



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
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September 27, 2013

Mark H. Smith
Chief, Environmental Restoration Program, 60 CES/CEANR
411 Airmen Drive, Building 570
Travis AFB, CA 94535-2001

Re: EPA Approval of *Travis Air Force Base Final Third Five-Year Review Report for NEWIOU and WABOU Groundwater Interim Remedial actions, NEWIOU Soil and Sediment Remedial Actions, WABOU Soil Remedial Actions*

Dear Mr. Smith:

We have received the *Final Third Five-Year Review Report* for Travis Air Force Base (AFB), California, dated September 25, 2013 (FYR Report). The Third FYR Report provides the description and evaluation of the protectiveness of the remedial actions implemented at the following Operable Units (OUs) for Travis AFB, summarized as follows:

1. OU 1: North/East/West Industrial Operable Unit (NEWIOU) Groundwater Interim Record of Decision (ROD) dated December 3, 1997: *Protective in the Short-term*
2. OU 2: NEWIOU Soil, Sediment, and Surface Water ROD dated April 24, 2006: *Protective*
3. OU 3: West/Annexes/Basewide Operable Unit (WABOU) Groundwater Interim ROD dated March 16, 1999: *Protective in the Short-term*.
4. OU 4: WABOU Soil ROD dated December 11, 2002: *Protective*.

EPA concurs with the findings, recommendations, and protectiveness statements of the Third FYR. EPA appreciates that Travis AFB has already initiated actions to address the long-term protectiveness issues for the NEWIOU and WABOU Groundwater interim remedial actions, such as developing a Work Plan for addressing capture issues at NEWIOU Site LF007C, and working with the regulatory agencies to develop a Groundwater Sites Record of Decision to supercede the Interim Groundwater RODs. If you have any questions, do not hesitate to contact Nadia Hollan Burke (415-972-3187).

Sincerely,

Michael M. Montgomery
Associate Director
Federal Facilities & Site Cleanup Branch

cc: Adriana Constantinescu/RWQCB
Jose Salcedo/DTSC

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Travis Air Force Base

Final
Third Five Year Review Report
for
NEWIOU and WABOU Groundwater Interim Remedial Actions
NEWIOU Soil and Sediment Remedial Actions
WABOU Soil Remedial Actions

Contract No. W9128F-11-D-0014
Task Order 0003

Prepared For:



U.S. Army Corps of Engineers
Omaha District



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Travis Air Force Base, California

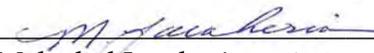
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September 25, 2013

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Executive Summary

The U.S. Air Force, with public and regulatory acceptance, is carrying out groundwater interim remedial actions (IRAs) and soil/sediment remedial actions (RAs) at multiple contaminated sites at Travis Air Force Base (Travis AFB), California. This *Third Five-Year Review Report* provides descriptions and evaluations of these actions and discusses whether they are protective of human health and the environment and whether they are functioning as designed.

Background

This *Third Five-Year Review Report* is required by statute and is prepared in accordance with the U.S. Environmental Protection Agency (EPA) *Comprehensive Five-Year Review Guidance* and supplementals (EPA, 2001, 2012). This report covers the period of August 2008 through February 2013, with evaluation of data collected through February 2013.

Travis AFB is the lead agency and responsible party for the groundwater, soil, and sediment remediation efforts being evaluated in this five-year review. EPA, San Francisco Bay Regional Water Quality Control Board (Water Board), and Department of Toxic Substances Control (DTSC) provide regulatory agency oversight.

Ongoing groundwater IRAs are being conducted in accordance with the final Groundwater Interim Record of Decision (IROD) for the North/East/West Industrial Operable Unit (NEWIOU), designated by EPA as OU 1, and the final Groundwater IROD for the West/Annexes/Basewide Operable Unit (WABOU), designated by EPA as OU 3.

The groundwater IRAs were designed and constructed to quickly begin remediation of groundwater contamination, reduce the levels of contamination and potential risk, and collect data necessary for the selection of final cleanup levels and technically and economically feasible long-term actions.

The use of IRODs allowed actions to proceed without having final designated cleanup levels, as will be required for the pending Travis AFB Groundwater Record of Decision (ROD). The interim actions taken under the IRODs use interim remediation goals (IRGs) as performance objectives. These are not legally enforceable standards, but are simply goals during the period of interim groundwater remediation.

All soil RAs in the WABOU are completed in accordance with final Soil Record of Decision for the WABOU, designated by EPA as OU 4. Similarly, within the NEWIOU, all soil RAs are completed in accordance with the final NEWIOU Soil, Sediment, and Surface Water ROD, designated by EPA as OU 2. The two RODs specify soil and sediment cleanup levels that are protective of human health and the environment.

Groundwater and Soil and/or Sediment Contamination

As a result of past waste management and disposal practices, groundwater and soil and/or sediment at Travis AFB have been impacted by chemical contamination at multiple locations. These locations are shown on Figures ES-1 and ES-2.

The primary groundwater contaminants exceeding the IRGs established by the NEWIOU and WABOU groundwater IRODs include chlorinated volatile organic compounds (CVOCs),

primarily trichloroethene (TCE) and related compounds. Petroleum-fuel constituents, organochlorine pesticides, and other contaminants are also present at some sites.

Contamination in soil/sediment that required remediation to protect human health and the environment primarily included semivolatile organic compounds (SVOCs), polychlorinated biphenyls (PCBs), and organochlorine pesticides.

Groundwater Interim Remedial Actions

Travis AFB is currently conducting groundwater IRAs at multiple sites to address the groundwater contamination. The groundwater IRAs have been designed and optimized to achieve the following interim objectives:

- **Source Control** – hydraulically contain and remove contaminant mass from the groundwater and vadose zone using groundwater extraction and treatment (GET) and vapor extraction and treatment in areas where groundwater volatile organic compound (VOC) concentrations are relatively high.
- **Migration Control** – hydraulically contain contamination using a GET system and/or contain contamination using natural physical, chemical, and/or biological processes through monitored natural attenuation (MNA). Site LF006 is the only site at which MNA was selected as all, or part, of the groundwater IRA in the applicable IROD. At all sites, the viability of MNA as all, or part, of the final groundwater remedy was assessed during the period of interim remediation. The formal selection of MNA as all, or part, of the final groundwater RA at a site will be made in the pending Travis AFB Groundwater ROD.
- **Off Base Remediation** – hydraulically contain and reduce contaminant concentrations in off base plumes to the contaminant-specific interim remediation goal (IRG) using a GET system.

For the most part, the groundwater IRAs have operated successfully. After more than a decade of interim remediation, the residual contaminant concentrations at most of the Environmental Restoration Program (ERP) sites are much lower than the initial values, but are still high enough to require continued and, in most cases, more effective cleanup actions. This prompted Travis AFB to consider more aggressive groundwater cleanup strategies, including those targeting areas of high residual contaminant concentrations. As a result, remedial process optimizations (RPOs) were performed at several ERP sites. RPOs consisted of bioreactors, emulsified vegetable oil (EVO) to enhance in-situ bioremediation, and modified GET systems (including taking extraction wells off-line and/or installing new extraction wells). Combined, these technologies have been implemented for source control and migration control.

IRAs as currently optimized are reducing the size of the contaminated areas in groundwater and reducing the contaminant levels. Travis AFB is now transitioning out of interim remediation and starting the process to select and implement final remedial actions at each site based on optimization studies. The Proposed Plan for Groundwater Cleanup was finalized October 2012; the next step is execution of a Travis AFB Groundwater ROD, which is currently under regulatory review and revision. The final Travis AFB Groundwater ROD is expected to be signed in 2013.

Table ES-1 provides a summary of the groundwater IRA objectives (IRAOs) at each contaminated site along with a summary of remedial action performance.

TABLE ES-1
 Summary of Groundwater Interim Remedial Action Performance
 Third Five-Year Review Report, Travis AFB, California

IRA	Site	IRA and RPO (if applicable)	IRA Objective ^a					Performance Assessment Criteria			Performance Assessment Summary
			Source Control	Migration Control	Off-Base Remediation	MNA	MNA Assessment	Question A – Functioning as Intended by IROD?	Question B – Remedy Assumptions Still Valid?	Question C – New Information Regarding Protectiveness?	
North IRA	FT004	GET	√				√ ^b	Yes	Yes	No	The combination of GET in the areas with the highest residual concentrations and MNA in the downgradient areas has been effective. VOC concentrations at Site SD031 have declined below the target concentration (100 micrograms per liter [µg/L]). With the exception of a small area, VOC concentrations at Site FT004 have also declined below the target concentrations. Consequently, the GET system at both sites has been shut down for a rebound study. The rebound study will be continued over the interim period leading up to the Travis AFB Groundwater ROD. No rebound was observed over the 2010-2011 reporting period. MNA appears to be a viable remedy for the residual groundwater contamination at Sites SD031 and FT004.
	SD031	MNA Assessment in Distal Area	√				√ ^b	Yes	Yes	No	
	LF006	MNA					√	Yes	Yes	No	
	LF007B	MNA Assessment					√	Yes	Yes	No	
	LF007C	GET		√	√		_c	No	Yes	No	
	LF007D	MNA Assessment					√	Yes	Yes	No	
South IRA	SS030	GET	√	√	√			Yes	Yes	No	The source control, migration control, and off-base remediation objectives of the Site SS030 IRAs have largely been achieved. Contaminant concentrations are declining in all of the extraction wells and all but two of the monitoring wells. Investigation into the extent of contamination in the eastern portion of the plume was performed in 2009-2010. The extent of capture of the Site SS030 GET has been improved by bringing all of the extraction wells on-line and reducing groundwater extraction at adjacent Site FT005 GET, which had been influencing groundwater flow directions at Site SS030. The 2Q11 groundwater elevation contours indicate that the eastern portion of the plume is within the extent of hydraulic capture. However, continued monitoring of the easternmost monitoring wells will be needed to verify the capture extent. TCE concentrations in the easternmost well pair MW2001A/Bx30 declined slightly over the reporting period. It is expected that TCE concentrations will continue to decline at this well pair if plume capture is achieved.
	SS029	GET		√				Yes	Yes	No	The migration control objective has been achieved. The Site SS029 GET system has achieved hydraulic capture of the plume and is preventing off-base migration of the contaminant plume.
	FT005	GET		√	√			Yes	Yes	No	The migration control and off-base remediation objectives at Site FT005 have largely been achieved. A large portion of the Site FT005 plume has been remediated to non-detect. Consequently, the Site FT005 GET was shut down for a rebound study, which will continue through the interim period leading up to the Travis AFB Groundwater ROD. However, groundwater extraction continues in areas of Site FT005 where COC concentrations continue to exceed the IRGs.

