UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
75 Hawthorne Street
San Francisco, CA 94105

September 24, 2009

Maurice Benson
Defense Logistics agency
Defense Distribution Depot San Joaquin
P.O. Box 960001
Stockton, CA 95296-0320

Re: U.S. EPA Concurrence on Final Second Five Year Review Report for DDJC-Sharpe

Dear Mr. Benson:

The U.S. Environmental Protection Agency (U.S. EPA) Region 9 has received and reviewed "Final Second Five Year Review Report Defense Logistics Agency, Defense Distribution Depot San Joaquin California, Sharpe Site, California", dated May 29, 2009 (Sharpe Final Five Year Review). The Sharpe Final Five Year Review reflects the Defense Logistics Agency (DLA) responses to U.S. EPA's February 10, 2009, review comments on a December 2008, Draft Five Year Review. The Sharpe Final Five Year Review addresses completed and ongoing remedial actions taken pursuant to Superfund decision documents prepared to date.

Based upon our review, U.S. EPA agrees with the findings, conclusions, and recommendations as they relate to protectiveness, and concurs with the DLA that the remedies for groundwater and soil remain protective of human health and the environment in the short term. While there appears to be no current exposure to contaminated groundwater from the site, the Five Year Review does indicate that there remains some potential for off-depot migration of contaminant plumes due to lack of complete capture by the existing extraction system. U.S. EPA agrees with DLA recommendations to address any potential long-term problem through a series of additional monitoring and investigation activities, as well as optimization of the existing remedy.

U.S. EPA looks forward to continued coordination with the DLA on cleanup activities at Sharpe. If you have any questions concerning this matter, please contact Phillip Ramsey of my staff at (415) 972-3006.

Sincerely,

Michael Montgomery
Assistant Director
Federal Facilities and Site Cleanup Branch

cc: Peter MacNicholl, DTSC
James Brownell, RWQCB
Michael Thomas, URS

18600311.02030

FINAL

DEFENSE LOGISTICS AGENCY
DEFENSE DISTRIBUTION DEPOT SAN JOAQUIN CALIFORNIA
SHARPE SITE, CALIFORNIA

DDJC-SHARPE
SECOND FIVE-YEAR REVIEW REPORT

Prepared by:

URS Group, Inc.
2870 Gateway Oaks Drive, Suite 150
Sacramento, California 95833

Prepared for:

HQ AFCEE/EXA
3300 Sidney Brooks
Brooks City-Base, Texas 78235-5112

Contract No. FA8903-08-D-8783
Task Order No. 0014

May 2009

URS
Project Staff

Principal-In-Charge
Dennis Bane, P.G., Vice President

Program Manager
Michael Thomas

Task Manager
Sarah Tourre, P.G.

Project Staff
Debbie Casagrande
Thomas Cudzilo, Ph.D., C.HG.
Laurel Hanson
Gregory Korose, P.G.
Virginia Lenvik
Linda Littleton
Corinne Marks, P.E.
Pete Phillips
Lynn Sandsor
Lucy Trumbull

Report Production
Gayle Gideon
Katherine Reed
Eric Stewart

Peer Review
Stephanie Benedict
Rich Beyak, P.E.
Kent Parrish, C.HG.
John Sciacca, P.G.

Quality Control Manager
Anne Wanken

TABLE OF CONTENTS

Page

ES.0 EXECUTIVE SUMMARY ES-1
ES.1 Progress Since First Five-Year Review ES-1
ES.2 Findings and Issues of Second Five-Year Review ES-1
ES.2.1 OU 1 ..... ES-1
ES.2.2 OU 2 ..... ES-2
ES.3 Protectiveness Statement and Follow-Up Actions ES-2
ES.3.1 OU 1 ..... ES-2
ES.3.2 OU 2 ..... ES-2

1.0 INTRODUCTION 1-1

2.0 CHRONOLOGY 2-1

3.0 BACKGROUND 3-1
3.1 Physical Characteristics 3-1
3.1.1 Surface Water Hydrology 3-1
3.1.2 Regional Geology 3-2
3.1.3 Site Geology and Groundwater Hydrology 3-2
3.2 Land and Resource Use 3-3
3.3 History of Contamination 3-4
3.4 Initial Response 3-4
3.4.1 Initial Groundwater Response Actions 3-5
3.4.2 Initial Soil Response Actions 3-5
3.5 Basis for Taking Action 3-5
3.5.1 Basis for Groundwater Action 3-5
3.5.2 Basis for Soil Action 3-6

4.0 REMEDIAL ACTIONS 4-1
4.1 Groundwater Remedy 4-2
4.1.1 Remedy Selection 4-2
4.1.2 Remedy Implementation 4-4
4.1.3 Groundwater Treatment System O & M 4-14
4.2 Soil Remedy 4-15
4.2.1 Remedy Selection 4-15
4.2.2 Remedy Implementation 4-16
4.2.3 LUCs 4-24

5.0 PROGRESS SINCE LAST REVIEW 5-1
5.1 Protectiveness Statement from First Five-Year Review 5-1
5.1.1 OU 1 5-1
5.1.2 OU 2 5-1
5.2 Recommendations and Follow-Up Actions from First Five-Year Review 5-2
5.2.1 OU 1 5-2
5.2.2 OU 2 5-8

TABLE OF CONTENTS (Continued)

Page

6.0 FIVE-YEAR REVIEW PROCESS 6-1
- 6.1 Administrative Components 6-1
- 6.2 Community Involvement and Notification 6-1
- 6.3 Document Review 6-2
- 6.4 Data Review 6-5
  - 6.4.1 Hydraulic Data Summary 6-6
  - 6.4.2 Analytical Data Summary 6-6
- 6.5 Site Inspection 6-9
- 6.6 Interviews 6-9

7.0 TECHNICAL ASSESSMENT 7-1
- 7.1 Question A: Is the OU 1 groundwater remedy functioning as intended by the OU 1 ROD? 7-1
  - 7.1.1 Remedial Action Performance 7-1
  - 7.1.2 System Operations/O&M 7-7
  - 7.1.3 Opportunities for Optimization 7-7
  - 7.1.4 Early Indicators of Potential Issues 7-7
  - 7.1.5 Implementation of ICs and Other Measures 7-7
- 7.2 Question B: Are the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of the OU 1 groundwater remedy selection still valid? 7-8
  - 7.2.1 Changes in Standards and TBCs 7-8
  - 7.2.2 Changes in Exposure Pathways 7-9
  - 7.2.3 Changes in Toxicity and Other Contaminant Characteristics 7-17
  - 7.2.4 Changes in Risk Assessment Methods 7-17
  - 7.2.5 Expected Progress Toward Meeting RAOs 7-17
- 7.3 Question C: Has any other information come to light that could call into question the protectiveness of the OU 1 groundwater remedy? 7-22
- 7.4 Question A: Are the OU 2 soil remedies functioning as intended by the OU 2 ROD? 7-22
  - 7.4.1 Remedial Action Performance for TCE in Soil 7-22
  - 7.4.2 System Operations/O&M 7-23
  - 7.4.3 Opportunities for Optimization 7-23
  - 7.4.4 Early Indicators of Potential Issues 7-23
  - 7.4.5 Implementation of ICs and Other Measures 7-23
  - 7.4.6 Remedial Action Performance for Metals in Soil 7-23
  - 7.4.7 System Operations/O&M 7-24
  - 7.4.8 Opportunities for Optimization 7-24
  - 7.4.9 Early Indicators of Potential Issues 7-24
  - 7.4.10 Implementation of ICs and Other Measures 7-24
  - 7.4.11 Remedial Action Performance for Pesticides in Soil 7-24
  - 7.4.12 System Operations/O&M 7-24
  - 7.4.13 Opportunities for Optimization 7-25
  - 7.4.14 Early Indicators of Potential Issues 7-25
  - 7.4.15 Implementation of ICs and Other Measures 7-25

TABLE OF CONTENTS (Continued)

Page

7.5 Question B? Are the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of the selection of the OU 2 remedies still valid? 7-25
7.5.1 Changes in Standards and TBCs for TCE in Soil 7-25
7.5.2 Changes in Exposure Pathways 7-27
7.5.3 Changes in Toxicity and Other Contaminant Characteristics 7-27
7.5.4 Changes in Risk Assessment Methods 7-27
7.5.5 Expected Progress Toward Meeting RAOs 7-29
7.5.6 Changes in Standards and TBCs for Metals and Pesticides in Soil 7-29
7.5.7 Changes in Exposure Pathways 7-30
7.5.8 Changes in Toxicity and Other Contaminant Characteristics 7-32
7.5.9 Changes in Risk Assessment Methods 7-32
7.5.10 Expected Progress Toward Meeting RAOs 7-33
7.6 Question C: Has any other information come to light that could call into question the protectiveness of the OU 2 soil remedies? 7-33

8.0 ISSUES 8-1
8.1 OU 1 8-1
8.2 OU 2 8-2
8.2.1 TCE in Soil Gas 8-2
8.2.2 Metals in Soil 8-2

9.0 RECOMMENDATIONS AND FOLLOW-UP ACTIONS 9-1
9.1 OU 1 9-1
9.2 OU 2 9-2
9.2.1 TCE in Soil Gas 9-2
9.2.2 Metals in Soil 9-2

10.0 PROTECTIVENESS STATEMENT 10-1
10.1 OU 1 10-1
10.2 OU 2 10-1
10.2.1 TCE in Soil Gas 10-1
10.2.2 Metals in Soil 10-2
10.2.3 Pesticides in Soil 10-2

11.0 NEXT FIVE-YEAR REVIEW 11-1
11.1 OU 1 11-1
11.2 OU 2 11-1
11.3 Conclusion 11-1

12.0 REFERENCES 12-1

APPENDIX A – Summary of Groundwater Treatment System Construction and Performance References, 1985 – 2007, DDJC-Sharpe
APPENDIX B – Exceedances of NPDES Requirements/WDRs
APPENDIX C – Groundwater Treatment System Improvements and Major Repairs, 1996 – 2007, DDJC-Sharpe
APPENDIX D – Summary of Construction and Performance References, SVE Sites, DDJC-Sharpe
APPENDIX E – Summary of Construction and Performance References, Sites S-3 and S-26, DDJC-Sharpe
APPENDIX F – Site Inspection Checklists
APPENDIX G – Photograph Log of Site Inspections
APPENDIX H – Interview Records
APPENDIX I – Risk and Hazard Evaluation of ACLs
APPENDIX J – Evaluation of Worker and Construction Worker Exposure Scenarios
APPENDIX K – Cumulative Risk Analysis of Soil Gas Analytes

LIST OF TABLES

Page

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

4-1 Remedial Actions at DDJC-Sharpe 4-1
4-2 Remedial Performance Standards – Aquifer Cleanup Levels, DDJC-Sharpe 4-2
4-3 Elements of the Groundwater Remedy, OU 1 ROD 4-3
4-4 Groundwater Extraction Wells, DDJC-Sharpe 4-4
4-5 Description of OU 1 Remediation Systems, DDJC-Sharpe 4-5
4-6 Effluent Discharge Standards, DDJC-Sharpe 4-7
4-7 Number of Well Samples Collected, 2003–2007, DDJC-Sharpe 4-9
4-8 Optimization Activities, DDJC-Sharpe 4-11
4-9 Purpose of 2007/2008 CPT/HydroPunch Investigation, DDJC-Sharpe 4-13
4-10 Annual Cost-Per-Pound of Mass Removed from 2003-2007, DDJC-Sharpe 4-15
4-11 Summary of OU 2 ROD Components, DDJC-Sharpe 4-17
4-12 Status of TCE Soil Sites, DDJC-Sharpe 4-18
4-13 TCE Soil Sites Requiring No Remedial Action Based on Further Characterization, DDJC-Sharpe 4-19
4-14 Metals Soil Sites Requiring No Remedial Action Based on Further Characterization, DDJC-Sharpe 4-23

5-1 Risk Results from Modeling of Soil Gas Results from Building 655, South Balloon 5-5

6-1 Five-Year Review Schedule, DDJC-Sharpe 6-1
6-2a Documents Reviewed – Basis for the Response Action 6-2
6-2b Documents Reviewed – Implementation of the Response 6-3
6-2c Documents Reviewed – Remedy Performance 6-4
6-2d Documents Reviewed – Operation and Maintenance 6-4
6-2e Documents Reviewed – Legal Documentation 6-5
6-2f Documents Reviewed – Community Involvement 6-5

7-1 2Q08 Capture Zone and Containment Summary, DDJC-Sharpe 7-4
7-2 Evaluation of Cleanup Standards Presented in the OU 1 ROD 7-10
7-3 Evaluation of Action-Specific ARARs, OU 1 and OU 2 RODs 7-12
7-4 Evaluation of the Exposure Assumptions Presented in the OU 1 ROD 7-16
7-5 Evaluation of Carcinogenicity Factors Presented in the OU 1 ROD 7-18
7-6 Evaluation of Noncancer Toxicity Factors Presented in the OU 1 ROD 7-20
7-7 Evaluation of the Exposure Assumptions Presented in the OU 2 ROD 7-31

9-1 Follow-Up Action Schedule of Completion, DDJC-Sharpe 9-5

LIST OF FIGURES

3-1 DDJC-Sharpe Location Map – Regional Area
3-2 DDJC-Sharpe Location Map – Local Area
3-3 Site Map, DDJC-Sharpe
3-4 Stratigraphic and Hydrostratigraphic Nomenclature, DDJC-Sharpe

4-1 Operable Unit 1 Remedy, Groundwater Extraction and Treatment, DDJC-Sharpe
4-2 Flow Schematic and Discharge Sampling Locations for DDJC-Sharpe Groundwater Treatment Plants Prior to Implementation of Extraction Well Optimization Test
4-3 Flow Schematic and Discharge Sampling Locations for DDJC-Sharpe Groundwater Treatment Plants After Implementation of Extraction Well Optimization Test
4-4 Flow Schematic and Discharge Sampling Locations for DDJC-Sharpe Groundwater Treatment Plants After Expiration of NPDES Permit
4-5 Well Locations, DDJC-Sharpe
4-6 Municipal Wells and Off-Depot Piezometer Locations, DDJC-Sharpe
4-7 Monitoring Well Sampling Frequency Decision Logic for DDJC-Sharpe
4-8 2007/2008 CPT/HydroPunch Investigation Areas, DDJC-Sharpe
4-9 Operable Unit 2 Soil Sites, DDJC-Sharpe

5-1 Areas Addressed by Recommendations from First Five-Year Review, DDJC-Sharpe

6-1 Potentiometric Surface Contours in the A Zone, Third Quarter 2007, DDJC-Sharpe
6-2 Potentiometric Surface Contours in the B Zone, Third Quarter 2007, DDJC-Sharpe
6-3 Potentiometric Surface Contours in the C Zone, Third Quarter 2007, DDJC-Sharpe
6-4 Maximum TCE Concentrations in Groundwater, North Balloon A, B, C, and D Zones, Third Quarter 2007, DDJC-Sharpe
6-5 Maximum TCE Concentrations in Groundwater, South Balloon and Central Area A, B, C, and D Zones, Third Quarter 2007, DDJC-Sharpe
6-6 Conceptual Site Model Update – TCE in A Zone Groundwater, Pre- and Post-CPT/HydroPunch Investigation, DDJC-Sharpe
6-7 Conceptual Site Model Update – TCE in B Zone Groundwater, Pre- and Post-CPT/HydroPunch Investigation, DDJC-Sharpe
6-8 Conceptual Site Model Update – TCE in C Zone Groundwater, Pre- and Post-CPT/HydroPunch Investigation, DDJC-Sharpe
6-9 Hydrogeologic Cross-Section Locations, DDJC-Sharpe
6-10 TCE Vertical Isoconcentration Profile, Hydrogeologic Cross-Section A-A´, South Balloon, Third Quarter 2007, DDJC-Sharpe
6-11 TCE Vertical Isoconcentration Profile, Hydrogeologic Cross-Section B-B´, Central Area, Third Quarter 2007, DDJC-Sharpe
6-12 TCE Vertical Isoconcentration Profile, Hydrogeologic Cross-Section C-C´, North Balloon, Third Quarter 2007, DDJC-Sharpe
6-13 Hydrogeologic Cross-Section D–D´, North Balloon Area, DDJC-Sharpe
6-14 Hydrogeologic Cross-Section E–E´, P-5A Source Area, DDJC-Sharpe
6-15 Hydrogeologic Cross-Section F–F´, South Balloon Source Area, DDJC-Sharpe
6-16 Maximum PCE Concentrations in Groundwater, North Balloon, A, B, C, and D Zones, Third Quarter 2007, DDJC-Sharpe
6-17 Maximum PCE Concentrations in Groundwater, South Balloon and Central Area, A, B, C, and D Zones, Third Quarter 2007, DDJC-Sharpe
6-18 TCE Concentrations in Groundwater in Potable Water Wells, Third Quarter 2007, DDJC-Sharpe
6-19 PCE Concentrations in Groundwater in Potable Water Wells, Third Quarter 2007, DDJC-Sharpe
6-20 Other Volatile Organic Compound Detections Greater than Aquifer Cleanup Levels, Third Quarter 2007, DDJC-Sharpe

LIST OF FIGURES (Continued)

7-1 TCE Comparison Map, A, B, and C Zones, 2003-2007, DDJC-Sharpe
7-2 PCE Comparison Map, A, B, and C Zones, 2003-2007, DDJC-Sharpe
7-3 Extent of TCE by Zone with CPT Investigation Results, DDJC-Sharpe
7-4 Extent of PCE by Zone with CPT Investigation Results, DDJC-Sharpe
7-5 Interpreted Extraction Well Capture and Plume Boundaries in the A Zone, Second Quarter 2008, DDJC-Sharpe
7-6 Interpreted Extraction Well Capture and Plume Boundaries in the B Zone, Second Quarter 2008, DDJC-Sharpe
7-7 Interpreted Extraction Well Capture and Plume Boundaries in the C Zone, Second Quarter 2008, DDJC-Sharpe
7-8 Layer 1: DDJC-Sharpe Transport Model Results for TCE
7-9 Layer 2: DDJC-Sharpe Transport Model Results for TCE
7-10 Layer 3: DDJC-Sharpe Transport Model Results for TCE
7-11 Layer 4: DDJC-Sharpe Transport Model Results for TCE

This page intentionally left blank

LIST OF ACRONYMS AND ABBREVIATIONS

ACL	aquifer cleanup level
AFCEE	Air Force Center for Engineering and the Environment
AHA	Administrative and Housing Area
ALM	adult lead model
ARAR	applicable or relevant and appropriate
BACT	best available control technology
bgs	below ground surface
BTEX	benzene, toluene, ethylbenzene, and xylenes
B240	Building 240
Cal/EPA	California Environmental Protection Agency
CCl_4	carbon tetrachloride
CCR	California Code of Regulations
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CEQA	California Environmental Quality Act
CFR	Code of Federal Regulations
cm	centimeter
cm^2	square centimeter
COC	contaminant of concern
CPT	cone penetrometer test
CSM	conceptual site model
DCA	dichloroethane
DCE	dichloroethene
DDD	dichlorodiphenyldichloroethane
DDE	dichlorodiphenyldichloroethene
DDJC	Defense Distribution Depot San Joaquin California
DDT	dichlorodiphenyltrichloroethane
DDRW	Defense Distribution Region West
DESJC	Defense Enterprise Support San Joaquin California
DHS	Department of Health Services
DI WET	deionized water waste extraction test
DLA	Defense Logistics Agency
DLR	detection limits for purposes of reporting
DoD	United States Department of Defense
DTSC	California Department of Toxic Substances Control
DWR	California Department of Water Resources
EE/CA	engineering evaluation/cost analysis
EHC	redox (Eh) compound
EOS	emulsified oil substrate
EPA	United States Environmental Protection Agency
ESE	Engineering Science and Engineering
EW	extraction well

LIST OF ACRONYMS AND ABBREVIATIONS (Continued)

FFA	Federal Facilities Agreement
FRG	final remediation goal
FS	feasibility study
GMS	groundwater modeling system
gpm	gallons per minute
GWTP	groundwater treatment plant
HERD	Human and Ecological Risk Division
HHRA	human health risk assessment
hr	hour
IC	institutional control
IRIS	Integrated Risk Information System
IRP	Installation Restoration Program
ISV	in situ volatilization
J&E	Johnson and Ettinger
kg	kilogram
$KMnO_4$	potassium permanganate
L	liter
lb	pound
LUC	land use control
MCL	maximum contaminant level
mg/cm^2	milligrams per square centimeter
mg/day	milligrams per day
mg/kg	milligrams per kilogram
mg/kg-day	milligrams per kilogram per day
mg/L	milligrams per liter
MLE	most likely exposure
msl	mean sea level
m^3/workday	cubic meters per 8-hour workday
NE	not established
NFA	no further action
NCP	National Hazardous Substances and Oil Pollution Contingency Plan
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
O&M	operation and maintenance
OEHHA	Office of Environmental Health Hazard Assessment
OU	operable unit

LIST OF ACRONYMS AND ABBREVIATIONS (Continued)

PCE	tetrachloroethene
PCOR	preliminary closeout report
PHG	public health goal
PLC	programmable logic controller
ppbv	parts per billion by volume
ppmv	parts per million by volume
PRG	preliminary remediation goal
PSS	public safety services
RAO	remedial action objective
RAR	remedial action report
RCP	response completion plan
RI	remedial investigation
RME	reasonable maximum exposure
ROD	record of decision
RPM	Remedial Project Manager
RSL	regional screening level
RTC	response to comment
RWQCB	California Regional Water Quality Control Board–Central Valley Region
SCADA	supervisory control and data acquisition
SJCEHD	San Joaquin County Environmental Health Department
SJVAPCD	San Joaquin Valley Air Pollution Control District
SSJIDC	South San Joaquin Irrigation District Canal
SVE	soil vapor extraction
SVOC	semivolatile organic compound
SWMU	solid waste management unit
SWRCB	State Water Resources Control Board
TBC	to be considered
TCA	trichloroethane
TCE	trichloroethene
TCRA	time critical removal action
TPH	total petroleum hydrocarbons
TRC	technical review committee
URS	URS Group, Inc.
USACE	United States Army Corps of Engineers
USAEC	United States Army Environmental Center
USATHAMA	United States Army Toxic and Hazardous Materials Agency
USGS	United States Geological Survey
UST	underground storage tank
VOC	volatile organic compound

LIST OF ACRONYMS AND ABBREVIATIONS (Continued)

WDR	waste discharge requirement
WES	Waterways Experiment Station
WWTP	wastewater treatment plant
yr	year
µg/dL	micrograms per deciliter
µg/L	micrograms per liter
µg/mg	micrograms per milligram
$\mu g/m^3$	micrograms per cubic meter
3-D	three-dimensional
4Q06	fourth quarter 2006

ES.0 EXECUTIVE SUMMARY

This is the second five-year review for remedial actions taken at the Defense Distribution Depot San Joaquin California, Sharpe site (DDJC-Sharpe) pursuant to the Operable Unit (OU) 1 and OU 2[1] records of decision (RODs).

- The *Remedial Investigation/Feasibility Study at DDRW-Sharpe Site Record of Decision, Operable Unit 1* (1993) specifies extraction of contaminated groundwater, treatment by air stripping, and either industrial reuse of treated groundwater or discharge to surface water, percolation ponds, or injection wells for groundwater recharge.

- The *Record of Decision, Basewide Remedy for DDRW-Sharpe Site* (1996) specifies excavation and off-site disposal for metals-contaminated soil and soil vapor extraction and treatment by vapor-phase granular activated carbon for contaminated soil vapor.

This review evaluates the performance of the remedial actions conducted during the second five-year review period, as well as actions taken in response to recommendations made in the first five-year review, to determine whether the remedial actions are protective of human health and the environment. The first five-year review period was 1998 through 2002. This second five-year period is 2003 through 2007.

ES.1 Progress Since First Five-Year Review

Actions implemented to improve the performance of the OU 1 remedy (groundwater extraction and treatment) and to address the recommendations in the first five-year review included: installation and sampling of additional groundwater monitoring wells; development of a three-dimensional (3-D) numerical groundwater flow model and a numerical fate-and-transport model; optimization of the groundwater extraction well system; optimization and consolidation of the groundwater treatment plants; development of a response completion plan (RCP); and additional characterization of potential source areas and plume extents, including cone penetrometer testing (CPT) and groundwater sampling investigations.

For OU 2, the remedial action (excavation and off-site disposal) for lead- and chromium-contaminated soil at Site S-26, Area 6, was completed during this five-year review period. Because the cleanup standards established in the OU 2 ROD for metals-contaminated soil are based on industrial land use only, land use controls (LUCs) to prohibit residential development and use will be implemented at Sites S-3, S-26, S-30, S-33/29, and S-36. No remedial actions were performed during the period of this second five-year review for tricholoroethene (TCE)- or pesticide-contaminated soils, as remedial actions for these sites were completed during or prior to the period of the first five-year review.

ES.2 Findings and Issues of Second Five-Year Review

ES.2.1 OU 1

Potential for Off-Depot Plume Migration. Interpreted capture zones for the A, B, and C Zones in the South Balloon indicate that a VOC plume is migrating toward and beyond the DDJC-Sharpe depot boundary. HydroPunch data from the 2007/2008 CPT/HydroPunch investigation indicate a portion of the plume is beyond the capture zones of existing on-depot extraction wells in the South Balloon.

[1] To facilitate environmental cleanup at DDJC-Sharpe, two OUs were established. OU 1 consists of contaminated groundwater, and OU 2 consists of contaminated soil and soil vapor above the water table (also called the vadose zone).

Contaminant plumes in the North Balloon may be migrating vertically to depths greater than the existing extraction system due to downward vertical gradients. There is potential, supported by predictions of the groundwater model, that after reaching the C/D transition zone or the D Zone, the plume could migrate northerly beyond the depot boundary under the influence of horizontal gradients.

Plumes that migrate beyond the western or northern depot boundaries may pose a long-term threat, but not an imminent threat to users of privately owned, potable supply wells. Natural attenuation may be occurring in plumes downgradient from extraction wells. Data from monitoring wells within the migration paths of the contaminant plumes will be collected to develop lines of evidence to confirm plume containment by natural attenuation.

Partial Capture of Off-Depot Plumes. Data from off-depot monitoring wells and HydroPunch results from the 2007/2008 CPT/HydroPunch investigation suggest that a portion of the TCE plume in the C Zone and C/D transition zone migrated north of EWCC3 before the well began operating. EWCC3 is the deepest treatment system extraction well and produces the greatest volume of groundwater of the DDJC-Sharpe extraction wells. It is also the most westerly located extraction well outside of the DDJC-Sharpe depot boundary. EWCC3 is hydraulically affecting groundwater several hundred feet down-gradient from its location; however, its ability to capture the entire C Zone and C/D transition zone plume is doubtful. Results from samples collected in the off-depot area west of the South Balloon also suggest that contaminant of concern (COC) plumes have migrated off-depot in the B and C Zones. Data from the 2007/2008 CPT/HydroPunch investigation west of the depot have bounded the extent of the VOC plumes. Data from monitoring wells within the migration paths of the contaminant plumes will be collected to develop lines of evidence to confirm plume containment by natural attenuation.

Time to Achieve Cleanup. Predictions of cleanup times made using the known extent of TCE contamination in third quarter 2007 (3Q07) suggest that TCE will not reach the ACL in DDJC-Sharpe groundwater plumes for at least 30 years. Results from additional site characterization indicate that COC plumes are more extensive than initially interpreted. Revised interpretations of residual mass in source areas are likely to increase the estimated time to cleanup. Pilot tests of mass removal technologies are being performed to determine whether use of other technologies can potentially reduce the cleanup time. The long-term cost of cleanup to aquifer cleanup levels (ACLs) is a concern.

ES.2.2 OU 2

TCE in Soil Gas. Since the first five-year review, results from groundwater monitoring and additional characterization have identified an area of TCE soil gas contamination at Site P-5A. A maximum TCE concentration of 8.3 parts per million by volume (ppmv) in soil gas was detected, which exceeds the soil vapor cleanup level of 0.35 ppmv. Soil gas concentrations exceeding the cleanup level at Site P-5A require a remedial action to remain protective of groundwater.

Metals in Soil. Cleanup standards for metals sites are based on industrial land use and do not allow for unlimited use and unrestricted exposure (i.e., residential use); therefore, LUCs are needed at the five metals sites (S-3, S-26, S-30, S-33/29, and S-36) to protect human health and the environment.

ES.3 Protectiveness Statement and Follow-Up Actions

ES.3.1 OU 1

The OU 1 remedy remains protective of human health and the environment in the short-term. Results from the 2007/2008 CPT/HydroPunch investigation suggest that the plumes are not migrating to privately owned, potable supply wells even though contaminant plume capture is incomplete west of the depot

boundary. However, additional data collection is necessary to confirm that the plumes will be sufficiently contained to provide long-term protectiveness.

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

- To address potential off-depot migration of COC plumes:
  - Monitoring well clusters will be constructed in off-depot areas for long-term monitoring to assist in determining the extent and stability of plumes that are not within capture zones.
  - Soil and groundwater samples collected from new off-depot monitoring well borings will be analyzed for natural attenuation constituents and parameters.
  - Incorporate data from the 2007/2008 CPT/HydroPunch investigation and any future monitoring wells into the groundwater model to reduce uncertainty in its predictions.
- Develop and implement a water contingency plan to help ensure the protectiveness of downgradient potable well users.
- Monitor vertical gradients, potential causes of gradients (on-depot potable well operation), and contaminant concentration changes in the North Balloon C Zone and C/D transition zone to determine whether the TCE plume continues to migrate vertically.
- To address capture or containment:
  - Continue to optimize the extraction well array to maximize COC plume containment using available lines of evidence, including the updated groundwater model.
  - Evaluate CPT and groundwater sample results, monitoring well data, and groundwater model predictions to assess whether an alternative response action is warranted. If an alternative response action is warranted, an amendment to the OU 1 ROD will be prepared.
- Complete the treatment technology pilot studies and evaluate whether full-scale implementation of one or more treatment technologies can cost-effectively reduce the cleanup time of residual COC source mass in groundwater. If an alternative response action is warranted, an amendment to the OU 1 ROD will be prepared.

ES.3.2 OU 2

TCE in Soil Gas. The OU 2 ROD remedy for TCE in soil currently protects human health and the environment in the short-term because remedial actions have been implemented and completed at TCE-contaminated sites identified in the OU 2 ROD or following post-ROD characterization. Long-term protectiveness depends on the performance of the OU 2 ROD remedy (soil vapor extraction [SVE]) at Site P-5A, which will be implemented during the period of the third five-year review.

The following is a recommendation and follow-up action for the OU 2 remedy for TCE in soil gas.

- Implement SVE at Site P-5A.

Metals in Soil. The OU 2 ROD remedy for metals in soil currently protects human health and the environment in the short-term because remedial actions have been implemented and completed at metals-contaminated sites identified in the OU 2 ROD. Because the cleanup standards for metals are based on industrial land use and do not allow for unlimited use and unrestricted exposure, LUCs are required for

long-term protection of human health and the environment. The forthcoming *Amendment to the Record of Decision Basewide Remedy for DDJC-Sharpe (Operable Unit 2 – Soils)* documents the addition of LUCs to prohibit residential development and use at Sites S-3, S-26, S-30, S-33/29, and S-36.

The following is a recommendation and follow-up actions for the OU 2 remedy for metals in soil.

- Implement LUCs to prohibit residential development and use at the five metals sites.
  - Monitor that the LUCs are in place and effective.
  - Report the results in the Federal Facilities Agreement (FFA) Annual Progress Reports.

Pesticides in Soil. The remedy for pesticides in soil at OU 2 was completed prior to signing of the OU 2 ROD and remains protective of human health and the environment.

Five-Year Review Summary Form
(Statutory Review)

SITE IDENTIFICATION		
Site name *(from WasteLAN)*: Sharpe Army Depot (US Army)		
EPA ID *(from WasteLAN)*: CA8210020832		
Region: 9	**State:** CA	**City/County:** Lathrop/San Joaquin
SITE STATUS		
NPL status: **Final** Deleted Other (specify)		
Remediation status (choose all that apply): Under Construction **Operating** **Complete**		
Multiple OUs?* **YES** No	**Construction completion date:** 27 June 2003 (PCOR)	
Has site been put into reuse? YES **NO**		
REVIEW STATUS		
Lead agency: EPA State Tribe Other Federal Agency **Defense Logistics Agency**		
Author name: Maurice Benson		
Author title: Remedial Project Manager	**Author affiliation:** DESJC	
Review period: **July 2008 to May 2009		
Date(s) of site inspection: 27 August 2008		
Type of review: **Post-SARA** Pre-SARA NPL-Removal only Non-NPL Remedial Action Site NPL State/Tribe-lead Regional Discretion		
Review number: 1 (first) **2 (second)** 3 (third) Other (specify) _____		
Triggering action: Actual RA Onsite Construction at OU #____ Actual RA Start at OU #____ Construction Completion **Previous Five-Year Review Report** Other (specify)		
Triggering action date *(from WasteLAN)*: 01 / 12 / 2004		
Due date *(five years after triggering action date)*: 01 / 12 / 2009		

*["OU" refers to operable unit.]

****[Review period should correspond to the actual start and end dates of the Five-Year Review in WasteLAN.]**

Five-Year Review Summary Form (cont'd.)

Issues:

Operable Unit 1

Potential for Off-Depot Plume Migration. Interpreted capture zones for the A, B, and C Zones in the South Balloon indicate that a VOC plume is migrating toward and beyond the DDJC-Sharpe depot boundary. HydroPunch data from the 2007/2008 CPT/HydroPunch investigation indicate a portion of the plume is beyond the capture zones of existing on-depot extraction wells in the South Balloon.

Contaminant plumes in the North Balloon may be migrating vertically to depths greater than the existing extraction system due to downward vertical gradients. There is potential, supported by predictions of the groundwater model, that after reaching the C/D transition zone or the D Zone, the plume could migrate northerly beyond the depot boundary under the influence of horizontal gradients.

Plumes that migrate beyond the western or northern depot boundaries may pose a long-term threat, but not an imminent threat to users of privately owned, potable supply wells. Natural attenuation may be occurring in plumes downgradient from extraction wells. Data from monitoring wells within the migration paths of the contaminant plumes will be collected to develop lines of evidence to confirm plume containment by natural attenuation.

Partial Capture of Off-Depot Plumes. Data from off-depot monitoring wells and HydroPunch results from the 2007/2008 CPT/HydroPunch investigation suggest that a portion of the TCE plume in the C Zone and C/D transition zone migrated north of EWCC3 before the well began operating. EWCC3 is the deepest treatment system extraction well and produces the greatest volume of groundwater of the DDJC-Sharpe extraction wells. It is also the most westerly located extraction well outside of the DDJC-Sharpe depot boundary. EWCC3 is hydraulically affecting groundwater several hundred feet downgradient from its location; however, its ability to capture the entire C Zone and C/D transition zone plume is doubtful. Results from samples collected in the off-depot area west of the South Balloon also suggest that COC plumes have migrated off-depot in the B and C Zones. Data from the 2007/2008 CPT/HydroPunch investigation west of the depot have bounded the extent of the VOC plumes. Data from monitoring wells within the migration paths of the contaminant plumes will be collected to develop lines of evidence to confirm plume containment by natural attenuation.

Time to Achieve Cleanup. Predictions of cleanup times made using the known extent of TCE contamination in 3Q07 suggest that TCE will not reach the ACL in DDJC-Sharpe groundwater plumes for at least 30 years. Results from additional site characterization indicate that COC plumes are more extensive than initially interpreted. Revised interpretations of residual mass in source areas are likely to increase the estimated time to cleanup. Pilot tests of mass removal technologies are being performed to determine whether use of other technologies can potentially reduce the cleanup time. The long-term cost of cleanup to ACLs is a concern.

Groundwater Treatment Plant O&M. Many of the extraction well flow meters and in-well water level measuring devices (transducers) have passed their expected service life. Several flow meters in operating extraction wells require frequent repair.

Operable Unit 2

TCE in Soil Gas. Since the first five-year review, results from groundwater monitoring and additional characterization have identified an area of TCE soil gas contamination at Site P-5A. A maximum TCE concentration of 8.3 ppmv in soil gas was detected, which exceeds the soil vapor cleanup level of 0.35 ppmv. Soil gas concentrations exceeding the cleanup level at Site P-5A require a remedial action to remain protective of groundwater.

Metals in Soil. Because cleanup standards for metals sites are based on industrial land use and do not allow for unlimited use and unrestricted exposure (i.e., residential use), LUCs are needed at the five metals sites (S-3, S-26, S-30, S-33/29, and S-36) to protect human health and the environment.

Recommendations and Follow-Up Actions:

Operable Unit 1

- Continue containment and mass removal with the 15 extraction well array until the additional activities described in this section are completed.
- To address potential off-depot migration of COC plumes:
  - Monitoring well clusters will be constructed in off-depot areas for long-term monitoring to assist in determining the extent and stability of plumes that are not within capture zones.
  - Soil and groundwater samples collected from new off-depot monitoring well borings will be analyzed for natural attenuation constituents and parameters.
  - Incorporate data from the 2007/2008 CPT/HydroPunch investigation and any future monitoring wells into the groundwater model to reduce uncertainty in its predictions.
- Develop and implement a water contingency plan to help ensure the protectiveness of downgradient potable well users.
- Monitor vertical gradients, potential causes of gradients (on-depot potable well operation), and contaminant concentration changes in the North Balloon C Zone and C/D transition zone to determine whether the TCE plume continues to migrate vertically.
- To address capture or containment:
  - Continue to optimize the extraction well array to maximize COC plume containment using available lines of evidence, including the updated groundwater model.
  - Evaluate CPT and groundwater sample results, monitoring well data, and groundwater model predictions to assess whether an alternative response action is warranted to enhance containment of COC plumes. If an alternative response action is warranted, an amendment to the OU 1 ROD will be prepared.
- Identify locations on DDJC-Sharpe where treatment plant effluent can be discharged, should capacity be needed as a result of optimized groundwater extraction and to avoid high water levels during the wet season at the Central Area percolation ponds.

- Prepare technical memoranda that report the analytical results of any new off-depot groundwater and soil sampling activities; the results from the recalibrated groundwater model; results from groundwater treatment system optimization; and results of treatment plant effluent discharge testing at the alternative discharge location.

- Complete the treatment technology pilot studies and evaluate whether full-scale implementation of one or more treatment technologies can cost-effectively reduce the cleanup time of residual COC source mass in groundwater. If an alternative response action is warranted, an amendment to the OU 1 ROD will be prepared.

- To address the groundwater treatment system O&M issues:

  - Replace outdated equipment, as needed.
  - Replace or update electronic groundwater extraction well measuring instrumentation, as needed.

Replace extraction well flow meters for currently operating extraction wells. Replace flow meters in extraction wells brought back into service, as needed.

Operable Unit 2

TCE in Soil Gas

- Implement the OU 2 ROD remedy (SVE) at Site P-5A.

Metals in Soil

- Implement LUCs to prohibit residential development and use at the five metals sites. As a follow-up action, monitor that the LUCs are in place and effective. Report the results in the FFA Annual Progress Reports.

Protectiveness Statement:

Operable Unit 1

The OU 1 remedy remains protective of human health and the environment in the short-term. Results from the 2007/2008 CPT/HydroPunch investigation suggest that the plumes are not migrating to privately owned, potable supply wells even though contaminant plume capture is incomplete west of the depot boundary. However, additional data collection is necessary to confirm that the plumes will be sufficiently contained to provide long-term protectiveness.

Operable Unit 2

TCE in Soil Gas. The OU 2 ROD remedy for TCE in soil currently protects human health and the environment in the short term because remedial actions have been implemented and completed at TCE-contaminated sites identified in the OU 2 ROD. Long-term protectiveness depends on the performance of the OU 2 ROD remedy (SVE) at Site P-5A, which will be implemented during the period of the third five-year review.

Metals in Soil. The OU 2 ROD remedy for metals in soil currently protects human health and the environment in the short term because remedial actions have been implemented and completed at metals-contaminated sites identified in the OU 2 ROD. Because the cleanup

standards for metals are based on industrial land use and do not allow for unlimited use and unrestricted exposure, LUCs are required for long-term protection of human health and the environment. The draft ***Amendment to the Record of Decision Basewide Remedy for DDJC-Sharpe (Operable Unit 2 – Soils)*** documents the addition of LUCs to prohibit residential development and use at Sites S-3, S-26, S-30, S-33/29, and S-36.

Pesticides in Soil. The remedy for pesticides in soil was completed prior to the OU 2 ROD and remains protective of human health and the environment.

1.0 INTRODUCTION

This is the second five-year review report for remedial actions taken at the Defense Distribution Depot San Joaquin California, Sharpe site (DDJC-Sharpe) pursuant to the Operable Unit (OU) 1 and OU 2[1] records of decision (RODs) (Environmental Science and Engineering, Inc. [ESE], 1993 and 1996, respectively)[2]. The first five-year review period was 1998 through 2002. This second five-year period is 2003 through 2007. Five-year reviews of remedial actions at DDJC-Sharpe are required under CERCLA because hazardous substances, pollutants, or contaminants remain at the site above levels that allow for unlimited use and unrestricted exposure.

The purpose of a five-year review is to determine whether the remedial response actions are protective of human health and the environment and, as necessary, to provide recommendations for attaining and/or maintaining sustainable protection. As this is the second five-year review for OU 1 (groundwater) and OU 2 (soil) remedial actions at DDJC-Sharpe, this review evaluated changes in remedy implementation during this five-year period and actions taken in response to recommendations in ***DDJC-Sharpe Five-Year Review Report*** (URS, 2004a), the first five-year review report. The first five-year review for DDJC-Sharpe can be viewed at http://www.epa.gov/superfund/sites/fiveyear/f04-09004.pdf.

Executive Order 12580 delegates review responsibility to federal facilities that control the sole source of the release. This five-year review for DDJC-Sharpe was conducted by the DLA/DESJC, using URS under contract to the Air Force Center for Engineering and the Environment (AFCEE).

DLA is responsible for managing regional and local environmental programs at DDJC, including the Installation Restoration Program (IRP). The IRP at DDJC-Sharpe is managed in accordance with the Federal Facilities Agreement (FFA) developed specifically for DDJC-Sharpe. The FFA has enforceable schedules; it ensures that environmental impacts are thoroughly investigated and that appropriate cleanup actions are taken to protect human health, welfare, and the environment. As described in the FFA, authority for IRP decision making rests with a team of Remedial Project Managers (RPMs) from DESJC, United States Environmental Protection Agency Region 9 (EPA), and the California Environmental Protection Agency (Cal/EPA), including the Department of Toxic Substances Control (DTSC) and RWQCB. DLA is the lead agency responsible for funding and implementing remedial actions. EPA provides final approval for decisions regarding remedial actions taken at DDJC-Sharpe. EPA, DTSC, and RWQCB also provide regulatory oversight, including technical support, review, and comment on all investigative and remedial work at DDJC-Sharpe.

DLA is providing this five-year review report in accordance with CERCLA §121 and the National Hazardous Substances and Oil Pollution Contingency Plan (NCP). CERCLA §121 states:

> *If the President selects a remedial action that results in any hazardous substances, pollutants, or contaminants remaining at the site, the President shall review such remedial action no less often*

[1] To facilitate environmental cleanup at DDJC-Sharpe, two OUs were established. OU 1 consists of contaminated groundwater and OU 2 consists of contaminated soil and soil vapor above the water table (the vadose zone).

[2] Underground storage tanks (USTs) containing petroleum only are exempt from the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) process (see CERCLA §101[14]) and are not discussed in this five-year review other than the following summary. DDJC-Sharpe's UST Program was initiated in 1988, when the installation first began to remove or decommission (close in place) its existing USTs and sumps. Past investigations and remedial activities at UST sites at DDJC-Sharpe have been overseen by San Joaquin County Environmental Health Department (SJCEHD) or the California Regional Water Quality Control Board–Central Valley Region (RWQCB). Ninety-two UST sites have been identified at DDJC-Sharpe, including tanks, sumps, and vaults. All USTs have been removed. Of the 92 sites, a total of 73 sites were closed before 2004 by either the SJCEHD or the RWQCB. In 2004, 13 additional sites were granted closure by the RWQCB (RWQCB, 2004). Four sites (12, 147, 148, and the former fueling station) remain open because of residual contamination that could threaten beneficial uses of groundwater (URS Group, Inc. [URS], 2008a). Groundwater sampling at UST sites is limited to UST Site 12 and UST Site 147. Two other sites (62 and 76) are in the closure process under Defense Logistics Agency (DLA) Enterprise Support San Joaquin California (DESJC), the United States Army Corps of Engineers (USACE), Sacramento District, and SJCEHD (URS, 2008b).

> *than each five years after the initiation of such remedial action to assure that human health and the environment are being protected by the remedial action being implemented. In addition, if upon such review it is the judgement of the President that action is appropriate at such site in accordance with section [104] or [106], the President shall take or require such action. The President shall report to the Congress a list of facilities for which such review is required, the results of all such reviews, and any actions taken as a result of such reviews.*

The EPA interpreted this requirement further in the NCP; 40 Code of Federal Regulations (CFR) §300.430(f)(4)(ii) states:

> *If a remedial action is selected that results in hazardous substances, pollutants, or contaminants remaining at the site above levels that allow for unlimited use and unrestricted exposure, the lead agency shall review such action no less often than every five years after the initiation of the selected remedial action.*

This second five-year review was prepared using the guidelines provided in *Comprehensive Five-Year Review Guidance* (EPA, 2001). The trigger for this statutory review is the signing of the first five-year review. EPA signed the first five-year review report for DDJC-Sharpe on 12 January 2004. This second review was initiated in July 2008 and spans the five-year period between 2003 and 2007. The completion due date of 12 January 2009 for this second five-year review report was extended to incorporate the results of an extraction well optimization test and a groundwater investigation that were ongoing at the end of 2007. The extraction well optimization test began in December 2006, and an evaluation of its performance was published in January 2009 (URS, 2009a). The groundwater investigation was completed in November 2008, and a draft version of the evaluation of the results was published in February 2009 (URS, 2009b). Results from these activities have been used in this second five-year review to the extent that they were needed to assist in the determination of the protectiveness of the OU 1 remedy.

As suggested in Appendix E of *Comprehensive Five-Year Review Guidance* (EPA, 2001), this five-year review report is presented in the following sections.

Executive Summary − Provides a summary of the progress made since the first five-year review and a summary of the findings, follow-up actions, and protectiveness statements for the second five-year review.

Section 1, Introduction − Identifies the purpose of the review, the authority for conducting the review, the areas of the site addressed in the review and those areas not addressed in the review, and the action that triggered the review.

Section 2, Chronology − Lists important site events.

Section 3, Background − Provides a succinct description of site characteristics. The purpose of the section is to identify the threat posed to the public and environment at the time of the ROD so that the performance of the remedy can be easily compared with the site conditions the remedy was intended to address.

Section 4, Remedial Actions − Provides a concise description of implementation history and the current status of the remedy. As this is the second five-year review, this section focuses on implementation activities that have occurred since the first five-year review.

Section 5, Progress Since Last Review − Restates the recommendations from the first five-year review and discusses actions taken or relevant events that have occurred since.

Section 6, Five-Year Review Process − Describes activities performed during the five-year review (e.g., site inspection and document review) and summarizes the findings, as appropriate.

Section 7, Technical Assessment − Provides answers to the three questions required for the assessment (i.e., Question A: Is the remedy functioning as intended by the decision documents? Question B: Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives (RAOs) used at the time of remedy selection still valid? Question C: Has any other information come to light that could call into question the protectiveness of the remedy?)

Section 8, Issues − Identifies issues related to current site operations, conditions, or activities, noting which issues, if any, prevent the remedy from being protective, currently or in the future.

Section 9, Recommendations and Follow-Up Actions − Specifies required and suggested improvements to current site operations, activities, remedies, or conditions for those issues that affect current and/or future protectiveness.

Section 10, Protectiveness Statement − Provides a protectiveness statement for each OU at which a remedial action has begun.

Section 11, Next Five-Year Review – Identifies the need and timeframe for the next five-year review.

Section 12, References – Provides reference information for sources cited in the document.

The report is supplemented with the following appendices:

Appendix A – Summary of Groundwater Treatment System Construction and Performance References, 1985 – 2007, DDJC-Sharpe
Appendix B – Exceedances of NPDES Requirements/WDRs
Appendix C – Groundwater Treatment System Improvements and Major Repairs, 1996 – 2007, DDJC-Sharpe
Appendix D – Summary of Construction and Performance References, SVE Sites, DDJC-Sharpe
Appendix E – Summary of Construction and Performance References, Sites S-3 and S-26, DDJC-Sharpe
Appendix F – Site Inspection Checklists
Appendix G – Photograph Log of Site Inspections
Appendix H – Interview Records
Appendix I – Risk and Hazard Evaluation of ACLs
Appendix J – Evaluation of Worker and Construction Worker Exposure Scenarios
Appendix K – Cumulative Risk Analysis of Soil Gas Analytes

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
Soil and groundwater contamination initially discovered	1980
Initial RI begun	1982
Remediation plan for groundwater contamination developed	1985
Pilot-scale demonstration of South Balloon groundwater extraction and treatment system conducted	1985
DDJC-Sharpe added to NPL by EPA	July 1987
South Balloon groundwater extraction and treatment system operation begun	March 1987
Initial NPDES waste discharge permit issued by RWQCB	1988
North Balloon groundwater extraction and treatment system design developed	1988
FFA signed by DLA, EPA, RWQCB, and DTSC	March 1989
TRC charter created; first TRC meeting conducted	June 1990
North Balloon groundwater extraction and treatment system operation begun	October 1990
Basewide RI completed	June 1991
OU 2 SVE pilot-scale testing in South Balloon and Central Area conducted	July 1991
FFA amended	October 1991
OU 1 FS completed	November 1991
OU 1 Proposed Plan released to public	February 1992
Substantive WDR permit issued by RWQCB	November 1992
North Balloon petroleum-contaminated soil excavation completed	December 1992
OU 2 SVE pilot-scale testing in North Balloon and South Balloon conducted	December 1992
OU 1 ROD signed by DLA, EPA, RWQCB, and DTSC	January 1993
Central Area groundwater extraction and treatment system design completed	March 1993
North Balloon Pesticide Mix Area EE/CA completed	October 1993
OU 2 RI/FS completed	December 1994
North Balloon pesticide-contaminated soil excavation completed	December 1994
OU 2 Proposed Plan released to the public	February 1995
Additional North Balloon pesticide-contaminated soil excavation completed	March 1995
Central Area groundwater extraction and treatment system operation begun	May 1995
OU 2 SVE pilot-scale testing in North Balloon conducted	October 1995
Renewed NPDES waste discharge permit adopted by RWQCB	December 1995
Basewide OU 2 ROD signed by DLA, EPA, RWQCB, and DTSC	February 1996
OU 2 TCE-contaminated soil remedial design (SVE) completed	May 1996
OU 2 SVE pilot-scale testing at OU 2 ROD sites conducted	August 1996
Additional North Balloon pesticide-contaminated soil excavation completed	October 1996
OU 2 metals-contaminated soil remedial design (excavation) completed	August 1997
OU 2 SVE 100% design completed	August 1997
OU 2 SVE system construction completed	July 1998
OU 2 metals-contaminated soil excavation completed	July 1998
OU 2 SVE Phase 1 operation begun	October 1998

Table 2-1. (Continued)

Event	Date
OU 2 metals RAR completed	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	December 2001
Additional OU 2 soil gas closure/confirmation sampling conducted	January 2002
OU 2 SVE RAR completed	May 2002
Renewed NPDES waste discharge permit adopted by RWQCB	December 2002
DDJC-Sharpe PCOR signed by EPA	June 2003
Phase 1 percolation ponds pilot-scale study completed	July 2003
First five-year review signed by DLA, EPA, RWQCB, and DTSC	January 2004
Phase 2 percolation ponds pilot-scale study completed	April 2004
TSO to comply with NPDES permit effluent limitation for arsenic adopted by RWQCB	December 2005
Central Area percolation pond testing completed	May 2006
Additional OU 2 metals-contaminated soil excavation (Site S-26/Area 6) completed	November 2006
Compliance feasibility report for Time Schedule Order completed	July 2007
NPDES permit terminated	December 2007
OU 2 RAR for Site S-26/Area 6 completed	January 2008
OU 1 emulsified oil pilot-scale study started	April 2008
OU 1 solid potassium permanganate pilot-scale study started	May 2008
OU 1 EHC pilot-scale study started	August 2008

DDJC = Defense Distribution San Joaquin California
DLA = Defense Logistics Agency
DTSC = Department of Toxic Substances Control
EE/CA = engineering evaluation/cost analysis
EHC = redox (Eh) compound
EPA = United States Environmental Protection Agency
FFA = Federal Facilities Agreement
FS = feasibility study
NFA = no further action
NPDES = National Pollutant Discharge Elimination System
NPL = National Priorities List
OU = operable unit
PCOR = preliminary closeout report
RAR = remedial action report
RI = remedial investigation
ROD = record of decision
RWQCB = Regional Water Quality Control Board
SVE = soil vapor extraction
TCE = trichloroethene
TSO = Time Schedule Order
TRC = technical review committee
WDR = waste discharge requirement

3.0 BACKGROUND

DDJC-Sharpe is a distribution depot operated by DLA to supply all military services with the equipment needed to fulfill their missions. The activities that resulted in contamination at the facility and the physical characteristics that influence contaminant behavior and remediation are described in this section. The initial response actions taken prior to signing of the RODs are also described, as are the results of risk evaluations.

3.1 Physical Characteristics

DDJC-Sharpe is located in California's primarily agricultural San Joaquin Valley (Figure 3-1). The installation lies in San Joaquin County, within the city limits of the City of Lathrop, a community that was incorporated in 1989 (Figure 3-2). The unincorporated community of French Camp borders Lathrop to the northwest, and the City of Manteca borders Lathrop to the east. Nearby large urban communities include the City of Stockton, approximately 9 miles to the north, and the City of Modesto, approximately 20 miles south of the depot.

The installation forms an approximate rectangle 0.5 mile wide (east-west) and 2 miles long (north-south) (Figure 3-2). It encompasses approximately 720 acres and ranges in elevation from 15 to 23 feet above mean sea level (msl). 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. 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.

The installation is divided into four major areas: the Administrative and Housing Area (AHA), located at the extreme northern end of the installation; the North Balloon, located just south of the AHA; the South Balloon, located at the southern end of the installation; and the Central Area, located between the North and South Balloon areas (Figure 3-3). The North and South Balloons are named after the shapes of areas enclosed by railroad tracks, which in map view look like hot-air balloons.

3.1.1 Surface Water Hydrology

Surface water runoff is collected in stormwater drains throughout the installation and catch basins at the western installation boundary. Most surface water runoff is collected by the stormwater drainage system that discharges to the SSJIDC, which parallels the eastern boundary of the installation (Figure 4-1). Prior to 4 December 2006, water discharged at the outfall to the irrigation canal also included treated ground-water from the groundwater treatment systems. The irrigation canal drains to the north into French Camp Slough, which is a tributary of the San Joaquin River. The river discharges into the Sacramento-San Joaquin Delta just west of Stockton, California.

Stormwater detention ponds are also used to collect stormwater where storm drainage system piping is undersized (e.g., Building 240 [B240]). Stormwater runoff collects in trenches that lead to the stormwater ponds. Water infiltrates the ground surface and migrates toward the water table. If the water levels in the stormwater ponds are too high, stormwater discharges to the storm drainage system. Stormwater runoff from pavement also can enter the ponds through concrete-lined swales along the edges of the ponds and drop inlets.

Wastewater from the depot is treated at the depot's wastewater treatment plant (WWTP) prior to discharge to the unlined WWTP percolation pond located south of the WWTP on the eastern boundary of the installation.

All of the extracted groundwater treated at DDJC-Sharpe is currently discharged to the Central Area percolation ponds located north of the Central Area groundwater treatment plant (GWTP). The ponds are able to accept all of the Central Area GWTP effluent (i.e., up to 500 gallons per minute [gpm], the design flow rate of the Central Area GWTP). The B240 stormwater detention ponds are used for backup discharge capacity on an as needed basis during the dry season. The B240 ponds were designed to discharge stormwater to the storm drain when water levels are too high. Therefore, the discharge lines from the B240 ponds are plugged when the ponds are used for disposal of treated groundwater, thus preventing discharge to the storm drainage system and ultimately the SSJIDC.

3.1.2 Regional Geology

DDJC-Sharpe is located in the eastern part of the San Joaquin River basin in the Central Valley. The geology beneath the depot is characterized by a veneer of reworked soil and fill overlying alluvial fan and stream deposits of the Victor Formation (also known as the Modesto/Riverbank Formation) and the underlying Laguna Formation. Fine sand and clay in flood basin deposits occur near the course of the ancestral San Joaquin River. Both formations are heterogeneous, containing gravels, sands, silts, and clays. The contact between the Victor and Laguna Formations is not readily apparent at DDJC-Sharpe.

