BEALE AFB

SECOND FIVE-YEAR REVIEW REPORT

(JANUARY 2011 - JUNE 2016)

FINAL

MARCH 2018

TASK ORDER NO. 0022
PROJECT NO. BAEY20167505

CONFIRMATION NOTICE NO. 004

SECOND FIVE-YEAR REVIEW REPORT

(JANUARY 2011 THROUGH JUNE 2016)

PROJECT BAEY20167505

BEALE AIR FORCE BASE, CALIFORNIA

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CONTRACTOR:	AECOM
CONTRACT NUMBERS:	FA3002-07-D-0015, Task Order No. 0022
DATE OF THIS NOTICE:	March 7, 2018
SUBJECT:	Second Five-Year Review Report (Final)

Enclosed for your use is the Second Five-Year Review Report for Multiple Environmental Restoration Program Sites at Beale Air Force Base, California. Please direct any questions or concerns to Scott Dressler by e-mail, scott.dressler@aecom.com, or by phone, 916-717-0829.

60514645.6

SECOND FIVE-YEAR REVIEW REPORT
(JANUARY 2011 THROUGH JUNE 2016)

BEALE AFB, CALIFORNIA

Prepared for:

Air Force Civil Engineer Center
USAF Contract No. FA3002-07-D-0015, Task Order No. 0022

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March 2018

SECOND FIVE-YEAR REVIEW REPORT
(JANUARY 2011 – JUNE 2016) FOR
BEALE AIR FORCE BASE
CALIFORNIA

March 2018

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REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY (Leave blank)

2. REPORT DATE
07 March 2018

3. REPORT TYPE AND DATES COVERED
Draft

4. TITLE AND SUBTITLE
Second Five-Year Review Report (January 2011 through June 2016)

5. FUNDING NUMBERS
BAEY20167505

6. AUTHOR(S)
AECOM

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
AECOM
2020 L Street, Suite 400
Sacramento, CA 95811

8. PERFORMING ORGANIZATION REPORT NUMBER
FA3002-07-D-0015,
Task Order No. 0022

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
AFCEC/CZRW
3515 S. General McMullen
San Antonio TX 78226

10. SPONSORING/MONITORING AGENCY REPORT NUMBER
60514645.6

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION/AVAILABILITY STATEMENT
Unclassified/Unlimited

12b. DISTRIBUTION CODE

13. ABSTRACT (Maximum 200 words)

This document presents the results of the second Five-Year Review of multiple Environmental Restoration Program (ERP) Sites at Beale Air Force Base, California. The program review activities that were performed during this process included a review of Administrative Record documents, evaluation of analytical data, personal interviews, site inspection, and an assessment of risk conducted following U.S. Environmental Protection Agency (EPA) Comprehensive Five-Year Review Guidance (EPA 2001). This second Five-Year Review summarizes information obtained from 1 January 2011 through 30 June 2016, supporting the determination that the remedies implemented to clean up Beale AFB have been, and will continue to be, protective of human health and the environment.

14. SUBJECT TERMS
Second Five-Year Review (January 2011 through June 2016)

15. NUMBER OF PAGES

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	Unlimited

Disclaimer

This second Five-Year Review Report has been prepared for Beale Air Force Base (AFB) under contract with the Air Force Center for Engineering and the Environment, Contract No. FA3002-07-D-0015, Task Order No. 0022. This document summarizes information obtained from 1 January 2011 through 30 June 2016, supporting the determination that the remedies implemented to clean up Beale AFB have been, and will continue to be, protective of human health and the environment.

This report has been developed based on certain key assumptions made by AECOM, which substantially affect the efforts. These assumptions, although thought to be reasonable and appropriate at the time, may not prove true in the future. Some of the data and assumptions were not developed by AECOM, and AECOM has accepted them at face value. AECOM is not responsible for the validity or accuracy of non-AECOM information.

This report has been prepared by AECOM under the review of registered professionals. The conclusions and recommendations herein are based on AECOM's interpretation of the available information. The interpretations and the conclusions drawn have been governed by AECOM's experience and professional judgment.

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Acronyms and Abbreviations

1,2-DCE	1,2-Dichloroethene
9 RW	9th Reconnaissance Wing
$\mu g/m^3$	microgram(s) per cubic meter
ACC	Air Combat Command
AF	attenuation factor
AFB	Air Force Base
AFCEC	Air Force Civil Engineer Center
Air Force	U.S. Air Force
AOC	Area of Concern
Army	U.S. Army
ARAR	Applicable or Relevant and Appropriate Requirement
AST	aboveground storage tank
BGMP	Basewide Groundwater Monitoring Program
bgs	below ground surface
BTEX	benzene, toluene, ethylbenzene, and xylene
CA	cost analysis
Cal/EPA	California Environmental Protection Agency
CAP	Corrective Action Plan
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cPAH	carcinogenic polycyclic aromatic hydrocarbon
CHHSL	California Human Health Screening Level
CMI	Corrective Measures Implementation
COC	chemical of concern
COEC	contaminant of ecological concern
COPC	chemical of potential concern
CVWB	Central Valley Regional Water Quality Control Board
DBCP	1,2-dibromo-3-chloropropane
DCE	dichloroethene
DNAPL	dense non-aqueous phase liquid
DTSC	California Department of Toxic Substances Control
DU	decision unit
EcoSSL	ecological soil screening level
ECP	Environmental Compliance Program
EE	engineering evaluation
EHB	Emergency Holding Basin
EISB	enhanced in situ bioremediation
ELCR	excess lifetime cancer risk
EOD	explosive ordnance disposal
EPA	U.S. Environmental Protection Agency
EPC	exposure point concentration
ERD	enhanced reductive dechlorination
ERP	Environmental Restoration Program
EVO	emulsified vegetable oil
FFS	Focused Feasibility Study
FPTA	Fire Protection Training Area
FS	Feasibility Study
ft/ft	feet per foot
ft/yr	feet per year
FY	fiscal year
GAC	granular activated carbon
gpm	gallon(s) per minute
General Plan	Beale Air Force Base General Plan
GTS	groundwater treatment system
HHERA	human health and ecological risk assessment

HHRA	human health risk assessment
HI	hazard index
HPAH	high molecular weight polycyclic aromatic hydrocarbon
HQ	hazard quotient
ICG	interim cleanup goal
ICM	interim corrective measure
IDP	Installation Development Plan
IRA	interim remedial action
IRIS	Integrated Risk Information System
IROD	Interim Record of Decision
ISCO	in situ chemical oxidation
ISM	Incremental Sampling Methodology
J	estimated quantity
JP	jet propellant
LNAPL	light non-aqueous phase liquid
LTCP	Low-Threat Closure Policy
LUC	land use control
LUFT	Leaking Underground Fuel Tank
MCL	maximum containment level
µg/dL	microgram per deciliter
mg/kg	milligram(s) per kilogram
mg/L	milligram(s) per liter
MRP	Monitoring and Reporting Program
msl	mean sea level
MTBE	methyl tert-butyl ether
NFA	No Further Action
NFRAP	No Further Response Action Planned
ng/g	nanogram(s) per gram
No.	Number(s)
NPL	National Priorities List
O&M	operation and maintenance
OB/OD	open burn/open detonation
OEHHA	California Office of Environmental Health Hazard Assessment
OES	optimized exit strategy
ORC	oxygen reducing compound
OWS	oil/water separator
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PCE	tetrachloroethene
PCG	preliminary cleanup goal
PCMP	Post-Closure Maintenance Plan
POL	petroleum, oil, and lubricants
ppbv	part per billion by volume
PRB	permeable reactive barrier
PRG	preliminary remediation goal
PSL	project screening level
PWTP	photographic wastewater treatment plant
RAB	Restoration Advisory Board
RAO	remedial action objective
RAWP	Remedial Action Work Plan
RBSL	risk-based screening level
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
RI	remedial investigation
ROD	Record of Decision
RPM	remedial project manager
RSL	regional screening level

State Water Board	State Water Resources Control Board
SoB	Statement of Basis
SVE	soil vapor extraction
TAME	tert-amyl methyl ether
TBA	tert-butyl alcohol
TCA	trichloroethane
TCE	trichloroethene
TCDD	tetrachlorodibenzodioxin
TDS	total dissolved solids
TECA	tetrachloroethane
TEFA	Technical and Economic Feasibility Analysis
TEQ	toxicity equivalent
TOC	total organic carbon
TPH	total petroleum hydrocarbons
TPH-D	total petroleum hydrocarbons as diesel
TPH-G	total petroleum hydrocarbons as gasoline
TPP	transfer pump pit
TRV	toxicity reference value
TS	treatability study
UCL	upper confidence limit
UE	unrestricted exposure
UST	underground storage tank
UU	unlimited use
VEW	vapor extraction well
VGAC	vapor phase granular activated carbon
VI	vapor intrusion
VMP	vapor monitoring point
VOC	volatile organic compound
WDR	Waste Discharge Requirement
WQG	water quality guideline
WSA	weapons storage area
YCWA	Yuba County Water Agency
ZVI	zero-valent iron

1. Introduction

This document is the second five-year review for remedial actions taken pursuant to the Beale Air Force Base (AFB) Environmental Restoration Program (ERP). The Beale AFB ERP includes sites managed per CERCLA, the Resource Conservation and Recovery Act (RCRA), and Leaking Underground Fuel Tank (LUFT) programs.

Statutory five-year reviews are required under CERCLA for final remedial actions when upon remedy completion hazardous substances, pollutants, or contaminants remain at a site above levels that allow unlimited use (UU) and unrestricted exposure (UE). Policy reviews are done when, even though upon remedy completion hazardous substances, pollutants and contaminants will not exceed UU/UE, it will take five or more years to achieve such levels after the remedy is in place. Although the Beale AFB ERP has established 38 sites, only 10 CERCLA, four RCRA, and three LUFT sites have been identified by the Air Force as currently undergoing some form of remedial action, where contaminants remain in one or more environmental media at the site. The remaining 21 sites either have attained or are anticipated by the Air Force to attain closeout prior to 1 June 2017. The general status of the sites reviewed in this five-year review and the status of their remedies as of 30 June 2016 are shown in Table 1.1-1.

Table 1.1-1. List of Beale AFB Second Five-Year Review Sites and Status Summary

Site Identification	Remedial Action(s)	Status Summary
CERCLA Sites		
CG041: Basewide Groundwater includes sites: CG041-003, CG041-010, CG041-013, CG041-016, CG041-017, CG041-018, CG041-029, CG041-031, CG041-032, CG041-035, CG041-039, CG041-040, CG041-508, CG041-509, and CG041-517	• Pump and treat in place at CG041-013 • Bioreactor in place at CG041-013 and CG041-035 • PRB, slurry wall, slough realignment, groundwater treatment, phyto-pumping in place at CG041-017 • LNAPL skimmer in place at CG041-018 and CG041-509 • ISCO at CG041-003 and CG041-032 • EISB at CG041-010, CG041-031, CG041-039, and CG041-040 • EVO injections at CG041-517 and CG041-508 • Long-term groundwater monitoring at remaining sites	• Interim RIP for CG041
SD011: Aerospace Ground Equipment Area	• Biovent • SVE • Lead contaminated soil removal	• Biovent complete • SVE complete • Performance groundwater monitoring part of site CG041-032 • Lead contaminated soil removal to be completed March 2017
LF013: Former Landfill No. 1	• SVE (east and west) • M-5 ointment tube excavation • Landfill cover • Bioreactor	• SVE complete • M-5 ointment tube trench excavation complete • Landfill cover: O&M • Bioreactor: O&M
OT017: Best Slough	• Source zone interim action (i.e., containment barrier, slough realignment)	• LUCs implemented in 2017
ST018: Bulk Fuel Storage Facility	• Biovent • SVE	• SVE and Biovent complete • LUCs

Site Identification	Remedial Action(s)	Status Summary
SD032: Building 1086	• SVE (north and south)	• SVE complete • LUCs
SS035: Munitions Storage Area	• Bioreactor • SVE	• Bioreactor: O&M • SVE: O&M
DP038: Former Skeet and trap Range	• Lead/PAH-contaminated soil removal	• Soil PAH excavation complete • Soil lead excavation to be completed October 2016 • No groundwater issues
SS039: Building 2145	• EVO injection • SVE	• EVO: O&M • SVE complete • SC expected September 2016
RCRA Sites		
LF002: Landfill No. 2	• Cap in place • Long-term groundwater monitoring	• RC with LUCS • Long-term groundwater monitoring ongoing
LF003: Landfill No. 3	• Cap in place • Long-term groundwater monitoring	• RC with LUCS • Long-term groundwater monitoring ongoing
SS023: SWMU23 East and West Transformer Storage Area	• ISCO • Long-term groundwater monitoring	• RIP for soil and groundwater • Long-term groundwater monitoring ongoing
PL582: Lincoln Receiver Site	• Soil Removal • Long-term groundwater monitoring	• NFA for soil with LUCS • Long-term groundwater monitoring ongoing
LUFT Sites		
TU002: Former Capehart Gas Station	• Pump & Treat/LTO&M	• CAP for soil • RIP for groundwater
TU509: Clinic USTs	• UST removal and over-excavation of soil	• UST removals complete • RC with LUCs
ST022: Underground Storage Tanks–Basewide	• UST removal and over-excavation of soil • Biovent • SVE • Long-term groundwater monitoring	• UST removals complete • Biovent shut down • SVE shut down • Long-term groundwater monitoring ongoing

AFB = Air Force Base
CAP = Corrective Action Plan
EVO = emulsified vegetable oil
EISB = enhanced in situ bioremediation
GTS = groundwater treatment system
ISCO = in situ chemical oxidation
LUC = land use control
LNAPL = light non-aqueous phase liquid
LTO&M = long term operations and maintenance
NFRAP = no further response action planned
O&M = operation and maintenance
PAH = polycyclic aromatic hydrocarbons
PRB = permeable reactive barrier
RC = response complete
RIP = remedy in place
SVE = soil vapor extraction
UST = underground storage tank

The Air Force is performing this second five-year review to provide continued documentation of the environmental restoration progress achieved at each site to date, and to determine whether interim and final remedial response actions are protective of human health and the environment. This review includes recommendations to attain and maintain sustainable protection.

As lead agency, the Air Force is responsible for managing regional and local environmental programs, including the ERP. As the lead agency, the Air Force ensures that environmental impacts are thoroughly investigated and that appropriate cleanup actions are taken to protect human health and welfare, and the environment. Authority for ERP decision-making rests with a team of remedial project managers (RPMs) from the Air Force Civil Engineer Center (AFCEC), and the California Environmental Protection Agency (Cal/EPA), including the California Department of Toxic Substances Control (DTSC) and the Central Valley Regional Water Quality Control Board (CVWB). The Air Force is the lead agency responsible for funding and implementing remedial actions, and provides final approval for decisions regarding remedial actions taken at Beale AFB. DTSC and CVWB provide regulatory oversight, including technical support and review, and comment on all investigative and remedial work at Beale AFB.

This second five-year review for Beale AFB was prepared using the guidelines provided in the Comprehensive Five-Year Review Guidance (EPA 2001). Five-year reviews are required by statute for all locations for which a selected final remedial action results in hazardous substances, pollutants, or contaminants remaining at the individual Beale AFB sites above levels that allow UU/UE. Policy reviews are conducted for sites that, on completion of a final remedial action, will allow UU/UE but will require at least 5 years to attain the cleanup levels specified in the decision document. The five-year review process is the same regardless whether required by statute or identified as a site to be reviewed as a matter of policy. This review was initiated in March 2017 and incorporates data and information generated from 01 January 2011 through 30 June 2016. Any new information, or changes in site condition, that are discovered after June 2016 will be considered in the third five-year review, which is anticipated to begin in 2021.

Beale AFB is located in Yuba County, California, approximately 10 miles east of the town of Marysville (Figure 1.1-1). Currently, 38 individual sites that are located throughout the base are listed as part of the Beale AFB ERP. Of these 38 ERP sites, only 16 are undergoing some form of remedial action and therefore are included in this five-year review. Figure 1.1-2 shows the 38 ERP sites.

The following are the active ERP sites included in this five-year review:

- CERCLA sites–SD011, LF013, OT017, ST018, SD032, SS035, DP038, SS039, and CG041
- RCRA sites–LF002, LF003, SS023, and PL582
- LUFT sites–TU002, ST022, and TU509

Closed sites that are not evaluated in this five-year review include the following:

- CERCLA sites–SD001, WP002, FT003, SD005, SD008, SD010, WP012, WP016, DP019, SD023, FT029, SD031, LF033, SS037, and CG040
- RCRA sites–OW034, SS508, CG517, NE580, and OW581
- LUFT sites–ST021 and TU001

At the time of this five-year review, Records of Decision (RODs) have been presented for eight CERCLA sites (SD011, LF013, OT017, ST018, SD032, LF033 SS035, and SS039). Decision documents also have been presented for four RCRA sites (LF002, LF003, PL582, and SS023) and three LUFT sites (TU002, ST022, and TU509), all discussed in this review. All active Beale AFB ERP sites have an interim remedy in place, as described in an interim planning document, such as an interim remedial action (IRA), a work plan, a treatability study (TS), or an action memorandum.

All recent Interim Record of Decisions (IRODs) and other interim decision documents address only source removal and include only interim remedies. The effectiveness of these interim remedies will be evaluated before development of a final remedy for each site. Moreover, the land use controls (LUCs), cleanup levels, and all remedial action objectives (RAOs) included in IRODs or other interim decision documents for Beale AFB must be re-evaluated during development of a final remedy for each site, to ensure that they comply with all CERCLA applicable or relevant and appropriate requirements and applicable State requirements. The Air Force and the State anticipate that final remedies will include LUCs, final cleanup levels, and RAOs that the Air Force and the State agree will allow UU/UE of groundwater after all response actions have been completed. In addition, final remedies must achieve compliance with all State requirements or will include all appropriate and necessary LUCs, if RAOs and cleanup levels that allow UU are not achieved.

This report was developed using the Comprehensive Five-Year Review Guidance (EPA 2001) and generally follows the order of suggested content when reviewing each site. Sites included in this review are presented by the regulatory program under which a particular site is managed (e.g., CERCLA, RCRA, LUFT). The suggested content for all site-related sections (as provided in the updated 2016 five-year review report template) is provided under separate subsections for each specific site.

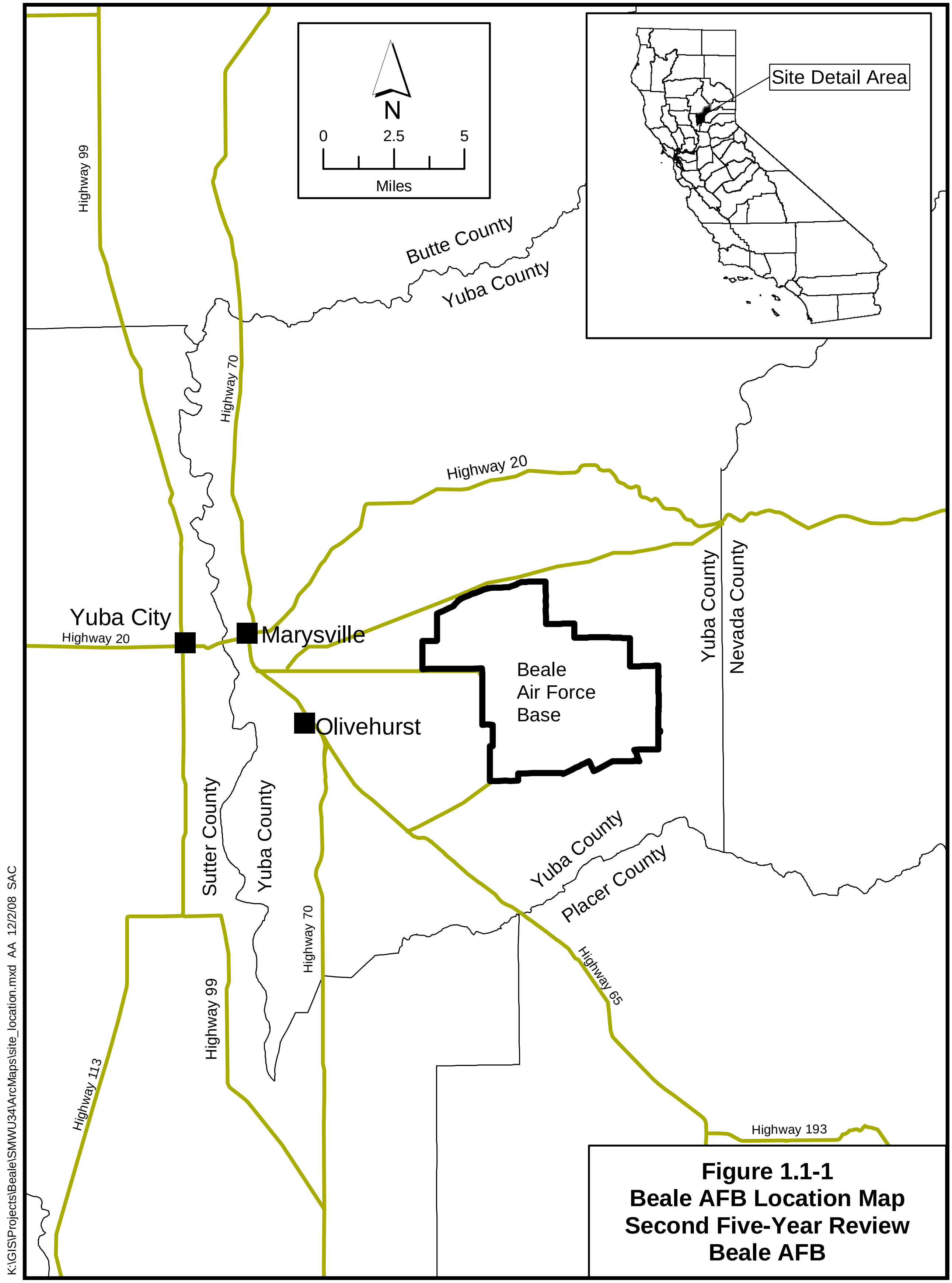

Figure 1.1-1
Beale AFB Location Map
Second Five-Year Review
Beale AFB

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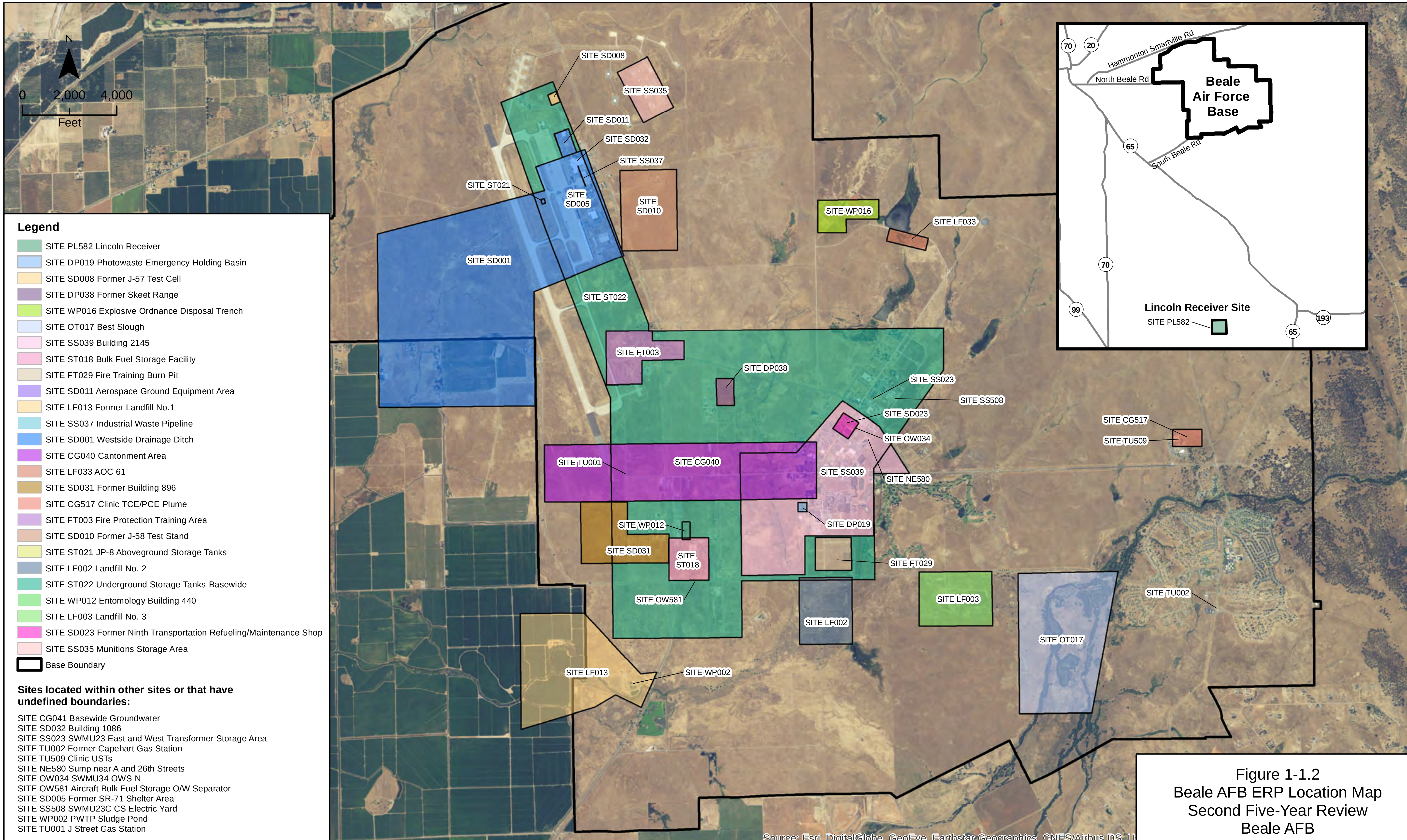

Figure 1-1.2
Beale AFB ERP Location Map
Second Five-Year Review
Beale AFB

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2. Chronology

Table 2.1-1 summarizes significant events and dates related to initial discoveries of contamination and implementation of sitewide remedies at Beale AFB.

Table 2.1-1. Basewide Chronology of Events

Event/Summary	Year
Phase I Records Search/Study defines initial 18 ERP sites.	1984
Phase II, Stage 1 Confirmation/Quantification Study confirms 18 sites (Sites 1–18).	1985
RWQCB issues Cleanup and Abatement Order No. 88-091 for 13 ERP sites.	1988
Stage 2-1 Remedial Investigation/Feasibility Study of 24 ERP sites (Sites 1-24).	1989
Basewide Groundwater Monitoring Program initiated.	1989
California regulatory agencies (CVWB and DTSC) ask the Air Force to enter into a Federal Facility Site Remediation Agreement that covers Beale AFB ERP sites; discussions initiated in 1990 and negotiations continue through 1996, but no agreement is ever reached.	1990
Preliminary Assessment/Site Inspection/Investigation identifies 66 AOCs and validates 6 of these as ERP sites (Sites 25–30); NFA concurrence received for 51 AOCs; 3 AOCs (22, 24, and 59) are transferred to the compliance program for further investigation.	1994
A Supplemental Site Inspection is performed at 7 AOCs; 3 AOCs are closed by NFA.	1997
NFA concurrence received for Sites 26, 27, 28, and 30.	1997
Landfills No. 2 and 3 (ERP Sites 6 and 15, respectively) removed from the ERP and transferred to the Air Force compliance program for post-closure monitoring.	1997
Site Inspection and Remedial Investigation at ERP sites	1998–2009
NFA concurrence received for Sites WP002, 4, 20, and 25.	1999
NFA concurrence received for Sites 5, 7, 9, and 14.	2000
NFA concurrence received for Site 24.	2003
NFA concurrence received for Sites DP019, LF033, OW034, and 36.	2004
NFA concurrence received for Site WP012.	2007
IRODs finalized and signed by Air Force for Sites OT017, SD031, and SD032/SD001 (Flightline Area), but not signed by regulatory agencies.	2007
Air Force and regulatory agencies finalize and sign IRODs for Sites SD010 (Area B) and LF013.	2010
Air Force and regulatory agencies finalize and sign IRODS for Sites WP016, ST018, SS035, and the Cantonment Area (Sites DP019, ST022, SS023, FT029, SS036, SS039, and CG040).	2011
NFA concurrence received for Site SWMU 23.	2012
Groundwater sites decoupled from active ERP sites and combined into Site CG041 (Basewide Groundwater).	2013
NFA concurrence received for Site WP016.	2014
Air Force and regulatory agencies finalize and sign ROD for Sites FT003, SD010, SD023, SD031, and SS037.	2014
SC achieved for Sites SD031 and FT003.	2015
Air Force and regulatory agencies finalize and sign RODs for Sites SD001, WP012.	2015
NFA concurrence received for SS508.	2015
Air Force and regulatory agencies finalize and sign RODs for Sites LF013 and LF033.	2016
NFA concurrence received for Site OW581.	2016

Notes:
AOC = area of concern; CVWB = Central Valley Regional Water Quality Control Board; DTSC = Department of Toxic Substances Control; ERP = Environmental Restoration Program; IROD = Interim Record of Decision; NFA = No Further Action

Tables 2.1-2 through 2.1-12 show significant events and dates associated with the site-specific chronology of events.

Table 2.1-2 Site Chronology, Flightline Area Sites

Event	Date
Site SD001	
RI field activities	1988–2002
Interim Remedial Action (off-base wellhead treatment)	2000
Grouped with other Flightline Area sites for RI and subsequent CERCLA phases	2003
Interim Remedial Action (drainage soil and sediment excavation)	2007
Site FT003	
RI field activities	1988–2006
Interim Remedial Action (SVE)	1997–2008
Interim Remedial Action (soil and sediment excavation and bench-scale study)	2006
FS (draft only)	2006
RI report (final)	2007
Interim Distal Area Remedy Assessment field work	2009–2011
Sites FT003, SD010, SD023, SD031, and SS037 ROD (*final*)	2014
Site Closeout	2015
Site SD008	
RI field activities	1988–2002
Interim Remedial Action (SVE and bioventing)	2004–2010
Treatability Study (air sparge and SVE)	2010
NFA Request Technical Memorandum	2014
Site SD008 Decommissioning Report	2016
Site SD010	
RI field activities	1988–2002
Interim Remedial Action (soil excavation)	1990 and 2004
Interim Remedial Action (SVE and bioventing)	1996–2004
RI and FS reports	2003
Interim Remedial Action (EISB)	2004
Site 10 (Area B) IROD	2007
Interim Distal Area Remedy Assessment field work	2010
EISB System Technical and Economic Feasibility Analysis	2011
SD010 Remedial System Decommissioning Report	2014
Sites FT003, SD010, SD023, SD031, and SS037 ROD (*final*)	2014
Site SD011	
RI field activities	1988–2002
Interim Remedial Action (SVE and bioventing)	1993–2008
Remedial of OWSs	1997

Event	Date
Grouped with other Flightline Area sites for RI and subsequent CERCLA phases	2003
Site SD011 Biovent Shutdown and Soil Closure Report	2010
Site ST021	
RI field activities	1988–2002
Interim Remedial Action (bioventing)	1993–2008
Remedial of ASTs and USTs	1997
Grouped with other Flightline Area sites for RI and subsequent CERCLA phases	2003
Site ST021 Remedial Action Completion Report (final)	2014
Decommissioning of Biovent System	2015
Site ST022	
UST Remedial and Investigation field activities	1990–2010
UST Closure reports (multiple)	1990–2007
Group 1 and 2 NFA request submitted	2015
Site SD032	
RI field activities	1998–2002
Interim Remedial Action (SVE)	2000
Interim Remedial Action (drainage soil and sediment excavation)	2007
Grouped with other Flightline Area sites for RI and subsequent CERCLA phases	2003
Site 32/1 FS	2005
Site 32/1 IROD	2007
Interim Remedial Action (ISCO)	2007
ISCO Technical and Economic Feasibility Analysis (draft only)	2010
Data gap investigation activities	2013–2014
Site SS035	
Site Inspection	2005
RI field activities	2008–2009
RI and FS reports	2010
Interim Remedial Action (bioreactor cell)	2010
Remedial action construction activities (soil vapor extraction)	2013–2014
Site SS035 ROD (draft)	2014
Site SS037	
Removal of OWSs	1997
Grouped with other Flightline Area sites for RI and subsequent CERCLA phases	2003
Sites FT003, SD010, SD023, SD031, and SS037 ROD (*final*)	2014

Notes:
AST = aboveground storage tank; CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act; EISB = enhanced in situ bioremediation; FS = feasibility study; IROD = Interim Record of Decision; ISCO = in situ chemical oxidation; OWS = oil/water separator; RI = remedial investigation; SVE = soil vapor extraction; UST = underground storage tank

Table 2.1-3. Site Chronology, Cantonment Area Sites

Event	Date
Site SS023	
RI field activities	1988–2002
Interim Remedial Action (OWS Remedial and soil excavation)	1996–1998
RI and FS reports	2005
Data Gap investigation/Corrective Measures Implementation activities	2013–2015
Site FT029	
RI field activities	1988–2009
Interim Remedial Action (SVE)	1997–2001
RI report	2010
Grouped with other Cantonment Area sites for RI and subsequent CERCLA phases	2010
Cantonment Area FS	2011
Cantonment Area IROD (*final*)	2011
Site FT029 ROD (*draft*)	2015
Site SS039	
RI field activities	2004–2009
Treatability Study (enhanced reductive dechlorination)	2009–2010
Grouped with other Cantonment Area sites for RI and subsequent CERCLA phases	2010
Cantonment Area FS	2011
Cantonment Area IROD (*final*)	2011
Treatability study	2014
Site SS039 ROD (*draft*)	2015
Site CG040	
RI field activities	2002–2009
Grouped with other Cantonment Area sites for RI and subsequent CERCLA phases	2010
Cantonment Area FS	2011
Cantonment Area IROD (*final*)	2011
Data Gap investigation activities	2013–2014
Site CG040 ROD (*draft*)	2015

Notes:
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act; OWS = oil/water separator;
FS = feasibility study; RI = remedial investigation; SVE = soil vapor extraction

Table 2.1-4. Site Chronology, Site TU002

Event	Date
Site Investigation field activities	1999–2002
Data Gap investigation activities	2013–2015

Table 2.1-5. Site Chronology, Site LF013

Event	Date
RI field activities	1988–2001
Alternative water supply provided to Deep Violet Farms	1992
Interim Remedial Action (SVE east and west)	1997–2010
Interim Remedial Action (M-5 ointment tube and ash excavation)	1996
Interim Remedial Action (groundwater treatability system)	1996
RI and FS reports	2001–2003
Interim Remedial Action (landfill soil cover)	2004
Interim Record of Decision	2007
Interim Remedial Action (bioreactor)	2011
Data Gap investigation activities	2013–2014
Site LF013 ROD (*final*)	2016

Notes:
FS = feasibility study; RI = remedial investigation; SVE = soil vapor extraction

Table 2.1-6. Site Chronology, Site OT017

Event	Date
RI field activities	1988–2008
Interim Remedial Action (Best Slough re-route, SBCW, phytoremediation plants installed)	2000–2001
RI and FS reports	2004
Site 17 Interim Record of Decision	2007
Interim Remedial Action (secondary SBCW with ZVI PRB)	2008

Notes:
FS = feasibility study; PRB = permeable reactive barrier; RI = remedial investigation; SBCW = soil/bentonite cutoff wall;
ZVI = zero-valent iron

Table 2.1-7. Site Chronology, Site ST018

Event	Date
RI field activities	1988–2008
Interim Remedial Action (bioventing at Jet Fuel Tank Farm)	1996–2008
Interim Remedial Action (SVE at MOGAS Tank Farm)	1997–2010
RI and FS reports (*draft only*)	2004–2005
FS addendum	2010
Site 18 IROD (*final*)	2011
Decommissioning activities	2013–2015
Site ST018 ROD (*draft*)	2015

Notes:
FS = feasibility study; MOGAS = motor gasoline; RI = remedial investigation; SVE = soil vapor extraction

Table 2.1-8. Site Chronology, Site DP019

Event	Date
RI field activities	1991–1997
NFRAP Approved	2004

Notes:
RI = remedial investigation; NFRAP = no further response action planned

Table 2.1-9. Site Chronology, Site SS023

Event	Date
RI field activities	1988–2002
Interim Remedial Action (OWS Remedial and soil excavation)	1996–1998
RI and FS reports	2005
Data Gap investigation/Corrective Measures Implementation activities	2013–2015

Table 2.1-10. Site Chronology, Site DP038

Event	Date
Site Inspection field activities	2004–2005
Engineering Evaluation/Cost Analysis and Action Memorandum	2005
Interim Remedial Action (soil excavation)	2005–2006
Data Gap investigation activities	2014–2015

Table 2.1-11. Site Chronology, Site CG041

Event	Date
Groundwater decoupled from existing ERP sites and combined into Site CG041 (Basewide Groundwater)	2013
FS Report	2016

Notes:
FS = feasibility study; MOGAS = motor gasoline; RI = remedial investigation; SVE = soil vapor extraction

Table 2.1-12. Site Chronology, Site TU509

Event	Date
Site Investigation field activities	1996–2009
RI field activities	2009–2012
Remedial action field activities	2014–2016

Notes:
FS = feasibility study; MOGAS = motor gasoline; RI = remedial investigation; SVE = soil vapor extraction

Table 2.1-13. Site Chronology, Site PL582

Event	Date
Site Investigation field activities	2000–2009
Data Gap investigation activities	2013–2015

Notes:
FS = feasibility study; MOGAS = motor gasoline; RI = remedial investigation; SVE = soil vapor extraction

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3. Background

Beale AFB is one of 16 Air Combat Command (ACC) bases in the United States, whose primary mission is aerial surveillance. The host wing is the 9th Reconnaissance Wing, which is responsible for providing national and theater command authorities with timely, reliable, high-quality, high-altitude reconnaissance products. The Air Force is responsible for managing regional and local environmental programs at Beale AFB, including the ERP. The ERP at Beale AFB is managed in accordance with Air Force Instruction. Beale AFB is a non-NPL installation under the National Contingency Plan. The Beale AFB ERP never entered into a Federal Facility Agreement with regulatory agencies. Authority for ERP decision-making rests with the support of a team of RPMs from Beale AFB, AFCEC, DTSC, and CVWB. The Air Force is the lead agency responsible for remedial decisions, funding, and implementing remedial actions.

This chapter summarizes background information for Beale AFB. Because of the large number of individual sites, site-specific backgrounds and summaries of the initial response and basis for taking action are provided under the sections dedicated to each individual site.

3.1 Physical Characteristics

3.1.1 Regional Geology

This section summarizes the physical setting at Beale AFB. The Air Force has completed a comprehensive evaluation of the geology and groundwater at the Base (LAW 1998). The discussion in this section is derived from that evaluation and has been updated based on more recent investigations.

Beale AFB lies on the boundary of the Sierra Nevada and Great Valley provinces in California. The Sierra Nevada Province is a strongly asymmetric, northwesterly trending mountain range, which formed as a huge block of the Earth’s crust, uplifted along a fault system on the east side of the range and tilted westward. Thus, the Sierra Nevada has a long, gentle western slope and a steep eastern escarpment.

The Great Valley Province was formed as a structural downwarp between the Coast Range Province on the west and the Sierra Nevada Province on the east. It has filled with alluvial deposits derived from the erosion of the Sierra Nevada and Coast Range provinces. On its eastern boundary, the alluvial deposits of the Great Valley overlap bedrock of the Sierra Nevada block, which slopes gently to the west.

Because of its location on the boundary of the two provinces, Beale AFB displays characteristics of both the Great Valley and the Sierra Nevada. The western portion of the Base is relatively flat grassland, characteristic of the Great Valley. Moving eastward, the plains transition to low, rolling hills that gradually merge with the foothills of the Sierra Nevada. The elevation ranges from approximately 80 to 90 feet above mean sea level (msl) along the western and southwestern boundaries of the Base, to more than 400 feet above msl in the northeastern part.

Three geomorphic units are present at Beale AFB: stream floodplains and channels, low alluvial plains and fans, and dissected uplands. Stream floodplains and channels lie along the major drainages. As these streams have meandered in recent (Holocene) geologic time, they have deposited sands and gravels along their channels, and silts and clays on their floodplains. Successive downcutting and redeposition over time as the stream channels have moved have resulted in an extremely complex geologic setting.

Low alluvial plains and fans compose most of the western part of Beale AFB. This unit is generally flat to gently rolling and is composed of alluvial (stream-laid) deposits, mainly of Pleistocene age. Unlike the stream floodplains and channels, little or no deposition takes place on this surface. Therefore, a mature soil profile has developed that contains cemented sediments in many locations. Surface water drainage is mainly southwesterly, perpendicular to the trend of the Sierra Nevada.

Dissected uplands form the eastern edge of the Great Valley and compose most of the central portion of Beale AFB. This unit ranges from gently rolling land to dissected hills, with relief of up to several hundred feet. The dissected uplands are composed of unconsolidated to semi-consolidated continental deposits, mainly of Pleistocene and Pliocene age.

Moving eastward into the foothills of the Sierra Nevada, the topography becomes progressively steeper, and outcrops are composed of mostly older consolidated sedimentary rocks of Oligocene to Pliocene age. On the eastern boundary of the base, the crystalline basement rock of the Sierra Nevada is exposed, ranging in age from Mesozoic to Paleozoic.

3.1.2 Geology

Unconsolidated deposits overlie consolidated sediments at Beale AFB, and these, in turn, overlie the basement complex of the Sierra Nevada. Groundwater occurs in the unconsolidated sediments that overlie the older, low-permeability sedimentary and crystalline bedrock. Depth to bedrock ranges from surface exposure in the eastern part of the Base to greater than 500 feet in the southwestern part (LAW 1998).

The western part of Beale AFB, west of the eastern edge of the Flightline Area, is within the Great Valley Province. This area is underlain by a series of unconsolidated units, deposited under alluvial conditions. These unconsolidated units consist of the Riverbank, Laguna, Mehrten, and Neroly formations. These formations are difficult to distinguish in the subsurface and consist of variable thicknesses of silt, sand, and low-permeability, fine-grained material, with frequent occurrences of pyroclastic mudflows. Sediment thickness increases to the west. Underlying the alluvial deposits are undifferentiated sedimentary rock and marine sedimentary rock that form a low-permeability base to groundwater flow (LAW 1998).

One stratigraphic unit that appears to have an impact on the groundwater flow direction at Beale AFB is a marine claystone formation that includes deposits of the Eocene Capay Formation and Upper Cretaceous marine sediments that may represent the Knoxville and Chico formations. This marine claystone is composed of poorly indurated to well-indurated, massive to finely bedded, variably fractured claystones, siltstones, and mudstones. Sandstone and conglomerates are interbedded with the fine-grained rocks. The degree of interbedding is highly variable, with some sections showing sandstone to be predominant over the finer-grained rocks.

The claystone formation has been encountered in boreholes throughout the Flightline Area; and in 2002, it was mapped using a seismic survey (CH2M HILL 2005b). At the southern end of the Flightline Area, at the southern end of Site ST025, the marine claystone formation rises abruptly to form a ridge at approximately 80 feet below ground surface (bgs) (60 feet msl) and causes the groundwater flow direction to be deflected to the west. From the Flightline Area, the ridge dips to the west and is encountered at more than 300 feet bgs in well 01R001MW (a groundwater monitoring well) near the southwestern corner of Site SD001, exerting little influence on the groundwater flow direction.

East of the Flightline Area, surface relief increases as the Sierra Nevada foothills increase in height, and local drainage is incised into the underlying units. The metavolcanic rocks of the Sierra Nevada Province are overlain by marine sedimentary siltstones and sandstones, and sediment thicknesses ranging from 0 to 200 feet. The greatest sediment thicknesses usually are along historical and modern drainages. In general, the lower permeability units are thicker and closer to the surface in the eastern portion of the Base than in the western portion (LAW 1998).

3.1.3 Hydrogeology

Groundwater near Beale AFB flows mainly through the alluvial deposits of the Riverbank, Laguna, Neroly, and Mehrten formations. Because of the complexity of the alluvial deposits, local aquifers are not clearly defined. Alluvium is composed of the sediments that have been deposited by water in streambeds, floodplains, lakes, and fans. Stream channels constantly have shifted their positions and velocities through geologic time. The alluvial deposits are characterized by extreme heterogeneity of particle size and distribution, resulting in highly variable hydraulic properties. The stratigraphy encountered at Beale AFB is shown in Table 3.1-1, as adopted from the *Basewide Groundwater Monitoring Program 2009 Annual Report* (CH2M HILL 2010i).

The meandering stream depositional environment produces relatively thin, laterally discontinuous channel deposits. Channel deposits of coarse-grained materials, which are narrow in cross-section, may be continuous for long distances in the direction of stream flow. Because groundwater flows preferentially through materials of higher hydraulic conductivity, these channel deposits may serve as primary contaminant-migration pathways. However, these pathways often may not be correlated on geologic cross-sections constructed from soil boring logs.

The layered character of alluvial deposits causes the aquifer system to display a strong horizontal versus vertical anisotropy. Usually, the horizontal hydraulic conductivity of aquifer materials will be much greater than the vertical hydraulic conductivity. Because of the heterogeneity and anisotropy characteristic of alluvial systems both horizontally and vertically, aquifer characteristics, such as hydraulic conductivity, may vary by several orders of magnitude within a few feet in any given direction.

Coarse-grained deposits at Beale AFB tend to be minor and embedded within fine-grained deposits, although a thick sequence of coarse sands and gravels has been noted at several sites in the northern and western parts of the Base, particularly at Site SD001 (Westside Drainage Ditch). Sands and gravels also predominate at Site OT017 (Best Slough) near the stream. However, the predominance of fine-grained silts and clays over much of the Base causes the groundwater to be confined or semi-confined locally. These clay and silt deposits are lenticular and gradational. Near-surface groundwater may be perched in certain locations, such as Site SD010.

With increasing depth, the groundwater typically exhibits greater degrees of confinement; the response of groundwater to pumping may be complex. Beale AFB is located on the eastern margin of the Sacramento Basin Hydrologic Area, as designated by the California Department of Water Resources. At the turn of the twentieth century, groundwater moved westward through this margin from the Sierra Nevada foothills to discharge in the Feather and Sacramento rivers. Because of extensive groundwater extraction, primarily for irrigation, the main groundwater discharge now is through well withdrawals. This discharge has altered the direction of groundwater movement near Beale AFB. The rivers no longer serve as the groundwater discharge points. In fact, water from the river channels recharges the groundwater system.

Another source of recharge to the regional groundwater system is along outcrops of the alluvial formations on the eastern edge of the Great Valley, which, at depth, constitute the major water supply aquifers. Percolation of rainwater or irrigation water through these materials reaches the groundwater reservoir. Recharge from groundwater in fractures of the consolidated rocks also contributes water to the regional aquifers. Historically, the primary discharge point for groundwater at Beale AFB has been to a large cone of depression that was created by historical agricultural pumping west of the Base. Over time, this pumping caused groundwater elevations in a large area west and south of the Base to decrease in excess of 100 feet. In 1983, the completion of the South Yuba Canal increased use of surface water for irrigation and decreased groundwater pumping.

Table 3.1-1. Stratigraphic and Hydrostratigraphic Nomenclature

Lithology	Formation	Hydrostratigraphic Unit	Age
Younger Alluvial Sediments			
Unconsolidated alluvial silt, sand, and gravel and overbank clay, silt, and fine-grained sand.	Recent Deposits	HSU-1	Holocene (0 – 11,000 years)
Alluvial silt, sand, and gravel derived from erosion of the Laguna Formation.	Riverbank	HSU-1	Pleistocene (150,000 to 450,000 years)
Predominantly fine-grained sediments consisting of reddish-brown to yellowish-brown silts and clays with discontinuous lenticular interbeds of mostly siliceous sands and some gravels.	Laguna	HSU-1	Pleistocene to Pliocene (1.6 to 3.4 million years)
Upper Volcaniclastic Sediments			
Predominantly grayish volcanic fluvial deposits consisting of volcaniclastic cobble conglomerate, sandstone, clayey siltstone, andesitic sands, and gravels with few interbedded silts and clays and minor intervals of tuff.	Neroly	HSU-2	Pliocene to late Miocene (5 to 22 million years)
Pyroclastic Mudflow Deposits			
Pyroclastic debris flows and volcanic mudflows deposited on the western front of the Sierra Nevada. Predominantly andesitic, but ranges from basaltic to rhyolitic. The flows consist of indurated ash and tuff containing andesitic breccia and pumiceous sands and silts.	Mehrten	HSU-2/3	Pliocene to late Miocene (5 to 22 million years)
Low-Permeability, Fine-grained Sediments			
Predominantly fine-grained sediments consisting of clay, claystone, silt, and siltstone with few local interbedded sands and trace gravels.	Neroly	HSU-3	Pliocene to late Miocene (5 to 22 million years)
Lower Volcaniclastic Sediments			
Predominantly coarse-grained grayish volcanic fluvial sediments consisting of andesitic sands and gravels with interbedded conglomerates, sandstones, siltstones, and claystones. Locally coarser-grained than the upper volcaniclastic unit.	Neroly	HSU-4	Pliocene to late Miocene (5 to 22 million years)
Undifferentiated Older Sedimentary Rocks			
Predominantly tuffaceous sandstone with basal conglomerate containing marine fossils. The sandstone is overlain by thinly bedded fissile, tuffaceous shale. A pink volcanic mudflow overlays the shale, and at the top of the formation lies well-bedded spheroidal shale with interbeds of lignite.	Wheatland	HSU-4	Oligocene (25 to 38 million years)
Predominantly light-colored argillaceous quartzitic sandstone, interbedded claystone, kaolinitic clay, and dark reddish-brown sandstone	Ione	HSU-4	Early to Middle Eocene (44 to 45 million years)
Marine Sedimentary Rocks			
Dark greenish-gray, fossiliferous siltstone and claystone interbedded with sandstone and occasional conglomerate.	Capay	HSU-5	Early Eocene (50 to 55 million years)
Dark- to light-colored, fossiliferous marine sandstone, interbedded with siltstone and shale. Thin to thick beds, some cross-bedded.	Upper Cretaceous marine sediments	HSU-5	Upper Cretaceous (144 million years)
Metavolcanic Rock			
Dark greenish-gray to bluish-gray metamorphosed volcanic and some sedimentary rock, variably fractured, commonly exhibiting amphibole, feldspar, and chlorite grains.	Sierran Basement Complex	NA	Upper Paleozoic to Jurassic Upper Paleozoic to Jurassic (208 to 360 million years) (208 to 360 million years)

Groundwater elevations in the vicinity of Beale AFB began to rise in approximately 1984. Between 1989 and 2007, groundwater elevations in monitoring wells near the Base boundary rose approximately 60 feet. As groundwater has recovered from historical agricultural pumping over time, the large groundwater depression located west of the Base has migrated southward and currently is centered near Wheatland. Since approximately 2007, the groundwater elevations have stabilized and even have begun to decrease in some locations. It is too soon to know whether this change is a short-term response to drought conditions or if this change signifies the beginning of a new long-term trend in groundwater elevations.

Between August 2008 and August 2010, groundwater elevations stabilized and even began to decrease in many sites across the Base. Large groundwater elevation declines occurred in several Beale AFB monitoring wells located near the western Base boundary over this period, particularly at former Site SD001 and CG041-013. The decline in groundwater elevations from 2008 through 2010, which was particularly pronounced along the western Base boundary, was most likely because of increased pumping by Yuba Basin water districts.

In 2007, the Yuba County Water Agency (YCWA) began a water transfer program, to have local farmers pump groundwater from selected irrigation wells and discharge the pumped water to the canal system, or to have the local farmers use the pumped water for irrigation wells in lieu of taking water from the canal system. The excess water was conveyed downstream and sold to other water districts through a water transfer agreement. Water transfers occurred between 2007 and 2010. From 2008 through 2010, Brophy Water District (located along the western Base boundary) pumped 62,708 acre-feet as part of a groundwater substitution transfer program (YCWA 2012). No groundwater transfers took place from spring 2011 through spring 2013 (YCWA 2013). In 2011 and 2012, groundwater elevations at Beale AFB began to rise again, in response to the reduced off-base pumping. The rise and fall in groundwater elevations is particularly notable in monitoring wells located along the western Base boundary (CG041-003, CG041-013, CG041-031, CG041-032, and CG041-040).

The recent drought in California put more pressure on water supplies statewide. In 2014, YCWA again implemented the water transfer program. This resulted in normally idle irrigation wells near the western Base boundary being pumped relatively aggressively (Altare 2014). This increased groundwater pumping resulted in significant depression of groundwater levels around the western and southwestern margin of the Base. For example, the hydraulic gradient in the CG041-040 wells near the Base boundary was 14 times greater in summer 2015 than in summer 2012, when the water transfer program was not in effect.

The steeper gradient from off-base pumping resulted in increased groundwater flow velocity, which in turn resulted in increased plume migration. The groundwater substitution pumping for 2015 was only 30,000 acre-feet. However, YCWA was unable to deliver sufficient surface water to the local irrigation districts, so many irrigators pumped groundwater from their own wells to compensate for the surface water shortfall. This discretionary pumping by individual irrigators was not metered or reported, so the total volume pumped in 2015 is unknown. Plumes along the western Base boundary were affected by off-base irrigation pumping. As long as California remains in a drought or its population continues to grow, political and economic pressure to use the water transfers to the maximum extent possible is likely to occur.

Recharge to the local groundwater system near Beale AFB is from the Yuba, Bear, and Feather rivers, from the South Yuba Canal, and from the mountains on the eastern part of the Base. In effect, all of Beale AFB is within the zone of groundwater recharge to the groundwater depressions west and southwest of the Base. Flowlines throughout the Base converge on the groundwater depression. In addition, location within a zone of recharge implies that an overall downward vertical component of groundwater flow exists. Contaminants that enter the groundwater system near Beale AFB move downgradient toward the depression.

Regionally, groundwater flows mainly toward the west-southwest across the Base. Near the southeastern Base boundary, groundwater flows to the west from Site TU002 and toward CG041-017. However, groundwater flow direction in the immediate vicinity of Best Slough, at CG041-017, mainly is toward the south, and then bends westward toward the regional depression west of the Base, along with recharging groundwater from the Bear River. Chemical distributions (mainly trichloroethene [TCE] and other volatile organic compounds [VOCs]) confirm that, although the main flow is toward the south at CG041-017, a western component of flow also exists.

The close spacing of the groundwater contour lines in the central (eastern-central) portion of the Base marks the boundary between the Great Valley and the Sierra Nevada provinces. The groundwater gradient is steep in the foothills and much shallower in the valley. Groundwater elevation contour lines show a trough-shaped depression, extending from well BGC002MW toward Building 2145 (in the south-central portion of the Base). Groundwater flowlines converge toward this trough, likely because a subsurface zone of relatively higher permeability materials is in this area.

Groundwater elevation contour lines indicate another trough-shaped depression, extending from piezometer BWL001PZ toward the northwestern portion of the Base. Soil borings recorded in that area indicate that permeable, coarse-grained materials predominate in the subsurface at CG041-032. East of the trough at CG041-032, a groundwater divide is apparent. The groundwater divide extends from piezometer BWL002PZ toward monitoring well 01L005MW in a northwestern-southeastern direction beneath the main Flightline Area. A low-permeability marine claystone that forms a subsurface ridge and dips toward the west likely causes the groundwater divide in this area. This unit has been observed at a shallow depth in soil borings at former Site ST025 and at a greater depth at CG041-032 near the Base boundary (URS 2001).

3.2 Land and Resource Use

3.2.1 Operational History

Beale AFB opened in October 1942 as Camp Beale and served as a training ground for infantry and armor units. During World War II, Camp Beale also was used as a personnel deployment depot and German prisoner-of-war encampment, and was the site of a large, 1,000-bed hospital. As many as 60,000 personnel were stationed at Camp Beale during that time.

After World War II, Camp Beale was transferred to the Air Force. From 1948 to 1951, it was known as the Beale Bombing and Gunnery Range, and was used for bombardier and navigator training. In 1951, the range was designated as Beale AFB and was under several jurisdictions, including the Air Training Command, the Aviation Engineering Force, the Strategic Air Command, and the ACC. The first runway became operational in 1958.

Over the years, Beale AFB has been associated mainly with Air Force refueling and reconnaissance missions. In 1959, Beale AFB received its first KC-135 jet Stratotanker, which was assigned to the 903rd Air Refueling Squadron of the 456th Bombardment Wing. B-52 aircraft were assigned to the Base between 1960 and 1976. The 4200th Strategic Reconnaissance Wing was activated in 1965. In 1976, the 99th Strategic Reconnaissance Wing was assigned to Beale AFB. Aircraft, such as the U-2 and SR-73, have been associated with the strategic reconnaissance wings.

Currently, the host organization on Beale AFB is the 9th Reconnaissance Wing (9 RW), an ACC organization. The wing’s more than 4,200 personnel are organized into four groups (i.e., Operations, Maintenance, Support, and Medical), which are located at Beale AFB and four overseas locations. Beale also maintains two major associate units: the 7th Space Warning Squadron, which operates the Precision Acquisition Vehicle Entry, Phased Array Warning System radar system, and the 548th Intelligence Group, which operates the Deployable Ground Station-2 (part of the Air Intelligence Agency). The 9 RW is part of an intelligence system that is fully contained on the Base. The 9 RW’s U-2, Global Hawk (RQ-4), and MC-12 Liberty reconnaissance aircraft work in concert with ACC, Air Intelligence Agency squadrons, and the Deployable Ground Station-2 to acquire, analyze, and provide near real-time intelligence to customers “from the White House to the foxhole” (Beale AFB 2008). Approximately 10,000 military and civilian personnel are stationed at Beale AFB, working in support of the 9 RW and other base tenants (Beale AFB 2008).

3.2.2 Description of Surrounding Area

The area surrounding Beale AFB is rural, consisting of agricultural, industrial mining, recreational, and low-density residential uses. Abutting the Base to the west and south are large agricultural tracts, maintained in the California Department of Conservation’s Farmland Mapping and Monitoring Program Inventory as “important farmland” (Beale AFB 2008).

To the north of the Flightline Area are the Yuba Goldfields. This area has been identified by the California Division of Mines and Geology, under the California Surface Mining and Reclamation Act of 1975, as an area where significant

Portland cement concrete-grade aggregate deposits are present. This identification has led to a Mineral Resource Zone 2 classification, to protect access to the aggregate deposits (Beale AFB 2008).

North of the Base and housing areas is the River Highlands Community, a primarily rural residential development. The *River Highlands Community Plan* has controlled development in the area since 2003. The underlying planning principle for development of the area is to maintain a balance between open space and development, and to ensure that development retains the "rural foothill character and rural quality of life" (Beale AFB 2008).

Furthermore, to the east of the Base and military family main housing area is the Spenceville Wildlife Refuge and Recreation Area, which is managed by the California Department of Fish and Wildlife, and it provides picnicking, fishing, hunting, and hiking.

The town of Wheatland and the twin cities of Marysville and Yuba City are the closest neighbors to Beale AFB. Both Marysville and Yuba City are county seats, for Yuba County and Sutter County, respectively. Together, the cities and surrounding area are home to 148,000 inhabitants (Beale AFB 2008).

3.2.3 Land Use

According to the Beale AFB General Plan (General Plan) (Higginbotham/Briggs and Associates 2001), the Air Force identified the following 12 types of land uses at Beale AFB:

- Airfield–The airfield consists primarily of a 300 by 12,000-foot runway and taxiways within a 3,000 by 3,000-foot aircraft clear zone, which is completely contained within the Base.
- Aircraft Operations and Maintenance–Located in close proximity to the airfield, aircraft operations and maintenance (O&M) in this area promote operational efficiency.
- Industrial–Industrial areas are located near the Flightline Area, main base (Cantonment Area), small arms ranges, the wastewater treatment plant, and a fire station within the military family housing area.
- Administrative–Administrative areas are grouped primarily within the Cantonment Area and Flightline Area.
- Community Commercial–Beale AFB has two service stations, one on J Street at the intersection with Warren Shingle Boulevard and the other near the Vassar Lake Gate. The Base Exchange and dining establishments are located in the Cantonment Area.
- Community Service–Beale AFB has one community activity center, located on Warren Shingle Boulevard in the Cantonment Area.
- Medical–The base clinic is located on Warren Shingle Boulevard, northwest of the military family housing area.
- Housing (accompanied)–Also known as military family housing, this housing area is located primarily in the Sierra Foothills of the eastern portion of the base.
- Housing (unaccompanied)–Unaccompanied housing and temporary lodging primarily are separated from the military family housing area and are located in the Cantonment Area.
- Outdoor Recreation–Beale AFB maintains the 18-hole Pheasant Run Golf Course, a rod and gun club, many walking trails and bike path segments, neighborhood parks, and many small lakes.
- Open Space–The majority of the land use at Beale AFB is designated as open space. Airfield clearances, explosive safety zones, electromagnetic radiation safety zones, range fans, Military Munitions Response Program/ERP/Environmental Compliance Program (ECP) sites, wetlands, and floodplains, threatened and endangered species habitat, and other constraints limit the amount of open space at Beale AFB that is available for future development.
- Water–Surface water bodies (e.g., lakes, creeks, sloughs) are present at Beale AFB, but most are located a substantial distance from the Flightline Area. Groundwater makes up Beale AFB's water supply. Nine water supply wells located west of the Flightline Area provide all potable water, process water, and fire water for the Base.

The General Plan describes the Air Force's use of a compatibility matrix, which is used as the starting point for developing land use plans that will support the collocation of compatible activities in the most effective and efficient manner (Beale AFB 2008).

3.3 History of Contamination

The records search that was performed in the early 1980s identified waste disposal practices conducted between 1940 and the mid-1980s that may have contaminated soil and groundwater in the disposal areas. Historical activities at Beale AFB that may have resulted in environmental contamination include industrial operations, pesticide use, fire protection training, fuel management, spill management, and waste disposal. Industrial operations consist mainly of aircraft and vehicle maintenance and repair activities. Wastes potentially generated include jet fuel, waste oils and lubricants, acid and alkaline cleaning solutions, various solvents, paint strippers, and paints.

The fuel management system at Beale AFB has included handling substantial volumes of jet fuels, diesel fuel, motor vehicle gasoline, unleaded gasoline, and No. 2 fuel oil. Fuels are delivered by pipeline, train, or truck to on-base storage tanks. Jet fuels are pumped through pipelines to hydrant systems for refueling aircraft. Trucks also are used to refuel aircraft. Fuel and oil spills have occurred mainly in fueling, maintenance, and shop areas. These spills have been contained with absorbent materials, washed into oil/water separators (OWSs) connected to the sanitary sewer, or washed down storm drains. Fuel spills along the Flightline Area have been washed down with large volumes of water. The water either was channeled directly to the surface drainage system or allowed to evaporate.

Wastes from Beale AFB operations have been disposed in various ways. In the past, unknown quantities were disposed by discharge to the sanitary or storm sewer system. Other wastes were allowed to run off onto surface soils adjacent to maintenance facilities or were discharged directly to the land. Some materials were disposed at the Base landfills. Waste oils, fuels, and solvents also were disposed in aboveground storage tanks (ASTs) and underground storage tanks (USTs). Explosives were disposed in an explosive ordnance disposal (EOD) area. Currently, wastes are stored at bulk hazardous waste accumulation areas and are disposed by contractors (CH2M HILL 2010i).

The following areas were identified as potential threats to human health and the environment:

- Landfills (4)
- Areas of Concern (AOCs) (73)
- UST sites (more than 1,000)

Site investigations conducted as part of the Beale AFB ERP resulted in 38 of those areas becoming ERP sites. Of those 38 ERP sites, 21 sites now are closed (assigned a No Further Action [NFA] status) or have been transferred to the Air Force ECP. Figure 1.1-2 shows all the ERP sites.

Table 3.3-1 summarizes past uses of the active ERP sites included in this five-year review.

Table 3.3-1. Background Summary of Active Five-Year Review Sites

ERP Site	Brief Description of Use
CERLCA Sites	
SD011: Aerospace Ground Equipment Maintenance Area	Maintenance and storage area for aerospace ground equipment.
LF013: Former Landfill No. 1	Historical landfill containing agricultural, domestic, and WWII-era military refuse.
OT017: Best Slough	Riparian area where spent solvent waste-containing drums were disposed.
ST018: Bulk Fuel Storage Facility	Bulk jet fuel and motor fuel storage tank farms.
SD032: Building 1086	Building in Flightline Area historically used for variety of maintenance and fabrication activities.
SS035: Munitions Storage Area	Secured facility for ordnance and munitions storage.
DP038: Former Skeet and trap range	Historical skeet and trap range.
SS039: Building 2145	Secured building historically used for photographic processing.
CG041: Basewide Groundwater	Groundwater decoupled from existing ERP sites.
RCRA Sites	
LF002: Former Landfill No. 2	Historical landfill containing agricultural, domestic, and WWII-era military refuse.
LF003: Former Landfill No. 3	Historical landfill containing agricultural, domestic, and WWII-era military refuse.
SS023: SWMU23 East and West Transformer Storage Area	Electrical transformer storage area inside the civil engineering yard.
PL582: Lincoln Receiver Site	Backup electrical generator facility at the McClellan AFB Lincoln Communications Annex.
LUFT Sites	
TU002: Former Capehart Service Station	Underground storage tanks associated with the former Capehart Service Station.
ST022: Underground Storage Tanks - Basewide (ST22)	All underground storage tanks identified at Beale including <100-gallon heating oil tanks up to >20,000-gallon fuel storage tanks.
TU509: Clinic USTs	Underground storage tanks located at the Base Clinic

Notes:
ERP = Environmental Restoration Program; WWII = World War II; < = less than; > = greater than

3.4 Initial Response

In early 1980, a records search identified several AOCs at Beale AFB with contaminants that could migrate to off-base locations. The records search concluded that waste disposal practices between 1940 and the mid-1980s—including the use of burning to dispose wastes, the operation of underground sumps/tanks, and the use of unlined drainage and sewage leaching ponds—probably were responsible for the reported contamination.

The Air Force completed a Phase I, Records Search/Study that defined the initial 18 ERP sites. Phase I was followed by the Phase II, Stage 1 Confirmation/Quantification Study that confirmed the initial 18 ERP sites. Based on the findings reported, CVWB issued Cleanup and Abatement Order No. 88-091 to the Air Force for 13 ERP sites at Beale AFB.

In 1988, a Stage 2-1 remedial investigation/feasibility study (RI/FS) of 24 ERP sites was performed (Sites 1-24), and the Air Force subsequently began the Basewide Groundwater Monitoring Program (BGMP) (semi-annual groundwater monitoring and reporting). Cal/EPA regulatory agencies (CVWB and DTSC) requested that the Air Force enter a Federal Facility Site Remediation Agreement covering the Beale AFB ERP. Discussions were begun in 1990, and negotiations continued through 1996, but no agreements were reached.

Preliminary assessment and site inspection projects continued between 1994 and 2006, and resulted in a cumulative total of 73 AOCs, 38 of which progressed to become ERP sites. Of the 38 ERP sites, 21 have either been closed or transferred to the ECP. At the time of this five-year review, RODs or IRODs have been prepared for Sites SD011, LF013, OT017, ST018, SD032, SS035, and SS039. Decision documents also have been prepared for Sites LF002, LF003, DP019, SS023, TU002, ST022, and TU509.

3.5 Basis for Taking Action

The basis for taking remedial action for groundwater was the potential risk posed to human health and to the degradation of groundwater resources. Interim remedial actions for contaminated soil are based on the potential risk to human health and to the environment, including the protection of surface water and groundwater resources. Interim response actions that have been completed and/or are ongoing at Beale AFB are considered interim actions until documented as a final remedy in a ROD. IRODs, FSs, TSs, and other investigations have been completed at Beale AFB, and all refer to achieving the interim cleanup goals (ICGs) or preliminary cleanup goals (PCGs) of the contaminant concentrations as outlined in the interim response actions.

3.5.1 Basis for Groundwater Action

Contaminant concentrations in groundwater beneath Beale AFB exceed or have exceeded PCGs or ICGs at all of the sites included in Site CG041. The contaminants and concentrations vary by site, and details are discussed specifically by site in Section 5.9.

3.5.2 Basis for Soil Action

The Beale AFB ERP has completed several interim response actions with regard to soil, to reduce the potential threat to human health and the environment. Interim response actions have included bioventing, soil vapor extraction (SVE), excavation, and a landfill soil cover. The contaminants and concentrations vary by site, and the details are discussed specifically by site in Chapters 5.0 through 7.0.

4. Summary of Five-Year Review Process

This chapter describes activities performed during this second Beale AFB five-year review, including identifying the five-year review team, notifying the local community, reviewing relevant documents and data, inspecting current site conditions, and conducting interviews to assist in determining site status. Information about the five-year review process that applies to Beale AFB in general is presented next.

4.1 Administrative Components

The Beale AFB five-year review team is composed of the following RPMs:

- Darren Rector, Beale AFB Remedial Program Manager
- Dave Leeson, Air Force Civil Engineer Center (AFCEC), Contract Officer's Representative
- Mark Clardy, CVWB, Remedial Program Manager
- Dominique Forrester, DTSC, Remedial Program Manager

4.2 Community Involvement and Notification

Beale AFB has maintained an active community involvement program since the late 1990s. Key components of this program have included Restoration Advisory Board (RAB) meetings, site tours, and newsletters. Beale also has held public meetings to present milestone documents and solicit public review and comment, as required.

In accordance with EPA guidance (EPA 2001), the Air Force is required to notify the community of a Beale AFB five-year review, at both the beginning and the conclusion of the process. Notification of potentially interested parties has been made. The start of this five-year review was announced at the 17 November 2016 RAB meeting, and a public notice was published in the *Marysville Appeal-Democrat*. The announcements provided an overview of the five-year review process, the schedule for preparation of the draft document, and contact information for community members with questions or concerns.

As part of the five-year review process, Beale AFB solicited regional stakeholders for feedback regarding ongoing environmental restoration activities at Beale AFB. Feedback from community members was received in the form of completed interview questionnaires. Section 4.6 presents a summary of the interviews. No inquiries were received from the other public announcements.

A public notice will be published in the *Marysville Appeal-Democrat* to notify the community of the completion of the review process and finalization of the five-year review report. This notice will briefly summarize the review, note how and where the public can view the report, and list points of contact for community members who would like to obtain more information or ask questions about the results of the five-year review. The final five-year review report for Beale AFB will be available for viewing by the public at the Yuba County Library.

4.3 Document Review

The five-year review process included a review of documents relevant to the Beale AFB ERP, including RIs, FSs, EE (engineering evaluation)/CAs (cost analyses), and IRODs, to identify a comprehensive set of current RAOs, cleanup levels, and applicable or relevant and appropriate requirements (ARARs). Documents relevant to implementation and performance of the groundwater, soil gas, and soil interim remedies also were reviewed. RI, FS, and risk assessment documents were reviewed as needed. Documents that were consulted during preparation of this report are cited throughout this document and are included in the references that are presented in Chapter 8.0.

4.4 Data Review

In general, data reviewed for the technical assessments in this second five-year review included those generated between 01 January 2011 and 30 June 2016. Documents in the Beale AFB Administrative Record were made available by the Air Force for review. Documents reviewed included semi-annual and annual BGMP reports for groundwater, annual LUC inspection reports, long-term operations and monitoring reports for remedial system information, and site-specific RI, FS, EE/CA, and other similar documents for site characterization and remedy evaluation information. IRODs or similar decision documents were reviewed for sites where remedies have been selected. The site-specific summaries presented at the end of each technical assessment also identify deficiencies, if any, in the data reviewed.

4.5 Site Inspections

Beale AFB ERP personnel, the current ERP contractor (CH2M HILL), and AECOM inspected the ERP sites assessed in this five-year review on 14–15 February 2017. Site inspections were conducted to provide information about site status, and to visually confirm and document the conditions of the remedy, the site, and the surrounding area. Inspection forms were completed, documenting observations made. Information was combined on the forms to reduce redundancy. The forms were generated for off-site (PL582), on-Beale CERCLA sites, on-Beale LUFT sites, and on-Beale RCRA sites. Except where prohibited because of Air Force security restrictions, photographs were taken at all sites to show current site conditions and are provided in Appendix C.

No issues were identified with any of the remedial systems inspected as part of this review. The majority of the systems were either down for rebound during the visit or under some phase of decommissioning. Compared to the first five-year review when many active groundwater treatment systems (GTSs) were operating, the majority of remedies currently involve in-situ treatment of groundwater. Because no issues were identified during any site inspections, site inspections are not addressed in the site-specific review portions of this document. The site inspection forms are provided in Appendix B.

4.6 Interviews

As part of the five-year review process, a series of interviews were conducted to evaluate opinions and concerns regarding environmental restoration activities at Beale AFB. The interview process included two components: interviews with community members; and interviews with O&M representatives, including RPMs and the O&M contractor for Beale AFB.

Four of the 10 community representatives who were contacted participated in the five-year review interview process. Generally, the interviewees had good knowledge of the ongoing environmental restoration activities and indicated that they were well informed about the environmental restoration activities being conducted at Beale AFB. Interviewees noted concerns about the drought conditions, increased agricultural groundwater use in neighboring areas, and the related impacts on plumes. Community representative interview response forms are provided in Appendix B. O&M contractor (CH2M HILL) representatives who were contacted for an interview participated by returning a detailed summary of ERP activities and possible issues to consider in the future, such as decreasing water table levels and their impacts on the ERP cleanup. The interview response summary forms that were completed by CH2M HILL representatives are provided in Appendix B.

State regulators (RPMs) provided one combined interview response form regarding the ERP. The response describes how recent efforts have focused on contaminant source area removal and is complimentary of the program optimization and gain in efficiencies, permitting, and timely reporting achieved by the ERP. Issues described in the regulatory response included concerns about fluctuating groundwater levels, long-term or final remedy selection, and site-specific concerns. Interview records are provided in Appendix A. The responses to the five-year review interviews will be taken into account as Beale AFB moves forward with the public outreach program and continues its environmental restoration activities.

4.7 Stakeholder Comments

This draft second five-year review will be made available to all stakeholders for review. Paper and electronic copies will be made available for public review at the Yuba County Library. Comments received from both stakeholders and the public on the draft document will be included as an appendix to the final document.

General and site-specific comments provided for this draft five-year review by CVWB and DTSC RPMs will be incorporated into the final version to the extent possible.

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5. CERCLA

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5.1 Site SD011

5.1.1 Introduction

Site SD011 is an active fueling station located in the northwestern portion of the Base. It is situated in the flightline area, approximately 3,000 feet east of the northern end of the runway. The flightline area is characterized by extensive industrial development and is covered predominantly with pavement, gravel, and limited landscaping that is mowed routinely. In addition, an unlined drainage ditch runs through the site; however, the drainage ditch is a human-made feature that only intermittently contains water.

Site SD011 consists of the Aerospace Ground Equipment Maintenance Area, bounded by Arnold Avenue to the west and Curtis Street to the south. Two wash racks (including two former OWSs), historically used to clean vehicles, formerly were located on the eastern side of Site SD011. Current site features include an equipment maintenance building (Building 1225), three ASTs, and a small pump island. Figure 5.1-1 shows Site SD011.

5.1.2 Response Action Summary

An initial records search was conducted for Site SD011 in 1984. A flightline drainage study, facility investigations, and several investigations (including groundwater, soil, and soil vapor sampling) were conducted between 1985 and 1997. Surface and subsurface soil, soil vapor, and groundwater at Site SD011 were included in the investigation area for the Site 32/1 RI in 2004 (CH2M HILL 2004b). The 2004 RI report concluded that releases of TCE occurred from leaking OWSs and wash racks at Site SD011, resulting in TCE contamination of soil vapor.

The RI report also identified chemicals of concern (COCs) in groundwater at the site in association with a large plume originating near the flightline. Groundwater underlying Site SD011 is addressed as part of Site CG041 and is discussed in Section 5.9.

Metals contamination in surface soil also was identified; this was thought to be attributable to urban runoff from the developed area of the flightline. Lead and cadmium in surface soil at SD011 were identified in the 2004 RI report as requiring further investigation.

In 1992, three USTs were excavated and removed from the western side of Site SD011. In 1993, a pilot-scale biovent system was installed in the vicinity of the former USTs to address petroleum contamination remaining in soil. This biovent system was expanded to a full-scale system in 1996.

In 1997, the two OWSs (OWS-A and OWS-A'), located in the southeastern portion of Site SD011, were removed. Confirmation soil sampling was conducted; leachable diesel, total petroleum hydrocarbons (TPH) as gasoline (TPH-G) and TCE were detected in soil samples from both OWS-A and OWS-A'. Additional investigation was recommended at OWS-A to assess potential threats to groundwater, and OWS-A' was recommended for NFA.

In 1998, the biovent system was converted into an SVE system, to address chlorinated VOC contamination near the vehicle wash racks and the two OWSs. The highest concentrations of TPH as diesel (TPH-D), TPH-G, and VOCs in soil were in the area of the former OWS-A and the removed USTs. The soil contamination in these areas was within the capture zones of the SVE system and the former biovent system. Continued operation of the SVE system and, if needed, conversion to a biovent system, was selected as the interim remedy for Site SD011 in the Site 32/1 IROD (CH2M HILL 2007c). The interim remedy also included LUCs to restrict residential use in areas with residual soil contamination.

The SVE system was expanded in 2001 and continued to operate until 2007. In 2006 and 2007, the SVE system was evaluated for closure. Based on that evaluation, the SVE system was decommissioned in 2007, and two SVE wells were converted to bioventing wells to address residual petroleum contamination. Testing performed in August 2008 indicated that little to no biodegradation was occurring and little petroleum hydrocarbon contamination remained in the vadose zone. The biovent system was turned off on 14 August 2008. In 2010, the State approved permanent shutdown of the SVE and biovent systems, and concurred that no further remediation of vadose zone soil for VOCs was necessary to be protective of groundwater. As of 30 June 2016, the biovent system has not been fully decommissioned.

A draft proposed plan that was issued in 2014 identified the preferred alternative for addressing the remaining COC in soil (lead) to be excavation and off-site disposal. This remedial action is expected to remove soil with COC concentrations that may pose a risk to human health, and to attain the cleanup level necessary to meet the RAO (Air Force 2015g).

The current RAO for SD011 is to protect human health and the environment by preventing unacceptable exposure to lead in soil to allow UU/UE. The preliminary cleanup level for lead in soil within Exposure Area decision unit (DU) B is 80 milligrams per kilogram (mg/kg). This preliminary cleanup level was developed in the *SD011 Data Gap Investigation Work Plan* (CH2M HILL 2013b). Lead concentrations in soil at Site SD011, within Exposure Areas DU A, DU C, and DU D do not pose a threat to human health or the environment; therefore, NFA is required at these exposure areas to allow UU/UE. The final RAO and soil cleanup level for Site SD011 will be defined in the forthcoming ROD.

LUCs have been inspected semi-annually and reported annually following the Site 32/1 IROD. During this five-year review, no land disturbances or construction activities were observed. LUCs have remained effective at preventing potential exposure to soil at Site SD011.

5.1.3 Progress since the Last Review

The protectiveness statement for Site SD011, which included groundwater, in the first *Five-Year Review Report* (URS 2012) states:

> *The interim remedy for Site SD011 is considered protective of human health and the environment because LUCs are in place, there is no current or potential exposure, and groundwater monitoring and evaluation are ongoing. In addition, COC concentrations in groundwater are less than ICGs. If land use at Site SD011 were to change, or if a site closure decision was sought, then screening-specific or site-specific evaluation of potentially complete pathways for exposure via vapor intrusion would be necessary to ensure protectiveness.*

The status of the issues and recommendations presented in the first five-year review is shown in Table 5.1-1.

Table 5.1-1. Status of Recommendations from the First Five-Year Review, Site SD011

Issue	Recommendation	Current Status	Current Implementation Status Description
A consensus agreement on ARARs is necessary so that the cleanup goals and remedy can be finalized for Site 11.	Select a final remedy and finalize the ARARs and cleanup goals commensurate with future land use; prepare a decision document for Site SD011.	Ongoing	A draft proposed plan has been submitted specifying additional soil removal to address lead contamination. A ROD addressing final RAOs and cleanup levels is forthcoming.
The Air Force is required to conduct semi-annual monitoring (every 6 months), to provide annual reports to State regulatory agencies, to undertake prompt action to address an activity that is inconsistent with the LUC objectives or with use restrictions, and to address any action interfering with LUC effectiveness. The requirements for annual monitoring reports were instituted in the Site 32/1 IROD. Through 2010, annual monitoring reports on the status of the LUCs at Site 11 have not been completed.	Ensure that the LUCs established in the Site 32/1 IROD are monitored on a semi-annual basis, as required, and that the results are provided to the state regulatory agencies in annual monitoring reports.	Ongoing	LUCs at Site SD011 are monitored semi-annually as part of the Site SD032 LUC inspections, and the results are reported annually.

5.1.4 Data Review

During this five-year review, data presented in the *Site SD011 Data Gap Investigation and Risk Summary* (CH2M HILL 2014c) identified lead in surface soil from 0 to 0.5 foot bgs in two areas in Exposure Area DU B. Using Incremental Sampling Methodology (ISM), 12 replicate ISM samples were collected (three samples from each of the four DUs) and analyzed for lead and cadmium.

Exposure point concentrations (EPCs) for cadmium in the soil samples were less than the residential California Human Health Screening Level (CHHSL) (1.7 mg/kg); therefore, cadmium was not considered a COC for Site SD011. Lead was detected at concentrations less than the residential CHHSL of 80 mg/kg in Exposure Areas DU C and D and was not identified as a COC in these DUs. Lead also was not identified as a COC in Exposure Area DU A because only one sample had a concentration greater than the residential CHHSL. However, the EPC calculated for Exposure Area DU A was 286 mg/kg, which is much greater than the CHHSL. Lead detections in discrete samples that were collected to define subareas of DU A were greater than 80 mg/kg in only three samples, with concentrations ranging from 80.4 to 128 mg/kg. The 95 percent upper confidence limit (UCL) for these discrete samples was 69 mg/kg, which is less than the CHHSL. Based on these results, lead was not considered a COC in DU A.

In Exposure Area DU B, the EPC for lead in soil was 245 mg/kg. Only three replicate samples surpassed the 80 mg/kg CHHSL. However, 13 of the 26 discrete samples had lead concentrations greater than 80 mg/kg, with concentrations ranging from 81.2 to 1,980 mg/kg. The 95 percent UCL for the discrete samples is 272 mg/kg; therefore, lead was identified as a COC in soil in this DU. Table 5.1-2 shows the results for the discrete samples collected from Exposure Area DU B.

Table 5.1-2. Lead Concentrations from Discrete Soil Sample Results from Exposure Area DU B, Site SD011, May 2013

Sample Location	Result (mg/kg)
11C041HA	6.65
11C042HA	5.98
11C043HA	6.01
11C04HA	6.35
11C045HA	7.96
11C046HA	9.94
11C047HA	**81.2**
11C048HA	69.7
11C049HA	87
11C050HA	**117**
11C051HA	14.3
11C052HA	**81.4**
11C053HA	**112**
11C054HA	**241**
11C055HA	**141**
11C056HA	65.3
11C057HA	**185**
11C058HA	**221**
11C059HA	**110**
11060HA	63
11061HA	13.4
11062HA	18.4
11C063HA	21.1
11C064HA	9.12
11C065HA	**638**
11C066HA	**1,980**

Note:
Bold = Result is greater than the project screening level (80 mg/kg)
Source: CH2M HILL 2014c:Table 4-3

5.1.5 Technical Assessment

QUESTION A: Is the remedy functioning as intended by the decision documents?

Yes, the interim remedies are functioning as intended. COCs have been remediated in soil, with the exception of lead in Exposure Area DU B, and LUCs are in place and effective. Remaining lead contamination in Exposure Area DU B needing further remediation was identified in a draft proposed plan, with the intention of meeting the RAO of UU/UE. The forthcoming ROD for the site will define the Site SD011 RAOs and cleanup levels.

QUESTION B: Are the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of the remedy selection still valid?

Yes, assumptions used at the time of the remedy selection remain valid. Current and anticipated future land uses are identified in the General Plan. The current and future anticipated land use of SD011 is industrial. Previous investigations and risk management decisions were based on the assumption that future land use would remain industrial. Because of the flightline access restrictions at the site, Site SD011 is unlikely to be used for recreational purposes. In addition, ecological exposures and risk were concluded to be minimal because of the majority of the site being covered with concrete or asphalt, and the limited grassy areas are mowed regularly (CH2M HILL 2014c).

- Chemicals of concern in surface soil for human health were limited to cadmium and lead, and the primary COCs in soil vapor were TCE and cis-1,2-Dichloroethene (DCE) (Air Force 2015g; CH2M HILL 2013b). The assumptions regarding land use reflected in the human health and ecological risk assessment (HHERA) and supplemental documents are still valid (CH2M HILL 2013b, 2014c), commercial/industrial (hypothetical residential also evaluated to assess the need for land use controls), and no changes to the COCs are anticipated.
- Default exposure assumptions used by EPA for human health risk assessment have become slightly less conservative from 2006 to 2017, and therefore the former exposure assumptions remain valid with increased potential for overestimation of exposure (i.e., more conservative than necessary).
- Cadmium data collected during the 2013 data gaps evaluation demonstrated non-detect concentrations or detections below the method reporting limit (CH2M HILL 2014c). The detections below the reporting limit were also lower than the CHHSL for a residential scenario (1.7 mg/kg) (OEHHA 2010). This CHHSL is lower than the more current DTSC screening levels for cadmium in soil (residential = 5.2 mg/kg and commercial/industrial = 7.3 mg/kg) (DTSC 2017), supporting the previous conclusion that cadmium is not a COC in soil at SD011.
- In the draft proposed plan that has been submitted (Air Force 2015g), additional soil removal is proposed to address residual lead contamination in Exposure Area DU B. The preliminary cleanup level for lead is the CHHSL for residential soils of 80 mg/kg (OEHHA 2010), which was selected in the *SD011 Data Gap Investigation Work Plan* (CH2M HILL 2013b). This CHHSL is equivalent to the more current DTSC screening level for residential soil (DTSC 2017), and therefore is still protective of human health. The final RAO and soil cleanup level for Site SD011 will be defined in the forthcoming ROD.
- As part of the draft proposed plan (Air Force 2015g), risks associated with rebound soil vapor data collected in August 2007 were evaluated to determine if the residual VOC concentrations may be a concern for potential future residential use. The rebound sampling results were compared to soil-vapor-to-indoor-air risk-based screening levels (RBSLs). With the exception of TCE, all of the detected VOC concentrations, including the other primary COC (cis-1,2-DCE) are less than soil-vapor-to-indoor-air RBSLs. The associated estimated cancer risk is 2×10^{-6}, which is within EPA's risk management range of 10^{-6} to 10^{-4} (one in a million to one in ten thousand) for cancer risks (EPA 1990), and the hazard index (HI) is less than 1. Based on the lines of evidence (i.e., majority of VOC mass removed, low residual concentrations), the conclusion was made that no COCs in soil vapor exist.
- The potential for risk to burrowing rodents from inhalation of burrow air is also at an acceptable level because the most current DTSC (2011b) inhalation toxicity reference values (TRVs) for burrowing mammals for TCE (low TRV = 6,400 µg/m^3 and high TRV = 32,000 µg/m^3) and cis-1,2-DCE (low TRV = 19,000 µg/m^3 and high TRV = 94,000 µg/m^3) are higher than the human health RBSLs for soil vapor cited above on which risk management decisions were based.

As previously stated, land usage at SD011 remains consistent with the commercial/industrial scenario evaluated in the risk assessment and there is no change in habitats. Given the RAOs are based on protection of residential land use to allow UU/UE, the selected remedy to address residual lead contamination at Exposure Area DU B will be protective of human health should land use change for this site in the future. After the additional soil removal activities are completed for lead, the EPC (i.e., 95 percent UCL) for Exposure Area DU B will be recalculated and compared to the final cleanup goal.

QUESTION C: Has any other information come to light that could call into question the protectiveness of the remedy?

No other information has come to light that could call into question the protectiveness of the remedy.

5.1.6 Issues/Recommendations

The following issues were identified in the technical assessment for Site SD011:

- Lead concentrations remaining in soil in Exposure Area DU B do not allow UU/UE.
- A decision document is needed to establish the final remedy, RAOs, and cleanup goals commensurate with UU/UE for Site SD011.

The following recommendations and follow-up actions are intended to address the issues identified during the technical assessment for Site SD011:

- Implement the preferred remedial alternative of additional soil excavation in Exposure Area DU B, to reduce remaining lead concentrations to a level suitable for UU/UE.
- Select a final remedy in a decision document and establish the final RAOs and lead cleanup level for Site SD011.
- Post-remediation confirmation data will be collected for lead that will be used to recalculate the EPC for Exposure Area DU B to verify that the final cleanup goal has been met.

5.1.7 Protectiveness Statement

The interim remedy for Site SD011 is protective of human health and the environment in the short-term because LUCs are in place to prevent potential exposure to remaining contamination in soil. The remedy is expected to be protective in the long-term, when the final remedial actions are taken:

- *Remove the remaining lead contaminated soil in DU B.*
- *Finalize a decision document selecting NFA following completion of soil removal.*

In the interim, remedial activities completed to date have adequately addressed all exposure pathways that could result in unacceptable risk in these areas.

5.1.8 Next Review

The next five-year review report for Site SD011 is required five years from the completion date of this review.

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Figure 5.1-1
Site SD011 Features Map
Second Five-Year Review
Beale AFB

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5.2 Site LF013

5.2.1 Introduction

Site LF013 encompasses approximately 429 acres and is on the southwestern boundary of Beale AFB. Open fields and grazing land surround Site LF013, and Hutchinson Creek flows along the site's southern and western boundaries. Site LF013 is shown in Figure 5.2-1 and encompasses inactive former Landfill No. 1 and nearby Site WP002.

Former Landfill No. 1 was a trench-and-fill landfill used by local farmers for disposal of domestic waste prior to the establishment of Camp Beale in 1942. From 1942 to 1948, while the U.S. Army (Army) occupied Camp Beale, both the Army and civilians continued to use the landfill for disposal. Debris disposed during this period reportedly included Army personnel equipment, incinerator ash, domestic debris, and M-5 skin ointment tubes made of lead. Disposal of Base operations-related waste continued into the mid-1950s.

Subsite WP002 consisted of several facilities involved in transporting, treating, and disposing of wastewater from the photographic laboratory (Building 2145). The facilities included a 2.3-mile dedicated pipeline from the photographic laboratory to the photographic wastewater treatment plant (PWTP), two unlined sludge ponds, sand and limestone filters, filter surge tanks, and three abandoned injection wells. The PWTP operated from 1966 to 1990. In 1990, use of the PWTP and the two sludge ponds was discontinued. In 1991, the plant was decommissioned. Subsite DP019 consisted of a portion of the PWTP facility adjacent to Subsite WP002, and included a clarifier, neutralizer basin, drying beds, and blending basin. Subsite WP020, located northwest of the wastewater treatment plant, consisted of an unlined grease pit or trench constructed in 1974 and AOC 26, which consisted of two World War II-era disposal areas (one southwest and one northeast of the PWTP). The boundaries of Subsites DP019 and WP020 overlap the boundaries of Site LF013 in some areas; however, it has been determined that all residual contamination remaining at Subsite WP002 is part of Site LF013.

The no further response action planned decision document for Site WP002 specified continued industrial land use and established LUCs (Radian International 1999b). The CVWB concurred with the closure of Site WP002 in 2000 (Reeves 2000). Site WP002 was administratively closed as part of the Site LF013 ROD (Air Force 2016a). As Site WP002 is contained wholly within Site LF013, the LUCs for Site WP002 were transferred to Site LF013.

Contaminated groundwater beneath Site LF013 is addressed as part of Site CG041 in Section 5.9 and is not discussed further in this section.

5.2.2 Response Action Summary

Preliminary assessment/site inspection activities at Site LF013 began in 1985, and subsequently, a phased RI was conducted to delineate the extent of soil, soil vapor, and groundwater contamination at the site. Between 1996 and 2011, the Air Force completed several interim cleanup actions at Site LF013 to address contamination in soil and soil vapor.

The Site LF013 East SVE system, which began operating in 1996, was designed to address VOC contamination resulting from disposal of refuse. The East SVE system was shut down in January 2001 because soil vapor concentrations had reached interim cleanup goals and the treatment system was removed from the site in June 2003. The Site LF013 West SVE system began operating in 1997 to address VOC contamination in soil gas at the M-5 ointment tube disposal area. Upgrades were made to the West SVE system in 2005 and 2007. In June 2009, soil vapor samples were collected from the SVE West system extraction wells after a 6-week shutdown to assess potential rebound. The West SVE system was permanently shut down in December 2009 and was removed.

Between June 2004 and February 2005 all surface vegetation was cleared from the landfill and borrow soils were imported and placed in 10 to 12inch lifts and compacted to a total cover thickness of between 4 feet near the edges to a maximum thickness of 9 feet in the interior portions of the cover, with an average thickness of 6 feet. The placement of a soil cover over the former landfill is consistent with EPA's Municipal Landfill Presumptive Remedy and the application of the presumptive remedy to military landfills (EPA 1993). Because of the risks and cost associated with the removal of landfill wastes, the presumptive remedy establishes containment of waste/contaminants in place as the preferred remedy for landfills.

An IROD was approved for Site LF013 in April 2010 (Air Force 2010). The IROD presented remedy was intended to achieve the following RAOs:

- Continue to control and treat groundwater contamination to protect designated beneficial uses of water resources.
- Restore groundwater to interim cleanup goals within a reasonable time.
- Continue operation of the West SVE system to optimize groundwater cleanup and prevent the migration of contaminants from soil to groundwater at concentrations that could result in an exceedance of interim cleanup goals.
- Restrict potential exposure to chlorinated VOCs in groundwater.

In September 2010, the Site LF013 in situ bioreactor was installed to remove shallow soil near vapor monitoring point (VMP) 1, because of construction excavation, and to treat TCE contaminated groundwater. During the 2010 bioreactor excavation, additional M-5 ointment tubes and related debris were encountered, and an additional 150 tons of waste soil and tubes were removed. During the 2011 bioreactor expansion, the M-5 ointment tube disposal cell was re-encountered and subsequently excavated to the northwest. An additional 243 tons of waste materials were removed from the M-5 ointment tube disposal cell at that time.

In 2013, a data gap investigation was conducted to assess current concentrations of VOCs. The results of this investigation indicated that no further remediation of VOCs in vadose zone soil was required (CH2M HILL 2014b).

A final ROD for LF013 ROD was presented in February 2016 (Air Force 2016a) and establishes the following RAOs for soil at Site LF013:

- Protect human health by preventing exposure to COCs in soil that would result in an unacceptable risk to onsite residents and/or workers.
- Protect ecological receptors from exposure to COCs in soil that may pose an unacceptable risk.

To meet these RAOs, the Air Force selected LUCs to prohibit residential land use, restrict intrusive activities, and maintain the integrity of existing soil covers (Air Force 2016a).

5.2.2.1 Status of Implementation

The Site LF013 ROD continued LUCs as part of the selected remedy for the site (Air Force 2016a). LUCs have been implemented since the IROD in 2010 and inspections occur on a semi-annual basis. Inspection activities conducted are documented annually in the basewide LUC inspection report.

During the inspections, the former Landfill No. 1 soil cover, Site WP002 soil covers, and the GTS are inspected. In March 2015, approximately 6 to 12 inches of settlement was observed in the soil cover along the southern portion of the bioreactor (CH2M HILL 2016b). If ponding was observed in winter 2015–2016, clean fill would be placed and seeded to restore proper drainage. Additionally, cracks were observed in the soil mound along the east, west, and south edges of the south zone during both inspections. The cracks were patched with clean fill soil following both inspections in 2015.

Land disturbance was not observed during the 2015 annual inspection. LUC inspection activities also include inspections of portions of Deep Violet Farms to the west of the Base boundary that fall within the IROD LUC boundary. However, the Air Force cannot enforce LUCs off-base and all TCE concentrations at Deep Violet Farms are below the maximum containment level (MCL) (CH2M HILL 2016b). Therefore, no corrective actions are necessary.

5.2.2.2 Systems Operations/Operation and Maintenance

All remedial activities, with the exception of groundwater (addressed as Site CG041-013), were completed at Site LF013 before the period of this five-year review. Therefore, O&M activities are not discussed.

5.2.3 Progress since the Last Review

The protectiveness statement for Site LF013, which included groundwater, in the first *Five-Year Review Report* (URS 2012) states:

> *The remedy for LF013 is protective of human health and the environment in the short term because the off-base receptor (Deep Violet Farms) has been provided an alternate water supply source and there are currently no other at-risk receptors. A pump-and-treat system is currently capturing most of the contaminant plume. However, there are portions of the plume that are not being captured by the system, and the contaminant plume has migrated off base. Therefore, the groundwater remedy must be optimized to address these issues. Additionally, ICs protective of the groundwater resource must continue to be implemented to ensure that no receptors are exposed to COCs at concentrations greater than ICGs. If the current land use at Site LF013 were to be changed to unrestricted use, or if a building were to be constructed, the potential risk from vapor intrusion into enclosed spaces should be evaluated.*

The status of the issues and recommendations presented in the first five-year review is shown in Table 5.2-1.

Table 5.2-1. Status of Recommendations from the First Five-Year Review, Site LF013

Issue	Recommendation	Current Status	Current Implementation Status Description	Completion Date (if applicable)
The Air Force is required to conduct semi-annual monitoring (every 6 months), provide annual reports to State regulatory agencies, and undertake prompt action to address activity that is inconsistent with the LUC objectives or use restrictions, or any action that may interfere with LUC effectiveness. The requirements for annual monitoring reports were instituted in the Site 13 IROD. Through 2010, annual monitoring reports on the status of the LUCs at Site 13 have not been completed.	Ensure that the LUCs established in the Site 13 IROD are monitored on a semi-annual basis, as required, and that the results are provided to the state regulatory agencies in annual monitoring reports.	Ongoing	LUCs were established as part of the interim remedy in the LF013 IROD (2010) and were continued as the preferred remedy in the final ROD (2016). LUCs have been monitored semi-annually and reported annually since 2010.	N/A
	Evaluate the need for further operation of the SVE west system.	Completed	Both SVE systems have been shut down and removed based on evaluations for the need for further operation.	2009
A consensus agreement on ARARs is necessary so that the cleanup goals and remedy can be finalized for Site 13.	Finalize RAOs, ARARs, cleanup goals, and the remedial action components in a final document.	Completed	Soil RAOs and remedial actions are addressed in the Site LF013 ROD.	February 2016

5.2.4 Data Review

The final ROD did not identify any COCs for soil vapor, surface water, or sediment (Air Force 2016a). LUCs and a soil cover prevent exposure to remaining COCs as the final selected remedy for soil. Data collected during this five-year review is presented next.

During a 2013 data gap investigation at Site LF013 (CH2M HILL 2014b), no VOCs were detected in shallow (10 feet bgs or less) soil vapor at concentrations that exceeded project screening levels (PSLs). None of the vapor samples collected from borings situated along the perimeter of the former landfill contained detectable concentrations of VOCs in soil vapor, with the exception of one detection of TCE in a perimeter boring and one detection of tetrachloroethene (PCE) in another perimeter boring.

One detection of methane in deep soil vapor (30 to 33 feet bgs) exceeded the PSL selected for the protection of indoor air (5 percent lower explosive limit); methane was not detected at a depth of 5 feet bgs in an adjacent soil vapor boring. In addition, none of the perimeter borings contained any detectable concentrations of methane. These data suggest that installation of the soil cover did not promote lateral migration of VOCs or methane in soil vapor. These data also suggest that current concentrations of VOCs and methane in soil vapor do not pose an unacceptable risk to human health via the VI pathway CH2M HILL 2014b). Based on these data, no further remediation of VOCs (as soil vapor) in vadose zone soils is believed to be required.

Soil at Site LF013 is contaminated with metals (primarily lead) and dioxins/furans at concentrations greater than levels considered protective of human health and the environment; therefore, it does not support UU/UE. Contamination remains covered in place and no further remedial efforts are planned. Therefore, monitoring or sampling of soil at Site LF013 no longer occurs and focus is now on upholding the LUCs that include maintaining the integrity of the clean cap to minimize the potential for exposures by humans and wildlife.

5.2.5 Technical Assessment

QUESTION A: Is the remedy functioning as intended by the decision documents?

Yes, the Site LF013 remedy is functioning as intended by the Site LF013 IROD and, as of 2016, the final Site LF013 ROD. Through the implementation of interim remedies at Site LF013 including excavation, SVE, and bioventing, the concentration and volume of COCs at the site has been reduced. In addition, the installation of soil covers over the former landfill and portions of the former PWTP wastewater pipeline has also reduced the potential for exposure to remaining COCs. The Air Force implemented interim LUCs at Site LF013 to restrict land use (i.e., no residential land use) and invasive activities to minimize the potential for exposure and maintain the integrity of the existing soil covers. Those LUCs were selected as the final remedy for Site LF013 and will remain in place in perpetuity to provide long-term protectiveness at Site LF013.

LUCs are in place and effective. LUCs continue to be inspected semi-annually and reported in the Base *Land Use Control Inspection Report*. There are no outstanding issues associated with the LUC requirements at Site LF013.

QUESTION B: Are the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of the remedy selection still valid?

Yes, exposure assumptions, toxicity data, and RAOs used at the time of the Site LF013 ROD are still valid for protection of human exposure to COCs remaining in soil. Land uses and development capabilities are presented in the *Installation Development Plan* (IDP) (Michael Baker International 2015). The General Plan designates the Site LF013 area as an industrial area (the site lies adjacent to the Base wastewater treatment plant), thus residential land use is not currently allowed or planned for the foreseeable future. Beale AFB is expected to remain an active military installation into the foreseeable future. Current land use at the site is reasonably anticipated to continue indefinitely to support the mission of the facility.

- Chemicals of concern in soil for human health and the environment were limited to metals (primarily lead) and dioxins/furans. No COCs in sediment or surface water of Hutchinson Creek were identified, with the possible exception of nitrogen in surface water. However, the source of elevated nitrogen levels is most likely the wastewater treatment plant, and nitrogen is not believed to be a contaminant originating from Site LF013. Consequently, risk to fish and aquatic plants in surface water associated with Site LF013 was considered acceptable. The assumptions regarding land use reflected in the HHERA and supplemental documents are still valid (CH2M HILL 2001; Air Force 2016a), i.e., commercial/industrial (hypothetical residential also evaluated to assess the need for land use controls), and there are no anticipated changes to the COCs.
- Risk from exposure to groundwater will be addressed as part of Site CG041 (basewide groundwater) and was not presented in the Final ROD for LF013 (Air Force 2016a).
- TCE, 1,1,2,2-tetrachloroethane (TECA), 1,1,2-trichloroethane (TCA), and PCE were identified as COCs in soil vapor at Site LF013 in the RI (CH2M HILL 2001) and in the IROD (Air Force 2010). Following completion of the human health risk assessment (HHRA) (CH2M HILL 2001), additional soil vapor samples were collected during a 2013 data gap investigation and a screening-level VI assessment was conducted to assess levels of risk in recently remediated areas of Site LF013 and to evaluate migration of VOCs from soil to indoor air. Potential VI

risks from VOCs in soil vapor for future industrial and future residential exposures were evaluated using the 2013 soil vapor data collected after completion of remedial activities in areas of previously high soil vapor concentrations. Risk estimates for VOCs in soil vapor from those areas ranged from 4×10^{-9} to 5×10^{-7} for the commercial/industrial exposure scenario, which is below the acceptable risk threshold of 1×10^{-6} (de minimis). For the hypothetical residential scenario, risk estimates ranged from 4×10^{-8} to 5×10^{-6}. These risk estimates are less than EPA's risk management range of 10^{-6} to 10^{-4} (one in a million to one in ten thousand) for cancer risks (EPA 1990) and are still valid because the assumptions used to calculate the RBSLs for indoor air (CH2M HILL 2015i) for the risk-driving COCs in soil vapor are still valid based on current DTSC guidance for VI (DTSC 2011a) TCE = 3 µg/m^3, tetrachloroethene (PCE) = 2.1 µg/m^3, 1,1,2,2-TECA = 0.21 µg/m^3, and 1,1,2-TCA = 0.77 µg/m^3. CH2MHill (2015i) applied DTSC's current attenuation factor for future commercial buildings of 0.0005 to convert these indoor air RBSLs to soil vapor RBSLs for the purposes of estimating risk from soil vapor: TCE = 5,982 µg/m^3, PCE = 4,157 µg/m^3, 1,1,2,2-TECA = 420 µg/m^3, and 1,1,2-TCA = 1,533 µg/m^3. The indoor RBSLs for non-cancer effects are higher for these 3 COCs (i.e., cancer-based values would also protect for non-cancer effects).

Recent vapor intrusion guidance has been published by EPA recommending a default attenuation factor for screening assessments of 0.03 (EPA 2015). Applying this worst case attenuation factor to the indoor air RBSLs results in soil vapor RBSLs that are approximately sixty times lower than when using DTSC's attenuation factor for future commercial buildings (see table below). Using the soil vapor RBSLs with EPA's default attenuation factor and the most current soil vapor data collected as part of the 2013 data gaps investigation results in the following risk estimates:

Chemical of Concern	2013 Maximum Soil Vapor Concentrations (µg/m^3)	Soil Vapor RBSL - Attenuation Factor = 0.03 (µg/m^3)	Cancer Risk
TCE	500	100	5.0×10^{-6}
PCE	50	70	7.1×10^{-7}
1,1,2,2-TECA	137	7.0	2.0×10^{-5}
Total Cancer Risk			2.5×10^{-5}

1,1,2-TCA was not detected in soil vapor samples collected in July and September 2013.

These cancer risk estimates are within the EPA's risk management range, and are considered worst-case, conservative values because no buildings are currently present at LF013 and none are likely to be constructed in the future. LF013 is an old, small, mixed landfill located directly adjacent to the sludge drying beds from the wastewater treatment plant, and is not an ideal location for new construction or worker placement. In addition, 1,1,2,2-TECA (risk driver) was not detected in any shallow soil vapor samples, and this COC was only detected in deep samples isolated to the perimeter of the bioreactor, which is adequately addressing the remaining 1,1,2,2-TECA in deep soil gas as part of the groundwater remedy (CH2M Hill 2015i). TCE was only detected in one perimeter well boring sample in 2013.