TABLE ES-1
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IRA	Site	IRA and RPO (if applicable)	IRA Objective ^a					Performance Assessment Criteria			Performance Assessment Summary	
			Source Control	Migration Control	Off-Base Remediation	MNA	MNA Assessment	Question A – Functioning as Intended by IROD?	Question B – Remedy Assumptions Still Valid?	Question C – New Information Regarding Protectiveness?		
Central IRA	Northern SS016	GET Bioreactor ^d	√					Yes	Yes	No	<p>Hydraulic capture of the Site SS016 Tower Area Removal Action (TARA) area has been achieved, and VOC concentrations have declined below the target concentration (1,000 µg/L). Oil Spill Area (OSA) remediation has been hampered by the continued low yield from groundwater extraction wells. Therefore, in September 2010, the groundwater treatment was enhanced by installation of a bioreactor. During installation of the bioreactor, most of the contaminant mass was removed. The residual contamination will be treated in situ through enhanced biodegradation. The first two quarters of performance data indicate that the bioreactor is performing as designed: the bioreactor is removing over 99 percent of the TCE and nearly 93 percent of the total molar CVOCs entering the bioreactor.</p> <p>The portion of the commingled Site SS016 plume (OSA/TARA) that is not addressed by the bioreactor and is not hydraulically captured by the Source Control GET actions is ultimately hydraulically captured by the downgradient Site SS029 Migration Control GET system.</p>	
	ST027B			√			√	Yes*	Yes	No	<p>Site ST027 has historically been managed as part of the petroleum-only contaminated (POCO) program at Travis AFB because petroleum hydrocarbons were believed to be the only contaminants present at this site. However, an investigation conducted in 2007 resulted in the discovery of TCE and several other CVOCs in groundwater in the southwestern part of the site. This area of the site impacted by CVOCs has been designated as Site ST027B.</p> <p>MNA has been selected as the final remedy for the remaining fuels contamination, which is located in the eastern part of Site ST027 (designated as ST027A). MNA is an effective remedy for the fuel hydrocarbons at Site ST027A, as indicated by the stable or decreasing BTEX and TPH concentrations observed at the site through 2011.</p> <p>*A remedy has not been established for the CVOC plume in Site ST027B. The Final Technical Memorandum Site ST027-Area B Characterization Results (CH2M HILL, 2010) presented a preliminary evaluation of the effectiveness of natural attenuation for addressing the CVOC plume. MNA assessment continues over the interim period leading up to the Travis AFB Groundwater ROD. Data collected to date indicate that MNA is a suitable remedy to address the Site ST027B plume. The plume has not migrated over the reporting period.</p>	
West IRA	SS014 ^f	GET	√	√			√ ^b	Yes	Yes	No	<p>The combination of GET within individual plumes and MNA in the downgradient areas has been effective; however, VOC concentrations continued to exceed 1,000 µg/L in two small areas of the West Industrial Operable Unit (WIOU) plume. As an RPO, these areas of high residual contaminant concentrations (Sites SD036 and SD037) underwent EVO injection in 4Q10. To support the RPO, the WIOU GET has been shut down for a rebound study for the remainder of the interim period.</p> <p>The quarterly RPO performance monitoring indicates that the 2010 EVO injections in both the Site SD036 and Site SD037 areas have resulted in enhanced reductive dechlorination (ERD). TCE concentrations have decreased significantly (one to two orders of magnitude) in target wells. Cis-1,2-dichloroethene (cis-1,2-DCE) concentrations have increased in the treatment zone. Vinyl chloride is also being formed within the treatment zone. The presence of ethane and ethene within the treatment zone indicates that complete dechlorination of the cis-1,2-DCE and vinyl chloride is occurring. Consistent detections of vinyl chloride concentrations exceeding the IRG (0.5 µg/L) are restricted to the EVO injection areas; vinyl chloride is not migrating away from the EVO injection areas. Monitoring data collected to date indicate that the EVO injections are performing as designed.</p> <p>Outside the two EVO injection areas, the WIOU plume is being monitored for rebound. TCE and other COC concentrations continued to decline or were stable in most of the extraction wells, plume wells, and downgradient monitoring wells sampled over the reporting period. No rebound was evident in the plume, although by 2Q11, the GET system had been shut down for 1 year. The stable and decreasing COC concentration trends indicate that the attenuation capacity of the aquifer exceeds the mass loading from residual contamination within Sites SD036 and SD037. No VOCs were detected at concentrations exceeding IRGs in the downgradient wells during the reporting period. The data collected to date indicate that MNA is a viable remedy for the distal portion of the WIOU plume.</p>	
	SD033 ^g	MNA Assessment in Distal Area		√			√	Yes	Yes	No		
	SD034 ^h	EVO Injection ^d	√	√				Yes	Yes	No		
	SS035 ⁱ				√ ^b			..e	Yes	Yes		No
	SD036 ^j		√	√				..e	Yes	Yes		No
	SD037 ^k		√	√				√	Yes	Yes		No
	SS041 ^l				√				Yes	Yes		No
SD043 ^m				√				Yes	Yes	No		

TABLE ES-1
 Summary of Groundwater Interim Remedial Action Performance
 Third Five-Year Review Report, Travis AFB, California

IRA	Site	IRA and RPO (if applicable)	IRA Objective ^a					Performance Assessment Criteria			Performance Assessment Summary
			Source Control	Migration Control	Off-Base Remediation	MNA	MNA Assessment	Question A – Functioning as Intended by IROD?	Question B – Remedy Assumptions Still Valid?	Question C – New Information Regarding Protectiveness?	
	SS015	EVO Injection ^d					√	Yes	Yes	No	<p>A vegetable oil injection treatability study was performed at this site in 2000-2001. Elevated concentrations of breakdown products (cis-1,2-DCE and vinyl chloride) relative to the concentration of parent compounds (tetrachloroethene [PCE] and TCE) confirmed that the vegetable oil injection (2000-2001) enhanced biodegradation. However, TCE and PCE concentrations began to rebound in 2007, indicating that insufficient vegetable oil remained to complete the degradation process. An RPO involving EVO injection with high residual contaminant concentrations was performed in 4Q10.</p> <p>The EVO injection has resulted in a significant decline (one to two orders of magnitude) in CVOC concentrations. TCE, cis-1,2-DCE, and vinyl chloride concentrations have all declined. The decline in vinyl chloride concentrations and the detections of ethane and ethene indicate that vinyl chloride is being completely destroyed. Along with CVOC concentration trends, elevated total organic carbon (TOC) concentrations and geochemical parameters all support the conclusion that ERD is occurring in the EVO injection area. Monitoring data collected to date indicate that the EVO injection is performing as designed. Enhanced attenuation appears to be a viable remedy for Site SS015.</p>
	DP039	GET Testing of MNA Component of Alternative in Distal Area Bioreactor ^d Phytoremediation ^d EVO Permeable Reactive Biobarrier (PRB) ^d	√			√		Yes	Yes	No	<p>The dual-phase extraction (DPE) wells of the original GET system effectively removed a large amount of mass from the former acid neutralization sump area; however, high residual TCE concentrations remained. In 2008, a bioreactor was installed at Site DP039 as an AFCEE technical demonstration project. Through 2Q11, TCE reductions of more than 99 percent and total molar reductions of more than 95 percent have occurred in the aquifer within 30 feet of the bioreactor.</p> <p>In the downgradient portion of the plume, increasing TCE trends in some plume and downgradient monitoring wells indicated that MNA alone may not be an effective remedy for the distal portion of the plume. Consequently, the Air Force implemented enhanced natural attenuation by installing an EVO PRB in the middle of the plume in 2Q10. Performance monitoring data are showing significant (one to three orders of magnitude) reduction in TCE concentrations, minor cis-1,2-DCE accumulation, and no vinyl chloride accumulation along the EVO PRB. Monitoring data collected to date indicate that the EVO PRB is performing as designed.</p> <p>Ongoing monitoring is needed to verify whether mass reduction provided by the EVO PRB is sufficient to stabilize the distal portion of the plume.</p>
	LF008	GET		√				Yes	Yes	No	<p>While the GET IRAO has been achieved (the plume has not migrated), the GET has had minimal impact on the remaining low-level pesticide concentrations at Site LF008, based on stable long-term pesticide concentration trends and the unchanging extent of groundwater contamination over time. This is likely due to the strong adsorption of alpha-chlordane and other pesticides to natural organic carbon or fine-grained soil particles in the subsurface and the low permeability of the saturated sediments.</p> <p>In December 2008, the three Site LF008 groundwater extraction wells were shut down to perform a rebound study. No rebound in COC concentrations was evident over the 2010-2011 reporting period. In fact, the extent of the alpha-chlordane plume has decreased in size since the GET system was taken off-line.</p>

^a IRA objective specified in the Groundwater NEWIOU and WABOU IRODs.
^b IRA not specified in the Groundwater IROD for the NEWIOU, but implemented by the Air Force to address entirety of commingled plume.
^c Assessment of MNA not implemented because of interactions with the LF007C GET system.
^d Remedial Process Optimization (RPO)
^e Assessment of MNA not implemented because plume is hydraulically captured by adjacent GET system.
^f POCO Site SS014 comprises five noncontiguous sites, including Sites 1, 2, 3, 4, and 5. Only Site 1 has a source control objective (floating jet fuel).
^g ERP Site SD033 comprises five (5) noncontiguous sites: Facility 810, Facility 1917, Storm Sewer System II, the South Gate area, and the West Branch of Union Creek.
^h ERP Site SD034 is associated with Facility 811.
ⁱ ERP Site SS035 is associated with Facilities 818 and 819.
^j ERP Site SD036 is associated with Facilities 872, 873, and 876.
^k ERP Site SD037 is associated with the Sanitary Sewer System; Facilities 837, 838, 919, 977, 981; the Area G Ramp; and the Ragsdale/V Street area.
^l ERP Site SS041 is associated with Facility 905.
^m ERP Site SD043 is associated with Facility 916.

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Soil/Sediment Remedial Actions

Travis AFB has conducted RAs at multiple sites with historical soil/sediment contamination. A summary of the NEWIOU and WABOU soil/sediment sites and the associated RA objectives is provided in Tables ES-2 and ES-3. An RA is complete upon submittal of a remedial action report (RAR). In this five- year review, a soil ERP site is documented as closed on the date of the Final RAR. The locations of the sites are shown on Figure ES-2. The soil RAs were designed to achieve the following objectives:

- **Excavation/On-Base Consolidation** – remove contaminated soil through excavation to industrial cleanup levels. Excavated soil is placed in an on-base Corrective Action Management Unit (CAMU).
- **Land Use and Access Restrictions** – restrict site access and land use activities to prevent worker exposure.

The basic objective of the soil RAs was to remove contaminated soil down to levels protective of on-base workers and/or to restrict residential development and the unauthorized disturbance or relocation of soil. However, if excavation/on-base consolidation reduced residual contaminant concentrations to those that allow for unlimited use and unrestricted exposure, then land use controls (LUCs) would not be required. If excavation only reduced contaminant concentrations to industrial cleanup levels, then LUCs would be implemented to restrict site access and usage. At several sites, LUCs are the only remedy.

TABLE ES-2

Summary of NEWIOU Sites Soil and Sediment Remedial Actions
Third Five-Year Review Report, Travis AFB, California

ERP Site	Objective ^a	Implemented RA	Land Use Controls Status	Performance Summary
SD001	Remove sediment contaminants to industrial cleanup levels.	Excavation and LUCs	No LUC required.	RA completed in 2010. Residential cleanup levels achieved. Site closed on 12 July 2010.
FT003	Remove soil contaminants to industrial cleanup levels.	Excavation and LUCs	No LUC required.	RA completed in 2007. Residential cleanup levels achieved. Site closed on 29 September 2008.
FT004	Remove soil contaminants to industrial cleanup levels.	Excavation and LUCs	No LUC required.	RA completed in 2007. Residential cleanup levels achieved. Site is response complete for soil as of 29 September 2008.
FT005	Remove soil contaminants to industrial cleanup levels.	Excavation and LUCs	No LUC required.	RA completed in 2011. Residential cleanup levels achieved. Site is response complete for soil as of 28 September 2012.
LF007	Remove soil contaminants to industrial cleanup levels.	Excavation and LUCs	Land use restricted to industrial activities for CAMU portion of LF007.	RA completed in 2007. Base CAMU for consolidation of RA soil. Residential soil cleanup goals reached at LF007E, with no LUCs required. LUC inspection at CAMU portion of LF007 performed on 30 October 2012. No issues found.
SS015	Restrict site access to prohibit residential use. Prevent surface-disturbing activities that could create a risk of human exposure.	LUCs	Land use restricted to industrial activities only.	LUC inspection on 30 October 2012. No issues found.
SS016	Restrict site access to prohibit residential use. Prevent surface-disturbing activities that could create a risk of human exposure.	LUCs	Land use restricted to industrial activities only.	LUC inspection on 30 October 2012. No issues found.
SD033 (soil)	Restrict site access to prohibit residential use. Prevent surface-disturbing activities that could create a risk of human exposure.	LUCs	Land use restricted to industrial activities only.	LUC inspection on 30 October 2012. No issues found.

