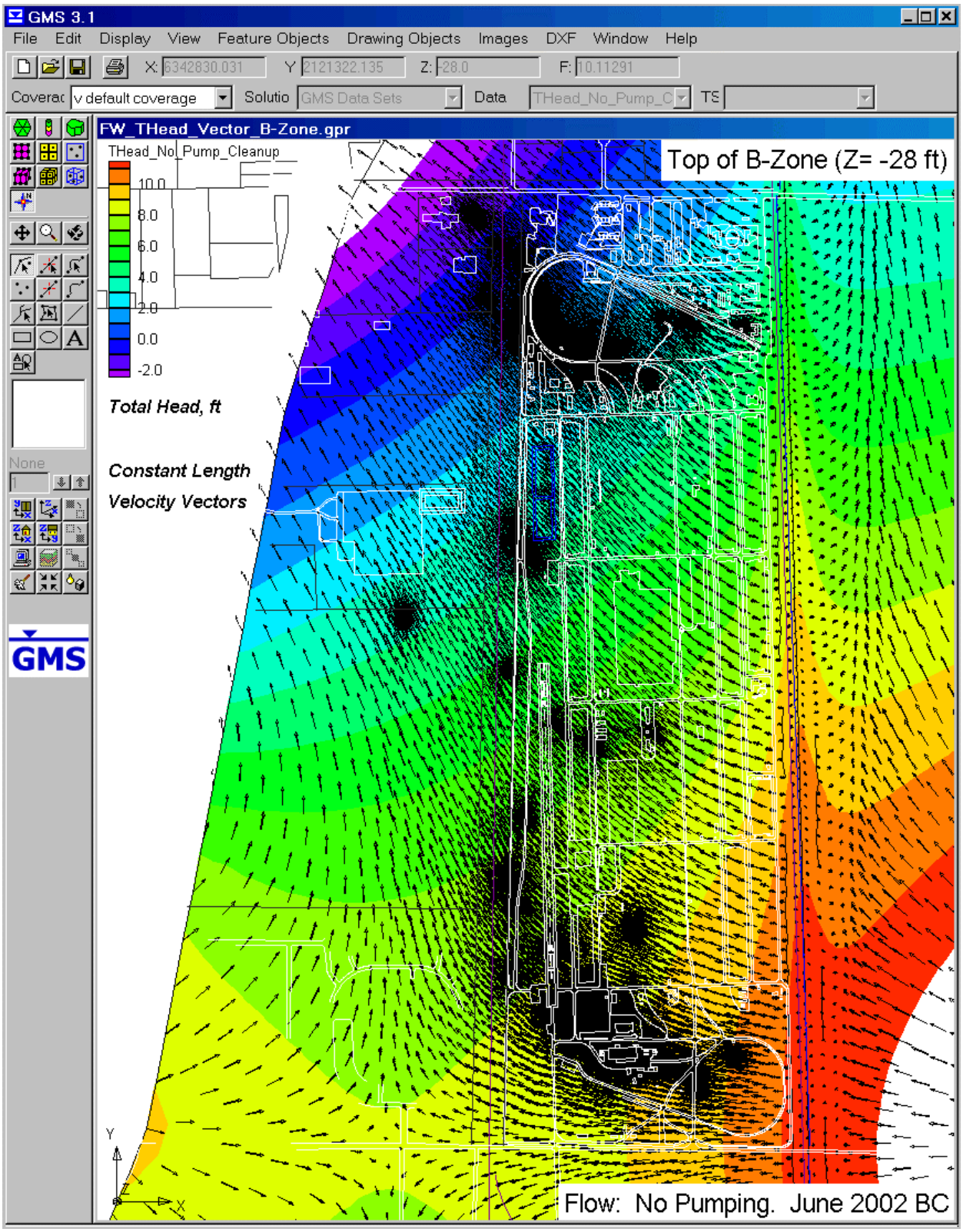


Figure D 26. Total head contours and constant length vectors of FEMWATER results of the no pumping condition using the 10-12 June 2002 boundary head conditions. The top of the B-zone, -28 ft elevation, is displayed.

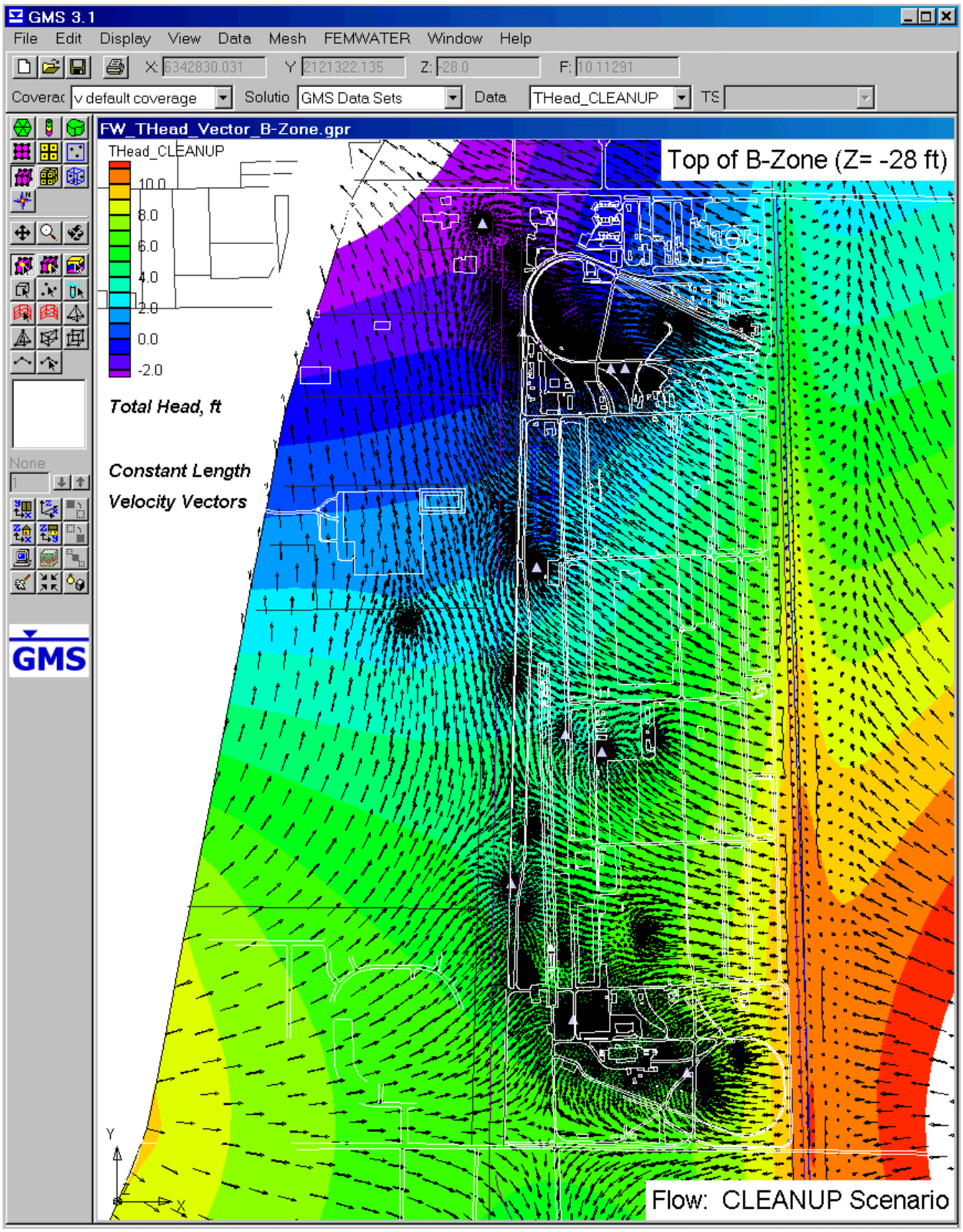
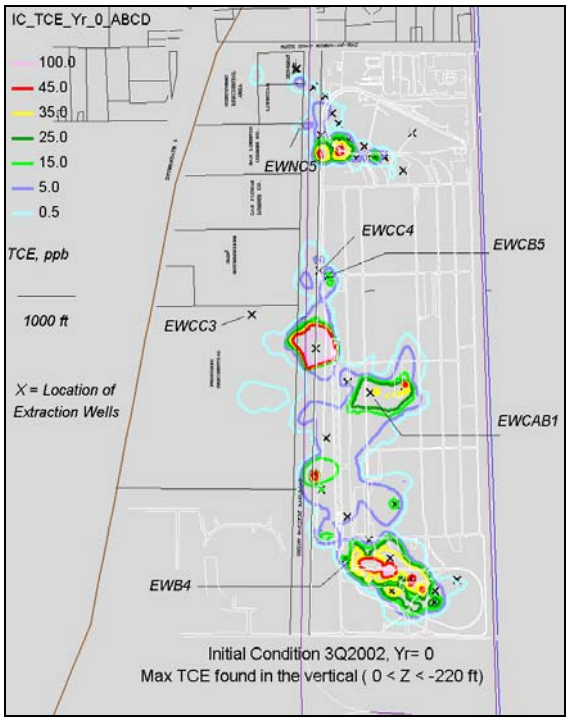
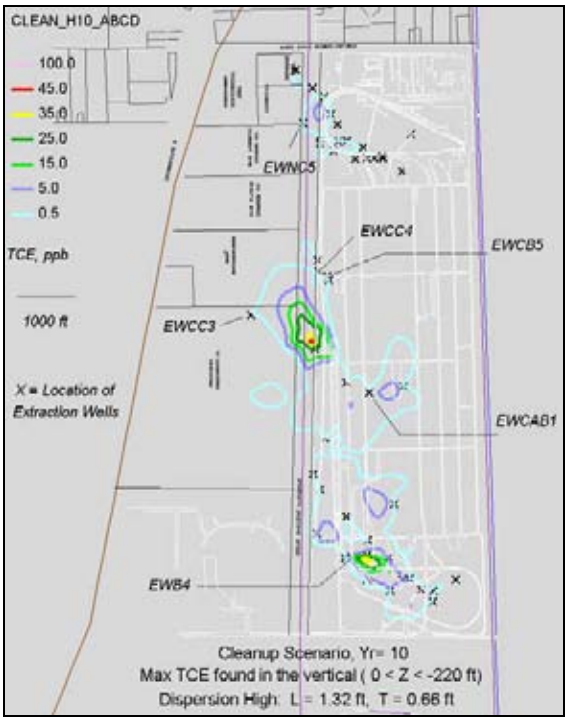


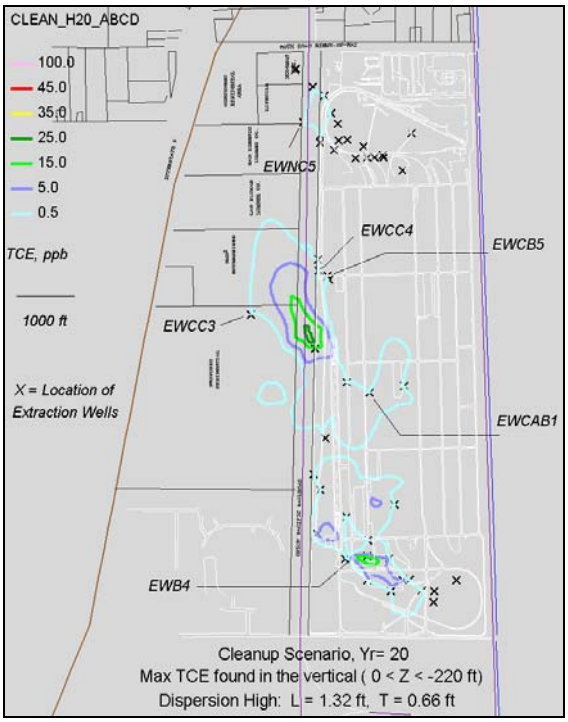
Figure D 27. Total head contours and constant length vectors of FEMWATER results of the CLEANUP scenario. The top of the B-zone, -28 ft elevation, is displayed. Triangles represent B-zone extraction wells.



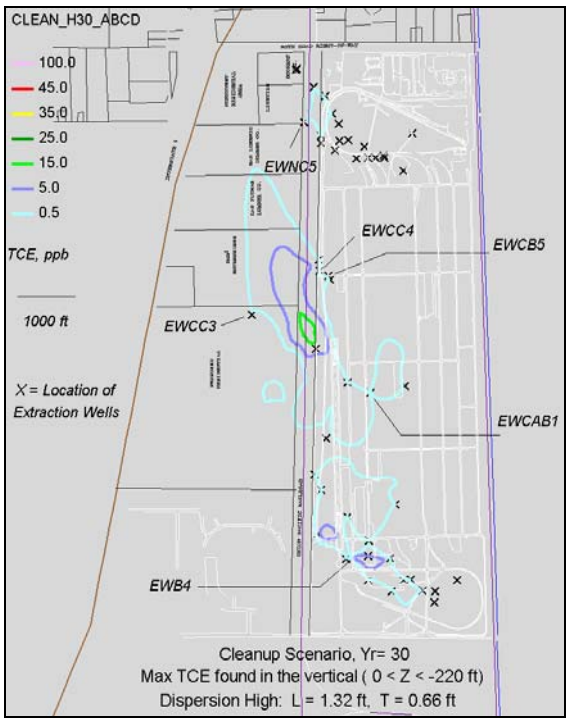
(a) Initial condition for 3Q2002, Year 0



(b) Cleanup, Year 10, high dispersion



(c) Cleanup, Year 20, high dispersion



(d) Cleanup, Year 30, high dispersion

Figure D 28. Long-term transport results for CLEANUP scenario, year 0, year 10, year 20, and year 30. For each (x,y) locations, the maximum concentration found in the vertical (0< Z < -220 ft) is plotted.

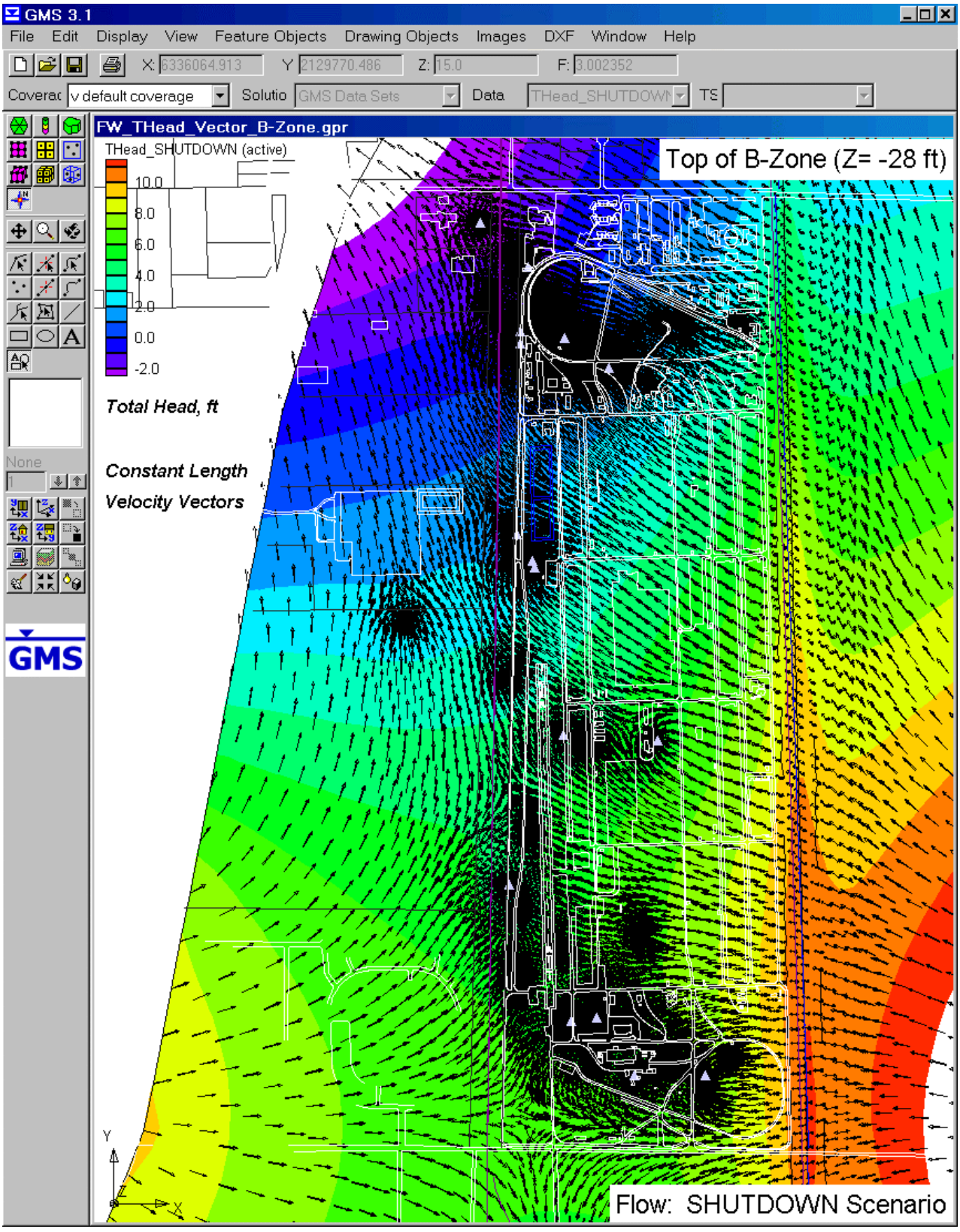
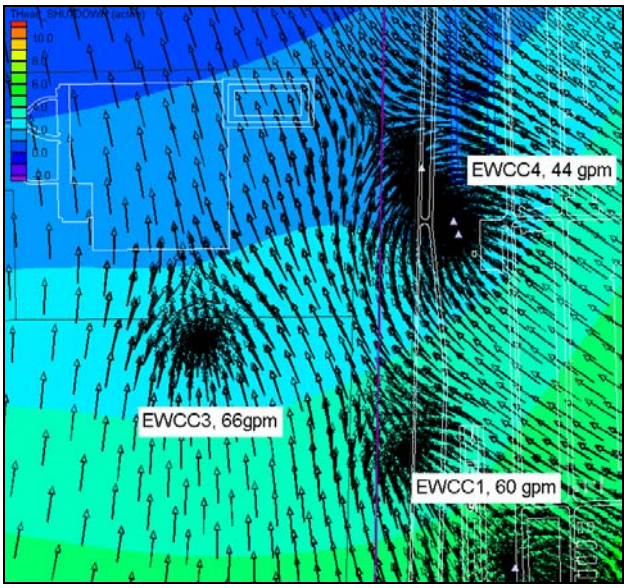
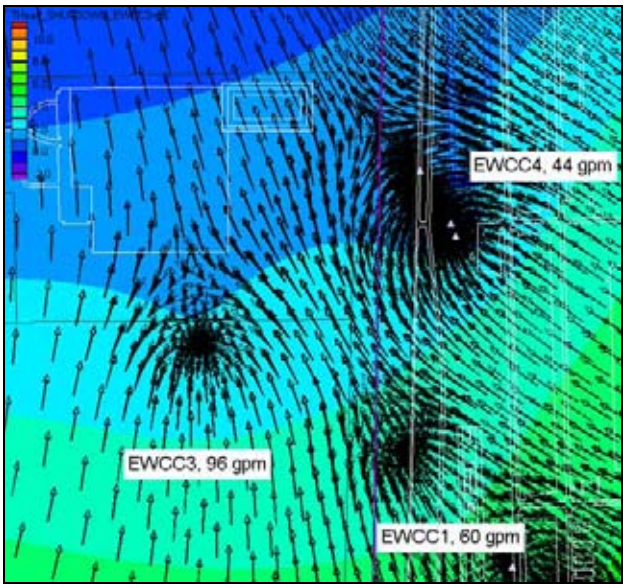