DDJC-Sharpe is located in the Eastern San Joaquin subbasin of the San Joaquin Valley groundwater basin. Figure 3-4 provides the stratigraphic and hydrostratigraphic nomenclature in use for the Eastern San Joaquin subbasin. In Stockton and Lathrop, groundwater is first encountered in the Victor Formation deposits at approximately 15 to 20 feet below ground surface (bgs). The saturated Victor deposits are approximately 55 feet thick, and are typically somewhat coarser grained and more permeable than the underlying Laguna deposits. The Laguna deposits are reported to average 1,400 feet thick near Stockton (California Department of Water Resources [DWR], 2006). The Laguna Formation is the time-stratigraphic equivalent of the Tulare Formation, which occurs in other portions of the San Joaquin Valley basin. Clay layers that are 20 to 40 feet thick occur within the depth interval of 180 to 250 feet bgs at the depot. These clay layers have sufficient continuity to serve as confining layers. A discontinuous “blue clay” has been reported at depths ranging from 230 to 280 feet bgs within the Laguna deposits in logs for certain wells at and near DDJC-Sharpe. These blue clays may represent lacustrine deposits identified elsewhere in the San Joaquin Valley basin. However, the regionally extensive Corcoran Clay member of the Tulare Formation, which separates that formation into an upper and lower aquifer, is not observed in the Eastern subbasin (Hotchkiss, 1972; DWR, 2006).

Beneath the clay deposits, the Laguna Formation contains interbedded gravel, sand, silt, and clays above its boundary with the Mehrten Formation. Both the deep Laguna and the Mehrten Formations produce groundwater for agricultural, private, and municipal water wells. The deepest freshwater aquifer in the Eastern San Joaquin subbasin is in the Mehrten Formation, which consists of stream-deposited semi-consolidated to consolidated clays, silts, sands, and gravels. These deposits coarsen downward. Because of extensive pumping, the Mehrten Formation and possibly the lower Laguna deposits have been affected by encroachment of saline water from the west of DDJC-Sharpe (Brown and Caldwell Consulting Engineers, 1985; United States Geological Survey [USGS], 2006).

3.1.3 Site Geology and Groundwater Hydrology

Subsurface deposits at the installation have been described to a depth of 300 feet bgs based on monitoring well logs, borehole geophysical logs, and seismic reflection survey data (ESE, 1994a). Surface soils are loam to sandy loam that have been disturbed by agricultural development, followed by industrial development. The predominant lithologies at the installation are silty sand and silt. Sand layers tend to be laterally discontinuous. Some clay layers at the installation are interpreted to extend laterally for several thousand feet; however, most clay layers are less continuous and pinch out between wells.

Groundwater across DDJC-Sharpe is first encountered at depths ranging from approximately 8 to approximately 22 feet bgs. Depths to groundwater are generally shallower in the south and deeper in the west and northwest. Groundwater generally flows from southeast to the west-northwest.

There is one complex, heterogeneous aquifer in which four hydrostratigraphic zones have been identified in the hydrogeologic system between 14 and 270 feet bgs (ESE, 1990). These hydrostratigraphic zones are considered monitoring zones for the purposes of monitoring hydraulic gradients and contaminant migration. 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.

In the A Zone, groundwater is generally unconfined; however, a confining layer in the lower A Zone and upper B Zone locally creates confining conditions. The confining layer consists of interbedded clay and silt deposits. Even though there is continuity of the confining layer across DDJC-Sharpe, groundwater can move from one zone to another. Furthermore, pumping of on-depot and off-depot water supply wells may cause downward vertical gradients in the areas near the wells.

Annual peak groundwater elevations occur approximately in the first or second quarter of each year. Water levels then decrease in the third and fourth quarters as agricultural and domestic pumping increases. Recharge resulting from percolating rainfall or surface discharges affects groundwater levels 12 to 14 months after rainfall occurs (URS, 2008a). The highest water level elevations occur near the Central Area percolation ponds, where treated groundwater has been discharged since early 2005 (at a rate of 400 to 500 gpm). The high water levels beneath the percolation ponds have not continued to rise; instead, the high water levels are stabilizing relative to groundwater around it. Annual fluctuations in water levels are greatest in the off-depot wells. The difference in water levels from highs in the south to lows in the north across DDJC-Sharpe may be caused by a greater number of active water supply wells off the depot to the west and in the North Balloon than in other areas in and around the depot.

3.2 Land and Resource Use

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 facilities were constructed during the Korean and Vietnam conflicts. Two large warehouse facilities and various improvements have been constructed during the current decade. Land use at DDJC-Sharpe is light industrial. 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 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.

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 residential developments lie to the west. A large residential development borders the depot's immediate southwestern boundary.

The baseline risk assessment assumed continued industrial use at the depot and did not account for changes in land use (ESE, 1994b). In general, a change in land use would require an evaluation to determine whether contamination left in place would pose an unacceptable risk to human health or the environment under any new exposure scenario.

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) (see Figure 4-5). These wells are screened at intervals ranging from 138 to 435 feet bgs.

3.3 History of Contamination

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. These tasks required the use of petroleum hydrocarbon fuels and a variety of other industrial chemicals (e.g., chlorinated solvents). Releases of these chemicals contaminated installation soil and groundwater through a variety of fate-and-transport processes.

Volatile organic compound (VOC) contamination in groundwater appears to have originated from chlorinated solvents used in industrial and vehicle maintenance activities being discharged or released into soil. VOCs may have migrated downward through the soil column via direct infiltration or through leaching (i.e., dissolving in percolating surface water). Contaminants dissolved in groundwater have migrated beyond the western and northern property boundaries of DDJC-Sharpe.

Non-VOC contaminants detected in soil at DDJC-Sharpe include metals, total petroleum hydrocarbons (TPH), and pesticides. Metals (lead and total chromium) contamination of soils occurred as a result of various activities, including the disposal of paints, paint solvents, and sandblasting wastes. TPH contamination of soils occurred as a result of leaking USTs. In addition, pesticides present in surface soil were the result of pesticide mixing and container rinsing operations (ESE, 1996). Metals (arsenic, selenium, chromium, and lead), the herbicide bromacil (used by DDJC-Sharpe to control weed growth until 1996), nitrate, and TPH have also been detected in groundwater samples. Among the non-VOCs detected in groundwater, only bromacil, TPH, lead, and chromium may have originated at source areas on DDJC-Sharpe.

3.4 Initial Responses

Environmental studies have been underway at DDJC-Sharpe since 1980 when groundwater contamination was first detected at DDJC-Sharpe. VOCs, metals, and pesticides were identified as groundwater contaminants. In 1982, the United States Army Environmental Center (USAEC), formerly the United States Army Toxic and Hazardous Materials Agency (USATHAMA), initiated a remedial investigation (RI) at DDJC-Sharpe.

Results led to DDJC-Sharpe being listed on CERCLA's NPL as a Superfund site in 1987. In 1989, DLA, EPA, RWQCB, and DTSC signed the FFA for DDJC-Sharpe (DLA, 1989). The FFA established two OUs to facilitate environmental cleanup at DDJC-Sharpe. OU 1 encompasses groundwater in four (A, B, C, and D) saturated monitoring zones contaminated primarily with VOCs released from activities on the installation. OU 2 consists of contaminated soil and soil vapor above the water table.

3.4.1 Initial Groundwater Response Actions

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

The groundwater remedy selected in the OU 1 ROD was extraction and treatment of VOC-contaminated groundwater by air stripping, with treated groundwater being used for industrial purposes or being discharged to surface water, percolation ponds, or injection wells (ESE, 1993). The two interim groundwater extraction and treatment systems constructed in the North and South Balloons were incorporated into the OU 1 remedy. Construction of a third groundwater treatment plant, located in the Central Area, was completed and operation began in May 1995. Construction completion of the OU 1 remedy was signified by the start of groundwater extraction from extraction well EWCC3 in March 1998.

3.4.2 Initial Soil Response Actions

Soil in several areas of DDJC-Sharpe was found to be contaminated with trichloroethene (TCE), lead, total chromium, and pesticides. As part of the feasibility study (FS) for soil, pilot-scale soil vapor extraction (SVE) studies were conducted in 1991, 1992, and 1995 to determine whether SVE was a feasible remedial technology for the treatment of TCE-contaminated soils at DDJC-Sharpe (ESE, 1992; 1994a; and Radian Corporation, 1996). In November 1994 and April 1995, excavation and off-site disposal of pesticide-contaminated soils from the former Pesticide Mix Area in the North Balloon was performed (ESE, 1994c; CKY Inc., 1995).

In February 1996, the OU 2 ROD was signed (ESE, 1996). The OU 2 ROD designated 111 solid waste management units (SWMUs) for no further action (including UST sites that are not remediated under CERCLA). In addition, because pesticide-contaminated soil at the former Pesticide Mix Area had been removed prior to the signing of the OU 2 ROD, the ROD stated that no further action would be required for the Pesticide Mix Area. The OU 2 ROD identified 14 TCE sites that required further investigation and/or remediation using in situ volatilization (ISV) (now more commonly referred to as SVE), and 14 areas with lead and/or chromium concentrations that required further investigation and/or remediation by excavation and off-site disposal. These 14 metals areas were consolidated into five metals sites.

3.5 Basis for Taking Action

The basis for the OU 1 groundwater remedial action was potential risk to human health. Remedial response actions for contaminated soil in OU 2 are based on potential risk to human health and the environment.

3.5.1 Basis for Groundwater Action

Contaminant concentrations in groundwater beneath DDJC-Sharpe exceed risk-based cleanup levels (ESE, 1993). The baseline risk assessment results indicated that health risks could result if on-installation concentrations of TCE and other VOCs were to migrate to areas of the groundwater system used for domestic water supply and were subsequently ingested. This prompted the remedial actions identified in the OU 1 ROD (ESE, 1993). The carcinogenic risk to human health calculated during the risk assessment resulted in the selection of aquifer cleanup levels (ACLs) for 21 VOC contaminants of concern (COCs). The ACLs for each COC are provided in Section 4.0.

3.5.2 Basis for Soil Action

The OU 2 ROD requires remediation of lead- and chromium-contaminated soil at DDJC-Sharpe to reduce the potential threat to human health and the environment. Cleanup levels for lead and chromium established in the OU 2 ROD are protective of human health if sites are used for industrial purposes. The lead cleanup level (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. The chromium cleanup level (300 mg/kg) was requested by the RWQCB because they considered 300 mg/kg more conservative and protective of groundwater than the dermatitis toxicity value of 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).

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. The TCE soil gas cleanup standard of 0.35 parts per million by volume (ppmv) established in the OU 2 ROD is 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) of TCE in groundwater (ESE, 1996).

The ecological risk assessment indicated that the principal risk to identified species was concentrations of lead and chromium in soils in the North and South Balloon (ESE, 1994b). Because of the high degree of land development and management within and adjacent to DDJC-Sharpe, natural resources are limited. Therefore, the area does not support a great diversity of wildlife species. Species that occur are those that can survive on the extremely limited resources within depot boundaries or in adjacent agricultural resources and marginal natural areas. The ecological risk assessment focused on a limited number of species that may come into contact with contaminated soil while in transit to viable habitats. No endangered plants or animals are currently found at DDJC-Sharpe, although a comprehensive inventory of wildlife composition has not been conducted at the depot. Even though most of the on-site areas appear uninhabitable, the black-tailed jackrabbit (*Lepus californicus*) and burrowing owl *(Athene cunicularia)* are observed commonly, especially along the border fence. Burrowing owls are considered a "Species of Special Concern" in California. The coyote (*Canis latrans*) is also occasionally observed on DDJC-Sharpe property. In addition, several species of field mouse (*Perognathus sp.*, *Onychomys sp.*, and *Peromyscus sp.*) exist in the area.

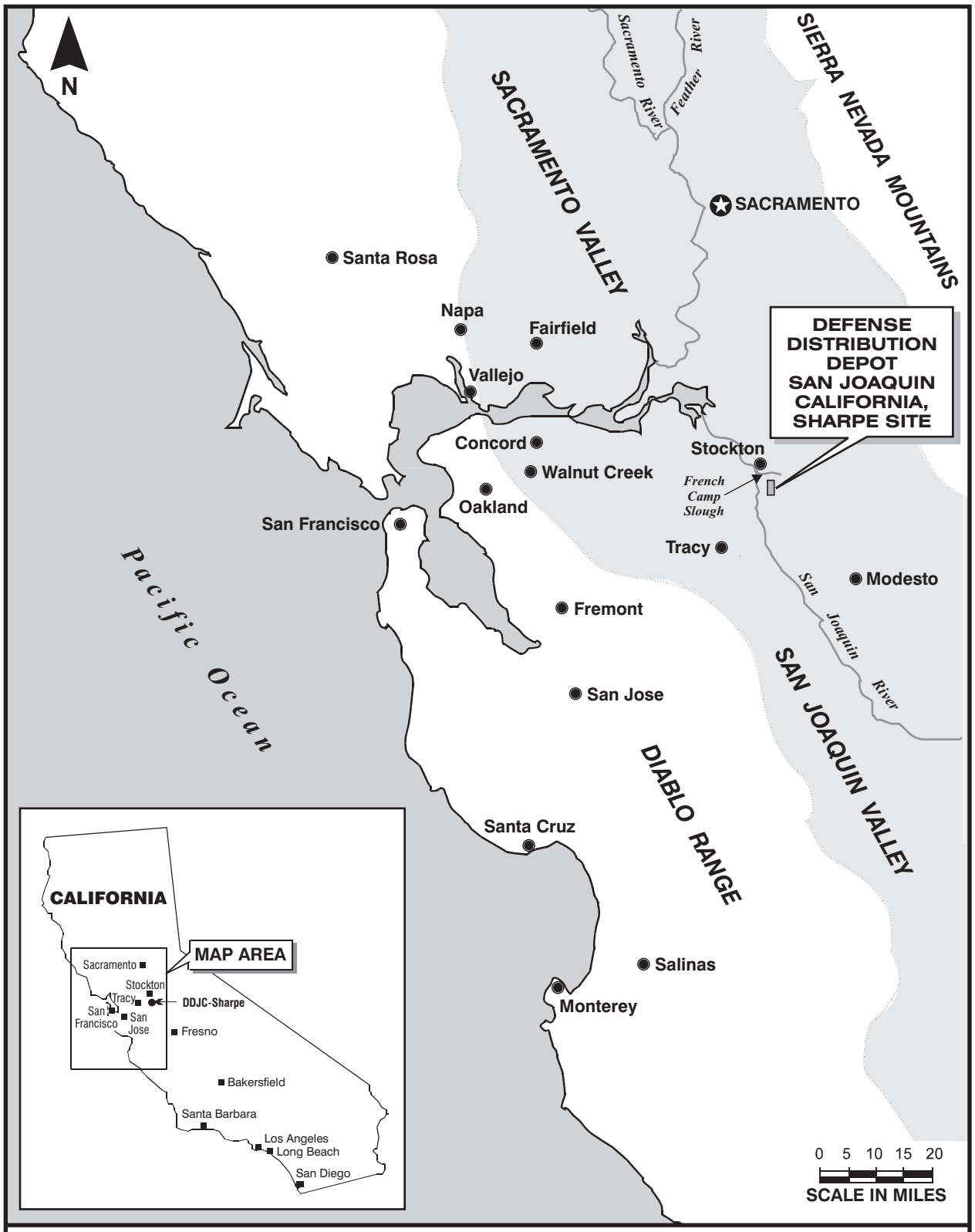


Figure 3-1. Location of DDJC-Sharpe

Sharpe\5yr Review\5yr-rev-sharpe-loc-map.cdr - LCT 11.26.08 SAC

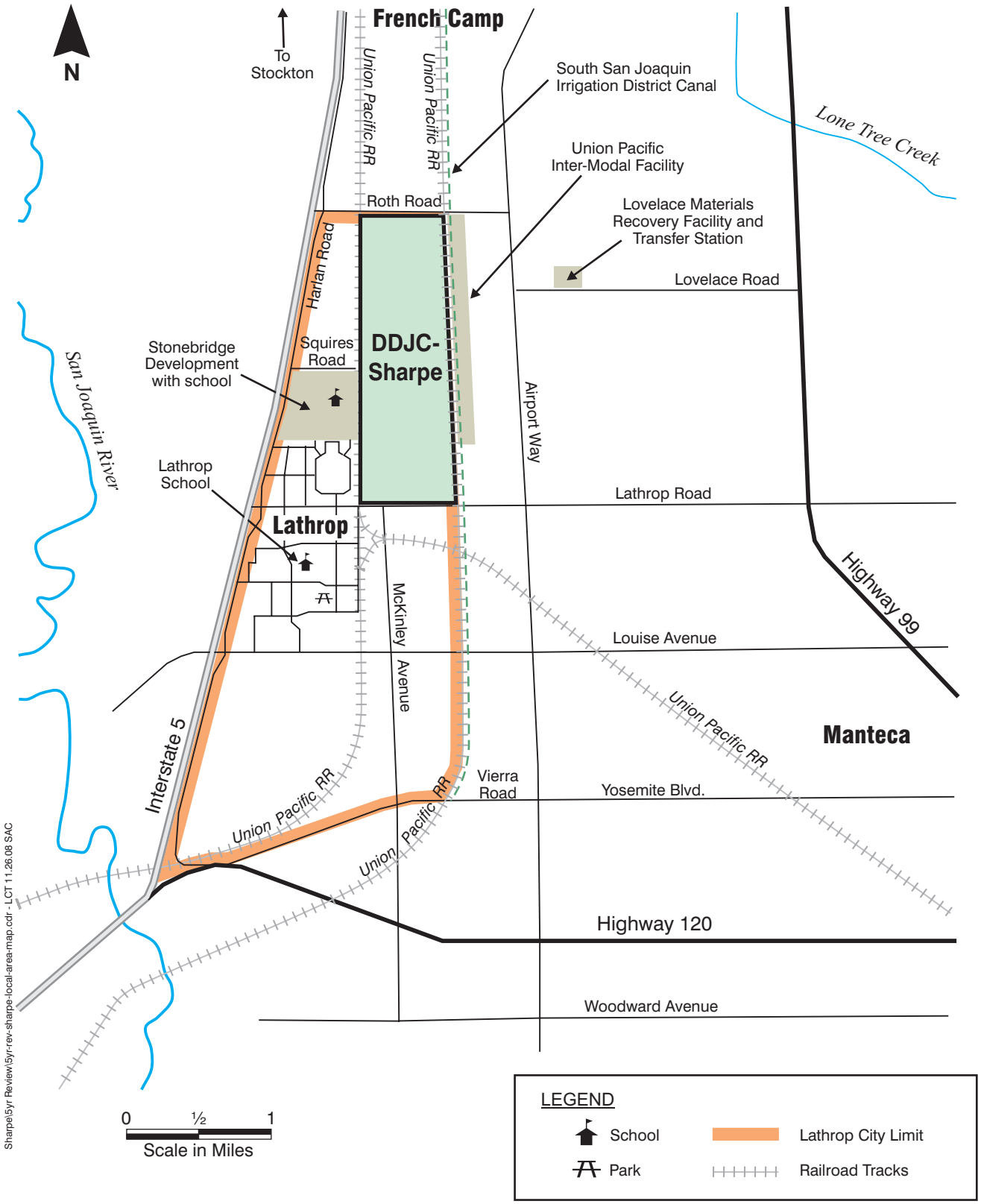


Figure 3-2. DDJC-Sharpe Location Map - Local Area

L:\Projects\Sharpe\Five_Year_review\ArcMaps\sharpe_2008_Sitemap_letter_fiveyear.mxd VRL 12/1/08 SAC

Figure 3-3. Site Map, DDJC-Sharpe

Age	Stratigraphic Units		Description	Regional Hydrostratigraphic Zones	Geologic Horizon Description	Av. Depth Below Surface (ft) (Top of Zone)	Monitoring Zone and Well Designations
Quaternary (Pleistocene and Holocene)	Alluvium	Holocene fan and terrace deposits	Unconsolidated clay, sand, and gravel.	Vadose Zone	Alluvial deposits in discontinuous layers and lenses; 5 to 12 feet thick sand layers; local stream deposits.	0	
		Interfan	Unconsolidated sand, silt, and clay.				
		Flood basin	Fine sand and clays.		Fluvial/overbank deposits, 5 to 10 feet thick, thickening to west.		
Tertiary & Quaternary (Pliocene and Pleistocene)		Victor Formation (Modesto/ Riverbank)	Interbedded gravel, sand, silt, and clay. Deposited in alluvial and fluvial environments.	Upper Aquifer— Upper waterbearing zone; contains water under semiconfined and unconfined conditions.	Alluvial deposits in discontinuous layers and lenses; 5 to 12 feet thick sand layers.	15	A
					Alluvial deposits in discontinuous layers and lenses; 5 to 12 feet thick sand layers.	40	B
		Laguna Formation	Interbedded gravel, sand, silt, and clay. Deposited in alluvial and fluvial environments.		Semi-consolidated sand, silt, and clay layers in discontinuous layers and lenses; 5 to 12 feet thick sand layers.	90	C
					Semi-consolidated sand, silt, and clay layers in discontinuous layers and lenses; 5 to 12 feet thick sand layers.	120	C/CD
						150	D
			Sandy clay, silty clay, silt, and clay interbedded with fine-grained sand.	Locally confining layers between the upper and lower water-bearing zones.	Clays 20 to 40 feet thick in this interval.	200	None
			Interbedded gravel, sand, silt, and clay.			240	None

Note: All depths and thicknesses are approximate.

Source: Engineering Technologies Associates, Inc., 1993, and DWR, 2006.

Figure 3-4. Stratigraphic and Hydrostratigraphic Nomenclature, DDJC-Sharpe

4.0 REMEDIAL ACTIONS

This section describes the remedial actions taken at DDJC-Sharpe in accordance with the OU 1 ROD (groundwater) and the OU 2 ROD (soil and soil gas above the water table, or vadose zone). This section identifies the RAOs associated with each ROD, describes the selected remedy and its implementation, and discusses operation and maintenance (O&M) (groundwater) or land use controls (LUCs) (soil). Table 4-1 summarizes the remedial action history for DDJC-Sharpe.

Table 4-1. Remedial Actions at DDJC-Sharpe

Operable Unit	Type of Action	Year Started	Nature of Action	Status
1	Groundwater Extraction and Treatment	1987	Groundwater extraction and treatment in South Balloon. Initiated as a non-TCRA.	Operating as pump station as of April 2007
	Groundwater Extraction and Treatment	1990	Groundwater extraction and treatment in North Balloon. Initiated as a non-TCRA.	Operating as pump station as of April 2007
	Groundwater Extraction and Treatment	1995	Groundwater extraction and treatment in Central Area.	Operating; as of April 2007, treats all extracted groundwater
2	Soil Excavation and Off-Site Disposal	1994	Excavation of soil in the Pesticide Mix Area.	Completed in 1996
	Soil Excavation and Off-Site Disposal	1998	Excavation of soil at Sites S-3 and S-26, Areas 1 through 5.	Completed in 1998
	Soil Excavation and Off-Site Disposal	2006	Excavation of soil and railroad ballast at Site S-26, Area 6.	Completed in 2006
	Soil Vapor Extraction	1992	Pilot-scale SVE study at Site P-8A	Completed in 1995; system decommissioned in 2002
	Soil Vapor Extraction	1998	SVE at Sites P-1A, P-1B, P-1C, P-1E, and P-6A.	Completed in 2001; system decommissioned in 2002
	Soil Vapor Extraction	TBD	Results from investigations conducted between 2006 and 2008 indicate the need for remedial action at Site P-5A.	SVE to be implemented in 2009-2010
	Land Use Controls	TBD	The land use controls will prohibit residential development and use of property at Sites S-3, S-26, S-30, S-33/29, and S-36.	DESJC submitted a draft ROD Amendment in April 2009

DDJC = Defense Distribution Depot San Joaquin California
DESJC = Defense Logistics Agency Enterprise Support San Joaquin California
non-TCRA = non-time critical removal action
ROD = record of decision
SVE = soil vapor extraction
TBD = to be determined

4.1 Groundwater Remedy

The first five-year review report, finalized in 2004, documented construction of the groundwater extraction and treatment systems at DDJC-Sharpe and almost 10 years of operational data. This section briefly describes the remedy selected for OU 1, its implementation, and O&M costs. The section focuses on events during the second five-year review period.

4.1.1 Remedy Selection

The OU 1 ROD was signed in January 1993 by DDJC, EPA, DTSC, and RWQCB to address contaminated groundwater at DDJC-Sharpe. The RAOs identified in the ROD are to "mitigate potential long-term contaminant migration and protect human health and the environment" (ESE, 1993, page 41). The goal of the remedial action is to "restore groundwater to its beneficial reuse" (ESE, 1993, page 56).

The COCs identified in the OU 1 ROD include 21 VOCs, for which the ROD also specifies ACLs that must be met to the extent practicable (Table 4-2). The ROD also lists four other VOCs (benzene, toluene, ethylbenzene, and xylenes [BTEX]) and one herbicide (bromacil) as COCs, but ACLs were not assigned because these five constituents are not regulated under CERCLA. State and federal applicable or relevant and appropriate requirements (ARARs) (i.e., MCLs) and the human health risk assessment (HHRA) were considered in the development of the ACLs.

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

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

Table 4-2. (Continued)

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

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

In addition, if any increases of lead or chromium concentrations are identified in groundwater, DDJC-Sharpe RPMs must evaluate the need for additional action (e.g., continued monitoring, additional trend analysis, soil sampling, or remedial action). This requirement was established in the OU 2 ROD, which addresses contaminants in soil and their potential impacts on groundwater (ESE, 1996). To date, DDJC-Sharpe RPMs have not determined a need for a remedial action for chromium or lead in groundwater, and groundwater monitoring for these metals has been discontinued (Section 6.4).

The selected remedy for OU 1 is groundwater extraction and air stripping. Treated water (effluent) can be made available for industrial reuse or it can be discharged to surface water, percolation ponds, or injection wells for groundwater recharge. The OU 1 ROD also states, "The selected remedy will include groundwater extraction for a period of 16 years" (ESE, 1993, page 57). Table 4-3 outlines the treatment system components, performance monitoring and optimization requirements, and maintenance requirements specified in the OU 1 ROD. In addition to these requirements, the Substantive Waste Discharge Requirements (WDRs) for Land Disposal specifies twice monthly analysis of influent and effluent samples (RWQCB, 1992). These WDRs are considered an addendum to the OU 1 ROD.

Table 4-3. Elements of the Groundwater Remedy, OU 1 ROD

Treatment System Components	Extraction well field and associated piping network to remove groundwater from the contaminated aquifer zones. Equalization tank designed to stabilize groundwater flow and influent VOC concentrations (Central Area only). Air stripping system consisting of countercurrent packed towers designed to remove VOC contamination from groundwater (including carbon adsorption of air stripper exhaust in the Central Area). Industrial reuse or discharge of treated effluent to surface water, percolation ponds, or injection wells.
Performance Monitoring and Optimization Components	Discontinue operation of extraction wells in areas where cleanup levels have been attained. Alternate pumping of extraction wells to eliminate stagnation points. Pulse-pump to allow aquifer equilibration and encourage adsorbed contaminants to partition into the groundwater. Conduct performance monitoring (requirements to be developed during the remedial design phase).
Maintenance Requirements	Maintenance requirements include replacement of pumps, periodic cleaning and acid washing of valves and pumps, well rehabilitation, replacement and adjustment of telemetry equipment, and other maintenance as needed.

OU = operable unit
ROD = record of decision
VOC = volatile organic compound

Source: Environmental Science and Engineering, Inc. 1993.

4.1.2 Remedy Implementation

Three GWTPs were constructed at DDJC-Sharpe to treat contaminated groundwater extracted from associated wellfields: the North Balloon GWTP, the South Balloon GWTP, and the Central Area GWTP (Figure 4-1). The three systems operate independently of each other; however, discharge of treated water from the systems is interconnected. Construction of the treatment plants, with their associated extraction wells and discharge facilities, meets the requirements of the OU 1 ROD (URS, 2004a). The "construction complete" milestone was achieved when EPA signed the *Installation-Wide Preliminary Close Out Report, DDJC-Sharpe* in June 2003 (URS, 2002a). Documents related to groundwater treatment system construction and performance are listed in Appendix A.

The three GWTPs are operational; however, the North and South Balloon GWTPs were converted to pump stations in April 2007 to convey extracted groundwater to the Central Area GWTP for treatment and discharge. The reduction from three treatment plants to one was part of an extraction well optimization test that began in 2006 and continues to the present.

Remedy effectiveness is monitored through the DDJC-Sharpe Well Monitoring Program, which samples monitoring wells, extraction wells, piezometers, and select off-depot wells. Optimization is an integral part of the system operation and monitoring program.

This section discusses remedy implementation, with emphasis on activities during this five-year review period (that is, since 2003). The O&M program and costs are described in Section 4.1.3.

4.1.2.1 Description of Extraction and Treatment Systems

The groundwater extraction and treatment systems include extraction wells, associated conveyance piping, and air stripping systems. Table 4-4 identifies extraction wells associated with each GWTP. A total of 48 groundwater extraction wells were installed at DDJC-Sharpe between 1986 and 2000. Three extraction wells were decommissioned in 2001. Prior to December 2006, nine extraction wells were shut down for a variety of reasons, including concentrations less than ACLs, poor plume capture, arsenic concentrations greater than 20 µg/L, and discharge reductions per National Pollutant Discharge Elimination System (NPDES) permit limits. Extraction wells turned off since 4 December 2006 have left 15 operating wells that are involved in an extraction well optimization test.

Table 4-4. Groundwater Extraction Wells, DDJC-Sharpe

Operating Wells		
North Balloon	**South Balloon**	**Central Area**
EWNA6	EWA5	EWCB5
EWNB5	EWC4	EWCC1
EWNB6	EWCA1	EWCC2
EWNC3R	EWCB1	EWCC3
EWNC4R		EWCC4
EWNC5		

Table 4-4. (Continued)

Wells Shut Down (Date of Shutdown)[a]		
North Balloon	**South Balloon**	**Central Area**
EWNA1 (9 July 2002)	EWA1 (28 September 2005)	EWCAB1 (4 December 2006)
EWNA2 (4 December 2006)	EWA2 (4 December 2006)	EWCAB2 (4 December 2006)
EWNA3 (9 July 2002)	EWA3 (13 May 2004)	EWCB2 (4 December 2006)
EWNA4 (4 December 2006)	EWA4 (decommissioned 18 June 2001)	EWCB3 (4 December 2006)
EWNA5 (9 July 2002)	EWA6 (4 December 2006)	EWCB4 (11 March 2008)
EWNA7 (decommissioned 18 June 2001)	EWA7 (4 December 2006)	
EWNA8 (11 March 2008)	EWA8 (4 December 2006)	
EWNA9 (4 December 2006)	EWA9 (9 July 2002)	
EWNA10 (4 December 2006)	EWA10 (4 December 2006)	
EWNB1 (9 July 2002)	EWB1 (4 December 2006)	
EWNB2 (4 December 2006)	EWB2 (4 December 2006)	
EWNB3 (9 July 2002)	EWB3 (decommissioned 19 June 2001)	
EWNC2R (4 December 2006)	EWC1 (9 July 2002)	
	EWC2 (4 December 2006)	
	EWC3 (1 February 2006)	

[a] Date well was turned off. Wells that were decommissioned are noted.

DDJC = Defense Distribution Depot San Joaquin California

Table 4-5 provides design information related to the three GWTPs. Extraction wells are connected to air strippers via conveyance pipelines and wellhead feeder pipes. Pipeline trenches also contain conduits that provide power, control, and signal wiring to each well. Each extraction well is equipped with a magnetic flow meter, level sensor, and pressure switch that allow remote monitoring and control. All extraction wells are also equipped with submersible pumps.

Table 4-5. Description of OU 1 Remediation Systems, DDJC-Sharpe

	North Balloon Groundwater Extraction/Treatment System	Central Area Groundwater Extraction/Treatment System	South Balloon Groundwater Extraction/Treatment System
Design Capacity and Actual Flow Rate	Designed to treat 500 gpm; the actual flow is approximately 150 gpm.	Designed to treat 500 gpm; the actual flow is approximately 245 gpm.	Designed to treat 300 gpm; the actual flow is approximately 100 gpm.
Extraction Wells	See Table 4-4	See Table 4-4	See Table 4-4
Effluent Discharge Locations	See Figure 4-1	See Figure 4-1	See Figure 4-1
Operation Began	1990	1995	1987
Current Status	In 2007, system converted for use as a pump station to convey extracted groundwater to the Central Area GWTP for treatment.	In 2007, system began treating extracted groundwater from the North and South Balloons and Central Area. Effluent is discharged to the Central Area percolation ponds.	In 2007, system converted for use as a pump station to convey extracted groundwater to the Central Area GWTP for treatment.

Table 4-5. (Continued)

DDJC	=	Defense Distribution Depot San Joaquin California
gpm	=	gallons per minute
GWTP	=	groundwater treatment plant
OU	=	operable unit

The North Balloon treatment system has two 5-foot-diameter, 24-foot-tall air stripping towers. The South Balloon system has two 4-foot-diameter, 25-foot-tall air stripping towers. The Central Area treatment system was designed with separate piping and treatment trains for A Zone and B/C Zone groundwater, although all Central Area influent is diverted currently 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.

System controls include influent and effluent flow meters and pressure switches. Chemical sequestrants can be added to the influent water at the treatment pads to minimize scale buildup within the air stripping towers.

The control building at each plant houses the primary control system/programmable logic controller (PLC), power breakers, and the supervisory control and data acquisition (SCADA) 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. The entire system can be remotely accessed and operated by modem.

In March and April 2007, the North and South Balloon GWTPs were converted to pumping stations to deliver untreated groundwater to the Central Area GWTP for treatment and discharge. The conversion involved piping modifications and communication upgrades. The piping modifications at the North and South Balloon GWTPs bypass the first air stripping tower and allowed the blower and transfer pump at each plant to be shut down. Upgrade of the communication systems allows the Central Area GWTP to control operating wells within the North and South Balloons. The upgrades ensure that all operating extraction wells will shut off if the Central Area GWTP is unable to treat groundwater because of a mechanical problem, power failure, or other reason. If necessary, the North and South Balloon GWTPs can still be operated as treatment systems.

4.1.2.2 Description of Effluent Disposal Methods and Requirements

Effluent disposal from the GWTPs was modified during this five-year review period as a result of regulatory changes and optimization activities. The treatment systems were originally designed to facilitate several effluent disposal options (Figure 4-1):

- Discharge via the storm drainage system to the SSJIDC, which flows into French Camp Slough (discontinued in 2006);
- Discharge to the San Joaquin Cogen Limited holding tank located at the south end of DDJC-Sharpe for industrial reuse (discontinued in 2006);
- Use of injection wells for discharge of Central Area effluent (discontinued in 2000); and

- Discharge to the Central Area percolation ponds.

During the period of this five-year review, the discharge of treated groundwater was governed by the substantive WDRs for Land Disposal and NPDES Permit No. CA0081931, Order No. R5-2002-0213, adopted by the RWQCB on 6 December 2002, effective 10 January 2003 (RWQCB, 1992; 2002). Table 4-6 provides the effluent discharge standards. RWQCB issued Time Schedule Order No. R5-2005-0169 in 2005 providing a time schedule for DDJC to test and construct sufficient land disposal locations to eliminate future discharge to surface water (RWQCB, 2005). DDJC-Sharpe submitted the *DDJC-Sharpe Compliance Feasibility Report for Central Valley Regional Water Quality Control Board, Time Schedule Order No. R5-2005-0169* in 2007 (URS, 2007a).The NPDES permit expired on 1 December 2007 and was not renewed. Therefore, only the substantive WDRs for land disposal currently govern the discharge of treated water.

Table 4-6. 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[b]	NE	40[b]
Chromium VI	NE	NE	11
Lead	NE	3.2	NE
Mercury	NE	NE	0.012[c]
Total volatile organic compounds	1	NE	<0.5
Total petroleum hydrocarbons	100	NE	<50
6.5 < pH < 8.5			
Average discharge flow < 1.9 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%		
Substantive WDRs for Discharge of Effluent to Land[d]			
Arsenic	279[e]	NE	NE
Selenium	24.4[e]	NE	NE
Nitrate	20.9[e]	NE	NE
Benzene	1	NE	0.5
BTEX	5	NE	0.5
Bromacil	90	NE	90
Tetrachloroethene	1	NE	0.5
Trichloroethene	1	NE	0.5
Total VOCs	5	NE	1
6.5 < pH < 8.5			

[a] NPDES Permit No. CA0081931, Order No. R5-2002-0213.
[b] Time Schedule Order No. R5-2005-0169 extended the effluent limitation for arsenic to 23 January 2009.
[c] Based on mass mercury study submitted to RWQCB in June 2004.
[d] Substantive WDRs for Land Disposal (Addendum to the Record of Decision).
[e] Limitation is based on the background concentration for the A monitoring zone.

BTEX = benzene, toluene, ethylbenzene, and xylenes
DDJC = Defense Distribution Depot San Joaquin California
NE = not established
NPDES = National Pollutant Discharge Elimination System
RWQCB = Regional Water Quality Control Board−Central Valley Region
VOC = volatile organic compound
WDR = waste discharge requirement
µg/L = micrograms per liter

In response to the lower NPDES effluent limit for arsenic that would have taken effect in January 2009, DDJC-Sharpe chose to evaluate the hydraulic impacts of continuous discharge of effluent to the Central Area percolation ponds from the Central Area GWTP and to the B240 stormwater ponds from the North Balloon GWTP. The evaluation determined that the Central Area percolation ponds are able to accept all of the Central Area GWTP effluent (i.e., up to 500 gpm, the design flow rate of the Central Area GWTP). The B240 ponds can provide only a partial solution to the potential need for an alternate discharge location because during part of each year the ponds must be available to receive stormwater runoff, which diminishes the available capacity for treatment plant discharge. As part of the extraction well optimization test begun in December 2006, all extracted water is treated at the Central Area GWTP and discharges only to the Central Area percolation ponds. Effluent can be discharged to the B240 stormwater ponds during the dry season, if needed (e.g., during Central Area pond maintenance). Figures 4-2 and 4-3 illustrate the discharge schematics before and after implementation of the extraction well optimization test. Figure 4-4 illustrates the discharge schematic since expiration of the NPDES permit.

During the period of this five-year review, compliance sampling was performed at the frequency required by the NPDES permit and/or the substantive WDRs. Figure 4-1 illustrates the sampling locations. Tables B-1 through B-13 in Appendix B summarize treatment plant effluent discharge limit exceedances and compliance with receiving water limitations from October 2002 through September 2007. Effluent was not discharged to land between October 2002 and January 2005; therefore, analytical results were not compared to substantive WDR criteria during that time. Because effluent was not discharged to the SSJIDC after 4 December 2006, compliance sampling under the NPDES permit was not conducted after that date.

4.1.2.3 Description of Monitoring Program

A Well Monitoring Program was established at DDJC-Sharpe to evaluate the effectiveness of the groundwater extraction and treatment remedy. The Well Monitoring Program provides a complete and current set of groundwater data from wells located on the installation and 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 is performed and reported annually in the FFA Annual Progress Report. The interpretation includes evaluation of groundwater level changes, gradients, flow directions, capture zones, and groundwater quality.

Figure 4-5 shows the locations of DDJC-Sharpe groundwater monitoring wells, extraction wells, injection wells, piezometers, observation wells, and potable water wells as of January 2008. Figure 4-6 shows the locations of the groundwater monitoring system boundary piezometers. As of January 2008, there are 357 wells at DDJC-Sharpe: 243 monitoring wells, 45 extraction wells, 10 injection wells, 6 injection observation wells, and 40 piezometers. There are 41 potable water supply wells on depot and off depot within approximately 1,500 feet to the west and 1,200 feet to the north of the depot. Thirty-seven of these potable water supply wells are currently sampled as part of the Well Monitoring Program.

The effort to reduce the number of wells sampled per year and the type of analyses performed has been continuous during this second five-year review period. Table 4-7 lists the actual number of samples collected from wells and the analyses performed during each of the sampling events since 2003. DESJC has evaluated long-term monitoring and operations to assure that only those data necessary for decision making are being collected. Documenting containment of the COC plumes is the principal focus of sampling. Therefore, the Well Monitoring Program is focused on sampling the leading edges of plumes where it is important to document plume behavior. The sampling approach includes an assignment of monitoring well categories based upon a well's location with respect to the nearest plume. The following well categories and frequencies are used:

- **Guard well:** Monitoring well located between a COC plume exceeding its respective ACL and a downgradient potable well that has had either no detectable COCs in any sample or a COC detected at less than the ACL in a sample. Sample twice a year.

- **Plume core well:** Monitoring well located within the core of a plume where COC concentrations have been the greatest in the plume over a period of years. Sample yearly.

- **Downgradient plume stability well:** Monitoring well located downgradient from the plume core and within the COC plume exceeding its respective ACL. Sample twice a year.

- **Plume stability well:** Monitoring well located cross-gradient from a designated plume core well that can provide samples to monitor the lateral extent of a COC plume. Sample yearly.

- **Background well:** Monitoring well located upgradient from all known COC source areas on DDJC-Sharpe. Sample every other year.

Table 4-7. Number of Well Samples Collected, 2003–2007, DDJC-Sharpe

Analyte Suite	Quarterly	Twice Yearly	Yearly
2003 (4Q02-3Q03)[a]			
VOCs	87	18	138
Arsenic	11	2	47
Chromium	12	1	22
Selenium	0	0	6
Pesticides	0	0	1
Bromacil	1	14	17
TPH (gasoline and diesel)	0	4	17 gasoline/18 diesel
SVOCs	0	2	1
Hexavalent chromium	0	1	26
2004 (4Q03-3Q04)[b]			
VOCs	89	39	59
Arsenic	0	0	31
Chromium	0	1	21
Selenium	0	0	4
Bromacil	0	3	6
TPH (gasoline and diesel)	0	2	3
SVOCs	0	0	0
Hexavalent chromium	0	0	4
2005 (4Q04-3Q05)[c]			
VOCs	51	36	146
Arsenic	0	1	23
Chromium	0	0	21
Selenium	0	0	5
Bromacil	0	4	7
TPH (gasoline and diesel)	0	2	4
SVOCs	0	0	1
Hexavalent chromium	0	0	6

Table 4-7. (Continued)

Analyte Suite	Quarterly	Twice Yearly	Yearly
2006 (4Q05& 3Q06)[d,e]			
VOCs	0	66	90
Arsenic	0	0	21
Chromium	0	0	9
Selenium	0	0	6
Bromacil	0	0	9
TPH (gasoline and diesel)	0	0	5
Hexavalent chromium	0	1	3
2007 (4Q06-3Q07)[f]			
VOCs	42	57	144
TPH (diesel)	0	1	3

[a] *DDJC-Sharpe, FFA Annual Progress Report: October 2002 through September 2003* (URS, 2004b).
[b] *DDJC-Sharpe, FFA Annual Progress Report: October 2003 through September 2004* (URS, 2005a).
[c] *DDJC-Sharpe, FFA Annual Progress Report: October 2004 through September 2005* (URS, 2006a).
[d] *DDJC-Sharpe, FFA Annual Progress Report: October 2005 through September 2006* (URS, 2007b).
[e] Samples were not collected in 1Q06 and 2Q06.
[f] *DDJC-Sharpe, FFA Annual Progress Report: October 2006 through September 2007* (URS, 2008a).

DDJC = Defense Distribution Depot San Joaquin California
FFA = Federal Facilities Agreement
SVOC = semivolatile organic compound
TPH = total petroleum hydrocarbons
URS = URS Group, Inc.
VOC = volatile organic compound
4Q02 = fourth quarter 2002 (quarter/year)

For all categories, the well must be screened within the same monitoring zone or zones as the COC plume and, in areas of downward vertical gradients, a guard or downgradient plume stability well should have a screen in a sand interval below the zone in which the plume is migrating. If there are multiple wells that may provide similar information, a “representative” well is selected for sampling and others will not be sampled. A representative well is expected to provide samples that are most representative of the COC plume in a specific portion of the aquifer. A well will be determined to be most representative based on (1) well screen interval (zone) relative to the plume location, (2) hydrogeology (including flow directions and horizontal and vertical hydraulic gradients), and (3) history of sample results (including contaminant trends and COC detections). An extraction well that is not operating may be sampled as a plume core or plume stability monitoring well. Monitoring wells that are not sampled may still be used for water level measurements.

Sampling Frequency for Monitoring Wells. An updated monitoring well sampling frequency decision logic was prepared to be used in conjunction with the well categories defined above. The monitoring well sampling frequency decision logic is provided on Figure 4-7.

Reduction of quarterly sampling was recommended for the 2008 Well Monitoring Program. The frequency reduction is warranted at DDJC-Sharpe based on the following lines of evidence: (1) the stability of COC concentrations on the leading edges of the known plumes, (2) decreasing COC concentrations (79% of statistically significant trends are decreasing), (3) maturity of the groundwater monitoring program (over 10 years of data), and (4) calculated contaminant migration rates using site-specific data (hydraulic conductivity, bulk density, total organic carbon, and horizontal hydraulic gradients) that indicate minimal plume migration is possible in three to six months. However, a well will be sampled quarterly if it is newly installed as part of the Well Monitoring Program and has had less than four samples collected. An analysis performed for the 2008 FFA Annual Progress Report shows that collecting data less than quarterly is sufficient for evaluating trends at this site (URS, 2008a).

Sampling Frequency for Extraction Wells. Each operating extraction well is sampled and analyzed for COCs twice per year. Any extraction well that is not operating may be sampled as a plume core or plume stability monitoring well, if it is a representative well.

Sampling Frequency for Potable Wells. Potable supply wells continue to be monitored by the Well Monitoring Program. However, revisions to the sampling network and frequency are currently being evaluated, and a decision logic is being developed (URS, 2009c, pending).

4.1.2.4 Remedy Optimization Activities

Optimization continues to be an element of the OU 1 remedy at DDJC-Sharpe to help achieve RAOs as efficiently as practical, while maintaining protection of human health and the environment. Optimization efforts implemented at DDJC-Sharpe during this five-year review period are identified in Table 4-8. The optimization activities related to the first item in the list (evaluation of extraction well effectiveness and the reduction in the number of operating extraction wells and treatment plants) are most pertinent to the protectiveness determination of the five-year review; therefore, those optimization activities are described in this section.

Table 4-8. Optimization Activities, DDJC-Sharpe

Optimization Activity	Documented In:
Evaluation of extraction well effectiveness and reduction in number of operating extraction wells and treatment plants.	FFA Annual Progress Reports for 2002 through present *Extraction Well Optimization Work Plan, DDJC-Sharpe* (URS, 2006b) *Evaluation of the Optimized Extraction Well Test, DDJC-Sharpe* (URS, 2009a).
Adjustment of well controls.	Groundwater Treatment Plant Monthly Performance Monitoring Reports
Addition of sequestrants to control scaling in pipelines.	Groundwater Treatment Plant Monthly Performance Monitoring Reports
Preventative maintenance of groundwater extraction and treatment systems, extraction well rehabilitation.	Groundwater Treatment Plant Monthly Performance Monitoring Reports
Focused extraction to remove additional mass of COCs from concentrated portions of South Balloon and Central Area plumes.	*DDJC-Sharpe Focused Groundwater Extraction Test Summary Report* (URS, 2007c)
Development of a three-dimensional groundwater model.	*DDJC Three-Dimensional Groundwater Model Report* (URS, 2006c)
Evaluation of alternative treatment technologies to increase mass removal in the saturated zone[a]: • Introduction of emulsified oil in the North Balloon began in April 2008; • Injection of solid potassium permanganate in the South Balloon began in May 2008; and • Injection of a redox compound in the Central Area began in August 2008.	*Treatment Technology Investigation Results Technical Memorandum, DDJC-Sharpe* (URS, 2006d) *Enhanced Reductive Dechlorination Technology, Emulsified Oil Pilot Study Work Plan* (URS, 2007d) *Oxidation Technology Solid Potassium Permanganate Using Hydraulic Fracturing Pilot Study Work Plan.* (URS, 2008c) *Hydraulic Fracturing and Injection of EHC Pilot Study Work Plan* (URS, 2008d)

[a] The pilot study field activities are expected to be completed by the end of 2009. The tests are designed to evaluate whether injection/introduction of in situ amendments can expedite COC mass destruction at DDJC-Sharpe source areas, thereby reducing the cleanup times estimated using groundwater pumping and extraction alone.

COC = contaminant of concern
DDJC = Defense Distribution Depot San Joaquin California
FFA = Federal Facilities Agreement
URS = URS Group, Inc.

Trend analysis of groundwater analytical data collected since 1996 indicated that concentrations in some portions of plumes were stabilizing and were decreasing to less than the ACLs at some extraction wells. Therefore, efforts were begun in 2004 to optimize the groundwater extraction and treatment system by turning off (but not yet decommissioning) extraction wells that were no longer contributing to achieving RAOs. Optimization of the groundwater extraction and treatment system was appropriate at this stage in the cleanup effort to continue the focus on plume capture, shorten remediation time, and use resources efficiently. Two separate extraction well optimization efforts have been conducted. The first was the adoption of a decision logic in May 2004 to identify extraction wells that were pumping groundwater with contaminant concentrations less than ACLs and to establish a protocol for well shutdown, monitoring, restart, and replacement. The decision logic, presented in the *DDJC-Sharpe FFA Annual Progress Report: October 2002 through September 2003* (URS, 2004b), provided a logical, repeatable process for evaluating extraction well usefulness. Hydrologic and water quality information from the monitoring program provided the basis for the annual decision logic evaluation. The decision logic was used from 2004 through 2006.

A more extensive optimization test of the groundwater extraction and treatment system was implemented in December 2006, as described in the *Extraction Well Optimization Work Plan, DDJC-Sharpe* (URS, 2006b). The extraction well optimization test was based on the premise that 15 extraction wells and natural attenuation mechanisms can contain VOC plumes as effectively as 36 extraction wells. Long-term containment of VOC plumes with 15 operating wells was supported with results from groundwater modeling (URS, 2006a). The rationale for the optimization test included more efficient use of resources (for example, eliminating redundant extraction wells), reduction in water removed from the aquifer, and reduction in potential for easterly migration of saline groundwater. The extraction well optimization test, approved by the regulatory members of the FFA, began in early December 2006 and has continued to the present (April 2009).

The reduced volume of extracted groundwater after extraction wells were shut down in December 2006 created capacity in the Central Area GWTP, allowing the North and South Balloon GWTPs to be converted from treatment facilities to pump stations in April 2007. Currently, all extracted groundwater is conveyed to the Central Area GWTP for treatment and to the Central Area percolation ponds for discharge.

Preliminary optimization test results were summarized in the *DDJC-Sharpe FFA Annual Progress Report: October 2006 through September 2007* (URS, 2008a). A more extensive evaluation of the extraction well optimization test was published in January 2009 (URS, 2009a). The technical assessment in Section 7.0 of this five-year review report uses information from the extraction well optimization test to evaluate plume capture and containment.

4.1.2.5 2007/2008 Cone Penetrometer Test/HydroPunch Investigation

Investigations are conducted at DDJC-Sharpe when deemed necessary to collect additional data for use in the ongoing evaluation and optimization of remedies. During 2007 and 2008, investigations were performed at several locations at DDJC-Sharpe to collect lithologic, soil gas, and/or groundwater data using cone penetrometer test (CPT) drilling and HydroPunch sampling methods. Table 4-9 identifies the site-specific objectives identified in work plans for each investigation, and Figure 4-8 shows the approximate investigation areas. The scope and purposes of the investigations may have evolved as data were collected and preliminary interpretations were made. The investigations are referred to collectively in this five-year review as the 2007/2008 CPT/HydroPunch investigation because the investigations were carried out in a coordinated mobilization effort using a CPT rig. Results from the 2007/2008 CPT/ HydroPunch investigation are documented in the *DDJC-Sharpe Comprehensive Cone Penetrometer Testing Investigation Results Report,* released in draft version in February 2009 (URS, 2009b).

Table 4-9. Purpose of 2007/2008 CPT/HydroPunch Investigation, DDJC-Sharpe

Location	Purpose Statement from Original Work Plan	Document
North Depot Off-Site Area	Collect groundwater samples to (1) define the extent of TCE and PCE along the northern and western depot boundaries, (2) bound the eastern extent of the PCE plume in the North Balloon, (3) determine whether TCE/PCE contamination has migrated north of Roth Road, and (4) determine whether PCE and other COCs detected in private wells PW021 and PW049 are present in groundwater west and east of these wells.	Draft *DDJC-Sharpe Comprehensive Cone Penetrometer Testing Investigation Work Plan* (URS, 2007e).
West Depot Off-Site Area	Collect groundwater samples to determine the downgradient extent of TCE in the C Zone beneath the off-depot area west of the Central Area and the North Balloon.	Final *DDJC-Sharpe CPT Groundwater Investigation Testing Work Plan of the Off-Depot TCE Plume* (URS, 2007f).
EWC4 Area	Confirm the extent of TCE and PCE in the western portion of the South Balloon, especially in the C Zone because of the potential for off-depot migration.	Final *DDJC-Sharpe Groundwater Investigation Work Plan in the Vicinity of EWC4, South Balloon* (URS, 2006e).
South Balloon Source Area	Collect groundwater samples to determine the distribution and continuity of TCE in low- to moderate-permeability soils, and evaluate whether these represent a residual source in the saturated zone near the MW418 well cluster.	Draft *DDJC-Sharpe Comprehensive Cone Penetrometer Testing Investigation Work Plan* (URS, 2007e).
North Balloon Source Area	Collect groundwater samples to better define the VOC mass in the B Zone, with the intent of increasing the effectiveness of the emulsified oil substrate pilot study planned for the area.	*DDJC-Sharpe Enhanced Reductive Dechlorination Technology Emulsified Oil Pilot Study Work Plan* (URS, 2007d).
Site P-2A	Collect soil vapor samples to determine whether TCE detected in soil vapor during the 1987 RI remains at concentrations greater than 0.35 ppmv. If so, collect vapor and water samples to bound the vadose zone contamination and determine whether TCE has impacted groundwater in this area.	Draft *DDJC-Sharpe Comprehensive Cone Penetrometer Testing Investigation Work Plan* (URS, 2007e).
Site P-5A	Collect soil vapor and groundwater samples to delineate the extent of TCE in soil vapor at concentrations greater than 0.350 ppmv. Evaluate the potential relationship between the Site P-5A TCE source area and dissolved TCE currently and historically detected in groundwater at MW437.	Draft *DDJC-Sharpe Comprehensive Cone Penetrometer Testing Investigation Work Plan* (URS, 2007e).

Note: The investigation results are provided in the *DDJC-Sharpe Comprehensive Cone Penetrometer Testing Investigation Results Report* (URS, 2009b).

COC = contaminant of concern
CPT = cone penetrometer test
DDJC = Defense Distribution Depot San Joaquin California
PCE = tetrachloroethene
ppmv = parts per million by volume
RI = remedial investigation
TCE = trichloroethene
VOC = volatile organic compound
URS = URS Group, Inc.

Preliminary 2007/2008 CPT/HydroPunch investigation results were used in preparation of the *DDJC-Sharpe FFA Annual Progress Report: October 2007 through September 2008* (URS, 2008e). The technical assessment in Section 7.0 of this five-year review report uses information from the 2007/2008 CPT/HydroPunch investigation to evaluate plume containment.

4.1.3 Groundwater Treatment System O&M

The groundwater remedy is operated in accordance with the O&M manuals for the North Balloon, South Balloon, and Central Area GWTPs, which describe procedures to operate and maintain the three groundwater treatment systems at DDJC-Sharpe (URS, 2003a; 2003b; and 2001a, respectively). The manuals were written to comply with the requirements in the *Remedial Design/Remedial Action Handbook* (EPA, 1995). Modifications to the groundwater 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 program. Accordingly, the decision making criteria and guidance for long-term management of the groundwater treatment systems are evaluated in the FFA Annual Progress Reports, not the O&M manuals.

Scheduled and unscheduled treatment system shutdowns are reported in GWTP monthly performance monitoring reports, which are provided to regulatory agencies. Numerous maintenance activities and system improvements have been implemented since the treatment plants have been put into operation. Appendix C lists system improvements for each treatment plant since 1996.

4.1.3.1 O&M Activities

O&M activities include daily, weekly, and monthly O&M inspections; monthly, quarterly, semiannual, and annual O&M service and calibration; and system shutdowns for scheduled and unscheduled maintenance or repair. Emergency maintenance includes correction of deficiencies that have rendered a treatment system, or part of a system, inoperable.

Other specialized maintenance activities may be required by other environmental program activities, such as groundwater monitoring or treatment plant optimization tasks. Specialized O&M activities during this five-year review period were associated with the conversion of the North and South Balloon GWTPs from treatment plants to pumping stations. The operational status of extraction wells (as of April 2009) is summarized in Table 4-4.