TABLE ES-2

Summary of NEWIOU Sites Soil and Sediment Remedial Actions
Third Five-Year Review Report, Travis AFB, California

ERP Site	Objective ^a	Implemented RA	Land Use Controls Status	Performance Summary
SD033 (sediment)	Remove contaminated sediment to industrial cleanup levels.	Excavation and LUCs	No LUC required.	RA completed in 2010. Residential cleanup levels achieved. Site is response complete for soil as of 12 July 2010.
SD037	Restrict site access to prohibit residential use. Prevent surface-disturbing activities that could create a risk of human exposure.	LUCs	Land use restricted to industrial activities only.	LUC inspection on 30 October 2012. No issues found.

^aSoil RA objective specified in the final NEWIOU Soil, Sediment, and Surface Water ROD.

TABLE ES-3

Summary of WABOU Sites Soil Remedial Actions
Third Five-Year Review Report, Travis AFB, California

ERP Site	Objective ^a	Implemented RA	LUC Status	Performance Summary
LF008	Remove soil contaminants to residential cleanup levels.	Excavation/Off-base Disposal	No LUC required.	RA complete. Residential cleanup levels achieved by excavation. Site is response complete for soil.
RW013	Remove soil contaminants to residential cleanup levels.	Excavation/Off-base Disposal	No LUC required.	RA complete. Residential cleanup levels achieved by excavation. Site closed on 12 May 2004.
DP039	Restrict site access to prohibit residential use. Prevent surface-disturbing activities that could create a risk of human exposure.	Land Use and Access Restrictions (i.e., LUC)	Land use restricted to industrial activities only.	LUC inspection on 30 October 2012. No issues found.
SS041	Remove soil contaminants to residential cleanup levels.	Excavation/On-base Consolidation	No LUC required.	RA complete. Residential cleanup levels achieved. Site is response complete for soil as of 27 August 2003.
SD042	Remove soil contaminants to residential cleanup levels.	Excavation/On-base Consolidation	No LUC required.	RA complete. Residential cleanup levels achieved. Site closed on 24 June 2005.
SD043	Restrict site access to prohibit residential use. Prevent surface-disturbing activities that could create a risk of human exposure.	Land Use and Access Restrictions (i.e., LUC)	Land use restricted to industrial activities only.	LUC inspection on 30 October 2012. No issues found.
LF044	Restrict site access to prohibit residential use. Prevent surface-disturbing activities that could create a risk of human exposure.	Land Use and Access Restrictions (i.e., LUC)	Land use restricted to industrial activities only.	RA complete. Recent construction of an AST facility which is consistent with LUC provisions. LUC inspection on 30 October 2012. No issues found
SD045	Remove soil contaminants to residential cleanup levels.	Excavation/On-base Consolidation	No LUC required.	RA completed in 2007. Residential cleanup levels achieved. Site closed on 29 September 2008.
SS046	Restrict site access to prohibit residential use. Prevent surface-disturbing activities that could create a risk of human exposure.	Land Use and Access Restrictions	Land use restricted to industrial activities only.	LUC inspection on 30 October 2012. No issues found

^aSoil RA objective specified in the Soil ROD for the WABOU.

Technical Assessment

The primary purpose of this *Third Five-Year Review Report* is to verify that the groundwater IRAs and soil/sediment RAs implemented at Travis AFB are protective of human health and the environment and are functioning as designed.

Groundwater Interim Remedial Actions

Groundwater IRAs are ongoing at multiple NEWIOU and WABOU sites. All groundwater IRAs have been constructed and are successfully operating. The IRAs are largely achieving the objectives specified in the two groundwater IRODs because Travis AFB has implemented RPOs. A performance summary of the groundwater IRAs implemented is provided in Table ES-1.

RPOs have been performed at Sites SS015, SS016, DP039, and the WIOU because IRAOs were either not being achieved or persistent elevated contaminant concentrations indicated that the IRAOs could be achieved more efficiently utilizing other technologies. In 2010, RPOs consisting of EVO injections were performed at Site SS015 and at Sites SD036 and SD037 of the WIOU. In 2010, an RPO consisting of the installation of an in-situ bioreactor was implemented at Site SS016. Several RPOs have been performed at Site DP039, including the installation of an in-situ bioreactor (2008), establishment of a phytoremediation area (1998), and the installation of an EVO permeable reactive barrier (PRB; 2010). Performance monitoring data collected to date indicate that all of the recent RPOs are operating as designed and supporting achievement of IRAOs.

Site LF007C remains the only area of interim groundwater remediation where IRAOs have not been achieved. However, an RPO is planned for Site LF007C in 2013. Data gaps investigations were performed from October 3 through December 30, 2011, to further characterize the horizontal and vertical extent of VOCs in groundwater. The results of the characterization and updated groundwater modeling were used to prepare a plan to optimize the existing GET system. This optimization consists of modifying existing extraction wells to pump at higher rates and/or adding a new extraction well in the southern portion of the site. Implementation of the optimization plan for site LF007C is planned for 2013.

There are sufficient data to support the development of the Travis AFB Groundwater ROD. The Final Proposed Plan for Groundwater Cleanup has undergone a public comment period and has been finalized. The Draft Travis AFB Groundwater ROD, prepared by Travis AFB in cooperation with the EPA, Water Board, and DTSC, is currently under regulatory review and revision. This ROD will stipulate the final groundwater cleanup concentrations and RAs at Travis AFB and is expected to be signed in 2013.

Soil and/or Sediment Remedial Actions

Through 2013, Travis AFB has successfully completed all soil and sediment RAs within the NEWIOU and WABOU. Summaries of the soil and/or sediment RAs' performances are provided in Tables ES-2 and ES-3.

Six NEWIOU and WABOU soil sites are considered closed (no further action) based on this five-year review, while four others are response complete for soils. Site closure was documented because all the following conditions were met:

- the RA met unlimited use and unrestricted use cleanup levels;
- there is regulatory approval of the Final Remedial Action Report (RAR); and
- the cleanup goals identified in the soil RODs are still valid.

Protectiveness Statements

Issues and recommendations from this Five-Year Review are outlined in the Five-Year Review Summary Form provided below. Protectiveness statements for the groundwater IRAs and soil/sediment RAs implemented at sites within the NEWIOU and WABOU are summarized as follows:

- Groundwater IRAs
 - NEWIOU IRAs – The groundwater interim remedies within the NEWIOU currently protect human health and the environment because exposure pathways that could result in unacceptable risks are being controlled. However, in order for the remedies to be protective in the long-term, the following actions need to be taken to ensure protectiveness:
 - For the remedy at Site LF007C to be protective in the long-term, follow-up actions relative to offsite plume capture need to be taken.
 - At sites where groundwater-to-indoor-air and shallow soil gas risk-based concentrations are exceeded, LUCs to ensure long-term protectiveness for the vapor intrusion pathway are needed.
 - WABOU IRAs IRAs – The groundwater interim remedies within the WABOU currently protect human health and the environment because exposure pathways that could result in unacceptable risks are being controlled. However, in order for the remedies to be protective in the long-term, the following actions need to be taken to ensure protectiveness:
 - At sites where groundwater-to-indoor-air and shallow soil gas risk-based concentrations are exceeded, LUCs to ensure long-term protectiveness for the vapor intrusion pathway are needed.
- Soil/Sediment RAs
 - NEWIOU Soil/ Sediment RAs – The remedies at the NEWIOU soil and sediment sites are protective of human health and the environment.
 - All RAs have been completed. RAOs for several sites included establishing LUCs which restrict the site to industrial land uses and prevent surface-disturbing activities. No issues were identified in LUC inspections conducted and LUCs are being successfully tracked and enforced by the Air Force.
 - WABOU Soil RAs – The remedies at the WABOU soil sites are protective of human health and the environment.
 - All RAs have been completed. RAOs for several sites included establishing LUCs which restrict the site to industrial land uses and prevent surface-disturbing activities. No issues were identified in LUC inspections conducted and LUCs are being successfully tracked and enforced by the Air Force.

Issues from the Second Five-Year Review

The second Five-Year Review was submitted as a draft document for regulatory agency review in April 2008. All issues raised by the regulatory agencies were resolved and the report was finalized by the AF on September 25, 2008, and approved by EPA on September 29, 2008. The groundwater interim remedies were protective in the short-term, and follow-up actions were identified to ensure long-term protectiveness. The completed soil and sediment remedial actions were protective, and the pending soil and sediment remedial actions were expected to be protective once the remedial actions were completed. The follow-up actions identified in the second Five-Year Review were all completed with the exception of two actions that had been initiated, but not yet completed as of the third Five-Year Review: the

effectiveness of capture at LF007C, and the final remedy selection for the groundwater sites. These issues were evaluated and incorporated into this *Third Five-Year Review Report*.

The second Five-Year Review also identified an emerging issue at Travis AFB, the potential vapor intrusion exposure pathway from groundwater-to-indoor air. This issue has since been addressed through a vapor intrusion assessment conducted at Travis AFB between 2009 and 2013. The findings from the vapor intrusion assessment at Travis AFB have been summarized in this *Third Five-Year Review Report*. Based on the 2013 Vapor Intrusion (VI) Assessment Update (CH2M HILL, 2013), there are no sites currently requiring action based on the vapor intrusion pathway. The Vapor intrusion pathway is a potential future concern under residential use at Sites FT004, LF007C, SS015, SS016, SS029, SS030, SD033, SD034, SS035, SD036, SD037, and DP039; LUCs in the form of passive ventilation systems or vapor barriers are necessary to ensure long-term protectiveness at these sites. The vapor intrusion pathway is a potential future concern under industrial use at Sites FT004, SS015, SS016, SS029, SD034, SD036, SD037, and DP039; LUCs are also necessary at these sites to ensure long-term protectiveness. The vapor intrusion pathway is not a potential future concern under either residential or industrial usage at Sites FT005, LF006, LF008, ST027B, SD031, and SD043. The need for LUCs has been addressed as part of issues/recommendations in this *Third Five-Year Review Report*.

Next Five-Year Review

The next five-year review of groundwater IRAs and soil/sediment RAs at Travis AFB is required by September 29, 2018. Travis AFB will also continue to implement and enforce LUCs at nine soil sites in accordance with the provisions in the Final NEWIOU Soil, Sediment, and Surface Water ROD and Final Soil ROD for the WABOU.

Before the next five-year review, it is anticipated that the Travis AFB Groundwater ROD will be in effect and supersede the current groundwater interim RODs. The Travis AFB Groundwater ROD is expected to be signed in 2013.

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Five-Year Review Summary Form

SITE IDENTIFICATION		
Site Name: Travis Air Force Base		
EPA ID: CA5570024575		
Region: 9	State: CA	City/County: Fairfield/Solano
SITE STATUS		
NPL Status: Final		
Multiple OUs? Yes	Has the site achieved construction completion? No	
REVIEW STATUS		
Lead agency: Other Federal Agency If "Other Federal Agency" was selected above, enter Agency name: U.S. Air Force		
Author name (Federal or State Project Manager): Endpoint Consulting, Inc.		
Author affiliation: N/A		
Review period: July 2012 – February 2013		
Date of site inspection: October 30-31, 2012		
Type of review: Statutory		
Review number: 3		
Triggering action date: September 29, 2008		
Due date (five years after triggering action date): September 29, 2013		

Five-Year Review Summary Form (continued)

The table below is for the purpose of the summary form and associated data entry and does not replace the two tables required in Section VIII and IX by the FYR guidance. Instead, data entry in this section should match information in Section VII and IX of the FYR report.