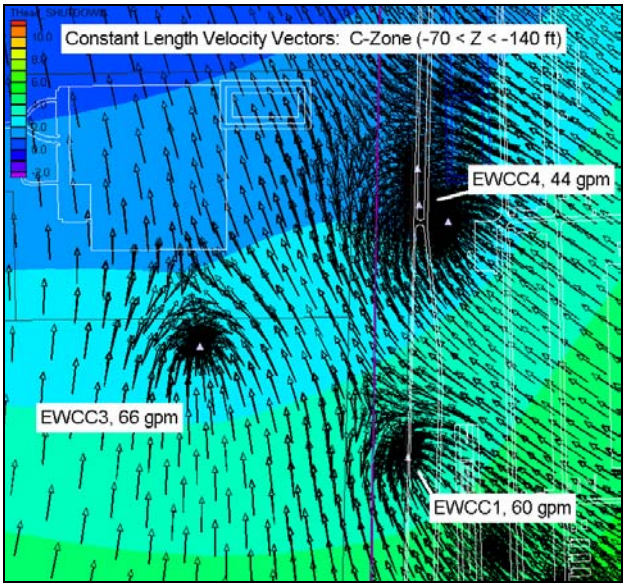
Figure D 29. Total head contours and constant length vectors of FEMWATER results of the SHUTDOWN scenario. The top of the B-zone, -28 ft elevation, is displayed. Triangles represent B-zone extraction wells.



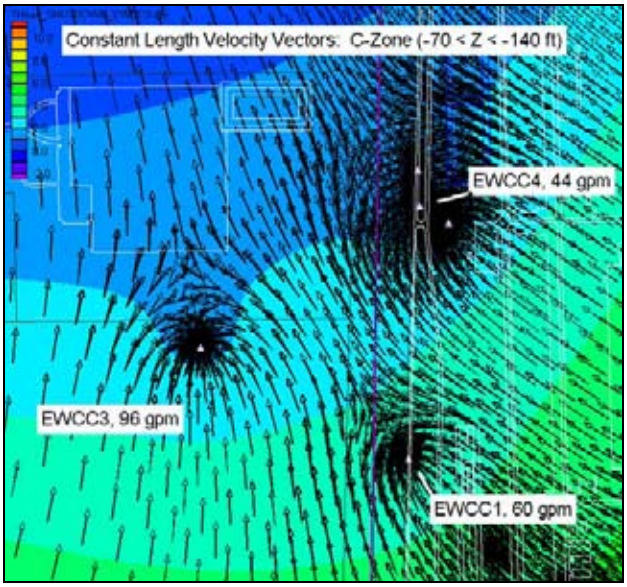
(a) SHUTDOWN, Top of B-zone (-28 < Z < -48 ft)



(b) SHUTDOWN, EWCC3 rate increased to 96gpm Top of B-zone (-28 < Z < -48 ft)

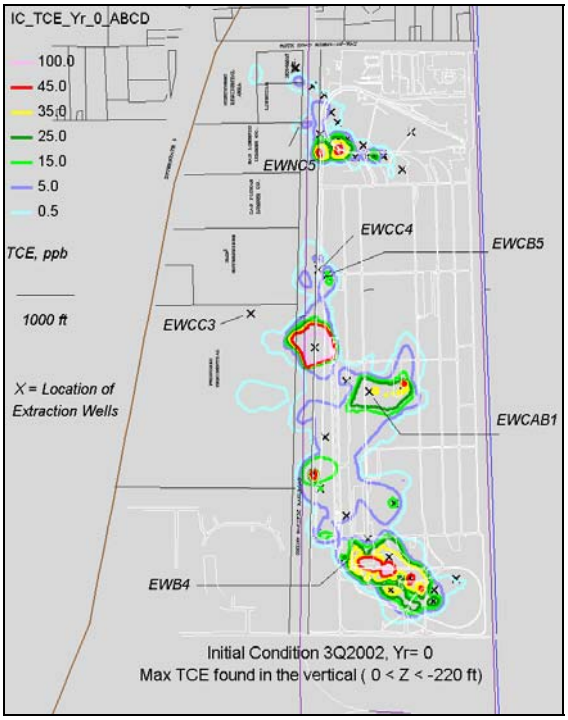


(c) SHUTDOWN, C-zone (-70 < Z < -140)

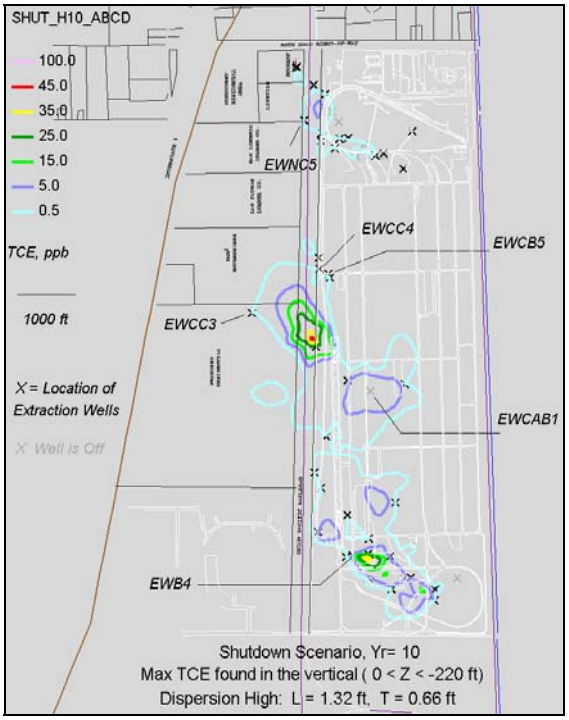


(d) SHUTDOWN, EWCC3 rate increased to 96gpm C-zone (-70 < Z < -140)

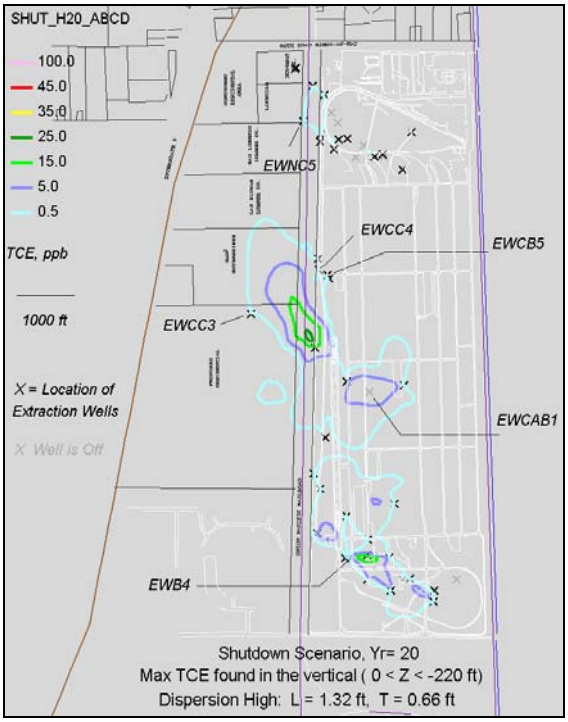
Figure D 30. Detail of total head contours constant length velocity vectors for the SHUTDOWN scenario. Experiment to determine the effect of increasing the pumping rate of EWCC3 from 66 to 96 gpm. Part a and b zooms in on the area of interest and isolates the top of the B-Zone (-28 < Z < -48 ft). Part c and d isolates the view for the C-Zone (-70 < Z < -140) horizon.



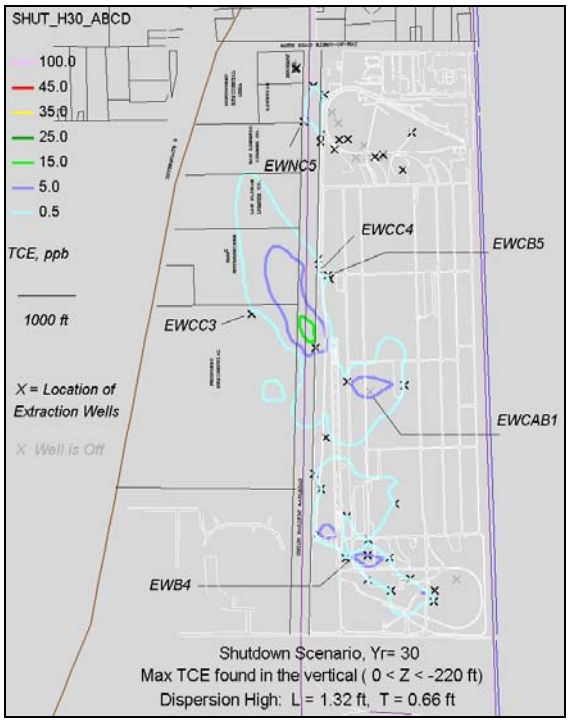
(a) Initial condition for 3Q2002, Year 0



(b) Shutdown, Year 10, high dispersion



(c) Shutdown, Year 20, high dispersion



(d) Shutdown, Year 30, high dispersion

Figure D 31. Long-term transport results for SHUTDOWN scenario, year 0, year 10, year 20, and year 30. For each (x,y) locations, the maximum concentration found in the vertical (0< Z < -220 ft) is plotted.

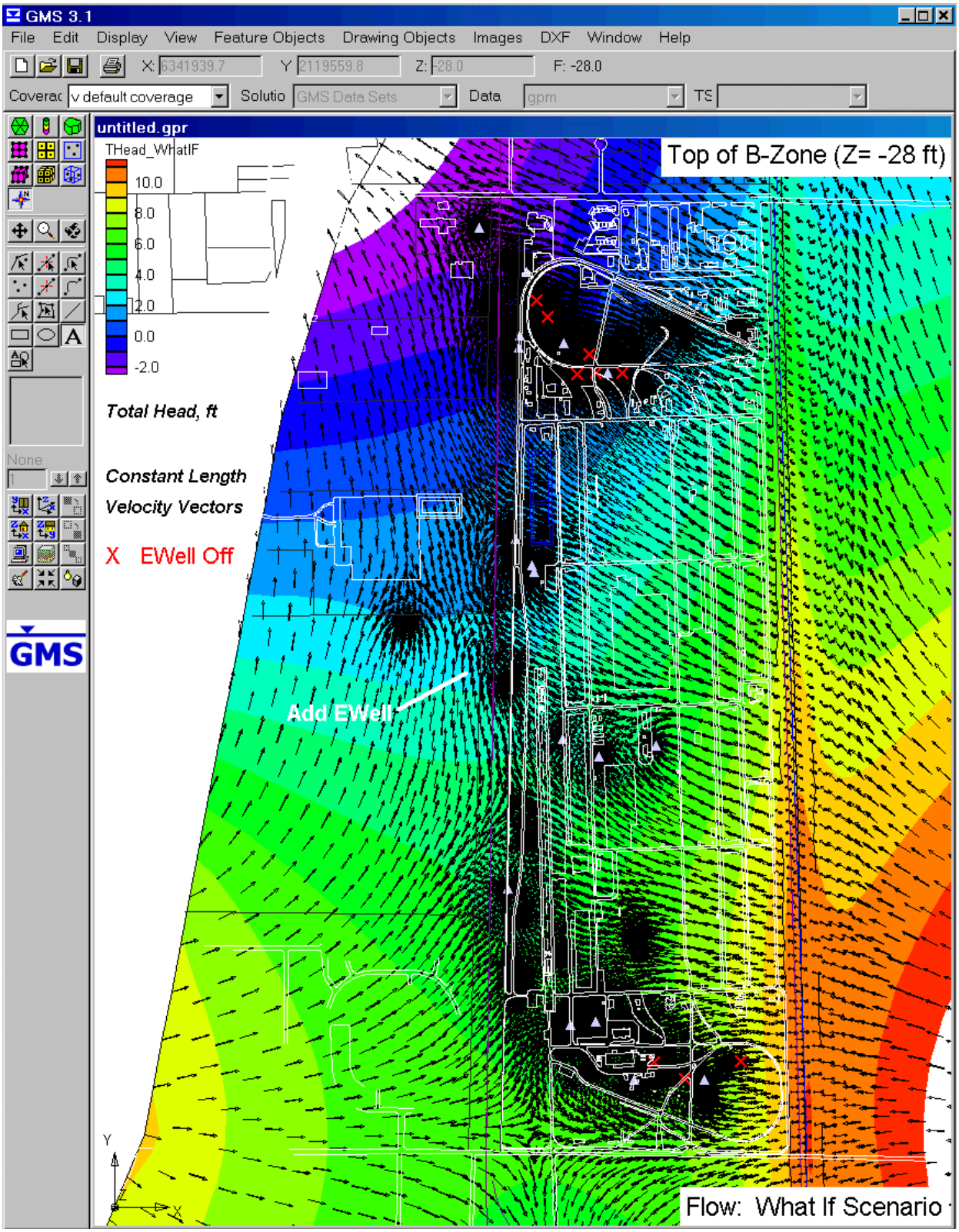
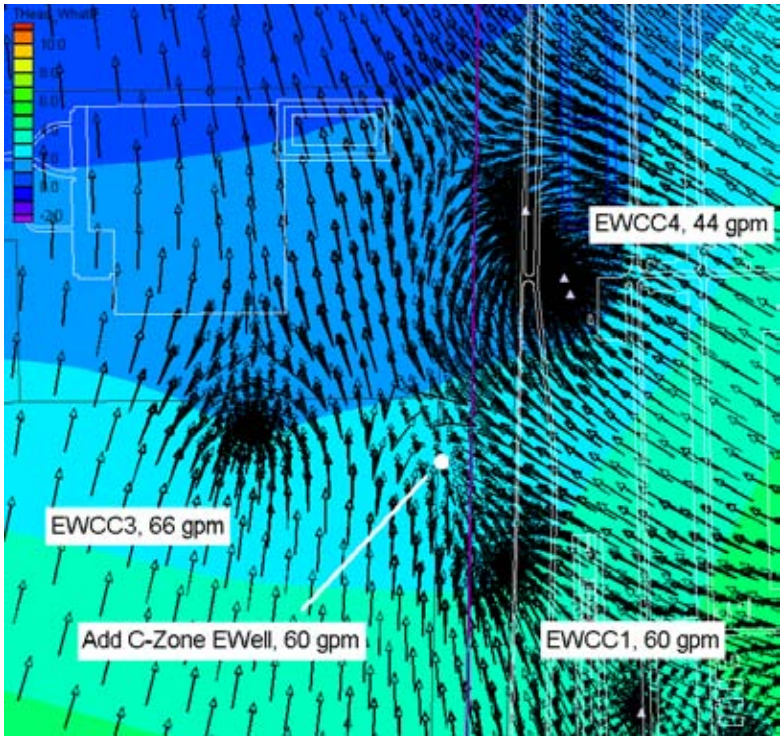
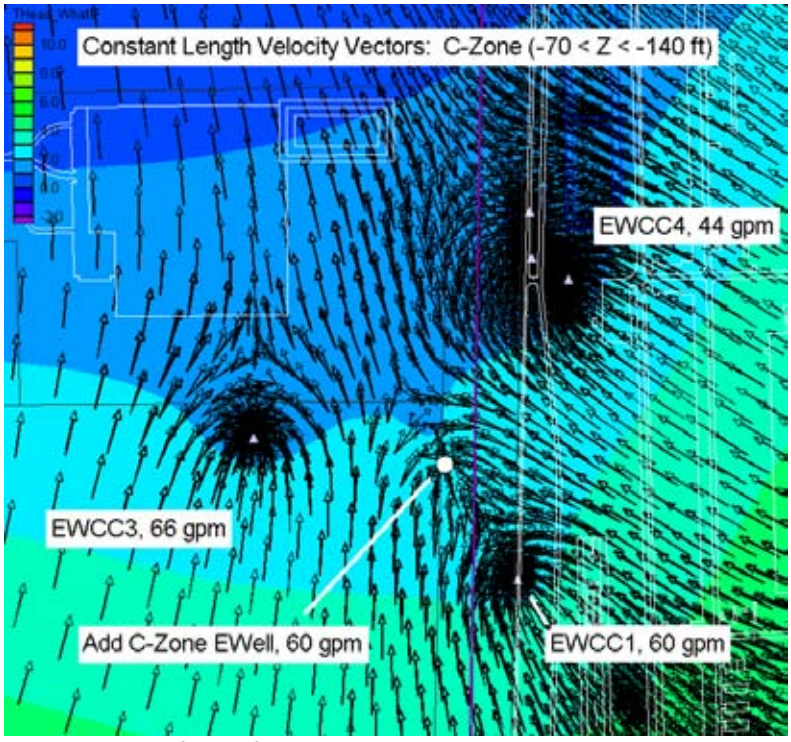