4.1.3.2 O&M Costs

From 1996 through September 2007, approximately 1,308 pounds (lbs) of COCs were removed from groundwater beneath the DDJC-Sharpe installation and treated by the groundwater treatment systems. Since 1996, approximately $14.7 million has been spent on groundwater remediation costs. Before 1996, approximately $13.0 million was spent on capital costs for installation of the three treatment systems and associated O&M and groundwater monitoring costs from 1984 through 1995. (Note: These capital costs were not used in the cost-per-pound calculations.) Therefore, the cost of the OU 1 remedial action (approximately $28 million) has far exceeded the estimated 1993 net present worth of $4.1 million (ESE, 1993). The estimated operating period of 16 years will be exceeded in 2014.

During this five-year review period, the average cost-per-pound of COCs removed was approximately $15,000 (Table 4-10). The costs used to calculate cost-per-pound for DDJC-Sharpe groundwater remediation includes costs for the O&M of the extraction and treatment plant systems, including the costs to perform improvements; the costs for performance monitoring (sampling, laboratory analysis, data validation, and reporting); and costs associated with the Well Monitoring Program, which is used to

evaluate groundwater remedy effectiveness. The annual average cost-per-pound of COC mass removed decreased after it peaked in 2001 ($19,000/lb), remaining relatively stable from 2003 through 2006. This decrease from the 2001 peak is largely the result of optimization efforts conducted in 2003 through 2006. In 2007, the cost-per-pound more than doubled due to decreased mass removed associated with the shutdown of some extraction wells as part of the extraction well optimization test effort.

Table 4-10. Annual Cost-Per-Pound of Mass Removed from 2003–2007, DDJC-Sharpe

Year	Annual Cost[a] ($)	Mass Removed[b] (lbs)	Average Cost Per Pound[c] ($/lb)
2003	1,167,827	85.59	13,644
2004	1,298,568	93.07	13,953
2005	1,358,825	93.13	14,591
2006	1,085,715[d]	78.96	13,749
2007	1,097,680	38.50	28,511
Total	**$6,008,615**	**389.25**	**$15,436[e]**

[a] Cost includes GWTP O&M costs, supporting performance monitoring costs, and Well Monitoring Program costs for the calendar year.
[b] Total pounds removed during the monitoring period October through September.
[c] Average cost per pound = cost/mass removed for that year.
[d] The monitoring program, which included both quarterly monitoring and GWTP sampling, was not funded for the first and second quarters of calendar year 2006.
[e] This value is the cumulative cost divided by the cumulative pounds of COC mass extracted.

COC = contaminant of concern
DDJC = Defense Distribution Depot San Joaquin California
GWTP = groundwater treatment plant
lbs = pounds
O&M = operation and maintenance
$/lb = cost per pound

4.2 Soil Remedy

This section briefly describes OU 2 remedies and their implementation, with emphasis on events that occurred during the second five-year review period.

4.2.1 Remedy Selection

The *Record of Decision Basewide Remedy for DDRW-Sharpe Site* (OU 2 ROD) was signed in February 1996 by DDJC, EPA, DTSC, and RWQCB to address TCE, metals, and pesticides in the soil and/or soil gas above the water table; the ROD also identifies 111 SWMUs for which no further action (NFA) or characterization is needed (ESE, 1996). For TCE and metals contamination in soil, the ROD identifies sites that required remedial action *and* sites that required further characterization in order to determine whether remedial action is necessary. The ROD identifies the remedial action for each of these contaminants, and it also identifies the investigation and evaluation criteria for determining whether remedial action is necessary. Figure 4-9 shows the locations of OU 2 soil sites and illustrates their current status using the following legend:

- Sites the OU 2 ROD identifies as needing no further action;
- Sites investigated after the ROD was signed and for which no remedial action was determined to be necessary;
- Sites at which remedial action has been implemented and completed; and
- Sites at which further characterization or action is still needed.

Table 4-11 summarizes the content of the OU 2 ROD, including cleanup standards and RAOs.

4.2.2 Remedy Implementation

The implementation of remedial actions for TCE, metals, and pesticide areas are described in Sections 4.2.2.1 through 4.2.2.3, respectively. The first five-year review confirmed that remedial actions completed prior to or during the first five-year review period were designed and implemented in accordance with the OU 2 ROD (URS, 2004a). The only remedial action performed during this five-year review period was completion of the soil excavation at metals site S-26, Area 6. During this review period, further characterization was performed at TCE sites P-2A and P-5A.

4.2.2.1 TCE

The OU 2 ROD selected SVE for soil with TCE concentrations in soil gas that pose a potential threat to groundwater quality (ESE, 1996). The TCE sites identified in the ROD were grouped according to those requiring SVE and those requiring further characterization to evaluate whether SVE was required to meet the RAOs. Table 4-12 identifies the sites for which SVE operations were performed. SVE operations were completed by 2001 and the systems were decommissioned in 2002. The first five-year review confirmed the SVE systems were designed, constructed, and operated in compliance with the OU 2 ROD (URS, 2004a). Appendix D lists documents related to the design, construction, and operation of SVE systems. No SVE systems operated during the period of this second five-year review.

Table 4-12 also identifies the TCE soil sites for which the ROD specifies the need for further characterization. For most of those sites, further characterization was performed prior to or during the first five-year review period and led to the conclusion that no remedial action was necessary to accomplish the RAOs. During this five-year period, characterization of Site P-2A was completed, and the investigation concluded that no remedial action is needed. Table 4-13 identifies TCE sites investigated after the OU 2 ROD was signed and provides conclusions from the investigations.

The DDJC-Sharpe Well Monitoring Program provides analytical data to evaluate whether the remedy continues to be protective of groundwater quality. For TCE soil site P-5A, groundwater data prompted further investigations, which were performed during this five-year review period. The results of the investigations indicate that a remedial action is required at Site P-5A.

The following paragraphs describe the investigations performed during this five-year review period for TCE soil sites P-2A and P-5A.

Table 4-11. Summary of OU 2 ROD Components, DDJC-Sharpe

Decision Document Title:	*Record of Decision, Basewide Remedy for DDRW-Sharpe Site*. Final. February 1996.
Sites:	The OU 2 ROD identifies 111 SWMUs for which no further action is needed. The OU 2 ROD identifies 22 SWMUs requiring remedial action **or** further characterization related to potential TCE, metals, and pesticide contamination.
TCE-Contaminated Soil Sites	
Remedial Action Objectives:	The ROD states that the TCE-contaminated soil sites do not pose a risk to human health (ESE, 1996, page 120). The RAO is to prevent further degradation of groundwater and minimize aquifer cleanup time by reducing the mass of TCE that reaches groundwater (ESE, 1996, page 104).
COC and Cleanup Standard:	TCE, 0.35 ppmv in soil vapor.
Remedy:	SVE.
Metals-Contaminated Soil Sites	
Remedial Action Objectives:	The RAO for metals-contaminated soil sites is to remove soil with concentrations of lead and chromium that could pose a threat to on-site adult workers (ESE, 1996, page 116). Following removal of contaminated soils, evaluate the impact or threat of impact to groundwater from the residual lead and chromium in the vadose zone (ESE, 1996, pages 99 and 102).
COCs and Cleanup Standards:	Total lead, 1,000 mg/kg. Total chromium, 300 mg/kg.
Remedy:	Excavation with off-site disposal.
Pesticide-Contaminated Soil Sites	
Remedial Action Objective:	The RAO for pesticide-contaminated soil is to remove soil with concentrations of pesticides that could pose a threat to human health, the environment, or groundwater quality (ESE, 1994c, page 3-1).
COCs and Cleanup Standards:	Chlordane, 1 mg/kg. Dichlorodiphenyldichloroethene (DDE), 2 mg/kg. Dichlorodiphenyldichloroethane (DDD), 3 mg/kg. Dichlorodiphenyltrichloroethane (DDT), 2 mg/kg. Dieldrin, 0.04 mg/kg.
Remedy:	Excavation with off-site disposal.

COC	=	contaminant of concern	ppmv	=	parts per million by volume
DDJC	=	Defense Distribution Depot San Joaquin California	RAO	=	remedial action objective
DDRW	=	Defense Distribution Region West	ROD	=	record of decision
ESE	=	Engineering Science and Engineering	SVE	=	soil vapor extraction
mg/kg	=	milligrams per kilogram	SWMU	=	solid waste management unit
OU	=	operable unit	TCE	=	trichloroethene

Table 4-12. Status of TCE Soil Sites, DDJC-Sharpe

TCE Soil Sites for which SVE has been Completed:	**P-1A, P-1B, P-1C, P-1E, and P-6A**. SVE system operated between July 1998 and December 2001. Vadose zone modeling of post-SVE TCE concentrations in soil gas predicted that the residual mass should not pose an unacceptable threat to groundwater. Remedial action completed; no further action required. SVE systems were decommissioned in 2002.
	P-8A. Pilot SVE system that operated in 1992 and 1995 remediated most of the vadose zone contamination; the area of the 0.35 ppmv TCE contour in soil gas has since been submerged by rising aquifer levels making further SVE economically infeasible.
TCE Soil Sites for which Further Characterization Determined No Remedial Action is Required:	**P-1D, P-1F, P-1G, P-2A, P-2B, P-3A, P-4A, P-4B, and P-4C**. See Table 4-13 for characterization conclusions.
TCE Soil Sites for which Remedial Action or Further Characterization is Needed:	**P-5A.** Groundwater monitoring data indicated the potential presence of a continuing source area. Results from soil gas samples collected during the 2007/2008 CPT/HydroPunch investigation indicate remedial action (SVE) is required.

CPT = cone penetrometer test
DDJC = Defense Distribution Depot San Joaquin California
ppmv = parts per million by volume
SVE = soil vapor extraction
TCE = trichloroethene

Table 4-13. TCE Soil Sites Requiring No Remedial Action Based on Further Characterization, DDJC-Sharpe

Site No.	Site Background	Impact to Groundwater	Conclusions[a]
P-1D	Maximum TCE in soil gas: 40.5 ppmv, measured during the 1987 RI/FS OU 2 ROD designation: "Design"	Monitoring data indicate that TCE has not been detected in groundwater beneath this site since 1996. There is no TCE groundwater plume beneath the site.	1996, 1997, and 1999 field investigation results indicate TCE concentrations in soil gas do not exceed the 0.35 ppmv decision level. Future impact to groundwater is insignificant to non-existent.
P-1F	Maximum TCE in soil gas: 3.93 ppmv, measured during the 1987 RI/FS OU 2 ROD designation: "Further Characterization"	Groundwater monitoring data suggest that VOC contamination in the vadose zone has not migrated to groundwater in the past 10 years. There is no TCE groundwater plume beneath the site.	1996, 1997, and 1999 field investigation results indicate TCE concentrations in soil gas do not exceed the 0.35 ppmv decision level. No future impact to groundwater is expected.
P-1G	Maximum TCE in soil gas: 2.929 ppmv, measured during the 1987 RI/FS OU 2 ROD designation: "Further Characterization"	Vadose zone modeling predicts no increase in total time of groundwater remediation. Groundwater monitoring data suggest that much of the vadose zone TCE mass has already migrated to groundwater.	Future impact to groundwater is expected to be minimal. Results of a technical and economic feasibility analysis indicate implementation of an SVE system is not economically feasible.
P-2A (East)	Maximum TCE in soil gas: 1.70 ppmv, measured during the 1996 investigation OU 2 ROD designation: "Further Characterization"	Vadose zone modeling predicts no increase in total time of groundwater remediation. Groundwater monitoring data indicate that the site is not a source of groundwater contamination.	Future impact to groundwater is expected to be minimal. Results of a technical and economic feasibility analysis indicate implementation of an SVE system is not economically feasible.
(West)	Maximum TCE in soil gas: 0.42 ppmv, measured during the 1987 RI/FS OU 2 ROD designation: "Further Characterization"	Groundwater monitoring data indicate that the site is not a source of groundwater contamination.	2007 field investigation results indicate TCE concentrations in soil gas do not exceed the 0.35 ppmv decision level. No future impact to groundwater is expected. No further action recommended in the *DDJC-Sharpe Comprehensive Cone Penetrometer Testing Investigation Results Report* (URS, 2009b).

Table 4-13. (Continued)

Site No.	Site Background	Impact to Groundwater	Conclusions[a]
P-2B	Maximum TCE in soil gas: 1.00 ppmv, measured during the 1996 field investigation Site was not included in OU 2 ROD but was characterized during the 1996, 1997, and 1999 field investigations	Vadose zone modeling predicts no increase in total time of groundwater remediation. Groundwater monitoring data suggest that VOC contamination in the vadose zone has not migrated to groundwater in the past 10 years. There is no TCE groundwater plume beneath the site.	Future impact to groundwater is expected to be minimal. 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 OU 2 ROD designation: "Further Characterization"	Vadose zone modeling predicts no increase in total time of groundwater remediation. Groundwater monitoring data suggest that much of the vadose zone TCE mass has already migrated to groundwater.	Future impact to groundwater is expected to be minimal. 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: 3.19 ppmv, measured during the 1987 RI/FS OU 2 ROD designation: "Further Characterization"	Groundwater monitoring data suggest that much of the vadose zone TCE mass has already migrated to groundwater. There is no TCE groundwater plume beneath the site.	1996, 1997, and 1999 field investigation results indicate TCE concentrations in soil gas do not exceed the 0.35 ppmv decision level. No further impact to groundwater is expected.
P-4B	Maximum TCE in soil gas: 2.70 ppmv, measured during the 2000 field investigation OU 2 ROD designation: "Further Characterization"	Vadose zone modeling predicts no increase in total time of groundwater remediation. Groundwater monitoring data suggest that the vadose zone TCE mass has already migrated to groundwater.	Future impact to groundwater is expected to be minimal. Results of a technical and economic feasibility analysis indicate implementation of an SVE system is not economically feasible.
P-4C	Maximum TCE in soil gas: 1.60 ppmv, measured during the 1987 RI/FS Site was not included in OU 2 ROD but was characterized further during the 1996, 1997, and 1999 field investigations	Groundwater monitoring data suggest that the vadose zone TCE mass has already migrated to groundwater.	1996, 1997, and 1999 field investigation results indicate TCE concentrations in soil gas do not exceed the 0.35 ppmv decision level. No further impact to groundwater is expected.

Table 4-13. (Continued)

Site No.	Site Background	Impact to Groundwater	Conclusions[a]
P-8A	Maximum TCE in soil gas: 4.12 ppmv, measured during the 1987 RI/FS OU 2 ROD designation: "Design" Pilot SVE system operated in 1993 and 1995	Vadose zone modeling predicts no increase in total time of groundwater remediation. Water levels have risen at the site, from a depth of 22 to 15.5 feet bgs.	Future impact to groundwater is expected to be minimal. Operation of pilot SVE system has remediated most of the vadose zone contamination. 1999 field investigation results indicate TCE concentrations in soil gas do not exceed the 0.35 ppmv decision level. The area of the 0.35 ppmv TCE contour in soil gas has been submerged by rising aquifer levels. Results of a technical and economic feasibility analysis indicate operation of the existing SVE system is not economically feasible.

[a] Unless noted otherwise, the conclusions are documented in *Operable Unit 2 No Further Action Remedial Action Report* (Radian International, 2000a).

bgs = below ground surface
DDJC = Defense Distribution Depot San Joaquin California
FS = feasibility study
OU = operable unit
ppmv = parts per million by volume
RI = remedial investigation
ROD = record of decision
SVE = soil vapor extraction
TCE = trichloroethene
VOC = volatile organic compound

Site P-2A

The OU 2 ROD called for further characterization of Site P-2A. As documented in the first five-year review (URS, 2004a), an SVE pre-design investigation conducted at the eastern portion of P-2A in 1996 indicated TCE concentrations in the vadose zone were less than the ROD cleanup objective of 0.35 ppmv in soil vapor. The eastern portion of the site, therefore, does not require remedial action, as documented in the *Operable Unit 2 No Further Action Remedial Action Report, DDJC-Sharpe* (NFA RAR) (Radian International, 2000a).

The western portion of Site P-2A was investigated in 2007 to complete the OU 2 ROD requirement for further characterization of TCE in soil vapor. Document reviews indicated that the area designated for further soil vapor investigation was based on one detection of TCE at 0.42 ppmv in one soil gas sample collected at approximately 5 feet bgs during the 1987 RI (Radian International, 1997a). The soil gas sample results from the 2007 investigation indicate TCE concentrations do not exceed the 0.35 ppmv soil vapor cleanup level and no future impact to groundwater is anticipated (URS, 2009b).

Site P-5A

Data from the Well Monitoring Program indicated the potential for a continuing TCE source in the area of Site P-5A, a site previously identified as requiring no remedial action (Radian International, 2000a). Additional investigations conducted at Site P-5A in 2006 and 2007 delineated a residual TCE source area (URS, 2007g; 2009b). Soil gas concentrations exceeding the cleanup level in this source area require a remedial action (i.e., SVE) to remain protective of groundwater. The implementation and operation of SVE at Site P-5A will be assessed in the third five-year review to determine whether the remedial action meets the requirements of the OU 2 ROD for TCE-contaminated sites. Those requirements are as follows:

- Delineate areas suspected of being sources of groundwater contamination using soil gas data.
- Construct SVE systems such that they can be operated independently of each other to remediate contamination at multiple sites. 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. Finally, install soil gas monitoring wells to monitor remediation progress.
- Collect soil gas monitoring data and track the cumulative mass of VOCs removed.
- Alternate extraction operations with rebound periods; during extraction periods, operate until VOC concentrations behave asymptotically.
- Discontinue the operation of extraction wells in areas where cleanup standards have been attained.
- Use modeling to predict the effects of the residual VOCs on groundwater.

4.2.2.2 Metals

The remedial action specified in the OU 2 ROD for soils with metals concentrations exceeding cleanup standards is excavation with off-site disposal (ESE, 1996). The OU 2 ROD identifies 14 areas as exceeding the soil cleanup standard of 1,000 mg/kg for total lead and/or 300 mg/kg for total chromium. These 14 areas were combined into five metals sites: S-30, S-33/29, S-36, S-3, and S-26 (Areas 1 through 6). The first five-year review confirmed that the investigations performed at the first three sites

were sufficient to conclude that no remedial action was required at these sites (Table 4-14). The first five-year review also confirmed that the excavations performed at Sites S-3 and S-26 (Areas 1 through 5) were completed in compliance with the OU 2 ROD. The remedial action at Site S-26, Area 6 was not performed during the first five-year review period. The documents associated with the completion of the selected remedy for metals contamination at soil sites are listed in Appendix E.

During this second five-year review period, the remedial action at Site S-26, Area 6 was completed. Also, DESJC will be submitting a ROD amendment to add LUCs at all five metals sites because the cleanup levels for lead and chromium are based on industrial land use; therefore, they do not allow for unlimited use and unrestricted exposure. This section describes completion of the remedial action at Site S-26 during the period of the second five-year review. Section 4.2.3 describes the LUCs proposed for the metals soil sites.

Table 4-14. Metals Soil Sites Requiring No Remedial Action Based on Further Characterization, DDJC-Sharpe

Site No.	Site Background	Conclusions[a]
S-30	Maximum lead and chromium concentrations in soil: 27,500 and 171 mg/kg, respectively, measured during the 1994 RI/FS using x-ray fluorescence analysis that was later considered unreliable because of poor correlation with confirmatory laboratory results OU 2 ROD designation: "Excavation/Off-Site Disposal" Maximum post-ROD lead and chromium concentrations in soil: 240 and 130 mg/kg, respectively, without excavation	Post-ROD 1996 and 1999 field investigation results indicated lead and chromium concentrations in soil do not exceed cleanup standards. Based on soluble lead and chromium results from DI WET analysis, future impacts to groundwater are expected to be minimal.
S-33/29	Maximum lead and chromium concentrations in soil: 1,542 and 329 mg/kg, respectively, measured during the 1994 RI/FS using x-ray fluorescence analysis that was later considered unreliable because of poor correlation with confirmatory laboratory results OU 2 ROD designation: "Excavation/Off-Site Disposal" Maximum post-ROD lead and chromium concentrations in soil: 670 and 32 mg/kg, respectively, without excavation	Post-ROD 1996 and 1998 field investigation results indicated lead and chromium concentrations in soil do not exceed cleanup standards. Based on soluble lead and chromium results from DI WET analysis, future impacts to groundwater are expected to be minimal.
S-36	Maximum lead and chromium concentrations in soil: 3,990 and 722 mg/kg, respectively, measured during the 1994 RI/FS using x-ray fluorescence analysis that was later considered unreliable because of poor correlation with confirmatory laboratory results OU 2 ROD designation: "Excavation/Off-Site Disposal" Maximum post-ROD lead and chromium concentrations in soil: 370 and 110 mg/kg, respectively, without excavation	Post-ROD 1996 and 1999 field investigation results indicated lead and chromium concentrations in soil do not exceed cleanup standards. Based on soluble lead and chromium results from DI WET analysis, future impacts to groundwater are expected to be minimal.

Table 4-14. (Continued)

[a] Unless otherwise noted, the conclusions are documented in *Operable Unit 2 No Further Action Remedial Action Report* (Radian International, 2000a).

DDJC	=	Defense Distribution Depot San Joaquin California	OU	=	operable unit
DI WET	=	deionized water waste extraction test	RI	=	remedial investigation
FS	=	feasibility study	ROD	=	record of decision
mg/kg	=	milligrams per kilogram			

Site S-26, Area 6

During the period of this five-year review, DESJC completed the remedial action at Site S-26, Area 6. The remedial action had been deferred due to the costs associated with removing railroad tracks present within the excavation design limits and the minimal potential risk to human health, the environment, and groundwater quality (Radian International, 1997b; CKY, Inc., 1998). At the November 2005 RPM meeting, RPMs agreed to use an industrial cleanup criterion of 800 mg/kg for total lead at Area 6 (URS, 2005b). This cleanup level is based on the October 2004 EPA industrial preliminary remediation goal (PRG) for lead (EPA, 2004a). The ROD cleanup objective for chromium remains at 300 mg/kg.

Excavation of Area 6 was conducted on 15 and 17 November 2006, and included removal of approximately 116 tons (approximately 87 cubic yards) of soil and railroad ballast. The soil excavation was carried out following the procedures and specifications given in *DDJC-Sharpe Site, Remedial Action Work Plan, Site S-26, Area 6* (URS, 2006f), which maintained the objectives of the earlier soil excavations, but modified some procedures due to the small excavation area. Soil and railroad ballast were excavated from an area of approximately 1,170 square feet to a depth of 2 feet bgs. Site S-26, Area 6 was backfilled with clean soil on 13 April 2007. The railroad tracks removed to allow site excavation were replaced in December 2008. Therefore, the remedial action at Site S-26 is complete and no further action is required to allow the site to be used for industrial purposes (Radian International, 2000b; URS, 2008f).

4.2.2.3 Pesticides

The only pesticide-contaminated site identified in the OU 2 ROD is the Pesticide Mix Area. The OU 2 ROD indicates that the soil removal action completed at the Pesticide Mix Area removed all soils determined to represent a potential threat to human health and the environment, as defined in *Removal Action Memorandum for Pesticide Mix Area, North Balloon Area, Lathrop, California* (ESE, 1994c). No actions for pesticides in soils were performed during the second five-year review period.

4.2.3 LUCs

Future land use assumptions are developed and considered throughout the CERCLA process, such as when performing a baseline risk assessment, developing remedial action alternatives, and selecting a remedy. When the selected remedy allows contaminants to be left in place at levels that do not allow for unlimited use and unrestricted exposure, LUCs are applied to ensure the selected remedies are protective of human health and the environment. LUCs help minimize the potential for human exposure to contamination by restricting activity, use, and access to properties with residual contamination.

Cleanup levels established in the OU 2 ROD for lead- and/or chromium-contaminated sites are based on industrial land use; thus, the remedy does not allow for unlimited use and unrestricted exposure. Therefore, LUCs are required to protect human health and the environment. A ROD amendment is being

prepared to document LUCs at Sites S-3, S-26, S-30, S-33/29, and S-36 (URS, 2009d). The objective of the LUCs will be to prohibit the development and use of property for residential housing; elementary and secondary schools; child care facilities; and playgrounds. The LUCs will be in effect indefinitely, unless lead and chromium concentrations in soil are reduced to concentrations that allow for unrestricted use of the land (e.g., if future excavations resulted in cleanup to residential use levels, the LUCs would no longer be needed). The forthcoming ROD amendment will replace previous documentation of LUCs in the area south of South Crane Way in the South Balloon (URS, 2002b; 2002c) because those LUCs were not promulgated in an enforceable decision document. Only Sites S-30, S-33/29, and S-36 in the South Balloon require LUCs, not the entire area south of South Crane Way.

The implementation of the LUC remedial action will occur following signature of the forthcoming ROD amendment (URS, 2009d). The implementation and effectiveness of the LUCs will be assessed in the third five-year review.

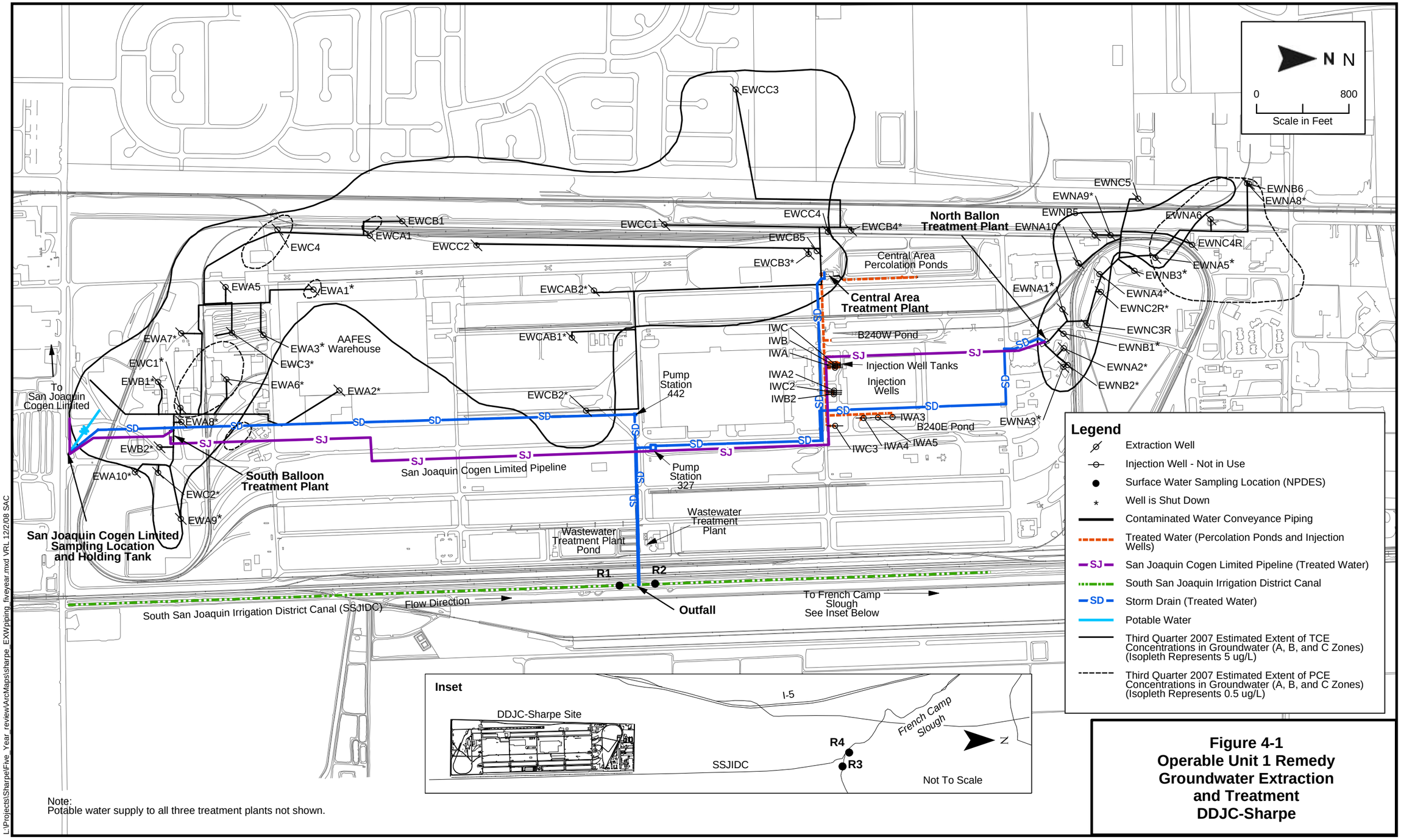


Figure 4-1
Operable Unit 1 Remedy Groundwater Extraction and Treatment DDJC-Sharpe

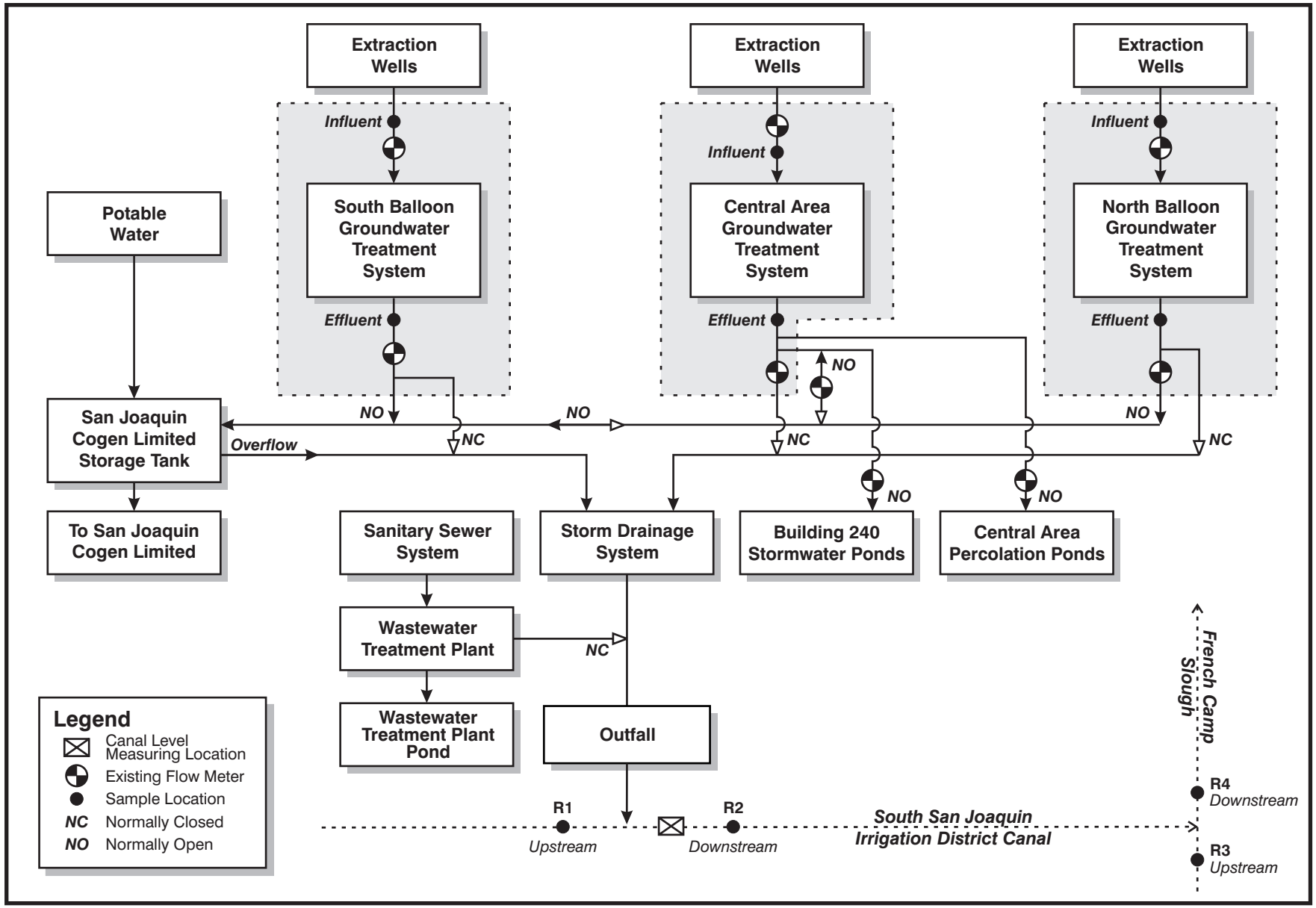


Figure 4-2. Flow Schematic and Discharge Sampling Locations for DDJC-Sharpe Groundwater Treatment Plants Prior to Implementation of Extraction Well Optimization Program (2003 - 4 December 2006)

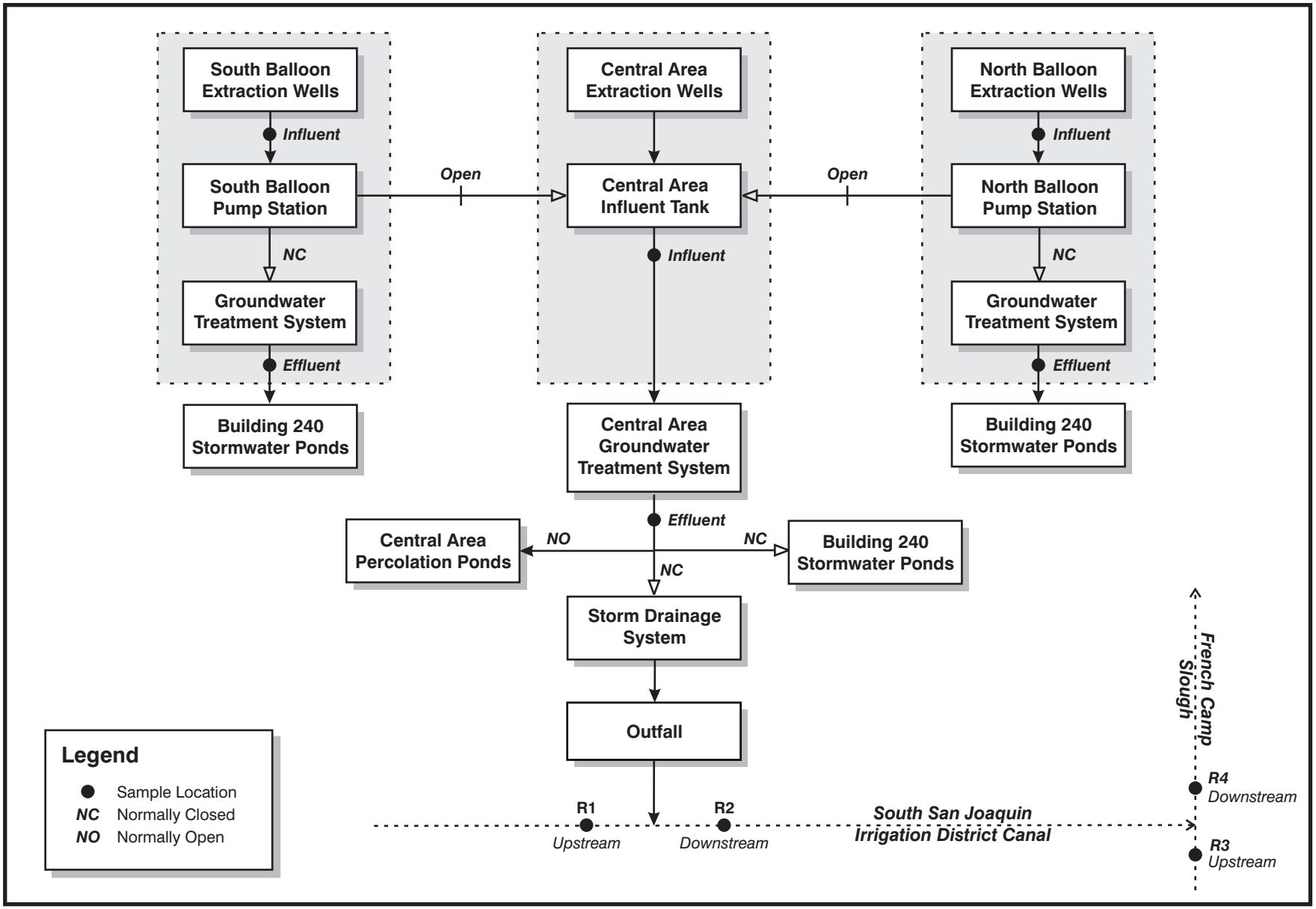


Figure 4-3. Flow Schematic and Discharge Sampling Locations for DDJC-Sharpe Groundwater Treatment Plants After Implementation of Extraction Well Optimization Program (5 December 2006 - 1 December 2007)

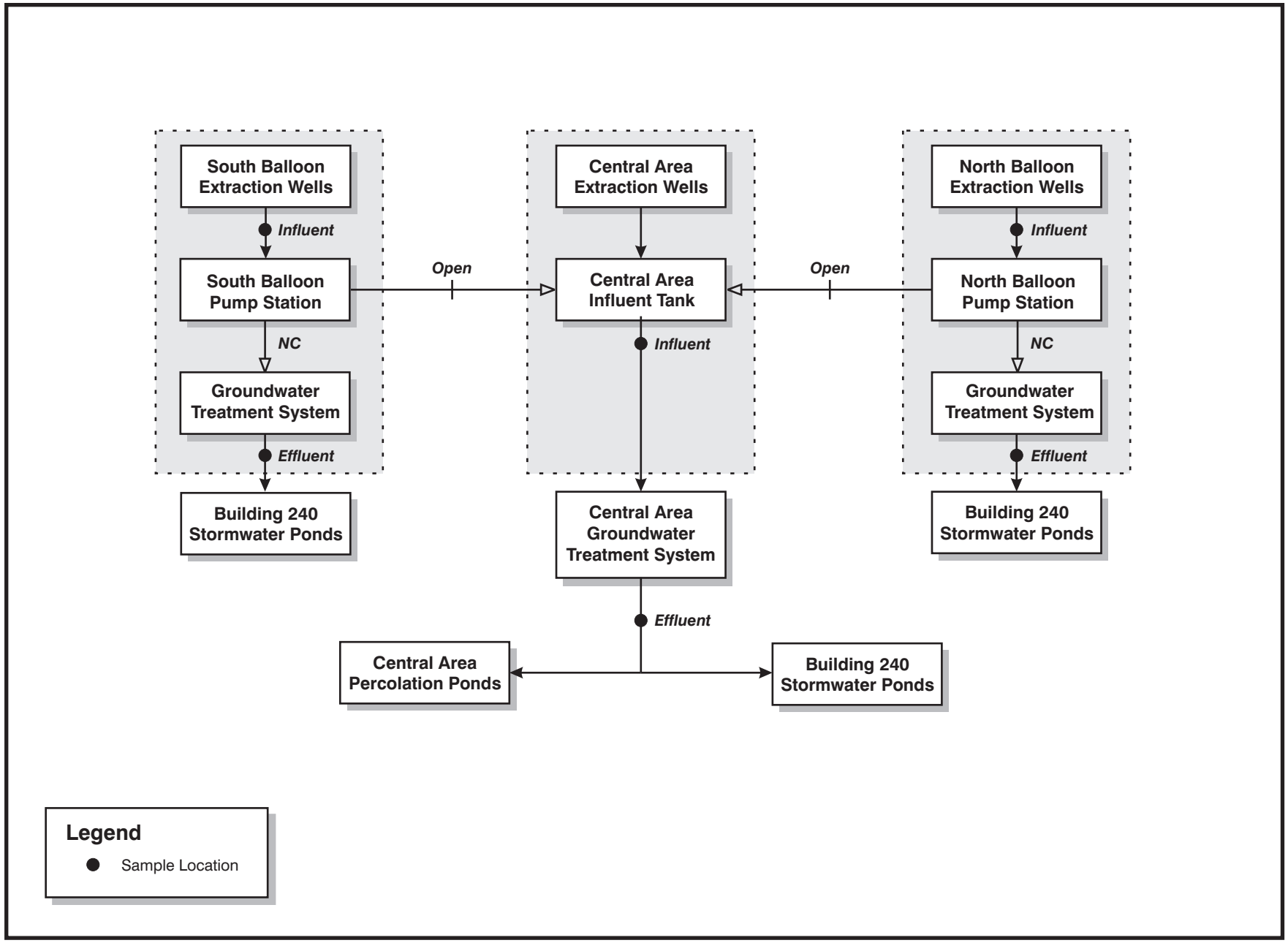


Figure 4-4. Flow Schematic and Discharge Sampling Locations for DDJC-Sharpe Groundwater Treatment Plants After Expiration of NPDES Permit (December 2007 - Present)

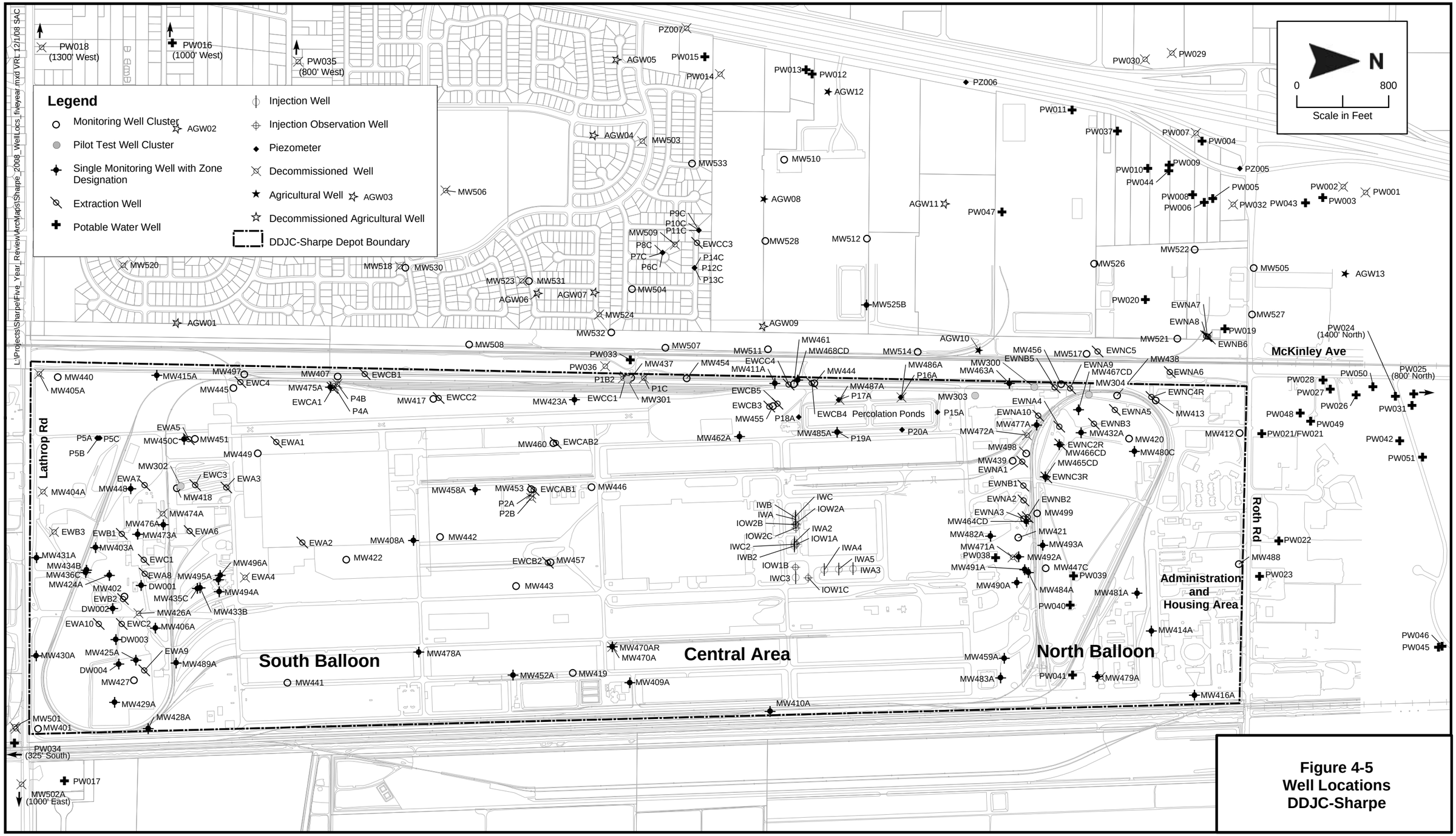


Figure 4-5
Well Locations
DDJC-Sharpe

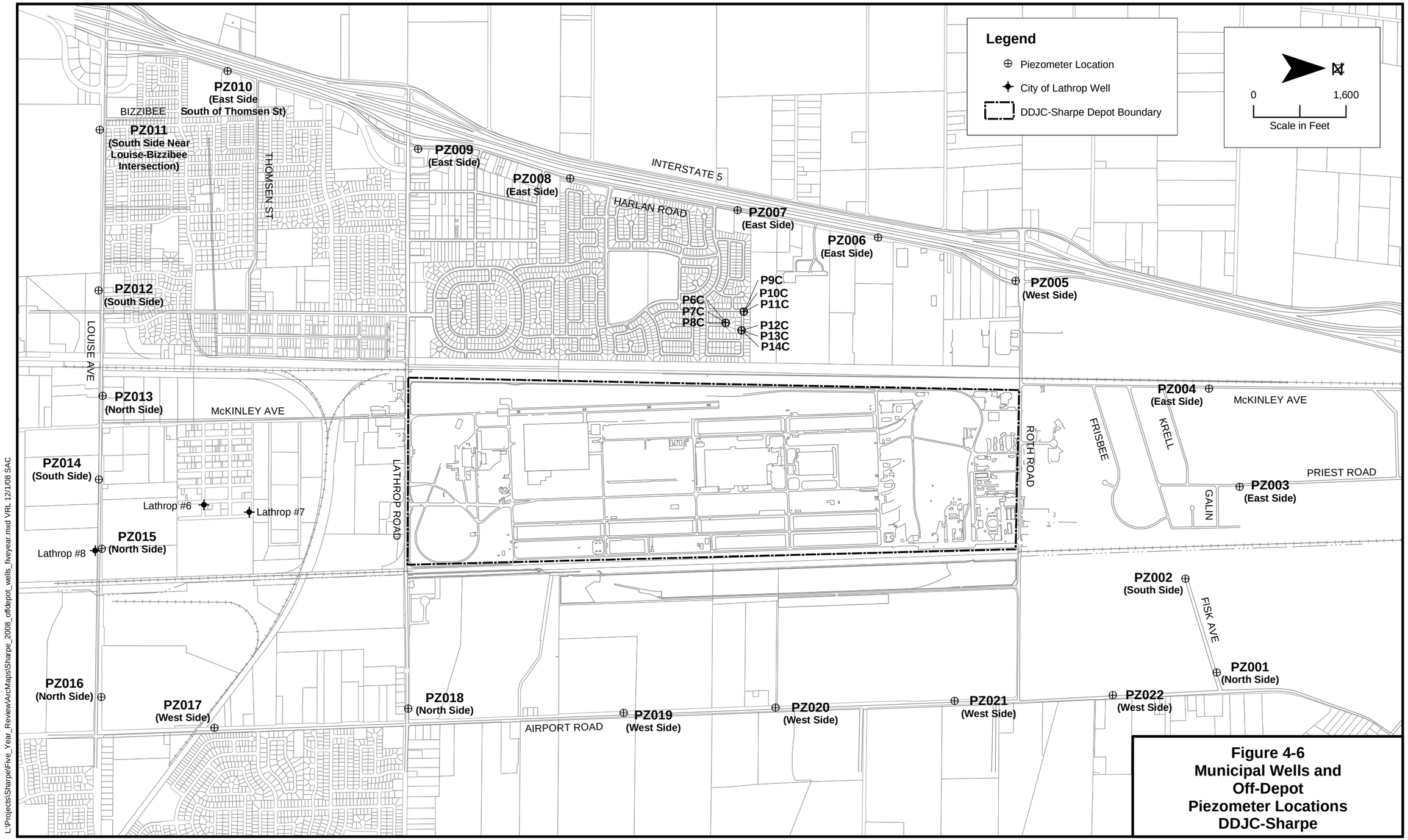


Figure 4-6
Municipal Wells and Off-Depot Piezometer Locations DDJC-Sharpe

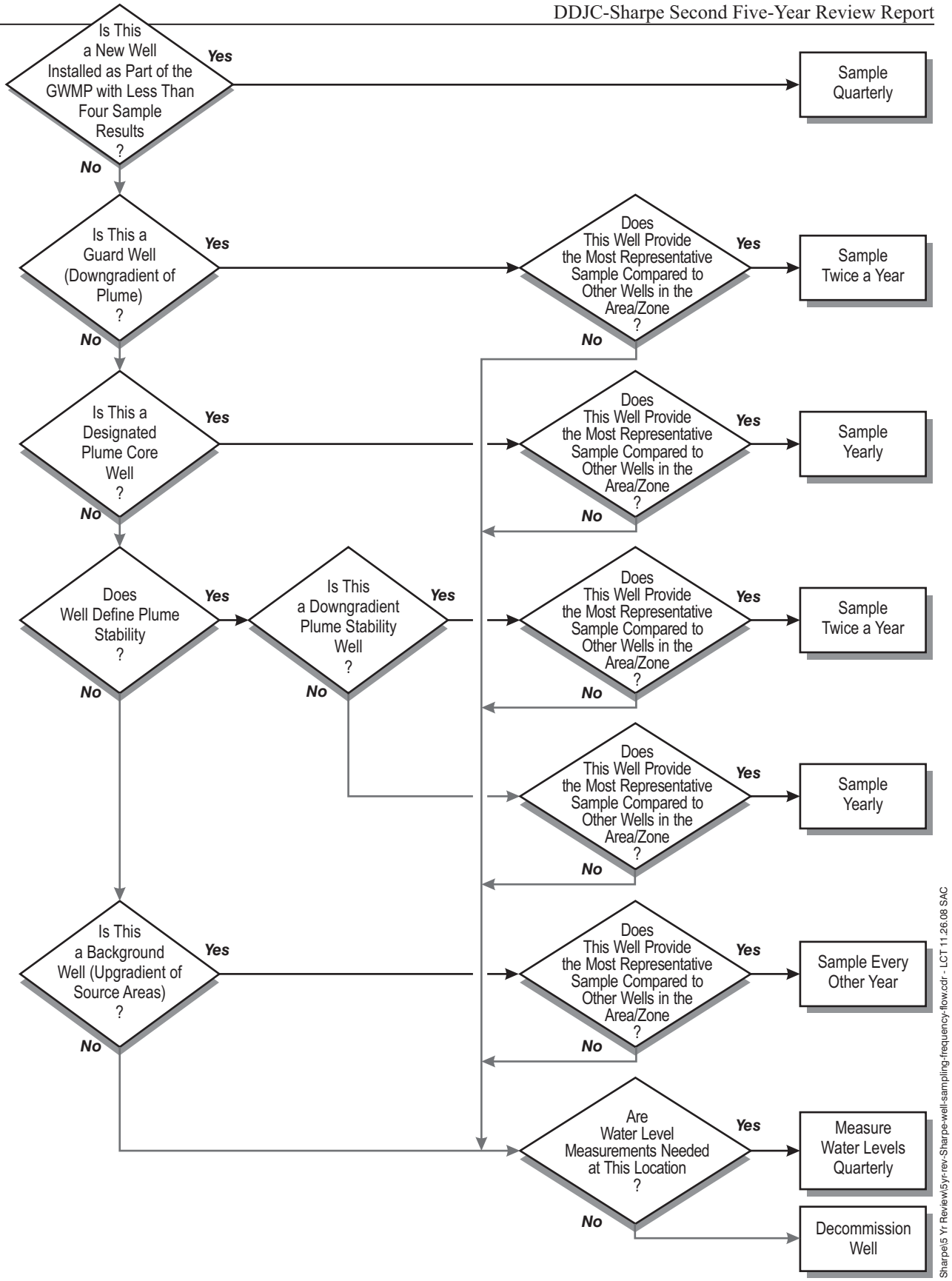


Figure 4-7. Monitoring Well Sampling Frequency Decision Logic for DDJC-Sharpe

L:\Projects\Sharpe\Five_Year_Review\ArcMaps\Sharpe_2008_SWMUs_TCE_CPT_investigations_letter.mxd VRL 4/22/09 SAC

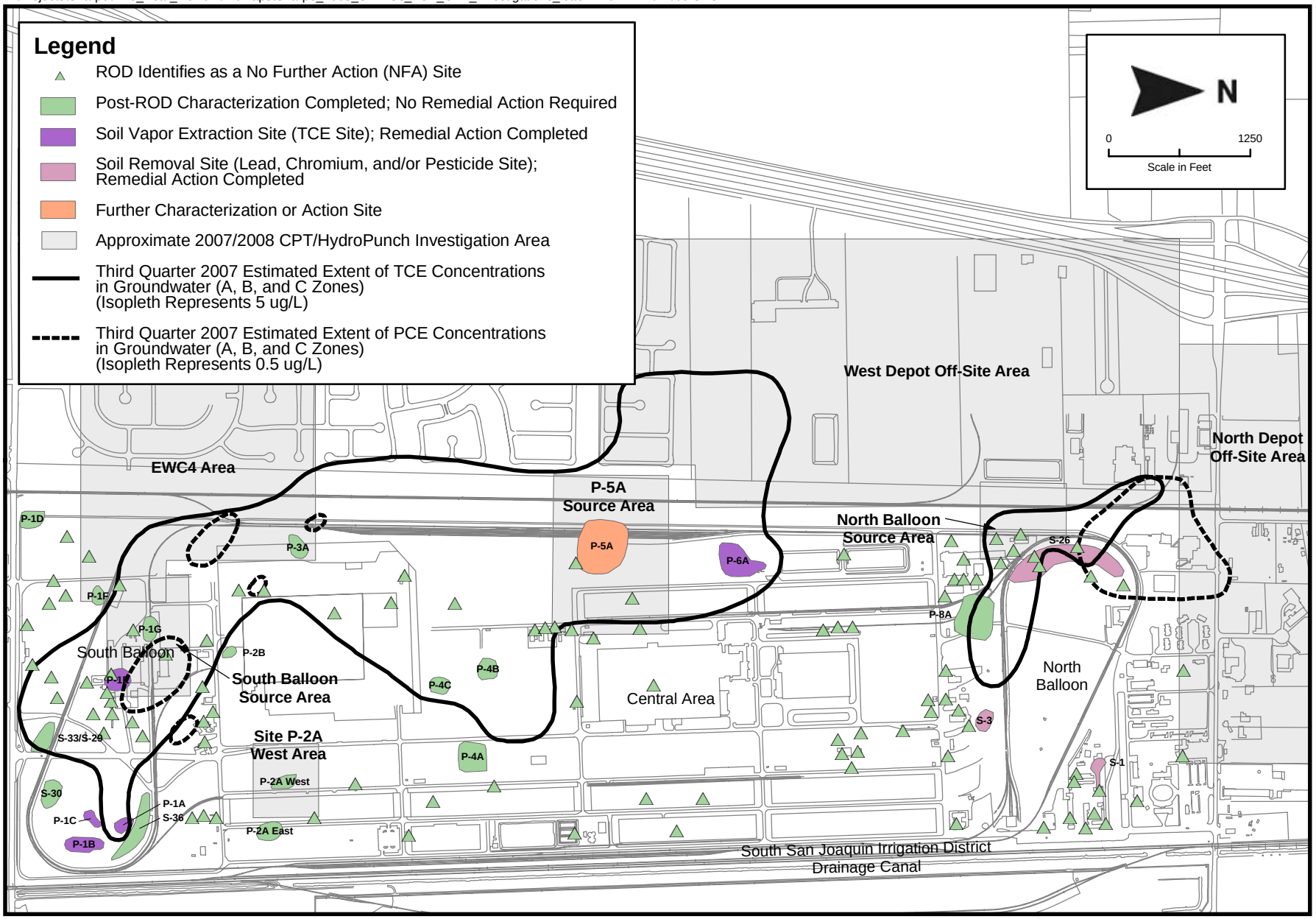


Figure 4-8. 2007/2008 CPT/HydroPunch Investigation Areas DDJC-Sharpe

L:\Projects\Sharpe\Five_Year_Review\ArcMaps\Sharpe_2008_SWMUs_fiveyear_letter.mxd VRL 5/6/09 SAC

Legend

- ROD Identifies as a No Further Action (NFA) Site
- Post-ROD Characterization Completed; No Remedial Action Required
- Soil Vapor Extraction Site (TCE Site); Remedial Action Completed
- Soil Removal Site (Lead, Chromium, and/or Pesticide Site); Remedial Action Completed
- Further Characterization or Action Site

N

0 1250

Scale in Feet

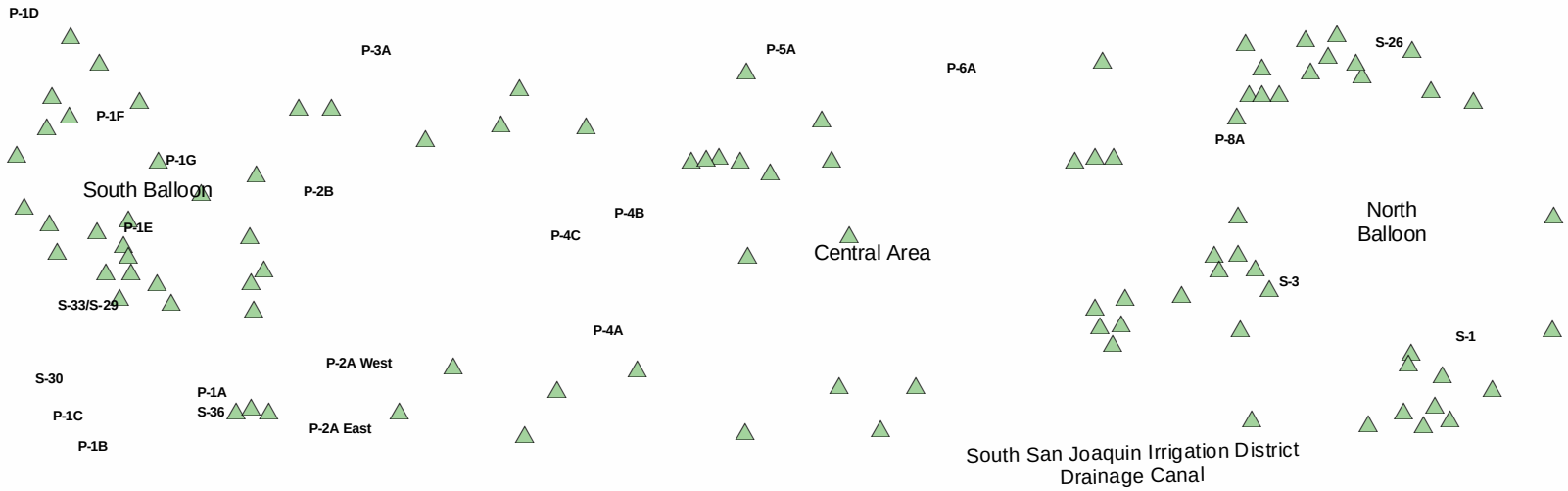


Figure 4-9. Operable Unit 2 Soil Sites, DDJC-Sharpe

5.0 PROGRESS SINCE LAST REVIEW

This section describes the progress since the first five-year review, including a description of the protectiveness statements and the status of recommendations and follow-up actions presented in the *DDJC-Sharpe Five-Year Review Report* (URS, 2004a).