Issues/Recommendations	
OU(s)* without Issues/Recommendations Identified in the Five-Year Review:	
NEWIOU Soil, Sediment and Surface Water (OU 2) and WABOU Soil (OU 4).	

Issues and Recommendations Identified in the Five-Year Review:				
OU(s): NEWIOU Groundwater- LF007C (OU 1)*	Issue Category: Remedy Performance			
	Issue: Capture off-base groundwater plume			
	Recommendation: Evaluate remedial process optimizations that can overcome the significant challenges in capturing both the on-site and off-site portions of the plume via a groundwater extraction system. The challenges hindering the current remedy in meeting IRAOs include the limited soil permeabilities, the presence of significant sources of groundwater recharge which minimize extraction well capture zones, and seasonal operation of extraction wells which limits off-site migration capture.			
Affect Current Protectiveness	Affect Future Protectiveness	Implementing Party	Oversight Party	Milestone Date
No	Yes	Federal Facility	EPA/State	12/31/2013

OU(s): NEWIOU Groundwater (OU 1)* and WABOU Groundwater (OU 3)*	Issue Category: Institutional Controls			
	Issue: LUC Procedures are Needed			
	Recommendation: LUCs are needed for sites where groundwater-to-indoor air and soil gas risk-based concentrations are exceeded. The need for LUCs and related procedures is expected to be incorporated into the pending Travis AFB Groundwater ROD, and should be assessed as part of future five-year reviews.			
Affect Current Protectiveness	Affect Future Protectiveness	Implementing Party	Oversight Party	Milestone Date
No	Yes	Federal Facility	EPA/State	12/31/2013

Protectiveness Statement(s)

Include each individual OU protectiveness determination and statement. If you need to add more protectiveness determinations and statements for additional OUs, copy and paste the table below as many times as necessary to complete for each OU evaluated in the FYR report.

<i>Operable Unit:</i> NEWIOU Groundwater Interim ROD	<i>Protectiveness Determination:</i> Short-term Protective
--	---

Protectiveness Statement:

The groundwater interim remedies within the NEWIOU are currently protective of human health and the environment because exposure pathways that could result in unacceptable risks are being controlled. However, in order for the remedies to be protective in the long-term, the following actions need to be taken to ensure protectiveness:

- For the remedy at Site LF007C to be protective in the long term, follow-up actions relative to offsite plume capture need to be taken.
- At sites where groundwater-to-indoor-air and shallow soil gas risk-based concentrations are exceeded, LUCs to ensure long-term protectiveness for the vapor intrusion pathway are needed.

<i>Operable Unit:</i> WABOU Groundwater Interim ROD	<i>Protectiveness Determination:</i> Short-term Protective
---	---

Protectiveness Statement:

The groundwater interim remedies within the WABOU are currently protective of human health and the environment because exposure pathways that could result in unacceptable risks are being controlled. However, in order for the remedies to be protective in the long-term, the following actions need to be taken:

- At sites where groundwater-to-indoor-air and shallow soil gas risk-based concentrations are exceeded, LUCs to ensure long-term protectiveness for the vapor intrusion pathway are needed.

<i>Operable Unit:</i> NEWIOU Soil, Sediment and Surface Water ROD	<i>Protectiveness Determination:</i> Protective
---	--

Protectiveness Statement:

The remedies at the NEWIOU soil and sediment sites are protective of human health

and the environment.

All RAs have been completed. RAOs for several sites included establishing LUCs which restrict the site to industrial land uses and prevent surface-disturbing activities. No issues were identified in LUC inspections conducted and LUCs are being successfully tracked and enforced by the Air Force. The LUCs are therefore protective of human receptors in an industrial use scenario.

<i>Operable Unit:</i> WABOU Soil ROD	<i>Protectiveness Determination:</i> Protective
---	--

Protectiveness Statement:

The remedies at the WABOU soil sites are protective of human health and the environment.

All RAs have been completed. RAOs for several sites included establishing LUCs which restrict the site to industrial land uses and prevent surface-disturbing activities. No issues were identified in LUC inspections conducted and LUCs are being successfully tracked and enforced by the Air Force. The LUCs are therefore protective of human receptors in an industrial use scenario.

*The following OUs subject to this Five-Year Review correlate with the following EPA designated OU numbers and the Air Force RODs and Environmental Restoration Program (ERP) sites:

OU 1 NEWIOU Groundwater: ERP sites FT004, FT005, LF006, LF007, SS015, SS016, SS029, SS030, SD031, SD033, SD034, SS035, SD036, and SD037

OU 2 NEWIOU Soil, Sediment and Surface Water: ERP sites SD001, FT003, FT004, FT005, LF007, SS015, SS016, SD033, and SD037.

OU 3 WABOU Groundwater: ERP sites LF008, DP039, SS041, and SD043
OU 4 WABOU Soil: ERP sites DP039, LF008, LF044, RW013, SD042, SD043, SD045, SS041, and SS046.

Site-wide Protectiveness Statement (if applicable)

For sites that have achieved construction completion, enter a site wide protectiveness determination and statement.

Protectiveness Determination:

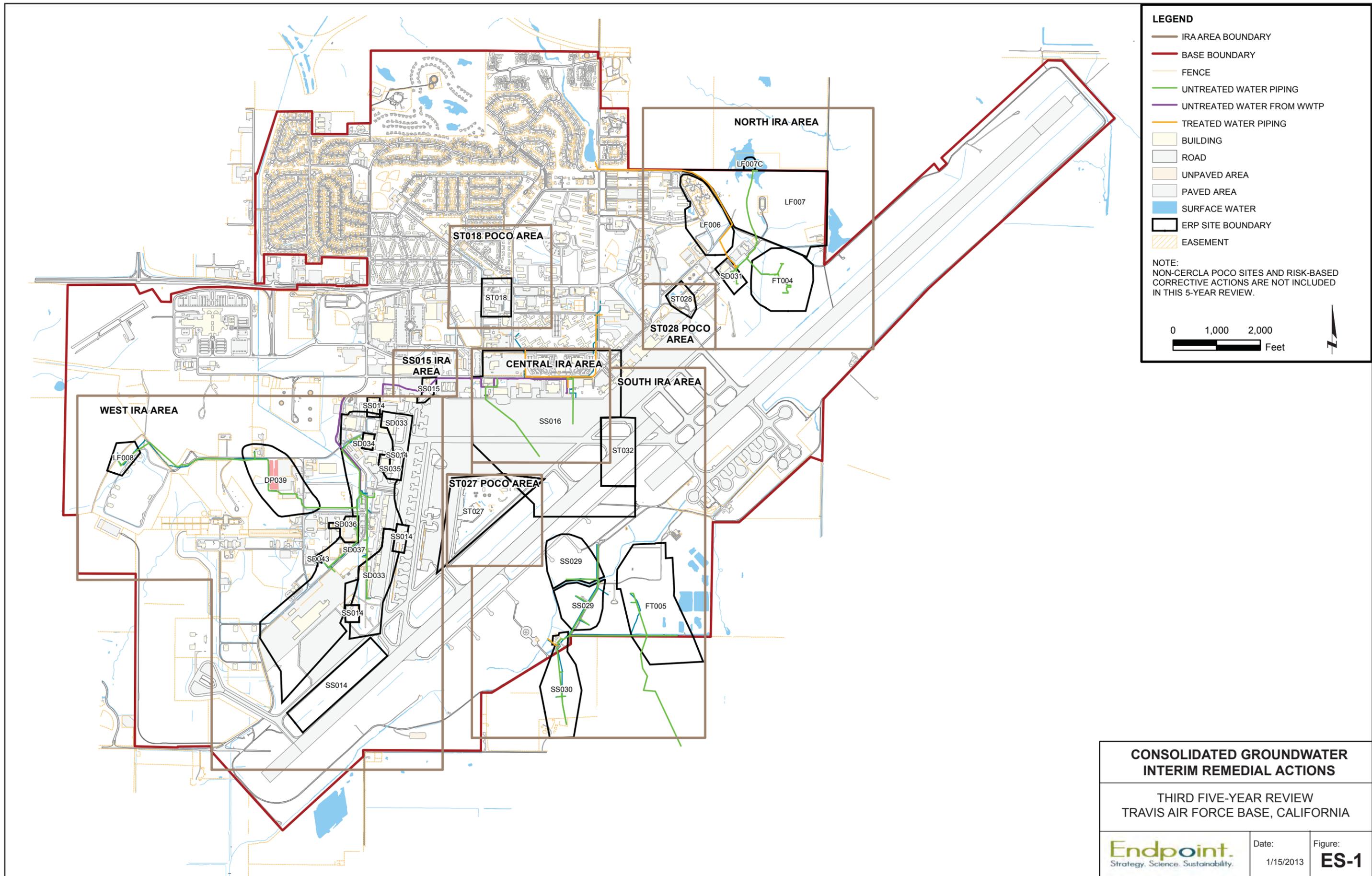
Addendum Due Date:

Not Applicable

Not Applicable

Protectiveness Statement:

Not Applicable



- LEGEND**
- IRA AREA BOUNDARY
 - BASE BOUNDARY
 - FENCE
 - UNTREATED WATER PIPING
 - UNTREATED WATER FROM WWTP
 - TREATED WATER PIPING
 - BUILDING
 - ROAD
 - UNPAVED AREA
 - PAVED AREA
 - SURFACE WATER
 - ERP SITE BOUNDARY
 - EASEMENT

NOTE:
 NON-CERCLA POCO SITES AND RISK-BASED
 CORRECTIVE ACTIONS ARE NOT INCLUDED
 IN THIS 5-YEAR REVIEW.

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 Feet



**CONSOLIDATED GROUNDWATER
 INTERIM REMEDIAL ACTIONS**

THIRD FIVE-YEAR REVIEW
 TRAVIS AIR FORCE BASE, CALIFORNIA

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SECTION 1

Introduction

This *Third Five-Year Review Report* provides descriptions and evaluations of the groundwater interim remedial actions (IRAs) and soil and/or sediment remedial actions (RAs) that have been implemented at Travis Air Force Base (Travis AFB), California. The location of Travis AFB is shown on Figure 1-1 (all figures are located at the end of the section or subsection in which they are referenced).

1.1 Purpose of a Five-Year Review

The purpose of a five-year review is to determine whether a remedy implemented at a site is, or is expected to be, protective of human health and the environment. The methods, findings, and conclusions of the review are documented in a five-year review report. In addition, a five-year review report identifies any important issues found during the review and provides potential follow up actions to address them.

The purpose of this *Third Five-Year Review Report* is to verify that the groundwater IRAs and soil and/or sediment RAs implemented at Travis AFB are protective of human health and the environment and are functioning as designed.

1.2 Authority and Guidance

The U.S. Air Force (Air Force) has prepared this five-year review pursuant to Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) Section 121 and the National Contingency Plan (NCP). CERCLA Section 121 states the following:

If the President selects a remedial action that results in any hazardous substances, pollutants, or contaminants remaining at the site, the President shall review such remedial action no less often than each five years after the initiation of such remedial action to assure that human health and the environment are being protected by the remedial action being implemented. In addition, if upon such review it is the judgment of the President that action is appropriate at such site in accordance with section [104] or [106], the President shall take or require such action. The President shall report to the Congress a list of facilities for which such review is required, the results of all such reviews, and any actions taken as a result of such reviews.

The U.S. Environmental Protection Agency (EPA) interpreted this requirement further in the NCP; 40 CFR Section 300.430(f)(4)(ii) states the following:

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

This *Third Five-Year Review Report* was prepared in accordance with EPA's Comprehensive Five-Year Review Guidance and its supplementals (EPA, 2012-2001). The Travis AFB groundwater IRAs are post-Superfund Amendments and Reauthorization Act actions that, upon completion, will not leave hazardous substances, pollutants, or contaminants on-site above levels that allow for

unlimited use and unrestricted exposure. However, these groundwater actions will require 5 or more years to complete.