Figure D 32. Total head contours and constant length vectors of FEMWATER results of the SHUTDOWN Alternative scenario ("What if". The top of the B-zone, -28 ft elevation, is displayed. Triangles represent B-zone extraction wells

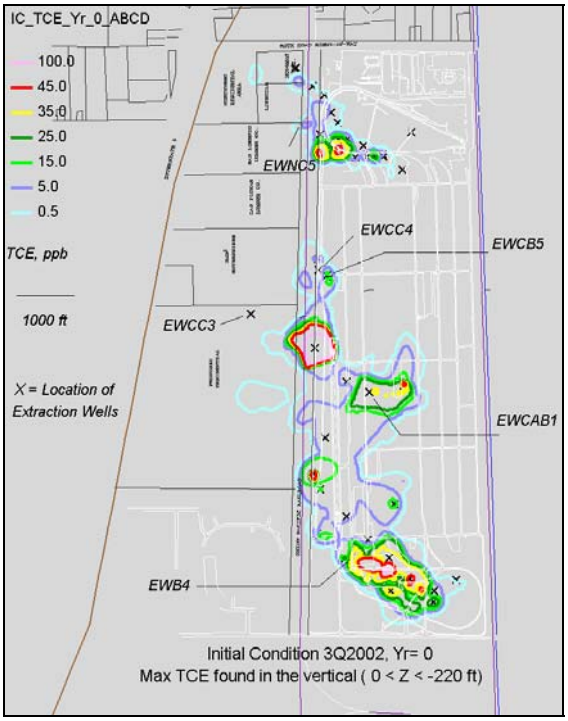


(a) SHUTDOWN alternative, top of B-Zone

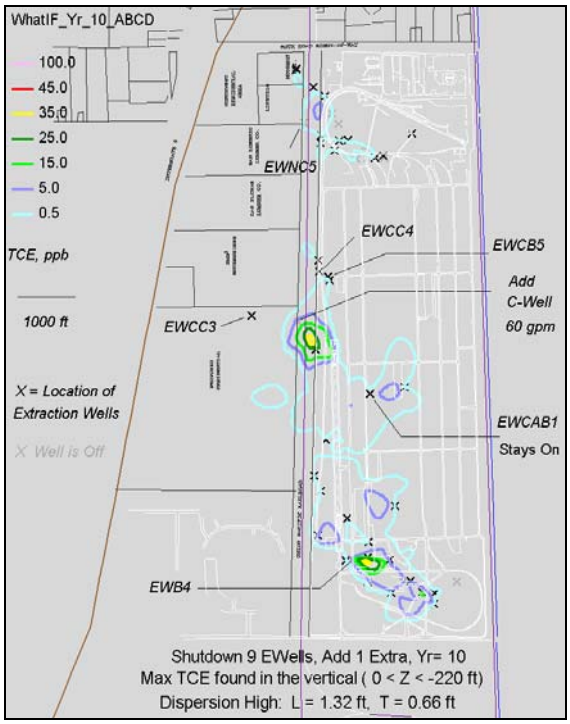


(b) SHUTDOWN alternative, C-Zone

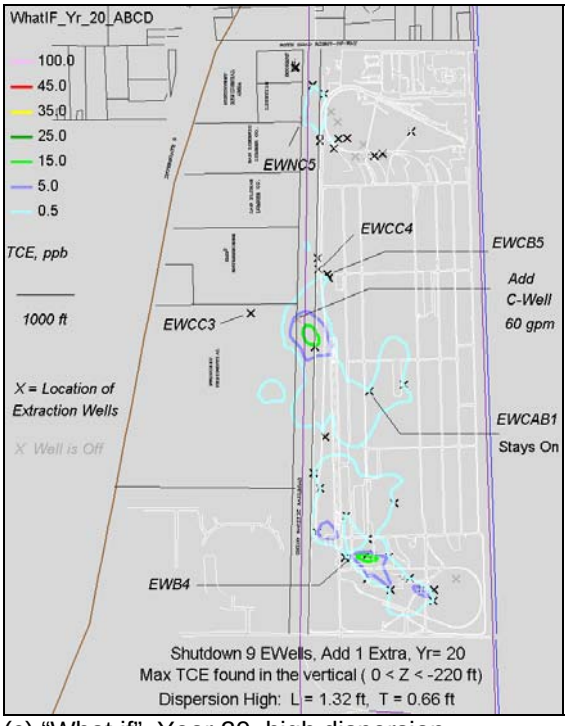
Figure D 33. Detail of total head contours constant length velocity vectors for the SHUTDOWN alternative. Part a zooms in on the area of interest and isolates the top of the B-Zone (-28 < Z < -48 ft). Part b isolates the view for the C-Zone (-70 < Z < -140) horizon.



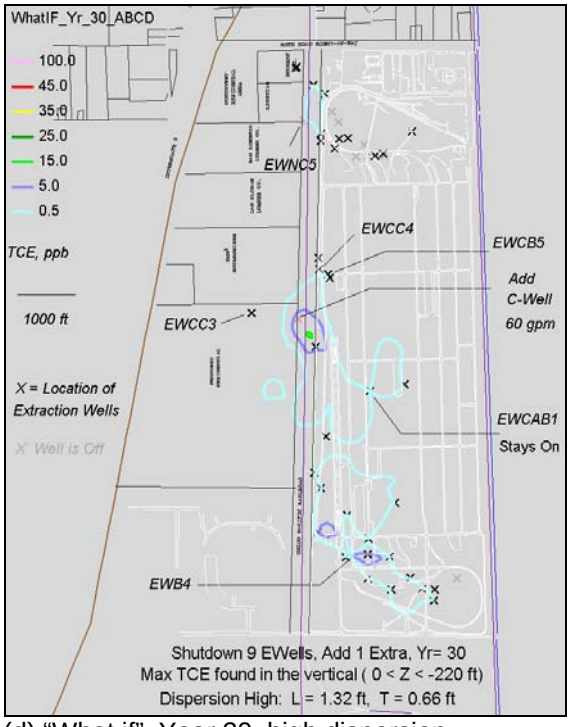
(a) Initial condition for 3Q2002, Year 0



(b) "What if", Year 10, high dispersion

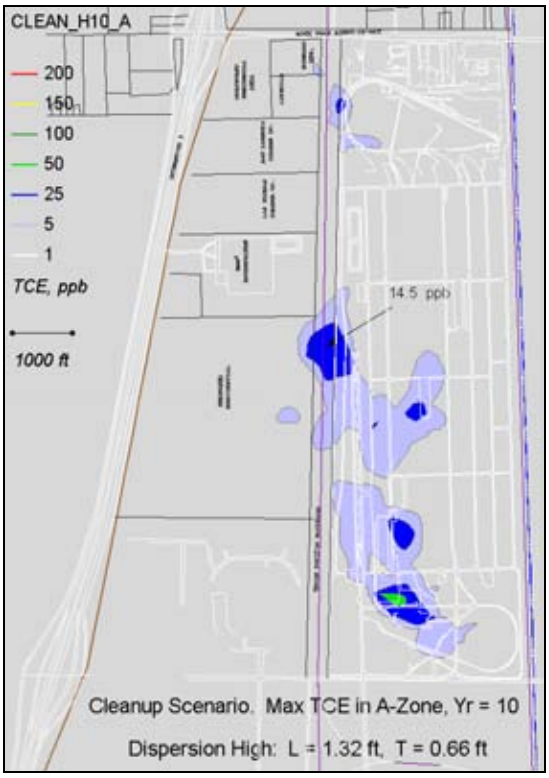


(c) "What if", Year 20, high dispersion

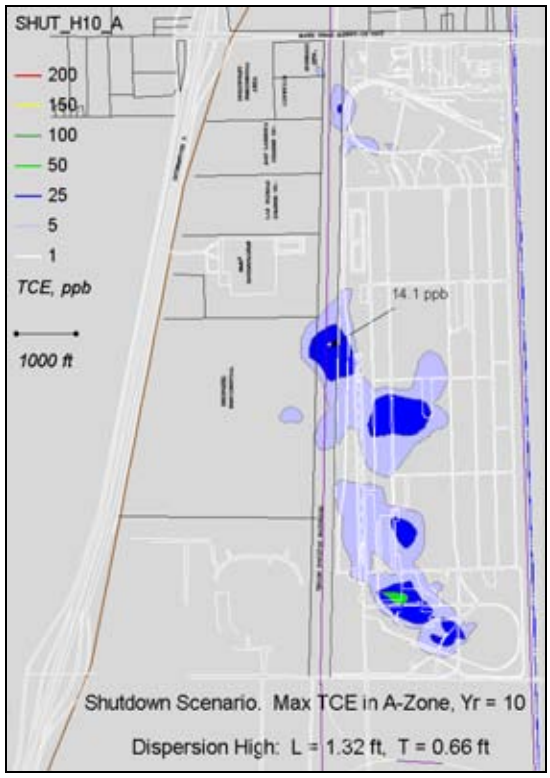


(d) "What if", Year 30, high dispersion

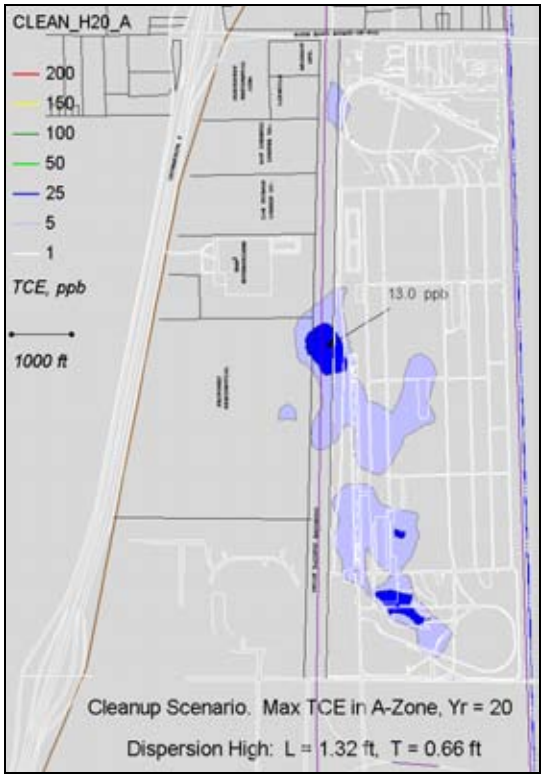
Figure D 34. Long-term transport results for SHUTDOWN alternative scenario ("What If"), year 0, year 10, year 20, and year 30. For each (x,y) locations, the maximum concentration found in the vertical (0< Z < -220 ft) is plotted.



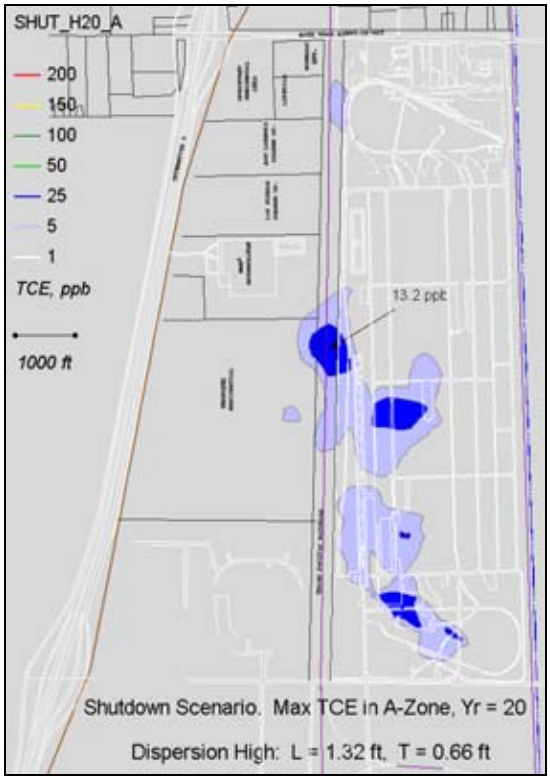
(a) Cleanup, A-Zone, Year=10



(b) Shutdown, A-Zone, Year=10

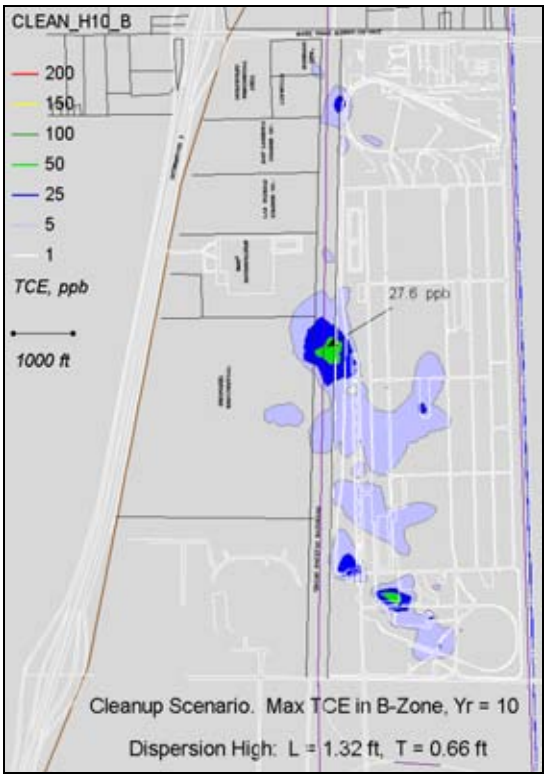


(a) Cleanup, A-Zone, Year=20

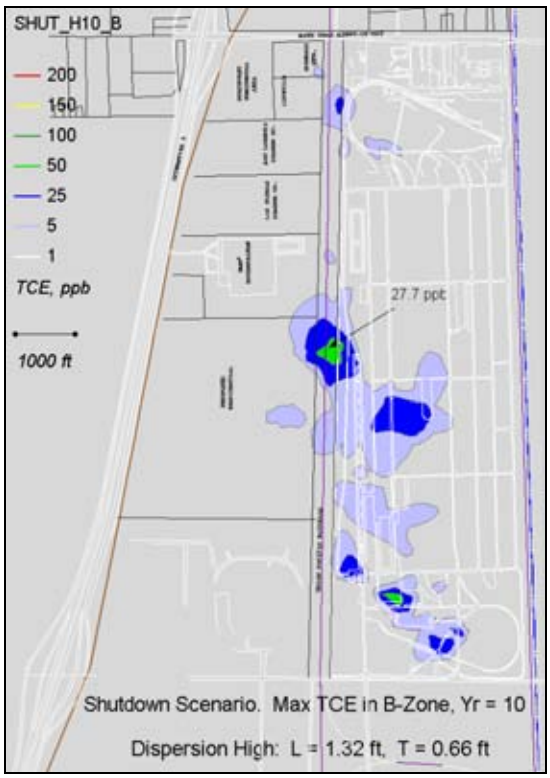


(b) Shutdown, A-Zone, Year=20

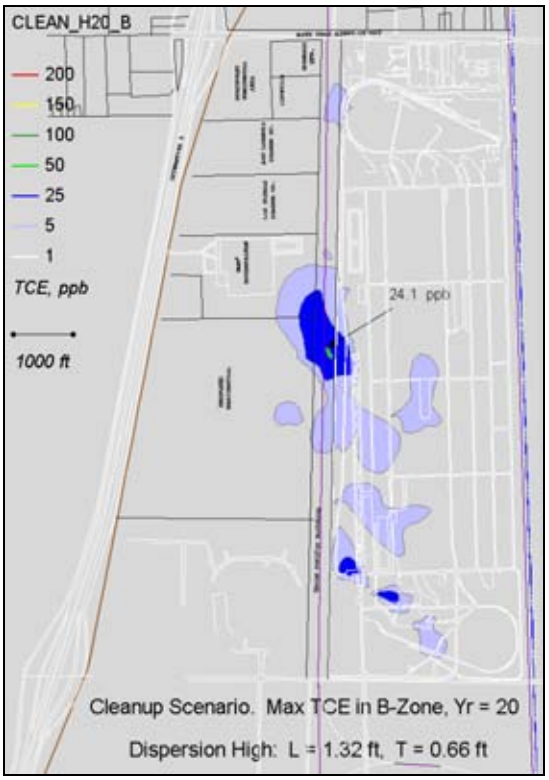
Figure D 35. Maximum TCE comparisons within A-Zone for CLEANUP versus SHUTDOWN scenario, for year 10 and year 20.