5.1 Protectiveness Statements from First Five-Year Review

5.1.1 OU 1

The protectiveness statement for OU 1 in the first five-year review report reads:

> *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.*

As described in Section 5.2, the OU 1 recommendations and follow-up actions presented in the first five-year review were implemented. The technical assessment of the OU 1 remedy in Section 7.0 of this report describes the groundwater investigations and evaluations conducted and the groundwater extraction and treatment system modifications made over the past five years to address the protectiveness concerns described in the first five-year review. The results of this assessment were used to develop the revised protectiveness statement presented in Section 10.0.

5.1.2 OU 2

The protectiveness statement for OU 2 in the first five-year review report reads:

> *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 milligrams per kilogram per day [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.*

Since the first five-year review, the remedial action at Site S-26 has been completed with the excavation of Area 6 in 2006. (Areas 1 through 5 at Site S-26 had been excavated in 1998 in accordance with ROD requirements.) However, LUCs to prohibit residential development and use will be implemented at Site S-26, Areas 1 through 6, as well as four other metals sites (S-3, S-30, S-33/29, and S-36) (Figure 5-1), because the cleanup standards established in the ROD for metals-contaminated soil are based on industrial land use only (URS, 2009d).

The higher TCE inhalation toxicity value (0.4 per milligrams per kilogram-day [mg/kg-day]) that was being evaluated at the time of the first five-year review has not been approved by EPA or the California

Office of Environmental Health Hazard Assessment (OEHHA). Therefore, assuming that the lower EPA-approved toxicity value (1.7E-02 per mg/kg-day) prevails, the concentrations of TCE remaining in soil gas after SVE ceased do not create an incrementally unacceptable cancer risk to occupants of a building constructed in an area where soil gas contamination had been present (URS, 2004a). Currently, no occupied structures are located over the SVE sites at DDJC-Sharpe.

5.2 Recommendations and Follow-Up Actions from First Five-Year Review

Areas addressed by recommendations from the first five-year review are shown on Figure 5-1.

5.2.1 OU 1

Recommendation: *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.*

Status: Complete. With the estimated average flow rate for EWCC1 at 60 gpm, and EWCC3 operating intermittently, estimated capture was 85% in 2002. The average flow rates for EWCC1 and EWCC3 were increased in 2003 to 66 and 78 gpm, respectively, and estimated capture improved (URS, 2004b). In August 2003, new pumps were installed in EWCC1 and EWCC3, increasing the flow rates at each to approximately 100 gpm.

In February 2006, extraction well EWCC1 was shut down as part of a focused extraction study at adjacent monitoring well MW437C (URS, 2005c), which operated from 20 March to 2 November 2006. EWCC1 remained shut down during the rebound study at MW437C and was restarted in March 2007. As approved by the regulatory members of the FFA, the flow rate at EWCC3 was reduced to 80 gpm on 4 December 2006 for the extraction well optimization test (URS, 2006b) (Section 4.1.2.4). EWCC1 and EWCC3 are currently operating at approximately 80 gpm each. The locations of EWCC1 and EWCC3 are shown on Figure 5-1.

Results of actions: Plumes are being captured at both wells with the exception of the portion of the TCE plume that is too far downgradient from the capture zone of EWCC3. Recently obtained data suggest the portion of the TCE plume that is not being captured is being contained by the action of natural attenuation mechanisms (URS, 2008a; 2009b). Collection of additional data from monitoring wells within the migration paths of the contaminant plumes may confirm plume containment by natural attenuation.

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

Status: Complete. In September and October 2005, monitoring well cluster MW528 was installed west of the depot and north of extraction well EWCC3 on the BMG2 Enterprises property (URS, 2005d) (Figure 5-1). Four monitoring wells (MW528BC/C/CD/D) were installed with two wells nested in each of two boreholes. The screen intervals for the four wells range from -48 feet msl (beginning depth of MW528BC) to -180 feet msl (end depth of MW528D). The wells were installed farther to the west than proposed in the first five-year review to help verify capture at EWCC3. Because of the increase in capture through optimization of flow in EWCC1 and EWCC3, installation of another C Zone extraction well west of the DDJC-Sharpe boundary was determined not to be necessary (URS, 2004b).

Results of action: The additional monitoring wells allow determination of groundwater gradients in the depth intervals in which they are screened, as well as assist in the determination of plume capture. The

wells are also used to monitor TCE concentrations in groundwater at the leading edge of the C Zone plume.

Recommendation: *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. Each cluster should have at least two wells to allow for determination of gradients in the interval.*

Status: Complete. In November 2004, monitoring well clusters MW498 and MW499 were installed in the North Balloon (URS, 2004c) (Figure 5-1). Two individual monitoring wells (MW498C/CD and MW499C/CD) were installed for each cluster. The screen intervals for the MW498 well cluster range from -136 feet msl (beginning depth of MW498C) to -173 feet msl (end depth of MW498CD). The screen intervals for the MW499 cluster range from -125 feet msl (beginning depth of MW499C) to -174 feet msl (end depth of MW499CD). The locations and screen depths of the well clusters differed slightly from that proposed in the first five-year review in order to monitor potential TCE migration downgradient from MW439CD and MW464CD (Figure 5-1).

Results of action: The new monitoring well clusters assist in the evaluation of the cause and extent of migration beneath the North Balloon extraction wells, as well as allow determination of groundwater gradients in the depth intervals in which they are screened. Concentration data from the MW498 and MW499 well clusters have defined the maximum vertical extent of TCE greater than the ACL in groundwater in the North Balloon. In 2007, concentration data from these and other C Zone and C/D transition zone wells suggested that there was a vertical gradient strong enough to draw TCE downward and potentially deeper than could be captured by any operating North Balloon C Zone extraction well (Section 7.0). In March 2008, EWNC3R, the deepest extraction well in the area where the C Zone to D Zone gradients may be strong, was restarted to reduce the downward gradient; EWNC3R had been shut down since 4 December 2006 for the extraction well optimization test.

Recommendation: *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, determine whether TCE is migrating into the screens of private water supply wells.*

Status: Ongoing. Potable water supply wells on and off depot continue to be monitored by the Well Monitoring Program. TCE and tetrachloroethene (PCE) were not detected at concentrations exceeding their respective MCLs in any potable well sampled in 2007.

Results of action: At on-depot potable wells PW038 and PW040 in the North Balloon (Figure 5-1), the concentrations of TCE increased between 2006 and 2007, though they are still less than MCLs. These results suggest that operation of the on-depot potable wells may be causing downward migration of TCE from the C Zone. The increased TCE concentration at downgradient well MW464CD supports the hypothesis of potable well pumping influence (URS, 2008a). However, it is uncertain whether the downward migrating TCE could migrate off depot to potable wells. An evaluation of the potable well program is currently underway and will include recommendations to address these uncertainties (URS, 2009c, pending).

Recommendation: *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.*

Status: Complete. The DDJC-Sharpe groundwater model simulations predicted cleanup of groundwater in the eastern portion of the Central Area would be extended by 10 to 20 years without operation of

EWCAB1 (URS, 2003c). (Note: These predictions were from the groundwater model developed by the Waterways Experiment Station [WES]; this model is no longer in use by DDJC-Sharpe.) The extraction well was restarted in February 2003 at a flow rate of approximately 24 gpm. However, as approved by the regulatory members of the FFA, EWCAB1 was shut down on 4 December 2006 for the extraction well optimization test that is currently (as of April 2009) ongoing (Section 4.1.2.4). The location of EWCAB1 is shown on Figure 5-1.

Results of action: The contaminant plume in the area of EWCAB1 is predicted to be captured by downgradient extraction well EWCC1. VOC mass that is not captured by EWCC1 is expected to be attenuated by natural mechanisms. The performance of the optimized well array is evaluated in Section 7.0.

Recommendation: *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.*

Status: Complete. The DDJC-Sharpe groundwater model simulations predicted that cleanup of groundwater in the B Zone interval in the South Balloon would be extended by 10 years without operation of EWB2 (URS, 2003c). (Note: These predictions were from the groundwater model developed by WES; this model is no longer in use by DDJC-Sharpe.) The extraction well was restarted in August 2003. Its flow rate fluctuated between approximately 4 and 13 gpm until December 2006. However, as approved by the regulatory members of the FFA, EWB2 was shut down on 4 December 2006 for the extraction well optimization test that is currently (as of April 2009) ongoing (Section 4.1.2.4). The location of EWB2 is shown on Figure 5-1.

Results of action: The contaminant plume in the area of EWB2 is predicted to be captured by down-gradient extraction well EWC4, and VOC mass that is not captured by EWC4 is expected to be attenuated by natural mechanisms. The performance of the optimized well array is evaluated in Section 7.0.

Recommendation: *To address concerns regarding the potential health risks caused by intrusion of VOC vapors into work places, 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.*

Status: Complete. Soil gas was sampled at 11 locations in three areas of DDJC-Sharpe for VOC analysis at shallow depths (3 and 6 feet bgs). Two of the three areas sampled include buildings that are occupied at least part-time by federal government employees (Building S-179 in the North Balloon and Building 655 in the South Balloon). The third area sampled in the Central Area near the west depot boundary has no occupied structures. Concentrations of only one VOC, TCE, were detected in only four of the samples collected. The four samples containing TCE were collected near Building 655 in the South Balloon (Figure 5-1).

Modeling with the Soil Gas Screen spreadsheet of the Johnson and Ettinger (J&E)/Human and Ecological Risk Division (HERD) model (EPA, 2004b) was performed for Building 655 in the South Balloon. The highest concentration (24 parts per billion by volume [ppbv] of TCE) and parameters for sand from surface to 3 feet bgs were used. These values provide the "worst case" scenario for vapor intrusion with data obtained from the site. The Soil Gas Screen spreadsheet provides the most conservative estimate of risk; therefore, other less conservative spreadsheets were not used.

Results of action: As shown on Table 5-1, the modeling results predict that there is a less than 1 in 10 million cancer risk from vapor intrusion for DDJC-Sharpe workers in a building standing over a TCE plume in the A Zone in the South Balloon. The results also predicted that occupants of a residence standing over a plume in the A Zone in the South Balloon would have a less than 1 in 10 million cancer risk from vapor intrusion (URS, 2004d).

Table 5-1. Risk Results from Modeling of Soil Gas Results for Building 655, South Balloon

Scenario Simulated	Contaminant in Soil Gas	Carcinogenic Risk	Hazard Quotient
Worker, 25 years, 250 days per year	TCE, 24 ppbv, at 3 feet bgs	2.2×10^{-8}	4.3×10^{-5}
Resident, 30 years, 350 days per year	TCE, 24 ppbv, at 3 feet bgs	3.7×10^{-8}	7.2×10^{-5}

bgs = below ground surface
ppbv = parts per billion by volume
TCE = trichloroethene

No modeling was performed for the North Balloon or the Central Area sampling locations because no VOCs were detected.

Recommendation: *To address concerns regarding hexavalent chromium (CrVI) 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.*

Status: Complete. Groundwater samples collected at DDJC-Sharpe through 2006 were analyzed for hexavalent chromium, though no MCL, ACL, or baseline concentration has been established for hexavalent chromium (an MCL of 50 µg/L has been established for total chromium). Hexavalent chromium migrating to operating extraction wells is not a concern unless compliance monitoring results indicate that it exceeds limits for effluent discharged to surface water.

Results of action: Hexavalent chromium has not exceeded effluent discharge limits and, as of December 2006, effluent is no longer discharged to surface waters. As approved by the regulatory members of the FFA, groundwater sampling for hexavalent chromium analysis was discontinued in 2007 (URS, 2007b).

Recommendation: *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.

Status: Complete. Potential percolation pond sites northeast and southwest of the South Balloon were tested in 2003 for use in discharge of treated groundwater. The first phase of testing consisted of percolation tests in boreholes drilled in three potential pond areas (URS, 2003d). In the second phase of testing, two pilot percolation ponds (approximately 1/8 acre each) were constructed at locations northeast of the South Balloon, and water was applied to each pond for approximately four weeks. The purpose of the second phase of testing was to gather field data to provide realistic infiltration rate data for use in sizing and design of full-scale percolation ponds at the proposed locations (URS, 2004e). However, no additional testing was conducted at these locations after the second phase of testing, and they were not constructed for full-scale operations.

Testing of the Central Area percolation ponds (shown on Figure 5-1) began in February 2005 (URS, 2005e). The purpose of testing was to determine whether operation of the percolation ponds would have a negative influence on the containment of the groundwater contaminant plumes in the Central Area and North Balloon and to verify whether the percolation ponds could be used as a primary, and possibly sole, discharge location for treated groundwater. Testing of the B240 stormwater ponds (shown on Figure 5-1) began in August 2005 to determine whether the ponds could accept consistent treatment plant discharge in dry seasons when they are not needed for stormwater detention (URS, 2005f).

Results of action: Testing results indicated that the Central Area percolation ponds are able to accept all of the Central Area treatment plant effluent (i.e., up to 500 gpm, the design flow rate of the Central Area GWTP) (URS, 2006g). The B240 ponds were found to be an acceptable discharge option for treated groundwater in the drier months. Since initiation of the extraction well optimization test in December 2006, all extracted water has been treated at the Central Area GWTP and discharged to the Central Area percolation ponds. The B240 stormwater detention ponds are used for backup discharge capacity on an as needed basis during the dry season. Treated groundwater is no longer discharged to surface water, eliminating the need to remove naturally occurring arsenic from the effluent in order to be in compliance with the 10 µg/L MCL for arsenic.

Recommendation: *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.*

Status: Complete. A response completion plan (RCP) was developed to evaluate approaches to better manage environmental liabilities at DDJC-Sharpe, given the extended timeframe that is likely to be required to achieve the OU 1 RAOs currently established for this facility (URS, 2005g).

Results of action: The RCP suggests that a change to the groundwater remedy may be warranted (URS, 2005g). An alternative response action may become evident as treatment technology investigations and pilot studies at DDJC-Sharpe are completed. Any proposed modification to the current groundwater remedy will be based on the best available science and treatment technologies applied to specific site conditions at DDJC-Sharpe. Any proposed modification that augments the current OU 1 groundwater remedy (groundwater extraction and treatment) with an alternate technology must meet the cleanup levels specified in the OU 1 ROD and would constitute a significant change to the OU 1 remedy. Documentation of a significant change will require the development and approval of an Explanation of Significant Differences. Any proposed change to the current OU 1 remedy that does not include groundwater extraction and treatment must meet the cleanup levels specified in the OU 1 ROD and would constitute a

fundamental change. Documentation of a fundamental change to provisions in the OU 1 ROD will require development and approval of a ROD Amendment.

Updates to activities proposed in the RCP for evaluating an alternative response action to the groundwater remedy are discussed in the following paragraphs.

Treatment Technology Investigations and Pilot Studies Update. In support of the RCP, natural attenuation and treatment technology field investigations of soil and groundwater were conducted to evaluate geochemical conditions and biological activity to select possible VOC treatment technologies that may reduce the residual COC source mass in groundwater at DDJC-Sharpe (URS, 2005h).

The results of the natural attenuation investigation indicated that biotic natural attenuation processes are occurring in portions of the aquifer; however, the evidence to support natural attenuation (due to biotic processes alone) as a sole remedy is limited. Abiotic natural attenuation mechanisms may be occurring in addition to biotic degradation processes (URS, 2006h).

Based on the results of the treatment technology investigation, a potassium permanganate ($KMnO_4$) pilot study was recommended for the South Balloon source area, and an emulsified oil substrate (EOS) pilot study was recommended for the North Balloon source area (URS, 2006d). Work plans for these two pilot studies were submitted in May 2007 (revised September 2007) and March 2008, respectively (URS, 2007d; 2008c). The EOS and $KMnO_4$ pilot study field activities started in April and May 2008, respectively, and are scheduled to be completed by the end of 2009. Figure 5-1 shows the locations of the $KMnO_4$ and the EOS pilot study areas.

As part of the 2007/2008 CPT/HydroPunch investigation, soil gas and HydroPunch groundwater samples were collected at Site P-5A in the Central Area (URS, 2007e). The results helped delineate a TCE soil vapor source (greater than 0.35 ppmv) beneath the northern portion of the DDJC-Sharpe runway (URS, 2007h). Further characterization of groundwater beneath this soil vapor source occurred from December 2007 through February 2008 (URS, 2009b). Results from this investigation indicate that TCE concentrations greater than 1,000 µg/L are present in fine-grained layers of the saturated zone at Site P-5A between 35 and 70 feet bgs (spanning the lower A and upper B Zones). Based on this investigation, a redox (Eh) compound (EHC) pilot study was recommended in the P-5A area (URS, 2008d) (Figure 5-1). The EHC pilot study activities started in August 2008 and are scheduled to be completed by the end of 2009.

Potable Well Users Update. Several existing potable wells northwest of DDJC-Sharpe, owned and operated by private parties, serve residential, commercial, and industrial users. Operation of these wells may contribute to a hydraulic gradient to the west and northwest, potentially pulling contaminated groundwater off site. The RCP indicated that many of the potable wells would be taken out of service to reduce the potential for contaminant migration and that these potable well users would be connected to the City of Lathrop water supply, thus removing a possible route of exposure to contaminants via ingestion of groundwater and providing more effective risk management. Connection of downgradient potable well users to the City of Lathrop water sources has been determined not to be feasible at this time (URS, 2009c, pending). To address the protectiveness of the potable well users, DESJC is preparing a water contingency plan.

Groundwater Modeling Update. A new three-dimensional (3-D) numerical model for groundwater beneath DDJC-Sharpe was developed and verified (URS, 2006c). The new model was developed using the United States Department of Defense (DoD) groundwater modeling system (GMS), Version 6.5 (Environmental Modeling Research Laboratory, 2008). The model computer code selected was MODFLOW, a 3-D, cell-centered, finite difference, saturated flow model developed by the USGS

(McDonald and Harbaugh, 1988). Contaminant transport simulations were conducted using the MT3DMS groundwater contaminant transport model code (Zheng and Wang, 1999). Other details of model development and testing are explained in the *DDJC-Sharpe Three-Dimensional Groundwater Model Report* (URS, 2006c).

The flow model simulates the flow of groundwater beneath the site, and the fate-and-transport model simulates how contaminants will move within the groundwater and predicts their behavior in the future. The model is used to analyze capture zones, optimize the existing groundwater extraction system, and predict cleanup times. The model can also be used to help evaluate the potential effectiveness of proposed future extraction system modifications and their effect on predicted cleanup times.

The analytical results and lithologic data from the 2007/2008 CPT/HydroPunch investigation will be used to update the DDJC-Sharpe conceptual site model (CSM) and to refine COC fate-and-transport simulations using the groundwater model. Revised plume extents and modeling results will, in turn, be used to evaluate potential source treatment response actions. If a source removal action is deemed appropriate based on the results of the treatment technology studies and fate-and-transport modeling simulations, an amendment to the OU 1 ROD will be prepared.

Recommendation: *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.*

Status: Ongoing. The results from the implementation of the first five-year review recommendations and follow-up actions are discussed in the FFA Annual Progress Reports, as appropriate, or in other technical memoranda submitted to the signatories to the FFA. Groundwater monitoring data and changes in capture and containment are evaluated and reported in each FFA Annual Progress Report.

5.2.2 OU 2

Recommendation: *No recommendations are proposed for the OU 2 remedy. Follow-up actions are to ensure that institutional controls (ICs) (i.e., LUCs) in the South Balloon are enforced and that ground-water monitoring downgradient of Site S-33/29 continues according to the proposed schedule. ICs 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.*

Status: Pending. The OU 2 ROD amendment will replace previous documentation of LUCs in the area south of South Crane Way in the South Balloon (URS, 2002b; 2002c) because those LUCs were not promulgated in an enforceable decision document. In addition, only Sites S-30, S-33/29, and S-36 in the South Balloon require LUCs rather than the entire area south of South Crane Way (Figure 5-1). The LUCs will also be implemented for Sites S-3 and S-26 in the North Balloon (Figure 5-1). The objective of the LUCs is to prohibit residential development and use of sites that contain contaminants (lead and/or chromium) at levels that do not allow for unlimited use and unrestricted exposure. DESJC will conduct annual monitoring of the LUC sites to ensure the objective of the LUCs is met and the land use restriction is being followed such that the remedy remains protective. The findings of the annual monitoring will be summarized in the FFA Annual Progress Reports.

Complete. Chromium and lead are not ROD-specified groundwater COCs, although, in accordance with the OU 2 ROD, baseline concentrations were established at each well sampled for chromium analysis. Groundwater sampling for chromium analysis at wells downgradient of Site S-33/29 in the South Balloon

continued through 2005. Sample results from five wells in the South Balloon showed significant decreasing trends for chromium. Groundwater sampling for chromium analysis was discontinued in 2007 (URS, 2007b). No wells had chromium concentrations that exceeded the MCL of 50 µg/L during the period of the second five-year review. Groundwater sampling for lead analysis was discontinued in 2001 because groundwater at DDJC-Sharpe is not considered contaminated by lead from soil (URS, 2004b).

Recommendation: *In the North Balloon, lead concentrations would exceed risk-based cleanup levels if the railroad ballast were removed and Site S-26 was 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.*

Status: Pending. During the period of the second five-year review, the remedial action at Site S-26, Area 6 was completed in accordance with the requirements of the OU 2 ROD (URS, 2008f). Excavation of Site S-26, Area 6 was completed in November 2006. Soil and railroad ballast were excavated from an area of approximately 1,170 square feet to a depth of 2 feet bgs. Site S-26, Area 6 was backfilled with clean soil in April 2007. The railroad tracks removed to allow site excavation were replaced in December 2008. LUCs to prohibit residential development and use will be implemented at Site S-26 (URS, 2009d).

L:\Projects\Sharpe\Five_Year_review\ArcMaps\sharpe_2008_progress_letter_fiveyear.mxd VRL 4/22/09 SAC

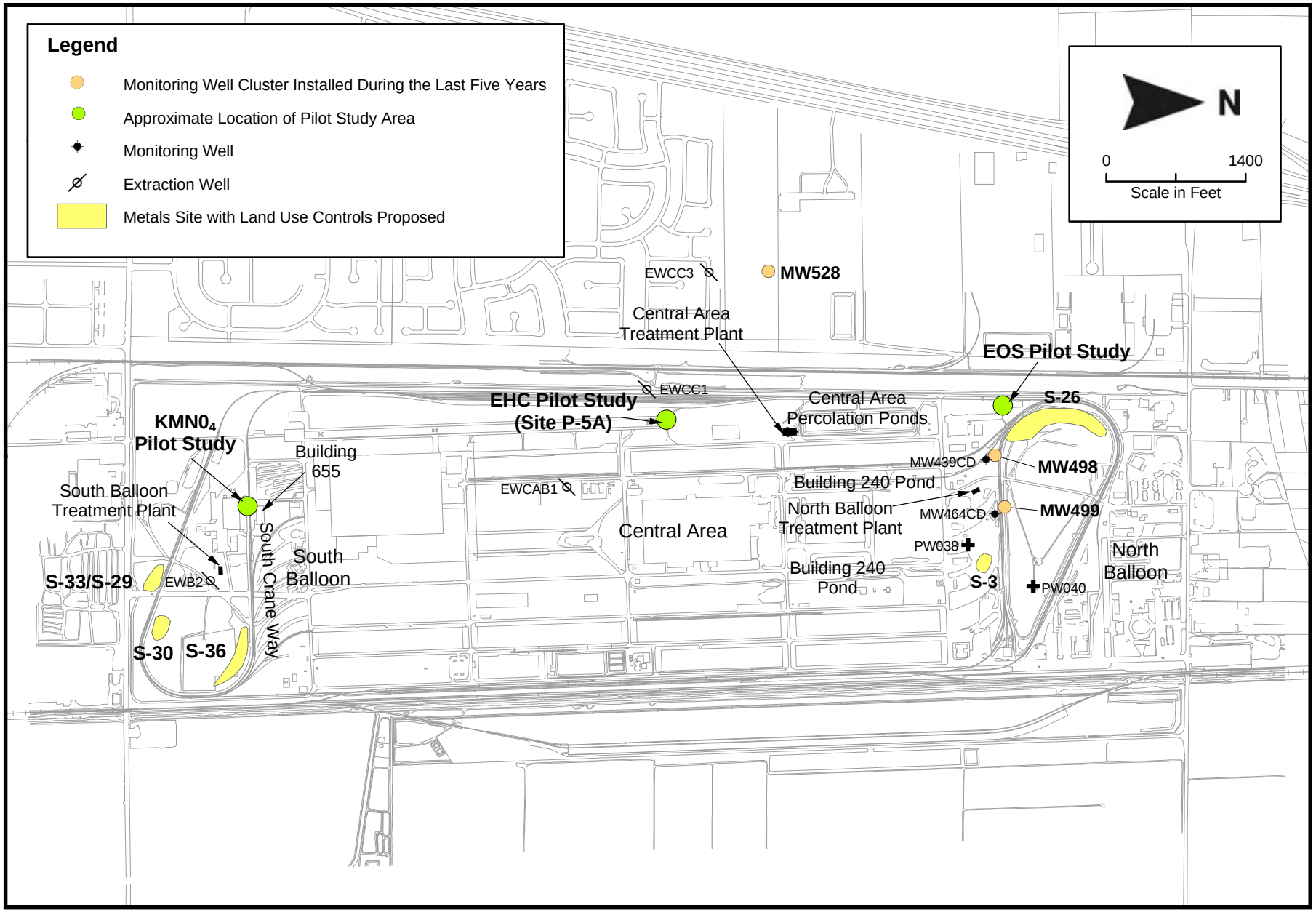


Figure 5-1. Areas Addressed by Recommendations from First Five-Year Review, DDJC-Sharpe

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: Maurice Benson, DESJC-Public Safety Services (PSS); Phillip Ramsey, EPA (Region 9); James Brownell, RWQCB; and Peter MacNicholl, DTSC. Members of the review team were notified of the initiation of the second five-year review for DDJC-Sharpe at the April and August 2008 RPM meetings. The schedule for this second five-year review report is presented in Table 6-1.

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

Document Title	Document Status	Draft			Final			Finalization Date
		Submission Date	Review Period	Comments Due Date	RTCs Due Date	Review Period for RTCs	Submission Date	
Second Five-Year Review Report	Primary	12 Dec 08	60 days	9 Feb 09	8 Apr 09	20 days	29 May 09	29 May 09

DDJC = Defense Distribution Depot San Joaquin California
RTCs = responses to comments

6.2 Community Involvement and Notification

The DDJC-Sharpe Environmental Office has maintained an active community involvement program since the 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 community mailing list that includes interested parties (approximately 200 addresses) and all mailing addresses within the postal zones surrounding the depot (more than 3,000 addresses).

- Notifying the community of program milestones and providing 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.

- Providing informal program updates to community members through the Technical Review Committee (TRC) or, more recently, through DDJC-Sharpe's Community Update Forum. To date, the Community Update Forum has held infrequent meetings.

In accordance with EPA guidance, DLA will notify the community of DDJC-Sharpe's second five-year review at both the beginning and the conclusion of the process (EPA, 2001).

A public notice was published on 13 and 17 August 2008 in the *Stockton Record*, *Tracy Press*, *Manteca Bulletin*, and *Vida en el Valle* (a regional Spanish language newspaper that serves the City of Lathrop). The notice provided an overview of the second five-year review process, outlined the five-year review schedule, and provided a list of contacts for community members who have questions or concerns.

As part of the second five-year review process, DLA solicited regional stakeholders for feedback regarding ongoing environmental restoration activities at DDJC-Sharpe. Stakeholders asked to participate in interviews included a cross-section of community leaders, including representatives from local government, civic leaders, community members, and members of the business community. A summary of the interviews is provided in Section 6.6.

A public notice will be published in the *Stockton Record*, *Tracy Press*, *Manteca Bulletin*, and *Vida en el Valle* to notify the community of the completion of the review process and finalization of the second five-year review. 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 would like to obtain more information or ask questions about the results of the second five-year review.

This second five-year review report for DDJC-Sharpe will be available for viewing by the public at the installation's Administrative Record, located at the DDJC-Tracy site, Tracy, California.

6.3 Document Review

The five-year review process included a review of relevant documents. Tables 6-2a through 6-2f list the documents that were reviewed, organized by purpose.

Table 6-2a. Documents Reviewed − Basis for the Response Action

Installation-Wide
DDJC-Sharpe Five-Year Review Report (URS, 2004a).
DDJC-Sharpe Response Completion Plan (URS, 2005g).
OU 1 (Groundwater)
Remedial Investigation/Feasibility Study at DDRW-Sharpe Site Record of Decision, Operable Unit 1 (ESE, 1993).
OU 2 (Soil)
Record of Decision, Basewide Remedy for DDRW-Sharpe Site (ESE, 1996).
Amendment to the Record of Decision Basewide Remedy for DDJC-Sharpe (Operable Unit 2 – Soils) (URS, 2009d).

DDJC = Defense Distribution Depot San Joaquin California
DDRW = Defense Distribution Region West
ESE = Environmental Science and Engineering
OU = operable unit
URS = URS Group, Inc.

Table 6-2b. Documents Reviewed − Implementation of the Response[a]

Installation-Wide
Installation-Wide Preliminary Close Out Report, DDJC-Sharpe (URS, 2002a).
OU 1 (Groundwater)
Operable Unit 1 Groundwater: Interim Remedial Action Report, DDJC-Sharpe (URS, 2001b).
OU 2 (No Further Action)
Operable Unit 2 No Further Action Remedial Action Report, DDJC-Sharpe (Radian International, 2000a).
OU 2 (TCE)
Operable Unit 2 Soil Vapor Extraction Remedial Action Report, DDJC-Sharpe (URS, 2002d).
Soil Vapor Extraction System Decommissioning Engineering Technical Memorandum, DDJC-Sharpe (URS, 2003e).
OU 2 (Metals)
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).
Engineering Technical Memorandum, Site 33/29 Metals Investigation, DDJC-Sharpe (Radian International, 1999).
Operable Unit 2 Metals Remedial Action Report, Sites S-3 and S-26, DDJC-Sharpe (Radian International, 2000b).
DDJC-Sharpe Operable Unit 2 Remedial Action Report, Site S-26, Area 6 (URS, 2008f).
OU 2 (Pesticides)
Removal Action Memorandum for Pesticide Mix Area, North Balloon Area, Lathrop, California (ESE, 1994c).
Contaminated Soil Removal at Pesticide Mix Area, Sharpe Facility, Lathrop, California (CKY, Inc., 1995).
Contaminated Soil Removal at Pesticide Mix Area, Sharpe Facility, Lathrop, California (Addendum to Final) (CKY, Inc., 1996).

[a] Other documents relevant to the construction and implementation of the groundwater and vadose zone remedies are summarized in the following appendices:
Appendix A, Summary of Treatment System Construction and Performance References, 1985−2007;
Appendix D, Summary of Construction and Performance References, SVE Sites; and
Appendix E, Summary of Construction and Performance References, Sites S-3 and S-26.

DDJC = Defense Distribution Depot San Joaquin California
ESE = Environmental Science and Engineering
OU = operable unit
SVE = soil vapor extraction
TCE = trichloroethene
URS = URS Group, Inc.

Table 6-2c. Documents Reviewed − Remedy Performance
OU 1 (Groundwater)
DDJC-Sharpe Extraction Well Optimization Technical Memorandum (URS, 2003f).
Evaluation of Proposed Extraction Well Shutdown Technical Memorandum, Defense Distribution Depot San Joaquin California, Sharpe Site (URS, 2003c).
DDJC-Sharpe Three-Dimensional Groundwater Model Report (URS, 2006c).
Natural Attenuation Investigation Results Technical Memorandum, DDJC-Sharpe (URS, 2006h).
Treatment Technology Investigation Results Technical Memorandum, DDJC-Sharpe (URS, 2006d).
DDJC-Sharpe Site P-5A Groundwater and Soil Vapor Investigation Results Technical Memorandum (URS, 2007g).
DDJC-Sharpe Comprehensive Cone Penetrometer Investigation – Sites P-2A and P-5A Soil Vapor Sampling Results (URS, 2007h).
Evaluation of the Optimized Extraction Well Test, DDJC-Sharpe (URS, 2009a).
DDJC-Sharpe Comprehensive Cone Penetrometer Testing Investigation Results Report (URS, 2009b).
OU 2 (Soil)
Evaluation of Vapor Intrusion Risk Potential with Soil Gas Sampling Data, DDJC-Sharpe Site (URS, 2004d).

[a] Other documents relevant to the performance of the groundwater and vadose zone remedies are summarized in the following appendices:
Appendix A, Summary of Treatment System Construction and Performance References, 1985−2007;
Appendix D, Summary of Construction and Performance References, SVE Sites; and
Appendix E, Summary of Construction and Performance References, Sites S-3 and S-26.

DDJC = Defense Distribution Depot San Joaquin California
OU = operable unit
SVE = soil vapor extraction
URS = URS Group, Inc.

Table 6-2d. Documents Reviewed − Operation and Maintenance[a]
DDJC-Sharpe Operation and Maintenance Manual for the Central Area Groundwater Treatment System (URS, 2001a).
DDJC-Sharpe Operation and Maintenance Manual for the North Balloon Groundwater Treatment System (URS, 2003a).
DDJC-Sharpe Operation and Maintenance Manual for the South Balloon Groundwater Treatment System (URS, 2003b).

[a] Documents relevant to the performance of the groundwater treatment plant are summarized in Appendix A, Summary of Treatment System Construction and Performance References, 1985−2007.

DDJC = Defense Distribution Depot San Joaquin California
URS = URS Group, Inc.

Table 6-2e. Documents Reviewed − Legal Documentation
Federal Facilities Agreement for Defense Distribution Region West-Sharpe. Effective Date: March 16 (DLA, 1989).
Substantive Waste Discharge Requirements for Land Disposal, DDRW-Sharpe (Addendum to the ROD, Attachment 2) (RWQCB, 1992).
Order No. R5-2002-0213, National Pollutant Discharge Elimination System No. CA0081931, Waste Discharge Requirements for DDRW-Sharpe (RWQCB, 2002).
Time Schedule Order No. R5-2005-0169 (RWQCB, 2005).
DDJC-Sharpe Compliance Feasibility Report for Central Valley Regional Water Quality Control Board, Time Schedule Order No. R5-2005-0169 (URS, 2007a).
DDJC = Defense Distribution Depot San Joaquin California DDRW = Defense Distribution Region West DLA = Defense Logistics Agency ROD = record of decision RWQCB = Regional Water Quality Control Board URS = URS Group, Inc.

Table 6-2f. Documents Reviewed − Community Involvement
Community Relations Plan, DDJC-Sharpe Site (URS, 2007i).
DDJC = Defense Distribution Depot San Joaquin California URS = URS Group, Inc.

6.4 Data Review

Groundwater level changes, gradients, flow directions, capture zones, and groundwater quality data are evaluated annually to update the DDJC-Sharpe CSM. This section provides a summary of the hydraulic and analytical data collected by the Well Monitoring Program during the 2007 monitoring period (4Q06 to 3Q07) and presented in the *DDJC-Sharpe FFA Annual Progress Report: October 2006 through September 2007* (URS, 2008a). In addition, this section provides an overview of the lithologic and HydroPunch data collected as part of the 2007/2008 CPT/HydroPunch investigation because the results are pertinent to the protectiveness determination for OU 1. A thorough evaluation of the results from the investigation, a significant portion of which was conducted beyond the time period of this second five-year review, are presented in a draft report published in February 2009, titled *DDJC-Sharpe Comprehensive Cone Penetrometer Testing Investigation Results Report* (URS, 2009b).

It should be noted that groundwater levels were not measured and groundwater samples were not collected or analyzed from DDJC-Sharpe monitoring or extraction wells during the first and second quarters of 2006; remedial project managers from the regulatory agencies were notified that sampling could not be conducted because of contractual and funding constraints. During the two quarters when samples were not collected, extraction wells and groundwater treatment plants continued to operate as they had prior to and following those two quarters. The similarity of data collected after the two quarter hiatus with the data collected before the hiatus indicated that plume capture had not changed, and

groundwater treatment was adequate for the entire 2006 monitoring year. Therefore, the remedy continued to function as intended.

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 vertical and horizontal groundwater gradients, and estimating capture zones of extraction wells. Figures 6-1, 6-2, and 6-3 present the groundwater potentiometric surface maps for the A, B, and C Zones drawn with data from 3Q07. The maps were developed using Surfer 8.0 software and professional judgment. Potentiometric surface maps are not developed for the D Zone 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

VOCs are the most widespread contaminants reported in groundwater beneath DDJC-Sharpe and off-depot areas. The most commonly detected VOC is TCE. During this five-year review period, analysis for other contaminants in groundwater samples has included or currently includes bromacil, total chromium, hexavalent chromium, arsenic, selenium, and TPH. Sampling for lead and nitrate was discontinued prior to the period of this second five-year review.

6.4.2.1 VOCs

TCE. The highest concentration of TCE at each well or well cluster in the A, B, C, and D Zones reported during the 3Q07 annual sampling event was used to create the composite plumes that show the estimated horizontal and vertical extent of TCE in groundwater on and off the installation (Figure 6-4 [North Balloon] and Figure 6-5 [South Balloon and Central Area]). A monitoring or extraction well may be shown within an area assigned a higher TCE concentration than the concentration reported for that well because the 3-D geological modeling program used to create the figures, EarthVision, uses the highest TCE value within a volume 3-D search to interpret the composite plume configuration. HydroPunch sample results from the 2007/2008 CPT/HydroPunch investigation were not used to refine the TCE composite plume configuration because data evaluation and interpretation were not completed at the time this report was written.

HydroPunch sample results from the 2007/2008 CPT/HydroPunch investigation were used, however, to refine the estimated extents of TCE in the individual monitoring zones. A depiction of the depot-wide pre- and post-CPT/HydroPunch investigation groundwater plumes in the A, B, and C monitoring zones are shown on Figures 6-6, 6-7, and 6-8. Data collected during this investigation, particularly those associated with three source areas (North Balloon Source Area, P-5A, and South Balloon Source Area) provided insight on source location, depth, extent, lithology, chemical composition, and fate-and-transport of contaminants in both groundwater and soil vapor (URS, 2009b).

Interpretation of the 2007/2008 CPT/HydroPunch data led to the following conclusions:

- The silt and clay deposits occurring in the lower A Zone and upper B Zone that contain much of the VOC mass at P-5A, North Balloon Source Area, and South Balloon Source Area appear to be relatively continuous, although variable in thickness, throughout DDJC-Sharpe with the exception of the southwestern portion of DDJC-Sharpe in the EWC4 Area. In off-site sampling locations (e.g., the West Depot Off-Site Area and portions of the North Depot Off-Site Area), this silt and clay deposit is generally not present or is discontinuous.

- Approximately 428 pounds of TCE mass are currently estimated to be present in groundwater beneath DDJC-Sharpe source areas, and 54% of this mass is estimated to be contained in the silt and clay deposits in the lower A and upper B Zones.

- A PCE/TCE/carbon tetrachloride (CCl_4) plume originating in the EWC4 Area has migrated in the B, C, and CD transition zones both on the depot and a few hundred feet west of the depot. The chemical composition and source for this plume is distinct from the TCE/cis-1,2-dichloroethene (DCE) plume originating at the South Balloon Source Area.

- The influence of historical pumping at one or more potable or agricultural wells has likely influenced the orientation of the P-5A TCE plume and the EWC4 Area PCE/TCE/CCl_4 plume at DDJC-Sharpe.

- Geochemical evidence indicates that abiotic and biologically mediated natural attenuation processes have been active and probably continue to be active at and downgradient of sources.

- The lateral and vertical extents of groundwater contamination west and north of DDJC-Sharpe (in the West Depot Off-Site Area and North Depot Off-Site Area) are consistent with previous interpretations (e.g., URS, 2008a; 2008e) of VOC extent in these areas.

Vertical Extent of TCE Contamination. In general, the maximum TCE plume depths did not change from 3Q06 to 3Q07. Figure 6-9 shows the locations of selected monitoring wells, extraction wells, and the lines of three hydrogeologic cross-sections. Figures 6-10 through 6-12 are vertical profiles of TCE concentrations in groundwater reported in 3Q07 along the hydrogeological cross-sections A-A´, B-B´, and C-C´, which pass through the South Balloon, Central Area, and North Balloons, respectively. For comparison, the vertical extent of TCE contamination in 3Q06 is also shown. HydroPunch sample results from the 2007/2008 CPT/HydroPunch investigation were not used to refine the extent of TCE groundwater contamination shown on Figures 6-10 through 6-12.

Lithologic and groundwater data from the 2007/2008 CPT/HydroPunch investigation support the conclusion that the highest concentrations of TCE in groundwater are present in silt and clay layers within the lower A and upper B Zones. Figures 6-13 through 6-15 are vertical profiles of TCE concentrations in groundwater reported from HydroPunch samples collected during the 2007/2008 CPT/ HydroPunch investigation along the hydrogeological cross-sections D-D´, E-E´, and F-F´, which pass through the North Balloon Source Area, P-5A, and South Balloon Source Area, respectively.

PCE. PCE results and plume extents for A, B, C, and D Zone wells sampled in 3Q07 in the North Balloon and in the South Balloon and Central Area are shown on Figures 6-16 and 6-17, respectively. The PCE composite plumes were drawn manually using the highest concentration of PCE reported at a well or well cluster in the A, B, C, and D Zones. HydroPunch sample results from the 2007/2008 CPT/ HydroPunch investigation were not used to define the extent of PCE groundwater contamination because data evaluation and interpretation were not completed at the time this report was written.

TCE and PCE in Potable Water Wells. TCE and PCE were detected in on-depot potable wells in the North Balloon and in off-depot potable wells to the north and west of the North Balloon during the 3Q07

sampling event (URS, 2008a). TCE was detected in PW006, PW009, PW010, PW020, PW021, PW038, PW040, and PW051 at concentrations less than the ACL and MCL of 5 µg/L (Figure 6-18). PCE was detected in PW021 at a concentration of 0.9 µg/L, which is slightly greater than the ACL of 0.5 µg/L but less than the MCL of 5 µg/L (Figure 6-19).

Other VOC Contamination. Excluding TCE and PCE, there are 19 COCs specified in the ROD for DDJC-Sharpe. Eleven of those COCs have not been detected above their ACLs for at least a year. Of those 11 COCs, 3 have not been detected since at least 1995 (1,1,2-trichloroethane, cis-1,3-dichloropropene, and trans-1,3-dichloropropene) and 4 have not been detected at greater than the ACL since at least 1995 (trans-1,2-dichloroethene, 1,1-dichloroethane, 1,1,1-trichloroethane, and 1,4-dichlorobenzene). There were seven COCs other than TCE and PCE detected in 2007 monitoring and extraction well samples at concentrations that exceed the ACLs. Figure 6-20 shows the location of wells with concentrations exceeding the ACLs collected during the 2007 sampling event.

A commingled PCE/TCE/CCl_4 plume that was known to be present in a few wells in the South Balloon was expanded to the south and southwest during the 2007/2008 CPT/HydroPunch investigation (URS, 2009b). HydroPunch sample results from the investigation identified this unique plume in which CCl_4 and PCE each have concentrations exceeding TCE concentrations in multiple borings south of the EWC4 Area and extending a few hundred feet off depot. The estimated lateral extent of CCl_4 exceeding the ACL using well and recently collected HydroPunch sample data from the 2007/2008 CPT/HydroPunch investigation is shown on Figure 6-20.

6.4.2.2 Bromacil

Bromacil is not regulated in groundwater and an ACL has not been established for this herbicide. Bromacil sampling at all wells was discontinued in 2007 (URS, 2007b).

6.4.2.3 Metals

Lead. Groundwater at DDJC-Sharpe is not considered contaminated by lead from soil. Lead was not reported greater than the baseline concentrations in groundwater samples collected in 1998 or 2000. An ACL has not been established for lead, and groundwater sampling for lead analysis was discontinued in 2001 (URS, 2001c).

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 were established in the first quarter that a sample was collected after the ROD was signed. No significant trends were identified for chromium, and groundwater sampling for chromium analysis was discontinued in 2007 (URS, 2007b).

6.4.2.4 Background Concentrations

Background concentrations 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 of other inorganic species are compared to MCLs. The following table lists the background concentrations that have been established for arsenic, selenium, and nitrate (Radian International, 2000c).

Background Concentrations			
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	0.026	0.0076	3.8

mg/L = milligrams per liter

Arsenic and Selenium. Arsenic and selenium from non-point sources have degraded groundwater quality in the shallow aquifer in the Eastern San Joaquin subbasin. For example, annual water quality data from 2002 through 2004 collected at four active Lathrop municipal water supply wells (Numbers 6 through 9), screened at depths ranging from 164 to 300 feet bgs and located more than 3,000 feet south or east (upgradient) of DDJC-Sharpe, indicated that groundwater produced by the wells exceeds the State and federal MCL of 0.010 milligram per liter (mg/L) for arsenic. Arsenic concentrations also routinely exceed the State and federal drinking water MCL in water from private domestic supply wells located north and west of the North Balloon area. Arsenic was detected greater than the MCL at all extraction wells in 2006; however, no results were greater than background. Selenium was detected in one groundwater sample at concentrations greater than both the background concentration and the MCL in 3Q06. Because arsenic and selenium concentrations are not considered to be DDJC-Sharpe related, sampling for arsenic and selenium was discontinued in 2007 (URS, 2007b).

Nitrate. Nitrate was reported at a concentration greater than background in only one groundwater sample collected in 2Q99. This was a sample collected as part of the background study for the WDRs. Sampling for nitrate was discontinued in 2001 (URS, 2001c).

6.5 Site Inspection

DESJC and URS inspected OU 1 and OU 2 remedial action sites on 27 August 2008. Representatives from the DTSC, RWQCB, and TechLaw, on behalf of EPA, participated in the inspections.

The purpose of the inspections was to assess the protectiveness of the remedial actions performed during the period of this five-year review, including the groundwater extraction and treatment system and the excavation of Area 6 at Site S-26. The sites at which remedial actions have been completed (Figure 4-9) and the current pilot study areas (Figure 5-1) were also visited. Site inspection forms were completed and photographs were taken to show the current site conditions. Site inspection checklists are provided in Appendix F and photographs taken during inspections are provided in Appendix G.

No significant issues were identified during site inspections. The groundwater extraction and treatment system was operational and in good condition at the time of the inspection; however, the South Balloon pump station and associated extraction wells were shut down temporarily due to conveyance pipeline maintenance activities. Area 6 of Site S-26 was excavated in 2006; the railroad tracks removed during the excavation were replaced in December 2008.

6.6 Interviews

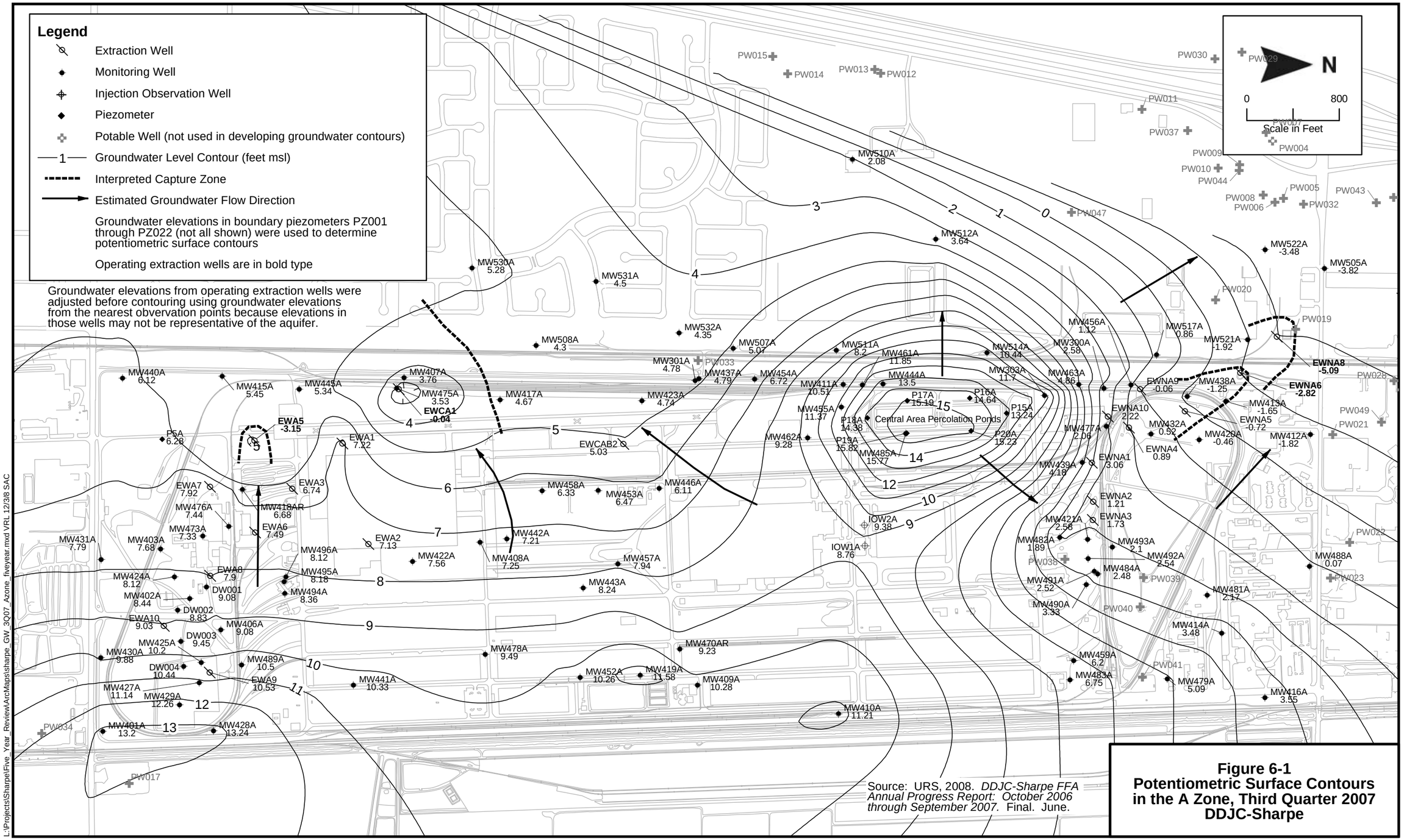
As part of the DDJC-Sharpe five-year review process, a series of interviews were conducted to evaluate opinions and concerns regarding the environmental restoration activities at DDJC-Sharpe. The interview process included two components – interviews with community members and interviews with O&M representatives, including the RPMs and O&M contractor for DDJC-Sharpe. The DDJC Office of Command Affairs requested face-to-face interviews but gave potential interviewees the option of

completing a survey by phone, mail, or electronic mail. Of the 26 individuals asked to participate in the interview process, 8 responded either by phone or electronic mail.

Three of the 16 community representatives who were contacted responded to DLA's request for input: a state Assemblywoman, the City of Lathrop's Community Development Director, and the Diamond Pet Foods Plant Manager. Both the Assemblywoman, a lifelong resident of San Joaquin County, and the Plant Manager, a 10-year employee of Diamond Pet Foods, expressed knowledge of DDJC-Sharpe's environmental operations. The City's Community Development Director, however, said she had only lived in the community for four years and was not aware of the environmental activities being conducted at DDJC-Sharpe. Neither the Assemblywoman nor the City's Community Development Director reported receiving complaints or concerns from community members regarding DDJC-Sharpe, but both respondents requested more regular updates on DDJC-Sharpe's environmental management program and operations.

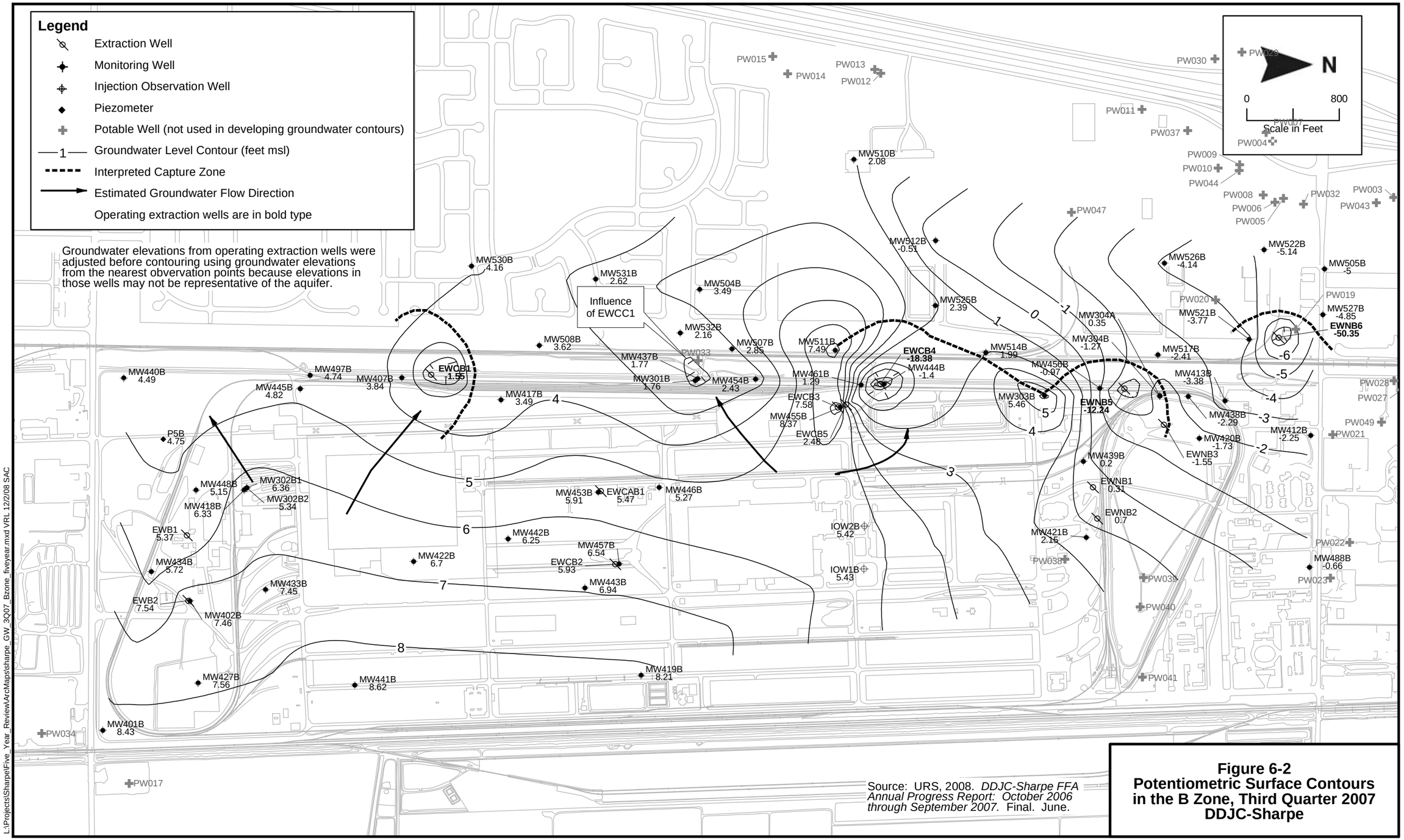
Five of the 10 O&M representatives who were contacted for an interview participated: the RPMs for DESJC, DTSC, and RWQCB; the O&M project manager; and the O&M GWTP supervisor. In general, the overall impression of the remedies selected for DDJC-Sharpe's IRP was favorable. At the time of the survey, all respondents felt the groundwater remedy was functioning as expected, although some concern was expressed regarding the effectiveness and cost of the pump-and-treat process. The greatest concerns regarding the groundwater remedy included changes in regulatory requirements over time, the cost of replacing aging infrastructure, the low rate of mass removal, the potential for overlooking persistent sources, and protection of the aquifer.