The soil and sediment RAs conducted at Travis AFB will minimally achieve industrial cleanup levels, or more stringent residential cleanup levels. At sites where the industrial cleanup levels are achieved, land use controls (LUCs) will be enforced to restrict site access and control usage. At sites where the soil RA reduces contaminant concentrations to residential cleanup levels, the land will be available for unlimited use and unrestricted exposure, and LUCs will not be required.

1.3 Scope of the Third Five-Year Review

The scope of this *Third Five-Year Review Report* includes the groundwater IRAs and soil/sediment RAs at Environmental Restoration Program (ERP) sites at Travis AFB, California. This report covers the period of August 2008 through February 2013 with evaluation of data collected through February 2013.

The Air Force is conducting the groundwater IRAs and soil/sediment RAs within the two operable units (OUs) that currently exist at Travis AFB. These OUs include the North/East/West Industrial Operable Unit (NEWIOU) and the West/Annexes/Basewide Operable Unit (WABOU), EPA designated OUs 1 and OU 3, respectively.

IRAs to address groundwater contamination at sites within both OUs are currently underway in accordance with the final Groundwater Interim Record of Decision (Irod) for the NEWIOU and the final Groundwater Irod for the WABOU. Since the last five-year review, remedial process optimization (RPO) measures have been implemented to improve effectiveness of the IRAs. These optimization measures have been successful at achieving the interim remedial action objectives (IRAOs) and are well documented in various work plans, reports, and Restoration Program Manager (RPM) Meeting minutes. The selection of final groundwater RAs will be made in the pending Travis AFB Groundwater Record of Decision (ROD).

All soil RAs at sites within the WABOU have been completed in accordance with the final Soil ROD for the WABOU, EPA designated OU 4. All soil/sediment RAs within the NEWIOU have been completed in accordance with the final NEWIOU Soil, Sediment, and Surface Water ROD, EPA designated OU 2.

This is the third five-year review of NEWIOU and WABOU groundwater IRAs and the second five-year review of WABOU soil RAs and NEWIOU soil/sediment RAs.

1.3.1 Groundwater Interim Remedial Actions

The scope of the five-year review includes groundwater IRAs at 14 NEWIOU and 4 WABOU ERP sites. A listing of the sites is provided in Table 1-1. Groundwater IRAs have been implemented at each of these sites in accordance with the Groundwater Irod for the NEWIOU or Groundwater Irod for the WABOU, as applicable.

TABLE 1-1
Summary of NEWIOU and WABOU Groundwater Sites
Third Five-Year Review Report, Travis AFB, California

NEWIOU Groundwater Sites ^{a, b}			WABOU Groundwater Sites ^c
FT004	SS016	SD034	DP039
FT005	SS029	SS035	LF008
LF006	SS030	SD036	SD043
LF007	SD031	SD037	SS041
SS015	SD033		

^a Identified in the Groundwater IROD for the NEWIOU as requiring remediation.

^b Site ST032 was in the NEWIOU IROD as a groundwater site but was transferred to the POCO program in 2009.

^c Identified in the Groundwater IROD for the WABOU as requiring remediation.

Travis AFB developed the groundwater IRODs for NEWIOU and WABOU, rather than a final groundwater ROD, to allow groundwater remediation to begin quickly, to reduce contamination and risk. The two groundwater IRODs establish an interim period to evaluate the effectiveness of the IRAs and to monitor the status of each contaminant plume. After over a decade of groundwater cleanup, Travis AFB has collected enough data to establish final groundwater cleanup levels and performed innovative technologies in support of a final Travis AFB Groundwater ROD. The Travis AFB Groundwater ROD is expected to be finalized in 2013.

1.3.2 Petroleum-Only Contaminated Sites

The Travis AFB Petroleum-Only Contaminated (POCO) Sites Program manages petroleum contamination sites. These POCO sites are not governed by either IROD:

- ST018 – North/South Gas Station
- ST027 – Facilities 1918, 1919, and 1754
- ST028 – Facilities 363 and 1201
- ST032 – MW246/MW-107 Areas

POCO sites are typically associated with surface and subsurface releases from fuel spills, piping leaks, oil-water separators (OWSs), or underground storage tanks. The POCO Sites Program includes the removal of underground storage tanks (USTs) and the remediation of POCO soil and groundwater using risk-based cleanup actions. The San Francisco Bay Regional Water Quality Control Board (Water Board) is the lead oversight agency for this program, because CERCLA excludes petroleum as a CERCLA contaminant. For this reason, the POCO sites were not addressed in either IROD.

However, Travis AFB does address petroleum contamination under CERCLA if it is commingled with CERCLA contaminants. Recent groundwater monitoring data collected as part of the 2010-2011 Groundwater Sampling and Analysis Program (GSAP) have confirmed that there are no petroleum plumes commingled with CERCLA contaminants specifically in the case of Site SS014 at Fuel Storage Area G and Site ST027. While Site ST027 has no commingled contamination, an investigation conducted in 2007 resulted in the discovery of trichloroethene (TCE) and several other chlorinated volatile organic compounds (CVOCs) in groundwater in the southwestern part of the site. The area of the site impacted by fuel hydrocarbons has been designated as Site ST027A, while the area of the site impacted by CVOCs has been designated as Site ST027B.

Based on the above rationale, no POCO Sites will be included in the pending Travis AFB Groundwater ROD, nor are they covered by this *Third Five-Year Review Report*.

1.3.3 Soil Remedial Actions

The scope of the five-year review includes soil RAs at 9 WABOU sites and soil/sediment RAs at 9 NEWIOU sites.

1.3.3.1 WABOU Soil Remedial Actions

The scope of the five-year review includes the following nine WABOU ERP soil sites where soil RAs have been completed in accordance with the Soil ROD for the WABOU:

- DP039 – Building 755, Travis AFB Battery and Electric Shop
- LF008 – Landfill 3
- LF044 – Landfill X
- RW013 – Radioactive Burial Site 2/Dry Waste Landfill
- SD042 – Buildings 929/931/940
- SD043 – Building 916
- SD045 – Former Small Arms Range
- SS041 – Building 905, Travis AFB Entomology Shop
- SS046 – Railhead Munitions Staging Area

1.3.3.2 NEWIOU Soil and Sediment Sites

Contaminated soil/sediment ERP sites within the NEWIOU that required RA in accordance with the final Soil, Sediment, and Surface Water ROD for the NEWIOU include the following:

- SD001 – Union Creek (sediment only)
- FT003 – Fire Training Area (FTA) 2
- FT004 – FTA-3
- FT005 – FTA-4
- LF007 – Landfill 2
- SS015 – Solvent Spill Area and Facilities 808, 1832, and 552
- SS016 – Oil Spill Area (OSA); Facilities 11, 13/14, 20, 42/1941; and portions of the storm sewer system
- SD033 – Storm Sewer II, South Gate Area, Facilities 810 and 1917, and West Branch of Union Creek: soil and sediment
- SD037 – Sanitary Sewer System; Facilities 837/838, 919, 977, 981; Ragsdale/V Street Area; and Area G Ramp

1.3.4 Old Skeet Range

The Air Force, through its Military Munitions Response Program (MMRP) and associated investigations, has identified one munitions response site (MRS) with chemicals of concern (COCs) exceeding applicable environmental screening levels. This site is referred to as the Old Skeet Range,

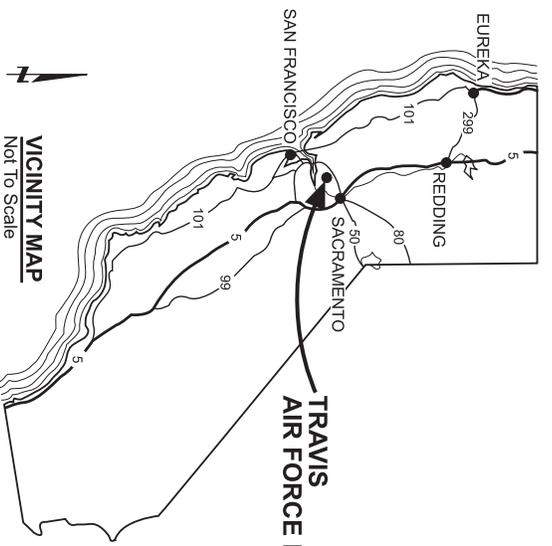
covering an approximate area of 0.44 acre and impacted by polynuclear aromatic hydrocarbons (PAHs) in surface soils. This site is a candidate for a non-time critical removal action (NTCRA); accordingly, an Engineering Evaluation/Cost Analysis (EE/CA) was prepared to evaluate the NTCRA alternatives, resulting in the selection of soil excavation and off-base disposal as the preferred alternative to meet the remedial action objectives and protect present and future receptors at the site. A Draft Action Memorandum is currently under preparation to guide cleanup activities at the Old Skeet Range under the Travis AFB MMRP program. This site is accordingly excluded from further evaluation in this *Five-Year Review Report*.

1.4 Third Five-Year Review Report Organization

The following list provides a brief summary of the organization and content of this *Third Five-Year Review Report*:

- **Section 1 – Introduction:** Describes the subject, purpose, scope, and plan of development of this *Third Five-Year Review Report*.
- **Section 2 – Chronology:** Provides summary descriptions of key historical events related to the NEWIOU and WABOU Groundwater IRAs and WABOU Soil RAs.
- **Section 3 – Background:** Summarizes the physical characteristics, land and resource use, history of contamination, initial responses, and the basis for taking action.
- **Section 4 – Groundwater Interim Remedial Actions and Soil Remedial Actions:** Describes the basis for the selection and implementation of the groundwater IRAs and soil RAs. Provides summary descriptions of system operations and operation and maintenance (O&M).
- **Section 5 – Progress Since the Last Five-Year Review:** Describes progress towards achieving groundwater interim remediation goals (IRGs) and soil cleanup goals.
- **Section 6 – Five-Year Review Process:** Summarizes the administrative components, community notification and involvement, documents reviewed, data reviewed, inspections conducted, and interviews conducted during the development of this report.
- **Section 7 – Technical Assessment:** Provides answers to the three key questions posed in the EPA guidance:
 - **Question A** – Is the remedy functioning as intended by the decision documents?
 - **Question B** – Are the assumptions used at the time of remedy selection still valid?
 - **Question C** – Has any other information come to light that could call into question the protectiveness of the remedy?
- **Section 8 – Issues and Follow-up Actions:** Describes issues and potential optimization of groundwater IRAs that may enhance their protectiveness. Also provides the date of the next five-year review.
- **Section 9 – Protectiveness Statements**
- **Appendices**
 - Appendix A: Acronyms and Abbreviations
 - Appendix B: References
 - Appendix C: LUC Inspection Report and Pictures
 - Appendix D: Groundwater Sites and Contamination
 - Appendix E: Responses to Comments

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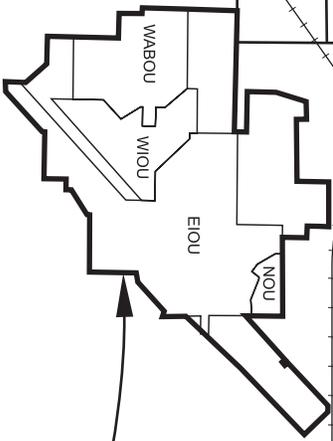


TRAVIS AIR FORCE BASE

SOUTHERN PACIFIC RAILROAD

FAIRFIELD

VACAVILLE



TRAVIS AIR FORCE BASE

NOTE:
THE NOU, EIOU, AND WIOU
COMPRISE THE NEWIOU

SOUTHERN PACIFIC RAILROAD

TRAVIS AFB LOCATION

THIRD FIVE-YEAR REVIEW
TRAVIS AIR FORCE BASE, CALIFORNIA



Date:
1/15/2013

Figure:
1-1

Figure 1-1 Continued

SECTION 2

Chronology

This section provides descriptions of key historical events related to the NEWIOU and WABOU Groundwater IRAs; and NEWIOU and WABOU Soil/Sediment RAs at Travis AFB.