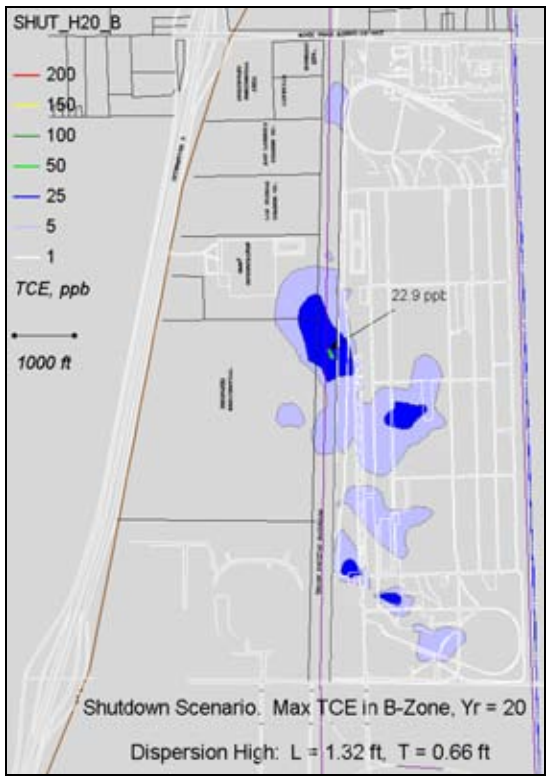
(a) Cleanup, B-Zone, Year=10



(b) Shutdown, B-Zone, Year=10

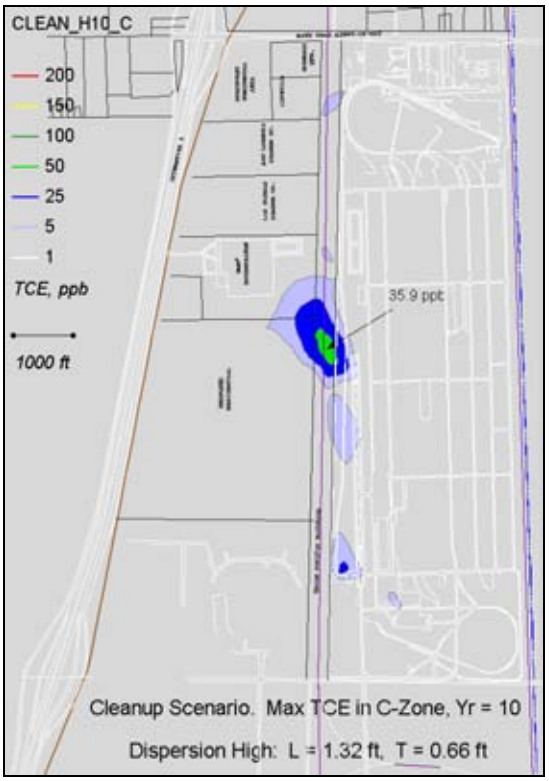


(c) Cleanup, B-Zone, Year=20

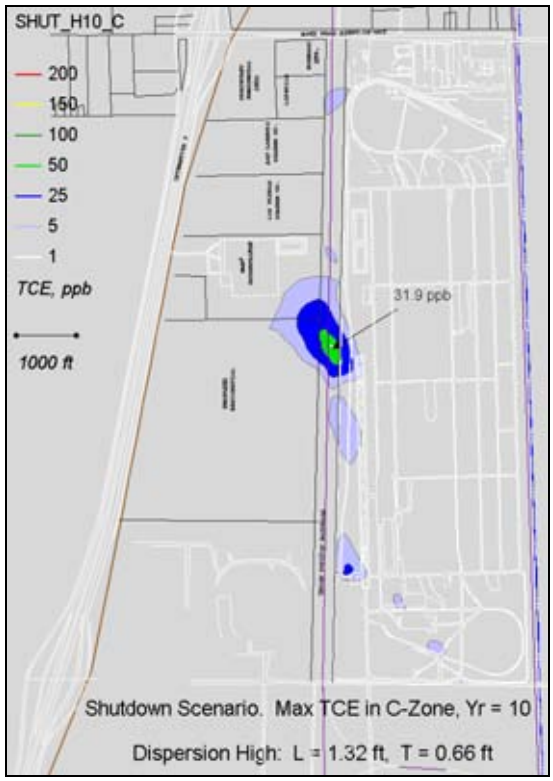


(d) Shutdown, B-Zone, Year=20

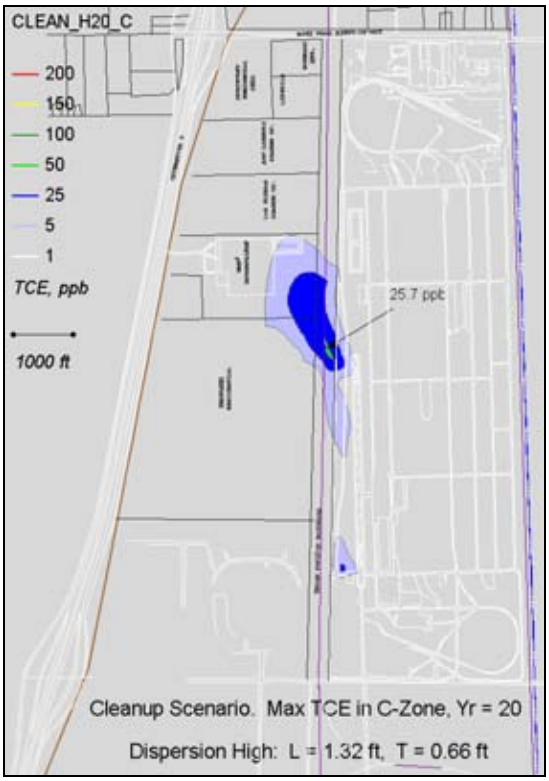
Figure D 36. Maximum TCE comparisons within B-Zone for CLEANUP versus SHUTDOWN scenario, for year 10 and year 20.



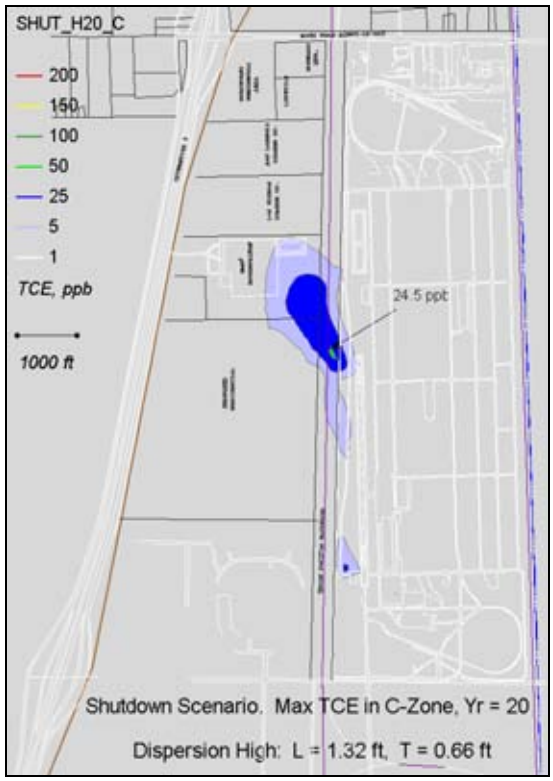
(a) Cleanup, C-Zone, Year=10



(b) Shutdown, C-Zone, Year=10

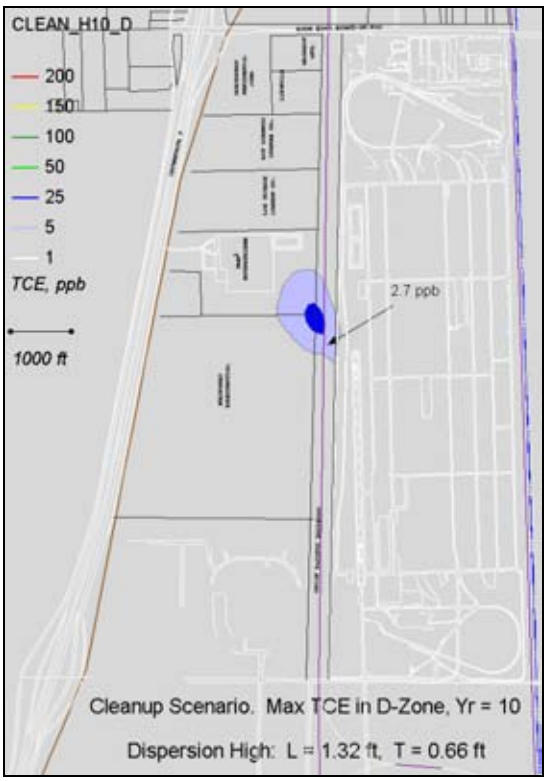


(a) Cleanup, C-Zone, Year=20

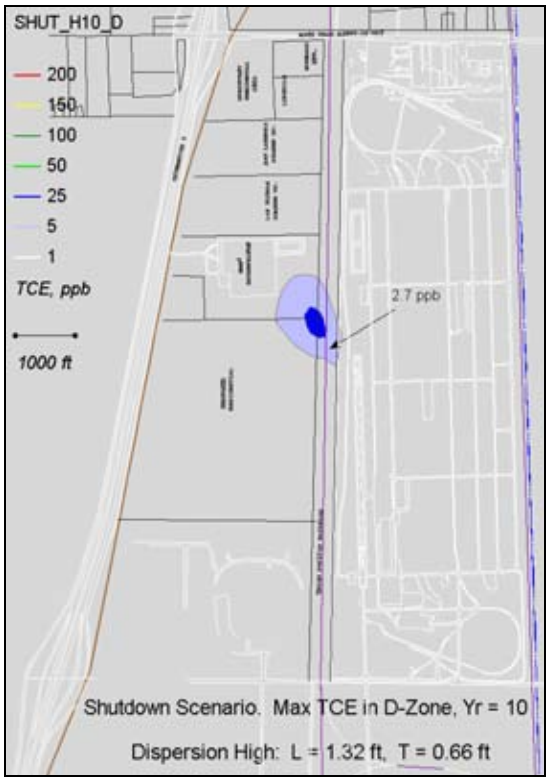


(b) Shutdown, C-Zone, Year=20

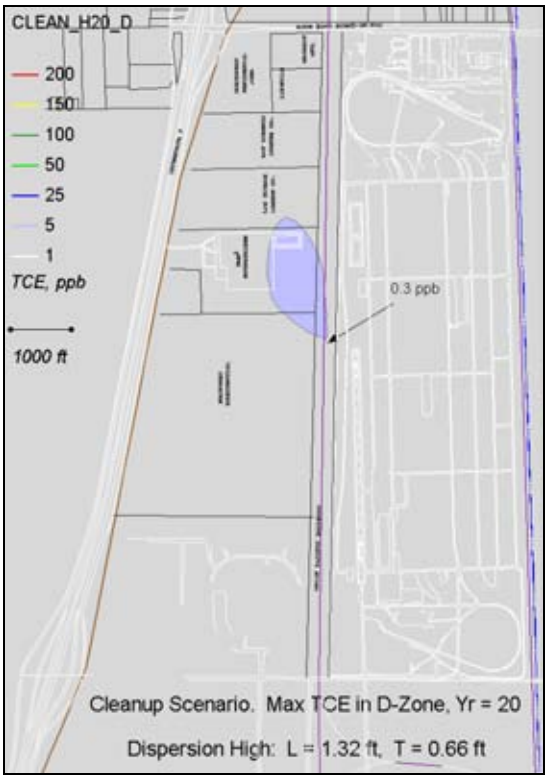
Figure D 37. Maximum TCE comparisons within C-Zone for CLEANUP versus SHUTDOWN scenario, for year 10 and year 20.



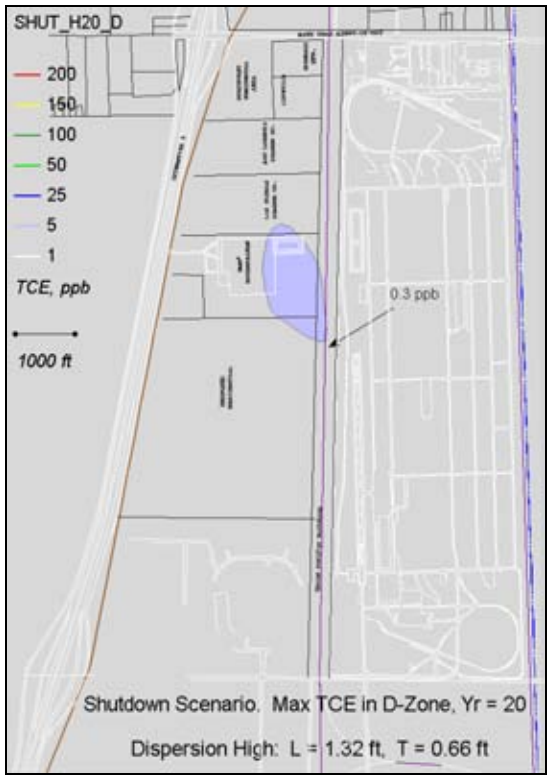
(a) Cleanup, D-Zone, Year=10



(b) Shutdown, D-Zone, Year=10



(c) Cleanup, D-Zone, Year=10



(d) Shutdown, D-Zone, Year=10

Figure D 38. Maximum TCE comparisons within D-Zone for CLEANUP versus SHUTDOWN scenario, year 10 and year 20.

ATTACHMENT 8

Inhalation Model Results

GW-SCREEN
Version 3.0; 04/03

Reset to Defaults

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION
(enter "X" in "YES" box and initial groundwater conc. below)

YES X

DTSC / HERD
Version 3.0-mod1; 07/03

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_w (µg/L)	Chemica
79016	1.40E+01	Trichloroethylene

MORE

ENTER Depth below grade to bottom of enclosed space floor, L_s (cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER SCS soil type directly above water table	ENTER Average soil/groundwater temperature, T_s (°C)	ENTER Average vapor flow rate into bldg (Leave blank to calculate) Q_{soil} (L/m)
15	381	SI	20	5

MORE

ENTER Vadose zone SCS soil type (Used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm^2)	ENTER Vadose zone SCS soil type (Lookup Soil Parameters)	ENTER Vadose zone soil dry bulk density, ρ_b^v (g/cm^3)	ENTER Vadose zone soil total porosity, n^v (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^v (cm^3/cm^3)
SI			SI	1.46	0.45	0.2

MORE

ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)	ENTER Averaging time for carcinogens, AT_a (yrs)	ENTER Averaging time for noncarcinogens, AT_{nc} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)
1.0E-06	1	70	30	30	350

Used to calculate risk-based groundwater concentration.