The responses to the five-year review interviews will be taken into account as DESJC moves forward with the public outreach program and continues its environmental restoration activities at DDJC-Sharpe. Interview records are provided in Appendix H.



Source: URS, 2008. *DDJC-Sharpe FFA Annual Progress Report: October 2006 through September 2007.* Final. June.

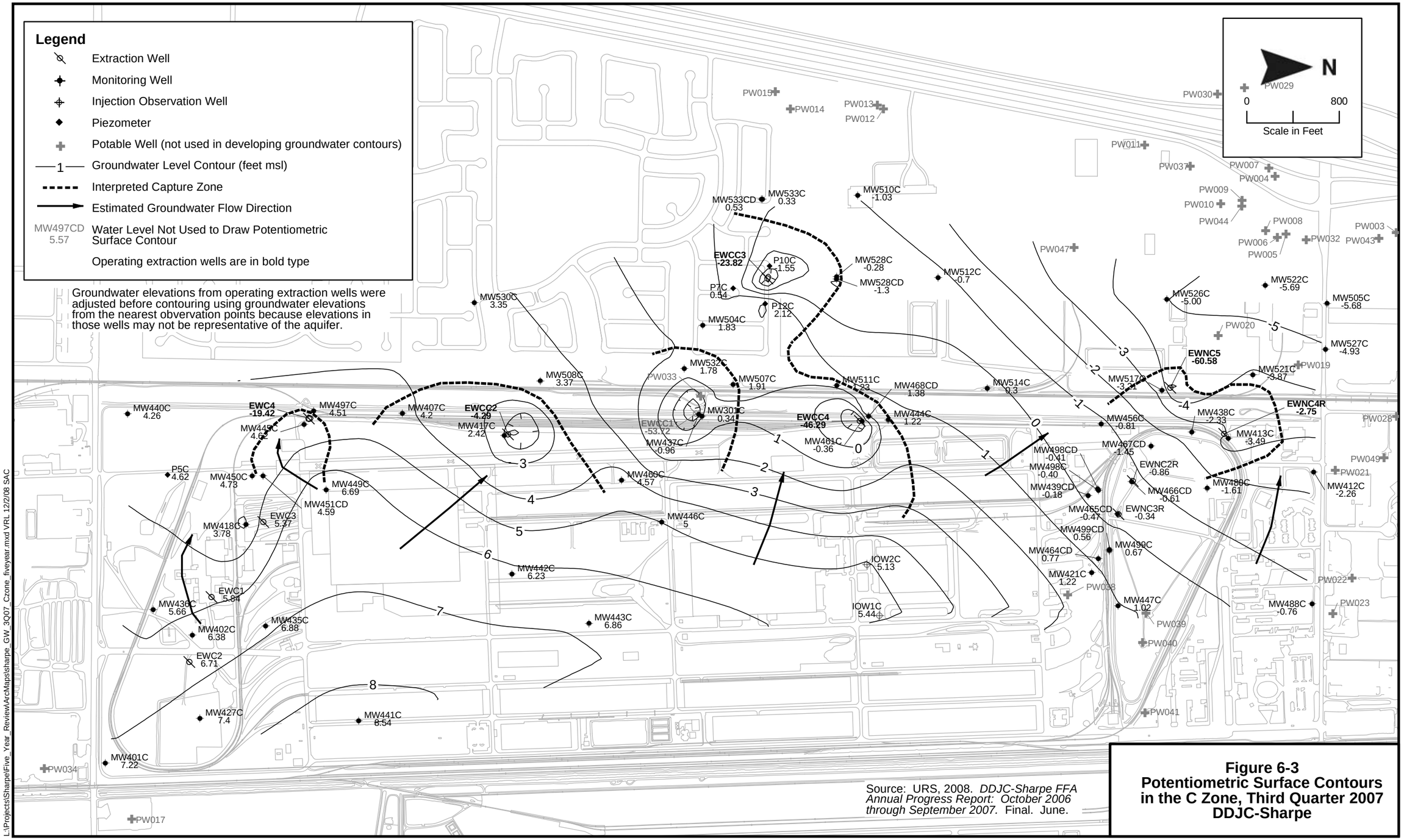
Figure 6-1
Potentiometric Surface Contours in the A Zone, Third Quarter 2007
DDJC-Sharpe



Source: URS, 2008. *DDJC-Sharpe FFA Annual Progress Report: October 2006 through September 2007.* Final. June.

Figure 6-2
Potentiometric Surface Contours in the B Zone, Third Quarter 2007
DDJC-Sharpe

L:\Projects\Sharpe\Five_Year_Review\ArcMaps\sharpe_GW_3Q07_Bzone_fiveyear.mxd VRL 12/2/08 SAC



Source: URS, 2008. *DDJC-Sharpe FFA Annual Progress Report: October 2006 through September 2007.* Final. June.

Figure 6-3
Potentiometric Surface Contours in the C Zone, Third Quarter 2007
DDJC-Sharpe

L:\Projects\Sharpe\Five_Year_Review\ArcMaps\sharpe_GW_3Q07_Czone_fiveyear.mxd VRL 12/2/08 SAC

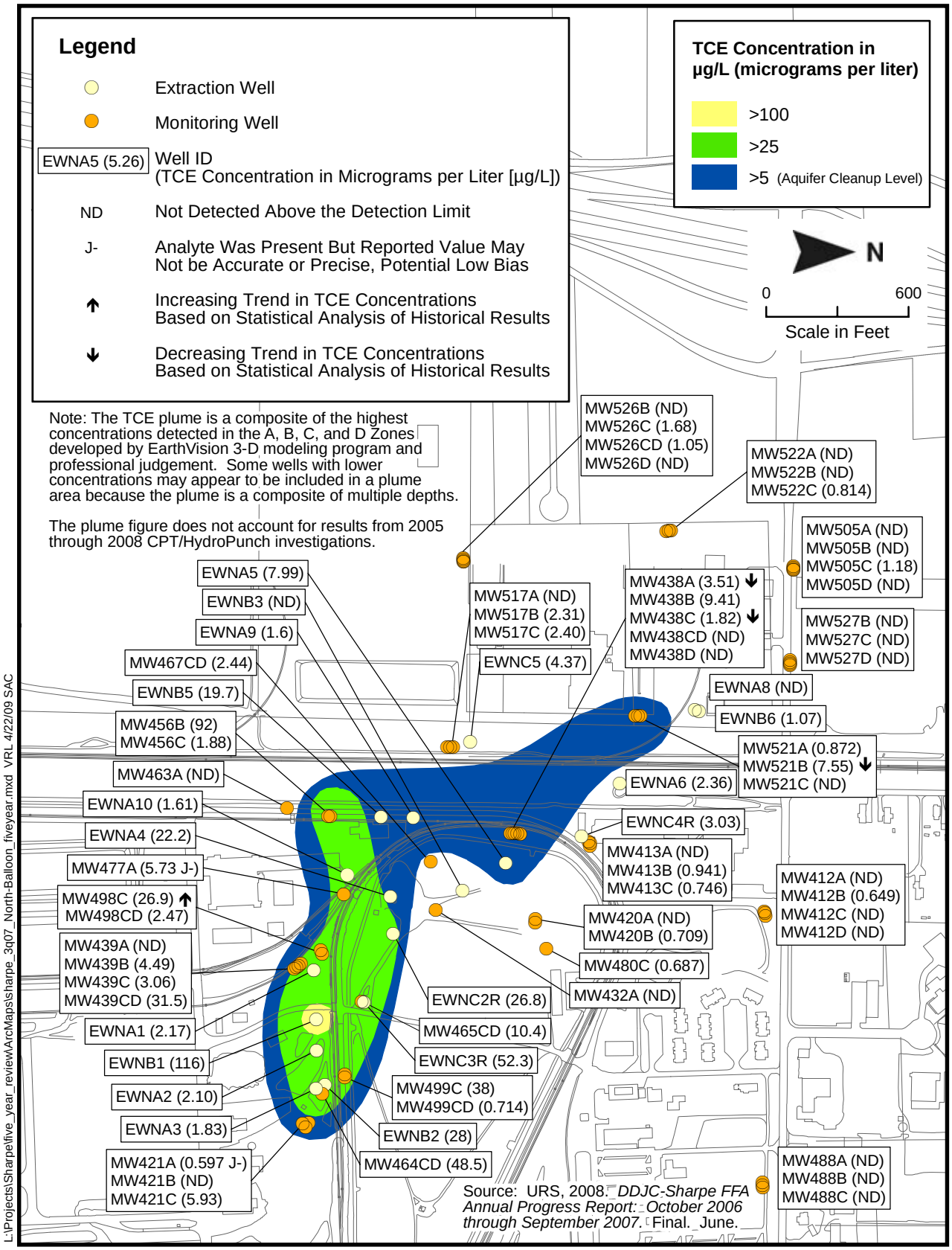


Figure 6-4. Maximum TCE Concentrations in Groundwater, North Balloon A, B, C, and D Zones, Third Quarter 2007, DDJC-Sharpe

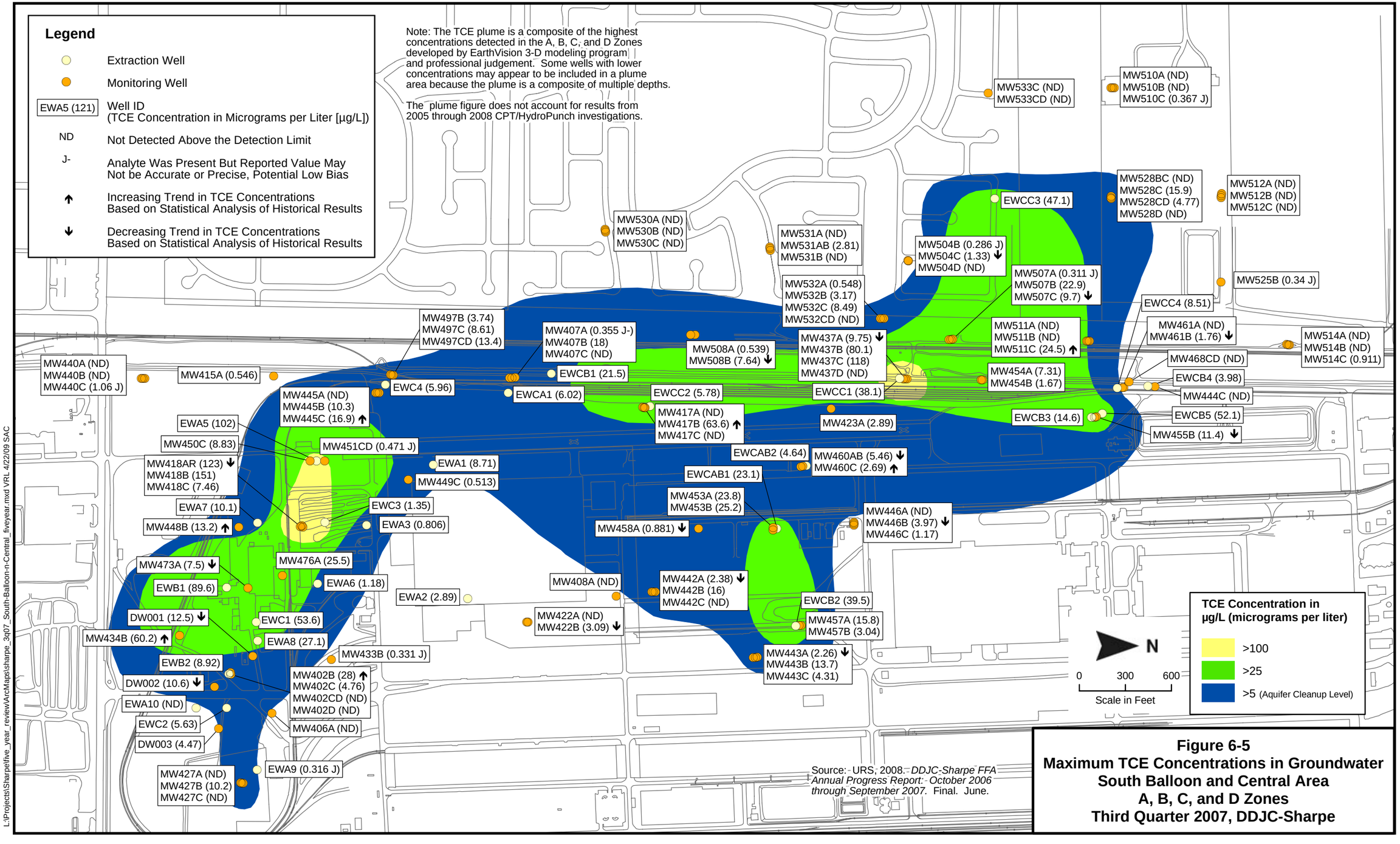
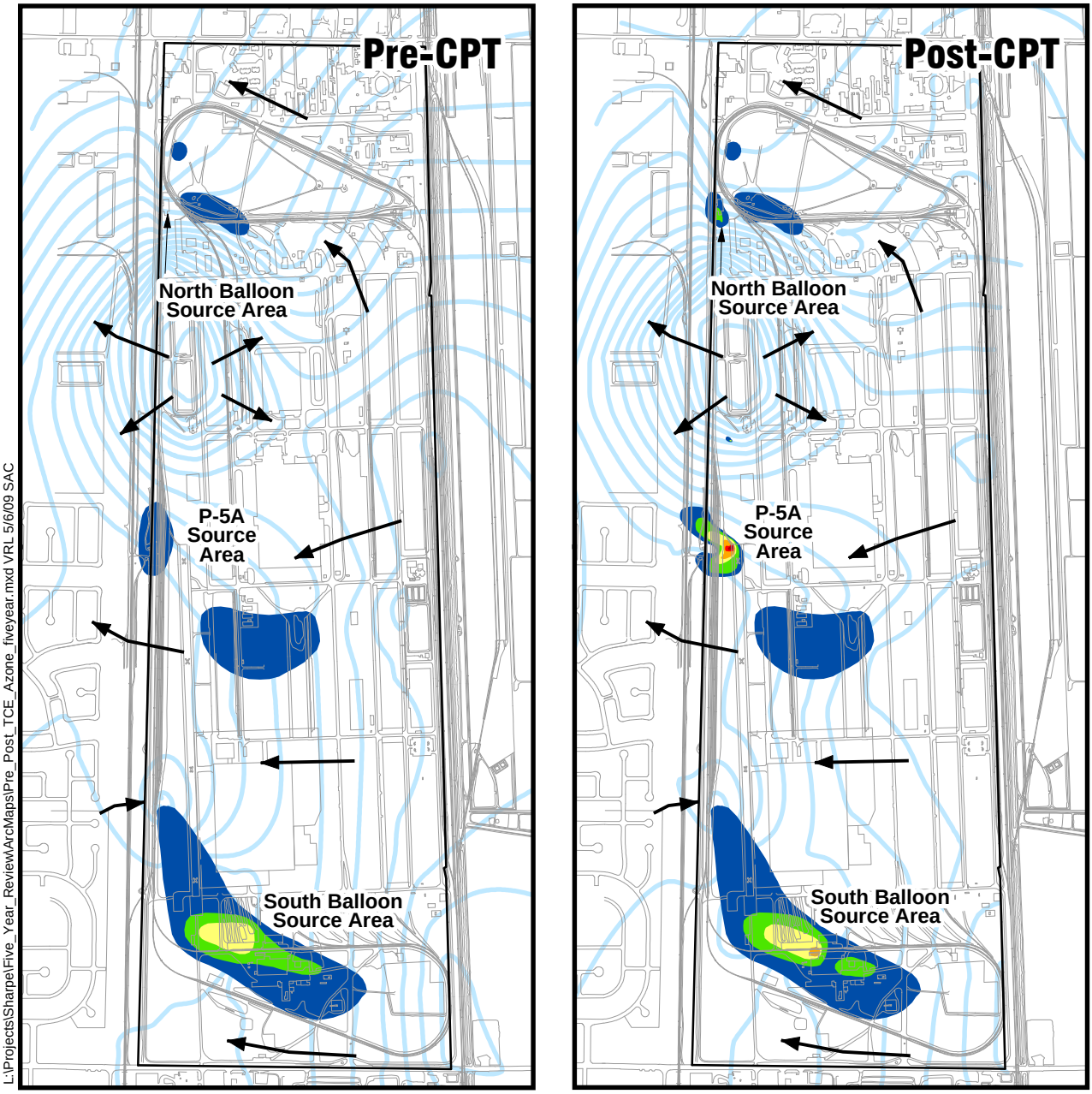
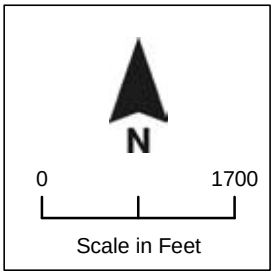


Figure 6-5
Maximum TCE Concentrations in Groundwater
South Balloon and Central Area
A, B, C, and D Zones
Third Quarter 2007, DDJC-Sharpe





Note:
Pre-CPT depiction of TCE in groundwater was taken from the *DDJC-Sharpe FFA Annual Progress Report: October 2006 through September 2007* (URS, 2008) and includes only monitoring well data collected through 3Q07.

Post-CPT depiction of TCE includes monitoring well data and HydroPunch sampling results from the *Comprehensive Cone Penetrometer Testing Investigation Results Report* (URS, 2009).

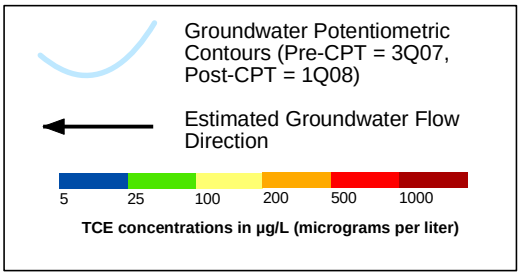
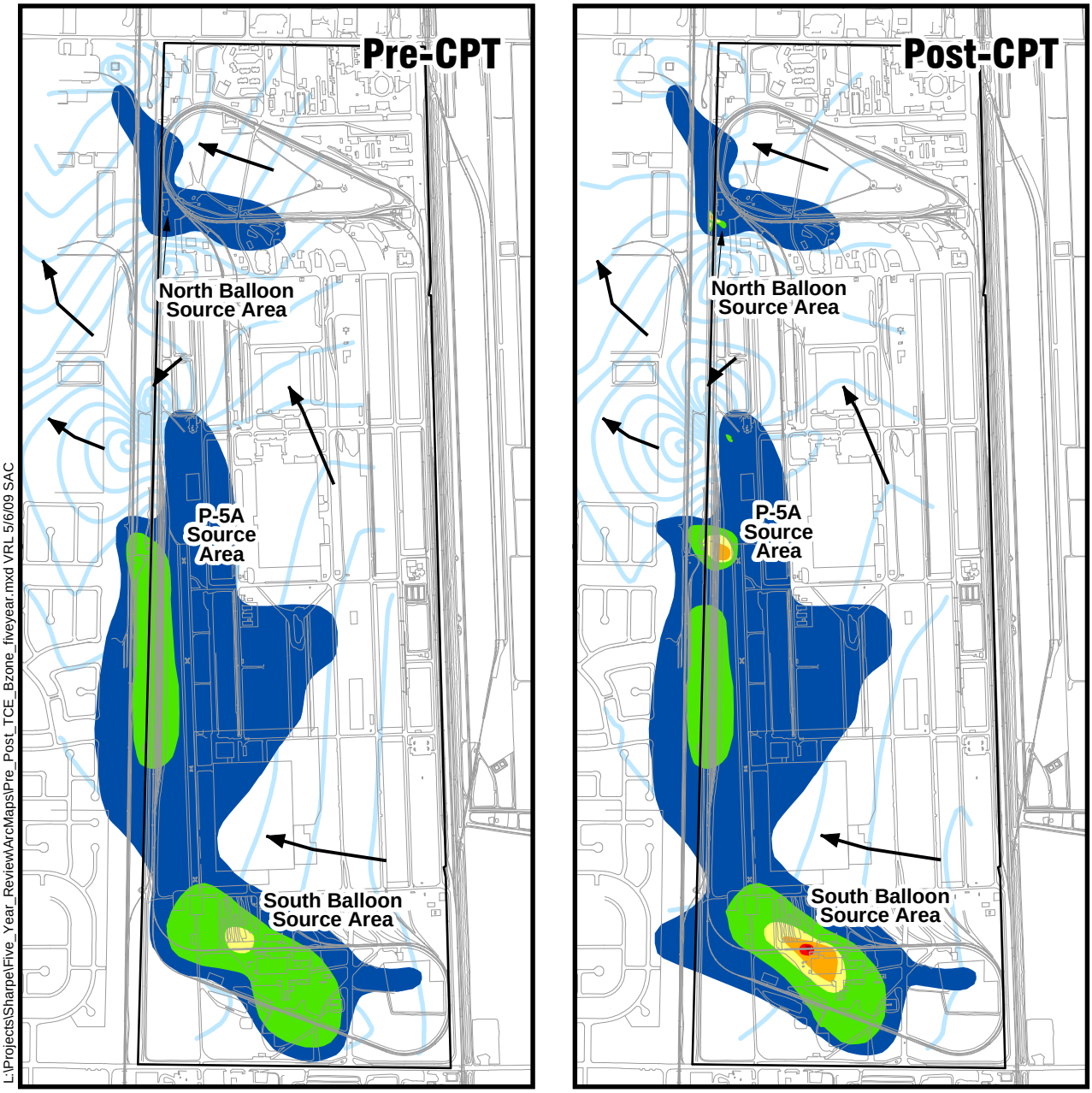
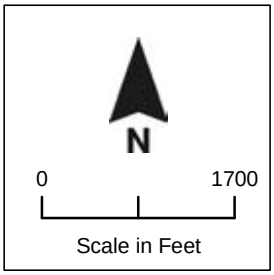


Figure 6-6. Conceptual Site Model Update — TCE in A Zone Groundwater, Pre- and Post-CPT/HydroPunch Investigation, DDJC-Sharpe





Note:
Pre-CPT depiction of TCE in groundwater was taken from the *DDJC-Sharpe FFA Annual Progress Report: October 2006 through September 2007* (URS, 2008) and includes only monitoring well data collected through 3Q07.

Post-CPT depiction of TCE includes monitoring well data and HydroPunch sampling results from the *Comprehensive Cone Penetrometer Testing Investigation Results Report* (URS, 2009).

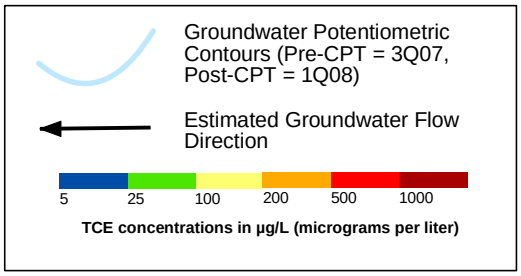
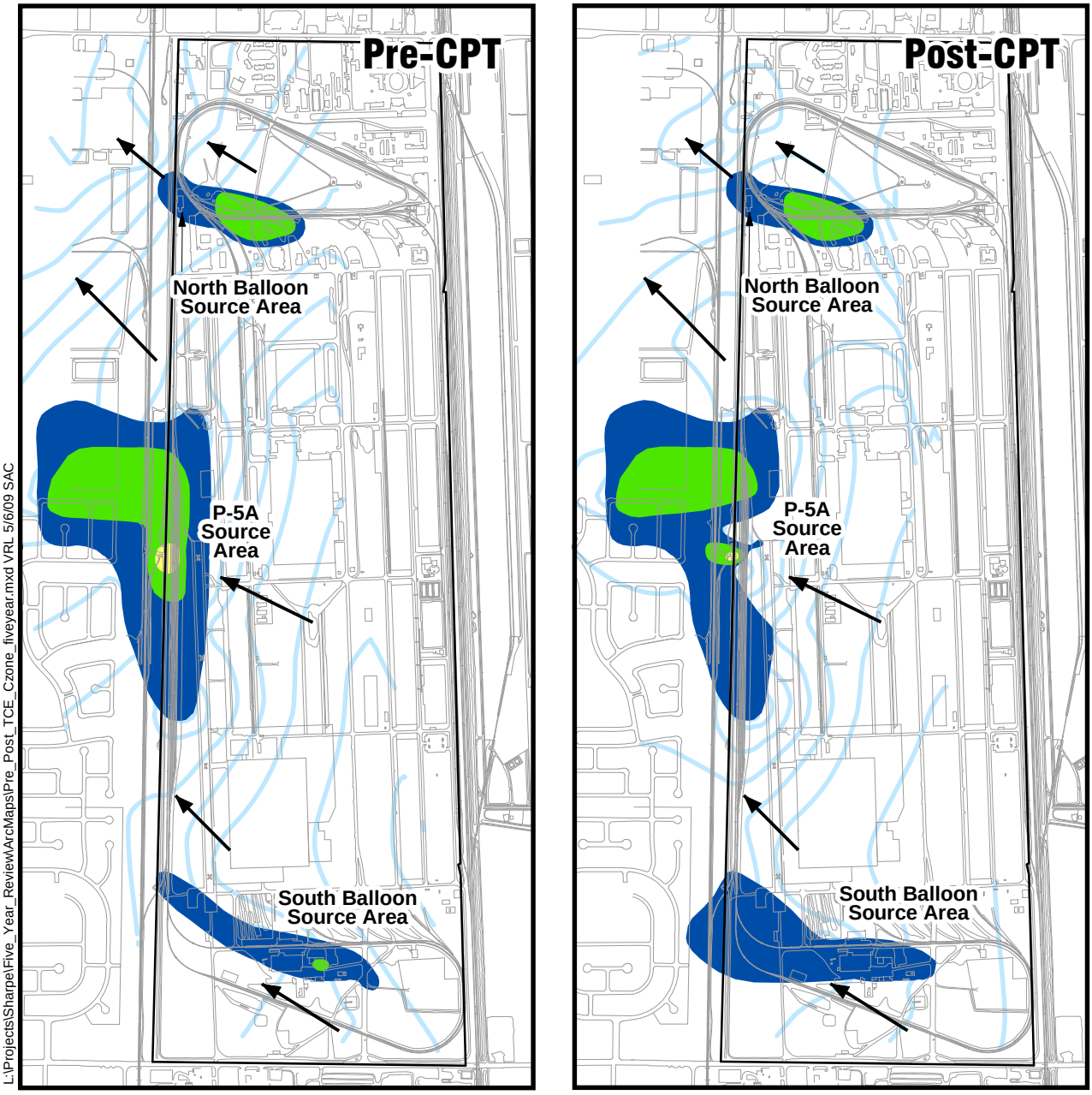
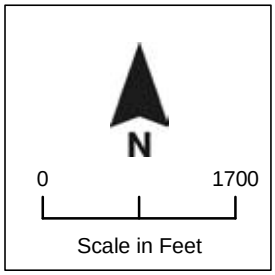


Figure 6-7. Conceptual Site Model Update — TCE in B Zone Groundwater, Pre- and Post-CPT/HydroPunch Investigation, DDJC-Sharpe





Note:
Pre-CPT depiction of TCE in groundwater was taken from the *DDJC-Sharpe FFA Annual Progress Report: October 2006 through September 2007* (URS, 2008) and includes only monitoring well data collected through 3Q07.

Post-CPT depiction of TCE includes monitoring well data and HydroPunch sampling results from the *Comprehensive Cone Penetrometer Testing Investigation Results Report* (URS, 2009).

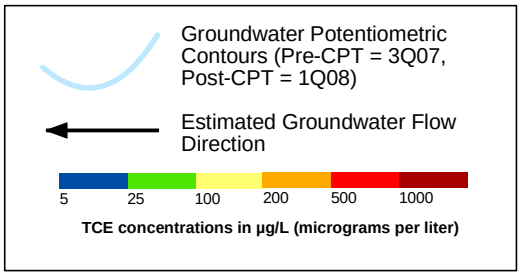


Figure 6-8. Conceptual Site Model Update — TCE in C Zone Groundwater, Pre- and Post-CPT/HydroPunch Investigation, DDJC-Sharpe

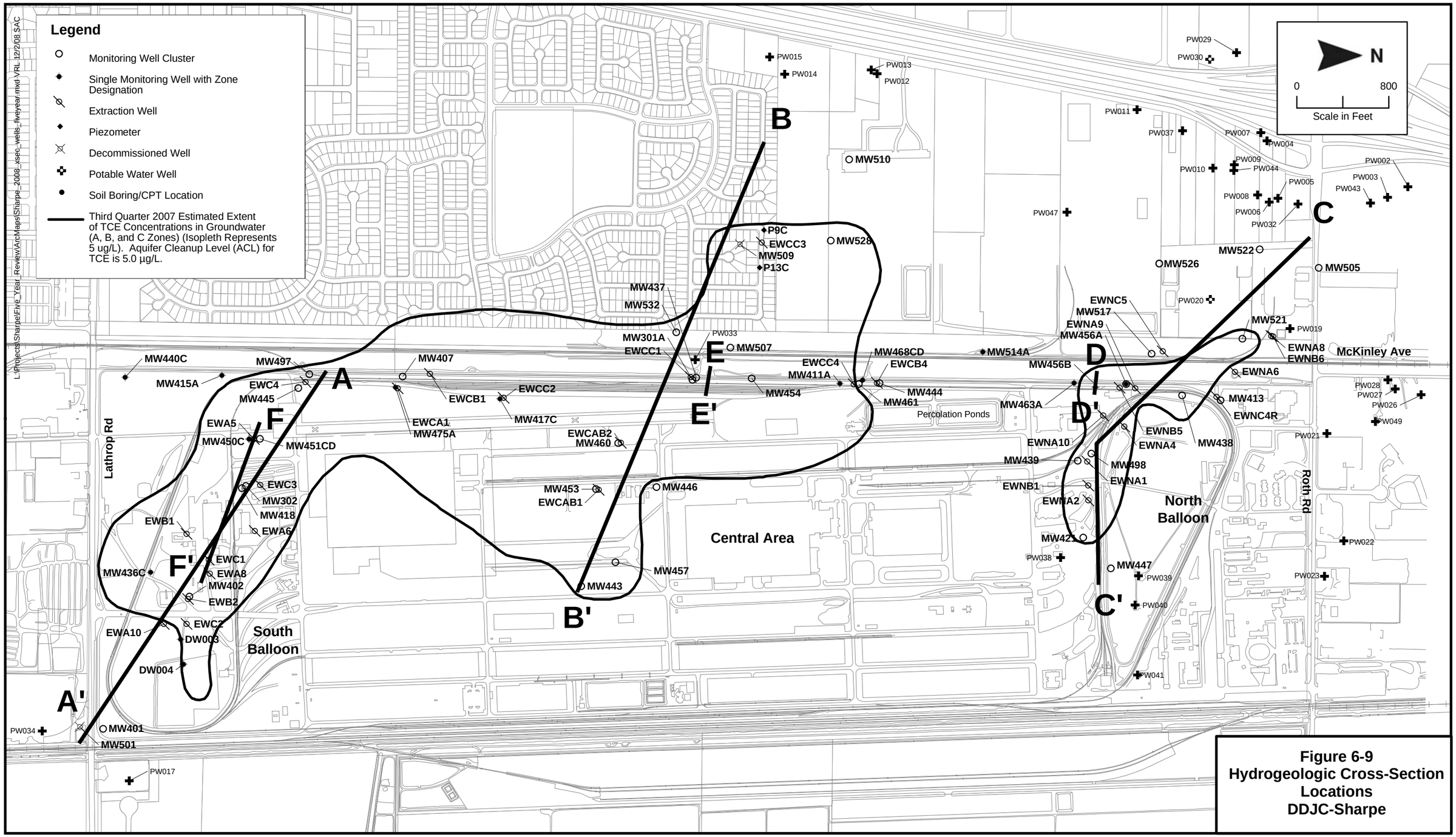


Figure 6-9
Hydrogeologic Cross-Section Locations
DDJC-Sharpe

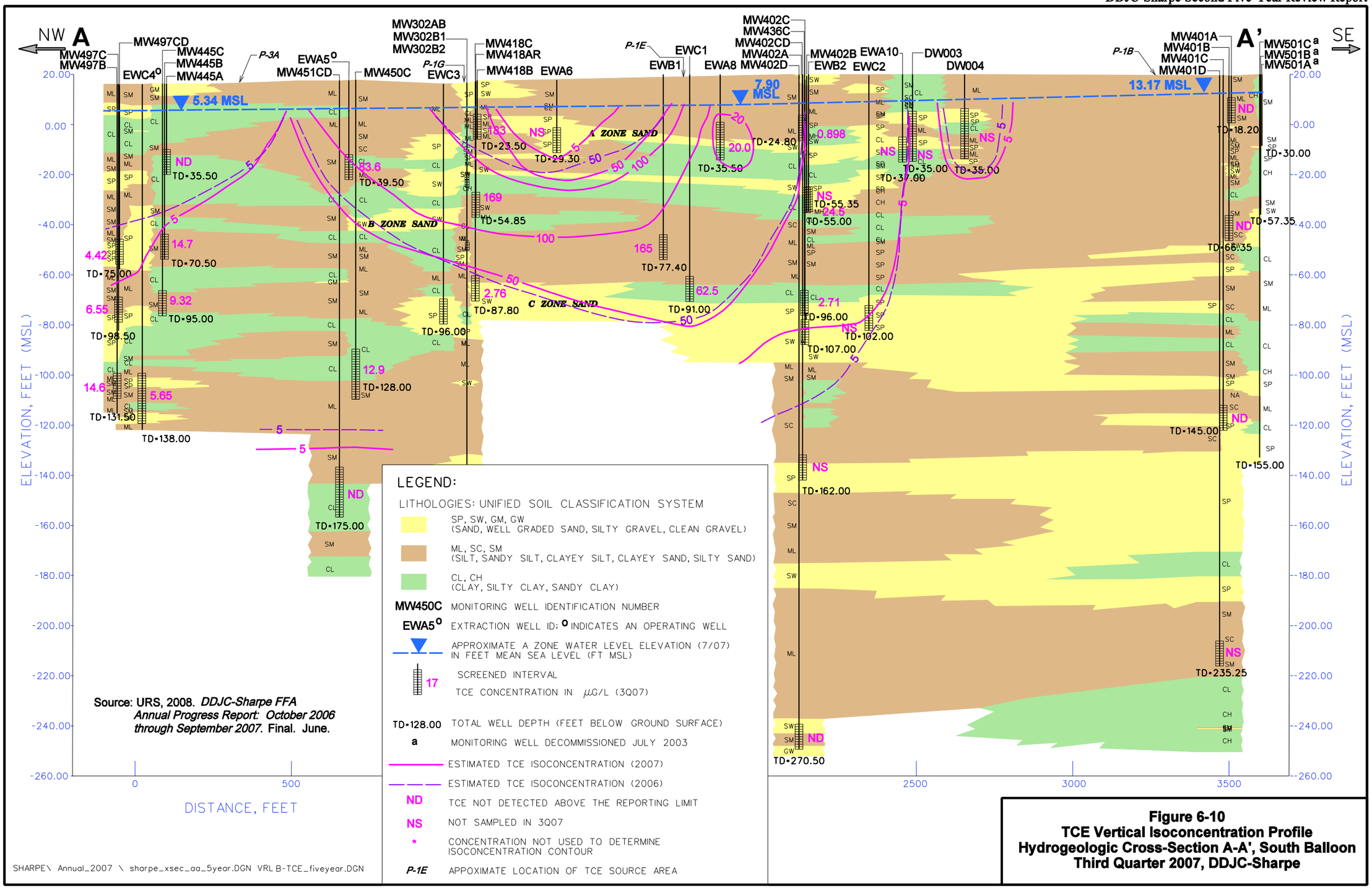


Figure 6-10
TCE Vertical Isoconcentration Profile
Hydrogeologic Cross-Section A-A', South Balloon
Third Quarter 2007, DDJC-Sharpe

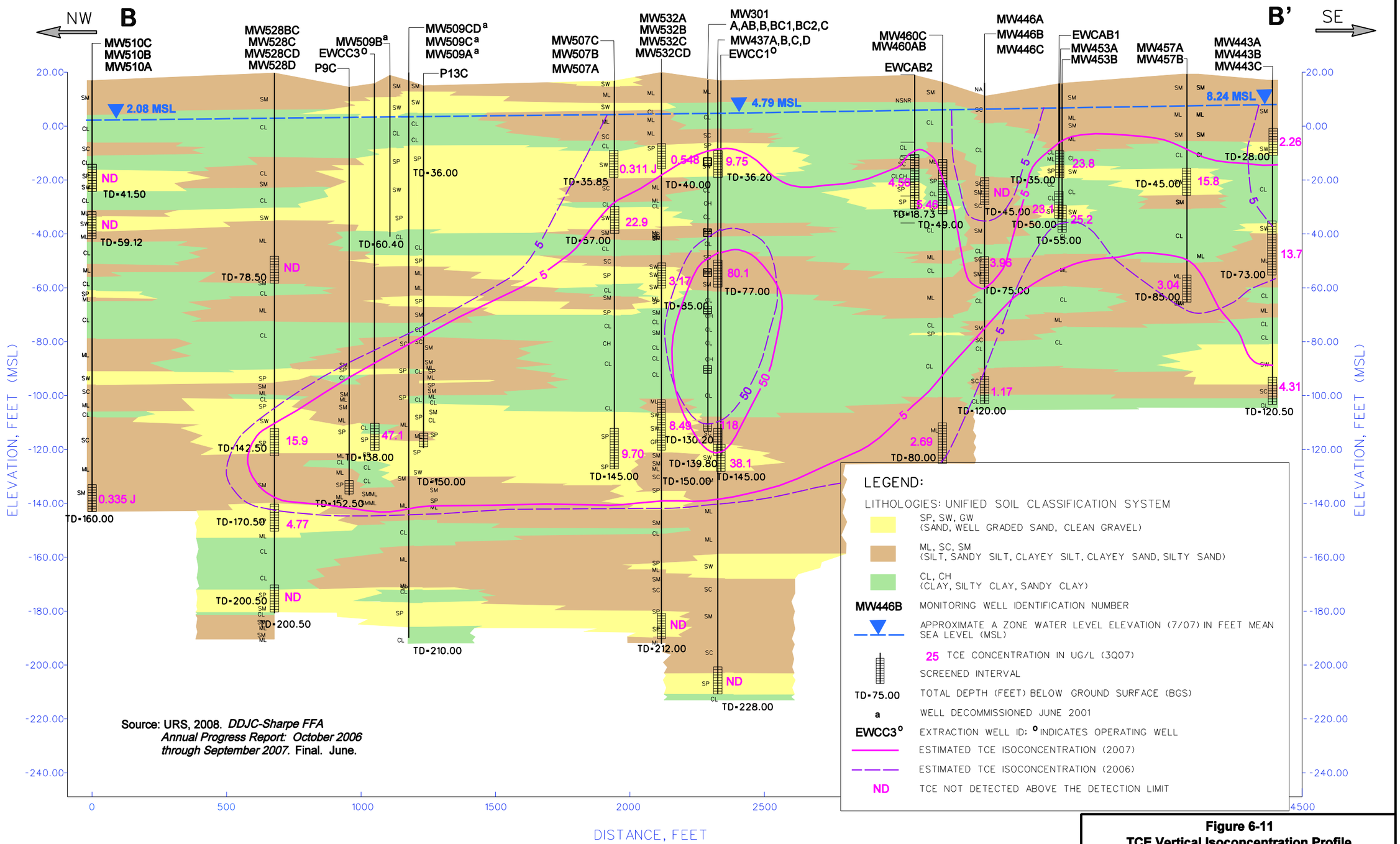


Figure 6-11
TCE Vertical Isoconcentration Profile
Hydrogeologic Cross-Section B-B', Central Area
Third Quarter 2007, DDJC-Sharpe

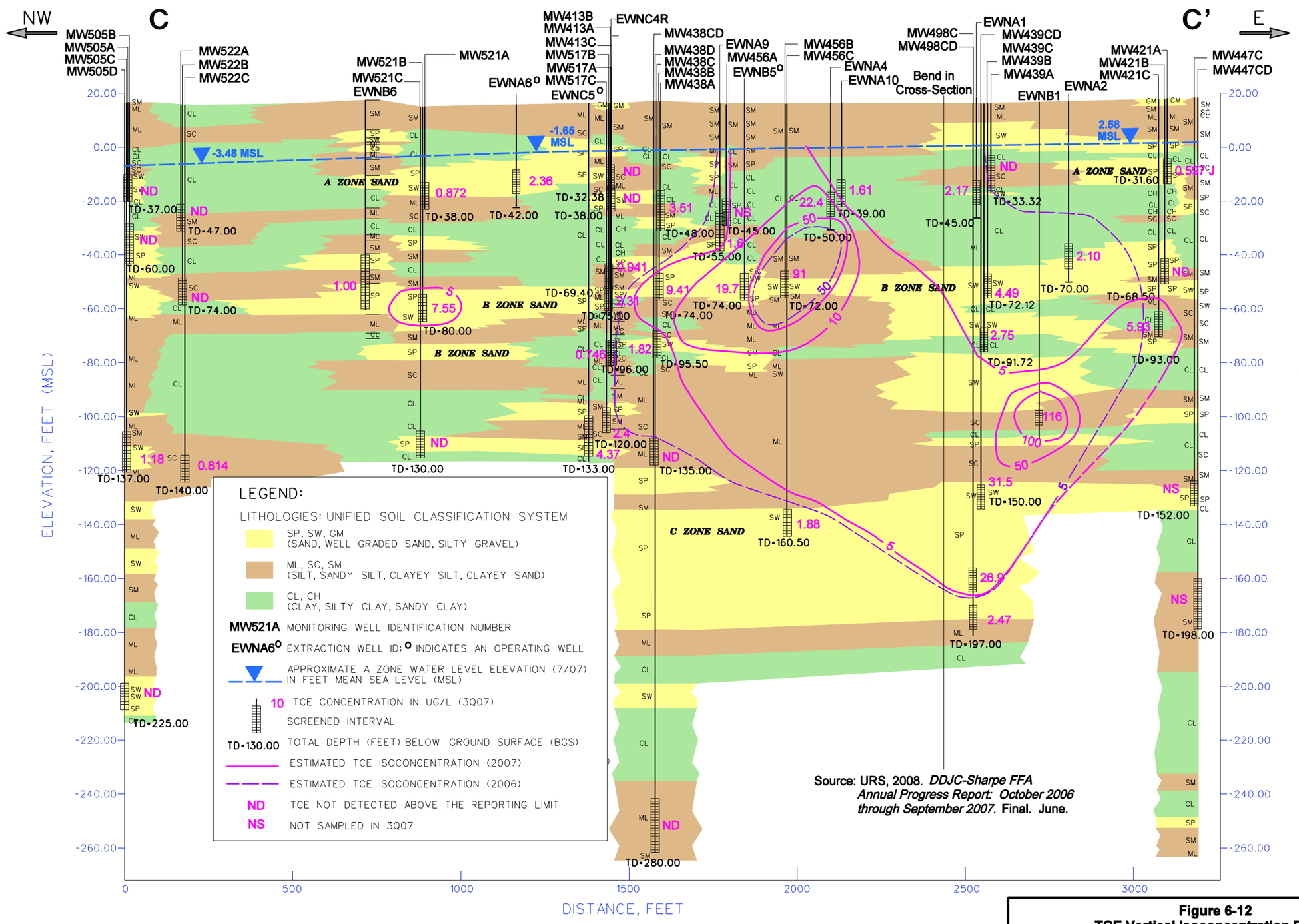
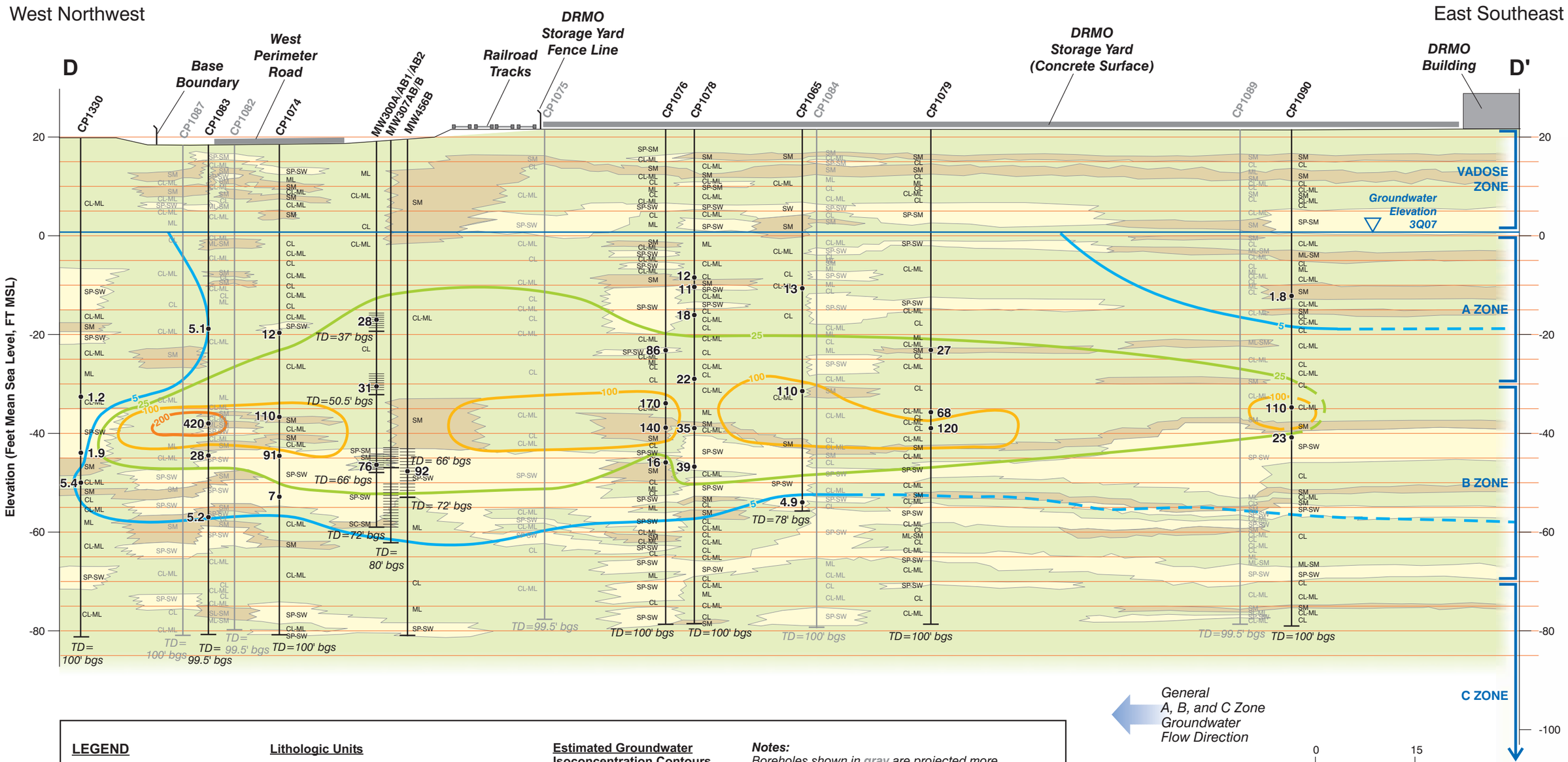


Figure 6-12
TCE Vertical Isoconcentration Profile
Hydrogeologic Cross-Section C-C', North Balloon
Third Quarter 2007
DDJC-Sharpe

SHARPE\ 2007_ANNUAL \ SHARPE_XSEC_DD_v3.DGN VRL D-TCE_fiveyear.DGN



LEGEND

Well Screen

2.8 TCE Concentration *(projected <50 feet from the cross-section plane)*

Lithologic Units

- *CL, CL-ML, CH, ML: clay, silty clay, sandy clay, and clayey silt*
- *SM, SC, ML: silty sand, clayey sand, silt, and sandy silt*
- *SP, SW, GP, GW: poorly graded sand, well graded sand, poorly graded gravel, and well graded gravel*

Estimated Groundwater Isoconcentration Contours for TCE (µg/L)

- > 5
- > 25
- > 100
- > 200

Notes:
Boreholes shown in gray are projected more than 50 feet from the cross-section plane.

MW307 well series was installed in 2Q08 as part of the Emulsified Oil Injection Pilot Study (URS, 2007.) Data were not used in contouring.

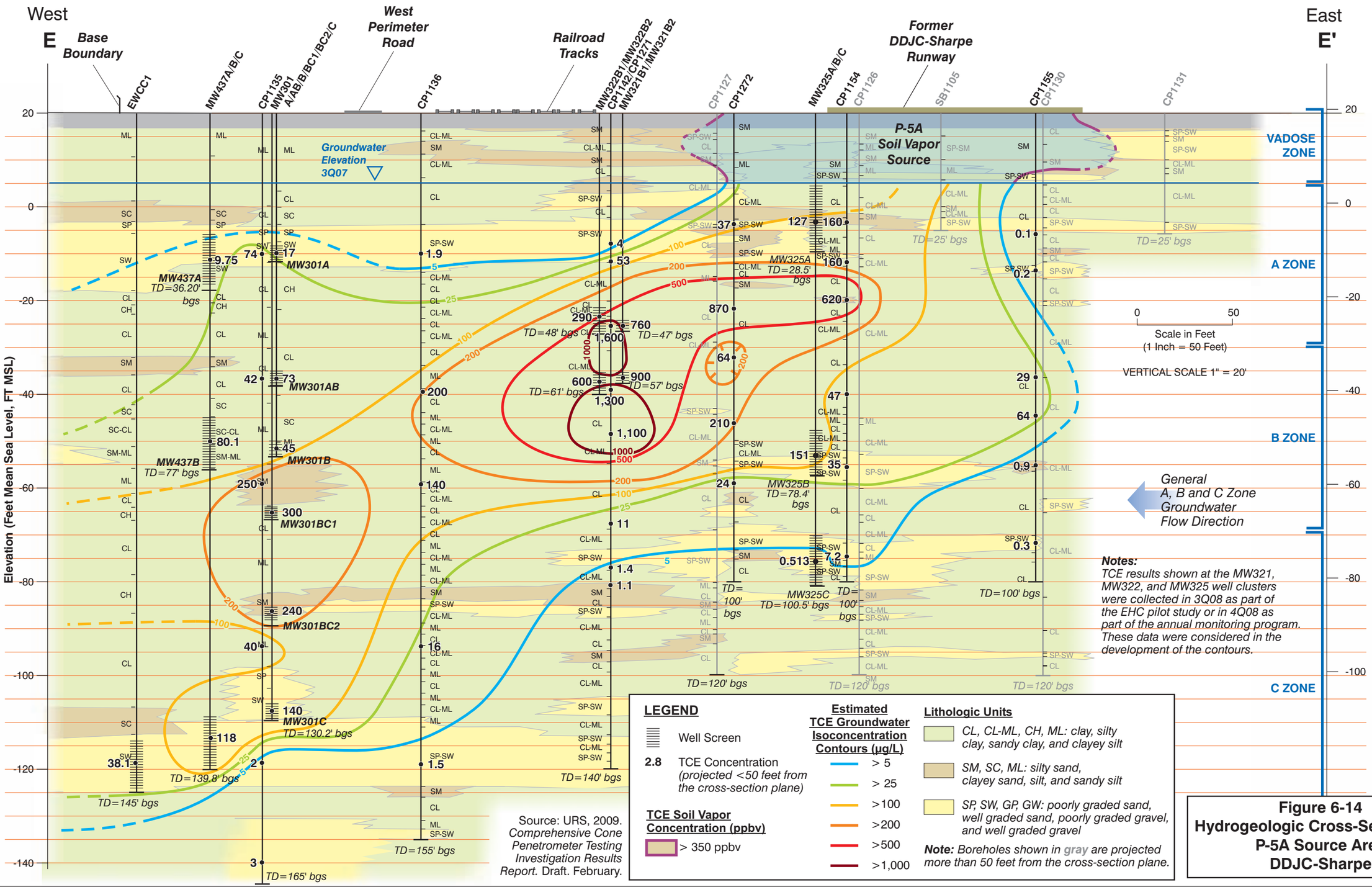
CP1065 sample results from 2005; see Natural Attenuation Investigation (URS, 2006)

DRMO = Defense Reutilization and Marketing Office

Source:
URS, 2009. *Comprehensive Cone Penetrometer Testing Investigation Results Report.* Draft. February.

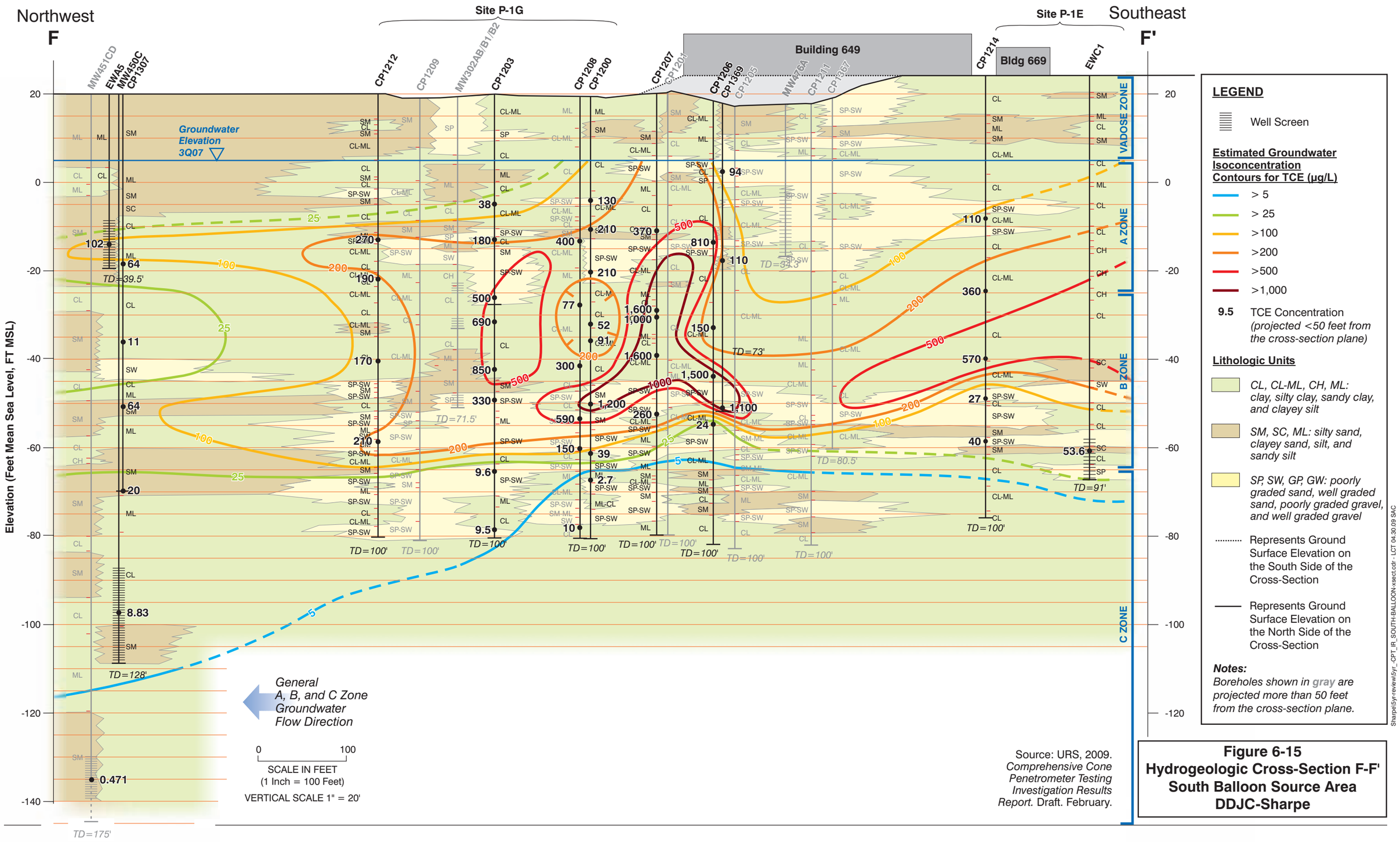
Figure 6-13
Hydrogeologic Cross-Section D-D'
North Balloon Source Area
DDJC-Sharpe

Sharpe\5yr-review\5yr_CPT_IR_North-Balloon-xsect.cdr - LCT 04.30.09 SAC



Source: URS, 2009. *Comprehensive Cone Penetrometer Testing Investigation Results Report.* Draft. February.