2.1 Key Events

As a result of past waste management and disposal practices, groundwater, soil, and sediment at Travis AFB were contaminated at multiple locations. Travis AFB has implemented groundwater IRAs and soil and/or sediment RAs to address this contamination in accordance with CERCLA, the National Oil and Hazardous Substances Pollution Contingency Plan, the final Groundwater IROD for the NEWIOU, the final Groundwater IROD for the WABOU, the final Soil ROD for the WABOU, and the final NEWIOU Soil, Sediment, and Surface Water ROD. The key events related to the Travis AFB environmental management program are summarized in Table 2-1.

TABLE 2-1
Chronology of Key Events
Third Five-Year Review Report, Travis AFB, California

Event	Date(s)
Phase I Preliminary Assessment	1983
Installation Restoration Program (IRP) investigations	1983 – 1994
Pre-National Priorities List (NPL) Response	1983 – 1989
NPL listing	21 November 1989
Federal Facility Agreement (FFA) signature	27 September 1990
Travis AFB Community Relations Plan (CRP) implemented	1991
Fact sheets describing restoration program activities and milestones published	1993 – present
FFA renegotiated to create four OUs	1993
Consolidation of East Industrial Operable Unit (EIOU), West Industrial Operable Unit (WIOU), and North Operable Unit (NOU) into the NEWIOU	October 1995
Travis AFB Restoration Advisory Board formed	1995
Quarterly restoration program newsletter published and mailed	1995 – present
CERCLA Remedial Investigation/Feasibility Studies	1993 – 1998
Central Groundwater Treatment Plant (CGWTP) on-line	1995
Final Groundwater IROD for NEWIOU signed	26 January 1998
Travis AFB CRP revised	1998
South Base Boundary Groundwater Treatment Plant on-line (five-year review trigger)	1998
Final Groundwater IROD for WABOU signed	24 June 1999
West Treatment and Transfer Plant on-line	2000
North Groundwater Treatment Plant on-line	2000
Final Soil ROD for the WABOU signed	December 2002

TABLE 2-1
Chronology of Key Events
Third Five-Year Review Report, Travis AFB, California

Event	Date(s)
WABOU Soil Remedial Designs /IRAs	2003 – 2007
First Five-Year Review	July 2003
Final NEWIOU Soil, Sediment, and Surface Water ROD signed	10 May 2006
Final Second Five-Year Review	24 September 2008
NEWIOU Soil and Sediment RAs completed (SD001, FT005, SD033)	2007-2010
Implementation of Remedial Process Optimizations	2009-2011
RD/RA QAPP Update	31 March 2010
Final Proposed Plan for Groundwater Cleanup	18 October 2012
Third Five-Year Review	03 July 2013 (current)
Travis AFB Groundwater ROD	Pending regulatory review and revisions (expected to be finalized in 2013)

Remediation of both NEWIOU and WABOU contaminated groundwater sites is conducted under two IRODs. These IRAs were implemented to quickly begin remediation of groundwater contamination, reduce the levels of contamination and potential risk, and collect some of the data necessary for the selection of final cleanup levels and technically and economically feasible long-term actions. The use of an IROD allowed groundwater IRAs to proceed without having final designated cleanup levels; they will be required in the Travis AFB Groundwater ROD.

The groundwater IRAs conducted under the NEWIOU and WABOU Groundwater IRODs use IRGs and interim cleanup goals (ICGs) as performance objectives. These IRGs and ICGs are not legally enforceable standards, but are simply goals used during the period of interim remediation (for the remainder of this report, the term IRG is used synonymously with ICG).

Soil and sediment RAs for Travis AFB are described in the final NEWIOU Soil, Sediment, and Surface Water ROD and final Soil ROD for the WABOU. Under both RODs, if an RA reduces residual contaminant concentrations to levels that allow for unlimited use and unrestricted exposure, then land use controls (LUCs) are not required. However, if excavation only reduces contaminant concentrations to industrial cleanup levels, then LUCs will be implemented to restrict residential development and soil disturbance activities.

2.2 NEWIOU and WABOU Groundwater and Soil Sites Chronology

In 1983, the Air Force initiated the Installation Restoration Program (IRP) to investigate the nature and extent of hazardous waste releases to the environment. On the basis of IRP data evaluated by EPA, Travis AFB was placed on the National Priorities List (NPL) on 21 November 1989 (54 Federal Register 48187). Approximately one year later, on 27 September 1990, the Air Force, EPA, California Department of Toxic Substances Control (DTSC), and the San Francisco Bay Water Board negotiated and signed the Federal Facility Agreement (FFA; Travis AFB, 1990), which established the framework and schedule for environmental cleanup at Travis AFB. Travis AFB is the lead agency and is responsible for conducting all follow-up actions related to the groundwater IRAs and soil RAs.

EPA Region 9, the Water Board, and DTSC provide regulatory agency oversight of the actions that may be taken by the Air Force.

2.3 NEWIOU Sites

Under the original FFA (Travis AFB, 1990), Travis AFB was treated as a single entity with one associated comprehensive cleanup schedule. Then, in May 1993, the FFA was amended to divide the Base into four OUs to facilitate the overall cleanup program. The OU boundaries are shown on Figure 2-1. The four OUs include the following:

- EIOU
- WIOU
- NOU
- WABOU

Between approximately 1983 and 1994, early IRP investigations, data gathering, and work planning efforts were conducted to preliminarily assess the nature of environmental contamination at Travis AFB. After these efforts were completed, more focused CERCLA Remedial Investigations (RIs) were performed within each of the Travis AFB OUs between 1994 and 1996. Following the completion of the EIOU, WIOU, and NOU RIs in October 1995, the EIOU, WIOU, and NOU were combined into the NEWIOU. A feasibility study (FS) was then completed for the NEWIOU, and remedial alternatives were developed, screened, and evaluated for each site (Radian, 1996).

2.3.1 NEWIOU Groundwater Sites

The NEWIOU FS was followed by the NEWIOU Groundwater Proposed Plan for Groundwater Cleanup, which proposed the preferred groundwater IRA alternative for each NEWIOU site. Subsequently, the groundwater IRA for each site was formally selected in the Groundwater IROD for the NEWIOU. IRAs have been implemented and are underway at each NEWIOU site identified in the IROD as requiring remediation.

For the most part, the groundwater IRAs have operated successfully. After more than a decade of the interim remediation, the residual contaminant concentrations at most of the ERP sites are much lower than initial values but are still high enough to require continued and, in most cases, more effective cleanup actions. This prompted Travis AFB to consider more aggressive groundwater cleanup strategies. As a result, remedial process optimizations (RPOs) were performed at several ERP sites. RPOs consisted of bioreactors, emulsified vegetable oil (EVO), and modified groundwater extraction and treatment (GET) systems (including taking extraction wells off-line and/or installing new extraction wells).

IRAs as currently optimized are reducing the size of the contaminated areas and reducing the contaminant levels. Travis AFB is now transitioning out of interim remediation and starting the process of selecting and implementing final remedial actions at each site based on remedial optimization studies.

2.3.2 NEWIOU Soil, Sediment, and Surface Water Sites

As with the groundwater sites, the NEWIOU FS included sites with contaminated soil, sediment, and surface water. The NEWIOU Proposed Plan for Soil, Sediment, and Surface Water was finalized in 1998. Final remedies for these sites were then selected when the final Soil, Sediment, and Surface Water ROD for the NEWIOU was signed in December 2006. Since that time, all soil/sediment RAs have been completed at all NEWIOU sites that were identified in the ROD.

2.4 WABOU Sites

The sequence of events for IRP sites within the WABOU is similar to that for the NEWIOU. After some preliminary IRP investigations and a planning phase, the WABOU RI Report was completed in May 1997. The subsequent WABOU FS Report was finalized in April 1998.

2.4.1 WABOU Groundwater Sites

Following the WABOU FS, a Groundwater Proposed Plan for the WABOU was developed and was finalized in April 1998. The final Groundwater IROD for the WABOU was completed in June 1999. Since that time, groundwater IRAs have been implemented and are currently underway at each WABOU site identified in the IROD as requiring remediation.

For the most part, the groundwater IRAs have operated successfully. Similar to the NEWIOU groundwater sites, residual contaminant concentrations are still high enough to require continued and, in most cases, more effective cleanup actions. This prompted Travis AFB to consider more aggressive groundwater cleanup strategies. As a result, RPOs consisting of bioreactors, EVO, and modified GET systems, were performed at several ERP sites.

IRAs as currently optimized are reducing the size of the contaminated areas and reducing the contaminant levels. Travis AFB is now transitioning out of interim remediation and starting the process of selecting and implementing final remedial actions at each site based on remedial optimization studies.

2.4.2 WABOU Soil Sites

The final Soil ROD for the WABOU was signed in December 2002. Since that time, soil RAs have been completed at all WABOU sites that were identified in the ROD.

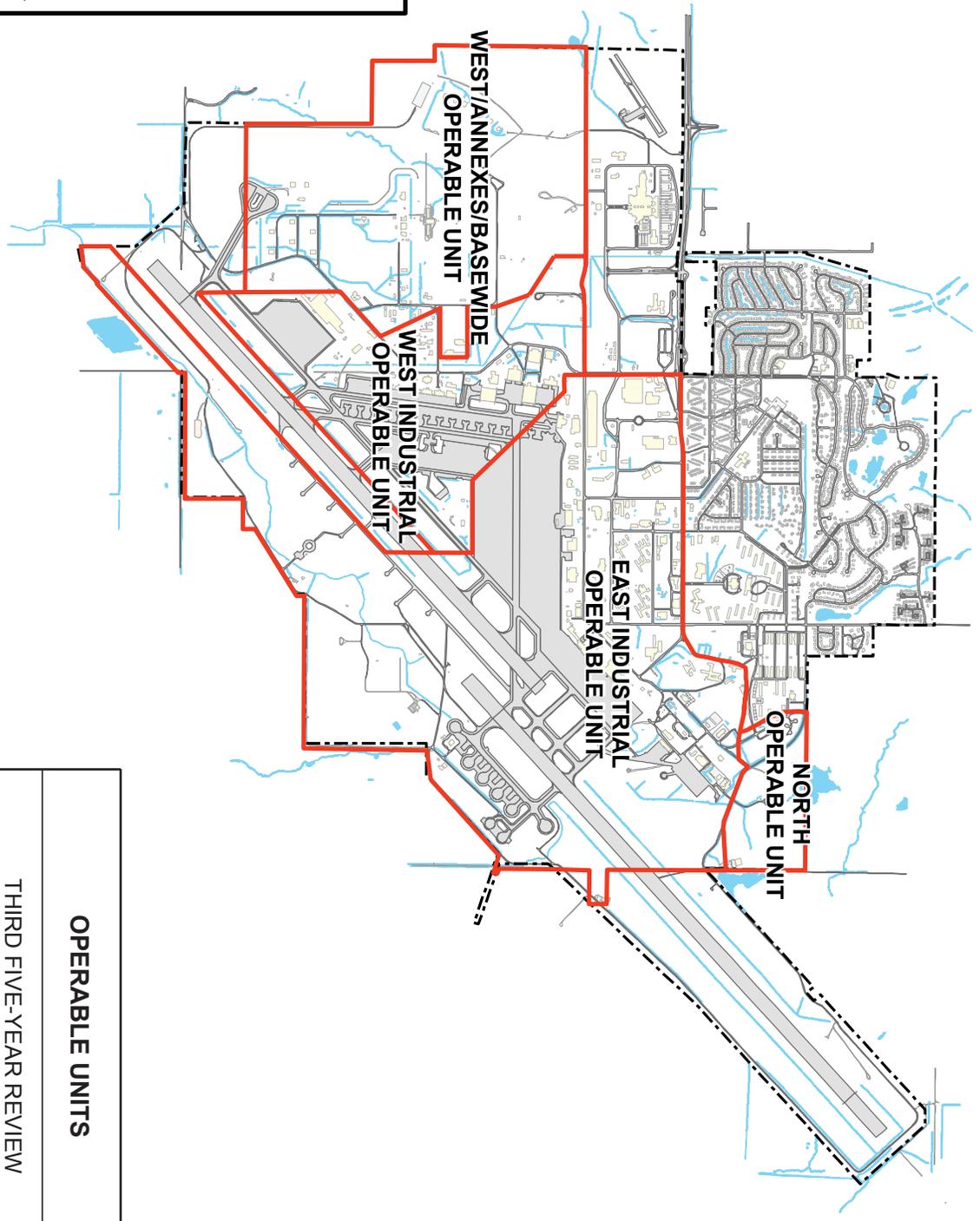
2.5 Travis AFB Groundwater Record of Decision

The Final Proposed Plan for Groundwater Cleanup was issued in October 2012. The Proposed Plan for Groundwater Cleanup is a precursor to the Travis AFB Groundwater ROD. The Travis AFB Groundwater ROD is undergoing regulatory review and revisions, and is expected to be signed in 2013.