In addition to EPA's updated vapor intrusion guidance, the DTSC issued health-based short-term indoor air criteria for TCE in their HHRA Note 5 (2014), which was published in response to EPA's release of its updated TCE guidance (EPA 2014). Both agencies concur with use of the *Accelerated Response Action Levels* and *Urgent Response Action Levels* for indoor air concentrations of TCE that have been developed for residential, commercial/industrial (8-hour workday), and commercial/industrial (10-hour workday) exposure scenarios (EPA 2014, DTSC 2014). The purpose of the Accelerated Response Action Levels is to assess short-term indoor inhalation exposures to protect sensitive and vulnerable populations (i.e., developing fetus). Commercial/ industrial land use is the only current and anticipated future use for the Site; therefore, the commercial/industrial (8-hour) action level of 8 µg/m^3 is the most appropriate screening level for the Site. As stated above, the indoor air RBSL for TCE selected for the commercial worker is 3 µg/m^3, i.e., the EPA Industrial Air RSL for TCE (EPA

2017), which corresponds to a long-term target cancer risk level of $1x10^{-6}$. This value is less than the short-term commercial/industrial accelerated action level protective of sensitive and vulnerable populations (DTSC 2014, USEPA 2014), (i.e., 8 µg/m^3). Thus, the site RBSL for TCE is already protective of the short-term non-cancer effects of TCE under a commercial land use scenario. Applying EPA's default attenuation factor of 0.03 and DTSC's attenuation factor of 0.0005 to the Accelerated Response Action Level of 8 µg/m^3 results in the following hazard estimates:

2013 TCE Soil Vapor Data (µg/m^3)	EPA Accelerated RAL – Attenuation Factor = 0.03 (µg/m^3)	Hazard Quotient	EPA Accelerated RAL – Attenuation Factor = 0.0005 (µg/m^3)	Hazard Quotient
500	267	1.9	16,000	0.03

The HQ for short-term exposures to TCE using EPA's worst-case attenuation factor is <2 times greater than the target of 1.0, while the HQ using DTSC's more realistic attenuation factor for future commercial buildings is less than this target.

- The potential for risk to burrowing rodents from inhalation of burrow air is also at an acceptable level because the most current DTSC (2011b) inhalation TRVs for burrowing mammals for TCE (low TRV = 6,400 µg/m^3 and high TRV = 32,000 µg/m^3), PCE (low TRV = 24,000 µg/m^3 and high TRV = 121,000 µg/m^3), and 1,1,2-TCA (low TRV = 810 µg/m^3 and high TRV = 8,100 µg/m^3) are higher than or equivalent to the human health RBSLs for soil vapor cited above on which risk management decisions were based (no inhalation TRV is available for 1,1,2,2-TECA).
- Although one detection of methane in deep soil vapor (30 to 33 feet bgs) exceeded the PSL, methane was not detected at a depth of 5 feet bgs in an adjacent soil vapor boring. In addition, none of the perimeter borings contained any detectable concentrations of methane. These data suggest that installation of the soil cover did not promote lateral migration of VOCs or methane in soil vapor, and that current concentrations of VOCs and methane in soil vapor do not pose an unacceptable risk to human health under an occupational scenario (Air Force 2016a).
- The DTSC LEADSPREAD spreadsheet was used to calculate risk to on-base workers and hypothetical future residents from concentrations of lead at Site LF013. As presented in the RI, the results indicated predicted blood lead concentrations of above the acceptable state criterion of 1 µg/dL, which is still a valid criterion (DTSC 2017). The elevated lead concentrations were primarily observed in subsurface soil at former Landfill No. 1 (which is currently beneath the existing soil cover). Lead is considered a COC but the current LUCs are effectively managing potential exposure of humans and wildlife.
- As presented in the RI, dioxins/furans in soil associated with the PWTP wastewater pipeline were identified as COCs that may result in a risk to invertivorous rodents. In addition, lead and zinc in soil within the former landfill were identified as COCs that may result in a risk to plants and soil invertebrates. However, as presented in the FS, these areas are small in relation to the amount of available similar habitat on the Base and in the surrounding region, and it was concluded that the levels of contamination in these areas are not expected to adversely affect populations not inhabiting the site. Given the lack of changes to land use and site habitat conditions and because of the clean soil cap on the landfill that is maintained as part of the LUCs, this is still a viable conclusion.

For soil, the selected remedy is protective of human health (based on current and anticipated site use) in the short and long term. As previously stated, land usage at LF013 remains consistent with the commercial/industrial scenario evaluated in the risk assessment and there is no change in habitats. If land usage does change at LF013, then a re-evaluation of the risk assessment may be warranted. Open space currently dominates the site, and risk estimates for metals and dioxins/furans in soil under a recreational exposure scenario are already low, ranging from 2×10^{-8} to 4×10^{-6} (Air Force 2016a) and less than or within the risk management range of 10^{-4} to 10^{-6}. Recreational outdoor air exposure is likely to be minor compared to the residential or industrial indoor air exposure scenario because of dilution by mixing with ambient air and wind effects in the outdoor scenario. Risks for exposure to indoor air under the residential and industrial scenarios are below or equal to the lower end of the risk management range and the HI are less than 1; therefore, recreational risks are considered de minimis (i.e., below the target risk management levels) (Air Force 2016a).

QUESTION C: Has any other information come to light that could call into question the protectiveness of the remedy?

No other information has come to light that could call into question the protectiveness of the remedy at Site LF013.

- Currently, groundwater at the base, including the TCE plume under LF013, is monitored on a sitewide basis, as groundwater is now considered a distinct operable unit that contains plumes from several sites. A review of the protectiveness of the groundwater RAOs by remedy type will be conducted in the 5-year review for basewide groundwater, which will include an assessment of the VI pathway with particular focus on sites with groundwater plumes and buildings present. Risk implications of constructing buildings in the future will also be discussed.

5.2.6 Issues/Recommendations

No issues or recommendations were identified for Site LF013.

5.2.7 Protectiveness Statement

The remedy at Site LF013 is protective of human health and the environment under current and anticipated future land uses. If these conditions change and, for example, buildings are constructed, the implications to human health risk may need to be re-evaluated.

5.2.8 Next Review

The next five-year review report for Site LF013 is required five years from the completion date of this review.

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Figure 5.2-1
Site LF013 Features Map
Second Five-Year Review
Beale AFB

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5.3 Site OT017

5.3.1 Introduction

Site OT017 occupies a low, gently sloping grassland and riparian habitat of approximately 500 acres adjacent to Best Slough in the southeastern portion of the Base. Best Slough, now relocated, flows along the northern side of the site, bends in a southerly direction, and continues to flow along the western side of the site. Dry Creek flows to the south along the eastern side of the site. Generally in summer, the groundwater flows into the streams. During storm episodes in winter, the streams recharge the groundwater. Parks Lake is a relatively small and shallow lake and is in the center of the southern area of Site OT017, between Best Slough and Dry Creek. Figure 5.3-1 shows Site OT017. The groundwater beneath Site OT017 is included as part of Site CG041 (basewide groundwater) and is identified as CG041-017. Collectively, Site OT017/CG041-017 is within a riparian habitat preservation area, as indicated in Beale AFB's Integrated Natural Resources Management Plan.

In 1985, eleven shallow trenches were identified in what was the floodplain of the northern side of the former location of Best Slough, west of the Gavin Mandery Drive Bridge over Best Slough. One of the trenches contained approximately 40 rusted 55-gallon steel drums. Other trenches contained remnants of steel drums, rock, and construction debris. These trenches were within the defined primary source area, which now is encompassed by a slurry wall. An underground sewer line crosses the northern portion of the site (CH2M HILL 2004c).

Historically, chlorinated solvents (i.e., PCE, TCE, and TCA) and/or fuel hydrocarbons (i.e., benzene, toluene, ethylbenzene, and xylene [BTEX]) have been detected in all media sampled at Site OT017 (Law 1995a). Groundwater is the only contaminated medium undergoing remediation that is associated with the site, but because of the shallow water table at the site (less than 10 feet bgs), groundwater has been identified as having the potential to contaminate surface water and soil vapor (from off-gassing of VOCs) (Air Force 2014a). Groundwater contamination at Site OT017 (addressed as Site CG041-017) is discussed in Section 5.9.

5.3.2 Response Action Summary

NFA was identified in the FS as the preferred remedy for soil (CH2M HILL 2005a) because additional soil remediation would not provide additional protection to groundwater. No COCs were identified for surface water or sediment. General RAOs for Site OT017 that are presented in the FS are as follows:

- Protect human health and the environment by reducing the risk of potential exposure to contaminants.
- Expedite cleanup and restoration of contaminated sites.
- Restore contaminated sites to the extent necessary to support existing and proposed land uses.
- Achieve compliance with ARARs.

RAOs specific to Site OT017 also were presented in the FS and are as follows:

- Continue to operate, maintain, and monitor the slurry-wall containment and pumping system to prevent the migration of groundwater contaminants away from the primary source area, and thus minimizing further degradation of groundwater quality.
- Restore the quality of groundwater at the site, to the extent technically and economically feasible, such that groundwater is acceptable for designated beneficial uses. Beneficial uses include municipal and domestic water supply, agricultural supply, industrial service supply, and industrial process supply.
- Control and monitor the migration of groundwater contaminants to minimize expansion of the dissolved-phase plume.
- Protect human health by preventing exposure to contaminants in groundwater that would result in an increased lifetime cancer risk greater than 1×10^{-6} or a hazard index greater than 1 under a residential exposure scenario.
- Prevent the migration of contaminants from soil to groundwater at concentrations that would result in further degradation of groundwater quality or would cause noncompliance with ARARs.

LUCs were selected as the interim remedy for soil (Air Force 2007), to prevent potential exposure as groundwater remediation continues. Groundwater response actions (addressed as part of CG041-017) are discussed in Section 5.9.

In 2013, the *Site OT017 Risk Summary and Path Forward* (CH2M HILL 2013i) report presented the following steps to achieve Response Complete for the site:

1. Prepare a Proposed Plan and Record of Decision, selecting No Action for soil and soil vapor (no COCs in sediment or surface water). The existing LUCs would be referenced in the Proposed Plan and Record of Decision. This would document Response Complete for Site OT017.
2. Continue semi-annual LUC inspections and annual LUC reporting under Site CG041.
3. Monitor surface water as part of the Basewide Groundwater Monitoring Program (Site CG041).
4. Manage groundwater and related issues as part of Site CG041.

LUC inspections have occurred every 6 months, as required, throughout this five-year review period. The dig permit process followed by the Operation Flight of the Civil Engineering Office has been effective in preventing disturbance of the ground surface at Site OT017 and in preventing exposure to soil vapor contaminated with VOCs from off-gassing at the groundwater surface (CH2M HILL 2011j, 2012c, 2013g, 2014f, 2016e).

5.3.3 Progress since the Last Review

The protectiveness statement for Site OT017, which included groundwater, in the first *Five-Year Review Report* (URS 2012) states:

> *The interim remedy for Site OT017 is protective of human health and the environment because there is no current risk to potential receptors. Best Slough has been rerouted and the DNAPL* [dense non-aqueous phase liquid] *is being contained. Dissolved-phase groundwater contamination is being treated passively through phytoremediation and a ZVI* [zero-valent iron] *PRB* [permeable reactive barrier]*. Groundwater monitoring and evaluation and LUCs are in place to ensure that potential receptors remain protected. The interim remedy is protective in the long term, as long as LUCs remain in place and adequate O&M of the hydraulic control system occurs to ensure that the DNAPL is contained.*

The status of the recommendations presented in the first five-year review is shown in Table 5.3-1*.*

Table 5.3-1. Status of Recommendations from the First Five-Year Review, Site OT017

Issue	Recommendation	Current Status	Current Implementation Status Description
The Air Force is required to conduct semiannual monitoring (every 6 months), provide annual reports to the State regulatory agencies, and undertake prompt action to address activity that is inconsistent with the LUC objectives or use restrictions, or any action that may interfere with LUC effectiveness. The requirements for annual monitoring reports were instituted in the Site 17 IROD. Through 2010, annual monitoring reports on the status of the LUCs at Site 17 have not been completed.	Ensure that the LUCs established in the Site 17 IROD are monitored on a semi-annual basis, as required, and that the results are provided to the state regulatory agencies in annual monitoring reports.	Ongoing	LUCs continue to be monitored on a semi-annual basis, and the results are reported annually.
Final ARARs and a final decision document that addresses all media of concern have not been completed for Site 17.	Finalize the ARARs and the selected remedy for all impacted media at Site 17, including possible removal of the DNAPL, and complete the final decision document for the site.	Ongoing	LUCs continue to be the interim remedy for all non-groundwater media. A final ROD for Site OT017 is forthcoming.

5.3.4 Data Review

Sampling activities for non-groundwater media at Site OT017 were not conducted during this five-year review period.

5.3.5 Technical Assessment

QUESTION A: Is the remedy functioning as intended by the decision documents?

Yes, the interim remedy is functioning as intended by the Site OT017 IROD. LUCs continue to limit access to site soils, preventing human exposure to VOCs potentially off-gassing from groundwater.

QUESTION B: Are the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of the remedy selection still valid?

Yes, exposure assumptions, toxicity data, ICGs, and RAOs used at the time of the Site OT017 Area B IROD still are valid for protection of the groundwater resource. All media (with the exception of groundwater) are identified as requiring NFA or do not contain any identified COCs. LUCs remain necessary to protect human health until groundwater RAOs are attained. Land use is controlled through the Beale AFB Master Planning process. Current and anticipated future land uses are identified in the General Plan. The General Plan designates this area as a riparian habitat preservation area. Site OT017 consists of an open space between two waterways (Best Slough and Dry Creek). The General Plan designates existing and planned future land use for Site OT017 as open space. Beale AFB is expected to remain an active military installation into the foreseeable future. Current land use is reasonably anticipated to continue indefinitely to support the mission of the facility. If future land use differs from the reasonably anticipated land use, the Air Force will re-assess risks appropriate for future use.

The groundwater beneath Site OT017 is included as part of Site CG041 (basewide groundwater) and is identified as CG041-017. Collectively, Site OT017/CG041-017 is within a riparian habitat preservation area in Beale AFB's Integrated Natural Resources Management Plan.

- As stated previously, COCs in soil (i.e., VOCs contributing to groundwater concentrations above drinking water standards) were remediated previously and NFA was identified in the FS as the preferred remedy for soil because additional soil remediation would not provide additional protection to groundwater (CH2M HILL 2005a). No COCs were identified for surface water or sediment. The assumptions regarding land use reflected in the HHERA and supplemental documents still are valid (i.e., commercial/industrial; hypothetical residential also evaluated to assess the need for land use controls), and no changes to the COCs are anticipated (CH2M HILL 2014f, 2015j, 2016e).
- Risk from exposure to groundwater will be addressed as part of Site CG041 (basewide groundwater), as OT017 groundwater is included in this operable unit and is identified as CG041-017.
- Previous human health risk assessments concluded that the risks were acceptable for UU/UE, but the VI exposure pathway was not evaluated in these reports (CH2MHILL 2004c). Therefore, this pathway for commercial/industrial and hypothetical future residential land use scenarios were evaluated in a follow-up risk evaluation, *Site OT017 Vapor Intrusion Risk Assessment Summary Report* (CH2M HILL 2015i) for Site OT017, to meet the AFCEC definition of site closure with UU/UE.
- TCE, 1,1,2,2-TECA and PCE were identified as COCs in groundwater and soil vapor at Site OT017 (CH2M HILL 2014f) and in the IROD (Air Force 2007). Risk estimates for VOCs in soil vapor in the 2015 VI risk assessment ranged from 4.5×10^{-8} to 9.1×10^{-5} for the commercial/industrial exposure scenario. For the hypothetical residential scenario, risk estimates ranged from 4.8×10^{-7} to 8.2×10^{-4}. Although these risk assessments are exceeded for soil vapor, lower risk estimates are not achievable given the shallow depth of groundwater at the site, and the residual concentrations of COCs in groundwater. These risk estimates still are valid because the assumptions used to calculate the RBSLs for indoor air (CH2M HILL 2015i) for the risk-driving COCs in soil vapor still are valid, based on current DTSC guidance for VI (DTSC 2011a). For the residential scenario, these RBSLs are as follows: TCE = 89 ppbv (479 micrograms per cubic meter [$\mu g/m^3$]), PCE = 71 ppbv (482 $\mu g/m^3$), and 1,1,2,2-TECA = 7 ppbv (48 $\mu g/m^3$).

- The potential for risk to burrowing rodents from inhalation of burrow air also is at an acceptable level because the most current DTSC (2011b) inhalation TRVs for burrowing mammals for TCE (low TRV = 6,400 µg/m^3 and high TRV = 32,000 µg/m^3) and PCE (low TRV = 24,000 µg/m^3 and high TRV = 121,000 µg/m^3) are higher than the human health RBSLs for soil vapor (cited above) on which risk management decisions were based (no inhalation TRV is available for 1,1,2,2-TECA).

As previously stated, existing and planned future land use for Site OT017 is open space and no change in habitats has occurred since the risk assessment. As concluded in the risk assessment (CH2M HILL 2015i), LUCs are necessary to prevent the VI exposure pathway from being a complete pathway, and if buildings are to be constructed on the site, a re-evaluation of the risk assessment may be warranted with newer data to adequately characterize this pathway. Open space currently dominates the site; recreational outdoor air exposure is likely to be minor compared to the residential or commercial/industrial indoor air exposure scenario because of dilution by mixing with ambient air and wind effects in the outdoor scenario. Risks for exposure to indoor air under the commercial/industrial scenario are within the acceptable cancer risk range and the HIs are less than 1 with one minor exception (HI = 1.5); therefore, recreational risks are considered de minimis.

QUESTION C: Has any other information come to light that could call into question the protectiveness of the remedy?

No other information has come to light that could call into question the protectiveness of the remedy. Currently, groundwater at the base, including the TCE plume under OT017, is monitored on a sitewide basis, because groundwater now is considered a distinct operable unit that contains plumes from several sites. All plumes are confined within the base property boundary. A review of the protectiveness of the groundwater RAOs by remedy type will be conducted in the five-year review for basewide groundwater, which will include an assessment of the VI pathway with particular focus on sites with groundwater plumes and buildings present. Risk implications of constructing buildings in the future also will be discussed.

5.3.6 Issues/Recommendations

The following issues were identified for Site OT017:

- A final decision document is needed that addresses Site OT017 media (with the exception of groundwater).
- Active remediation of soil is not likely to achieve unrestricted use levels until groundwater remediation is complete; therefore, LUCs still are needed to prevent exposure to soil vapor.

The following recommendations and follow-up actions are intended to address issues identified in the technical assessment for Site OT017:

- Prepare a final decision document. Existing LUCs should remain in effect because they provide protection from exposure to soil vapor.
- Ensure that established LUCs continue to be monitored on a semi-annual basis, as required, and that the results are provided to State regulatory agencies in annual monitoring reports.

5.3.7 Protectiveness Statement

The remedy at Site OT017 is protective of human health and the environment under current and anticipated future land uses. If these conditions change and, for example, buildings are constructed, the implications to human health risk may need to be re-evaluated.

5.3.8 Next Review

The next five-year review report for Site OT017 is required five years from the completion date of this review.

Figure 5.3-1
Site OT017 Features Map
Second Five-Year Review
Beale AFB

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5.4 Site ST018

5.4.1 Introduction

Site ST018, the Bulk Fuel Storage Facility, is located in the southwestern portion of Beale AFB, northeast of the intersection of Gavin Mandery Drive (6th Street) and J Street. A large portion of Site ST018 is developed or has disturbed ground, covered with concrete. Unpaved portions are covered by annual grasslands. The site is relatively flat, with low areas and drainage swales east of the former MOGAS Facility. Site ST018 consists of two tank farms and has been used for the storage and distribution of fuel products since 1958. Site ST018 is shown in Figure 5.4-1.

The Jet Fuel Tank Farm is the larger of the two tank farms and is in the northeastern corner of Site ST018. Historically, aviation fuels stored at the Jet Fuel Tank Farm have included aviation gasoline, jet propellant (JP)-4, and JP-7. JP-TS and JP-8 currently are stored and distributed from this location. JP-TS is delivered to the Jet Fuel Tank Farm by rail car and is distributed to the flightline through refueler trucks. Within the tank farm, JP-TS historically was pumped through 6-inch-diameter below-grade pipelines from the rail car unloading area to the storage tanks and from the storage tanks to the refueler loading rack. The JP-TS piping system was replaced in 2008 with aboveground piping.

The former MOGAS Tank Farm (former MOGAS Facility) is located in the southwestern portion of Site ST018, where motor vehicle fuels (i.e., diesel and unleaded gasoline) were stored and distributed until late 2008. The former MOGAS Facility was demolished in 2010.

Underlying groundwater that formerly was associated with Site ST018 now is being addressed as a part of Site CG041 (as Site CG041-018) and is discussed further in Section 5.9.

5.4.2 Response Action Summary

Environmental investigations were initiated at Site ST018 in 1985. These activities include a phased RI, a soil vapor investigation, and several groundwater sampling events. The environmental investigations concluded that petroleum hydrocarbons were released to soil from a long-term leak from the JP-TS pipeline near the Jet Fuel Tank Farm, and VOCs were released to soil from an unknown release or spill in the area east of the former MOGAS facility.

In addition, because Site ST018 was and continues to be an active site, several spills and leaks have been remediated as part of emergency actions or interim removal actions. Contaminated soil has been excavated and two remediation systems (i.e., biovent and SVE) have been installed to remediate residual contaminated soil acting as a continuing source to groundwater.

The Site 18 IROD (CH2M HILL 2011m) presented the following RAOs, to be achieved through remedial actions:

- Reduce concentrations of benzene, TCE, TPH-D, and TPH-G in underlying groundwater throughout the plumes to support designated beneficial uses of groundwater (e.g., domestic, agricultural, municipal, and industrial supply).
- Remove free product potentially affecting underlying groundwater, to support designated beneficial uses of groundwater (e.g., domestic, agricultural, municipal, and industrial supply), and minimize free product migration, to the maximum extent practicable.
- Reduce concentrations of TCE in soil (expressed as soil vapor) potentially affecting underlying groundwater, to support designated beneficial uses of groundwater (e.g., domestic, agricultural, municipal, and industrial supply).
- Restrict potential exposure to benzene and TCE in groundwater until concentrations are at such levels to allow UU/UE.

The following COC and respective cleanup level for soil vapor, shown in Table 5.4-1, also was established in the IROD. The soil vapor cleanup level was derived from the MCL and was established in the 2004 LTO&M Work Plan (CH2M HILL 2004a).

Table 5.4-1. Interim Cleanup Goals, Site ST018

COC	Soil Vapor Interim Cleanup Level (ppbv)	Basis for Cleanup Level
TCE	350	Federal Primary Maximum Contaminant Level

Note:
ppbv = part per billion by volume

Bioventing was implemented as an interim removal action from 1992 to 2008, to treat petroleum contamination near the Jet Fuel Tank Farm. July 2009 sampling results indicated that concentrations of VOCs, including BTEX, detected in soil vapor, and TPH-D and TPH-G detected in soil, were less than the established cleanup levels and were no longer a potential threat to groundwater quality (Air Force 2011c). The *Site ST018 East Biovent System Shutdown Report* (CH2M HILL 2010d) was completed in June 2010.

SVE was implemented in 1998 to treat VOCs in soil (represented as soil vapor) in the area east of the former MOGAS Facility. The SVE system operated between 1998 and 2012, with periods of restarts and rebounds beginning in February 2010. The system was shut down from January through October 2012 for an extended period of rebound testing. The system was restarted and then shut down again in February 2013. A STOP evaluation was completed in October 2013, and supported the permanent shutdown of the system (CH2M HILL 2013j).

Rebound soil vapor data and groundwater monitoring data showed that the lateral extent of remaining contamination has been defined at Site ST018, and the remaining mass of TCE is submerged below the water table. In addition, numerical modeling predicted that residual contamination in soil at Site ST018 does not present a threat to water quality. Risk assessments indicated that residual contaminant concentrations in soil are suitable for UU/UE, and no further response action has been requested for soil at Site ST018 (CH2M HILL 2013j).

A draft ROD for ST018, submitted in April 2015, identified NFA as necessary for Site ST018 (Air Force 2015b).

Operation and monitoring activities occurred during this five-year review, from 2011 to final system shutdown in February 2013. During this period, operation occurred normally, with the exception of several periods of rebounding and restarting. Cycling of operation began in approximately March 2006, with extended periods of rebound beginning in February 2011 until permanent shutdown.

Between May and September 2014, the ST018 SVE system was decommissioned, which included the abandonment of all site vapor extraction wells (VEWs) and VMPs, and removing SVE equipment, fencing, and the aboveground conveyance pipeline. All infrastructure has been destroyed, abandoned in place or removed, and no components remain aboveground (CH2M HILL 2015e).

5.4.3 Progress since the Last Review

A protectiveness statement for Site ST018 was not prepared during the first five-year review because a remedy addressing both soil and groundwater had not been implemented yet (URS 2012).

The status of the issues and recommendations presented in the first five-year review is shown in Table 5.4-2.

Table 5.4-2. Status of Recommendations from the First Five-Year Review, Site ST018

Issues	Recommendation	Current Status	Current Implementation Status Description
A consensus agreement on ARARs is necessary so that the cleanup goals and remedy can be finalized for Site 18.	Complete a decision document for Site ST018.	Ongoing	A draft Record of Decision (ROD) for Site ST018 soils has been submitted, specifying No Further Action for Site ST018. A final ROD is forthcoming.

5.4.4 Data Review

Rebound sampling of soil vapor for TCE occurred during this five-year review, from 2011 to SVE system shutdown in February 2013, as well as at the request of CVWB in 2014.

The most recent soil vapor data collected before SVE system shutdown occurred in September 2012. Vapor samples were collected at four wells associated with the system (VE-1, VMP-1S, VMP-2D, and VMP-2S). TCE and 1,1,2,2-TECA remained above cleanup levels (maximum concentrations of 1,600 and 110 ppbv, respectively) (CH2M HILL 2015a). 1,1,2,2-TECA had not been identified as a COC. The system was then restarted in October 2012 and subsequently shut down for rebound in February 2013. A record of rebound soil vapor samples collected after system shutdown could not be located, with the exception of those presented next.

Soil vapor samples were collected in May and June 2014, to confirm that a source of TCE no longer existed upgradient from groundwater monitoring well 18C020MW. Five soil vapor samples and one HydroPunch sample were collected from each of three borings. Vapor samples were collected at depths ranging from 5 to 50 feet bgs. TCE concentrations in the collected samples ranged from 0.5 estimated quantity (J) to 3.5 parts per billion. These data suggest that no upgradient TCE source is remaining in the soil vapor.

5.4.5 Technical Assessment

QUESTION A: Is the remedy functioning as intended by the decision documents?

Yes, the remedies are functioning or have functioned as intended. Bioventing and SVE have been completed. No further action necessary for protection of human health and the environment for soil, sediment, and surface water have been selected as the final response for the site (Air Force 2015b).

QUESTION B: Are the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of the remedy selection still valid?

Yes, exposure assumptions, toxicity data, interim cleanup goals, and RAOs still are valid. Current and anticipated future land uses are identified in the General Plan. The current and future anticipated land use of ST018 is industrial. Previous investigations and risk management decisions were based on the assumption that future land use would remain industrial, but also considered residential use for UU/UE.

- According to the final ROD, the receptors evaluated for the HHRA were on-site adult workers, construction workers, and hypothetical future adult-child resident. Cancer risks and noncancer health hazard from exposure to soil and/or soil vapor were below $1x10^{-6}$ and 1, respectively, for all receptors. Therefore, no soil or soil gas COCs were identified. The hypothetical future adult-child resident also was evaluated for exposure by potable use of groundwater of which cancer risk and noncancer health hazard exceeded the risk management range (10-6 to 10-4), with COCs being primarily TCE (although methylene chloride, 1,1,2-TCA, and chloroform also contributed to risk but were deemed to be not-site related).
- Cancer risk to surface soil for both on-site worker and hypothetical future resident was 2x10-11 and noncancer risks were 0.03 and 0.3, respectively. Cancer risk to subsurface soil (0–15 ft bgs) to on-site worker, construction worker, and resident were 9x10-10, 6x10-7, and 5x10-10, respectively. Noncancer hazard to on-site worker, construction worker, and resident were all well below 1.
- The excess lifetime cancer risks (ELCRs) and HI estimates do not account potential exposure to lead. The highest concentration of lead (12 mg/kg) detected in soil at Site 18 is below residential and industrial CHHSLs (the maximum detected concentration of lead that was noted is below the current DTSC [2017] soil screening level for residents), and lead was not detected in groundwater. Therefore, lead was not identified as a COC.
- For ecological risks, hazard quotients (HQs) for soil vapor are less than 1, and no ecological COCs were identified for soil vapor.
- Ecological risks for soil were calculated based on low and high TRVs, and only low TRV-based HQs were greater than 1.0 for lead and both HQs exceeded 1.0 for aluminum (URS 2005, CH2MHill 2011i). The maximum concentration of lead was detected at the former MOGAS Tank Farm (73 mg/kg), and is four times higher than the site-specific background level of 18 mg/kg. This maximum concentration also falls within the range of lead

concentrations detected in soil as part of the Kearny foundation metals soil survey (12.4-97.1 mg/kg; (Bradford et al. 1996), and is above the geometric mean concentration of 21.7 mg/kg. The maximum concentration of lead detected at the Bulk Fuel Storage Facility (two tank farms) of 12 mg/kg is below the site-specific background level.

Three soil samples from two locations at the MOGAS Tank Farm, 18C029 (0 to 1 foot bgs and 6 to 7 feet bgs) and 18C031 (0 to 1 foot bgs), had lead concentrations that exceeded the Final Low EcoRBC for soil (17 mg/kg; CH2MHill 2011i). The greater-depth sample at 18C029 (6 to 7 feet bgs) contained lead at less than 1.5 times the background lead concentration. The other two samples (both at 0 to 1 foot bgs) contained lead at greater than two times the background lead concentration (High EcoRBC not exceeded). Both locations are within the developed portion of the facility, where there is limited ecological habitat. The receptor-specific Low EcoRBCs for terrestrial plants (120 mg/kg) and soil invertebrates (1,700 mg/kg) were both higher than the maximum concentration, indicating no risk to these receptors. The receptor-specific Low EcoRBCs for birds and mammals ranged from 0.059 mg/kg (American robin) to 77 mg/kg (California vole); however, these values were not adjusted by an area use factor, so they are overly conservative. On the basis of the sampling locations, habitat quality, and conservativeness of the bird and mammalian Low EcoRBCs, it is unlikely that lead in soil poses an ecological risk (CH2MHill 2011i).

Although HQs for aluminum calculated for the Bulk Fuel Storage Facility were elevated (URS 2005), these risk estimates were based on a conservatively high potential for bioaccumulation, leading to an overestimate of exposure. According to USEPA, if pH levels are below 5.5, then aluminum should be retained as a COPC (USEPA 2003). Soils in the area of the two former tank farms are likely characterized by alkaline conditions (above the criterion of 5.5); therefore, aluminum is not expected to be bioavailable in site soils and does not need to be considered a COPC. Further, the maximum concentration of aluminum (23,500 mg/kg) is only 1.6 times higher than the site-specific background level of (15,000 mg/kg). Therefore, no COCs for ecological receptors were identified for soil.

As previously stated, existing and planned future land use for Site ST018 is commercial/industrial and no change in habitats has occurred since the risk assessment. The risk assessment addressed both commercial/industrial receptors and potential future residential receptors to determine whether UU/UE would be acceptable (URS 2005a), TCE and PCE in groundwater are the only COCs and are addressed as part of site CG041-018.

QUESTION C: Has any other information come to light that could call into question the protectiveness of the remedy?

No other information has come to light to call into question the protectiveness of the interim remedy.

5.4.6 Issues/Recommendations

The following issue was identified in the technical assessment for Site ST018:

- A decision document establishing NFA for Site ST018 has not been finalized yet.

The following recommendations and follow-up actions are intended to address issues identified in the technical assessment for Site ST018:

- Finalize the ROD for Site ST018, which selects NFA as the preferred remedial alternative.

5.4.7 Protectiveness Statement

Site conditions are protective of human health and ecological receptors based on current and anticipated future use of Site ST018 as a bulk fuel storage facility.

5.4.8 Next Review

Pending approval of the final ROD, no further five-year reviews are planned for Site ST018 because the site is suitable for UU/UE.

Figure 5.4-1
Site ST018 Features Map
2016 Five-Year Review
Beale AFB

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5.5 Site SD032

5.5.1 Introduction

Site SD032 is located in the eastern portion of the Flightline Area of Beale AFB along Arnold Avenue, approximately 400 feet south of Site SD011 (Aerospace Ground Equipment Maintenance Area) and directly west of Site WP004 (Battery Shop Dry Well). Site SD032 includes part of the flightline, areas used for aircraft maintenance and repair, and Building 1086. Historically, operations at Building 1086 included assembly of Titan missiles and maintenance of equipment used on B-52 bombers. Four USTs containing TCE, 1,1,1-trichloroethane (TCA), blending acids, and waste acids were located near the southwestern corner of Building 1086. In 1997, the two tanks containing solvents were removed (LCC 1998).

Additional features of interest at Site SD032 include 13 former oil-water separators, two vehicle wash pads, and an aircraft wash pad (Building 1072). Site SD032 also includes a former jet-fuel storage area, referred to as AOC 39, near Taxiway F and the former KC-135 parking area. Two 2,000-gallon former USTs near the area historically were used to store jet fuel. The former USTs were used to fuel KC-135 aircraft via an underground fuel line. Site SD032 is shown in Figure 5.5-1.

5.5.2 Response Action Summary

The AOC 39 biovent system began operation in March 1997. The system included two VEWs and 15 vapor monitoring points. The system remained operational until August 2011, and rebound monitoring was conducted in September 2011. Rebound sample data indicated that cleanup levels had been achieved, and no further need existed to operate the system (CH2M HILL 2013e). The biovent system components remained in place throughout this five-year review period.

An interim ROD was prepared to address both soil and groundwater contamination. Groundwater beneath Site SD032 is now addressed as Site CG041-032 and is discussed in Section 5.9. The Site 32/1 IROD (CH2M HILL 2007b) established RAOs for soil, soil vapor, and sediment, as follows:

- Protect human health by preventing exposure to COCs in soil that result in unacceptable health risk;
- Protect ecological receptors from exposure to soil and sediment contaminants that pose a significant risk; and
- Prevent the migration of contaminants from soil to groundwater and sediment to surface water.

The IROD also established interim remedies for soil and soil vapor relative to Site SD032, as follows:

- Continued bioventing at Site ST021 and Site SD032;
- Continued SVE at Site SD032; and
- LUCs prohibiting residential use and limiting excavation, grading, or trenching in areas with soil contamination.

The Site SD032 North SVE system began operating in April 1998 and continued to operate until June 2009. The Site SD032 South SVE system began operating in October 2002 and continued to operate until October 2008. A STOP evaluation was completed in February 2010 for both sites, and a recommendation for permanent shutdown of the SVE systems and NFA for soil based on residential land use was presented in the *Site 32 North and South SVE Systems Shutdown Report* (CH2M HILL 2010c). However, VOCs remained in soil vapor at concentrations that presented a risk to human health from the VI pathway (CH2M HILL 2013e). Based on this observation, a data gap investigation was performed to determine whether contamination existed above the PSL, based on CHHSLs (CalEPA 2011).

Following this investigation, CVWB requested the Air Force to evaluate the feasibility of limited operation of the north SVE system, to address TCE concentrations detected near wells VE-4S/D. DTSC also stated that further cleanup in the VE-4S/D area was necessary. Following these requests, a short-term SVE test was performed to provide evidence that TCE was diffusion-limited, relatively immobile, and not a threat to groundwater.

LUC inspections have occurred semi-annually, in accordance with IROD requirements. Annual reports of LUC inspections indicate the LUCs have been successful in preventing ground disturbances at Site SD032 and continue to prevent any exposures to potentially remaining contamination.

5.5.3 Progress since the Last Review

The protectiveness statement for Site SD032, which included groundwater in the first *Five-Year Review Report* (URS 2012), states:

> *The interim remedy for Site SD032 is considered protective of human health and the environment because LUCs are in place to protect potential future receptors from exposure to COCs in soil and groundwater at concentrations that exceed ICGs. However, the current occupants of existing buildings could be exposed to TCE through the vapor intrusion pathway, and an evaluation of groundwater concentrations underneath the buildings should be performed to evaluate whether a potential threat to human health exists.*

The status of the issues and recommendations presented in the first five-year review is shown in Table 5.5-1.

Table 5.5-1. Status of Recommendations from the First Five-Year Review, Site SD032

Issue	Recommendation	Current Status	Current Implementation Status Description
The Air Force is required to conduct semi-annual monitoring (every six months), provide annual reports to State regulatory agencies, and undertake prompt action to address activity that is inconsistent with the LUC objectives or use restrictions or any action that may interfere with LUC effectiveness. The requirements for annual monitoring reports were instituted in the Site 32/1 IROD. Through 2010, annual monitoring reports on the status of the LUCs at Site 32/1 have not been completed.	Ensure that the land use controls (LUCs) established in the Site 32/1 Interim Record of Decision are monitored on a semi-annual basis, as required, and that the results are provided to state regulatory agencies in annual monitoring reports.	Ongoing	LUCs at Site SD032 are monitored semi-annually, and the results are reported annually.

5.5.4 Data Review

Data gap investigation field activities conducted between June and December 2013 included collection of soil vapor samples from six existing dual completion vapor wells. Soil vapor samples also were collected from five soil borings adjacent to previous borings exceeding PSLs.

COCs were detected in soil samples at concentrations less than PSLs by at least one order of magnitude. In soil vapor samples, TCE, benzene, and 1,3-butadiene were the only VOCs detected. TCE was detected at several locations at concentrations greater than PSLs, but it was detected at the highest concentration in the vicinity of well VE-4S/D. UU/UE was recommended, based on the conclusion that residual concentrations of VOCs in soil vapor did not pose an unacceptable risk through the VI pathway (CH2M HILL 2014i).

During this effort, 12.62 and 0.58 pounds of TCE mass were removed from VE-4S and VE-4D, respectively. Although residual mass was removed during the test, mass transfer rates were shown to have decreased sharply throughout the test, supporting the claim that the remaining mass in soil is strongly diffusion-limited. In addition, the data indicated that residual contamination is not a threat to groundwater, based on TCE detections less than PSLs at submerged well VE-4D, as well as the observed decrease in TCE concentrations with depth from VE-4S to VE-4D. Based on the short-term SVE test, the findings of the 2013 data gap investigation were confirmed, and NFA for soil and UU/UE were recommended for SD032 (CH2M HILL 2015l). Both SVE systems remained in place during this five-year review.

Potential groundwater impacts were assessed using the HYDRUS-1D and SVEET models. Results from the HYDRUS-1D model predicted that residual TCE contamination in soil (as soil vapor) would affect groundwater beneath Site SD032 at a maximum increase to current TCE concentrations by 8.5 µg/L. The HYDRUS-1D model used TCE soil vapor concentrations collected before the short-term SVE test as inputs (CH2M HILL 2015l).

The SVEET model predicted that remaining vapor concentrations would affect groundwater at a concentration of 2 µg/L. This model scenario used post- short-term SVE test sampling results. The HYDRUS-1D results then were reduced by the ratio of post- and pre-SVE test residual mass, and based on the modified results, the model predicted a maximum TCE concentration of 2.5 µg/L (CH2M HILL 2015l). Both lines of evidence suggest that residual TCE vapor is not a threat to groundwater. Groundwater sample results concur with the conclusion that residual contamination is not threat to groundwater because results from the most recent groundwater samples collected from VE-4D were less than the predicted future impact on groundwater of between 2 and 2.5 µg/L.

Overall, TCE concentrations in soil vapor remain within the range of concentrations at which the CVWB previously concurred that no further remedial action for Site SD032 vadose soils was warranted. In addition, based on the original 1999 TCE mass estimate of 500 pounds, more than 99 percent of the mass has been removed (CH2M HILL 2015l). However, a NFA request was agreed upon by DTSC and LUCs remain in place to prevent exposure to soils around VE-4.

5.5.5 Technical Assessment

QUESTION A: Is the remedy functioning as intended by the decision documents?

Yes, the components of the interim remedy have functioned as intended: SVE and bioventing have successfully remediated COCs in soil to levels acceptable for UU/UE, with the exception of the soils around SVE well VE-4. LUCs established in the Site SD032 IROD will continue until conditions are suitable for UU/UE.

QUESTION B: Are the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of the remedy selection still valid?

Yes, the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of the interim remedy selection still are valid. No substantive changes in exposure pathways, land use designation, contaminants, or contaminant sources have occurred at Site SD032 since completion of the IROD, and LUCs to limit potential exposure are in place.

Yes, assumptions used at the time of the remedy selection remain valid. Current and anticipated future land uses are identified in the General Plan. Current and future planned land use at Site SD032 (including AOC 39) is industrial, and all previous investigations and risk management decisions were based on the assumption that future land use would remain industrial (CH2M HILL 2013e). Land use at this site will remain industrial for the foreseeable future. However, the Air Force’s goal is to attain unrestricted site closure status for Site SD032 (including AOC 39). Until concentrations allowing UU/UE (e.g., acceptable residential risk levels) are achieved, LUCs will be used to restrict land and groundwater access and use. In addition, ecological exposures and risk were concluded to be minimal because of the majority of the site being covered by buildings, gravel, concrete or asphalt, and limited landscaping. Site SD032 was recommended for no further investigation to protect ecological receptors in the Site 32/1 RI (CH2M HILL 2004b).

- Chemicals of concern in soil for human health were limited to 1,1-DCE, cis-1,2-DCE, and TCE, and the primary COCs in soil vapor were TCE and 1,3-butadiene (CH2M HILL 2014i). The assumptions regarding land use reflected in the HHERA and supplemental documents still are valid (i.e., commercial/industrial; hypothetical residential also evaluated to assess the need for LUCs), and no changes to the COCs are anticipated (CH2M HILL 2013e, 2014i).
- Default exposure assumptions used by EPA for human health risk assessment have become slightly less conservative from 2006 to 2017, and therefore the former exposure assumptions remain valid with increased potential for overestimation of exposure (i.e., more conservative than necessary).
- The soil COCs were evaluated as part of the data gaps investigation (CH2M HILL 2014i), and all detected concentrations were below the PSLs. These screening levels are risk-based concentrations for direct contact (e.g., incidental ingestion, dermal contact, and inhalation of particulates and volatiles) derived by assuming a residential exposure scenario using exposure parameters from the EPA RSLs (EPA 2013a), and the more

stringent of the EPA Integrated Risk Information System (IRIS) toxicity values (EPA 2013d) and the California Office of Environmental Health Hazard Assessment (OEHHA) Toxicity Criteria Database toxicity values (OEHHA 2013). Because of the trend described above for EPA default exposure assumptions (becoming slightly less conservative) and the fact that toxicity values for these three VOCs have not been updated recently (last updates: 1,1-DCE in 2002, cis-1,2-DCE in 2010, and TCE in 2011), the PSLs for soil, and hence the associated findings of no exceedances (no risk) still are valid and protective of human health.

- The soil vapor COCs also were evaluated as part of the data gaps investigation (CH2M HILL 2014i), and a follow-up assessment of the only potential risk driving COC in soil vapor (TCE) at VE-4S was conducted to inform final conclusions about the VI pathway (CH2M HILL 2015l). TCE concentrations in soil vapor samples collected shallower than 15 feet bgs were below risk-based PSLs. Based on these findings and the results of the short-term SVE test that confirmed the low mass of residual TCE in the small volume of soil near VE-4S, TCE does not represent a threat to indoor air or groundwater. TCE at depth is not migrating to the surface at levels that represent a VI risk (i.e., the excess lifetime cancer risk estimate is within the acceptable cancer risk range and the noncancer hazard index is less than 1). Thus, NFA for TCE in soil is necessary, and Site SD032 is suitable for UU/UE.
- This conclusion about the lack of COCs in soil vapor is valid because the assumptions used to calculate the PSLs for indoor air for the risk-driving COCs in soil vapor (CH2M HILL 2014i) still are valid, based on current DTSC guidance for VI (DTSC 2011a). For the residential scenario, PSLs were developed on a depth-specific basis, and the range of screening levels for subslab down to 70 feet bgs are as follows: TCE = 2 ppbv to 480 ppbv (11 $\mu g/m^3$ to 2,583 $\mu g/m^3$), 1,3-butadiene = 0.13 ppbv to 14 ppbv (0.29 $\mu g/m^3$ to 31 $\mu g/m^3$), and benzene = 0.53 ppbv to 140 ppbv (1.7 $\mu g/m^3$ to 448 $\mu g/m^3$).
- The potential for risk to burrowing rodents, if in the vicinity of the plume, from inhalation of burrow air also is at an acceptable level because the most current DTSC (2011b) inhalation TRVs for burrowing mammals for TCE (low TRV = 6,400 $\mu g/m^3$ and high TRV = 32,000 $\mu g/m^3$) and benzene (low TRV = 570 $\mu g/m^3$ and high TRV = 2,900 $\mu g/m^3$) are higher than the human health PSLs for soil vapor (cited above) on which risk management decisions were based (no inhalation TRV for 1,3-butadiene).

As previously stated, land usage at SD032 remains consistent with the commercial/industrial scenario evaluated in the risk assessment, and no change has occurred in habitats. In addition, the RAOs based on protection of residential land use to allow UU/UE also have been achieved in accordance with the most recent risk assessment guidance, except for the area around SVE Well VE-4.

QUESTION C: Has any other information come to light that could call into question the protectiveness of the remedy?

No other information has come to light that could call into question the protectiveness of the remedy.

5.5.6 Issues/Recommendations

The following issue was identified during this technical assessment:

- A final decision document is needed for Site SD032.

Based on the issue identified during the technical assessment, the following recommendation is made:

- Develop and finalize a decision document specifying NFA for Site SD032 soils.

5.5.7 Protectiveness Statement

The interim remedy for Site SD032 is considered protective of human health and the environment because it has remediated soil and soil vapor contamination to levels acceptable for restricted use in accordance with LUCs established in the Site SD032 IROD. LUCs continue to be implemented and will limit disturbances to the site until UU/UE is approved.

5.5.8 Next Review

The next five-year review report for Site SD032 is required five years from the completion date of this review.

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Figure 5.5-1
Site SD032 Features Map
Second Five Year Review
Beale AFB

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5.6 Site SS035

5.6.1 Introduction

Site SS035 covers an area of approximately 80 acres, located in the northern part of Beale AFB. Site SS035 has been operated as a weapons storage area (WSA) since its construction circa 1958. Titan missile operations were located at Beale AFB in the early 1960s, and the WSA was used to store and maintain missile warheads during that time. Maintenance of B-52 weapon systems took place on the site until the mid-1970s. Currently, the site is used for weapons storage, equipment maintenance, and office space. Only nonpropelled weaponry and explosive safety devices are stored at the site (Radian International 1999a). Site SS035 is shown in Figure 5.6-1.

Currently, 14 buildings are on the site. In 1995 and 1996, four USTs associated with Buildings 1320, 1322, 1324, and 1325 were removed and the cases were closed. An RI was conducted in 2008 and 2009, and it was documented in the *Site 35 Remedial Investigation Report* (CH2M HILL 2010e). RI data indicated that the area of greatest vadose zone and groundwater contamination is localized on the southern side of Building 1322 in the vicinity of the shed foundations. TCE concentrations were orders of magnitude lower or less than detection limits at soil gas sample locations west, east, and north of Building 1322 (CH2M HILL 2010e). The source area is suspected to have been caused by releases of solvents to the ground surface near the concrete foundations of the former sheds, by septic system leaks, and by historical spills/discharges of cleaning solutions to the ground surface, nearby ephemeral drainages, and seasonal creeks. The release of solvents is estimated to have occurred before the mid-1980s (CH2M HILL 2010g).

5.6.2 Response Action Summary

In the IROD for Site SS035, the Air Force selected continued operation of the bioreactor for groundwater remediation, SVE, evaluation monitoring for groundwater and soil vapor, and LUCs as the preferred remedial action alternative for the site (Air Force 2011a). Groundwater beneath SS035 currently is addressed as Site CG041-035 and is addressed in Section 5.9.

Interim cleanup levels were established for SS035 soil vapor COCs to achieve the interim RAOs. Final cleanup levels and RAOS will be established in the final ROD for the site. Interim RAOs are as follows (Air Force 2015f):

- Reduce VOC concentrations in soil (represented as soil vapor) to levels that allow UU/UE; and
- Reduce concentrations of VOCs in soil potentially affecting underlying groundwater to support designated beneficial uses of groundwater.

Interim cleanup levels for VOCs in soil vapor were calculated based on soil vapor concentrations that are protective of groundwater (Air Force 2015f). Cleanup levels for soil vapor are based on the lowest of either the State or federal MCL for a COC and are shown in Table 5.6-1.

Table 5.6-1. Interim Cleanup Goals for Site SS035 Soil Vapor Contaminants of Concern

COC	0 to 15 feet bgs (ppbv)	15 to 50 feet bgs (ppbv)
Carbon tetrachloride	586	145
1,1-DCE	15,500	2,600
cis-1,2,-DCE	1,025	425
PCE	4,150	800
TCE	600	575

Notes:
DCE = dichloroethene; MCL = maximum contaminant level; PCE = tetrachloroethene; ppbv = part per billion by volume; TCE = trichloroethene

As part of the bioreactor installation 1,110 cubic yards of soil were excavated from the most contaminated part of the VOC source area and were disposed off-site. The interim remedy also included installation of the SVE system, which began operating in October 2013 and continued operating through 2015. The final soil remedy is expected to include continued operation of the SVE system and additional soil excavation, as needed.

No action is planned for surface water and sediment. The site is suitable for UU/UE with respect to sediment and surface water contamination levels, and current and anticipated industrial uses with respect to soil (Air Force 2015f).

The proposed plan for remedial action at SS035 has been finalized, but a final ROD has not been completed yet. If additional cleanup of soil is necessary to comply with State requirements, a focused FS will evaluate alternatives for remediating soil vapor exceeding final cleanup levels.

LUCs are in place and are being maintained and monitored in accordance with the IROD requirements. The Beale AFB dig permit process has been effective in preventing any ground disturbing activities that would have interfered with the operation of the interim remedy or caused uncontrolled exposures to contaminants (CH2M HILL 2016b).

5.6.2.1 Systems Operations/Operation and Maintenance

O&M of the Site SS035 SVE system is ongoing. A chronology of O&M activities associated with the Site SS035 SVE system is as follows (CH2M HILL 2016b):

- October 2013: Startup of SVE system
- March 2014: 35C078VEW began operating as a passive vent well
- May 2014: Resumed operating 35C078VEW as a VEW and began operating 35C074VEW as a passive vent well; system shut down for construction of two vent wells (35C079VEW and 35C080VEW)
- June 2014: Resumed operating 35C074VEW as a VEW and began operating 35C079VEW and 35C080VEW as vent wells; system began repeatedly shutting down because of high ambient temperatures
- August 2014: Submittal of the *Final Site SS035 Interim Remedial Action–Construction Completion Report* (CH2M HILL 2014j)
- September 2014: SVE system resumed continuous operation after recalibrating the heat exchanger thermometer and changing the temperature switch set point to combat high ambient temperatures
- October 2014: Shut down of the SVE system to begin a 4-week rebound test
- November 2014: Collection of soil vapor samples from VEWs and select VMPs
- December 2014: Restart of the SVE system
- January 2015: Submittal of the Final Site SS035 Soil Vapor Cleanup Goals Technical Memorandum
- April 2015: Began remedial optimization measure of rotating one VEW to operate as a passive vent well on a monthly basis, while the other VEWs operated as extraction wells
- May 2015: Disconnected vapor phase granular activated carbon (VGAC) vessels from the SVE system after receiving permission from the Feather River Air Quality Management District
- July 2015: Began draining groundwater being treated by the CG041-035 in situ bioreactor as a remedial optimization measure; evacuated spent VGAC from the VGAC vessels
- August 2015: Completed draining the CG041-035 in situ bioreactor and began operating groundwater monitoring well 35C063MW as a passive vent well
- September 2015: Shut down the SVE system and closed all VEWs and vent wells to the atmosphere to begin a 6-week rebound test

The TCE concentration in extracted soil vapor has been less than the proposed cleanup level of 575 ppbv since January 2014. Decreases in contaminant concentrations were observed in extracted soil vapor between October 2013 and April 2014, at which time the concentrations and mass removed began to level off. These decreases suggest that COCs in the vadose zone may be diffusion-limited. Results from the 6-week rebound period will be used to evaluate optimization measures to increase flushing in the vadose zone in the future.

5.6.3 Progress since the Last Review

The protectiveness statement for Site SS035, which included groundwater, in the first *Five-Year Review Report* (URS 2012) states:

> *The remedy for Site SS035 is protective of human health and the environment in the short term because there is no current risk to potential receptors. TCE concentrations in the source area are anticipated to decrease with continued operation of the bioreactor, and groundwater monitoring is ongoing. However, to ensure protectiveness in the long term, the cleanup goals and the remedy for Site SS035 must be finalized in a decision document, and LUCs must be implemented to prevent exposure to contaminated groundwater until RAOs are achieved.*

The status of the issues and recommendations presented in the first five-year review is shown in Table 5.6-2.

Table 5.6-2. Status of Recommendations from the First Five-Year Review, Site SS035

Issue	Recommendation	Current Status	Current Implementation Status Description
LUCs have not been implemented to ensure potential receptors remain protected while RAOs are being attained.	Implement LUCs to prevent human exposure to residual VOCs in groundwater at concentrations exceeding PCGs until RAOs are achieved.	Ongoing	LUCs have been implemented at Site SS035, are monitored semi-annually, and the results are reported annually.
A consensus agreement on ARARs is necessary so that the cleanup goals and remedy can be finalized for Site 35.	Select a final remedy and finalize the ARARs and cleanup goals commensurate with future land use; prepare a decision document for Site 35.	Ongoing	A ROD for Site SS035 is forthcoming.

5.6.4 Data Review

At Site SS035, TCE continues to be the most widespread COC in soil and has the highest concentrations in soil vapor. However, COC concentrations have been decreasing, prompting a shutdown of the SVE system in September 2015, to allow a 6-week rebound test. The decrease in concentrations indicates that the interim remedy is effectively remediating contaminated soils. Table 5.6-3 shows extracted soil vapor concentrations for Site SS035 COCs from system startup in 2013 to 2015, measured at the influent (CH2M HILL 2016b), and shows that concentrations of COCs have been less than their cleanup levels (Table 5.6.1) since at least February 2014.

Table 5.6-3. Concentrations of COCs in Extracted Soil Vapor (2013–2015), Site SS035

Date Sampled	PCE	TCE	cis-1,2-DCE	1,1-DCE	Carbon Tetrachloride	Total VOCs
10/18/2013	ND	19.00	0.18	1.30	0.02	29.61
10/22/2013	ND	6.20	0.08	0.42	0.00	9.04
11/25/2013	ND	2.30	0.05	0.14	0.00	3.52
12/12/2013	ND	0.99	0.03	0.06	ND	1.48
1/9/2014	0.0003	0.49	0.02	0.02	0.00	0.84
2/18/2014	ND	0.22	0.01	0.01	0.00	0.45
3/25/2014	ND	0.16	0.01	0.01	0.00	0.35
4/8/2014	ND	0.16	0.01	0.01	0.00	0.34
5/7/2014	0.0005	0.16	0.01	0.01	0.00	0.39
6/11/2014	0.055	0.25	0.01	0.01	0.00	0.55
7/9/2014	ND	0.14	0.01	0.01	ND	0.38
8/21/2014	0.0003	0.34	0.01	0.02	0.00	0.66
9/16/2014	ND	0.10	0.00	0.01	0.00	0.30
10/14/2014	0.0002	0.06	0.00	0.01	ND	0.18
12/22/2014	0.0008	0.14	0.01	0.01	0.00	0.23
1/15/2015	0.0003	0.09	0.01	0.00	0.00	0.20
2/24/2015	ND	0.05	0.00	0.00	ND	0.21
3/12/2015	ND	0.05	0.00	0.00	0.00	0.16
4/16/2015	ND	0.04	0.00	0.00	ND	0.31
5/14/2015	0.0005	0.05	0.00	0.00	ND	0.21
6/11/2015	0.0004	0.03	0.00	0.00	ND	0.08
7/8/2015	ND	0.03	0.00	0.00	ND	0.06
8/13/2015	0.0004	0.07	0.01	0.00	ND	0.24
9/14/2015	ND	0.05	0.01	0.00	ND	0.09

Notes:
All concentrations in parts per million by volume (ppmv).
ND = not detected

5.6.5 Technical Assessment

QUESTION A: Is the remedy functioning as intended by the decision documents?

Yes, the interim remedy is functioning as intended: excavation of VOC-contaminated soil has occurred; an SVE system was installed in 2013 and has successfully reduced COC concentrations in soil that potentially could affect groundwater; ongoing monitoring and evaluation of COCs in soil are taking place; and the implementation and inspection of LUCs continues to prevent any access to remaining contamination in soil.

QUESTION B: Are the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of the remedy selection still valid?

Yes, exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of the interim remedy selection still are valid for protection of the groundwater. Federal and California MCLs (State Water Board 2014; California Code of Regulation, Title 22.2006) are the basis for interim cleanup goals for the VOC COCs in Site SS035 soil vapor and groundwater, and remain as the enforceable standards for drinking water quality. The RAOs establish conditions to be met for protection of the designated beneficial uses of Site SS035 groundwater, which have not been met yet.

5.6.5.1 Changes in Exposure Pathways

No substantive changes in exposure pathways, land use designation, contaminants, or contaminant sources have occurred that would alter the current remedial approach at Site SS035. Land uses and development are presented in the General Plan. The General Plan designates existing and planned future land use for Site SS035 as industrial and thus, residential land use currently is not allowed or planned for the foreseeable future. Beale AFB is expected to remain an active military installation. Current land use at Site SS035 is reasonably anticipated to continue indefinitely to support the mission of the facility.

The HHRA evaluated current and future land use receptors (on-site Base worker, construction/excavation worker, and hypothetical future resident) for three exposure areas: Exposure Area 1 (areas outside primary source area and oxidation ponds); Exposure Area 2 (near Building 1322 and primary source area); and Exposure Area 3 (oxidation pond).

On the basis of current and planned future land and water use by the on-site Base worker scenario and construction/excavation worker and a hypothetical future resident, no COCs were identified for soil in any exposure area. Estimated ELCRs ranged from 1×10^{-7} to 4×10^{-5} in the soil exposure scenarios. The majority of risk was attributed to PAHs, which were determined to be isolated and only exceeded background concentrations in two locations. Consequently, PAHs were not considered to be COCs.

Exposure Area 1:

The on-site Base worker exposure to surface soil/sediment with an ELCR of $1x10^{-7}$ and HI of 0.01, and exposure to soil/sediment (0–10 feet bgs) (excluding arsenic based on background) with an ELCR of $2x10^{-7}$ and HI of 0.01. The construction/excavation worker exposure to soil/sediment (0–15 feet bgs) (excluding arsenic and chromium based on background), with an ELCR of $5x10^{-7}$ and HI of 0.1. The hypothetical future resident with an ELCR of $3x10^{-7}$ and HI of 0.03, and exposure to soil/sediment (0–10 feet bgs) (excluding arsenic based on background), with an ELCR of $8x10^{-7}$ and HI of 0.02.

Exposure Area 2:

The on-site Base worker exposure to surface soil/sediment with an ELCR of $1x10^{-6}$ and HI of 0.002, and exposure to soil/sediment (0–10 feet bgs) (excluding arsenic based on background) with an ELCR of $7x10^{-6}$ and HI of 0.1. The construction/excavation worker exposure to soil/sediment (0–15 feet bgs) (excluding arsenic, cobalt, and chromium based on background) with an ELCR of $9x10^{-7}$ and HI of 0.06. The hypothetical future resident with an ELCR of $4x10^{-5}$ and HI of 0.01, and exposure to soil/sediment (0–10 feet bgs) (excluding arsenic based on background) with an ELCR of $3x10^{-5}$ and HI of 0.02.

Exposure Area 3:

The on-site Base worker exposure to soil/sediment (0–10 feet bgs) with an ELCR of $5x10^{-8}$ and HI of 0.000002. The construction/excavation worker exposure to soil/sediment (0–15 feet bgs), with an ELCR of $2x10^{-9}$ and HI of 0.00004. The hypothetical future resident exposure to soil/sediment (0–10 feet bgs), with an ELCR of $3x10^{-7}$ and HI of 0.0001.

The EPCs in Exposure Areas 1 and 3 are less than the CHHSL for residential land use (80 mg/kg) (which is still valid and consistent with DTSC [2017] soil screening levels). In Exposure Area 2, the lead EPC for soil (441 mg/kg) is greater than the CHHSL for residential land use (80 mg/kg). With the exception of two sample locations, lead was detected at concentrations less than background. Consequently, because elevated lead concentrations were isolated and the site was sufficiently characterized, overall risk was considered low, and lead was not considered a COC, which still is a valid conclusion.

Soil vapor was evaluated on a sample-by-sample basis. The on-site Base worker VI ELCR of $1x10^{-4}$ and HI of 0.5 primarily were because of TCE. Surface water was evaluated sitewide. Concentrations generally were less than MCLs or other relevant water quality goals, and no COCs were identified in surface water during the RI. Risk from exposure to groundwater will be addressed as part of the Site CG041 (basewide groundwater) ROD.

Cumulative risk results in an ELCR equal to or greater than 1×10^{-4}, and the HIs are greater than 1 for the both the on-site Base worker and the future resident. As discussed above, however, the drivers of noncancer hazards are naturally occurring metals that are consistent with background. The driver of cancer risk is TCE.

No COCs in soil were identified for ecological receptors, and only TCE in soil vapor was concluded as a COC for burrowing animals (Air Force 2015f). The potential for risk to burrowing rodents from inhalation of burrow air is also at an acceptable level because the most current DTSC (2011b) inhalation TRVs for burrowing mammals for TCE (low TRV = 6,400 µg/m^3 and high TRV = 32,000 µg/m^3) and PCE (low TRV = 24,000 µg/m^3 and high TRV = 121,000 μg/m^3) are higher than the cleanup levels for soil vapor (cited above), on which risk management decisions were based. Consequently, risk to ecological receptors is considered acceptable.

5.6.5.2 Expected Progress towards Meeting RAOs

Progress toward meeting the interim RAOs has been made (i.e., soil excavation to remove vadose zone contaminants, and to prevent further migration of contaminants to groundwater, and construction and operation of the SVE system), but COC concentrations in soil vapor have not decreased to levels acceptable for unrestricted use. Therefore, continued implementation of LUCs is necessary to protect human health until RAOs are attained.

QUESTION C: Has any other information come to light that could call into question the protectiveness of the remedy?

Data collected during a data gap investigation completed in 2013 indicated that the site bioreactor was operating with limited effectiveness due to the likelihood that the bioreactor’s shallow penetration and lack of intersection with the water table was allowing the flushing of vadose zone contamination to occur around and beneath the bioreactor as indicated by increasing concentration trends in source area groundwater monitoring wells. In reaction to these observations the operation of the bioreactor was suspended and a SVE system was installed to address remaining COC contamination in soil that poses a continuing source of contamination to groundwater. No further information has come to light to call into question the protectiveness of the remedy.

Currently, groundwater at the base, including the TCE plume, is monitored on a sitewide basis, because groundwater now is considered to be a distinct operable unit that contains plumes from several sites. All plumes are confined within the base property boundary (CH2M HILL 2016i). A review of the protectiveness of the groundwater RAOs by remedy type will be conducted in the five-year review for basewide groundwater, which will include an assessment of the vapor intrusion pathway, with particular focus on sites with groundwater plumes and buildings present. Risk implications of constructing buildings in the future also will be discussed.

5.6.6 Issues/Recommendations

The following issues were identified in the technical assessment for Site SS035:

- A potential exists for a completed exposure pathway as long as contamination greater than the cleanup goals remains in soil.
- A final decision document is needed for Site SS035.

The following recommendations and follow-up actions are intended to address issues identified in the technical assessment for Site SS035:

- Select a final remedy in a decision document and establish the final RAOs and cleanup levels for Site SS035.

5.6.7 Protectiveness Statement

The remedy for Site SS035 is protective of human health and the environment under current and anticipated future land uses (weapons storage area) in the short term because LUCs are in place to prevent potential exposure to remaining contamination in soil. the remedy is expected be protective in the long term upon completion. In the interim, remedial activities completed to date have adequately addressed all exposure pathways that could result in unacceptable risk in these areas.

5.6.8 Next Review

The next five-year review report for Site SS035 is required five years from the completion date of this review.

Figure 5.6-1
Site SS035 Features Map
Second Five-Year Review
Beale AFB

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5.7 Site DP038

5.7.1 Introduction

Site DP038 covers an area of approximately 47.3 undeveloped acres. Occasional military training exercises once were conducted at the site; however, the site is no longer being used for that purpose. Deteriorated concrete (remnants of 1940 to 1950 vintage barracks and other buildings) is present across the site; however, the majority of the concrete debris was removed from the site in November 2010. Site DP038 is shown in Figure 5.7-1.

Site DP038 is composed predominantly of unpaved, level terrain covered by annual grassland species. Approximately 4.5 acres of seasonal wetlands were identified at Site DP038 during the December 2012 wetlands and waters survey (CH2M HILL 2013c). Surface water typically is present only at Site DP038 in winter and spring. The northern, central, and southern portions of Site DP038 are adjacent to roads that are slightly elevated, with drainage ditches along the sides. Culverts direct water onto Site DP038 under E Street, which borders the site to the west.

Historical releases of contamination at Site DP038 include fuel and oil constituents from leaking USTs (previously used to heat the barracks buildings), lead from shotgun pellets, and polycyclic aromatic hydrocarbons (PAHs) from skeet and trap target (clay pigeon) debris associated with operation of the former skeet and trap range. Historical releases from leaking USTs have been addressed, and the USTs have been closed with regulatory agency approval (CVWB 1998).

5.7.2 Response Action Summary

The preliminary site assessment of DP038 (formerly Site 38) occurred in 1999, which included a records search, personnel interviews, and site visits (Radian International 1999b). The conclusion of the site assessment was that skeet and trap range activities may have affected soils at the site, and surface and subsurface soil and sediment sampling for lead and PAHs were recommended. Site inspection activities occurred between 2004 and 2005, during which 54 hand auger borings were completed and soil samples were collected at depths ranging from 0 to 3 feet bgs. Five samples had lead concentrations that exceeded EPA's industrial PRG (now RSL) for lead of 800 mg/kg, and 10 samples had benzo(a)pyrene concentrations that exceeded the industrial PRG of 0.210 mg/kg. DI-WET results were less than actionable levels (URS 2004, 2005b). PRGs were based on Cal/EPA industrial CHHSLs (URS 2004, 2005c).

An EE/CA prepared in 2005 recommended excavation with off-site soil disposal for lead and PAH contaminated soil (URS 2005c). The selected removal action was intended to achieve the following RAOs:

- Reduce the 95 percent UCL for the average lead concentration in surface and shallow subsurface soils to below the industrial PRG of 800 mg/kg.
- Reduce the 95 percent UCL for the average PAH concentration in surface and shallow subsurface soils to below the industrial PRG of 210 mg/kg.
- Reduce lead and PAH concentrations in site soils so that a NFRAP recommendation can be submitted and approved for site closure.

Between 2005 and 2006, 4,460 cubic yards of soil were removed from the site to address the previously identified lead and PAH contamination. To evaluate the extent of remaining contamination and document residual contamination levels, 175 confirmation soil samples were collected. An evaluation of the confirmation sampling results indicated that the remedial action achieved the regulatory agency-approved industrial-based PRGs (URS 2005b, 2006). In 2008, the *Removal Action Interim Decision Document for Site 38* (URS 2008) documented the removal action, confirmation sampling results, and estimated the residual risk to human health based on residential and industrial scenarios. However, the regulatory agencies concluded that the datasets used for the risk assessments and evaluations were insufficient, and the risk assessments and evaluations were not comprehensive (CH2M HILL 2012d). In 2009, the industrial CHHSL for lead (800 mg/kg) was revised to 320 mg/kg (OEHHA 2010). This lower value prevented finalization of the decision document.

Further site characterization activities were conducted in October and November 2010 (CH2M HILL 2012d). Direct-push surface and subsurface soil samples were collected from 16 locations, placed in proximity to post-excavation confirmation samples exceeding the revised industrial lead CHHSL of 320 mg/kg. An additional location was placed within the far eastern edge of the center arc of the skeet and trap range, at the request of DTSC's Office of Human and Ecological Risk. Additional surface and subsurface sample collection was performed at 11 locations outside the former excavation area. Surface water and sediment samples were collected from four locations in drainage ditches within the site boundary as well as along the leading edge of identified vernal pools. All samples were analyzed for lead and PAHs. Based on sample results, benzo(a)pyrene was identified as a risk driver, but not as a COC, in soil at Exposure Areas A, B, and D. NFA was recommended for benzo(a)pyrene in soil and sediment. Lead was identified as a COC in surface soil and sediment in Exposure Areas A, B, and C (CH2M HILL 2012d).

Furthermore, the site characterization report recommended the following:

- Conduct an additional data gap investigation to support further remedial action at the site.
- Evaluate further actions for lead in soil, sediment, and surface water.
- Evaluate further action for residual shotgun pellets and clay pigeon debris in soil and sediment.

The site characterization report (CH2M HILL 2012d) also documented RAOs and preliminary cleanup goals for the site. The site-specific RAOs identified were as follows:

- Reduce concentrations of lead in sediment and soil posing a potential risk to human health, ecological receptors, and surface water quality, if feasible.
- Restrict potential exposure to lead in sediment and soil until concentrations are at levels that allow UU/UE.

Preliminary lead cleanup goals to achieve unrestricted use were established based on evaluations of Beale AFB background concentrations, calculated risk-based PCGs for human and ecological exposures, and ARARs applicable to surface water quality (CH2M HILL 2012d).

The following PCGs for lead in soil and sediment were recommended to achieve unrestricted site use and are based on the California CHHSL for lead:

- Lead in soil and sediment–80 mg/kg

The following PCGs for lead in soil and sediment were recommended to achieve commercial/industrial site use and are based on protection of ecological receptors for lead:

- Lead in soil–133 mg/kg
- Lead in sediment–128 mg/kg

The following PCG for lead in surface water was recommended for the protection of water quality and is based on the MCL:

- Lead in surface water–5 μg/L

An additional data gap investigation was completed in November 2014, to close data gaps associated with delineating the nature and extent of lead contamination in site surface soil. A total of 85 samples were collected by hand; 31 of which were collected in Exposure Area A, 14 in Exposure Area B, and 40 in Exposure Area C. All samples were analyzed for lead. The sample results indicated that the majority of residual lead contamination exceeding 80 mg/kg appeared to be mostly limited to the 800-foot-radius lead shotfall area, with concentrations generally decreasing with distance outward on the shotfall fan (CH2M HILL 2015d).

A draft work plan that was prepared in July 2016 identifies excavation to be completed around sampling location 38C053, collected during the 2014 data gap investigation, which was found to drive the EPC for Exposure Area A beyond the RAO of the Action Memorandum of 800 mg/kg. The excavation will extend to 1 foot bgs, within the removal areas to be determined by the pre-design optimization sampling. Additional soil removal around sample location 39C059 also is being considered to further lower the EPC. The decision to remove soil from the vicinity of location 38C059 will be determined following removal action design sampling and optimization).

5.7.3 Progress since the Last Review

The protectiveness statement for Site DP038 in the first *Five-Year Review Report* (URS 2012) states:

> *The interim removal action for Site 38 was considered protective of human health and the environment at the time it was implemented. However, risk screening criteria used for lead, and the future land use scenario anticipated at the time of the removal action, are no longer valid for Site 38. Therefore, additional remedial action may be required to protect human health and the environment. Implementation of LUCs is also planned to protect human health and ecological receptors in the long term.*

The issues and recommendations made during the first five-year review are shown in Table 5.7-1.

Table 5.7-1. Status of Recommendations from the First Five-Year Review, Site DP038

Issue	Recommendation	Current Status	Current Implementation Status Description	Completion Date (if applicable)
Changes in the Air Force's planned future land use for Site 38 and the lowering of the health-protective screening level for lead at California sites has resulted in the inability to meet risk screening criteria that allow for unrestricted land use.	Complete an updated human health risk assessment, ecological risk assessment, and water resources assessment, evaluate remedial alternatives, conduct stormwater monitoring to determine whether remaining contaminants are migrating off site during storm events, and establish and implement LUCs for protection of human health and ecological receptors.	Completed	Updated risk assessments were presented in the 2012 *Site 38 Site Characterization Summary Report*. This report also recommended identifying the need for additional remedial actions including sampling of surface water and sediment sampling. LUCs were not recommended, and, therefore, have not been enforced.	May 2012
Pending additional investigation activities, a need may exist to re-evaluate RAOs and cleanup goals. After RAOs and cleanup goals are determined that are consistent with current and potential future land use and revised lead risk-screening levels, additional remedial action may be required to meet the revised RAOs and cleanup goals at Site 38.	Pending the results of the activities listed above, revise RAOs as needed to be consistent with current and potential future land use at Site 38 and consider the updated risk assessment findings.	Completed	Revised RAOs were presented in the *Site 38 Site Characterization Summary Report*.	May 2012
	Implement remedial actions that will achieve the revised RAOs.	Ongoing	Remedial actions and investigations have been completed following the first five-year review. Additional remedial actions were presented in July 2016.	May 2012; August 2015
	Finalize RAOs, ARARs, and cleanup goals commensurate with future land use and prepare a final decision document.	Ongoing	A final decision document has not yet been produced.	N/A

5.7.4 Data Review

Site assessments and remedial actions have occurred at Site DP038 since 1999. Data collection during this five-year review occurred as part of the data gap investigation that was completed in November 2014. As previously mentioned, 85 samples were collected by hand; 31 of which were collected in Exposure Area A, 14 in Exposure Area B, and 40 in Exposure Area C. Sample locations were selected based on judgment in an effort to collect samples in an approximate grid pattern (within 60 by 120-foot grid spacing) to fill in areas not sampled previously. Additional samples were placed approximately every 50 feet along the perimeter of the vernal pool in Exposure Area C, to allow data extrapolation to estimate concentrations within the pool. The exact grid size and number of samples varied, based on location of existing samples and locations of site features (CH2M HILL 2015j). No sediment or surface water samples were collected during this investigation. Sample locations are shown in Figure 5.7-1. Samples results by location are shown in Table 5.7-2.

Table 5.7-2. 2014, Site DP038 Lead Concentrations in Soil

Location	Beginning Depth (feet bgs)	Ending Depth (feet bgs)	Result (mg/kg)	MDL (mg/kg)
38C036	0	0.5	14	0.719
38C037	0	0.5	29.6 J	0.746
38C038	0	0.5	18.9	0.627
38C039	0	0.5	**254**	0.596
38C040	0	0.5	**95.8**	0.844
38C041	0	0.5	36.7	0.722
38C042	0	0.5	21.2	0.59
38C043	0	0.5	**198**	0.512
38C044	0	0.5	18.9	0.58
38C045	0	0.5	**89 J**	0.535
38C046	0	0.5	34	0.734
38C047	0	0.5	**254**	0.611
38C048	0	0.5	**450**	0.714
38C049	0	0.5	**420**	0.655
38C050	0	0.5	**103**	0.641
38C051	0	0.5	**122**	0.651
38C052	0	0.5	**122**	0.691
38C053	0	0.5	**35900**	102
38C054	0	0.5	**300**	0.648
38C055	0	0.5	51.8	0.633
38C056	0	0.5	34 J	0.602
38C057	0	0.5	17.1	0.552
38C058	0	0.5	**448**	1.05
38C059	0	0.5	**1780**	3.51
38C060	0	0.5	48.3	0.588
38C061	0	0.5	11.5	0.752
38C062	0	0.5	70.4	0.502
38C063	0	0.5	**169**	0.615
38C064	0	0.5	**526**	0.722
38C065	0	0.5	**170**	0.459
38C066	0	0.5	**255**	0.529
38C067	0	0.5	**598**	1.26
38C068	0	0.5	**613**	1.2
38C069	0	0.5	**1200**	2.79
38C070	0	0.5	**131**	0.733
38C071	0	0.5	**172**	0.621
38C072	0	0.5	**438**	1.1
38C073	0	0.5	**200**	0.541
38C074	0	0.5	**229**	0.684
38C075	0	0.5	**158**	0.586
38C076	0	0.5	**562**	1.27
38C077	0	0.5	**91**	0.528
38C078	0	0.5	11.6	0.648

Location	Beginning Depth (feet bgs)	Ending Depth (feet bgs)	Result (mg/kg)	MDL (mg/kg)
38C079	0	0.5	17.7	0.69
38C080	0	0.5	69.5	0.564
38C081	0	0.5	33.6	0.424
38C082	0	0.5	**277**	0.537
38C083	0	0.5	**326**	0.673
38C084	0	0.5	16.3	0.438
38C085	0	0.5	44.7	0.506
38C086	0	0.5	**718**	1.4
38C087	0	0.5	**279**	0.587
38C088	0	0.5	**222**	0.57
38C089	0	0.5	35.8	0.486
38C090	0	0.5	49	0.519
38C091	0	0.5	**588**	1.15
38C092	0	0.5	64.2	0.59
38C093	0	0.5	**185 J**	0.664
38C094	0	0.5	20	0.598
38C095	0	0.5	16.8	0.64
38C096	0	0.5	**139**	0.468
38C097	0	0.5	**108**	0.645
38C098	0	0.5	33.6	0.626
38C099	0	0.5	11.2	0.463
38C100	0	0.5	10.1	0.459
38C101	0	0.5	**165**	0.509
38C102	0	0.5	**86**	0.574
38C103	0	0.5	16.7	0.482
38C104	0	0.5	19.3	0.506
38C105	0	0.5	82.3	0.552
38C106	0	0.5	29.5	0.635
38C107	0	0.5	41.7	0.722
38C108	0	0.5	12.1	0.603
38C109	0	0.5	16	0.428
38C110	0	0.5	23.9	0.578
38C111	0	0.5	19.2	0.595
38C112	0	0.5	12.4	0.612
38C113	0	0.5	19.8	0.578
38C114	0	0.5	11.7	0.617
38C115	0	0.5	67.1	0.483
38C116	0	0.5	**170**	0.592
38C117	0	0.5	**281**	0.436
38C118	0	0.5	13.6	0.586
38C119	0	0.5	9.68	0.544
38C120	0	0.5	35.5	0.571

Notes:
Bold = exceeds the PCG of 80 mg/kg
bgs = below ground surface; J = estimated quantity; mg/kg = milligrams per kilogram

Of the 85 samples collected, 49 percent exceeded the lead PCG of 80 mg/kg, with the majority occurring in Exposure Area A. The highest lead concentrations were 35,900 mg/kg in Exposure Area A (38C053), 1,780 mg/kg in Exposure Area A (38C059), and 1,200 mg/kg in Exposure Area B (38C069). Exposure Area C had the highest ratio of samples with lead concentrations below the PCG (CH2M HILL 2015j).

The lowest concentrations were seen at the extreme northern and southern ends of the sampling area, at locations furthest out on the shotfall area, and at locations closest to the apex of the shotfall area (the west-central area of the site). In summary, the areas with the higher concentrations of detected lead included all of Exposure Area B, in the southeastern quadrant of Exposure Area A, and in the northeastern quadrant of Exposure Area C (CH2M HILL 2015j).

Most of the sample locations in Exposure Area C were located around the perimeter of the vernal pool in the northeastern quadrant. Six of the samples collected at locations 38C102, 38C097, 38C116, 38C117, 38C088, and 38C093 exceeded the PCG, and all were collected around the northwestern margin of the pool, nearest the former shooters stations. This vernal pool is relatively far from the shotfall area, and concentrations in samples on the eastern side of the vernal pool were below the PCG.

5.7.5 Technical Assessment

QUESTION A: Is the remedy functioning as intended by the decision documents?

Yes, interim soil removal actions completed to date are functioning as intended by reducing residual lead contamination in soil. However, a LUC boundary must be established and enforced to meet the RAOs identified in the 2012 site characterization report. Current lead concentrations remain above levels acceptable for UU/UE, but future remedial actions have been proposed that are intended to make further progress towards that goal.

QUESTION B: Are the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of the remedy selection still valid?

Yes, assumptions used at the time of the remedy selection remain valid. Land uses and development capabilities are presented in the IDP (Michael Baker International 2015). The IDP designates existing and planned future land use for the site as industrial. Beale AFB is expected to remain an active military installation into the foreseeable future. Current land use at the site is industrial, and the site is reasonably anticipated to continue to indefinitely support the mission of the facility (CH2M HILL 2016e).

- Chemicals of concern in surface soil and sediment for human health and the environment were limited to PAHs (human only) and lead. In addition, lead was identified as a COC in surface water. Selenium originally was identified as a COC in sediment but was concluded to be related to routine pesticide application rather than site-related sources (i.e., clay pigeons or skeet and trap-related activities). The assumptions regarding land use reflected in the HHERA and supplemental documents still are valid (i.e., commercial/industrial; hypothetical residential also evaluated to assess the need for land use controls), and no changes to the COCs are anticipated (URS 2006; CH2M HILL 2012d, 2016e.
- After the 2005–2006 non-time critical removal action, filtered and unfiltered samples were collected at routine surface water monitoring points near the culvert exiting the southeastern corner of Exposure Area B. Filtered samples were below the water quality guideline (WQG) of 15 µg/L (CH2MHILL 2012d) and were non-detect. The WQG is represented by the MCL, which still is the current value. In 2010, additional unfiltered samples were collected. Five of the 19 unfiltered surface water samples exceeded the WQG. The surface water sample with the highest exceedance over the WQG correlates to the area in close proximity to location 38C053, which has the highest lead in soil concentration and will be removed as part of the continued removal action (CH2M HILL 2016e). Furthermore, lead was not detected in recent surface water samples collected at the impounded drainage at Exposure Area A (northern section of the site), and surface water in Exposure Area C does not leave the site. Based on the most recent surface water sampling results, surface water with the potential to migrate off-site does not exceed the Action Level and the initial non-time critical removal action has effectively mitigated threats to surface water quality (CH2M HILL 2016e).
- Default exposure assumptions used by EPA for human health risk assessments have become slightly less conservative from 2006 to 2017, and therefore the former exposure assumptions remain valid with increased potential for overestimation of exposure (i.e., more conservative than necessary). In addition, soil excavations

have been replaced with clean fill, to further reduce the potential for exposure to residual COCs in subsurface soils.

- Benzo(a)pyrene was identified as a COC in soil and sediment in the HHRA (on-site worker and hypothetical residential scenarios), because of weathering clay pigeon debris. Data collected as part of a supplemental field investigation that was conducted in 2010 indicated that the lateral extent of benzo(a)pyrene in soil and sediment is defined adequately. Risk estimates for a commercial/industrial worker (7×10^{-8} to 2×10^{-6}) and hypothetical residential scenario (2×10^{-7} to 6×10^{-6}) are within the risk management range for soil and sediment. These risk assessments are less than or generally within EPA's risk management range of 10^{-6} to 10^{-4} (one in a million to one in ten thousand) for cancer risks [EPA 1990]). The clean fill cover further reduces the potential risk from exposure to contaminated soil (URS 2007b). Residual PAHs in soil and sediment are no longer a concern at DP038.
- Conclusions regarding ecological risk for PAHs still are valid, because these soil COCs are not expected to pose an unacceptable risk. Ecological soil screening levels (EcoSSLs) for PAHs, including high molecular weight PAHs (HPAHs) like benzo(a)pyrene, typically are less stringent than screening levels for human health: EcoSSL for HPAHs = 1.1 mg/kg versus the industrial RSL for benzo(a)pyrene = 0.29 mg/kg (EPA 2016).
- The lateral extent of lead is not completely defined (CH2M HILL 2012d). Additional lead data collected as part of the 2010 data gap investigation, as well as an additional data gap investigation conducted in 2014, indicated that the EPC (calculated as the 95 percent UCL) of lead in surface soil in the northern section of the site (referred to as Exposure Area A) still exceeded the RAO for lead in soil attributable to the concentration detected at one location. Therefore, continuation of the previous removal action is required in Exposure Area A at Site DP038.
- The cleanup goal for lead to meet the RAO is the EPA RSL of 800 mg/kg, which has not been updated. Therefore, the soil cleanup goal for lead remains valid with respect to EPA guidance. However, California currently uses a value of 320 mg/kg as a screening level for lead for commercial/industrial land use (DTSC 2017), corresponding to the CHHSLs values developed in 2009 (OEHHA 2010). Additional evaluation or removal is warranted to comply with DTSC's values

As previously stated, land usage at DP038 remains consistent with the commercial/industrial scenario evaluated in the risk assessment and no change in habitats has occurred. If land usage changes at DP038, then a re-evaluation of the risk assessment may be warranted. After the additional soil removal activities are completed for lead at Exposure Area A, the EPC (i.e., 95 percent UCL) will be recalculated and compared to the cleanup goal for lead (industrial RSL of 800 mg/kg). Open space currently dominates the site, and risk estimates for lead under a recreational exposure scenario already are low, ranging from 2×10^{-8} to 4×10^{-7} (CH2M HILL 2012d).

QUESTION C: Has any other information come to light that could call into question the protectiveness of the remedy?

Yes, information has come to light that could call into question the protectiveness of the remedy:

- The results from the 2010 and 2014 data gap investigations indicate that the EPC calculated as the 95 percent UCL for lead in surface soil in the northern portion of the site (Exposure Area A) still exceeds the RAO for lead in soil.
- Additional soil removal is necessary in Exposure Area A at Site DP038, to address lead contamination and meet the RAO of the Action Memorandum (URS 2006).
- Post-remediation confirmation data will be collected for lead that will be used to recalculate the EPC to verify that the cleanup goal of 800 mg/kg has been met.
- DTSC's screening level for lead for commercial/industrial land use (320 mg/kg) is lower than the RAO based on EPA's RSL. This warrants re-evaluation of the RAO for lead in soil.
- Recent changes in cancer toxicity values for benzo(a)pyrene and other carcinogenic PAHs have led to an approximately seven-fold increase (less stringent) in soil RSLs for carcinogenic polycyclic aromatic hydrocarbon (cPAHs). Therefore, risks related to cPAHs are likely to be approximately seven-fold lower than calculated in earlier risk assessments.

- If/when future surface water sampling is conducted from seasonal drainage ditches at the site, analytical results should be compared to National Ambient Water Quality Criteria to be protective of ecological health; sampling should include upstream and downstream sampling for hardness to support the comparison.

5.7.6 Issues/Recommendations

The following issue was identified in the technical assessment for Site DP038:

- A final decision document has yet to be completed, identifying the components of the final remedy as well final RAOs and cleanup goals.

The following recommendation is intended to address the issues that are identified in the technical assessment for Site DP038:

- Complete a final decision document for Site DP038.

5.7.7 Protectiveness Statement

The interim remedy at Site DP038 is not protective of human health and the environment because residual lead contamination remains in soil at concentrations unacceptable for UU/UE and LUCs are not in place to prevent potential exposures. LUCs need to be established and inspected to ensure protectiveness until the site is acceptable for UU/UE.

5.7.8 Next Review

The next five-year review report for Site DP038 is required five years from the completion date of this review.

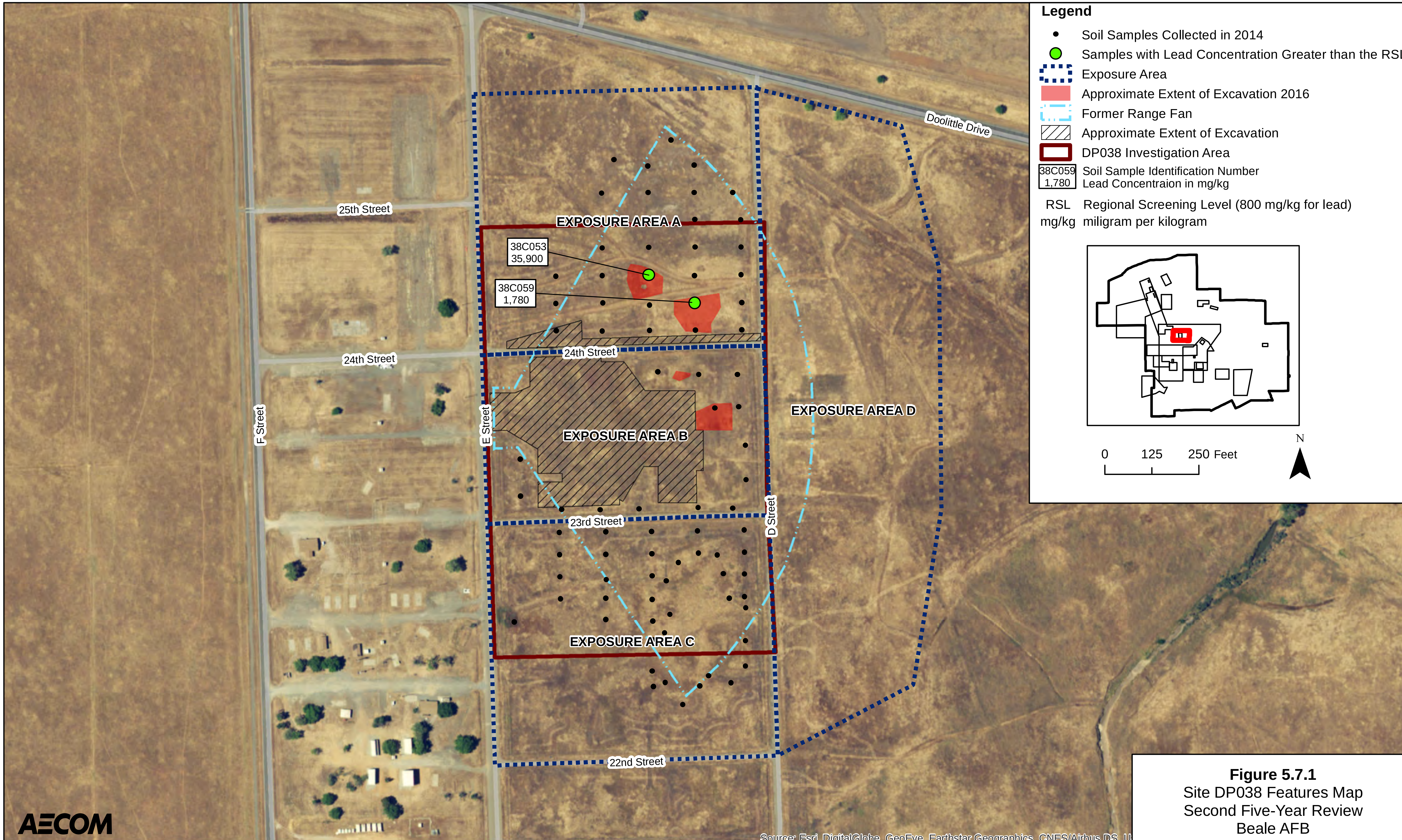

Figure 5.7.1
Site DP038 Features Map
Second Five-Year Review
Beale AFB

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5.8 Site SS039

5.8.1 Introduction

Site SS039 is located in the central portion of Beale AFB, approximately 1.8 miles southeast of the southern end of the flightline. Site SS039 is bounded on the north by Doolittle Drive and on the south by 9th Street; it includes the developed area that occurs primarily between A and C Streets. It also includes some of the undeveloped areas east of A Street and west of C Street. Site SS039 consists primarily of buildings, paved parking areas, paved streets, and open grassland.

Site SS039 originally consisted of Building 2145, several closed underground storage tanks formerly located near the building, and portions of the associated sanitary sewer system. Building 2145 consists of the Air Combat Command Center and the Beale AFB photography laboratory. Approximately 80 percent of the area adjacent to Building 2145 is paved. Site SS039 is shown in Figure 5.8-1.

5.8.2 Response Action Summary

Several environmental investigations have been conducted at Site SS039, including a preliminary assessment in 1999, a site inspection in 2002, and a phased RI from 2004 through 2009. In the RI report two contaminant source areas, Source Areas 1 and 2, were identified at Site SS039 (CH2M HILL 2010f).

Soil vapor data that was collected during the 2013 data gap investigation indicated substantial residual TCE and PCE remained in soil in Source Area 2 but was not present in soil at Source Area 1. A 2014 risk assessment identified TCE and PCE as COCs in soil vapor and concluded that additional treatment was necessary to remove these COCs from soil vapor at Source Area 2 (CH2M HILL 2014a). Soils beneath Site SS039 are predominantly fine-grained in Source Area 2, and additional TSs were deemed necessary to support a remedial design. The TS indicated that because of the soil type and location of contamination, SVE was a viable remedial option (CH2M HILL 2015c).

An SVE system was installed in July and August 2014, and began operating on August 26, 2014 (CH2M HILL 2015c). Cleanup goals for soil vapor, for VI and the protection of groundwater, were presented in the *Site SS039 Soil Vapor Cleanup Goals Technical Memorandum* and are shown in Table 5.8-1 (CH2M HILL 2015c). The most current version DTSC soil gas screening model (DTSC 2014) was used to derive health protective soil gas concentrations based on a target cancer risk of $5x10^{-6}$ and/or hazard quotient of 1. The lower of the calculated cleanup goals was selected as the soil vapor cleanup goal for each COC. The cleanup goal for PCE is based on the protection of groundwater. The cleanup value for TCE is based on the health protective value.

Table 5.8-1. Cleanup Goals, Site SS039

Chemicals of Concern	Soil Vapor Concentration (ppbv)
PCE	2,920
TCE	1,100

Notes:
PCE = tetrachloroethene
ppbv = part per billion by volume
TCE = trichloroethene

A draft ROD for soil was prepared in 2015 (Air Force 2015a).

The site-specific RAOs for Site SS039 in the draft ROD are to:

- Reduce VOC concentrations in soil (represented as soil vapor) to levels that allow UU/UE.
- Reduce concentrations of VOCs in soil potentially affecting underlying groundwater to support designated beneficial uses of groundwater.

To achieve these soil RAOs, the Air Force selected the following remedial action components (Air Force 2015a):

- **SVE:** Continued operation of the SVE system to treat VOCs in soil vapor.
- **STOP Evaluation:** SVE to be terminated when no longer technically or economically feasible. A STOP evaluation to be the sole criteria used to determine when no longer technically or economically feasible to continue SVE and when termination of SVE is appropriate.
- **LUCs:** LUCs to be implemented to restrict uncontrolled exposure to contaminants in soil and prohibit residential land uses until the concentration of COCs in soil vapor are at such levels to allow UU/UE.
- **Soil Vapor Monitoring:** A soil vapor monitoring program to evaluate the effectiveness of the remedy (i.e., increasing or decreasing concentration trends, ability to achieve the cleanup levels) and gather data to identify the areas requiring soil excavation.
- **Excavation:** Excavation and off-site disposal of soils with concentrations of COCs in soil vapor at such levels that do not allow UU/UE subsequent to the shutdown of the SVE system.

A request for permanent SVE shutdown was presented in the *Site SS039 Soil Vapor Extraction System Shutdown Report* (CH2M HILL 2016a). Rebound samples were collected after 6 weeks and 6 months of system shutdown, which occurred on March 25, 2015. Rebound soil data that was collected defined the lateral extent of remaining contamination. Numerical modeling and empirical groundwater data were presented as confirming that residual soil contamination did not pose a threat to groundwater quality and that permanent shutdown of the SVE system was appropriate (CH2M HILL 2016a).

The existing groundwater data from beneath Site SS039 indicated that VOCs were released to soil and migrated to groundwater at Source Area 1 (north of the movie theater) and Source Area 2 (north of Building 2145). Figure 5.8-1 shows the two source areas. In 2013, Site SS039 groundwater was administratively moved into Site CG041 (as CG041-039) and is discussed in Section 5.9.

LUCs were inspected and reported at Site SS039 following the Cantonment Area IROD (Air Force 2011b). LUCs were inspected semi-annually and reported annually throughout this five-year review. No major land disturbances were observed during this period. However, an SVE utility trench that was covered by asphalt was repaired in April 2015, and the parking lot adjacent to the SVE equipment and wells was repaved in summer 2015. In addition, during the September 2015 inspection, ground-disturbing construction activities were observed within the IROD LUC boundary but were located away from remaining contamination associated with Source Area 2 and were not considered a violation of the LUCs. The draft Site SS039 ROD defined a much smaller LUC boundary, to be implemented beginning with the 2016 LUC inspections (CH2M HILL 2016e).

5.8.2.1 Systems Operations/Operation and Maintenance

The SVE system was shut down for rebound testing in March 2015 and remained offline throughout the rest of 2015. No major issues were reported during the SVE system period of operation.

5.8.3 Progress since the Last Review

The protectiveness statement for Site SS039, which included groundwater, in the first *Five-Year Review Report* (URS 2012) states:

> *The remedy for Site SS039 is protective of human health and the environment because TCE concentrations in the source area have been reduced through in situ reductive dechlorination and groundwater monitoring is ongoing. However, current occupants of existing buildings could be exposed to TCE through the vapor intrusion pathway, and an evaluation of groundwater concentrations underneath the buildings should be performed to evaluate whether a potential threat to human health exists. To ensure protectiveness in the long term, the cleanup goals and the remedy for Site SS039 must be finalized in a decision document, and LUCs must be implemented to prevent exposure to contaminated groundwater until RAOs are achieved.*

The status of the issues and recommendations presented in the first five-year review is shown in Table 5.8-2.

Table 5.8-2. Status of Recommendations from the First Five-Year Review, Site SS039

Issues	Recommendation	Current Status	Current Implementation Status Description
A consensus agreement on ARARs is necessary so that the cleanup goals and remedy can be finalized for Site 39.	Finalize remedial action objectives, cleanup goals, and interim remedy in a decision document.	Ongoing	A draft Record of Decision for Site SS039 was completed in 2015. The finalized ROD is forthcoming.
LUCs have not been implemented to ensure that potential receptors remain protected while RAOs are being attained.	Implement land use controls (LUCs) to prevent human exposure to residual volatile organic compounds in groundwater.	Ongoing	LUCs have been implemented at Site SS039, are monitored semi-annually, and the results are reported annually.

5.8.4 Data Review

Minimal data has been collected during this five-year review and is related to the operation of the SVE system. The system operated between August 2014 and March 2015. Samples collected in February 2015, before shutdown, were substantially below established cleanup levels. The maximum detected TCE concentration of 278 ppbv was collected at well 39C082VEW. These results led to a request for SVE system shutdown.

The 6-week rebound samples were collected again in May 2015. The maximum detected concentration of 883 ppbv was collected at 39C081VMP (129 ppbv in February 2015). Additional sampling was completed in July 2015 at only three wells that were located in the source area (39C079VMP, 39C080VMP, and 39C081VMP). The maximum detected concentration of TCE was collected from 39C081VMP at 1,040 J ppbv. The 6-month rebound testing was conducted in October 2015. The maximum detected concentration of 550 ppbv was collected at 39C080VMP. The results from rebound testing showed that the SVE system had successfully remediated soil vapor concentrations to levels less than site-specific cleanup goals.

Under a reasonable maximum exposure scenario using the EPA's final VI guidance (EPA 2015), EPCs also were less than site-specific cleanup goals. In addition, area-weighted average concentrations were calculated from the 6-week rebound samples, using the EPA ProUCL software package (EPA 2013c). These concentrations also were less than cleanup goals (CH2M HILL 2015c). Overall, these data indicated that it was acceptable to cease SVE operations at Site SS039.

5.8.5 Technical Assessment

QUESTION A: Is the remedy functioning as intended by the decision documents?

Yes, the remedy is functioning as intended by the draft ROD for Site SS039, and permanent shutdown of the SVE system has been recommended because soil vapor COC concentrations are less than the cleanup goals for soil gas, which are protective of human health and groundwater.

LUCs are in place and effective. LUCs continue to be inspected semi-annually and reported in the Base Land Use Control Inspection Report. No outstanding issues are associated with the LUC requirements at Site SS039.

QUESTION B: Are the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of the remedy selection still valid?

Yes, the exposure assumptions, toxicity data, cleanup goals, and RAOs used at the time of the remedy selection still are valid. Site-specific cleanup goals for soil vapor were developed and remain the standards by which the remedial actions are judged. As noted in the ROD (Air Force 2015b), the cleanup goal for PCE is based on the protection of groundwater and the basis for the TCE cleanup goal is protection of human health. The outcome of the risk assessments, development of these cleanup goals, and relevant updates in risk guidance are described below:

- According to the ROD, the 2010 HHRA was performed using exposure areas and exposure scenarios that reflect the current and planned future land use (on-site Base worker and construction/excavation worker) at Site SS039 as part of Beale AFB, and that also took into account hypothetical future land use (residential). Soils and sediments were evaluated at multiple depths for the exposure areas determined for the site (sitewide, Source Area 1, and Source Area 2). Potential noncancer health effects from lead also were evaluated through comparison with CHHSLs for soil (Cal/EPA 2010). The CHHSL residential soil screening level for lead is 80 mg/kg, which still is valid and is consistent with the DTSC (2017) soil screening level.

– **Sitewide.** The cumulative risk estimate for exposure to surface soil (0 to 1 foot bgs), excluding 1,2-dibromo-3-chloropropane (DBCP) and naturally occurring chromium, is 8×10^{-6} for the residential exposure scenario. The cumulative risk estimate for exposure to mixed zone soil (0 to 10 feet bgs), excluding DBCP and naturally occurring chromium and arsenic, is 5×10^{-6} for the residential exposure scenario. The cumulative risk estimates for both surface and mixed zone soil is less than 10^{-5}. Based on the hypothetical future resident, the noncancer hazard estimate for exposure to surface soil and mixed zone soil is 1. Because the HQs do not exceed 1 for all COPCs, no primary contributors were identified in surface soil and mixed zone soil.

– **Source Area 1.** The cumulative risk estimate for exposure to mixed zone soil (0 to 10 feet bgs), excluding naturally occurring chromium and arsenic, is 1×10^{-6} for the residential scenario, which does not exceed the lower end of EPA's risk management range. The cumulative HQ for exposure to mixed zone soil (0 to 10 feet bgs), excluding naturally occurring arsenic, is 0.03 for the residential exposure scenario. EPCs for lead in surface soil (26.0 mg/kg) and mixed zone soil (1.5 mg/kg) are lower than the CHHSL (80 mg/kg) for lead under the residential scenario. Therefore, lead is not a COC in the Source Area 1 exposure area.

– **Source Area 2.** The cumulative cancer risk estimate, after excluding chromium, for exposure to surface soil (0 to 1 foot bgs) is 1×10^{-5}, and the noncancer hazard estimate does not exceed 1 for the residential exposure scenario. The cumulative risk estimate, after excluding chromium, for exposure to mixed zone soil (0 to 10 feet bgs) is 5×10^{-6}, and the noncancer hazard estimate does not exceed 1 for the residential exposure scenario. The cumulative risk estimates for both surface and mixed zone soil are less than or equal to 10^{-5}. The noncancer hazard estimate for exposure to surface soil and mixed zone soil is 1. Because the HI does not exceed 1 for all COPCs, no primary contributors are identified in surface soil and mixed zone soil. The EPC for lead in surface soil (81.7 mg/kg) only slightly exceeds the CHHSL (80 mg/kg) for lead under the residential scenario. The EPC for lead in surface soil is based on the maximum concentration of lead detected at Source Area 2. This single lead detection was the only detected concentration greater than the CHHSL, and thus the EPC for lead is considered conservative. The EPC for lead in mixed zone soil (44.8 mg/kg) is lower than the CHHSL. Therefore, lead is not a COC in the Source Area 2 exposure area.

- ***Soil Vapor Intrusion.*** **Source Area 1.** The residential cumulative cancer risk estimates ranged from 9×10^{-10} to 1×10^{-6} for the Source Area 1 exposure area soil vapor sampling locations. All residential noncancer HI estimates were less than 1. No COCs for soil vapor were identified for Source Area 1. The potential for TCE migration from Source Area 1 to the Base movie theater, located south of Source Area 1, is low. At Source Area 1, the soil contamination is delineated, is at steady-state conditions, and is located more than 100 feet from the movie theater. No utility lines, which could provide preferential migratory pathways between Source Area 1 and the movie theater, were identified by a records search and field observations.

- ***Soil Vapor Intrusion.*** **Source Area 2.** The cumulative residential lifetime cancer risk estimates range from 3×10^{-8} to 4×10^{-5}. With the exception of the cancer risk results from samples collected at locations 39C073SB and 39C075SB, the cancer risk estimates do not exceed 1×10^{-6}. Only the samples from 39C073SB at 5 and 10 feet bgs have cumulative noncancer HIs greater than 1 (HIs of 6 and 10, respectively). The primary contributors to the cancer risks at location 39C073SB are PCE, TCE, and vinyl chloride in the 5-foot sample; PCE, TCE, and vinyl chloride in the 10-foot sample; and PCE and TCE in the 15-foot sample. Vinyl chloride at 39C073SB likely is volatilizing from the groundwater (because of emulsified vegetable oil [EVO] injections treatment). Vinyl chloride associated with groundwater is being addressed as part of Site CG041 (basewide groundwater).

- The updated HHRA Screening Level Risk Assessment Summary Report (CH2M HILL 2014a) determined that the estimated cancer risk to future residents at Site SS039 from residual contaminants are within the acceptable risk management range of 10^{-6} to 10^{-4}, and noncancer hazard estimates were at or below the target noncancer hazard index of 1, except for TCE in soil vapor at Source Area 2. TCE in soil vapor at Source Area 2 is considered to be a COC at Site SS039. Soil, surface water, and sediment at Site SS039 are considered appropriate for UU/UE, and additional remedial effort is not warranted. Additional remedial action is required for TCE and PCE in soil vapor at Source Area 2 to achieve site close-out with UU/UE.

- Following submittal of the 2014 HHRA, site-specific soil vapor risk-based concentrations (RBCs) were calculated for a hypothetical future residential land use and were finalized following agency review (CH2M Hill 2015c). The soil vapor RBCs for TCE and PCE were calculated using the advanced version of the Johnson and Ettinger model (Johnson and Ettinger, 1991) and based on input parameters from DTSC's vapor intrusion guidance (DTSC, 2011, 2014). These soil vapor RBCs reflected the most recent technical findings concerning the vapor intrusion pathway at that time (EPA, 2004a; DTSC, 2011, 2014). The target cancer risk was set at 5×10^{-6} and target hazard quotient was set at 1.0. The following site-specific attenuation factors (AFs) were incorporated into the RBC calculations: 0.00035 TCE and 0.00026 PCE. The final selected cleanup goals for soil vapor were the lower of the cancer and noncancer RBCs, and for both COCs, the more conservative endpoint was non-carcinogenic effects (based on mutagenic effects for TCE): TCE cleanup goal = 1,100 ppbv and PCE cleanup goal = 23,000 ppbv (CH2M Hill 2015c).Therefore, non-cancer-based values would also protect for cancinogenic effects.

  Recent vapor intrusion guidance has been published by EPA recommending a default attenuation factor for screening assessments of 0.03 (EPA 2015). Applying this worst case attenuation factor to the indoor air RBCs results in soil vapor RBCs that are lower than when using the site-specific attenuation factors described above. Using the soil vapor RBCs with EPA's default attenuation factor and the most current soil vapor data collected during the 2015 6-month rebound testing results in the following risk estimates:

Chemical of Concern	2015 Maximum Soil Vapor Concentrations (µg/m^3)	Soil Vapor RBSL - Attenuation Factor = 0.03 (µg/m^3)	Hazard Quotient
TCE	2,956 (550 ppbv)	70	42
PCE	543 (80 ppbv)	1,400	0.4
	Hazard Index		43

  Note: Cancer risks estimated from the soil vapor RBCs with EPA's default attenuation factor and the 2013 maximum soil vapor concentrations range from 3×10^{-7} (PCE) to 4×10^{-5} PCE, based on target risk of 5×10^{-6}.