Figure 6-14
Hydrogeologic Cross-Section E-E'
P-5A Source Area
DDJC-Sharpe



Source: URS, 2009. *Comprehensive Cone Penetrometer Testing Investigation Results Report.* Draft. February.

Figure 6-15
Hydrogeologic Cross-Section F-F'
South Balloon Source Area
DDJC-Sharpe

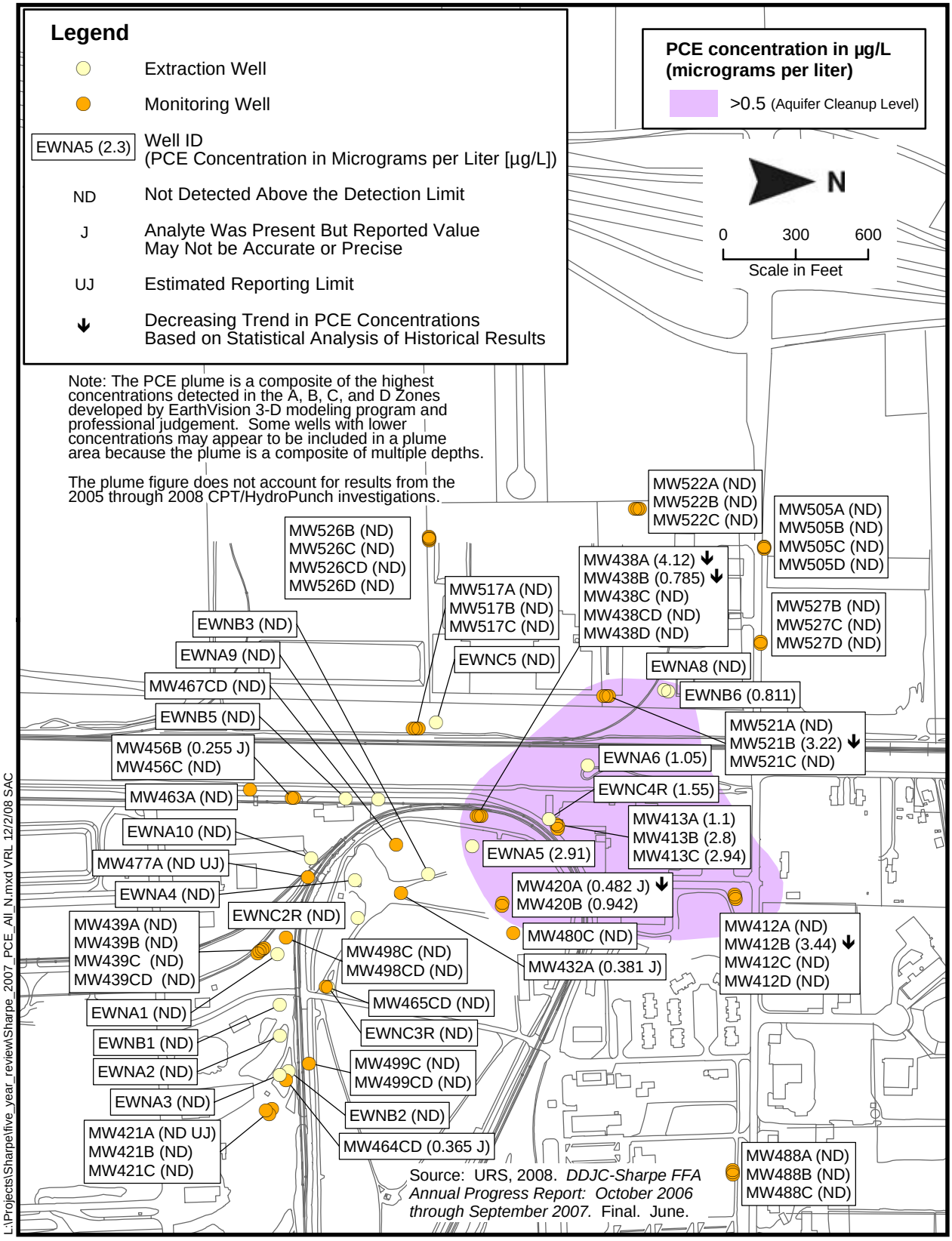
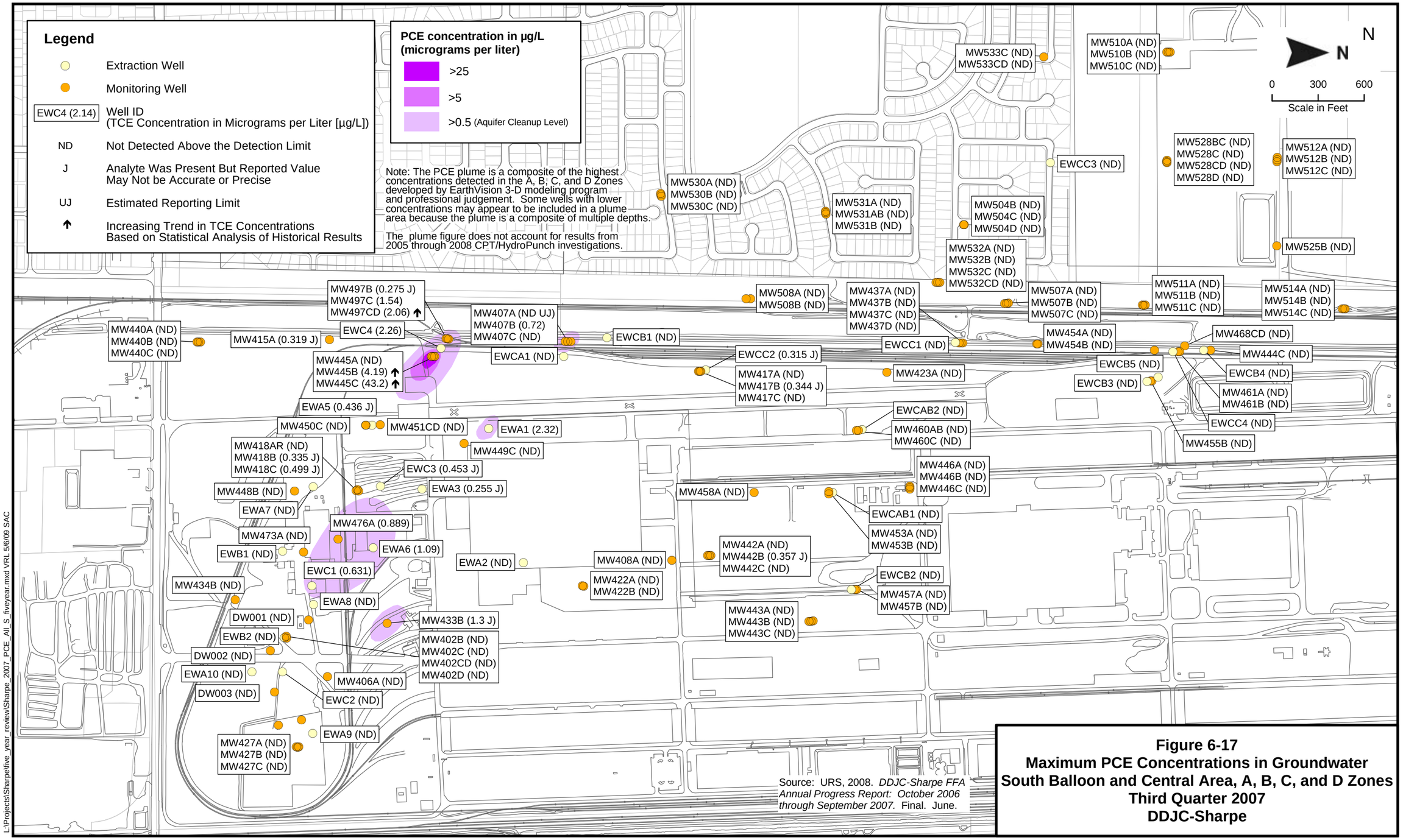
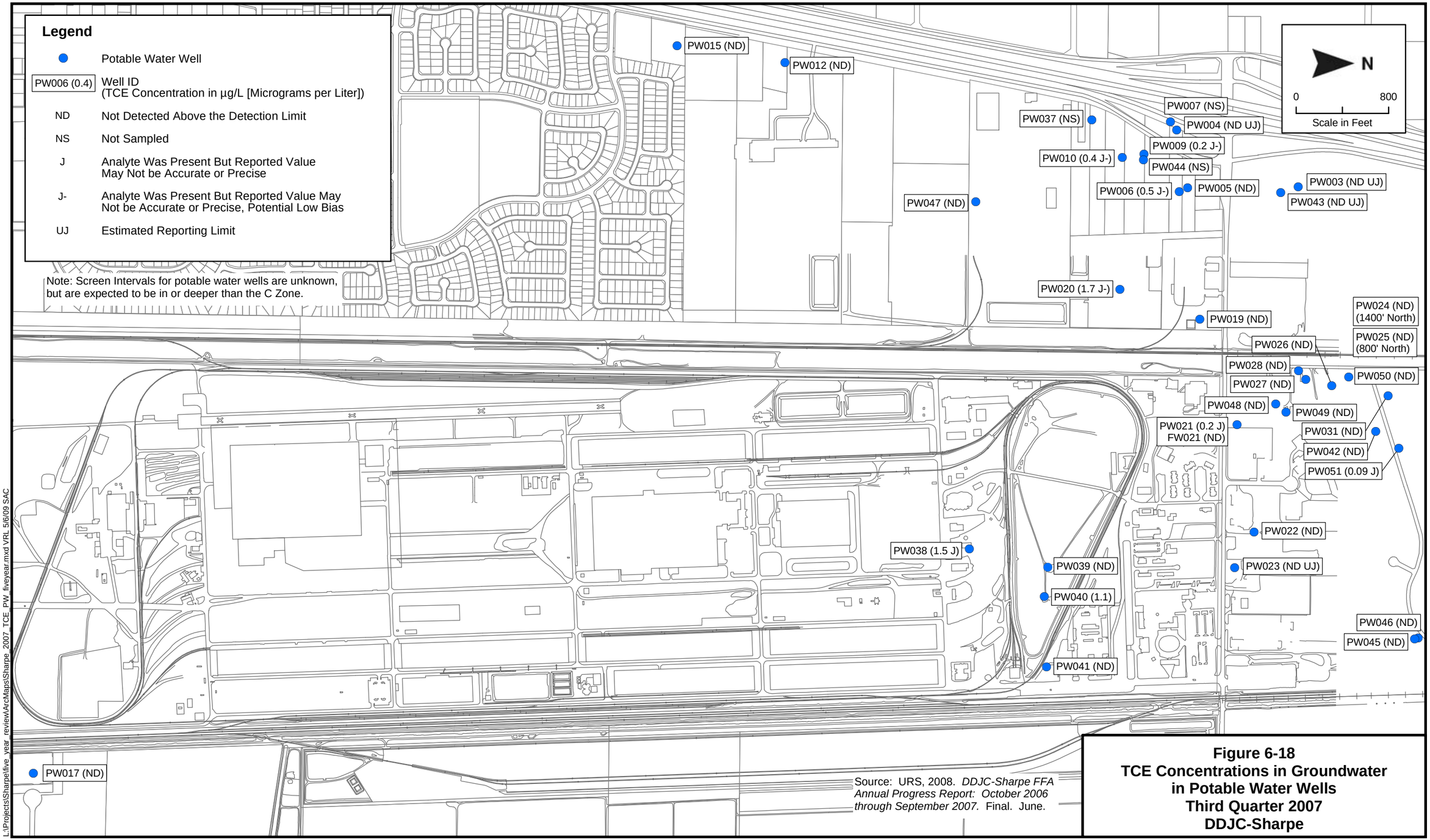


Figure 6-16. Maximum PCE Concentrations in Groundwater, North Balloon A, B, C, and D Zones, Third Quarter 2007, DDJC-Sharpe



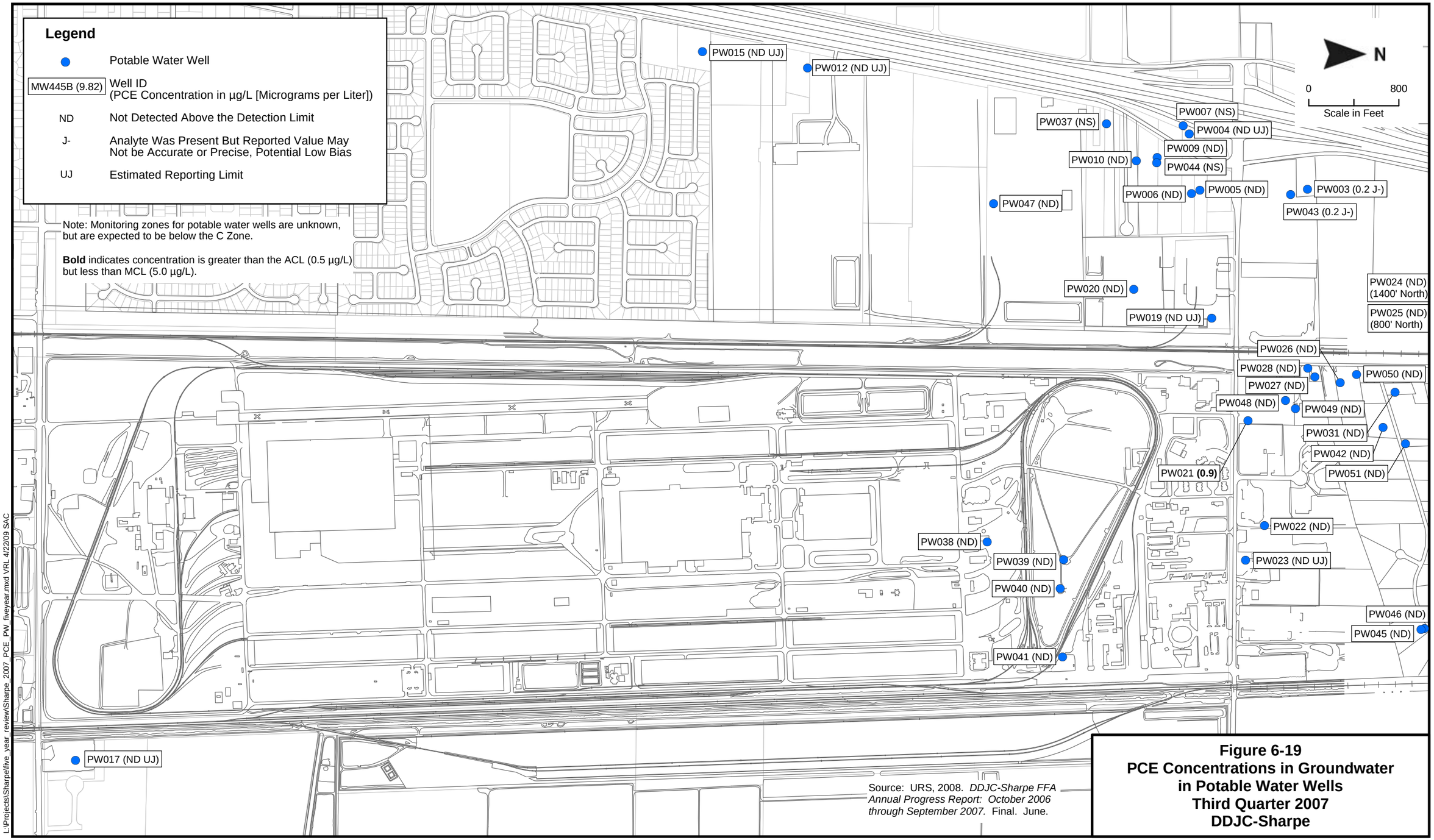
Source: URS, 2008. *DDJC-Sharpe FFA Annual Progress Report: October 2006 through September 2007.* Final. June.

Figure 6-17
Maximum PCE Concentrations in Groundwater
South Balloon and Central Area, A, B, C, and D Zones
Third Quarter 2007
DDJC-Sharpe



Source: URS, 2008. *DDJC-Sharpe FFA Annual Progress Report: October 2006 through September 2007.* Final. June.

Figure 6-18
TCE Concentrations in Groundwater in Potable Water Wells
Third Quarter 2007
DDJC-Sharpe



Source: URS, 2008. *DDJC-Sharpe FFA Annual Progress Report: October 2006 through September 2007.* Final. June.

Figure 6-19
PCE Concentrations in Groundwater in Potable Water Wells
Third Quarter 2007
DDJC-Sharpe

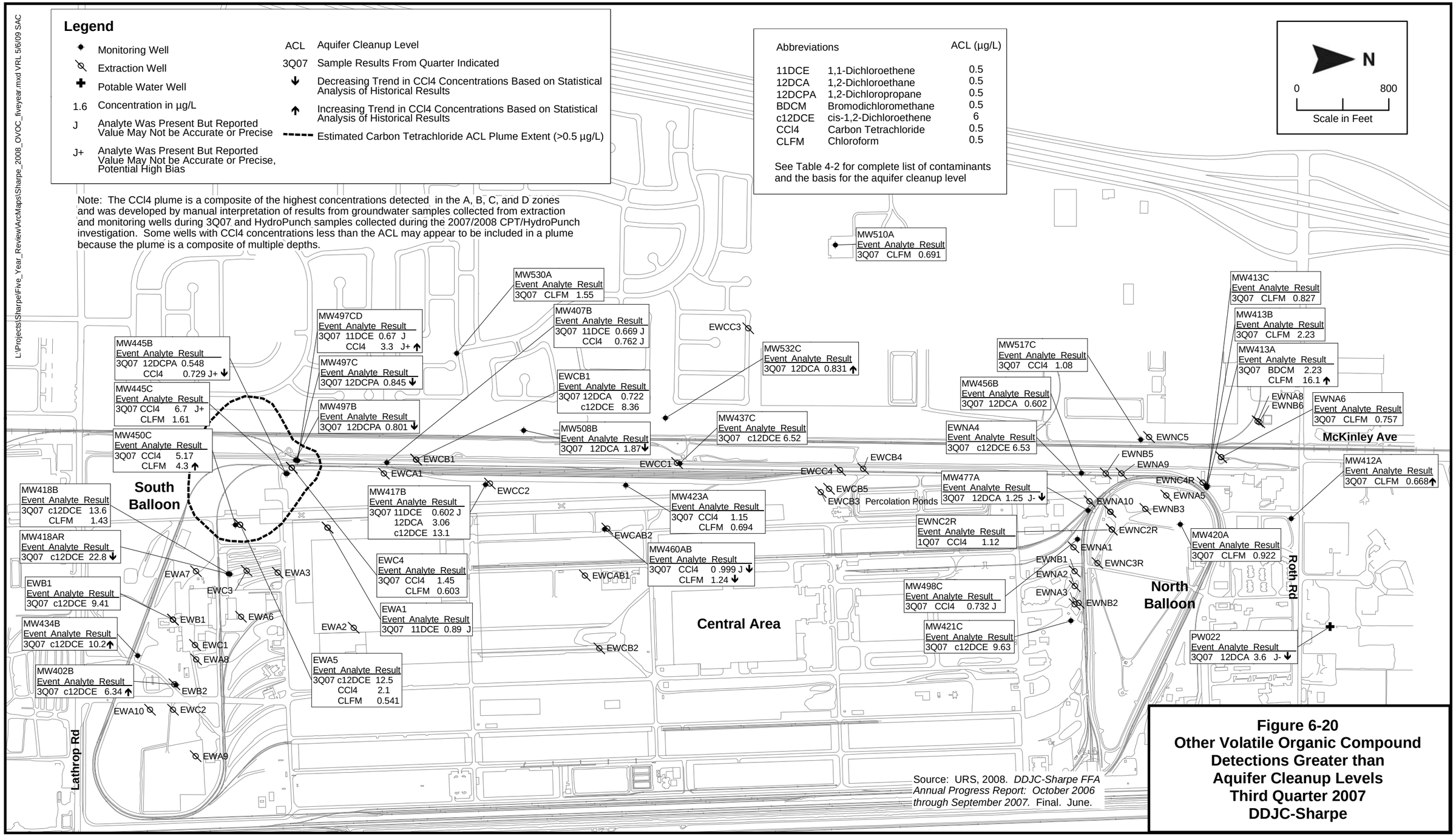


Figure 6-20
Other Volatile Organic Compound Detections Greater than Aquifer Cleanup Levels
Third Quarter 2007
DDJC-Sharpe

7.0 TECHNICAL ASSESSMENT

The technical assessment for remedial and removal actions at DDJC-Sharpe consists of determining whether those actions are, or upon completion will be, protective of human health and the environment. To reach a protectiveness determination, EPA guidance recommends that the following three questions be addressed for each action (EPA, 2001):

- Question A—Is the remedy functioning as intended by the decision documents?
- Question B—Are the exposure assumptions, toxicity data, cleanup standards, 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?

Answers to these three questions help ensure that all relevant issues are considered when determining the protectiveness of the remedy.

The following sections address the questions for the remedies implemented for OU 1 (Sections 7.1 through 7.3) and OU 2 (Sections 7.4 through 7.6).

7.1 Question A: Is the OU 1 groundwater remedy functioning as intended by the OU 1 ROD?

The assessment addresses the remedial action performance, O&M of the remedial system, optimization measures related to the existing remedial system, identification of potential protectiveness issues related to the implementation of the remedy, and effectiveness of ICs for groundwater at DDJC-Sharpe. These elements are addressed with consideration that the OU 1 remedy is operating in its optimized 15-well array (Section 4.1.2.4).

7.1.1 Remedial Action Performance

The RAOs identified in the ROD are to “mitigate potential long-term contaminant migration and protect human health and the environment” (ESE, 1993, page 41). The goal of the remedial action is to “restore groundwater to its beneficial reuse” (ESE, 1993, page 56). Criteria used to evaluate performance of the remedial action were: progress toward achieving ACLs in the groundwater; plume capture by the extraction well array; and model predictions indicating cleanup would be achieved in a reasonable time. While the remedy is generally performing as intended, HydroPunch data recently collected as part of the 2007/2008 CPT/HydroPunch investigation indicate that the extent and magnitude of VOC contamination in groundwater are greater than previously understood. DDJC-Sharpe is currently implementing pilot tests to evaluate an alternative response action to the groundwater remedy.

7.1.1.1 Progress Toward ACLs

Reduction in VOC plume concentrations were observed from 3Q03 to 3Q06. Comparisons of TCE and PCE plume shapes from the third quarters of 2003 through 2006 (Figures 7-1 and 7-2) indicate that the horizontal extents of TCE and PCE were also reduced. However, analytical data from groundwater samples collected from monitoring well cluster MW528, located west of the depot boundary (Figure 6-5) and which was installed on the basis of a recommendation in the first five-year review, indicate the TCE plume extent off depot is greater to the northwest than previously estimated (Figure 7-1). Post-3Q06 analytical results from newly installed groundwater monitoring wells and recently collected HydroPunch

samples from the 2007/2008 CPT/HydroPunch investigation indicate that concentrations of TCE greater than 1,000 µg/L are present in groundwater and that contaminant plume extents in some areas are greater than 3Q07 plume areas (Figures 6-6 through 6-8). The concentration increases (shown by larger green and yellow areas in the 2007 portion of Figure 7-1) between 2006 and 2007 data may have been the result of the shutdown of 21 extraction wells for the extraction well optimization test. The concentration increases generally occurred in the center of plumes near sources where extraction wells would have been removing concentrations of VOCs before they were shut down in December 2006.

HydroPunch data obtained from the 2007/2008 CPT/HydroPunch investigation indicate the presence of substantial residual VOC mass in the saturated zone that is not being reduced by groundwater extraction because of its distance from extraction wells and the characteristics of the fine-grained aquitard in which it is contained. Data from HydroPunch samples collected during the CPT investigation show high contaminant concentrations representing residual TCE mass in the Central Area (centered on Site P-5A) and the South Balloon (centered on Site P-1G) (Figure 7-3); no operating extraction wells are located within 400 feet of either site (Figure 6-5). HydroPunch sample results from the 2007/2008 CPT/ HydroPunch investigation have also been used to reinterpret the extent of PCE plumes exceeding 0.5 µg/L (Figure 7-4).

In an effort to evaluate alternative remedial technologies that may remove TCE mass and lower contaminant concentrations more effectively than extraction and treatment, DDJC-Sharpe is currently implementing pilot tests in the North Balloon (enhanced reductive dechlorination technology – EOS pilot study), Central Area (hydraulic fracturing and injection of EHC pilot study), and South Balloon (oxidation technology – solid $KMnO_4$ injection using hydraulic fracturing pilot study).

7.1.1.2 Contaminant Plume Capture Analysis

The evaluation of plume capture in 3Q06, 3Q07, and in this report (based on 2Q08 hydrologic data) indicates that, at several locations west of the depot boundary, there has been no capture of plumes (URS, 2007b; 2008a). HydroPunch sample results from the 2007/2008 CPT/HydroPunch investigation suggest that plumes are not migrating toward privately owned, potable wells (URS, 2009b). The hypothesis to explain apparent stability of plume extent without full capture is that abiotic natural attenuation, i.e., without the assistance of bacteria, is occurring at the leading edges of the off-depot plumes. The evidence obtained since 3Q07 supports containment of the plumes west and north of the depot boundary as a result of physical extraction and natural attenuation mechanisms. The evidence has not been confirmed.

Capture Analysis Methodology. Groundwater level data were used to estimate the areas of hydraulic influence of extraction wells as the initial step for analysis of contaminant plume capture by constructing potentiometric surfaces maps for the A, B, and C monitoring zones (Figures 7-5 through 7-7). The potentiometric surface contour maps were developed using Surfer 8.0 contouring software and adjusted with empirical data using professional judgment. Potentiometric surfaces for the A, B, and C monitoring zones (developed with 2Q08 data) were used to estimate the areas of hydraulic capture by the optimized 15-well array.

An upgradient curvature in several contour lines was considered an indication that one well or a group of closely spaced wells were creating a depression on the groundwater surface. The surface depression causes the flow lines to point toward a well location. A series of points exist in the downgradient direction from every extraction well (or group of wells) where a groundwater molecule could travel to the extraction wells or could be carried downgradient and away from the extraction wells. At those points which reflect the downgradient extent of capture for the given extraction wells, flow lines could point back toward the wells or away from the wells (stagnation points).

Capture zones for extraction wells were interpreted from the hydraulic gradients indicated by groundwater potentiometric contours. The downgradient extent to which a single well or group of wells had hydraulic influence was estimated from flow lines on a contour map for each zone and with particle tracks simulated by the DDJC-Sharpe groundwater flow model.

The simulated particle tracks were created by selecting imaginary water particles around each operating extraction well in its respective modeled layer (analogous to the monitoring zones) and simulating their movement over 30 years. In 2Q08, both particle-tracking results and potentiometric surface contours were used to interpret and draw capture zones.

Capture zone curves drawn on Figures 7-5 to 7-7 represent the series of points situated cross-gradient and downgradient of an extraction well where groundwater would be drawn into the well when it is operating. All capture zone curves are dashed because they are interpreted. The extents of the contaminant plumes are shown as solid-line isopleths with 3Q07 TCE concentrations greater than 5 µg/L and 3Q07 PCE concentrations greater than 0.5 µg/L on each capture zone map.

COC Plume Capture/Containment Evaluation. A summary of the interpreted capture and containment of plumes is provided in Table 7-1. Full plume containment through extraction well capture and natural attenuation processes is suggested by the stability in concentrations at the downgradient edge of the plumes and the very few detected concentrations at potable or guard wells downgradient from plumes. Although capture is less extensive with 15 extraction wells operating, there is no evidence that plumes are expanding.

7.1.1.3 Model Predictions

A new groundwater model was developed for DDJC-Sharpe during the time between the first and second five-year review periods. The new model was developed using DoD's GMS, Version 6.5 (Environmental Modeling Research Laboratory, 2008). The model computer code selected was MODFLOW, a 3-D, cell-centered, finite difference, saturated flow model developed by the USGS (McDonald and Harbaugh, 1988). Contaminant transport simulations were conducted using the MT3DMS groundwater contaminant transport model code (Zheng and Wang, 1999). Other details of model development and testing are explained in the *DDJC-Sharpe Three-Dimensional Groundwater Model Report* (URS, 2006c). Simulation values for TCE transport, longitudinal, transverse, and vertical dispersion and TCE retardation (which varied with lithology types throughout the model), and TCE decay/degradation were the same as those used during model verification (URS, 2006c).

Transport Simulation Results. The groundwater model was used to simulate the migration of contaminant plumes within each groundwater monitoring zone. Migration of TCE plumes was simulated for a period of 30 years with the assumption that the currently operating extraction well array (15 wells) continues to operate for the entire period at the current average discharge rates. Figures 7-8 through 7-11 show the predicted extent of the plumes in model Layers 1 through 4, respectively. Layer 1 generally correlates with the A Zone, Layer 2 correlates with the B Zone, Layer 3 correlates with the C Zone, and Layer 4 correlates with the deeper part of the C Zone and the C to D Zone transition.

Layer 1. The prediction for Layer 1 indicates that a portion of the A Zone TCE plume exceeding 5 µg/L will extend beyond the west DDJC-Sharpe boundary in the Central Area between 10 and 30 years (Figures 7-8a, 7-8b, and 7-8c). Monitoring data confirms that the A Zone TCE plume did not extend beyond the depot boundary in 3Q07; however, the model predicts that the A Zone TCE plume will migrate beyond the boundary between 2008 and 2017. One of the small TCE plumes near the depot boundary in the Central Area in 2008 appears to migrate a short distance, possibly to the area of very low hydraulic gradient, and then to shrink without further migration. The South Balloon TCE plume is

Table 7-1. 2Q08 Capture Zone and Containment Summary, DDJC-Sharpe

Geographic Area	Monitoring Zone	Capture/Containment Status	Lines of Evidence
North Balloon	A	TCE plumes: migrating into capture zone of EWNA6. Containment by NA likely. PCE plume: most of plume area within capture zone of EWNA6. Containment by NA likely.	Potentiometric contours; most particle tracks. Down-gradient extraction well (EWNA8) and monitoring wells in A Zone had low to no detectable concentrations of TCE and PCE in 3Q07. NA mechanisms have been active.
Central Area	A	TCE plumes: migrating southwesterly into very low gradient area because of hydraulic mound. No capture in A Zone. Vertical migration to B Zone or C Zone with capture by EWCB1 and EWCC3 probable. Containment by NA likely. No PCE plumes.	Potentiometric contours and particle tracks indicate migration to southwest and downward. NA mechanisms potentially active.
South Balloon	A	TCE plume: partially captured by EWA5 and EWCA1. West/northwest and downward migration expected. Containment by NA likely. PCE plumes: two plumes within capture zones of EWA5 and EWCA1.	Potentiometric contours; particle tracks. NA mechanisms probably active.
North Balloon	B	TCE plume: within capture zones of EWNB5 and EWNB6. PCE plume: partially captured by EWNB6. Containment by NA likely.	Potentiometric contours; particle tracks. Containment by NA mechanisms indicated by HydroPunch and downgradient monitoring well results.
Central Area	B	TCE plume: partial capture by EWCB5. Partial vertical migration to C Zone and capture by EWCC1, EWCC2, and EWCC4 is probable. Containment by NA likely. No PCE plumes.	Potentiometric contours; particle tracks. Containment by NA mechanisms indicated by HydroPunch and down-gradient monitoring well results.
South Balloon	B	TCE plume: partial capture by EWCB1 and partial vertical migration to C Zone and capture by EWC4. PCE plumes: one plume within EWCB1 capture zone; second plume partially migrates vertically into capture zone of EWC4; third plume predicted to migrate vertically and be captured by EWC4.	Potentiometric contours; particle tracks. Containment by NA mechanisms indicated by HydroPunch and down-gradient monitoring well results.

Table 7-1. (Continued)

Geographic Area	Monitoring Zone	Capture/Containment Status	Lines of Evidence
North Balloon	C	TCE plume: almost full capture by EWNC3R, EWNC4R, and EWNC5; vertical migration probable. Horizontal containment probable. PCE plume: within capture zone of EWNC4R. Horizontal containment probable.	Potentiometric contours; particle tracks. Horizontal containment by NA mechanisms indicated by HydroPunch and downgradient monitoring well results. Vertical TCE plume containment uncertain.
Central Area	C	TCE plume: partial capture by EWCC1, EWCC2, EWCC3, and EWCC4. Containment by NA likely. No PCE plumes.	Potentiometric contours; particle tracks. Containment by NA mechanisms indicated by HydroPunch and downgradient monitoring well results.
South Balloon	C	TCE plume: partial capture by EWC4. Containment by NA likely. PCE plumes: partial capture by EWC4. Containment by NA likely.	Potentiometric contours; particle tracks. Containment by NA mechanisms indicated by HydroPunch and downgradient monitoring well results.

DDJC = Defense Distribution Depot San Joaquin California
NA = natural attenuation
PCE = tetrachloroethene
TCE = trichloroethene
2Q08 = second quarter 2008 (quarter/year)

predicted to decrease in concentration and shrink inside the depot boundary from 10 to more than 30 years. The North Balloon A Zone TCE plume is predicted to shrink and decrease to concentrations less than the ACL before approximately 2027.

Layer 2. The prediction for Layer 2 indicates portions of the B Zone TCE plume will also migrate beyond the depot boundary in the South Balloon and the Central Area within the next 10 years (Figure 7-9a, 7-9b, and 7-9c). The Central Area B Zone TCE plume that exceeds 5 µg/L has been beyond the depot boundary for some time; however, concentrations greater than 25 µg/L (indicated by yellow areas on the figures) have not been detected beyond the depot boundary in this zone. The model predicts that from 10 to more than 30 years, the South Balloon and Central Area B Zone TCE plumes will not continue to migrate away from the depot and will shrink in areal extent. The North Balloon TCE plume in the B Zone is predicted to decrease to concentrations less than the ACL between 2027 and 2037.

Layer 3. The Layer 3 prediction indicates that only a portion of the South Balloon TCE plume will migrate west of the depot boundary; as confirmed by data from monitoring well MW497C (Figure 7-10a, 7-10b, and 7-10c). The Central Area Layer 3 TCE plume is predicted to migrate to Layer 4 and decrease to concentrations less than the ACL in Layer 3.

Layer 4. The model predicts that the only off-depot TCE plume existing in Layer 4 after 10 years will be west of the Central Area (Figure 7-11a, 7-11b, and 7-11c). As indicated above, this plume migrated vertically from Layer 3. No Layer 4 plume is predicted to remain on depot or off depot in the South Balloon. However, the TCE plume in the North Balloon is predicted to migrate north of the depot boundary between 2027 and 2037 as the plume shrinks. The model predicts that by 2037, the only TCE plume exceeding the ACL in Layer 4 will be straddling the north depot boundary. Extraction from the C/D transition zone or the D Zone was not simulated because there are no extraction wells screened at those depths.

Transport Simulation Conclusions. In using the model simulation results, it is important to consider that groundwater models are simplifications of the natural environment and, therefore, have inherent limitations. Therefore, some uncertainty exists in the ability of the model used for this evaluation to predict groundwater flow and contaminant transport. There was a concerted effort to minimize model uncertainties by using measured, site-specific values as input parameters whenever those data were available and by conducting numerous model simulations to calibrate and verify the model. Uncertainties of the model output are caused by uncertainties in the conceptual model, the input parameters, and inability of the model to adequately simulate real-world conditions and processes. Predicted cleanup times must be considered estimates with their own inherent uncertainties. For additional explanation of limitations and uncertainties, the reader is directed to the DDJC-Sharpe model report (URS, 2006c).

Assuming that plumes migrate and TCE naturally attenuates as the groundwater model predicts, the model suggests that TCE will migrate short distances west of the South Balloon and Central Area in the A, B, and C Zones. In the Central Area and North Balloon, plumes are predicted to migrate vertically from the C Zone to the C to D transition interval, and potentially into the D Zone. The predictive simulations also indicate that the plumes will decrease in concentration and ultimately shrink whether they are within or beyond depot boundaries. Data obtained from monitoring (plume edge and guard) wells suggest that plumes are attenuating and not expanding, as suggested by model results.

Data from the 2007/2008 CPT/HydroPunch investigation will be incorporated into the model as they become available.

7.1.2 System Operations/O&M

The groundwater treatment system implemented as part of the OU 1 ROD essentially operated in two modes during the second five-year review period. During both periods, the treatment systems operated as intended, removing VOCs from the extracted groundwater, discharging treated effluent as planned, and meeting ARARs.

The three groundwater plants (North Balloon, South Balloon, and Central Area) operated as designed from 2003 to late 2006. Operating procedures undertaken during that time period were consistent with effective implementation of the response action for OU 1 groundwater. Although the cost-per-pound to remediate COCs has far exceeded initial estimates from 1993, O&M costs from 2003 to late 2006 for the groundwater treatment systems did not vary significantly.

The groundwater treatment system at DDJC-Sharpe was modified in late 2006 and early 2007 by reducing the number of operating extraction wells from 36 to 15 and reducing the number of treatment plants from three to one (Section 4.1.2). This modification was implemented to optimize the extraction well array. If the 15-well system with one treatment plant and on-depot effluent discharge were to continue long-term, it would result in cost avoidance relative to the operation of 36 wells and multiple treatment plants. There are fewer wells using power, fewer pumps to replace, and fewer pipelines from which to remove scale. On-depot effluent discharge alone is an improvement from the 36-well array because off-depot discharge of effluent containing arsenic concentrations greater than the MCL into surface water bodies is no longer necessary.

7.1.3 Opportunities for Optimization

Opportunities for optimization of the groundwater treatment system were undertaken by DDJC-Sharpe in 2003 through 2006. These optimization efforts focused on removing more pounds of contaminants for lower costs. DDJC-Sharpe also implemented the extraction well optimization test in 2006 to determine whether 15 operating extraction wells and natural attenuation mechanisms could contain VOC plumes as effectively as the extraction array of 36 operating wells. The optimization test continues to the present (April 2009). An evaluation of the optimization test has been considered in this review.

7.1.4 Early Indicators of Potential Issues

Although no major issues related to O&M activities have been identified in the O&M inspections for the 2003 through 2007 operational period, some O&M service inspection issues have been noted. Specifically, the majority of the extraction well flow meters and in-well water level measuring devices (transducers) relied on for data collection, have passed their manufacturer's life expectancy. This equipment is being replaced as needed. In addition, a number of electronic communications components for the extraction wells are outdated, no longer manufactured, or difficult to replace.

7.1.5 Implementation of ICs and Other Measures

No ICs for groundwater were identified in the OU 1 ROD and none have been planned or developed during the first or second five-year review periods. Any ICs or other protective measures for groundwater implemented during the next five-year review period will be assessed in the third five-year review, if warranted.

7.2 Question B: Are the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of the OU 1 groundwater remedy selection still valid?

Exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of the remedy selection are still valid and do not affect the protectiveness of the remedy.

Since approval of the first five-year review in 2003, there have been changes in promulgated regulatory standards or "to be considereds" (TBCs), and in exposure assumptions, toxicity data, and methods of standardized risk assessment procedures. Therefore, the RAOs were re-evaluated to assess whether changes affect the protectiveness of the groundwater remedy. The original assumptions regarding current and future land and groundwater uses and COCs were re-evaluated to determine whether they are still valid, and whether any physical features (or understanding of physical site conditions) have changed (e.g., changes in anticipated direction or rate of contaminant migration).

7.2.1 Changes in Standards and TBCs

Under CERCLA, a remedy is required to protect human health and the environment. To achieve this requirement, remedial actions must meet ARARs. The ARARs can be defined as requirements in promulgated state and federal environmental laws as they relate to on-site remedial actions. Where ARARs are insufficient or not available, TBCs (e.g., non-promulgated advisories, criteria, guidance, or proposed standards) issued by federal and state agencies are identified (40 CFR §300.400(g)(3)). These TBC documents are not enforceable nor are they legally binding and do not have the same status has ARARs. However, guidance documents are considered when developing cleanup levels and evaluating risks to human health or the environment.

In the five-year review process, requirements promulgated or modified after the ROD is signed must be addressed if they are necessary to ensure that the remedy is protective of human health and the environment (40 CFR §300.430(f)(ii)(B)(1)).

Chemical-Specific ARARs. The OU 1 remedial goals (ACLs) were initially established through available environmental or health-based standards. These standards were presented as ARARs in the ROD. Where ARARs were not sufficiently protective, the HHRA, regulatory agencies' recommendations, and TBCs were used to establish cleanup levels. For example, the California Department of Health Services (DHS) action level (now known as a public health goal [PHG]) is a TBC used as an ACL for ortho-dichlorobenzene.

The OU 1 ROD established ACLs as cleanup standards for 21 VOCs. ACLs for six of these COCs (1,4-dichlorobenzene, 1,1-dichloroethane [DCA], cis- and trans-1,2-DCE, 1,1,1-trichloroethane [TCA], and TCE) are chemical-specific ARARs based on California or federal MCLs. TCE was the primary COC because it was the most frequently detected and at the highest concentrations; its chemical-specific ARAR is the California and federal MCL of 5 µg/L. Fifteen COCs did not have California or federal MCLs; ACLs for these 15 COCs were established at values equivalent to the then-current lower limits of analytical detection. The HHRA component of the 1991 RI/FS risk assessment determined that analytical detection limit-based ACLs for these 15 constituents are necessary to ensure that the cumulative drinking-water exposure to all the VOCs in groundwater is within the acceptable risk management range of 1E-04 to 1E-06 incremental cancer risk (ESE, 1991).

Since approval of the ROD, California has promulgated MCLs for additional VOCs that are identified in the ROD as warranting cleanup. Table 7-2 compares the OU 1 ROD ACLs and current MCLs and other guideline values. The guideline values include concentrations in drinking water that correspond to a

de minimus (inconsequential) cancer risk of 1E-06 (EPA, 2008a; 2008b) or concentrations that are not expected to cause any adverse noncarcinogenic effects for a lifetime of exposure (EPA, 2006). Human toxicity data do not exist for the herbicide bromacil; consequently, no risk-based guideline value can be estimated. Table 7-2 also provides, *for comparative purposes only*, the California PHGs and detection limits for purposes of reporting (DLRs). MCLs are legally enforceable standards that are agency derived after formal review of health risk and technological and economic considerations; PHGs are based solely on health risk assessment while the DLRs are indicators of the analytical sensitivity that must be achieved by a chemical laboratory. As indicated previously, many of the OU 1 ACLs were established at values equivalent to the DLR to ensure that cumulative risks are within acceptable bounds when the concurrent exposure to TCE was included.

The protectiveness of the OU 1 ROD ACLs can be evaluated through a comparison of the new or modified chemical-specific requirements and the OU 1 ROD ACLs (Table 7-2). Groundwater ACLs remain protective of human health because the values of the ACLs are generally equal to, or less than, a corresponding MCL and many are also lower than the corresponding PHG.

Action- and Location-Specific ARARs. Action-specific ARARs are usually technology- or activity-based requirements, while location-specific ARARs are restrictions placed on the chemical contaminant or the remedial activities based on the site's geographic or ecological features. The action-specific ARARs presented in the OU 1 ROD were re-evaluated for protectiveness (Table 7-3). No changes to the action-specific ARARs were identified that affect the protectiveness of the remedy, and no location-specific ARARs are documented in the OU 1 ROD.

In 2003, California developed a new action-specific requirement for documenting LUCs in decision documents (e.g., ROD, remedial action/remedial design) with specific emphasis on property transfers at federal facilities. When the selected remedy allows contaminants to be left in place at levels that do not allow for unlimited use and unrestricted exposure, LUCs are applied to ensure the remedy is protective of human health and the environment. Because there has been no evidence of exposure to receptors from contaminants in groundwater, the new LUC requirement does not affect the protectiveness of the remedy for OU 1. Consequently, documenting a post-ROD change only for the new LUC requirement is not necessary.

There are no new action- or location-specific requirements that have a bearing on the protectiveness of the selected remedy. The action-specific ARARs continue to support the protectiveness of the remedy for OU 1.

There are no revised or newly promulgated standards or TBCs that affect the protectiveness of the remedy.

7.2.2 Changes in Exposure Pathways

No additional receptors, exposure pathways, land use changes, contaminants, remedy toxic byproducts, or physical site condition changes have been identified since the first five-year review. However, because risk-assessment methods have changed since 1991, the ACLs were re-evaluated to ensure that they remain health protective. Receptors (types of people that might be exposed to site-related contaminants) that were evaluated in the 1991 RI/FS risk assessment included on-site workers and residents and off-site residents. These receptor types were evaluated for their potential exposure to groundwater primarily through (hypothetical) drinking of shallow-aquifer groundwater and exposure to VOCs in groundwater through inhalation. Skin exposures were not directly included in the evaluation since it was concluded in the 1991 RI/FS risk assessment to be inconsequential. These receptors and exposure pathways are still

Table 7-2. Evaluation of Cleanup Standards Presented in the OU 1 ROD

	OU 1 ROD		Current (2008) Standards	
Constituent	**Aquifer Cleanup Level[a] (µg/L)**	**Basis[a]**	**Current MCLs and Other Guidelines (µg/L)**	**Basis**
Benzene	—	—	1	California MCL (DLR=0.5; PHG=0.15)
Bromacil	—	—	70	EPA Lifetime Health Advisory
Bromodichloromethane	0.5	HHRA	0.6	1E-06 Risk Level in Drinking Water; EPA IRIS
Bromoform	0.5	HHRA	4	1E-06 Risk Level in Drinking Water; EPA IRIS
Carbon Tetrachloride	0.5	HHRA	0.5	California MCL (DLR=0.5; PHG=0.1)
Chloroform	0.5	HHRA	0.19	EPA Regional Screening Level
Chlorodibromomethane	0.5	HHRA	0.4	1E-06 Risk Level in Drinking Water; EPA IRIS
1,2-Dichlorobenzene	10	California DHS Action Level	600	California MCL (DLR=0.5; PHG=600)
1,4-Dichlorobenzene	5	California MCL	5	California MCL (DLR=0.5; PHG=6)
1,2-Dichloroethane	0.5	HHRA	0.5	California MCL (DLR=0.5; PHG=0.4)
1,1-Dichloroethene	0.5	HHRA	6	California MCL (DLR=0.5; PHG=10)
cis-1,2-Dichloroethene	6	California MCL	6	California MCL (DLR=0.5; PHG=100)
trans-1,2-Dichloroethene	10	California MCL	10	California MCL (DLR=0.5; PHG=60)
1,1-Dichloroethane	5	California MCL	5	California MCL (DLR=0.5; PHG=3)
1,2-Dichloropropane	0.5	HHRA	5	California MCL (DLR=0.5; PHG=0.5)
1,3-Dichloropropene	0.5	HHRA	0.5	California MCL (DLR=0.5; PHG=0.2)
Ethylbenzene	—	—	700	California MCL (DLR=0.5; PHG=300)
Methylene Chloride	0.5	HHRA	5	California MCL (DLR=0.5; PHG=4)
1,1,1-Trichloroethane	200	California MCL	200	California MCL (DLR=0.5; PHG=1,000)
1,1,2-Trichloroethane	0.5	HHRA	5	California MCL (DLR=0.5; PHG=0.3)
1,1,2,2-Tetrachloroethane	0.5	HHRA	1	California MCL (DLR=0.5; PHG=0.1)
Tetrachloroethene	0.5	HHRA	5	California MCL (DLR=0.5; PHG=0.06)
Trichloroethene	5	EPA and California MCL	5	California MCL (DLR=0.5; PHG=0.8 [2008 draft PHG=1.7])
Toluene	—	—	150	California MCL (DLR=0.5; PHG=150)
Vinyl Chloride	0.5	HHRA	0.5	California MCL (DLR=0.5; PHG=0.05)
Xylenes	—	—	1,750	California MCL (DLR=0.5; PHG=1,800)

Table 7-2. (Continued)

[a] From Table 8 in the OU 1 ROD (ESE, 1993)

DLR	=	(Lower) detection limit for purposes of reporting (the DLR, or lower, must be achieved by the analytical laboratory); the DLR is a parameter that is set by regulation for each reportable analyte, is not laboratory specific, and is independent of the analytical method used.
EPA	=	United States Environmental Protection Agency
HHRA	=	human health risk assessment
IRIS	=	Integrated Risk Information System (EPA)
MCL	=	maximum contaminant level (considers health risk, technical, and economic factors).
OU	=	operable unit
PHG	=	public health goal (considers health risk only)
ROD	=	record of decision
RWQCB	=	Regional Water Quality Control Board
µg/L	=	micrograms per liter
"—"	=	An aquifer cleanup level for this analyte was deferred to the RWQCB.

Table 7-3. Evaluation of Action-Specific ARARs, OU 1 and OU 2 RODs

Regulation	Citation	Prerequisite	Requirement	ROD Reference	Comment
Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities	40 CFR §264.190 - 264.192	Treatment and storage of hazardous waste in tank systems.	Design and installation of new tank systems and components.	OU 1 ROD (1993)	Relevant and appropriate. Tanks used to contain hazardous waste (equalizer tank) for the air stripping system were designed and installed within the performance specifications in these regulations.
Guidelines Establishing Test Procedures for the Analysis of Pollutants	40 CFR §136.1 et seq.	Approved test methods for waste constituents discharge to Waters of the U.S.	Detailed requirements for analytical procedures and quality controls are provided.	OU 1 ROD (1993)	Requirements will be followed for discharge to Waters of the U.S. Surface water discharge of treated groundwater has been discontinued indefinitely. This requirement is no longer relevant and could be removed as an ARAR in future post-ROD changes.
Prohibition of Movement of Fluid into Underground Sources of Drinking Water	40 CFR §144.12	Class V underground injection wells include waste that does not include hazardous, radioactive, natural gas, or mining waste.	Ensure that reinjection of treated groundwater will not cause the aquifer underlying the site to violate primary drinking water regulations.	OU 1 ROD (1993)	Applicable. The requirements for Class V injection wells (40 CFR 144.12) are the most appropriate for discharge of treated ground-water.
Inventory Requirements	40 CFR §144.26	Inventory information reporting for injection of groundwater.	The owner or operator of an injection well which is authorized under this requirement shall submit inventory information to the EPA.	OU 1 ROD (1993)	Inventory information reporting for injection of groundwater is in compliance with 40 CFR §144.26. This is an administrative requirement and should be removed as an ARAR in future post-ROD changes.

Table 7-3. (Continued)

Regulation	Citation	Prerequisite	Requirement	ROD Reference	Comment
Guidelines for the Implementation of CEQA	14 CCR §15000 et seq.	California agencies providing discretionary approval are responsible for complying with CEQA Guidelines.	The DTSC has approved a negative declaration and CEQA. CEQA requirements have been satisfied.	OU 1 ROD (1993)	This is an administrative requirement and should be removed as an ARAR in future post-ROD changes.
Water Quality Control Plan (Basin Plan) for the Sacramento River and San Joaquin River Basins	Porter-Cologne Water Quality Act §13240	Requires development of a basin plan. The act and the basin plan protect the beneficial uses of groundwater. Defines beneficial use levels for constituents in groundwater.	Surface water and groundwater of the state meeting specific criteria are considered existing or potential sources of drinking water. Levels of constituents in residual contaminated soils that may affect water quality must not result in water quality exceeding water quality objectives.	OU 1 ROD (1993) OU 2 ROD (1996) – lead and chromium in soil OU 2 ROD (1996) – TCE in soil	Applicable. Reinjection of treated groundwater in the contaminated aquifer will not affect the beneficial uses or degrade the water quality of the receiving body. The existing groundwater treatment systems are capturing and treating VOC plumes. All soils with designated levels of metals are located within capture zones of one of the three groundwater treatment plants.
SWRCB Anti-Degradation Policy	SWRCB Resolution No. 68-16	Protects the beneficial uses of groundwater.	Surface waters and groundwater of the state meeting specific criteria are considered existing or potential sources of drinking water.	OU 1 ROD (1993)	Applicable. Reinjection of treated ground-water in the contaminated aquifer will not affect the beneficial uses or degrade the water quality of the receiving body.

Table 7-3. (Continued)

Regulation	Citation	Prerequisite	Requirement	ROD Reference	Comment
Water Wells	Lathrop Municipal Code Title 8 - Health & Safety, Chap. 8.36	Reinjection of groundwater within the City of Lathrop.	Groundwater extracted shall be reinjected into the area of the ground-water table the water was extracted.	OU 1 ROD (1993)	This requirement may have been repealed; unable to locate the requirement. Only state and federal requirements are ARARs. This requirement should be removed as an ARAR in future post-ROD changes.
SJVAPCD Rules and Regulations	Rule 209.1 - New and Modified Stationary Source Review Rule	Applies to new emissions from stationary sources.	Comply by implementing BACT.	OU 1 ROD (1993) OU 2 ROD (1996) – TCE in soil	Applicable. The rule has been modified and is now Rule 2201. The treatment systems will employ a BACT (i.e., carbon adsorption) for emission treatment, if necessary. Currently, emissions from the air strippers are below the de minimus threshold for BACT.
Water Quality Monitoring and Response Programs for Permitted Facilities	22 CCR §66264.90 et seq.	Requires monitoring to detect, characterize, and respond to releases from waste management units.	If releases are detected, appropriate corrective action must be taken to achieve compliance with water quality protection standards.	OU 2 ROD (1996) – lead and chromium in soil OU 2 ROD (1996) – TCE in soil	Relevant and appropriate. Groundwater downgradient of soils with designated levels of metals will be monitored to assure protection of the beneficial uses of groundwater.
SWRCB Sources of Drinking Water Policy	SWRCB Resolution No. 88-63	Protection of groundwater and surface water for beneficial uses.	Surface waters and groundwater of the state meeting specific criteria are considered existing or potential sources of drinking water.	OU 2 ROD (1996) – lead and chromium in soil OU 2 ROD (1996) – TCE in soil	Applicable. The underlying groundwater at the site meets the criteria as a potential drinking water source and will require protection for beneficial uses.

Table 7-3. (Continued)

Regulation	Citation	Prerequisite	Requirement	ROD Reference	Comment
Requirements for Land Use Covenants	California Civil Code §1471(a&e); 22 CCR §67391(1)(b) and (e)	LUCs established for state remedial actions with hazardous substances remaining at the site.	California cannot concur with any decision document that does not have an LUC or IC defined in a decision document. For federal to nonfederal entity transfers, California will not concur with transfer unless a land use covenant is established. For federal to federal entity transfers, use other methods to ensure future land use compatibility.	New requirement Not addressed in OU 1 or OU 2 RODs.	Relevant and appropriate. LUC information should be provided in decision document or other mechanisms such as master plans, monuments, or agreements.

ARAR = Applicable or Relevant and Appropriate Requirement
BACT = best available control technology
CCR = California Code of Regulations
CEQA = California Environmental Quality Act
CFR = Code of Federal Regulations
DTSC = Department of Toxic Substances Control
EPA = United States Environmental Protection Agency
IC = institutional control
LUC = land use control
OU = operable unit
ROD = record of decision
SJVAPCD = San Joaquin Valley Air Pollution Control District
SWRCB = State Water Resources Control Board
TCE = trichloroethene
VOC = volatile organic compound

valid and appropriate for a contemporary risk assessment. The additional VOC mass identified during the 2007/2008 CPT/HydroPunch investigation does not affect the protectiveness of the groundwater remedy or the ACL re-evaluation.

The values used in the 1991 RI/FS risk assessment to evaluate exposure are generally equivalent to those used in a contemporary risk assessment for residential receptors, as summarized in Table 7-4. The primary differences between the 1991 RI/FS risk assessment and a contemporary risk assessment involve inhalation and dermal exposure pathways, which were not directly evaluated in the 1991 RI/FS risk assessment (the 1991 RI/FS risk assessment used a simple factor of 2 to account for inhalation exposures, and did not include dermal estimates because of a then-demonstrated inconsequential contribution to the overall risk and hazard estimates). Given the differences in computational methods between the 1991 RI/FS risk assessment and contemporary methods, the ACLs must be re-evaluated to ensure that they remain within acceptable risk limits. The ACL re-evaluation is presented in Appendix I and summarized in Section 7.2.4.