END

INTERMEDIATE CALCULATIONS SHEET

Source-building separation, L_T (cm)	Vadose zone soil air-filled porosity, θ_a^V (cm^3/cm^3)	Vadose zone effective total fluid saturation, S_e (cm^3/cm^3)	Vadose zone soil intrinsic permeability, k (cm^2)	Vadose zone soil relative air permeability, k_{rg} (cm^2)	Vadose zone soil effective vapor permeability, k_v (cm^2)	Thickness of capillary zone, L_{cz} (cm)	Total porosity in capillary zone, n_{cz} (cm^3/cm^3)	Air-filled porosity in capillary zone, $\theta_{a,cz}$ (cm^3/cm^3)	Water-filled porosity in capillary zone, $\theta_{w,cz}$ (cm^3/cm^3)	Floor-wall seam perimeter, X_{crack} (cm)
356	0.280	0.395	6.86E-08	0.714	4.90E-08	183.04	0.43	0.048	0.382	4,000

Bldg. ventilation rate, $Q_{building}$ (cm^3/s)	Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. groundwater temperature, H_{TS} ($atm\cdot m^3/mol$)	Henry's law constant at ave. groundwater temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Vadose zone effective diffusion coefficient, D^{eff}_v (cm^2/s)	Capillary zone effective diffusion coefficient, D^{eff}_{cz} (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)
1.69E+04	1.00E+06	4.00E-04	15	8,433	8.06E-03	3.30E-01	1.78E-04	3.20E-03	2.27E-06	5.27E-05

Diffusion path length, L_d (cm)	Convection path length, L_p (cm)	Source vapor conc., C_{source} ($\mu g/m^3$)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, exp(Pe^f) (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
366	15	4.69E+03	0.10	8.93E+01	3.20E-03	4.00E+02	4.16E+282	9.48E-06	3.98E-02	2.9E-06	9.0E-01

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (µg/L)	Indoor exposure groundwater conc., noncarcinogen (µg/L)	Risk-based indoor exposure groundwater conc., (µg/L)	Pure component water solubility, S (µg/L)	Final indoor exposure groundwater conc., (µg/L)
NA	NA	NA	1.47E+06	NA

MESSAGE SUMMARY BELOW:

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
8.3E-08	6.4E-05

END

GW-SCREEN
Version 3.0; 04/03

Reset to Defaults

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

DTSC / HERD
Version 3.0-mod1; 07/03

YES

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION
(enter "X" in "YES" box and initial groundwater conc. below)

YES | X

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_{wi} (µg/L)	Chemical
127184	1.10E+00	Tetrachloroethylene

MORE

ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER SCS soil type directly above water table	ENTER Average soil/ groundwater temperature, T_S (°C)	ENTER Average vapor flow rate Q (Leave blank to calculate) Q_{soil} (L/m)
15	366	SI	20	E

MORE

ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm^2)	ENTER Vadose zone SCS soil type (Leave Soil Parameters)	ENTER Vadose zone soil dry bulk density, ρ_b^V (g/cm^3)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm^3/cm^3)
SI			SI	1.48	0.43	0.2

MORE

ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/y)
1.0E-06	1	70	30	30	350

Used to calculate risk-based groundwater concentration.

END

INTERMEDIATE CALCULATIONS SHEET

Source-building separation, L_T (cm)	Vadose zone soil air-filled porosity, θ_a^V (cm^3/cm^3)	Vadose zone effective total fluid saturation, S_{te} (cm^3/cm^3)	Vadose zone soil intrinsic permeability, k_i (cm^2)	Vadose zone soil relative air permeability, k_{rg} (cm^2)	Vadose zone soil effective vapor permeability, k_v (cm^2)	Thickness of capillary zone, L_{cz} (cm)	Total porosity in capillary zone, n_{cz} (cm^3/cm^3)	Air-filled porosity in capillary zone, $\theta_{a,cz}$ (cm^3/cm^3)	Water-filled porosity in capillary zone, $\theta_{w,cz}$ (cm^3/cm^3)	Floor-wall seam perimeter, X_{crack} (cm)
366	0.230	0.395	6.86E-09	0.714	4.90E-09	163.04	0.43	0.048	0.382	4 000

Bldg. ventilation rate, $Q_{building}$ (cm^3/s)	Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. groundwater temperature, H_{TS} (atm-m^3/mol)	Henry's law constant at ave. groundwater temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_S (g/cm-s)	Vadose zone effective diffusion coefficient, D^{eff}_v (cm^2/s)	Capillary zone effective diffusion coefficient, D^{eff}_{cz} (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)
1.69E+04	1.00E+06	4.00E-04	15	9,451	1.40E-02	5.81E-01	1.78E-04	2.92E-03	1.92E-05	4.28E-05

Diffusion path length, L_d (cm)	Convection path length, L_p (cm)	Source vapor conc., C_{source} ($\mu g/m^3$)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, exp(Pe^f) (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
366	15	6.29E+02	0.10	8.33E+01	2.92E-03	4.00E+02	#NUM!	6.90E-06	4.41E-03	5.9E-06	3.5E-02

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (µg/L)	Indoor exposure groundwater conc., noncarcinogen (µg/L)	Risk-based indoor exposure groundwater conc., (µg/L)	Pure component water solubility, S (µg/L)	Final indoor exposure groundwater conc., (µg/L)
NA	NA	NA	2.00E+05	NA

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
1.1E-08	1.2E-04

MESSAGE SUMMARY BELOW:

END

GW-SCREEN
Version 3.0; 04/03

Reset to Defaults

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION
(enter "X" in "YES" box and initial groundwater conc. below)

YES X

DTSC / HERD
Version 3.0-mod1; 07/03

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W (µg/L)	Chemical
79016	1.40E+01	Trichloroethylene

MORE

ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER SCS soil type directly above water table	ENTER Average soil / groundwater temperature, T_S (°C)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
15	991	SI	20	5

MORE

ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm^2)	ENTER Vadose zone SCS soil type (Look-up Soil Parameters)	ENTER Vadose zone soil dry bulk density, ρ_b^d (g/cm^3)	ENTER Vadose zone soil total porosity, n^v (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^v (cm^3/cm^3)
SI			SI	1.45	0.49	0.2

MORE

ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)
1.0E-06	1	70	30	25	250

Used to calculate risk-based groundwater concentration.

END

INTERMEDIATE CALCULATIONS SHEET

Source-building separation, L_T (cm)	Vadose zone soil air-filled porosity, θ_a^{vz} (cm^3/cm^3)	Vadose zone effective total fluid saturation, S_{te} (cm^3/cm^3)	Vadose zone soil intrinsic permeability, k_i (cm^2)	Vadose zone soil relative air permeability, k_{rg} (cm^2)	Vadose zone soil effective vapor permeability, k_v (cm^2)	Thickness of capillary zone, L_{cz} (cm)	Total porosity in capillary zone, n_{cz} (cm^3/cm^3)	Air-filled porosity in capillary zone, $\theta_{a,cz}$ (cm^3/cm^3)	Water-filled porosity in capillary zone, $\theta_{w,cz}$ (cm^3/cm^3)	Floor-wall seam perimeter, X_{crack} (cm)
366	0.280	0.395	6.80E-09	0.714	4.90E-09	163.04	0.43	0.048	0.382	4,000

Bldg. ventilation rate, $Q_{building}$ (cm^3/s)	Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,ts}$ (cal/mol)	Henry's law constant at ave. groundwater temperature, H_{TS} ($atm\cdot m^3/mol$)	Henry's law constant at ave. groundwater temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Vadose zone effective diffusion coefficient, D^{eff}_v (cm^2/s)	Capillary zone effective diffusion coefficient, D^{eff}_{cz} (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)
1.69E+04	1.00E+06	4.00E-04	15	8,493	8.06E-03	3.35E-01	1.78E-04	3.20E-03	2.37E-05	5.27E-05

Diffusion path length, L_d (cm)	Convection path length, L_p (cm)	Source vapor conc., C_{source} ($\mu g/m^3$)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, exp(Pe^f) (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
366	15	4.69E+03	0.10	8.33E+01	3.20E-03	1.00E+02	4.18E+282	8.48E-06	3.98E-02	2.0E-06	9.0E-01

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (µg/L)	Indoor exposure groundwater conc., noncarcinogen (µg/L)	Risk-based indoor exposure groundwater conc., (µg/L)	Pure component water solubility, S (µg/L)	Final indoor exposure groundwater conc., (µg/L)
NA	NA	NA	1.47E+06	NA

MESSAGE SUMMARY BELOW:

END

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
1.9E-08	3.8E-05

GW-SCREEN
Version 3.0; 04/05

Reset to Defaults

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION
(enter "X" in "YES" box and initial groundwater conc. below)

YES: X

OTSC / HERD
Version 3.0-mod1; 07/08

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_{w} (ug/L)	Chemical
127184	1.10E+00	Tetrachloroethylene

MORE

ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER SCS soil type directly above water table	ENTER Average soil/ groundwater temperature, T_S (°C)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
15	381	SI	20	5

MORE

ENTER Vadose zone SCS soil type (used to estimate soil vapo permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm²)	ENTER Vadose zone SCS soil type (Lookup Soil Parameters)	ENTER Vadose zone soil dry bulk density, ρ_b^V (g/cm³)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm³/cm³)
SI			SI	1.46	0.49	0.2

MORE

ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)
1.0E-06	1	70	30	26	250

Used to calculate risk-based groundwater concentration.

END

INTERMEDIATE CALCULATIONS SHEET

Source-building separation, L_T (cm)	Vadose zone soil air-filled porosity, θ_a^v (cm^3/cm^3)	Vadose zone effective total fluid saturation, S_{te} (cm^3/cm^3)	Vadose zone soil intrinsic permeability, k_i (cm^2)	Vadose zone soil relative air permeability, k_{rg} (cm^2)	Vadose zone soil effective vapor permeability, k_v (cm^2)	Thickness of capillary zone, L_{cz} (cm)	Total porosity in capillary zone n_{cz} (cm^3/cm^3)	Air-filled porosity in capillary zone, $\theta_{a,cz}$ (cm^3/cm^3)	Water-filled porosity in capillary zone, $\theta_{w,cz}$ (cm^3/cm^3)	Floor-wall seam perimeter, X_{crack} (cm)
366	0.280	0.395	6.86E-09	0.714	4.90E-09	163.04	0.43	0.048	0.382	4,000

Bldg. ventilation rate, $Q_{building}$ (cm^3/s)	Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,Ts}$ (cal/mol)	Henry's law constant at ave. groundwater temperature, H_{Ts} (atm-m^3/mol)	Henry's law constant at ave. groundwater temperature, H'_{Ts} (unitless)	Vapor viscosity at ave. soil temperature, μ_{Ts} (g/cm-s)	Vadose zone effective diffusion coefficient, D^{eff}_v (cm^2/s)	Capillary zone effective diffusion coefficient, D^{eff}_{cz} (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)
1.69E+04	1.00E+06	4.00E-04	15	9,451	1.40E-02	5.81E-01	1.78E-04	2.92E-03	1.92E-05	4.28E-05

Diffusion path length, L_d (cm)	Convection path length, L_p (cm)	Source vapor conc., C_{source} ($\mu g/m^3$)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, exp(Pe') (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
366	15	6.39E+02	0.10	8.33E+01	2.92E-03	4.00E+02	#NUM!	6.90E-06	4.41E-03	5.9E-06	3.5E-02

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (µg/L)	Indoor exposure groundwater conc., noncarcinogen (µg/L)	Risk-based indoor exposure groundwater conc., (µg/L)	Pure component water solubility, S (µg/L)	Final indoor exposure groundwater conc., (µg/L)
NA	NA	NA	2.00E+05	NA

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
6.4E-09	7.2E-05

MESSAGE SUMMARY BELOW:

END

DATA ENTRY SHEET

GW-SCREEN
Version 3.0; 04/03

Reset to Defaults

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION
(enter "X" in "YES" box and initial groundwater conc. below)

YES X

DTSC / HERD
Version 3.0-mod1; 07/03

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_w (µg/L)	Chemical
79016	4.40E+00	Trichloroethylene

MORE

ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER SCS soil type directly above water table	ENTER Average soil/ groundwater temperature, T_S (°C)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
15	549	S	20	5

MORE

ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm^2)	ENTER Vadose zone SCS soil type (Lookup Soil Parameters)	ENTER Vadose zone soil dry bulk density, ρ_b^V (g/cm^3)	ENTER Vadose zone soil total porosity, n^V (Unitless)	ENTER Vadose zone soil water filled porosity, θ_w^V (cm^3/cm^3)
S			LS	1.45	0.48	0.2

MORE

ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)
1.0E-06	1	70	30	30	350

Used to calculate risk-based groundwater concentration.

INTERMEDIATE CALCULATIONS SHEET

Source-building separation, L_T (cm)	Vadose zone soil air-filled porosity, θ_a^V (cm^3/cm^3)	Vadose zone effective total fluid saturation, S_{te} (cm^3/cm^3)	Vadose zone soil intrinsic permeability, k_i (cm^2)	Vadose zone soil relative air permeability, k_{rg} (cm^2)	Vadose zone soil effective vapor permeability, k_v (cm^2)	Thickness of capillary zone, L_{cz} (cm)	Total porosity in capillary zone, n_{cz} (cm^3/cm^3)	Air-filled porosity in capillary zone, $\theta_{a,cz}$ (cm^3/cm^3)	Water-filled porosity in capillary zone, $\theta_{w,cz}$ (cm^3/cm^3)	Floor-wall seam perimeter, X_{crack} (cm)
534	0.230	0.390	1.01E-07	0.524	5.29E-08	17.05	0.43	0.177	0.253	4,000

Bldg. ventilation rate, $Q_{building}$ (cm^3/s)	Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,Ts}$ (cal/mol)	Henry's law constant at ave. groundwater temperature, H_{Ts} (atm-m^3/mol)	Henry's law constant at ave. groundwater temperature H'_{Ts} (unitless)	Vapor viscosity at ave. soil temperature, μ_{Ts} (g/cm-s)	Vadose zone effective diffusion coefficient, D^{eff}_v (cm^2/s)	Capillary zone effective diffusion coefficient, D^{eff}_{cz} (cm^2/s)	Total overall effective diffusion coefficient, D^{eff} (cm^2/s)
1.69E+04	1.00E+06	4.00E-04	15	8,493	8.05E-03	3.35E-01	1.78E-04	3.20E-03	1.38E-03	3.06E-03

Diffusion path length, L_d (cm)	Convection path length, L_p (cm)	Source vapor conc., C_{source} ($\mu g/m^3$)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, exp(Pe') (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
534	15	1.47E+04	0.10	8.33E+01	3.20E-03	4.00E+02	4.18E+292	3.17E-04	4.67E+00	2.0E-06	6.0E-01

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (µg/L)	Indoor exposure groundwater conc., noncarcinogen (µg/L)	Risk-based indoor exposure groundwater conc., (µg/L)	Pure component water solubility, S (µg/L)	Final indoor exposure groundwater conc., (µg/L)
NA	NA	NA	1.47E+08	NA

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
9.8E-06	7.5E-03

MESSAGE SUMMARY BELOW:

END

DATA ENTRY SHEET

GW-SCREEN
Version 3.0; 04/03

Reset to Defaults

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION
(enter "X" in "YES" box and initial groundwater conc. below)

YES X

DTSC / HERD
Version 3.0-mod1; 07/03

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_w (µg/L)	Chemical
79016	4.40E+01	Trichloroethylene

MORE

ENTER Depth below grade to bottom of enclosed space floor, L_s (cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER SCS soil type directly above water table	ENTER Average soil/ groundwater temperature, T_S (°C)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
15	548	S	20	5

MORE

ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	CR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm^2)	ENTER Vadose zone SCS soil type (Lookup Soil Parameters)	ENTER Vadose zone soil dry bulk density, ρb^v (g/cm^3)	ENTER Vadose zone soil total porosity, n^v (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^v (cm^3/cm^3)
S			LS	1.48	0.43	0.2

MORE

ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)	ENTER Averaging time for carcinogens, AT_c (yrs)	ENTER Averaging time for noncarcinogens, AT_{nc} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)
1.0E-06	1	70	80	25	250

Used to calculate risk-based groundwater concentration.

INTERMEDIATE CALCULATIONS SHEET

Source-building separation, L_T (cm)	Vadose zone soil air-filled porosity θ_a^V (cm^3/cm^3)	Vadose zone effective total fluid saturation, S_{te} (cm^3/cm^3)	Vadose zone soil intrinsic permeability, k_i (cm^2)	Vadose zone soil relative air permeability, k_{rg} (cm^2)	Vadose zone soil effective vapor permeability, k_v (cm^2)	Thickness of capillary zone, L_{cz} (cm)	Total porosity in capillary zone, n_{cz} (cm^3/cm^3)	Air-filled porosity in capillary zone, $\theta_{a,cz}$ (cm^3/cm^3)	Water-filled porosity in capillary zone, $\theta_{w,cz}$ (cm^3/cm^3)	Floor-wall seam perimeter, X_{crack} (cm)
534	0.230	0.390	1.01E-07	0.524	5.29E-08	17.05	0.43	0.177	0.253	4,000

Bldg. ventilation rate, $Q_{building}$ (cm^3/s)	Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. groundwater temperature, H_{TS} (atm-m^3/mol)	Henry's law constant at ave. groundwater temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Vadose zone effective diffusion coefficient, D^{eff}_v (cm^2/s)	Capillary zone effective diffusion coefficient, D^{eff}_{cz} (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)
1.69E+04	1.30E+06	4.00E-04	15	8,433	8.06E-03	3.35E-01	1.78E-04	3.20E-03	1.39E-03	3.06E-03

Diffusion path length, L_d (cm)	Convection path length, L_p (cm)	Source vapor conc., C_{source} ($\mu g/m^3$)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, exp(Pe^f) (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Unit risk factor, URF ($\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
534	15	1.47E+04	0.10	8.33E+01	3.20E-03	4.00E+02	4.18E+282	3.17E-04	4.67E+00	2.0E-06	6.0E-01

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (µg/L)	Indoor exposure groundwater conc., noncarcinogen (µg/L)	Risk-based indoor exposure groundwater conc., (µg/L)	Pure component water solubility, S (µg/L)	Final indoor exposure groundwater conc., (µg/L)
NA	NA	NA	1.47E+06	NA

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
2.3E-06	4.4E-03

MESSAGE SUMMARY BELOW:

END

GW-SCREEN
Version 3.0; 04/08

Reset to Defaults

CALCULATE RISK BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" in "YES" box and initial groundwater conc. below)

YES X

DTSC / HERD
Version 3.0-mod1; 07/09

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_w (µg/L)	Chemical
79016	4.23E+01	Trichloroethylene

MORE

ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to water table, L_{wT} (cm)	ENTER SCS soil type directly above water table	ENTER Average soil/ groundwater temperature, T_S (°C)	ENTER Average vapor flow rate into bldg (Leave blank to calculate) Q_{soil} (L/m)
15	690	CL	20	5

MORE

ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm²)	ENTER Vadose zone SCS soil type (Look Up Soil Parameters)	ENTER Vadose zone soil dry bulk density, ρ_b^d (g/cm³)	ENTER Vadose zone soil total porosity, n^v (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^v (cm³/cm³)
LS			LS	1.45	0.48	0.2

MORE

ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)
1.0E-05	1	70	30	30	350

Used to calculate risk-based groundwater concentration.