  These risk and hazard estimates are considered worst-case, conservative values because LUCs are currently in place that restrict access to residual soil contamination and prevent residential land uses. LUCs will be enforced until the site is suitable for UU/UE. TCE concentrations in soil vapor have exhibited a decreasing trend through this five-year review period and have decreased to levels below interim clean up goals.

- As discussed above in Section 5.2.5, the DTSC issued new health-based short-term indoor air criteria for TCE in their HHRA Note 5 (2014), which was published in response to EPA's release of its updated TCE guidance (EPA 2014). Both agencies concur with use of the recently developed *Accelerated Response Action Levels* and *Urgent Response Action Levels* for indoor air concentrations of TCE, which allow for assessment of short-term indoor inhalation exposures to protect sensitive and vulnerable populations (i.e., developing fetus). The RAO is to meet conditions favorable to UU/UE, and therefore, the residential action level of 2 µg/m^3 is the most appropriate screening level for the Site. The site-specific indoor air RBC for TCE for hypothetical future residents is equivalent to this value at 2.1 µg/m^3 (CH2MHill 2015c), which represents EPA's current residential non-cancer RSL for indoor air (EPA 2017). Thus, the site cleanup goal for TCE is already protective of the short-term non-cancer effects of TCE under a hypothetical future land use scenario. Applying EPA's default attenuation factor of 0.03 and the site-specific attenuation factor of 0.00035 to the Accelerated Response Action Level of 2 µg/m^3 results in the following hazard estimates:

2015 Maximum Soil Vapor Concentrations ($\mu g/m^3$)	EPA Accelerated RAL – Attenuation Factor = 0.03 ($\mu g/m^3$)	Hazard Quotient	EPA Accelerated RAL – Attenuation Factor = 0.00035 ($\mu g/m^3$)	Hazard Quotient
2,956	67	44	5,714	0.09

The HQ for short-term exposures to TCE using EPA's worst-case attenuation factor is approximately 40 times greater than the target of 1.0, while the HQ using the more realistic site-specific attenuation factor for future residential buildings is below this target. The selected remedy for Site SS039 is expected to reduce concentrations of VOCs in soil that may potentially affect underlying groundwater and pose a risk to human health (vapor intrusion), and LUCs serve to restrict uncontrolled exposure to contaminants and prohibit residential land uses until COCs are at such levels to allow for UU/UE will be implemented.

- The EcoRA identified lead as a contaminant of ecological concern (COEC) in surface soils (0 to 1 foot bgs) and lead in surface water in Source Area 1. Although the estimated lead dose in soil exceeded the low TRV for various birds and mammals, it did not exceed the high TRV for bird or mammal receptors. In addition, concentrations of lead exceeding background generally were located in paved areas that do not provide quality habitat. The risk posed by lead in surface water was limited to one of three locations and represents a small percentage of overall site risk. Consequently, no action was required for lead in surface water.
- Although lead and Aroclor-1260 are present in surface soils and sediment in drainages, because of the low residual concentrations within the drainages and the low value of the wetland function that they provide, further action was not recommended in the Cantonment Area IROD (Air Force 2011b). No data relevant to ecological receptors have been collected since the IROD was issued. Site conditions have remained unchanged since the issuance of the IROD. Therefore, the conclusions made in the IROD are still relevant. Risk to ecological receptors was not predicted, and no COECs were identified for the site.

QUESTION C: Has any other information come to light that could call into question the protectiveness of the remedy?

No information has come to light that could call into question the effectiveness of the remedy for soil. Currently, groundwater at the base is monitored on a sitewide basis, as groundwater now is considered to be a distinct operable unit that contains plumes from several sites. All plumes are confined within the Base property boundary (CH2M HILL, 2016i). A review of the protectiveness of the groundwater RAOs by remedy type will be conducted in the five-year review for basewide groundwater, which will include an assessment of the vapor intrusion pathway, with particular focus on sites with groundwater plumes and buildings present.

5.8.6 Issues/Recommendations

The following issue was identified in the technical assessment for Site SS039:

- A final decision document has yet to be completed, identifying the components of the final remedy as well final RAOs and cleanup goals.

The following recommendation is made following this technical assessment for Site SS039:

- Complete a final decision document, identifying site-specific RAOs and cleanup goals as well as a final remedy.

5.8.7 Protectiveness Statement

Site conditions are protective of human health and ecological receptors, based on current and anticipated future use of SS039. Site media (soil, sediment, and surface water) are currently acceptable for UU/UE, however, groundwater conditions beneath Site SS039 require LUCs to remain in place to prevent future ground disturbances and exposure to groundwater contamination.

5.8.8 Next Review

Pending approval of the final ROD, no further five-year reviews are planned for Site SS039 because the site is suitable for UU/UE.

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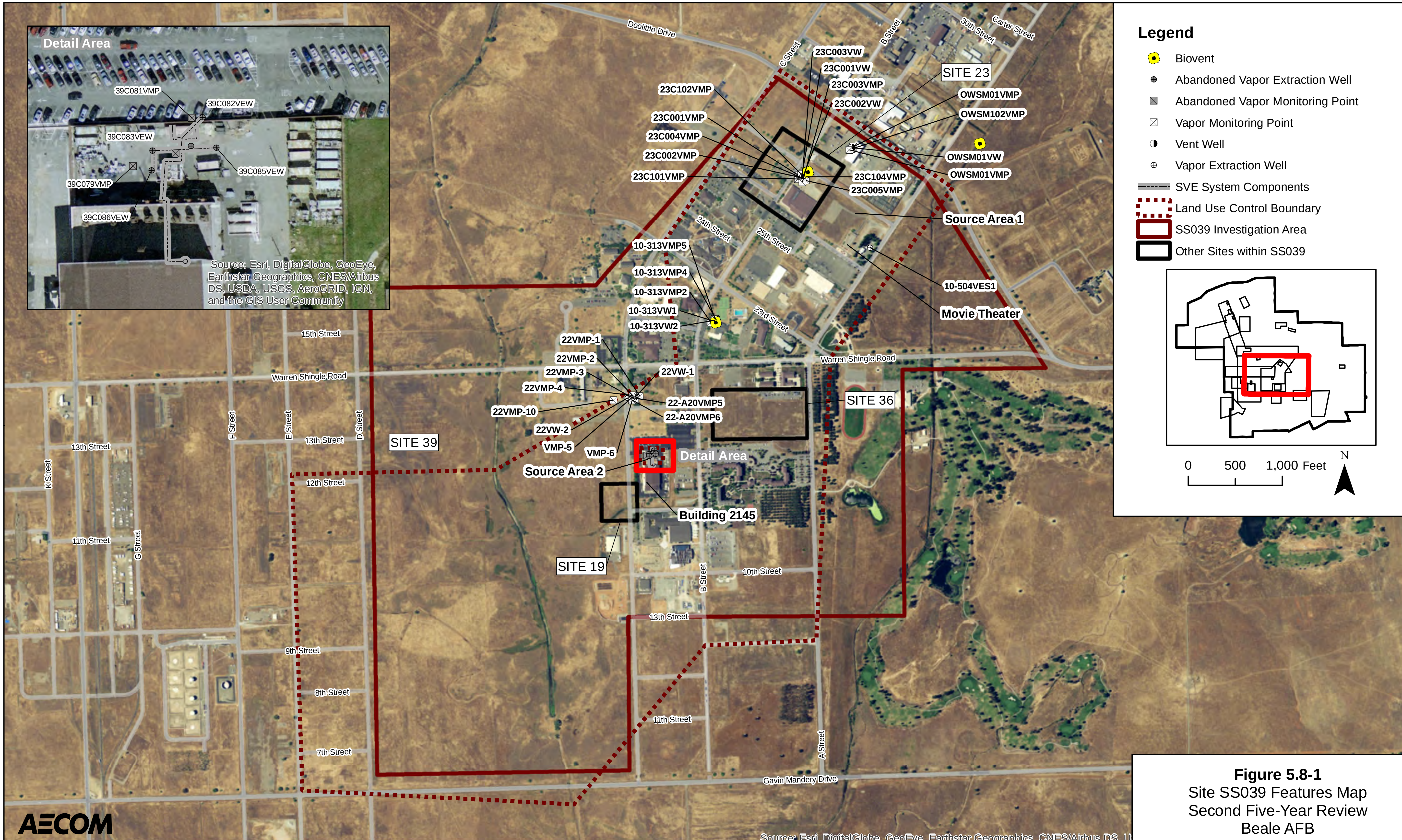

Figure 5.8-1
Site SS039 Features Map
Second Five-Year Review
Beale AFB

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5.9 Site CG041

5.9.1 Introduction

Beale AFB has investigated groundwater quality since the mid-1980s. Sampling activities have been conducted under the BGMP since 1992. Currently, more than 1,000 groundwater monitoring wells, extraction wells, and piezometers are found on the Base.

In 2013, groundwater plumes formerly associated with 12 CERCLA sites, two RCRA sites, and one LUFT site at Beale AFB were decoupled from their original sites and transferred to a combined basewide groundwater site identified as CG041. CG041 plumes addressed in this five-year review, along with the sites from which they were decoupled, are shown in Table 5.9-1.

Table 5.9-1. Basewide Groundwater (CG041) Sites, Beale AFB

Groundwater Plume	Beale AFB Originating Site	Site Description	Regulatory Program
CG041-003	FT003	Fire Protection Training Area	CERCLA
CG041-010	SD010	J-58 Test Cell	CERCLA
CG041-013	LF013	Landfill No. 1	CERCLA
CG041-016	WP016	Explosives Ordnance Disposal Area	CERCLA
CG041-017	OT017	Best Slough	CERCLA
CG041-018	ST018	Bulk Fuel Storage Area	CERCLA
CG041-029	FT029	Burn Pit	CERCLA
CG041-031	SD031	Building T-896	CERCLA
CG041-032	SD032	Building 1086	CERCLA
CG041-035	SS035	Weapons Storage Area	CERCLA
CG041-039	SS039	Building 2145	CERCLA
CG041-040	CG040	Monitoring Well UBL002MW Area	CERCLA
CG041-508	SS508	PCE Groundwater Plume Civil Engineering Yard	RCRA
CG041-509	TU509	Beale AFB Clinic Underground Storage Tanks	LUFT
CG041-517	CG517	Beale AFB Clinic PCE Plume	RCRA

COCs in groundwater at CG041 sites were established after an RI or a RCRA Facility Investigation (RFI) and risk assessment were performed, and after specific chemicals were found to pose an unacceptable risk (either to human health or to the environment). In interim decision documents stakeholders then established and agreed on remediation goals for the COCs. To date, groundwater COCs have been established at all Beale AFB plumes addressed under CG041. Groundwater COCs for Site CG041 groundwater plumes were re-evaluated in 2015 as part of the final *Focused Feasibility Study for Basewide Groundwater, Site CG041* (Former ERP Sites) (FFS) (CH2M HILL 2015f) and are shown in Table 5.9-2. The final ROD for CG041 is forthcoming.

Table 5.9-2. Groundwater Plume Chemicals of Concern, CG041

Groundwater Plume	Chemicals of Concern
CG041-003	Carbon tetrachloride, DCA, PCE, TCE, TPH-G
CG041-010	TCE, PCE, cis-1,2-DCE, trans-1,2-DCE, vinyl chloride
CG041-013	TCE, PCE, cis-1,2-DCE, trans-1,2-DCE, TECA, 1,1,2,2-TECA, TCA, 1,1-DCE
CG041-016	Perchlorate
CG041-017	TCE, carbon tetrachloride, cis-1,2-DCE, chloroform, 1,2-DCA, 1,1-DCE, 1,1,2-TCA, PCE, 1,1,2,2-TECA, trans-1,2-DCE, vinyl chloride, TPH-D
CG041-018	Benzene, TCE, TPH-D, TPH-G
CG041-029	Carbon tetrachloride, cis-1,2-DCE, TCE
CG041-031	TCE
CG041-032	1,1,2,2-TECA, 1,2-DCA, chloroform, cis-1,2-DCE, ethylbenzene, methylene chloride, PCE, TCE. Trans-1,2-DCE, vinyl chloride, xylenes
CG041-035	Carbon tetrachloride, 1,1-DCE, TCE
CG041-039	Carbon tetrachloride, cis-1,2-DCE, 1,1-DCE, PCE, TCE, vinyl chloride, TPH-D, TPH-G
CG041-040	Carbon tetrachloride, cis-1,2-DCE, 1,1-DCE, PCE, TCE, vinyl chloride
CG041-508	PCE
CG041-509	Benzene, naphthalene, TPH-D
CG041-517	PCE

Narrative RAOs provide a general description of what cleanup will accomplish; they are used to guide the selection of numerical cleanup goals and serve as the design basis for remedial alternatives. Site-specific RAOs for CG041 identified in the FFS (CH2M HILL 2015g) include:

- Reduce and/or monitor reductions in concentrations of COCs in groundwater to support restoration of groundwater to designated beneficial uses (i.e., domestic, municipal, agricultural, and industrial supply).
- Restrict potential exposure to COCs in groundwater until concentrations are at such levels to allow UU/UE.

Preliminary numerical cleanup goals have been identified for basewide groundwater (CG041) to achieve the RAOs (CH2M HILL 2015g). The goals are based on the lowest of either federal or State primary MCLs (EPA 2013b; State Water Board 2011).

Risk-based groundwater concentrations protective of the indoor air pathway at Site CG041 were calculated and presented in the FFS (CH2M HILL 2015g). Risk-based cleanup levels are higher than the MCLs. Thus, cleaning up to MCLs will be protective of the VI pathway. In addition, the FFS presented remedial alternatives and comparative analyses of those alternatives for each site under Site CG041. Final remedies, RAOs, and cleanup goals will be established in the forthcoming Site CG041 ROD. Because the Site CG041 ROD was not finalized during this five-year review, the information and evaluations presented in the following sections for the CERCLA groundwater plumes focus on their interim response actions.

5.9.2 Response Action Summary

Interim remedies are currently in place at all sites under Site CG041. Remedial technologies implemented to date include the following:

- Enhanced reductive dechlorination (ERD)
- In situ chemical oxidation (ISCO)
- Groundwater treatment system (GTS)
- Bioremediation
- Enhanced attenuation
- Land use controls (LUCs)

A brief discussion of each site under CG041, including remedial actions implemented during this five-year review, are presented next.

5.9.2.1 CG041-003

Fire Protection Training Area (FPTA) Numbers (Nos.) 1 through 4 historically were identified as sources of TCE groundwater contamination at CG041-003. An SVE system operated from 1997 to 2009, removing VOCs in soil (expressed as soil vapor) at FPTA Nos. 1, 2, 3, and 4 (CH2M HILL 2010b). An agreement with CVWB to terminate the Site FT003 SVE system was reached in 2010 (CVWB 2010), and the system was decommissioned in 2014.

Historically, VOCs (TCE, PCE, and carbon tetrachloride) and TPH in groundwater extended from FPTA Nos. 1 and 2 approximately 1,800 feet to the southwest (URS 2007a). However, VOC concentrations in this area, also referred to as the Eastern source area, have decreased over time to less than MCLs or PSLs.

Concentrations have increased west of FPTA Nos. 3 and 4, near a concrete pad that is adjacent to a former dry well (CH2M HILL 2011h). Spills occurred on the pad in the past. However, contamination from FPTA Nos. 3 and 4 also has merged with the groundwater contamination associated with the concrete pad. The concrete pad and FPTA Nos. 3 and 4 are referred to as the western source area.

In 2011, the *Site 3 Action Memorandum for Time-critical Removal Action* (CH2M HILL 2011k) identified RAOs for the protection of groundwater beneath Site FT003, including:

- Reduce concentrations of COCs (carbon tetrachloride, 1,2-DCA, PCE, TCE, and TPH-G) in underlying groundwater to support designated beneficial uses of groundwater (i.e., domestic, municipal, agricultural, and industrial supply), if feasible.
- Restrict potential exposure to COCs in groundwater until concentrations are at levels that allow UU/UE.

Preliminary COCs and preliminary cleanup goals (PCGs) for groundwater also were established in the action memorandum. The PCGs are the federal drinking water MCL for PCE and TCE, and the California drinking water MCLs for carbon tetrachloride and 1,2-DCA. The following COCs and their respective PCGs were established in the action memorandum:

- Carbon tetrachloride–0.5 µg/L
- 1,2-DCA–0.5 µg/L
- PCE–5 µg/L
- TCE–5 µg/L

The removal action selected in the action memorandum consisted of ISCO, evaluation monitoring, and LUCs. The ISCO removal action was implemented in the area of the concrete pad in 2011. Analytical data indicate that TCE concentrations in groundwater in the CG041-003 western source area have decreased in the treatment zone. Post-injection monitoring was conducted quarterly from 2011 to 2015, in accordance with the Monitoring and Reporting Program (MRP) specified in Waste Discharge Requirement (WDR) Order R5-2008-0149-032 (CVWB 2011). Monitoring frequency was reduced to semi-annually in accordance with MRP revisions in August 2015 (CVWB 2015a). Monitoring is conducted to demonstrate performance of the ISCO remedy and ensure groundwater downgradient from the treatment zone is not adversely affected. During this five-year review, LUC inspections were conducted semi-annually and were reported in the annual Land Use Control Inspection Reports. No ground disturbances or exposures were recorded.

A draft proposed plan was prepared, identifying hot spot treatment with ISCO, enhanced attenuation monitoring, and LUCs as the preferred remedial alternatives to address groundwater contamination at CG041-003 and to achieve Site CG041 RAOs (Air Force 2016b). COCs and cleanup goals for Site CG041-003 are the same as those established in the action memorandum, with TCE being identified as the primary COC. A map of CG041-003 site features is shown in Figure 5.9-1.

5.9.2.2 CG041-010

The Site CG041-010 plume was decoupled from Site SD010, located in the north-central portion of Beale AFB, east of Doolittle Drive and the Flightline Area. A portion of Site SD010 was used as a jet engine test stand for SR-71 engines from 1959 to 1990. Two 10,000-gallon ASTs that contained JP-7 supplied fuel for engines on the test stand. As engines were tested, fuel was discharged onto the concrete pad and eventually washed onto the surrounding ground surface. Spills and leaks during these operations also deposited chemicals on bare soil (LAW 1996).

An enhanced in situ bioremediation (EISB) system, designed to provide sodium lactate to the groundwater to stimulate enhanced reductive dechlorination (ERD) of chlorinated ethenes in the Site SD010 source area, was installed in three phases. Phase 1 began operation in January 2005. The EISB treatment system was expanded in June and July 2006, with installation of the second and third transects of injection/extraction wells. The target treatment area for the EISB system was the 500-µg/L TCE plume in groundwater.

Phase 1 of the EISB system was shut down in 2006, and Phase 2 was shut down in December 2008. Because the TCE concentrations in the treatment zone remained low, Phase 3 of the EISB system was shut down in January 2009, to assess rebound as recommended in the *Long-Term Operation and Maintenance 2008 Annual Report, Beale Air Force Base, California* (CH2M HILL 2009b). Groundwater monitoring remains ongoing under the BGMP.

An interim ROD for source zone area groundwater beneath Site SD010 was finalized in 2010 (Air Force 2010a). The IROD established the following RAOs:

- Continue to control and treat groundwater contamination to achieve MCLs.
- Restore groundwater to interim cleanup goals within a reasonable time frame.
- Restrict potential exposure to chlorinated VOCs in groundwater.

The IROD also identified continued operation of the EISB, with performance monitoring and LUCs as the preferred remedy for the site. Interim COCs and their respective cleanup goals established in the IROD include:

- trans-1,2-DCE – 10 µg/L
- TCE – 5 µg/L
- cis-1,2-DCE – 6 µg/L
- PCE – 5 µg/L
- vinyl chloride – 0.5 µg/L

During this five-year review, LUC inspections were conducted semi-annually and were reported in the annual Land Use Control Inspection Reports. No ground disturbances or exposures were recorded.

In February 2016, a draft proposed plan (Air Force 2016b) was prepared, identifying treatment with ERD (if monitoring indicates that concentrations are increasing [i.e., rebounding]), enhanced attenuation monitoring, and LUCs as the preferred remedial alternatives to address groundwater contamination at CG041-010 and to achieve the Site CG041 RAOs. COCs and cleanup goals are the same as those established in the 2010 IROD. A map of CG041-010 site features is shown in Figure 5.9-3.

5.9.2.3 CG041-013

Former Landfill No. 1 (Site LF013) received waste from local private sources before the establishment of Camp Beale in the early 1940s. Waste disposal continued at Site LF013 until Landfill No. 2 (Site LF002) became active in the mid-1950s (LAW 1995b). A map of CG041-013 site features is shown in Figure 5.9-5.

Groundwater contamination at CG041-013 is addressed by a GTS and an in situ bioreactor. From 1996 through 2009, soil contamination was addressed by SVE. The in situ bioreactor was constructed in September 2010 and was expanded in July and August 2011.

An IROD addressing Site LF013 contamination was finalized in 2010 (Air Force 2010b). The remedy presented in the IROD was intended to achieve the following RAOs:

- Continue to control and treat groundwater contamination to protect designated beneficial uses of water resources.
- Restore groundwater to interim cleanup goals within a reasonable time.
- Continue operation of the West SVE system to optimize groundwater cleanup and prevent the migration of contaminants from soil to groundwater at concentrations that could result in an exceedance of interim cleanup goals.
- Restrict potential exposure to chlorinated VOCs in groundwater.

The IROD identified continued operation of the GTS, continued operation of the West SVE system, and LUCs as the preferred remedy. The following COCs and cleanup goals were established in the IROD:

- trans-1,2-DCE–10 µg/L
- TCE–5 µg/L
- cis-1,2-DCE–6 µg/L
- PCE–5 µg/L
- 1,1,1,2-TECA–none
- 1,1,2,2-TECA–1 µg/L
- 1,1,2-TCA–1 µg/L
- 1,1-DCE–6 µg/L

During this five-year review, LUCs inspections were conducted semi-annually and were reported in the annual Land Use Control Inspection Reports. No ground disturbances or exposures were recorded.

The February 2016 draft CG041 proposed plan identifies hotspot treatment with ERD, GTS, continued drinking water supply to Deep Violet Farms, enhanced attenuation monitoring, and LUCs as the preferred remedial alternatives to address groundwater contamination at CG041-013 and to achieve Site CG041 RAOs (CH2M HILL 2016b).

5.9.2.4 CG041-016

Site WP016 is a former unlined disposal trench at the EOD Range, where burned or exploded ordnance from the open burn/open detonation (OB/OD) unit, SWMU 12, was placed for temporary disposal before transport off-site. Groundwater associated with this site is managed under Site CG041 as CG041-016. A map of CG041-016 site features is shown in Figure 5.9-7.

Sediment, surface water, and groundwater samples that were collected during the 2007 RI were used to complete the *Site 16 Remedial Investigation Report* (CH2M HILL 2009a). The RI identified perchlorate in groundwater as the only COC and concluded that perchlorate was released to soil within the unlined former disposal trench or immediate vicinity, potentially through incidental spills of munitions materials or solid rocket fuel materials. No additional sources of chemical contamination were discovered during investigations at CG041-016 (CH2M HILL 2016i).

The selected interim remedy for CG041-016 from the Final Site WP016 IROD (Air Force 2011d) is evaluation monitoring and LUCs. The interim remedy was selected to monitor reductions in concentrations of perchlorate in groundwater, to support designated beneficial uses and attain the interim cleanup level based on the California MCL (6 µg/L). During this five-year review, LUC inspections were conducted semi-annually and were reported in the annual Land Use Control Inspection Reports. No ground disturbances or exposures were recorded.

The draft February 2016 CG041 proposed plan identifies enhanced attenuation monitoring to address perchlorate in groundwater and LUCs, to restrict groundwater use as the preferred remedial alternative for CG041-016 to achieve the Site CG041 RAOs (CH2M HILL 2016i).

5.9.2.5 CG041-017

Site OT017 occupies a low, gently sloping grassland and riparian habitat of approximately 500 acres adjacent to Best Slough in the southeastern portion of the Base. The groundwater beneath Site OT017 is included as part of Site CG041 and is identified as CG041-017. A map of CG041-017 site features is shown in Figure 5.9-9.

The Site 17 IROD identified the construction of a slurry wall coupled with a permeable reactive barrier (PRB) containing zero-valent iron (ZVI) (Air Force 2007a). LUCs also were identified to prevent potential exposure to site contaminants. Interim RAOs established in the IROD include:

- Control and treat groundwater contamination to protect designated beneficial uses of water resources to the extent technically and economically feasible.
- Control and monitor the migration of groundwater contaminants to minimize or prevent expansion of the dissolved plume.
- Prevent possible exposures to contaminated groundwater that could result in human health risks that exceed the EPA risk management range.

The following COCs and cleanup goals were established in the IROD:

- 1,1,2,2-TECA–1 µg/L
- 1,1,2-TCA–5 µg/L
- 1,1-DCE–6 µg/L
- 1,2-DCA–0.5 µg/L
- carbon tetrachloride–0.5 µg/L
- cis-1,2-DCE–6 µg/L
- chloroform–80 µg/L
- methylene chloride–5 µg/L
- PCE–5 µg/L
- trans-1,2-DCE–10 µg/L
- TCE–5 µg/L
- vinyl chloride–0.5 µg/L
- TPH-D–none

CG041-017 groundwater contamination has been categorized as follows (CH2M HILL 2016i):

- **Primary Source Area (Area A)–**The primary source area is a 5-acre area containing the former disposal trenches. These are contained and managed by the slurry wall interim remedial action. A GTS (primarily for hydraulic control within the slurry wall) and a phytoremediation system also have been implemented. The soil and groundwater in this area contain contaminants in the form of DNAPL. The interim remedy at Area A is preventing contamination from spreading outside the contained area and provides some treatment via the GTS and phytoremediation.
- **Secondary Source Area (Area B)–**The secondary source area is approximately 4 acres just south of the primary source area. Portions of this area (approximately 0.6 acre) also are suspected to contain DNAPL in soil and groundwater. A soil bentonite cutoff wall and a PRB made of sand and ZVI have been constructed to contain DNAPL and to treat dissolved-phase chlorinated VOCs in groundwater in this area.
- **Dissolved Plume–**The dissolved plume is the portion of the site groundwater in which contaminants from the primary and secondary source areas have dissolved and moved south or west with the flow of groundwater. The groundwater in this area is monitored as part of the interim remedial action. The dissolved plume of groundwater contamination exceeding MCLs extends approximately 1,400 feet south of the PRB.

During this five-year review, LUC inspections were conducted semi-annually and were reported in the annual Land Use Control Inspection Reports. No ground disturbances or exposures were recorded.

The draft proposed plan for CG041 prepared in 2016 identifies hotspot treatment with ERD, PRB with ISCR, enhanced attenuation monitoring, and LUCs (including restricting exposure via VI from groundwater into indoor air) as the preferred remedial alternatives to address groundwater contamination at CG041-017 and to achieve Site

CG041 RAOs. Until a final ROD is in place, the IROD interim cleanup goals and RAOs continue to be the cleanup goals and RAOs for CG041-017.

5.9.2.6 CG041-018

Site ST018, the Bulk Fuel Storage Facility, is a 69-acre tract of land northeast of the intersection of Gavin Mandery Drive (6th Street) and J Street, in the southwestern portion of the Base. The groundwater beneath Site ST018 is included as part of Site CG041 and is identified as CG041-018. A map of CG041-018 site features is shown in Figure 5.9-11.

In the fourth quarter of 2006, one monitoring well (18U007BMW) located in the northern portion of CG041-018 (near the long-term leak from the JP-TS pipeline) was found to contain several feet of light nonaqueous phase liquid (LNAPL) floating petroleum product. The Air Force evaluated treatment options and selected free product recovery, as documented in the *Site 18 Feasibility Study Addendum* (CH2M HILL 2008a).

In 2011, an IROD was finalized that identified interim remedies for both the petroleum plume and TCE plume associated with CG041-018 (Air Force 2011c). The interim remedy for the petroleum plume consisted of continued LNAPL recovery, evaluation monitoring, and LUCs. The interim remedy selected for the TCE plume was SVE, evaluation monitoring, and LUCs. These remedial actions were selected to achieve the following RAOs:

- Reduce concentrations of benzene, TCE, TPH-D, and TPH-G in underlying groundwater throughout the plumes to support designated beneficial uses of groundwater (i.e., domestic, agricultural, municipal, and industrial supply).
- Remove free product potentially affecting underlying groundwater to support designated beneficial uses of groundwater (i.e., domestic, agricultural, municipal, and industrial supply) and minimize free product migration, to the maximum extent practicable.
- Reduce concentrations of TCE in soil (expressed as soil vapor) potentially affecting underlying groundwater to support designated beneficial uses of groundwater (i.e., domestic, agricultural, municipal, and industrial supply).
- Restrict potential exposure to benzene and TCE in groundwater until concentrations are at such levels to allow UU/UE.

COCs and cleanup goals were established in the IROD to support the evaluation of the performance of the selected remedy. Cleanup goals were based on the lowest of California and federal MCLs and are as follows:

- benzene–1 µg/L
- TCE–5 µg/L

In June 2013, the passive free product skimmer, installed in 18U007BMW as part of the interim remedial action, was removed to facilitate routine groundwater monitoring after product levels were reduced at the well in February 2013 to approximately 0.003 gallon (10 milliliters [mL]). However, during the 2013 annual sampling event on August 6 and 7, free product was measured in well 18U007BMW at thicknesses of 8.84 and 9.30 feet. Subsequently, a new passive free product skimmer was installed in 18U007BMW in September 2013.

During the 2014 annual sampling event, one monitoring well (18U008BMW) near the long-term leak from the JP-TS pipeline was found to contain approximately 33 feet of LNAPL floating petroleum product. Data were presented during the July 2014 Tier 1 meeting, and the Air Force and regulators concurred on installing a passive free product skimmer, in accordance with the *Site 18 Free Product Skimmer Installation Plan* (CH2M HILL 2011a). On September 27, 2014, a passive free product skimmer was installed in monitoring well 18U008BMW. The top of the screen in wells 18U007BMW and 18U008BMW is more than 40 feet below the water table. Apparently, some NAPL that was submerged by rising water levels over the years found its way into these wells and accumulated in the casing. Groundwater skimming and monitoring are ongoing as of the time of this five-year review (CH2M HILL 2016i).

During this five-year review, LUC inspections were conducted semi-annually and were reported in the annual Land Use Control Inspection Reports. No ground disturbances or exposures were recorded.

A draft proposed plan has been prepared that identifies hot spot treatment (TCE greater than 300 µg/L) with ERD, enhanced attenuation monitoring, and LUCs as the preferred remedial alternatives to address the TCE plume at CG041-018 and to achieve Site CG041 RAOs. In addition, the proposed plan identifies hot spot treatment (benzene greater than 3 µg/L) with biodegradation, enhanced attenuation monitoring, and LUCs as the preferred remedial alternatives to address the benzene plume at CG041-018 and to achieve Site CG041 RAOs. Final remedial strategies, cleanup goals, and RAOs will be identified and presented in the CG041 ROD. The interim remedial action for LNAPL (passive skimming at 18U007BMW and 18U008BMW), along with evaluation monitoring, and LUCs, will continue to be implemented until the CG041 ROD is finalized.

5.9.2.7 CG041-029

Site FT029 is between A and B Streets and is approximately 300 feet south of 8th Street. The site is a former unlined burn pit, reportedly used for fire-fighting training exercises in the late 1950s or early 1960s. Responses for contaminated groundwater underlying this site are being addressed with Site CG041, and the site is identified as CG041-029. A map of CG041-029 site features is shown in Figure 5.9-14.

Evaluation monitoring and LUCs were implemented as an interim remedy, in accordance with the Cantonment Area IROD (Air Force 2011b) for groundwater in 2011. The IROD specified the following RAOs:

- Reduce and/or monitor reductions in concentrations of VOCs (i.e., carbon tetrachloride, cis-1,2-DCE, and TCE) in underlying groundwater originating at Site 29 to support restoration of groundwater to designated beneficial uses (i.e., domestic, municipal, agricultural, and industrial supply).
- Restrict potential exposure to COCs in groundwater until concentrations are at such levels to allow UU/UE.

COCs and cleanup goals also were identified in the Cantonment Area IROD for CG041-029. Cleanup goals are based on the lowest of either State or federal MCLs and are as follows:

- carbon tetrachloride–0.5 µg/L
- cis-1,2-DCE–6 µg/L
- TCE–5 µg/L

During this five-year review, LUC inspections were conducted semi-annually and were reported in the annual Land Use Control Inspection Reports. No ground disturbances or exposures were recorded.

In 2016, a draft proposed plan was prepared, identifying enhanced attenuation monitoring and LUCs as the preferred remedial alternative to address groundwater contamination at CG041-029 and to achieve Site CG041 RAOs (Air Force 2016b).

5.9.2.8 CG041-031

Site SD031 is in the south-central portion of Beale AFB, near the southwestern corner of the intersection of 9th and K Streets. Site SD031 (former Building 896) was listed as “LDY 20” on the 1944 Completion Map for Camp Beale. No other documentation has been found regarding the former use of Building 896. The groundwater beneath Site SD031 is managed under Site CG041, and the site is identified as CG041-031. A map of CG041-031 site features is shown in Figure 5.9-16.

The 2007 Site 31 IROD specified in situ bioremediation and LUCs as the interim remedy (Air Force 2007b). TCE was the only COC identified in the IROD and has a cleanup goal of 5 µg/L. The IROD also established the following RAOs:

- Protect human health by preventing exposure to contaminants in groundwater that exceed MCLs.
- Reduce TCE concentrations in groundwater to the maximum extent practicable in the target treatment zone to achieve MCLs in a cost-effective and timely manner.
- Monitor and/or control the migration of contaminants in groundwater to prevent further degradation of groundwater.
- Implement LUCs to prevent the installation of water supply wells or other groundwater impacts to Site 31.

In 2007, an enhanced EISB treatment system was constructed at CG041-031 as the interim remedy to treat chlorinated VOC contamination in the groundwater source area (defined as groundwater with TCE concentrations exceeding 1,000 µg/L). The CG041-031 EISB treatment system consisted of 10 extraction wells and 12 injection wells (CH2M HILL 2008b). In 2007, CVWB issued WDRs (Order R5-2007-0044) that specified ongoing monitoring and reporting requirements as part of the EISB operation.

In March 2010, the EISB treatment system was shut down for a rebound assessment. Following this action, EVO was injected in the Site SD031 source area to provide long-term groundwater treatment. EVO was injected into 14 existing groundwater wells to provide a longer-term electron donor to support continued reduction of TCE (CH2M HILL 2010h).

During this five-year review, LUC inspections were conducted semi-annually and were reported in the annual Land Use Control Inspection Reports. No ground disturbances or exposures were recorded.

The preferred remedial alternatives identified in the draft proposed plan for CG041-031 include hot spot treatment with ERD, using a biobarrier approach (where hot spots exceed 300 µg/L of TCE), enhanced attenuation monitoring of COCs, and LUCs to address groundwater contamination at CG041-031 and to achieve Site CG041 RAOs (Air Force 2016b).

5.9.2.9 CG041-032

The Flightline Area groundwater investigation location of CG041-032 is in the northwestern portion of Beale AFB, extending southwest to the Base boundary. This area encompasses the southern portion of the flightline and extends from the western side of the runway to the western Base boundary. The primary source of contamination was Building 1086 (Site SD032). A map of CG041-032 site features is shown in Figure 5.9-18.

The final Site 32/1 IROD (CH2M HILL 2007c) established the following RAOs for groundwater:

- Protect human health by preventing exposure to groundwater and surface water COCs that exceed MCLs for potential sources of drinking water.
- Reduce VOCs in groundwater in targeted areas of highest concentration to the extent technically and economically feasible.
- Reduce COC concentrations to meet interim cleanup standards in the treatment zones.
- Monitor and control the migration of contaminants in groundwater in the source areas that are targeted by this interim cleanup action to prevent further degradation of groundwater.

These RAOs were to be achieved through the selected interim remedy, consisting of ISCO treatment, evaluation monitoring, and LUCs. Interim groundwater COCs and cleanup goals include:

- 1,1,2,2-tetrachloroethane–1 µg/L
- 1,2-dichloroethane–6 µg/L
- aluminum–1,000 µg/L
- cis-1,2-dichloroethylene–6 µg/L
- tetrachloroethylene–5 µg/L
- trans-1,2-dichloroethylene–10 µg/L
- trichloroethylene–5 µg/L
- vinyl chloride–0.5 µg/L
- methylene chloride–5 µg/L

In situ chemical oxidation (ISCO) was implemented in two separate source areas at CG041-032. As part of an ISCO pilot study in 2005, potassium permanganate was injected into the southern source area. In 2007, an ISCO injection was completed in the northern source area at CG041-032.

A Technical and Economic Feasibility Analysis (TEFA) was conducted in 2011. The TEFA concluded that no significant rebound in VOC concentrations in groundwater had occurred since ISCO treatment was implemented at CG041-032 in early 2007. The TEFA further concluded that the treatment area had been remediated to the extent technically and economically feasible using ISCO. Groundwater modeling predicted that the TCE plume will attenuate to less than the cleanup goal in a reasonable time (by approximately 2024) and that TCE at concentrations greater than the cleanup goal would not migrate off-base. However, a recently increasing TCE concentration in monitoring well 01C008CMW indicates that the plume may be migrating off-base. As of September 2014, 97 percent of the TCE mass had been removed from the ISCO treatment area.

During this five-year review, LUC inspections were conducted semi-annually and were reported in the annual Land Use Control Inspection Reports. No ground disturbances or exposures were recorded.

The 2016 draft proposed plan identifies hotspot treatment with ISCO (TCE greater than 300 µg/L), continued wellhead treatment and bottled water delivery at existing off-base residences, enhanced attenuation monitoring, and LUCs as the preferred remedial alternatives to address groundwater contamination at CG041-032 and to achieve Site CG041 RAOs (Air Force 2016b).

5.9.2.10 CG041-035

Site SS035 covers an area of approximately 80 acres located in the northern part of Beale AFB. Site SS035 has been operated as a WSA since its construction circa 1958. Groundwater associated with Site SS035 is managed under Site CG041 as CG041-035. A map of CG041-035 site features is shown in Figure 5.9-20.

An interim ROD for Site SS035 was finalized in 2011 (Air Force 2011a). The selected interim remedy consisted of the in situ treatment of the source area with a bioreactor, evaluation monitoring, and LUCs. The IROD also established the following RAOs:

- Reduce concentrations of COCs in soil (represented as soil vapor) potentially impacting underlying groundwater to support designated beneficial uses of groundwater (i.e., agricultural, municipal, domestic, and industrial supply).
- Reduce concentrations of COCs in underlying groundwater throughout the plume to support designated beneficial uses of groundwater (i.e., domestic, municipal, agricultural, and industrial supply).
- Restrict potential exposure to COCs in groundwater until concentrations are at such levels to allow UU/UE.

The following groundwater COCs and their respective cleanup goals were established in the IROD:

- carbon tetrachloride–0.5 µg/L
- 1,1-DCE–6 µg/L
- TCE–5 µg/L

An in situ bioreactor was installed in the primary source area in October 2010, as part of the selected interim remedy for Site SS035 (CH2M HILL 2013c). It was shut down in 2013 in preparation for Site SS035 SVE system installation and operation, and remained off throughout 2014 and 2015, during continued SVE activities. During this five-year review, LUC inspections were conducted semi-annually and were reported in the annual Land Use Control Inspection Reports. No ground disturbances or exposures were recorded.

A draft proposed plan that was prepared in 2016 identifies hotspot treatment with ERD (TCE greater than 300 µg/L), enhanced attenuation monitoring, and LUCs as the preferred remedial alternatives to address groundwater contamination at CG041-035 and to achieve Site CG041 RAOs (Air Force 2016b).

5.9.2.11 CG041-039

Site SS039 is bounded on the north by Doolittle Drive and on the south by 8th Street; it includes the developed area between A and C Streets. Site SS039 also includes the undeveloped areas east of A Street and west of C Street. The groundwater beneath Site SS039 is managed under Site CG041, and the site is identified as CG041-039. A map of CG041-039 site features is shown in Figure 5.9-22.

The selected interim remedy consisted of ERD, evaluation monitoring, and LUCs. The remedy was intended to achieve the following RAOs:

- Reduce concentrations of VOCs (carbon tetrachloride, cis-1,2-DCE, 1,1-DCE, PCE, TCE, and vinyl chloride) in underlying groundwater originating at Sites 39 and 40 and TPH (TPH-D, TPH-G) in underlying groundwater originating at Site 39 to support designated beneficial uses of groundwater (domestic, municipal, agricultural, and industrial supply).
- Restrict potential exposure to COCs in groundwater until concentrations are at such levels to allow UU/UE.

The Cantonment Area IROD established COCs, cleanup goals, RAOs, and an interim remedy for CG041-039 (Air Force 2011b). The COCs and their respective cleanup goals include:

- carbon tetrachloride–0.5 µg/L
- cis-1,2-DCE–6 µg/L
- 1,1-DCE–6 µg/L
- PCE–5 µg/L
- TCE–5 µg/L
- vinyl chloride–0.5 µg/L

Interim remedial actions have been implemented to address groundwater contamination at two source areas. In 2007, an ERD TS was initiated at Source Area 2 to address TCE concentrations in groundwater that exceeded 500 µg/L (CH2M HILL 2010f). The Source Area 2 TS began in fall 2007 and included installation of three injection wells in the suspected VOC source area. Groundwater monitoring through September 2012 showed an estimated 94 percent decrease in TCE mass in the Source Area 2 ERD treatment zone (CH2M HILL 2013c).

In 2009, a TS was initiated at Source Area 1, where TCE concentrations were greater than 1,000 µg/L (CH2M HILL 2011e). Additional site investigations to characterize the source area began in summer 2009 and included installation of nine injection wells. Groundwater monitoring through September 2012 showed an estimated 83 percent decrease in TCE mass in the Source Area 1 ERD treatment zone (CH2M HILL 2013c).

During this five-year review, LUC inspections were conducted semi-annually and were reported in the annual Land Use Control Inspection Reports. No ground disturbances or exposures were recorded.

A draft proposed plan was prepared in 2016, identifying hot spot treatment with ERD (TCE greater than 300 µg/L), enhanced attenuation monitoring, and LUCs, including restricting exposure via VI from groundwater into indoor air, as the preferred remedial alternatives to address groundwater contamination at CG041-039 and to achieve Site CG041 RAOs (Air Force 2016b).The final remedy will be established in the forthcoming basewide groundwater ROD.

5.9.2.12 CG041-040

Site CG040 formerly was designated AOC 73 (URS 2003) and is located in the north-central portion of Beale AFB, west of CG041-039 in the Cantonment Area, and extends west to the Base boundary. Site CG040 and the five other ERP sites associated with the Cantonment Area were combined for evaluation in the Cantonment Area RI and FS reports (CH2M HILL 2010f, 2011g). The preferred interim remedies were provided for public comment in the Cantonment Area Proposed Plan (Air Force 2011e), and the interim remedies selected for these sites were provided in the Cantonment Area IROD (Air Force 2011b). However, the Site CG040 groundwater plume is distinct from the eastern Cantonment Area plume and was incorporated into the new basewide groundwater site (CG041) in 2013, and the site is identified as CG041-040. A map of CG041-040 site features is shown in Figure 5.9-24.

Site CG040 East, near C Street and Warren Shingle Road, consists primarily of paved roads that are no longer used as public roads, and parking areas between E and F Streets north of 15th Street. The western area of Site CG040 (Site CG040 West), west of the J Street Gas Station, consists primarily of flat, open annual grassland with a few trees and a few paved roads. The pattern of TCE concentrations and the different ratios of 1,1-DCE to TCE indicate that the CG041-040 West groundwater plume is chemically distinct from the VOC plume emanating from CG041-040 East near 40C009MW (CH2M HILL 2011g).

The selected interim remedy consisted of ERD, evaluation monitoring, and LUCs. This selected remedy was intended to achieve the following RAOs:

- Reduce concentrations of VOCs (carbon tetrachloride, cis-1,2-DCE, 1,1-DCE, PCE, TCE, and vinyl chloride) in underlying groundwater originating at Sites 39 and 40, and TPH (TPH-D, TPH-G) in underlying groundwater originating at Site 39, to support designated beneficial uses of groundwater (i.e., domestic, municipal, agricultural, and industrial supply).

- Restrict potential exposure to COCs in groundwater until concentrations are at such levels to allow UU/UE.

The Cantonment Area IROD established COCs, cleanup goals, RAOs and an interim remedy for CG041-040 (Air Force 2011). The COCs and their respective cleanup goals identified in the IROD include:

- carbon tetrachloride–0.5 µg/L
- cis-1,2-DCE–6 µg/L
- 1,1-DCE–6 µg/L
- PCE–5 µg/L
- TCE–5 µg/L
- vinyl chloride–0.5 µg/L

In 2011, an ERD TS was conducted in the western area of CG041-040 to treat chlorinated VOCs (primarily TCE) in groundwater. The TS included installation of four injection wells and subsequent injections of EVO to form a biobarrier.

In 2013, an additional passive soil vapor survey was conducted at Site CG040 West as part of a data gap investigation, to identify the VOC source in soil that is affecting groundwater in CG041-040 West. This effort did not identify the source of VOCs in Site CG040 West that appears to contribute to groundwater contamination (CG041-040).

During this five-year review, LUC inspections were conducted semi-annually and were reported in the annual Land Use Control Inspection Reports. No ground disturbances or exposures were recorded.

In 2016, a draft proposed plan was prepared, identifying hotspot treatment with ERD (TCE greater than 300 µg/L), monitoring, and LUCs as the preferred remedial alternatives to address groundwater contamination at CG041-040 and to achieve Site CG041 RAOs (Air Force 2016b).

5.9.2.13 CG041-508

Site SS508 is in the northern Cantonment Area of Beale AFB, northwest of the intersection of A Street and Doolittle Drive, and east of Building 2540. The groundwater beneath Site SS508 is managed under Site CG041, and the site is identified as CG041-508. Site SS508 does not have an established site boundary but encompasses Building 2548 and its surrounding gravel and asphalt areas. A map of CG041-508 site features is shown in Figure 5.9-26.

A data gap investigation was conducted in 2014 to further characterize the extent of PCE contamination in groundwater at CG041-508 (CH2M HILL 2014e). Based on the 2014 data gap investigation, it was confirmed that a suspected surface release of PCE in the Civil Engineering Yard resulted in impacts on the shallow groundwater system at CG041-508. Although the exact nature and location of the surface release was not identified, based on soil and soil vapor data, the release likely occurred near Buildings 2530 and 2548, and possibly in the former wash pads (CH2M HILL 2014e).

The final *CG041-508 Pre-design Investigation Work Plan* (CH2M HILL 2015f) identified the following four objectives for filling data gaps at the site:

- Determine the extent of PCE to the east of SS508C004MW.
- Determine the extent of PCE to the northwest of SS508C003MW.
- Determine whether the water line trench is a preferential pathway for PCE migrating away from the source area.
- Determine whether PCE in groundwater is discharging to surface water to the north or east of the source.

Consequently, four groundwater monitoring wells (SS508C009MW through SS508C012MW) were constructed and three surface water sampling locations (SS508C013 through SS508C015) were sampled. Fieldwork was performed between June 8 and July 23, 2015. In addition, the revised final *CG041-508 Statement of Basis/Corrective Measures Implementation Work Plan* (Air Force 2016c) was prepared. The corrective measures selected include ERD, enhanced attenuation monitoring, and LUCs. Eight injection wells will be installed. Work is anticipated to occur in late 2016 or early 2017. CG041-508 is regulated under RCRA criteria, and although it is included with CG041 (basewide groundwater), it is not regulated under CERCLA and will not be addressed in the forthcoming CG041 ROD.

5.9.2.14 CG041-509

Site TU509 is located at the Beale AFB medical clinic, located at 15301 Warren Shingle Boulevard south of the intersection with Camp Beale Highway. Two groundwater plumes have been identified at the clinic under Site CG041: CG041-509, which includes the clinic USTs and related TPH plume; and CG041-517, which includes the clinic PCE plume (discussed in the next subsection). Three 8,000 gallon diesel USTs are the source of petroleum hydrocarbons in groundwater at CG041-509. USTs 5702-3 and 5702-4 were east of Building 5702; UST 5702-5 was west of the building. In April 1998, UST 5702-5 was excavated and removed, and USTs 5702-3 and 5702-4 were closed in place. USTs 5702-3 and 5702-4 were excavated and removed in 2009 (CH2M HILL 2012b). A map of CG041-509 site features is shown in Figure 5.9-28.

Excavation and enhanced bioremediation with LUCs were the selected corrective actions to address remaining petroleum hydrocarbon contamination at Site TU509 (Air Force 2015h). These actions include excavating TPH-D contaminated soil, followed by an application of oxygen reducing compound (ORC) advanced to the bottom of the excavation through perforated piping installed before backfilling.

Soil excavation was completed in February 2015. Excavation consisted of removal of 717 tons of smear zone soil from the former UST source area. ORC-A injections were completed in October 2015. Approximately 3,800 pounds of reagent were injected into vertical borings within the 1,000-µg/L TPH-D groundwater plume axis and into the horizontal perforated pipes that were installed during excavation activities.

Monitoring and removal of free product continues. Free product is measured and removed from three monitoring wells when detected. In addition, monitoring and maintenance of the LUCs continues to occur semi-annually and is reported in the annual Land Use Control Inspection Reports. Performance monitoring also is ongoing to ensure performance goals are met, and the results are reported in the annual Basewide Groundwater Monitoring Report. After performance goals have been met, a request to terminate remedial actions will be submitted to CVWB. Monitoring and maintenance of LUCs at Site TU509 and CG041-509 will continue until NFA is approved by CVWB. CG041-509 is regulated under LUFT criteria, and although it is included with CG041 (basewide groundwater), it is not regulated under CERCLA and will not be addressed in the forthcoming CG041 ROD.

5.9.2.15 CG041-517

As noted above, two groundwater plumes have been identified at the Beale AFB medical clinic under Site CG041: CG041-509 and CG041-517. A suspected surface release near the northeastern corner of Building 5702 is believed to be the source of PCE in groundwater at CG041-517 (CH2M HILL 2012b). A map of CG041-517 site features is shown in Figure 5.9-30.

In 2016, the revised final *Site CG517 and CG041-517 Statement of Basis/Corrective Measures Implementation Work Plan* (CH2M HILL 2016d) was prepared. The corrective measures selected include active treatment of the PCE-contaminated groundwater, using in situ ERD, enhanced attenuation monitoring, and LUCs until concentrations are reduced to levels that allow UU/UE. Work is anticipated to start in late 2016 or early 2017. CG041-517 is regulated under RCRA criteria, and although it is included with CG041 (basewide groundwater), it is not regulated under CERCLA and will not be addressed in the forthcoming CG041 ROD.

5.9.3 Systems Operations/Operation and Maintenance

As of 2015, the Long-Term Operation and Maintenance Project at Beale AFB includes O&M of four CG041 sites: CG041-013, CG041-017, CG041-018, and CG041-035. A summary of O&M activities completed at each site is presented next.

5.9.3.1 CG041-013

The CG041-013 GTS currently consists of 14 wells that are configured as extraction wells, associated pumps and piping, and two air strippers (CH2M HILL 2016b). Since startup of the GTS, 785 pounds of TCE have been removed from groundwater, with 12.5 pounds removed in 2015. In 2015, system uptime typically was greater than 90 percent. At the beginning of 2015, the GTS experienced several short circuiting events that prevented continuous system operation. The electrical issues were repaired and the system resumed normal operations. Routine maintenance continues at the GTS as needed.

Along with the GTS, the in situ bioreactor at CG041-013 requires periodic maintenance. The bioreactor consists of twelve wells with one well configured as an extraction well. Until February 2015, the bioreactor pump operated at a flow rate of 2 gallons per minute (gpm), at which time the flow rate was increased to 4 gpm. The bioreactor was installed in 2010 and subsequently was expanded in August 2011 (CH2M HILL 2011f). The bioreactor was shut down in September 2012, because of an electrical malfunction associated with the GTS. The system was restarted in August 2013, and the bioreactor has operated with little issue since that time. In January 2014, the bioreactor was recharged with 250 gallons of EVO. EVO and fresh water were injected into both treatment zones. Routine maintenance continues as needed.

5.9.3.2 CG041-017

Routine O&M of the interim P&T system is ongoing at the site. The granular activated carbon (GAC) in the lead carbon treatment vessel was replaced in March 2015. Treated groundwater is no longer supplied to the irrigation system supporting phytoremediation operations at the site. Irrigation water now is supplied by the potable Base auxiliary supply. The irrigation systems currently are not being used (CH2M HILL 2016b).

5.9.3.3 CG041-018

LNAPL recovered from passive skimmers in monitoring wells 18U007BMW and 18U008BMW at CG041-018 is characterized as weathered JP-TS and is considered a non-Resource Conservation and Recovery Act hazardous waste in California. Approximately once per month, the LNAPL is bailed from the wells and immediately transferred to the Beale AFB petroleum, oil, and lubricants (POL) contractor (CH2M HILL 2016b). The amount of recovered LNAPL transferred to the POL contractor is recorded on a waste tracking log. The POL contractor is responsible for management and disposal of the recovered LNAPL.

In 2015, no product was recovered during the April, May, or June monitoring events. Cumulatively, 19.3 gallons and 9.9 gallons have been removed from the wells since product skimming began in 2007, respectively. Remaining LNAPL likely is trapped below the water table. Since 2013, measured LNAPL thicknesses have been generally less than 1 foot. Free product recoveries typically are greatest in summer and early fall. Because of uncertainty in off-base pumping trends and groundwater elevations affecting LNAPL presence and migration, the monitoring frequency is anticipated to remain monthly for the two wells with passive skimmers.

5.9.3.4 CG041-035

Treatment of the source area portion of the CG041-035 groundwater plume with an in situ solar-powered mulch bioreactor began in 2010. However, the bioreactor has not operated since 2013 because of ongoing SVE operations, and no O&M activities have been reported. The bioreactor will not operate again until SVE operations are completed. After the bioreactor resumes operation, operation is expected to occur for approximately 5 years (CH2M HILL 2015h).

5.9.4 Progress since the Last Review

In 2013, during the time period covered by this five-year review, groundwater contamination was decoupled from its respective soil site and combined into the basewide groundwater site CG041.Therefore, a protectiveness statement addressing basewide groundwater was not included in the first five-year review. The protectiveness statement for each soil site with groundwater contamination that was included in the first five-year review is presented next. The status of any recommendation related to a groundwater issue also is presented. All other issues and recommendations from the first five-year review are presented in each respective soil site section.

5.9.4.1 CG041-003

The protectiveness statement for Site FT003 in the first *Five-Year Review Report* (URS 2012) states:

> *Although no remedy is currently in place for Site FT003 groundwater, there is no evidence of current exposure. The SVE system functioned, soil removal occurred, and groundwater concentrations are being monitored. However, to ensure protectiveness in the long term, a remedy and cleanup goals for the site must be finalized in a decision document, and LUCs must be implemented to ensure protectiveness as long as COC concentrations in soil and/or groundwater remain at levels that do not allow unrestricted use.*

The status of the issues and recommendations presented in the first five-year review is shown in Table 5.9-3.

Table 5.9-3. Status of Recommendations from the First Five-Year Review, Site CG041-003

Issue	Recommendation	Current Status	Current Implementation Status Description	Completion Date (if applicable)
Since the draft FS was developed in 2006, VOC contamination in groundwater originating from a dry well has been discovered in the northwestern corner of Site 3. This area was not previously addressed in an engineering evaluation/cost analysis (EE/CA) or an FS. A decision document for Site 3 has not been prepared; therefore, LUCs have not been implemented, even though COC concentrations in site soil and groundwater are at levels that do not allow unrestricted use.	Complete ongoing site characterization activities.	Completed	All media have been fully characterized. A Record of Decision (ROD) for CG041-003 is expected in 2018.	June 2015
	Re-evaluate applicable components of the Site FT003 risk assessment because of recent site characterization data (including an evaluation of risk from vapor intrusion if buildings were to be constructed above the site groundwater plume).	Ongoing	Groundwater remedial activities are currently ongoing, and risk assessments for groundwater associated with Site CG041-003 will be presented in the forthcoming ROD.	N/A
	Finalize and implement land use controls (LUCs) to prevent human exposure to residual volatile organic compounds in groundwater at concentrations greater than maximum contaminant levels.	Ongoing	LUCs have been implemented since being selected as part of the interim remedy identified in the Site 3 Action Memorandum. A final ROD for CG041 is anticipated in 2018 and will include LUCs.	N/A
	Finalize the Site FT003 Feasibility Study using all recent concentration data and newly identified sources of contamination.	Completed	A Focused Feasibility Study was finalized for CG041, including CG041-003.	June 2015
	Finalize remedial action objectives (RAOs), Applicable or Relevant and Appropriate Requirements (ARARs), and cleanup goals commensurate with future land use and prepare a decision document for Site FT003.	Completed /Ongoing	RAOs, ARARs, and cleanup goals for Site CG041-003 will be established in the forthcoming CG041 ROD, anticipated in 2018.	N/A
	Downgradient portion of plume not fully defined. Increased off-base agricultural pumping caused by persistent drought conditions has increased plume migration down off-base pumping centers.	Ongoing	The Air Force is in the process of creating a new site, CG044, which will address plume migration changes that are being caused by increased off-base agricultural pumping.	N/A

5.9.4.2 CG041-010

The protectiveness statement for Site SD010 in the first *Five-Year Review Report* (URS 2012) states:

> *The interim remedy for Site SD010 is protective of human health and the environment because there is no current risk to potential receptors, and ICs are in place to ensure that an exposure pathway is not completed while RAOs are being attained. However, the vapor intrusion exposure pathway needs to be evaluated if a*

building intended for occupation was constructed over the Site SD010 groundwater plume (CG041-010) or if future land use was to be changed from the current industrial use to unrestricted residential use.

The status of the issues and recommendations presented in the first five-year review is shown in Table 5.9-4.

Table 5.9-4. Status of Recommendations from the First Five-Year Review, Site CG041-010

Issue	Recommendation	Current Status	Current Implementation Status Description	Completion Date (if applicable)
TCE and its daughter products remain in Site 10 groundwater at levels that exceed ICGs.	Evaluate the need for installing additional monitoring wells downgradient from the target EISB area and continue monitoring to ensure that trichloroethene (TCE) concentrations and its daughter products will decrease in a reasonable time frame.	Completed	A Focused Feasibility Study was finalized for CG041-010 that evaluates remedial alternatives addressing TCE remediation and includes the installation of monitoring wells across the site.	June 2015
	Monitor groundwater downgradient from the target enhanced in situ bioremediation (EISB) area for secondary water quality parameters (e.g., arsenic, total dissolved solids, manganese) to ensure water quality has not been adversely affected by the reductive conditions.	Ongoing	Groundwater downgradient from the target EISB area is monitored in accordance with the requirements of the Central Valley Regional Water Quality Control Board's Waste Discharge Requirement Order No. R5-2004-0131 for Site SD010. No adverse impacts of secondary water quality parameters have been observed in downgradient compliance wells since EISB began in 2005.	N/A
The Air Force is required to conduct semiannual monitoring (every 6 months), provide annual reports to the State regulatory agencies, and undertake prompt action to address activity that is inconsistent with the IC objectives or use restrictions or any action that may interfere with IC effectiveness. The requirements for annual monitoring reports were instituted in the Site 10 IROD. Through 2010, annual monitoring reports on the status of the ICs at Site 10 have not been completed.	Continue to implement institutional controls (ICs) until remedial action objectives (RAOs) are achieved.	Ongoing	Land use controls (LUCs) have been implemented as required by the Site SD010 Interim Record of Decision (IROD). All proposed remedial alternatives for CG041-010 in the forthcoming Site CG041 ROD include LUCs.	N/A
A final decision document has not been developed for Site 10.	Finalize RAOs, Applicable or Relevant and Appropriate Requirements (ARARs), and cleanup goals commensurate with future land use and prepare a final decision document for Site SD010.	Ongoing	RAOs, ARARs, cleanup goals for CG041-010 will be established in the forthcoming Site CG041 ROD, anticipated in 2018.	N/A
The Air Force is required to conduct semiannual monitoring (every 6 months), provide annual reports to the State regulatory agencies, and undertake prompt action to address activity that is inconsistent with the IC objectives or use restrictions or any action that may interfere with IC effectiveness. The requirements for annual monitoring reports were instituted in the Site 10 IROD. Through 2010, annual monitoring reports on the status of the ICs at Site 10 have not been completed.	Ensure that the ICs established in the Site SD010 IROD are monitored on a semi-annual basis, as required, and that the results are provided to the state regulatory agencies in annual monitoring reports.	Ongoing	ICs established in the Site SD010 IROD are monitored semi-annually and the results are reported in the annual Land Use Control Inspection Report.	N/A

5.9.4.3 CG041-013

The protectiveness statement for Site LF013 in the first *Five-Year Review Report* (URS 2012) states:

> *The interim remedy for LF013 is protective of human health and the environment in the short term because the off-base receptor (Deep Violet Farms) has been provided an alternate water supply source and there are currently no other at-risk receptors. A pump-and-treat system is currently capturing most of the contaminant plume. However, there are portions of the plume that are not being captured by the system, and the contaminant plume has migrated off base. Therefore, the groundwater remedy must be optimized to address these issues. Additionally, ICs protective of the groundwater resource must continue to be implemented to ensure that no receptors are exposed to COCs at concentrations greater than ICGs. If the current land use at Site LF013 were to be changed to unrestricted use, or if a building were to be constructed, the potential risk from vapor intrusion into enclosed spaces should be evaluated.*

The status of the issues and recommendations presented in the first five-year review is shown in Table 5.9-5.

Table 5.9-5. Status of Recommendations from the First Five-Year Review, Site CG041-013

Issue	Recommendation	Current Status	Current Implementation Status Description	Completion Date (if applicable)
Because of increased groundwater pumping off-base, an increased hydraulic gradient exists from the former source area to the western AFB boundary, and beyond. A bioreactor is in place to reduce high concentrations but had not yet started operation at the time of this review. Final RAOs and a final decision document have not been developed for the site.	Further evaluate the influence of off-base pumping on the westward groundwater hydraulic gradient.	Ongoing	Monitoring of groundwater elevations and hydraulic gradients continue as part of the Basewide Groundwater Monitoring Program (BGMP).	N/A
	Optimize the monitoring well and groundwater extraction well network to contain areas that are not in the extraction capture zone and to reduce/prevent any plume migration off base.	Ongoing	The results from wells sampled during semi-annual and annual events are continuously evaluated and tailored to suit remedial action goals.	N/A
	Perform a pilot study of the bioreactor and report the results, along with recommendations for continued operation or optimization.	Ongoing	Bioreactor effectiveness is being determined by monitoring well sampling results within and adjacent to the bioreactor with the sampling results and any recommendations provided in the annual BGMP reports.	N/A
The Air Force is required to conduct semiannual monitoring (every 6 months), provide annual reports to the State regulatory agencies, and undertake prompt action to address activity that is inconsistent with the LUC objectives or use restrictions, or any action that may interfere with LUC effectiveness. The requirements for annual monitoring reports were instituted in the Site 13 IROD. Through 2010, annual monitoring reports on the status of the LUCs at Site 13 have not been completed.	Ensure that the land use controls (LUCs) established in the Site LF013 Interim Record of Decision (IROD) are monitored on a semi-annual basis, as required, and that the results are provided to the state regulatory agencies in annual monitoring reports.	Completed	LUCs established as part of the interim remedy for CG041-013 are monitored semi-annually and the results are reported in the annual Land Use Control Inspection Report.	2010
A consensus agreement on ARARs is necessary so that the cleanup goals and remedy can be finalized for Site 13.	Finalize remedial action objectives (RAOs), Applicable or Relevant and Appropriate Requirements (ARARs), cleanup goals, and the remedial action components in a final decision document.	Ongoing	RAOs, ARARs, cleanup goals for CG041-013 will be established in the forthcoming Site CG041 ROD, anticipated in 2018.	N/A
	Downgradient portion of plume has been affected by increased off-base agricultural pumping due to persistent drought conditions.	Ongoing	The Air Force is in the process of creating a new site, CG044, which will address plume migration changes that are being caused by increased off-base agricultural pumping.	N/A

5.9.4.4 CG041-016

The protectiveness statement for Site WP016 in the first *Five-Year Review Report* (URS 2012) states:

The interim remedy for Site WP016 is protective of human health and the environment in the short term because no completed exposure pathway exists at the present time. All surface water concentration results are below PCGs, and the groundwater is not currently being used for beneficial purposes. However, to ensure the remedy remains protective in the long term, the selected remedy, as finalized in the IROD, should include implementation of ICs to prohibit groundwater use in areas where perchlorate concentrations do not allow unrestricted use and exposure, and implementation of a contingency plan to address the possibility of perchlorate plume expansion. The IROD should also evaluate the possibility that the MCL for perchlorate may be lowered as a result of the lower PHG for this constituent.

The status of the issues and recommendations presented in the first five-year review is shown in Table 5.9-6.

Table 5.9-6. Status of Recommendations from the First Five-Year Review, Site CG041-016

Recommendation	Current Status	Current Implementation Status Description	Completion Date (if applicable)
The Interim Record of Decision (IROD) should be finalized for Site WP016. The IROD should define the selected remedy, including implementation of institutional controls (ICs) and a contingency plan, similar to what is described in the Feasibility Study.	Completed	The Site WP016 IROD has been completed.	August 2011
The IROD should also evaluate and finalize the cleanup goal for perchlorate, considering the lower public health guideline (PHG) of 1 µg/L and the possibility of a lower California maximum contaminant level (MCL).	Ongoing	The Site WP016 IROD established the California MCL for perchlorate (6 µg/L) as the interim cleanup goal. A final cleanup goal will be presented in the CG041 ROD, anticipated in 2018.	N/A

5.9.4.5 CG041-017

The protectiveness statement for Site OT017 in the first *Five-Year Review Report* (URS 2012) states:

The interim remedy for Site OT017 is protective of human health and the environment because there is no current risk to potential receptors. Best Slough has been rerouted and the DNAPL is being contained. Dissolved-phase groundwater contamination is being treated passively through phytoremediation and a ZVI PRB. Groundwater monitoring and evaluation and LUCs are in place to ensure that potential receptors remain protected. The interim remedy is protective in the long term, as long as LUCs remain in place and adequate O&M of the hydraulic control system occurs to ensure that the DNAPL is contained.

The status of the issues and recommendations presented in the first five-year review is shown in Table 5.9-7.

Table 5.9-7. Status of Recommendations from the First Five-Year Review, Site CG041-017

Issues	Recommendation	Current Status	Current Implementation Status Description
Regulatory concern exists regarding potential long-term impacts of the SBCW leakage that occurred in 2008 (The DTSC and RWQCB interview records are provided in Appendix A). DNAPL at Site 17 has been contained but not treated or destroyed, requiring that DNAPL containment be maintained indefinitely.	Collect necessary data to address the regulatory concern regarding the potential long-term impacts of the 2008 leakage of the soil bentonite cutoff wall.	Ongoing	Monthly monitoring activities continue to ensure an inward gradient is maintained by the interim remedy to prevent leakage.
	If needed, increase the monitoring frequency of the hydraulic control system to ensure any component breakdown is short-lived and does not result in future leakage.	Ongoing	Monthly monitoring activities continue to ensure an inward gradient is maintained by the interim remedy to prevent leakage.
The Air Force is required to conduct semiannual monitoring (every 6 months), provide annual reports to the State regulatory agencies, and undertake prompt action to address activity that is inconsistent with the LUC objectives or use restrictions, or any action that may interfere with LUC effectiveness. The requirements for annual monitoring reports were instituted in the Site 17 IROD. Through 2010, annual monitoring reports on the status of the LUCs at Site 17 have not been completed.	Ensure that the land use controls (LUCs) established in the Site 17 Interim Record of Decision (IROD) are monitored on a semi-annual basis, as required, and that the results are provided to the state regulatory agencies in annual monitoring reports.	Ongoing	LUCs are monitored on a semi-annual basis and the results are reported in the annual Land Use Control Inspection Report.
Final ARARs and a final decision document that addresses all media of concern have not been completed for Site 17.	Finalize the Applicable or Relevant and Appropriate Requirements (ARARs) and the selected remedy for all impacted media at Site OT017, including possible removal of the dense non-aqueous phase liquid, and complete the final decision document for the site.	Ongoing	ARARs and the remedial action for CG041-017 will be established in the forthcoming Site CG041 ROD, anticipated in 2018.

5.9.4.6 CG041-018

A protectiveness statement was not made during the first five-year review because an interim remedy addressing both soil and groundwater had not been implemented yet at CG041-018 (URS 2012).

The status of the issues and recommendations presented in the first five-year review is shown in Table 5.9-8.

Table 5.9-8. Status of Recommendations from the First Five-Year Review, Site CG041-018

Issue	Recommendation	Current Status	Current Implementation Status Description
No LUCs are in place to ensure protection of human health.	Select a remedy that addresses total petroleum hydrocarbons and volatile organic compound contamination in site groundwater and implements LUCs until remedial action objectives are achieved.	Ongoing	The remedy for CG041-018 will be established in the forthcoming Site CG041 Record of Decision (ROD), anticipated in 2018.
A consensus agreement on ARARs is necessary so that the cleanup goals and remedy can be finalized for Site 18.	Finalize the Applicable or Relevant and Appropriate Requirements (ARARs) and cleanup goals commensurate with future land use.	Ongoing	ARARs and cleanup goals for CG041-018 will be established in the forthcoming Site CG041 ROD, anticipated in 2018.
	Complete a decision document for Site ST018.	Ongoing	The Site CG041 ROD, which includes CG041-018, is anticipated in 2018.

5.9.4.7 CG041-029

The protectiveness statement for Site FT029 in the first *Five-Year Review Report* (URS 2012) states:

> *The interim remedy for Site FT029 is protective of human health and the environment in the short term because there is no evidence that there is current exposure. SVE has removed vadose zone contaminants, and groundwater quality is being monitored and evaluated. However, to ensure protectiveness in the long term, the interim remedy and cleanup goals must be finalized in a decision document, and LUCs must be implemented to ensure exposure pathways are not completed when concentrations of residual VOCs in groundwater are greater than cleanup goals.*

The status of the issues and recommendations presented in the first five-year review is shown in Table 5.9-9.

Table 5.9-9. Status of Recommendations from the First Five-Year Review, Site CG041-029

Issue	Recommendation	Current Status	Current Implementation Status Description
A decision document has not been finalized for Site 29.	Finalize remedial action objectives (RAOs), cleanup goals, and the interim remedy in a decision document.	Ongoing	RAOs, cleanup goals, and the remedial action for CG041-029 will be established in the forthcoming Site CG041 Record of Decision, anticipated in 2018.
LUCs have not been implemented to ensure potential receptors remain protected while RAOs are being achieved.	Implement land use controls (LUCs) to prevent human exposure to residual volatile organic compounds in groundwater at concentrations exceeding preliminary cleanup goals.	Ongoing	LUCs have been implemented and continue to be monitored semi-annually and the results reported in the annual Land Use Control Inspection Report.

5.9.4.8 CG041-031

The protectiveness statement for Site SD031 in the first *Five-Year Review Report* (URS 2012) states:

> *The interim remedy for Site SD031 is protective of human health and the environment because there is no current risk to potential receptors, and until RAOs are achieved, LUCs are in place to ensure the exposure pathway is not completed. TCE concentrations in the source area are being reduced via in situ reductive dechlorination, and groundwater monitoring is ongoing. Vapor intrusion could pose a health risk if buildings are constructed over the Site 31 plume footprint. However, it is unlikely that buildings would be built in this area, as it is located in the approach area to the runway. In addition, changing hydrogeological conditions may be affecting plume migration characteristics and should be closely monitored.*

The status of the issues and recommendations presented in the first five-year review is shown in Table 5.9-10.

Table 5.9-10. Status of Recommendations from the First Five-Year Review, Site CG041-031

Issue	Recommendation	Current Status	Current Implementation Status Description	Completion Date (if applicable)
The proximity of Site 31 to the western base boundary implies that increased off-base pumping could result in an increase in the groundwater gradient flowing from the Site 31 contaminant source area on-base toward off-base receptors.	Evaluate, preferably through fate and transport modeling, the influence of off-base agricultural pumping on the hydrogeological characteristics of the Site SD031 plume and if needed, install additional monitoring wells to address regulatory concerns.	Completed	Solute transport modeling was completed and the results were presented in the CG041 Focused Feasibility Study.	2015
As of the first quarter of 2010, TCE concentrations had increased in two CMWs compared to baseline sampling results. In addition, a regulatory concern exists that the spacing of the monitoring well network and the site's changing hydrogeologic conditions may make it difficult to fully evaluate the source area remedies and evaluate plume stability prior to the proposed final basewide ROD in 2018 (The DTSC and RWQCB interview records are provided in Appendix A).	Continue to evaluate secondary water quality parameters, including concentrations of total dissolved solids, manganese, and iron, in compliance monitoring wells (CMWs) and other wells located downgradient from the enhanced in situ bioremediation (EISB) system, and add arsenic to the parameters.	Ongoing	Secondary water quality parameters are monitored as part of the Basewide Groundwater Monitoring Program (BGMP) in accordance with the requirements of Central Valley Regional Water Quality Control Board's (CVWB) Waste Discharge Requirement (WDR) Order No. R5-2007-0044 for Site SD031. Arsenic was not added to the monitoring program because it is naturally occurring in groundwater and a site-specific baseline concentration was not established before enhanced reductive dechlorination implementation (CH2M HILL 2013b).	N/A
The ICGs only address TCE, but EISB has resulted in an increase in concentrations of TCE daughter products in some site wells. Arsenic is not included in the performance monitoring program because it is not a requirement of the MRP, but if present in the subsurface, arsenic could mobilize into groundwater and migrate as a by-product of the EISB treatment process.	Continue to evaluate trichloroethene (TCE) concentrations and its daughter products in CMWs and other wells downgradient from the EISB system.	Ongoing	Groundwater monitoring and evaluation are ongoing as part of the BGMP in accordance with the requirements of CVWB's WDR Order No. R5-2007-0044 for Site SD031.	N/A
The ICGs only address TCE, but EISB has resulted in an increase in concentrations of TCE daughter products in some site wells. Arsenic is not included in the performance monitoring program because it is not a requirement of the MRP, but if present in the subsurface, arsenic could mobilize into groundwater and migrate as a by-product of the EISB treatment process.	Establish final cleanup goals for TCE and its daughter products.	Ongoing	Cleanup goals for CG041-031 will be established in the forthcoming Site CG041 ROD, anticipated in 2018.	N/A
Final ARARs that have regulatory consensus and a final ROD have not been completed for Site 31.	Finalize remedial action objectives (RAOs), Applicable or Relevant and Appropriate Requirements (ARARs) (with regulatory agency concurrence), and cleanup goals commensurate with future land use and prepare a final decision document for	Ongoing	RAOs, ARARs, and cleanup goals for CG041-031 will be established in the forthcoming Site CG041 ROD, anticipated in 2018.	N/A

Issue	Recommendation	Current Status	Current Implementation Status Description	Completion Date (if applicable)
	Site 31.			
LUCs have not been implemented to ensure potential receptors remain protected while RAOs are being achieved.	Ensure that the land use controls (LUCs) established in the Site SD031 Interim Record of Decision (IROD) are monitored on a semi-annual basis, as required, and that the results are provided to the state regulatory agencies in annual monitoring reports.	Ongoing	LUCs have been implemented and are monitored semi-annually and the results are reported in the annual Land Use Control Inspection Report.	N/A
LUCs have not been implemented to ensure potential receptors remain protected while RAOs are being achieved.	Continue to implement LUCs until RAOs are achieved.	Ongoing	LUCs will be included as part of the final remedy to be established in the forthcoming Site CG041 ROD, anticipated in 2018.	N/A

5.9.4.9 CG041-032

The protectiveness statement for Site SD032 in the first *Five-Year Review Report* (URS 2012) states:

> *The interim remedy for Site SD032 is considered protective of human health and the environment because LUCs are in place to protect potential future receptors from exposure to COCs in soil and groundwater at concentrations that exceed ICGs. However, the current occupants of existing buildings could be exposed to TCE through the vapor intrusion pathway, and an evaluation of groundwater concentrations underneath the buildings should be performed to evaluate whether a potential threat to human health exists.*

The status of the issues and recommendations presented in the first five-year review is shown in Table 5.9-11.

Table 5.9-11. Status of Recommendations from the First Five-Year Review, Site CG041-032

Issue	Recommendation	Current Status	Current Implementation Status Description	Completion Date (if applicable)
	Continue monitoring and evaluation of distal plume areas at Site SD032 to ensure that concentrations continue to decrease.	Ongoing	As part of the Basewide Groundwater Monitoring Program evaluation monitoring is ongoing at the site including at downgradient/distal wells.	N/A
	Update and rerun the Site 32 groundwater model annually until cleanup goals are reached to ensure that plume stability and reduction will be attained in a reasonable time frame.	Completed	Previous groundwater modeling efforts have predicted that the trichloroethene plume will attenuate to concentrations less than screening levels by 2024.	N/A
The Air Force is required to conduct semiannual monitoring (every 6 months), provide annual reports to the State regulatory agencies, and undertake prompt action to address activity that is inconsistent with the LUC objectives or use restrictions or any action that may interfere with LUC effectiveness. The requirements for annual monitoring reports were instituted in the Site 32/1 IROD. Through 2010, annual monitoring reports on the status of the LUCs at Site 32/1 have not been completed.	Ensure that land use controls (LUCs) established in the Site 32/1 Interim Record of Decision (IROD) are monitored on a semi-annual basis, as required, and that the results are provided to state regulatory agencies in annual monitoring reports.	Ongoing	LUCs are monitored semi-annually and the results are reported in the annual Land Use Control Inspection Report.	N/A
In 2010, TCE concentrations in groundwater samples from some monitoring wells exceeded the screening levels for vapor intrusion concerns. Also, at sites where the interim source area remedy has been implemented and deemed completed (such as Site 32), a general regulatory Concern exists that the size of the distal plume areas, the spacing of the monitoring wells, and site hydrogeologic conditions “may make it difficult to fully evaluate the source area remedies and evaluate plume stability before the proposed Final Basewide ROD in 2018” (the five-year review regulatory interview is provided in Appendix A).	Evaluate groundwater concentrations beneath existing buildings to ensure that no vapor intrusion concerns are warranted.	Considered But Not Implemented	Groundwater concentrations continue to be monitored as specified in the IROD and vapor intrusion based on current data is not a concern as documented in the Site SD032 Short-Term Soil Vapor Extraction Test Technical Memorandum (CH2M HILL 2015l).	N/A

5.9.4.10 CG041-035

The protectiveness statement for Site SS035 in the first *Five-Year Review Report* (URS 2012) states:

> *The remedy for Site SS035 remains protective of human health and the environment in the short term because there is no current risk to potential receptors. TCE concentrations in the source area are anticipated to decrease with continued operation of the bioreactor, and groundwater monitoring is ongoing. However, to ensure protectiveness in the long term, the cleanup goals and the remedy for Site SS035 must be finalized in a decision document, and LUCs must be implemented to prevent exposure to contaminated groundwater until RAOs are achieved.*

The status of the issues and recommendations presented in the first five-year review is shown in Table 5.9-12.

Table 5.9-12. Status of Recommendations from the First Five-Year Review, Site CG041-035

Issue	Recommendation	Current Status	Current Implementation Status Description
	Continue operation and maintenance of the Site SS035 bioreactor until remedial action objectives (RAOs) are met.	Ongoing	Bioreactor shutdown for soil vapor extraction (SVE) system operation; restart pending SVE STOP evaluation.
COC concentrations in groundwater remain greater than PCGs in the source area and in distal portions of the VOC plume at Site 35. A potential exists for a completed exposure pathway as long as contamination greater than PCGs remains in the groundwater.	Continue monitoring and evaluation of the volatile organic compound (VOC) plume at Site SS035 to ensure concentrations continue to decrease.	Ongoing	As part of the Basewide Groundwater Monitoring Program and in accordance with Central Valley Regional Water Quality Control Board's Waste Discharge Requirement Order No. R5-2008-0022 for Site SS035, evaluation monitoring is ongoing at the site.
LUCs have not been implemented to ensure potential receptors remain protected while RAOs are being attained.	Implement land use controls (LUCs) to prevent human exposure to residual VOCs in groundwater at concentrations exceeding preliminary cleanup goals until RAOs are achieved.	Ongoing	LUCs have been implemented and are monitored semi-annually and the results are reported in the annual Land Use Control Inspection Report.
A consensus agreement on ARARs is necessary so that the cleanup goals and remedy can be finalized for Site 35. A decision document has not been completed for Site 35.	Select a final remedy and finalize the Applicable or Relevant and Appropriate Requirements (ARARs) and cleanup goals commensurate with future land use; prepare a decision document for Site SS035.	Ongoing	The final remedy, ARARs, and cleanup goals for CG041-035 will be established in the forthcoming Site CG041 ROD, anticipated in 2018.
	Downgradient portion of plume has been affected by increased off-base agricultural pumping due to persistent drought conditions.	Ongoing	The Air Force is in the process of creating a new site, CG044, which will address plume migration changes that are being caused by increased off-base agricultural pumping.

5.9.4.11 CG041-039

The protectiveness statement for Site SS039 in the first *Five-Year Review Report* (URS 2012) states:

> *The remedy for Site SS039 is protective of human health and the environment because TCE concentrations in the source area have been reduced through in situ reductive dechlorination and groundwater monitoring is ongoing. However, current occupants of existing buildings could be exposed to TCE through the vapor intrusion pathway, and an evaluation of groundwater concentrations underneath the buildings should be performed to evaluate whether a potential threat to human health exists. To ensure protectiveness in the long term, the cleanup goals and the remedy for Site SS039 must be finalized in a decision document, and LUCs must be implemented to prevent exposure to contaminated groundwater until RAOs are achieved.*

The status of the issues and recommendations presented in the first five-year review is shown in Table 5.9-13.

Table 5.9-13. Status of Recommendations from the First Five-Year Review, Site CG041-039

Issue	Recommendation	Current Status	Current Implementation Status Description	Completion Date (if applicable)
An ERD TS performed in two different source areas has resulted in reductions in TCE concentrations and TCE mass, but concentrations of cis-1,2-DCE and vinyl chloride (daughter products of PCE/TCE in the reductive pathway) remain elevated. Also, secondary water parameters, including concentrations of iron, manganese, and TDS are being monitored per the ERD work plan, but arsenic was not proposed for secondary water parameter monitoring. Arsenic concentrations in groundwater can increase as part of ERD.	Continue monitoring of chemicals of concern (COCs) and other constituents in the treatability study wells to ensure that a cis-1,2- dichloroethene or vinyl chloride stall does not occur.	Ongoing	Sampling of site wells (including treatability study wells) is ongoing; COC stall has not been observed.	N/A
An ERD TS performed in two different source areas has resulted in reductions in TCE concentrations and TCE mass, but concentrations of cis-1,2-DCE and vinyl chloride (daughter products of PCE/TCE in the reductive pathway) remain elevated. Also, secondary water parameters, including concentrations of iron, manganese, and TDS are being monitored per the ERD work plan, but arsenic was not proposed for secondary water parameter monitoring. Arsenic concentrations in groundwater can increase as part of ERD.	Continue monitoring secondary water quality parameters (total dissolved solids and arsenic) to ensure they do not increase in compliance wells.	Ongoing	Secondary water quality parameters continue to be monitored as part of the Site CG041-039 monitoring program.	N/A
	Evaluate the need for additional enhanced reductive dechlorination (ERD) within and downgradient from the source areas.	Ongoing	The final Record of Decision (ROD) for CG041-039 will address the possible implementation of additional ERD.	N/A
COC concentrations in groundwater remain greater than PCGs in the source area and distal portions of the plume, and there is a potential for a completed exposure pathway as long as contaminant concentrations greater than PCGs remain in the groundwater or do so at concentrations greater than the vapor intrusion screening concentrations.	Continue to monitor and evaluate groundwater concentrations underneath existing buildings to ensure no vapor intrusion concerns are present; consider the installation of vapor monitoring points adjacent to buildings near Source Area 1 (e.g., the base theater).	Ongoing	Groundwater monitoring is ongoing at Site CG041-039 to monitor potential risks to human health. The forthcoming CG041 ROD will further address the groundwater to indoor air pathway.	N/A
A consensus agreement on ARARs is necessary so that the cleanup goals and remedy can be finalized for Site 39. A decision document has not been completed for Site 39.	Finalize remedial action objectives (RAOs), cleanup goals, and interim remedy in a decision document.	Ongoing	The final remedy, RAOs, and cleanup goals for CG041-039 will be established in the forthcoming Site CG041 ROD, anticipated in 2018.	N/A
LUCs have not been implemented to ensure that potential receptors remain protected while RAOs are being attained.	Implement land use controls (LUCs) to prevent human exposure to residual volatile organic compounds in groundwater at concentrations exceeding the preliminary cleanup goals until RAOs are attained.	Ongoing	LUCs have been implemented and are monitored semi-annually and the results are reported in the annual Land Use Control Inspection Report.	N/A

5.9.4.12 CG041-040

The protectiveness statement for Site CG040 in the first *Five-Year Review Report* (URS 2012) states:

The remedy for Site CG040 is protective of human health and the environment in the short term because there is no current risk to potential receptors. Treatment of TCE and PCE concentrations in groundwater by the biobarrier is anticipated, and groundwater monitoring is ongoing. However, to ensure protectiveness in the long term, the cleanup goals and remedy for Site CG040 must be finalized in a decision document, and LUCs must be implemented to prevent exposure to contaminated groundwater until RAOs are achieved.

The status of the issues and recommendations presented in the first five-year review is shown in Table 5.9-14.

Table 5.9-14. Status of Recommendations from the First Five-Year Review, Site CG041-040

Issue	Recommendation	Current Status	Current Implementation Status Description
COC concentrations in groundwater remain greater than PCGs in the source areas and distal portions of the Site 40 plume. ERD is proposed to treat contamination from Source Areas 3 and 4 via a biobarrier installed along M Street, which will cause the formation of TCE and PCE daughter products such as 1,2-DCE and vinyl chloride. In addition, ERD could cause concentrations of iron, manganese, arsenic, and TDS in the groundwater to increase as a result of the treatment process.	Continue monitoring chemicals of concern (COCs) and other constituents in the biobarrier performance groundwater monitoring wells to ensure cis-1,2- dichloroethene or vinyl chloride stall does not occur and secondary water quality parameters (e.g., total dissolved solids and arsenic) do not increase in the compliance wells.	Ongoing	Monitoring of site wells is ongoing under the Basewide Groundwater Monitoring Program and in accordance with Central Valley Regional Water Quality Control Board's Waste Discharge Requirement Order R5-2008-0149-031. COC stall has not been observed. Secondary parameters continue to be monitored as part of the CG041-040 monitoring program.
	Evaluate the need for additional and/or ongoing enhanced reductive dechlorination (ERD) treatment at the biobarrier.	Ongoing	The final Record of Decision (ROD) for CG041-040 will address the possible implementation of additional ERD.
A consensus agreement on ARARs is necessary so that the cleanup goals and remedy can be finalized for Site 40. A decision document has not been completed for Site 40.	Finalize remedial action objectives (RAOs), cleanup goals, and interim remedy in a decision document.	Ongoing	The final remedy, RAOs, and cleanup goals for CG041-040 will be established in the forthcoming Site CG041 ROD, anticipated in 2018.
LUCs have not been implemented to ensure potential receptors remain protected while RAOs are being achieved.	Implement land use controls (LUCs) to prevent human exposure to residual volatile organic compounds in groundwater at concentrations exceeding preliminary cleanup goals until RAOs are attained.	Ongoing	LUCs have been implemented and are monitored semi-annually and the results are reported in the annual Land Use Control Inspection Report.
	Downgradient portion of plume has been affected by increased off-base agricultural pumping due to persistent drought conditions.	Ongoing	The Air Force is in the process of creating a new site, CG044, which will address plume migration changes that are being caused by increased off-base agricultural pumping.

5.9.4.13 CG041-508

This is the first five-year review for CG041-508.

5.9.4.14 CG041-509

The USTs located at Site TU509 were addressed under Site ST022 (basewide USTs) in the first *Five-Year Review Report* (URS 2012). The protectiveness statement for Site ST022 states:

The remediation and closure process implemented as part of an aggressive UST removal and cleanup program for Site ST022 at Beale AFB is protective of human health and the environment because it has successfully removed 1,028 USTs, cleaned up the associated contamination where identified, and met the state regulatory requirements for case closure. Although 27 UST cases remain open at Beale AFB, only 4 of the 27 cases require additional characterization.

The status of the issues and recommendations presented in the first five-year review is shown in Table 5.9-15.

Table 5.9-15. Status of Recommendations from the First Five-Year Review, Site CG041-509

Issue	Recommendation	Current Status	Current Implementation Status Description	Completion Date (if applicable)
A need exists for reconciliation between the Beale AFB UST database and RWQCB records. Seven UST cases that are considered open have been determined to be aboveground storage tanks, in inaccessible areas, or USTs mapped in historical documents that have never been identified in the field.	**Complete the characterization of underground storage tank (UST) cases 09-019, 11-003, 11-004, and 13-046.**	**Complete**	**USTs 11-003 and 11-004 were located at Site TU509. They were removed in 2009 and ORC-A treatment of the excavation floor followed. Characterization is complete.**	**2009**

5.9.4.15 CG041-517

This is the first five-year review for CG041-517.

5.9.5 Data Review

Groundwater monitoring data are collected at Beale AFB under the BGMP, which monitors groundwater quality at 25 sites at the Base, including the 15 groundwater plume sites combined under the basewide groundwater site identified as CG041, discussed in this section. Groundwater monitoring data are collected to support ongoing investigations and the selection of final groundwater remedies identified in final decision documents. Collected data also are used to assess the performance of the selected remedies. Data are presented in semi-annual and annual reports that include the semi-annual (first quarter), second quarter, annual (third quarter), and fourth quarter sampling events. The annual BGMP report also presents contaminant trends, effects from remedial actions, and conclusions drawn from the annual data. The data presented in the 2015 annual report are the most current groundwater data available for evaluation during this five-year review and are the focus of this section (CH2M HILL 2016i). In addition, periodic (2010, 2013, 2015) groundwater contaminant plume maps are shown for each groundwater plume site to visually portray the change of plume extent over time.

5.9.5.1 CG041-003

As of the date of this five-year review, 60 monitoring wells have been installed at or near CG041-003. In 2015, 27 wells were sampled during the semi-annual event and 33 were sampled during the annual event. Twenty-one of the wells were sampled in support of WDR Order R5-2008-0149-032 (CVWB 2011) as revised (CVWB 2015a), which specifies an ongoing MRP at CG041-003 as part of the 2011 ISCO treatment. Table 5.9-16 shows results for all wells sampled during the 2015 sampling events as well as long-term TCE trends for each well. A summary of the data discussion provided in the 2015 report follows. Figure 5.9-1 shows the 2015 plume along with additional site features. Figure 5.9-2 shows the location of the CG041-003 TCE groundwater contaminant plume in 2010, 2013, and 2015.

Table 5.9-16. 2015 TCE Data and Trends, Site CG041-003

Well	Type	2015 Semi-annual TCE (µg/L)	2015 Annual TCE (µg/L)	Time-series Plot Trend
03C018MW	MRP Treatment	**225**	**268**	Decreasing
03C019AMW	MRP Treatment	**224**	**187**	Decreasing
03C019BMW	MRP Treatment	**35**	**28.9**	Decreasing
03C032MW	MRP Treatment	**66**	**57.7**	Recently Decreasing
03C050IW	MRP Treatment	1.6	0.68	Decreasing
03C051IW	MRP Treatment	**8.9**	**28**	**Recently Increasing**
03C052IW	MRP Treatment	0.27 J	ND	Decreasing
03C053IW	MRP Treatment	**71.6**	**20.6**	Recently Variable
03C054IW	MRP Treatment	ND	ND	Decreasing
03C055IW	MRP Treatment	ND	ND	Decreasing
03C056MW	MRP Treatment	**35.1**	**21.7**	Decreasing
03C057MW	MRP Treatment	**70.8**	**52.5**	Decreasing
03C030MW	MRP Transition	**97.2**	**120 J**	Decreasing
03C045AMW	MRP Transition	**238**	**139**	Decreasing
03C013AMW	MRP Compliance	**135**	**111**	Decreasing
03C015AMW	MRP Compliance	NS	**13.5**	Recently Decreasing
03C015BMW	MRP Compliance	NS	2.13	**Increasing**
03C031MW	MRP Compliance	**79.6**	**65.9**	Decreasing
03C045BMW	MRP Compliance	NS	1.23	Decreasing
03R001MW	MRP Compliance	**11.8**	**8.25**	**Increasing**
03R003MW	MRP Compliance	**31.9**	**25.9**	**Increasing**
03C013BMW	Plume	NS	ND	Decreasing
03C021MW	Plume	**142**	**109**	None
03C046AMW	Plume	**17.8**	**15.8**	Decreasing
03C046BMW	Plume	0.38 J	0.42 J	Decreasing
03C048MW	Plume	**70.7**	**95.2**	**Increasing**
03C049MW	Plume	**38.9**	**18.2**	Variable
FT03PEW4	Plume	1.1	2.49	Variable
FT03VW5D	Plume	ND	ND	None
FT03VW7D	Plume	**9.4**	3.98	Variable
03C011MW	Downgradient	NS	ND	None
03L001MW	Downgradient	**15.4**	**8.53**	Variable
03R002MW	Downgradient	NS	**3.32**	**Increasing**

Notes:

Bold = Exceeds project screening levels (5 µg/L) or shows an increasing trend

µg/L = micrograms per liter; J = estimated quantity; MRP = Monitoring and Reporting Program;
ND = not detected; NS = not sampled

To date the TCE plume extends approximately 1,500 feet from an area northwest of FPTA Nos. 3 and 4 towards the southwest and 27th Street (1,100 feet from the former dry well.) The TCE plume has a width of nearly 900 feet near the former dry well and 600 feet in its distal portion. The 2015 trend results indicate that TCE concentrations in the western source area have decreased since ISCO treatment was implemented in 2011. No concentrations of TCE were reported greater than the ISCO treatment action level of 350 µg/L in 2015, but exceeded the PSL of 5 µg/L in 20 of the wells sampled during the annual event. TCE reductions have been observed at the six ISCO injection wells: 03C050IW—03C055IW. These wells were reassigned as MRP treatment zone wells in August 2015. Samples collected during the 2015 annual sampling event indicate that MRP compliance wells continue to meet the provisions set forth in the WDR.

In addition to TCE, carbon tetrachloride, 1,2-DCA, and PCE also were detected in groundwater at concentrations exceeding interim cleanup goals. The horizontal distribution of these contaminants generally is within the TCE plume boundary. Carbon tetrachloride was detected at a concentration greater than the interim cleanup level of 0.5 µg/L at 25 wells in 2015. The maximum detected carbon tetrachloride concentration during the 2015 annual event was 3.67 µg/L at downgradient MRP compliance well 03R003MW.

1,2-DCA was detected at nine wells in 2015, and at a maximum concentration of 1.9 µg/L. 1,2-DCA concentrations exceeded the interim cleanup level of 0.5 µg/L at only three wells (03C019AMW, 03C052IW, and 03C053IW). All three of these wells are located in the vicinity of the former dry well. PCE exceeded its interim cleanup goal (5 µg/L) at 15 wells and was detected at a maximum concentration of 51.2 µg/L in MRP treatment well 03C019AMW.

During this five-year review period, TCE and vinyl chloride concentrations increased in downgradient wells from 2011 to 2012, but began to decrease in 2013. In 2014 and 2015, increases in the downgradient well concentrations of both COCs again were observed, indicating that plume migration is occurring in the deep groundwater zone. The VOC plumes currently are not defined to interim cleanup levels along their downgradient edge. VOCs may be migrating beneath the flightline in this area (CH2M HILL 2016i).

Cross-gradient well pair 03C012AMW/BMW and well 03R011MW were not monitored in 2015 because VOC concentrations in these wells did not exceed interim cleanup levels in 2014, but since 2012, increasing TCE trends have been observed, which indicates off-base agricultural pumping west of CG041-003 may be influencing VOC migration in this direction (CH2M HILL 2016i). Based on these trends, additional monitoring of the cross-gradient wells will be performed.

5.9.5.2 CG041-010

As of the date of this five-year review, 80 groundwater monitoring wells have been constructed at CG041-010, although one has been abandoned. Groundwater samples were collected at 22 of these monitoring wells during the 2015 annual event in support of revised WDR Order R5-2004-0131 (CVWB 2012, 2015a), which specifies an ongoing MRP at CG041-010 as part of the EISB treatment system, which has been shut down since 2009. Annual results for TCE, cis-1,2-DCE and vinyl chloride, along with chemical time-series plot trends for TCE, are shown in Table 5.9-17 (the results from the seven downgradient wells sampled are not included). A summary of the discussion provided in the 2015 Basewide Groundwater Monitoring Program annual report follows. Figure 5.9-3 shows the 2015 plume along with additional site features. Figure 5.9-4 shows the location of the CG041-010 TCE groundwater contaminant plume in 2010, 2013, and 2015.

Table 5.9-17. 2015 TCE, cis-1,2-DCE, and Vinyl Chloride Data and TCE Trends, Site CG041-010

Well	Type	2015 Annual TCE (µg/L)	2015 Annual cis-1,2-DCE (µg/L)	2015 Annual Vinyl Chloride (µg/L)	Time-series Plot Trend
10C035RW	MRP Treatment	**29.9**	2.5	ND	Decreasing
10C044RW	MRP Treatment	**197**	**162**	**10.5**	**Increasing**
10C045RW	MRP Treatment	**40.2**	**12**	ND	Decreasing
10C048MW	MRP Treatment	**5.27**	**211**	**584**	No Trend
10M004MW	MRP Treatment	1.26	2.16	**2.13**	No Trend
10C027MW	MRP Treatment	**116**	**19.2**	ND	No Trend
10C050RW	MRP Treatment	0.26	0.24 J	**1.35**	No Trend
10C003MW	MRP Compliance	1.39	ND	ND	No Trend
10C006MW	MRP Compliance	3.77	ND	ND	**Increasing**
10C009MW	MRP Compliance	**38**	3.51	ND	Recently Decreasing
10C028MW	MRP Compliance	**41.9**	**24.6**	0.21	**Increasing**
10C029MW	MRP Compliance	**59.9**	**34.4**	**1.59**	Decreasing
10M007MW	MRP Compliance	0.26 J	0.19 J	ND	No Trend
10R003MW	MRP Compliance	4.64	ND	ND	**Increasing**
10C041RW	Plume	0.2 J	ND	ND	Decreasing

Notes:
Bold = Exceeds project screening levels or shows an increasing trend
µg/L = micrograms per liter; J = estimated quantity; MRP = Monitoring and Reporting Program; ND = not detected

TCE concentrations in the CG041-010 source and plume area wells ranged from an estimated 0.2 to 197 µg/L in 2015. These data indicate that TCE concentrations remain relatively low in the treatment area, where concentrations are decreasing or show no overall trend, except at 10C044RW. TCE has been increasing over the last 4 years at this well (CH2M HILL 2016i).

During the 2015 annual event, cis-1,2-DCE concentrations ranged from not detected to 211 µg/L, and vinyl chloride concentrations ranged from not detected to 584 µg/L. The presence of these daughter products of TCE degradation in compliance wells indicate reduced groundwater is migrating from the former treatment zone. Incomplete degradation is to be expected 6 years after the EISB was shut down; however, the daughter products indicate remedial progress of the CG041-010 plume. Daughter product concentrations have been increasing at treatment well 10C044RW over the last few years. In addition, PCE was detected at this well during the 2015 annual event at a concentration of 11.8 µg/L, exceeding the PSL of 5 µg/L. This is the only instance of PCE being detected above the PSL at CG041-010 (CH2M HILL 2016i).

Vinyl chloride was detected at a maximum concentration of 584 µg/L in treatment well 10C048MW. The historical results from this well likely show evidence of the diffusion of mass out of the fine-grained material near the former source area. Concentrations now appear to be stabilizing following an initial rapid increase since 2010 (CH2M HILL 2016i). In general, TCE concentrations, as well as those of its daughter products, are decreasing or show no time-series trend, indicating plume stability. In most downgradient monitoring wells, TCE is detected sporadically and at trace concentrations. TCE was detected at a concentration greater than the interim cleanup goal of 5 µg/L in only one downgradient well (12.9 µg/L at 10R004MW). Cis-1,2-DCE and PCE were detected at concentrations less than their respective interim cleanup levels at well 10R004MW. No other site COCs were detected at any downgradient wells, which further demonstrates the stability of the CG041-010 VOC plumes.

In 2015, all MRP wells were sampled as specified in the revised MRP, with the exception of well 10C040RW, which could not be sampled because it was dry. Sample results indicate the EISB treatment system is in compliance with the MRP provisions established by the WDR. Based on the MRP data, the beneficial uses of groundwater outside the CG041-010 treatment area have not been adversely affected (CH2M HILL 2016i).

5.9.5.3 CG041-013

Groundwater was sampled from 63 monitoring wells during the 2015 annual sampling event. CVWB issued WDR Order R5-2008-0149-018 in 2010 (revised in 2011), which established an MRP to support monitoring of the CG041-013 bioreactor (CVWB 2010, 2011); other non-MRP wells also are sampled to help define the CG041-013 groundwater plume and monitor long-term trends. In 2015, TCE, cis-1,2-DCE, trans-1,2-DCE, and 1,1,2-TCA were the only COCs detected at concentrations greater than PSLs. Concentrations of TCE, the primary site COC, and time-series plot trends are shown in Table 5.9-18. Figure 5.9-5 shows the 2015 plume along with additional site features. Figure 5.9-6 shows the location of the CG041-013 TCE groundwater contaminant plume in 2010, 2013, and 2015.

Table 5.9-18. 2015 TCE Data and Trends, Site CG041-013

Well ID	Type	HSU	2015 Annual TCE (µg/L)	TCE Time-series Plot Trend
13C064IW	MRP	HSU-2A	**8.31**	Decreasing
13C070VEW	MRP	HSU-1	NS	Decreasing
13C077VEW	MRP	HSU-1	NS	Decreasing
13C079VEW	MRP	HSU-1	3.22	Decreasing
13C083MW*	MRP	HSU-1/2A	0.92	Decreasing
13C084MW	MRP	HSU-1	**18.6**	Decreasing
13C085MW*	MRP	HSU-1/2A	**26**	Decreasing
13C086MW	MRP	HSU-1	**41.3**	None
13C088MW	MRP	Screened with the bioreactor.	ND	None
13C091MW	MRP	Screened within the bioreactor.	ND	None
13C051EW*	MRP	HSU-2A	**42**	Decreasing
13L004EW*	MRP	HSU-2A/2C	**20.1**	Decreasing
13C010EW	Plume	HSU-2C	0.21 J	Decreasing
13C081EW	Plume	HSU-1/2A	4.04	Decreasing
13L001EW*	Plume	HSU-2A/2C	**13.7**	Decreasing
13L001MW	Plume	HSU-2B	**7.97**	Decreasing
13L002EW	Plume	HSU-2A/2C	**8.18**	Decreasing
13L003EW	Plume	HSU-2A/2C	**13.1**	Decreasing
13L004MW*	Plume	HSU-2A	**21.4**	Decreasing
13L005MW*	Plume	HSU-2C	**8.21**	Decreasing
13L006MW	Plume	HSU-2C	**12.3**	Decreasing
13L010MW	Plume	HSU-2A	**7.83**	**Recently Increasing**
13L011MW*	Plume	HSU-2A	**7.7**	Decreasing
13L022MW	Plume	HSU-2D	**6.71**	**Increasing**
13C006MW*	Plume/downgradient	HSU-2A	**6.51**	Decreasing
13C011EW*	Plume/downgradient	HSU-2D	1.84	Decreasing
13C050EW*	Plume/downgradient	HSU-2D	2.79	Decreasing
13L027MW*	Plume/downgradient	HSU-2C	2.42	Decreasing
13O005EW*	Plume/downgradient	HSU-2A/2B/2C	2.76	Decreasing

Notes:

* = Active extraction well during 2015 annual sampling

Bold = Value exceeds project screening levels (5 µg/L) or shows an increasing trend
µg/L = micrograms per liter; J = estimated quantity; MRP = Monitoring and Reporting Program;
ND = not detected; NS = not sampled

The time-series plot analyses presented in the 2015 annual report indicate an overall decreasing trend in the source area and Site LF013 plume area (CH2M HILL 2016i). During the 2015 annual event, TCE was not detected at a concentration greater than the source area treatment target concentration of 100 µg/L, but was detected above the PSL of 5 µg/L in 17 wells. TCE concentrations have rapidly decreased by orders of magnitude in the vicinity of the bioreactor. These decreases may be attributed to recharging the bioreactor with EVO in 2014. The TCE concentration increased to greater than the PSL in one operating extraction well (13C006MW) but has remained less than the PSL since 2011 in four other operating wells. Analytical data from monitoring wells located along the base boundary indicate that downgradient plume contamination is decreasing, stable, or not detected. As indicated by the low TCE concentrations in the on-base downgradient monitoring wells, the GTS is effectively capturing or containing contamination along the Base boundary (CH2M HILL 2016i).

In addition to TCE, three other site COCs (i.e., 1,1,2,2-TECA, cis-1,2-DCE, and trans-1,2-DCE) were detected in an area surrounding the bioreactor at concentrations exceeding their respective PSLs. These COCs were not detected at concentrations greater than their PSLs at any well outside the bioreactor treatment zone. Vinyl chloride, although not a COC, was detected at well 13C070VEW and is a daughter product that demonstrates the bioreactor is continuing to reductively dechlorinate TCE.

TCE was the only COC detected at off-base wells and was detected at eight of the 17 wells sampled. The maximum off-base concentration in 2015 was 2.9 µg/L at well 13L030MW, and this was a decrease from the 2014 maximum of 3.7 µg/L (also detected at 13L030MW). The TCE concentration trend at 13L030MW generally is increasing. TCE also is increasing at deep off-base wells (13C054MW and 13C055MW). However, TCE concentrations continue to remain less than the PSL at all off-base monitoring wells.

In 2015, all MRP wells were sampled as specified in the revised MRP. Sample results indicate the bioreactor remedy is in compliance with the MRP provisions established by the WDR. Based on the MRP data, the beneficial uses of groundwater outside the CG041-013 treatment area have not been adversely affected (CH2M HILL 2016i).