Table 7-4. Evaluation of the Exposure Assumptions Presented in the OU 1 ROD

Exposure Parameter Description	Variable	Units	RI/FS Value[a] RME Scenario	RI/FS Value[a] MLE Scenario	EPA Standard Default Values for Unrestricted Land Use
Averaging Time, Carcinogens	AT_c	yr	70	70	70
Averaging Time, Noncarcinogens	AT_{nc}	yr	30	9	30 total (24 adult, 6 child)
Body Weight	BW	kg	70	70	70 adult; 15 child
Exposed Body Surface Area	SA	cm^2	18,150	18,150	18,000 adult, 6600 child
Exposure Duration	ED	yr	30	9	30 total (24 adult, 6 child)
Exposure Frequency	EF	day/yr	365	365	350
Exposure Time	ET	hr/day	0.2	0.2	0.58 hr adult; 1 hr child
Permeability Coefficient	PC	cm/hr	8.4E-04	8.4E-04	—[b]
Water Ingestion Rate	IRW	L/day	2	1.4	2 adult; 1 child

[a] Section 4 (ESE, 1991)
[b] Current practice for dermal exposure assessment differs from that used in the 1991 RI/FS risk assessment; permeability coefficients for DDJC-Sharpe groundwater COCs generally occur in the range of 1E-02 or 1E-03 cm/hr.

cm = centimeter
cm^2 = square centimeter
COC = contaminant of concern
DDJC = Defense Distribution Depot San Joaquin California
EPA = United States Environmental Protection Agency
FS = feasibility study
hr = hour
kg = kilogram
L = liter
MLE = most likely exposure
OU = operable unit
RI = remedial investigation
RME = reasonable maximum exposure
ROD = record of decision
yr = year

No new contaminants have been identified since the first five-year review. Arsenic has been detected at a concentration greater than the MCL of 10 µg/L at all extraction wells; however, no detections were greater than established background concentrations. Groundwater sampling of monitoring and extraction wells for arsenic analysis was discontinued after 2006 because discharge to surface water ceased in December 2006. However, quarterly arsenic monitoring of the GWTP effluent has continued under substantive WDRs for land disposal.

7.2.3 Changes in Toxicity and Other Contaminant Characteristics

There have been changes to agency-promulgated toxicity values since the original risk assessment, as well as since the first five-year review. Table 7-5 summarizes the differences in cancer toxicity factors, and Table 7-6 summarizes the differences in noncancer toxicity factors between the 1991 RI/FS risk assessment and contemporary factors. Some contemporary values are more stringent than historical values, while others are less stringent, as indicated in the tables by shading and bolding. Given the differences in toxicity factors between the 1991 RI/FS risk assessment and contemporary methods, the ACLs were re-evaluated to ensure that they remain within acceptable risk limits. The ACL re-evaluation is presented in Appendix I and summarized in Section 7.2.4.

7.2.4 Changes in Risk Assessment Methods

A variety of differences in exposure factors, toxicity factors, and risk-assessment methods exist between the 1991 RI/FS risk assessment and contemporary processes. Because of these differences, a re-analysis of the ACLs established in the OU 1 ROD was conducted to determine whether the existing ACLs remain protective of human health. This re-analysis is provided in Appendix I, and is based on standardized default EPA factors for risk assessment. As indicated on the summary table (Appendix I, Table I-3), the cumulative risk for estimated exposure to all chemicals at the OU 1 ROD-established ACLs is 1E-04, equal to the upper limit of the acceptable risk range of 1E-04 to 1E-06 and is equal to the 1.0 point-of-departure threshold for noncancer health hazards.

These risk estimates assume a ***residential use*** of VOC-containing groundwater, which is not a current nor a reasonably anticipated land use for the site. These risk estimates also assume residential receptors were exposed to groundwater in which concentrations of ***all*** analytes are equal to their respective ACLs. Many of the ACLs are based on detection-limit values; results reported at less than detection limits indicate concentrations are actually somewhere between zero (absence of the VOC) and the detection-limit value. If VOC results were all less than detection limits, it is extremely unlikely that ***all*** compounds would be present at concentrations just less than the detection limit. Groundwater monitoring data from wells at DDJC-Sharpe indicate that many of the COCs are not currently detected (URS, 2008a). Consequently, a health-protective ("conservative") assumption could be reasonably assumed under a scenario where exposure to VOCs was at detection-limit concentrations. Because of the conservative assumptions, and the estimated cumulative risk and hazards that are still within the acceptable risk-management range, the ACLs established in the OU 1 ROD remain protective of human health.

7.2.5 Expected Progress Toward Meeting RAOs

The RAOs for groundwater in the OU 1 ROD are to "mitigate potential long-term contaminant migration and to protect human health and the environment" (ESE, 1993, page 41). The groundwater extraction and treatment system has made progress toward meeting groundwater RAOs. This conclusion is based on information presented in Section 7.1.1, and the plume capture and containment evaluations presented in the DDJC-Sharpe FFA Annual Progress Reports for 2003 through 2006 (URS, 2004b; 2005a; 2006a; and 2007b).

Modifications were made to the operation of the groundwater extraction and treatment system in late 2006 to optimize the extraction well array, reducing the number of active extraction wells from 36 to 15. At this time, the system continues to make progress toward meeting the RAO, by partially capturing the contaminant plumes. It is not clear that uncertainties associated with plume capture are a result of the optimized 15-extraction well array, because the areas where capture is incomplete (e.g., B and C Zones

Table 7-5. Evaluation of Carcinogenicity Factors Presented in the OU 1 ROD

	Cancer Slope Factor – Oral			Cancer Slope Factor – Inhalation				
	RI/FS[a]	EPA	OEHHA	RI/FS[a]	EPA		OEHHA	
Constituent	SF_o $(mg/kg\text{-}d)^{-1}$	SF_o $(mg/kg\text{-}d)^{-1}$	SF_o $(mg/kg\text{-}d)^{-1}$	SF_i $(mg/kg\text{-}d)^{-1}$	URF_i $(\mu g/m^3)^{-1}$	Converted to SF_i[b] $(mg/kg\text{-}d)^{-1}$	URF_i $(\mu g/m^3)^{-1}$	Converted to SF_i[b] $(mg/kg\text{-}d)^{-1}$
2-Chloroethyl Vinyl Ether	—	—	—	—	—	—	—	—
Dichlorobenzenes	2.4E-02	—	—	—	—	—	—	—
1,2-Dichlorobenzene	2.4E-02	—	—	—	—	—	—	—
1,4-Dichlorobenzene	2.4E-02	—	5.4E-03	—	—	—	1.1E-05	**3.9E-02**
Benzene	2.9E-02	**5.5E-02 I**	**1.0E-01**	2.9E-02	7.8E-06	2.7E-02 I	2.9E-05	**1.0E-01**
Bromodichloromethane	1.3E-01	6.2E-02 I	1.3E-01	—	—	—	3.7E-05	**1.3E-01**
Bromoform	7.9E-03	7.9E-03 I	—	3.9E-03	1.1E-06	3.9E-03 I	1.1E-06	3.9E-03
Methyl Bromide	—	—	—	—	—	—	—	—
Carbon Tetrachloride	1.3E-01	1.3E-01 I	**1.5E-01**	1.3E-01	1.5E-05	5.3E-02 I	4.2E-05	**1.5E-01**
Chlorobenzene	—	—	—	—	—	—	—	—
Chloroethane	—	—	—	—	—	—	8.3E-07	**2.9E-03**
Chloroform	6.1E-03	—	**3.1E-02**	8.1E-02	2.3E-05	8.1E-02 I	5.3E-06	1.9E-02
Chloromethane	1.3E-02	1.3E-02 H	—	6.3E-03	1.8E-06	6.3E-03 H	1.8E-06	6.3E-03
Chlorodibromomethane	8.4E-02	8.4E-02 I	**9.4E-02**	—	—	—	2.7E-05	**9.5E-02**
Dichlorodifluoromethane	—	—	—	—	—	—	—	—
1,1-Dichloroethane	9.1E-02	—	5.7E-03	9.1E-02	—	—	1.6E-06	5.6E-03
1,2-Dichloroethane	9.1E-02	9.1E-02 I	4.7E-02	9.1E-02	2.6E-05	9.1E-02 I	2.1E-05	7.4E-02
1,1-Dichloroethene	6.0E-01	—	—	1.2E+00	3.4E-04	1.2E+00 H	3.4E-04	1.2E+00
cis-1,2-Dichloroethene	—	—	—	—	—	—	—	—
trans-1,2-Dichloroethene	—	—	—	—	—	—	—	—
1,2-Dichloropropane	6.8E-02	—	3.6E-02	—	—	—	1.0E-05	**3.5E-02**
1,3-Dichloropropene	1.8E-01	1.0E-01 I	9.1E-02	1.3E-01	4.0E-06	**1.4E-02 I**	1.6E-05	5.6E-02
cis-1,3-Dichloropropene	1.8E-01	—	—	1.3E-01	—	—	—	—
trans-1,3-Dichloropropene	1.8E-01	—	—	1.3E-01	—	—	—	—
Ethylbenzene	—	—	**1.1E-02**	--	—	—	2.5E-06	**8.8E-03**
Methylene Chloride	7.5E-03	7.5E-03 I	**1.4E-02**	1.6E-03	4.7E-07	1.6E-03 I	1.0E-06	**3.5E-03**
1,1,2,2-Tetrachloroethane	2.0E-01	2.0E-01 I	**2.7E-01**	2.0E-01	5.8E-05	2.0E-01 I	5.8E-05	2.0E-01
Tetrachloroethene	5.1E-02	—	**5.4E-01**	1.8E-02	—	—	5.9E-06	**2.1E-02**
Toluene	—	—	—	—	—	—	—	—
1,1,1-Trichloroethane	—	—	—	—	—	—	—	—
1,1,2-Trichloroethane	5.7E-02	5.7E-02 I	**7.2E-02**	5.7E-02	1.6E-05	5.6E-02 I	1.6E-05	5.6E-02
Trichloroethene	1.1E-02	—	**1.3E-02**	1.7E-02	—	—	2.0E-06	7.0E-03

Table 7-5. (Continued)

Constituent	Cancer Slope Factor – Oral			Cancer Slope Factor – Inhalation				
	RI/FS[a]	EPA	OEHHA	RI/FS[a]	EPA		OEHHA	
	SF_o $(mg/kg\text{-}d)^{-1}$	SF_o $(mg/kg\text{-}d)^{-1}$	SF_o $(mg/kg\text{-}d)^{-1}$	SF_i $(mg/kg\text{-}d)^{-1}$	URF_i $(\mu g/m^3)^{-1}$	Converted to SF_i[b] $(mg/kg\text{-}d)^{-1}$	URF_i $(\mu g/m^3)^{-1}$	Converted to SF_i[b] $(mg/kg\text{-}d)^{-1}$
Trichlorofluoromethane	—	—	—	—	—	—	—	—
Vinyl Chloride	1.9E+00	1.5E+00 I	2.7E-01	2.9E-01	8.8E-06	**3.1E-02 I**	7.8E-05	2.7E-01
Xylenes	—	—	—	—	—	—	—	—

[a] Value from Table 1 (ESE, 1993)

[b] Conversion of an Inhalation Unit Risk Factor (URF_i) to an Inhalation Cancer Slope Factor (SF_i): SF_i $(mg/kg\text{-}d)^{-1}$ = URF_i $(\mu g/m^3)^{-1}$ × 1 d/20 m^3air × 70 kg_{BW} × 1,000 µg/mg

EPA = United States Environmental Protection Agency
ESE = Environmental Science and Engineering, Inc.
FS = feasibility study
H = Value from Health Effects Assessment Summary Tables (EPA, 1997)
I = Value from Integrated Risk Information System (EPA, 2008a)
mg/kg-d = milligrams per kilogram per day
OEHHA = Office of Environmental Health Hazard Assessment
OU = operable unit
RI = remedial investigation
ROD = record of decision
SF_i = slope factor, inhalation
SF_o = slope factor, oral
URF_i = unit-risk factor, inhalation
µg/mg = micrograms per milligram
$\mu g/m^3$ = micrograms per cubic meter
"—" = no published toxicity value

Bold entries indicate current toxicity values are more stringent than that used in the 1991 RI/FS risk assessment.

Grayed entries indicate current toxicity values are less stringent than the value used in the 1991 RI/FS risk assessment.

Table 7-6. Evaluation of Noncancer Toxicity Factors Presented in the OU 1 ROD

	Reference Dose - Oral		Reference Concentration - Inhalation				
	RI/FS[a]	EPA	RI/FS[a]	EPA		OEHHA	
Constituent	RfD_o (mg/kg-d)	RfD_o (mg/kg-d)	RfD_i (mg/kg-d)	RfC (µg/m^3)	Converted to RfD_i[b] (mg/kg-d)	RfC (µg/m^3)	Converted to RfD_i[b] (mg/kg-d)
2-Chloroethyl Vinyl Ether	—	—	—	—	—	—	—
Dichlorobenzenes	9.0E-02	—	4.0E-02	—	—	—	—
1,2-Dichlorobenzene	9.0E-02	9.0E-02 I	4.0E-02	2.0E+02	5.7E-02 H	—	—
1,4-Dichlorobenzene	9.0E-02	—	4.0E-02	8.0E+02	2.3E-01 I	8.0E+02	2.3E-01
Benzene	2.0E-02	4.0E-03 I	—	3.0E+01	**8.6E-03 I**	6.0E+01	**1.7E-02**
Bromodichloromethane	2.0E-02	2.0E-02 I	—	—	—	—	—
Bromoform	2.0E-02	2.0E-02 I	—	—	—	—	—
Methyl Bromide	1.4E-03	1.4E-03 I	1.7E-03	5.0E+00	**1.4E-03 I**	5.0E+00	**1.4E-03**
Carbon Tetrachloride	7.0E-04	7.0E-04 I	—	1.9E+02	**5.4E-02 A**	4.0E+01	**1.1E-02**
Chlorobenzene	2.0E-02	2.0E-02 I	5.0E-03	5.0E+01	1.4E-02 P	1.0E+03	2.9E-01
Chloroethane	—	—	2.8E+00	1.0E+04	2.9E+00 I	3.0E+04	8.6E+00
Chloroform	1.0E-02	1.0E-02 I	—	9.8E+01	**2.8E-02 A**	3.0E+02	**8.6E-02**
Chloromethane	—	—	—	9.0E+01	**2.6E-02 I**	—	—
Chlorodibromomethane	2.0E-02	2.0E-02 I	—	—	—	—	—
Dichlorodifluoromethane	2.0E-01	2.0E-01 I	1.0E-01	2.0E+02	**5.7E-02 H**	—	—
1,1-Dichloroethane	1.0E-01	1.0E-01 H	—	5.0E+02	**1.4E-01 H**	—	—
1,2-Dichloroethane	7.0E-02	2.0E-02 P	—	2.4E+03	**6.9E-01 A**	4.0E+02	**1.1E-01**
1,1-Dichloroethene	9.0E-03	**5.0E-02 I**	—	2.0E+02	**5.7E-02 I**	7.0E+01	2.0E-02
cis-1,2-Dichloroethene	1.0E-02	1.0E-02 P	—	—	—	—	—
trans-1,2-Dichloroethene	2.0E-02	2.0E-02 I	—	6.0E+01	**1.7E-02 P**	—	—
1,2-Dichloropropane	—	—	—	4.0E+00	**1.1E-03 I**	—	—
1,3-Dichloropropene	3.0E-04	**3.0E-02 I**	5.7E-03	2.0E+01	5.7E-03 I	—	—
cis-1,3-Dichloropropene	3.0E-04	—	5.7E-03	—	—	—	—
trans-1,3-Dichloropropene	3.0E-04	—	5.7E-03	—	—	—	—
Ethylbenzene	1.0E-01	1.0E-01 I	2.9E-01	1.0E+03	2.9E-01 I	2.0E+03	5.7E-01
Methylene Chloride	6.0E-02	6.0E-02 I	8.6E-01	--	8.6E-01 H	4.0E+02	**1.1E-01**
1,1,2,2-Tetrachloroethane	—	**4.0E-03 P**	—	—	—	—	—
Tetrachloroethene	1.0E-02	1.0E-02 I	—	—	—	3.5E+01	**1.0E-02**
Toluene	2.0E-01	**8.0E-02 I**	5.7E-01	5.0E+03	1.4E+00 I	3.0E+02	**8.6E-02**
1,1,1-Trichloroethane	9.0E-02	2.0E+00 I	3.0E-01	5.0E+03	1.4E+00 I	1.0E+03	**2.9E-01**
1,1,2-Trichloroethane	4.0E-03	4.0E-03 I	—	—	—	—	—

Table 7-6. (Continued)

Constituent	Reference Dose - Oral		Reference Concentration - Inhalation				
	RI/FS[a]	EPA	RI/FS[a]	EPA		OEHHA	
	RfD_o (mg/kg-d)	RfD_o (mg/kg-d)	RfD_i (mg/kg-d)	RfC (µg/m^3)	Converted to RfD_i[b] (mg/kg-d)	RfC (µg/m^3)	Converted to RfD_i[b] (mg/kg-d)
Trichloroethene	4.0E-01	—	—	—	—	6.0E+02	**1.7E-01**
Trichlorofluoromethane	3.0E-01	3.0E-01 I	2.0E-01	7.0E+02	2.0E-01 H	—	—
Vinyl Chloride	—	**3.0E-03 I**	—	1.0E+02	**2.9E-02 I**	—	—
Xylenes	2.0E+00	2.0E-01 I	8.6E-02	1.0E+02	**2.9E-02 I**	7.0E+02	2.0E-01

[a] Table 1 (ESE, 1993)

[b] Conversion of an Inhalation Reference Concentration (RfC) to an Inhalation Reference Dose (RfD_i): RfD_i (mg/kg-d) = RfC (µg/m^3) × 20 m^{3}air/d × 1/70 kg_{BW} × 0.001 mg/µg

A = value from the Agency for Toxic Substances and Disease Registry (EPA, 2008b)
EPA = United States Environmental Protection Agency
ESE = Environmental Science and Engineering, Inc.
FS = feasibility study
H = Value from Health Effects Assessment Summary Tables (EPA, 1997)
I = Value from Integrated Risk Information System (EPA, 2008a)
mg/kg-d = milligrams per kilogram per day
OEHHA = Office of Environmental Health Hazard Assessment
OU = operable unit
P = provisional peer-reviewed toxicity value (EPA, 2008b)
RfC = reference concentration
RfD_i = reference dose, inhalation
RfD_o = reference dose, oral
RI = remedial investigation
ROD = record of decision
mg/µg = milligrams per microgram
µg/m^3 = micrograms per cubic meter
"—" = no published toxicity value

Bold entries indicate current toxicity values are more stringent than that used in the 1991 RI/FS risk assessment.

Grayed entries indicate current toxicity values are less stringent than the value used in the 1991 RI/FS risk assessment.

in the South Balloon or C/D transition zone north of EWCC3) were also not complete under the 36-extraction well array. Other plumes at DDJC-Sharpe that may not be captured also show evidence of containment through natural attenuation (URS, 2008a). Portions of plumes where concentrations increased from 2006 to 2007 were generally in plume cores near sources but not in leading edge containment areas.

7.3 Question C: Has any other information come to light that could call into question the protectiveness of the OU 1 groundwater remedy?

As discussed elsewhere in this document, in 2006 and 2007, groundwater monitoring data suggested the existence of previously unidentified VOC source masses. The 2007/2008 CPT/HydroPunch investigation was undertaken to identify and delineate these source masses. As discussed in Section 7.1.1.1, the investigation data show that the magnitude and extent of VOCs in groundwater are greater than understood when the OU 1 ROD was signed. DDJC-Sharpe is currently testing potential alternative response actions to the OU 1 remedy.

A review of the groundwater data presented in the 2003 through 2007 FFA Annual Progress Reports indicates that most of the outer extents of COC plumes have not expanded or increased in concentration even where the plumes are not fully captured (URS, 2004b, 2005a, 2006a, 2007b, and 2008a). Interpretation of those data has led to the recognition that natural attenuation mechanisms have been effective in containing the plumes; because of those mechanisms, COC concentrations near potable wells are either not detected or less than half of MCLs. Therefore, users continue to be protected.

No new or additional information regarding potential ecological risks has been developed or come to light during the second five-year review period that could call into question the protectiveness of the groundwater remedy. There have been no impacts to the groundwater remedial action due to natural disasters during this time period.

7.4 Question A: Are the OU 2 soil remedies functioning as intended by the OU 2 ROD?

The technical assessment documented in the first five-year review (URS, 2004a) pertaining to remedial action performance, system operations/O&M, optimization measures, potential protectiveness issues related to remedy implementation, and effectiveness of ICs for the OU 2 soil remedies is summarized in the following sections. Specific changes or developments that have occurred during this second five-year review period regarding these assessment criteria are also documented. For ease of review, discussions have been grouped into TCE in soil, metals contamination in soil, and pesticide contamination in soil.

7.4.1 Remedial Action Performance for TCE in Soil

As documented in the first five-year review, SVE treatment systems were constructed, operated, and functioned as designed in accordance with requirements of the remedy set forth in the OU 2 ROD. Remedial actions at the SVE sites are still considered complete. The OU 2 ROD specifies 0.35 ppmv as the cleanup level for TCE contamination in soil gas. TCE concentrations in soil gas samples for all SVE sites became asymptotic. Closure/confirmation sampling concluded that the lateral and vertical extent of TCE contamination in soil gas had been reduced at most of the SVE sites to concentrations at or less than the 0.35 ppmv cleanup level. Vadose zone leaching modeling results predicted that the TCE residual mass would not cause leachate to raise groundwater concentrations above drinking water levels at any of the SVE sites (URS, 2002d). All SVE systems at DDJC-Sharpe were decommissioned in December 2002 after approval by all regulatory members of the FFA, and no further action is required (URS, 2002d; 2003e).

Site P-5A (Figure 4-9) was identified in the OU 2 ROD as a site requiring SVE. After additional post-ROD characterization (1996 to 1999), no further action was required at P-5A (Radian International, 2000a). More recently, groundwater concentrations that increased to greater than 600 µg/L in 2002 and 2003 in the area warranted further investigation of soil vapor in 2006 and 2007. The results of these investigations indicate that a residual TCE source area exists in Site P-5A soil and that a remedial action (i.e., SVE) is needed to remain protective of groundwater quality (URS, 2009b). An evaluation of the performance of the remedial action at Site P-5A will be included in the third five-year review.

7.4.2 System Operations/O&M

As noted above, the active SVE systems at DDJC-Sharpe were decommissioned in December 2002. Assessment of system operations and O&M related to the implementation of SVE at Site P-5A will be included in the third five-year review.

7.4.3 Opportunities for Optimization

Due to the relatively short period of implementation of the SVE remedy for soil gas and its apparent effectiveness during the first five-year review period, optimization of the SVE systems was not a factor, and the SVE systems were decommissioned in December 2002. Opportunities for optimization of SVE system operations at Site P-5A will be assessed in the third five-year review.

7.4.4 Early Indicators of Potential Issues

There were no issues related to equipment breakdown or changes in remedy implementation during the period of the second five-year review because all the SVE systems were decommissioned in December 2002. At the time of the first five-year review, the remedial action for TCE was considered protective under current land use and is likely to be protective in the future because TCE concentrations will reduce naturally with time. Assessment of potential issues related to implementation of SVE at Site P-5A will be completed in the third five-year review.

7.4.5 Implementation of ICs and Other Measures

No access controls (fencing, warning signs, etc.) or ICs that prevent exposure at the SVE sites were established during the first or second five-year review periods. Because there are no immediate threats to human health or the environment from SVE sites, no other measures have been implemented. Assessment of the need for ICs or other protective measures at Site P-5A will be completed in the third five-year review.

7.4.6 Remedial Action Performance for Metals in Soil

The OU 2 ROD required excavation and off-site disposal of lead and/or chromium contaminated soil at five metals sites (S-3, S-26, S-30, S-33/29, and S-36) (ESE, 1996). However, post-ROD characterization determined that only Sites S-3 and S-26 required remedial action. The remedial action consisted of sampling, excavation, waste profiling, transportation, disposal, and backfilling of soil areas contaminated with lead and/or chromium at concentrations greater than the OU 2 ROD cleanup levels (1,000 mg/kg and 300 mg/kg, respectively). Remedial actions at Sites S-3 and S-26 were conducted in 1998 (during the period of the first five-year review) in accordance with the requirements set forth in the OU 2 ROD. The cleanup level requirements were achieved at both sites, with the exception of one area at Site S-26 (Area 6), which was not excavated. During the period of this second five-year review, Area 6 of Site S-26 was remediated in accordance with the OU 2 ROD (URS, 2008f). The remedial actions at Sites S-3 and Site-26 were completed in accordance with the OU 2 ROD, and no further action is required (Radian

International, 2000b; URS, 2008f). However, as the soil cleanup levels are based on an industrial exposure scenario and do not allow for unlimited use and unrestricted exposure (i.e., residential use), implementation of LUCs is planned.

At Sites S-30, S-33/29, and S-36, post-ROD characterization indicated that concentrations of lead and/or chromium were less than the OU 2 ROD cleanup levels; therefore, a remedial action was not required (Radian International, 2000a). However, as noted above for Sites S-3 and S-26, concentrations of lead and/or chromium that remain in soil at these sites do not allow for residential use, and LUCs will be implemented at these sites.

7.4.7 System Operations/O&M

No systems were constructed as part of implementation of remedial action at Sites S-3 and S-26.

7.4.8 Opportunities for Optimization

Because remedial systems were not constructed as part of implementation and completion of the remedy for metals in soil, optimization of system performance, reduction of monitoring costs, and sampling requirements associated with remedial system operation are not relevant.

7.4.9 Early Indicators of Potential Issues

The remedial actions conducted for metals in soil were accomplished without issues related to equipment breakdown. The OU 2 ROD is not fully protective of human health and the environment because lead and chromium cleanup levels for metals sites do not allow for unlimited use and unrestricted exposure.

7.4.10 Implementation of ICs and Other Measures

No access controls or ICs (fencing, warning signs, etc.) at the five metals sites are in place. LUCs that prohibit residential development and use are included in the forthcoming OU 2 ROD amendment (URS, 2009d). The effectiveness of the LUCs will be assessed in the third five-year review. No other measures (soil removal or otherwise) have been completed.

7.4.11 Remedial Action Performance for Pesticides in Soil

As documented in the first five-year review, a removal action was conducted between 1994 and 1996 to remediate pesticides present in soil as a result of past site activities in a portion of the North Balloon identified as the Pesticide Mix Area (Site S-1 on Figure 4-9). Final remediation goals (FRGs) (i.e., cleanup levels) established in the *Removal Action Memorandum for Pesticide Mix Area, North Balloon Area, Lathrop, California* (ESE, 1994c) were based on then-current residential EPA PRGs for the pesticides chlordane, dichlorodiphenyldichloroethene (DDE), dichlorodiphenyldichloroethane (DDD), dichlorodiphenyltrichloroethane (DDT), and dieldrin. Implementation of the removal action required excavation, transportation, off-site disposal, confirmation sampling, and backfilling of soil within the Pesticide Mix Area where concentrations of pesticides in excess of the FRGs were present. The removal action completed at the Pesticide Mix Area met the FRGs for pesticide-contaminated soils, and no further action is required (ESE, 1996).

7.4.12 System Operations/O&M

No systems were constructed as part of the Pesticide Mix Area removal action.

7.4.13 Opportunities for Optimization

Because remedial systems were not constructed as part of implementation and completion of the remedy for pesticides in soils at the Pesticide Mix Area, optimization of system performance, reduction of monitoring costs, and sampling requirements associated with remedial system operation are not relevant.

7.4.14 Early Indicators of Potential Issues

As noted above, no systems were constructed for the Pesticide Mix Area remedial action. Therefore, there were no potential issues related to equipment breakdown or changes in implementation of the remedy. No specific issues were identified during implementation and completion of the remedial action at the Pesticide Mix Area. The remedial action is protective under current land use.

7.4.15 Implementation of ICs and Other Measures

No access measures or ICs (fencing, warning signs, etc.) to prevent exposure to pesticides at the Pesticide Mix Area are in place because soils were remediated to allow for unlimited use and unrestricted exposure of the site. Additional actions (soil removal or otherwise) are not necessary.

7.5 Question B: Are the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of the selection of the OU 2 remedies still valid?

Since the OU 2 ROD was signed, there have been changes in exposure assumptions, toxicity data, and methods of standardized risk assessment processes, and additional data have been collected. Because of these changes and additional available data, the potential health risks from VOCs in soil gas and from metals and pesticides in soil are re-evaluated in the following sections to assess if the ROD remedies remain protective of human health.

The conclusion of the re-evaluation is that ROD remedies remain protective of the health of industrial workers. In addition, because there have been no changes to the ACL for TCE, the soil gas cleanup level of 0.35 ppmv continues to be protective of groundwater. For ease of review, discussions have been grouped into TCE in soil and metals and pesticide contamination in soil.

7.5.1 Changes in Standards and TBCs for TCE in Soil

Chemical-Specific ARARs. There are no chemical-specific ARARs or TBCs pertaining to soil gas, and the 1994 RI/FS risk assessment demonstrated that TCE in soil was not a potential threat to human health (ESE, 1994b). A cleanup level for TCE in soil gas was developed to be protective of groundwater quality. The cleanup level for TCE in soil gas established in the OU 2 ROD is 0.35 ppmv, which is based on maintaining TCE concentrations in groundwater less than the ACL if TCE in soil vapor were to migrate to groundwater and attain a state of equilibrium. This value was first proposed in the *Remedial Investigation/Feasibility Study at DDRW-Sharpe Site: Soils Feasibility Study Report* (ESE, 1994a). The cleanup level was derived using Henry's Law and represents the equilibrium relationship for a chemical that can partition between liquid and gas phases:

$$C_{sg} = C_w \times H' \times \frac{R \times T}{P} \times \frac{1}{MW} \times CF \qquad \text{(Equation 7-1)}$$

Where:

C_{sg}	=	concentration of TCE in soil gas (0.35 ppmv = 0.35 µL TCE/L_{air});
C_w	=	concentration of TCE in groundwater (ACL = 5 µg TCE/L_{water});
H'	=	Henry's Law constant (0.372 $L_{water}/L_{soil\ gas}$) (Radian International, 2000a);
R	=	universal gas constant (8.21×10^{-5} [atm•m^3]/[mole•°Kelvin]);
T	=	standard temperature (298° Kelvin = 25° Celsius);
P	=	standard atmospheric pressure (1 atmosphere [atm]);
CF	=	conversion factor (1×10^{-3} [µg•L]/[g•m^3]); and
MW	=	gram molecular weight (131 g TCE/mole TCE).

Because there have been no changes to the ACL for TCE, the cleanup level of 0.35 ppmv continues to be protective of groundwater.

In determining the TCE soil gas cleanup level, other potential routes of exposure to VOCs were not considered significant at the time of the 1994 RI/FS risk assessment because 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. The first five-year review addressed the potential human health threat from VOCs emanating from soil gas and from groundwater by performing vapor intrusion analyses using the J&E computational model (URS, 2004a). The soil gas analysis predicted incremental cancer risks to a hypothetical on-site resident ranging from 3.1E-08 to 3.7E-07 (below the ***de minimus*** limit of 1E-06) as posed by TCE in soil vapor migrating to indoor air. The groundwater analysis predicted incremental cancer risks to a hypothetical on-site resident ranging from 9.4E-10 to 3.8E-07 for PCE vapor migrating from groundwater into indoor air, and ranging from 2.6E-09 to 3.7E-06 for TCE vapor migrating from groundwater into indoor air. Risks to an industrial receptor ranged from 6.4E-09 to 2.2E-7 for estimated exposure to PCE and from 4.8E-09 to 2.3E-06 for estimated exposure to TCE.

To address subsequent regulatory agency concerns, a follow-up study was performed in 2004 to collect soil gas data and evaluate the threat posed by VOCs in soil gas over portions of groundwater plumes in the A Zone where TCE concentrations are estimated to be greatest. The 2004 follow-up soil gas study demonstrated a less than 1E-07 incremental cancer risk to hypothetical residents and on-site workers from estimated vapor intrusion of TCE in hypothetical buildings standing over a TCE plume in the A Zone shallow aquifer (URS, 2004d). However, because the 2004 study did not address cumulative risk and DTSC has made recent minor changes to the J&E computational model, the soil gas data were re-evaluated to ensure that they remain within acceptable risk limits (Section 7.5.4).

Action- and Location-Specific ARARs. Action-specific ARARs are usually technology- or activity-based requirements, while location-specific ARARs are restrictions placed on the chemical contaminant or the remedial activities based on the site's geographic or ecological features. The action-specific ARARs presented in the OU 2 ROD were evaluated for protectiveness (Table 7-3). No changes to the action-specific ARARs were identified that affect the protectiveness of the remedy, and no location-specific ARARs were documented in the OU 2 ROD.

In 2003, California developed a new action-specific requirement for documenting LUCs in decision documents (e.g., ROD, remedial action/remedial design) with specific emphasis on property transfers at federal facilities. When the selected remedy allows contaminants to be left in place at levels that do not allow for unlimited use and unrestricted exposure, LUCs are applied to ensure the remedy is protective of human health and the environment. Because there has been no evidence of exposure to receptors from TCE at OU 2, the new LUC requirement does not affect the protectiveness of the remedy for TCE in soil. Consequently, documenting a post-ROD change only for the new LUC requirement is not necessary.

There are no new action- or location-specific requirements that have a bearing on the protectiveness of the selected remedy for TCE. The action-specific ARARs continue to support the protectiveness of the remedy for TCE in soil.

There are no revised or newly promulgated standards or TBCs that affect the protectiveness of the remedy for TCE in soil.

7.5.2 Changes in Exposure Pathways

Intrusion of vapors originating from volatile chemicals in subsurface media (soil or groundwater) into building interiors potentially utilized by workers or residents is an exposure pathway that was not addressed in the RI/FS risk assessments (ESE, 1991; 1994b). The vapor intrusion pathway was partially addressed in the first five-year review, using soil gas and groundwater data. The first five-year review concluded that vapor intrusion from subsurface soil gas was *de minimus* (inconsequential) for unrestricted land use (URS, 2004a). However, vapor intrusion risk estimates based on groundwater data exceeded the *de minimus* level (1E-06) for unrestricted land use, but were within the risk-management range (1E-04 to 1E-06) for industrial land use.

Because of large uncertainty in the mathematical modeling of the transport of chemicals from groundwater to indoor air, DTSC recommended collecting additional soil gas samples for further evaluation of the vapor intrusion pathway. The use of soil gas analytical data presents less uncertainty in modeling movement of subsurface vapor to indoor air than modeling groundwater to vapor to indoor air movement. Soil gas samples were collected in three areas where A Zone groundwater plumes are present, and the results of the vapor intrusion modeling using the soil gas data demonstrated a less than 1E-07 incremental cancer risk from vapor intrusion for DDJC-Sharpe residents or workers occupying hypothetical buildings standing over a TCE plume in the A Zone shallow aquifer (URS, 2004d).

The 2004 analysis did not address cumulative risk from exposure to multiple chemicals (in part because TCE was the only chemical detected in soil gas samples out of 40 total VOCs analyzed). In addition, the DTSC has recently modified the J&E computational model for the vapor-intrusion risk-assessment model. Given this revision in the risk-assessment method, the soil gas data must be re-evaluated to ensure that cumulative risk remains within acceptable risk limits. The re-evaluation is presented in Section 7.5.4.

Since the first five-year review, additional characterization of DDJC-Sharpe indicates that a residual TCE source area exists at Site P-5A in the Central Area (URS, 2009b). However, no buildings are located above the area of Site P-5A. SVE, which will be implemented at Site P-5A to protect groundwater quality, will also mitigate the threat of potential vapor intrusion if a building were constructed in this area.

No additional land use changes, remedy toxic byproducts, or physical site condition changes were identified since the first five-year review.

7.5.3 Changes in Toxicity and Other Contaminant Characteristics

As noted previously, DTSC has recently modified the J&E computational model for the vapor-intrusion risk assessment model. These modifications include updates to the toxicity criteria used in the J&E computational model and are incorporated into the analysis described in Section 7.5.4.

7.5.4 Changes in Risk Assessment Methods

The vapor intrusion analysis in the first five-year review addressed the potential threat from VOCs emanating from soil gas and groundwater. To address subsequent agency concerns, a follow-up study was

performed in 2004 to collect soil gas and evaluate the potential threat posed by VOCs in soil gas (URS, 2004d). This 2004 study addressed the potential health risk from TCE (the only compound detected in soil gas samples), using then-available versions of EPA's J&E computational model (EPA, 2004b), as modified by DTSC. The 2004 study demonstrated a less than 1E-07 incremental cancer risk from estimated vapor intrusion of TCE. Because the 2004 study did not address cumulative risk to multiple chemicals (only 1 VOC was detected out of the 40 detectable chemicals in the TO 14 analytical method suite) and because of recent minor changes made by the DTSC to the J&E computational model, soil gas data were re-evaluated to ensure that cumulative risk remains within acceptable risk limits.

The following health-protective assumptions were incorporated into the analysis:

- Exposure concentrations used were the maximum detected concentration of TCE in soil gas (24 ppbv) and the maximum detection limit concentration[3] for all the other VOCs (4.3 ppbv) based on 2004 data collected from under Building 655 in the South Balloon Area;

- The shallowest soil depth of sample collection was used (3 feet bgs);

- A "sand" soil type was assumed (the most permeable and least-retentive soil type evaluated within the J&E model); and,

- A "residential" exposure scenario was evaluated (30 years exposure, 350 days per year, in a relatively small hypothetical residence).

Appendix K, Table K-1 provides the input data that were used in "EPA Version 2.0; 04/03" of the J&E "HERD Soil Gas Screening Model 2005," as last modified by the DTSC in January 2005 (DTSC, 2008).

Results of this evaluation (Appendix K, Table K-4) indicate the cumulative risk for estimated exposure to the maximum detected concentration of TCE and the detection limit concentrations of the other 39 VOCs (that can be measured using the TO 14 analytical methods) is 6E-06, just greater than the lower limit of the acceptable risk range of 1E-04 to 1E-06, and less than the 1.0 point-of-departure threshold for noncancer health hazards. The risk estimate for TCE alone, as the only detected compound, was 2E-07, below the ***de minimus*** level.

These risk estimates (Appendix K, Table K-4) assume a ***residence*** is present over VOC-containing soil, which is not a current nor a reasonably anticipated future land use for the site. These risk estimates also assume exposure occurred at concentrations equal to the detection limit for ***all 39*** of the other analytes that can be detected by the TO 14 analytical method. It should be noted that results reported at less than detection limits actually indicate concentrations somewhere between zero (absence of the VOC) and the detection-limit value.

Because of the conservative assumptions included in the model, and the estimated cumulative risk and hazard estimates that are within the acceptable risk-management range, the 2004 analysis is still considered protective of human health in an industrial setting. If VOC results were predominantly less than detection limits, it is extremely unlikely that ***all*** compounds would be present at concentrations just less than the detection limit. Evaluation of analytical results from the 22 samples of soil gas collected in 2004 indicate that nearly all of the VOC analytes were not detected (the lone detected compound was TCE). Consequently, a conservative assumption can be made that a hypothetical receptor exposed to detection-limit concentrations of VOCs would be health-protective. The possible exception is Site P-5A in the Central Area (though no buildings are currently located above the soil gas detections and SVE will

[3] Detection limit concentrations were included to evaluate the adequacy of the analytical method for health risk assessment purposes.

be implemented). In addition, the cancer risk estimate for the soil gas cleanup level (0.35 ppmv) is 3E-06, near the lower limit of the acceptable risk range of 1E-04 to 1E-06 for industrial land uses. Therefore, the soil gas cleanup level of 0.35 ppmv is still considered protective of industrial workers.

7.5.5 Expected Progress Toward Meeting RAOs

SVE treatment systems were constructed in accordance with the requirements of the selected remedy set forth in the OU 2 ROD and were confirmed to be effective (URS, 2002d). Concentrations of VOCs in soil gas at the SVE treatment sites are less than detection limits or have reached concentrations that will not significantly impact groundwater (URS, 2002d). No new SVE treatment systems were installed during the second five-year review period. Assessment of the progress toward, or achievement of, the RAO for TCE-contaminated soil at Site P-5A will be included in the third five-year review.

7.5.6 Changes in Standards and TBCs for Metals and Pesticides in Soil

Chemical-Specific ARARs for Lead and Chromium. A soil cleanup level of 300 mg/kg for total chromium in soil is specified for the DDJC-Sharpe facility in the OU 2 ROD, based primarily on the threat to groundwater. A health risk based acceptable concentration was determined to be 500 mg/kg. Equivalent contemporary health-based guideline values for chromium can be found in the EPA regional screening levels (RSLs) (formerly termed “PRGs”) (EPA, 2008b). The RSL concentration in soil that is acceptable for industrial land use is 200 mg/kg if all chromium (Cr) is in the hexavalent form (CrVI). The RSL method results in a pure concentration if all the chromium is in the trivalent form (CrIII) (i.e., CrIII is not toxic to humans). The RSL is 1,400 mg/kg if it is assumed that chromium is distributed in a 1:6 ratio of CrVI:CrIII in soil. This ratio is a common assumption for soil. Consequently, the 300 mg/kg cleanup level for chromium in soil at DDJC-Sharpe is well below the 2008 RSL for total chromium and remains health protective.

The OU 2 ROD also establishes a soil cleanup level of 1,000 mg/kg for lead in soil at DDJC-Sharpe. A supplemental cleanup level of 800 mg/kg for the excavation of Area 6 at Site S-26 was established in 2005 (URS, 2005b). The 800 mg/kg concentration is health protective (under commercial or industrial land use) based on EPA’s Adult Lead Model (ALM) (EPA, 2003). The ALM estimates the fetal blood-lead concentration associated with occupational exposure of a mother to lead-contaminated soil. For the EPA, an “acceptable level” is a soil concentration that results in a predicted 95th-percentile blood-lead concentration that does not exceed 10 micrograms of lead per deciliter (µg/dL) of blood. The ALM documentation provides several estimates of acceptable concentrations of lead in soil, depending on ethnicity or national region, which range from approximately 800 mg/kg to approximately 1,370 mg/kg. The overall average acceptable concentration of lead in soil (all ethnic groups, all regions) is predicted by the ALM to be approximately 1,200 mg/kg. The 1,000 mg/kg cleanup level for lead in soil at DDJC-Sharpe is below the average acceptable concentration and in the approximately 25th percentile of the range of results (as determined by the ALM) and is, therefore, health protective of a generally diverse population.

Chemical-Specific ARARs for Pesticides. A remedial action was completed between 1994 and 1996 to remove pesticide-contaminated soil from the Pesticide Mix Area. The extent of soil excavation from the Pesticide Mix Area was based on FRGs for concentrations of five pesticides (1 mg/kg chlordane, 2 mg/kg 4,4´-DDD, 3 mg/kg 4,4´-DDE, 2 mg/kg 4,4´-DDT, and 0.04 mg/kg dieldrin). The FRGs were established as values near the then-available PRGs published by EPA Region 9 for concentrations in soil acceptable for residential land uses. The FRGs were approved by the regulatory members of the FFA in 1994 to be health protective for cumulative exposures to the five pesticides at risk estimates near the lower end of the risk-management range of 1E-04 to 1E-06.

EPA has recently updated the PRGs to RSLs (EPA, 2008b), and the new RSL values for residential soil are 1.6 mg/kg chlordane, 2 mg/kg 4,4´-DDD, 1.4 mg/kg 4,4´-DDE, 1.7 mg/kg 4,4´-DDT, and 0.03 mg/kg dieldrin. RSLs for industrial soil are 6.5 mg/kg chlordane, 7.2 mg/kg 4,4´-DDD, 5.1 mg/kg 4,4´-DDE, 7.0 mg/kg 4,4´-DDT, and 0.11 mg/kg dieldrin. The FRGs are still within the general range of acceptable risk for residential land uses, and are all well below the RSLs for acceptable concentrations in industrial soils, which is a land use consistent with current conditions at DDJC-Sharpe.

Action- and Location-Specific ARARs. Action-specific ARARs are usually technology- or activity-based requirements while location-specific ARARs are restrictions placed on the chemical contaminant or the remedial activities based on the site's geographic or ecological features. The action-specific ARARs presented in the OU 2 ROD were evaluated for protectiveness (Table 7-3). No changes to the action-specific ARARs were identified that affect the protectiveness of the remedy, and no location-specific ARARs are documented in the OU 2 ROD.

In 2003, California developed a new action-specific requirement for documenting LUCs in decision documents (e.g., ROD, remedial action/remedial design) with specific emphasis on property transfers at federal facilities. When the selected remedy allows contaminants to be left in place at levels that do not allow for unlimited use and unrestricted exposure, LUCs are applied to ensure the remedy is protective of human health and the environment. Because there has been no evidence of exposure to receptors from contaminants at OU 2, the new LUC requirement does not affect the protectiveness of the remedy for OU 2. LUCs for the five metals sites will be documented in a ROD amendment (URS, 2009d).

There are no new action- or location-specific requirements that would have a bearing on the protectiveness of the selected remedy. The action-specific ARARs continue to support the protectiveness of the remedy for OU 2.

There are no revised or newly promulgated standard or TBCs that could affect the protectiveness of the remedy.

7.5.7 Changes in Exposure Pathways

Lead and Chromium. Three exposure scenarios were evaluated during the 1994 RI/FS risk assessment, OU 2 ROD, and first five-year review. These include: (1) on-site residents exposed to soil via ingestion, dermal contact, and, dust inhalation; (2) on-site workers exposed to soil via ingestion, dermal contact, and dust inhalation; and (3) intermittent, “recreational” exposure of a child via ingestion, dermal contact, and dust inhalation. These scenarios were appropriately evaluated and accepted through the 1994 RI/FS risk assessment, OU 2 ROD, and first five-year review processes. A “construction worker” scenario has since become part of contemporary risk assessment practice. This scenario is used to address the potential for health effects in a person who has a relatively shorter term exposure (e.g., 1 year, instead of 25 years) but who also has much greater contact rates with contaminated soil, for example, during trenching or other intrusive activities. The construction worker scenario is addressed in Section 7.5.9.

Many of the values used in the 1994 RI/FS risk assessment to evaluate exposure to resident, worker, and recreational receptors are generally equivalent to those used in a contemporary risk assessment, as summarized in Table 7-7. The 1994 RI/FS risk assessment’s residential scenario was site-specific, whereas the contemporary residential scenario is typically a 30-year duration for purposes of evaluating the potential for unrestricted land use. As DDJC-Sharpe is currently not pursuing an unrestricted use designation, the difference between the 1994 RI/FS risk assessment and contemporary residential

Table 7-7. Evaluation of the Exposure Assumptions Presented in the OU 2 ROD

Exposure Parameter Description	Variable	Units	RI/FS Value[a]				Contemporary Default Values			
			Resident Adult	Resident Child	Worker	Intermittent ("Recreational") Child	Resident Adult	Resident Child	Worker	Construction Worker
Dermal Absorption Factor	ABS	dimensionless								
Hexavalent chromium			0.15	0.15	0.15	0.15	0	0	0	0
Other inorganic compounds			0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Semivolatile organic compounds			0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Volatile organic compounds			0.25	0.25	0.25	0.25	None	None	None	None
Skin Adherence Factor	AF	mg/cm^2	1.45	1.45	1.45	1.45	0.07	0.2	0.2	0.8
Averaging Time, carcinogens	AT_c	years	70	70	70	70	70	70	70	70
Averaging Time, noncarcinogens	AT_{nc}	years	3	6	25	6	24	6	25	1
Body Weight	BW_a	kg	70	15	70	15	70	15	70	70
Exposure Duration	ED	years	3	6	25	6	24	6	25	1
Exposure Frequency	EF	days/year	350	350	250	50	350	350	250	250
Inhalation Rate (worker only)	IR_a	m^3/workday	—	—	20	—	—	—	14	20
Ingestion Rate	IR_s	mg/day	100	200	50	200	100	200	100	330
Surface Area of exposed skin	SA	cm^2	5,596	4,019	2,679	4,019	5,700	2,900	5,700	5700

[a] From Appendix C (ESE, 1994b)

cm^2 = square centimeters
kg = kilograms
m^3/workday = cubic meters per 8-hour workday
mg/cm^2 = milligrams per square centimeter
mg/day = milligrams per day
OU = operable unit
ROD = record of decision

scenarios is not significant. Exposure factors for dermal assessment were considerably more stringent in the 1994 RI/FS risk assessment for absorption and adherence factors and only slightly less than contemporary default values for surface area. No additional land use changes, contaminants, remedy toxic byproducts, or physical site condition changes were identified since the first five-year review.

Pesticides. There are no changes to exposure pathways for unrestricted use. No additional receptors, exposure pathways, land use changes, contaminants, remedy toxic byproducts, or physical site condition changes were identified since the first five-year review.

7.5.8 Changes in Toxicity and Other Contaminant Characteristics

Lead and Chromium. There have been changes to agency-promulgated toxicity values for chromium since the 1994 RI/FS risk assessment and the risk characterization in the OU 2 ROD. Collectively, the changes have resulted in an overall slightly decreased toxicity recognized for chromium (CrVI, CrIII, and as combined into "total chromium"). This decrease in toxicity has been manifested in a slightly raised RSL; lesser toxicity means that the acceptable exposure concentration can be greater. The health-based remedial goal derived in the OU 2 ROD was 500 mg/kg (however, 300 mg/kg was established to be protective of groundwater), and the current industrial RSL for total chromium is 1,400 mg/kg (EPA, 2008b).

The endpoint of interest for lead toxicity has remained at a blood-lead level of 10 µg/dL. However, increased complexity and specificity in assessing occupational exposure to lead have resulted in models which predict slightly lower acceptable soil concentrations. The range of acceptable exposure concentrations predicted by the EPA's ALM model is 800 to 1,370 mg/kg (EPA, 2003), which bounds the DDJC-Sharpe facility-wide cleanup goal for lead of 1,000 mg/kg.

Pesticides. Toxicity criteria for 4,4´-DDD, 4,4´-DDE, 4,4´-DDT, and dieldrin are unchanged since development of the FRGs, while the cancer-toxicity value for chlordane has increased slightly (i.e., an increased potency). Despite the slight increase in the toxicity value for chlordane, the FRGs are still within the general range of acceptable risk for residential land uses, and are all well below the EPA's RSLs for acceptable concentrations in industrial soils (EPA, 2008b), which is a land use consistent with current conditions at DDJC-Sharpe.

7.5.9 Changes in Risk Assessment Methods

Lead and Chromium. The construction worker scenario is used to address the potential for health effects in a person who has a relatively short-term exposure (e.g., 1 year, instead of 25 years) but with much greater contact rates (relative to other exposure scenarios). This represents a supplemental exposure scenario (incorporating modifications to specific exposure factors) and not a methodological change in risk assessment methods. As detailed in Appendix J, the RI worker scenario evaluated in the 1994 RI/FS risk assessment for soils at the DDJC-Sharpe facility is generally equivalent to a standardized "commercial/industrial receptor" as defined by EPA default conditions in 2008. There are mathematical differences in the values of some of the exposure factors, but taken in combination, the risk and/or hazard estimate results would be generally similar and the differences would not alter any overall conclusions of the 1994 RI/FS risk assessment.

A related question is whether the RI worker scenario is also protective of a construction worker scenario, which was not evaluated previously. For cancer risk estimates, the 1-year exposure dose for the construction worker receptor and the 25-year exposure dose for the RI worker receptor are each averaged over a 70-year lifetime. The lifetime average exposure of the RI worker receptor to potential cancer-causing contamination is, therefore, greater than that estimated for the construction worker receptor and

cancer risk estimates for the RI worker are greater than the cancer risk estimates for the construction worker. Consequently, the RI worker scenario evaluated in the RI/FS risk assessment encompasses (and is protective of) the construction worker scenario.

However, for noncancer endpoints, the exposure doses are not averaged over a lifetime, but are averaged over the specific exposure duration for the particular scenario. Thus, a construction worker receives 1 year of exposure averaged over 1 year and the RI worker receives 25 years of exposure averaged over 25 years. Because the construction worker scenario has a greater rate of incidental soil ingestion and a greater inhalation rate than the RI worker scenario, the construction worker receptor receives a greater estimated exposure than does the RI worker. Noncancer hazard estimates for the RI worker are less than the noncancer hazard estimates for the construction worker. Consequently, the RI worker scenario evaluated in the 1994 RI/FS risk assessment is less protective of the construction worker scenario, which was not evaluated in the 1994 RI/FS risk assessment.

Despite this greater exposure predicted for the construction worker, the conclusions of the 1994 RI/FS risk assessment would not have changed because the 1994 RI/FS risk assessment determined that only lead and chromium exceeded background and only lead and chromium would have been identified as inorganic COCs for the purpose of establishing cleanup objectives. The values of the cleanup objectives are protective of a construction worker receptor (even with the greater exposure) because the cleanup level for lead (800 mg/kg) is based on protection of a more-sensitive receptor (a developing fetus in a female worker). The cleanup level for chromium (300 mg/kg) is based on protection of groundwater, and the acceptable concentration is 1,400 mg/kg for a worker exposed to total chromium in industrial soil.

Pesticides. There have been no changes to standard risk assessment methods to assess residential (i.e., unrestricted) exposure since the first five-year review.

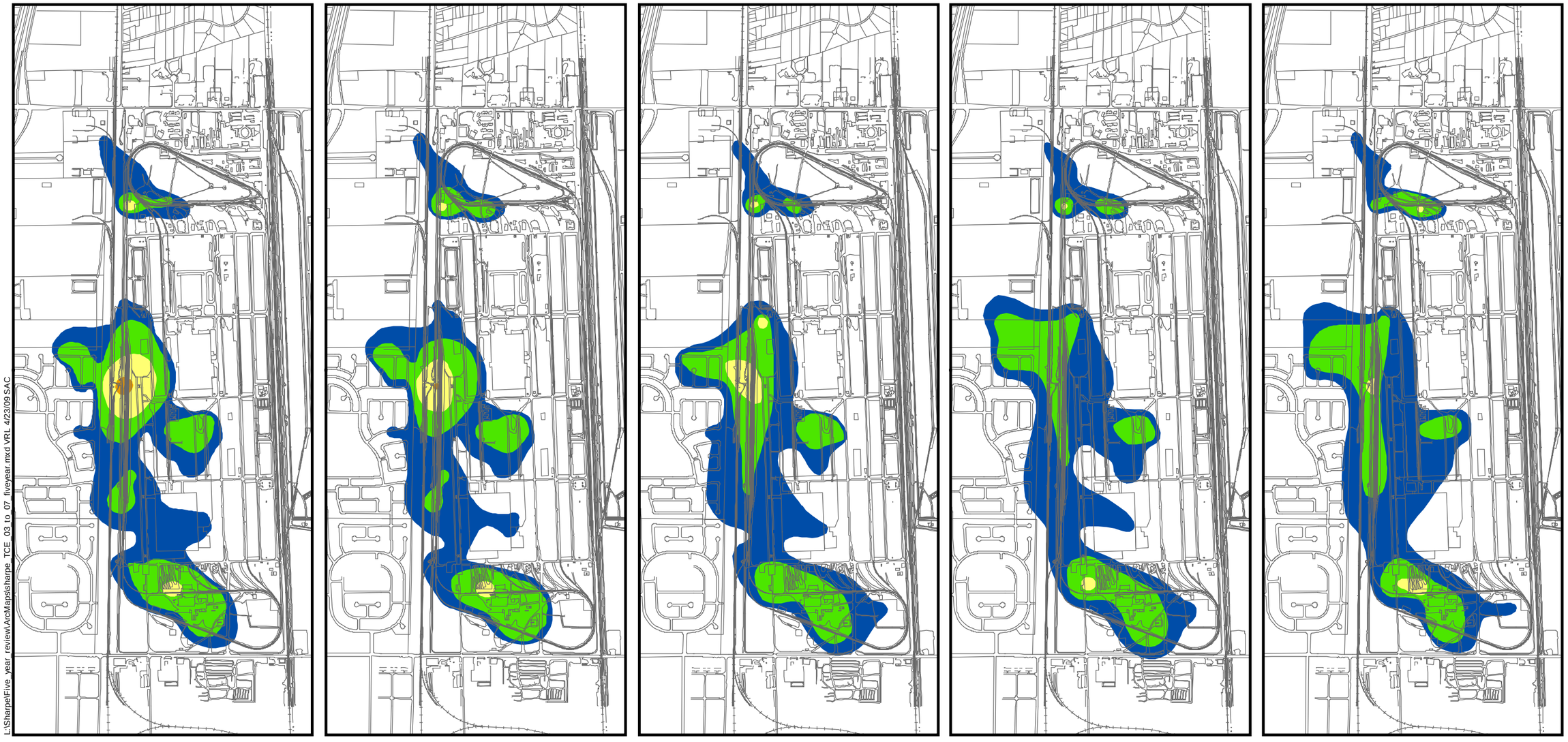
7.5.10 Expected Progress Toward Meeting RAOs

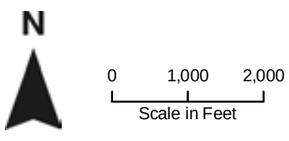
The RAOs have been met for lead, chromium, and pesticide contamination in soil in accordance with the OU 2 ROD. The removal actions taken as part of the lead and chromium excavation effort at Sites S-3 and S-26 were completed in accordance with the OU 2 ROD (Radian International, 2000b; URS, 2008f), and for the three other metals sites (S-30, S-33/29, and S-36), a remedial action was not required because concentrations of lead and/or chromium did not exceed cleanup levels (Radian International, 2000a). However, because soil cleanup levels are based on an industrial exposure scenario and do not allow for unlimited use and unrestricted exposure (i.e. residential use), implementation of LUCs is planned.