LEGEND

- BASE BOUNDARY
- ROAD
- UNPAVED AREA
- PAVED AREA
- BUILDINGS
- SURFACE WATER
- INTERMITTENT STREAM
- OPERABLE UNIT (OU) BOUNDARY

NOTE:
 THE NEWIOU COMPRISES THE NORTH OPERABLE UNIT (NOU), EAST INDUSTRIAL OPERABLE UNIT (EIOU), AND WEST INDUSTRIAL OPERABLE UNIT (WIOU).



OPERABLE UNITS

THIRD FIVE-YEAR REVIEW
 TRAVIS AIR FORCE BASE, CALIFORNIA

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SECTION 3

Background

This section provides summary descriptions of Travis AFB physical characteristics, land and resources use, and habitats and wildlife. Also provided are brief histories of contamination at the ERP groundwater and soil and/or sediment sites within the NEWIOU and WABOU, the initial response actions at some of these sites, and the basis for taking action to address groundwater and soil and/or sediment contamination.

3.1 Physical Characteristics

Travis AFB is located midway between San Francisco and Sacramento, California, on low-lying ground within 1 mile of Suisun Marsh, an estuary of San Francisco Bay. It is located 3 miles east of downtown Fairfield in Solano County. The Base occupies over 6,000 acres and maintains ownership of, or administrative control over, several properties at off-base locations. Facilities include two major runways, associated taxiways and aircraft parking aprons, numerous hangars, buildings, shops, offices, freight handling and storage areas, and maintenance facilities.

Travis AFB is part of Air Mobility Command and is host to the 60th Air Mobility Wing and other units. The 60th Air Mobility Wing operates C-5 Galaxy and C-17 Globemaster III cargo aircraft and KC-10 Extender refueling aircraft. The primary missions of Travis AFB, since its establishment in 1943, have been strategic reconnaissance and airlift of freight and troops.

3.1.1 Geology and Hydrogeology

Travis AFB is located on the western edge of the Sacramento Valley segment of the Great Valley geomorphic province, which is a southeast-trending, sediment-filled synclinal basin. Just west of Travis AFB lies the Coast Range geomorphic province, which is composed of folded and uplifted bedrock.

The geomorphology of the area is characterized by gently sloping alluvial plains and fans overlying Tertiary sedimentary rock. Coalescing, low-relief fans have been deposited by streams (e.g., Union Creek and Laurel Creek) migrating across the Base over time. The majority of “Older Alluvium” was deposited during the Pleistocene Epoch prior to the last glaciation. Drainages were incised in Older Alluvium during the last glacial period in response to dropping sea levels. Incised channels were filled with “Younger Alluvium” over the past 11,000 years to produce a complex hydrogeologic environment comprising discontinuous beds of sand and silty sand suspended in a matrix of fine-grained silt and clay. Sand lenses are typically elongated parallel to (former) streams, trending south-southeast across the Base. Where present, lenses of sand vary in continuity and thickness. Alluvium ranges in thickness from 0 to approximately 70 feet in the area. The thickness of alluvium generally increases to the southeast. West of Travis AFB, the thickness of alluvium increases to over 200 feet.

3.1.2 Groundwater

The alluvium is underlain by bedrock consisting of semi-consolidated to consolidated sedimentary units; the alluvium and bedrock are sometimes difficult to distinguish in the field. Bedrock underlying the site includes Tertiary and Pliocene sedimentary rocks overlying Late Cretaceous sedimentary rocks. Individual stratigraphic units outcropping on the base include, from oldest to youngest, the Domengine Sandstone, the Nortonville Shale, the Markley Sandstone, and the Tehama Formation. Regionally, Travis AFB is located along the eastern edge of the Fairfield-Suisun Hydrologic Basin

adjacent to the Sacramento Valley segment of the Central Valley province. The primary water-bearing deposits in the area are the Older and Younger Alluvium. Within the alluvium, discontinuous lenses of sand and silty sand are the highest permeability units, elongated parallel to (former) streams and trending south-southeast in most locations. Alluvium varies in thickness from a few feet to approximately 70 feet where present, and is saturated to within 10 to 20 feet of the land surface. The depth of alluvium has been estimated from drilling. In the western part of the Base, wells penetrating the full thickness of alluvium are sparse, and the depth to bedrock is poorly understood.

The groundwater flow system at Travis AFB is influenced by the configuration of alluvium and bedrock at the Base. Shallow groundwater flow within the alluvium is consistently toward the south; however, groundwater mounding has been observed within the northeastern and northwestern portions of the base, created in response to the presence of lower-permeability bedrock geologic materials. Shallow bedrock also influences groundwater flow in the central portion of the base, including contributing to the formation of a groundwater divide in this area.

Groundwater generally flows from north to south across the Base from the foot of the Vaca Mountains to Luco and Hill Sloughs through the alluvium. Flow is primarily lateral. On a local scale, groundwater tends to flow from areas of elevated bedrock (outcrop) toward channels of higher transmissivity alluvium and south to southeast through the latter.

Groundwater is unconfined or semi-confined within the alluvium (depending on location). Infiltration of precipitation, runoff, and irrigation waters; leakage from streams; and lateral flow from the north and northwest recharges alluvial sediments. Groundwater is discharged from alluvium as evapotranspiration (ET), as leakage to streams, through pumping at extraction wells, and as flow to Luco and Hill Sloughs. Groundwater seepage velocities have been estimated as high as 100 feet per year.

The western branch of Union Creek is a gaining stream (a stream reach in which the water table adjacent to the stream is higher than the water surface in the stream), at least during part of the year. As such, groundwater discharges into Union Creek and supports the base flow of this stream. Evidence supporting the gaining-stream hypothesis includes low concentrations of CVOCs in creek samples, which may have originated from groundwater, and the shape of groundwater elevation contours, which converge toward the creek. An upward vertical gradient at Site SS029 along the bank of Union Creek indicates that this portion of the creek in the south-central area of Travis AFB also may be a gaining stream.

3.2 Land and Resource Use

The following subsections describe the usage of land, groundwater, and surface water at Travis AFB.

3.2.1 Land Use

Travis AFB occupies about 6,383 acres of land near the center of Solano County, California, and is located approximately 3 miles east of downtown Fairfield and 8 miles south of downtown Vacaville. Solano County's population in 2010 was approximately 413,344. The 2010 population estimates for Fairfield and Vacaville were 106,116 and 93,076, respectively (U.S. Census Bureau, 2010).

According to the Travis AFB Office of Public Affairs, Travis AFB currently employs about 7,750 active military personnel and 3,323 reservists. Approximately 5,613 people live in 3,466 on-base housing units. There are 3,006 civilians employed at Travis AFB. Approximately 17,000 military and civilian personnel are present daily on the Base.

The land use areas of Travis AFB are grouped into the following eight functional categories:

- **Mission** – Uses are closely associated with the airfield and include facilities, such as maintenance hangars and docks, avionics facilities, and other maintenance facilities. Aircraft operations facilities include control towers, Base operations, flight simulators, and other instructional facilities.
- **Administrative** – Uses include personnel, headquarters, legal, and other support functions.
- **Community** – Uses include both commercial and service activities. Examples of commercial uses include the Base Exchange, dining halls, service station, and clubs; service uses include the schools, chapel, library, and the family support center.
- **Housing** – Uses include both accompanied housing for families and unaccompanied housing for singles, temporary personnel, and visitors.
- **Base Support/Industrial** – Uses are for the storage of supplies and maintenance of Base facilities and utility systems.
- **Medical** – Uses include facilities for medical support, including the David Grant Medical Center.
- **Outdoor Recreation** – Uses include ball fields, golf course, equestrian center, swimming pools, and other recreational activities.
- **Open Space** – Used as buffers between Base facilities and to preserve environmentally sensitive areas.

The lands surrounding Travis AFB on the northeast and east are primarily used for ranching and grazing. Areas to the south are a combination of agricultural and marshland. A few commercial/light industrial areas are present to the north of the Base. The area west of Travis AFB is predominantly residential.

Land use within the WABOU is varied and consists of open grasslands, light industrial support areas, administrative areas, personnel training areas, ammunition storage, and service/storage areas.

Within the NEWIOU, land use mainly includes two major aircraft runways, associated taxiways and aircraft parking aprons, numerous hangars, buildings, shops, offices, freight handling and storage areas, and maintenance facilities.

The future land use at Travis AFB is expected to remain as an Air Force base; hence, future land use is expected to remain unchanged relative to the current land use summarized above.

3.2.2 Groundwater Use

No on-base wells are used for potable water production at Travis AFB.

Intensive extraction of groundwater for human consumption generally occurs only to the west of Travis AFB and Fairfield, where the alluvium is thicker and contains a greater abundance of coarse-grained sediment. Groundwater wells in the area of Travis AFB are limited to domestic, stock-watering, and irrigation wells with typical screened depths within 100 feet of ground surface (Weston, 1995). Domestic wells, several of which are downgradient from Travis AFB, are used typically for households and gardens (Weston, 1993). Solano County does not supply water to the residences surrounding Travis AFB. The two nearest domestic wells are within 1,700 feet of the south boundary of Travis AFB.

3.2.3 Surface Water

Surface water is not used as a potable water source at Travis AFB.

Travis AFB is located in the northeastern portion of the Fairfield-Suisun Hydrologic Basin. Within the basin, water generally flows south to southeast toward Suisun Marsh, an 85,000-acre tidal marsh that is the largest contiguous estuarine marsh and the largest wetland in the continental United States. Suisun Marsh drains into Grizzly and Suisun Bays. Water from these bays flows through the Carquinez Straits to San Pablo Bay and San Francisco Bay, and ultimately discharges into the Pacific Ocean near the City of San Francisco.

Union Creek is the primary surface water pathway for runoff at Travis AFB. The headwaters of Union Creek are located approximately 1 mile north of the Base, near the Vaca Mountains, where the creek is an intermittent stream. Union Creek splits into two branches north of the Base, with the main (eastern) branch being impounded into a recreational pond designated as the Duck Pond. At the exit from the Duck Pond, the creek is routed through a storm sewer to the southeastern Base boundary, where it empties into an open creek channel.