5.9.5.4 CG041-016

The groundwater monitoring network associated with CG041-016 consists of 24 monitoring wells. Groundwater samples were collected at 13 of those wells during the 2015 annual sampling event. Two surface water samples also were collected during the 2015 semi-annual event. The 13 wells and two surface water sample locations are as follows:

- **Plume Wells:** 16C001MW, 16C002MW, 16C011AMW, 16C012AMW, 16C013AMW, 16C015MW, and 16L002MW
- **Downgradient Wells:** 16C017AMW, 16C017BMW, 16C018MW, 16C031MW, and 16C032MW
- **Cross-gradient Well:** 16C014BMW
- **Surface Water Locations:** 16C004SW and 16C006SW

Figure 5.9-7 shows the 2015 perchlorate plume along with additional site features. Figure 5.9-8 shows the location of the CG041-016 perchlorate groundwater contaminant plume in 2010, 2013, and 2015.

Perchlorate is the only COC identified in groundwater at CG041-016. The conclusion of the 2015 annual monitoring report indicated that perchlorate concentrations are stable or decreasing at 11 of the 13 monitoring wells sampled during the 2015 annual event, and the plume is stable and decreasing in size (CH2M HILL 2016i).

Perchlorate was detected at concentrations ranging from 7.5 to 61 µg/L at the seven plume wells in 2015. All detected concentrations were greater than the perchlorate PSL of 6 µg/L; however, compared to historical results, the concentrations indicate that the perchlorate plume is stable and not migrating. This observation is confirmed by samples collected from downgradient wells associated with the site. Perchlorate was not detected at a concentration greater than the PSL in any of the downgradient wells sampled. Time-series plots associated with sample data from downgradient wells do not exhibit any long-term increasing concentration trends. Perchlorate was detected in the cross-gradient well sampled at a concentration less than the PSL, indicating that the plume is not migrating (CH2M HILL 2016i).

In addition, perchlorate was not detected at a concentration greater than the PSL in either of the surface water samples collected during the semi-annual sampling event. Only a trace estimated concentration of 0.04 µg/L was detected in one of the samples.

5.9.5.5 CG041-017

Groundwater samples were collected from 41 monitoring wells during the 2015 event. Three surface water locations also were sampled. The surface water samples were collected from Best Slough, Parks Lake, and Dry Creek. No COCs were detected in the surface water samples collected in 2015. Although several COCs have been identified at CG041-017, TCE is the primary site contaminant and the most widespread. The following discussion primarily focuses on TCE.

Sampled wells with TCE concentrations and time-series plot trends presented in the *Basewide Groundwater Monitoring Program 2015 Annual Report* (CH2M HILL 2016i) are summarized in Table 5.9-19. Figure 5.9-9 shows the 2015 plume along with additional site features. Figure 5.9-10 shows the location of the CG041-017 TCE groundwater contaminant plume in 2010, 2013, and 2015.

Table 5.9-19. 2015 TCE Data and Trends, Site CG041-017

Well ID	Type	Maximum 2015 TCE (µg/L)	Time-series Plot Trend
17C017MW	Source	**87,400**	Variable
17C018MW	Source	**42,600**	**Increasing**
17C019MW	Source	**21**	Decreasing
17C156MW	Source	**54**	**Recently Increasing**
17C160MW	Source	**190**	No Trend
17C161MW	Source	**301**	**Increasing**
17H20AMW	Source	**43**	No Trend
17H20BMW	Source	**8,220**	No Trend
17L005MW	Source	**268,000**	**Increasing**
17L006MW	Source	**216,000**	No Trend
17L008MW	Source	**191,000**	**Increasing**
17U11AMW	Source	**1,580**	No Trend
17U11BMW	Source	**315**	Decreasing
17U12AMW	Source	**27,800**	No Trend
17U12BMW	Source	**269,000**	No Trend
17V002MW	Source	**195**	Decreasing
17V007MW	Source	**82,300**	No Trend
17V008MW	Source	**418**	No Trend
17V010MW	Source	**113,000**	**Increasing**
17V011MW	Source	4	Decreasing
17C015AMW	Plume	**157**	No Trend
17C015BMW	Plume	ND	No Trend
17C157MW	Plume	**52.7**	Decreasing
17C159MW	Plume	**104**	Fluctuating
17C162MW	Plume	ND	No Trend
17C164MW	Plume	ND	Decreasing
17C165BMW	Plume	**166**	**Increasing**
17C166MW	Plume	**165**	**Increasing**
17H16BMW	Plume	**81.9**	**Increasing**
17L010MW	Plume	1.8	Decreasing
17V001MW	Plume	ND	Decreasing
17V012MW	Plume	**389**	Decreasing

Notes:
Bold = exceeds interim cleanup goal of 5 µg/L
µg/L = micrograms per liter; J = estimated quantity; ND = not detected

TCE concentrations within the slurry walls containing the Primary and Secondary Source Areas continue to remain orders of magnitude greater than the interim cleanup goal of 5 µg/L. Residual pure-phase TCE is suspected to be present near the source area monitoring wells. Time-series data for most of the source area wells indicate no trends or variable trends, which suggest that the movement of pure-phase TCE is occurring within the slurry walls.

An inward hydraulic gradient continues to be maintained by the interim remedy, but elevated concentrations continue to persist at well 17V012MW (389 µg/L), which is outside the Primary Source Area wall. TCE concentrations exceeded 1,000 µg/L during the 2007 and 2008 annual events but have decreased since 2008. An inward hydraulic gradient has been maintained since the Primary Source Area slurry wall was constructed, except for a short period in 2008. Therefore, a local source of TCE contamination may exist near well 17V012MW and outside the wall (CH2M HILL 2016i). An alternate explanation for this source of contamination is that contaminant leakage is occurring through the wall or underneath the wall.

Decreasing TCE concentrations have been observed south and west of the Secondary Source Area wall, indicating that the wall continues to effectively contain contamination in this area. In addition, no increasing trends have been identified in either the western or southern downgradient wells, with the exception monitoring well 17C166MW. All detections are less than PSLs in these wells, with the exception of 17C169MW. Overall, the data indicate that the downgradient portions of the plume have retracted approximately 2,500 feet in the last 15 years (CH2M HILL 2016i).

5.9.5.6 CG041-018

As of the date of this five-year review, 51 groundwater monitoring wells have been constructed at CG041-018. Samples were collected at four wells during the 2015 semi-annual event and at 27 wells during the 2015 annual event (CH2M HILL 2016i). Figure 5.9-11 shows the 2015 plumes along with additional site features. Figure 5.9-12 shows the location of the CG041-018 TCE groundwater contaminant plume in 2010, 2013, and 2015. Figure 5.9-13 shows the location of the TPH-D and TPH-G plumes in 2010, 2013, and 2015.

TCE is the only chlorinated COC at CG041-018, and its primary source is in the southern portion of the site, east of the former MOGAS Facility. TCE concentrations exceeded the PSL of 5 µg/L at six locations during the 2015 annual event. TCE concentrations along with long-term trends from sampled wells are shown in Table 5.9-20.

Table 5.9-20. 2015 TCE Data and Trends, Site CG041-018

Well	Type	2015 Semi-annual TCE (µg/L)	2015 Annual TCE (µg/L)	Long-term TCE Trend
18C046MW	Upgradient	NS	ND	No Trend
18C047MW	Upgradient	1.8	1.77	**Increasing**
18L005MW	Upgradient	NS	0.29 J	No Trend
18C020MW	Source	NS	**158**	Recently Decreasing
18C023MW	Source	NS	**186**	Fluctuating
18C028MW	Source	NS	**81.1**	Fluctuating
18C021AMW	Plume	NS	ND	Fluctuating
18C021BMW	Plume	**6.3**	**6.75**	Increasing
18C022MW	Plume	NS	4.59	Fluctuating
18C024MW	Plume	NS	**42.9**	**Increasing**
18C044MW	Plume	**18.8 J**	**16.1**	**Increasing**
18C043MW	Downgradient	NS	ND	No Trend
18C045MW	Downgradient	NS	0.17	No Trend
18U004MW	Downgradient	NS	ND	No Trend
18U006AMW	Downgradient	NS	1.68	**Increasing**
18U006BMW	Downgradient	NS	ND	No Trend
18U006CMW	Downgradient	NS	ND	No Trend

Notes:
Bold = value exceeds project screening level of 5 µg/L or shows increasing trend
µg/L = micrograms per liter; J = estimated quantity; ND = not detected; NS = not sampled

TCE was not detected greater than the PSL in any upgradient wells. Source area and plume well data indicate the TCE plume currently is 500 feet long by 400 feet wide. Increasing trends in one upgradient well, three plume wells, and one downgradient well indicate that the plume is migrating, although the plume remains within the boundary of the site. TCE was detected at only two downgradient wells, at concentrations less than the PSL of 5 µg/L. Most of the downgradient wells continue to show no TCE concentration trend, further indicating that although the plume is migrating, it has not migrated off-site.

Fuel-related compounds such as TPH-D and TPH-G are found mainly in the northern portion of the site, near a long-term leak from the JP-TS pipeline in the area east of the Jet Fuel Tank Farm. TPH-D and TPH-G concentrations along with long-term trends for TPH-D from wells sampled during the 2015 annual event are shown in Table 5.9-21.

Table 5.9-21. 2015 TPH-D/TPH-G Data and TPH-D Trends, Site CG041-018

Well	Type	2015 Annual TPH-D (µg/L)	2015 Annual TPH-G (µg/L)	Long-term TPH-D Trend
18L001MW	Upgradient	ND	ND	No Trend
18L005MW	Upgradient	ND	ND	No Trend
18U007AMW	Source	**1,570**	**680**	Decreasing
18U007BMW	Source	**51,500 J**	**2,780**	Fluctuating
18U008AMW	Source	58.1 J	**45.1 J**	Decreasing
18U008BMW	Source	**14,100**	**1,120**	Fluctuating
18U008CMW	Source	43.7 J	**53.4 J**	**Increasing**
18L002MW	Plume	ND	ND	No Trend
18U005MW	Plume	ND	ND	No Trend
18U006AMW	Downgradient	ND	ND	No Trend
18U006BMW	Downgradient	ND	ND	No Trend
18U006CMW	Downgradient	ND	ND	No Trend

Notes:
Bold = value exceeds project screening level of 100 µg/L for TPH-D or 5 µg/L for TPH-G or shows increasing trend
µg/L = micrograms per liter; J = estimated quantity; ND = not detected

During the 2015 sampling event, TPH-D and TPH-G were detected only in source area wells. The highest concentration of TPH-D (51,500 µg/L) was detected at well 18U007BMW. A new maximum TPH-D concentration (14,100 µg/L) was detected at well 18U008BMW. Free product has been and continues to be removed from these wells when present. In general, TPH-D concentrations are highly variable. This variability likely is related to the presence of floating product (CH2M HILL 2016i).

TPH-G was detected in all five source wells. The highest concentrations of TPH-G were detected in wells previously noted for having free product LNAPL and subject to hydro-skimming (18U007BMW and 18U008BMW). Sampling and groundwater elevation data indicate TPH-D and TPH-G contamination originate from a zone submerged approximately 40 feet below the water table. At the time of the original release, the water table was at a depth of 90 feet bgs. Over time, the water table has risen, fully submerging and trapping the remaining contamination. TPH-D and TPH-G were not detected in downgradient wells.

Benzene was detected greater than the PSL of 1 µg/L at two monitoring wells in 2015, 18U007BMW and 18U008BMW. It also was detected in one additional well but at a concentration less than the PSL. All three wells are located west of the former JP-TS pipeline leak, which is the primary source of petroleum contamination.

5.9.5.7 CG041-029

Groundwater samples were collected from 12 monitoring wells during the 2015 annual event to define the CG041-029 plume and monitor long-term trends. TCE results along with chemical time-series trends are shown in Table 5.9-22 (CH2M HILL 2016i). A brief discussion of these results follows the table. Figure 5.9-14 shows the 2015 plume along with additional site features. Figure 5.9-15 shows the location of the CG041-029 TCE groundwater contaminant plume in 2010, 2013, and 2015.

Table 5.9-22. 2015 TCE Data and Trends, Site CG041-029

Well	Type	2015 Annual TCE (µg/L)	Time-series Plot Trend
29VW004	Plume	**27.8**	Decreasing
29C008AMW	Plume	0.65	No Trend
29C008BMW	Plume	**58.5**	**Increasing**
29L004MW	Plume	**7.7**	**Increasing**
29C009BMW	Plume	0.94	Decreasing
29C038AMW	Plume	0.49 J	No Trend
29C038BMW	Plume	**5.4**	No Trend
29C040AMW	Downgradient	4.24	**Increasing**
29C040BMW	Downgradient	1.31	No Trend
29C010AMW	Cross-gradient	0.93	**Increasing**
29C037AMW	Cross-gradient	ND	No Trend
29C037BMW	Cross-gradient	2.89	No Trend

Notes:
Bold = exceeds project screening levels or shows an increasing trend
µg/L = micrograms per liter; J = estimated quantity; ND = not detected

Only four of the 12 wells sampled had TCE concentrations greater than the PSL of 5 µg/L, and TCE was the only COC to have concentrations exceed a PSL at CG041-029 in 2015. A maximum TCE concentration of 58.5 µg/L was detected at well 29C008BMW. Concentrations rebounded following a decrease in 2008, but may be fluctuating because of the effects of off-base pumping on the groundwater elevations and gradients. For example, the concentration at 29C008BMW reached a historical maximum of 78 µg/L in 2012, decreased to 25.3 µg/L in 2013, and increased in 2014 and 2015. A gradient shift to the west in the deep zone is likely to be the cause of these changes (CH2M HILL 2016i).

Additional data from other CG041-029 monitoring wells supports the observation of migrating TCE. Increasing trends in plume wells 29C008BMW and 29L004MW indicate migration of the central portion of the plume. An increasing trend of TCE concentrations has been noted in the area of downgradient well 29C040BMW, which further supports the hypothesis that some contaminant migration is occurring (CH2M HILL 2016i). To date, the downgradient extent of the plume remains defined to the PSL. TCE concentrations in cross-gradient wells remain less than the PSL and indicate that the plume is not migrating to the northwest or the southeast.

5.9.5.8 CG041-031

As of the date of this five-year review, 83 wells have been constructed at CG041-031. Forty-three of these wells were sampled during the 2015 annual sampling event. Thirty-one of the wells sampled are source and plume area wells, used as MRP wells to evaluate the performance and compliance of the interim remedy, in accordance with the revised draft WDR Order No. R5-2007-0044 (CVWB 2012). TCE is the only groundwater COC at CG041-031. TCE results, along with chemical time-series trends, are shown in Table 5.9-23 (CH2M HILL 2016i). A brief discussion of these results follows the table. Figure 5.9-16 shows the 2015 plume along with additional site features. Figure 5.9-17 shows the location of the CG041-031 TCE groundwater contaminant plume in 2010, 2013, and 2015.

Table 5.9-23. 2015 TCE Data and Trends, Site CG041-031

Well	Type	2015 Annual TCE (µg/L)	Time-series Plot Trend
31C003MW	MRP Treatment	**239**	Decreasing
31C005AMW	MRP Treatment	4.05	Decreasing
31C010AMW	MRP Treatment	**63**	Decreasing
31C013MW	MRP Treatment	0.16	Decreasing
31C014MW	MRP Treatment	ND	Decreasing
31C015MW	MRP Treatment	0.37	Decreasing
31C018MW	MRP Treatment	0.16	Decreasing
31C020MW	MRP Treatment	1.93	Decreasing
31C022MW	MRP Treatment	**85**	Decreasing
31C025MW	MRP Treatment	1.37	Decreasing
31C026MW	MRP Treatment	**6.25**	Decreasing
31C030MW	MRP Treatment	ND	Decreasing
31C032MW	MRP Treatment	ND	Decreasing
31C033MW	MRP Treatment	ND	Decreasing
31C034MW	MRP Treatment	1.17	Decreasing
31C035MW	MRP Treatment	0.43	Decreasing
31M003MW	MRP Treatment	ND	Decreasing
31R004AMW	MRP Treatment	0.64	No Trend
31U001AMW	MRP Treatment	**6,650**	**Recently Increasing**
31C002BMW	MRP Transition	0.16	Decreasing
31C005BMW	MRP Transition	4.83	Decreasing
31M002MW	MRP Transition	ND	Decreasing
31R004BMW	MRP Transition	ND	Decreasing
31U001BMW	MRP Transition	ND	Decreasing
31C006AMW	MRP Compliance	1.21	Decreasing
31C006BMW	MRP Compliance	0.28	Decreasing
31C006CMW	MRP Compliance	**12.3**	Decreasing
31C008AMW	MRP Compliance	0.47	Decreasing
31M001MW	MRP Compliance	3.53	**Increasing**
31R003MW	MRP Compliance	**62.4**	**Increasing**
31U003BMW	MRP Compliance	**84.3**	Recently Decreasing
31C011AMW	Plume	**75.9**	**Increasing**
31C011BMW	Plume	3.13	**Increasing**
31C012AMW	Plume	**11.2**	**Increasing**
31C012BMW	Plume	10	Variable
31U003AMW	Plume	ND	Decreasing
31C009MW	Downgradient	1.05	Insufficient Data
31C037AMW	Downgradient	1.64	Decreasing
31C037BMW	Downgradient	ND	No Trend
31C041AMW	Downgradient	ND	No Trend
31C041BMW	Downgradient	**17.3**	**Recently Increasing**
31U003CMW	Downgradient	0.33	No Trend

Notes:
Bold = exceeds project screening levels or shows an increasing trend
µg/L = micrograms per liter; MRP = Monitoring and Reporting Program; ND = not detected

As the data trends indicate, TCE concentrations in the treatment zone have continued to decrease, following EISB and EVO treatments. Concentrations in the treatment zone wells have decreased continually since the start of treatment in 2007. Although concentrations at the majority of wells within the treatment area have decreased over time, five wells still have concentrations of TCE greater than the PSL of 5 µg/L. TCE was detected at a maximum concentration of 6,650 µg/L in well 31U001AMW, which has had an increasing TCE concentration trend since 2012 (CH2M HILL 2016i). Before 2012, the TCE concentration at 31U001AMW decreased to less than the PSL in 2010, following EISB treatment.

TCE rebound also has been observed at wells 31C003MW and 31C022MW in the source area. Concentrations at these wells exceeded the PSL of 5 µg/L and the treatment target of 1,000 µg/L before treatment in 2010. Following treatment, concentrations decreased to less than the PSL in 2011, but increased to concentrations of 239 and 85 µg/L, respectively, in 2015. Rebound of TCE likely is the result of the EVO being consumed and TCE diffusing from fine-grained soils at these locations (CH2M HILL 2016i). Additional treatment may be needed to address the rebound observed at these source area wells.

Data from transition, compliance, and additional plume wells also indicate that reductive dechlorination is occurring, based on decreasing TCE concentrations and increasing cis-1,2-DCE and vinyl chloride concentrations. Concentration decreases in compliance well 31U003BMW are evidence that off-base pumping is pulling the plume to the southwest (CH2M HILL 2016i). This observation is supported further by recent TCE concentration increases at wells 31C012AMW and 31C012BMW.

TCE migration also is supported by a TCE concentration increase at downgradient well 31C041BMW. Concentrations have been consistently at trace levels in downgradient wells since installation but recently have begun increasing at 31C041BMW. The results from 31C041BMW indicate that the CG041-031 plume is migrating downgradient and is unbounded to the west (CH2M HILL 2016i).

Overall, an 89 percent reduction in TCE mass was calculated for the target treatment area, based on 2015 data. This represents an increase in TCE mass of 99.7 percent from the February 2013 calculation. The mass increase may be related to TCE concentration variability at well 31U001AMW. TCE was detected at this well at a concentration of 5.8 µg/L in 2012, which is slightly greater than the PSL of 5 µg/L, but increased to 6,650 µg/L in 2015. The increase likely is because of the consumption of EVO and the diffusion of TCE from the fine-grained soils at this location (CH2M HILL 2016i).

In 2015, all MRP compliance wells were sampled, as specified in the WDR. Results from MRP well sampling indicate that the EISB system is in compliance with WDR Order R5-2007-0025.

5.9.5.9 CG041-032

Groundwater beneath Site SS032 is sampled semi-annually and reported annually. During the 2015 semi-annual event, 11 wells were sampled, and during the annual event, 57 monitoring wells were sampled. Sampling associated with the CG041-032 ISCO area was performed at 21 wells in 2015, in accordance with the revised MRP issued by CVWB on August 28, 2012 (CVWB 2012) and as specified by WDR Order R5-2007-0025. The 36 other wells that were sampled help define the groundwater plume associated with the Flightline Area and monitor long-term contaminant trends. TCE was detected at several wells at concentrations greater than the PSL of 5 µg/L. Cis-1,2-DCE was detected at a concentration greater than the PSL at one well. TCE continues to be the most widespread and detected COC in groundwater at CG041-032. TCE concentrations detected during the 2015 semi-annual and annual events are shown in Table 5.9-24 (CH2M HILL 2016i). Figure 5.9-18 shows the 2015 shallow TCE plume along with additional site features. Figure 5.9-19 shows the location of the CG041-032 TCE shallow groundwater contaminant plume in 2010, 2013, and 2015.

Table 5.9-24. 2015 TCE Data and Trends, Site CG041-032

Well	Type	2015 Semi-annual TCE (µg/L)	2015 Annual TCE (µg/L)	TCE Time-Series Plot Trend
Northern Source Area				
32M002MW	MRP Treatment	NS	**32.2**	Recently Decreasing
32M001MW	MRP Treatment	NS	**83.5**	Decreasing
32C036MW	MRP Treatment	NS	3.67	Decreasing
32C039MW	MRP Treatment	NS	**14.7**	Decreasing
32M003MW	MRP Treatment	NS	0.66	Decreasing
32C068MW	MRP Treatment	**41.3**	**27.6**	Decreasing
32C004MW	MRP Treatment	**41.4**	**17.6**	Recently Decreasing
32C064MW	MRP Treatment	NS	**6.85**	Decreasing
SD32VE4D	MRP Treatment	1.6	ND	Decreasing
Southern Source Area				
32C040MW	Plume	NS	**25.6**	Decreasing
32C037MW	MRP Treatment	NS	1.35	Decreasing
32C042MW	MRP Treatment	NS	4.21	Decreasing
32C024MW	MRP Treatment	NS	**36.3**	Decreasing
32C067MW	MRP Transition	**170**	**21.8**	Decreasing
05C005MW	MRP Transition	NS	**26.8**	None
05R001MW	MRP Compliance	NS	ND	None
05R002MW	MRP Compliance	NS	**25**	**Increasing**
32C026IW	MRP Compliance	**37.4**	**66.8**	**Increasing**
32C027EW	MRP Compliance	**24**	**32.7**	**Increasing**
05R003MW	Plume	**39.3**	**16.9**	**Increasing**
Distal Plume Area (west of source areas)				
21L002MW	Plume	NS	**9.46**	**Recently Increasing**
01C103AMW	Plume	**30.9**	**49.8**	None
01C103BMW	Plume	NS	0.22 J	None
01C009AMW	Plume	NS	2.55	**Increasing**
01C009BMW	Plume	**24.5**	**13.3**	**Increasing**
01C009CMW	Plume	0.69	0.74	None
Cross-gradient				
32C009AMW	NW Cross-gradient	NS	**8.75**	**Increasing**
32C009BMW	NW Cross-gradient	NS	ND	Decreasing
01C102AMW	NW Cross-gradient	ND	ND	None
01C102BMW	NW Cross-gradient	ND	ND	None
01C104AMW	SE Cross-gradient	NS	2.72	Decreasing
01C104BMW	SE Cross-gradient	NS	2.85	Decreasing
01R008MW	NW Cross-gradient	NS	ND	None

Notes:
Bold = value exceeds project screening levels or shows an increasing trend
µg/L = micrograms per liter; J = estimated quantity; MRP = Monitoring and Reporting Program;
ND = not detected; NS = not sampled

Before ISCO treatment, the maximum detected TCE concentration at CG041-032 was 2,650 µg/L (32C038MW), with several other wells having TCE detections greater than 1,000 µg/L. Since ISCO treatment in 2007, TCE concentrations have decreased by one or more orders of magnitude in the northern source area. During the 2015 annual event, TCE was detected at a concentration greater than the PSL in six of the nine sampled wells in the northern source area, indicating minor rebound is occurring; however, concentrations of TCE are decreasing in seven of the nine wells, with all concentrations less than 100 µg/L. In general, concentrations at the northern source area wells are decreasing.

Similar decreasing trends have been observed at the southern source area wells. Although time-series plots indicate some variability at these wells, concentrations are trending downward and are less than pre-ISCO treatment concentrations. The results from cross- and downgradient monitoring wells continue to delineate the TCE plume extent. TCE concentrations are less than the PSL or are not detected at all cross-gradient wells sampled. Distal downgradient well 21L002MW is 2,200 feet southwest from the southern source area and has had two pulses of contamination, indicating TCE migration to the west beneath the flightline. The most recent pulse occurred during the 2014 semi-annual event, when TCE was detected at a concentration of 59.3 µg/L. Concentrations have since decreased to near the PSL as of the 2015 annual event. Other distal area plumes show increasing TCE trends, indicating that contamination from CG041-032 source areas is continuing to migrate.

The results from downgradient and guard wells also indicate migration that is likely the result of off-base pumping. The TCE concentration at 01C008CMW exceeded the PSL for the first time in 2014 and continues to show an increasing trend in the area along the western Base boundary. Downgradient wells designated as guard wells for the Base water supply wells did not have detections of TCE in 2015. Data from these wells indicates that the plume has stabilized in this area, and that contamination has not migrated to the Base water supply.

Twenty-two off-base residential wells are sampled as part of the CG041-032 monitoring network. TCE is the only VOC consistently detected in the off-base wells. Three wells (OBL004AW, OBL005AW, and OBL008AW) have been equipped with wellhead treatment systems, and residents have been provided with bottled water. Sampling results consistently have shown that the water contains trace levels of TCE, at concentrations less than the MCL of 5 µg/L. TCE at concentrations greater than MCL has not migrated to off-base wells (CH2M HILL 2016i).

In 2015, all MRP compliance wells were sampled as specified in the WDR. Concentrations from all analytes in the treatment zone were within acceptable ranges for monitoring wells associated with the ISCO remedy. No exceedances were reported except from transition zone well 32M003MW, where permanganate was detected at a concentration that exceeded the PSL of 1 µg/L. Overall, MRP well data indicate that the CG041-032 remedy is in compliance with the WDR (CH2M HILL 2016i).

5.9.5.10 CG041-035

In support of WDR Order R5-2008-0149-022 (CVWB 2010), which specifies an ongoing MRP at CG041-035, nine monitoring wells were sampled during the 2015 annual event. An additional five wells were sampled in 2015, to help define the groundwater plume and monitor long-term trends. TCE continues to remain the most widespread COC in groundwater at CG041-035, having the highest concentrations of all detected COCs. Table 5.9-25 shows 2015 groundwater monitoring TCE data along with time-series plot concentration trends (CH2M HILL 2016i). Figure 5.9-20 shows the 2015 plume along with additional site features. Figure 5.9-21 shows the location of the CG041-035 TCE groundwater contaminant plume in 2010, 2013, and 2015.

Table 5.9-25. 2015 TCE Data and Trends, Site CG041-035

Well ID	Well Type	2015 Semi-annual TCE (µg/L)	2015 Annual TCE (µg/L)	TCE Time-Series Plot Trend
35C005MW	Background Compliance	0.92	0.92	**Increasing** (recently decreasing)
35C017MW	Treatment	**238 J**	**205**	Decreasing
35C063MW	Treatment	0.5	ND	Decreasing
35C064MW	Treatment	**1,140**	**1,250**	**Increasing**
35C065MW	Treatment	3.4	4.17	Decreasing
35C010MW	Compliance	ND	0.27 J	No Trend
35C014MW	Compliance	**10.2**	**12.4**	Decreasing
35C059MW	Compliance	1.4	2.84	No Trend
35C067MW	Compliance	**35.8**	**27.5**	**Increasing**
35C058MW	Source	**348**	**295**	Recently decreasing
35C056MW	Downgradient	NS	ND	No trend
35C066MW	Downgradient	NS	ND	No trend
35C081MW	Cross-gradient	NS	ND	No trend
35C082MW	Cross-gradient	NS	ND	No trend

Notes:
Bold = greater than the project screening level of 5 µg/L
µg/L = micrograms per liter; J = estimated quantity; ND = not detected; NS = not sampled

Five monitoring wells had TCE concentrations greater than the PSL during the 2015 annual sampling event, with the highest concentration of 1,250 µg/L being detected at treatment well 35C064MW. However, TCE concentrations were reported as stable or decreasing in 12 of the 14 groundwater monitoring wells sampled during the 2015 annual sampling event, indicating the interim remedy remains effective, even with the shutdown of the bioreactor in 2013. In addition, TCE was not detected in the downgradient wells. Ongoing SVE operations are reducing the mass of TCE in the vadose zone that is contributing to groundwater contamination. A lack of increasing trends in downgradient compliance wells within which no exceedances of the TCE PSL have been reported in 5 years of monitoring indicates that the plume is stable (CH2M HILL 2016i).

1,1-DCE was detected at six wells during the 2015 annual sampling event. The detected concentrations of 1,1-DCE ranged from 0.19 to 27 µg/L. 1,1-DCE concentrations were greater than the PSL of 6 µg/L at wells 35C058MW and 35C064MW in 2015, at 25.5 and 27 µg/L, respectively. Carbon tetrachloride was detected at three wells in 2015. The PSL of 0.5 µg/L was exceeded only at 35C064MW, which had a maximum estimated concentration of 0.82 µg/L during the 2015 annual event (CH2M HILL 2016i).

All required MRP wells were sampled in 2015. Detected concentrations at the compliance wells did not exceed baseline values. Therefore, no contingency actions were triggered. The CG041-035 bioreactor is in compliance with the MRP (CH2M HILL 2016i). The constituents analyzed according to the MRP include ethane, ethane, methane, TOC, sulfate, iron, manganese, and TDS. It should be noted that only TOC, manganese, and TDS in compliance wells trigger contingency actions.

5.9.5.11 CG041-039

5.9.5.11.1 Source Area 1

The most elevated TCE concentrations in the main Cantonment Area TCE plume are at Site CG041-039 Source Area 1. Table 5.9-26 shows 2015 annual sampling TCE concentrations from wells associated with Source Area 1. Figure 5.9-22 shows the 2015 plume along with additional site features. Figure 5.9-23 shows the location of the CG041-039 TCE groundwater contaminant plume in 2010, 2013, and 2015.

Table 5.9-26. 2015 TCE Data and Trends, Source Area 1, Site CG041-039

Site Association	Well ID	Type	2015 Annual TCE (µg/L)	Time-series Plot Trend
CG041-039	39C017AMW	Source	**87.9**	Decreasing
	39C017BMW	Source	**26.6**	Decreasing
	39C045AMW	Source	**2,560**	Increasing
	39C045BMW	Source	**1,240**	Increasing
Site SS023	SWMU23U002AMW	Plume	**40.3**	No Trend
	SWMU23U002BMW	Plume	**75**	**Increasing**
CG041-039	39C015AMW	Plume	**45.3**	No Trend
	39C015BMW	Plume	**68.2**	Decreasing
	39C025MW	Plume	**9.43**	**Increasing**
	39C044MW	Plume	**297**	**Increasing**
	39C046MW	Plume	**298**	**Increasing**
	39C047MW	Plume	**198**	Decreasing
	39C048AMW	Plume	**116**	Decreasing
	39C048BMW	Plume	**245**	No Trend
	39U006AMW	Plume	**110**	Decreasing
	39U006BMW	Plume	0.41 J	No Trend
	39U007AMW	Plume	3.21	Decreasing
	39U007BMW	Plume	**49.7**	No Trend
	39U007CMW	Plume	**54.6**	Decreasing
	39U008APZ	Plume	**27**	**Increasing**
	39U008BPZ	Plume	**99.2**	Decreasing
	A72U001AMW	Plume	**9.13**	**Increasing**
	A72U001BMW	Plume	ND	No Trend
	A72U002AMW	Plume	ND	No Trend
	A72U002BMW	Plume	**46.1**	No Trend
	A72U002CMW	Plume	**33.3**	No Trend

Notes:

Bold = value exceeds interim cleanup goal or shows an increasing trend

µg/L = micrograms per liter; J = estimated quantity; ND = not detected

TCE concentrations at source wells (39C045AMW/BMW) rebounded sharply, following ERD injections in 2009 and 2010 (CH2M HILL 2016i). TCE concentrations also have rebounded slightly in source wells 39C017AMW/BMW after sharply decreasing, following ERD injections; however, concentrations remain much less than before injection.

Monitoring wells in the Source Area 1 plume indicate that most wells downgradient and within the 100 µg/L plume generally are decreasing. Wells farther downgradient from the 100 µg/L plume extent (A72U001A/BMW and A72U002A/B/CMW) also had TCE concentrations that decreased in 2015. In addition, 36 monitoring wells cross-gradient of the northern portion of the plume were sampled in 2015 and had concentrations of TCE less than the interim cleanup goal.

The Cantonment Area plume apparently is continuing to migrate to the west-southwest at its farthest downgradient edge, based on data from wells 39C016MW and UBL001MW. TCE was detected at both wells in 2015, at concentrations less than the PSL of 5 µg/L. TCE concentrations at 39C016MW have remained stable. A long-term increasing TCE trend has been observed at UBL001MW, although since 2013, concentrations have decreased (CH2M HILL 2016i).

Performance monitoring of the ERD treatment remains ongoing at CG041-039. Monitored parameters including dissolved hydrocarbon gases (i.e., ethane, ethene, and methane), dissolved iron, dissolved manganese, sulfate, and total organic carbon (TOC) are analyzed at source area and plume wells near Source Area 1. Data are used to evaluate whether anaerobic biodegradation processes are occurring.

Methane was detected at wells 39C017AMW, 39C045AMW, and 39C046MW, at concentrations ranging from 138 to 2,760 µg/L. The presence of methane indicates that complete dechlorination (destruction of vinyl chloride) is occurring. Methane concentrations greater than 500 µg/L are indicative of highly reducing conditions (CH2M HILL 2016i).

Elevated concentrations of iron and manganese in groundwater are indirect evidence of iron-reducing conditions. A concentration of dissolved iron greater than 1 milligram per liter (mg/L) is an indicator that redox conditions are adequate for reductive dechlorination to occur. Dissolved iron was detected at concentrations greater than 1 mg/L in samples from wells 39C017AMW (9.44 mg/L) and 39C045AMW (6.3 mg/L). Dissolved manganese was detected at 12 wells at concentrations ranging from an estimated 0.00109 mg/L (23L003MW) to 7.65 mg/L (39C045AMW). The highest concentrations were detected at source area wells 39C017AMW and 39C045AMW, confirming that reducing conditions are occurring in the source area (CH2M HILL 2016i).

All other monitored parameters, with the exception of TOC, confirmed that anaerobic conditions have been established and continue to persist, and that these parameters are in their optimal ranges for a microbial reductive pathway (CH2M HILL 2016i). TOC was not detected at concentrations greater than 20 mg/L, which indicates that the remaining TOC concentrations are insufficient to support complete dechlorination, and that much of the injected EVO has been consumed. The TCE mass estimated from groundwater concentrations in 2015 represents a 92 percent reduction in TCE mass in the treatment zone since treatment began. This is a 20 point increase from 2014, but only a 9-point increase from the percent reduction calculated in 2012 (83 percent). The calculated mass of TCE in the treatment zone increased between 2012 and 2014, mainly because of a large increase in TCE concentrations in well 39C045BMW and the HydroPunch data from the Site SS039 data gap investigation, performed in 2013 (CH2M HILL 2016i).

5.9.5.11.2 Source Area 2

In Source Area 2, TCE concentrations have been consistently less than the interim cleanup goal, with the exception of 39U001BMW, which had a TCE concentration greater than the interim cleanup goal. The TCE concentration at this well typically fluctuates around the interim cleanup goal and likely was not affected by the 2007 EVO injection. At the other Source Area 2 source wells, TCE concentrations decreased by two or more orders of magnitude following EVO injection. Table 5.9-27 shows 2015 annual sampling TCE concentrations from wells associated with Source Area 2. Figure 5.9-22 shows the 2015 plume along with additional site features. Figure 5.9-23 shows the location of the CG041-039 TCE groundwater contaminant plume in 2010, 2013, and 2015.

Table 5.9-27. 2015 TCE Data and Trends, Source Area 2, Site CG041-039

Site Association	Well ID	Type	2015 Annual TCE (µg/L)	Time-series Plot Trend
CG041-039	39C027MW	Source	0.43 J	Decreasing
	39C028MW	Source	0.53 J	Decreasing
	39C029MW	Source	ND	Decreasing
	39U001AMW	Source	0.49 J	Decreasing
	39U001BMW	Source	**7.34**	**Increasing**
	39U002MW	Source	0.37 J	Decreasing
	19C001MW	Plume	**40.4**	**Increasing**
	19C002MW	Plume	**69.6**	**Increasing**
	19C003MW	Plume	**38.6**	**Increasing**
	19L001MW	Plume	**39.9**	**Increasing**
	19L002MW	Plume	**60.3**	Decreasing
	39C013AMW	Plume	ND	No Trend
	39C013BMW	Plume	**23.4**	**Increasing**
	39C014AMW	Plume	**36.1**	Decreasing
	39C014BMW	Plume	4.49	**Increasing**
	39U003AMW	Plume	ND	No Trend
	39U003BMW	Plume	**17**	Decreasing
	39U003CMW	Plume	ND	No Trend
	39U008AMW	Plume	ND	No Trend
	39U008BMW	Plume	**5.89**	No Trend
	39U009AMW	Plume	**29.5**	**Increasing**
	39U009BMW	Plume	2.48	No Trend
	A72U003AMW	Plume	1.07	Decreasing
	A72U003BMW	Plume	**24.4**	Fluctuating
	A72U003CMW	Plume	**7.01**	Decreasing

Notes:
Bold = value exceeds interim cleanup goal or shows an increasing trend
µg/L = micrograms per liter; J = estimated quantity; ND = not detected

The results from wells in the plume area of Source Area 2 continue to indicate lateral contaminant movement from Source Area 1 into Source Area 2, as well as vertical contaminant movement from shallower to deeper zones in Source Area 2. Monitoring well 39C013BMW is screened upgradient from Source Area 2 but consistently has elevated TCE concentrations, which likely are related to migration from Source Area 1. Wells 39C014AMW and 39C014BMW downgradient from the source area continue to have opposite trending concentrations, with 39C014AMW concentrations decreasing and 39C014BMW concentrations increasing, suggesting downward vertical movement of TCE. Wells farther downgradient from Source Area 2 continue to have TCE concentrations that are steadily increasing, suggesting plume migration is occurring. TCE concentrations at cross-gradient wells continue to remain less than the interim cleanup goal (CH2M HILL 2016i).

Performance monitoring data from Source Area 2 wells are similar to those reported at Source Area 1. Groundwater conditions remain reductive, and anaerobic conditions continue to persist. TOC concentrations, similar to Source Area 1, generally are less than 20 mg/L, indicating that much of the EVO injected in this area also has been consumed (CH2M HILL 2016i). The TCE mass estimated from groundwater concentrations in 2015 represents a 98 percent reduction in the treatment zone since treatment began. This mass reduction generally has been unchanged since 2011, and reflects the fact that mass removal has reached an asymptotic level, with most of the mass (and TOC) having been consumed (CH2M HILL 2016i).

5.9.5.12 CG041-040

Groundwater samples were collected from 46 monitoring wells and four injection wells during the 2015 annual event. Sample results were used to evaluate the performance and compliance of the ERD biobarrier TS, as well as to define the groundwater plume at CG041-040 and monitor long-term trends. In 2011, CVWB issued WDR Order No. R5-2008-0149-031 that specifies an ongoing MRP in support of the interim remedy at CG041-040 (CVWB 2011). As of the date of this five-year review, two plumes have been identified at CG041-040: CG041-040 East and CG041-040 West. TCE results from the 2015 annual sampling event along with chemical time-series trends are shown for each plume in Tables 5.9-28 and 5.9-29, respectively (CH2M HILL 2016i). A brief discussion of these results follows each table. Figure 5.9-24 shows the 2015 plumes along with additional site features. Figure 5.9-25 shows the location of the CG041-040 TCE groundwater contaminant plumes in 2010, 2013, and 2015.

Table 5.9-28. 2015 TCE Data and Trends, Site CG041-040 East

Well	Type	2015 Annual TCE (µg/L)	Time-series Plot Trend
40C002AMW	Plume	NS	No Trend
40C002BMW	Plume	**11.7**	Decreasing
40C002CMW	Plume	NS	Decreasing
40C005AMW	Plume	1.51	No Trend
40C005BMW	Plume	**13.9**	No Trend
40C005CMW	Plume	**220**	No Trend
40C009AMW	Plume	**48.9**	Decreasing
40C009BMW	Plume	1.83	Decreasing
40C009CMW	Plume	NS	**Increasing**
40C025MW	Plume	**14.7**	Decreasing
UBL002MW	Plume	**36.4**	Decreasing

Notes:
Bold = value exceeds interim cleanup goal or shows an increasing trend; µg/L = micrograms per liter; NS = not sampled

The time-series plots indicate that TCE concentrations in most of the eastern CG041-040 plume wells are either decreasing or show no trend, with the exception of well 40C009CMW, which has an increasing trend. Concentrations at this well have been historically variable with substantially increasing concentrations between 2011 and 2012, and then decreasing concentrations in 2013 and 2014 (CH2M HILL 2016i). TCE was detected at a maximum concentration of 220 µg/L at plume well 40C005CMW. Concentrations at this well also have been historically variable, with decreasing concentrations from 2006 to 2010, increasing concentrations from 2010 through 2012, and a decrease beginning with the 2013 annual event (CH2M HILL 2016i).

PCE and 1,1-DCE were the only other site-related COCs to be detected at concentrations greater than PSLs in 2015. 1,1-DCE exceeded the PSL of 6 µg/L at two wells. PCE was detected in samples from six wells, but the concentration of PCE only exceeded the PSL of 5 µg/L at three wells. Four cross-gradient wells were sampled in 2015, and no site-related COCs were detected at three of the wells. TCE and 1,1-DCE were detected at trace concentrations of 1.3 µg/L and 0.18 J µg/L, respectively, at 40C016MW. No concentration trends are apparent in the chemical time-series plots for these wells (CH2M HILL, 2016).

The farthest downgradient wells at CG041-040 are well pair 40C020AMW and 40C020BMW, screened at depths of 100 to 110 and 190 to 200 feet bgs. These wells are located along North Beale Road, about 200 feet east of the Base boundary. TCE was not detected at these wells in 2015, which is consistent with historical results. However, no well is present at this location that is screened at a depth between the screen intervals of those two wells (i.e., between approximately 140 and 170 feet bgs), which is where TCE is most prevalent at wells upgradient from this well pair. Therefore, it is uncertain whether the TCE plume is bounded in the downgradient direction at CG041-040 (CH2M HILL 2016i).

No trends in TCE concentrations are apparent in the chemical time-series plots for the downgradient wells. TCE concentrations have remained well below the PSLs at these wells since their installation. No other site-related COCs were detected in the downgradient wells (CH2M HILL 2016i).

Table 5.9-29. 2015 TCE Data and Trends, Site CG041-040 West

Well	Type	2015 Annual TCE (µg/L)	Time-series Plot Trend
40C017MW	MRP Background	**73.4**	Decreasing
40C040IW	MRP Injection Well	ND	Decreasing
40C041IW	MRP Injection Well	**18.9**	Decreasing
40C042IW	MRP Injection Well	ND	Decreasing
40C043IW	MRP Injection Well	0.17 J	Decreasing
40C026MW	MRP Transition Zone	**13.7**	Recently Decreasing
40C034AMW	MRP Transition Zone	**45.9**	Recently Decreasing
40C034BMW	MRP Transition Zone	**70.5**	No Trend
40C035MW	MRP Transition Zone	**315**	Recently Decreasing
40C039MW	MRP Transition Zone	**139**	Recently Decreasing
40C033AMW	MRP Compliance	**53.5**	Recently Decreasing
40C033BMW	MRP Compliance	**38.8**	Recently Decreasing
40C033CMW	MRP Compliance	ND	No Trend
40C018AMW	Plume	0.39 J	No Trend
40C018BMW	Plume	**40.9**	Recently Decreasing
40C021AMW	Plume	ND	No Trend
40C021BMW	Plume	ND	No Trend
40C022MW	Plume	**35.9**	Recently Decreasing
40C023MW	Plume	**37.3**	Recently Decreasing
40C024AMW	Plume	3.43	Recently Decreasing
40C024BMW	Plume	**43.1**	Recently Decreasing
40C036MW	Plume	**64.2**	Recently Decreasing
40C037AMW	Plume	0.16 J	No Trend
40C037BMW	Plume	**41.3**	Recently Decreasing
40C037CMW	Plume	3.88	No Trend
40C038MW	Plume	**852**	**Increasing**
40C044MW	Plume	**26.7**	**Increasing**
40C054MW	Plume	**29.4**	Decreasing

Notes:
Bold = value exceeds interim cleanup goal or shows an increasing trend; µg/L = micrograms per liter; J = estimated quantity; MRP = Monitoring and Reporting Program; ND = not detected

Similar to the eastern CG041-040 plume, the western CG041-040 TCE plume also exhibits decreasing or no trends at the majority of monitoring wells. Only two wells sampled during the 2015 annual event showed increasing TCE concentration trends (40C038MW and 40C044MW). The majority of wells sampled have TCE concentrations greater than the PSL of 5 µg/L. TCE was detected at a maximum concentration of 852 µg/L at plume well 40C038MW. In general, sample results indicate that the plume is continuing to migrate to the west, at a depth of approximately 140 to 170 feet bgs.

Cis-1,2-DCE and 1,1-DCE were the only other site-related COCs detected at concentrations greater than PSLs at wells within the G041-040 West plume in 2015. 1,1-DCE was detected at concentrations ranging from 0.16 to 6.42 µg/L at 20 wells in CG041-040 West, but exceeded the PSL of 6 µg/L at only one well (40C024AMW, 6.42 µg/L). Cis-1,2-DCE was detected at ten CG041- 040 West plume wells, but only exceeded the PSL of 6 µg/L at one well (40C041IW, 40.7 µg/L). No other site-related COCs exceeded their respective PSLs at wells sampled within the CG041-040 plume (CH2M HILL 2016i).

Thirteen wells were sampled in 2015, in accordance with the MRP for CG041-040 West. The biobarrier MRP specifies several analytes that are designed to monitor for potential water quality degradation outside the treatment zone, resulting from the biobarrier. MRP compliance samples indicate that reducing conditions are present within the biobarrier but are not migrating downgradient from the biobarrier (CH2M HILL 2016i).

A primary objective of the ERD biobarrier TS is to reduce the mass flux of TCE out of the target treatment zone by up to 80 percent (CH2M HILL 2011e). Prior to injecting EVO in July 2011, the baseline mass flux of TCE through the biobarrier was estimated at 0.002 pound per square foot per day (CH2M HILL 2011e). During the 2015 annual event, TCE was not detected or detected at trace concentrations in three of the four biobarrier wells, and at the fourth well (40C041IW), TCE was detected at a concentration of 18.9 µg/L, which is greater than the PSL. As of the 2015 annual event, the mass flux of TCE through the biobarrier was less than 20 percent, meeting the design objective (CH2M HILL 2011e). However, evidence exists that TCE is migrating south of the biobarrier from an upgradient source, south of Warren-Shingle Road (CH2M HILL 2016i).

5.9.5.13 CG041-508

The CG041-508 source area is located in the Cantonment Area, approximately 250 feet northeast of Site SS023. Several wells associated with other sites or groundwater plumes are used to define and monitor PCE groundwater contamination associated with plume CG041-508, including wells at Sites ST022, SS023, OW034, SS507, and CG041-039. PCE is the only COC in groundwater at CG041-508.

During the 2015 annual sampling event, 19 wells associated with the CG041-508 PCE plume contained PCE concentrations greater than the PSL of 5 µg/L. Concentrations at four wells in the CG041-508 source area exceeded 100 µg/L. Outside the source area, concentrations ranged from 5.49 to 45.7 µg/L. The PCE plume greater than 5 µg/L extends 250 feet north and 500 feet east of Building 2548. PCE concentrations detected in source area wells are shown in Table 5.9-30. Figure 5.9-26 shows the 2015 plume along with additional site features. Figure 5.9-27 shows the location of the CG041-508 PCE groundwater contaminant plume in 2010, 2013, and 2015.

Table 5.9-30. 2015 PCE Data, Site CG041-508 Source Area

Well	Type	2015 Annual PCE (µg/L)
SS508C001AMW	Source	**107**
SS508C001BMW	Source	2.85
SS508C002MW	Source	1.53
SS508C003MW	Source	**12.7**
SS508C004MW	Source	**278**
SS508C005MW	Source	0.84
SS508C006MW	Source	**168**
SS508C007MW	Source	**241**
SS508C009MW	Source	1.24
SS508C010MW	Source	**45.7**
SS508C011MW	Source	0.37

Note:
Bold = value exceeds interim cleanup goal; µg/L = micrograms per liter

PCE extends approximately 1,700 feet to the southwest and is commingled with plumes at Sites SS023, OW034, and CG041-039 south of Doolittle Drive. During the 2015 annual event, 19 wells contained PCE at concentrations greater than the PSL of 5 µg/L, and at four source area wells, concentrations were greater than 100 µg/L. PCE concentrations at downgradient well cluster 39U006A/BMW were less than the PSL and defined the downgradient extent of the PCE plume to the PSL. Historical data showed an increasing PCE trend at 39U006A/BMW; however, 2015 results suggest a possible decrease or stabilization of PCE, which potentially could be related to the remedial actions being conducted at Sites SS023 and CG041-039 (CH2M HILL 2016i). Alternatively, PCE may be preferentially migrating through coarser grained deposits, in which case stratigraphic controls are responsible for the stable or decreasing PCE trends. Implementation of the selected corrective measures (i.e., ERD, enhanced attenuation monitoring, and LUCs) at the CG041-508 source area is planned for 2018.

5.9.5.14 CG041-509

Groundwater samples were collected from four source wells and 15 plume wells during the 2015 annual event. TPH-D concentrations along with time-series plot trends for each well are shown in Table 5.9-31. Figure 5.9-28 shows the 2015 plume along with additional site features. Figure 5.9-29 shows the location of the CG041-509 TPH-D groundwater contaminant plume in 2010, 2013, and 2015.

Table 5.9-31. 2015 TPH-D Data and Trends, Site CG041-509

Well	Type	2015 Annual TPH-D (µg/L)	Time-series Plot Trend
MW-1A	Source	**1,730**	Decreasing
MW-1B	Source	**613**	Decreasing
MW-2A	Source	**721**	Decreasing
MW-2B	Source	**105 J**	Decreasing
HUST10AMW	Plume	75.1 J	Recently Decreasing
HUST10BMW	Plume	57.6 J	No Trend
HUST011AMW	Plume	91.1 J	No Trend
HUST011BMW	Plume	59.4 J	No Trend
HUST012AMW	Plume	37.6 J	Decreasing
HUST012BMW	Plume	85.1 J	Recently Decreasing
HUST013MW	Plume	81.8 J	Recently Decreasing
HUST014AMW	Plume	55.5 J	**Increasing**
HUST015AMW	Plume	42.4 J	No Trend
HUST015BMW	Plume	56	No Trend
MW-6A	Plume	**713**	No Trend
MW-6B	Plume	**152**	No Trend
MW-7A	Plume	66.6 J	No Trend
MW-8A	Plume	ND	No Trend
MW-8B	Plume	44.1 J	No Trend

Notes:
Bold = value exceeds interim cleanup goals or shows an increasing trend
µg/L = micrograms per liter; J = estimated quantity; ND = not detected

The highest TPH-D detections (greater than 1,000 µg/L) were in source area wells MW-2A and MW-1A. Both wells also contained LNAPL in 2015: 1.38 feet thick at MW-1A and 0.01 foot thick at MW-2A. Concentrations exceeded the

PSL of 100 µg/L in all four source area wells and two of the 15 plume wells sampled in 2015. Most source and plume wells exhibit decreasing or no TPH-D concentration trends. TPH-D concentrations have been historically variable but decreased at source area wells and plume axis wells between 2014 and 2015, most likely because of the excavation of more than 700 tons of contaminated smear zone soil from the source area in winter 2014–2015. Concentrations are expected to be further reduced with the injection of ORC into vertical borings within the axis of the groundwater plume and into horizontal perforated pipes that were installed in the floor of the excavation. These injections were conducted in October 2015, which was after the 2015 annual sampling event.

Nine downgradient wells were sampled during the 2015 annual event. Beginning in 2014, all detections of TPH-D at these wells have been less than the PSL. TPH-D was not detected at a concentration greater than the PSL at any cross-gradient well in 2015. The results from the downgradient and cross-gradient wells define the extent of the CG041-509 TPH-D plume.

Benzene and naphthalene concentrations also exceeded their respective PSLs (1 µg/L and 17 µg/L) at source wells MW-1A, MW-1B, and MW-2A, and plume well MW-6A. Benzene was not detected at any other site wells, and naphthalene was detected at only two other wells, at concentrations less than the PSL.

5.9.5.15 CG041-517

The CG041-517 PCE source area is a suspected surface release near the northeastern corner of Building 5702. As of the 2015 annual sampling event, the estimated plume dimensions were 300 feet long by 200 feet wide. During the 2015 annual sampling event, groundwater samples were collected from 19 source area and plume wells. PCE concentrations along with time-series plot trends are shown in Table 5.9-32. Figure 5.9-30 shows the 2015 plume along with additional site features. Figure 5.9-31 shows the location of the CG041-517 PCE groundwater contaminant plume in 2010, 2013, and 2015.

Table 5.9-32. 2015 PCE Data and Trends, Site CG041-517

Well	Type	2015 Annual PCE (µg/L)	Time-series Plot Trend
BCC010AMW	Source	**41.8**	No Trend
BCC010BMW	Source	**156**	Variable
BCC015AMW	Plume	**7.85**	Insufficient Data
BCC015BMW	Plume	**5.57**	Insufficient Data
BCC016MW	Plume	2.22	Insufficient Data
BCC018AMW	Plume	1.01	Insufficient Data
BCC018BMW	Plume	**9.62**	Insufficient Data
HUST010AMW	Plume	1.8	No Trend
HUST010BMW	Plume	**15.3**	No Trend
HUST011AMW	Plume	**7.56**	**Increasing**
HUST011BMW	Plume	**8.84**	**Increasing**
HUST015AMW	Plume	4.77	**Increasing**
HUST015BMW	Plume	**5.16**	**Increasing**
MW-3A	Plume	**6.96**	Decreasing
MW-3B	Plume	**7.2**	No Trend
MW-7A	Plume	**7.91**	**Increasing**
MW-7B	Plume	**5.9**	**Increasing**
MW-8A	Plume	4.42	No Trend
MW-8B	Plume	4.43	No Trend

Note:
Bold = value exceeds interim cleanup goal or shows an increasing trend; µg/L = micrograms per liter

PCE exceeded the PSL of 5 µg/L in 14 of the 19 plume wells sampled during the 2015 annual event. PCE was detected at a maximum concentration of 156 µg/L in source well BCC010BMW. PCE concentrations at deep source well BCC010BMW had been variable from the time the well was installed in 2010 until 2014, when concentrations began to decrease. PCE concentrations also have been variable at shallow well BCC010AMW. Concentrations appear to be increasing in six of the 19 wells sampled during the 2015 annual event. These increasing concentration trends indicate that the plume may be migrating to the south. Daughter products of PCE reduction (TCE and cis-1,2-DCE) were detected at concentrations less than PSLs in 17 of 19 wells in 2015 (CH2M HILL 2016i).

PCE was detected at one cross-gradient well, at a trace concentration of 0.38 µg/L. Chemical time-series plots show no trends in PCE concentrations at cross-gradient wells. TCE, a daughter product of PCE reduction, was detected at concentrations less than its PSL of 5 µg/L at two cross-gradient wells in 2015 (CH2M HILL 2016i).

PCE was detected at a concentration less than the PSL at five downgradient wells, with concentrations ranging from 0.79 to 2.79 µg/L. However, the chemical time-series plot for one of those four downgradient wells (HUST014BMW) shows a gradually increasing trend, which indicates that the plume may be migrating toward the southwest. The toe of the PSL PCE plume is bound downgradient to the southwest near the northwestern corner of Building 5700 and to the west near the northwestern corner of Building 5704. Groundwater samples from these locations had PCE concentrations less than the PSL (CH2M HILL 2016i).

Implementation of the selected corrective measures (i.e., ERD, enhanced attenuation monitoring, and LUCs) at CG041-517 is planned for 2018.

5.9.6 Technical Assessment

QUESTION A: Is the remedy functioning as intended by the decision documents?

Yes, the interim remedies in place for each of the sites making up CG041 are functioning as intended and are making progress toward achieving interim RAOs. Although different remedial actions have been implemented at each site, long-term monitoring and LUCs are components of every interim remedy selected. LUCs have been effective in restricting access to groundwater by prohibiting the installation of water supply wells, thus preventing human consumption of contaminated water until concentrations of COCs are at such levels that allow UU/UE. In addition to monitoring the performance of the remedial actions and compliance with WDRs, where applicable, long-term monitoring has been effective in identifying potential threats to downgradient receptors before exposure can occur. In addition, interim remedies have reduced the concentrations of COCs at each plume where they have been implemented. However, concentrations of one or more COC remain above PSLs at all sites. As the interim remedies continue to progress and remedies are finalized and implemented, further reductions in contaminant mass and concentrations are expected. The timelines for restoring groundwater to designated beneficial uses vary, but progress is being made towards achieving that goal. To date, RODs have not been finalized for all of the CERCLA plumes under CG041, but the interim remedies currently in place for each site that have been protective of human health and the environment as of the date of this five-year review will continue to be implemented and monitored.

Sites CG041-508, -509, and -517 will not be addressed by the CG041 (CERCLA) ROD. Instead, decision documents (i.e., Statement of Basis/Corrective Measures Implementation Work Plans for Sites CG041-508 (Air Force 2016d) and -517 (Air Force 2016e) and a Corrective Action Plan for Site CG041-509 (Air Force 2015h) have been prepared under the regulatory framework applicable to the specific site. These documents have established the final remedies, as well as site-specific RAOs and cleanup goals. These final remedies are expected to be protective of human health and the environment.

QUESTION B: Are the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of the remedy selection still valid?

Yes in part, the assumptions made during the selection of interim remedies remain valid, primarily because the currently established cleanup levels are based on the lowest of either State or federal regulations. These data also are expected to be reviewed and updated, if necessary, as part of the ROD development process. For example, some sites that overly contaminant plumes do not have LUCs established. Part of this process will entail review of the assumptions used to develop the groundwater cleanup goals that address vapor intrusion reflect EPA’s short-term exposure action levels for TCE published in July 2014, as well as the updated EPA vapor intrusion guidance published in June 2015. The CG041 ROD is expected in 2018 and any update to those assumptions made during the IROD development process for each formerly individual site within CG041 will be considered at that time. While many sites have LUCs, some individual plumes do not yet have LUCs but will as the ROD is finalized.

QUESTION C: Has any other information come to light that could call into question the protectiveness of the remedy?

No other information has come to light that calls into question the protectiveness of the remedies.

5.9.7 Issues/Recommendations

The following issues were identified in the technical assessment for CG041:

- Groundwater cleanup goals based upon aquatic ecological toxicity criteria have not been established for sites where surface discharge of groundwater is occurring.
- A decision document needs to be prepared that establishes the final RAOs, COCs, cleanup levels, and remedies for CG041.

The following recommendations are intended to address the issues identified during the technical assessment for CG041:

- For sites where surface discharge of groundwater is occurring, cleanup goals protective of aquatic ecological receptors should be established; sampling should include upstream and downstream sampling for hardness to support the comparison.
- Complete and finalize the ROD for Site CG041.

5.9.8 Protectiveness Statement

The interim remedies for Site CG041 are protective of human health and the environment because LUCs established in interim decision documents remain in place to prevent potential exposures through the vapor intrusion or direct contact pathways. LUCs and groundwater monitoring and evaluation should be a part of any final remedy selected until such time as RAOs are achieved and the site is suitable for UU/UE.

5.9.9 Next Review

The next five-year review report for Site CG041 is required 5 years from the completion date of this review.

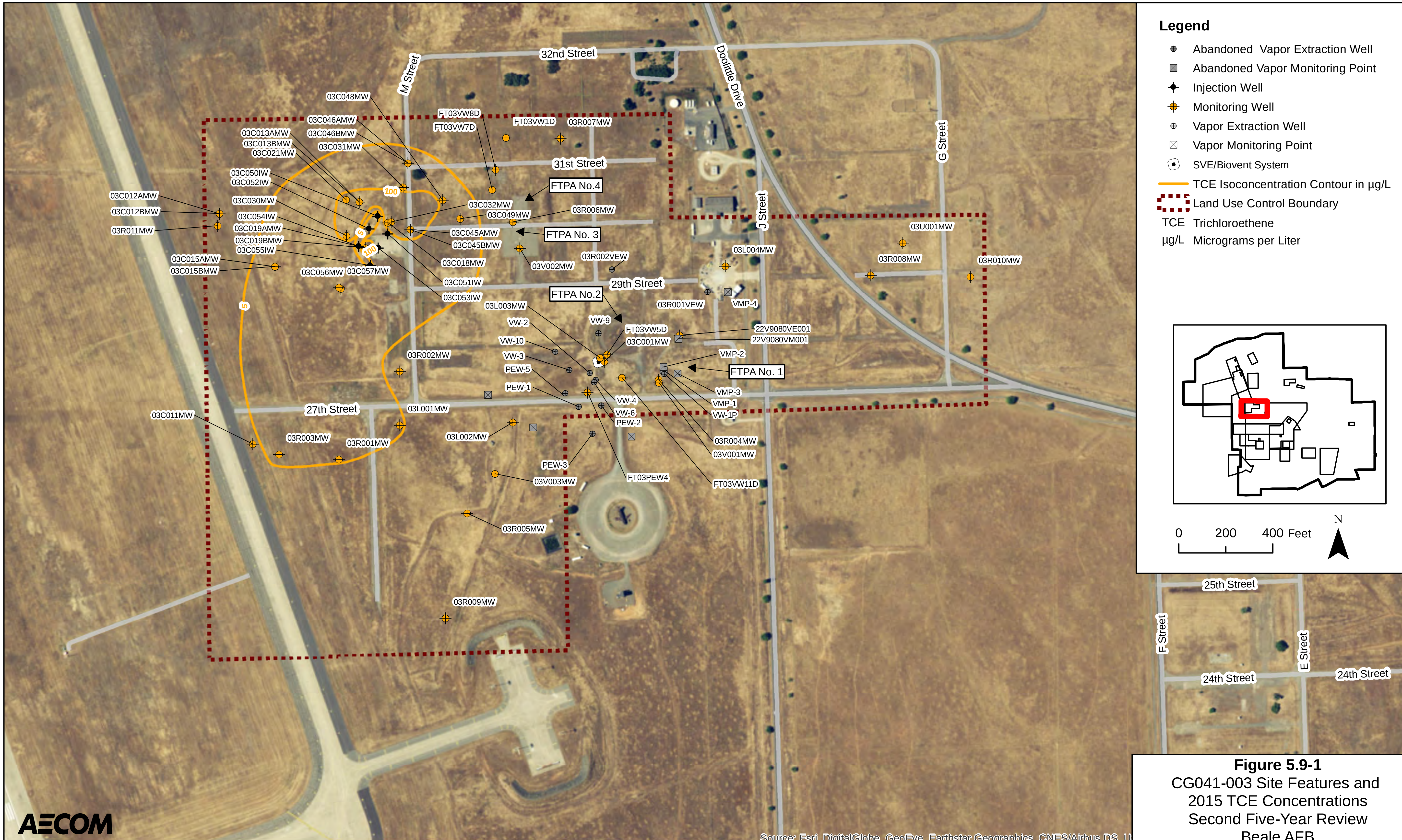

Figure 5.9-1
CG041-003 Site Features and
2015 TCE Concentrations
Second Five-Year Review
Beale AFB

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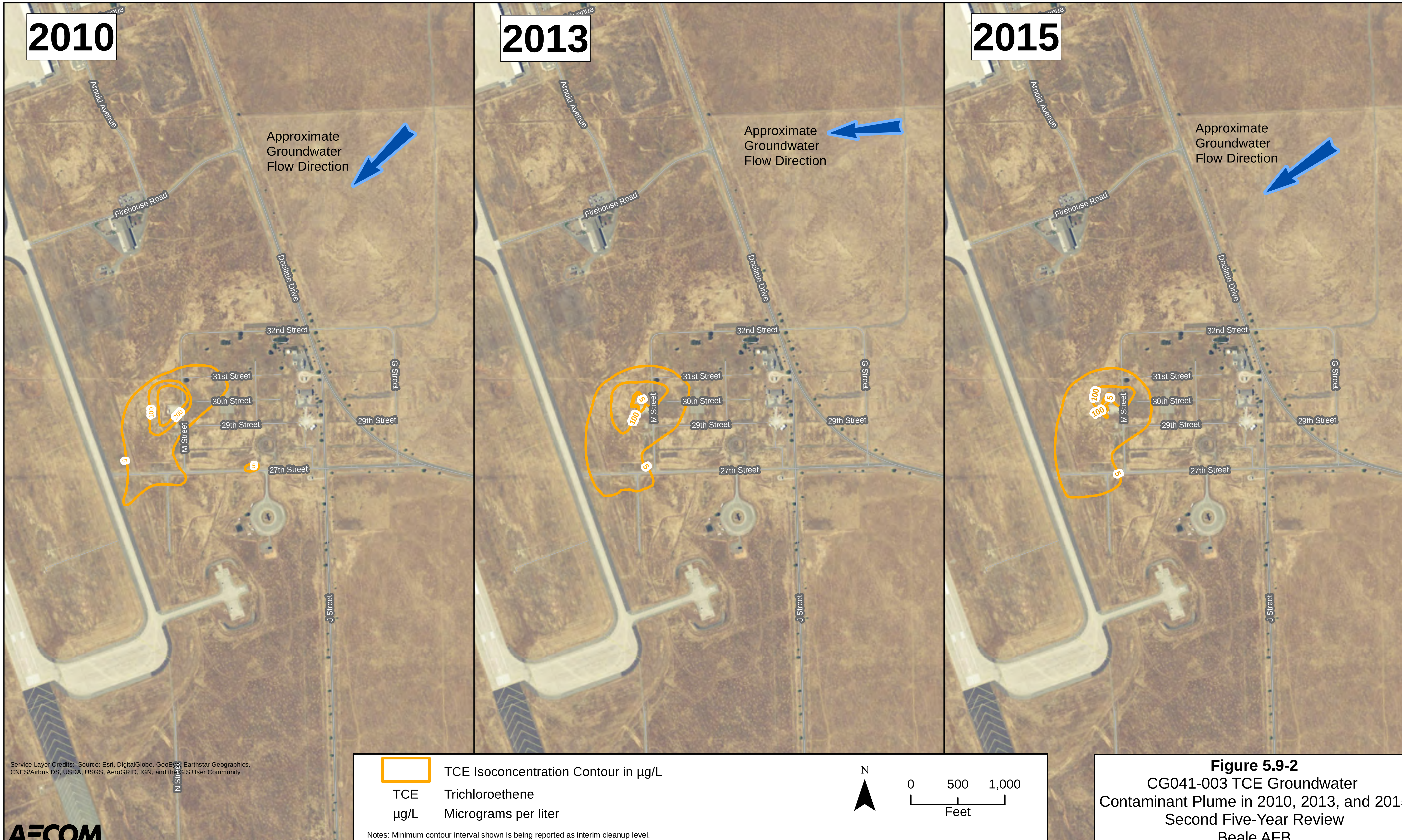

Figure 5.9-2
CG041-003 TCE Groundwater Contaminant Plume in 2010, 2013, and 2015
Second Five-Year Review
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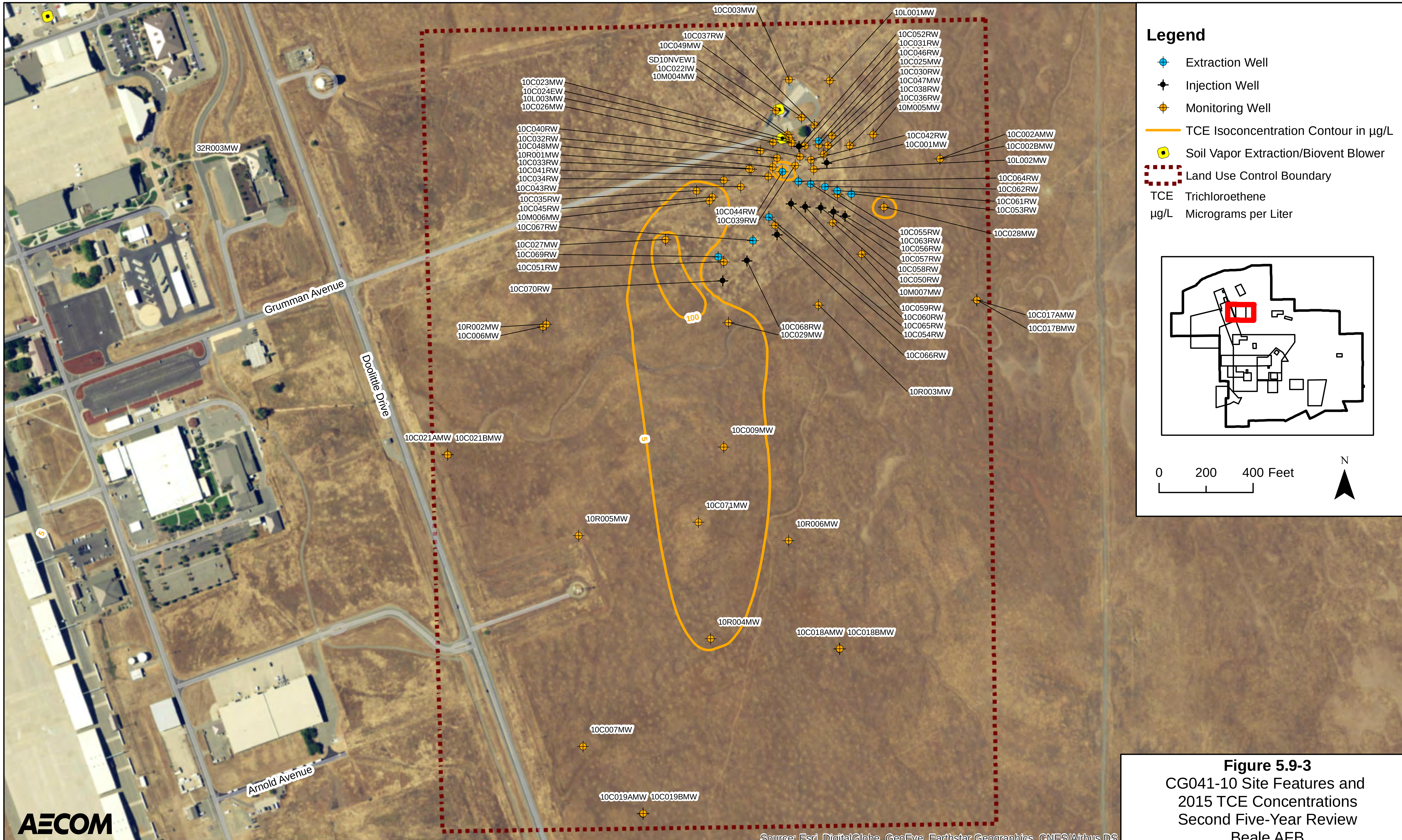

Figure 5.9-3
CG041-10 Site Features and
2015 TCE Concentrations
Second Five-Year Review
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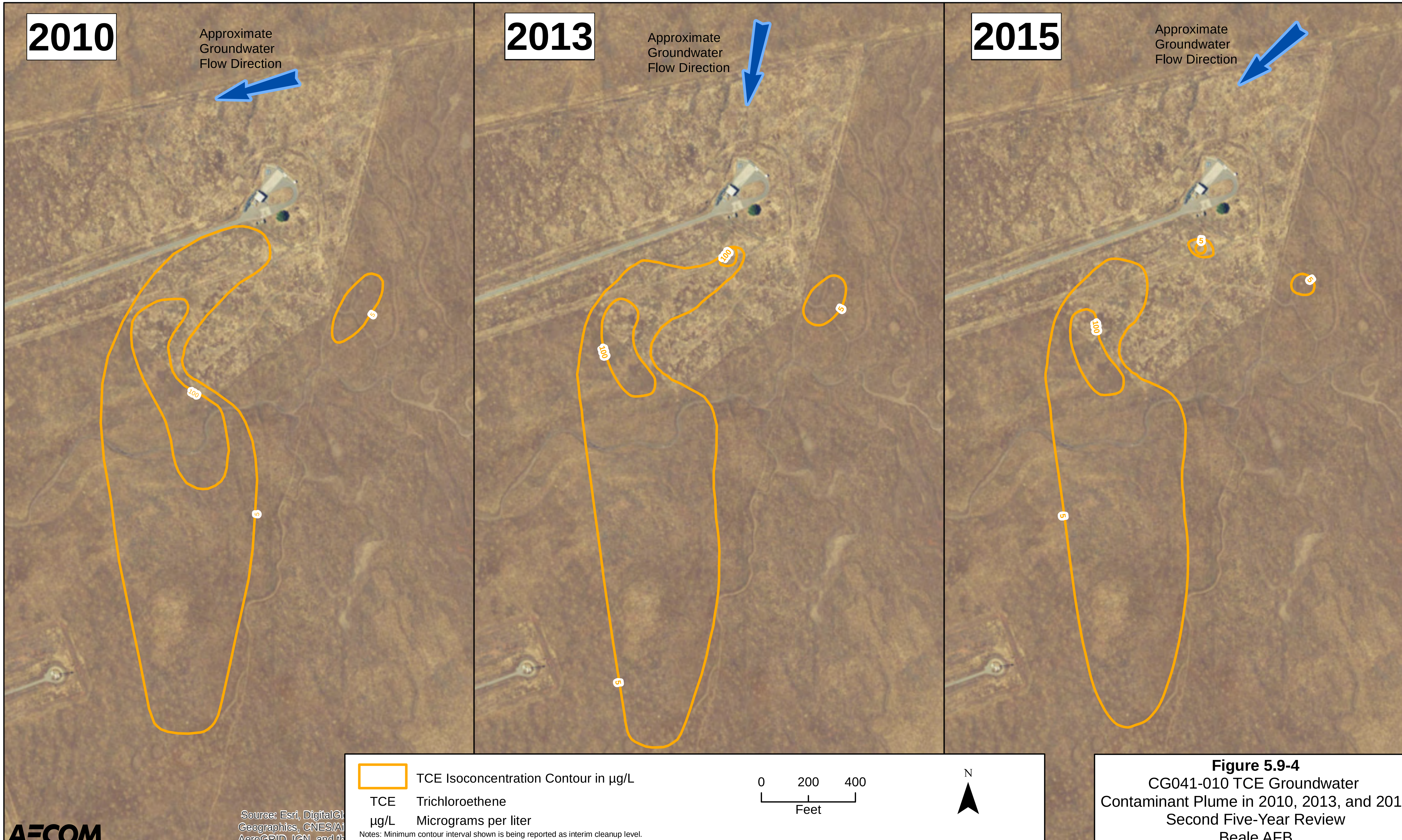

Figure 5.9-4
CG041-010 TCE Groundwater Contaminant Plume in 2010, 2013, and 2015
Second Five-Year Review
Beale AFB

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Figure 5.9-5
CG041-13 Site Features and 2015 TCE Concentrations
Second Five-Year Review
Beale AFB

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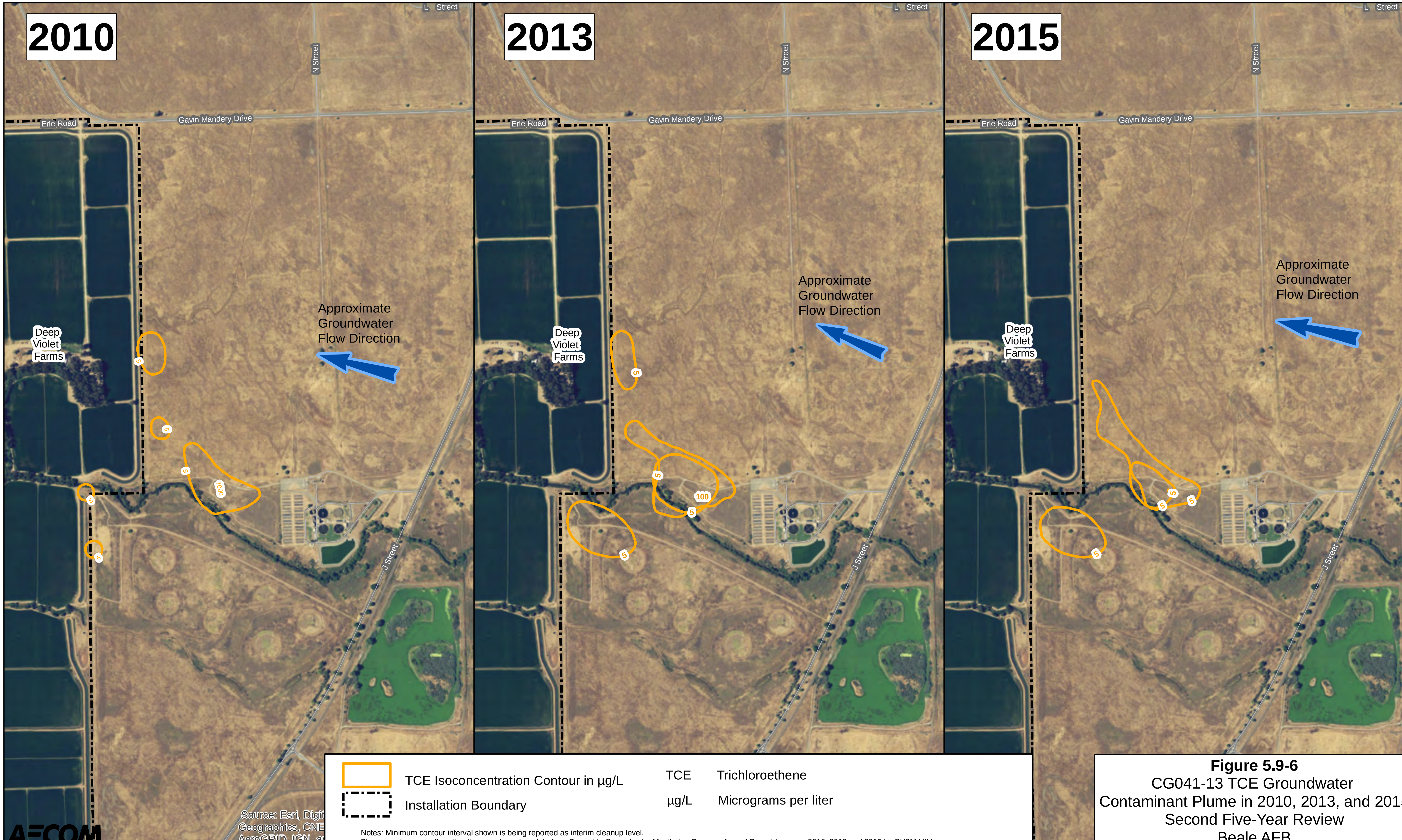

Figure 5.9-6
CG041-13 TCE Groundwater Contaminant Plume in 2010, 2013, and 2015
Second Five-Year Review
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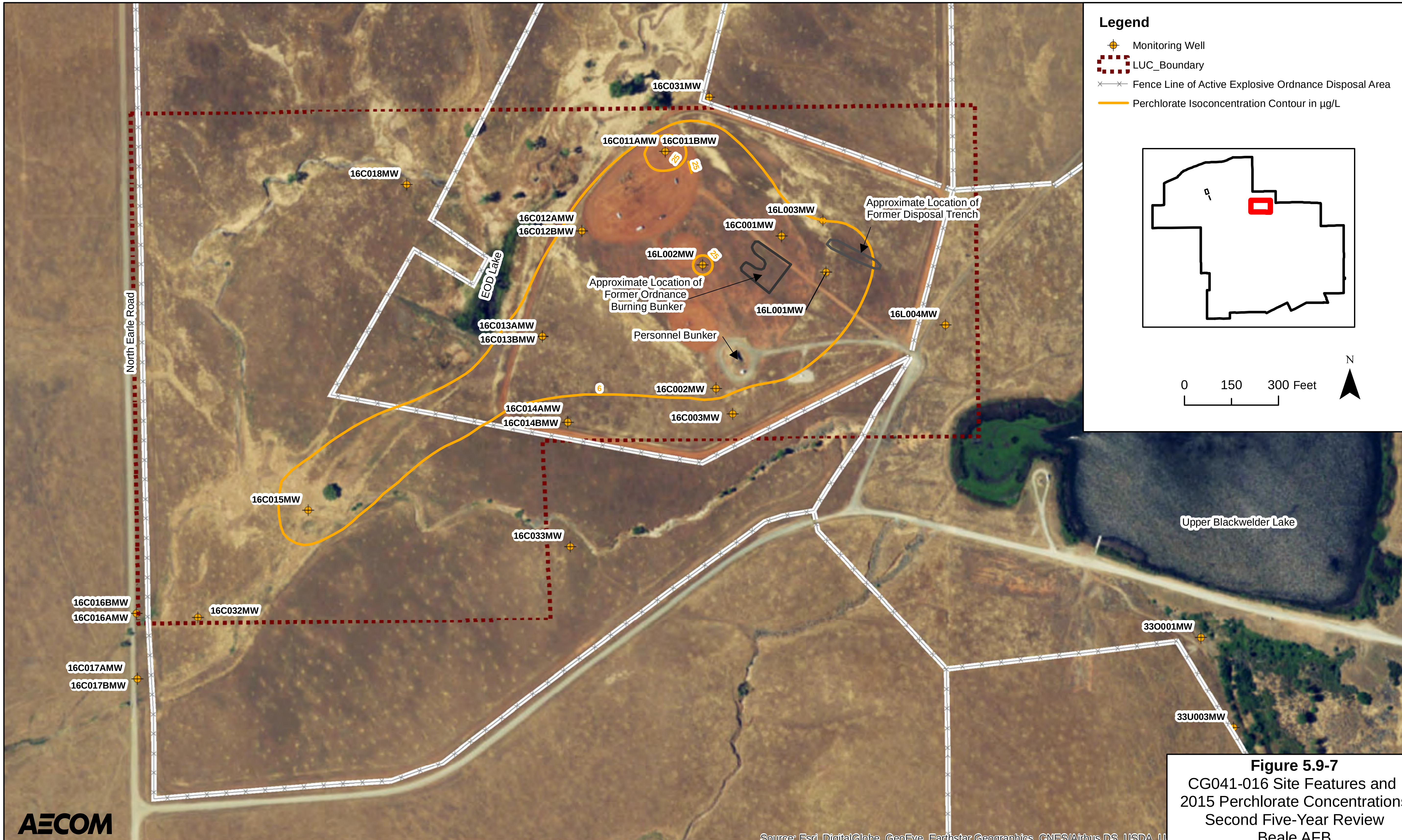

Figure 5.9-7
CG041-016 Site Features and
2015 Perchlorate Concentrations
Second Five-Year Review
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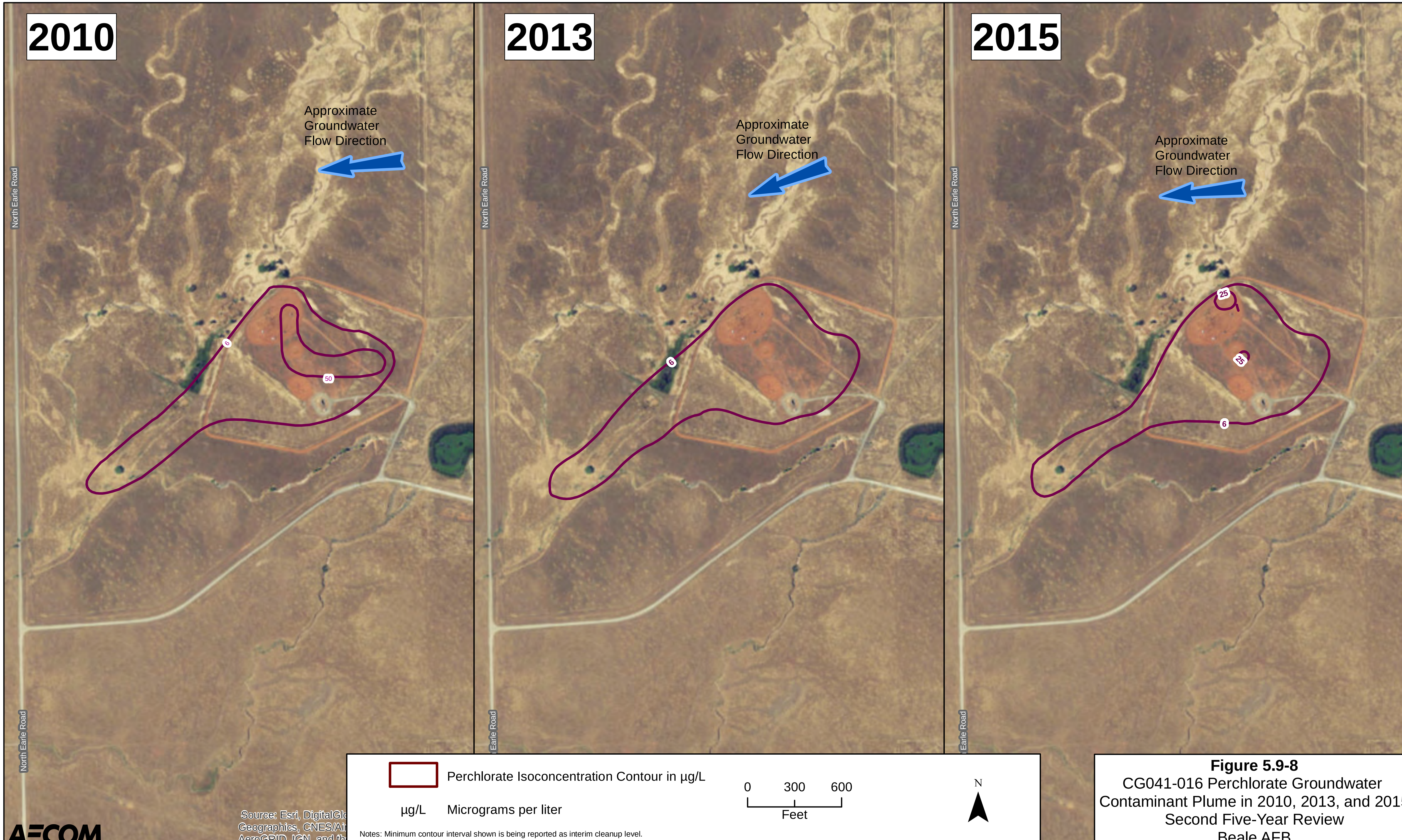

Perchlorate Isoconcentration Contour in µg/L

µg/L Micrograms per liter

0 300 600
Feet

N

Notes: Minimum contour interval shown is being reported as interim cleanup level.
Plumes and average flow directions are based on data from Basewide Groundwater Monitoring Program Annual Report for years 2010, 2013 and 2015 by CH2M HILL.

Figure 5.9-8
CG041-016 Perchlorate Groundwater Contaminant Plume in 2010, 2013, and 2015
Second Five-Year Review
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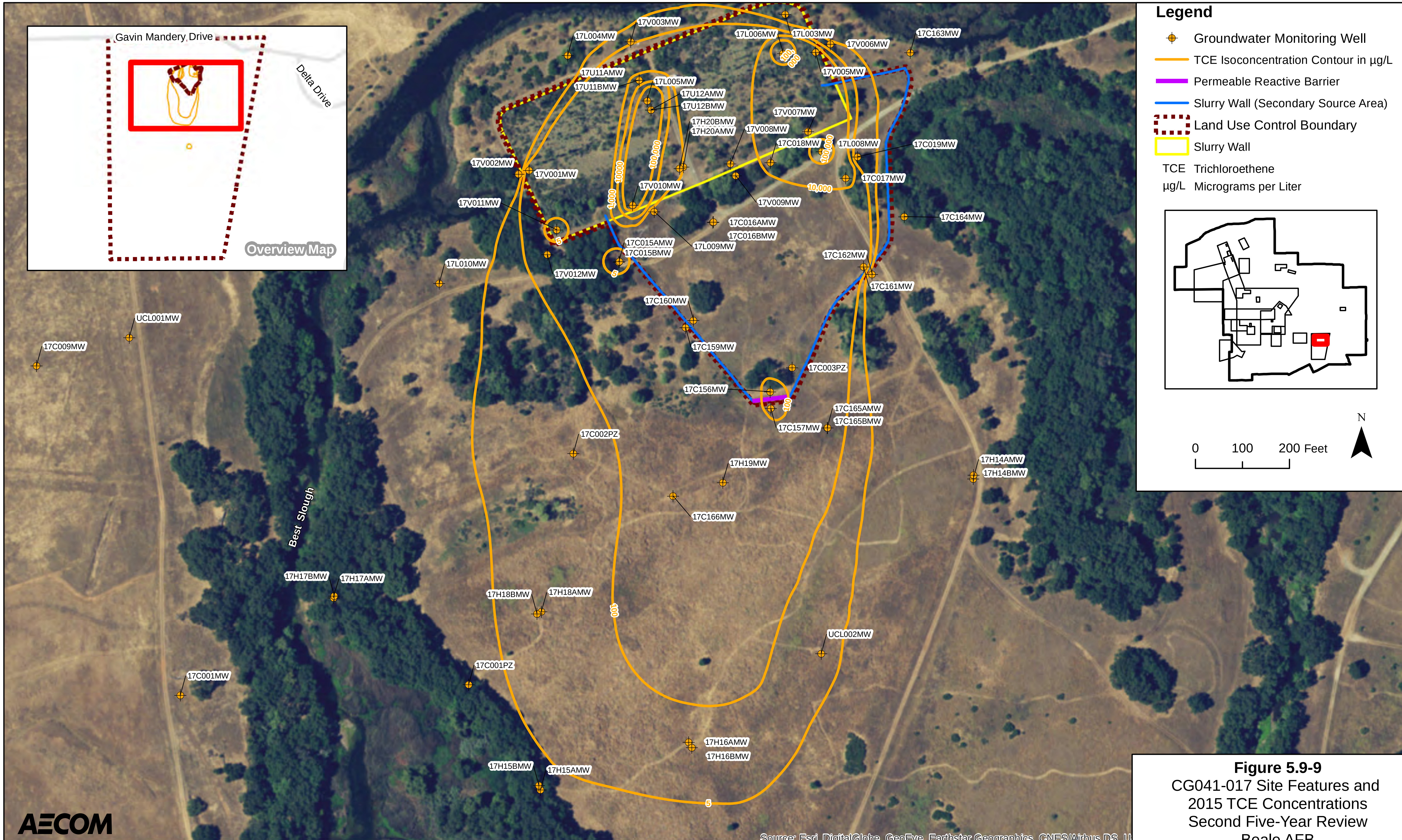

Figure 5.9-9
CG041-017 Site Features and
2015 TCE Concentrations
Second Five-Year Review
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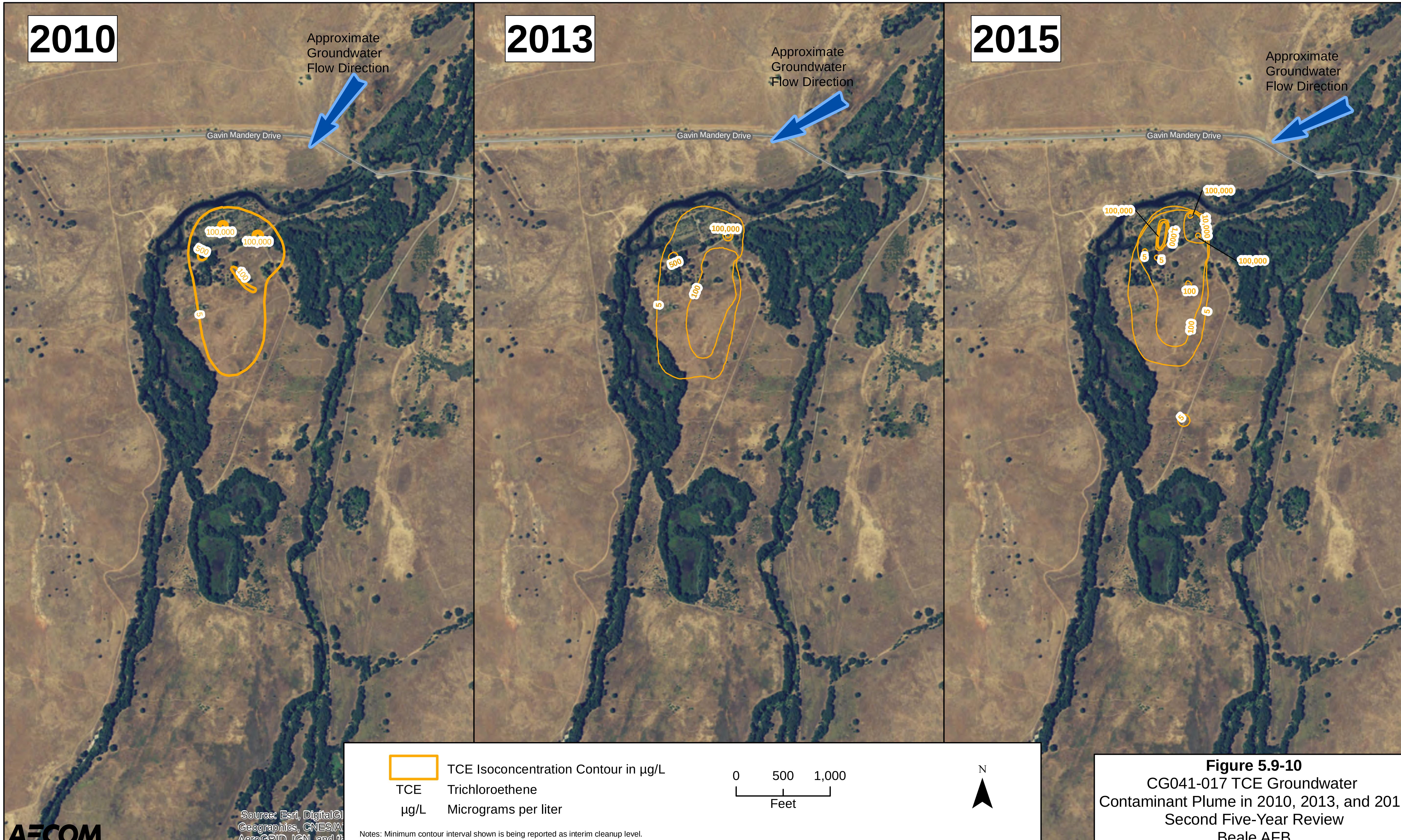

Notes: Minimum contour interval shown is being reported as interim cleanup level.
Plumes and average flow directions are based on data from Basewide Groundwater Monitoring Program Annual Report for years 2010, 2013 and 2015 by CH2M HILL.

Figure 5.9-10
CG041-017 TCE Groundwater Contaminant Plume in 2010, 2013, and 2015
Second Five-Year Review
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Figure 5.9-11
CG041-018 Site Features and
2015 TCE/TPH-D Concentrations
Second Five-Year Review
Beale AFB

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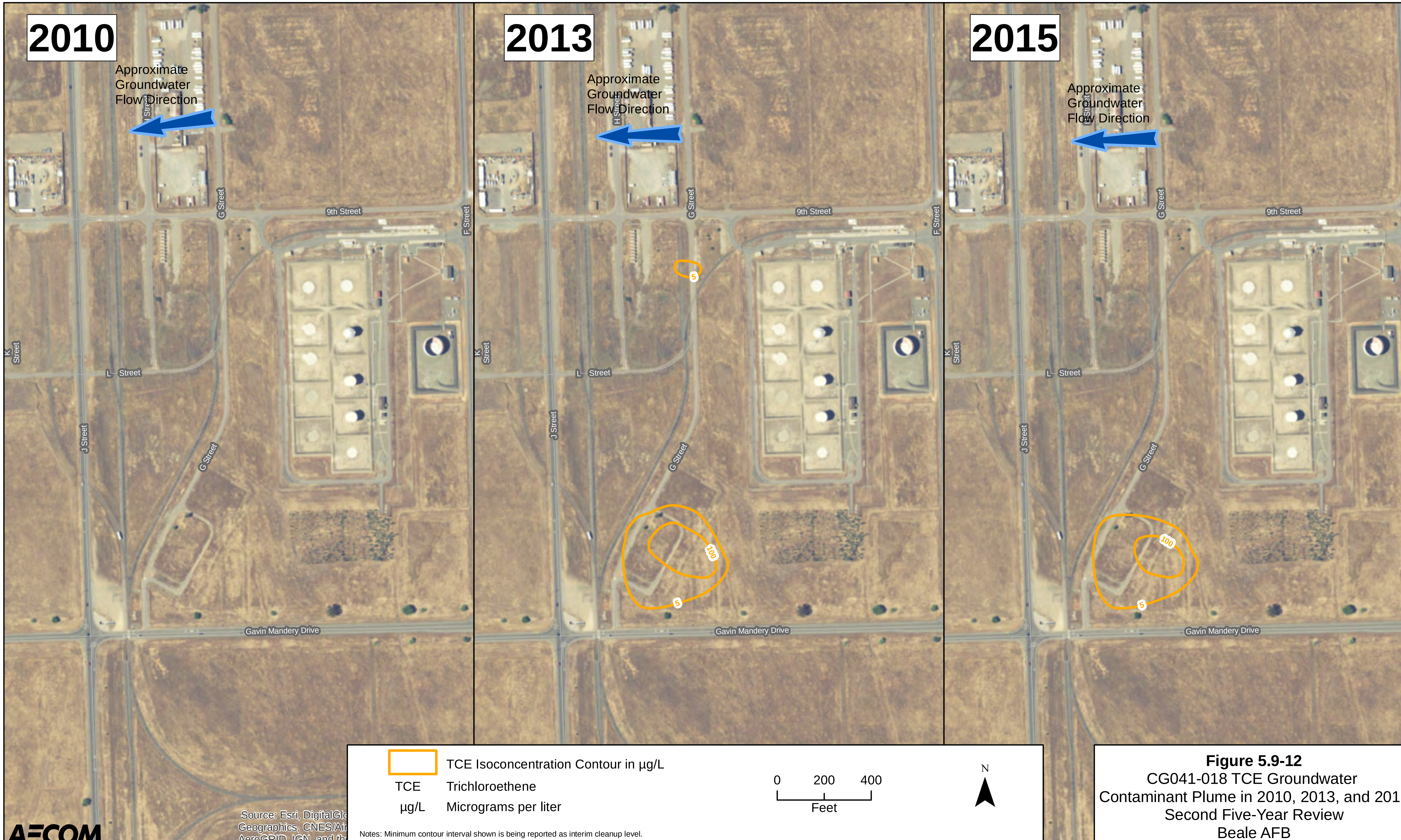

TCE Isoconcentration Contour in µg/L
TCE Trichloroethene
µg/L Micrograms per liter

0 200 400
Feet

N

Notes: Minimum contour interval shown is being reported as interim cleanup level.
Plumes and average flow directions are based on data from Basewide Groundwater Monitoring Program Annual Report for years 2010, 2013 and 2015 by CH2M Hill.

Figure 5.9-12
CG041-018 TCE Groundwater Contaminant Plume in 2010, 2013, and 2015
Second Five-Year Review
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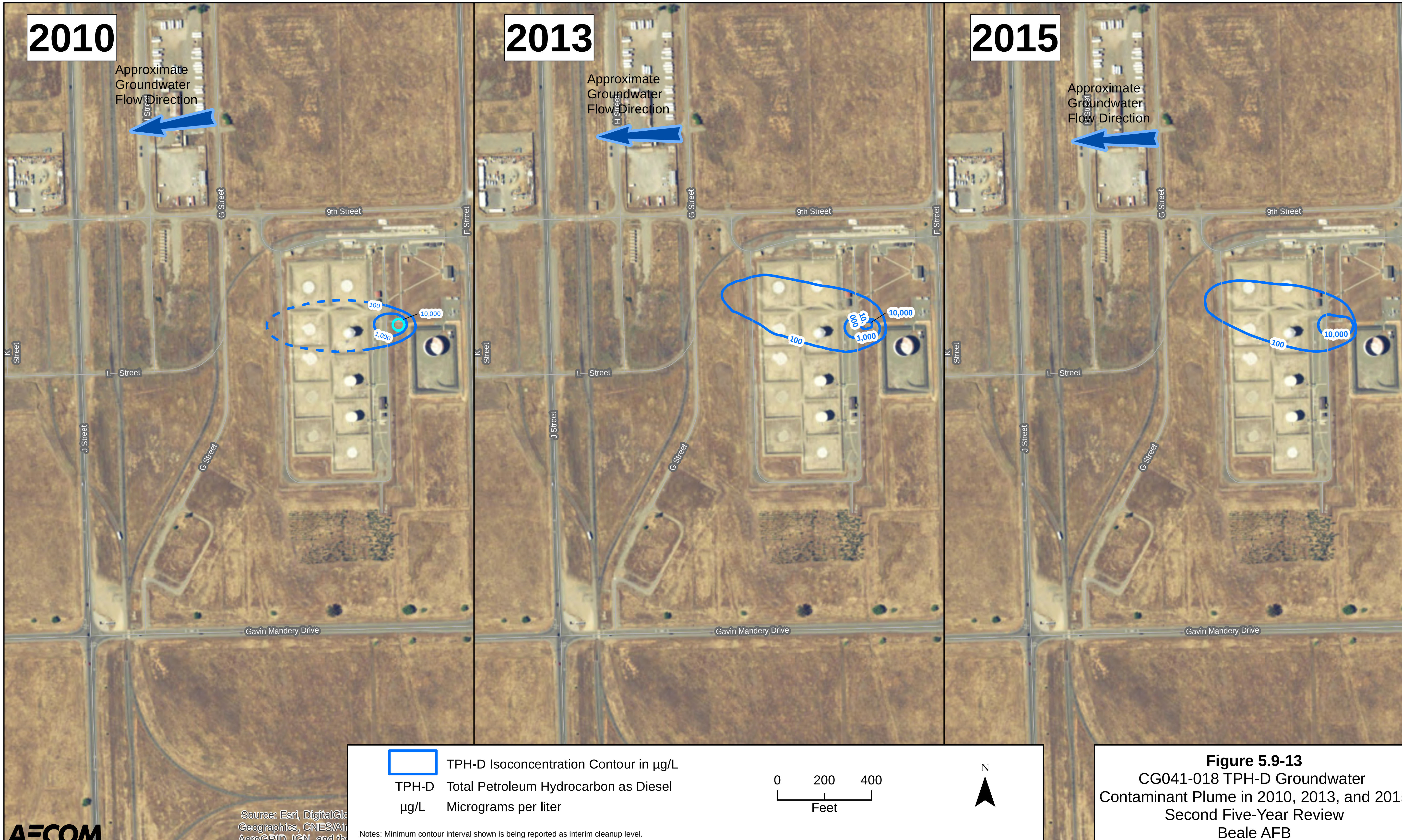

TPH-D Isoconcentration Contour in µg/L
TPH-D Total Petroleum Hydrocarbon as Diesel
µg/L Micrograms per liter

0 200 400
Feet

N

Notes: Minimum contour interval shown is being reported as interim cleanup level.
Plumes and average flow directions are based on data from Basewide Groundwater Monitoring Program Annual Report for years 2010, 2013 and 2015 by CH2M Hill.