The OU 2 ROD indicated that the soil removal action at the Pesticide Mix Area was completed in accordance with the removal action memorandum signed in October 1994 (ESE, 1996). Therefore, no further action is required at the Pesticide Mix Area.

7.6 Question C: Has any other information come to light that could call into question the protectiveness of the OU 2 soil remedies?

New or Additional Information. No new or additional information regarding ecological risks has been developed or come to light during the second five-year review period associated with the remedial actions for VOCs, metals, or pesticides in soil that could call into question the protectiveness of the OU 2 remedies. There have also been no impacts to the soil remedial actions due to natural disasters during this time period that could jeopardize the protectiveness of the soil remedies.





TCE concentrations in µg/L (micrograms per liter)

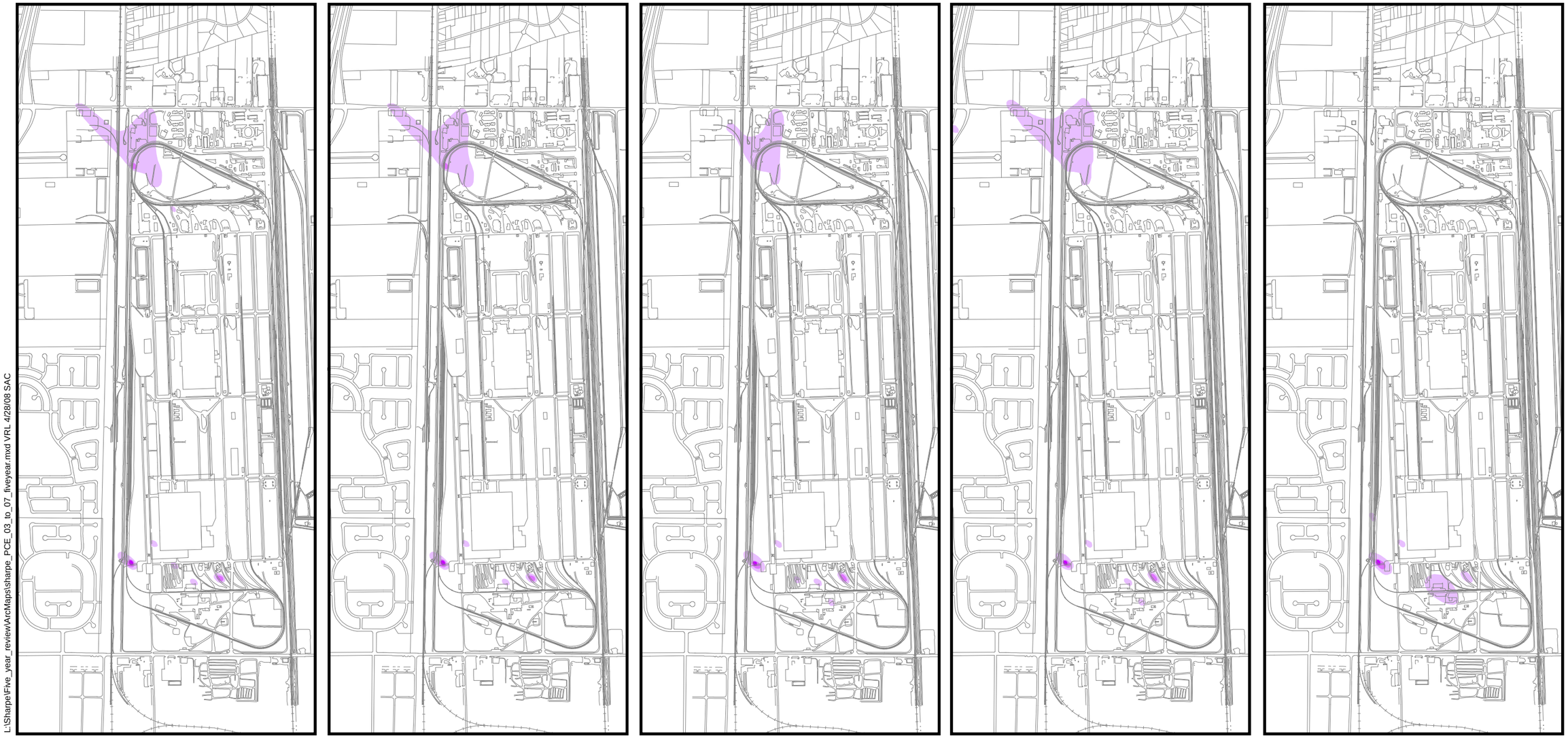
Note: TCE concentrations represent data from groundwater samples collected at extraction and monitoring wells in the third quarter of each year or most recent sampling event within the previous four quarters.

The plumes were developed by EarthVision, a 3-D modeling program.

The 2005 through 2007 plume figures do not account for HydroPunch or other samples collected during site-specific investigations.

Source: URS, 2008. *DDJC-Sharpe FFA Annual Progress Report: October 2006 through September 2007.* Final. June.

Figure 7-1
TCE Comparison Map
A, B, and C Zones, 2003-2007
DDJC-Sharpe



N

0 1,000 2,000
Scale in Feet

0.5 5 25

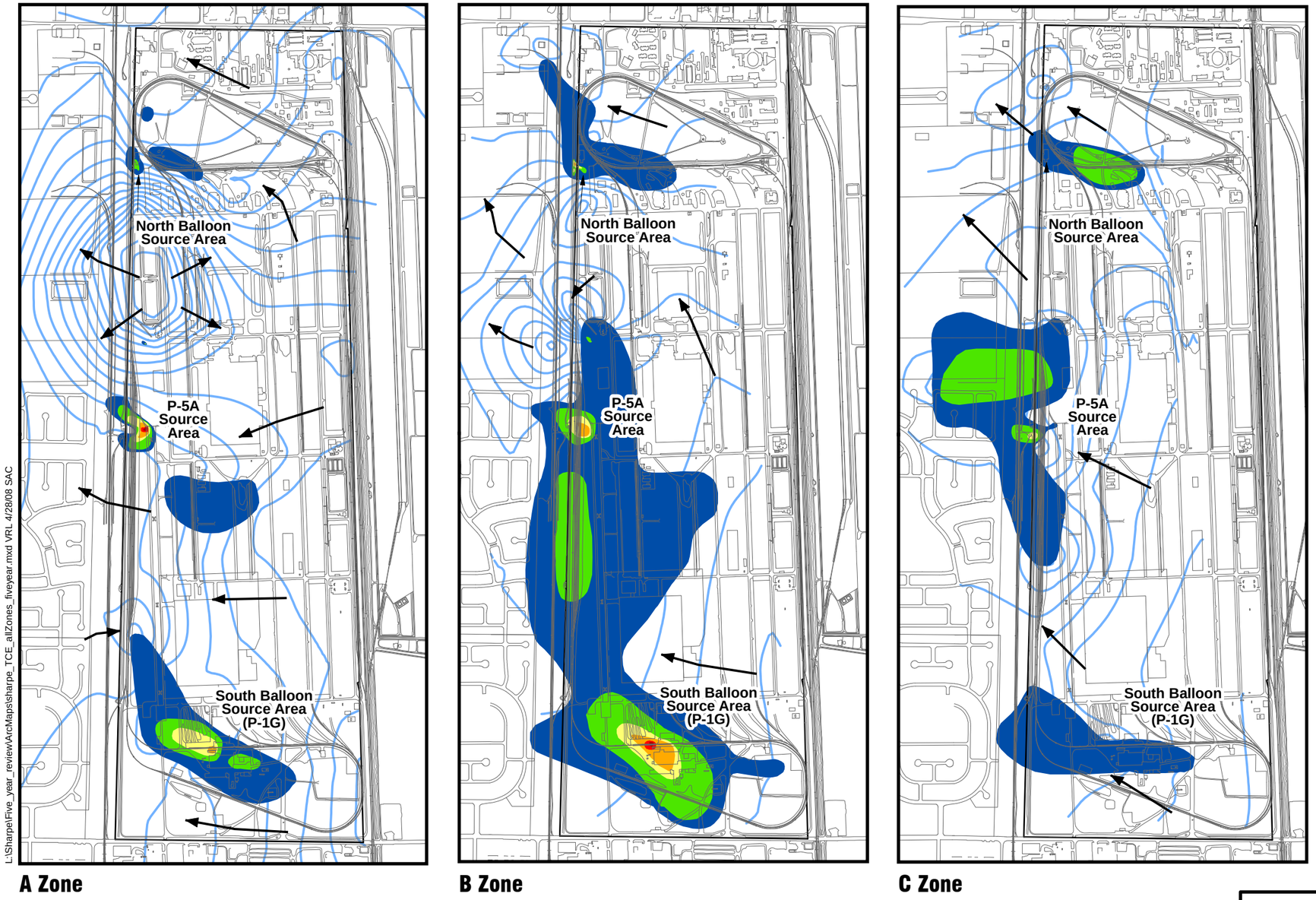
PCE concentrations in µg/L (micrograms per liter)

Note: PCE concentrations represent data from groundwater samples collected at extraction and monitoring wells in the third quarter of each year or most recent sampling event within the previous four quarters.

PCE plumes were manually drawn for each monitoring zone. The 2005 through 2007 plume figures do not account for HydroPunch or other samples collected during site-specific investigations.

Source: URS, 2008. *DDJC-Sharpe FFA Annual Progress Report: October 2006 through September 2007.* Final. June.

Figure 7-2
PCE Comparison Map
A, B, and C Zones, 2003-2007
DDJC-Sharpe



N

0 1,500
Scale in Feet

Groundwater Potentiometric Contours (1Q08)

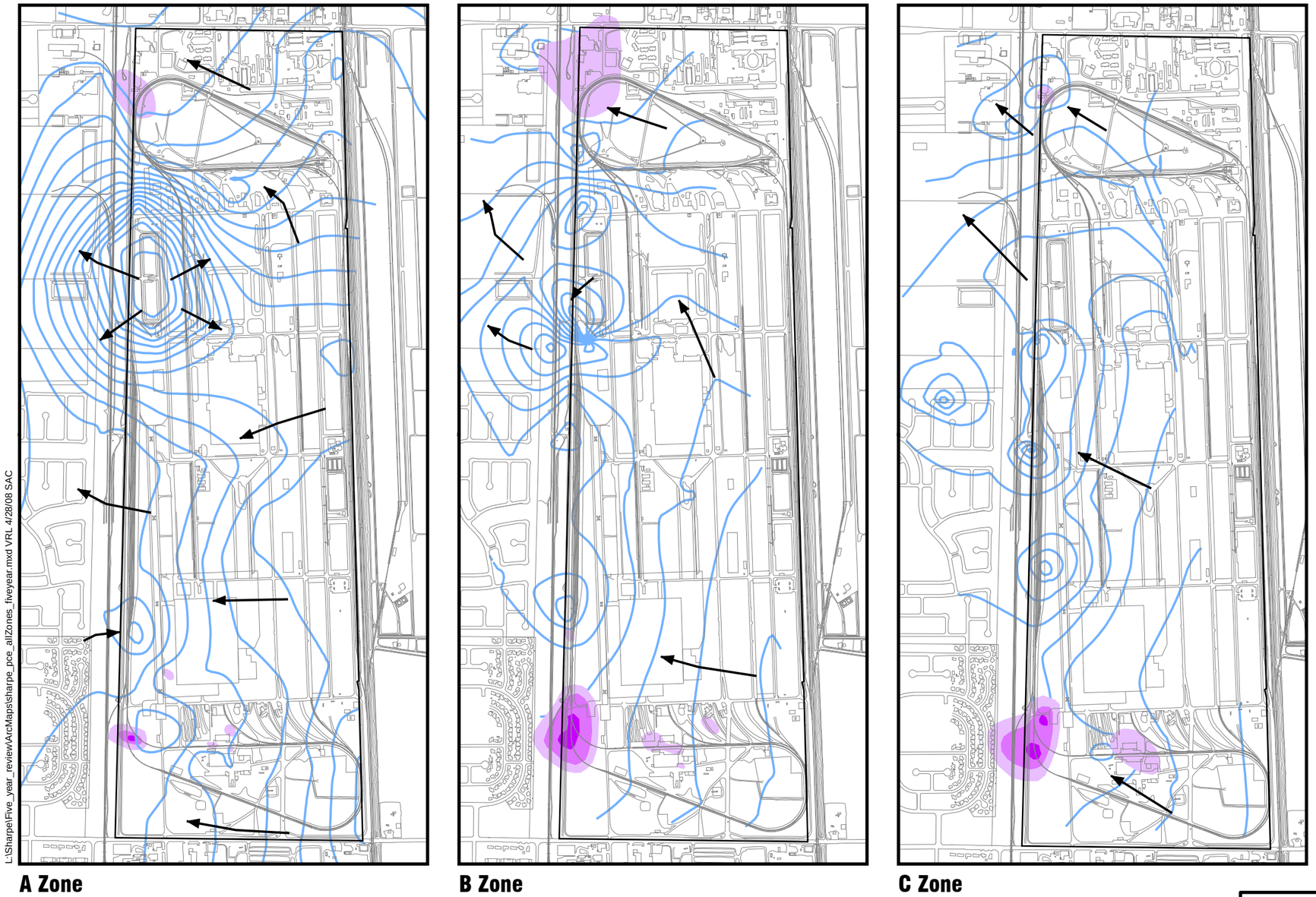
Estimated Groundwater Flow Direction

5 25 100 200 500 1000

TCE concentrations in µg/L (micrograms per liter)

Note: Groundwater concentration areas were drawn with 3Q07 monitoring well and extraction well data input to EarthVision, a 3-D modeling program. The modeled shapes were modified with data collected in the 2007/2008 CPT/HydroPunch investigation.

Figure 7-3
Extent of TCE by Zone with CPT/HydroPunch Investigation Results
DDJC-Sharpe



N

0 1,400
Scale in Feet

Groundwater Potentiometric Contours (1Q08)

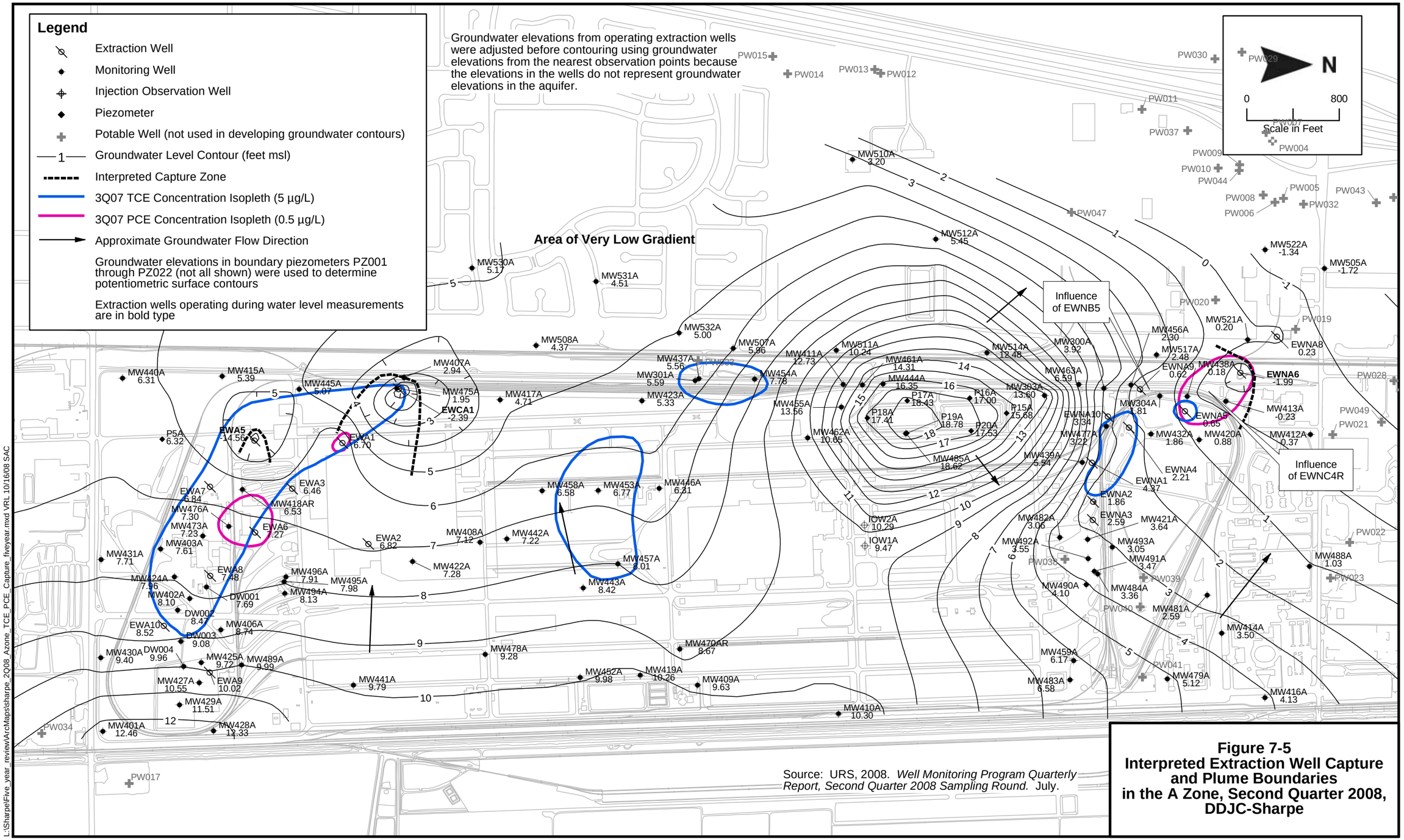
Estimated Groundwater Flow Direction

0.5 5 25

PCE concentrations in µg/L (micrograms per liter)

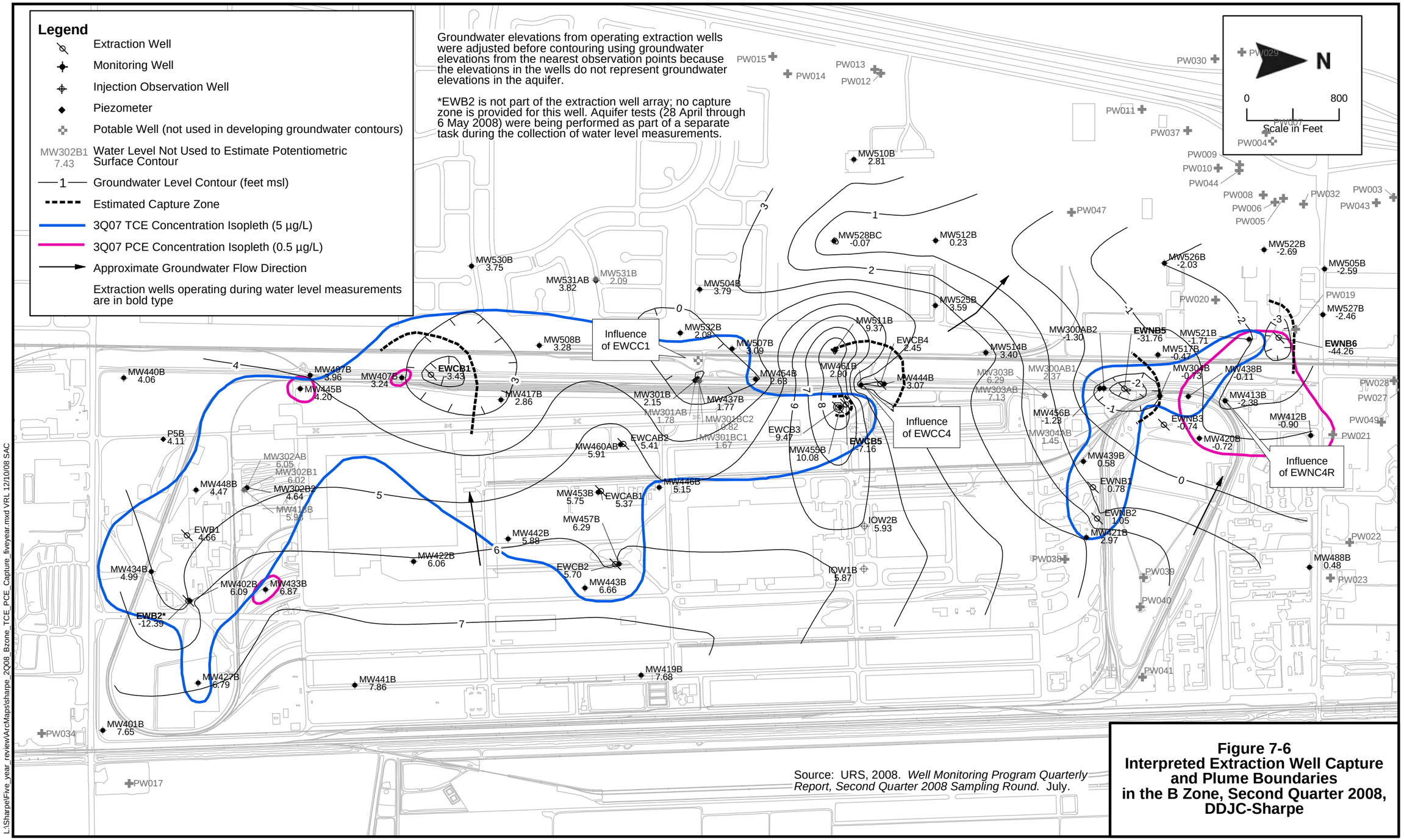
Note: Groundwater concentration areas were drawn with 3Q07 monitoring well and extraction well data input to EarthVision, a 3-D modeling program. The modeled shapes were modified with data collected in the 2007/2008 CPT/HydroPunch investigation.

Figure 7-4
Extent of PCE by Zone with CPT/HydroPunch Investigation Results
DDJC-Sharpe



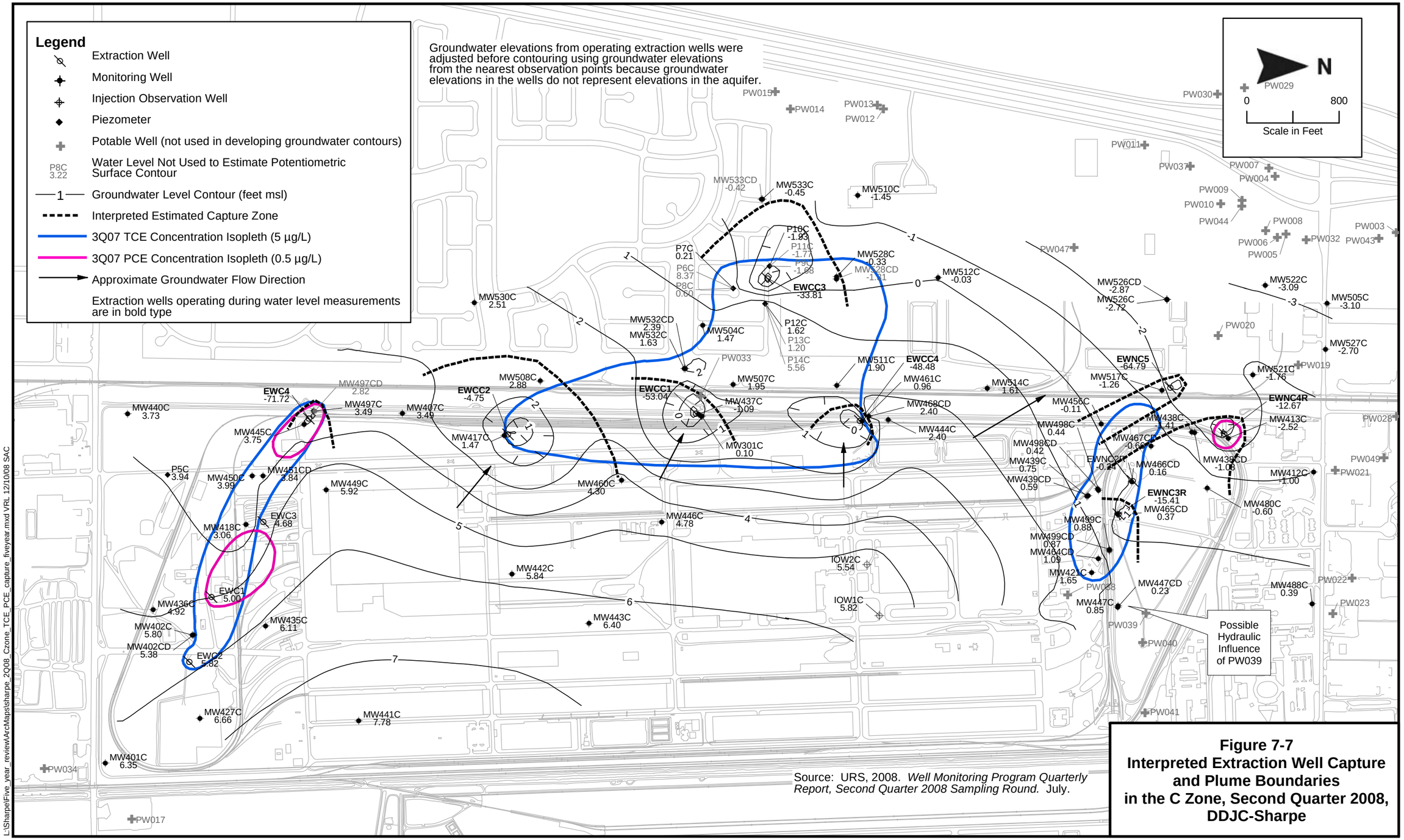
Source: URS, 2008. *Well Monitoring Program Quarterly Report, Second Quarter 2008 Sampling Round.* July.

Figure 7-5
Interpreted Extraction Well Capture and Plume Boundaries in the A Zone, Second Quarter 2008, DDJC-Sharpe



Source: URS, 2008. *Well Monitoring Program Quarterly Report, Second Quarter 2008 Sampling Round.* July.

Figure 7-6
Interpreted Extraction Well Capture and Plume Boundaries in the B Zone, Second Quarter 2008, DDJC-Sharpe



Source: URS, 2008. *Well Monitoring Program Quarterly Report, Second Quarter 2008 Sampling Round.* July.

Figure 7-7
Interpreted Extraction Well Capture and Plume Boundaries in the C Zone, Second Quarter 2008, DDJC-Sharpe

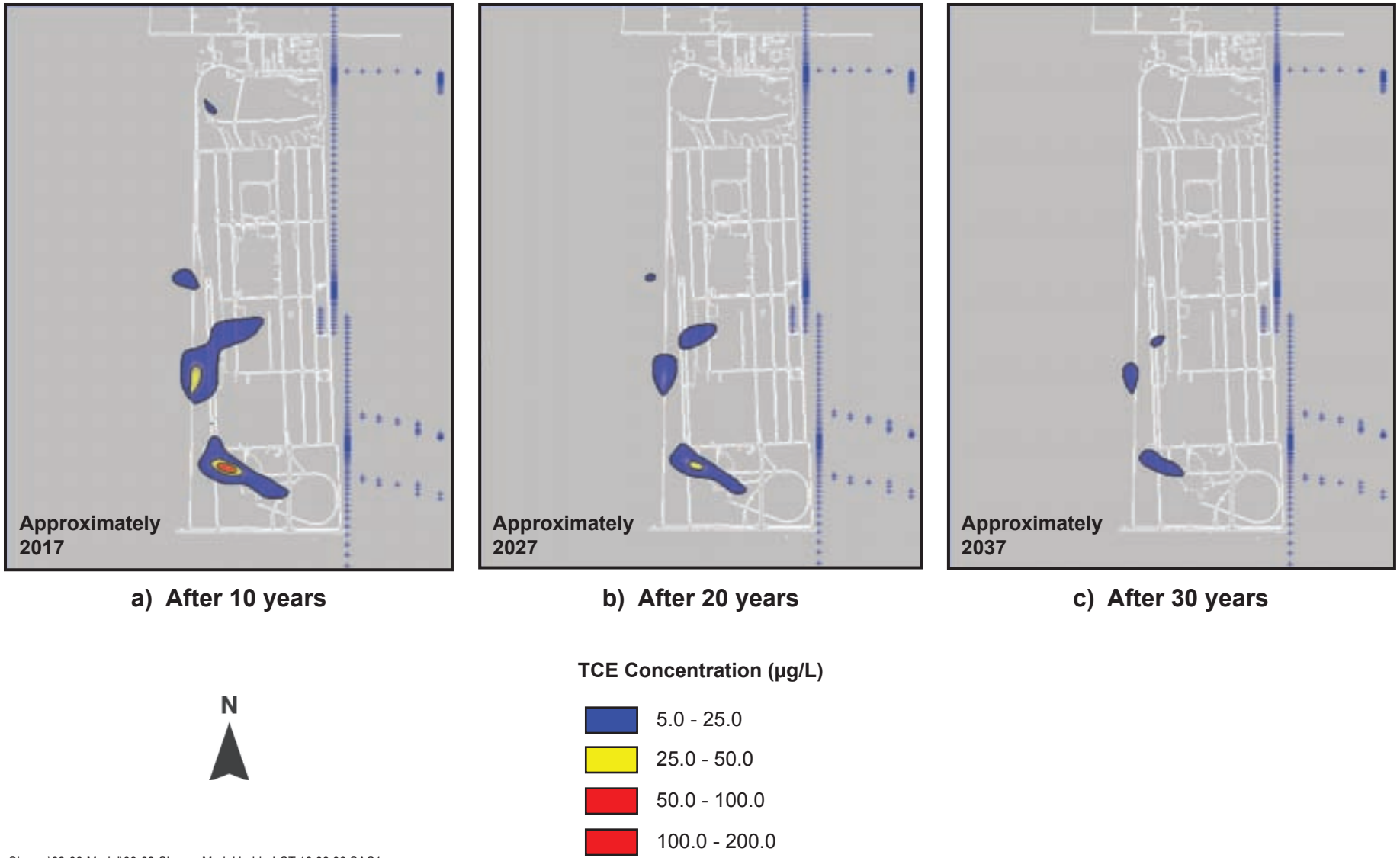


Figure 7-8. Layer 1: DDJC-Sharpe Transport Model Results for TCE

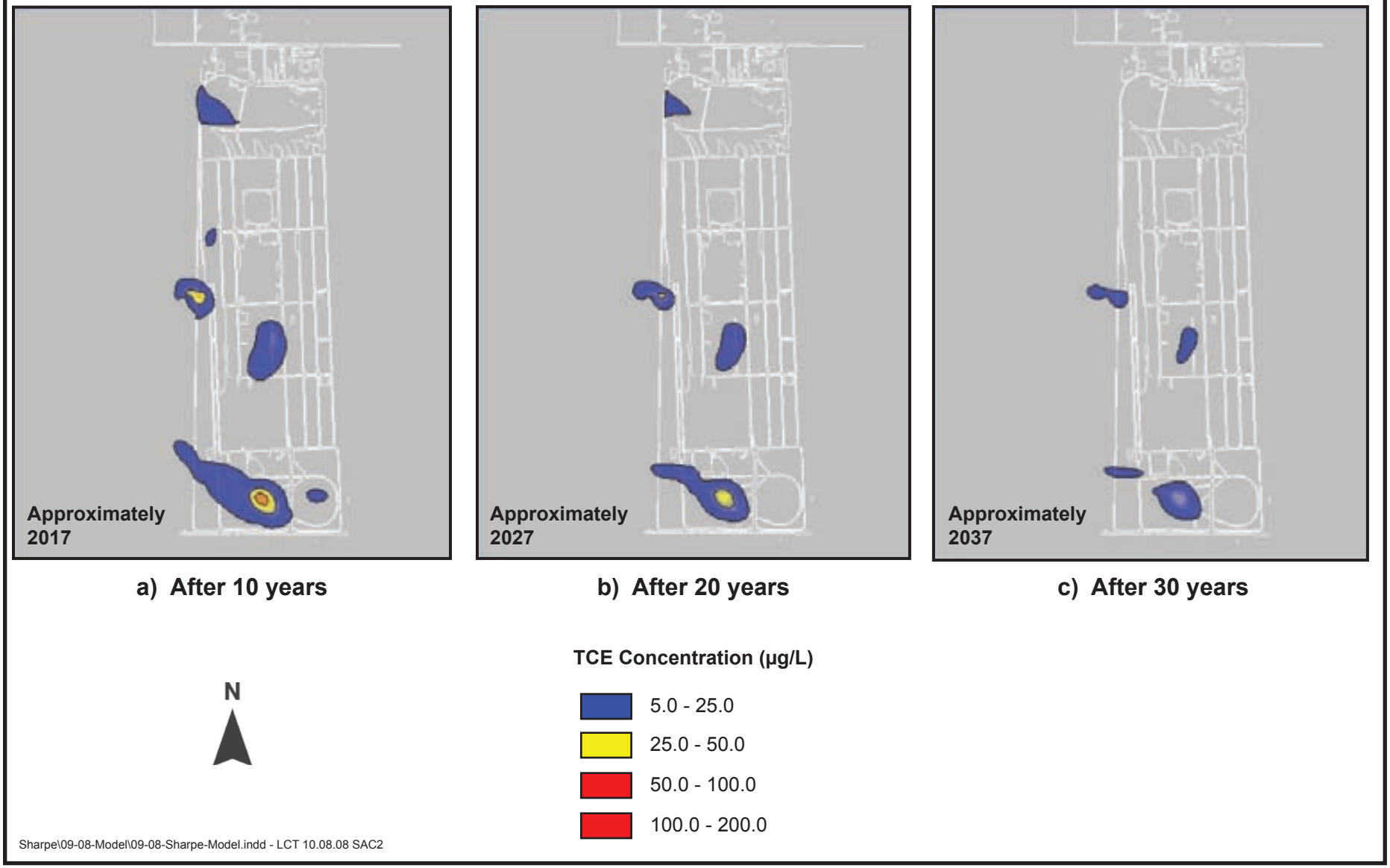


Figure 7-9. Layer 2: DDJC-Sharpe Transport Model Results for TCE

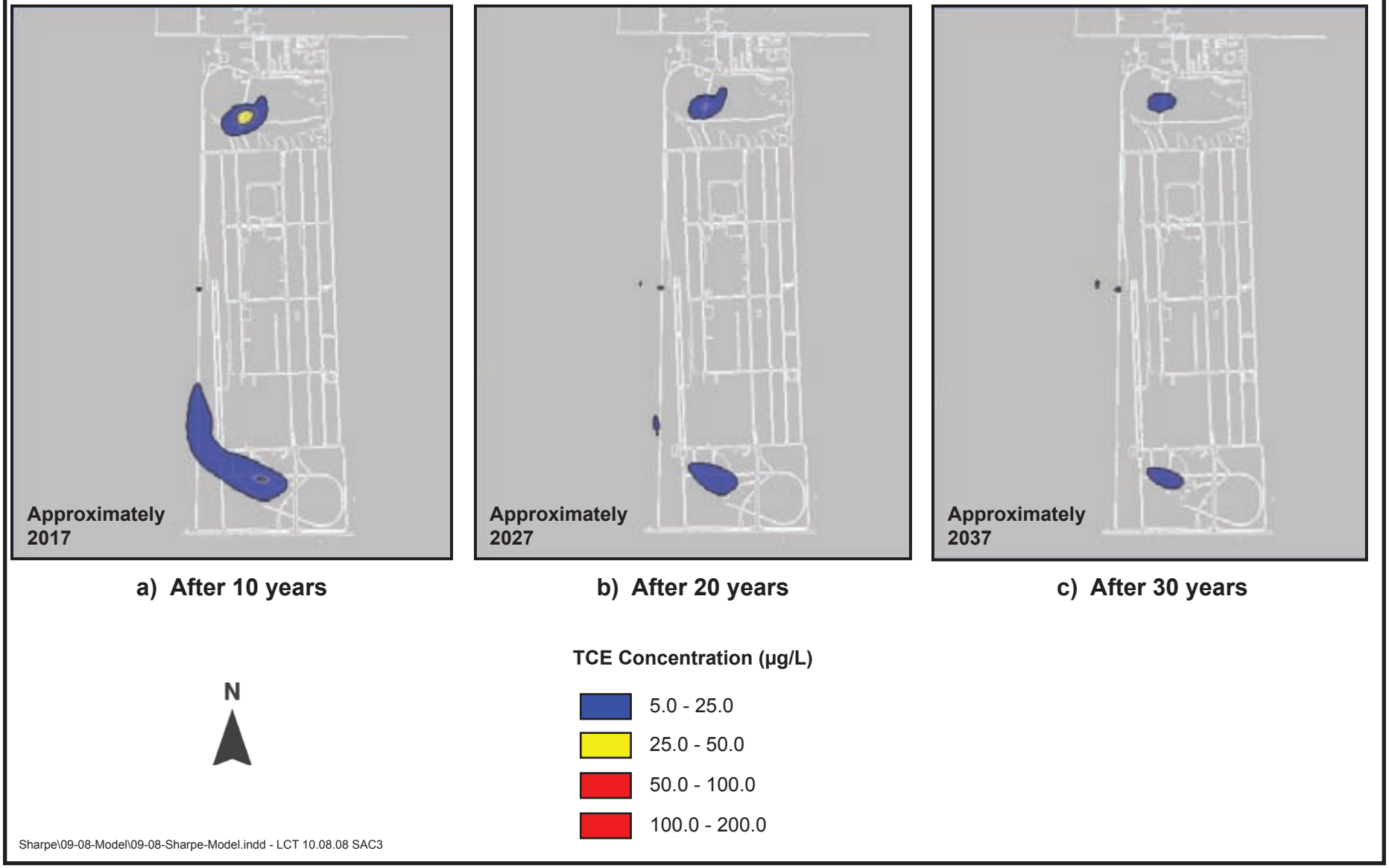


Figure 7-10. Layer 3: DDJC-Sharpe Transport Model Results for TCE

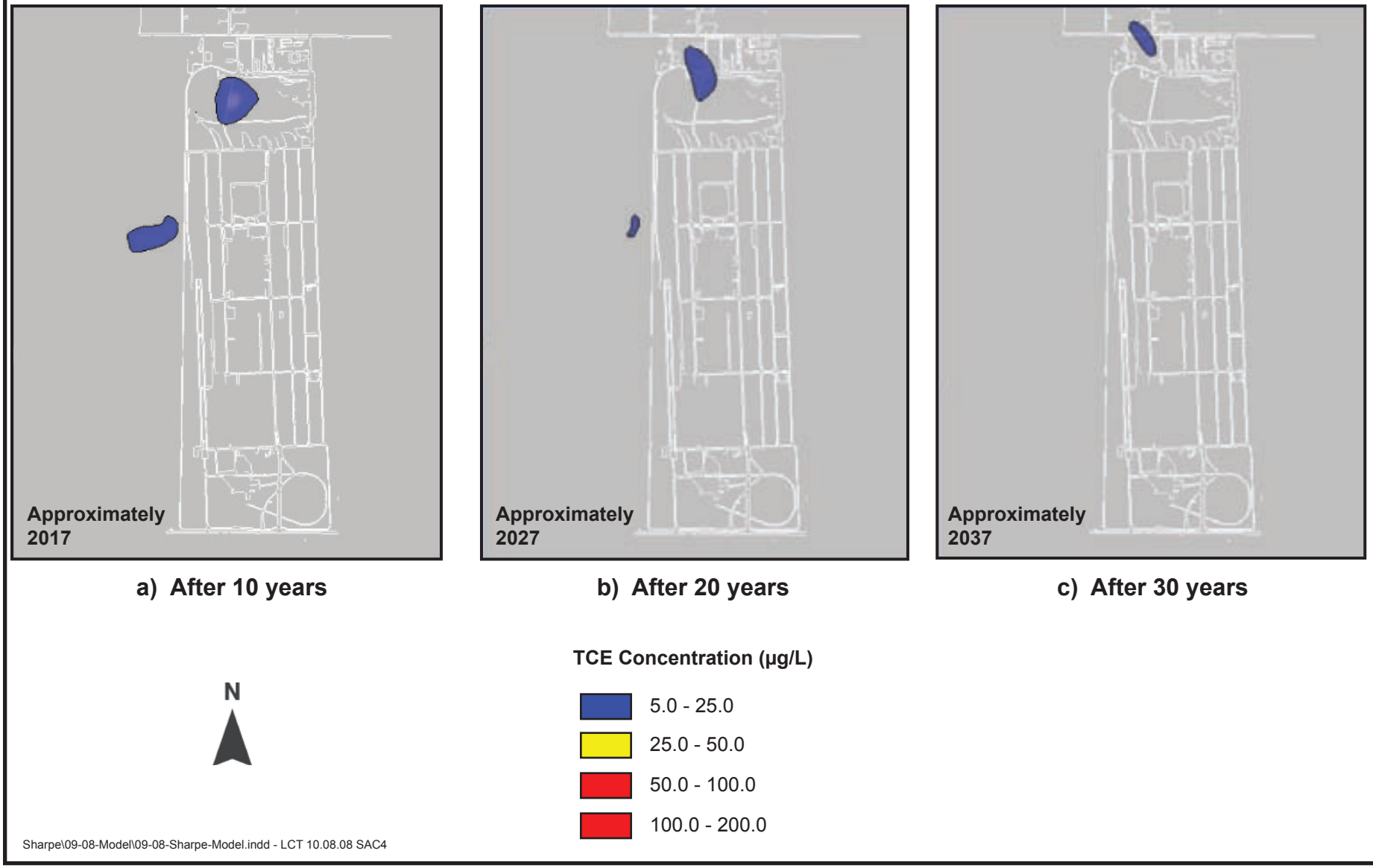


Figure 7-11. Layer 4: DDJC-Sharpe Transport Model Results for TCE

8.0 ISSUES

Issues identified in this five-year review include the presence and extent of VOC contamination in groundwater that is greater than had been identified previously. The presence of this additional mass is likely to affect the time to clean up the aquifer. VOCs have also been identified in the vadose zone at Site P-5A at concentrations that require implementation of the OU 2 remedy.

8.1 OU 1

Potential for Off-Depot Plume Migration. Interpreted capture zones for the A, B, and C Zones in the South Balloon indicate that a VOC plume is migrating toward and beyond the DDJC-Sharpe depot boundary. HydroPunch data from the 2007/2008 CPT/HydroPunch investigation indicate a portion of the plume is beyond the capture zones of existing on-depot extraction wells in the South Balloon (URS, 2009b).

Contaminant plumes in the North Balloon may be migrating vertically to depths greater than the existing extraction system due to downward vertical gradients. There is potential, supported by predictions of the groundwater model, that after reaching the C/D transition zone or the D Zone, the plume could migrate northerly beyond the depot boundary under the influence of horizontal gradients.

Plumes that migrate beyond the western or northern depot boundaries may pose a long-term threat, but not an imminent threat to users of privately owned, potable supply wells. Natural attenuation may be occurring in plumes downgradient from extraction wells. Data from monitoring wells within the migration paths of the contaminant plumes will be collected to develop lines of evidence to confirm plume containment by natural attenuation.

Partial Capture of Off-Depot Plumes. Data from off-depot monitoring wells and HydroPunch results from the 2007/2008 CPT/HydroPunch investigation suggest that a portion of the TCE plume in the C Zone and C/D transition zone migrated north of EWCC3 before the well began operating. EWCC3 is the deepest treatment system extraction well and produces the greatest volume of groundwater of the DDJC-Sharpe extraction wells. It is also the most westerly located extraction well outside of the DDJC-Sharpe depot boundary. EWCC3 is hydraulically affecting groundwater several hundred feet downgradient from its location; however, its ability to capture the entire C Zone and C/D transition zone plume is doubtful. Results from samples collected in the off-depot area west of the South Balloon also suggest that COC plumes have migrated off-depot in the B and C Zones (URS, 2009b). Data from the 2007/2008 CPT/HydroPunch investigation west of the depot have bounded the extent of the VOC plumes. Data from monitoring wells within the migration paths of the contaminant plumes will be collected to develop lines of evidence to confirm plume containment by natural attenuation.

Time to Achieve Cleanup. Predictions of cleanup times made using the known extent of TCE contamination in 3Q07 suggest that TCE will not reach the ACL in DDJC-Sharpe groundwater plumes for at least 30 years. Results from additional site characterization indicate that COC plumes are more extensive than initially interpreted (URS, 2009b). Revised interpretations of residual mass in source areas are likely to increase the estimated time to cleanup. Pilot tests of mass removal technologies are being performed to determine whether use of other technologies can potentially reduce the cleanup time. The long-term cost of cleanup to ACLs is a concern.

GWTP O&M. Many of the extraction well flow meters and in-well water level measuring devices (transducers) have passed their expected service life. Several flow meters in operating extraction wells require frequent repair.

8.2 OU 2

8.2.1 TCE in Soil Gas

Since the first five-year review, results from groundwater monitoring and additional characterization have identified an area of TCE soil gas contamination at Site P-5A (URS, 2007g; 2007h; and 2009b). A maximum TCE concentration of 8.3 ppmv in soil gas was detected, which exceeds the soil vapor cleanup level of 0.35 ppmv. Soil gas concentrations exceeding the cleanup level at Site P-5A require a remedial action to remain protective of groundwater.

8.2.2 Metals in Soil

Because cleanup standards for metals sites are based on industrial land use and do not allow for unlimited use and unrestricted exposure (i.e., residential use), LUCs are needed at the five metals sites (S-3, S-26, S-30, S-33/29, and S-36) to protect human health and the environment (URS, 2009d).

9.0 RECOMMENDATIONS AND FOLLOW-UP ACTIONS

This section provides recommendations and follow-up actions to address issues identified in the technical assessment. These recommendations are specific to the remedies documented in the OU 1 and OU 2 RODs. Follow-up actions for the alternative treatment technologies or remedies are also included. Table 9-1 at the end of this section provides estimated dates, where appropriate, for completion of the follow-up actions.

This section also includes a brief discussion of natural attenuation at DDJC-Sharpe and the role it may play in future groundwater remedial actions.

9.1 OU 1

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

- Continue containment and mass removal with the 15-extraction well array until the additional activities described in this section are completed.
- To address potential off-depot migration of COC plumes:
  - Monitoring well clusters will be constructed in off-depot areas for long-term monitoring to assist in determining the extent and stability of plumes that are not within capture zones.
  - Soil and groundwater samples collected from new off-depot monitoring well borings will be analyzed for natural attenuation constituents and parameters.
  - Incorporate data from the 2007/2008 CPT/HydroPunch investigation and any future monitoring wells into the groundwater model to reduce uncertainty in its predictions.
- Develop and implement a water contingency plan to help ensure the protectiveness of downgradient potable well users.
- Monitor vertical gradients, potential causes of gradients (on-depot potable well operation), and contaminant concentration changes in the North Balloon C Zone and C/D transition zone to determine whether the TCE plume continues to migrate vertically.
- To address capture or containment:
  - Continue to optimize the extraction well array to maximize COC plume containment using available lines of evidence, including the updated groundwater model.
  - Evaluate CPT and groundwater sample results, monitoring well data, and groundwater model predictions to assess whether an alternative response action is warranted to enhance containment of COC plumes. If an alternative response action is warranted, an amendment to the OU 1 ROD will be prepared.
- Identify locations on DDJC-Sharpe where treatment plant effluent can be discharged, should capacity be needed as a result of optimized groundwater extraction and to avoid high water levels during the wet season at the Central Area percolation ponds.
- Prepare technical memoranda that report the analytical results of any new off-depot groundwater and soil sampling activities; the results from the recalibrated groundwater model; results from

groundwater treatment system optimization; and results of treatment plant effluent discharge testing at the alternative discharge location.

- Complete the treatment technology pilot studies and evaluate whether full-scale implementation of one or more treatment technologies can cost-effectively reduce the cleanup time of residual COC source mass in groundwater. If an alternative response action is warranted, an amendment to the OU 1 ROD will be prepared.

- To address the groundwater treatment system O&M issues:

  – Replace outdated equipment, as needed.

  – Replace or update electronic groundwater extraction well measuring instrumentation, as needed.

  – Replace extraction well flow meters for currently operating extraction wells. Replace flow meters in extraction wells brought back into service, as needed.

9.2 OU 2

The following are recommendations and follow-up actions for the OU 2 soil remedies.

9.2.1 TCE in Soil Gas

- Implement the OU 2 ROD remedy (SVE) at Site P-5A.

9.2.2 Metals in Soil

- Implement LUCs to prohibit residential development and use at the five metals sites (URS, 2009d). As a follow-up action, monitor that the LUCs are in place and effective. Report the results in the FFA Annual Progress Reports.

9.3 Natural Attenuation

The increased understanding of natural attenuation of groundwater contaminants at DDJC-Sharpe is supported by data presented in the FFA Annual Progress Reports (URS, 2006a; 2007b; 2008a; 2008e) and, more recently, the 2007/2008 CPT/HydroPunch investigation (URS 2009b). To confirm the role natural attenuation is playing in groundwater at DDJC-Sharpe, DESJC intends to collect additional groundwater and soil data to support the working hypothesis that natural attenuation is occurring at the leading edges of plumes that are not currently captured.

The hypothesis to explain apparent stability of plume extent without full capture is that natural attenuation is occurring at the leading edges of the off-depot plumes. Evidence obtained since 3Q07 supports containment of the plumes west and north of the depot boundary as a result of physical extraction and natural attenuation mechanisms. However, the evidence and type of natural attenuation must be confirmed.

DESJC will install groundwater monitoring well clusters in off-depot areas for long-term monitoring to assist in determining the extent and stability of plumes that are not within capture zones. Soil and groundwater samples collected from these new, off-depot monitoring well borings will be analyzed for natural attenuation constituents and parameters to confirm the role of natural attenuation in groundwater remediation.

Based on results of the evaluation of the type(s), role, and extent of natural attenuation occurring within the subsurface materials at DDJC-Sharpe, DESJC will consider either a modification to the OU 1 ROD groundwater remedy to include natural attenuation or an amendment to the OU 1 ROD groundwater remedy to replace groundwater extraction and treatment by air stripping with monitored natural attenuation.

DESJC understands that, at a minimum, amending the selected OU 1 ROD groundwater remedy will require technical justification for the remedy change; redefinition of the treatment system, performance monitoring, and optimization components; and specification of maintenance requirements for the monitoring network. DESJC anticipates starting the ROD amendment process in fiscal year 2010 with completion of the OU 1 ROD Amendment in fiscal year 2011.

This page intentionally left blank

Table 9-1. Follow-Up Action Schedule of Completion, DDJC-Sharpe

Action	Reporting Document	Completion Date (Quarter of Fiscal Year)
Operable Unit 1		
Continue containment and mass removal with the existing 15-extraction well array.	FFA Annual Progress Reports	Annually (3Q)
Continue to optimize the extraction well array to maximize COC plume containment. • Prepare optimization recommendations.	FFA Annual Progress Reports	Annually (3Q)
Installation of monitoring well clusters in off-depot areas.	FFA Annual Progress Reports	Annually (3Q)
Collect groundwater and soil samples from borings during drilling and installation of well clusters in off-depot areas. • Prepare technical memoranda reporting analytical results from groundwater and soil sampling activities.	Technical Memoranda	Multiple events during next five years
Incorporate data from the 2007/2008 CPT/HydroPunch investigation and any future monitoring wells into the groundwater model. • Prepare annual technical memoranda reporting the results of the recalibrated groundwater model.	Technical Memoranda	Annually (2Q)
Monitor vertical gradients, potential influences for gradients, and contaminant concentration changes in the North Balloon C Zone and C/D Transition Zone. • Prepare a technical memoranda reporting the results of vertical gradient monitoring, gradient influence monitoring and concentration changes in North Balloon C Zone and C/D Transition Zone.	Technical Memoranda	3Q/2009
Identify alternate discharge locations for treatment plant effluent and connect treated groundwater pipeline to selected locations. • Prepare technical memoranda reporting results of identification of alternate discharge locations and connection of treated groundwater pipeline to new discharge locations.	Technical Memoranda	3Q/2009
Develop and implement a water contingency plan.	Water Contingency Plan	3Q/2009
Complete and evaluate the treatment technology pilot studies. • Prepare technical memoranda for the three treatment technology pilot studies including results and recommendations.	EOS Pilot Study Technical Memoranda $KMnO_4$ Pilot Study Technical Memoranda EHC Pilot Study Technical Memoranda	4Q/2009 1Q/2010 1Q/2010

Table 9-1. (Continued)

Action	Reporting Document	Completion Date (Quarter of Fiscal Year)
Operable Unit 1 (continued)		
Evaluate CPT and groundwater sample results, monitoring well data, treatment technology pilot study results, and groundwater model predictions to assess whether an alternative response action is warranted.	Engineering Evaluation/Cost Analysis	2Q/2010
Implement alternative groundwater response action.	OU 1 ROD Amendment	3Q/2011
Replace or update outdated GWTP system equipment and instrumentation.	GWTP Monthly Performance Monitoring Report	Monthly
Replace extraction well flow meters for currently operating extraction wells.	GWTP Monthly Performance Monitoring Report	Monthly
Operable Unit 2		
Implement the OU 2 ROD remedy (SVE) at Site P-5A.	Remedial Action Work Plan	4Q/2009
Implement LUCs to prohibit residential land use at five metals sites.	OU 2 ROD Amendment DDJC-Sharpe Installation Master Plan	4Q/2009 4Q/2009
Monitor LUCs annually for effectiveness at five metals sites and report monitoring results.	FFA Annual Progress Reports	Annually (3Q)

COC = contaminant of concern
CPT = cone penetrometer test
DDJC = Defense Distribution Depot San Joaquin California
EHC = redox (EH) compound
EOS = emulsified oil substrate
FFA = Federal Facilities Agreement
GWTP = groundwater treatment plant
$KMnO_4$ = potassium permanganate
LUCs = land use controls
OU = operable unit
ROD = record of decision
SVE = soil vapor extraction
3Q = third quarter

10.0 PROTECTIVENESS STATEMENT

The following statements address the protectiveness of the removal and remedial actions taken at the DDJC-Sharpe site for OUs 1 and 2.

10.1 OU 1

The OU 1 remedy remains protective of human health and the environment in the short-term. Results from the 2007/2008 CPT/HydroPunch investigation suggest that the plumes are not migrating to privately owned, potable supply wells even though contaminant plume capture is incomplete west of the depot boundary. However, additional data collection is necessary to confirm that the plumes will be sufficiently contained to provide long-term protectiveness.

10.2 OU 2

10.2.1 TCE in Soil Gas

The OU 2 ROD remedy for TCE in soil currently protects human health and the environment in the short-term because remedial actions have been implemented and completed at TCE-contaminated sites identified in the OU 2 ROD. Long-term protectiveness depends on the performance of the OU 2 ROD remedy (SVE) at Site P-5A, which will be implemented during the period of the third five-year review.

10.2.2 Metals in Soil

The OU 2 ROD remedy for metals in soil currently protects human health and the environment in the short-term because remedial actions have been implemented and completed at metals-contaminated sites identified in the OU 2 ROD. Because the cleanup standards for metals are based on industrial land use and do not allow for unlimited use and unrestricted exposure, LUCs are required for long-term protection of human health and the environment. The draft *Amendment to the Record of Decision Basewide Remedy for DDJC-Sharpe (Operable Unit 2 – Soils)* documents the addition of LUCs to prohibit residential development and use at Sites S-3, S-26, S-30, S-33/29, and S-36.

10.2.3 Pesticides in Soil

The remedy for pesticides in soil was completed prior to the OU 2 ROD and remains protective of human health and the environment.

11.0 NEXT FIVE-YEAR REVIEW

The third five-year review for DDJC-Sharpe will span the time period between 2008 and 2012 and is tentatively required to be completed by April 2014, five years from the date of this second five-year review.

11.1 OU 1

The third five-year review will provide a comprehensive summary of results from the 2007/2008 CPT/ HydroPunch investigation and groundwater sampling investigation, a significant portion of which was conducted beyond the time period of this second five-year review. The results of that investigation, as well as the findings from the ongoing extraction well optimization test (started in December 2006), have been used in this second five-year review to the extent that they were needed to assist in the determination of the protectiveness of the OU 1 remedy. Data from these activities, as well as the Well Monitoring Program, will be used to update the DDJC-Sharpe CSM and to refine groundwater model COC fate-and-transport simulations. In addition, the third five-year review will present the results of the three treatment technology pilot studies, which are scheduled to be completed by the end of 2009.

11.2 OU 2

A review of the implementation and performance of SVE at Site P-5A will be provided in the third five-year review. In addition, the implementation and effectiveness of the LUCs that are expected to be added to the OU 2 remedy via an amendment to the OU 2 ROD for the five metals sites will be assessed in the third five-year review.

11.3 Conclusion

Actions taken in response to recommendations in this second five-year review and any future optimization of or modifications to the OU 1 and OU 2 remedies will be evaluated in the third five-year review to ensure that the OU 1 and OU 2 remedies continue to be protective of human health and the environment.