END

INTERMEDIATE CALCULATIONS SHEET

Source-building separation, L_T (cm)	Vadose zone soil air-filled porosity, θ_a^v (cm^3/cm^3)	Vadose zone effective total fluid saturation, S_{te} (cm^3/cm^3)	Vadose zone soil intrinsic permeability, k_i (cm^2)	Vadose zone soil relative air permeability, k_{rg} (cm^2)	Vadose zone soil effective vapor permeability, k_v (cm^2)	Thickness of capillary zone, L_{cz} (cm)	Total porosity in capillary zone, n_{cz} (cm^3/cm^3)	Air-filled porosity in capillary zone, $\theta_{a,cz}$ (cm^3/cm^3)	Water-filled porosity in capillary zone, $\theta_{w,cz}$ (cm^3/cm^3)	Floor-wall seam perimeter, X_{crack} (cm)
515	0.230	0.398	1.35E-08	0.700	1.16E-08	163.04	0.43	0.048	0.382	4,000

Bldg. ventilation rate, $Q_{building}$ (cm^3/s)	Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. groundwater temperature, H_{TS} (atm-m^3/mol)	Henry's law constant at ave. groundwater temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Vadose zone effective diffusion coefficient, D^{eff}_v (cm^2/s)	Capillary zone effective diffusion coefficient, D^{eff}_{cz} (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)
1.69E+04	1.00E+06	4.00E-04	15	8,433	8.06E-03	3.35E-01	1.78E-04	3.20E-03	2.37E-05	7.36E-05

Diffusion path length, L_d (cm)	Convection path length, L_p (cm)	Source vapor conc., C_{source} ($\mu g/m^3$)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, exp(Pe') (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
515	15	1.41E+04	0.10	8.33E+01	3.20E-03	4.00E+02	4.18E+282	8.42E-06	1.18E-01	2.0E-06	6.0E-01

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (µg/L)	Indoor exposure groundwater conc., noncarcinogen (µg/L)	Risk-based indoor exposure groundwater conc., (µg/L)	Pure component water solubility, S (µg/L)	Final indoor exposure groundwater conc., (µg/L)
NA	NA	NA	1.47E+06	NA

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
9.7E-08	1.9E-04

MESSAGE SUMMARY BELOW:

END

GW-SCREEN
Version 3.0; 04/08

Reset to Defaults

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" in "YES" box and initial groundwater conc. below)

YES: X

DTSC / HERD
Version 3.0-mod1; 07/08

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_{w} (µg/L)	Chemical
79016	4.20E+01	Trichloroethylene

MORE

ENTER Depth below grade to bottom of enclosed space floor, L_f (cm)	ENTER Depth below grade to water table, L_{wt} (cm)	ENTER SCS soil type directly above water table	ENTER Average soil/ groundwater temperature, T_S (°C)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
15	500	SI	20	5

MORE

ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm²)	ENTER Vadose zone SCS soil type	ENTER Vadose zone soil dry bulk density, ρ_b^V (g/cm³)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm³/cm³)
LS			LS (Loamy Soil Parameters)	1.45	0.43	0.2

MORE

ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)	ENTER Averaging time for carcinogens, AT_c (yrs)	ENTER Averaging time for noncarcinogens, AT_{nc} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency EF (days/yr)
1.0E-06	1	70	30	25	250

Used to calculate risk-based groundwater concentration.

END

INTERMEDIATE CALCULATIONS SHEET

Source-building separation, L_T (cm)	Vadose zone soil air-filled porosity, θ_a^V (cm^3/cm^3)	Vadose zone effective total fluid saturation, S_{te} (cm^3/cm^3)	Vadose zone soil intrinsic permeability, k_i (cm^2)	Vadose zone soil relative air permeability, k_{rg} (cm^2)	Vadose zone soil effective vapor permeability, k_v (cm^2)	Thickness of capillary zone, L_{cz} (cm)	Total porosity in capillary zone, n_{cz} (cm^3/cm^3)	Air-filled porosity in capillary zone, $\theta_{a,cz}$ (cm^3/cm^3)	Water-filled porosity in capillary zone, $\theta_{w,cz}$ (cm^3/cm^3)	Floor-wall seam perimeter, X_{crack} (cm)
515	0.290	0.396	1.65E-08	0.700	1.16E-08	163.04	0.43	0.048	0.382	4,000

Bldg. ventilation rate, $Q_{building}$ (cm^3/s)	Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,Ts}$ (cal/mol)	Henry's law constant at ave. groundwater temperature, H_{Ts} (atm-m^3/mol)	Henry's law constant at ave. groundwater temperature, H'_{Ts} (unitless)	Vapor viscosity at ave. soil temperature, μ_{Ts} (g/cm-s)	Vadose zone effective diffusion coefficient, D^{eff}_v (cm^2/s)	Capillary zone effective diffusion coefficient, D^{eff}_{cz} (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)
1.69E+04	1.00E+06	4.00E-04	15	8,439	8.06E-03	3.35E-01	1.78E-04	3.20E-03	2.37E-05	7.36E-05

Diffusion path length, L_d (cm)	Convection path length, L_p (cm)	Source vapor conc., C_{source} ($\mu g/m^3$)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, exp(Pe) (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Unit risk factor, URF $(ug/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
515	15	1.41E+04	0.10	8.33E+01	3.20E-09	4.00E+02	4.18E+282	8.42E-06	1.18E-01	2.0E-06	6.0E-01

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (µg/L)	Indoor exposure groundwater conc., noncarcinogen (µg/L)	Risk-based indoor exposure groundwater conc., (µg/L)	Pure component water solubility, S (µg/L)	Final indoor exposure groundwater conc., (µg/L)
NA	NA	NA	1.47E+06	NA

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
5.8E-08	1.1E-04

MESSAGE SUMMARY BELOW:

END

GW-SCREEN
Version 3.0: 04/03

Reset to Defaults

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" in "YES" box and initial groundwater conc. below)

YES: X

DTSC / HERD
Version 3.0-mod1: 07/03

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_w (µg/L)	Chemical
79016	1.E+01	Trichloroethylene

MORE

ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER SCS soil type directly above water table	ENTER Average soil/ groundwater temperature, T_S (°C)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
15	634	C	20	5

MORE

ENTER Vadose zone SCS soil type used to estimate soil vapor permeability	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm^2)	ENTER Vadose zone SCS soil type (Lookup Soil Parameters)	ENTER Vadose zone soil dry bulk density, ρ_b^d (g/cm^3)	ENTER Vadose zone soil total porosity, n^v (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^v (cm^3/cm^3)
LS			LS	1.45	0.43	0.2

MORE

ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)
1.0E-06	1	70	30	30	350

Used to calculate risk-based groundwater concentration.

END

INTERMEDIATE CALCULATIONS SHEET

Source-building separation, L_T (cm)	Vadose zone soil air-filled porosity, θ_a^V (cm^3/cm^3)	Vadose zone effective total fluid saturation, S_{te} (cm^3/cm^3)	Vadose zone soil intrinsic permeability, k_i (cm^2)	Vadose zone soil relative air permeability, k_{rg} (cm^2)	Vadose zone soil effective vapor permeability, k_v (cm^2)	Thickness of capillary zone, L_{cz} (cm)	Total porosity in capillary zone, n_{cz} (cm^3/cm^3)	Air-filled porosity in capilary zone, $\theta_{A,cz}$ (cm^3/cm^3)	Water-filled porosity in capillary zone, $\theta_{W,cz}$ (cm^3/cm^3)	Floor-wall seam perimeter, X_{crack} (cm)
819	0.280	0.396	1.65E-08	0.700	1.16E-08	81.52	0.43	0.018	0.412	4,000

Bldg. ventilation rate, $Q_{building}$ (cm^3/s)	Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. groundwater temperature, H_{TS} (atm-m^3/mol)	Henry's law constant at ave. groundwater temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Vadose zone effective diffusion coefficient, D^{eff}_v (cm^2/s)	Capillary zone effective diffusion coefficient, D^{eff}_{cz} (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)
1.69E+04	1.50E+06	4.00E-04	15	8,433	8.06E-03	3.35E-01	1.79E-04	3.20E-03	8.34E-06	8.18E-05

Diffusion path length, L_d (cm)	Convection path length, L_p (cm)	Source vapor conc., C_{source} ($\mu g/m^3$)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, exp(Pe^f) (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Unit risk factor, URF ($\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
819	15	5.36E+03	0.10	8.33E+01	3.20E-03	4.00E-02	4.18E+282	5.89E-06	3.16E-02	2.0E-06	6.0E-01

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (µg/L)	Indoor exposure groundwater conc., noncarcinogen (µg/L)	Risk-based indoor exposure groundwater conc., (µg/L)	Pure component water solubility, S (µg/L)	Final indoor exposure groundwater conc., (µg/L)
NA	NA	NA	1.47E+06	NA

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
2.6E-08	5.0E-05

MESSAGE SUMMARY BELOW:

END

GW-SCREEN
Version 3.0; 04/03

Reset to Defaults

CALCULATE RISK BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION
(enter "X" in "YES" box and initial groundwater conc. below)

YES X

OTSC / HERO
Version 3.0-mod1; 07/03

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W (µg/L)	Chemical
79016	1.60E+01	Trichloroethylene

MORE

ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER SCS soil type directly above water table	ENTER Average soil/ groundwater temperature, T_S (°C)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
15	334	C	20	5

MORE

ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm^2)	ENTER Vadose zone SCS soil type (used to estimate Pate value)	ENTER Vadose zone soil dry bulk density, ρ_b^d (g/cm^3)	ENTER Vadose zone soil total porosity, n^T (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^T (cm^3/cm^3)
LS			LS	1.66	0.33	0.2

MORE

ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)
1.0E-05	1	70	30	25	250

Used to calculate risk-based groundwater concentration.

END

INTERMEDIATE CALCULATIONS SHEET

Source-building separation, L_T (cm)	Vadose zone soil air-filled porosity, θ_a^V (cm^3/cm^3)	Vadose zone effective total fluid saturation, S_{te} (cm^3/cm^3)	Vadose zone soil intrinsic permeability, k_i (cm^2)	Vadose zone soil relative air permeability, k_{rg} (cm^2)	Vadose zone soil effective vapor permeability, k_v (cm^2)	Thickness of capillary zone, L_{cz} (cm)	Total porosity in capillary zone, n_{cz} (cm^3/cm^3)	Air-filled porosity in capillary zone, $\theta_{a,cz}$ (cm^3/cm^3)	Water-filled porosity in capillary zone, $\theta_{w,cz}$ (cm^3/cm^3)	Floor-wall seam perimeter, X_{crack} (cm)
819	0.230	0.398	1.65E-08	0.700	1.16E-08	81.52	0.43	0.018	0.412	4,000

Bldg. ventilation rate, $Q_{building}$ (cm^3/s)	Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,Ts}$ (cal/mol)	Henry's law constant at ave. groundwater temperature, H_{Ts} (atm-m^3/mol)	Henry's law constant at ave. groundwater temperature, H'_{Ts} (unitless)	Vapor viscosity at ave. soil temperature, μ_{Ts} (g/cm-s)	Vadose zone effective diffusion coefficient, D^{eff}_v (cm^2/s)	Capillary zone effective diffusion coefficient, D^{eff}_{cz} (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)
1.69E+04	1.00E+06	4.00E-04	15	8,433	8.06E-03	3.35E-01	1.78E-04	3.20E-03	8.34E-06	8.18E-05

Diffusion path length, L_d (cm)	Convection path length, L_p (cm)	Source vapor conc., C_{source} ($\mu g/m^3$)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, exp(Pe^f) (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
819	15	5.36E+03	0.10	8.33E+01	3.20E-03	4.00E+02	4.18E+282	5.89E-06	3.16E-02	2.0E-06	6.0E-01

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (µg/L)	Indoor exposure groundwater conc., noncarcinogen (µg/L)	Risk-based indoor exposure groundwater conc., (µg/L)	Pure component water solubility, S (µg/L)	Final Indoor exposure groundwater conc., (µg/L)
NA	NA	NA	1.47E+06	NA

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
1.5E-08	3.0E-05

MESSAGE SUMMARY BELOW:

END

GW-SCREEN
Version 3.0; 04/03

Reset to Defaults

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" in "YES" box and initial groundwater conc. below)

YES: X

DTSC / HERD
Version 3.0-mod1; 05/03

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_{gi} (µg/L)	Chemical
79016	5.00E+00	Trichloroethylene

MORE

ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER SCS soil type directly above water table	ENTER Average soil/ groundwater temperature, T_S (°C)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
15	777	C	20	5

MORE

ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm²)	ENTER Vadose zone SCS soil type	ENTER Vadose zone soil dry bulk density, ρ_b^V (g/cm³)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm³/cm³)
LS			LS	1.45	0.43	0.2

MORE

ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)
1.0E-06	1	70	30	30	350

Used to calculate risk based groundwater concentration.

END

INTERMEDIATE CALCULATIONS SHEET

Source-building separation, L_s (cm)	Vadose zone soil air-filled porosity, θ_a^V (cm^3/cm^3)	Vadose zone effective total fluid saturation, S_{te} (cm^3/cm^3)	Vadose zone soil intrinsic permeability, k_i (cm^2)	Vadose zone soil relative air permeability, k_{rg} (cm^2)	Vadose zone soil effective vapor permeability, k_v (cm^2)	Thickness of capillary zone, L_{cz} (cm)	Total porosity in capillary zone, n_{cz} (cm^3/cm^3)	Air-filled porosity in capillary zone, $\theta_{a,cz}$ (cm^3/cm^3)	Water-filled porosity in capillary zone, $\theta_{w,cz}$ (cm^3/cm^3)	Floor-wall seam perimeter, X_{crack} (cm)
762	0.230	0.398	1.65E-08	0.700	1.16E-08	81.52	0.43	0.018	0.412	4,000

Bldg. ventilation rate, $Q_{building}$ (cm^3/s)	Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. groundwater temperature, H_{TS} (atm-m^3/mol)	Henry's law constant at ave. groundwater temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Vadose zone effective diffusion coefficient, D^{eff}_v (cm^2/s)	Capillary zone effective diffusion coefficient D^{eff}_{cz} (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)
1.89E+04	1.00E+06	4.00E-04	15	8,493	9.06E-03	3.35E-01	1.78E-04	3.20E-03	8.34E-06	7.63E-05

Diffusion path length, L_d (cm)	Convection path length, L_p (cm)	Source vapor conc., C_{source} ($\mu g/m^3$)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, $exp(Pe^f)$ (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
762	15	1.68E+03	0.10	5.33E+01	3.20E-03	4.00E+02	4.19E+282	5.90E-06	9.88E-03	2.0E-06	6.0E-01

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (µg/L)	Indoor exposure groundwater conc., noncarcinogen (µg/L)	Risk-based Indoor exposure groundwater conc., (µg/L)	Pure component water solubility, S (µg/L)	Final indoor exposure groundwater conc., (µg/L)
NA	NA	NA	1.47E+06	NA

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
8.1E-09	1.6E-05

MESSAGE SUMMARY BELOW:

END

GW-SCREEN
Version 3.0: 04/03

Reset to Defaults

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter 'X' in 'YES' box)

YES

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION
(enter 'X' in 'YES' box and initial groundwater conc. below)

YES X

DTSC / HERD
Version 3.0-mod1; 07/03

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_w (µg/L)	Chemical
79016	5.00E+00	Trichloroethylene

MORE

ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER SCS soil type directly above water table	ENTER Average soil/groundwater temperature, T_S (°C)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
15	777	C	20	5

MORE

ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm²)	ENTER Vadose zone SCS soil type (Lookup Soil Parameters)	ENTER Vadose zone soil dry bulk density, ρ_b^V (g/cm³)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm³/cm³)
LS			L3	1.45	0.43	0.2

MORE

ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)
1.0E-06	1	70	30	25	350

Used to calculate risk based groundwater concentration.