Figure 5.9-13
CG041-018 TPH-D Groundwater
Contaminant Plume in 2010, 2013, and 2015
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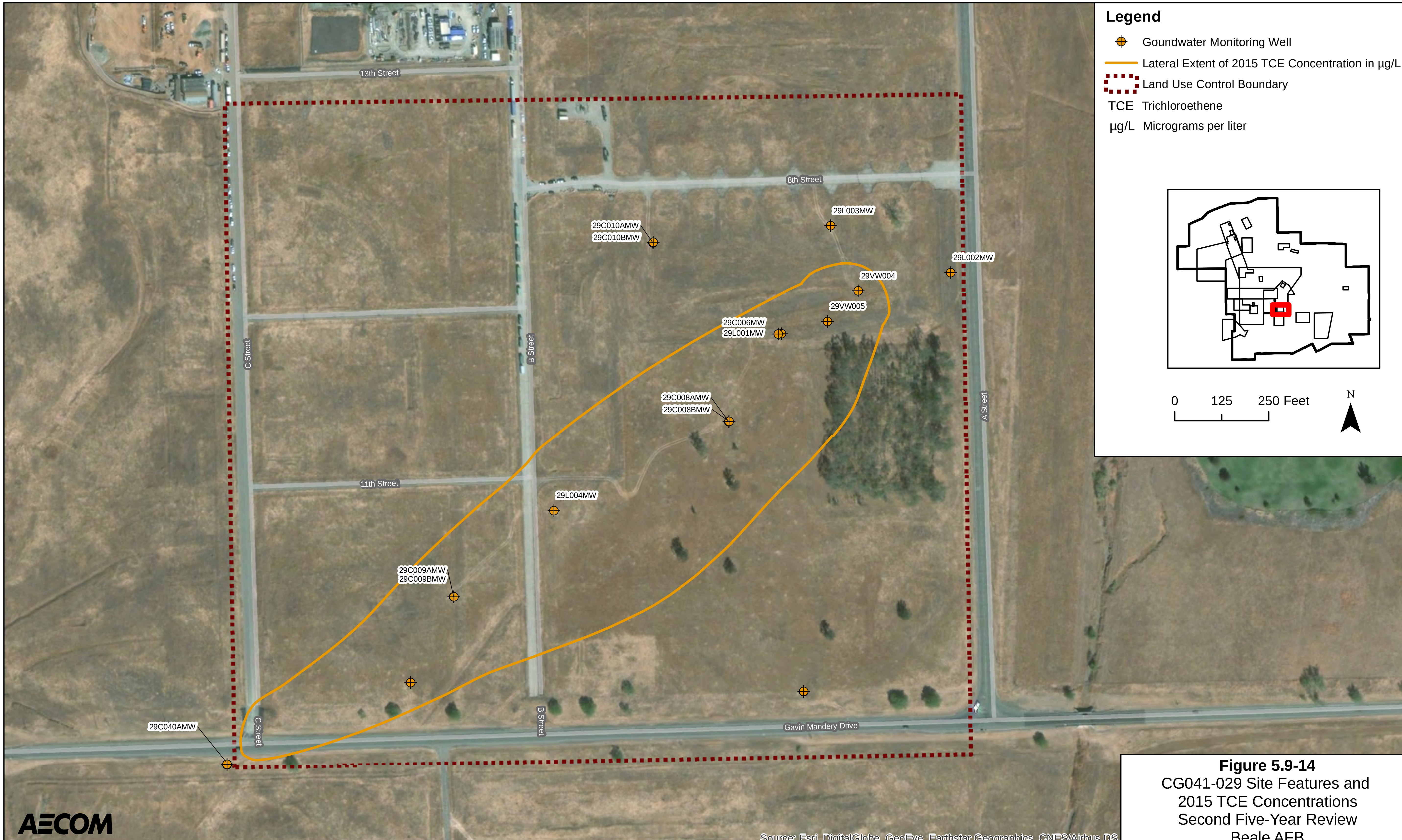

Figure 5.9-14
CG041-029 Site Features and
2015 TCE Concentrations
Second Five-Year Review
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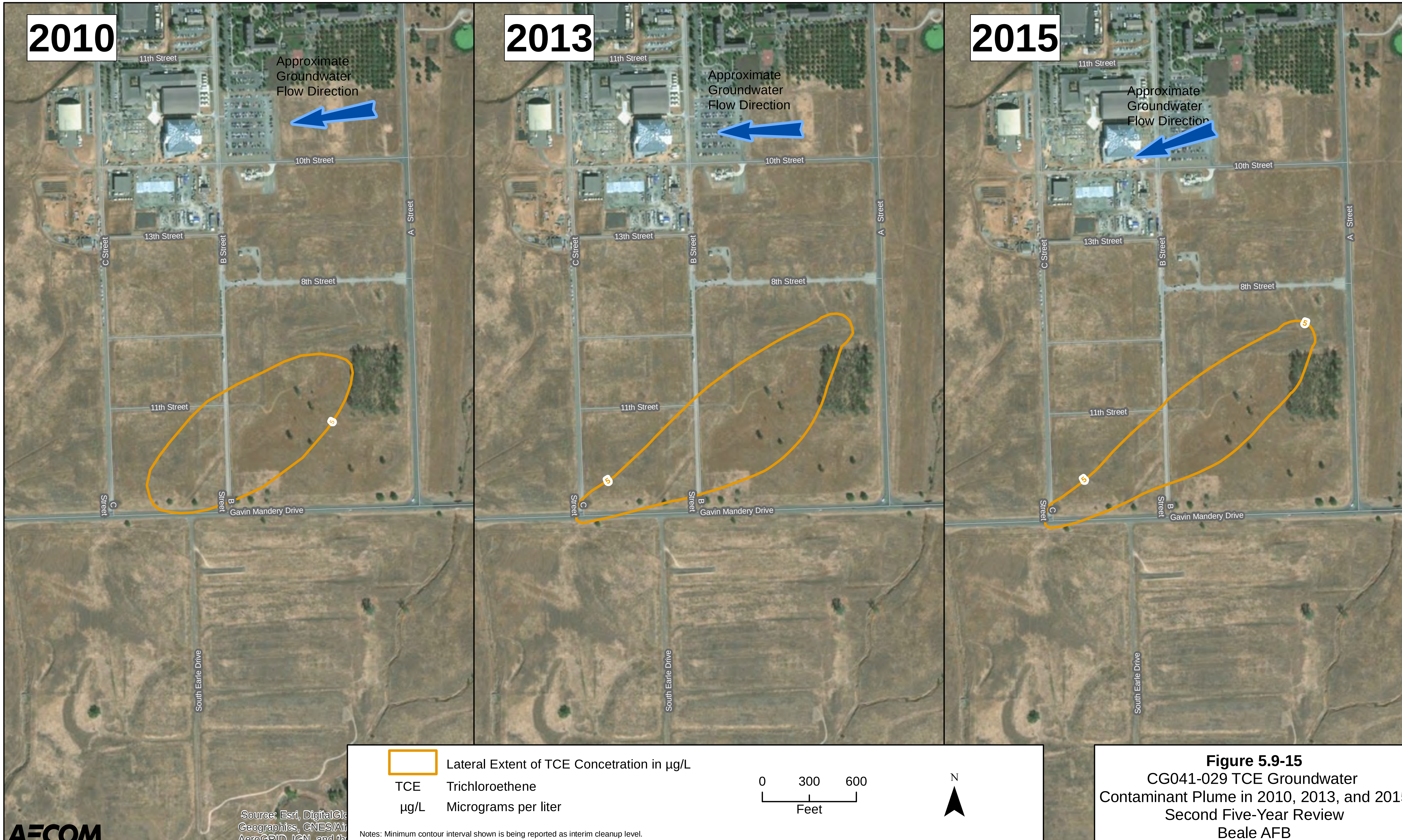

Lateral Extent of TCE Concetration in µg/L

TCE Trichloroethene

µg/L Micrograms per liter

0 300 600
Feet

N

Notes: Minimum contour interval shown is being reported as interim cleanup level.
Plumes and average flow directions are based on data from Basewide Groundwater Monitoring Program Annual Report for years 2010, 2013 and 2015 by CH2M Hill.

Figure 5.9-15
CG041-029 TCE Groundwater Contaminant Plume in 2010, 2013, and 2015
Second Five-Year Review
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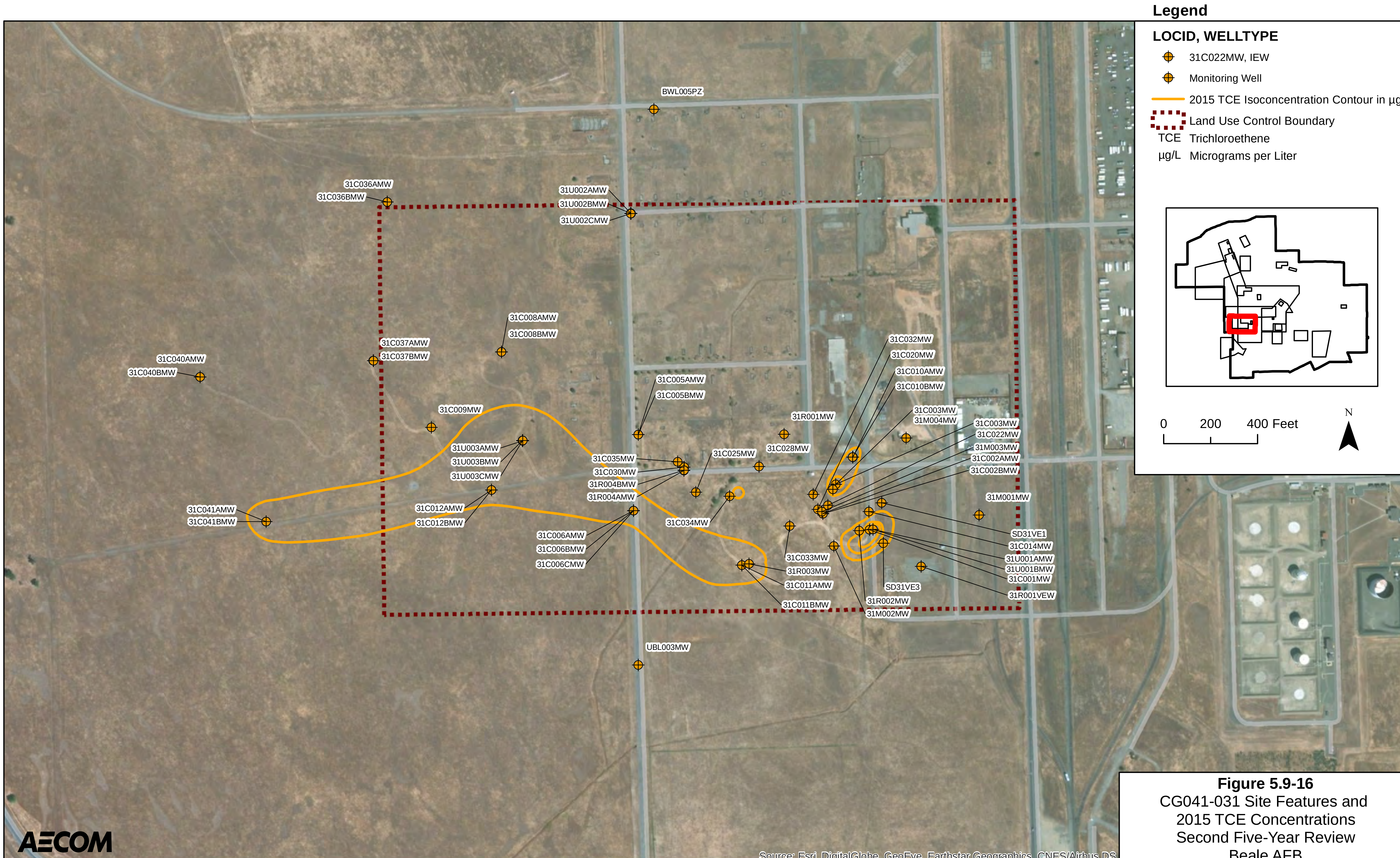

Figure 5.9-16
CG041-031 Site Features and
2015 TCE Concentrations
Second Five-Year Review
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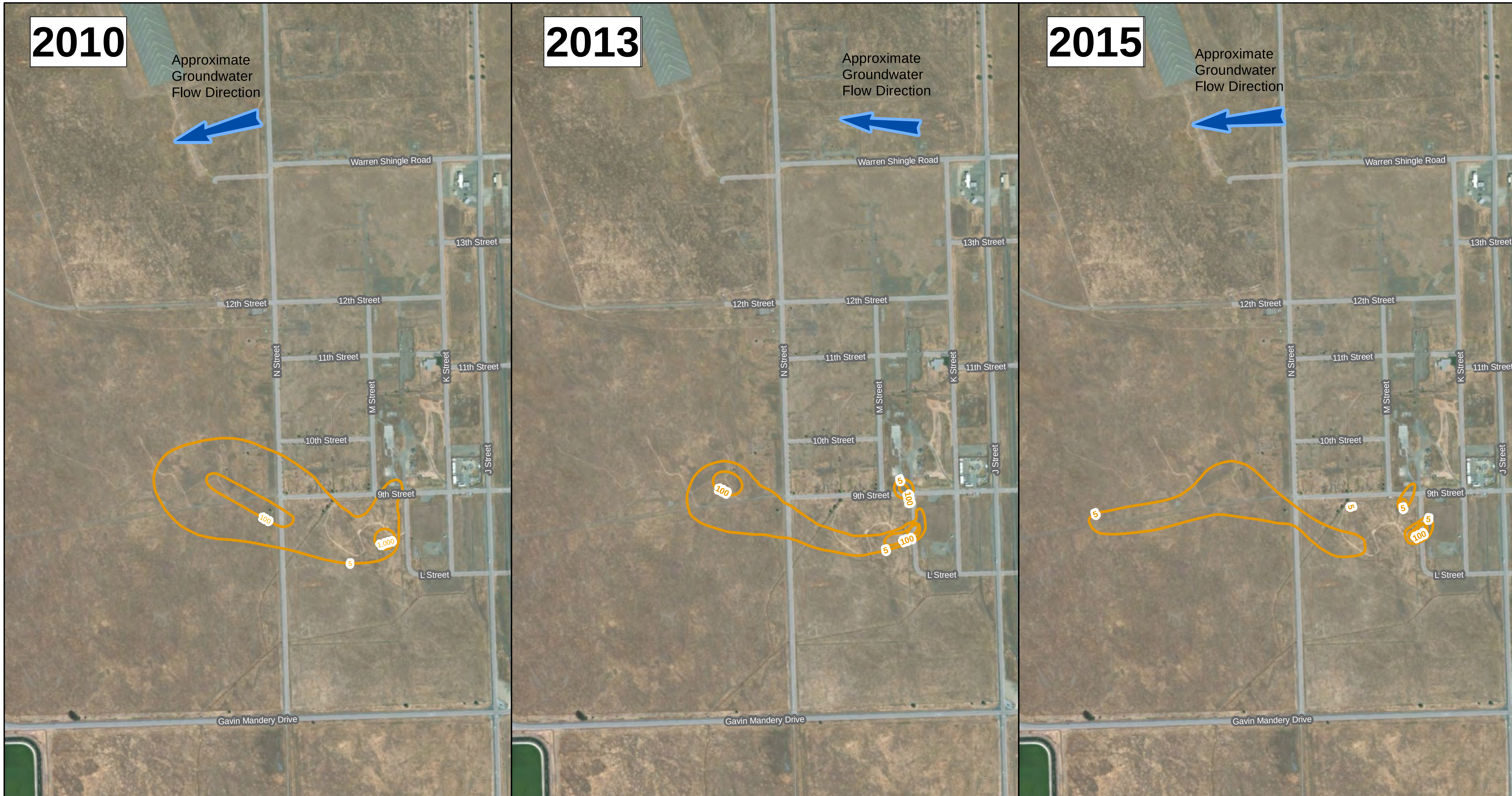

	TCE Isoconcentration Contour in µg/L
TCE	Trichloroethene
µg/L	Micrograms per liter

0 400 800
Feet

N

Notes: Minimum contour interval shown is being reported as interim cleanup level.
Plumes and average flow directions are based on data from Basewide Groundwater Management Plan for years 2010, 2013 and 2015 by CH2M Hill

Figure 5.9-17
CG041-031 TCE Groundwater Contaminant Plume in 2010, 2013, and 2015
Second Five-Year Review
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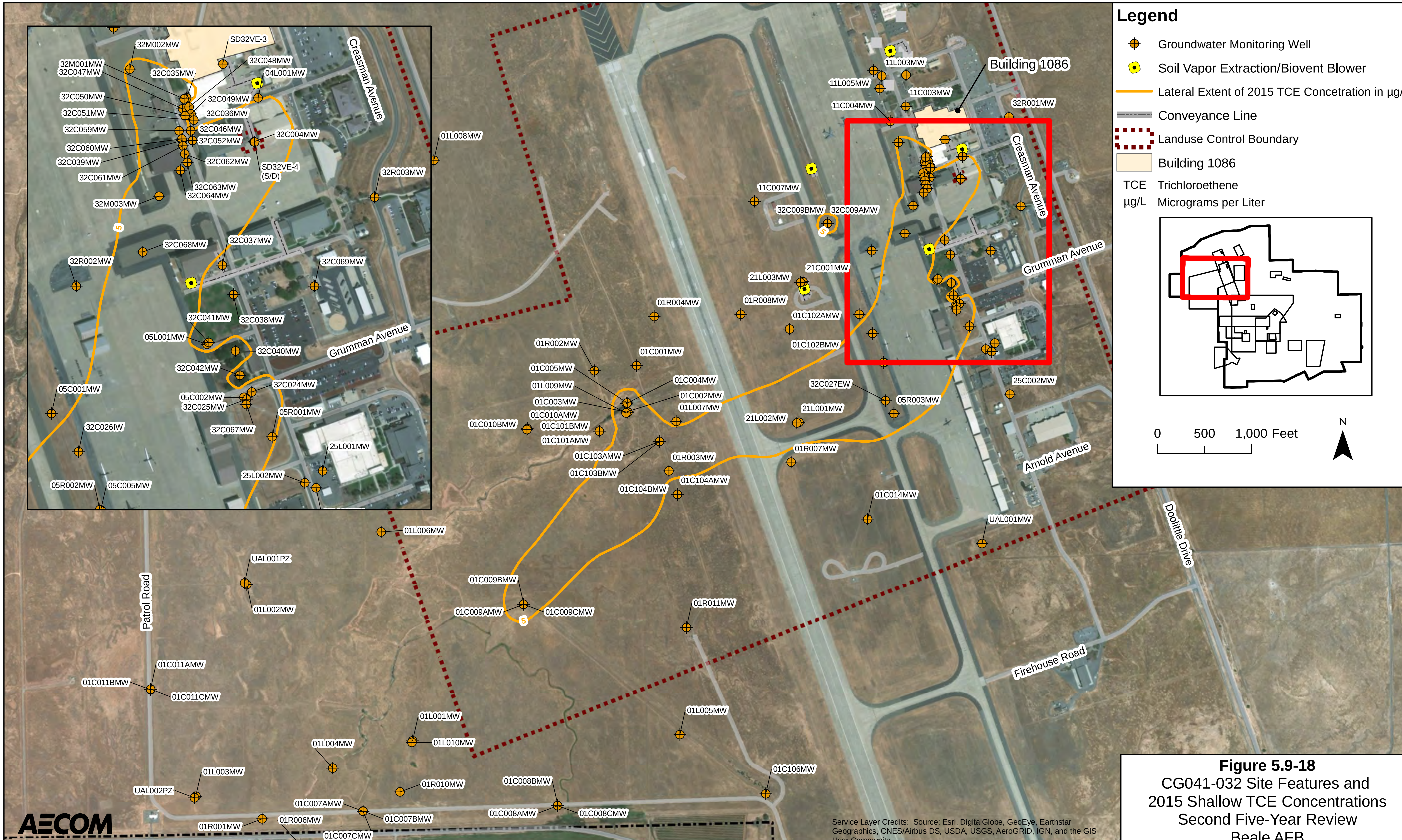

Figure 5.9-18
CG041-032 Site Features and
2015 Shallow TCE Concentrations
Second Five-Year Review
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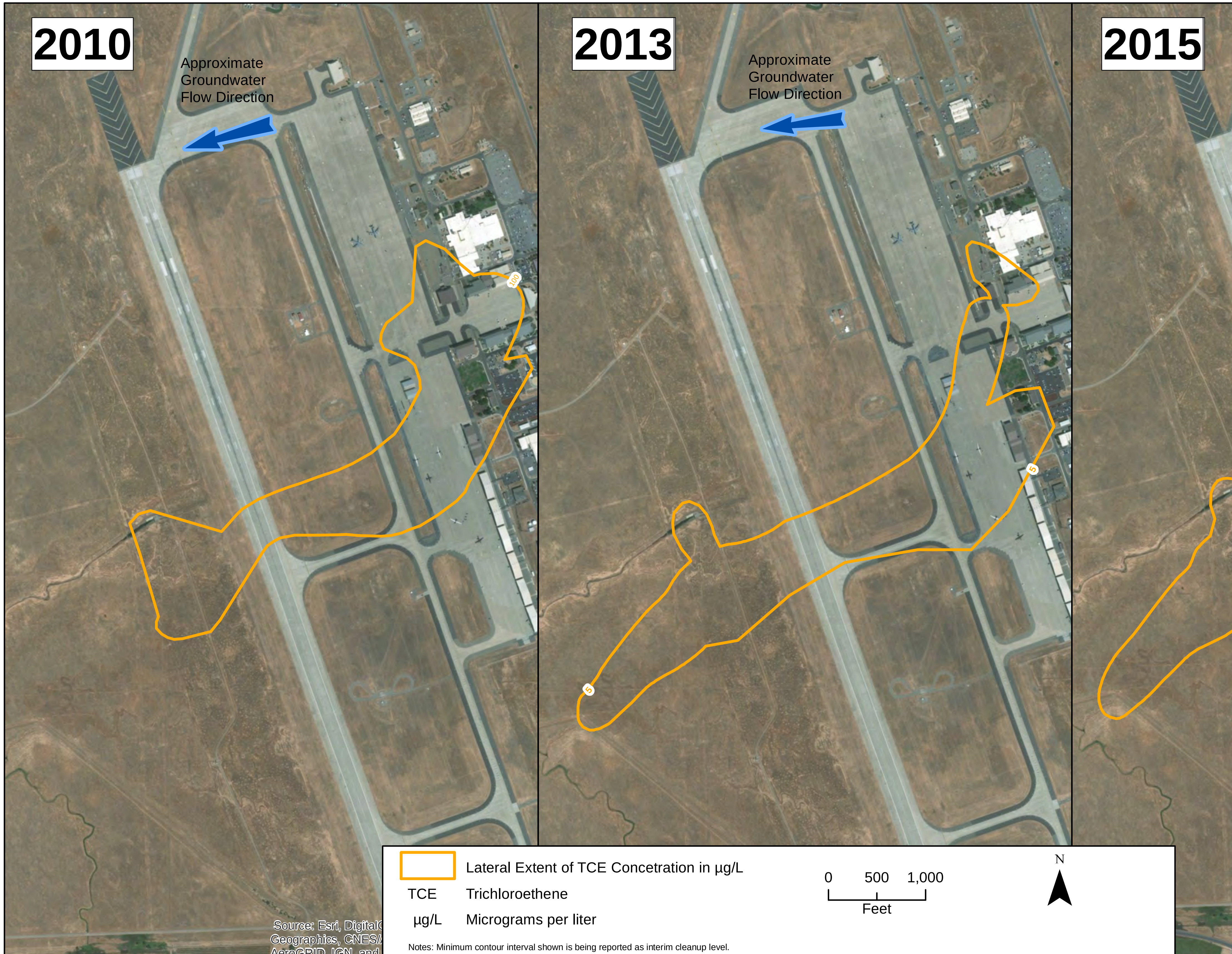

Figure 5.9-19
CG041-032 Shallow TCE
Contaminant Plume in 2010, 2013, and 2015
Second Five-Year Review
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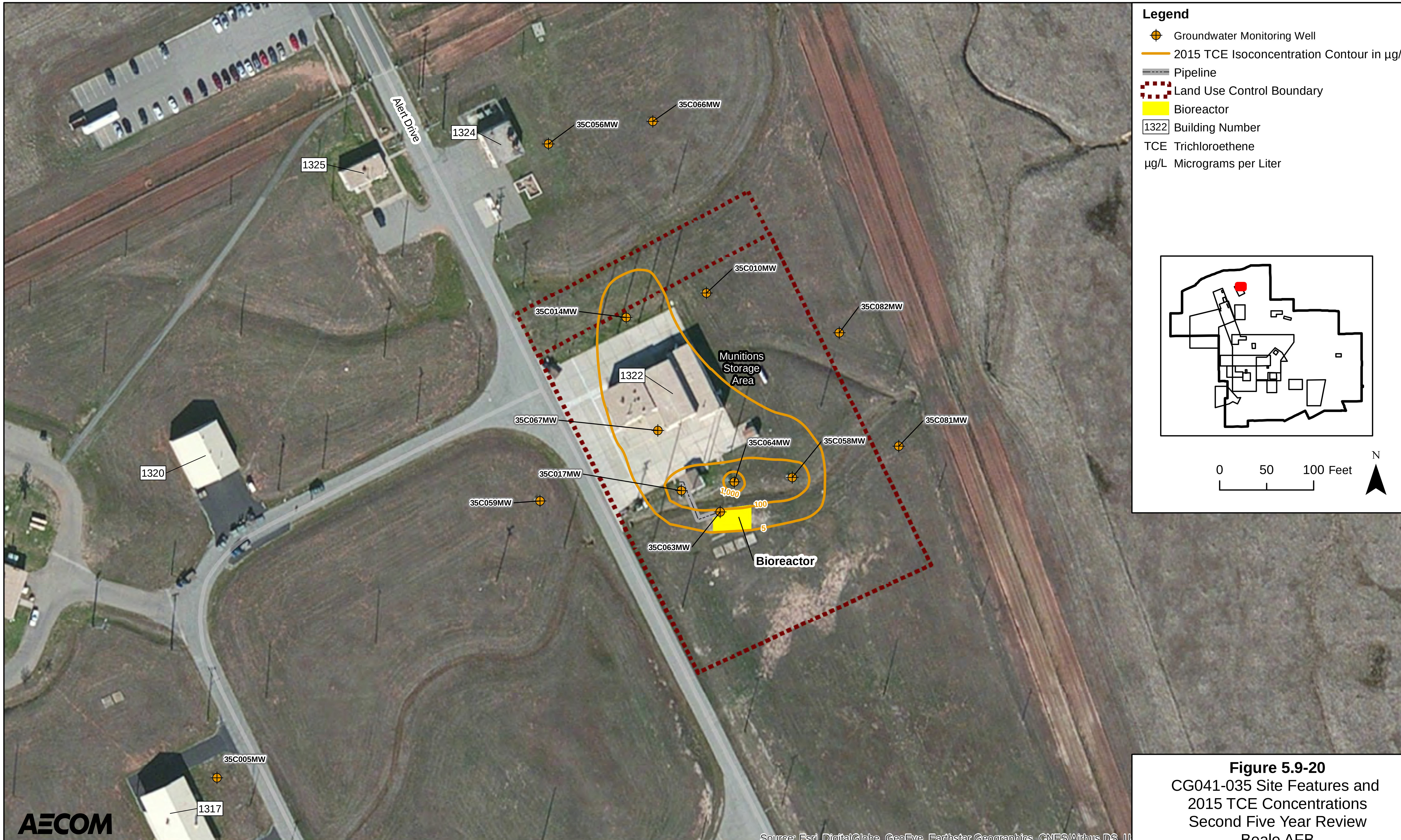

Figure 5.9-20
CG041-035 Site Features and
2015 TCE Concentrations
Second Five Year Review
Beale AFB

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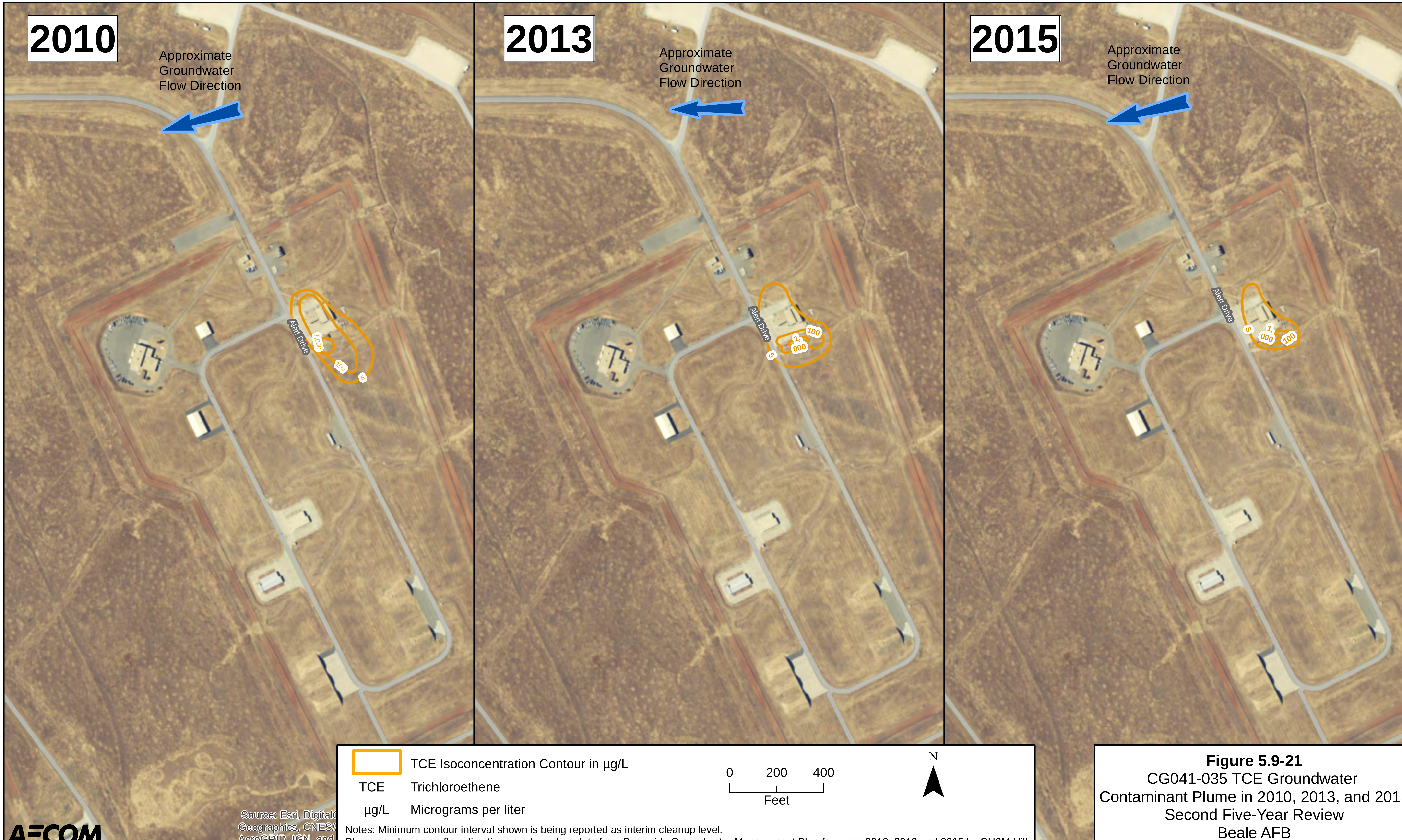

Figure 5.9-21
CG041-035 TCE Groundwater Contaminant Plume in 2010, 2013, and 2015
Second Five-Year Review
Beale AFB

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Figure 5.9-22
CG041-039 Site Features and 2015 TCE Concentrations
Second Five-Year Review
Beale AFB

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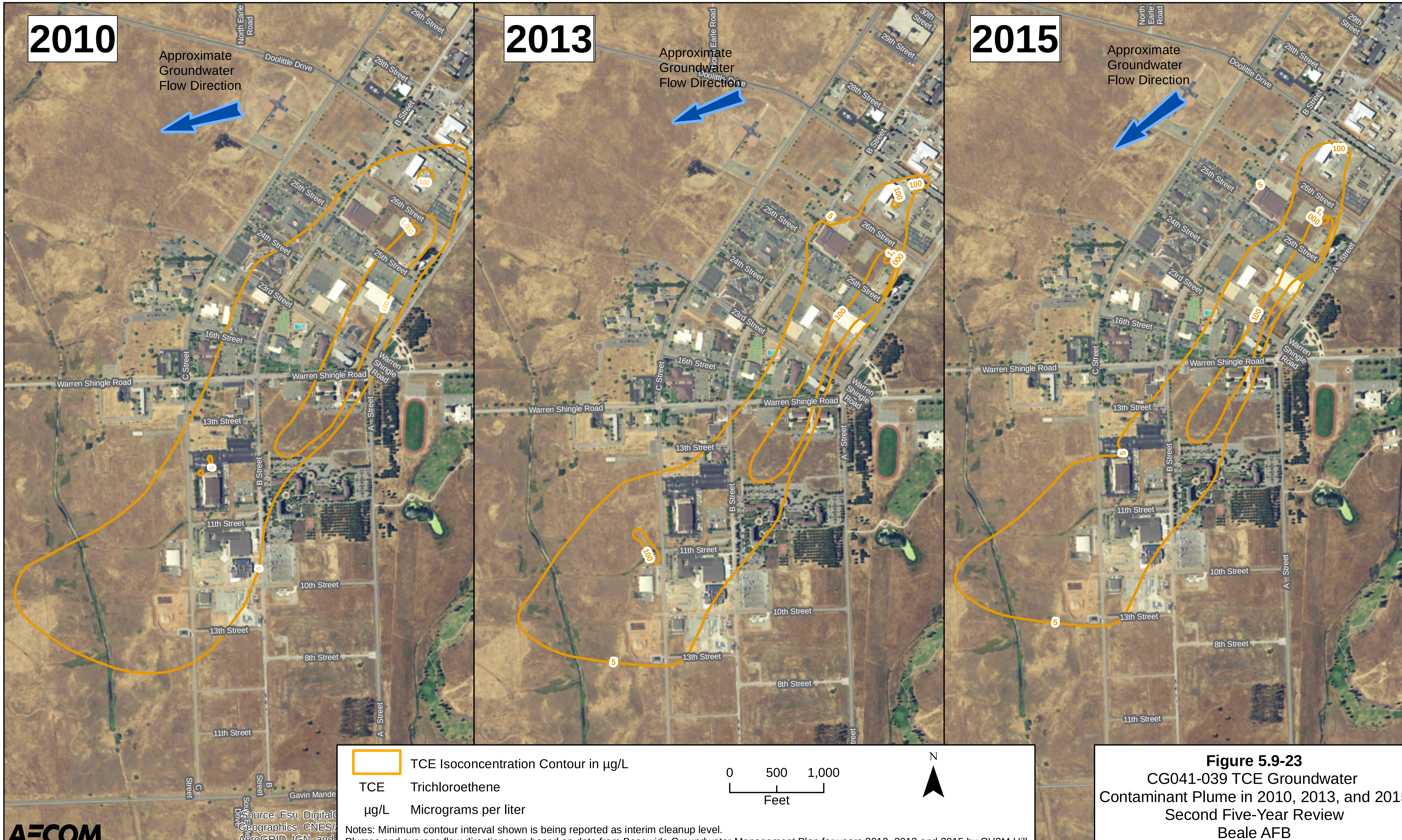

Figure 5.9-23
CG041-039 TCE Groundwater Contaminant Plume in 2010, 2013, and 2015
Second Five-Year Review
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Figure 5.9-24
CG041-040 Site Features and
2015 TCE Concentrations
Second Five-Year Review
Beale AFB

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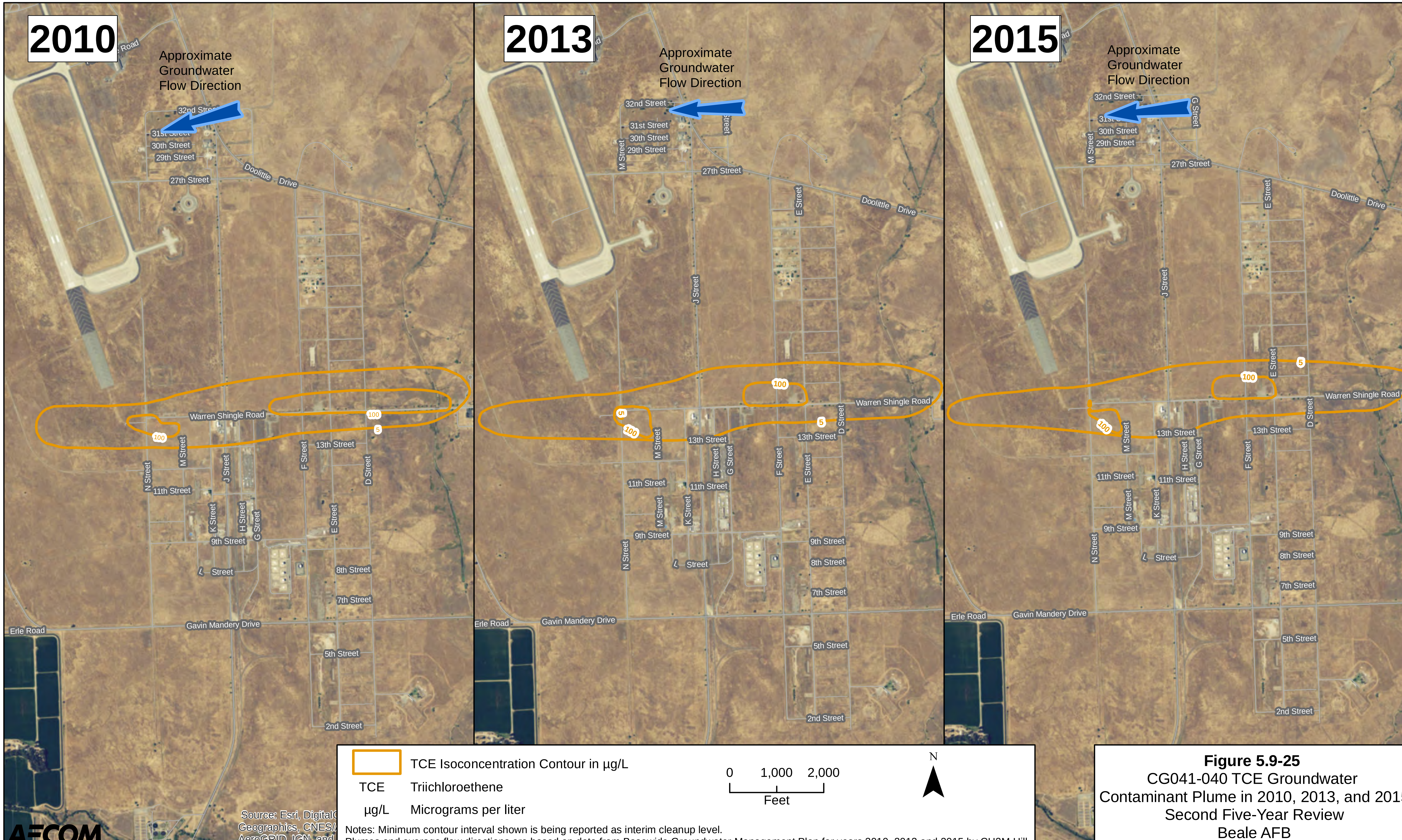

TCE Isoconcentration Contour in µg/L

TCE Triichloroethene

µg/L Micrograms per liter

0 1,000 2,000 Feet

N

Notes: Minimum contour interval shown is being reported as interim cleanup level.
Plumes and average flow directions are based on data from Basewide Groundwater Management Plan for years 2010, 2013 and 2015 by CH2M Hill

Figure 5.9-25
CG041-040 TCE Groundwater Contaminant Plume in 2010, 2013, and 2015
Second Five-Year Review
Beale AFB

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Figure 5.9-26
CG041-508 Site Features and
2015 PCE Concentrations
Second Five-Year Review
Beale AFB

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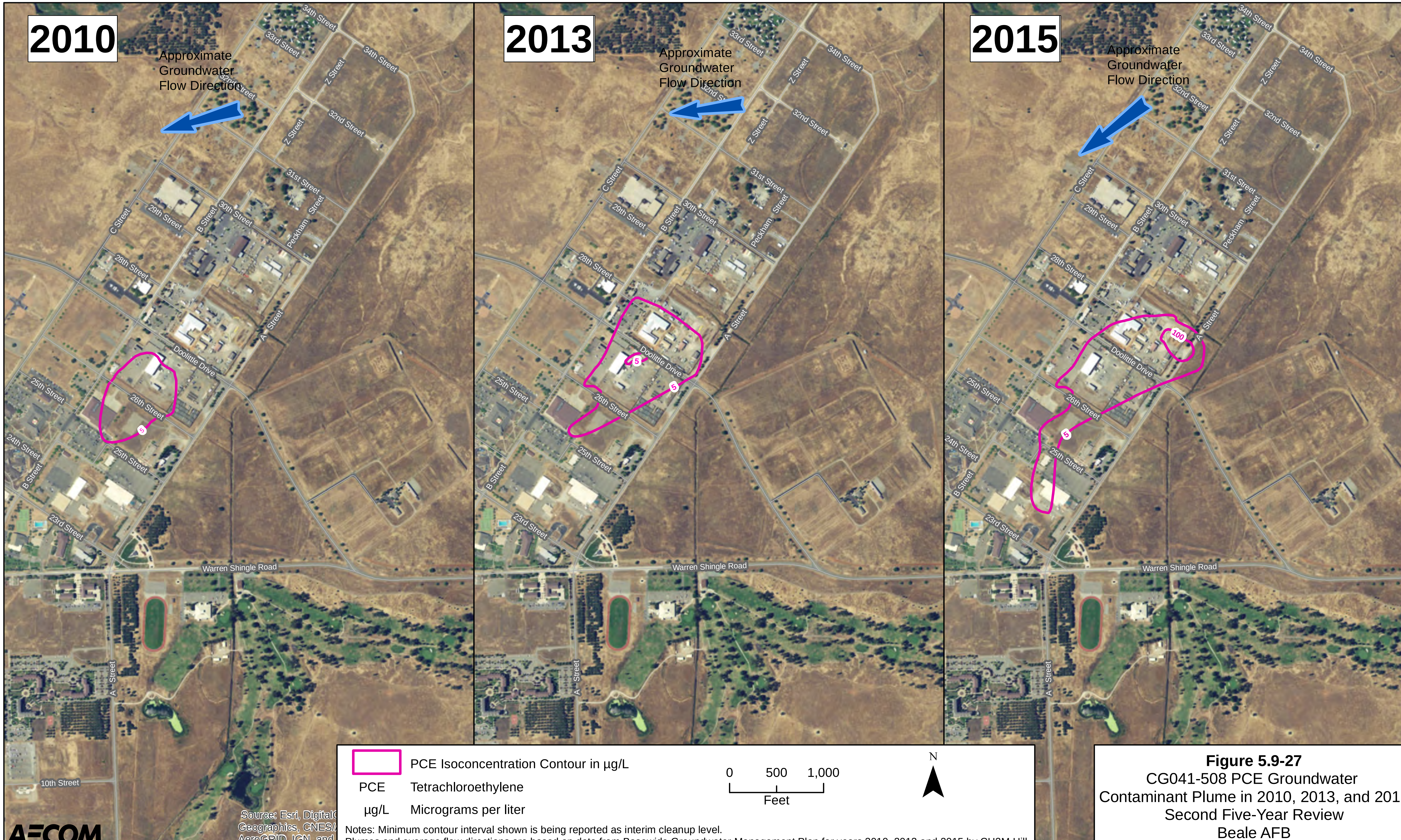

PCE Isoconcentration Contour in µg/L

PCE Tetrachloroethylene

µg/L Micrograms per liter

0 500 1,000 Feet

N

Notes: Minimum contour interval shown is being reported as interim cleanup level.
Plumes and average flow directions are based on data from Basewide Groundwater Management Plan for years 2010, 2013 and 2015 by CH2M Hill

Figure 5.9-27
CG041-508 PCE Groundwater Contaminant Plume in 2010, 2013, and 2015
Second Five-Year Review
Beale AFB

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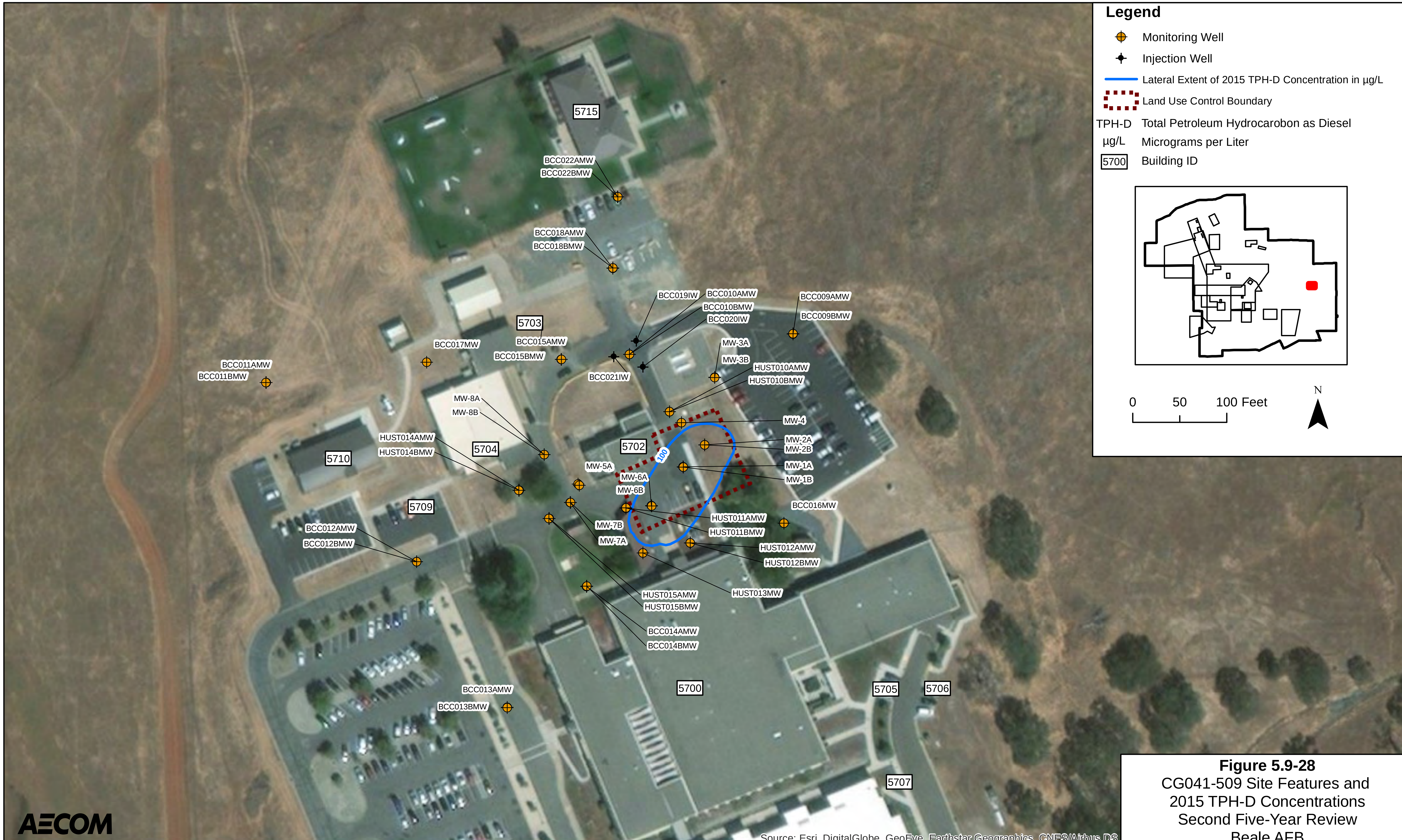

Figure 5.9-28
CG041-509 Site Features and
2015 TPH-D Concentrations
Second Five-Year Review
Beale AFB

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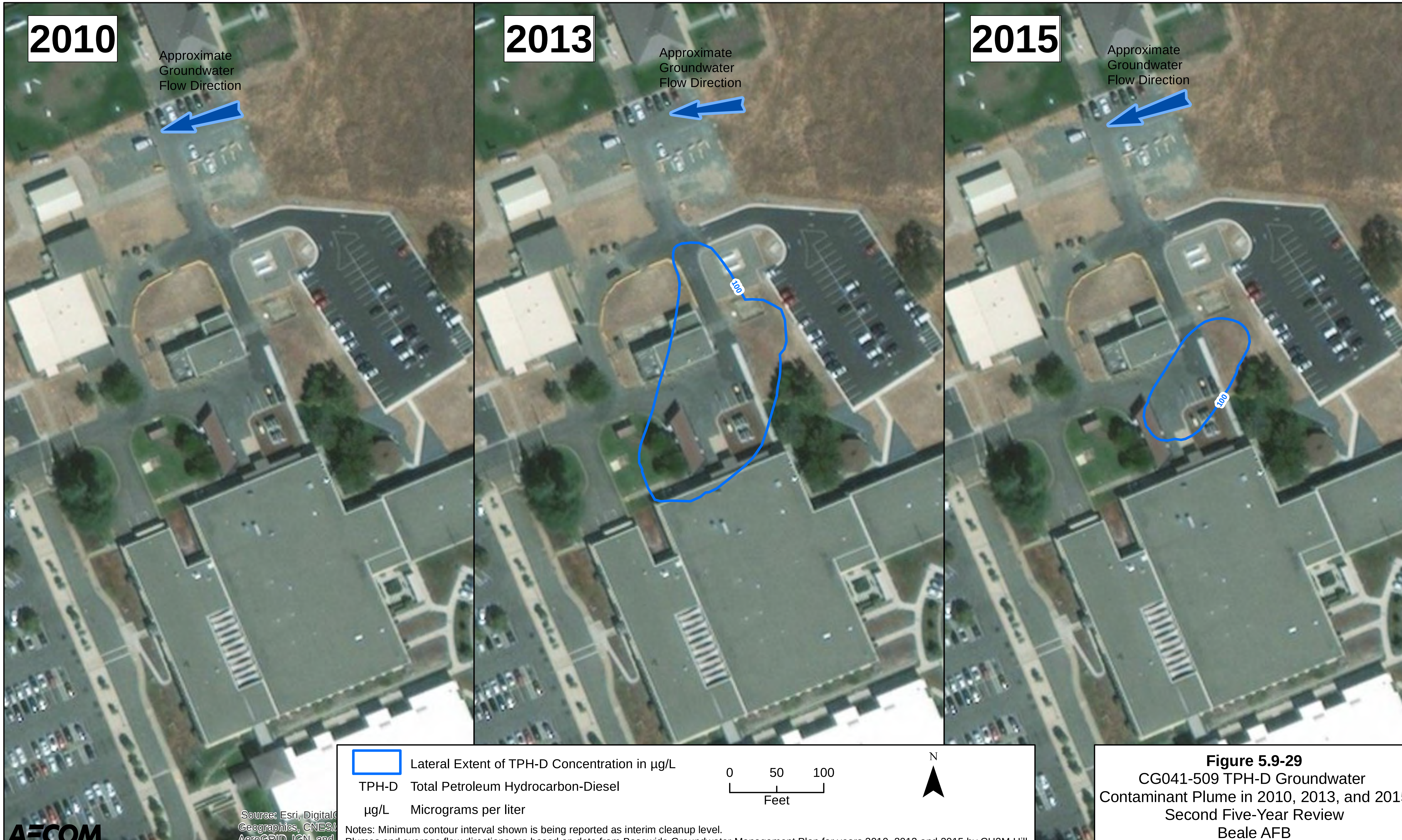

Figure 5.9-29
CG041-509 TPH-D Groundwater Contaminant Plume in 2010, 2013, and 2015
Second Five-Year Review
Beale AFB

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Figure 5.9-30
CG041-517 Site Features and 2015 PCE Concentrations
Second Five-Year Review
Beale AFB

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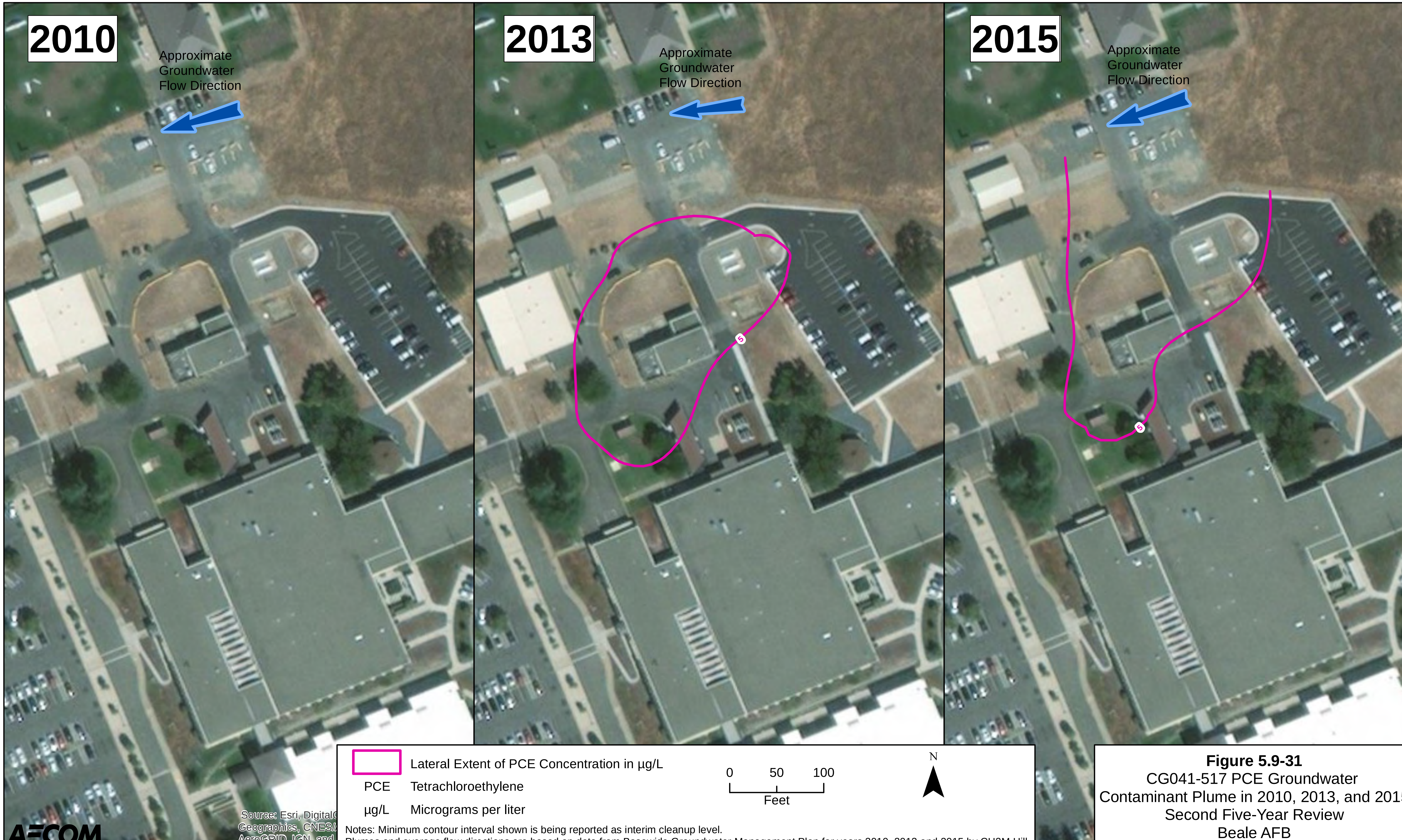

Figure 5.9-31
CG041-517 PCE Groundwater Contaminant Plume in 2010, 2013, and 2015
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Beale AFB

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6. RCRA

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6.1 Site LF002

6.1.1 Introduction

Site LF002 is located in the south-central part of the Base and occupies approximately 88 acres. It is bounded by Gavin Mandery Drive on the north, Hutchinson Creek on the west, and an unnamed tributary to Hutchinson Creek on the south and east (Figure 6.1-1).

Prior to 1952, the Site LF002 area was occupied by buildings that are believed to have been associated with cattle grazing operations. From 1952 through 1980, the site served as the landfill for Beale AFB. Initial disposal operations consisted of sidecast dumping and burning of refuse. Prior to 1964, refuse was deposited in a series of unlined, east-west trending trenches, which were 15 to 20 feet deep (Law 1994). From 1967 to 1978, approximately 380 cubic yards of sludge from the Photo Wastewater Treatment Plant were disposed in this landfill (Law 1994). An undetermined quantity of chemicals and petroleum products was part of the waste stream. Whether ordnance was disposed at this site is unknown. Site LF002 has been inactive since the opening of Site LF003 in 1980, except for limited construction debris disposal until 1993 (CVWB 2006).

6.1.2 Response Action Summary

Final cap construction for Site LF002 was completed in 1998 (CH2M HILL 2013h). A prescriptive cover system consisting of a 1-foot-thick compacted clay barrier (low-hydraulic conductivity layer) and an 18-inch-thick erosion-resistant layer were used to construct the cap. The clay barrier was compacted to achieve a permeability of 1×10^{-6} centimeters per second or less. The foundation layer of the cap consisted partially of soil previously contaminated with petroleum hydrocarbons that was treated using natural biodegradation (Metcalf and Eddy 1994).

The *Final Closure and Post-Closure Maintenance Plan* [PCMP] *Landfill No. 2 Revised Amendment* (Haling and Associates 2007) was prepared for Site LF002 in October 2007. The plan specifies that the following be monitored for Site LF002:

- Six groundwater monitoring wells (upgradient wells MWP-1 and 06C001MW, and point of compliance wells 06A001MW, 06A002MW, 06L003MW, and 06L004MW);
- Seven landfill gas monitoring probes (GMP-1 through GMP-7), installed in 1998;
- 20 passive landfill vents (V-1 through V-6, installed as Phase I of the methane gas extraction system, and V-7 through V-20, installed during the third quarter of 2002 as Phase II of the methane gas extraction system); and
- Surface water monitoring on Hutchinson Creek and an unnamed tributary to Hutchinson Creek.

To address screen submergence caused by rising water levels in MWP-1, 06A001MW, and 06L003MW, three new wells (MWP-1A, 06A001MW-A, and 06L003MW-A) were installed in July 2008. In June 2010, the other three of the original six monitoring wells (06A002MW, 06C001MW, and 06L004MW) were replaced by 06A002MW-A, 06C001MW-A, and 06L004MW-A for the same reason.

Landfill gas monitoring for methane gas was begun in 1998 on a quarterly basis. Monitoring was revised to semi-annual in 2013, in accordance with the PCMP (CH2M HILL 2013h). Perimeter probes at GMP-1 were removed from the monitoring program in 2000, because methane concentrations exceeded the limit of 5 percent per volume (the lower explosive limit for methane). The landfill boundary was extended north, and new perimeter probes were installed at GMP-8 and GMP-9. Perimeter probes at GMP-2 were removed from the monitoring program in 2013, under the PCMP (CH2M HILL 2013h).

Annual surface water monitoring is conducted at an unnamed tributary to Hutchinson Creek at locations 06L001SW and 06L002SW, and on Hutchinson Creek at locations 06L003SW, 06L004SW, and 06L005SW, in accordance with the PCMP (CH2M HILL 2013h). Monitoring points 06L001SWand 06L005SW are upstream from Site LF002, and the other points are crossgradient or downstream from the landfill.

In accordance with the PCMP (CH2M HILL 2013h), the monitoring and reporting requirements for Site LF002 are as follows:

- Groundwater elevations are measured semi-annually, generally in February and August.
- Groundwater sampling is performed semi-annually for the following parameters: (1) field parameters; (2) general chemistry (i.e., total dissolved solids, total alkalinity, and total hardness); and (3) VOCs. Groundwater sampling is performed annually for: (1) major anions; (2) major cations; and (3) dissolved inorganics. Sampling typically takes place during the first and third quarters, to coincide with the typical maximum and minimum seasonal groundwater elevations.
- Groundwater COC sampling is performed every 5 years (in addition to the semi-annual sampling constituents listed above, semi-volatile organic compounds are sampled).
- Surface water sampling is performed on an annual basis for field parameters, general chemistry, major anions, major cations, VOCs, and dissolved inorganics, and is subject to the availability of water. Surface water sampling typically occurs during the first quarter.
- Landfill gas monitoring (i.e., for methane, carbon dioxide, oxygen, and barometric pressure) is performed at landfill gas probes and selected vents on a semi-annual basis.
- Maintenance inspections are performed semi-annually, typically during the first and third quarters, to coincide with landfill gas and groundwater monitoring. Inspections include a complete site walk with visual examination of final cover areas and drainage ditches. Inspections also include standard observations for erosion and subsidence, monitoring for leachate seeps, and inspection of landfill facilities. The third quarter inspection verifies that site winterization is complete.
- The landfill cover and drainage facilities also are inspected for damage after significant storm events (i.e., where precipitation of 2.5 inches or more falls within a 24-hour period).
- Landfill maintenance typically is performed during the dry season, to minimize impacts on sensitive areas (e.g., vernal pool and wetland features) in the vicinity of the landfill. Re-seeding of affected areas typically occurs in the fall, to coincide with initial rainfall events.
- The waste discharge requirements specify that an aerial survey be performed every 5 years, to update site topography.
- Monitoring reports are prepared annually.

These activities are completed to achieve the objectives as set forth in the PCMP. The PCMP objectives are as follows:

- Minimize threat to public health and the environment;
- Minimize infiltration of water into the landfill;
- Protect against stormwater run-on and runoff;
- Detect possible contamination of groundwater;
- Detect possible lateral migration of soil gas; and
- Maintain environmental control systems.

The lowest levels of the California or federal MCLs are used for comparison to analytical samples collected at Site LF002. If no primary MCL exists, then the California RSLs/CHHSLs are is used. Post-closure maintenance is expected to occur for approximately 15 more years, according to the original PCMP in 1996–1997, or until the wastes no longer pose a threat to water quality.

6.1.2.1 Systems Operations/Operation and Maintenance

LF002 O&M responsibilities consist primarily of cap inspection, maintenance, and repair. Inspections include looking for and documenting animal burrows. As noted above, inspections occur semi-annually, coincident with semi-annual monitoring activities. AOCs typically are identified during the first quarter inspection and are remedied before the third quarter inspection. Common AOCs include areas of cap erosion or depression caused by precipitation events and landfill compaction. In accordance with the PCMP, facilities also are inspected immediately after significant storm events. A summary of the inspection and maintenance activities that were conducted during this five-year review are presented next. Maintenance and inspection activities reports for 2011 were not available for review during preparation of this five-year review.

6.1.2.1.1 2012

- Maintenance inspections, performed quarterly; and
- Site winterization inspection completed in August.

6.1.2.1.2 2013

- Maintenance inspections, performed quarterly;
- Sampled for 5-year COCs, all concentrations less than MCLs; and
- Site winterization inspection completed in November.

6.1.2.1.3 2014

Inspections were performed in February and August. The following is a summary of actions performed during and in association with these inspections:

- Identified seven AOCs of cap erosion (AOCs 1–7) in February;
- Repaired seven AOCs in August;
- Identified two additional AOCs of cap erosion (AOC-10 and AOC-11) in August;
- Re-seeded and re-mulched seven AOCs in October; and
- Conducted two post-storm inspections in December.

6.1.2.1.4 2015

Inspections were performed in February and August. The following is a summary of actions performed along with these inspections:

- Identified seven AOCs (AOCs 12-18) in February;
- Identified existing AOCs (AOC-2 and AOC-11) in need of repair in February;
- Conducted site walk in April;
- Completed repairs (i.e., BMP installation, mowing and grubbing, backfilling, grading, compacting, and hydroseeding) to seven AOCs (AOC-2, AOC-11, and AOCs 12-18) in July; and
- Identified three new AOCs in Waste Areas A, B, and D in August.

6.1.3 Progress since the Last Review

This is the first five-year review for Site LF002.

6.1.4 Data Review

As outlined in the Site LF002 PCMP, groundwater is measured and sampled on a semi-annual basis. Landfill gas samples are collected during the same events as groundwater. Surface water samples are collected annually. Sampling has occurred at the required intervals during this five-year review. No monitoring and sampling activities beyond those established in the PCMP were reported from 2012 through 2014. A discussion of the results from monitoring and sampling performed in 2015 is provided next (CH2M HILL 2015n).

During the February and June 2015 semi-annual sampling events, groundwater elevations in six shallow monitoring wells (06A001MW-A, 06A002MW-A, 06C001MW-A, 06L003MW-A, 06L004MW-A, and MWP-1A) and six deep monitoring wells (06A001MW, 06A002MW, 06C001MW, 06L003MW, 06L004MW, and MWP-1) were recorded, and groundwater samples were collected from the six shallow wells. Landfill gas parameters were collected in February and August 2015, from all perimeter monitoring probes and five randomly selected landfill gas vents. Surface water samples were collected in February 2015. All monitoring locations are shown in Figure 6.1-1.

6.1.4.1 Groundwater

Groundwater beneath Site LF002 typically flows to the southwest. The average groundwater gradient in the shallow zone was calculated as 0.006 feet per foot (ft/ft) and 0.007 ft/ft to the southwest for the February and June monitoring events, respectively. For the deep zone, the average hydraulic gradients for the same sampling events were 0.004 ft/ft and 0.006 ft/ft to the southwest, respectively. Calculated groundwater velocities ranged from 14 feet per year (ft/yr) to 24 ft/yr.

Field parameter data were within the range of previous measurements for each monitoring well. The pH remained near neutral, with a minimum value of 6.7 measured in 2015. General chemistry analytical results were consistent with previously detected concentrations at each monitoring well, except for historically high nitrogen detection (11.2 mg/L) from 06A002MW-A in June. This concentration also slightly exceeded the federal and State MCL of 10 mg/L. All other analytes detected were at concentrations less than their respective MCLs or secondary MCLs. All samples from the LF002 area showed a mixed cation signature, based on Piper diagrams. Almost all wells showed bicarbonate dominance, except for 06A002MW-A (mixed). The results for the wells with historical major ion data are consistent with previous analyses, except for 06A001MW-A, which previously showed sulfate dominance.

No VOCs were detected in groundwater at concentrations greater than MCLs in either 2015 sampling event. In addition, all detected inorganic concentrations were less than MCLs. Five-year COCs were not sampled in 2015. Monitoring for five-year COCs will be performed in 2018.

6.1.4.2 Landfill Gas

Monitoring was performed in February and August 2015. Carbon dioxide, methane, and oxygen were measured in monitoring probes and five random landfill gas vents. No methane was detected at perimeter probes in 2015. Methane was detected at one vent (V-19), at a concentration of 3.6 percent by volume, during the August sampling event. Methane was not detected at any other vents in August and was not detected at any vents in February.

6.1.4.3 Surface Water

Samples were collected at the five surface water sample locations (shown in Figure 6.1-1) in February 2015. No analytes were detected at concentrations greater than MCLs. The pH of surface water remained near neutral, with values ranging from 7.8 to 8.1 in February 2015. Concentrations of dissolved inorganics were similar at upstream and downstream locations and, in most cases, higher concentrations were detected at upstream locations. VOCs were not detected in any surface water samples.

6.1.5 Technical Assessment

QUESTION A: Is the remedy functioning as intended by the decision documents?

Yes, the current remedy (i.e., landfill cap, inspection, maintenance, and monitoring) is functioning as intended by the PCMP and is minimizing the threat to public health and the environment. The landfill cap has limited infiltration of water into the landfill, and semi-annual inspections continue to verify that the cap is protected from stormwater run-on and run-off. Per the original PCMP, maintenance and monitoring is expected to occur for approximately 15 more years at Site LF002.

QUESTION B: Are the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of the remedy selection still valid?

Land use at Site LF002 has not changed and is expected to remain as-is, indefinitely. All assumptions made in the August 2013 revision to the original PCMP remain valid, and no new exposure pathways have been introduced. As reported in recent post-closure monitoring reports, groundwater and surface water results are compared to the most current California and federal MCLs. If no primary MCL exists, then the California RSLs/CHHSLs are used

QUESTION C: Has any other information come to light that could call into question the protectiveness of the remedy?

No other information has come to light that calls into question the protectiveness of the remedy.

6.1.6 Issues/Recommendations

The following issue was identified in the technical assessment of Site LF003:

- Surface water sampling results are not compared to toxicological criteria protective of aquatic ecological receptors.

The following recommendation is intended to address the issue identified during the technical assessment for Site LF003:

- Compare the analytical results from future surface water sampling activities to toxicological criteria protective of aquatic ecological receptors; sampling should include upstream and downstream sampling for hardness to support the comparison.

6.1.7 Protectiveness Statement

The remedy at Site LF002 is protective of human health and the environment.

6.1.8 Next Review

The next five-year review report for Site LF002 is required five years from the completion date of this review.

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Figure 6.1-1
Site LF002 Features Map
Second Five-Year Review
Beale AFB

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6.2 Site LF003

6.2.1 Introduction

Site LF003 is located in the south-central part of the Base and occupies approximately 33 acres. Site LF003 is south of Gavin Mandery Drive and 100 feet northeast of an ephemeral unnamed tributary of Hutchinson Creek (Figure 6.2-1).

Site LF003 received solid waste from Beale AFB residences and activities from 1980 until fall 1993. The *Preliminary Closure Plan and Post-Closure Maintenance Plan* (B&V Waste Science and Technology 1993) estimated that at the time of the final waste receipt, approximately 74,500 tons of solid waste had been placed in the landfill. The waste was placed in unlined trenches that were rectangular in cross section, 20 to 60 feet wide, 15 to 25 feet deep, and 100 to 1,700 feet long (Harding Lawson Associates 1996).

6.2.2 Response Action Summary

The final cover for Site LF003 consists of a 24-inch-thick (minimum) foundation layer, a 60-mil high-density polyethylene geomembrane barrier layer, and a 12-inch-thick (minimum) erosion resistant layer. Closure was completed in 1997.

Following closure of Site LF003, the following monitoring systems were installed (Haling and Associates 2007):

- Six groundwater monitoring wells (MWP-1—different than the well at Site LF002 with the same designation—through MWP-6);
- Six landfill gas probe pairs (SGP-1 through SGP-6), each with a shallow and deep probe;
- 48 gas vents (V1 through V48); and
- Surface water monitoring at natural drainage locations.

Landfill gas monitoring for methane gas was begun in 1997 on a quarterly basis. Monitoring was revised to semi-annual in 2013, in accordance with the PCMP (CH2M HILL 2013h). Landfill gas probes were installed at SGP-7 through SGP-11 in 2009; SGP-11 consisted of a shallow and deep probe. Perimeter probes at SGP-4, SGP-5, and SGP-11 were removed from the monitoring program in 2009 because methane concentrations exceeded the CCR Title 27, Section 20921 limit of 5 percent per volume, the lower explosive limit for methane (Haling and Associates 2007). The landfill boundary was extended to the limits shown in Figure 6.2-1, and probes at SGP-12 and SGP-13 were installed along the new boundary.

Gas vents V31, V32, and V33 were removed at some time prior to the fall of 2012, when CH2M HILL began monitoring and reporting on Site LF003. Available historical reports do not document the removal of V31, V32, and V33.

Annual surface water monitoring is conducted at unnamed natural drainage locations SWMP-1, SWMP-2, and SWMP-3 in accordance with the PCMP (CH2M HILL 2013h). The SWMP-1 location is upstream from Site LF003, and sample locations SWMP-2 and SWMP-3 are downstream from Site LF003.

In accordance with the PCMP (CH2M HILL 2013h), the monitoring and reporting requirements for Site LF003 are as follows:

- Groundwater elevations are measured semi-annually, during the first and third quarters.
- Groundwater sampling is performed semi-annually for the following parameters: (1) field parameters; (2) general chemistry (i.e., total dissolved solids, total alkalinity, and total hardness); and (3) VOCs. Groundwater sampling is performed annually for: (1) major anions; (2) major cations; and (3) dissolved inorganics. Sampling typically takes place during the first and third quarters to coincide with the typical maximum and minimum seasonal groundwater elevations.

- Groundwater COC sampling is performed every 5 years (in addition to the semi-annual sampling constituents listed above, semi-volatile organic compounds are sampled).
- Surface water sampling is performed on an annual basis for field parameters, general chemistry, major anions, major cations, VOCs, and dissolved inorganics, and is subject to the availability of water. Surface water sampling typically occurs during the first quarter.
- Landfill gas monitoring (i.e., for methane, carbon dioxide, oxygen, and barometric pressure) is performed at landfill gas probes and selected vents on a semi-annual basis.
- Maintenance inspections are performed semi-annually, typically during the first and third quarters to coincide with landfill gas and groundwater monitoring. Inspections include a complete site walk with visual examination of final cover areas and drainage ditches. Inspections also include standard observations for erosion and subsidence, monitoring for leachate seeps, and inspection of landfill facilities. The third quarter inspection verifies that site winterization is complete.
- The landfill cover and drainage facilities also are inspected for damage after significant storm events (i.e., where precipitation of 2.5 inches or more falls within a 24-hour period).
- Landfill maintenance typically is performed during the dry season, to minimize impacts on sensitive areas (e.g., vernal pool and wetland features) in the vicinity of the landfill. Re-seeding of affected areas typically occurs in the fall, to coincide with initial rainfall events.
- The waste discharge requirements specify that an aerial survey be performed every 5 years, to update site topography.
- Monitoring reports are prepared annually.

These activities are completed to achieve the objectives as set forth in the PCMP. The PCMP objectives are as follows:

- Minimize threat to public health and the environment;
- Minimize infiltration of water into the landfill;
- Protect against stormwater run-on and runoff;
- Detect possible contamination of groundwater;
- Detect possible lateral migration of soil gas; and
- Maintain environmental control systems.

The lowest levels of the California or federal MCLs are used for comparison to analytical samples collected at Site LF003. If no primary MCL exists, then the California RSLs/CHHSLs are is used. Post-closure maintenance is expected to occur for approximately 15 more years according to the original PCMP in 1996–1997, or until the wastes no longer pose a threat to water quality.

6.2.2.1 Systems Operations/Operation and Maintenance

LF003 O&M responsibilities consist primarily of cap inspection, maintenance and repair. As noted above, inspections occur semi-annually, coincident with semi-annual monitoring activities. AOCs typically are identified during the first quarter inspection and are remedied before the third quarter inspection. Common AOCs include areas of cap erosion or depression caused by precipitation events and landfill compaction. In accordance with the PCMP, facilities also are inspected immediately after significant storm events. A summary of the inspection and maintenance activities that were conducted during this five-year review are presented next. Maintenance and inspection activities reports for 2011 were not available for review during preparation of this five-year review.

6.2.2.1.1 2012

- Maintenance inspections, performed quarterly; and
- Site winterization inspection completed in August.

6.2.2.1.2 2013

- Maintenance inspections, performed quarterly;

- Sampled for 5-year COCs, all concentrations less than MCLs; and
- Site winterization inspection completed in November.

6.2.2.1.3 2014

Inspections were performed in February and August. The following is a summary of actions performed during and in association with these inspections:

- Two gas vents (V-45 and V-47) were observed to be leaning approximately 27 degrees from vertical because of subsidence in February; and
- Two post-storm inspections were conducted in December.

6.2.2.1.4 2015

Inspections were performed in February and August. The following is a summary of actions performed along with these inspections:

- No additional subsidence was observed at gas vents V-45 and V-47, and no repairs were performed in February.

6.2.3 Progress since the Last Review

This is the first five-year review for Site LF003.

6.2.4 Data Review

As outlined in the Site LF003 PCMP, groundwater is measured and sampled on a semi-annual basis. Landfill gas samples are collected during the same events as groundwater. Surface water samples are collected annually. Sampling has occurred at the required intervals during this five-year review. No monitoring and sampling activities beyond those established in the PCMP were reported from 2012 through 2014. A discussion of results from monitoring and sampling performed in 2015 is provided next (CH2M HILL 2015n).

During the February and June 2015 semi-annual sampling events, groundwater elevations in seven monitoring wells (MWP-1, MWP-2, MWP-3, MWP-4, MWP-4A, MWP-5, and MWP-6) were recorded. Groundwater samples were collected from six of the seven wells (MWP-4 being the exception). Landfill gas parameters were collected in February and August 2015, from all perimeter monitoring probes and five randomly selected landfill gas vents. Surface water samples were collected in February 2015. All monitoring locations are shown in Figure 6.2-1.

6.2.4.1 Groundwater

Groundwater flow directions, gradients, and velocities that were estimated from groundwater elevations collected during each sampling event remained consistent with values previously calculated for the site. Groundwater beneath the site flows predominantly to the west. For both 2015 sampling events, the average hydraulic gradient was 0.001 ft/ft to the west and the groundwater velocity was 3.4 ft/yr.

Field parameters that were measured during each sampling event generally were within the range of historical measurements for each monitoring well. Groundwater pH remained near neutral at 6.7. General chemistry analytical results indicated that all analytes detected in groundwater were less than their respective MCLs or secondary MCL values. Analytical results also were within each monitoring well's historical range, except for historical high concentrations of bicarbonate and total alkalinity in MWP-4A, MWP-5, and MWP-6. Piper diagrams that were constructed with June 2015 major ion measurements indicated bicarbonate-type water for all monitoring points, except for MWP-5 (plotted as mixed bicarbonate-chloride water). MWP-2 and MWP-5 had sodium as the dominant cation, while all other wells showed a mixed cation signature.

No VOCs were detected in groundwater at concentrations greater than MCLs in either 2015 sampling event. Consistent with historical monitoring events, TCE was detected at MWP-1, but the concentrations were less than the MCL of 5 µg/L. Acetone at MWP-5 and chloromethane at MWP-2 also were detected, but at concentrations less than their reporting limits.

Dissolved inorganics also were detected during each sampling event, but all detections were less than MCLs. Historically high concentrations of copper and zinc were detected at MWP-4A, but were well below the MCLs. Low levels of lead also were detected at MWP-4A, but were within the range of historical detections for this well.

6.2.4.2 Landfill Gas

Landfill gas monitoring was performed in February and August 2015. Carbon dioxide, methane, and oxygen concentrations were measured in perimeter monitoring probes and five randomly selected landfill gas vents. No methane was detected at perimeter probes or selected vents in the entire year of sampling.

6.2.4.3 Surface Water

Samples were collected at the three surface water sample locations (shown in Figure 6.2-1) in February 2015. Field parameters that were collected during the sampling event were within the range of results from previous events. The pH of surface water at Site LF003 remained near neutral, with values ranging from 6.7 to 7.4. No analytes were detected above primary MCLs. Iron and manganese concentrations exceeded California secondary MCLs of 0.3 mg/L and 0.05 mg/L, respectively. Iron was detected at concentrations up to 11.5 mg/L in both the upstream and downstream samples. Manganese exceeded the secondary MCL at a concentration of 0.09 mg/L at SWMP-2. Arsenic, chromium, copper, lead, and nickel also were detected at historically high concentrations, but were well below MCLs.

6.2.5 Technical Assessment

QUESTION A: Is the remedy functioning as intended by the decision documents?

Yes, the current remedy (i.e., landfill cap, inspection, maintenance, and monitoring) is functioning as intended by the PCMP and is minimizing the threat to public health and the environment. The landfill cap has limited infiltration of water into the landfill, and semi-annual inspections continue to ensure that the cap is protected from stormwater run-on and run-off. Per the original PCMP, maintenance and monitoring is expected to occur for approximately 15 more years at Site LF003.

QUESTION B: Are the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of the remedy selection still valid?

Land use at Site LF003 has not changed and is expected to remain as-is, indefinitely. All assumptions made in the August 2013 revision to the original PCMP remain valid, and no new exposure pathways have been introduced. As reported in recent post-closure monitoring reports, groundwater and surface water results are compared to the most current California and federal MCLs, and California secondary MCLs (State Water Board 2014; Title 22, California Code of Regulation 2006).

QUESTION C: Has any other information come to light that could call into question the protectiveness of the remedy?

No other information has come to light that calls into question the protectiveness of the remedy.

6.2.6 Issues/Recommendations

- The following issue was identified in the technical assessment of Site LF003:Surface water sampling results are not compared to toxicological criteria protective of aquatic ecological receptors.

The following recommendation is intended to address the issue identified during the technical assessment for Site LF003:

- Compare the analytical results from future surface water sampling activities to toxicological criteria protective of aquatic ecological receptors.

6.2.7 Protectiveness Statement

The remedy at Site LF003 is protective of human health and the environment.

6.2.8 Next Review

The next five-year review report for Site LF003 is required five years from the completion date of this review.

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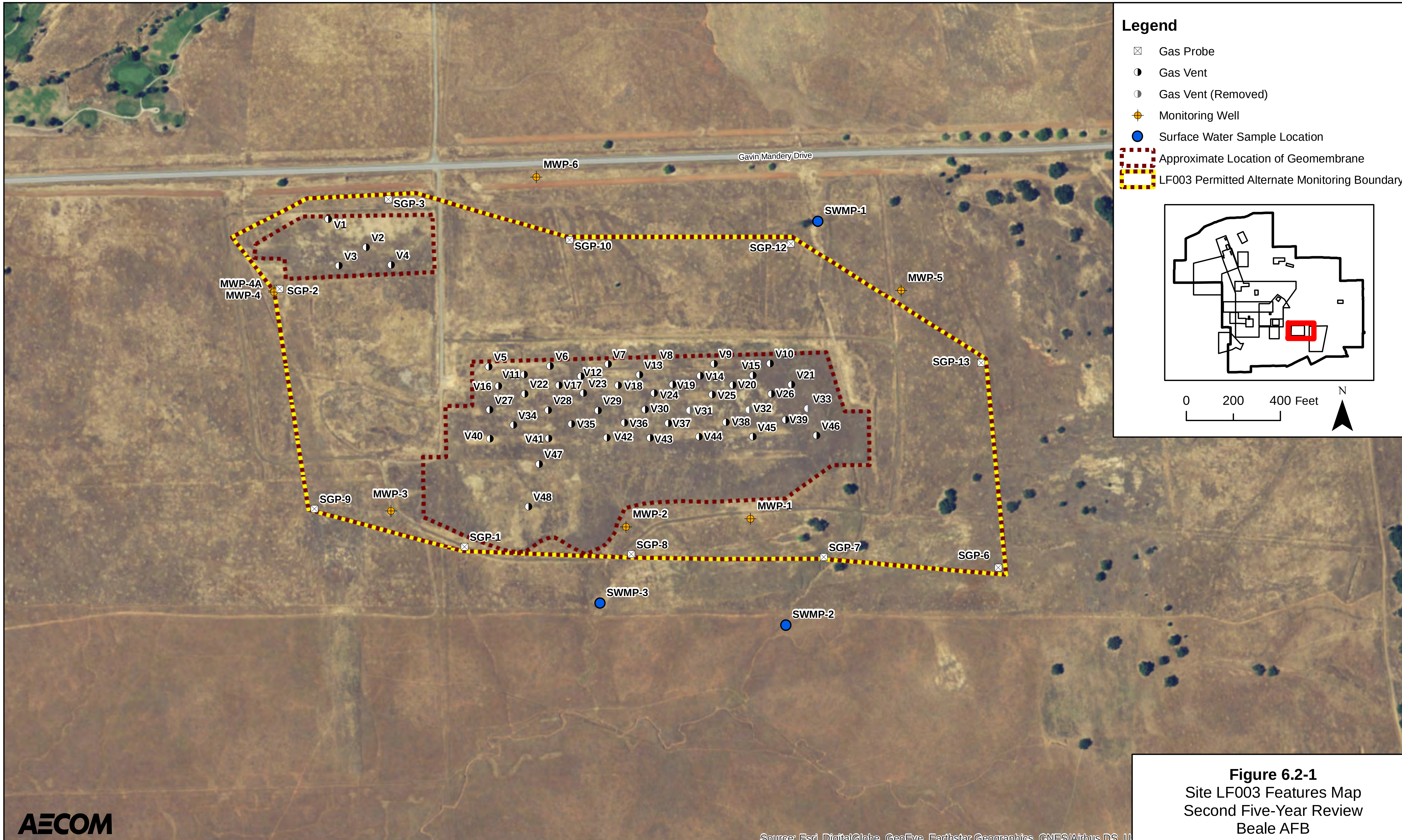

Figure 6.2-1
Site LF003 Features Map
Second Five-Year Review
Beale AFB

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6.3 Site SS023

6.3.1 Introduction

Site SS023 is an electrical transformer storage area located inside the Civil Engineering yard at Beale AFB, approximately 700 feet southeast of Site SD023. Although Site SD023 and Site SS023 are named similarly, chemical releases from the sites are unrelated historically. Site SS023 consists of two concrete pads measuring 52 by 60 feet, located approximately 80 feet south of Building 2539. The concrete pads are both adjacent to the northern side of the fence along Doolittle Drive. Electrical equipment, used transformers, and transformer oil were stored as part of O&M activities at the exterior electrical shop in Building 2539 (URS 2004b). The site currently is used for storage by the 9th Civil Engineering Squadron. Materials currently stored at the site (such as transformers, gravel/sand, utility poles, and generators) do not contain significant quantities of polychlorinated biphenyls (PCBs) or chlorinated solvents. Site SS023 is zoned for industrial use (CH2M HILL 2013d). Site SS023 is shown in Figure 6.3-1.

6.3.2 Response Action Summary

Phased corrective actions and interim corrective measures have been conducted at Site SS023 since 1994 and have included soil excavation and groundwater treatment actions (operation of a groundwater treatment system [2002–2003] and operation of an ozone/air sparge system [2005–2012]). In 2012, NFA was requested for soil and soil vapor at Site SS023 (CH2M HILL 2012a) and selected as the final remedy in the *Site SS023 Statement of Basis/Corrective Measures Implementation Work Plan* (Air Force 2014b).

Groundwater monitoring has been conducted at the site since 1997, and current response actions are being implemented under RCRA regulations. Groundwater beneath Site SS023 is monitored as part of the Cantonment Area. During this five-year review period, ISCO, EA, and LUCs were selected as the corrective measures for groundwater (Air Force 2014b). PCE and TCE were the only COCs identified in groundwater, with TCE being the most widespread and detected contaminant at Site SS023. Cleanup levels of 5 µg/L were established for each COC, respectively.

ISCO injections were completed between November 5, 2014 and January 23, 2015, with follow-up injections occurring in October 2015. ISCO performance monitoring has been conducted since the initial injections to demonstrate plume stability and TCE concentration reductions. Performance monitoring will be conducted semiannually following the completion of ISCO injections. Compliance monitoring will occur for one year or until the objectives of the MRP are met.

6.3.3 Progress since the Last Review

This is the first five-year review for Site SS023.

6.3.4 Data Review

6.3.4.1 Groundwater

Groundwater contamination associated with Site SS023 has comingled with other groundwater plumes in the Cantonment Area and is sampled during Cantonment Area sampling activities within the BGMP. Currently Cantonement Area contamination extends 6,500 feet southwest from an area beneath Site SS023. The plume is approximately 400 feet wide in the Site SS023 source area. Figure 6.3-1 shows the 2015 TCE plume along with additional site features. Figure 6.3-2 shows the location of the Site SS023 TCE groundwater contaminant plume in 2010, 2013, and 2015.

During 2015 annual sampling activities the following wells, listed along with their respective location relative to the SS023 source area, were sampled:

- **Source Wells**: 23SWMU1MW and SWMU23C009MW
- **Plume wells**: BAT-1MW, BAT-3MW, BAT-4AMW, BAT-4BMW, BAT-5AMW, BAT-8MW, 23U001AMW, 23U001BMW, 23U002AMW (Site OW034), 23U002BMW (Site OW034), 39C023MW (CG041-039),

SWMU23C008MW, SWMU23C014IW, SWMU23C015IW, SWMU23C016IW, SWMU23C017IW, SWMU23U004AMW, SWMU23U004BMW, SWMU23U005AMW, SWMU23U005BMW, SWMU23U006AMW, SWMU23U006BMW, SWMU23U007AMW, SWMU23U007BMW, SWMU34U001MW, SWMU34U002MW, and OWSM-C001MW

Table 6.3-1 presents TCE concentrations detected during 2015 sampling activities from wells associated with the SS023 source area and ISCO area MRP wells (CH2M HILL 2016i).

Table 6.3-1 2015 TCE Data and Trends, Site SS023

Site Association	Well ID	Well Type	2015 Semi-annual TCE (µg/L)	2015 Annual TCE (µg/L)	TCE Time-Series Plot Trend
Site SS023 ISCO MRP	SWMU23U003AMW	MRP background/upgradient	NS	ND	No Trend
	BAT-1MW	MRP treatment/plume	0.64	1.53	Decreasing
	BAT-4AMW	MRP treatment/Plume	1.2	ND	Decreasing
	BAT-4BMW	MRP treatment/Plume	0.68	0.69	Decreasing
	SWMU34U002MW	MRP treatment/Plume	ND	0.56	Decreasing
	23SWMU1MW	SS023 source/MRP injection well	NS	ND	Decreasing
	SWMU23C009MW	SS023 source/MRP injection well	NS	ND	Decreasing
	SWMU23C014IW	MRP injection well/plume	NS	ND	No Trend
	SWMU23C015IW	MRP injection well/plume	NS	ND	No Trend
	SWMU23C016IW	MRP injection well/plume	NS	ND	No Trend
	SWMU23C017IW	MRP injection well/plume	NS	ND	No Trend
	BAT-5AMW	MRP transition/plume	**393 J**	**220**	**Increasing**
	SWMU23C008MW	MRP transition/plume	**73.6 J**	**25.4**	No Trend
	SWMU23U004AMW	MRP transition/plume	**41.5 J**	**47.6**	**Increasing**
	SWMU23U005AMW	MRP transition/plume	0.7	**12.3**	**Increasing**
	SWMU23U006AMW	MRP transition/plume	1.8 J	**146**	**Increasing**
	SWMU23U007AMW	MRP transition/plume	4.5	**21.5**	No Trend
	23U001BMW	MRP compliance/plume	1.1	**5.74**	No Trend
CG041-039	39C023MW	MRP compliance/plume	**46.9**	**33.8**	No Trend
Site SS023	23U001AMW	Plume	NS	1.29	No Trend
	BAT-3MW	Plume	NS	0.56	No Trend
	BAT-5BMW	Plume	NS	NS	Decreasing
	BAT-8MW	Plume	NS	NS	**Increasing**
	SWMU23U004BMW	Plume	NS	3.33	No Trend
	SWMU23U005BMW	Plume	**31.6**	**29.5**	**Increasing**
	SWMU23U006BMW	Plume	NS	2.43	Decreasing
	SWMU23U007BMW	Plume	NS	1.3	Decreasing
	SWMU34U001MW	Plume	NS	**11**	No Trend
	OWSM-C001MW	Plume	NS	**16.8**	**Increasing**
Site OW034	23U002AMW	Plume	ND	ND	Decreasing
	23U002BMW	Plume	NS	**10.2**	Decreasing

Notes:
Bold = greater than the project screening level of 5 µg/L
µg/L = micrograms per liter; J = estimated quantity; ND = not detected; NS = not sampled

Based on data collected during the 2015 annual sampling event ISCO injections have been effective in decreasing TCE concentrations in source area and injection wells to nondetect levels. TCE concentrations ranged from nondetect to a maximum of 0.56 µg/L in MRP treatment wells.

TCE was detected in the 12 plume wells above the PSL, including all transition wells. Transition zone concentrations have been reduced since the initial ISCO injections but concentrations remain elevated (> 100 µg/L) in MRP wells BAT-5AMW and SWMU23U006AMW, which indicates that the TCE mass was mobilized by the ISCO injections that occurred directly ugradient. These wells were targeted by the ISCO injections that occurred in October 2015 with ISCO being directly injected into these wells.

TCE was detected at concentrations greater than the cleanup goal of 5 µg/L at several MRP compliance wells during the 2015 annual event with increasing time-series plot trends being observed at wells OWSM-C001MW and SWMU23U005BMW. All other compliance wells had stable or decreasing trends.

TCE was also detected in downgradient wells 39C023MW, 23U001AMW, and 23U001BMW. Concentrations were below the cleanup goal at well 23U001AMW, but greater than the cleanup goal at wells 39C023MW and 23U001BMW at 33.8 µg/L and 5.74 µg/L, respectively. Overall, the highest TCE concentrations remain within the MRP transition zone, which was targeted by the October 2015 ISCO injections.

Monitoring of geochemical changes associated with ISCO injections was also conducted during the 2015 semiannual and annual events as required by the MRP. Constituents monitored as part of the MRP include dissolved metals (chromium and manganese), permanganate, TDS, sodium, total chlorides, and total selenium. Exceedances of baseline for dissolved chromium, manganese, and permanganate trigger contingency actions as specified in the contingency plan. Only manganese was detected above a baseline concentration (0.329 mg/L) in the 2015 annual event at 0.443 mg/L, at compliance well 23U001BMW. This value is below the trigger level (0.658 mg/L). No compliance wells exceeded the trigger concentrations in 2015 (CH2M HILL 2016i).

6.3.4.2 Soil

NFA was selected for Site SS023 soil and soil vapor in 2012 (CH2M HILL 2012a) and finalized in the SS023 Statement of Basis/Corrective Measures Implementation Work Plan (Air Force, 2014b), and no data related to Site SS023 soils was collected. Groundwater beneath Site SS023 is sampled semi-annually and reported as part of the Cantonment Area monitoring activities.

6.3.5 Technical Assessment

QUESTION A: Is the remedy functioning as intended by the decision documents?

Yes, the remedy has functioned as intended. During this five-year review, a NFA decision was recommended for soil and soil vapor at Site SS023 under the RCRA corrective action program because further action for soil is not necessary for the protection of human health and the environment (CH2M HILL 2012a).

QUESTION B: Are the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of the remedy selection still valid?

Yes, exposure assumptions, toxicity data, and RAOs reflected in the Corrective Measures Implementation Study (CH2M HILL 2015n) still are valid for protection of human health and the environment. Current and future planned land use at Site SS023 is industrial (CH2M HILL 2013d). However, the Air Force's goal is to attain unrestricted site close-out status at SS023. Until concentrations allowing unrestricted use/unlimited exposure (UU/UE) are achieved, land use controls will be used to restrict land and groundwater access and use. Land use is controlled through the Beale AFB Master Planning process. Current and anticipated future land uses are identified in the General Plan. Land use at Site SS023 will remain industrial for the foreseeable future. The findings of the ERA that evaluated the potential for adverse effects on ecological receptors from contaminants detected in soil vapor concluded that no adverse effects will occur on populations of burrowing mammals or terrestrial biota (URS 2004b).

- The HHRA indicated that contaminants remaining on-site in soil and soil vapor allow UU/UE, and do not pose a threat to the beneficial uses of underlying groundwater (CH2M HILL 2012a). NFA has been recommended for soil and soil vapor at Site SS023 under the RCRA corrective action program, because further action for soil is not necessary for the protection of human health and the environment.

- The results of the HHRA indicated that TCE and PCE in groundwater are the only COCs at Site SS023 (CH2M HILL 2011, 2012a, 2015k). As concluded in the screening-level HHRA that was conducted as part of the CMS Report (CH2M HILL 2011n), VOCs related to SWMU23B (i.e., SS023) activities were not detected in soil. Risk from direct contact with soil was not estimated, but it was assumed that the risk would be below regulatory thresholds that would necessitate remediation (CH2M HILL 2013d), which is a reasonable assumption.
- The HHRA concluded that the threat to indoor air quality potentially caused by upward migration of VOCs in gas phase to the surface also is unlikely (URS 2008). Additional soil vapor sampling for VOC analysis was conducted in 2013 above the area where groundwater contained the highest TCE concentration. No VOCs were detected at concentrations exceeding RBSLs, including TCE (80 ppbv) and PCE (61 ppbv) (Air Force 2014b). These soil vapor screening levels are the CHHSLs, based on a future residential scenario (OEHHA 2010). Based on these findings, soil vapor was no longer considered a medium of concern at Site SS023 (Air Force 2014b), which is still a valid conclusion. Although the basis of these RBSLs is not completely clear, they are valid based on current DTSC guidance for vapor intrusion (DTSC 2011a) because the RBSLs for 80 ppbv for TCE and 61 ppbv for PCE are slightly lower (more stringent) than those RBSLs used for the residential scenario in more current HHRAs, conducted at other sites at Beale AFB, namely: TCE = 89 ppbv (479 $\mu g/m^3$), PCE = 71 ppbv (482 $\mu g/m^3$) (see reports for RCRA Site PL582 and CERCLA Site OT017).
- TCE and PCE are present in groundwater at concentrations above the project screening levels (i.e., MCLs—5 µg/L—same value for both VOCs), which are the most current California and federal MCLs (State Water Board 2014).
- The potential for risk to burrowing rodents from inhalation of burrow air also is at an acceptable level because the most current DTSC (2011b) inhalation TRVs for burrowing mammals for TCE (low TRV = 6,400 $\mu g/m^3$ and high TRV = 32,000 $\mu g/m^3$) and PCE (low TRV = 24,000 $\mu g/m^3$ and high TRV = 121,000 $\mu g/m^3$) are higher than the human health RBSLs for soil vapor (cited above), on which risk management decisions were based.

As previously stated, existing and planned future land use for Site SS023 is commercial/industrial, and no change in habitats has occurred since the risk assessment. The risk assessment addressed both commercial/industrial receptors and potential future residential receptors to determine whether UU/UE is acceptable (CH2M HILL 2012a; Air Force 2014), TCE and PCE in groundwater are the only COCs. Groundwater monitoring data are compared to the most current State and federal MCLs (State Water Board 2014), and the RAOs still are protective of human health and the environment.

QUESTION C: Has any other information come to light that could call into question the protectiveness of the remedy?

No information has come to light to call into question the protectiveness of the remedy at Site SS023.

6.3.6 Issues/Recommendations

No issues that affect the protectiveness of the remedy were identified for Site SS023.

6.3.7 Protectiveness Statement

The remedy at Site SS023 is protective of human health and the environment.

6.3.8 Next Review

The next five-year review report for Site SS023 is required five years from the completion date of this review.

Figure 6.3-1
Site SS023 Site Features and
2015 TCE Concentrations
Second Five-Year Review
Beale AFB

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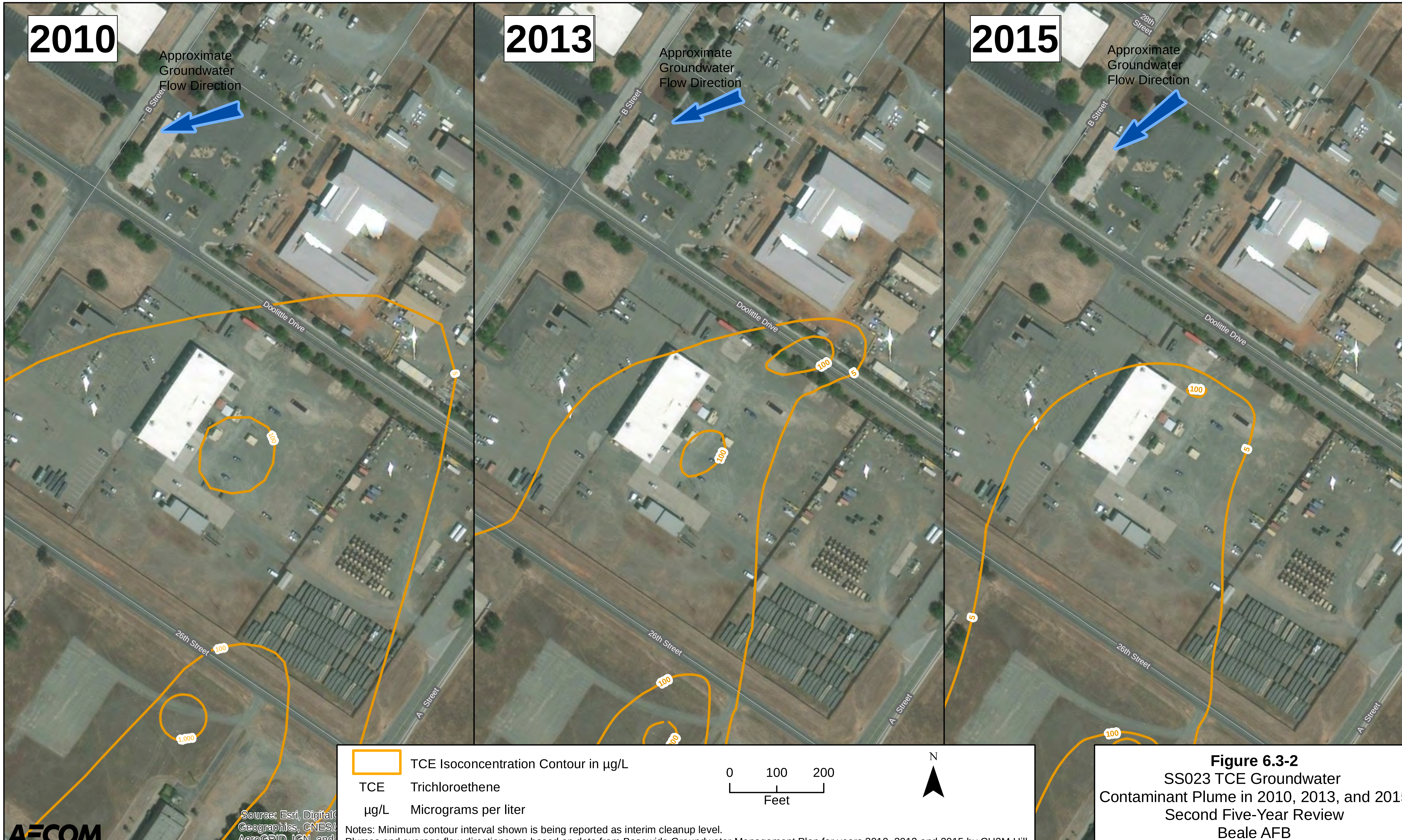

TCE Isoconcentration Contour in µg/L

TCE Trichloroethene

µg/L Micrograms per liter

Notes: Minimum contour interval shown is being reported as interim cleanup level.
Plumes and average flow directions are based on data from Basewide Groundwater Management Plan for years 2010, 2013 and 2015 by CH2M Hill

Figure 6.3-2
SS023 TCE Groundwater
Contaminant Plume in 2010, 2013, and 2015
Second Five-Year Review
Beale AFB

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6.4 Site PL582

6.4.1 Introduction

The Lincoln Receiver Site (Site PL582) is located on Moore Road, west of the town of Lincoln in Placer County, California, and is approximately 25 miles south of Beale AFB (Figure 6.4-1). Site PL582 formerly was used as a backup electrical generator facility in support of communication activities at the former McClellan AFB. Use of the site as a backup generator facility was discontinued in 1999 when McClellan AFB was closed, and management of the site was transferred to Beale AFB. The site currently is considered a “remote site,” where most of the electrical systems still operating are monitored remotely. Personnel generally are on-site and use Building 4131 once per week (but sometimes up to three times per week), for less than a full day, to check on or repair the electrical systems.

Indications of releases of diesel fuel were observed from three leaking USTs and associated distribution piping, which led to their removal in June 1989. The USTs were located along the western edge of the property. Two 4,000-gallon aboveground storage tanks were installed to continue to provide diesel fuel for the backup generators.

The release mechanism for the TCE source area is not known precisely. Historical documents attribute TCE contamination in soil vapor and groundwater to “past waste management practices.” A transformer pad is located on the northwestern side of Building 4131, near the highest observed concentrations of TCE in soil vapor. The current transformer pad replaced a former transformer pad that was located closer to the northwestern corner of Building 4131, according to classified building engineering drawings. McClellan personnel signed a no-PCB certification that the former and current transformers did not contain PCB oil (McClellan AFB 2000); however, past transformer maintenance practices at the site sometimes included the use of a vapor degreasing solvent (such as TCE) to clean out the old oil from the transformer before adding new oil or decommissioning a unit. This may have resulted in a release of TCE in the transformer area (Tetra Tech 2009). The precise location of the source of TCE in soil could not be confirmed via sampling.

6.4.2 Response Action Summary

The results of facility investigations conducted at PL582 between 1988 and 2011 indicated that TPH-D leaked from USTs and contaminated the underlying soil and groundwater. Three USTs were removed in September 1988, with over-excavation of the UST area occurring in June 1989 (McClellan AFB 2000). The excavation area was backfilled with clean soil, sourced 300 feet southwest of Building 4131.

During excavation activities, perched water was encountered at a depth of 10 feet bgs. Analytical samples of the perched water contained TPH-D, TPH-G, and several fuel-related VOCs (i.e., ethylbenzene, toluene, xylenes, and naphthalene). A trench drain was installed in 1999 to a depth of 12 feet bgs, to dewater the perched zone. Collected water was pumped to a holding tank on-site and periodically was sampled and drained. The extent of VOC contamination in perched water is believed to be limited to the footprint of the northwestern portion of Building 4131. The extent of TPH-D in perched water has been shown to coincide with the extent of TPH-D in shallow soil. By June 2000, little to no perched water was observed in the drain (McClellan AFB 2000).

As part of an interim corrective measures (ICMs) implementation, 701 tons of affected soil were removed from the former UST piping area west/northwest of Building 4131. Sidewall confirmation samples that were collected at 5 feet bgs contained TPH-D concentrations ranging from 8.9 to 7,200 mg/kg. Floor and sidewall samples from 10 feet bgs contained TPH-D concentrations less than the investigation goal (83 mg/kg), except for sample SW9 that contained TPH-D at 530 mg/kg, indicating not all of the source materials were removed during excavation.

As part of the ICM field activities, two 40-foot-long, 2-inch-diameter, 0.02-inch slotted Schedule 40 polyvinyl chloride pipes were installed at the bottom of the excavation floor for possible future remedial activities. Before backfilling, Oxygen Release Compound Advanced was applied to the sidewalls and floor of the excavation area and was mixed with gravel to treat any residual hydrocarbon compounds that may have migrated into the excavation (Tetra Tech 2008).

In addition to petroleum hydrocarbons, previous investigations indicated that soil vapor contamination was present at the northern portion of the site. The primary contaminant detected was TCE, with the highest concentrations being present along the northern end of Building 4131. Consistent with previous investigation reporting units, a project screening level concentration for TCE was established as approximately 430 µg/m^3 (80 ppbv).

Contamination also has been detected in groundwater beneath the site. TCE is the primary contaminant in groundwater, with its lateral extent having been defined except to the northwest. TCE concentrations in deep wells (screened 90 to 100 feet bgs) have decreased from initial detections greater than the MCL of 5.0 µg/L to concentrations less than the PSL of 5 µg/L. Groundwater PSLs are based on California Department of Public Health MCLs, Department of Public Health State Notification Levels, and taste and odor thresholds published in *A Compilation of Water Quality Goals* (Cal/EPA and State Water Board 2011). In shallow wells (screened 40 to 70 feet bgs), TCE has exceeded the PSL in wells north-northwest of Building 4131 but appear to have decreased since 2014 (CH2M HILL 2016i). The maximum detected concentration of TCE was 75.5 µg/L.

A data gap investigation was conducted in 2015, to fully delineate the extent of TPH-D and VOCs in soil, soil vapor, and groundwater (CH2M HILL 2016h). The analytical results of the data gap investigation were used in conjunction with existing data to develop an HHRA, Ecological Risk Assessment, and Water Resources Assessment. The results of the investigation indicated that the nature and extent of contamination and potential risks at Site PL582 had been sufficiently characterized to develop and evaluate corrective measure alternatives for the site.

Corrective measures were presented in the draft *Statement of Basis/Corrective Measures Implementation Work Plan* (Air Force 2015d). Justification for NFA for soil and soil vapor were provided and included the HHRA results, which indicated that the risks from TCE in soil vapor were at the low end of the risk management range. The only COC identified as requiring action was TCE in groundwater. Long-term monitoring and LUCs were selected as the corrective measures for groundwater. A final Statement of Basis/Corrective Measures Implementation Work Plan is anticipated in 2018.

6.4.3 Progress since the Last Review

This is the first five-year review for Site PL582.

6.4.4 Data Review

The most recent data collected from Site PL582 is associated with the data gap investigation completed in 2015 (CH2M HILL 2016h). The purpose of the investigation was to fully delineate TPH and VOCs in soil, soil vapor, and groundwater. The results of this investigation are presented next. Groundwater monitoring locations are shown in Figure 6.4-1.

6.4.4.1 Groundwater

Chloroform, cis-1,2-DCE, and TCE were detected in groundwater, with only TCE exceeding its MCL (5 µg/L). TCE concentrations greater than the MCL extended from the source area 1,050 feet northwest and downgradient towards wells PL582C029MW and PL582C031MW. The highest detected concentration was in LRSMW8 (16.6 µg/L), located approximately 350 feet downgradient from the source area. The downgradient extent of TCE has been delineated, and time-series data from older monitoring wells indicated that the plume was stable. Maps of TCE concentrations from 2011, 2013, and 2015 are shown in Figure 6.4-2.

6.4.4.2 Soil

Soil samples were collected from nine borings at depths ranging from 1 to 46 feet bgs. TPH-D was detected in all samples at concentrations ranging from 13 to 1,1710 mg/kg. Samples also were analyzed for leachable TPH-D via the DI-WET method. Leachable TPH-D was not detected in the samples, with one exception. A sample collected from 4 to 5 feet bgs (boring PL582C028) had a concentration of 238 µg/L of leachable TPH-D, which was less than the PSL of 1,000 µg/L. PSLs were calculated using exposure factors for RSLs (EPA 2013b), toxicity values in OEHHA's Toxicity Criteria Database, and the EPA Integrated Risk Information System toxicity value database (EPA 2013d). These data indicate that petroleum hydrocarbons do not present a human health risk. TCE was detected in soil samples, but concentrations did not exceed the PSL.

6.4.4.3 Soil Vapor

Soil vapor samples were collected from 13 borings at approximate depths of 6, 16, 26, and 46 feet bgs, to assess the lateral extent of contamination and assess the VI pathway. All reported benzene concentrations were less than the industrial PSL (87 ppbv), which is the State Water Resources Control Board (State Water Board) commercial scenario, low-threat soil gas criterion for direct measurement of soil gas concentrations (State Water Board 2012b). Concentrations of benzene in two 26-foot-bgs interval soil vapor samples exceeded the residential PSL (26 ppbv) in borings PL582C018 (35 ppbv) and PL582C036 (27.5 ppbv). Concentrations in shallower samples from both these locations were less than the residential PSL. Ethylbenzene and naphthalene were detected at concentrations less than the industrial and residential PSLs.

TCE concentrations exceeded the residential PSL of 80 ppbv in only five samples from three locations (PL582C021, PL582C034, and PL582C036). However, all three locations had shallower samples that had TCE concentrations that were less than the residential PSL.

Five indoor air samples from within Building 4131 were collected as part of the soil vapor portion of the data gap investigation. Two outdoor samples also were collected. In addition, a building survey was conducted to differentiate potential environmental sources of contamination from sources not related to the data gap investigation. Naphthalene was the only petroleum constituent in indoor air samples identified as a risk driver by the HHRA. However, it was not detected at concentrations greater than industrial or residential PSLs in soil vapor and did not appear to be migrating from soil into indoor air. TCE was detected in indoor air samples, but at concentrations less than the industrial PSL of 0.56 ppbv.

6.4.5 Technical Assessment

QUESTION A: Is the remedy functioning as intended by the decision documents?

Although the groundwater remedies selected in the draft Statement of Basis/Corrective Measures Implementation Work Plan are not finalized yet, remedies implemented to date have functioned as intended and have remediated TPH and VOC contamination in soil and soil vapor to levels acceptable for NFA (Air Force 2015d). Long-term monitoring and LUCs are the selected corrective measures for TCE in groundwater at Site PL582. LUCs will restrict access to groundwater until conditions are suitable for UU/UE.

QUESTION B: Are the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of the remedy selection still valid?

Yes, exposure assumptions, toxicity data, and RAOs used in development of the SoB/CMI WP (Air Force 2015d) still are valid for protection of human health and the environment. Building 4131 currently is being used as a remote site, where electrical systems still operating are monitored remotely. Personnel generally are on-site only once per week, to check on or repair the electrical systems. Potentially exposed receptors at the site include current and future industrial workers. Although future residential land use of Site PL582 is not anticipated, this scenario was included in the risk assessment to determine whether UU/UE is acceptable at this site (CH2M HILL 2015o). The results of the ERA for Site PL582, conducted in 2015 in accordance with current State and federal guidance, indicated that no unacceptable ecological risks and no chemicals were retained for further evaluation in a predictive assessment.

- The results of the data gap investigation and human health risk assessment indicated that TCE in groundwater is the only COC at Site PL582 (CH2M HILL 2016h). The cumulative cancer risk and noncancer HI estimates for the site-related chemicals for the current and future industrial worker exposed to indoor air, soil vapor, and soil are $2x10^{-06}$ and 0.11, respectively. The HI is less than 1, and the cumulative ELCR is within EPA's risk management range of 10^{-6} to 10^{-4}, one in a million to one in ten thousand for cancer risks (EPA 1990). No COCs were identified for indoor air, soil, or soil vapor for current and future industrial workers. The cumulative cancer risk estimates for a future residential receptor exposed to soil, soil vapor, and groundwater (direct contact exposure pathway) is $3x10^{-05}$, which also is within EPA's risk management range, and the cumulative noncancer HI ranges from 3 to 4 with TCE identified as a risk driver in groundwater. Shallower samples were used to confirm that TCE is not a vapor intrusion risk. TCE in groundwater was the only COC identified.
- Risk drivers for petroleum in soil (i.e., benzene, ethylbenzene, and naphthalene) were detected at concentrations well below both commercial and residential PSLs, which are based on the State Water Board's

residential low-threat soil screening levels for the direct contact and outdoor air exposure pathways (State Water Board 2012b). These data indicate that petroleum hydrocarbons do not present a human health risk, and this finding still is valid because the low-threat closure screening levels have not been updated since 2012.

- TCE is present in groundwater at concentrations above the PSL (i.e., MCL of 5 µg/L), which is the most current California and federal MCL (State Water Board 2014).
- Petroleum related compounds in soil vapor (e.g., benzene, ethlybenzene, naphthalene) were reported at concentrations below the PSLs for industrial workers, represented by the current low-threat screening levels; some individual borings had benzene concentrations above the PSL for residential land use (State Water Board 2012b).
- For non-petroleum VOCs, lack of a correlation between detected concentrations in indoor air and detected concentrations in other media was used as evidence to identify TCE as the only VOC potentially associated with a vapor intrusion source. TCE was the primary contributor to future groundwater-to-indoor-air ELCR estimates, with risks from $3x10^{-08}$ to $6x10^{-06}$ (industrial) and $2x10^{-07}$ to $4x10^{-05}$ (residential). However, it was concluded that soil vapor TCE risks do not indicate a vapor intrusion source for future land use scenarios (only two locations slightly above the soil vapor RBSL) (CH2M HILL 2016h). These risk assessments are less than or generally within EPA's risk management range of 10^{-6} to 10^{-4} (one in a million to one in ten thousand thousand) for cancer risks [EPA 1990]).These risk estimates still are valid because the assumptions used to calculate the RBSLs for indoor air (CH2M HILL 2016h) for TCE still are valid, based on current DTSC guidance for vapor intrusion (DTSC 2011a). For the residential scenario, the RBSL for TCE is 89 ppbv (479 µg/m^3).
- The potential for risk to burrowing rodents from inhalation of burrow air also is at an acceptable level because the most current DTSC (2011b) inhalation TRVs for burrowing mammals for TCE (low TRV = 6,400 µg/m^3 and high TRV = 32,000 µg/m^3) are higher than the human health RBSL for soil vapor (cited above), on which risk management decisions were based.

As previously stated, existing and planned future land use for Site PL582 is commercial/industrial and no change in habitats has occurred since the risk assessment. The risk assessment addressed both commercial/industrial receptors and potential future residential receptors to determine whether UU/UE is acceptable (CH2M HILL 2016h). TCE in groundwater is the only COC. Groundwater monitoring data are compared to the most current State and federal MCL (State Water Board 2014), and the RAOs still are protective of human health and the environment.

QUESTION C: Has any other information come to light that could call into question the protectiveness of the remedy?

No information has come to light to call into question the protectiveness of the remedy.

6.4.6 Issues/Recommendations

During this technical review, the following issue was identified:

- Corrective measures and a final cleanup level for TCE in groundwater have not been finalized in a decision document for Site PL582.

Based on the issue identified during this technical assessment, the following recommendation is made:

- Finalize a decision document establishing corrective measures and a TCE cleanup level for groundwater at Site PL582.

6.4.7 Protectiveness Statement

The corrective measures presented for Site PL582 are expected to be protective of human health and the environment on completion. In the interim, remedial actions completed to date have adequately addressed all exposure pathways that could result in unacceptable risks in these areas. Therefore, these interim actions are considered protective of human health and the environment for the short-term. However, for the remedy to be protective in the long term, the following action needs to be taken: establish LUCs for groundwater use in the final Statement of Basis/Corrective Measures Implementation Work Plan.

6.4.8 Next Review

The next five-year review report for Site PL582 is required five years from the completion date of this review.

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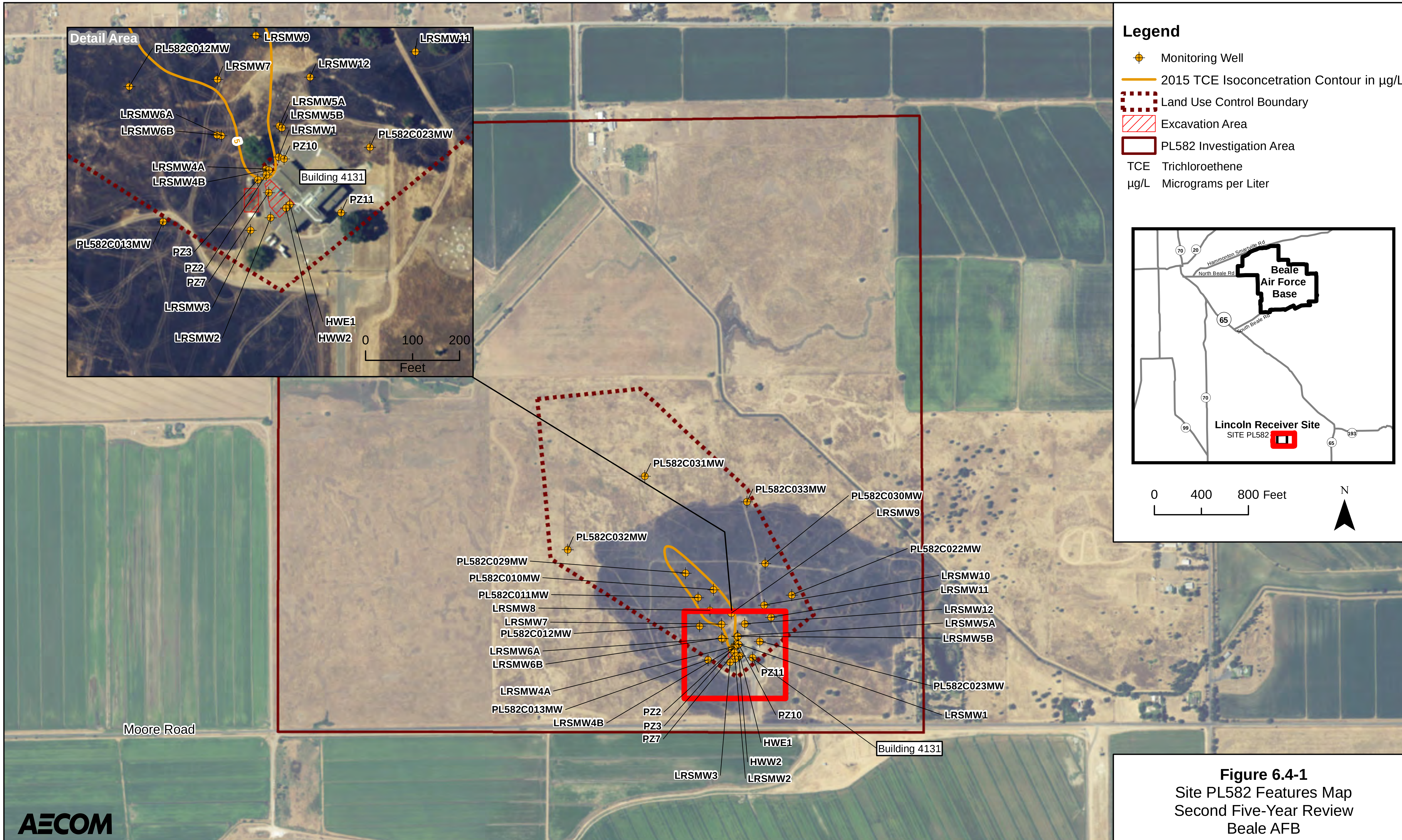

Figure 6.4-1
Site PL582 Features Map
Second Five-Year Review
Beale AFB

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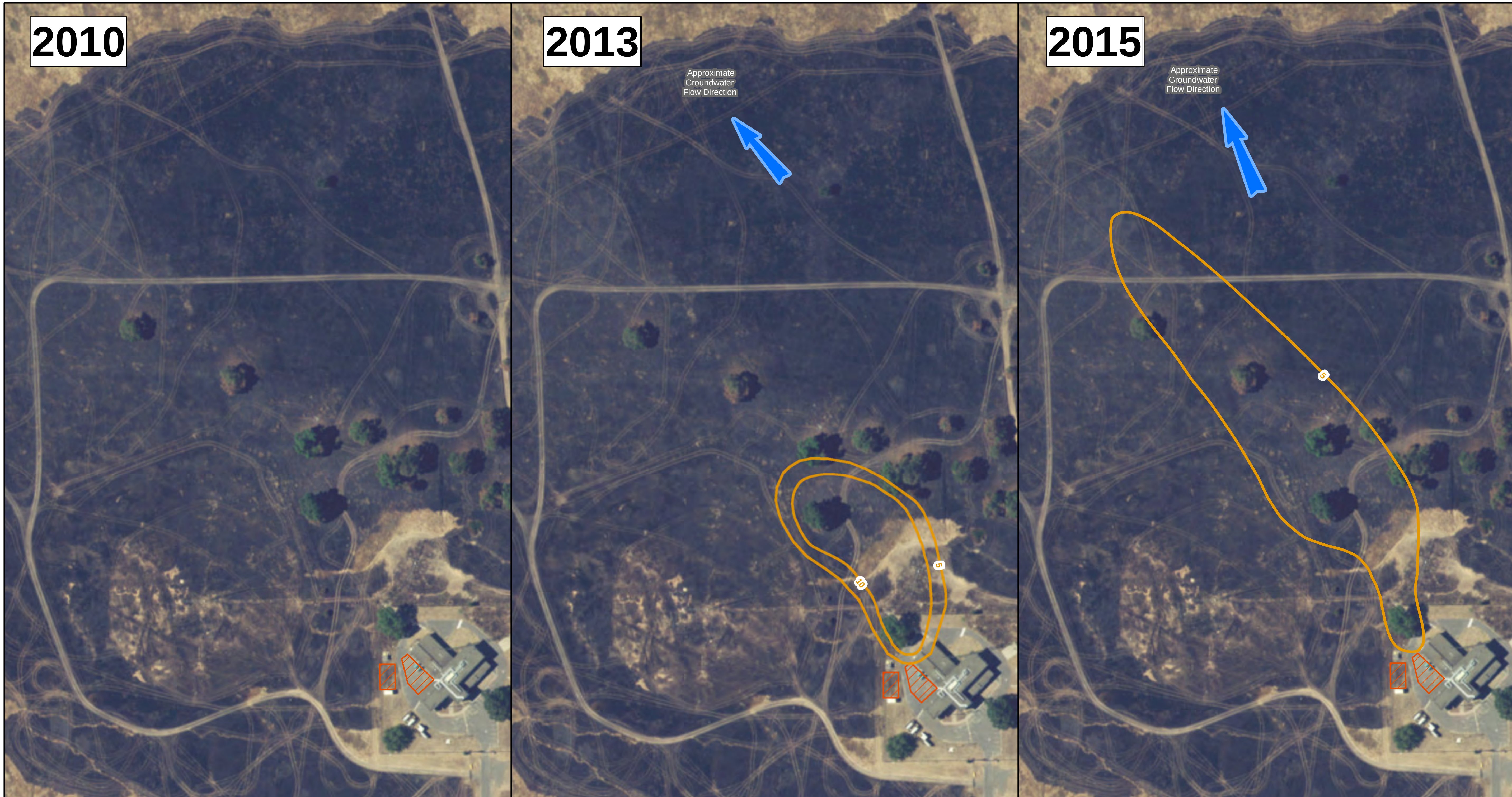

TCE Isoconcentration Contour in µg/L
TCE Trichloroethylene
µg/L Micrograms per liter

0 100 200
Feet

N

Notes: Minimum contour interval shown is being reported as interim cleanup level.
Plumes and average flow directions are based on data from Basewide Groundwater Monitoring Program for years 2010, 2013 and 2015 by CH2M Hill

Source: Esri, DigitalG
Geographics, CNES/
AeroGRID, IGN, and

AECOM

Figure 6.4-2
Site PL582 TCE Groundwater
Contaminant Plume in 2010, 2013, and 2015
Second Five-Year Review
Beale AFB

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7. LUFT

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7.1 Site TU002

7.1.1 Introduction

Site TU002 is the former Capehart Service Station, located northeast of the Vassar Lake Gate at the intersection of Camp Beale Highway and East Garryana Street, within the Base Housing Area (Figure7.1-1).

The first-generation USTs at the former service station consisted of three 10,000-gallon USTs, which were located north of the service station building (Building 3304), on the eastern side of Camp Beale Highway, within a landscaped area. The first-generation USTs were identified as sources of contamination during their removal in 1999, based on holes observed in one of the USTs and soil/water samples collected from the UST excavation, which contained methyl tert-butyl ether (MTBE) (Geofon 1999b).

As part of a remodel in 1999, three new 10,000-gallon USTs (referred to as the second-generation USTs) were installed approximately 100 feet east of Building 3304. In February 2009, the service station was permanently closed, and a new Capehart Service Station (Building 4793) was constructed on the western side of Camp Beale Highway. The second-generation USTs located east of the former service station were removed, and the tank pit was backfilled by Tepa EC, LLC in October 2009. The second-generation USTs also were a source of contamination to groundwater through vapor leaks (Metcalf and Eddy and AECOM 2008). The former service station was demolished in 2013.

Groundwater is the only affected media at Site TU002 because of the relatively shallow groundwater levels across the site. Groundwater depths fluctuate from less than 1 foot bgs to more than 15 feet bgs. Leaking USTs likely directly intersected the shallow groundwater zone at the time of release (CH2M HILL 2014d).

7.1.2 Response Action Summary

Response actions associated with Site TU002 began in 1999; the three 10,000-gallon first-generations USTs were removed and confirmation sampling was conducted (Geofon 1999b). Following the removal of the tanks, 17 groundwater monitoring wells (MW-1 through MW-17) and eight piezometers (P1 through P8) were installed from 2000 to 2006 (Metcalf and Eddy 2000; Metcalf and Eddy and Haling & Associates 2001; Haling & Associates 2002; Haling & Associates and Metcalf and Eddy and AECOM 2006).

A GTS was installed in 2001, to treat MTBE-contaminated groundwater in the shallow groundwater zone only. Groundwater was extracted from converted groundwater monitoring wells MW-2 and MW-3. Corrective action alternatives for groundwater were evaluated in the Engineering Analysis, which identified air stripping and GAC treatment as the preferred remedial alternative (Metcalf and Eddy and AECOM 2008). The remedy for deep groundwater began operation in September 2008. The system was configured to pump groundwater from deep monitoring wells MW-1 and MW-7.

In 2009, the three second-generation USTs were removed and confirmation sampling was conducted within the excavation pit (TEPA EC 2009). An additional groundwater monitoring well (MW-18) was installed after the removal. In 2011, monitoring wells MW-19 to MW-21 were installed (AECOM 2011).

In November 2011, MW-13 was converted to a deep extraction well. Monitoring wells MW-22 to MW-24 were installed during a data gap investigation that was conducted in 2013. The GTS was expanded to extract MTBE-contaminated groundwater from three additional converted monitoring wells (MW-6, MW-11, and MW-23) (CH2M HILL 2014d). The expanded GTS began operation in January 2015.

Cleanup goals for Site TU002 were established in the Site TU002 Corrective Action Plan (CAP) (CH2M HILL 2014d). Cleanup goals were the California MCLs because they represented the minimum standard for groundwater designated for domestic or municipal water supply. The CAP identified MTBE and benzene as the only petroleum constituents of concern that historically have exceeded MCLs in groundwater beneath Site TU002. MCLs for MTBE and benzene are shown in Table 7.1-1.

Table 7.1-1. Site TU002 Groundwater Cleanup Goals

Chemicals of Concern	Groundwater Cleanup Goal (µg/L)
MTBE	13
Benzene	1

MTBE is the primary COC because benzene has not exceeded the cleanup goal since 2011 (CH2M HILL 2016c). TPH-G, BTEX, TBA, and TAME also have been detected in groundwater at Site TU002, but have not exceeded MCLs, have not been detected in recent years, or have been detected at concentrations similar to MTBE. PSLs, protective of groundwater based on the lowest California Department of Public Health maximum contaminant levels, have been established for other petroleum constituents not identified as COCs.

An optimized exit strategy (OES) plan was finalized in February 2016 and defines the process for achieving site closure. The OES identified the optimized GTS as the best remedial value and considered additional in-situ treatments infeasible. Enhancements to the GTS also were deemed unnecessary because all site-related wells with concentrations of MTBE greater than cleanup levels were operating as groundwater extraction wells (CH2M HILL 2016c).

The OES specified five performance goals, one of which included striving to achieve an 85 percent reduction of the mean baseline MTBE concentration in groundwater (339 µg/L) by 2017. After the required reduction percentage is achieved and maintained over a 6-month period while extraction wells are not pumping (rebound period), the performance metric will be considered fulfilled. Additional performance objectives include: reduction in the number of monitoring wells sampled in 2016 by 40, relative to the number of wells sampled in 2014; achievement of the Air Force and regulatory definition of “response complete”; achievement of unrestricted regulatory site closure; and completion of final decommissioning activities.

7.1.2.1 Systems Operations/Operation and Maintenance

The currently operating Site TU002 groundwater extraction system consists of 25 monitoring wells, five of which were converted to extraction wells. Extracted groundwater is treated by a GAC system. According to the *Long-Term Operation and Maintenance Fiscal Year 2015 Annual Report,* 22.1 pounds of MTBE have been removed by the system since startup (CH2M HILL 2016c). In fiscal year 2015 (FY15), 304,852 gallons of groundwater were extracted. The cumulative total volume extracted by the system as of FY15 was 3,985,049 gallons.

In general, the system operates as designed, with little more than routine maintenance (e.g., carbon change-outs and well head maintenance). Minor issues involving pressure transducers not recording water levels in Site TU002 extraction wells have occurred at various times throughout the five-year review period but were quickly addressed and remedied. Overall, the system is maintained and operated as necessary.

7.1.3 Progress since the Last Review

This is the first five-year review for Site TU002.

7.1.4 Data Review

Groundwater is the only affected media at Site TU002. Groundwater is sampled semi-annually and reported annually as part of the Basewide Groundwater Monitoring Program. A summary of activities completed during the 2011 to 2014 sampling events are presented next, followed by a more detailed discussion of 2015 sampling event data.

7.1.4.1 2011–2012

- MW-2 was converted from an extraction well back to a monitoring well in November 2011.
- TPH-G (maximum detection, 51 µg/L) and benzene (maximum detection, 2.1 µg/L) were the only petroleum constituents to exceed MCLs in shallow groundwater.

- MTBE (maximum detection, 2,700 µg/L) and TPH-G (maximum detection, 410 µg/L) were the only COCs to exceed MCLs in deep groundwater.
- The extraction system appeared to be preventing further plume migration.

7.1.4.2 2013

- Benzene was detected in only one well, at a concentration less than the cleanup goal.
- No COCs were detected at concentrations greater than MCLs in shallow groundwater in 2013.
- MTBE was the only COC to be detected (MW-7) in any upgradient or cross-gradient well. The detected concentration was less than the cleanup goal.
- MTBE (maximum concentration, 2,2,60 µg/L [MW-23]) and TPH-G (maximum concentration 620 µg/L [MW-23]) were detected during every event in deep groundwater plume wells.
- MTBE was not detected in any downgradient well. TPH-G was detected in only one sample, at a concentration less than the MCL.
- The sample results indicated the plume was defined in all directions.

7.1.4.3 2014

- No COCs were detected at concentrations greater than cleanup goals in shallow zone wells.
- No COCs were detected in upgradient or cross-gradient deep zone wells.
- MTBE and TPH-G were detected at concentrations greater than MCLs in every deep groundwater plume well, except for MW-22. The highest concentrations of MTBE and TPH-G were detected at MW-23. Data indicated MTBE and TPH-G contamination was not being captured in this area.
- MW-6, MW-11, and MW-23 were converted to extraction wells, to address westward COC migration in the area of MW-23. (Extraction began in January 2015.)

7.1.4.4 2015

The monitoring network at Site TU002 in 2015 consisted of:

- **Source Area and Plume Wells:** MW-1, MW-2 (shallow), MW-6, MW-11, MW-13, and MW-23
- **Cross-gradient Well:** MW-22
- **Downgradient Wells:** MW-9, MW-10, MW-20, and MW-24

The shallow groundwater zone at the site is variably saturated; therefore, only MW-2 was sampled in 2015. No COCs were detected at concentrations greater than the cleanup goals at this well.

Deep zone wells remain saturated throughout the year. MTBE was the only COC detected in the deep zone source area and plume wells. MTBE was detected at concentrations greater than the cleanup goal in plume wells MW-11, MW-13, and MW-23. Based on previous sampling data, MTBE was migrating in the direction of MW-23, but MW-23 was converted to an extraction well, preventing further migration of the MTBE plume. MW-22 was the only cross-gradient well sampled in 2015, and no COCs were detected. A summary of MTBE detections in deep wells is shown in Table 7.1-2. The extent of the Site TU002 MTBE plume in 2015 is shown in Figure 7.1-2.

Table 7.1-2. 2015 MTBE Concentrations in Groundwater, Site TU002

Well ID	2015 Semi-annual MTBE (µg/L)	2015 Annual MTBE (µg/L)
MW-1	NS	2.78
MW-6	NS	0.41 J
MW-11	NS	**411**
MW-13	NS	**235**
MW-23	**781**	**361**

Notes:
Bold = concentration exceeds the MCL (13 µg/L)
J = estimated quantity; NS = not sampled

7.1.5 Technical Assessment

QUESTION A: Is the remedy functioning as intended by the decision documents?

Yes, the remedy is functioning as intended. The optimized GTS is extracting groundwater from all monitoring wells that have MTBE concentrations greater than the site cleanup goal. The MTBE plume is considered to be hydraulically controlled and stable. Overall, the remedy is progressing toward an 85 percent reduction in the mean baseline MTBE concentration, and strives to achieve the performance objective by the end of calendar year 2017. If this goal is attained, the site then will be able to progress toward Site Closure once COC concentrations are below MCLs (13 µg/L MTBE, 1 µg/L benzene).

QUESTION B: Are the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of the remedy selection still valid?

Yes, all assumptions used at the time of remedy selection remain valid. The site remains in similar condition as when the CAP was finalized in 2014, and all exposure assumptions remain valid. No additional site contaminants have been identified, and as of 2016, MTBE was the only COC detected at concentrations greater than its cleanup goal. The cleanup goals for the two COCs (i.e., MTBE and benzene) are the California MCLs, which have not changed after being established in the 2014 CAP (CH2M HILL 2014d). The California MCLs for MTBE and benzene were last updated in May 17, 2000 and February 25, 1989, respectively (State Water Board 2014).

QUESTION C: Has any other information come to light that could call into question the protectiveness of the remedy?

No other information has come to light that could call into question the protectiveness of the remedy.

7.1.6 Issues/Recommendations

No issues that affect the protectiveness of the remedy were identified for Site TU002.

7.1.7 Protectiveness Statement

The corrective measures implemented to date at Site TU002 have adequately addressed all exposure pathways that could result in unacceptable risks in these areas and remain protective of human health.

7.1.8 Next Review

The next five-year review report for the Site TU002 is required five years from the completion date of this review.

Figure 7.1-1
Site TU002 Features Map
Second Five-Year Review
Beale AFB

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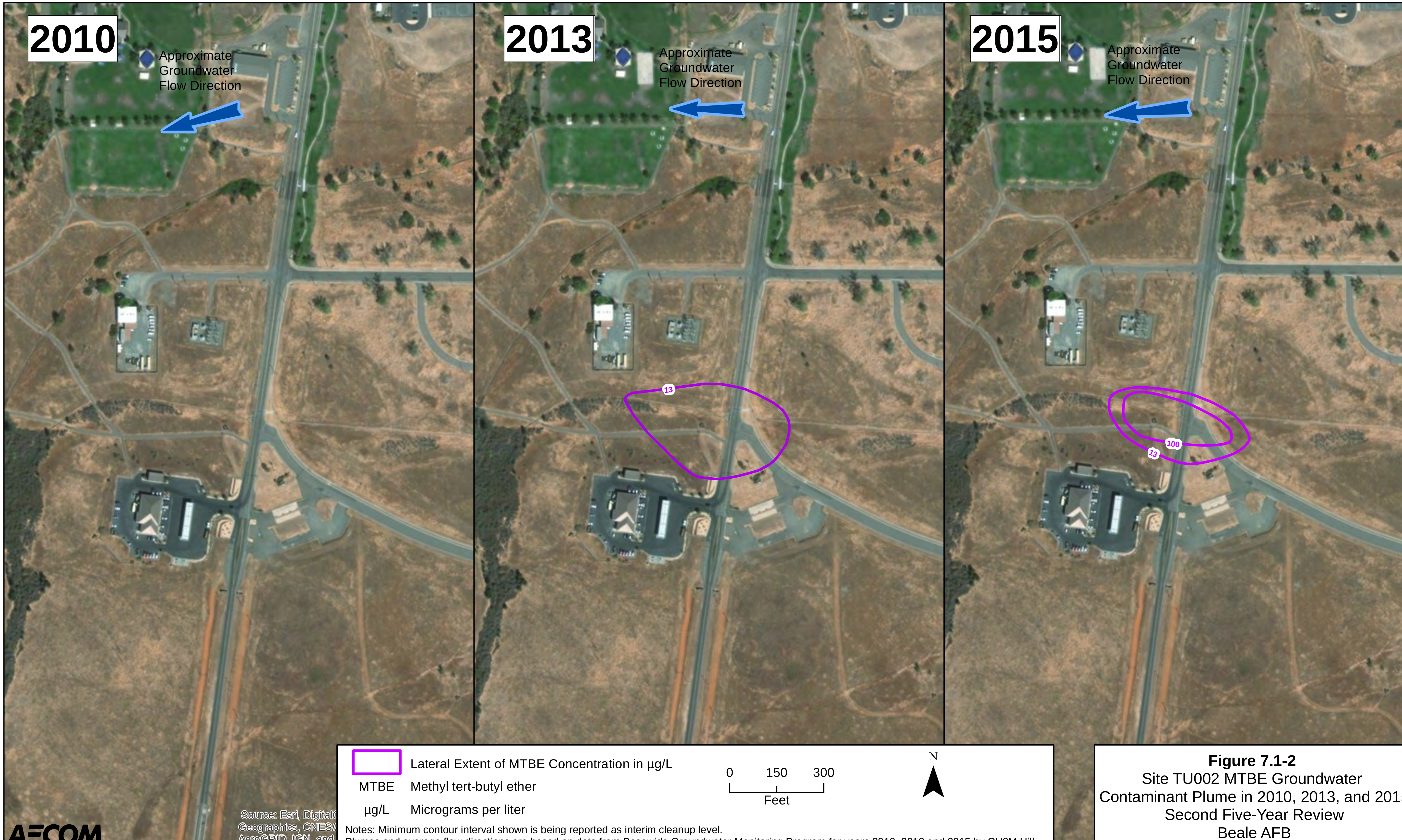

Lateral Extent of MTBE Concentration in µg/L

MTBE Methyl tert-butyl ether

µg/L Micrograms per liter

0 150 300
Feet

N

Notes: Minimum contour interval shown is being reported as interim cleanup level.
Plumes and average flow directions are based on data from Basewide Groundwater Monitoring Program for years 2010, 2013 and 2015 by CH2M Hill

Figure 7.1-2
Site TU002 MTBE Groundwater Contaminant Plume in 2010, 2013, and 2015
Second Five-Year Review
Beale AFB

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7.2 Site ST022

7.2.1 Introduction

Site ST022 consists of the current and former USTs at Beale AFB. A total of 1,097 USTs have been identified in historical records reviews. 1,024 of these USTs have received regulatory closure. Thirty-one of the 73 USTs that have not received closure currently are active USTs with no evidence of releases and are not considered sources of contamination. Of the 42 remaining former USTs, seven are being addressed as part of sites other than ST022. USTs 09-080 through 09-082 are being addressed as part of the response actions for Site FT003. USTs 11-001 through 11-004 are located at the Base medical clinic and are a part of Site TU509. Site ST022 is shown in Figure 7.2-1.

The remaining inactive 35 USTs that have not received closure concurrence are addressed as part of Site ST022. These USTs ranged in size from 580 to 50,000 gallons and were used to store heating oil, diesel, jet fuel, or gasoline. The locations of these former USTs are known based on information in Beale AFB reference maps, including the 1944 Completion Reports Unit Layout maps, the 1958 Liquid Fuel Systems maps, and the 1966 Liquid Fuel System Maps. USTs 05-076, 05-077, and 10-511 were not located on reference maps but are located based on field evidence (10-511) or are thought to never have existed, based on available data (05-076 and 05-077).

7.2.2 Response Action Summary

Because of past fueling and storage activities, petroleum hydrocarbons have been released into the subsurface from leaking USTs, product conveyance lines associated with the USTs, and spills during fueling operations. The primary constituents of concern related to these releases are TPH-D; TPH-G; BTEX; naphthalene; and, in areas where gasoline was stored or dispensed, lead, 1,2-dichloroethane, ethylene dibromide, and methyl tert-butyl ether (MTBE).

Because of the large number of tanks historically present at Beale AFB, the UST program was streamlined through development of a remediation and closure decision tree that was described in detail in the *Risk-Based Cleanup Level Assessment of Petroleum Contaminated Soils* (Metcalf and Eddy 1996). This decision tree has been followed during the UST remediation process at Beale AFB since approximately 1995 (Metcalf and Eddy 1996). The decision tree allows standardized decision-making during the UST removal and remediation process for most USTs.

As indicated in the decision tree, USTs are removed through excavation, and the surrounding soils are inspected visually. If hydrocarbon contamination is observed or suspected in the surrounding soils, up to approximately 500 cubic yards of soil may be removed at each UST. If the amount of contaminated soil exceeds 500 cubic yards, additional remediation is implemented. For the UST cases where soil contamination is associated with TPH-D, the decision tree indicates that bioventing is the selected remedy. For the UST cases where soil contamination is associated with TPH-G, the decision tree indicates that SVE is the selected remedy. For UST cases where TPH contamination has migrated toward groundwater and is within 20 vertical feet of reaching the groundwater table, as determined through either sampling and analysis or visual observations, groundwater monitoring wells are installed to facilitate monitoring TPH in groundwater.

Recent remedial efforts have focused on addressing data gaps for the remaining open USTs and moving towards regulatory closure based on the criteria developed by the State Water Board in its UST Case Low-Threat Closure Policy (LTCP) (State Water Board 2012a). The *Site ST022 Data Gap Investigation Work Plan* (CH2M HILL 2013a) identified data gaps at 26 of the 33 open, suspected or known USTs. The USTs where data gaps were identified included:

- USTs 05-015 through 05-021 and 05-030 through 05-033 (11 USTs)
- UST 09-019
- UST 10-157
- UST 10-216
- UST 10-266
- UST 10-267
- UST 10-313
- UST 10-406
- UST 10-453
- UST 10-494 through 10-496 (three USTs)
- UST 10-504
- UST 10-511
- UST 13-041
- UST 13-046

The seven remaining USTs had adequate data from historical investigations to evaluate risks; therefore, no data gaps were identified. These USTs included:

- USTs 05-039 through 05-041 (three USTs)
- USTs 05-064 through 05-066 (three USTs)
- UST 10-364

Following the data gap investigation, 17 of the 33 open USTs were recommended for low-threat closure in the *Site ST022 Corrective Action Plan/Remedial Action Work Plan* (CAP/RAWP) (CH2M HILL 2015d) and included:

- USTs 05-039 through 05-041 (three USTs)
- USTs 05-064 through 05-066 (three USTs)
- UST 09-019
- UST 10-157
- UST 10-216
- UST 10-266
- UST 10-267
- UST 10-364
- UST 10-453
- UST 10-504
- UST 10-511
- UST 13-041
- UST 13-046

Subsequently, site closure with NFA was requested for the above 17 USTs in 2015 (CH2M HILL 2015h).

The remaining 16 USTs were selected for additional monitoring well installation and groundwater monitoring, although closure criteria for soil and soil vapor were met (CH2M HILL 2015d). Those 16 USTs and their selected actions include:

- **USTs 05-015 through 05-021 and 05-030 through 05-033 (11 USTs):** Installation of one new monitoring well (22C022MW), to verify whether regional shallow groundwater was affected and monitor groundwater conditions directly downgradient from the source area.
- **UST 10-313:** Installation of one new monitoring well (22C023MW), to monitor groundwater conditions directly downgradient from the former source area.
- **UST 10-406:** Installation of one new monitoring well (22C024MW), to monitor groundwater conditions where TPH-D previously was detected in groundwater downgradient from the former UST 10-406 source area.
- **USTs 10-494 through 10-496 (three USTs):** Completion of additional groundwater monitoring, to evaluate concentration trends in plume axis monitoring wells 10-494V3MW and 10-494V4MW, and downgradient monitoring wells 22C018MW and 22C019MW.

The three new groundwater monitoring wells (22C022MW, 22C023MW, 22C024MW) noted in the above bullets were installed, developed, and sampled in May 2015. Based on the results from the data gap investigation and the new groundwater monitoring well sampling, site closure with NFA was requested for the remaining 16 USTs (CH2M HILL 2016j). On regulatory agency approval of the NFA requests, the only UST cases at Beale AFB that will remain open are at Sites FT003 and TU509 (discussed in Sections 5.9 and 7.3, respectively).

7.2.3 Progress since the Last Review

The protectiveness statement for Site ST022 in the first *Five-Year Review Report* (URS 2012) states:

> *The remediation and closure process implemented as part of an aggressive UST removal and cleanup program for Site ST022 at Beale AFB is protective of human health and the environment because it has successfully removed 1,028 USTs, cleaned up the associated contamination where identified, and met the state regulatory requirements for case closure. Although 27 UST cases remain open at Beale AFB, only 4 of the 27 cases require additional characterization.*

The status of the issues and recommendations presented in the first five-year review is shown in Table 7.2-1.

Table 7.2-1. Status of Recommendations from the First Five-Year Review, Site ST022

Issue	Recommendation	Current Status	Current Implementation Status Description	Completion Date (if applicable)
A need exist for reconciliation between the Beale AFB UST database and RWQCB records. Seven UST cases that are considered open have been determined to be aboveground storage tanks (ASTs), in inaccessible areas, or USTs mapped in historical documents that have never been identified in the field.	Complete the characterization of underground storage tank (UST) cases 09-019, 11-003, 11-004, and 13-046.	Completed	UST cases 09-019 and 13-046 were included in the 2013 data gap investigation, and subsequently, site closure with NFA was requested. UST cases 11-003 and 11-004 are associated with Site TU509 (see Section 7.3.1 of this five-year review).	2009; 2013
There is the need for reconciliation between the Beale AFB UST database and RWQCB records. Seven UST cases that are considered open have been determined to be ASTs, in inaccessible areas, or USTs mapped in historical documents that have never been identified in the field.	Reconcile the UST database for Beale AFB with the Central Valley Regional Water Quality Control Board (CVWB) files to show that the open-case USTs that are aboveground storage tanks are in inaccessible locations or never verified in the field, are closed cases.	Completed	1,097 UST cases have been identified from review of CVWB correspondence in the Beale AFB Administrative Record. All current and former USTs have been identified at Beale AFB.	2013

7.2.4 Data Review

During this five-year review, site closure with NFA has been requested for all 33 open UST cases associated with Site ST022 on the basis of the LTCP criteria. A brief data review is provided for each of these sites next. The locations of these USTs are shown in Figure 7.2-1.

USTs 05-015 to 05-021 and 05-030 to 05-033: USTs 05-015 through 05-021 and 05-030 through 05-033 were formerly located near Building 1016 on the flightline and were associated with the hydrant refueling system for Beale AFB's SR-71 mission. The hydrant fueling system included a pump house (former Building 1016), 10 former 50,000-gallon USTs (USTs 05-016 through 05-021 and 05-030 through 05-033), and one former 2,000-gallon UST (UST 05-015). All 11 former USTs stored JP, grade 7 (JP-7), and were removed in 1997 (LCC 1997a).

A data gap investigation was completed in 2013 (CH2M HILL 2015h). BTEX and naphthalene were not detected in any of the soil samples collected. The leachable TPH-D concentration from a sample collected at 5 feet bgs (1.3 mg/L) slightly exceeded the PSL of 1 mg/L, but the concentrations from other samples did not exceed the PSL. The PSL was selected for the protection of groundwater and is based on the lowest of either State or federal regulatory levels. TPH-D concentrations ranged from not detected to 1,030 mg/kg, with the highest concentration detected at 5 feet bgs. TPH-G concentrations ranged from not detected to 30.9 mg/kg, with the highest concentrations detected at 29 feet bgs (CH2M HILL 2016j).

One new monitoring well (22C013MW) was drilled and installed during the data gap investigation, to assess groundwater impacts in the former UST source area. Groundwater samples were collected from the 22C013MW boring during drilling (a HydroPunch sample was collected at 54 feet bgs) in June 2013 and from the installed monitoring well during groundwater monitoring events in August and November 2013.

TPH-D was detected in the HydroPunch sample that was collected in June 2013, at a concentration of 940 µg/L. In the sample collected from the monitoring well in August 2013, TPH-D was detected at an estimated concentration of 540 µg/L, but this result qualified as not detected because of laboratory method blank contamination. TPH-D was not detected in the groundwater sample collected in November 2013. TPH-G and fuel-related VOCs were not detected in the three samples collected in 2013 (CH2M HILL 2016j).

To assess perched groundwater, samples were collected from eight vent wells and VMPs in August 2013. TPH-D concentrations ranged from 2.2 to 13.1 mg/L, and TPH-G concentrations ranged from not detected to 0.92 mg/L. The highest concentrations of TPH-D and TPH-G were detected at VMW1-5. Only low or trace concentrations of BTEX were detected, and none of the BTEX concentrations detected in the perched groundwater samples exceeded PSLs. Naphthalene concentrations ranged from not detected to 38.9 µg/L, and concentrations at BVW-1 and VMW2-1 exceeded the PSL (CH2M HILL 2016j). The Site ST022 CAP/RAWP (CH2M HILL 2015d) concluded that residual contamination in the vadose zone and in shallow perched groundwater does not pose an unacceptable threat to human health or regional groundwater.

The Site ST022 CAP/RAWP recommended NFA and UU/UE for soil and soil vapor and additional groundwater characterization, to confirm the absence of constituents in regional groundwater at concentrations greater than water quality goals. CVWB concurred with the recommendations in a letter dated January 28, 2015 (CVWB 2015b).

In accordance with the recommendation in the Site ST022 CAP/RAWP, an additional groundwater monitoring well (22C022MW) was installed immediately downgradient from the source area in May 2015, and 22C013MW and 22C022MW were monitored between the second quarter of 2015 and the second quarter of 2016 (CH2M HILL 2016j). TPH-D concentrations at 22C013MW slightly exceeded the water quality goal of 100 µg/L in 2014, but did not exceed the water quality goal during the 2015 or 2016 sampling events. Other fuel constituents, including naphthalene, have never been detected at 22C013MW. At 22C022MW, fuel constituents also have never been detected. Concentrations of fuel constituents in perched groundwater exceeded water quality goals, but because of the presence of a clay layer between approximately 12 and 35 feet, residual contamination in perched groundwater is not migrating to or affecting the regional groundwater system.

Benzene, ethylbenzene, and naphthalene were not detected in soil samples collected during historical investigations or the 2013 data gap investigation. Therefore, no unacceptable risk exists to human receptors via the direct contact and outdoor air exposure pathways. For VI, the majority of the area at Site ST022 USTs 05-015 through 05-021 and 05-030 through 05-033 has met the LTCP criteria, except for the benzene concentration detected in VMW1-5. The detected concentration exceeded the soil gas criterion for no bioattenuation zone present (26.6 ppbv) but was well below the criteria when a bioattenuation zone was present (26,600 ppbv). Soil samples collected from BVW-6 and 21C005 indicated that a bioattenuation zone[1] was present. Estimated cancer risks for the residential receptor from contaminants in perched groundwater were all less than or within EPA's risk management range. Therefore, no unacceptable risk exists to human receptors via the VI pathway (CH2M HILL 2016j).

Former USTs 05-015 through 05-021 and 05-030 through 05-033 have met the groundwater-specific criteria for low-threat closure. TPH-D is the only fuel constituent that historically has slightly exceeded a water quality goal. However, TPH-D has not been detected at a concentration greater than its water quality goal in site-related wells since 2014. Both the general and media-specific criteria for NFA under the LTCP have been met for former USTs 05-015 through 05-021 and 05-030 through 05-033 (CH2M HILL 2016j).

USTs 05-039 to 05-041: USTs 05-039 to 05-041 formerly were located 60 feet east of Arnold Avenue and 150 feet north of Curtis Street (LCC 1998). USTs 05-039 and 05-040 were 1,000-gallon tanks, and UST 05-041 was a 5,000-gallon tank (Metcalf and Eddy 1995). All three USTs were removed in 1992, along with an undocumented quantity of affected soil, and were replaced with ASTs.

[1] Bioattenuation zone means an area of soil with conditions that support biodegradation of petroleum hydrocarbon vapors (State Water Board 2012a).

Historical concentrations in soil vapor samples were less than applicable LTCP residential soil vapor criteria, except for three samples collected from VMP-2 and VMP-3 in 2006 that contained concentrations of benzene greater than the soil vapor criterion. However, based on estimated cancer risks and noncancer hazards, no unacceptable risk exists to human receptors via the VI pathway. For soil, concentrations of fuel-related VOCs in historical soil samples both within and outside the UST source area were less than the LTCP residential soil levels for 0- to 5-foot and 5- to 10-foot intervals. Therefore, no unacceptable risk exists to human receptors via the direct contact and outdoor air exposure pathways. Groundwater has not been affected by the historical releases at the former USTs 05-039 to 05-041. Both the general and media-specific criteria for NFA under the LTCP have been met for former USTs 05-039 to 05-041 (CH2M HILL 2015h).

USTs 05-064 to 05-066: USTs 05-064 to 05-066 were formerly located west of Building 1025, which is positioned within the flightline support area in the northern part of Beale AFB (Metcalf and Eddy 1996). USTs 05-064, 05-065, and 05-066 were 2,000-gallon tanks that were used to store unleaded gasoline, diesel fuel, and gasoline, respectively (Metcalf and Eddy 1996). All three USTs and associated piping were removed in 1992, along with an undocumented quantity of affected soil, and were replaced with ASTs.

The CVWB granted soil closure in 1999 (Radian International 1999b), and groundwater has not been affected by the historical releases at former USTs 05-064 to 05-066. Fuel-related VOCs have not been detected in groundwater in over 10 years, and TPH has not been detected in groundwater since 2005. Both the general and media-specific criteria for NFA under the LTCP have been met for former USTs 05-064 to 05-066 (CH2M HILL 2015h).

UST 09-019: UST 09-019 formerly was located at the northeast corner of 10th and N Streets, 80 feet north of 10th Street and 115 feet east of N Street (Metcalf and Eddy 1995). UST 09-019 was a 1,150-gallon heating oil tank associated with former Building T-1130 (Metcalf and Eddy 1995). UST-09-019 was investigated in 1996, 2001, 2006, and 2013. Contaminated soil was excavated in 1996 and between 2004 and 2006. No UST was found during the initial investigation in 1996, but stained soil was discovered, and approximately 1,000 cubic yards of soil were excavated and removed. Approximately 915 additional tons of soil were excavated between 2004 and 2006.

As part of the data gap investigation in 2013, soil boring 22C003SB was drilled approximately 30 feet downgradient from the former excavation boundary, to determine whether groundwater had been affected by historical releases from the UST. A HydroPunch groundwater sample was collected and analyzed. Fuel-related VOCs were not detected. TPH-D was detected at a concentration of 130 J µg/L, which slightly exceeded the PSL of 100 µg/L. Fuel constituents in downgradient wells were not detected during the most recent sampling events. Therefore, the TPH-D plume, if one exists, has met the groundwater-specific criteria for low-threat closure (CH2M HILL 2015h).

Benzene and ethylbenzene were not detected or were detected at concentrations less than LTCP residential soil screening levels at the 0- to 5-foot and 5- to 10-foot intervals. Naphthalene was not analyzed in historical soil samples from UST 09-019. However, an evaluation of data from similar diesel fuel and heating oil release sites across Beale AFB has shown that naphthalene has not been a significant contaminant at these sites (CH2M HILL 2015d). No unacceptable risk exists to human receptors at former UST 09-019 via the direct contact and outdoor air exposure pathways (CH2M HILL 2015h). Both the general and media-specific criteria for NFA under the LTCP have been met for former UST 09-019.

UST 10-157: UST 10-157 formerly was located near the southeast corner of Building 2159, 180 feet south of Warren Shingle Road and 250 feet west of C Street (Metcalf and Eddy 1995). UST 10-157 was identified as a 2,000-gallon diesel UST on the 1958 Liquid Fuel System Map. UST 10-157 was investigated in 1992, 2004, and 2013. During the 1992 investigation, the UST was removed, and two confirmation soil samples were collected from the northern and southern ends of the excavation and were analyzed. TPH-D was detected at 1,100 mg/kg in the northern sample and at 4.6 mg/kg in the southern sample. BTEX was not detected.

As part of the data gap investigation in 2013, soil samples were collected from boring 22C004SBA, to determine whether residual contamination remained at the northern end of the 1992 excavation, where an elevated concentration of TPH-D was detected in 1992. Soil samples were collected at 4, 9, and 14 feet bgs and were analyzed. Leachable TPH-D was detected in each of the samples, with estimated concentrations ranging from 0.1 to 0.12 mg/L, which did not exceed the PSL of 1 mg/L. Total TPH-D concentrations in soil ranged from not detected to 92.8 mg/kg. TPH-G, BTEX, and naphthalene were not detected in soil (CH2M HILL 2015h).

Benzene, ethylbenzene, and naphthalene were not detected in historical and 2013 soil samples. Therefore, no unacceptable risk exists to human receptors via the direct contact and outdoor air exposure pathways. With respect to groundwater impacts and VI, historical and 2013 site characterization data indicated that UST 10-157 was a soil-only case (CH2M HILL 2015h). Both the general and media-specific criteria for NFA under the LTCP have been met for former UST 10-157.

UST 10-216: UST 10-216 formerly was located northwest of Building 2440, 100 feet south of 24th Street and 80 feet east of C Street (Metcalf and Eddy 1995). Former UST 10-216 was a 600-gallon heating oil tank, reportedly excavated and removed in 1992 (Versar 2002), and was further investigated in 1996, 2001, and 2013. In 1996, the site was re-excavated, and 40 cubic yards of stained soil were removed.

As part of the 2013 data gap investigation, two soil borings (22C014SB and 22C015SB) were drilled adjacent to the 1996 excavation, to characterize potential residual vadose zone contamination near the former UST. Soil samples were collected at 4, 9, and 19 feet bgs and were analyzed. VOCs were not detected in any of the soil samples. Total TPH-D was detected in only one sample. Leachable TPH-D was detected in each of the samples, except for the sample collected from boring 22C014SB at 9 feet bgs. All detections were less than PSLs (CH2M HILL 2015h).

Benzene, ethylbenzene, and naphthalene were not detected in historical and 2013 soil samples. Therefore, no unacceptable risk exists to human receptors via the direct contact and outdoor air exposure pathways. Also, no unacceptable risk exists to human receptors via the VI pathway, based on groundwater and soil results. Groundwater has not been affected by releases at former UST 10-216, and no evidence exists that contaminants ever were present in soil at concentrations that could affect groundwater above water quality goals. Both the general and media-specific criteria for NFA under the LTCP have been met for former UST 10-216 (CH2M HILL 2015h).

UST 10-266: UST 10-266 formerly was located near Building T-6480, 198 feet north of 13th Street and 43 feet west of C Street (Metcalf and Eddy 1995). Former UST 10-266 was a 580-gallon heating oil tank. Former UST 10-266 was investigated in 1995 and 2013. Six soil borings reportedly were advanced in 1995, to characterize UST 10-266 (Versar 2002). The former UST was not found during the 1995 investigation.

In 2013, one soil boring was drilled (22C005SB) at the known location of UST 10-266, to determine whether the subsurface had been affected by potential historical releases from the UST. Soil samples were collected at 4, 9, and 14 feet bgs and were analyzed. Fuel-related VOCs were not detected. TPH-D was not detected in any of the samples, except the one collected from 14 to 15 feet bgs. Leachable TPH-D was detected in each of the samples. All detections were less than PSLs (CH2M HILL 2015h).

Benzene, ethylbenzene, and naphthalene were not detected in the 2013 soil samples. Therefore, no unacceptable risk exists to human receptors via the direct contact and outdoor air exposure pathways. With respect to groundwater impacts and VI, site characterization data indicated that UST 10-266 was a soil-only case with minimal effects in soil. Both the general and media-specific criteria for NFA under the LTCP have been met for former UST 10-266 (CH2M HILL 2015h).

UST 10-267: UST 10-267 formerly was located west of Building 2171, 100 feet north of 13th Street and 90 feet east of C Street (Metcalf and Eddy 1995). Former UST 10-267 was a 600-gallon UST used to store heating oil for Building 2171 (CH2M HILL 2006). Former UST 10-267 was investigated in 1990, 1991, 1996, 2002, and 2013. In 1990, approximately 600 cubic yards of contaminated soil were excavated during removal of the UST. The depth of the excavation extended to up to 28 feet bgs (LCC 1997a). After removal of the UST, an SVE system was installed in 1991, and began operation in 1992. In 1994, the SVE system was converted to a bioventing system and operated between 1994 and 2003, and between 2005 and 2007 (CH2M HILL 2015h).

Two soil borings (22C006SB and 22C007SB) were drilled as part of the 2013 data gap investigation near existing vapor monitoring points 22-A20VMP-2, 22-A20VMP-3, and 22 A20VMP-4, where the highest concentrations of TPH and fuel-related VOCs were detected in historical soil samples. Soil and HydroPunch groundwater samples were collected from the two borings, to determine whether petroleum hydrocarbons remained in soil and groundwater at concentrations greater than screening levels. VOCs were not detected in any of the soil samples from either boring location. Leachable TPH-D concentrations in soil ranged from an estimated 0.1 to 22.3 mg/L, with concentrations in three samples exceeding the PSL of 1 mg/L. Total TPH-D concentrations in soil ranged from not detected to 626 mg/kg, with the highest concentrations detected at 15 feet in 22C006SB (461 mg/kg) and at 9 feet in 22C007SB (626 mg/kg) (CH2M HILL 2015h).

HydroPunch groundwater samples were collected from 25 to 30 feet bgs from borings 22C006SB and 22C007SB. VOCs were not detected at either boring, except for benzene, which was detected at 22C006SB at an estimated concentration of 0.21 μg/L, less than the PSL of 1 μg/L. Total TPH-D was detected at concentrations of 2,400 and 2,500 μg/L in 22C006SB and 22C007SB, respectively.

Benzene, ethylbenzene, and naphthalene were not detected in the 2013 data gap investigation soil samples. Therefore, no unacceptable risk exists to human receptors via the direct contact and outdoor air exposure pathways. Based on historical groundwater sampling results within and downgradient from the site, benzene concentrations in groundwater, where detected, were less than 100 μg/L. In addition, UST 10-267 also has met the LTCP criteria for benzene and ethylbenzene in soil vapor. Therefore, no unacceptable risk exists to human receptors via the VI pathway.

For groundwater, the concentration of TPH-D detected in the 2013 HydroPunch groundwater samples and downgradient monitoring wells 22E001MW and 22E002MW exceeded the water quality goal of 100 μg/L. Mann Kendall and Seasonal Kendall tests indicated a significantly decreasing trend for TPH-D concentrations at 22E001MW and no significant trend for the TPH-D concentrations at 22E002MW. Both tests indicated no significant trend in TPH-G concentrations at both wells. Based on evaluation of the time-series plots and the results of the statistical tests, TPH-D concentrations in 22E001MW are decreasing, and TPH-D concentrations in 22E002MW are stable or decreasing.

The time to reach the water quality goal for TPH-D in source area monitoring well 22E001MW was estimated from the existing data set and the first order linear decay constant for the data set. TPH-D concentrations in 22E001MW are estimated to reach the water quality goal of 100 μg/L between 2020 (best estimate) and 2044 (90 percent confidence interval). The TPH-D plume at UST 10-267 has met the groundwater specific criteria for low-threat closure. Both the general and media-specific criteria for NFA under the LTCP have been met for former UST 10-267 (CH2M HILL 2015h).

UST 10-313: UST 10-313 formerly was located approximately 110 feet north of 16th Street and 127 feet east of B Street. Based on this information, the former location of UST 10-313 is adjacent to the north side of Building 2418, which houses the Harris Fitness Center. Former UST 10-313 was a 1,150-gallon tank that contained heating oil. Former UST 10-313 was removed at some time in the past, but the date of its removal was not documented. A geophysical investigation conducted in 2000 found no evidence of a UST or distribution piping where UST 10-313 formerly was located (CH2M HILL 2002). Multiple investigations were conducted at UST 10-313 between 1994 and 2001.

A data gap investigation was completed in 2013 to: (1) determine whether leachable TPH-D concentrations remained in the vadose zone at concentrations that could threaten groundwater; (2) determine the eastern extent of contamination that remained in the source area, if any; and (3) determine whether groundwater was still affected because of historical releases at the site. Two soil borings (22C008SB and 22C016SB) were drilled, and HydroPunch groundwater samples were collected from both borings. TPH-D was detected in the groundwater samples from 22C008SB and 22C016SB at estimated concentrations (200 μg/L and 160 μg/L, respectively) that exceeded the PSL of 100 μg/L. BTEX and naphthalene were not detected in either groundwater sample.

Soil samples were collected at depths ranging from 4 to 19 feet bgs and were analyzed. Total TPH-D concentrations in soil ranged from an estimated 4 to 11,800 mg/kg, with concentrations that exceeded 1,000 mg/kg occurring at 9 and 12 feet bgs at 22C008SB. Trace concentrations of ethylbenzene, toluene, xylenes, and naphthalene were detected in the 4 and 9-foot-bgs soil samples from 22C008SB, but these concentrations were all less than PSLs. Leachable TPH-D concentrations exceeded the PSL in samples collected at 4, 9, and 12 feet bgs from boring 22C008SB. The leachable TPH-D concentrations at these depths were 2.1, 2.3, and 32.1 mg/L, respectively. A layer of lean clay was present in boring 22C008SB at 12 to 14 feet bgs. The soil sample collected below the lean clay layer at 19 feet bgs contained only trace concentrations of total and leachable TPH-D, and the concentration of leachable TPH-D did not exceed the PSL (CH2M HILL 2016j).

The Site ST022 CAP/RAWP (CH2M HILL 2015d) recommended NFA for soil at former UST 10-313, and the CVWB concurred with NFA for soil in a letter dated January 28, 2015 (CVWB 2015b). Additional groundwater monitoring data were recommended to verify that TPH-D concentrations in groundwater were stable or decreasing and could be expected to reach the water quality goal in a reasonable time frame. One new monitoring well (22C023MW) was drilled and installed at the former UST location in 2015.

Following installation, 22C023MW was sampled quarterly between the second quarter of 2015 and the second quarter of 2016. TPH-D and fuel-related VOCs were not detected during any of the monitoring events. TPH-G was detected (at a concentration of 28.5 µg/L) and exceeded the PSL only once, which occurred during the third quarter 2015 event. Former UST 10-313 has met the groundwater-specific criteria for low-threat closure.

Concentrations of benzene, ethylbenzene, and naphthalene in historical and 2013 soil samples were all less than the residential soil levels for 0 to 5-foot and 5- to 10-foot intervals, identified in the LTCP. Therefore, no unacceptable risk exists to human receptors via the direct contact and outdoor air exposure pathways.

For VI, UST 10-313 has met the LTCP criteria. Based on historical groundwater sampling results within and downgradient from the site, benzene concentrations in groundwater have been less than 100 µg/L. Soil samples collected in 2013 indicated that a bioattenuation zone is present, with TPH concentrations in soil less than 100 mg/kg between the water table (24 feet bgs) and approximately 15 feet bgs in 22C008SB, and between the water table and ground surface in 22C016SB. UST 10-313 also has met the LTCP criteria for benzene and ethylbenzene in soil vapor. Therefore, no unacceptable risk exists to human receptors via the VI pathway.

Both the general and media-specific criteria for NFA under the LTCP have been met for former UST 10-313 (CH2M HILL 2016j).

UST 10-364: UST 10-364 was located between former Buildings T-7703 and T-7709. The area currently is covered by a concrete parking lot that serves Building 26216, located approximately 170 feet to the east (Metcalf and Eddy 1995). UST 10-364 has been identified as a 580-gallon tank that contained heating oil. Former UST 10-364 was investigated in 1994, 1995, and 2001. In 1994, an initial investigation was conducted to identify the location of UST 10-364.

In 2001, the UST 10-364 location was excavated by Versar. Initially, an area 10 feet by 24 feet by 5 feet deep was excavated. Field observations identified residual contamination at the north end of the excavation; therefore, the depth of the excavation was increased to 11.5 feet. Soil samples were collected from each of the sidewalls and the bottom of the excavation, and were analyzed. The site then was further excavated to a total depth of 13 feet, a length of 28 feet, and a width of 10 feet. Again, soil samples were collected from each of the sidewalls and the bottom of the excavation, and were analyzed. Leachable TPH-D, TPH-G, and BTEX were not detected in the final confirmation samples. A total of 90 cubic yards of soil were removed from the excavation (Versar 2002).

Analytical results for all historical soil samples were nondetect and less than the residential soil levels identified in the LTCP for 0 to 5-foot and 5 to 10-foot intervals. Naphthalene was not analyzed in historical soil samples from UST 10-364. However, an evaluation of data from similar diesel fuel and heating oil release sites across Beale AFB has shown that naphthalene has not been a significant contaminant at these sites (CH2M HILL 2015d). No unacceptable risk exists to human receptors at former UST 10-364 via the direct contact and outdoor air exposure pathways. For VI, UST 10-364 has met the LTCP criteria. Based on historical groundwater sampling results within and downgradient from the site, benzene concentrations in groundwater were less than 100 µg/L. Final excavation confirmation soil sample results indicated that a bioattenuation zone is present, with TPH concentrations in soil less than 100 mg/kg between ground surface and groundwater. Therefore, no unacceptable risk exists to human receptors via the VI pathway. Groundwater has not been affected by releases at former UST 10-364, and remaining concentrations in soil are protective of groundwater resources. Both the general and media-specific criteria for NFA under the LTCP have been met for former UST 10-364 (CH2M HILL 2015h).

UST 10-406: UST 10-406 was located 150 feet west of B Street and 180 feet south of 16th Street and was a 600-gallon UST that contained diesel fuel. The tank was removed in 1992 by Martech, Inc. After the UST was removed, the Beale AFB Law Center, Building 2419, was constructed over the former UST location (Versar 2005).

A data gap investigation was completed in 2013. Two soil borings, 22C009SB and 22C010SB, were drilled to characterize the capillary fringe and the top of the saturated zone downgradient from former UST 10-406.TPH-D and VOCs were not detected in any of the soil samples. TPH-G was detected only in the soil sample from boring 22C010SB, at 19 feet bgs. Leachable TPH-D was detected in each of the samples, at estimated concentrations that ranged from 0.095 to 0.55 mg/L. All results were less than the PSLs (CH2M HILL 2013a).

Groundwater samples were collected at 22C009SB and 22C0010SB using a HydroPunch sampler, at depths of 29 and 25 feet bgs, respectively. TPH-G and fuel-related VOCs were not detected in the groundwater samples. TPH-D was detected in the groundwater sample from boring 22C010SB, at an estimated concentration of 350 µg/L, which was greater than the PSL of 100 µg/L. The Site ST022 CAP/RAWP concluded that UST 10-406 had met the LTCP general and media-specific criteria for soil and VI, and possibly had met the media-specific criteria for groundwater. The CVWB concurred with NFA for soil in a letter dated January 28, 2015 (CVWB 2015b). The Site ST022 CAP/RAWP recommended additional groundwater monitoring data, to verify that TPH-D concentrations in groundwater were stable or decreasing.

One new monitoring well (22C024MW) was drilled and installed hydraulically downgradient from the former UST location in 2015. The new well was sampled quarterly between the second quarter of 2015 and the second quarter of 2016. TPH-D was detected twice, once during the second quarter of 2015 and again during the first quarter of 2016, but the reported concentrations during both of these events were well below the PSL of 100 µg/L. TPH-G and fuel-related VOCs were not detected during any of the monitoring events. Former UST 10-406 has met the groundwater-specific criteria for low-threat closure.

Concentrations of benzene, ethylbenzene, and naphthalene in historical soil samples, collected in the former UST source area, and in soil samples collected from the capillary fringe downgradient from the source area in 2013 were all less than the residential soil levels for 0 to 5-foot and 5 to 10-foot intervals, identified in the LTCP. Therefore, no unacceptable risk exists to human receptors via the direct contact and outdoor air exposure pathways.

Potential VI directly over former UST 10-406 could not be evaluated using direct evidence because a building sits over the former UST location. However, indirect evidence, presented in the Site ST022 CAP/RAWP (CH2M HILL 2015h), indicated that no VI risk exists from residual contamination in soil or dissolved contamination in groundwater at UST 10-406 (CH2M HILL 2015d).

Both the general and media-specific criteria for NFA under the LTCP have been met for former UST 10-406 (CH2M HILL 2016j).

UST 10-453: UST 10-453 formerly was located 150 feet east of B Street and 85 feet south of 26th Street, at the northeast corner of Building 2470. Based on review of the 1958 Liquid Fuel Systems Map for Beale AFB, UST 10-453 was a 2,000-gallon UST used to store heating oil (Metcalf and Eddy 1997). UST 10-453 was removed and contaminated soil was excavated in 1993. Additional contaminated soil was excavated in 1996 (CH2M HILL 2015h).

OWS N was located approximately 75 feet west of former UST 10-453. OWS N was part of OW034. The CVWB concurred with NFA for vadose zone soil and soil vapor at OW034 in 2014 (Air Force 2014). In 2004, a biovent system was installed and began operating to clean up contamination from OWS N. The vent wells associated with this biovent system are less than 50 feet away from former UST 10-453 (CH2M HILL 2015h). Groundwater west and southwest of former UST 10-453 has been affected by petroleum hydrocarbons released from OWS N. In situ chemical oxidation was implemented in 2012, to treat groundwater contamination associated with OWS N.

In May 2013, one soil boring (22C017SB) was drilled to characterize groundwater conditions directly beneath the former UST 10-453 excavation. A groundwater sample was collected from 27 to 30 feet bgs, using a HydroPunch sampler. The groundwater sample that was collected from boring 22C017SB contained TPH-D at an estimated concentration of 120 µg/L, which slightly exceeded the PSL of 100 µg/L. TPH-D detected in 22C017SB represents the cross-gradient edge of the OWS N plume and was not from a release from former UST 10-453 (CH2M HILL 2015h). VOCs were not detected in the groundwater sample collected from 22C017SB.

Fuel-related VOCs were not detected in the final excavation, and all historical results were less than the residential soil levels established in the LTCP for 0 to 5-foot and 5 to 10-foot intervals. Naphthalene was not analyzed in historical soil samples from UST 10-453. However, an evaluation of data from similar diesel fuel and heating oil release sites across Beale AFB has shown that naphthalene has not been a significant contaminant at these sites (CH2M HILL 2015d). For VI, UST 10-453 has met the LTCP criteria. Benzene was not detected in groundwater directly beneath the former UST area, and a bioattenuation zone is present between the water table and ground surface in which TPH concentrations are less than 100 mg/kg. UST 10-453 also has met the LTCP criteria for benzene and ethylbenzene in soil gas. Therefore, no unacceptable risk exists to human receptors via the VI pathway. In addition, UST 10-453 has not been a source of groundwater contamination. Both the general and media-specific criteria for NFA under the LTCP have been met for former UST 10-453 (CH2M HILL 2015h).

UST 10-494 to 10-496: USTs 10-494 through 10-496 formerly were located approximately 100 feet southeast of the corner of 30th and A Streets. All three tanks were 12,000-gallon gasoline tanks and reportedly were installed in the 1940s and removed prior to 1962. The USTs were mounted on concrete saddles that were set at approximately 6 feet bgs. The USTs were used primarily for gasoline storage and were part of a series of six armored tank division fueling stations along A Street. USTs 10-494 through 10-496 were investigated in 1994, 1995, 1996, 2001, and 2013.

During the 2013 data gap investigation, two new monitoring wells (22C018MWand 22C019MW) were drilled and installed, and then were sampled, along with other site monitoring wells, as part of the basewide groundwater monitoring program annual monitoring event. TPH-D concentrations ranged from not detected to 160 µg/L in downgradient plume axis well 10-494V4MW. TPH-D also was detected in new downgradient monitoring well 22C018MW at 130 µg/L, but was not detected in new downgradient monitoring well 22C019MW. TPH-G was detected in the two new wells. Detected TPH-G concentrations ranged from an estimated 24 to 110 µg/L, with the highest concentration detected in plume axis well 10-494V4MW. Trace concentrations of benzene, toluene, xylenes, and naphthalene also were detected, but all concentrations were less than 1 µg/L.

The Site ST022 CAP/RAWP concluded that former USTs 10-494 through 10-496 had met all the general and media-specific criteria that pertain to soil and soil vapor, and that NFA is required for vadose zone soil. The CVWB concurred with NFA for soil in a letter dated January 28, 2015 (CVWB 2015b). The Site ST022 CAP/RAWP recommended additional groundwater monitoring from the expanded monitoring well network, to further assess concentration trends and plume stability. Using the expanded monitoring well network, groundwater was monitored between the third quarter of 2013 and the first quarter of 2016.

Between the third quarter of 2013 and the first quarter of 2016, TPH-D concentrations exceeded the PSL of 100 µg/L intermittently in source area monitoring well 10-494P1MW, plume axis well 10-494V3MW, and downgradient well 22C018MW. In plume axis well 10-494V4MW, TPH-D concentrations consistently exceeded the PSL between the third quarter of 2013 and the first quarter of 2015. However, TPH-D concentrations were less than the PSL in second quarter of 2015 samples collected from all wells. TPH-G was detected and exceeded the PSL of 5 µg/L in plume axis wells 10-494V3MW and 10-494V4MW, downgradient well 22C018MW, and cross- gradient well 22C019MW. In During second quarter 2015, TPH-G was detected only in the sample from plume axis well 10-494V4MW. BTEX and naphthalene were not detected in site-related wells after 2013 (CH2M HILL 2016j).

Concentrations of benzene, ethylbenzene, and naphthalene in historical soil samples were all less than the residential soil levels for 0 to 5-foot and 5 to 10-foot intervals, identified in the LTCP. Therefore, no unacceptable risk exists to human receptors via the direct contact and outdoor air exposure pathways. For VI, USTs 10-494 through 10-496 have met the LTCP criteria. Based on historical groundwater sampling results within and downgradient from the site, benzene concentrations in groundwater were less than 100 µg/L, and 15 of the 19 historical soil sample locations had concentrations less than 100 mg/kg of TPH. The impacts associated with the four soil samples where TPH concentrations exceeded 100 mg/kg likely are associated with the smear zone because the samples are not located near the former USTs. These areas were treated aggressively with Oxygen Release Compound ORC in 2004. Based on this information, USTs 10-494 through 10-496 present no unacceptable VI risk (CH2M HILL 2016j).

Former USTs 10-494 through 10-496 have met the groundwater-specific criteria for low-threat closure. TPH-G was the only petroleum constituent present in groundwater at concentrations greater than water quality goals. The contaminant plume that exceeds water quality goals is less than 250 feet in length. Benzene has not been detected in groundwater since 2013, and has never exceeded its maximum contaminant level. TPH concentrations that exceeded water quality goals were relatively low and were very limited in extent. The plume is stable or decreasing in extent and poses a low or no threat to human health and the environment. Both the general and media-specific criteria for NFA under the LTCP have been met for former USTs 10-494 through 10-496 (CH2M HILL 2016j).

UST 10-504: UST 10-504 formerly was located 105 feet northwest of A Street and 320 feet southwest of 26th Street. Based on review of the 1958 Liquid Fuel Systems Map for Beale AFB and the 1944 Completion Reports Unit Layout Map for Camp Beale, UST 10-504 was a 5,000-gallon UST used to store motor fuel. The site is currently located in the parking lot of a Burger King restaurant on A Street, between 25th and 26th Streets (Metcalf and Eddy 1997).

Former UST 10-504 was investigated in 1995, 1996, and 2013. The 1995 investigation consisted of drilling two soil borings (SB-1 and SB-2) and collecting and analyzing soil samples. The 1996 investigation consisted of drilling seven soil borings (BH1 through BH6 and BH10), installing five groundwater monitoring wells (10-504M1MW through 10-

504M5MW), and one vent well (VES1) within 50 feet of the former UST location, and collecting and analyzing soil samples (CH2M HILL 2015h).

As part of the 2013 data gap investigation, one soil boring (22C011SB) was drilled to a depth of 15 feet bgs, to verify that the residual fuel constituent concentrations in the soil and soil vapor in the source area were less than PSLs. Soil samples were collected at depths of 7, 11, and 14 feet bgs, and were analyzed. A soil vapor sample also was collected from soil boring 22C011SB, at 6 feet bgs, and was analyzed for VOCs. Leachable TPH-D concentrations in soil were all less than the 1mg/L PSL. Total TPH-D was detected in only one sample (the sample collected at 7 feet bgs), at an estimated concentration of 118 mg/kg. TPH-G was not detected in soil except for one detection of 0.18 mg/kg in the sample collected at 11 feet bgs. BTEX and naphthalene were not detected in soil, and lead concentrations in soil were all less than the PSL of XX mg/kg. Benzene and toluene were detected at low or trace concentrations in the soil vapor sample, but the concentrations did not exceed PSLs.

Benzene, ethylbenzene, and naphthalene concentrations for all 2013 soil samples were less than the residential soil levels identified in the LTCP for 0 to 5-foot and 5 to 10-foot intervals. Therefore, no unacceptable risk exists to human receptors via the direct contact and outdoor air exposure pathways. For VI, former UST 10-504 has met the LTCP criteria with benzene, ethylbenzene, and naphthalene concentrations less than the LTCP residential soil vapor criteria. Therefore, no unacceptable risk exists to human receptors via the petroleum VI to indoor air pathway.

The petroleum hydrocarbon groundwater plume at former UST 10-504 has met the groundwater-specific criteria for low-threat closure. The plume is less than 100 feet in length, and no receptors are within 250 feet of the site. TPH-G has not been detected in site-related monitoring wells since 2005. TPH-D has been detected sporadically in site wells. Mann-Kendall and Seasonal Kendall test results have indicated no significant trend or a significantly decreasing trend for TPH-G and TPH-D, except for TPH-D at 10-504M5MW, where a significantly increasing trend was indicated. However, this result was because of a trace-level detection of TPH-D in 2012. Except for one estimated detection of TPH-D at 110 µg/L in 1999, TPH-D has not been detected at 10-504M5MW during all other monitoring events, going back to 1996.

Both the general and media-specific criteria for NFA under the LTCP have been met for former UST 10-504 (CH2M HILL 2015h).

UST 10-511: UST 10-511 is believed to have been located northwest of the corner of 23rd and A Streets. During two separate investigations, the tank was not located. According to the Beale AFB plan drawings, UST 10-511 was located 290 feet north of 23rd Street and 125 feet west of A Street, and was identified as a 580-gallon tank (Metcalf and Eddy 1995). The tank contents were not identified, but based on the size of the tank, it likely stored heating oil (CH2M HILL 2015h).

Former UST 10-511 evidently was removed prior to the 1990s. The area was investigated in 1993, 1995, and 2013. Associated groundwater monitoring wells 39U006AMW and 39U006BMW were sampled most recently for TPH-D and TPH-G in 2013. TPH-D and TPH-G were not detected in either well. 39U006AMW and 39U006BMW were sampled most recently for VOCs in 2014. Fuel-related VOCs, including naphthalene, were not detected in either well (CH2M HILL 2015h).

The location of UST 10-511, as documented in the 1995 UST database, was not investigated prior to 2013 because the trenches excavated in 1993 and 1995 were dug in the wrong place. However, in 2013, one boring (22C012SB) was drilled to 20 feet bgs, using a direct-push drill rig to evaluate fuel constituents (i.e., leachable TPH-D, total TPH-D, TPH-G, and VOCs) at the UST 10-511 location that was identified in the 1995 UST Database Summary Table (revised) (Metcalf and Eddy 1995). All soil results were less than PSLs.

Benzene, ethylbenzene, and naphthalene concentrations for all 2013 soil samples were less than the residential soil levels that were identified in the LTCP for 0 to 5-foot and 5 to 10-foot intervals. Therefore, no unacceptable risk exists to human receptors via the direct contact and outdoor air exposure pathways. For soil vapor, former UST 10-511 has met the LTCP criteria. Based on 2013 sampling results, benzene concentrations in groundwater were less than 100 µg/L, and the TPH concentrations in soil at boring 22C012SB were less than 100 mg/kg at all depths sampled. Therefore, no unacceptable risk exists to human receptors from petroleum constituents via the VI pathway. Groundwater has not been affected by releases at former UST 10-511, and concentrations in soil are protective of groundwater. Both the general and media-specific criteria for NFA under the LTCP have been met for former UST 10-511 (CH2M HILL 2015h).

UST 13-041: UST 13-041 was located near Building 411, 152 feet south of 9th Street and 500 feet east of G Street. Based on this information, the former location of UST 13-041 is adjacent to the southeastern corner of Building 411. Former UST 13-041 was identified as a 2,000-gallon tank that contained diesel fuel (Metcalf and Eddy 1996). Former UST 13-041 was removed in 1993. The area was investigated in 1993, 2001, 2002, 2005, 2008, and 2013.

Groundwater monitoring well 18V001MW was sampled in the third quarter of 2013, to characterize current groundwater conditions in the UST source area, where leachable TPH-D concentrations in historical soil samples exceeded the PSL. No analytes (i.e., TPH-D, TPH-G, and VOCs) were detected.

Analytical results for all soil samples were all less than the residential soil levels that were identified in the LTCP for 0 to 5-foot and 5 to 10-foot intervals. Naphthalene was not analyzed in historical soil samples from UST 13-041. However, an evaluation of data from similar diesel fuel and heating oil release sites across Beale AFB has shown that naphthalene has not been a significant contaminant at these sites (CH2M HILL 2015d). No unacceptable risk exists to human receptors at former UST 13-041 via the direct contact and outdoor air exposure pathways. For VI, former UST 13-041 has met the LTCP criteria. Based on historical groundwater sampling results within and downgradient from the site, benzene concentrations in groundwater have been less than 100 µg/L. Historical soil sample data have indicated that a bioattenuation zone is present with TPH concentrations in soil less than 100 mg/kg. Former UST 13-041 also has met the LTCP criteria for benzene and ethylbenzene in soil vapor. Therefore, no unacceptable risk exists to human receptors via the VI pathway. Groundwater has not been affected by releases at former UST 13-041. Both the general and media-specific criteria for NFA under the LTCP have been met for former UST 13-041 (CH2M HILL 2015h).

UST 13-046: UST 13-046 formerly was located near the corner of Gavin Mandery Drive and D Street. According to the 1944 Completion Reports Unit Layout Maps, UST 13-046 was located 195 feet north of 6th Street (Gavin Mandery Drive) and 168 feet east of D Street, and was identified as a 1,150-gallon tank (Metcalf and Eddy 1995). No documentation is in the Beale AFB Administrative Record indicating that this UST was ever investigated prior to 2013, but the UST excavation grave was identified in 2013, based on a shallow rectangular depression near the historically documented location of the former UST (CH2M HILL 2015h). Based on the UST's size and location, it likely was a heating oil UST (CH2M HILL 2015h).

In 2013, soil samples were collected from two borings (22C020SB and 22C021SB), located at the eastern and western ends of the UST excavation grave, to determine whether residual impacts remain at the former UST location. Soil samples were collected at 4, 9, and 19 feet bgs and were analyzed. Leachable TPH-D was not detected in soil. Total TPH-D was detected only in the samples collected at 4 feet bgs in both borings. TPH-G was detected in the sample from 19 feet bgs in 22C020SB and the samples from 9 and 19 feet bgs in 22C021SB. All TPH-D and TPH-G detections were less than PSLs. BTEX and naphthalene were not detected in soil (CH2M HILL 2015h).

Benzene, ethylbenzene, and naphthalene were not detected in the 2013 soil samples. Therefore, no unacceptable risk exists to human receptors via the direct contact and outdoor air exposure pathways. With respect to potential groundwater impact and VI, site characterization data collected in 2013 indicated minimal impacts on soil adjacent to the UST excavation grave. Leachable TPH-D and fuel-related VOCs were not detected, and no indication exists that contaminants ever were present in soil at concentrations that could cause a VI concern or affect groundwater at concentrations greater than water quality goals. Both the general and media-specific criteria for NFA under the LTCP have been met for former UST 13-046 (CH2M HILL 2015h).

7.2.5 Technical Assessment

QUESTION A: Is the remedy functioning as intended by the decision documents?

Yes, the remedies have functioned as intended. Regulatory closure is pending for the 33 open UST cases at Site ST022, based on all sites meeting both general and media-specific criteria for NFA under the State Water Board's LTCP.

QUESTION B: Are the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of the remedy selection still valid?

The Site ST022 USTs are not addressed as part of an ERP decision document. The State Water Board UST Program maintains jurisdiction over UST cases at Beale AFB. Evaluation of a site for closure follows the current LTCP criteria (State Water Board 2012a), which consider the protection of human health and the environment.

QUESTION C: Has any other information come to light that could call into question the protectiveness of the remedy?

No additional information has come to light that could call into question the protectiveness of the remedies.

7.2.6 Issues/Recommendations

No issues that affect the protectiveness of the remedies were identified for Site ST022.

7.2.7 Protectiveness Statement

The remedies at Site ST022 are protective of human health and the environment.

7.2.8 Next Review

Pending approval of the NFA requests submitted for the remaining open UST case, no further five-year reviews are planned for Site ST022.

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Figure 7.2-1
Site ST022 Features Map
Second Five-Year Review
Beale AFB

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7.3 Site TU509

7.3.1 Introduction

Site TU509 is located at the Base medical clinic, at 15301 Warren Shingle Boulevard near the intersection with Camp Beale Highway (Figure 7.3-1). The Base medical clinic was constructed in the late 1950s and enlarged in mid-1960. The clinic was identified as an environmental site in 1998, when soil contamination was discovered during removal of one diesel UST and the in-place abandonment of two diesel USTs. The contaminated area associated with these three former USTs has been designated as Site TU509. During subsequent investigations (Metcalf and Eddy and Haling & Associates 2003; URS 2009), chlorinated solvent contamination was discovered in groundwater approximately 50 feet north of Building 5702. The chlorinated solvent contamination is separate from TU509 contamination and has been designated as Site CG041-517.CG041-517 is discussed in Section 5.9. The TPH-D groundwater plumes beneath Site TU509 also are addressed as part of Site CG041 as Site CG041-509, and are discussed in Section 5.9.

7.3.2 Response Action Summary

Beginning in 1989, several remedial investigations and actions were conducted at Site TU509. USTs 5702-3 and 5702-4 were abandoned in place following cleaning/rinsing and being filled with sand slurry cement. UST 5702-5 was excavated and removed from an overall excavation footprint that was 15 feet wide by 22 feet long by 10 feet deep (Geofon 1999a). In addition, in 2009, USTs 5702-3 and 5702-4 were removed and disposed off-site. The excavations then were backfilled with clean fill (CH2M HILL 2010a).

Remedial investigations at Site TU509 continued to occur from 2001 to 2010, in which time 31 soil borings were advanced and 37 groundwater monitoring wells were constructed (URS 2001, 2009;; CH2M HILL 2010a).

Contaminants were identified in soil, soil vapor, and groundwater at Site TU509. TPH-D and naphthalene were identified as COCs in soil, although TPH-D in soil is believed to be derived from smearing of groundwater contamination resulting from fluctuating groundwater levels (CH2M HILL 2015b). Naphthalene was detected in confirmation soil samples following soil excavation in February 2015, at concentrations less than the cleanup level identified in the CAP. The Air Force has sought site closure through the State Water Board Low-Threat Closure Policy (LTCP) (State Water Board 2012a) for Site TU509, but the CVWB has not concurred yet because of concerns of potential recontamination of soil by the TPH-D smearing of groundwater contamination (CH2M HILL 2016f).

Benzene, ethylbenzene, and naphthalene typically are considered the primary risk-driving chemicals at petroleum release sites (State Water Board 2015). These three analytes were detected in soil vapor samples at concentrations less than PSLs, as identified in the *TU509 and CG517 Data Gap Investigation Work Plan* (CH2M HILL 2014g),collected during a data gap investigation that was conducted in May 2014 (CH2M HILL 2015b). Therefore, NFA is required to address petroleum constituents in soil vapor (CH2M HILL 2016g).

Excavation, enhanced bioremediation targeting groundwater, and LUCs were the corrective actions selected in the CAP (CH2M HILL 2015b). These actions included excavating TPH-D contaminated soil and installation of perforated piping on the bottom of the excavated area to facilitate the application of oxygen reducing compound, advanced to remediate groundwater at a later date. The soil excavation was completed in January 2015 and consisted of the removal of 717 tons of smear zone soil from the former UST source area. Confirmation samples were collected from the sidewalls before installation of the perforated piping and backfilling.

Groundwater monitoring, free-product removal, and maintenance and monitoring of LUCs are the current remedy components in place for Site CG041-509). No additional remedies have been proposed for TU509 soils. These remedial actions will continue until NFA is approved by the CVWB.

LUCs, as specified in the CAP Addendum, have been monitored semi-annually and reported annually, beginning in 2015. No site disturbances have been observed during inspections other than those related to remedial activities that have been maintained in accordance with CAP requirements.

7.3.3 Progress since the Last Review

The USTs located at Site TU509 were addressed under Site ST022 (basewide USTs) in the first *Five-Year Review Report* (URS 2012). The protectiveness statement for Site ST022 states:

> *The remediation and closure process implemented as part of an aggressive UST removal and cleanup program for Site ST022 at Beale AFB is protective of human health and the environment because it has successfully removed 1,028 USTs, cleaned up the associated contamination where identified, and met the state regulatory requirements for case closure. Although 27 UST cases remain open at Beale AFB, only 4 of the 27 cases require additional characterization.*

Clinic USTs 5702-3 (formerly identified as UST 11-003) and 5702-4 (formerly identified as UST 11-004) at Site TU509 were two of the four UST cases identified as needing additional characterization. As of this five-year review, characterization is considered to be complete, and a draft OES document has been prepared (CH2M HILL 2016g). The status of the issue and recommendation from the first five-year review is presented in Table 7.3-1.

Table 7.3-1. Status of Recommendations from the First Five-Year Review, Site TU509

Issue	Recommendation	Current Status	Current Implementation Status Description	Completion Date (if applicable)
A need exists for reconciliation between the Beale AFB UST database and RWQCB records. Seven UST cases that are considered open have been determined to be aboveground storage tanks, in inaccessible areas, or USTs mapped in historical documents that have never been identified in the field.	Complete the characterization of underground storage tanks (USTs) cases 09-019, 11-003, 11-004, and 13-046.	Complete	USTs 11-003 and 11-004 were located at Site TU509. They were removed in 2009, and ORC-A treatment of the excavation floor followed. Characterization is complete.	2009

7.3.4 Data Review

As of the date of this second five-year review, groundwater is considered to be the only contaminated media at Site TU509 requiring further remedial action. Residual contamination in soil is believed to be caused by smearing of groundwater contamination by rising and falling water levels. Remediation of smear zone contamination was not an objective of the selected corrective action alternative that was identified in the Site TU509 CAP. However, excavation has been implemented to remove as much smear zone contamination as possible within and downgradient from the source area to: (1) reduce the mass of TPH-D contamination in the subsurface to accelerate cleanup of groundwater (CG041-509); and (2) remove any remaining concentrations of naphthalene above the cleanup goal of 9.7 mg/kg in the upper part of the smear zone that potentially could pose an unacceptable risk to human health during the dry season, when groundwater levels are as deep as 13 feet bgs (CH2M HILL 2016f).

Confirmation samples were collected following excavation from excavation area side walls, where all visible signs of staining had been removed or where interfering structures prevented further excavation. Confirmation samples were not collected from the floor because soil was removed to the top of the saturated zone, which was not the focus of the correction action. A minimum of one sample was collected from each sidewall. Multiple samples were collected where contamination was left in place because of existing structures that prevented further excavation.

All samples contained leachable TPH-D concentrations below the cleanup goal (1 mg/L), except for samples TU509C010 through TU509C015, which were located along the southern half of the excavation area where existing structures prevented further excavation. The highest concentration of leachable TPH-D was 42 mg/L in sample TU509C013. Naphthalene was detected below the cleanup goal (9.7 mg/kg) in all confirmation soil samples. Site TU509 meets all general and media-specific criteria in the LTCP that pertain to soil and soil vapor (CH2M HILL 2016f).

7.3.5 Technical Assessment

QUESTION A: Is the remedy functioning as intended by the decision documents?

Yes, in part, the remedy is functioning as intended. Soil and soil vapor at Site TU509 meet the low-threat closure criteria (State Water Board 2012a); however, UU/UE will not be approved by the CVWB until groundwater also meets the criteria for low-threat closure. Groundwater remains an ongoing issue because of the presence of immobile light non-aqueous phase liquid (LNAPL) present below the water table in fractured metavolcanic bedrock. LUCs prevent groundwater use and potential exposure to petroleum COCs in soil from groundwater. Further excavation at the site is not feasible because the residual contamination is below the water table; therefore, the remedy for soil is considered protective of human health and the environment for the long term. Ongoing LNAPL presence will prevent site closure in the short term and may persist in the long term, depending on local groundwater level fluctuations.

QUESTION B: Are the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of the remedy selection still valid?

The Site TU509 USTs are not addressed as part of an Environmental Restoration Program (ERP) decision document. The State Water Board UST Program maintains jurisdiction over UST cases at Beale AFB. Evaluation of a site for closure follows the current LTCP criteria (State Water Board 2012a), which consider the protection of human health and the environment.

QUESTION C: Has any other information come to light that could call into question the protectiveness of the remedy?

No other information has come to light that could call into question the protectiveness of the remedy.

7.3.6 Issues/Recommendations

No issues were identified during the Site TU509 technical review.

7.3.7 Protectiveness Statement

The remedy at Site TU509 is protective of human health and the environment.

7.3.8 Next Review

The next five-year review report for Site TU509 is required five years from the completion date of this review.

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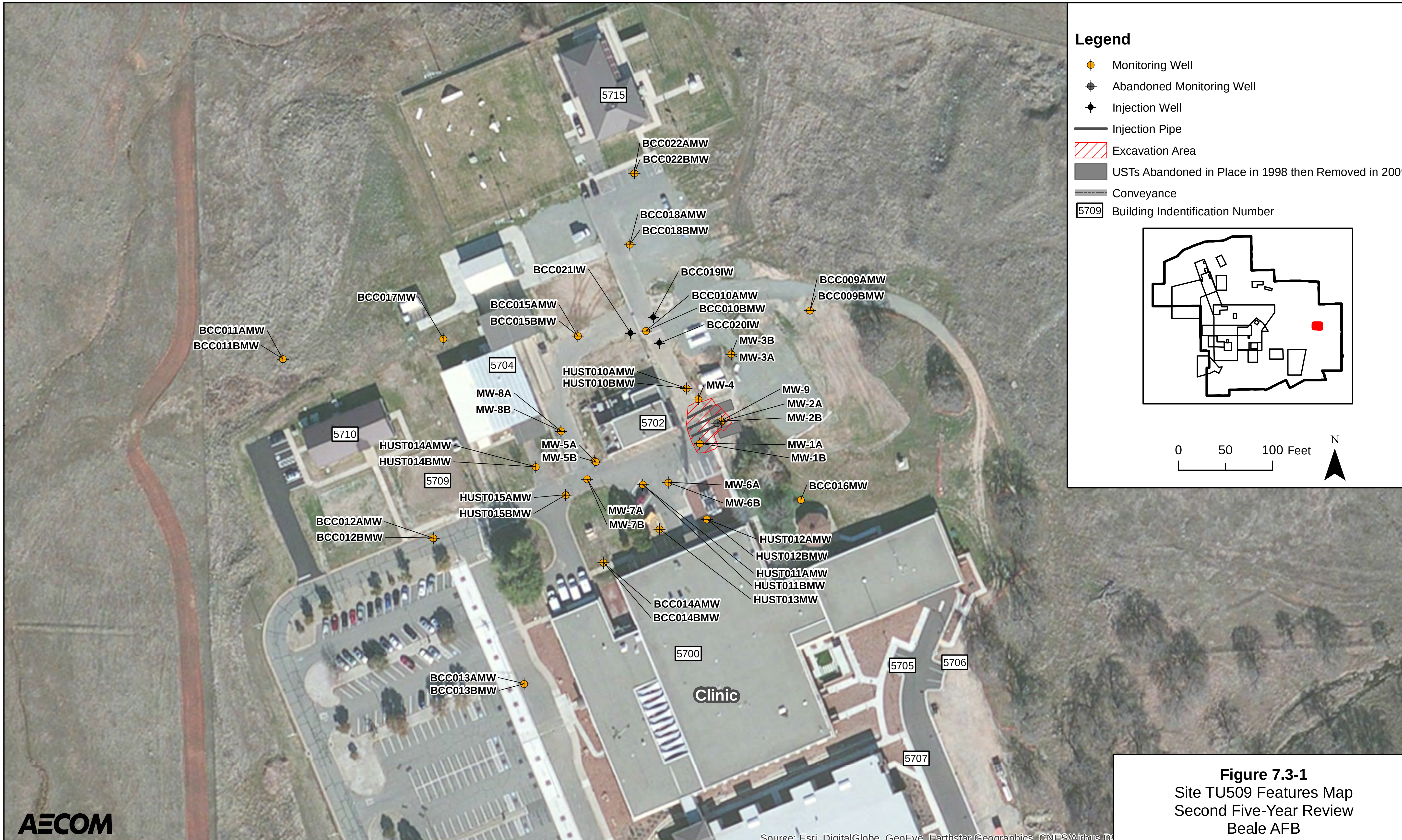

Figure 7.3-1
Site TU509 Features Map
Second Five-Year Review
Beale AFB

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Appendix A Regulatory Agency Comment Letters and Interview Records

Interview Records: Restoration Advisory Board Members

From November 17, 2016 Meeting

INTERVIEW RECORD

Facility Name: Beale AFB, California	**EPA ID No.: N/A**	
Subject: 2016 Five-Year Review Interview	**Time: N/A**	**Date:**
Type: Telephone Visit Other (e-mail) **Location of Visit:**	Incoming Outgoing	

Contact Made By:

Name: Scott Dressler	**Title: Project Manager**	**Organization: AECOM**

Individual Contacted:

Name: Joan Saunders	**Title:** Community member	**Organization:**
Telephone No: 530-743-0315 **Fax No:** **E-Mail Address:**	**Street Address:** 1807 Sierra Way **City, State, Zip:** Marysville, Ca. 95901	

Interview Questions

1. What is your overall impression of the remedies selected for Beale AFB's Environmental Restoration Program (ERP) (e.g. Excavation, SVE, Groundwater Extraction and Treatment)?

We are not told about remedies until after they've been used. They seem to be working well.

2. Are the groundwater remedies functioning as expected? Do you have any concerns regarding the function of the remedies?

3. Have there been unexpected Operations and Maintenance (O&M) difficulties or costs at the site since startup?

If there are any difficulties, the RAB members are not told about them.

4. Has the site been in compliance with permitting and reporting requirements?

5. Do you have any comments, suggestions, or recommendations regarding the implementation of the ERP remedies or how the program has been conducted, in general?

6. Do you have any comments on the operation of the ERP remedies related to future effectiveness or optimization of operations?

7. What is your single greatest concern regarding the ongoing performance of the ERP remedies? The length of time it's taking to restore Beale's environment (20 some yrs.) and to keep the contamination from spreading outside of the base parimater.

8. Does the monitoring data show any trends that contaminant levels are increasing or decreasing? Have any new or emerging Contaminants of Concern (COCs) been identified? If so, have they impacted the effectiveness of the remedies?

9. Would you say that O&M and/or sampling efforts have been optimized? Please describe how improved efficiency has or has not occurred.

INTERVIEW RECORD

Facility Name: Beale AFB, California	**EPA ID No.: N/A**	
Subject: 2016 Five-Year Review Interview	**Time: N/A**	**Date:**
Type: Telephone Visit Other (e-mail) **Location of Visit:**	Incoming Outgoing	

Contact Made By:

Name: Scott Dressler	**Title: Project Manager**	**Organization: AECOM**

Individual Contacted:

Name: John Nicoletti	**Title:** Community Mem	**Organization:** Yuba County
Telephone No: 530 701 1773 **Fax No:** **E-Mail Address:** johnnicoletti@gmail.com	**Street Address:** 1915 Boulton Wy **City, State, Zip:** Marysville, CA 95901	

Interview Questions

1. What is your overall impression of the remedies selected for Beale AFB's Environmental Restoration Program (ERP) (e.g. Excavation, SVE, Groundwater Extraction and Treatment)?

I am very impressed – it has been a terrific education

2. Are the groundwater remedies functioning as expected? Do you have any concerns regarding the function of the remedies?

A yes

B no

3. Have there been unexpected Operations and Maintenance (O&M) difficulties or costs at the site since startup?

none that I am aware of

4. Has the site been in compliance with permitting and reporting requirements?
5. Do you have any comments, suggestions, or recommendations regarding the implementation of the ERP remedies or how the program has been conducted, in general?
6. Do you have any comments on the operation of the ERP remedies related to future effectiveness or optimization of operations?
7. What is your single greatest concern regarding the ongoing performance of the ERP remedies?
8. Does the monitoring data show any trends that contaminant levels are increasing or decreasing? Have any new or emerging Contaminants of Concern (COCs) been identified? If so, have they impacted the effectiveness of the remedies?
9. Would you say that O&M and/or sampling efforts have been optimized? Please describe how improved efficiency has or has not occurred.

INTERVIEW RECORD

Facility Name: Beale AFB, California	EPA ID No.: N/A	
Subject: 2016 Five-Year Review Interview	Time: N/A	Date:
Type: Telephone Visit Other (e-mail) Location of Visit:	Incoming Outgoing	

Contact Made By:

Name: Scott Dressler	Title: Project Manager	Organization: AECOM

Individual Contacted:

Name: Sandy Saunders	Title: Community Member	Organization: BAFB RAB
Telephone No: 530 743 0315 Fax No: E-Mail Address:	Street Address: 1807 Sierra Way City, State, Zip: Marysville, CA 95901	

Interview Questions

1. What is your overall impression of the remedies selected for Beale AFB's Environmental Restoration Program (ERP) (e.g. Excavation, SVE, Groundwater Extraction and Treatment)?

I am very impressed by the remedies used in the restoration program

2. Are the groundwater remedies functioning as expected? Do you have any concerns regarding the function of the remedies?

I have no concerns. According to the information from our news letters and quarterly meetings most are functioning as expected.

3. Have there been unexpected Operations and Maintenance (O&M) difficulties or costs at the site since startup?

Unknown.

4. Has the site been in compliance with permitting and reporting requirements? Yes
5. Do you have any comments, suggestions, or recommendations regarding the implementation of the ERP remedies or how the program has been conducted, in general? The programs are very interesting I have learned alot
6. Do you have any comments on the operation of the ERP remedies related to future effectiveness or optimization of operations? None
7. What is your single greatest concern regarding the ongoing performance of the ERP remedies? Migrating beyond the Base limits
8. Does the monitoring data show any trends that contaminant levels are increasing or decreasing? Have any new or emerging Contaminants of Concern (COCs) been identified? If so, have they impacted the effectiveness of the remedies? Unknown
9. Would you say that O&M and/or sampling efforts have been optimized? Please describe how improved efficiency has or has not occurred. No Comment

INTERVIEW RECORD

Facility Name: Beale AFB, California	EPA ID No.: N/A	
Subject: 2016 Five-Year Review Interview	Time: N/A	Date: 11/17/16
Type: Telephone Visit Other (e-mail) Location of Visit: RAB MTG In person	Incoming 10:00	Outgoing 8:00

Contact Made By:

Name: Scott Dressler	Title: Project Manager	Organization: AECOM

Individual Contacted:

Name: Phil Graham	Title: General Manager	Organization: Recology
Telephone No: 530 743-6321 Fax No: 530 743-8649 E-Mail Address: pgraham@recology.com	Street Address: ~~5900~~ 5900 Ostrom Rd City, State, Zip: Wheatland, CA 95692	

Interview Questions

1. What is your overall impression of the remedies selected for Beale AFB's Environmental Restoration Program (ERP) (e.g. Excavation, SVE, Groundwater Extraction and Treatment)?

That the appropriate remedies were ~~selected~~ selected.

2. Are the groundwater remedies functioning as expected? Do you have any concerns regarding the function of the remedies?

All seems to be functioning as intended

3. Have there been unexpected Operations and Maintenance (O&M) difficulties or costs at the site since startup?

Not to my knowledge

4. Has the site been in compliance with permitting and reporting requirements?

   YES

5. Do you have any comments, suggestions, or recommendations regarding the implementation of the ERP remedies or how the program has been conducted, in general?

   No

6. Do you have any comments on the operation of the ERP remedies related to future effectiveness or optimization of operations?

   No

7. What is your single greatest concern regarding the ongoing performance of the ERP remedies?

   Costs To comply w/ Regulations due to efforts required

8. Does the monitoring data show any trends that contaminant levels are increasing or decreasing? Have any new or emerging Contaminants of Concern (COCs) been identified? If so, have they impacted the effectiveness of the remedies?

   ~~Yes~~ No

9. Would you say that O&M and/or sampling efforts have been optimized? Please describe how improved efficiency has or has not occurred.

   YES

Interview Records: California Regulatory Agencies

INTERVIEW RECORD

Facility Name: Beale AFB, California	**EPA ID No.: N/A**	
Subject: 2016 Five-Year Review Interview	**Time: N/A**	**Date: 2/13/17**
Type: Telephone Visit <u>Other</u> (e-mail) **Location of Visit: N/A**	<u>Incoming</u> Outgoing	

Contact Made By:

Name: Scott Dressler	**Title: Project Manager**	**Organization: AECOM**

Individual Contacted:

Name: Mark Clardy	**Title: Remedial Project Manager**	**Organization: Central Valley Water Board**

Telephone No: (916) 464-4719 **Fax No: (916) 464-4797** **E-Mail Address: Mark.Clardy@waterboards.ca.gov**	**Street Address: 11020 Sun Center Dr., #200** **City, State, Zip: Rancho Cordova, CA 95670**

Interview Questions

1. What is your overall impression of the remedies selected for Beale AFB's Environmental Restoration Program (ERP) (e.g. Excavation, SVE, Groundwater Extraction and Treatment)?

My overall impression is that the remedies selected thus far have been appropriate for the specific sites and targeted media. Many of these remedies have been implemented as interim measures until a final remedy has been selected in a Record of Decision.

2. Are the groundwater remedies functioning as expected? Do you have any concerns regarding the function of the remedies?

The groundwater remedies implemented under the RCRA and LUFT programs are generally performing as expected. Final remedies for sites being addressed under CERCLA have yet to be selected. There have been some problems with proper functioning of the bioreactor at Plume CG041-035 due to surrounding fine grained soils preventing infiltration. Also, there is a concern regarding capture of TCE exceeding the MCL at Plume CG041-013 which is probably due to offbase agricultural pumping. At Plume CG041-017, heavy rains and flooding have recently prevented containment of groundwater within the slurry wall.

3. Have there been unexpected Operations and Maintenance (O&M) difficulties or costs at the site since startup?

   In July 2016, there was an unexpected shutdown of the Plume CG041-013 groundwater pump-and-treat system due to a Base power outage. The system restarted itself improperly without automatically contacting O&M personnel as designed. As a result, untreated effluent was discharged to the ground surface near the air strippers and treatment compound.

4. Has the site been in compliance with permitting and reporting requirements?

   Yes, however in 2015 due to an exceedance of hexavalent chromium at a compliance well at Plume CG041-003, the Monitoring and Reporting Program Order (MRP) was revised to expand the treatment zone and identify a new compliance well. At the Air Force's request, several MRPs have recently been revised to reduce the monitoring frequency, and sampling and analytical programs until a final remedy is selected and implemented.

5. Do you have any comments, suggestions, or recommendations regarding the implementation of the ERP remedies or how the program has been conducted, in general?

   My involvement with the project began in October 2014. Most of the remedies implemented to date have been interim measures until a final remedy has been selected. One comment I have pertains to decoupling of soil and groundwater media at various sites in 2013 in order to gain regulatory closure of the soil sites while addressing the underlying groundwater plumes separately. This has led to some difficulty in regulating the sites, particularly for vapor intrusion issues as the VOC source may be in the vadose zone, groundwater, or both. Shallow groundwater conditions have also compounded this issue.

6. Do you have any comments on the operation of the ERP remedies related to future effectiveness or optimization of operations?

   There is no comment regarding the soil sites as many have received no further action determinations and have been found to be suitable for unlimited use and unrestricted exposure (UU/UE). Final remedies for the CERCLA plumes have yet to be selected and those in place for the RCRA and LUFT program sites are relatively new and require more time for evaluation of their effectiveness.

7. What is your single greatest concern regarding the ongoing performance of the ERP remedies?

   My single greatest concern is related to increased offbase agricultural pumping due to ongoing drought conditions that may be drawing groundwater plumes offbase past the western base boundary. The selected remedies will have to account for this effect and mitigate it by design.

8. Does the monitoring data show any trends that contaminant levels are increasing or decreasing? Have any new or emerging Contaminants of Concern (COCs) been identified? If so, have they impacted the effectiveness of the remedies?

   Increasing groundwater contaminant trends have been observed at Plumes CG044-003, CG044-031, CG041-039, and CG044-040, and downgradient at Plume CG044-032.

   Perfluorinated compounds (PFCs) typically found in aqueous film-forming foam used during firefighting are a group of emerging compounds. The presence of PFCs at Beale AFB is being investigated by the Air Force. Also, while not a new or emerging COC, hexavalent chromium has a new MCL of 10 ug/L established by the California Department of Public Health in April 2014.

   The impact of emerging PFCs is currently under evaluation. The new MCL for hexavalent chromium should only affect in situ remedies that may locally generate the compound as a result of treatment since there are no known sources of hexavalent chromium at Beale AFB.

9. Would you say that O&M and/or sampling efforts have been optimized? Please describe how improved efficiency has or has not occurred.

In my opinion, sampling efforts have been optimized. Most of the interim groundwater remedies have been in place for a number of years and sufficient data has been collected to evaluate remedy performance under existing MRPs. Based on this, several MRPs have recently been revised to reduce the monitoring frequency and sampling and analytical programs until a final groundwater remedy has been selected. This should streamline sampling efforts and save money for the program.

INTERVIEW RECORD

Facility Name: Beale AFB, California	**EPA ID No.: N/A**	
Subject: 2016 Five-Year Review Interview	**Time: N/A**	**Date: 11/8/2017**
Type: Telephone Visit <u>Other</u> (e-mail) **Location of Visit: N/A**	<u>Incoming</u> Outgoing	

Contact Made By:

Name: Scott Dressler	**Title: Project Manager**	**Organization: AECOM**

Individual Contacted:

Name: Dominique Forrester	**Title: Former Remedial Project Manager**	**Organization: Department of Toxic Substances Control**
Telephone No: (916) 255-3661 **Fax No: (916) 255-3734** **E-Mail Address: Dominique.Forrester@dtsc.ca.gov**	**Street Address: 8800 Cal Center Drive** **City, State, Zip: Sacramento, CA, 95826**	

Interview Questions

1. What is your overall impression of the remedies selected for Beale AFB's Environmental Restoration Program (ERP) (e.g. Excavation, SVE, Groundwater Extraction and Treatment)?

My overall impression of the remedies selected for Beale AFB's ERP during the time in which I was the DTSC RPM is that the remedies, so far, are functioning as intended. Several interim remedies were implemented to address immediate threats to public health and the environment. Future, final remedies are still required and being developed through the RCRA and CERCLA process to ensure more permanent protection of public health and the environment.