END

INTERMEDIATE CALCULATIONS SHEET

Source-building separation, L_T (cm)	Vadose zone soil air-filled porosity, θ_a^v (cm^3/cm^3)	Vadose zone effective total fluid saturation, S_{te} (cm^3/cm^3)	Vadose zone soil intrinsic permeability, k_i (cm^2)	Vadose zone soil relative air permeability, k_{rg} (cm^2)	Vadose zone soil effective vapor permeability, k_v (cm^2)	Thickness of capillary zone, L_{cz} (cm)	Total porosity in capillary zone, n_{cz} (cm^3/cm^3)	Air-filled porosity in capillary zone, $\theta_{a,cz}$ (cm^3/cm^3)	Water-filled porosity in capillary zone, $\theta_{w,cz}$ (cm^3/cm^3)	Floor-wall seam perimeter, X_{crack} (cm)
762	0.230	0.896	1.65E-09	0.700	1.16E-08	81.52	0.43	0.018	0.412	4,000

Bldg. ventilation rate, $Q_{building}$ (cm^3/s)	Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. groundwater temperature, H_{TS} (atm-m^3/mol)	Henry's law constant at ave. groundwater temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Vadose zone effective diffusion coefficient, D^{eff}_v (cm^2/s)	Capillary zone effective diffusion coefficient, D^{eff}_{cz} (cm^2/s)	Total overall effective diffusion coefficient D^{eff}_T (cm^2/s)
1.69E+04	1.00E+06	4.00E-04	15	8,433	8.06E-03	3.35E-01	1.78E-04	3.20E-03	8.34E-06	7.83E-05

Diffusion path length, L_d (cm)	Convection path length, L_p (cm)	Source vapor conc., C_{source} ($\mu g/m^3$)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, exp(Pe^f) (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Unit risk factor, URF ($\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
762	15	1.68E+03	0.10	8.33E+01	3.20E-09	4.00E+02	4.18E+282	5.90E-06	9.88E-03	2.0E-06	6.0E-01

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (µg/L)	Indoor exposure groundwater conc., noncarcinogen (µg/L)	Risk-based indoor exposure groundwater conc., (µg/L)	Pure component water solubility, S (µg/L)	Final indoor exposure groundwater conc., (µg/L)
NA	NA	NA	1.47E+06	NA

MESSAGE SUMMARY BELOW:

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
4.8E-09	9.4E-06

END

GW-SCREEN
Version 3.0; 04/03

Reset to Defaults

CALCULATE RISK BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

DTSC / HERD
Version 3.0-mod1; 07/03

YES [ ]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION
(enter "X" in "YES" box and initial groundwater conc. below)

YES [X]

ENTER Chemical CAS No (numbers only no dashes)	ENTER Initial groundwater conc., C_W (µg/L)	Chemical
127184	1.40E+00	**Tetrachloroethene**

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER SCS soil type directly above water table	ENTER Average soil/ groundwater temperature, T_S (°C)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
15	771	LS	20	5

MORE ↓

ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm²)	ENTER Vadose zone SCS soil type (Lookup Soil Parameters)	ENTER Vadose zone soil dry bulk density, ρ_b^V (g/cm³)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm³/cm³)
LS			LS	1.45	0.43	0.2

MORE ↓

ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)
1.0E-06	1	70	30	30	350

Used to calculate risk-based groundwater concentration.

END

INTERMEDIATE CALCULATIONS SHEET

Source-building separation, L_T (cm)	Vadose zone soil air-filled porosity, θ_a^v (cm^3/cm^3)	Vadose zone effective total fluid saturation, S_{te} (cm^3/cm^3)	Vadose zone soil intrinsic permeability, k_i (cm^2)	Vadose zone soil relative air permeability, k_{rg} (cm^2)	Vadose zone soil effective vapor permeability, k_v (cm^2)	Thickness of capillary zone, L_{cz} (cm)	Total porosity in capillary zone, n_{cz} (cm^3/cm^3)	Air-filled porosity in capillary zone, $\theta_{a,cz}$ (cm^3/cm^3)	Water-filled porosity in capillary zone, $\theta_{w,cz}$ (cm^3/cm^3)	Floor-wall seam perimeter, X_{crack} (cm)
756	0.230	0.396	1.65E-08	0.700	1.16E-08	18.75	0.43	0.127	0.303	4,000

Bldg. ventilation rate, $Q_{building}$ (cm^3/s)	Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. groundwater temperature, H_{TS} (atm-m^3/mol)	Henry's law constant at ave. groundwater temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Vadose zone effective diffusion coefficient, D^{eff}_v (cm^2/s)	Capillary zone effective diffusion coefficient, D^{eff}_{cz} (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)
1.69E+04	1.00E+06	4.00E-04	15	9,451	1.40E-02	5.81E-01	1.78E-04	2.92E-03	4.10E-04	2.58E-03

Diffusion path length, L_d (cm)	Convection path length, L_p (cm)	Source vapor conc., C_{source} ($\mu g/m^3$)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, exp(Pe^f) (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
756	15	8.14E+02	0.10	8.33E+01	2.92E-03	4.00E+02	#NUM!	1.90E-04	1.55E-01	5.9E-06	3.5E-02

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (µg/L)	Indoor exposure groundwater conc., noncarcinogen (µg/L)	Risk-based indoor exposure groundwater conc., (µg/L)	Pure component water solubility, S (µg/L)	Final indoor exposure groundwater conc., (µg/L)
NA	NA	NA	2.00E+05	NA

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
3.8E-07	4.2E-03

MESSAGE SUMMARY BELOW:

END

SW-SCREEN
Version 3.0; (04/03)

Reset to Defaults

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" in "YES" box and initial groundwater conc. below)

YES X

DTSC / HERD
Version 3.0-mod1; 07/08

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W (µg/L)	Chemical
127184	1.40E+00	**Tetrachloroethylene**

MORE

ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER SCS soil type directly above water table	ENTER Average soil/ groundwater temperature, T_S (°C)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
15	771	LS	20	5

MORE

ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm^2)	ENTER Vadose zone SCS soil type (Lookup Soil Parameters)	ENTER Vadose zone soil dry bulk density, ρ_b^V (g/cm^3)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm^3/cm^3)
LS			LS	1.45	0.43	0.2

MORE

ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)
1.0E-06	1	70	30	26	250

Used to calculate risk-based groundwater concentration.

END

INTERMEDIATE CALCULATIONS SHEET

Source-building separation, L_T (cm)	Vadose zone soil air-filled porosity, θ_a^v (cm^3/cm^3)	Vadose zone effective total fluid saturation, S_{te} (cm^3/cm^3)	Vadose zone soil intrinsic permeability, k_i (cm^2)	Vadose zone soil relative air permeability, k_{rg} (cm^2)	Vadose zone soil effective vapor permeability, k_v (cm^2)	Thickness of capillary zone, L_{cz} (cm)	Total porosity in capillary zone, n_{cz} (cm^3/cm^3)	Air-filled porosity in capillary zone, $\theta_{a,cz}$ (cm^3/cm^3)	Water-filled porosity in capillary zone, $\theta_{w,cz}$ (cm^3/cm^3)	Floor-wall seam perimeter, X_{crack} (cm)
756	0.230	0.396	1.65E-08	0.700	1.16E-08	18.75	0.43	0.127	0.303	4,000

Bldg. ventilation rate, $Q_{building}$ (cm^3/s)	Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. groundwater temperature, H_{TS} (atm-m^3/mol)	Henry's law constant at ave. groundwater temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Vadose zone effective diffusion coefficient, D^{eff}_v (cm^2/s)	Capillary zone effective diffusion coefficient, D^{eff}_{cz} (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)
1.69E+04	1.00E+06	4.00E-04	15	9,451	1.40E-02	5.81E-01	1.78E-04	2.92E-03	4.10E-04	2.59E-03

Diffusion path length, L_d (cm)	Convection path length, L_p (cm)	Source vapor conc., C_{source} ($\mu g/m^3$)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, exp(Pe^f) (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
756	15	8.14E+02	0.10	8.33E+01	2.92E-03	4.00E+02	#NUM!	1.90E-04	1.55E-01	5.9E-06	3.5E-02

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (µg/L)	Indoor exposure groundwater conc., noncarcinogen (µg/L)	Risk-based indoor exposure groundwater conc., (µg/L)	Pure component water solubility, S (µg/L)	Final indoor exposure groundwater conc., (µg/L)
NA	NA	NA	2.00E+05	NA

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
2.2E-07	2.5E-03

MESSAGE SUMMARY BELOW:

END

GW-SCREEN
Version 3.0; 04/08

Reset to Defaults

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION
(enter "X" in "YES" box and initial groundwater conc. below)

YES X

DTSC / HERD
Version 3.0+no(1); 07/08

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_w (ug/L)	Chemical
79016	1.00E+00	Trichloroethylene

MORE

ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER SCS soil type directly above water table	ENTER Average soil/ groundwater temperature, T_S (°C)	ENTER Average vapor flow rate into bldg (Leave blank to calculate) Q_{soil} (L/m)
15	694	0	20	5

MORE

ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm^2)	ENTER Vadose zone SCS soil type (Lookup Soil Parameters)	ENTER Vadose zone soil dry bulk density, ρ_b^V (g/cm^3)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm^3/cm^3)
SI			SI	1.45	0.48	0.2

MORE

ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)
1.0E-06	1	70	50	50	350

Used to calculate risk-based groundwater concentration.

END

INTERMEDIATE CALCULATIONS SHEET

Source-building separation, L_T (cm)	Vadose zone soil air-filled porosity, θ_a^V (cm^3/cm^3)	Vadose zone effective total fluid saturation, S_{te} (cm^3/cm^3)	Vadose zone soil intrinsic permeability, k_i (cm^2)	Vadose zone soil relative air permeability, k_{rg} (cm^2)	Vadose zone soil effective vapor permeability, k_v (cm^2)	Thickness of capillary zone, L_{cz} (cm)	Total porosity in capillary zone, n_{cz} (cm^3/cm^3)	Air-filled porosity in capillary zone, $\theta_{a,cz}$ (cm^3/cm^3)	Water-filled porosity in capillary zone, $\theta_{w,cz}$ (cm^3/cm^3)	Floor-wall seam perimeter, X_{crack} (cm)
619	0.230	0.395	6.86E-09	0.714	4.90E-09	81.52	0.43	0.018	0.412	4,000

Bldg. ventilation rate, $Q_{building}$ (cm^3/s)	Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. groundwater temperature, H_{TS} (atm-m^3/mol)	Henry's law constant at ave. groundwater temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Vadose zone effective diffusion coefficient, D^{eff}_v (cm^2/s)	Capillary zone effective diffusion coefficient, D^{eff}_{cz} (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)
1.69E+04	1.00E+06	4.00E-04	15	8,493	8.06E-03	3.35E-01	1.78E-04	3.20E-03	8.34E-06	6.22E-05

Diffusion path length, L_d (cm)	Convection path length, L_P (cm)	Source vapor conc., C_{source} ($\mu g/m^3$)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, exp(Pe^f) (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
619	15	6.37E+02	0.10	9.33E+01	3.20E-03	4.00E+02	4.18E+282	5.93E-06	3.77E-03	2.0E-06	6.0E-01

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (µg/L)	Indoor exposure groundwater conc., noncarcinogen (µg/L)	Risk-based indoor exposure groundwater conc., (µg/L)	Pure component water solubility, S (µg/L)	Final indoor exposure groundwater conc., (µg/L)
NA	NA	NA	1.47E+06	NA

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
3.1E-09	6.0E-06

MESSAGE SUMMARY BELOW:

END

GW-ADV
Version 3.0; 02/08

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

DTSC / HERD
Version 3.0-mod1; 07/08

YES

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" in "YES" box and initial groundwater conc. below)

YES X

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W (µg/L)	Chemical
79016	1.40E+01	Trichloroethylene

MORE

ENTER Average soil/ groundwater temperature, t_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to water table, L_W (cm)	ENTER Totals must add up to value of L_{WT} (cell G88) Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum directly above water table, (Enter A, B, or C)	ENTER SCS soil type directly above water table	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability k_v (cm²)
20	15	381	381	0	0	A	SI	SI		

MORE

ENTER Stratum A SCS soil type	ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm³)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm³/cm³)	ENTER Stratum B SCS soil type	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm³)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm³/cm³)	ENTER Stratum C SCS soil type	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm³)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm³/cm³)
S	1.46	0.439	0.2								

MORE

ENTER Enclosed space floor thickness, L_{slab} (cm)	ENTER Soil-bldg. pressure differential, ΔP (g/cm-s²)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)	ENTER Average vapor flow rate into bldg. OR Leave blank to calculate Q_{soil} (L/m)
15	40	1000	1000	366	0.1	0.25	5

MORE

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	30	30	350	1.0E-05	1

Used to calculate risk-based groundwater concentration.

END

INTERMEDIATE CALCULATIONS SHEET

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_a^C (cm^3/cm^3)	Stratum A effective total fluid saturation, S_{te} (cm^3/cm^3)	Stratum A soil intrinsic permeability, k_i (cm^2)	Stratum A soil relative air permeability, k_{ra} (cm^2)	Stratum A soil effective vapor permeability, k_v (cm^2)	Thickness of capillary zone, L_{cz} (cm)	Total porosity in capillary zone, n_{cz} (cm^3/cm^3)	Air-filled porosity in capillary zone, $\theta_{a,cz}$ (cm^3/cm^3)	Water-filled porosity in capillary zone, $\theta_{w,cz}$ (cm^3/cm^3)	Floor-wall seam perimeter, X_{crack} (cm)
9.46E+08	366	0.230	ERROR	ERROR	0.385	6.86E-09	0.714	4.90E-09	183.04	0.43	0.048	0.382	4,000

Bldg. ventilation rate, $Q_{building}$ (cm^3/s)	Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. groundwater temperature, H_{TS} (atm-m^3/mol)	Henry's law constant at ave. groundwater temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Stratum A effective diffusion coefficient, D^{eff}_A (cm^2/s)	Stratum B effective diffusion coefficient, D^{eff}_B (cm^2/s)	Stratum C effective diffusion coefficient, D^{eff}_C (cm^2/s)	Capillary zone effective diffusion coefficient, D^{eff}_{cz} (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)	Diffusion path length, L_d (cm)
2.54E+04	1.06E+06	3.77E-04	15	8,433	8.06E-03	3.35E-01	1.78E-04	3.20E-03	0.00E+00	0.00E+00	2.37E-05	5.27E-05	366

Convection path length, L_p (cm)	Source vapor conc., C_{source} (ug/m^3)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, exp(Pe') (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Unit risk factor, URF $(ug/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
15	4.69E+03	0.10	8.33E+01	3.20E-03	4.00E-02	4.18E+282	5.99E-06	2.81E-02	2.0E-06	6.0E-01

END

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (µg/L)	Indoor exposure groundwater conc., noncarcinogen (µg/L)	Risk-based indoor exposure groundwater conc., (µg/L)	Pure component water solubility, S (µg/L)	Final indoor exposure groundwater conc., (µg/L)
NA	NA	NA	1.47E+06	NA

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
2.3E-08	4.5E-05

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)

SCROLL DOWN TO "END"

END

GW-ADV
Version 3.0; 02/03

Reset to Defaults

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" in "YES" box and initial groundwater conc. below)

YES X

DTSC / HERD
Version 3.0-mod1; 07/08

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_w (µg/L)	Chemical
127184	1.13E+00	Tetrachloroethylene

MORE

ENTER Average soil/ groundwater temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER Totals must add up to value of L_{WT} (cell G29) Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum directly above water table, (Enter A, B, or C)	ENTER SCS soil type directly above water table	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm^2)
20	15	561	561	0	0	A	SI	SI		

MORE

ENTER Stratum A SCS soil type (Lookup Soil Parameters)	ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm^3/cm^3)	ENTER Stratum B SCS soil type (Lookup Soil Parameters)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm^3)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm^3/cm^3)	ENTER Stratum C SCS soil type (Lookup Soil Parameters)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm^3)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm^3/cm^3)
SI	1.45	0.453	0.2								

MORE

ENTER Enclosed space floor thickness, L_{slab} (cm)	ENTER Soil-bldg. pressure differential, ΔP ($g/cm-s^2$)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)	ENTER Average vapor flow rate into bldg. OR Leave blank to calculate Q_{soil} (L/m)
15	40	1000	1000	366	0.1	0.25	5

MORE

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	30	30	350	1.0E-06	1

Used to calculate risk-based groundwater concentration

END

INTERMEDIATE CALCULATIONS SHEET

Exposure duration, t (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_a^C (cm^3/cm^3)	Stratum A effective total fluid saturation, S_{te} (cm^3/cm^3)	Stratum A soil intrinsic permeability, k_i (cm^2)	Stratum A soil relative air permeability, k_{rg} (cm^2)	Stratum A soil effective vapor permeability, k_v (cm^2)	Thickness of capillary zone, L_{cz} (cm)	Total porosity in capillary zone, n_{cz} (cm^3/cm^3)	Air-filled porosity in capillary zone, $\theta_{a,cz}$ (cm^3/cm^3)	Water-filled porosity in capillary zone, $\theta_{w,cz}$ (cm^3/cm^3)	Floor-wall seam perimeter, X_{crack} (cm)
9.46E+08	366	0.230	ERROR	ERROR	0.396	5.86E-09	0.714	4.90E-09	163.04	0.43	0.048	0.382	4.000