2. Are the groundwater remedies functioning as expected? Do you have any concerns regarding the function of the remedies?

   The groundwater remedies which have been implemented are generally performing as expected. Groundwater remedies have been implemented for RCRA and LUFT sites; however, final remedies for sites being addressed under CERCLA have not been finalized. Interim groundwater remedies have been implemented for several of the CERCLA sites.

   There have been some functional issues with the following groundwater sites (interim remedies):

   - *CG041-013 – Offbase agricultural pumping causing potential issues with TCE plume capture*
   - *CG041-017 – Heavy rainfall year (2016/2017) has inundated the slurry wall containment preventing capture*
   - *CG041-035 – Fine grain soils preventing infiltration to bioreactor*
   - *CG041-039 – Potential issues (data gaps) from soil gas due to groundwater off gassing and unknown whether impacting existing buildings atop plume at the gym, community center, Buildings 24175, 24176, or 24177 near previous soil boring "39U006SB".*

3. Have there been unexpected Operations and Maintenance (O&M) difficulties or costs at the site since startup?

   On 13 July 2016, a Beale AFB power outage occurred that affected operation of the CG041-013 Groundwater Treatment System (GTS). The GTS SCADA computer did not call to report the power outage or a GTS shutdown, as the computer would normally have done. The two air stripper blowers were off, the secondary containment berm around the air strippers was full of water, water had overflowed the berm onto adjacent soil, and water was flowing out of the blowers. The groundwater extraction pumps had not shut down as they should have following the Beale AFB power outage. Water that escaped the secondary containment berm, discharged onto the ground surface adjacent to the southwest corner of containment berm, but did not enter any drainage ditches or surface water bodies. The Air Force documented the event, sampled the water that was discharged, and provided a Technical Report to regulatory agencies summarizing the detected VOCs in the water samples from the Air Stripper Containment Berm and future corrective actions.

   The corrective actions included:
   - *Identifying and purchasing new and more powerfull battery backup to supply electricity to the GTS master PLC in the event of a Beale AFB power outage.*
   - *Beginning quarterly testing of the UPS for the master PLC.*
   - *Determining if there is any existing alarm logic that would shut down the GTS.*

4. Has the site been in compliance with permitting and reporting requirements?

   Yes, the Site seems to be in compliance with Waterboard Monitoring and Reporting Program (MRP) and Feather River AQMD permitting requirements. However, DTSC defers to the Waterboard and Feather River AQMD to verify compliance with their respective permitting and reporting requirements.

5. Do you have any comments, suggestions, or recommendations regarding the implementation of the ERP remedies or how the program has been conducted, in general?

   In general, decoupling of environmental media such as soil and groundwater has created issues in addressing, among other things, soil gas contamination. Contaminants migrating through the vapor intrusion pathway can occur from either soil contaminant sources or groundwater contaminant sources off-gassing. It seems that when a "soil site" is closed, it is sometimes presumed soil gas is no longer an issue when that is not always the case.

   Further, preselecting remedies during the performance based contract (PBC) negotiation phase has made it difficult for regulatory agency concerns to be fully addressed. This is because remedies are prematurely selected during development of the PBC before the CERCLA process has been fully executed, which minimizes the worth of State and Community/Public Acceptance. Predetermining remedies causes the consultant, in some instances, to be unwilling to change remedial approaches because it wasn't accounted for in their PBC and contract modifications are extremely cumbersome and difficult to accomplish.

6. Do you have any comments on the operation of the ERP remedies related to future effectiveness or optimization of operations?

   Most soil sites at Beale AFB have received no further action determinations and have been found to be suitable for unrestricted use (residential use). Final remedies for the CERCLA plumes have yet to be finalized and those in place for the RCRA and LUFT program sites require additional time to validate effectiveness.

7. What is your single greatest concern regarding the ongoing performance of the ERP remedies?

   My single greatest concern is that soil gas contamination is not completely accounted for because of the decoupling approach to closing sites and the future risks that vapor intrusion issues may present to public health. Further, of equal concern is that the final groundwater remedies which are implemented for the CERCLA sites may be significantly impacted due to offbase agricultural pumping.

8. Does the monitoring data show any trends that contaminant levels are increasing or decreasing? Have any new or emerging Contaminants of Concern (COCs) been identified? If so, have they impacted the effectiveness of the remedies?

   Defer to the Waterboard, per below:

   Increasing groundwater contaminant trends have been observed at Plumes CG044-003, CG044-031, CG041-039, and CG044-040, and downgradient at Plume CG044-032.

   Perfluorinated compounds (PFCs) typically found in aqueous film-forming foam used during firefighting are a group of emerging compounds. The presence of PFCs at Beale AFB is being investigated by the Air Force. To date, no information has emerged which would indicate the effectiveness of remedies being impacted by PFCs.

9. Would you say that O&M and/or sampling efforts have been optimized? Please describe how improved efficiency has or has not occurred.

   I would say that sampling efforts have been optimized through the decades of sampling that has gone on at Beale AFB. The annual and semiannual groundwater monitoring program is an effective approach to ensure optimization.

Interview Records: Air Force Contractor Input

Interview Record
Raeann Rainwater and Brad Shearer/CH2M HILL
Beale Air Force Base 2016 Five-Year Review
February 2016

1. What is your overall impression of the remedies selected for Beale AFB's Environmental Restoration Program (ERP) (e.g. Excavation, SVE, Groundwater Extraction and Treatment)?

During the five year review (FYR) period from June 2011 through September 2016, CH2M HILL continued long-term operation and maintenance (LTO&M) of three groundwater extraction and treatment systems (GETS [CG041-013, CG041-017, and TU002]), three soil vapor extraction (SVE) systems (ST018, SS035, and SS039), one biovent system (Area of Concern [AOC] 39), one air sparge/SVE system (SD008), one air sparge/biovent system (TU001), one ozone/air sparge system (SS023), two in situ bioreactors (CG041-013 and CG041-035), two passive skimmer systems (CG041-018), and three offbase residential wellhead activated carbon treatment systems (CG041-001). Soil at TU509 was excavated. In addition to the active remedies, CH2M HILL has implemented or monitored many in situ remedies that do not require active LTO&M. These include enhanced reductive dechlorination (ERD) at plumes CG041-010, CG041-013, CG041-031, CG041-035, CG041-039, and CG041-040; in situ chemical oxidation (ISCO) at plumes CG041-003 and CG041-032, and Sites SS023 and OW034; aerobic bioremediation at CG041-509; and containment walls with a permeable reactive barrier (PRB) at plume CG041-017.

In general, the remedies selected and installed at Beale AFB have met or are in the process of meeting their Remedial Action Objectives (RAO). Many of these remedies were implemented as interim remedies, while disagreements between the Air Force and State of California over ARARs were resolved. In 2013, a technical memo was published providing the path forward for most of the long standing disagreements. During this time, those interim remedies have now been completed and shut down, as described in the following bullets:

- Of nine biovent systems, eight were shut down or decommissioned prior to June 2011, and AOC 39 was shut down during the review period.
- Of 11 SVE systems, eight were shut down or decommissioned prior to July 2011, two were shut down during the review period (ST018 and SS039), and one remains active (SS035).
- The SD008 air sparge/SVE system and TU001 air sparge/biovent system were both shut down during the review period.
- The ozone/air sparge system at SS023 was shut down in August 2012. During the review period, CH2M HILL implemented an ISCO remedy at SS023 injecting sodium permanganate.
- The CG041-035 in situ bioreactor was shut down in May 2013 prior to construction and operation of the SS035 SVE system. During the review period, both solar-powered groundwater extraction pumps were removed from the bioreactor. ERD of the residual TCE contamination in CG041-035 groundwater is included in the Site CG041 ROD.
- During the review period, CH2M HILL decommissioned five biovent systems (SD010 North, ST018 East, ST021, AOC 39, and OW034 [Oil Water Separator N]), nine SVE systems (FT003, SD010 South, LF013 West, ST018 West, FT029, SD031, SD032 North, SD032 South, and SS039), the SD008 air

sparge/SVE system, and the TU001 air sparge/biovent system. Decommissioning activities typically included abandonment of wells, conduit, and belowground piping and removal of remediation equipment from the site.

As of September 2016, one biovent system remains to be decommissioned (SD011). In addition, as of September 2016, the three GETSs, SS035 SVE system, CG041-013 in situ bioreactor, two passive skimmer systems, and three offbase residential wellhead treatment systems continue operating. Several new in situ remedies have been implemented at the end of 2016, including ERD at CG041-508 and CG041-517; and aerobic bioremediation following excavation at CG041-509.

Across the base, these remedies continue to help achieve RAOs at most sites as shown by stable or decreasing groundwater contaminant trends, with the exception of Site CG044 (western plumes including CG044-003, -013, -031, -032, and -040). In addition, the primary COCs at most groundwater sites have decreased significantly from historical maximums (See summary of sites in Table 1, Attachment 1).

Ongoing monitoring will serve to evaluate how well the remedies continue meeting RAOs; comply with the terms of Monitoring and Reporting Programs (MRP) administered by the State; ensure that downstream receptors are protected; and gather data to support the eventual selection of a final remedy that will be documented in the CG041 ROD. The CG041 ROD is currently scheduled for 2017. Site CG044 is undergoing data gap investigation to support a focused feasibility study. The CG044 ROD is anticipated no sooner than 2020.

2. Are the groundwater remedies functioning as expected? Do you have any concerns regarding the function of the remedies?

Yes. In general, the groundwater remedies are functioning as expected.

During the previous FYR, large-scale groundwater withdrawals by Yuba County Water Agencies (YCWA) were a big concern. This continues to be a concern now, specifically in relation to sites along the western base boundary. These groundwater withdrawals by YCWA have reversed a long-term trend of rising groundwater elevations at Beale AFB. If the groundwater withdrawals continue, then the declining groundwater elevations could have an effect on some of the remedies at Beale AFB. No groundwater transfers took place from spring 2011 through spring 2013. As a result, and in response to the reduced offbase pumping, groundwater elevations at Beale AFB began to rise again in 2011 and 2012. However, these conditions coupled with the unprecedented drought conditions in California between 2014 and 2016 put pressure on water supplies statewide. In 2014, YCWA again implemented the water transfer program. This resulted in normally idle irrigation wells near the western Base boundary being pumped relatively aggressively. This increased groundwater pumping resulted in significant depression of groundwater levels around the western and southwestern margin of the Base. For instance, the hydraulic gradient in the CG041-040 wells near the Base boundary were 14 times greater in summer 2015 than in summer 2012, when the water transfer program was not in effect. As a result of the change in groundwater characteristics, impacts have been identified at five of the Site CG041 groundwater contaminant plumes (CG041-003, -013, -031, -032, and - 040) (western plumes). The Air Force has created a new site (Site CG044) for these 5 plumes. The intent is to evaluate these plumes in light of the increased offbase pumping and select remedies that are protective.

3. Have there been unexpected Operations and Maintenance (O&M) difficulties or costs at the site since startup?

For the most part, difficulties have been minor, thanks to routine O&M. Use of the observational approach and Remedial Process Optimization (RPO) have maximized the effectiveness of the systems. However, four sites which have had unexpected difficulties are CG041-017, CG041-013, SS035, and CG041-001. Most notably, at CG041-017, which was designed and constructed as a phytoremediation system with a GET component, five issues have come to light over the last few years which were unexpected. First, many of the original poplar trees in the phytoremediation system died during the previous five year review period (2006 to 2011) due to a combination of voles stripping the bark and girdling from plastic weed barrier. In 2010, the damaged poplar trees were replaced with cottonwood trees, which also died. Maintenance of the trees was discontinued in 2014. The original CG041-017 design assumed the trees would eventually provide sufficient pumping to maintain an inward gradient through the slurry wall, which has not been the case. A beaver dam along Best Slough has increased water levels outside the slurry wall, which also increases the pumping required to maintain an inward gradient. The CG041 ROD proposes shutting down pumping, installing a PRB in the primary slurry wall, and treating the source areas with ERD.

For the in situ remedies installed during the last five years, difficulties have been minimal. Rebound has been observed at CG041-039 (source area 1) and at CG041-031. Additional source treatment is required for these source areas. In addition, a small area near well 10C048MW within CG041-010 requires additional treatment.

The CG044-013 GTS has been increasing summer pumping rates to counter the influence of offbase pumping. However, the base is in the process of bypassing their Wastewater Treatment Plant (WWTP). The discharge from the GTS is permitted under the WWTP Waste Discharge Requirement. Therefore, a new WDR will be required for the GTS effluence once the WWTP is decommissioned. The GTS effluent primary discharge point will be Pond 4 (eventually land applied for irrigation). However, Beale is evaluating alternative discharge options.

4. Has the site been in compliance with permitting and reporting requirements?

In general, yes. The Air Force believes that no permits may be issued by the State of California (or local jurisdictions) per CERCLA 42 USC 9621(e)(1) and 40 CFR 300.400(e)(1). However, the Air Force follows the substantive requirements of permits, including reporting requirements. Thus, for example, the Air Force follows the requirements of the Monitoring and Reporting Programs (MRP) issued as part of Waste Discharge Requirements (WDR) by the Water Board. These apply to the in situ remedies listed previously.

The CG041-013 GTS discharges to the Base WWTP, which is regulated under a WDR. In addition, the Air Force follows the air quality requirements imposed by the Feather River Air Quality Management District (FRAQMD) to control emissions from Beale AFB’s SVE systems and air strippers.

During the review period, the following remediation systems were affected or potentially affected by State monitoring and reporting requirements: CG041-013 GTS (WWTP WDR and FRAQMD), CG041-017 GETS (FRAQMD), ST018 SVE (FRAQMD), SS035 SVE (FRAQMD), SS039 SVE (FRAQMD), SD008 air sparge/SVE (FRAQMD), TU001 air sparge/biovent (FRAQMD), CG041-013 in situ bioreactor (WDR), and CG041-035 in situ bioreactor (WDR). For example, the CG041-013 GTS effluent met discharge requirements included in the WWTP WDR with one exception. A release of partially treated groundwater from the GTS to the WWTP aeration pond occurred on July 13, 2016. The TCE concentration in the partially treated water was 5.57 µg/L, which slightly exceeded the MCL of 5 µg/L. The State of California did not issue a notice of violation or other sanction as a result of this incident. During review period, the two GTS air strippers were in compliance with FRAQMD operating conditions.

For groundwater sites at Beale AFB, the Air Force follows the requirements of the Monitoring and Reporting Programs (MRP) issued as part of Waste Discharge Requirements (WDR) by the Water Board. These apply to Site CG041 (subsites: -003, -010, -013, -031, -032, -035, -040, -509, -517) and Sites SS023 and OW034. During 2015 and 2016, major optimizations and revisions to the MRPs for Sites CG041-003, CG041-010, CG041-013, CG041-032, CG041-031, and CG041-040 were approved by the Central Valley Water Board including reducing well frequencies, reassigning well designations, and changing select analyses (for example, at CG041-003 the MRP was revised to remove selenium). There was one exceedance at CG041-003 in May 2015, when dissolved chromium exceeded the maximum contaminant level (MCL) of 50 micrograms per liter (µg/L) at downgradient compliance well 03C056MW. The initial notification of an exceedance was provided during the Tier 1 meeting on April 16, 2015, then followed-up with an official notification letter to the Water Board on May 27, 2015. The Water Board revised the CG041-003 MRP in August 2015 to replace dissolved chromium with hexavalent chromium and added a downgradient compliance well. The chromium concentration in 03C056MW has peaked and is now declining. All other sites have been in compliance with their respective MRP. Compliance with the MRPs are discussed in the annual BGMP reports. In 2015, the Site OW034 CMI Report confirmed decreasing concentrations of benzene, TPH-D, and TPH-G. On September 18, 2015, the Central Valley Water Board issued a Notice of Termination for WDR R5-2008-0149-037. On December 24, 2015, the Central Valley Water Board issued a Conditional No Further Action letter for Site OW034. During the FYR period, maintenance, monitoring of, and reporting on the closed landfills at Sites LF002 and LF003 were in compliance with WDRs and the Final *Sites LF002 and LF003 Revised Post-closure Maintenance Plan* that was issued by the USAF and approved by the state agencies in 2013.

5. Do you have any comments, suggestions, or recommendations regarding the implementation of ERP remedies or how the program has been conducted in general?

In general the program is conducted very well.

There has been some improvements in receiving AF and regulatory approvals for remedy implementation over the last few years. Additional communication during Tier 1 Meetings and conference calls between the entire team have helped facilitate a better understanding of the remedies selected, concerns, and ways to optimize the remedy and meet schedules. This has helped reduce some inefficiency between reviews and reduce unforeseen comments.

6. Do you have any comments on the operation of the ERP remedies related to future effectiveness or optimization of operations?

Most of the groundwater and soil vapor remedies under Site CG041 were implemented as interim remedies to address source areas. This provides the Air Force the opportunity to continue to collect data in support of the final remedy while reducing contaminant mass. The Site CG041 ROD is currently scheduled for 2017. During the interim period, LUCs will protect human health and the environment and ongoing monitoring will serve to evaluate how well the remedies are meeting RAOs; comply with the terms MRPs; and ensure that downstream receptors are protected. Annual groundwater monitoring reports, long-term operation and maintenance (LTO&M) reports, and Five-Year Reviews will provide opportunities to review performance and compliance data, and make adjustments as needed. MRPs issued by the State provide another mechanism to monitor the remedy performance and ensure that human health and environment are protected.

In general, the remaining active remedies (the three GETSs, SS035 SVE system, CG041-013 in situ bioreactor, and two passive skimmer systems) have mostly been optimized to the extent feasible. Additional future optimization is possible at the CG041-013 GTS via groundwater modeling and changes to the pumping scheme used to contain the TCE plume. The Air Force plans to conduct groundwater modeling to estimate the impacts of offbase agricultural and groundwater substitution transfer pumping on the CG041-013 TCE plume. Modeling could also be used to evaluate different groundwater extraction regimes to maintain capture of and minimize duration of pumping (e.g., move pumping toward the source area). The SS035 SVE system is undergoing a 6-month rebound study and may be permanently shut down in 2017, depending upon the rebound sample results. Operation of the CG041-013 in situ bioreactor has remediated much of the source area TCE mass and will be discontinued in June 2017. The function of the CG041-001 offbase residential wellhead treatment systems is not plume treatment or mass removal, but to provide the residents with clean water for bathing and domestic landscape maintenance. An exit strategy is needed for these systems.

7. What is your single greatest concern regarding the ongoing performance of the ERP remedies?

Similar to five year ago, the single greatest concern is still the regional decline in the water table, caused by the large-scale extraction of groundwater by the water district to the west of Beale AFB, will have unpredictable effects on the remedies at most of the ERP sites. These effects will likely be most pronounced near the base boundary, and become less pronounced in the interior of the base. Migration of plumes offbase has significant consequences. The Air Force has created a new site (Site CG044) to address western plumes most impacted by offbase pumping. The Air Force is proposing to maintain interim in situ remedies while final remedies are evaluated.

8. Does the monitoring data show any trends that contaminant levels are increasing or decreasing? Have any new or emerging Contaminants of Concern (COCs) been identified? If so, have they impacted the effectiveness of the remedies?

Long-term data continue to indicate that the contaminant levels at most sites continue to decrease (see attachment). Although large diffuse areas remain where contaminants are present above cleanup goals in groundwater, substantial strides have been made at Beale AFB. During the FYR period, we reached site closeout (SC) at 19 soil sites, response complete at 2 sites (LF013 and OW034), and remedy in place at one site (SS023). Site closeout indicates the completion of site remediation activities. Closed soil sites included Sites SD001, WP002, FT003, SD005, SD010, WP012, WP016, ST021, SD023, FT029, SD031, LF033, SS037, TU001, CG517, OT584, SS010, OW581, and SS508. As mentioned in response to question 1 above, 10 of 11 SVE systems have been shut down; only one remains (Site SS035). The SD008 air sparge/SVE system and TU001 air sparge/biovent system were both shut down. Of these, five biovent and nine SVE systems were decommissioned. This shows the remedies at these sites have successfully reduced contaminant concentrations and therefore, have helped us to achieve SC at numerous soil sites.

Since the last FYR, perfluorinated compounds (PFCs) have been identified as an emerging contaminant at Beale. Beale has conducted a preliminary assessment and is in the process of a site investigation. The Air Force has been addressing PFCs in a programmatic fashion. The new health advisories are being used as screening levels for PFOS and PFOA.

9. Would you say that O&M and/or sampling efforts have been optimized? Please describe how improved efficiency has or has not occurred.

Remediation system O&M has been continually optimized, as evidenced by the successful shut-down and decommissioning of many systems and by the progress made in meeting RAOs at remaining systems. The LTO&M reports produced during the review period document RPO evaluations and recommendations for each system semiannually. Some examples of optimizations performed during the review period are provided here.

In December 2013, CH2M HILL revised the CG041-017 SCADA program to not pump groundwater in response to gradients at the LTW4, LTE4, and LTE3 transducer well pairs. As a result of this optimization, the volume of groundwater extracted during fiscal year 2014 (2.4 million gallons) was approximately 60 percent less than the total extracted groundwater volume in each of the previous four fiscal years (FY10 through FY13). Until pumping can be turned off, the RPO undertaken in December 2013 will reduce pumping at CG041-017, improve sustainability, and reduce the burden on the Base’s water storage ponds (e.g., Pond 4) during the winter months.

In January 2014, CH2M HILL recharged the CG041-013 in situ bioreactor with emulsified vegetable oil (EVO). A total of 250 gallons (2,100 pounds) of concentrated EVO was injected into each zone of the bioreactor. Recharging the bioreactor with EVO resulted in TCE mass decreasing in source area groundwater following the injection.

Groundwater sampling continues to be extensively optimized, through use of a Decision Tree and the State of California imposed MRPs. There have been a total of 15 sites with MRPs at groundwater sites at Beale AFB. Since the last FYR in 2011, the State of California imposed MRPs on four additional sites and two sites have been terminated at this time. Additionally, optimizations to MRPs at two sites were implemented and the MRPs revised to included reductions in sampling frequency, wells sampled, and analyses performed. The Air Force continues works closely with the state on which wells will be sampled, at what frequency, and for which laboratory analyses as part of the MRPs. An exit strategy for these MRPs is undefined. The Water Board would like to see concentrations of all analytes return to baseline before terminating the WDRs. This results in long term monitoring costs. For example, permanganate was injected at CG041-032 in May of 2007. Despite the area being a flightline and no potential receptors for that groundwater, the Water Board will not terminate the WDR because secondary water quality impacts have not returned to baseline conditions. This limits the optimization of the monitoring program for Beale.

Optimization measures to the Basewide groundwater monitor program (BGMP) are ongoing. Basewide groundwater elevation surveys continue to be performed annually. Starting in 2013, the annual survey was optimized to only include monitoring wells needed to evaluate site-specific (local) groundwater conditions, regional groundwater flow, and ongoing interim remedies or other site-specific requirements. Approximately 115 monitoring well locations were removed from the annual basewide groundwater elevation survey during the 2013 annual event. The locations removed from the annual basewide survey included extraction wells, injection wells, wells that were redundant (i.e., in close proximity to another well at a similar depth), and wells that were routinely excluded from site-specific groundwater contour maps because of significant difference in well screened intervals compared to other site wells.

The focus over the last five years has shifted from individual sites to groundwater plumes. This refocusing has helped optimize the BGMP field effort by reducing the number of wells previously sampled. For sites with larger, comingled plumes, such as TCE contamination in groundwater in the

Cantonment Area, we focused our sampling on locations that help evaluate the plume and track long-term trends. To the extent practicable, samples are collected using passive-diffusion bag samplers to reduce costs. These devices are used at locations where samples are being collected for VOC analysis only. As time goes by, and remedies have had a chance to impact groundwater quality, the number of wells being monitored should continue to decrease.

ATTACHMENT 1
Summary of Site Background
Beale Air Force Base, California

Groundwater Site	Corresponding Site	Site Description	Source of Groundwater COCs	Remedial Actions	Documents	Groundwater COCs (µg/L)	Primary COC	Historical Level (µg/L) (year)	2016 Max Level (µg/L)	Status
CG041-032 and Offbase Residential	Flightline area – Sites SD001, WP004, SD005, SD011, ST021, ST025, SD032, and SS037	CG041-032 plume originates from sources at Sites SD001, SD011, and SD032. Site SD001 (Western Drainage Ditch) Site SD011 (AGE Maintenance Area) Site SD032 (Building 1086) is approximately 400 feet south of Site SD011 and includes parts of the flightline, areas used for aircraft maintenance repair. Site SD032 includes a jet fuel storage area, AOC 39. Offbase residential wells located to the west of the Base and downgradient from the flightline area have been monitored since the 1980s to determine whether offbase contaminant migration had occurred.	Operations at Building 1086 included assembly of Titan missiles and maintenance of equipment used on B-52 bombers. These operations included the use and storage of TCE and 1,1,1-TCA.	• USTs removed • Two SVE systems at Site SD032 • SVE system at Site SD011 • Biovent system at AOC 39 • ISCO in two separate source areas at CG041-032	Site 32/1 RI Report (CH2M HILL, 2004) Site 32 ISCO BS/IR (CH2M HILL, 2007) Site 32/1 ISCO TEFA (CH2M HILL, 2011a) Revised MRP R5-2007-0025 (Central Valley Water Board, 2012a)	cis-1,2-DCE and TCE	TCE	5,400 (1997)	363	• Sites WP004, SD005, and ST025 closed. • 1,645 pounds (about 98 percent TCE) of total VOCs removed by the Site SD032 North SVE System. • SVE systems turned off in 2009. • 94 percent of the TCE mass has been removed from the ISCO treatment area. • Minor rebound is occurring in the ISCO northern source area. • TCE migration is apparently moving west (downgradient from the northern and southern source areas). • Separate TCE source is present in the immediate vicinity of the storm sewer outfall, just west of the runway. • Three offbase domestic wells (OBL004AW, OBL005AW, and OBL008AW) have been equipped with wellhead treatment systems due to consistent sampling results with trace levels of TCE (below the PSL).
CG041-003	Site FT003	Between 1942 and 1952, the Camp Beale Hospital complex occupied the site, and heating oil was stored in numerous USTs located throughout the site. Between 1952 and 1988, the site was used for fire training. Four FPTAs are located across the site. Flammable liquids were stored in three 25,000-gallon USTs and chemicals burned included waste oils, spent solvents, and aviation fuels.	FPTA Nos. 1, 2, 3, and 4 have been identified as sources of TCE groundwater contamination. Dry well located in the western portion of Site FT003.	• Five USTs and adjacent soil removed • Biovent/SVE system at FPTAs • Excavation of soil near FPTAs and former dry well • ISCO in western source area • Evaluation monitoring and LUCs	Site 3 Action Memorandum for Time-Critical Removal Action (Air Force, 2011a) Revised MRP R5-2008-0149-032 (Central Valley Water Board, 2015a) Site FT003 Remediation System Decommissioning Report (CH2M HILL, 2015a)	Carbon tetrachloride, 1,2-DCA, PCE, TCE, and TPH-G	TCE	4,900 (1993)	243	• In 2010, Final SVE Shutdown Report submitted. • No potential risks to groundwater from soil at Site FT003. • TCE concentrations in groundwater have declined in the injection wells and increased at a few treatment area wells after ISCO was implemented in 2011. • 73 percent of the TCE mass has been removed from the ISCO treatment area. • Additional ISCO is required to effectively treat the target treatment area. • Remedy proposed includes hot spot treatment with ISCO, EA, monitoring of COCs, and LUCs.
CG041-010	Site SD010	A portion of the site was used as a jet engine test stand for SR-71 engines from 1959 to 1990. Two 10,000-gallon ASTs that contained JP-7 supplied fuel for the engines. In addition, 55-gallon drums, which contained solvents and other cleaning agents, were stored on a metal rack adjacent to the test stand.	Runoff during cleaning of engines from the test stand potentially included jet fuel, petroleum distillates, soap, oil, and solvents. Spills and leaks during these operations also deposited chemicals on bare soil.	• EISB system using sodium lactate installed in 2005 • Expansion of EISB in June and July 20016	Site 10 Remedial Action-Construction Summary Report (CH2M Hill, 2005) Revised MRP R5-2004-0131 (Central Valley Water Board, 2015b) Draft Final Proposed Plan for ERP Site CG041 (CH2M HILL, 2016a) Draft ROD for Site CG041 (CH2M HILL, 2016b)	TCE, PCE, cis-1,2-DCE, trans-1,2-DCE, vinyl chloride	TCE	3,440 (2004)	310	• Two ASTs were removed in 1997. • Phase 1 of EISB shut down in 2006. • Phase 2 of EISB shut down in December 2008. • Phase 3 of EISB shut down in January 2009. • 94 percent of the TCE mass has been removed from the EISB treatment area. • Reducing conditions have remained within the treatment zone since shut down of EISB. • TCE concentrations in 2016 are below the target treatment concentration of 500 µg/L. • Site COCs are currently detected above their respective PSLs except for trans-1,2-DCE. • Remedy proposed includes treatment with ERD at wells where concentrations are increasing, enhanced attenuation of COCs, land use advisory, and LUCs.

ATTACHMENT 1
Summary of Site Background
Beale Air Force Base, California

Groundwater Site	Corresponding Site	Site Description	Source of Groundwater COCs	Remedial Actions	Documents	Groundwater COCs (µg/L)	Primary COC	Historical Level (µg/L) (year)	2016 Max Level (µg/L)	Status
CG041-013	Site LF013	Former Landfill No. 1 received waste from local private sources prior to the establishment of Camp Beale in the early 1940s. Waste from Base operations was disposed of here until the mid-1950s. After transfer to the Air Force, the landfill was used for disposal of clarifier skimmings from the Base WTP.	Waste disposal activities. Former M-5 ointment tube disposal trench.	• GTS and in situ bioreactor • Excavation of soil • SVE systems (Site LF013 east and west) • Soil cover over the former landfill area and photographic waste pipeline • LUCs	Site 13 IROD (Air Force, 2010) Site LF013 Data Gap Investigation Summary Report (CH2M HILL, 2014b) MRP R5-2008-0149-018 (Central Valley Water Board, 2011a) Final Site LF013 ROD (Air Force, 2016)	TCE, PCE, cis-1,2-DCE, trans-1,2-DCE, 1,1,1,2-TeCA, 1,1,2,2-TeCA, 1,1,2-TCA, and 1,1-DCE	TCE	680,000 (1992)	36.3	• TCE historically detected in offbase monitoring wells located west of the site. • GTS initiated in 1984 and expanded in 1997, 1999, and 2007. • East SVE system decommissioned in 2003. • West SVE system decommissioned in 2009 to accommodate the bioreactor. • Bioreactor constructed in 2010 and expanded in 2011. • TCE in groundwater stable or declining in the majority of the source area and plume wells. • Immediate vicinity of the bioreactor, TCE in groundwater has rapidly decreased by several orders of magnitude. • Recent increase in groundwater elevations after drought in 2014 and 2015. • TCE was not detected at concentrations above the source area treatment target of 100 µg/L in 2016. • Groundwater contamination along the NW base boundary is effectively controlled by GTS. • Much of residual contamination within submerged vadose zone may have been released to groundwater and little contamination may remain.
CG041-016	Site WP016	EOD Area	Unlined former disposal trench	• Excavation of soil and ordnance from the disposal trench • Evaluation monitoring and LUCs	Site 16 IROD (Air Force, 2011b) Draft Final Proposed Plan for ERP Site CG041 (CH2M HILL, 2016a) Draft ROD for Site CG041 (CH2M HILL, 2016b)	Perchlorate	Perchlorate	492 (2001)	100	• RCRA Closure Plan concluded soil, sediment, and surface water in EOD Area do not pose a significant risk to human health or the environment, and no further remediation activities are needed. • Risk-based clean closure of soils (unrestricted use) within the EOD Area in 2006. • Deferred closure of ordnance to the MMRP and groundwater to CERCLA. • Perchlorate in groundwater is either decreasing or stable and the plume is not migrating to the southwest.
CG041-017	Site OT017	Best Slough	Steel drums found in several shallow disposal trenches and other wastes that may have been placed in the trenches	• Removal of drums and fill in the trenches • Rerouting of the northern extent of Best Slough • Slurry wall • Phytopumping system • Soil bentonite cutoff wall/ permeable reactive barrier • LUCs	Site 17 IROD (Air Force, 2007a) Draft Final Proposed Plan for ERP Site CG041 (CH2M HILL, 2016a) Draft ROD for Site CG041 (CH2M HILL, 2016b)	Carbon tetrachloride, TCE, cis-1,2-DCE, chloroform, 1,2-DCA, 1,1-DCE, 1,1,2-TCA, PCE, 1,1,2,2-TeCA, trans-1,2-DCE, vinyl chloride, and TPH-D	TCE	399,000 (2002)	185,000 (inside wall) 193 (outside wall)	• TCE detected at concentrations in the primary and secondary source areas indicate the presence of DNAPL. • TCE at much lower concentrations (up to 683 µg/L) in the dissolved plume in 2012. • Best Slough and Dry Creek are hydraulically connected to groundwater. • 1,1,1,2-TeCA (COC in the IROD) was detected at concentrations below the reporting limit and not retained as a COC. • Remedy includes hot spot treatment with ERD (10,000 µg/L TCE inside slurry wall and 500 µg/L outside slurry wall), a PRB with in situ chemical reduction (ISCR), EA monitoring of COCs, and LUCs, including restricting exposure via vapor intrusion from groundwater into indoor air
CG041-018	Site ST018	Bulk Fuel Storage Area	East of the former MOGAS Facility:	• SVE system east of the	Site 18 IROD	TCE	TCE	788 (2013)	170	• SVE system installed in 1998 addressing VOCs in soil. SVE

ATTACHMENT 1
Summary of Site Background
Beale Air Force Base, California

Groundwater Site	Corresponding Site	Site Description	Source of Groundwater COCs	Remedial Actions	Documents	Groundwater COCs (µg/L)	Primary COC	Historical Level (µg/L) (year)	2016 Max Level (µg/L)	Status
			undocumented release or spill	former MOGAS Facility • Evaluation monitoring and LUCs	(Air Force, 2011c)					decommissioned in 2015. • TCE increasing in several wells. • In 2008, biovent system was shut down and received regulatory approval in 2010. • LNAPL distributed non-uniformly in the subsurface to approximately 100 feet bgs; historically migrated through more permeable soil, and has limited mobility. • Remedy includes hot spot treatment with ERD (300 µg/L TCE), EA monitoring of COCs, Land use advisory, and LUCs.
			Jet Fuel Tank Farm: Long-term leak from the JP-TS pipeline	• Biovent system in the Jet Fuel Tank Farm • LNAPL recovery (skimming) • Evaluation monitoring and LUCs		Benzene, TCE, TPH-D, and TPH-G	Benzene	33.9 (2005)	1.19	
Site ST022		Current and former USTs at Beale AFB Active USTs under investigation: • 05-015 through 05-021 and 05-030 through 05-033 • 10-313 • 10-406 • 10-494 through 10-496	Unknown releases from USTs	• Historical records have identified 1,097 USTs at Beale AFB. • 51 USTs have not received closure concurrence, 31 of which are active and currently in use with no evidence of releases. • Addressed under the LUFT program.	Site ST022 CAP/RA WP (CH2M HILL, 2015c) Site ST022 Group 2 NFA TM (CH2M HILL, 2016c)	1,2-DCA, EDB, naphthalene, TPH-D, TPH-G, BTEX, and fuel oxygenates (MTBE, DIPE, ETBE, TAME, and TBA)	NA	NA	NA	• Case closure concurrence has been received from the Central Valley Water Board for USTs 10-267 and 10-504. • NFA request submitted to Central Valley Water Board. If granted, a decommission work plan will be submitted.
CG041-031	Site SD031	Building T-896	Undocumented release or spill	• EISB (sodium lactate treatment of source area portion of the plume to 500 µg/L) • EVO • LUCs	Site 31 IROD (Air Force, 2007b) MRP R5-2007-0044 (Central Valley Water Board, 2012b)	TCE	TCE	18,000 (2005)	2,300	• In 2001, bioremediation cell was decommissioned. • In 2004, SVE system was shut down and subsequently decommissioned in 2006. • EISB treatment system operated from 2007 to 2010. • EVO injected in 14 monitoring wells in 2010. • Plume is stable, and TCE concentrations are not increasing in wells downgradient of the plume. • Significant rebound in source area (31U001AMW). • 97 percent of the TCE mass has been removed from the treatment area.
CG041-035	Site SS035	Weapon Storage Area	Likely release of solvents near concrete foundations of the former sheds	• SVE system • Four diesel USTs removed • Bioreactor (treatment of source area portion of the plume to 1,000 µg/L) • Evaluation monitoring and LUCs	Site 35 IROD (Air Force, 2011d) MRP R5-2008-0149-022 (Central Valley Water Board, 2010) Draft Final Proposed Plan for ERP Site CG041 (CH2M HILL, 2016a) Draft ROD for Site CG041 (CH2M HILL, 2016b)	Carbon tetrachloride, 1,1-DCE, and TCE	TCE	5,140 (2013)	1,280	• In October 2010, soil with highest VOCs was excavated and disposed of offsite during construction of the bioreactor. • The in situ bioreactor was turned off in March 2013. • TCE mass reductions of 92 percent in the 5-µg/L plume and 85 percent in the target treatment zone since August 2010. • The SVE system at Site SS035 began operation in October 2013 and continued operating through 2016. • TCE has increased at wells immediately downgradient of the bioreactor following shutdown of the bioreactor. • TCE concentrations are stable or decreasing. Plume is stable. • Remedy includes Hot spot treatment with ERD (hot spot generally defined by residual TCE greater than 300 µg/L), EA monitoring of COCs, Land use advisory, and LUCs
Cantonment Area – CG041-039	ERP Site SS039	Building 2145	Undocumented release near movie theater (Source Area 1) Historical leaks from the sanitary sewer or	• ERD (treatment of source area portion of the plume to 1,000 µg/L [Source Area 1],	Cantonment Area IROD (Air Force, 2011e) Draft Final Proposed Plan	Carbon tetrachloride, cis-1,2-DCE, 1,1-DCE, PCE, TCE, vinyl	TCE	4,240 (2014)	2,360	• With the exception of one well, TCE has declined and not rebounded at Source Area 1. • Reductive dechlorination occurring within the treatment

ATTACHMENT 1
Summary of Site Background
Beale Air Force Base, California

Groundwater Site	Corresponding Site	Site Description	Source of Groundwater COCs	Remedial Actions	Documents	Groundwater COCs (µg/L)	Primary COC	Historical Level (µg/L) (year)	2016 Max Level (µg/L)	Status
Source Area 1 **Source Area 2**			storm drains located north of Building 2145 (Source Area 2)	500 µg/L [Source Area 2]) • Evaluation monitoring and LUCs	for ERP Site CG041 (CH2M HILL, 2016a) Draft ROD for Site CG041 (CH2M HILL, 2016b)	chloride, TPH-D, and TPH-G				area at Source Area 1. • TCE declined to 111 µg/L at Source Area 2. • 92 percent of the TCE mass has been removed from the ERD treatment area in Source Area 1. • 98 percent of the TCE mass has been removed from the treatment area in Source Area 2. • Remedy includes hot spot (300 µg/L TCE) treatment with ERD, EA monitoring of COCs, land use advisory, and LUCs
Cantonment Area – CG041-508	RCRA Site SS508	PCE Groundwater Plume CE Equipment Yard	Leaks and spills associated with parts cleaning activities in the vicinity of Buildings 2530 and 2548, located in the CE Equipment Yard, and possibly at the wash pads (Site PRI 5)	• No previous corrective measures conducted • EVO injection in 2016	CG041-508 Pre-design Investigation WP (CH2M HILL, 2015c) CG041-508 SB/CMI WP (Air Force, 2016) CG041-508 CMI Report (Air Force, 2017)	PCE	PCE	1,330 (2016)	1,330	• EVO treatment was selected and performed in September and October 2016.
Cantonment Area – Site SS023	RCRA Site SS023 Site SD023	SWMU 23 Former Maintenance Shop Site SS023 is located north of Doolittle Drive between A and B Streets.	TCE from an electrical transformer storage area TCE plume that originates at the electrical transformer storage area and extends south of Doolittle Drive	• Steam injection • Ozone/AS system installed • SVE system • OWS N and surrounding soil excavated • Biovent system • ISCO in 2014 and 2015	Site SS023 CMI Report (CH2M HILL, 2015d) MRP R5-2008-0149-054 (Central Valley Water Board, 2015e) Revised MRP R5-2015-0012-011 (Central Valley Water Board, 2015f)	NA	TCE	1,324 (2001)	80.4	• Ozone/AS system was turned off on August 14, 2012. • TCE declining near source area. • TCE not detected in ISCO injection wells in 2015. • Injection in 2015 to treat TCE above the source area treatment concentration of 100 µg/L in two wells.
Cantonment Area - Site SS507	SWMU 23B	1,1-DCE Groundwater Plume emanating from sewer defects along the western side of B Street and on the northwestern corner of Doolittle Drive and B Street.	Solvents discharged to OWS M, which then discharged to the sanitary sewer.	• No previous corrective measures conducted		1,1-DCE	1,1-DCE	45 (2011)	30.8	• Statement of Basis for SS507 is being prepared. • The proposed remedy is NFA for soil, and MNA and LUCs for groundwater.
CG041-040	Site CG040	Monitoring Well UBL002MW Former AOC 73	VOCs (primarily TCE) were released from two suspected source areas: Site CG040 East, near C Street and Warren Shingle Road Site CG040 West, west of the J Street Gas Station at the Building 469 Loading Dock and Railroad Track Off-Loading Area. Hot Spot identified at the southeast corner of 2013 soil vapor survey near the railroad tracks.	• ERD (biobarrier to prevent migration of greater than 500 µg/L) in 2011 • Evaluation monitoring and LUCs	Site 40 West Treatability Study Summary Report (CH2M HILL, 2011b) MRP No. R5-2008-0149-031 (Central Valley Water Board, 2011b)	Carbon tetrachloride, cis-1,2-DCE, 1,1-DCE, PCE, TCE, and vinyl chloride	TCE PCE	1290(2016) 149 (2016)	1,290 149	• The East plume has migrated and commingled with the downgradient West plume. • The mass flux of TCE through the biobarrier is less than 20 percent. • The TCE plume is gradually getting deeper as it moves west towards the base boundary, contained within depths of about 150 and 180 feet bgs. • Western (downgradient) extent of TCE is not defined to the MCL. • TCE detected approximately 200 feet east of the Base boundary. • Revised MRP was submitted to Central Valley Water Board and approved until a new remedy for this area is implemented.
CG041-509 and CG041-517	Beale AFB Clinic	Clinic USTs and related TPH plume (CG041-509)	Spills from three 8,000-gallon diesel USTs	• UST excavation • Enhanced bioremediation • LNAPL skimming	Site TU509 RA-CCR Report (CH2M HILL, 2015g) Site TU509 CAP (CH2M HILL, 2015h)	Benzene, naphthalene, and TPH-D	TPH-D	560,000 (2008)	9,380 J	• CG041-509 corrective action identified in the CAP (2015) identifies excavation of smear zone soil and injection or ORC as remedies. • LNAPL skimming from MW-1A, MW-4, and MW-6A.

ATTACHMENT 1
Summary of Site Background
Beale Air Force Base, California

Groundwater Site	Corresponding Site	Site Description	Source of Groundwater COCs	Remedial Actions	Documents	Groundwater COCs (µg/L)	Primary COC	Historical Level (µg/L) (year)	2016 Max Level (µg/L)	Status
		Clinic PCE plume (CG041-517)	Suspected surface releases near the northeastern corner of Building 5702	• ERD in 2016	Site TU509 Groundwater CAP Addendum (CH2M HILL, 2016) MRP No. R5-2015-0012-012 (Central Valley Water Board, 2015j) CG041-517 SB/CMI WP (Air Force, 2015)	PCE	PCE	336 (2013)	160	• CG041-517 corrective action identified in the SB/CMI WP as in situ ERD using EVO and a microbial consortium (KB-1)
PL582	Lincoln Receiver Site	Backup electrical generator facility and storage area for fuel	Releases from the USTs Undocumented historical spills and releases Transformer pad located along the northwestern side of Building 4131 is considered the source area.	• Removal of USTs in 1988	Site PL582 Data Gap Investigation Summary Report (CH2M HILL, 2016k) Site PL582 SOB/CMI WP (CH2M HILL, 2016)	TCE and TPH-D	TCE	75.5 (2013)	18.9	• Plume extends approximately 1,200 feet north-northwest from the source area. • TPH-D contamination is limited to the perched water zone. • Long term monitoring and LUCs were selected as the corrective measure
TU002	Capehart Service Station LUFT Site	Former Capehart Gas Station, which contained fuel island pumps and several 10,000-gallon gasoline USTs	Spills from three 10,000-gallon gasoline USTs located on the northern side of the former Capehart Gas Station.	• Three 10,000- gallon gasoline USTs located on the northern side were removed in 1999. • Three 10,000-gallon USTs located to the east of the former service station were removed in 2009. • GETS in 2001.	Site TU002 CAP (CH2M HILL, 2014)	MTBE and benzene	MTBE	4,400 (2010)	99.1	• Plume is defined in the crossgradient and downgradient directions. • Elevated MTBE concentrations detected along the axis of the plume in 2014 indicated contamination is migrating toward the west. • Three new wells constructed downgradient were added to address this migration.

Notes:

µg/L = microgram(s) per liter
AFB = Air Force Base
AGE = Aerospace Ground Equipment
AOC = Area of Concern
AS = air sparge
BGMP = Basewide Groundwater Monitoring Program
bgs = below ground surface
BS/IR = Baseline Summary/Implementation Report
BTEX = benzene, toluene, ethylbenzene, and xylenes
CAP = Corrective Action Plan
CE = Civil Engineering
Central Valley Water Board = Central Valley Regional Water Quality Control Board
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act
CMI = Corrective Measures Implementation
COC = chemical of concern
DCA = dichloroethane
DCE = dichloroethene
DIPE = di-isopropyl ether
DNAPL = dense nonaqueous phase liquid
EA = enhanced attenuation
EDB = ethylene dibromide
EISB = enhanced in situ bioremediation
EOD = explosives ordnance disposal
ERD = enhanced reductive dechlorination
ERP = Environmental Restoration Program
ETBE = ethyl tert-butyl ether
EVO = emulsified vegetable oil
FPTA = fire protection training area
GET = groundwater extraction and treatment
GETS = groundwater extraction and treatment system
GTS = groundwater treatment system
IROD = interim record of decision
ISCO = in situ chemical oxidation
JP-TS = jet propellant thermally stable
LNAPL = light nonaqueous phase liquid
LUC = land use control
LUFT = leaking underground fuel tank
MCL = maximum contaminant level
MMRP = Military Munitions Response Program
MOGAS = motor gasoline
MRP = Monitoring and Reporting Program
MTBE = methyl tert butyl ether
NA = not applicable
ORC = oxygen release compound
OWS = oil/water separator
PCE = tetrachloroethene
PSL = project screening level
RA = remedial action
RCRA = Resource Conservation and Recovery Act
RI = remedial investigation
ROD = record of decision
SB = Statement of Basis
SWMU = solid waste management unit
SVE = soil vapor extraction
TAME = tert-amyl methyl ether
TBA = tert-butyl alcohol
TCA = trichloroethane
TCE = trichloroethene
TeCA = tetrachloroethane
TEFA = technical and economic feasibility analysis
TPH-D = total petroleum hydrocarbons as diesel
TPH-G = total petroleum hydrocarbons as gasoline
UST = underground storage tank
WP = work plan

Regulatory Comments and Responses on Draft Final Document

Second Five-Year Review (January 2011 – June 2016)

Beale AFB, CA

November 2017

CALIFORNIA
Water Boards

Edmund G. Brown Jr.
Governor

Matthew Rodriquez
Secretary for
Environmental Protection

Central Valley Regional Water Quality Control Board

10 January 2018

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DRAFT SECOND FIVE-YEAR REVIEW REPORT, BEALE AIR FORCE BASE (AFB), YUBA COUNTY

Central Valley Regional Water Quality Control Board staff (Central Valley Water Board staff) has reviewed the *Draft Second Five-Year Review Report* (Report) received on 22 November 2017 for Beale AFB. The Report, prepared by AECOM on behalf of the Air Force, evaluates the protectiveness of remedies implemented at sixteen environmental restoration program (ERP) sites at Beale AFB. The sites are being regulated following guidelines established by the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), Resource Conservation and Recovery Act (RCRA), and State of California Leaking Underground Fuel Tank (LUFT) programs. Although the Beale AFB ERP has established 38 sites, only 10 CERCLA, four RCRA, and three LUFT sites have been identified by the Air Force as undergoing some form of remedial action, where contaminants remain in one or more environmental media at the site. The Report incorporates data and information generated during the period from 1 January 2011 through 30 June 2016.

The Second Five-Year Review Report evaluates remedy protectiveness at the following sites:

CERCLA Sites

- CG041, Basewide Groundwater, including sites CG041-003, CG041-010, CG041-013, CG041-016, CG041-017, CG041-018, CG041-029, CG041-031, CG041-032, CG041-035, CG041-039, CG041-040, CG014-508, CG041-509, and CG041-517
- SD011: Aerospace Ground Equipment Area
- LF013: Former Landfill No. 1
- OT017: Best Slough
- ST018: Bulk Fuel Storage Facility
- SD032: Building 1086
- SS035: Munitions Storage Area
- DP038: Former Skeet Range
- SS039: Building 2145

RCRA Sites

- LF002: Landfill No. 2
- LF003: Landfill No. 3
- SS023: SWMU23 East and West Transformer Storage Area
- PL582: Lincoln Receiver Site

LUFT Sites

- TU002: Former Capehart Gas Station
- TU509: Clinic USTs
- ST022: Underground Storage Tanks – Basewide

The Air Force as the lead agency is responsible for funding and implementing remedial actions, and provides final approval for decisions regarding remedial actions taken at Beale AFB. The California Environmental Protection Agency (Cal/EPA), represented by the California Department of Toxic Substances Control (DTSC) and the Central Valley Water Board (CVWB), provides regulatory oversight, including technical support and review, and comment on all investigative and remedial work at Beale AFB. General and specific comments on the Draft Second Five-Year Review Report are provided below.

GENERAL COMMENTS

1. Beginning in Section 5.1.5 in the fifth bullet on page 5-6 and elsewhere as it occurs throughout the Report, 1×10^{-4} should be described as one in ten thousand, instead of one in a hundred thousand.

2. Protectiveness statements for Sites SD010, SD031, SD032, and SS039 in the previous five-year review report recommended an evaluation of groundwater conditions underneath buildings or the potential for vapor intrusion over groundwater plumes where no building exists to determine the potential threat to human health. It is unclear why this recommendation was not followed during the review period. We acknowledge the intent in current protectiveness statements to fulfill the recommendation as part of the next five-year review cycle, though this represents a ten-year period since the initial recommendation was made. Please discuss the reason for lack of follow-up on this issue during the review period.

3. Page 5-104 is missing from the electronic version provided on CD though was found in the hard copy. Please ensure that the page is included in the next electronic version of the Report.

SPECIFIC COMMENTS

1. Site LF013, Section 5.2.5, Technical Assessment, page 5-15: The third bullet in the response to Question B concludes that the risk estimates are still valid because the assumptions used to calculate the risk-based screening levels (RBSLs) for indoor air for the risk-driving chemicals of concern (COCs) in soil vapor are still valid based on current

2011 DTSC guidance. The risk estimates are based on a RBSL of 370 parts per billion by volume (ppbv) trichloroethene (TCE) in soil gas. The Report should acknowledge that more recent vapor intrusion guidance has been published by EPA Region 9. In July 2014, a memo was published concerning response action levels for TCE in indoor air (EPA, 2014) and a technical guide for assessing and mitigating the vapor intrusion pathway was published in June 2015 (EPA, 2015). The Report should cite RBSLs for TCE vapor intrusion and attenuation factor (AF) as established by these two documents and evaluate site-specific data using these criteria.

2. Site ST018, Section 5.4.5, Technical Assessment, page 5-27: The last two sentences of the first paragraph pertain to land use controls (LUCs) to restrict groundwater use and state that the LUCs were selected as the final remedy for Site ST018. First, this is a groundwater issue and should be addressed as part of Site CG041-018. Secondly, the LUCs adopted in the Site ST018 Record of Decision (ROD) prevent residential land use due to the uncertainty concerning polycyclic aromatic hydrocarbons (PAHs) in soil. Please revise the sentence regarding final remedy selection.

3. Site ST018, Section 5.4.5, Technical Assessment, page 5-28: The last two sentences in the last paragraph following Question B pertain to groundwater beneath Site ST018. Groundwater beneath the site is being addressed as Site CG041-018, therefore statements regarding groundwater conditions are not appropriate in this section. Only media addressed as part of Site ST018 should be discussed. Please revise the paragraph to omit statements concerning groundwater exposure risks. Likewise, the answer to Question C only contemplates groundwater exposure protectiveness. Please revise the answer to Question C to cite only media addressed as part of Site ST018 (i.e., soil, sediment, and surface water).

4. Site ST018, Section 5.4.7, Protectiveness Statement, page 5-28: The protectiveness statement includes items related to groundwater exposure which should be covered as part of Site CG041-018. Similar to the previous comment, please revise the protectiveness statement to omit items related to groundwater exposure.

5. Site SD032, Section 5.5.1, Introduction, page 5-31: The second paragraph describes multiple physical features located at Site SD032. It would be helpful to depict some of these items on Figure 5.5-1, Site SD032 Features Map. Please depict features on Figure 5.5-1 that are described in the text.

6. Site SD032, Section 5.5.5, Technical Assessment, page 5-33: The answer to Question A is not entirely true. Since DTSC did not concur with no further action (NFA), LUCs were established in the ROD to prevent residential use around SVE well VE-4. The LUCs will remain in effect until conditions are suitable for unlimited use and unrestricted exposure (UU/UE).

7. Site SD032, Section 5.5.8, Next Review, page 5-34: Since the site was not suitable for UU/UE at the time of the ROD, another five-year review will be required for Site SD032.

8. Site SS035, Section 5.6.5.1, Changes in Exposure Pathway, page 5-41: The end of the third paragraph of the section is inaccurate. PAHs were never detected in the background data set samples, therefore, the statement that they were determined to exceed background at only two locations is incorrect. PAHs were actually found to be a

COC and were listed as such in the subsequent Site SS035 ROD. Please check the information and revise the paragraph accordingly.

9. Site SS035, Section 5.6.5.1, Changes in Exposure Pathway, page 5-41: Risk estimates are provided for three exposure areas at Site SS035. Please either show the exposure areas on a figure or describe the extent of each area in the text.

10. Site SS035, Section 5.6.5.1, Changes in Exposure Pathway, page 5-41: The end of the sixth paragraph says that lead not being considered as a COC is still a valid conclusion. This statement disagrees with the ROD that was completed for Site SS035 which lists lead as a COC in soil. Please check the information and correct the statement if warranted.

11. Site DP038, Section 5.7.5, Technical Assessment, page 5-51: The fifth bullet in the answer to Question C may be incorrect because recent changes in PAH cancer toxicity values for benzo(a)pyrene have resulted in apparently lower screening concentrations than used in earlier risk assessments. Please cite specific past and current screening values to support the statement that the screening values for benzo(a)pyrene and other carcinogenic PAHs have become less stringent (an approximately seven-fold increase).

12. Site SS039, Section 5.8.2, Response Action Summary, page 5-56: The last paragraph mentions ground-disturbing activities observed during the September 2015 site inspection. Please describe the location of the activities and whether they were located above the groundwater volatile organic compound (VOC) plume CG041-039.

13. Site SS039, Section 5.8.3, Progress since the Last Review, page 5-56: The protectiveness statement from the first five-year review recommended an evaluation of groundwater conditions underneath buildings to determine whether a potential threat to human health exists. It is unclear why this recommendation was not followed by the Air Force during the review period. As requested in General Comment 2, please discuss the reason for the lack of follow-up on this issue during the review period.

14. Site SS039, Section 5.8.5, Technical Assessment, page 5-57: The second paragraph states that LUCs are in place and effective. The statement cannot be made with confidence because the previous five-year review's recommendation to evaluate human health protectiveness for the groundwater to indoor air pathway was not followed. The pathway is to be evaluated as part of the Site CG041 ROD.

15. Site SS039, Section 5.8.5, Technical Assessment, page 5-57: The response to Question B states that the exposure assumptions, toxicity data, cleanup goals, and RAOs used at the time of remedy selection are still valid. The AF of 0.0012 used to derive the soil vapor cleanup goal for human health protection is reportedly in line with the 2011 DTSC recommended AF of 0.001 for a future residential building. As discussed in Specific Comment 1, more recent vapor intrusion guidance has been published by EPA. The response should cite RBSLs and the AF recommended by EPA guidance and evaluate site-specific data using these criteria (EPA, 2014; EPA, 2015).

16. Site SS039, Section 5.8.5, Technical Assessment, page 5-58: CVWB staff disagrees with the interpretation that the potential for TCE migration from Source Area 1 to the movie theater is low as discussed in the next to last paragraph. A groundwater TCE plume emanating from Source Area 1 which could volatilize TCE exists beneath the

building. Although no utility line connections exist from Source Area 1 to the movie theater, the sewer line connections on the west side of the building could serve as preferential pathway for vapors migrating from groundwater. Please acknowledge this potential preferential pathway in the Report.

17. Site SS039, Section 5.8.5, Technical Assessment, page 5-59: The answer to Question C should reflect new information from EPA. Specifically, the short-term exposure criteria for TCE and vapor intrusion guidance published by EPA in July 2014 and June 2015, respectively, should be cited in this section.

18. Site SS039, Section 5.8.7, Protectiveness Statement, page 5-59: The protectiveness statement discusses exposure to groundwater, although groundwater is not part of Site SS039. Please revise the statement to limit it to environmental media covered as part of Site SS039 (i.e., soil, sediment, and surface water).

19. Site CG041, Section 5.9.2.9, CG041-032, page 5-71: The fifth paragraph indicates that groundwater modeling predicts the plume will not migrate past the base boundary at concentrations greater than the cleanup goal. The paragraph should also state that the increasing TCE concentration trend observed at well 01C008CMW located just north of North Beale Road indicates that the plume is potentially migrating offbase as it becomes submerged beneath cleaner groundwater. Please add this information to the Report as it is an important indication of plume migration observed during the review period.

20. Site CG041, Section 5.9.2.14, CG041-509, page 5-75: The third paragraph of the section incorrectly states that soil excavation was completed in February 2012. The excavation was actually completed in February 2015. Please check the dates and revise as necessary.

21. Site CG041, Section 5.9.3.4, CG041-035, page 5-76: Treatment of the source area portion of the groundwater plume is reportedly anticipated to continue for five years after SVE operations are complete. The Site CG041 ROD does not include bioreactor operation as part of the selected remedy for CG041-035. Please check the information and revise the paragraph to correspond with the remedy identified in the Site CG041 ROD. Also, the reference at the end of the paragraph cites the CG041-508 Pre-design Investigation Work Plan while it probably should refer to the Focused Feasibility Study for Basewide Groundwater. Please check the reference and correct if appropriate.

22. Site CG041, Table 5.9-3, Status of Recommendations from the First Five-Year Review, Site CG041-003, page 5-77: The first row of the table pertains to the previous recommendation to complete site characterization activities at Site CG041-003. The current implementation status description states that all media have been fully characterized as of June 2015. This statement is not true because data gap investigation activities are being proposed to delineate the extent of groundwater contamination to the west and the presence of VOCs in soil gas overlying groundwater plume CG041-003. Please revise the table accordingly.

23. Site CG041, Table 5.9-3, Status of Recommendations from the First Five-Year Review, Site CG041-003, page 5-77: The recommendation in the second row of the table is to re-evaluate applicable components of the Site FT003 Risk assessment, including an evaluation of risk from vapor intrusion if buildings were to be constructed above the site groundwater plume. The current implementation status states that risk assessments for

groundwater associated with Site CG041-003 will be presented in the forthcoming ROD. This statement is incorrect as the Site CG041 ROD no longer includes this site since it is being managed under Site CG044. It is anticipated however, that the future Site CG044 ROD will include an assessment of the groundwater to indoor air pathway. Please note that this comment also applies to Table 5.9-5 for Site CG041-013, Table 5.9-10 for Site CG041-031, and Table 5.9-14 for CG041-040.

24. Site CG041, Table 5.9-11, Status of Recommendations from the First Five-Year Review, Site CG041-032, page 5-84: The first recommendation is to continue monitoring and evaluating distal plume areas to ensure that concentrations are continuing to decrease. The current implementation status indicates that evaluation monitoring as part of WDRs Order No. R5-2007-0025 is ongoing which includes monitoring of downgradient/distal wells. The intent of groundwater monitoring under the WDRs is not to evaluate whether contaminant concentrations are decreasing, but to demonstrate that no deleterious effects are occurring to groundwater outside the treatment zone. In fact, TCE concentrations have increased above the maximum contaminant level (MCL) at well 01C008CMW located near the base boundary. Data from the associated well cluster indicates that TCE exceeding the MCL is submerged beneath cleaner groundwater and potentially migrating offbase. The Air Force is planning offbase monitoring well installations to evaluate downgradient plume migration. Please revise the current implementation status to reflect increasing TCE concentrations observed near the base boundary during the review period which supports further investigation planning.

25. Site CG041, Table 5.9-13, Status of Recommendations from the First Five-Year Review, Site CG041-039, page 5-86: The recommendation in the fourth row of the table is to continue to monitor and evaluate groundwater concentrations underneath existing buildings to ensure no vapor intrusion concerns are present, and to consider the installation of vapor monitoring points adjacent to buildings near Source Area 1. The current implementation status summarizes the findings from the *Site SS039 Screening Level Risk Assessment Summary Report* which concluded that soil vapor in the Source Area 1 Exposure Area is suitable for UU/UE. CVWB staff disagrees with the status because the referenced report did not evaluate the groundwater to indoor air vapor intrusion pathway for Site CG041-039. The more appropriate response is that the upcoming Site CG041 ROD will include provisions to evaluate the groundwater to indoor air pathway (i.e., through the collection of indoor air samples from existing buildings overlying Site CG041-039).

26. Site CG041-040, Table 5.9-4, Status of Recommendations from the First Five-Year Review, page 5-87: The current implementation status in the second and third rows of the table refer to the Site CG041 ROD for upcoming information concerning the final remedy. Cleanup of the plume is actually being addressed as part of Site CG044 which was established by the Air Force in May 2016 to address five plumes along the western base boundary. The Site CG044 ROD is anticipated in approximately 2020. The table should be revised to reflect the Site CG044 designation and associated ROD.

27. Site CG041-003, Table 5.9-16, 2015 TCE Data and Trends, page 5-89: According to the legend, data exceeding project screening levels (PSLs) or showing an increasing trend are highlighted in bold type. Although multiple entries fit the criteria, none of the data is shown in bold type. Please check the table and revise it as indicated by the legend. Note that this comment also applies to Table 5.9-17 through Table 5.9-31.

28. Site CG041-013, Section 5.9.5.3, page 5-92: The first paragraph refers to Table 5.11-18 for TCE data and time-series plot trends. Please note that the information is actually provided in Table 5.9-18. Also, Table 5.9-18 contains an asterisk annotation for some well entries though the asterisk is not explained in the legend. Lastly, the hydrostratigraphic unit (HSU) entry for wells 13C088MW and 13C091MW is incomplete as it shows "screened" and is probably intended to show "screened within the bioreactor." Please check these inconsistencies and correct as warranted.

29. Site CG041-017, Section 5.9.5.5, page 5-94: The second paragraph refers to Table 5.11-19 for TCE data and time-series plot trends while it should cite Table 5.9-19.

30. Site CG041-017, Section 5.9.5.5, page 5-95: The next to last paragraph of the section concludes that a local source of TCE contamination may exist near well 17V012MW and outside the slurry wall causing increasing concentrations. An alternate explanation is that there is contaminant leakage through or below the wall causing increasing concentrations outside the wall. The anticipated remedy for the site includes installation of a zero-valent iron (ZVI) permeable reactive barrier (PRB) at this location (along alignment of existing slurry wall) and in situ chemical oxidation (ISCO). The ISCO and ZVI PRB will provide further treatment and help mitigate concerns related to contaminant leakage through the wall. Please add the interpretation of contaminant leakage through the slurry wall to the explanation at the end of the paragraph.

31. Site CG041-017, Section 5.9.5.5, page 5-95: The last paragraph of the section says that no increasing TCE trends have been observed in either the western or southern downgradient wells. A review of the information in Table 5.9-19 shows an increasing TCE trend at downgradient wells 17C165BMW and 17C166MW. Please check the data and revise the statement if appropriate.

32. Site CG041-018, Table 5.9-20, TCE Data and Trends, page 5-95: Wells 18C046MW and 18C047MW are listed in the table though are not shown in Figure 5.9-11. Please add these two wells to Figure 5.9-11.

33. Site CG041-018, Section 5.9.5.6, page 5-96: The last paragraph indicates that benzene was detected at concentrations greater than the PSL of 1 microgram per liter (ug/L) at two monitoring wells in 2015. Please list the two wells, 18U007BMW and 18U008BMW, where benzene was reported at concentrations greater than the PSL.

34. Site CG041-029, Section 5.9.5.7, page 5-97: The last sentence states that TCE concentrations in cross-gradient wells remain less than the PSL and indicate that the plume is not migrating to the northeast or southeast. The sentence should probably refer to northwest as cross-gradient because northeast is actually upgradient from the source area.

35. Site CG041-031, Section 5.9.5.8, page 5-99: The third paragraph of the section discusses TCE rebound at wells 31C003MW and 31C022MW in the source area. Please show the location of well 31C022MW in Figure 5.9-16.

36. Site CG041-032, Table 5.9-24, 2015 TCE Data and Trends, page 5-100: The entry for the time-series plot trend column for well 21L002MW is incomplete as it only lists "Recently." Please complete the entry with the appropriate trend. Also, wells 01C009AMW/BMW/CMW are listed in the table, but are not shown in Figure 5.9-18.

Please add the wells to Figure 5.9-18 as they are important in identifying an area of increasing TCE concentration in groundwater.

37. Site CG041-032, Section 5.9.5.9, page 5-101: The third from last paragraph discusses the increasing TCE concentration trend at well 01C008CMW located just north of North Beale Road. Downgradient triple well cluster 01C008AMW/BMW/CMW is important because it is near the base boundary and indicates that the plume is submerged and may be migrating offbase. Please show the location of well cluster 01C008MW on Figure 5.9-18 or include another figure showing the wells with deep plume TCE data.

38. Site CG041-035, Section 5.9.5.10, page 5-102: The last paragraph indicates that detected concentrations at the compliance wells in 2015 did not exceed baseline values. Please list the constituents analyzed according to the Monitoring and Reporting Program (MRP) that were evaluated to make this determination.

39. Site CG041-039, Table 5.9-26, 2015 TCE Data and Trends, Source Area 1, page 5-103; and Table 5.9-27, 2015 TCE Data and Trends, Source Area 2, page 5-105: Wells 39U008APZ and 39U008BPZ are listed in Table 5.9-26 though are not shown in Figure 5.9-22. Also, multiple wells listed in Table 5.9-27 are not found in the figure. Please depict the missing well locations in Figure 5.9-22.

40. Site CG041-058, Section 5.9.5.13, page 5-109: The last paragraph discusses tetrachloroethene (PCE) data at downgradient well cluster 39U006A/BMW. Please show the location of well cluster 39U006MW in Figure 5.9-26 to aid the reader.

41. Site CG041-058, Section 5.9.5.13, page 5-109: The penultimate sentence indicates that the decrease or stabilization of PCE suggested by 2015 data is potentially related to remedial actions conducted at Sites SS023 and CG041-039. Another possible explanation is related to stratigraphic control of contaminant migration. A review of boring logs and cross-sections suggests that PCE may be preferentially migrating through coarse grained stream channel deposits within finer grained floodplain sediments. Please add this as an alternate explanation of PCE plume transport at the site.

42. Section 5.9.6, Technical Assessment, page 5-111: The answer to Question B should reflect the EPA short-term exposure action levels for TCE published in July 2014 and updated EPA vapor intrusion guidance published in June 2015. Based on the information in those publications, it is unlikely that the Site CG041 ROD will use the same assumptions for vapor intrusion as during the interim record of decision (IROD) development process for each formerly individual site within CG041. Please revise the response accordingly.

43. Site CG041, Section 5.9.8, Protectiveness Statement, page 5-112: CVWB staff does not concur with the protectiveness statement for Site CG041. The Report states that the interim remedies for Site CG041 are protective because LUCs are in place to prevent potential exposures through the vapor intrusion or direct contact pathways. There are no LUCs in place to prevent exposure through the vapor intrusion pathway, therefore, this portion of the statement should be excluded from the Report.

44. Site CG041-029, Figure 5.9-15, TCE Contaminant Groundwater Plume in 2010, 2013, and 2015: The 5 ug/L TCE isoconcentration contours drawn for 2013 and 2015 combine

data from both shallow and deep groundwater zones. If the contours are to be depicted in a single plan view, then only the lateral extent should be shown. Please revise the figure to show the lateral extent of the contours in this manner. This comment also applies to concentration contours in Figure 5.9-29 for Site CG041-509, Figure 5.9-30 and Figure 5.9-31 for Site CG041-517, and Figure 7.1-2 for Site TU002.

45. Site CG041-032, Figure 5.9-18 and Figure 5.9-19: The two figures show site features and shallow groundwater TCE plumes at the site. The figures should be supplemented with corresponding figures depicting deep groundwater TCE plumes for the site. As recommended for other plumes with shallow and deep groundwater contamination, the lateral extent of the deep plumes can alternatively be added to the shallow groundwater figures by showing their outline. This will help show the full extent of groundwater contamination beneath the site including locations north of North Beale Road where TCE exceeded the MCL during the review period.

46. Site CG041-039, Figure 5.9-22, Site Features and 2015 TCE Concentrations: The TCE isoconcentration contours in the figure are not labeled with their corresponding concentrations. Please label the contours with the appropriate concentrations. Also, please add the TCE contours and corresponding concentrations to the inset map.

47. Site CG041-509, Figure 5.9-28, Site Features and 2015 TPH-D Concentrations: The legend contains a numbered rectangle defined as “Micrograms per Liter.” In review of the figure, this symbol apparently denotes a building number. Please check the figure and correct as appropriate. This comment also applies to Figure 5.9-30 for Site CG041-517.

48. Site SS023, Section 6.3.2, Response Action Summary, page 6-17: The last sentence of the paragraph states that groundwater beneath Site SS023 is being addressed as part of the Cantonment Area, Site CG041-040. Although Site SS023 is being addressed as part of the Cantonment Area in the Basewide Groundwater Monitoring Program (BGMP), it is not being addressed as Site CG041-040, only as Site SS023. Also, please note that there is no Section 5.11 in the Report as mentioned at the end of the sentence nor is groundwater beneath Site SS023 discussed elsewhere in the document. Please revise the sentence accordingly.

49. Site SS023, Section 6.3.4, Data Review, page 6-17: Similar to the previous comment, there is no Section 5.11 as discussed at the end of the paragraph. Please revise or omit the sentence.

50. Site SS023, Section 6.3.8, Next Review, page 6-18: The section concludes that since NFA has been approved for Site SS023, no further five-year reviews are planned. This reasoning is invalid because while soil and soil vapor at the site have received an NFA determination through a Statement of Basis, underlying groundwater is still undergoing remediation. Due to the remaining groundwater contamination, a subsequent five-year review will be required. Please revise the section accordingly.

51. Site PL582, Section 6.4.5, Technical Assessment, page 6-23: The reply to Question A ends by stating that LUCs will prevent exposure to TCE until concentrations are at or less than the MCL. The statement should be revised to better align with the Statement of Basis which says that LUCs will restrict access to soil vapor and to groundwater contaminated with TCE at concentrations above the MCL until the concentrations of TCE

in soil vapor and groundwater allow for UU/UE. The Report can summarize that statement by stating that LUCs will restrict access to groundwater and exposure to TCE in soil vapor until conditions are suitable for UU/UE.

52. Site TU002, Section 7.1.2, Response Action Summary, page 7-4: The section ends with a description of the optimum exit strategy (OES) for the site. One of the performance goals is to achieve an 85 percent reduction of the mean baseline methyl tertiary butyl ether (MTBE) concentration in groundwater (339 ug/L) in 2017 and to maintain the reduction over a six-month rebound period. Please be aware that the OES utilizes internal Air Force performance objectives and is unrelated to obtaining site closure (SC) through the regulatory agencies.

53. Site TU002, Section 7.1.7, Protectiveness Statement, page 7-6: An OES developed for Site TU002 is discussed in this section which states that if the goals of the OES are achieved, the site will be suitable for Response Complete (RC). A discussion of the OES is inappropriate for the protectiveness statement since it is not directly related to protectiveness and therefore should be omitted.

If you have any questions or comments concerning this letter, please contact me at (916) 464-4719 or by email at Mark.Clardy@waterboards.ca.gov.

Mark W. Clardy

Mark W. Clardy, P.G.
Engineering Geologist
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REFERENCES

U.S. Environmental Protection Agency (EPA). 2014. *EPA Region 9 Response Action Levels and Recommendations to Address Near-Term Exposures to TCE in Air from Subsurface Vapor Intrusion,* Memorandum from Enrique Manzanilla - Director, Superfund Division, to Region 9 Superfund Division Staff and Management. July.

U.S. Environmental Protection Agency (EPA). 2015. *OSWER Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Vapor Sources to Indoor Air.* Office of Solid Waste and Emergency Response, Washington, D.C. OWSER Publication 9200.2-154. June.

cc: Mr. D. Scott Dressler, AECOM, Sacramento, CA (via email)
Ms. Hiral Doshi, Department of Toxic Substances Control, Sacramento, CA (via email)

Department of Toxic Substances Control

Matthew Rodriquez
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TO: Hiral Doshi, Project Manager
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FROM: Farah Esfandiari, Ph.D.
Staff Toxicologist
Human and Ecological Risk Office (HERO)

DATE: February 05, 2018

SUBJECT: Beale Air Force Base, California

Second Five-Year Review Report

PCA: 14718 Site: 100018-47

Document Reviewed: Second Five-Year Review Report, Beale Air Force Base, California. Report is prepared by AECOM (Sacramento, CA) and dated November 2017.

Background: Five-year reviews are required under Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) for final remedial actions when hazardous substances or contaminants remain at a site above levels that allow unlimited use and unrestricted exposure (UU/UE). This Five-Year Review Report (the Report) evaluates the protectiveness of remedies implemented at sixteen environmental restoration program (ERP) sites at Beale AFB that include the CERLCA Sites CG041 (Basewide Groundwater), SD011 (Aerospace Ground Equipment Area), LF013 (Former Landfill No. 1), OT017 (Best Slough), ST018 (Bulk Fuel Storage Facility), SD032 (Building 1086), SS035 (Munitions Storage Area), DP038 (Former Skeet Range) and SS039 (Building 2145); the RCRA Sites LF002 (Landfill No. 2), LF003 (Landfill No. 3), SS023 (WMU23 East and West Transformer Storage Area), PL582 (Lincoln Receiver Site); and LUFT Sites TU002 (Former Capehart Gas Station), TU509 (Clinic USTs) and ST022 (Underground Storage Tanks – Basewide).

Scope of Review: HERO's review was limited to aspects relevant to human health risk assessment and ensuring protection of human health.

General Comments:

HERO reviewed all the Sites under the Five-Year Review and provides comments that generally apply to all the sixteen ERP sites at Beale AFB.

HERO has the following comments and recommendations:

1. Technical Assessment Sections: Cleanup Levels and Remedial Action Objectives (RAOs) for Indoor Air vapor intrusion (VI) risk assessment:

This comment applies to all the Sites with indoor air vapor intrusion issues:

Subsection 5.1.5 (page 5-6, last paragraph) states "This conclusion about the lack of COCs in soil vapor is valid because the assumptions used to calculate the risk based soil gas screening levels (RBSLs) for indoor air for the risk-driving COCs in soil vapor are still valid…". HERO do not totally agree with these conclusions. Risk based soil gas screening concentrations based on the USEPA 2015 empirically- derived attenuation factor of 0.03 should be developed and used to estimate risk and hazard for the unrestricted land use scenario, in addition to those based on the attenuation factor of 0.001 (2011 DTSC VI Guidance). Please note that DTSC will be requiring using attenuation factor of 0.03 for calculation of RBSLs and VI risks in their upcoming statewide VI guidance which is planned for finalization by the end of 2018.

2. Protectiveness Statement Subsections:

Subsection 5.5.7 (page 5-34) states "The interim remedy for Site SD032 is considered protective of human health and the environment because it has remediated soil and soil vapor contamination to levels acceptable for UU/UE".

A. HERO disagrees with this statement because cumulative human health risk cannot be assessed by evaluating different vapor sources such as soil gas and groundwater (GW) separately (decoupling soil and GW). Considering the presence of a contaminated GW plume underneath this Site and the potential for soil recontamination through seasonal variation of GW depth, post remediation confirmatory soil gas data are required for the proper site risk evaluation particularly in regard to vapor intrusion risk. Typically, VI risk evaluation won't be considered complete until evaluation of the VI risk for all the potential vapor sources (soil/GW) has been completed.

B. HERO also recommends a cumulative human health risk assessment assessing all exposure pathways (soil and GW) for all the receptors before allowing for unlimited use/unlimited exposure or UU/UE. This comment applies to all the Sites above the contaminated GW plumes. Report should be revised and rewritten accordingly.

3. Short term Trichloroethene (TCE) Exposure:

The below comments/recommendations apply to all the Sites with potential TCE vapor exposure.

A. Subsection 5.8.5 (page 5-59, first paragraph) states "Estimated cancer risk to future residents at Site SS039 from residual contaminants are within the acceptable risk management range of 1E-06 to 1E-04, and noncancer hazard estimates were at or below the target noncancer hazard index of 1, except for TCE in soil vapor at Source Area 2". Considering the acute noncancer toxicity concerns with respect to the potential TCE adverse effect on developmental toxicity (HHRA HERO Note 5), the previously proposed cleanup/remediation may not be protective of human health under all exposure scenarios and future conditions. Please note that TCE acute toxic effects play a more prominent role in risk management decisions and must be discussed and considered during five-year review.
http://www.dtsc.ca.gov/AssessingRisk/humanrisk2.cfm

B. Subsection 5.4.2 (page 5-25, last paragraph) states "The soil vapor cleanup level was derived from the MCL". HERO does not recommend eliminating indoor air measurements of TCE based solely on groundwater concentrations less than 5 µg/L (HHRA HERO Note 5). As commented above, HERO is especially concerned with the use of the TCE MCL which was established prior to the TCE toxicity reevaluation that has shown developmental cardiac effects from short term gestational exposures.

C. Please explain what steps have been taken to ensure sensitive receptors (women of child bearing age and pregnant women which currently occupy the existing buildings) are protected with regard to TCE exposure to indoor/outdoor air.

4. Chemicals of Potential Concern: Volatile organic compounds, primarily TCE, are the main contaminants of concern associated with the CG041-003 and -029 GW plumes. Since the GW contamination associated with these Plumes are originated from fire-fighting/protection training exercises at several fire protection training areas (FPTAs), Perfluorinated Compounds (PFCs) such as perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA) are potential chemicals of concern in GW. HERO recommends adding PFCs to the list of chemicals of potential concern in these Sites. This means that soil and groundwater samples should be tested for presence of this group of compounds.

Conclusion:

HERO has reviewed the Second Five-Year Review Report for Beale AFB. The Report should be revised addressing the above comments.

If you have additional questions please feel free to contact me at 916-255-6431 or e-mail Farah.esfandiari@dtsc.ca.gov.

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MEMORANDUM

TO: Hiral Doshi
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FROM: J. Michael Eichelberger, Ph.D. J. Michael Eichelberger
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DATE: January 22, 2018

SUBJECT: SECOND FIVE-YEAR REVIEW REPORT BEALE AFB, CALIFORNIA

Project: DTSC100018-47 Activity: 14718

Background

The Ecological Risk Assessment Section, at the request of the DTSC project manager, is providing comment on the aforementioned report in the subject line above. The 5-year review is of multiple sites that include the CERCLA designated sites SD011, LF013, OT017, ST018, SD032, SS035, DP038, SS039, CG041; and the RCRA Sites LF02, LF03, SS023, PL582, TU002, ST022, and TU509.

Document Reviewed

ERAS reviewed the "Second Five-Year Review Report Beale AFB, California", dated November 2017, and prepared by AECOM (Sacramento, CA). ERAS received the report via an EnviroStor request dated December 19, 2017.

Scope of the Review

The report was reviewed for scientific content related to the ecological risk assessment. Grammatical or typographical errors that do not affect the interpretation of the text have not been noted. We assume that regional personnel have evaluated the adequacy of site characterization, sampling of environmental media, and analytical chemistry data and quality.

General Comments

ERAS reviewed all of the Sites under the 5-year review and provides comments that largely apply to all of the sites. Not all sites appear to have impacts to ecological receptors. Groundwater sampling does not provide for comparison to aquatic ecological toxicity criteria. Comparison is only made to the MCL which is inadequate for determining if there is potential risk to ecological receptors.

Specific Comments

Site ST018

1. Pdf page 65 of 35 Section 5.4.5, 3, second bullet. The report states "*Based on low and high TRVs, HQs for metals in soil (aluminum and lead) are greater than 1 for terrestrial birds (e.g., western meadowlark and burrowing owl) and mammals (e.g., deer mouse, California vole, shrew, red fox). Aluminum and lead were attributed to naturally occurring conditions at Site 18 and are not related to site-related activities*". It is not plausible to believe that lead at site soil concentrations that are required to generate an average daily dose (ADD) BTAG TRV-High hazard quotient (HQ) of 1, is not associated with the site. As an example, a back-calculated safe soil concentration for the vole would be 8,500 mg/kg, a concentration that clearly would not be allowed to remain following remediation. The Kearny foundation survey of 50-California soils (https://envisci.ucr.edu/downloads/chang/kearney_special_report_1996.pdf) found lead concentrations in soil ranging from 12.4 mg/kg to 97.1 mg/kg with a geometric mean concentration of 21.7 mg/kg. It is implausible that lead concentrations are not site-related. ERAS understands the 5-year review is not a risk assessment but statements that allude to risk levels should be supported by presentation of the risk level, in this case the HQ value based on the BTAG TRV-High. Please note, ERAS no longer supports the use of BTAG TRV-highs. Based on the presented text, site-related soil concentrations are not protective of ecological receptors. ERAS suspects the meaning of the text was lost in the construction of the sentences. This section needs to be rewritten to convey the appropriate meaning.

   Aluminum toxicity is not evaluated unless the soil pH is less than 5.5 (USEPA 2003) which is unlikely for Site ST018. The report should so indicate. This is an additional line of evidence that would suggest that aluminum does not pose risk to ecological receptors.

2. Pdf page 65 of 353, Section 5.4.7, Protectiveness Statement. The report states "*Site conditions are protective of human health and ecological receptors based on current and anticipated future use of Site 18 as a bulk fuel storage facility, and the overall risks of exposure to COCs are relatively small because groundwater currently is not used. Current data suggest that the COCs dissolved in groundwater are not migrating off-site, and concentrations appear to be decreasing. No drinking water wells are threatened.*" This statement addresses only groundwater, but says nothing regarding soil concentration levels and their associated risks to ecological receptors. Limiting the discussion to groundwater may be acceptable if the lead risk levels in soil can be clarified as described in Specific Comment 1 above.

<u>Site DP038</u>

3. Pdf page 80 of 353, Response Action Summary. The lead MCL of 5 μg/L is not protective of aquatic ecological receptors. Site DP038 is reported to have 4.5-acres of seasonal wetlands. The National Ambient Water Quality Criteria (NAWQC) criterion continuous concentration (CCC) for lead is 2.5 μg/L which is half the MCL concentration. The MCL is not protective of aquatic ecological receptors.

   The lead preliminary cleanup goal (PCG) of 128 mg/Kg in sediment is the probable effects concentration (PEC). This is an appropriate PCG if the vernal pools do not have threatened or endangered (T&E) species associated with them. Some Beale Air Base vernal pools are known to contain threatened or endangered species. The report needs to specify that the vernal pools have been examined for T&E species and they have been found not to contain them. Otherwise, the lead sediment PCG should be the threshold effects concentration (TEC) of 35.8 mg/kg.

<u>Site SS039</u>

4. Pdf page 92 of 353, third bullet on page. The report states "*No data relevant to ecological receptors have been collected since the IROD was issued. Therefore, the conclusions made in the IROD still are relevant. Risk to ecological receptors was not predicted, and no COECs were identified for the site.*" The second sentence should be removed. The absence of additional data does not support the supposition that there is no risk to ecological receptors. The five-year should state whether site conditions have changed and if not, the conclusions of the ROD (no risk, no COECs) are still relevant.

Site CG 041

5. Pdf page 95 of 353. The report states that groundwater preliminary numerical cleanup goals have been identified base-wide and that these goals are based on federal or state MCLs. These may be protective of human health, but may not be adequate for protection of ecological receptors. Ecological groundwater cleanup goals need to be identified to assure that if groundwater comes into contact with ecological receptors that the cleanup goals are protective of them as well. A first-tier goal would be the Ambient Water Quality Criteria (AWQC) (https://www.epa.gov/wqc/national-recommended-water-quality-criteria-aquatic-life-criteria-table) criterion continuous concentrations (CCC). If an AWQC is not available a secondary source will need to be identified.

Site LF002

6. Pdf page 177 of 353, 4th bullet. The report indicates surface samples are taken on an annual basis and compared to MCLs. Please explain why comparisons of surface water samples are not also made to ecological aquatic criteria?

7. Pdf page 177 of 353, sixth bullet on page. The report indicates the landfill cap consists of a 1-foot compacted clay barrier and an 18-inch overlying erosion-resistant layer. There is no mention of a geotextile barrier. Please indicate what the erosion resistant layer is composed of and identify if the inspections include identification of burrows and what measures are proposed to address burrowing animals if burrows are found.

Site TU509

8. Pdf page 185 of 353, Section 6.2.4.3, Surface Water. The report indicates that "*no analytes were detected above primary MCLs*". As with previous comments, please indicate why surface water concentrations were not compared to protective aquatic ecological receptor criteria.

Conclusions

The report should be revised according to the comments above. If there is potential for groundwater to come into contact with ecological receptors, groundwater concentrations should be compared to the AWQC CCCs; if a CCC is not available, a protective aquatic criterion from a secondary source should be used.

Reference

USEPA, 2003 Ecological Soil Screening Level for Aluminum Interim Final. https://nepis.epa.gov/Exe/ZyPDF.cgi/P100K40O.PDF?Dockey=P100K40O.PDF.

Reviewed by: Edward A. Fendick, Ph.D. Ed Fendick
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Concurrence: Brian Faulkner, Ph.D. Ed Fendick for B.F.
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State of California
Department of Fish and Wildlife

M e m o r a n d u m

Date: DRAFT

To: Hiral Doshi, P.E.
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From: "Allen" C.L. Tsao, Associate Toxicologist
Carolyn Rech, Senior Environmental Scientist
California Department of Fish and Wildlife
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Subject: **CDFW-OSPR Comments on the Second Five-Year Review Report, Beale Air Force Base, California**

The California Department of Fish and Wildlife, Office of Spill Prevention and Response (CDFW-OSPR) received the Second Five-Year Review Report for Beale Air Force Base on December 19, 2017. The CDFW is the State's Trustee for fish and wildlife resources pursuant to Fish and Game Code Section 711.7. The CDFW is also designated to act on behalf of the public as a Trustee for natural resources pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Section 107 (f)(2)(B). The review conducted by CDFW-OSPR focused on ecological risk considerations as part of our role as a natural resource Trustee for the State of California.

Background

Beale Air Force Base (AFB) covers approximately 22,900 acres of land located less than 10 miles east of Marysville in Yuba County, California. The base is situated in the Sacramento Valley and lower foothills of the Sierra Nevada range.

Because the Ecological Risk Assessment Section (ERAS) of DTSC has taken up the ecological toxicology review at many of the sites at Beale AFB, CDFW-OSPR limited the review to the following three sites: DP038, OT-17, and SS035.

Global Comment

Many of the actions described for Site 38 (or DP038), and other sites in the subject document, are in future tense; however, several of the actions described in the subject document have already occurred (e.g., Site DP038's second removal action "*will extend to 1 ft below ground surface*" but the removal action has already taken place between October and November, 2016; for SS035, the text states that the Record of Decision (ROD) is "*forthcoming*" but the ROD was finalized in January 2017). CDFW-OSPR recognizes that there is a lag time between drafting the second five-year review and submitting it for agencies review. Please clarify a date for beyond which is not subject to the Second Five-Year Review report so that the start of the Third Five-Year Review may be resumed on the appropriate date. This global comment is for all the sites under the subject document.

DP038 (or Site 28, Former Skeet and Trap Shooting Range)

General Comments

1. Please revise the description to include trap range as another former use of the site. According to the 2006 action memorandum for DP038 (URS, 2006), a trap hut and other range features were constructed at the site; clay targets were launched from the trap hut in an easterly direction. The conceptual site model would benefit from knowing this feature so that it can help inform the location of the target fall area.

2. CDFW-OSPR agrees with the Air Force that further action for residual shotgun pellets and clay pigeon debris in soil and sediment should be evaluated. However, all samples taken to-date by the Air Force or its contractors have focused on the fine soil fraction and no appropriate sampling for shotgun pellets or clay pigeon debris has been conducted. The lack of sampling for shotgun pellets and clay pigeon debris/fragments should be identified as a data gap to be filled by the Air Force.

3. CDFW-OSPR agrees with DTSC-ERAS's memorandum to DTSC Project Manager dated January 22, 2018, that the stated lead Maximum Contaminant Level (MCL) of 15 µg/L is not protective of aquatic receptors. CDFW-OSPR would like to clarify that the National Ambient Water Quality Criteria Criterion Continuous Concentration (CCC) for lead in a filtered water sample of 2.5 µg/L assumes water hardness of 100 mg/L $CaCO_3$. Toxicity of lead to aquatic organisms is dependent on water hardness. Waters in the Central Valley are

known to be much softer. Thus, surface water samples should also be analyzed for hardness as $CaCO_3$ so that the CCC can be adjusted appropriately. If water hardness is 50 mg/L CaCO3, this would result in a CCC of 1.2 µg/L that would be more than twice as toxic if the hardness were at 100 mg/L $CaCO_3$.

4. The ecological risk posed by clay pigeon debris/fragments and the resulting PAHs in soil and sediment have not been agreed upon by the agencies. CDFW-OSPR recommends that statement "*conclusion regarding ecological risk for PAHs are still valid*" be removed from the subject document.

Specific Comments

1. p. 5-46, Section 5.7.2 Response Action Summary.
    a. CDFW-OSPR agrees with DTSC-ERAS that the Probable Effects Threshold (PEC)[1] of 128 mg/kg lead (MacDonald et. al., 2000) is not protective of federally listed vernal pool crustaceans. Without site-specific bioassays, the default lead preliminary cleanup goal for the legally protected vernal pool crustaceans would be the Threshold Effects Concentration (TEC)[2], which is 35.8 mg/kg (MacDonald et al., 2000).
    b. A lead particle (or pellet) density should also be established since that is the source of the contamination; lead in soil/sediment and water are secondary sources. The exact lead particle/pellet density PCG should be established in consultation with the Air Force, DTSC, and the Regional Water Quality Control Board.

2. p. 5-50, Section 5.7.5 Technical Assessment. The text states "*Selenium originally was identified as a COC in sediment but was concluded to be related to routine pesticide application rather than site-related sources (i.e., clay pigeons or skeet-related activities)*." CDFW-OSPR maintains our ongoing recommendation that samples be analyzed in areas where selenium is elevated to determine if Site SD038 also contains unacceptable levels of pesticides (Tsao, 2012).

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[1] Consensus-based PECs are values intended to identify contaminant concentrations above which harmful effects on benthic invertebrates were expected to frequently occur (MacDonald et al., 2000).
[2] Consensus-based TECs are values intended to identify contaminant concentrations below which harmful effects on benthic invertebrates were not expected to occur (MacDonald et al., 2000).

OT-017 (or Site 17, Best Slough)

General Comment

In our review of the site history for OT-017, CDFW-OSPR noticed that there are additional trenches and pits that do not appear to have been investigated (see Attachment 1). These features should be considered in the Third Five-Year Review report. If no intrusive soil investigation has been conducted, CDFW-OSPR maintains our ongoing recommendation that the Air Force exclude these areas from the Site OT-17 investigation boundary lines. In a recent Air Force response to CDFW-OSPR's comments on the Draft Record of Decision for OT-017 (Wilburn, 2017), the Air Force proposed to scale back the site investigation boundary to Dry Creek (not including the creek or the creek bed, boundary line stops at the edge of the western bank of Dry Creek); however, southern portion of the Air Force proposed site investigation boundary would remain unchanged and include Parks Lake.

CDFW-OSPR does not object to this proposal to include Parks Lake to the south with the understanding that the proposed site investigation boundary is designed to address the potential migration of contamination from the Northern Exposure Area (Source Areas A and B). As with all cleanup recommendations, CDFW-OSPR reserves the right to raise any appropriate environmental related issues should additional information concerning the environmental condition of OT-017 become available in the future (e.g., contamination found in Park Lake not related to leaks from discarded drums from the Northern Exposure Area).

SS035 (or Site 35, Weapons Storage Area)

CDFW-OSPR has no specific comment on this site; please see the global comment above.

Conclusion

CDFW-OSPR appreciates the opportunity to review and provide comments on this document. If you have any questions or require further details, please contact Allen Tsao at (916) 323-4731 (e-mail Allen.Tsao@wildlife.ca.gov).

Peer-reviewer: Charlie Huang, Ph.D., Staff Toxicologist

References

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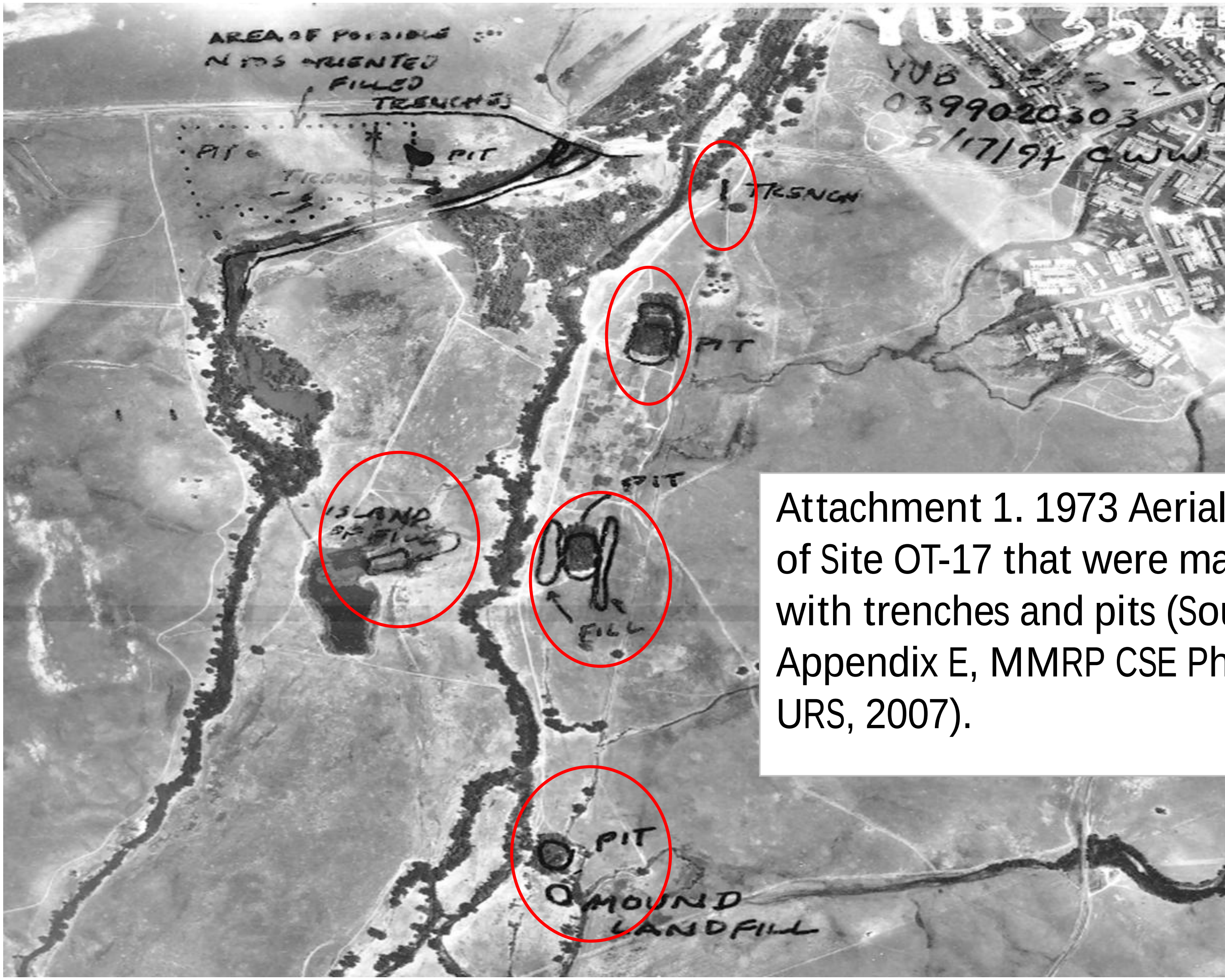
Attachment

Attachment 1. 1973 Aerial Photos of Site OT-17 that were marked up with trenches and pits



Attachment 1. 1973 Aerial Photos of Site OT-17 that were marked up with trenches and pits (Source: Appendix E, MMRP CSE Phase I, URS, 2007).

COMMENT AND RESPONSE WORKSHEET					
Date 1/24/2018				Draft Final Second Five-Year Report (January 2011 through June 2016) Beale Air Force Base, California	Contract Number: FA3002-07-D-0015 Task Order No. 0022
Item#	Source	Section	Page*	Comment	Response
General Comments					
1	CVWB, Mark Clardy	5.1.5	5-6	Beginning in Section 5.1.5 in the fifth bullet on page 5-6 and elsewhere as it occurs throughout the Report, 1 x 10^{-4} should be described as one in ten thousand, instead of one in a hundred thousand.	Text has been revised as requested to describe 1 x 10^{-4} as one in ten thousand for all occurrences.
2	CVWB, Mark Clardy	Various	Various	Protectiveness statements for Sites SD010, SD031, SD032, and SS039 in the previous five-year review report recommended an evaluation of groundwater conditions underneath buildings or the potential for vapor intrusion over groundwater plumes where no building exists to determine the potential threat to human health. It is unclear why this recommendation was not followed during the review period. We acknowledge the intent in current protectiveness statements to fulfill the recommendation as part of the next five-year review cycle, though this represents a ten-year period since the initial recommendation was made. Please discuss the reason for lack of follow-up on this issue during the review period.	Groundwater plumes were decoupled from their respective soils sites in 2013 and combined into a single groundwater site identified as CG041 (Basewide Groundwater). These plumes and the evaluation of groundwater conditions contributing to a human health risk through the groundwater to indoor air vapor intrusion pathway will be evaluated in the CG041 ROD which had not been presented during this five-year review period. It should be noted that in the case of Sites SD010 and SD031 the protectiveness statements issued in the first five-year review stated that the groundwater to indoor vapor intrusion pathway would need to be evaluated if construction were to occur at these sites. Current and future land use plans and LUCs have prevented construction activities at these sites as of the end of this five-year review period (30 June 2016), therefore, an evaluation of the groundwater to indoor air pathway has not been warranted.
3	CVWB, Mark Clardy		5-104	Page 5-104 is missing from the electronic version provided on CD though was found in the hard copy. Please ensure that the page is included in the next electronic version of the Report.	Noted. Page 5-104 will be included in the electronic version of the FYR Report.
Specific Comments					
1	CVWB, Mark Clardy	5.2.5	5-15	Site LF013, Section 5.2.5, Technical Assessment, page 5-15: The third bullet in the response to Question B concludes that the risk estimates are still valid because the assumptions used to calculate the risk-based screening levels (RBSLs) for indoor air for the risk-driving chemicals of concern (COCs) in soil vapor are still valid based on current 2011 DTSC guidance. The risk estimates are based on a RBSL of 370 parts per billion by volume (ppbv) trichloroethene (TCE) in soil gas. The Report should acknowledge that more recent vapor intrusion guidance has been published by EPA Region 9. In July 2014, a memo was published concerning response action levels for TCE in indoor air (EPA, 2014) and a technical guide for assessing and mitigating the vapor intrusion pathway was published in June 2015 (EPA, 2015). The Report should cite RBSLs for TCE vapor intrusion and attenuation factor (AF) as established by these two documents and evaluate site-specific data using these criteria.	The screening level of 370 ppbv is a project screening level for TCE, and the RBSLs selected as cleanup goals and used to calculate risk in CH2MHill 2015i will be added to the text. In addition, an acknowledgement of EPA's most recent vapor intrusion guidance documents (2014 and 2015) will be added. Text has been revised.
2	CVWB, Mark Clardy	5.4.5	5-27	Site ST018, Section 5.4.5, Technical Assessment, page 5-27: The last two sentences of the first paragraph pertain to land use controls (LUCs) to restrict groundwater use and state that the LUCs were selected as the final remedy for Site ST018. First, this is a groundwater issue and should be addressed as part of Site CG041-018. Secondly, the LUCs adopted in the Site ST018 Record of Decision (ROD) prevent residential land use due to the uncertainty concerning polycyclic aromatic hydrocarbons (PAHs) in soil. Please revise the sentence regarding final remedy selection.	The text has been revised to state: "Yes, the remedies are functioning or have functioned as intended. Bioventing and SVE have been completed. No further action necessary for protection of human health and the environment for soil, sediment, and surface water have been selected as the final response for the site (Air Force 2015b)."
3	CVWB, Mark Clardy	5.4.5	5-28	Site ST018, Section 5.4.5, Technical Assessment, page 5-28: The last two sentences in the last paragraph following Question B pertain to groundwater beneath Site ST018. Groundwater beneath the site is being addressed as Site CG041-018, therefore statements regarding groundwater conditions are not appropriate in this section. Only media addressed as part of Site ST018 should be discussed. Please revise the paragraph to omit statements concerning groundwater exposure risks. Likewise, the answer to Question C only contemplates groundwater exposure protectiveness. Please revise the answer to Question C to cite only media addressed as part of Site ST018 (i.e., soil, sediment, and surface water).	Text revised to address only media associated with Site ST018.
4	CVWB, Mark Clardy	5.4.7	5-29	Site ST018, Section 5.4.7, Protectiveness Statement, page 5-28: The protectiveness statement includes items related to groundwater exposure which should be covered as part of Site CG041-018. Similar to the previous comment, please revise the protectiveness statement to omit items related to groundwater exposure.	Text revised to address only media associated with Site ST018.
5	CVWB, Mark Clardy	5.5.1	5-31	Site SD032, Section 5.5.1, Introduction, page 5-31: The second paragraph describes multiple physical features located at Site SD032. It would be helpful to depict some of these items on Figure 5.5-1, Site SD032 Features Map. Please depict features on Figure 5.5-1 that are described in the text.	Figure revised as requested.

6	CVWB, Mark Clardy	5.5.5	5-35	Site SD032, Section 5.5.5, Technical Assessment, page 5-33: The answer to Question A is not entirely true. Since DTSC did not concur with no further action (NFA), LUCs were established in the ROD to prevent residential use around SVE well VE-4. The LUCs will remain in effect until conditions are suitable for unlimited use and unrestricted exposure (UU/UE).	The text has be revised to state: "Yes, the components of the interim remedy have functioned as intended: SVE and bioventing have successfully remediated COCs in soil to levels acceptable for UU/UE, with the exception of the soils around SVE well VE-4. LUCs established in the Site SD032 IROD will continue until conditions are suitable for UU/UE."
7	CVWB, Mark Clardy	5.5.8	5-37	Site SD032, Section 5.5.8, Next Review, page 5-34: Since the site was not suitable for UU/UE at the time of the ROD, another five-year review will be required for Site SD032.	Text revised to state that another five-year review will be required for Site SD032.
8	CVWB, Mark Clardy	5.6.5.1	5-44	Site SS035, Section 5.6.5.1, Changes in Exposure Pathway, page 5-41: The end of the third paragraph of the section is inaccurate. PAHs were never detected in the background data set samples, therefore, the statement that they were determined to exceed background at only two locations is incorrect. PAHs were actually found to be a COC and were listed as such in the subsequent Site SS035 ROD. Please check the information and revise the paragraph accordingly.	Per the final Proposed Plan for Site SS035 (Air Force 2015), only COCs in soil vapor were identified. PAHs were not included. If PAHs were later identified as a COC in the final ROD for the site they will be addressed in the next five-year review, as the final ROD was presented after the end of the five-year review period (30 June 2016). No revision to the text has been made.
9	CVWB, Mark Clardy	5.6.5.1	5-44	Site SS035, Section 5.6.5.1, Changes in Exposure Pathway, page 5-41: Risk estimates are provided for three exposure areas at Site SS035. Please either show the exposure areas on a figure or describe the extent of each area in the text.	Figure revised as requested.
10	CVWB, Mark Clardy	5.6.5.1	5-44	Site SS035, Section 5.6.5.1, Changes in Exposure Pathway, page 5-41: The end of the sixth paragraph says that lead not being considered as a COC is still a valid conclusion. This statement disagrees with the ROD that was completed for Site SS035 which lists lead as a COC in soil. Please check the information and correct the statement if warranted.	As of the final Proposed Plan for Site SS035 (Air Force 2015) lead was not identified as a COC. If lead was later identified as a COC in the final ROD for the site it will be addressed in the next five-year review, as the final ROD was presented after the end of the five-year review period (30 June 2016). No revision to the text has been made.
11	CVWB, Mark Clardy	5.7.5	5-54	Site DP038, Section 5.7.5, Technical Assessment, page 5-51: The fifth bullet in the answer to Question C may be incorrect because recent changes in PAH cancer toxicity values for benzo(a)pyrene have resulted in apparently lower screening concentrations than used in earlier risk assessments. Please cite specific past and current screening values to support the statement that the screening values for benzo(a)pyrene and other carcinogenic PAHs have become less stringent (an approximately seven-fold increase).	Comment noted. Recent changes in cancer toxicity values have become less stringent. For the purposes of this review that ended in June 2016, the more stringent value will be retained. No changes were made to the document.
12	CVWB, Mark Clardy	5.8.2	5-59	Site SS039, Section 5.8.2, Response Action Summary, page 5-56: The last paragraph mentions ground-disturbing activities observed during the September 2015 site inspection. Please describe the location of the activities and whether they were located above the groundwater volatile organic compound (VOC) plume CG041-039.	The locations of the disturbing activities are provided in the 2015 Land Use Control Inspection report (CH2M HILL 2016). After a review of the presented locations, all three were determined to be located above the groundwater VOC 5 ug/L plume boundary. However, as stated in the five-year review, these disturbances were determined to not be in violation of the LUCs established for Source Area 2 and will not be addressed further in the discussion of Site SS039.
13	CVWB, Mark Clardy	5.8.3	5-59	Site SS039, Section 5.8.3, Progress since the Last Review, page 5-56: The protectiveness statement from the first five-year review recommended an evaluation of groundwater conditions underneath buildings to determine whether a potential threat to human health exists. It is unclear why this recommendation was not followed by the Air Force during the review period. As requested in General Comment 2, please discuss the reason for the lack of follow-up on this issue during the review period.	Groundwater plumes were decoupled from their respective soils sites in 2013 and combined into a single groundwater site identified as CG041 (Basewide Groundwater). An evaluation of groundwater conditions contributing to a human health risk through the vapor intrusion pathway for GG041-039 will be addressed in the future as part of CG041.
14	CVWB, Mark Clardy	5.8.5	5-60	Site SS039, Section 5.8.5, Technical Assessment, page 5-57: The second paragraph states that LUCs are in place and effective. The statement cannot be made with confidence because the previous five-year review's recommendation to evaluate human health protectiveness for the groundwater to indoor air pathway was not followed. The pathway is to be evaluated as part of the Site CG041 ROD.	Comment noted. See above response (#13).
15	CVWB, Mark Clardy	5.8.5	5-62	Site SS039, Section 5.8.5, Technical Assessment, page 5-57: The response to Question B states that the exposure assumptions, toxicity data, cleanup goals, and RAOs used at the time of remedy selection are still valid. The AF of 0.0012 used to derive the soil vapor cleanup goal for human health protection is reportedly in line with the 2011 DTSC recommended AF of 0.001 for a future residential building. As discussed in Specific Comment 1, more recent vapor intrusion guidance has been published by EPA. The response should cite RBSLs and the AF recommended by EPA guidance and evaluate site-specific data using these criteria (EPA, 2014; EPA, 2015).	Text has been revised to acknowledge EPA's most recent vapor intrusion guidance documents.