Bldg. ventilation rate, $Q_{building}$ (cm^3/s)	Area of enclosed space below grade A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. groundwater temperature, H_{TS} (atm-m^3/mol)	Henry's law constant at ave. groundwater temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Stratum A effective diffusion coefficient, D^{eff}_A (cm^2/s)	Stratum B effective diffusion coefficient, D^{eff}_B (cm^2/s)	Stratum C effective diffusion coefficient, D^{eff}_C (cm^2/s)	Capillary zone effective diffusion coefficient, D^{eff}_{cz} (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)	Diffusion path length, L_d (cm)
1.86E+04	1.06E+06	3.77E-04	15	9,451	1.40E-02	5.81E-01	1.78E-04	2.92E-03	0.00E+00	0.00E+00	1.92E-05	4.26E-05	366

Convection path length, L_p (cm)	Source vapor conc., C_{source} ($\mu g/m^3$)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, exp(Pe') (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
15	6.39E+02	0.10	8.33E+01	2.92E-03	4.00E+02	#NUM!	6.71E-06	4.29E-03	5.9E-06	3.5E-02

END

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (µg/L)	Indoor exposure groundwater conc., noncarcinogen (µg/L)	Risk-based indoor exposure groundwater conc., (µg/L)	Pure component water solubility, S (µg/L)	Final indoor exposure groundwater conc., (µg/L)
NA	NA	NA	2.00E+05	NA

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
1.0E-08	1.2E-04

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)

SCROLL DOWN TO "END"

END

GW-ADV
Version 3.0; 02/03

Reset to Defaults

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter 'X' in "YES" box)

DTSC / HERD
Version 2.0-mod1; 07/03

YES

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter 'X' in "YES" box and initial groundwater conc. below)

YES X

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_w (µg/L)	Chemical
79016	1.40E+07	Trichloroethylene

MORE ↓

ENTER Average soil/ groundwater temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_B (cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER Totals must add up to value of L_{WT} (cell G28): Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum directly above water table, (Enter A, B or C)	ENTER SCS soil type directly above water table	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm^2)
20	15	391	391	0	0	A	SI	SI		

MORE ↓

ENTER Stratum A SCS soil type (Lookup Soil Parameters)	ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm^3/cm^3)	ENTER Stratum B SCS soil type (Lookup Soil Parameters)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm^3)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm^3/cm^3)	ENTER Stratum C SCS soil type (Lookup Soil Parameters)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm^3)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm^3/cm^3)
SI	1.45	0.453	0.2								

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP (g/cm-s^2)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Foundation/wall crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)	ENTER Average vapor flow rate into bldg. OR Leave blank to calculate Q_{soil} (L/m)
15	40	34136	21984	762	0.1	0.25	6

MORE ↓

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	30	25	350	1.0E-06	1

Used to calculate risk-based groundwater concentration.

END

INTERMEDIATE CALCULATIONS SHEET

Exposure duration, t (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_a^C (cm^3/cm^3)	Stratum A effective total fluid saturation, S_{te} (cm^3/cm^3)	Stratum A soil intrinsic permeability, k_i (cm^2)	Stratum A soil relative air permeability, k_{rg} (cm^2)	Stratum A soil effective vapor permeability, k_v (cm^2)	Thickness of capillary zone, L_{cz} (cm)	Total porosity in capillary zone, n_{cz} (cm^3/cm^3)	Air-filled porosity in capillary zone, $\theta_{a,cz}$ (cm^3/cm^3)	Water-filled porosity in capillary zone, $\theta_{w,cz}$ (cm^3/cm^3)	Floor-wall seam perimeter, X_{crack} (cm)
7.88E+08	366	0.230	ERROR	ERROR	0.395	6.88E-09	0.714	4.90E-09	183.04	0.43	0.048	0.382	117.044

Bldg. ventilation rate, $Q_{building}$ (cm^3/s)	Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,ts}$ (cal/mol)	Henry's law constant at ave. groundwater temperature, H_{ts} (atm-m^3/mol)	Henry's law constant at ave. groundwater temperature, H'_{ts} (unitless)	Vapor viscosity at ave. soil temperature, μ_{ts} (g/cm-s)	Stratum A effective diffusion coefficient, D^{eff}_A (cm^2/s)	Stratum B effective diffusion coefficient, D^{eff}_B (cm^2/s)	Stratum C effective diffusion coefficient, D^{eff}_C (cm^2/s)	Capillary zone effective diffusion coefficient, D^{eff}_{cz} (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)	Diffusion path length, L_d (cm)
4.40E+07	8.34E+06	1.40E-05	15	8,433	9.06E-03	3.35E-01	1.78E-04	9.20E-03	0.00E+00	0.00E+00	2.37E-05	5.27E-05	366

Convection path length, L_p (cm)	Source vapor conc., C_{source} ($\mu g/m^3$)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, exp(Pe^f) (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
15	1.69E+03	0.10	8.38E+01	3.20E-03	1.17E+04	4.56E+09	1.12E-06	5.24E-03	2.0E-06	6.0E-01

END

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (µg/L)	Indoor exposure groundwater conc., noncarcinogen (µg/L)	Risk-based indoor exposure groundwater conc., (µg/L)	Pure component water solubility, S (µg/L)	Final indoor exposure groundwater conc., (µg/L)
NA	NA	NA	1.47E+06	NA

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
2.6E-09	5.0E-06

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)

SCROLL DOWN TO "END"

END

GW-ADV
Version 3.0; 02/03

Reset to Defaults

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" in "YES" box and initial groundwater conc. below)

YES X

DTSC / HERD
Version 3.0-mod1; 07/03

MORE

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W (µg/L)	Chemical
127184	1.10E+00	Tetrachloroethylene

MORE

ENTER Average soil/groundwater temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER Totals must add up to value of L_{WT} (cell G28) Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, h_B (Enter value or 0) (cm)	ENTER Thickness of soil stratum C, h_C (Enter value or 0) (cm)	ENTER Soil stratum directly above water table, (Enter A, B, or C)	ENTER SCS soil type directly above water table	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm^2)
20	15	331	561	0	0	A	SI	SI		

MORE

ENTER Stratum A SCS soil type (Lookup Soil Parameters)	ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm^3/cm^3)	ENTER Stratum B SCS soil type (Lookup Soil Parameters)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm^3)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm^3/cm^3)	ENTER Stratum C SCS soil type (Lookup Soil Parameters)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm^3)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm^3/cm^3)
SI	1.45	0.430	0.2								

MORE

ENTER Enclosed space floor thickness, L_{slab} (cm)	ENTER Soil-bldg. pressure differential, ΔP ($g/cm-s^2$)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)	ENTER Average vapor flow rate into bldg. OR Leave blank to calculate Q_{soil} (L/m)
15	40	84138	24344	762	0.1	0.25	E

MORE

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	30	25	250	1.0E-06	1

Used to calculate risk-based groundwater concentration.

END

INTERMEDIATE CALCULATIONS SHEET

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_a^n (cm^3/cm^3)	Stratum A effective total fluid saturation, S_e (cm^3/cm^3)	Stratum A soil intrinsic permeability, k_i (cm^2)	Stratum A soil relative air permeability, k_{rg} (cm^2)	Stratum A soil effective vapor permeability, k_v (cm^2)	Thickness of capillary zone, L_{cz} (cm)	Total porosity in capillary zone, n_{cz} (cm^3/cm^3)	Air-filled porosity in capillary zone, $\theta_{a,cz}$ (cm^3/cm^3)	Water-filled porosity in capillary zone, $\theta_{w,cz}$ (cm^3/cm^3)	Floor-wall seam perimeter, X_{crack} (cm)
7.88E+08	356	0.230	ERROR	ERROR	0.395	6.86E-09	0.714	4.90E-09	163.04	0.43	0.048	0.382	117,044

Bldg. ventilation rate, $Q_{building}$ (cm^3/s)	Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. groundwater temperature, H_{TS} (atm-m^3/mol)	Henry's law constant at ave. groundwater temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Stratum A effective diffusion coefficient, D^{eff}_A (cm^2/s)	Stratum B effective diffusion coefficient, D^{eff}_B (cm^2/s)	Stratum C effective diffusion coefficient, D^{eff}_C (cm^2/s)	Capillary zone effective diffusion coefficient, D^{eff}_{cz} (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)	Diffusion path length, L_d (cm)
4.40E+07	8.34E+08	1.40E-06	15	9,451	1.43E-02	5.81E-01	1.78E-04	2.92E-03	0.00E+00	0.00E+00	1.92E-05	4.20E-05	366

Convection path length, L_p (cm)	Source vapor conc., C_{source} ($\mu g/m^3$)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, exp(Pe^f) (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
15	8.39E+02	0.10	8.33E+01	2.92E-03	1.17E+04	3.97E+10	1.02E-06	8.53E-04	5.9E-06	3.5E-02

END

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (µg/L)	Indoor exposure groundwater conc., noncarcinogen (µg/L)	Risk-based indoor exposure groundwater conc., (µg/L)	Pure component water solubility, S (µg/L)	Final indoor exposure groundwater conc., (µg/L)
NA	NA	NA	2.00E+05	NA

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
9.4E-10	1.1E-06

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)

SCROLL DOWN TO "END"

END

DATA ENTRY SHEET

GW-ADV
Version 3.0; 02/03

Reset to Defaults

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

DTSC / HERD
Version 3.0-mod1; 07/03

YES

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" in "YES" box and initial groundwater conc. below)

YES X

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_w (µg/L)	Chemical
79016	4.40E+01	Trichloroethylene

MORE ↓

ENTER Average soil/ groundwater temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER Totals must add up to value of L_{WT} (cell G28): Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum directly above water table, (Enter A, B, or C)	ENTER SCS soil type directly above water table	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm^2)
20	15	549	350	199	0	B	S	LS		

MORE ↓

ENTER Stratum A SCS soil type (Lookup Soil Parameters)	ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm³)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm^3/cm^3)	ENTER Stratum B SCS soil type (Lookup Soil Parameters)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm³)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm^3/cm^3)	ENTER Stratum C SCS soil type (Lookup Soil Parameters)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm³)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm^3/cm^3)
LS	1.45	0.430	0.2	S	1.45	0.43	0.2				0.064

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP (g/cm-s²)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)	ENTER Average vapor flow rate into bldg. OR Leave blank to calculate Q_{soil} (L/m)
10	40	1000	1000	250	0.1	0.25	5

MORE ↓

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	30	30	350	1.0E-05	1

Used to calculate risk-based groundwater concentration

END

INTERMEDIATE CALCULATIONS SHEET

Exposure duration, t (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_a^C (cm^3/cm^3)	Stratum A effective total fluid saturation S_{te} (cm^3/cm^3)	Stratum A soil intrinsic permeability, k_i (cm^2)	Stratum A soil relative air permeability, k_{rg} (cm^2)	Stratum A soil effective vapor permeability, k_v (cm^2)	Thickness of capillary zone, L_{cz} (cm)	Total porosity in capillary zone, n_{cz} (cm^3/cm^3)	Air-filled porosity in capillary zone, $\theta_{a,cz}$ (cm^3/cm^3)	Water-filled porosity in capillary zone, $\theta_{w,cz}$ (cm^3/cm^3)	Floor-wall seam perimeter, X_{crack} (cm)
9.46E+08	534	0.230	0.230	ERROR	0.396	1.66E-08	0.700	1.16E-08	7.05	0.48	0.177	0.253	4,000

Bldg. ventilation rate, $Q_{building}$ (cm^3/s)	Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. groundwater temperature, H_{TS} (atm-m^3/mol)	Henry's law constant at ave. groundwater temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Stratum A effective diffusion coefficient, D^{eff}_A (cm^2/s)	Stratum B effective diffusion coefficient, D^{eff}_B (cm^2/s)	Stratum C effective diffusion coefficient, D^{eff}_C (cm^2/s)	Capillary zone effective diffusion coefficient, D^{eff}_{cz} (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)	Diffusion path length, L_d (cm)
1.86E+04	1.06E+06	8.77E-04	15	9,433	8.06E-03	3.35E-01	1.79E-04	3.20E-03	3.20E-03	0.00E+00	1.33E-03	3.08E-03	534

Convection path length, L_p (cm)	Source vapor conc., C_{source} ($\mu g/m^3$)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, exp(Pe), (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Unit risk factor, URF ($\mu g/m^3$)$^{-1}$	Reference conc., RfC (mg/m^3)
15	1.47E+04	0.10	8.33E+01	3.20E-03	4.00E+02	4.18E+282	3.07E-04	4.52E+00	2.0E-06	6.0E-01

END

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (µg/L)	Indoor exposure groundwater conc., noncarcinogen (µg/L)	Risk-based indoor exposure groundwater conc., (µg/L)	Pure component water solubility, S (µg/L)	Final indoor exposure groundwater conc., (µg/L)
NA	NA	NA	1.47E+06	NA

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
3.7E-06	7.2E-03

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)

SCROLL DOWN TO "END"

END

DATA ENTRY SHEET

GW-ADV
Version 3.0; 02/03

Reset to Defaults

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" in "YES" box and initial groundwater conc. below)

YES X

DTSC / HERD
Version 3.0-mod1; 07/03

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W (µg/L)	Chemical
79016	4.40E+01	Trichloroethylene

MORE ↓

ENTER Average soil/ groundwater temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER Totals must add up to value of L_{WT} (cell B28) Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum directly above water table, (Enter A, B, or C)	ENTER SCS soil type directly above water table	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm²)
20	15	549	360	189	0	B	S	LS		

MORE ↓

ENTER Stratum A SCS soil type (Lookup Soil Parameters)	ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm³)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm³/cm³)	ENTER Stratum B SCS soil type (Lookup Soil Parameters)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm³)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm³/cm³)	ENTER Stratum C SCS soil type (Lookup Soil Parameters)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm³)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm³/cm³)
LS	1.46	0.430	0.2	S	1.46	0.43	0.2				0.054

MORE ↓

ENTER Enclosed space floor thickness, L_{floor} (cm)	ENTER Soil-bldg. pressure differential, ΔP (g/cm-s²)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)
10	40	9144	4572	366	0.1	0.25

ENTER Average vapor flow rate into bldg. OR Leave blank to calculate Q_{soil} (L/m)
5

MORE ↓

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	30	25	250	1.0E-06	1

Used to calculate risk-based groundwater concentration.

END

INTERMEDIATE CALCULATIONS SHEET

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_a^C (cm^3/cm^3)	Stratum A effective total fluid saturation, S_{te} (cm^3/cm^3)	Stratum A soil intrinsic permeability, k_i (cm^2)	Stratum A soil relative air permeability, k_{rg} (cm^2)	Stratum A soil effective vapor permeability, k_v (cm^2)	Thickness of capillary zone, L_{cz} (cm)	Total porosity in capillary zone, n_{cz} (cm^3/cm^3)	Air-filled porosity in capillary zone, θ_{acz} (cm^3/cm^3)	Water-filled porosity in capillary zone, θ_{wcz} (cm^3/cm^3)	Floor-wall seam perimeter, X_{crack} (cm)
7.88E+08	584	0.290	0.290	ERROR	0.396	1.85E-08	0.700	1.18E-08	17.05	0.43	0.177	0.253	27,432

Bldg. ventilation rate, $Q_{building}$ (cm^3/s)	Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,ts}$ (cal/mol)	Henry's law constant at ave. groundwater temperature, H_{TS} ($atm-m^3/mol$)	Henry's law constant at ave. groundwater temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Stratum A effective diffusion coefficient, D^{eff}_A (cm^2/s)	Stratum B effective diffusion coefficient, D^{eff}_B (cm^2/s)	Stratum C effective diffusion coefficient, D^{eff}_C (cm^2/s)	Capillary zone effective diffusion coefficient, D^{eff}_{cz} (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)	Diffusion path length, L_d (cm)
1.06E+06	4.22E+07	8.50E-05	15	8,493	5.06E-03	3.35E-01	1.79E-04	3.20E-03	3.20E-03	0.00E+00	1.33E-03	3.06E-03	532

Convection path length, L_p (cm)	Source vapor conc., C_{source} ($\mu g/m^3$)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number exp(Pe'); (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Unit risk factor, URF ($\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
15	1.47E+04	0.10	8.33E+01	3.20E-03	2.74E-09	1.82E-41	5.84E-05	8.60E-01	2.0E-06	9.0E-01

END

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (µg/L)	Indoor exposure groundwater conc., noncarcinogen (µg/L)	Risk-based Indoor exposure groundwater conc., (µg/L)	Pure component water solubility, S (µg/L)	Final Indoor exposure groundwater conc., (µg/L)
NA	NA	NA	1.47E+06	NA

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to Indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
4.2E-07	8.2E-04

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)

SCROLL DOWN TO "END"

END