16	CVWB, Mark Clardy	5.8.5	5-62	Site SS039, Section 5.8.5, Technical Assessment, page 5-58: CVWB staff disagrees with the interpretation that the potential for TCE migration from Source Area 1 to the movie theater is low as discussed in the next to last paragraph. A groundwater TCE plume emanating from Source Area 1 which could volatilize TCE exists beneath the building. Although no utility line connections exist from Source Area 1 to the movie theater, the sewer line connections on the west side of the building could serve as preferential pathway for vapors migrating from groundwater. Please acknowledge this potential preferential pathway in the Report.	The technical assessment addressed the potential for TCE in soil vapor to migrate from Source Area 1 to the movie theater. Groundwater contamination is addressed as part of CG041-039. Exposure discussions in this section will be limited to environmental media covered as part of Site SS039 (i.e. soil, sediment, and surface water).
17	CVWB, Mark Clardy	5.8.5	5-62	Site SS039, Section 5.8.5, Technical Assessment, page 5-59: The answer to Question C should reflect new information from EPA. Specifically, the short-term exposure criteria for TCE and vapor intrusion guidance published by EPA in July 2014 and June 2015, respectively, should be cited in this section.	Text has been revised to acknowledge EPA's most recent vapor intrusion guidance documents.
18	CVWB, Mark Clardy	5.8.7	5-63	Site SS039, Section 5.8.7, Protectiveness Statement, page 5-59: The protectiveness statement discusses exposure to groundwater, although groundwater is not part of Site SS039. Please revise the statement to limit it to environmental media covered as part of Site SS039 (i.e., soil, sediment, and surface water).	The text has been revised to state: "Site conditions are protective of human health and ecological receptors, based on current and anticipated future use of SS039. Site media (soil, sediment, and surface water) are currently acceptable for UU/UE, however, groundwater conditions beneath Site SS039 require LUCs to remain in place to prevent future ground disturbances and exposure to groundwater contamination."
19	CVWB, Mark Clardy	5.9.2.9	5-76	Site CG041, Section 5.9.2.9, CG041-032, page 5-71: The fifth paragraph indicates that groundwater modeling predicts the plume will not migrate past the base boundary at concentrations greater than the cleanup goal. The paragraph should also state that the increasing TCE concentration trend observed at well 01C008CMW located just north of North Beale Road indicates that the plume is potentially migrating offbase as it becomes submerged beneath cleaner groundwater. Please add this information to the Report as it is an important indication of plume migration observed during the review period.	The following text was added: "However, a recently increasing TCE concentration in monitoring well 01C008CMW indicates that the plume may be migrating off-base. "
20	CVWB, Mark Clardy	5.9.2.14	5-80	Site CG041, Section 5.9.2.14, CG041-509, page 5-75: The third paragraph of the section incorrectly states that soil excavation was completed in February 2012. The excavation was actually completed in February 2015. Please check the dates and revise as necessary.	Text revised to state excavation was completed in February 2015. Two excavations actually took place at TU509 (CG041-509) one in 2009 with the tank removal and one in 2015.
21	CVWB, Mark Clardy	5.9.3.4	5-81	Site CG041, Section 5.9.3.4, CG041-035, page 5-76: Treatment of the source area portion of the groundwater plume is reportedly anticipated to continue for five years after SVE operations are complete. The Site CG041 ROD does not include bioreactor operation as part of the selected remedy for CG041-035. Please check the information and revise the paragraph to correspond with the remedy identified in the Site CG041 ROD. Also, the reference at the end of the paragraph cites the CG041-508 Pre-design Investigation Work Plan while it probably should refer to the Focused Feasibility Study for Basewide Groundwater. Please check the reference and correct if appropriate.	The site CG041 ROD was presented after the five-year review period (30 June 2016). The remedy identified in the CG041 ROD will be addressed in the next five-year review. Reference revised to Focused Feasibility Study (CH2M HILL 2015h).
22	CVWB, Mark Clardy	5.9.4.1	5-81	Site CG041, Table 5.9-3, Status of Recommendations from the First Five-Year Review, Site CG041-003, page 5-77: The first row of the table pertains to the previous recommendation to complete site characterization activities at Site CG041-003. The current implementation status description states that all media have been fully characterized as of June 2015. This statement is not true because data gap investigation activities are being proposed to delineate the extent of groundwater contamination to the west and the presence of VOCs in soil gas overlying groundwater plume CG041-003. Please revise the table accordingly.	This statement remained true throughout the five-year review period which ended 30 June 2016. Proposed data gap activities which render the statement untrue were presented outside of the five-year review period and will be addressed in the next five-year review.
23	CVWB, Mark Clardy	5.9.4.1	5-81	Site CG041, Table 5.9-3, Status of Recommendations from the First Five-Year Review, Site CG041-003, page 5-77: The recommendation in the second row of the table is to re-evaluate applicable components of the Site FT003 Risk assessment, including an evaluation of risk from vapor intrusion if buildings were to be constructed above the site groundwater plume. The current implementation status states that risk assessments for groundwater associated with Site CG041-003 will be presented in the forthcoming ROD. This statement is incorrect as the Site CG041 ROD no longer includes this site since it is being managed under Site CG044. It is anticipated however, that the future Site CG044 ROD will include an assessment of the groundwater to indoor air pathway. Please note that this comment also applies to Table 5.9-5 for Site CG041-013, Table 5.9-10 for Site CG041-031, and Table 5.9-14 for CG041-040.	The Air Force agrees that the plume is not defined in the downgradient direction and this was suspected to be due in part to off-base agricultural groundwater pumping during the dorught years. As the Air Force recognized this was occuring, Site CG044 was created subsequent to the 30 June 2016 review period of this document, to account for increased agricultural pumping and additional VI concerns caused by plume movement. The text on tables 5.9-3, 5-9.5, 5.9-10, and 5.9-14 will be updated to reflect this.

24	CVWB, Mark Clardy	5.9.4.9	5-89	Site CG041, Table 5.9-11, Status of Recommendations from the First Five-Year Review, Site CG041-032, page 5-84: The first recommendation is to continue monitoring and evaluating distal plume areas to ensure that concentrations are continuing to decrease. The current implementation status indicates that evaluation monitoring as part of WDRs Order No. R5-2007-0025 is ongoing which includes monitoring of downgradient/distal wells. The intent of groundwater monitoring under the WDRs is not to evaluate whether contaminant concentrations are decreasing, but to demonstrate that no deleterious effects are occurring to groundwater outside the treatment zone. In fact, TCE concentrations have increased above the maximum contaminant level (MCL) at well 01C008CMW located near the base boundary. Data from the associated well cluster indicates that TCE exceeding the MCL is submerged beneath cleaner groundwater and potentially migrating offbase. The Air Force is planning offbase monitoring well installations to evaluate downgradient plume migration. Please revise the current implementation status to reflect increasing TCE concentrations observed near the base boundary during the review period which supports further investigation planning.	The reference to groundwater monitoring under WDR R5-2007-0025 has been removed. The increasing concentrations observed at monitoring well 01C008CMW are discussed in Section 5.9.2.9 and Section 5.9.5.9.
25	CVWB, Mark Clardy	5.9.4.11	5-91	Site CG041, Table 5.9-13, Status of Recommendations from the First Five-Year Review, Site CG041-039, page 5-86: The recommendation in the fourth row of the table is to continue to monitor and evaluate groundwater concentrations underneath existing buildings to ensure no vapor intrusion concerns are present, and to consider the installation of vapor monitoring points adjacent to buildings near Source Area 1. The current implementation status summarizes the findings from the *Site SS039 Screening Level Risk Assessment Summary Report* which concluded that soil vapor in the Source Area 1 Exposure Area is suitable for UU/UE. CVWB staff disagrees with the status because the referenced report did not evaluate the groundwater to indoor air vapor intrusion pathway for Site CG041-039. The more appropriate response is that the upcoming Site CG041 ROD will include provisions to evaluate the groundwater to indoor air pathway (i.e., through the collection of indoor air samples from existing buildings overlying Site CG041-039).	The text has been revised to state: "Groundwater monitoring is ongoing at Site CG041-039 to monitor potential risks to human health. The forthcoming CG041 ROD will further address the groundwater to indoor air pathway."
26	CVWB, Mark Clardy	5.9.4.2	5-92	Site CG041-040, Table 5.9-4, Status of Recommendations from the First Five-Year Review, page 5-87: The current implementation status in the second and third rows of the table refer to the Site CG041 ROD for upcoming information concerning the final remedy. Cleanup of the plume is actually being addressed as part of Site CG044 which was established by the Air Force in May 2016 to address five plumes along the western base boundary. The Site CG044 ROD is anticipated in approximately 2020. The table should be revised to reflect the Site CG044 designation and associated ROD.	The statement remained correct through the end of the five-year review period (30 June 2016). CG041-003 appears to have been administratively moved to CG044 after this time, therefore, this move and all subsequent decisions made for Site CG041-003 and CG044 will be addressed in the next five-year review report.
27	CVWB, Mark Clardy	Various	Various	Site CG041-003, Table 5.9-16, 2015 TCE Data and Trends, page 5-89: According to the legend, data exceeding project screening levels (PSLs) or showing an increasing trend are highlighted in bold type. Although multiple entries fit the criteria, none of the data is shown in bold type. Please check the table and revise it as indicated by the legend. Note that this comment also applies to Table 5.9-17 through Table 5.9-31.	Data exceeding PSLs or showing an increasing trend have been revised in bold type for all tables referenced.
28	CVWB, Mark Clardy	5.9.5.3	5-97	Site CG041-013, Section 5.9.5.3, page 5-92: The first paragraph refers to Table 5.11-18 for TCE data and time-series plot trends. Please note that the information is actually provided in Table 5.9-18. Also, Table 5.9-18 contains an asterisk annotation for some well entries though the asterisk is not explained in the legend. Lastly, the hydrostratigraphic unit (HSU) entry for wells 13C088MW and 13C091MW is incomplete as it shows “screened” and is probably intended to show “screened within the bioreactor.” Please check these inconsistencies and correct as warranted.	Text has been revised as requested.
29	CVWB, Mark Clardy	5.9.5.5	5-99	Site CG041-017, Section 5.9.5.5, page 5-94: The second paragraph refers to Table 5.11-19 for TCE data and time-series plot trends while it should cite Table 5.9-19.	Text has been revised as requested.
30	CVWB, Mark Clardy	5.9.5.5	5-100	Site CG041-017, Section 5.9.5.5, page 5-95: The next to last paragraph of the section concludes that a local source of TCE contamination may exist near well 17V012MW and outside the slurry wall causing increasing concentrations. An alternate explanation is that there is contaminant leakage through or below the wall causing increasing concentrations outside the wall. The anticipated remedy for the site includes installation of a zero-valent iron (ZVI) permeable reactive barrier (PRB) at this location (along alignment of existing slurry wall) and in situ chemical oxidation (ISCO). The ISCO and ZVI PRB will provide further treatment and help mitigate concerns related to contaminant leakage through the wall. Please add the interpretation of contaminant leakage through the slurry wall to the explanation at the end of the paragraph.	Text has been added to state: "An alternate explanation for this source of contamination is that contaminant leakage is occurring through the wall or underneath the wall."
31	CVWB, Mark Clardy	5.9.5.5	5-100	Site CG041-017, Section 5.9.5.5, page 5-95: The last paragraph of the section says that no increasing TCE trends have been observed in either the western or southern downgradient wells. A review of the information in Table 5.9-19 shows an increasing TCE trend at downgradient wells 17C165BMW and 17C166MW. Please check the data and revise the statement if appropriate.	Monitoring well 17C165BMW is a downgradient well located on the eastern side of the plume. Text has been revised to state "In addition, no increasing trends have been identified in either the western or southern downgradient wells, with the exception monitoring well 17C166MW. "

32	CVWB, Mark Clardy	5.9.5.6	5-100	Site CG041-018, Table 5.9-20, TCE Data and Trends, page 5-95: Wells 18C046MW and 18C047MW are listed in the table though are not shown in Figure 5.9-11. Please add these two wells to Figure 5.9-11.	Figure revised as requested.
33	CVWB, Mark Clardy	5.9.5.6	5-102	Site CG041-018, Section 5.9.5.6, page 5-96: The last paragraph indicates that benzene was detected at concentrations greater than the PSL of 1 microgram per liter (ug/L) at two monitoring wells in 2015. Please list the two wells, 18U007BMW and 18U008BMW, where benzene was reported at concentrations greater than the PSL.	Text has been revised to include the wells as requested.
34	CVWB, Mark Clardy	5.9.5.7	5-102	Site CG041-029, Section 5.9.5.7, page 5-97: The last sentence states that TCE concentrations in cross-gradient wells remain less than the PSL and indicate that the plume is not migrating to the northeast or southeast. The sentence should probably refer to northwest as cross-gradient because northeast is actually upgradient from the source area.	Text revised as requested.
35	CVWB, Mark Clardy	5.9.5.8	5-104	Site CG041-031, Section 5.9.5.8, page 5-99: The third paragraph of the section discusses TCE rebound at wells 31C003MW and 31C022MW in the source area. Please show the location of well 31C022MW in Figure 5.9-16.	Figure revised as requested.
36	CVWB, Mark Clardy	5.9.5.9	5-105	Site CG041-032, Table 5.9-24, 2015 TCE Data and Trends, page 5-100: The entry for the time-series plot trend column for well 21L002MW is incomplete as it only lists "Recently." Please complete the entry with the appropriate trend. Also, wells 01C009AMW/BMW/CMW are listed in the table, but are not shown in Figure 5.9-18. Please add the wells to Figure 5.9-18 as they are important in identifying an area of increasing TCE concentration in groundwater.	Text and figure revised as requested.
37	CVWB, Mark Clardy	5.9.5.9	5-106	Site CG041-032, Section 5.9.5.9, page 5-101: The third from last paragraph discusses the increasing TCE concentration trend at well 01C008CMW located just north of North Beale Road. Downgradient triple well cluster 01C008AMW/BMW/CMW is important because it is near the base boundary and indicates that the plume is submerged and may be migrating offbase. Please show the location of well cluster 01C008MW on Figure 5.9-18 or include another figure showing the wells with deep plume TCE data.	Figure revised as requested.
38	CVWB, Mark Clardy	5.9.5.10	5-107	Site CG041-035, Section 5.9.5.10, page 5-102: The last paragraph indicates that detected concentrations at the compliance wells in 2015 did not exceed baseline values. Please list the constituents analyzed according to the Monitoring and Reporting Program (MRP) that were evaluated to make this determination.	The following text was added to clarify: "The constituents analyzed according to the MRP include ethane, methane, TOC, sulfate, iron, manganese, and TDS. It should be noted that only TOC, manganese, and TDS in compliance wells trigger contingency actions."
39	CVWB, Mark Clardy	5.9.5.11	5-108	Site CG041-039, Table 5.9-26, 2015 TCE Data and Trends, Source Area 1, page 5-103; and Table 5.9-27, 2015 TCE Data and Trends, Source Area 2, page 5-105: Wells 39U008APZ and 39U008BPZ are listed in Table 5.9-26 though are not shown in Figure 5.9-22. Also, multiple wells listed in Table 5.9-27 are not found in the figure. Please depict the missing well locations in Figure 5.9-22.	Figure revised as requested.
40	CVWB, Mark Clardy	5.9.5.13	5-114	Site CG041-508, Section 5.9.5.13, page 5-109: The last paragraph discusses tetrachloroethene (PCE) data at downgradient well cluster 39U006A/BMW. Please show the location of well cluster 39U006MW in Figure 5.9-26 to aid the reader.	Figure revised as requested.
41	CVWB, Mark Clardy	5.9.5.13	5-114	Site CG041-508 Section 5.9.5.13, page 5-109: The penultimate sentence indicates that the decrease or stabilization of PCE suggested by 2015 data is potentially related to remedial actions conducted at Sites SS023 and CG041-039. Another possible explanation is related to stratigraphic control of contaminant migration. A review of boring logs and cross-sections suggests that PCE may be preferentially migrating through coarse grained stream channel deposits within finer grained floodplain sediments. Please add this as an alternate explanation of PCE plume transport at the site.	Text revised to include: "Alternatively, PCE may be preferentially migrating through coarser grained deposits, in which case stratigraphic controls are responsible for the stable or decreasing PCE trends. "

42	CVWB, Mark Clardy	5.9.6	5-116	Section 5.9.6, Technical Assessment, page 5-111: The answer to Question B should reflect the EPA short-term exposure action levels for TCE published in July 2014 and updated EPA vapor intrusion guidance published in June 2015. Based on the information in those publications, it is unlikely that the Site CG041 ROD will use the same assumptions for vapor intrusion as during the interim record of decision (IROD) development process for each formerly individual site within CG041. Please revise the response accordingly.	The following text (bold, italics) will be added to the paragraph under Question B: "Yes, *in part* , the assumptions made during the selection of interim remedies remain valid, primarily because the currently established cleanup levels are based on the lowest of either State or federal regulations. These data also are expected to be reviewed and updated, if necessary, as part of the ROD development process. *Part of this process will entail a review of the assumptions used to develop the groundwater cleanup goals that address vapor intrusion. It will be verified that these assumptions incorporate EPA's short-term exposure action levels for TCE published in July 2014, as well as the updated EPA vapor intrusion guidance published in June 2015* . The CG041 ROD is expected in 2018 and any updates to the assumptions made during the IROD development process for each formerly individual site within CG041 will be considered at that time.*While many sites have LUCs, some plumes now included in CG041 do not yet have LUCs but will as the ROD is finalized.*
43	CVWB, Mark Clardy	5.9.8	5-117	Site CG041, Section 5.9.8, Protectiveness Statement, page 5-112: CVWB staff does not concur with the protectiveness statement for Site CG041. The Report states that the interim remedies for Site CG041 are protective because LUCs are in place to prevent potential exposures through the vapor intrusion or direct contact pathways. There are no LUCs in place to prevent exposure through the vapor intrusion pathway, therefore, this portion of the statement should be excluded from the Report.	LUCs were established for coupled soil/groundwater sites prior to groundwater being administratively moved to CG041. The LUCs established prior to this change have remained enforced even though they were not directly associated with a decision document for CG041. LUCs are anticipated to be included as part of the selected remedy for CG041, which is indicated by the draft Proposed Plan for Site CG041 presented during this review period. The text has been revised to address the fact that LUCs established through previous decision documents continue to prevent potential exposures to groundwater and support the statement that the interim remedies are protective.
44	CVWB, Mark Clardy	Figure	Figure	Site CG041-029, Figure 5.9-15, TCE Contaminant Groundwater Plume in 2010, 2013, and 2015: The 5 ug/L TCE isoconcentration contours drawn for 2013 and 2015 combine data from both shallow and deep groundwater zones. If the contours are to be depicted in a single plan view, then only the lateral extent should be shown. Please revise the figure to show the lateral extent of the contours in this manner. This comment also applies to concentration contours in Figure 5.9-29 for Site CG041-509, Figure 5.9-30 and Figure 5.9-31 for Site CG041-517, and Figure 7.1-2 for Site TU002.	Figures revised to show comined lateral extent of plume only.
45	CVWB, Mark Clardy	Figure	Figure	Site CG041-032, Figure 5.9-18 and Figure 5.9-19: The two figures show site features and shallow groundwater TCE plumes at the site. The figures should be supplemented with corresponding figures depicting deep groundwater TCE plumes for the site. As recommended for other plumes with shallow and deep groundwater contamination, the lateral extent of the deep plumes can alternatively be added to the shallow groundwater figures by showing their outline. This will help show the full extent of groundwater contamination beneath the site including locations north of North Beale Road where TCE exceeded the MCL during the review period.	Figures revised to show comined lateral extent of plume only.
46	CVWB, Mark Clardy	Figure	Figure	Site CG041-039, Figure 5.9-22, Site Features and 2015 TCE Concentrations: The TCE isoconcentration contours in the figure are not labeled with their corresponding concentrations. Please label the contours with the appropriate concentrations. Also, please add the TCE contours and corresponding concentrations to the inset map.	Figure revised as requested.
47	CVWB, Mark Clardy	Figure	Figure	Site CG041-509, Figure 5.9-28, Site Features and 2015 TPH-D Concentrations: The legend contains a numbered rectangle defined as "Micrograms per Liter." In review of the figure, this symbol apparently denotes a building number. Please check the figure and correct as appropriate. This comment also applies to Figure 5.9-30 for Site CG041-517.	Figure revised as requested.

48	CVWB, Mark Clardy	6.3.2	6-18	Site SS023, Section 6.3.2, Response Action Summary, page 6-17: The last sentence of the paragraph states that groundwater beneath Site SS023 is being addressed as part of the Cantonment Area, Site CG041-040. Although Site SS023 is being addressed as part of the Cantonment Area in the Basewide Groundwater Monitoring Program (BGMP), it is not being addressed as Site CG041-040, only as Site SS023. Also, please note that there is no Section 5.11 in the Report as mentioned at the end of the sentence nor is groundwater beneath Site SS023 discussed elsewhere in the document. Please revise the sentence accordingly.	Text has been revised to include a discussion of groundwater beneath Site SS023.
49	CVWB, Mark Clardy	6.3.4	6-18	Site SS023, Section 6.3.4, Data Review, page 6-17: Similar to the previous comment there is no Section 5.11 as discussed at the end of the paragraph. Please revise or omit the sentence.	Text has been revised removing reference to Section 5.11.
50	CVWB, Mark Clardy	6.3.8	6-22	Site SS023, Section 6.3.8, Next Review, page 6-18: The section concludes that since NFA has been approved for Site SS023, no further five-year reviews are planned. This reasoning is invalid because while soil and soil vapor at the site have received an NFA determination through a Statement of Basis, underlying groundwater is still undergoing remediation. Due to the remaining groundwater contamination, a subsequent five-year review will be required. Please revise the section accordingly.	Text revised to state that a subsequent five-year review will be necessary.
51	CVWB, Mark Clardy	6.4.5	6-26	Site PL582, Section 6.4.5, Technical Assessment, page 6-23: The reply to Question A ends by stating that LUCs will prevent exposure to TCE until concentrations are at or less than the MCL. The statement should be revised to better align with the Statement of Basis which says that LUCs will restrict access to soil vapor and to groundwater contaminated with TCE at concentrations above the MCL until the concentrations of TCE in soil vapor and groundwater allow for UU/UE. The report can summarize that statement by stating that LUCs will restrict access to groundwater and exposure to TCE in soil vapor until conditions are suitable for UU/UE.	Text has been revised as requested.
52	CVWB, Mark Clardy	7.1.2	7-4	Site TU002, Section 7.1.2, Response Action Summary, page 7-4: The section ends with a description of optimum exit strategy (OES) for the site. One of the performance goals is to achieve an 85 percent reduction of the mean baseline methyl tertiary butyl ether (MTBE) concentration in groundwater (339 ug/L) in 2017 and to maintain the reduction over a six-month period. Please be aware that the OES utilizes internal Air Force performance objectives and is unrelated to obtaining site closure (SC) through the regulatory agencies.	Noted.
53	CVWB, Mark Clardy	7.1.7	7-6	Site TU002, Section 7.1.7, Protectiveness Statement, page 7-6: An OES developed for Site TU002 is discussed in this section which states that if the goals of the OES are achieved, the site will be suitable for Response Complete (RC). A discussion of the OES is inappropriate for the protectiveness statement since it is not directly related to protectiveness and therefore should be omitted.	Text has been revised as requested.
COMMENT AND RESPONSE WORKSHEET					
Date 1/24/2018		From: DTSC ERAS		Draft Final Second Five-Year Report (January 2011 through June 2016) Beale Air Force Base, California	Contract Number: FA3002-07-D-0015 Task Order No. 0022
Item#	Source	Section	Page	Comment	Response
General Comments					
1	DTSC ERAS	Various	Various	ERAS reviewed all of the Sites under the 5-year review and provides comments that largely apply to all of the sites. Not all sites appear to have impacts to ecological receptors. Groundwater sampling does not provide for comparison to aquatic ecological toxicity criteria. Comparison is only made to the MCL which is inadequate for determining if there is potential risk to ecological receptors.	Noted. Groundwater sampling data are currently and have previously only been compared to MCLs in monitoring program reports documenting groundwater sampling activities at Beale AFB. The FYR will be revised to make the recommendation that future groundwater sampling results are compared to aquatic ecological toxicity criteria for sites where the potential for surface discharge of groundwater exists.
Specific Comments					
				Pdf page 65 of 35 Section 5.4.5, 3, second bullet. The report states "*Based on low and high TRVs, HQs for metals in soil (aluminum and lead) are greater than 1 for terrestrial birds (e.g., western meadowlark and burrowing owl) and mammals (e.g., deer mouse, California vole, shrew, red fox). Aluminum and lead were attributed to naturally occurring conditions at Site 18 and are not related to site-related activities* ". It is not plausible to believe that lead at site soil concentrations that are required to generate an average daily dose (ADD) BTAG TRV-High hazard quotient (HQ) of 1, is not associated with the site. As an example, a back-calculated safe soil concentration for the vole would be 8,500 mg/kg, a concentration that clearly would not be allowed to remain following remediation. The Kearny foundation survey of 50-California soils (https://envisci.ucr.edu/downloads/chang/kearney_special_report_1996.pdf) found lead concentrations in soil ranging from 12.4 mg/kg to 97.1 mg/kg with a geometric mean concentration of 21.7 mg/kg. It is implausible that lead concentrations are not site-related. ERAS understands the 5-year review is not a risk assessment but statements that allude to risk levels should be	

1	DTSC ERAS	5.4.5	5-29	supported by presentation of the risk level, in this case the HQ value based on the BTAG TRV- High. Please note, ERAS no longer supports the use of BTAG TRV-highs. Based on the presented text, site-related soil concentrations are not protective of ecological receptors. ERAS suspects the meaning of the text was lost in the construction of the sentences. This section needs to be rewritten to convey the appropriate meaning. Aluminum toxicity is not evaluated unless the soil pH is less than 5.5 (USEPA 2003) which is unlikely for Site ST018. The report should so indicate. This is an additional line of evidence that would suggest that aluminum does not pose risk to ecological receptors.	The text in the ecological risk bullet in question will be clarified, as the risk results currently summarized in this bullet reflect the maximum concentration of lead (126 mg/kg) from Site 31, as data from Sites 18 and 31 were combined in the 2005 HHERA. Risks driven by the concentation of lead from Site 31 are not relevant to this bullet as it is a seperate and distinct site. In addition, the text will be augmented to provide more supportive documentation for lead and aluminum risks being minimal for ecological receptors.
2	DTSC ERAS	5.4.7	5-29	Pdf page 65 of 353, Section 5.4.7, Protectiveness Statement. The report states *"Site conditions are protective of human health and ecological receptors based on current and anticipated future use of Site 18 as a bulk fuel storage facility, and the overall risks of exposure to COCs are relatively small because groundwater currently is not used. Current data suggest that the COCs dissolved in groundwater are not migrating off-site, and concentrations appear to be decreasing. No drinking water wells are threatened."* This statement addresses only groundwater, but says nothing regarding soil concentration levels and their associated risks to ecological receptors. Limiting the discussion to groundwater may be acceptable if the lead risk levels in soil can be clarified as described in Specific Comment 1 above.	The protectiveness statement has been revised as follows: "Site conditions are protective of human health and ecological receptors based on current and anticipated future use of Site ST018 as a bulk fuel storage facility."
3	ERAS	5.7.2	5-48	Pdf page 80 of 353, Response Action Summary. The lead MCL of 5 µg/L is not protective of aquatic ecological receptors. Site DP038 is reported to have 4.5-acres of seasonal wetlands. The National Ambient Water Quality Criteria (NAWQC) criterion continuous concentration (CCC) for lead is 2.5 µg/L which is half the MCL concentration. The MCL is not protective of aquatic ecological receptors. The lead preliminary cleanup goal (PCG) of 128 mg/Kg in sediment is the probable effects concentration (PEG). This is an appropriate PCG if the vernal pools do not have threatened or endangered (T&E) species associated with them. Some Beale Air Base vernal pools are known to contain threatened or endangered species. The report needs to specify that the vernal pools have been examined for T&E species and they have been found not to contain them. Otherwise, the lead sediment PCG should be the threshold effects concentration (TEC) of 35.8 mg/kg.	The updated 2016 INRMP (Air Force 2016) identifies the area where DP038 lies (Dragontown) as General Plan Development Areas (GPDAs) and not as a vernal pool management area and is not a Federal Critical Habitat for species (USFS 2003). Per similar comments below, the text will be revised to recommend that future surface water sampling include water hardness analysis, and future results compared to aquatic ecological toxicity criteria.
4	ERAS	5.8.5	5-63	Pdf page 92 of 353, third bullet on page. The report states "*No data relevant to ecological receptors have been collected since the IROD was issued . Therefore, the conclusions made in the IROD still are relevant. Risk to ecological receptors was not predicted, and no COECs were identified for the site.* " The second sentence should be removed. The absence of additional data does not support the supposition that there is no risk to ecological receptors. The five-year should state whether site conditions have changed and if not, the conclusions of the ROD (no risk, no COECs) are still relevant.	Text has been revised as follows: "No data relevant to ecological receptors have been collected since the IROD was issued. Site conditions have remained unchanged since the issuance of the IROD, therefore, the conclusions made in the IROD are still relevant. Risk to ecological receptors was not predicted, and no COECs were identified for the site."
5	DTSC ERAS	5.9.1	5-68	Pdf page 95 of 353. The report states that groundwater preliminary numerical cleanup goals have been identified base-wide and that these goals are based on federal or state MCLs. These may be protective of human health, but may not be adequate for protection of ecological receptors. Ecological groundwater cleanup goals need to be identified to assure that if groundwater comes into contact with ecological receptors that the cleanup goals are protective of them as well. A first- tier goal would be the Ambient Water Quality Criteria (AWQC) (https://www.epa.gov/wqc/national-recommended-water-quality-criteria-aquatic- life-criteria-table) criterion continuous concentrations (CCC). If an AWQC is not available a secondary source will need to be identified.	Noted. Groundwater sampling data are currently and have previously only been compared to MCLs in groundwater monitoring program reports documenting sampling activities at Beale AFB. The FYR will be revised to make the recommendation that future groundwater sampling results are compared to aquatic ecological toxicity criteria for sites where the potential for surface discharge of groundwater exists and that ecological toxicity criteria be considered when establishing final cleanup goals.

6	DTSC ERAS	6.1.2	6-4	Pdf page 177 of 353, 4th bullet. The report indicates surface samples are taken on an annual basis and compared to MCLs. Please explain why comparisons of surface water samples are not also made to ecological aquatic criteria?	The Air Force agrees with DTSC's recommendation to consider adding the most current national AWQC CCCs, in addition to the MCLs, to the list of screening levels applied to surface water data collected as part of ongoing monitoring activities at LF002 and LF003. Evaluation of surface water samples from the seasonal drainage ditches monitored in the vicinity of the former landfills will be conducted with caution in recognition of the conservative nature of the CCCs, i.e., protective of 95% of all aquatic taxa, many of which are likely sensitive species (e.g., fish) that are not present in the small seasonal drainages. Upstream surface water samples as well as downstream samples will be compared to the CCCs to provide context to this evaluation (site-related vs. non-site-related).
7	DTSC ERAS	6.1.2	6-4	Pdf page 177 of 353, sixth bullet on page. The report indicates the landfill cap consists of a 1-foot compacted clay barrier and an 18-inch overlying erosion-resistant layer. There is no mention of a geotextile barrier. Please indicate what the erosion resistant layer is composed of and identify if the inspections include identification of burrows and what measures are proposed to address burrowing animals if burrows are found.	The cap is a 24 inch foundation, 12 inch compacted barrier, 18 inch cover. The soil makeup, compaction, and shear strengths can be found in Appendix A of the *Revised Final Closure and Postclosure Maintenance Plan* , Landfill No. 2 (HLA 1997). The cap composite and the landfill is inspected semiannually by the Lead Enforcement Agency (LEA [Yuba County CUPA]) and does include burrow identification. If the burrows are large, the species is caught, removed, and the burrows filled in. No large burrows have been discovered for the past five years. Small rodent burrows are only watched to ensure they don't cause any erosion or subsidence. The text will be clarified that semiannual inspections do include burrow observations.
8	DTSC ERAS	6.2.4.3	6-14	Pdf page 185 of 353, Section 6.2.4.3, Surface Water. The report indicates that " no analytes were detected above primary MCLs" . As with previous comments, please indicate why surface water concentrations were not compared to protective aquatic ecological receptor criteria.	The Air Force agrees with DTSC's recommendation to consider adding the most current national AWQC CCCs, in addition to the MCLs, to the list of screening levels applied to surface water data collected as part of ongoing monitoring activities at LF002 and LF003. Evaluation of surface water samples from the seasonal drainage ditches monitored in the vicinity of the former landfills will be conducted with caution in recognition of the conservative nature of the CCCs, i.e., protective of 95% of all aquatic taxa, many of which are likely sensitive species (e.g., fish) that are not present in the small seasonal drainages. Upstream surface water samples as well as downstream samples will be compared to the CCCs to provide context to this evaluation (site-related vs. non-site-related).

* All page numbers provided from Microsoft Word document.

References:

Harding Lawson Associates (HLA). 1997 (January). *Closure and Post-Closure Maintenance Plan Landfill No. 2, Beale Air Force Base, California* . Revised Final.

U.S. Air Force (Air Force). 2016 (October). *Integrated Natural Resource Management Plan, Beale Air Force Base, California* . Final.

United States Fish and Wildlife Service (USFS). 2003 (August). *Endangered and Threatened Wildlife and Plants; Final Designation of Critical Habitat for Four Vernal Pool Crustaceans and Eleve*

COMMENT AND RESPONSE WORKSHEET					
Date 2/5/2018		From: HERO		Draft Final Second Five-Year Report (January 2011 through June 2016) Beale Air Force Base, California	Contract Number: FA3002-07-D-0015 Task Order No. 0022
1	HERO	5.1.5	5-6	Objectives (RAOs) for Indoor Air vapor intrusion (VI) risk assessment: This comment applies to all the Sites with indoor air vapor intrusion issues: Subsection 5.1.5 (page 5-6, last paragraph) states. "This conclusion about the lack of COCs in soil vapor is valid because the assumptions used to calculate the risk based soil gas screening levels (RBSLs) for indoor air for the risk-driving COCs in soil vapor are still valid...". HERO do not totally agree with these conclusions. Risk based soil gas screening concentrations based on the USEPA 2015 empirically- derived attenuation factor of 0.03 should be developed and used to estimate risk and hazard for the unrestricted land use scenario, in addition to those based on the attenuation factor of 0.001 (2011 DTSC VI Guidance). Please note that DTSC will be requiring using attenuation factor of 0.03 for calculation of RBSLs and VI risks in their upcoming statewide VI guidance which is planned for finalization by the end of 2018.	The sixth bullet under Question B will be removed in acknowledgment that DTSC may issue revised VI guidance in 2018. However, at this time, the Air Force's position is that there is no evidence to warrant re-evaluation of the soil vapor-to-indoor air exposure pathway at Site SD011 or other similar sites where SVE operations met shutdown criteria. Shut down criteria were met at SD011 in 2007 and the system and all monitoring points have been decommissioned. Comparisons of new screening criteria to data collected more than 10 years ago is not recommended. Furthermore, while outside of the review period of this Five-Year Review, the SD011 RACR was finalized in June 2017 in accordance with the SD011 ROD. A statement will be added to CG041 regarding short term TCE exposure from potential VI per 2015 EPA guidance has not yet been addressed but will be recommended for consideration in forthcoming RODs.
2	HERO	5.5.7	5-34	Protectiveness Statement Subsections: Subsection 5.5.7 (page 5-34) states "The interim remedy for Site SD032 is considered protective of human health and the environment because it has remediated soil and soil vapor contamination to levels acceptable for UU/UE".	
2.A	HERO	5.5.7	5-34	A. HERO disagrees with this statement because cumulative human health risk cannot be assessed by evaluating different vapor sources such as soil gas and groundwater (GW) separately (decoupling soil and GW). Considering the presence of a contaminated GW plume underneath this Site and the potential for soil recontamination through seasonal variation of GW depth, post remediation confirmatory soil gas data are required for the proper site risk evaluation particularly in regard to vapor intrusion risk. Typically, VI risk evaluation won't be considered complete until evaluation of the VI risk for all the potential vapor sources (soii/GW) has been completed.	The AF accepts the comment and will revise the statement to: "The interim remedy for Site SD032 is considered protective of human health and the environment because it has remediated soil and soil vapor contamination to levels acceptable for restricted use in accordance with LUCs established in the Site SD032 ROD ."
2.B	HERO	5.5.7	5-34	B. HERO also recommends a cumulative human health risk assessment assessing all exposure pathways (soil and GW) for all the receptors before allowing for unlimited use/unlimited exposure or UU/UE. This comment applies to all the Sites above the contaminated GW plumes. Report should be revised and rewritten accordingly	The Technical Assesment of Site SD032 has been clarified to state: "SVE and bioventing have successfully remediated COCs in soil to levels acceptable for UU/UE, with the exception of the soils around SVE well VE-4. NFA has been recommended for soil, and this determination is pending approval of the finalized ROD for the site. LUCs established in the Site SD032 IROD will continue to be implemented until that timeconditions are suitable for UU/UE." This revision will carried through Sections 5.5.5-5.5.7
3	HERO			Short term Trichloroethane (TCE) Exposure: The below comments/recommendations apply to all the Sites with potential TCE vapor exposure.	
3.A	HERO	5.8.5	5-59	Subsection 5.8.5 (page 5-59, first paragraph) states "Estimated cancer risk to future residents at Site SS039 from residual contaminants are within the acceptable risk management range of 1E-06 to 1E-04, and noncancer hazard estimates were at or below the target noncancer hazard index of 1, except for TCE in soil vapor at Source Area 2". Considering the acute noncancer toxicity concerns with respect to the potential TCE adverse effect on developmental toxicity (HHRA HERO Note 5), the previously proposed cleanup/remediation may not be protective of human health under all exposure scenarios and future conditions. Please note that TCE acute toxic effects play a more prominent role in risk management decisions and must be discussed and considered during five-year review. http://www.dtsc.ca.gov/AssessinqRisk/humanrisk2.cfm	DTSC's concerns are acknowldeged. It should be noted that this five-year review has stated that further remedial action is necessary to address TCE contmaination in soil vapor at Source Area 2. When TCE soil vapor concentrations have been remediated to levels considered acceptable for UU/UE the acute toxic effects of residual TCE in soil vapor will then be evaluated as part of final risk management decisions. Considering that soil vapor remediation is ongoing at Source Area 2. The text has also been revised in consideration of multiple VI attenuation factors per CVWB Comment 14.

3.B	HERO	5.4.2	5-25	Subsection 5.4.2 (page 5-25, last paragraph) states "The soil vapor cleanup level was derived from the MCL". HERO does not recommend eliminating indoor air measurements of TCE based solely on groundwater concentrations less than 5 µg/L (HHRA HERO Note 5). As commented above, HERO is especially concerned with the use of the TCE MCL which was established prior to the TCE toxicity reevaluation that has shown developmental cardiac effects from short term gestational exposures.	Comment noted. Common practice of the AF has been to evaluate VI risk from TCE concentrations in groundwater in areas where the MCL of 5 µg/L is exceeded as standards less than the MCL are not promulgated.Therefore, common practice has been to derive soil vapor screening levels considering MCLs, depth to groundwater, and Henry's Law. In ackowledgement of HERO's concerns, the AF is in the process of addressing potential VI by performing indoor air sampling at specific sites, as described in forthcoming Remedial Action Work Plans. As those data are not currently available, no changes will be made to this document.
3.C	HERO			Please explain what steps have been taken to ensure sensitive receptors (women of child bearing age and pregnant women which currently occupy the existing buildings) are protected with regard to TCE exposure to indoor/outdoor air.	To date no additional steps (other than ongoing SVE) have been taken to protect sensitive receptors at Site SS039 because it has been determined by the draft Site SS039 ROD that only TCE in soil vapor at Source Area 2 poses an unacceptable risk to human health. The only building potentially effected by this remaining contamination is Building 2145 which is located approximately 25 feet south of Source Area 2. Soil vapor samples have been collected from the area between Source Area 2 and Building 2145 and are less than the site cleanup goals established to protect human health. A statement will be added to CG041 regarding short term TCE exposure from potential VI per 2015 EPA guidance has not yet been addressed but will be recommended for consideration in forthcoming RODs.
4	HERO			Chemicals of Potential Concern: Volatile organic compounds, primarily TCE, are the main contaminants of concern associated with the CG041-003 and -029 GW plumes. Since the GW contamination associated with these Plumes are originated from fire- fighting/protection training exercises at several fire protection training areas (FPTAs), Perfluorinated Compounds (PFCs) such as perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA) are potential chemicals of concern in GW. HERO recommends adding PFCs to the list of chemicals of potential concern in these Sites. This means that soil and groundwater samples should be tested for presence of this group of compounds.	The AF has completed a Site Inspection and provided the final document to DTSC/RWQCB. The AF has identified areas in groundwater where concentrations exceed the US EPA's lifetime provisional health advisory and may need additional investigation as guidance becomes available. A Remedial Investigation (RI) may be conducted separately in the future. However, no promulgated regulatory requirements have been developed to require perfluorinated alkyl substances (PFASs) to be investigated as a contaminant of concern. PFASs have only been identified as potential contaminants of concern and should not be investigated simply on the potential. Defense Environmental Restoration Account (DERA) funds cannot be expended to investigation potential contaminants of concern without promulgated regulatory requirements.

Global	CDFW-OSPR			Many of the actions described for Site 38 (or DP038) and other sites in the subject document are in future tense; however, several of the actions described in the subject document have already occurred (e.g., Site DP038's second removal action "*will extend to 1 ft below ground surface* " but the removal action has already taken place between October and November, 2016; for SS035, the text states that the Record of Decision (ROD) is "*forthcoming* " but the ROD was finalized in January 2017). CDFW-OSPR recognizes that there is a lag time between drafting the second five-year review and submitting it for agencies review. Please clarify a date for beyond which is not subject to the Second Five-Year Review report so that the start of the Third Five-Year Review may be resumed on the appropriate date. This global comment is for all the sites under the subject document.	Per the Second Five-Year Review Work Plan finalized in November 2016, this document reviews site activites completed prior to 30 June 2016. The sentence in question will be clarified with "as-of" type of language.
1	CDFW-OSPR			1. Please revise the description to include trap range as another former use of the site. According to the 2006 action memorandum for DP038 (URS, 2006), a trap hut and other range features were constructed at the site; clay targets were launched from the trap hut in an easterly direction. The conceptual site model would benefit from knowing this feature so that it can help inform the location of the target fall area.	References to "skeet" in the text will be revised to "trap and skeet".
2	CDFW-OSPR			2. CDFW-OSPR agrees with the Air Force that further action for residual shotgun pellets and clay pigeon debris in soil and sediment should be evaluated. However, all samples taken to-date by the Air Force or its contractors have focused on the fine soil fraction and no appropriate sampling for shotgun pellets or clay pigeon debris has been conducted. The lack of sampling for shotgun pellets and clay pigeon debris/fragments should be identified as a data gap to be filled by the Air Force.	Comment noted. Comment does not result in changes to this document as it pertains to future discussions about the site.
3	CDFW-OSPR			3. CDFW-OSPR agrees with DTSC-ERAS's memorandum to DTSC Project Manager dated January 22, 2018, that the stated lead Maximum Contaminant Level (MCL) of 15 µg/L is not protective of aquatic receptors. CDFW-OSPR would like to clarify that the National Ambient Water Quality Criteria Criterion Continuous Concentration (CCC) for lead in a filtered water sample of 2.5 µg/L assumes water hardness of 100 mg/L CaCO3. Toxicity of lead to aquatic organisms is dependent on water hardness. Waters in the Central Valley are known to be much softer. Thus, surface water samples should also be analyzed for hardness as CaCO3 so that the CCC can be adjusted appropriately. If water hardness is 50 mg/L CaCO3, this would result in a CCC of 1.2 µg/L that would be more than twice as toxic if the hardness were at 100 mg/L CaCO3.	Comment noted. Comment does not result in changes to this document as it pertains to future discussions about the site.
4	CDFW-OSPR			4. The ecological risk posed by clay pigeon debris/fragments and the resulting PAHs in soil and sediment have not been agreed upon by the agencies. CDFW-OSPR recommends that statement "conclusion regarding ecological risk for PAHs are still valid" be removed from the subject document.	The statement will be removed as requested.
DP038 Specific Comments				p. 5-46, Section 5.7.2 Response Action Summary.	
1.a	CDFW-OSPR	5.7		a. CDFW-OSPR agrees with DTSC-ERAS that the Probable Effects Threshold (PEC) of 128 mg/kg lead (MacDonald et. al., 2000) is not protective of federally listed vernal pool crustaceans. Without site-specific bioassays, the default lead preliminary cleanup goal for the legally protected vernal pool crustaceans would be the Threshold Effects Concentration (TEC) , which is 35.8 mg/kg (MacDonald et al., 2000).	Comment noted. Comment does not result in changes to this document as it pertains to future discussions about the site.
1.b	CDFW-OSPR	5.7		b. A lead particle (or pellet) density should also be established since that is the source of the contamination; lead in soil/sediment and water are secondary sources. The exact lead particle/pellet density PCG should be established in consultation with the Air Force, DTSC, and the Regional Water Quality Control Board.	Comment noted. Comment does not result in changes to this document as it pertains to future discussions about the site.
2	CDFW-OSPR	5.7		2. p. 5-50, Section 5.7.5 Technical Assessment. The text states "Selenium originally was identified as a COC in sediment but was concluded to be related to routine pesticide application rather than site-related sources (i.e., clay pigeons or skeet-related activities)." CDFW-OSPR maintains our ongoing recommendation that samples be analyzed in areas where selenium is elevated to determine if Site SD038 also contains unacceptable levels of pesticides (Tsao, 2012).	Comment noted. Comment does not result in changes to this document as it pertains to future discussions about the site.
OT-017 (or Site 17, Best Slough) General Comments					
				General Comment	

	CDFW-OSPR			In our review of the site history for OT-017, CDFW-OSPR noticed that there are additional trenches and pits that do not appear to have been investigated (see Attachment 1). These features should be considered in the Third Five-Year Review report. If no intrusive soil investigation has been conducted, CDFW-OSPR maintains our ongoing recommendation that the Air Force exclude these areas from the Site OT-17 investigation boundary lines. In a recent Air Force response to CDFW-OSPR's comments on the Draft Record of Decision for OT-017 (Wilburn, 2017), the Air Force proposed to scale back the site investigation boundary to Dry Creek (not including the creek or the creek bed, boundary line stops at the edge of the western bank of Dry Creek); however, southern portion of the Air Force proposed site investigation boundary would remain unchanged and include Parks Lake. CDFW-OSPR does not object to this proposal to include Parks Lake to the south with the understanding that the proposed site investigation boundary is designed to address the potential migration of contamination from the Northern Exposure Area (Source Areas A and B). As with all cleanup recommendations, CDFW-OSPR reserves the right to raise any appropriate environmental related issues should additional information concerning the environmental condition of OT-017 become available in the future (e.g., contamination found in Park Lake not related to leaks from discarded drums from the Northern Exposure Area).	Comment noted. Comment does not result in changes to this document as it pertains to future discussions about the site.
SS035 (or Site 35, Weapons Storage Area)				CDFW-OSPR has no specific comment on this site; please see the global comment above.	Comment noted.

References

CH2M HILL. 2007. Final Interim Record of Decision Site 17 Area B. Prepared for Beale Air Force Base, CA. June 20.

Tsao, C.L. 2012. Email to Terry Escarda, DTSC Project Manager. RE: Site 38 Draft Comments - version 3, with attachment: Site_38_draft_comments_mk_version3.doc. California Department of Fish and Wildlife, Office of Spill Prevention and Response, Sacramento, CA. April 17th.

URS. 2006. Final Action Memorandum for Site 38 Removal Action, Beale Air Force Base. Prepared for 9 CES/CEVR, Beale AFB, CA. November.

URS. 2007. Comprehensive Site Evaluation Phase I. Final Report. Beale Air Force Based. September.

Appendix B Site Inspection Forms

Five-Year Review Site Inspection Checklist

I. SITE INFORMATION	
Site name: **Beale AFB CERCA Sites**	**Date of inspection: 15-16 February 2017**
Location and Region: Beale AFB, CA	**EPA ID: NA**
Agency, office, or company leading the five-year review: AECOM	**Weather/temperature: Cool/45-60° F**

Remedy Includes: (Check all that apply)

☑ Landfill cover/containment
☑ Access controls
☑ Institutional controls
☐ Groundwater pump and treatment
☐ Surface water collection and treatment
☑ Other___In-Situ Treatment ____
☑ Monitored natural attenuation
☐ Groundwater containment
☑ Vertical barrier walls

Attachments: ☑ Inspection Photograph Log attached ☑ Site map attached

II. INTERVIEWS (Check all that apply)

1. **O&M site manager** ____ Raeann Rainwater ____ Project Manager___ _15 February 2017_
Name Title Date
Interviewed: ☑ **at site** ☐ at office ☐ by phone Phone no. 916.286.0257_______________
Problems, suggestions; ☐ Report attached ____

2. **O&M staff** ___Kevin Roberts______________ __Field Supervisor________ __15 February 27_________
Name Title Date
Interviewed ☑ at site ☐ at office ☐ by phone
Problems, suggestions; ☐ Report attached ____

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

Agency _ California Department of Toxic Substances Control __________________
Contact ___ Dominique Forrester ___ Remedial Program Manager 916-255-3609_
Name Title Phone no.
Problems; suggestions; ☑ Report attached ____

Agency __ California Regional Water Quality Control Board ___________________________
Contact ___ Mark Clardy ___ Remedial Program Manager 916-464-4719_ ___________
Name Title Date Phone no.
Problems; suggestions; ☑ Report attached ____

Agency ______________________________
Contact ______________________________ ___________________ ________ ____________
Name Title Date Phone no.
Problems; suggestions; ☐ Report attached ____

Agency ______________________________
Contact ______________________________ ___________________ ________ ____________
Name Title Date Phone no.
Problems; suggestions; ☐ Report attached ____

4. **Other interviews** (optional) ☑ Reports attached.

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

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

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

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

4. **Permits and Service Agreements**
☐ Air discharge permit ☐ Readily available ☐ Up to date ☑ N/A
☐ Effluent discharge ☐ Readily available ☐ Up to date ☑ N/A
☐ Waste disposal, POTW ☐ Readily available ☐ Up to date ☐ N/A
☑ Other permits_WDR (General)__________________ ☐ Readily available ☐ Up to date
Remarks____

5. **Gas Generation Records** ☐ Readily available ☐ Up to date ☑ N/A
Remarks____

6. **Settlement Monument Records** ☐ Readily available ☐ Up to date ☑ N/A
Remarks____

7. **Groundwater Monitoring Records** ☑ Readily available ☑ Up to date ☐ N/A
Remarks____

8. **Leachate Extraction Records** ☐ Readily available ☐ Up to date ☑ N/A
Remarks____

9. **Discharge Compliance Records**
☐ Air ☐ Readily available ☐ Up to date ☑ N/A
☐ Water (effluent) ☐ Readily available ☐ Up to date ☑ N/A
Remarks____

10. **Daily Access/Security Logs** ☐ Readily available ☐ Up to date ☑ N/A
Remarks____

V. ACCESS AND INSTITUTIONAL CONTROLS ☑ Applicable ☐ N/A
A. Fencing
1. **Fencing damaged** ☐ Location shown on site map ☐ Gates secured ☑ N/A Remarks____________________
B. Other Access Restrictions
1. **Signs and other security measures** ☐ Location shown on site map ☑ N/A Remarks____________________

C. Institutional Controls (ICs)

1. **Implementation and enforcement**
Site conditions imply ICs not properly implemented ☐ Yes ☑ No ☐ N/A
Site conditions imply ICs not being fully enforced ☐ Yes ☑ No ☐ N/A

Type of monitoring (*e.g.*, self-reporting, drive by) ___Contractor Site Visits______________________
Frequency __Varies____
Responsible party/agency ____
Contact ____________________________ ____________________ _________ ____________
Name Title Date Phone no.

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

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

2. **Adequacy** ☑ ICs are adequate ☐ ICs are inadequate ☐ N/A
Remarks____

D. General

1. **Vandalism/trespassing** ☐ Location shown on site map ☑ No vandalism evident
Remarks____

2. **Land use changes on site** ☑ N/A
Remarks____

3. **Land use changes off site** ☑ N/A
Remarks____

VI. GENERAL SITE CONDITIONS

A. Roads ☑ Applicable ☐ N/A

1. **Roads damaged** ☐ Location shown on site map ☑ Roads adequate ☐ N/A
Remarks____

B. Other Site Conditions

Remarks ____

____

____

____

____

____

VII. LANDFILL COVERS ☑ Applicable N/A

A. Landfill Surface

1. **Settlement** (Low spots) ☐ Location shown on site map ☑ Settlement not evident
Areal extent______________ Depth____________
Remarks____
____

2. **Cracks** ☐ Location shown on site map ☑ Cracking not evident
Lengths____________ Widths___________ Depths__________
Remarks____
____

3. **Erosion** ☐ Location shown on site map ☑ Erosion not evident
Areal extent______________ Depth____________
Remarks___ ____
____

4. **Holes** ☐ Location shown on site map ☑ Holes not evident
Areal extent______________ Depth____________
Remarks____
____

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

6. **Alternative Cover (armored rock, concrete, etc.)** ☐ N/A
Remarks____
____

7. **Bulges** ☐ Location shown on site map ☑ Bulges not evident
Areal extent______________ Height____________
Remarks____
____

8.	**Wet Areas/Water Damage**	☑ Wet areas/water damage not evident	
	☐ Wet areas	☐ Location shown on site map	Areal extent______________
	☐ Ponding	☐ Location shown on site map	Areal extent______________
	☐ Seeps	☐ Location shown on site map	Areal extent______________
	☐ Soft subgrade	☐ Location shown on site map	Areal extent______________
	Remarks___________________________________		
9.	**Slope Instability** ☐ Slides	☐ Location shown on site map	☑ No evidence of slope instability
	Areal extent______________		
	Remarks___________________________________		
B. Benches	☐ Applicable	☑ N/A	
	(Horizontally constructed mounds of earth placed across a steep landfill side slope to interrupt the slope in order to slow down the velocity of surface runoff and intercept and convey the runoff to a lined channel.)		
1.	**Flows Bypass Bench**	☐ Location shown on site map	☐ N/A or okay
	Remarks___________________________________		
2.	**Bench Breached**	☐ Location shown on site map	☐ N/A or okay
	Remarks___________________________________		
3.	**Bench Overtopped**	☐ Location shown on site map	☐ N/A or okay
	Remarks___________________________________		
C. Letdown Channels	☐ Applicable	☑ N/A	
	(Channel lined with erosion control mats, riprap, grout bags, or gabions that descend down the steep side slope of the cover and will allow the runoff water collected by the benches to move off of the landfill cover without creating erosion gullies.)		
1.	**Settlement**	☐ Location shown on site map	☐ No evidence of settlement
	Areal extent______________	Depth____________	
	Remarks___________________________________		
2.	**Material Degradation**	☐ Location shown on site map	☐ No evidence of degradation
	Material type_______________	Areal extent_____________	
	Remarks___________________________________		
3.	**Erosion**	☐ Location shown on site map	☐ No evidence of erosion
	Areal extent______________	Depth____________	
	Remarks___________________________________		

4. **Undercutting** ☐ Location shown on site map ☐ No evidence of undercutting
Areal extent______________ Depth____________
Remarks____
____

5. **Obstructions** Type_____________________ ☐ No obstructions
☐ Location shown on site map Areal extent______________
Size____________
Remarks____
____

6. **Excessive Vegetative Growth** Type____________________
☐ No evidence of excessive growth
☐ Vegetation in channels does not obstruct flow
☐ Location shown on site map Areal extent______________
Remarks____
____

D. Cover Penetrations ☑ Applicable N/A

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

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

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

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

5. **Settlement Monuments** ☐ Located ☐ Routinely surveyed ☑ N/A
Remarks____
____

E. Gas Collection and Treatment ☐ Applicable ☑ N/A

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

2. **Gas Collection Wells, Manifolds and Piping**
☐ Good condition ☐ Needs Maintenance
Remarks____
____

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

F. Cover Drainage Layer ☐ Applicable ☑ N/A

1. **Outlet Pipes Inspected** ☐ Functioning ☐ N/A
Remarks____
____

2. **Outlet Rock Inspected** ☐ Functioning ☐ N/A
Remarks____
____

H. Retaining Walls ☐ Applicable ☑ N/A		
1.	**Deformations** ☐ Location shown on site map ☐ Deformation not evident Horizontal displacement_____________ Vertical displacement_______________ Rotational displacement_____________ Remarks____ ____	
2.	**Degradation** ☐ Location shown on site map ☐ Degradation not evident Remarks____ ____	
I. Perimeter Ditches/Off-Site Discharge ☐ Applicable ☑ N/A		
1.	**Siltation** ☐ Location shown on site map ☐ Siltation not evident Areal extent_______________ Depth_____________ Remarks____ ____	
2.	**Vegetative Growth** ☐ Location shown on site map ☐ N/A ☐ Vegetation does not impede flow Areal extent_______________ Type_____________ Remarks____ ____	
3.	**Erosion** ☐ Location shown on site map ☐ Erosion not evident Areal extent_______________ Depth_____________ Remarks____ ____	
4.	**Discharge Structure** ☐ Functioning ☐ N/A Remarks____ ____	
VIII. VERTICAL BARRIER WALLS ☐ Applicable ☑ N/A		
1.	**Settlement** ☐ Location shown on site map ☐ Settlement not evident Areal extent_______________ Depth_____________ Remarks____ ____	
2.	**Performance Monitoring** Type of monitoring___________________________ ☐ Performance not monitored Frequency_________________________________ ☐ Evidence of breaching Head differential___________________________ Remarks____ ____	

IX. GROUNDWATER/SURFACE WATER REMEDIES ☑Applicable N/A
A. Groundwater Extraction Wells, Pumps, and Pipelines ☑ Applicable N/A
1. **Pumps, Wellhead Plumbing, and Electrical** Good condition ☑ All required wells properly operating ☑ Needs Maintenance □ N/A Remarks______________________________
2. **Extraction System Pipelines, Valves, Valve Boxes, and Other Appurtenances** ☑ Good condition □ Needs Maintenance Remarks______________________________
3. **Spare Parts and Equipment** □ Readily available ☑ Good condition □ Requires upgrade □ Needs to be provided Remarks______________________________
B. Surface Water Collection Structures, Pumps, and Pipelines □ Applicable ☑ N/A
1. **Collection Structures, Pumps, and Electrical** □ Good condition□ Needs Maintenance Remarks______________________________
2. **Surface Water Collection System Pipelines, Valves, Valve Boxes, and Other Appurtenances** □ Good condition□ Needs Maintenance Remarks______________________________
3. **Spare Parts and Equipment** □ Readily available □ Good condition□ Requires upgrade □ Needs to be provided Remarks______________________________

C. Treatment System	☑Applicable N/A	
2.	**Electrical Enclosures and Panels** (properly rated and functional) ☐ N/A ☑ Good condition ☐ Needs Maintenance Remarks________________________________	
3.	**Tanks, Vaults, Storage Vessels** ☐ N/A ☑ Good condition ☑ Proper secondary containment ☐ Needs Maintenance Remarks________________________________	
4.	**Discharge Structure and Appurtenances** ☐ N/A ☑ Good condition ☐ Needs Maintenance Remarks________________________________	
5.	**Treatment Building(s)** ☐ N/A ☑ Good condition (esp. roof and doorways) ☐ Needs repair ☐ Chemicals and equipment properly stored Remarks________________________________	
6.	**Monitoring Wells** (pump and treatment remedy) ☑ Properly secured/locked ☑ Functioning ☑ Routinely sampled ☑ Good condition ☐ All required wells located ☐ Needs Maintenance ☐ N/A Remarks________________________________	
D. Monitoring Data		
1.	Monitoring Data ☑ Is routinely submitted on time ☑ Is of acceptable quality	
2.	Monitoring data suggests: ☑ Groundwater plume is effectively contained ☐ Contaminant concentrations are declining	

D. Monitored Natural Attenuation

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

X. OTHER REMEDIES

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

XI. OVERALL OBSERVATIONS

A. Implementation of the Remedy

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

Please see Report.

B. Adequacy of O&M

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

C.	**Early Indicators of Potential Remedy Problems**
	Describe issues and observations such as unexpected changes in the cost or scope of O&M or a high frequency of unscheduled repairs, that suggest that the protectiveness of the remedy may be compromised in the future. No issues were Identified.____
D.	**Opportunities for Optimization**
	Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy.

☑

Five-Year Review Site Inspection Checklist

I. SITE INFORMATION	
Site name: Lincoln Receiver Site: PL582	**Date of inspection: 15-16 February 2017**
Location and Region: Placer County, CA	**EPA ID: NA**
Agency, office, or company leading the five-year review: AECOM	**Weather/temperature: Cool/45-60° F**

Remedy Includes: (Check all that apply)

☐ Landfill cover/containment
☑ Access controls
☑ Institutional controls
☐ Groundwater pump and treatment
☐ Surface water collection and treatment
☐ Other______________________________
☑ Monitored natural attenuation
☐ Groundwater containment
☐ Vertical barrier walls

Attachments: ☑ Inspection Photograph Log attached ☑ Site map attached

II. INTERVIEWS (Check all that apply)

1. **O&M site manager** ____ Raeann Rainwater ____ Project Manager___ _15 February 2017_
   Name Title Date
   Interviewed: ☑ **at site** ☐ at office ☐ by phone Phone no. 916.286.0257_______________
   Problems, suggestions; ☐ Report attached ____

2. **O&M staff** ___Kevin Roberts______________ __Field Supervisor________ ___15 February 27________
   Name Title Date
   Interviewed ☑ at site ☐ at office ☐ by phone
   Problems, suggestions; ☐ Report attached ____

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

Agency _ California Department of Toxic Substances Control __________________
Contact ___ Dominique Forrester ___ Remedial Program Manager 916-255-3609_
Name Title Phone no.
Problems; suggestions; ☑ Report attached ______________________________

Agency __ California Regional Water Quality Control Board ___________________________
Contact ___ Mark Clardy ___ Remedial Program Manager 916-464-4719_ ___________
Name Title Date Phone no.
Problems; suggestions; ☑ Report attached ______________________________

Agency ______________________________
Contact ______________________________ ___________________ ________ ____________
Name Title Date Phone no.
Problems; suggestions; ☐ Report attached ______________________________

Agency ______________________________
Contact ______________________________ ___________________ ________ ____________
Name Title Date Phone no.
Problems; suggestions; ☐ Report attached ______________________________

4. **Other interviews** (optional) ☑ Reports attached.

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

V. ACCESS AND INSTITUTIONAL CONTROLS ☑ Applicable □ N/A
A. Fencing
1. **Fencing damaged** □ Location shown on site map □ Gates secured ☑ N/A Remarks____
B. Other Access Restrictions
1. **Signs and other security measures** □ Location shown on site map ☑ N/A Remarks____

C. Institutional Controls (ICs)

1. **Implementation and enforcement**

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

Type of monitoring (*e.g.*, self-reporting, drive by) ___Contractor Site Visits_______________________

Frequency __Varies____

Responsible party/agency ____

Contact ______________________________ ____________________ _________ ____________

Name Title Date Phone no.

Reporting is up-to-date	☑ Yes	□ No	□ N/A
Reports are verified by the lead agency	☑ Yes	□ No	□ N/A
Specific requirements in deed or decision documents have been met	☑ Yes	□ No	□ N/A
Violations have been reported	□ Yes	☑ No	□ N/A

Other problems or suggestions: □ Report attached

2. **Adequacy** ☑ ICs are adequate □ ICs are inadequate □ N/A

Remarks____

D. General

1. **Vandalism/trespassing** □ Location shown on site map ☑ No vandalism evident

Remarks____

2. **Land use changes on site** ☑ N/A

Remarks____

3. **Land use changes off site** ☑ N/A

Remarks____

VI. GENERAL SITE CONDITIONS

A. Roads ☑ Applicable □ N/A

1. **Roads damaged** □ Location shown on site map ☑ Roads adequate □ N/A

Remarks____

B. Other Site Conditions	
	Remarks ______________________________

VII. LANDFILL COVERS ☐ Applicable ☑ N/A	
A. Landfill Surface	
1.	**Settlement** (Low spots) ☐ Location shown on site map ☐ Settlement not evident Areal extent______________ Depth____________ Remarks______________________________
2.	**Cracks** ☐ Location shown on site map ☐ Cracking not evident Lengths____________ Widths___________ Depths__________ Remarks______________________________
3.	**Erosion** ☐ Location shown on site map ☐ Erosion not evident Areal extent______________ Depth____________ Remarks______________________________
4.	**Holes** ☐ Location shown on site map ☐ Holes not evident Areal extent______________ Depth____________ Remarks______________________________
5.	**Vegetative Cover** ☐ Grass ☐ Cover properly established ☐ No signs of stress ☐ Trees/Shrubs (indicate size and locations on a diagram) Remarks______________________________
6.	**Alternative Cover (armored rock, concrete, etc.)** ☐ N/A Remarks______________________________
7.	**Bulges** ☐ Location shown on site map ☐ Bulges not evident Areal extent______________ Height____________ Remarks______________________________

8. **Wet Areas/Water Damage** ☑ Wet areas/water damage not evident
□ Wet areas □ Location shown on site map Areal extent______________
□ Ponding □ Location shown on site map Areal extent______________
□ Seeps □ Location shown on site map Areal extent______________
□ Soft subgrade □ Location shown on site map Areal extent______________
Remarks____
____

9. **Slope Instability** □ Slides □ Location shown on site map ☑ No evidence of slope instability
Areal extent______________
Remarks____
____

B. Benches □ Applicable ☑ N/A
(Horizontally constructed mounds of earth placed across a steep landfill side slope to interrupt the slope in order to slow down the velocity of surface runoff and intercept and convey the runoff to a lined channel.)

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

2. **Bench Breached** □ Location shown on site map □ N/A or okay
Remarks____
____

3. **Bench Overtopped** □ Location shown on site map □ N/A or okay
Remarks____
____

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

1. **Settlement** □ Location shown on site map □ No evidence of settlement
Areal extent______________ Depth____________
Remarks____
____

2. **Material Degradation** □ Location shown on site map □ No evidence of degradation
Material type_______________ Areal extent_____________
Remarks____
____

3. **Erosion** □ Location shown on site map □ No evidence of erosion
Areal extent______________ Depth____________
Remarks____
____

4. **Undercutting** ☐ Location shown on site map ☐ No evidence of undercutting
Areal extent______________ Depth____________
Remarks____
____

5. **Obstructions** Type_____________________ ☐ No obstructions
☐ Location shown on site map Areal extent______________
Size____________
Remarks____
____

6. **Excessive Vegetative Growth** Type____________________
☐ No evidence of excessive growth
☐ Vegetation in channels does not obstruct flow
☐ Location shown on site map Areal extent______________
Remarks____
____

D. Cover Penetrations ☐ Applicable ☑ N/A

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

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

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

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

5. **Settlement Monuments** ☐ Located ☐ Routinely surveyed ☐ N/A
Remarks____
____

E. Gas Collection and Treatment	☐ Applicable ☑ N/A
1. **Gas Treatment Facilities** ☐ Flaring ☐ Thermal destruction ☐ Collection for reuse ☐ Good condition ☐ Needs Maintenance Remarks________________________________ ________________________________	
2. **Gas Collection Wells, Manifolds and Piping** ☐ Good condition ☐ Needs Maintenance Remarks________________________________ ________________________________	
3. **Gas Monitoring Facilities** (*e.g.*, gas monitoring of adjacent homes or buildings) ☐ Good condition ☐ Needs Maintenance ☐ N/A Remarks________________________________ ________________________________	
F. Cover Drainage Layer	☐ Applicable ☑ N/A
1. **Outlet Pipes Inspected** ☐ Functioning ☐ N/A Remarks________________________________ ________________________________	
2. **Outlet Rock Inspected** ☐ Functioning ☐ N/A Remarks________________________________ ________________________________	

H. Retaining Walls ☐ Applicable ☑ N/A

1. **Deformations** ☐ Location shown on site map ☐ Deformation not evident
Horizontal displacement_____________ Vertical displacement________________
Rotational displacement_____________
Remarks____
____

2. **Degradation** ☐ Location shown on site map ☐ Degradation not evident
Remarks____
____

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

1. **Siltation** ☐ Location shown on site map ☐ Siltation not evident
Areal extent_______________ Depth_____________
Remarks____
____

2. **Vegetative Growth** ☐ Location shown on site map ☐ N/A
☐ Vegetation does not impede flow
Areal extent_______________ Type_____________
Remarks____
____

3. **Erosion** ☐ Location shown on site map ☐ Erosion not evident
Areal extent_______________ Depth_____________
Remarks____
____

4. **Discharge Structure** ☐ Functioning ☐ N/A
Remarks____
____

VIII. VERTICAL BARRIER WALLS ☐ Applicable ☑ N/A

1. **Settlement** ☐ Location shown on site map ☐ Settlement not evident
Areal extent_______________ Depth_____________
Remarks____
____

2. **Performance Monitoring** Type of monitoring___________________________
☐ Performance not monitored
Frequency_________________________________ ☐ Evidence of breaching
Head differential___________________________
Remarks____
____

IX. GROUNDWATER/SURFACE WATER REMEDIES ☑ Applicable ☐ N/A
A. Groundwater Extraction Wells, Pumps, and Pipelines ☑ Applicable (TU002) ☐ N/A
1. **Pumps, Wellhead Plumbing, and Electrical** ☑ Good condition ☐ All required wells properly operating ☐ Needs Maintenance ☐ N/A Remarks________________
2. **Extraction System Pipelines, Valves, Valve Boxes, and Other Appurtenances** ☑ Good condition ☐ Needs Maintenance Remarks________________
3. **Spare Parts and Equipment** ☐ Readily available ☑ Good condition ☐ Requires upgrade ☐ Needs to be provided Remarks________________
B. Surface Water Collection Structures, Pumps, and Pipelines ☐ Applicable ☑ N/A
1. **Collection Structures, Pumps, and Electrical** ☐ Good condition ☐ Needs Maintenance Remarks________________
2. **Surface Water Collection System Pipelines, Valves, Valve Boxes, and Other Appurtenances** ☐ Good condition ☐ Needs Maintenance Remarks________________
3. **Spare Parts and Equipment** ☐ Readily available ☐ Good condition ☐ Requires upgrade ☐ Needs to be provided Remarks________________

C. Treatment System ☑ Applicable ☐ N/A	
2.	**Electrical Enclosures and Panels** (properly rated and functional) ☐ N/A ☐ Good condition ☐ Needs Maintenance Remarks______________________________
3.	**Tanks, Vaults, Storage Vessels** ☐ N/A ☑ Good condition ☐ Proper secondary containment ☐ Needs Maintenance Remarks______________________________
4.	**Discharge Structure and Appurtenances** ☐ N/A ☑ Good condition ☐ Needs Maintenance Remarks______________________________
5.	**Treatment Building(s)** ☐ N/A ☑ Good condition (esp. roof and doorways) ☐ Needs repair ☐ Chemicals and equipment properly stored Remarks______________________________
6.	**Monitoring Wells** (pump and treatment remedy) ☑ Properly secured/locked ☐ Functioning ☑ Routinely sampled ☑ Good condition ☐ All required wells located ☐ Needs Maintenance ☐ N/A Remarks______________________________
D. Monitoring Data	
1.	Monitoring Data ☑ Is routinely submitted on time ☑ Is of acceptable quality
2.	Monitoring data suggests: ☑ Groundwater plume is effectively contained ☐ Contaminant concentrations are declining

D. Monitored Natural Attenuation

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

X. OTHER REMEDIES

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

XI. OVERALL OBSERVATIONS

A. Implementation of the Remedy

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

Please see Report.

B. Adequacy of O&M

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

C.	**Early Indicators of Potential Remedy Problems**
	Describe issues and observations such as unexpected changes in the cost or scope of O&M or a high frequency of unscheduled repairs, that suggest that the protectiveness of the remedy may be compromised in the future. No issues were Identified.____
D.	**Opportunities for Optimization**
	Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy.

☑

Five-Year Review Site Inspection Checklist

I. SITE INFORMATION	
Site name: Beale AFB RCRA Sites: LF002, LF003, and SS023	**Date of inspection: 15-16 February 2017**
Location and Region: Beale AFB, CA	**EPA ID: NA**
Agency, office, or company leading the five-year review: AECOM	**Weather/temperature: Cool/45-60° F**
Remedy Includes: (Check all that apply) ☑ Landfill cover/containment ☑ Monitored natural attenuation ☑ Access controls ☐ Groundwater containment ☑ Institutional controls ☐ Vertical barrier walls ☐ Groundwater pump and treatment ☐ Surface water collection and treatment ☑ Other___In-Situ Treatment at SS023____ ____	
Attachments: ☑ Inspection Photograph Log attached ☑ Site map attached	
II. INTERVIEWS (Check all that apply)	
1. **O&M site manager** ____ Raeann Rainwater ____ Project Manager___ _15 February 2017_ Name Title Date Interviewed: ☑ **at site** ☐ at office ☐ by phone Phone no. 916.286.0257_______________ Problems, suggestions; ☐ Report attached ____ ____	
2. **O&M staff** ___Kevin Roberts______________ __Field Supervisor________ __15 February 27________ Name Title Date Interviewed ☑ at site ☐ at office ☐ by phone Problems, suggestions; ☐ Report attached ____ ____	

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

Agency _ California Department of Toxic Substances Control ___________________
Contact ___ Dominique Forrester ___ Remedial Program Manager ______ 916-255-3609_
Name Title Phone no.
Problems; suggestions; ☑ Report attached ______________________________________

Agency __ California Regional Water Quality Control Board ______________________
Contact ____ Mark Clardy ___ Remedial Program Manager ______ 916-464-4719_____________
Name Title Date Phone no.
Problems; suggestions; ☑ Report attached ______________________________________

Agency ______________________________
Contact ______________________________ ___________________ ________ ____________
Name Title Date Phone no.
Problems; suggestions; □ Report attached ______________________________________

Agency ______________________________
Contact ______________________________ ___________________ ________ ____________
Name Title Date Phone no.
Problems; suggestions; □ Report attached ______________________________________

4. **Other interviews** (optional) ☑ Reports attached.

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

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

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

3. **O&M and OSHA Training Records** ☑ Readily available ☑ Up to date ☐ N/A
Remarks____
____

4. **Permits and Service Agreements**
☐ Air discharge permit ☐ Readily available ☐ Up to date ☑ N/A
☐ Effluent discharge ☐ Readily available ☐ Up to date ☑ N/A
☐ Waste disposal, POTW ☐ Readily available ☐ Up to date ☐ N/A
☑ Other permits_WDR (General)___________________ ☐ Readily available ☐ Up to date
Remarks____
____

5. **Gas Generation Records** ☐ Readily available ☐ Up to date ☑ N/A
Remarks____
____

6. **Settlement Monument Records** ☐ Readily available ☐ Up to date ☑ N/A
Remarks____
____

7. **Groundwater Monitoring Records** ☑ Readily available ☑ Up to date ☐ N/A
Remarks____
____

8. **Leachate Extraction Records** ☐ Readily available ☐ Up to date ☑ N/A
Remarks____
____

9. **Discharge Compliance Records**
☐ Air ☐ Readily available ☐ Up to date ☑ N/A
☐ Water (effluent) ☐ Readily available ☐ Up to date ☑ N/A
Remarks____
____

10. **Daily Access/Security Logs** ☐ Readily available ☐ Up to date ☑ N/A
Remarks____
____

V. ACCESS AND INSTITUTIONAL CONTROLS ☑ Applicable □ N/A
A. Fencing
1. **Fencing damaged** □ Location shown on site map □ Gates secured ☑ N/A Remarks______________________________
B. Other Access Restrictions
1. **Signs and other security measures** □ Location shown on site map ☑ N/A Remarks______________________________

C. Institutional Controls (ICs)

1. **Implementation and enforcement**
Site conditions imply ICs not properly implemented ☐ Yes ☑ No ☐ N/A
Site conditions imply ICs not being fully enforced ☐ Yes ☑ No ☐ N/A

Type of monitoring (*e.g.*, self-reporting, drive by) ___Contractor Site Visits______________________
Frequency __Varies____
Responsible party/agency ____
Contact ______________________ ______________ ________ __________
Name Title Date Phone no.

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

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

2. **Adequacy** ☑ ICs are adequate ☐ ICs are inadequate ☐ N/A
Remarks____

D. General

1. **Vandalism/trespassing** ☐ Location shown on site map ☑ No vandalism evident
Remarks____

2. **Land use changes on site** ☑ N/A
Remarks____

3. **Land use changes off site** ☑ N/A
Remarks____

VI. GENERAL SITE CONDITIONS

A. Roads ☑ Applicable ☐ N/A

1. **Roads damaged** ☐ Location shown on site map ☑ Roads adequate ☐ N/A
Remarks____

B. Other Site Conditions

Remarks ____

VII. LANDFILL COVERS ☑ Applicable N/A

A. Landfill Surface

1. **Settlement** (Low spots) □ Location shown on site map ☑ Settlement not evident
Areal extent______________ Depth____________
Remarks____

2. **Cracks** □ Location shown on site map ☑ Cracking not evident
Lengths____________ Widths___________ Depths__________
Remarks____

3. **Erosion** □ Location shown on site map □ Erosion not evident
Areal extent______________ Depth____________
Remarks___Some erosion noted during previous inspection but repaired.____

4. **Holes** □ Location shown on site map ☑ Holes not evident
Areal extent______________ Depth____________
Remarks____

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

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

7. **Bulges** □ Location shown on site map ☑ Bulges not evident
Areal extent______________ Height____________
Remarks____

8. **Wet Areas/Water Damage** ☑ Wet areas/water damage not evident
□ Wet areas □ Location shown on site map Areal extent______________
□ Ponding □ Location shown on site map Areal extent______________
□ Seeps □ Location shown on site map Areal extent______________
□ Soft subgrade □ Location shown on site map Areal extent______________
Remarks____
____

9. **Slope Instability** □ Slides □ Location shown on site map ☑ No evidence of slope instability
Areal extent______________
Remarks____
____

B. Benches □ Applicable ☑ N/A
(Horizontally constructed mounds of earth placed across a steep landfill side slope to interrupt the slope in order to slow down the velocity of surface runoff and intercept and convey the runoff to a lined channel.)

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

2. **Bench Breached** □ Location shown on site map □ N/A or okay
Remarks____
____

3. **Bench Overtopped** □ Location shown on site map □ N/A or okay
Remarks____
____

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

1. **Settlement** □ Location shown on site map □ No evidence of settlement
Areal extent______________ Depth____________
Remarks____
____

2. **Material Degradation** □ Location shown on site map □ No evidence of degradation
Material type_______________ Areal extent_____________
Remarks____
____

3. **Erosion** □ Location shown on site map □ No evidence of erosion
Areal extent______________ Depth____________
Remarks____
____

4. **Undercutting** ☐ Location shown on site map ☐ No evidence of undercutting
Areal extent_______________ Depth____________
Remarks____
____

5. **Obstructions** Type_____________________ ☐ No obstructions
☐ Location shown on site map Areal extent______________
Size____________
Remarks____
____

6. **Excessive Vegetative Growth** Type____________________
☐ No evidence of excessive growth
☐ Vegetation in channels does not obstruct flow
☐ Location shown on site map Areal extent______________
Remarks____
____

D. Cover Penetrations ☑ Applicable N/A

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

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

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

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

5. **Settlement Monuments** ☐ Located ☐ Routinely surveyed ☑ N/A
Remarks____
____

E. Gas Collection and Treatment ☐ Applicable ☑ N/A	
1.	**Gas Treatment Facilities** ☐ Flaring ☐ Thermal destruction ☐ Collection for reuse ☐ Good condition ☐ Needs Maintenance Remarks____
2.	**Gas Collection Wells, Manifolds and Piping** ☐ Good condition ☐ Needs Maintenance Remarks____
3.	**Gas Monitoring Facilities** (*e.g.*, gas monitoring of adjacent homes or buildings) ☐ Good condition ☐ Needs Maintenance ☐ N/A Remarks____
F. Cover Drainage Layer ☐ Applicable ☑ N/A	
1.	**Outlet Pipes Inspected** ☐ Functioning ☐ N/A Remarks____
2.	**Outlet Rock Inspected** ☐ Functioning ☐ N/A Remarks____

H. Retaining Walls		☐ Applicable	☑ N/A
1.	**Deformations** Horizontal displacement____________ Rotational displacement____________ Remarks____	☐ Location shown on site map Vertical displacement____________	☐ Deformation not evident
2.	**Degradation** Remarks____	☐ Location shown on site map	☐ Degradation not evident
I. Perimeter Ditches/Off-Site Discharge		☐ Applicable	☑ N/A
1.	**Siltation** ☐ Location shown on site map ☐ Siltation not evident Areal extent____________ Depth____________ Remarks____		
2.	**Vegetative Growth** ☐ Vegetation does not impede flow Areal extent____________ Type____________ Remarks____	☐ Location shown on site map	☐ N/A
3.	**Erosion** Areal extent____________ Depth____________ Remarks____	☐ Location shown on site map	☐ Erosion not evident
4.	**Discharge Structure** Remarks____	☐ Functioning	☐ N/A
VIII. VERTICAL BARRIER WALLS		☐ Applicable	☑ N/A
1.	**Settlement** Areal extent____________ Depth____________ Remarks____	☐ Location shown on site map	☐ Settlement not evident
2.	**Performance Monitoring** Type of monitoring____________________ ☐ Performance not monitored Frequency____________________ ☐ Evidence of breaching Head differential____________________ Remarks____		

IX. GROUNDWATER/SURFACE WATER REMEDIES Applicable ☑ N/A	
A. Groundwater Extraction Wells, Pumps, and Pipelines Applicable ☑ N/A	
1.	**Pumps, Wellhead Plumbing, and Electrical** Good condition □ All required wells properly operating □ Needs Maintenance □ N/A Remarks___
2.	**Extraction System Pipelines, Valves, Valve Boxes, and Other Appurtenances** Good condition □ Needs Maintenance Remarks___
3.	**Spare Parts and Equipment** □ Readily available Good condition □ Requires upgrade □ Needs to be provided Remarks___
B. Surface Water Collection Structures, Pumps, and Pipelines □ Applicable ☑ N/A	
1.	**Collection Structures, Pumps, and Electrical** □ Good condition□ Needs Maintenance Remarks___
2.	**Surface Water Collection System Pipelines, Valves, Valve Boxes, and Other Appurtenances** □ Good condition□ Needs Maintenance Remarks___
3.	**Spare Parts and Equipment** □ Readily available □ Good condition□ Requires upgrade □ Needs to be provided Remarks___

C. Treatment System ☐Applicable ☑ N/A	
2.	**Electrical Enclosures and Panels** (properly rated and functional) ☐ N/A ☐ Good condition ☐ Needs Maintenance Remarks____
3.	**Tanks, Vaults, Storage Vessels** ☐ N/A ☐ Good condition ☐ Proper secondary containment ☐ Needs Maintenance Remarks____
4.	**Discharge Structure and Appurtenances** ☐ N/A ☐ Good condition ☐ Needs Maintenance Remarks____
5.	**Treatment Building(s)** ☐ N/A ☐ Good condition (esp. roof and doorways) ☐ Needs repair ☐ Chemicals and equipment properly stored Remarks____
6.	**Monitoring Wells** (pump and treatment remedy) ☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition ☐ All required wells located ☐ Needs Maintenance ☐ N/A Remarks____
D. Monitoring Data	
1.	Monitoring Data ☑ Is routinely submitted on time ☑ Is of acceptable quality
2.	Monitoring data suggests: ☑ Groundwater plume is effectively contained ☐ Contaminant concentrations are declining

D. Monitored Natural Attenuation

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

X. OTHER REMEDIES

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

XI. OVERALL OBSERVATIONS

A. Implementation of the Remedy

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

Please see Report.

B. Adequacy of O&M

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

C.	**Early Indicators of Potential Remedy Problems**
	Describe issues and observations such as unexpected changes in the cost or scope of O&M or a high frequency of unscheduled repairs, that suggest that the protectiveness of the remedy may be compromised in the future. No issues were Identified.____
D.	**Opportunities for Optimization**
	Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy.

☑

Five-Year Review Site Inspection Checklist

I. SITE INFORMATION	
Site name: Beale AFB LUFT Sites: TU002, ST022, TU509	**Date of inspection: 15-16 February 2017**
Location and Region: Beale AFB, CA	**EPA ID: NA**
Agency, office, or company leading the five-year review: AECOM	**Weather/temperature: Cool/45-60° F**
Remedy Includes: (Check all that apply) ☐ Landfill cover/containment ☑ Monitored natural attenuation ☑ Access controls ☐ Groundwater containment ☑ Institutional controls ☐ Vertical barrier walls ☑ Groundwater pump and treatment (TU002) ☐ Surface water collection and treatment ☐ Other____________________	
Attachments: ☑ Inspection Photograph Log attached ☑ Site map attached	
II. INTERVIEWS (Check all that apply)	
1. **O&M site manager** ____ Raeann Rainwater _____ Project Manager___ _15 February 2017_ Name Title Date Interviewed: ☑ **at site** ☐ at office ☐ by phone Phone no. 916.286.0257_______________ Problems, suggestions; ☐ Report attached ____________________	
2. **O&M staff** ___Kevin Roberts_______________ __Field Supervisor_________ ___15 February 27_________ Name Title Date Interviewed ☑ at site ☐ at office ☐ by phone Problems, suggestions; ☐ Report attached ____________________	

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

Agency _ California Department of Toxic Substances Control __________________
Contact ___ Dominique Forrester ___ Remedial Program Manager 916-255-3609_
Name Title Phone no.
Problems; suggestions; ☑ Report attached ________________________________

Agency __ California Regional Water Quality Control Board ___________________________
Contact ___ Mark Clardy ___ Remedial Program Manager 916-464-4719_____________
Name Title Date Phone no.
Problems; suggestions; ☑ Report attached ________________________________

Agency ______________________________
Contact ______________________________ ___________________ _________ _____________
Name Title Date Phone no.
Problems; suggestions; ☐ Report attached ________________________________

Agency ______________________________
Contact ______________________________ ___________________ _________ _____________
Name Title Date Phone no.
Problems; suggestions; ☐ Report attached ________________________________

4. **Other interviews** (optional) ☑ Reports attached.

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

V. ACCESS AND INSTITUTIONAL CONTROLS ☑ Applicable □ N/A
A. Fencing
1. **Fencing damaged** □ Location shown on site map □ Gates secured ☑ N/A Remarks______________________________
B. Other Access Restrictions
1. **Signs and other security measures** □ Location shown on site map ☑ N/A Remarks______________________________

C. Institutional Controls (ICs)

1. **Implementation and enforcement**
Site conditions imply ICs not properly implemented ☐ Yes ☑ No ☐ N/A
Site conditions imply ICs not being fully enforced ☐ Yes ☑ No ☐ N/A

Type of monitoring (*e.g.*, self-reporting, drive by) ___Contractor Site Visits_______________________
Frequency __Varies____
Responsible party/agency ____
Contact ______________________________ ___________________ _________ _____________
Name Title Date Phone no.

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

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

2. **Adequacy** ☑ ICs are adequate ☐ ICs are inadequate ☐ N/A
Remarks____

D. General

1. **Vandalism/trespassing** ☐ Location shown on site map ☑ No vandalism evident
Remarks____

2. **Land use changes on site** ☑ N/A
Remarks____

3. **Land use changes off site** ☑ N/A
Remarks____

VI. GENERAL SITE CONDITIONS

A. Roads ☑ Applicable ☐ N/A

1. **Roads damaged** ☐ Location shown on site map ☑ Roads adequate ☐ N/A
Remarks____

B. Other Site Conditions

Remarks ____
____
____
____
____
____

VII. LANDFILL COVERS ☐ Applicable ☑ N/A

A. Landfill Surface

1. **Settlement** (Low spots) ☐ Location shown on site map ☐ Settlement not evident
Areal extent_______________ Depth____________
Remarks____
____

2. **Cracks** ☐ Location shown on site map ☐ Cracking not evident
Lengths____________ Widths___________ Depths__________
Remarks____
____

3. **Erosion** ☐ Location shown on site map ☐ Erosion not evident
Areal extent_______________ Depth____________
Remarks____
____

4. **Holes** ☐ Location shown on site map ☐ Holes not evident
Areal extent_______________ Depth____________
Remarks____
____

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

6. **Alternative Cover (armored rock, concrete, etc.)** ☐ N/A
Remarks____
____

7. **Bulges** ☐ Location shown on site map ☐ Bulges not evident
Areal extent_______________ Height____________
Remarks____
____

8.	**Wet Areas/Water Damage**	☑ Wet areas/water damage not evident		
	☐ Wet areas	☐ Location shown on site map	Areal extent______________	
	☐ Ponding	☐ Location shown on site map	Areal extent______________	
	☐ Seeps	☐ Location shown on site map	Areal extent______________	
	☐ Soft subgrade	☐ Location shown on site map	Areal extent______________	
	Remarks______________________________			
9.	**Slope Instability**	☐ Slides	☐ Location shown on site map	☑ No evidence of slope instability
	Areal extent______________			
	Remarks______________________________			
B. Benches		☐ Applicable	☑ N/A	
	(Horizontally constructed mounds of earth placed across a steep landfill side slope to interrupt the slope in order to slow down the velocity of surface runoff and intercept and convey the runoff to a lined channel.)			
1.	**Flows Bypass Bench**	☐ Location shown on site map	☐ N/A or okay	
	Remarks______________________________			
2.	**Bench Breached**	☐ Location shown on site map	☐ N/A or okay	
	Remarks______________________________			
3.	**Bench Overtopped**	☐ Location shown on site map	☐ N/A or okay	
	Remarks______________________________			
C. Letdown Channels		☐ Applicable	☑ N/A	
	(Channel lined with erosion control mats, riprap, grout bags, or gabions that descend down the steep side slope of the cover and will allow the runoff water collected by the benches to move off of the landfill cover without creating erosion gullies.)			
1.	**Settlement**	☐ Location shown on site map	☐ No evidence of settlement	
	Areal extent______________	Depth____________		
	Remarks______________________________			
2.	**Material Degradation**	☐ Location shown on site map	☐ No evidence of degradation	
	Material type_______________	Areal extent_____________		
	Remarks______________________________			
3.	**Erosion**	☐ Location shown on site map	☐ No evidence of erosion	
	Areal extent______________	Depth____________		
	Remarks______________________________			

4. **Undercutting** ☐ Location shown on site map ☐ No evidence of undercutting
Areal extent______________ Depth____________
Remarks____
____

5. **Obstructions** Type_____________________ ☐ No obstructions
☐ Location shown on site map Areal extent______________
Size____________
Remarks____
____

6. **Excessive Vegetative Growth** Type____________________
☐ No evidence of excessive growth
☐ Vegetation in channels does not obstruct flow
☐ Location shown on site map Areal extent______________
Remarks____
____

D. Cover Penetrations ☐ Applicable ☑ N/A

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

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

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

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

5. **Settlement Monuments** ☐ Located ☐ Routinely surveyed ☐ N/A
Remarks____
____

E. Gas Collection and Treatment ☐ Applicable ☑ N/A	
1.	**Gas Treatment Facilities** ☐ Flaring ☐ Thermal destruction ☐ Collection for reuse ☐ Good condition ☐ Needs Maintenance Remarks____ ____
2.	**Gas Collection Wells, Manifolds and Piping** ☐ Good condition ☐ Needs Maintenance Remarks____ ____
3.	**Gas Monitoring Facilities** (*e.g.*, gas monitoring of adjacent homes or buildings) ☐ Good condition ☐ Needs Maintenance ☐ N/A Remarks____ ____
F. Cover Drainage Layer ☐ Applicable ☑ N/A	
1.	**Outlet Pipes Inspected** ☐ Functioning ☐ N/A Remarks____ ____
2.	**Outlet Rock Inspected** ☐ Functioning ☐ N/A Remarks____ ____

H. Retaining Walls	□ Applicable ☑ N/A	
1.	**Deformations** □ Location shown on site map □ Deformation not evident Horizontal displacement_____________ Vertical displacement________________ Rotational displacement_____________ Remarks____ ____	
2.	**Degradation** □ Location shown on site map □ Degradation not evident Remarks____ ____	
I. Perimeter Ditches/Off-Site Discharge	□ Applicable ☑ N/A	
1.	**Siltation** □ Location shown on site map □ Siltation not evident Areal extent_______________ Depth_____________ Remarks____ ____	
2.	**Vegetative Growth** □ Location shown on site map □ N/A □ Vegetation does not impede flow Areal extent_______________ Type_____________ Remarks____ ____	
3.	**Erosion** □ Location shown on site map □ Erosion not evident Areal extent_______________ Depth_____________ Remarks____ ____	
4.	**Discharge Structure** □ Functioning □ N/A Remarks____ ____	
VIII. VERTICAL BARRIER WALLS	□ Applicable ☑ N/A	
1.	**Settlement** □ Location shown on site map □ Settlement not evident Areal extent_______________ Depth_____________ Remarks____ ____	
2.	**Performance Monitoring** Type of monitoring___________________________ □ Performance not monitored Frequency_________________________________ □ Evidence of breaching Head differential___________________________ Remarks____ ____	

IX. GROUNDWATER/SURFACE WATER REMEDIES ☑ Applicable □ N/A
A. Groundwater Extraction Wells, Pumps, and Pipelines ☑ Applicable (TU002) □ N/A
1. **Pumps, Wellhead Plumbing, and Electrical** ☑ Good condition □ All required wells properly operating □ Needs Maintenance □ N/A Remarks________________________________
2. **Extraction System Pipelines, Valves, Valve Boxes, and Other Appurtenances** ☑ Good condition □ Needs Maintenance Remarks________________________________
3. **Spare Parts and Equipment** □ Readily available ☑ Good condition □ Requires upgrade □ Needs to be provided Remarks________________________________
B. Surface Water Collection Structures, Pumps, and Pipelines □ Applicable ☑ N/A
1. **Collection Structures, Pumps, and Electrical** □ Good condition□ Needs Maintenance Remarks________________________________
2. **Surface Water Collection System Pipelines, Valves, Valve Boxes, and Other Appurtenances** □ Good condition□ Needs Maintenance Remarks________________________________
3. **Spare Parts and Equipment** □ Readily available □ Good condition□ Requires upgrade □ Needs to be provided Remarks________________________________

C. Treatment System	☑ Applicable (TU002) ☐ N/A
2.	**Electrical Enclosures and Panels** (properly rated and functional) ☐ N/A ☐ Good condition ☐ Needs Maintenance Remarks_______________
3.	**Tanks, Vaults, Storage Vessels** ☐ N/A ☑ Good condition ☐ Proper secondary containment ☐ Needs Maintenance Remarks_______________
4.	**Discharge Structure and Appurtenances** ☐ N/A ☑ Good condition ☐ Needs Maintenance Remarks_______________
5.	**Treatment Building(s)** ☐ N/A ☑ Good condition (esp. roof and doorways) ☐ Needs repair ☐ Chemicals and equipment properly stored Remarks_______________
6.	**Monitoring Wells** (pump and treatment remedy) ☑ Properly secured/locked ☐ Functioning ☑ Routinely sampled ☑ Good condition ☐ All required wells located ☐ Needs Maintenance ☐ N/A Remarks_______________
D. Monitoring Data	
1.	Monitoring Data ☑ Is routinely submitted on time ☑ Is of acceptable quality
2.	Monitoring data suggests: ☑ Groundwater plume is effectively contained ☐ Contaminant concentrations are declining

D. Monitored Natural Attenuation

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

X. OTHER REMEDIES

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

XI. OVERALL OBSERVATIONS

A. Implementation of the Remedy

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

Please see Report.

B. Adequacy of O&M

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

C.	**Early Indicators of Potential Remedy Problems**
	Describe issues and observations such as unexpected changes in the cost or scope of O&M or a high frequency of unscheduled repairs, that suggest that the protectiveness of the remedy may be compromised in the future. No issues were Identified.____
D.	**Opportunities for Optimization**
	Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy.

Appendix C Site Photographs

Photo 1 – PL582 Former UST Area

Photo 2 – PL582 Monitoring Wells 6A/6B

Photo 3 – PL582 Antenna Area

Photo 4 – LF003 Landfill Cap and Passive Venting (to Southeast)

Photo 5 – LF003 Landfill Cap and Passive Venting (to South)

Photo 6 – LF003 Landfill Cap (to North)

Photo 7 – LF002 Landfill Cap (to West)

Photo 8 – LF003 Landfill Cap and Well on East Side

Photo 9 – LF002 Landfill Cap with Passive Vent

Photo 10 – LF002 West Side of Landfill Cap

Photo 11 – LF002 Landfill Cap (to South)

Photo 12 – LF002 Landfill Cap (to Southeast)

Photo 13 – LF002 Landfill Cap (to East)

Photo 14 – LF002 Landfill Cap East Side

Photo 15 – LF002 Landfill Cap East Side Erosion Control

Photo 16 – LF002 Landfill Cap East Side Erosion Control

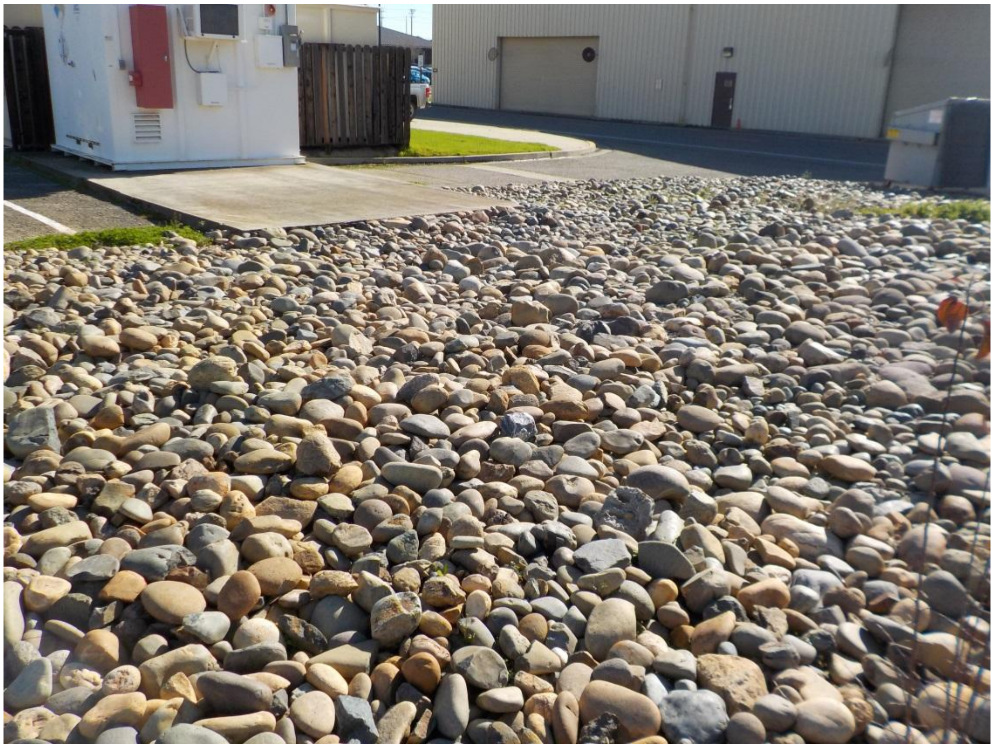


Photo 17 – SD032 Former SVE Area

Photo 18 – SD011 Planned Soil Removal Area

Photo 19 – Former UST Area

Photo 20 – SS035 SVE System Manifold (in Rebound)

Photo 21 – SS035 SVE Conveyance Pipe to SVE Wells

Photo 22 – SS035 Buildings and SVE Area

Photo 23 - WP016 Former Explosive Ordnance Disposal Area

Photo 24 – WP016 Entrance Sign

Photo 25 – CG517 Treatment Area

Photo 26 – TU509 Former UST and Treatment Area

Photo 27 – TU509 Treatment Area

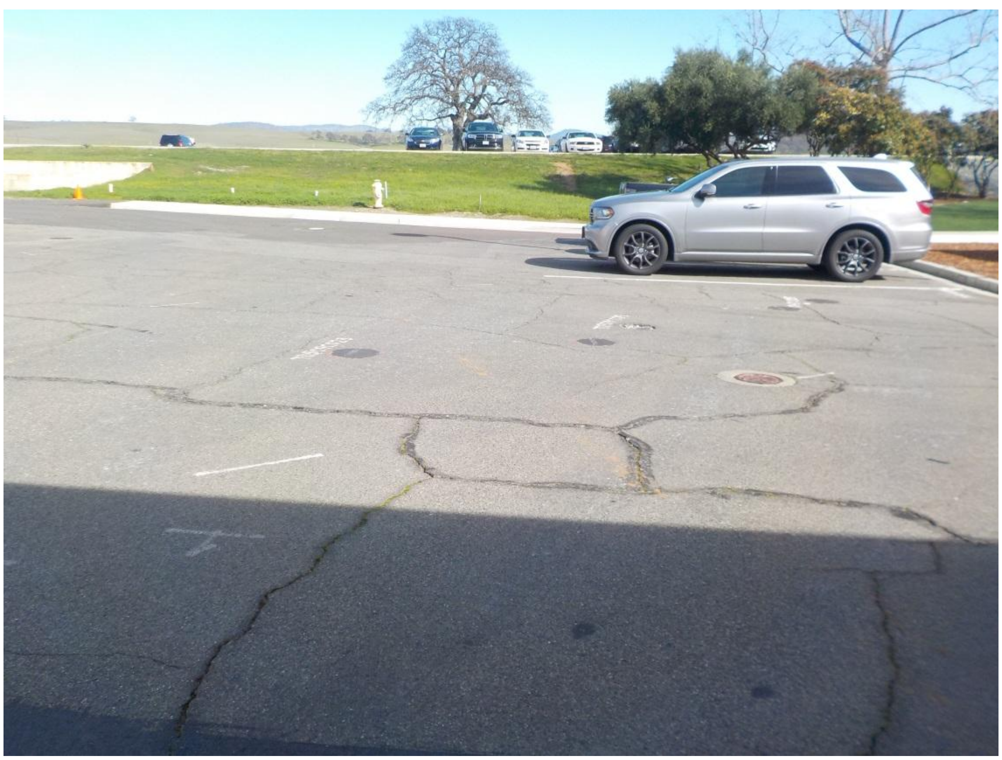


Photo 28 – TU509 Treatment Area

Photo 29 – TU002 Granular Activated Carbon Vessels

Photo 30 – TU002 Groundwater Extraction System Control Panel and Manifold

Photo 31 – TU002 System Security Enclosure

Photo 32 – TU002 Monitoring Well on Bike Path

Photo 33 – TU002 Treatment Area

Photo 34 – FT029 Former SVE Treatment Area

Photo 35 – FT029 Former SVE System Location

Photo 36 – SS039 Former SVE Treatment Area

Photo 37 – SS039 Former SVE System Security Enclosure

Photo 38 – DP019 Location of Former Emergency Holding Basin (to West)

Photo 39 – DP019 Location of Former Emergency Holding Basin (to Southwest)

Photo 40 – CG041-40 Groundwater Treatment Area

Photo 41 – CG041-31 Remnants of Former Groundwater Treatment System

Photo 42 – CG041-31 Groundwater Treatment Area

Photo 43 – CG041-018 Groundwater Treatment Area

Photo 44 – CG041-018 Groundwater Treatment Area

Photo 45 – CG041-018 Groundwater Monitoring Wells and Recovery Well

Photo 46 – CG041-018 Groundwater Recovery Well

Photo 47 – SS023 Groundwater Treatment Area (to North)

Photo 48 – SS023 Groundwater Treatment Area (to Northwest)

Photo 49 – CG041-017 Groundwater Extraction and Treatment System

Photo 50 – CG041-017 Groundwater Extraction and Treatment System

Photo 51 – OT017 Best Slough

Photo 52 – OT017 Best Slough Vegetation

Photo 53 – CG041-017 Best Slough Slurry Wall Alignment

Photo 54 – CG041-017 Best Slough Planned Slurry Wall Extension Area

Photo 55 – CG041-013 Groundwater Treatment System (Air Strippers)

Photo 56 – CG041-013 Groundwater Treatment System

Photo 57 – LF013 Landfill Cap (to South)

Photo 58 – LF013 Landfill Cap (to West)

Photo 59 – CG041-013/LF013 Groundwater Wells and Remnants of Former SVE System

Photo 60 – CG041-013/LF013 Groundwater Wells and Remnants of Former SVE System

Photo 61 – CG041-013/LF013 Groundwater Wells and Remnants of Former SVE System

Photo 62 – CG041-013 Groundwater Extraction Well Field (to Northwest)

Photo 63 – CG041-013 Groundwater Extraction Well Field (to West)

Photo 64 – CG041-003 Area (to West)

Photo 65 – CG041-003 Former Fire Training Area

Photo 66 – CG041-010 Remnants of Former Groundwater Treatment System

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