The West Branch of Union Creek flows south and enters the northwestern border of Travis AFB east of the David Grant Medical Center in an excavated channel. This channel flows south to the northeast corner of the WABOU. The channel forms the boundary between the WIOU and the WABOU and parallels Ragsdale Street for about 4,000 feet. Flow in the channel is then directed to a culvert under the runway and discharges to the main channel of Union Creek at Outfall II. From Outfall II, Union Creek flows southwest, and discharges into Hill Slough, a wetland located 1.6 miles from the Base boundary. Surface water from Hill Slough flows into Suisun Marsh.

Local drainage patterns have been substantially altered within the Base by the rerouting of Union Creek, the construction of the aircraft runway and apron, the installation of storm sewers and ditches, and general development (e.g., the Base Exchange, industrial shops, maintenance yards, roads, housing, and other facilities). Surface water is collected in a network of underground pipes, culverts, and open drainage ditches. The surface water collection system divides the Base into eight independent drainage areas. The eastern portion of the Base is served by one of the drainage systems that collects runoff from along the runway and the inactive sewage treatment plant area and directs it to Denverton Creek and Denverton Slough. Denverton Creek is an intermittent stream near the Base. The northwestern portion of the WABOU drains to the west toward the McCoy Creek drainage area. McCoy Creek is also an intermittent stream near the Base. With the exception of these drainages, the remaining six drainage areas at the Base empty into Union Creek. As previously indicated, the western branch of Union Creek and portions of the creek in the south-central area of Travis AFB (near Site SS029) appear to be gaining streams, with evidence of groundwater discharge to the creek for at least portions of the year.

The surface water at the base does not present an unacceptable risk to ecological or human receptors. Hence, a no-action alternative was selected for surface water within the Soil, Sediment, and Surface Water RODs for the NEWIOU and WABOU, relying in part on extraction and treatment of groundwater, implemented under the NEWIOU and WABOU Groundwater IRODs, to address the potential contribution of contamination to surface water from underlying groundwater.

3.2.4 Habitats and Wildlife

Travis AFB has a variety of terrestrial and aquatic/wetland habitats and wildlife that are typical of the region.

3.2.4.1 Terrestrial Habitats

The terrestrial habitats at Travis AFB and adjacent areas consist of herbaceous-dominated habitats (annual grassland pasture and early ruderal habitat) and urban habitat (industrial areas, lawns, and ornamental plants), according to the California Department of Fish and Game (CDFG) classification system (Mayer and Laudenslayer, 1988). Aquatic/wetland habitats at Travis AFB include riverine

(Union Creek) and riparian habitat, lacustrine (Duck Pond), and herbaceous-dominated wetlands marshes, and vernal pools.

In general, annual grassland habitat is dominated by non-native plant species, such as slender wild oat (*Avena fatua*), fescues (*Festuca*), soft chess (*Bromus hordeaceus*), field bindweed (*Convolvulus arvensis*), and yellow star-thistle (*Centaurea solstitialis*). Some native plants, such as bunchgrass (*F. viridula*) and johnny-tuck (*Triphysaria eriantha*), may also be found, usually associated with undisturbed areas.

Mowed/disc'd grassland is generally composed of soft chess, Italian ryegrass (*Lolium multiflorum*), and wild oats (*Chasmanthium latifolium*). Pasture grassland can contain varying frequencies of filaree (*Erodium* sp.), ripgut brome (*Bromus diandrus*), soft chess, Italian ryegrass, and yellow star-thistle. Ruderal grasslands, on the other hand, contain higher numbers of perennial species and, in some areas, woody species such as coyote brush (*Baccharis pilularis*), eucalyptus (*Eucalyptus* sp.), Peruvian pepper-tree (*Schinus molle*), and black locust (*Robinia pseudoacacia*).

The urban habitat on-base contains maintained lawns and trees and shrubs, such as eucalyptus, Fremont cottonwood (*Populus fremontii*), arroyo willow (*Salix lasiolepis*), and coyote brush. Most isolated stands of shrubs or trees are located within or near urban areas, permanent water sources, or near artificial surface mounds (for example, rail lines, blast protection, and building and road foundations).

3.2.4.2 Aquatic and Wetland Habitats

Herbaceous wetland vegetation is found along the permanent (natural or artificial) drainages on-base and can also occur seasonally within vernal pools, swales, and ditches. Native species include salt grass (*Distichlis spicata*); non-native species include meadow fescue (*Festuca elatior*), sickle grass (*Parapholis incurva*), and cattails (*Typha* sp.). Vernally inundated areas support seasonal vegetation such as non-native Mediterranean barley (*Hordeum murinum* ssp. *leporinum*) and brass buttons (*Cotula coronopifolia*) and native plants such as downingia (*Downingia* sp.) and toad rush (*Juncus bufonius*).

Travis AFB has limited topographic relief, and the clayey soils prevent rapid drainage. This swale topography leads to the formation of vernal pools. Vernal pools are shallow depressions or small, shallow pools that fill with water during the winter rainy season, then dry out during the spring and become completely dry during the summer. The annual cycle of vernal pools includes standing water during the winter and spring, and desiccation during the summer and fall. During the time that the vernal pools contain water, biotic communities develop over relatively restricted areas. In the larger areas, grasslands form; in more confined, deeper areas, wetlands form. The vernal wetlands are concentrated along the western, southern, and southeastern boundaries of the Base. All of the surface water bodies on and near the Base empty into the Suisun Marsh. No springs have been recorded within the confines of Travis AFB.

The vernal pools at Travis AFB contain indicator species such as goldfields (*Lasthenia fremontii*), coyote thistle (*Eryngium vaseyi*), dwarf woolly-heads (*Psilocarphus brevissimum*), water pygmy-weed (*Crassula aquatica*), and one or more species of downingia and popcornflower (*Plagiobothrys* sp.).

Although a few willows and coyote brush can be found along Union Creek, the dominant plant species found in the riparian zone of Union Creek are mainly herbaceous and consist of beardless wild rye (*Leymus triticoides*), broad-leaved pepperwort (*Lepidium latifolium*), Harding grass (*Phalaris aquatica*), and saltgrass. Hydrophytes such as cattails and rushes are also common.

3.2.4.3 Wildlife

Terrestrial vertebrates associated with non-native annual grasslands are commonly found on-base. Typical avian species include ring-necked pheasant (*Phasianus colchicus*), American kestrel (*Falco sparverius*), American robin (*Turdus migratorius*), and the western meadowlark (*Sturnella neglecta*). Reptiles observed, or potentially occurring, at the Base include the western fence lizard (*Sceloporus occidentalis*), gopher snake (*Pituophis melanoleucus*), and California red-sided garter snake (*Thamnophis sirtalis* ssp. *infernalis*). Common mammals identified include deer mouse (*Peromyscus maniculatus*), California ground squirrel (*Spermophilus beecheyi*), Botta's pocket gopher (*Thomomys bottae*), black-tailed hare (*Lepus californicus*), and red fox (*Vulpes vulpes*).

Permanent wetlands and seasonally wet areas support aquatic invertebrates, fish, amphibians, reptiles, birds, and mammals. Some aquatic invertebrate species observed in herbaceous wetlands and vernal pools at Travis AFB include vernal pool fairy shrimp (*Branchinecta lynchi*), damselflies (*Odonata* sp.), crayfish (*Orconectes virilis*), and aquatic snails. Amphibian species identified include bullfrog (*Rana catesbeiana*), Pacific tree frog (*Hyla regilla*), and California tiger salamander (*Ambystoma californiense tigrinum*). Aquatic birds observed on or near the Base include mallard (*Anas platyrhynchos*), great egret (*Casmerodius albus*), and great blue heron (*Ardea herodias*).

Because wildlife use riverine and riparian habitat somewhat similarly, these habitats are discussed together. Many aquatic invertebrates and amphibians are the same as those discussed above in herbaceous wetlands and vernal pools. These include damselflies, crayfish, aquatic snail, bullfrog, Pacific tree frog, and California tiger salamander. Fish species include mosquitofish (*Gambusia affinis*), fathead minnow (*Pimephales promelas*), threespine stickleback (*Gasterosteus aculeatus*), and bluegill (*Lepomis macrochirus*). Riverine/riparian habitats are also used extensively by birds and terrestrial mammals for forage, shelter, and as a source of water. These include red-winged blackbird (*Agelaius phoeniceus*), raccoon (*Procyon lotor*), muskrat (*Ondatra zibethicus*), and beaver (*Castor canadensis*).

Habitats that support special-status species are considered sensitive habitats. Sensitive aquatic/wetland areas include vernal pools, swales, and ditches that can support special-status plants and animals. Urban environments, scattered throughout the Base, can also support special-status species. For example, burrowing owls (*Speotyto cunicularia*) may use man-made culverts, perches, and bare earth areas that contain burrows provided by ground squirrels. Loggerhead shrikes (*Lanius ludovicianus*) may nest on antenna wires and forage in grasslands. Both owls and shrikes are typical species of the grassland habitats on-base. Also, vernal pool fairy shrimp have been found in artificially created depressions that seasonally fill with water.

3.2.4.4 Ecological Risk Assessments

Travis AFB has completed Ecological Risk Assessments (ERA) for all of the soil, sediment, and groundwater sites within the NEWIOU and WABOU.

WABOU ERA. Section 3.2.2 of the final Soil ROD for the WABOU describes the environmental risk assessment (ERA) for WABOU soil sites. Section 3.2 of the final Groundwater IROD for the WABOU provides a similar discussion of the ERA for WABOU groundwater sites.

Section 3.3 of the final Soil ROD for the WABOU provides a description and history for each WABOU soil site. This section also identifies, for each site, the chemicals of ecological concern (COECs) for surface and subsurface soil, the maximum concentrations detected, and the ecological hazard quotients associated with each contaminant. These findings are summarized in Table II-3-2 of the ROD. Similarly, Section 5.3 of the ROD provides the selected remedial action for each WABOU site, the potential ecological receptors, and the soil cleanup levels determined to be protective of potential ecological receptors.

NEWIOU ERA. Section 3.2.2 of the final NEWIOU Soil, Sediment, and Surface Water ROD describes the ERA for NEWIOU soil and sediment sites. Section 3.3 of the final Groundwater IROD for the NEWIOU describes the ERA for NEWIOU groundwater sites.

Section 3.3 of the final Soil, Sediment, and Surface Water ROD for the NEWIOU provides a description and history for each NEWIOU soil and sediment site. This section also identifies the site-specific COEC for surface soil, subsurface soil, and sediment; the maximum concentrations detected; and the ecological hazard quotients associated with each contaminant. These findings are summarized in Tables II-3-2 and II-3-3 of the final NEWIOU Soil, Sediment, and Surface Water ROD. Similarly, Section 5.3 of the ROD provides the selected remedial action for each NEWIOU site, the potential ecological receptors, and the soil cleanup levels determined to be protective of ecological receptors.

3.3 History of Contamination

As a result of past waste management and disposal practices, groundwater and soil and/or sediment at Travis AFB are contaminated at multiple locations. The locations of the groundwater sites are shown on Figures 3-1 and 3-2. Figure 3-1 shows the groundwater sites and current (2011) plumes. Figure 3-2 shows the groundwater sites and the historical maximum plumes. Similarly, the locations of soil/sediment sites are shown on Figure 3-3.

More extensive and detailed documentation of the historical groundwater and/or soil and sediment contamination at all the ERP sites is provided in the following applicable RI reports:

- NOU RI Report (Radian, 1995)
- EIOU RI Report (Weston, 1995)
- WIOU RI Report (Radian, 1996)
- WABOU RI Report (CH2M HILL, 1997).

3.3.1 Environmental Restoration Program Groundwater Sites

Summaries of the contaminated groundwater ERP sites identified in the Groundwater IROD for the NEWIOU and Groundwater IROD for the WABOU as requiring IRAs are provided in the following subsections, referencing current maximum chemical concentrations based on reported groundwater data through 2011. The summaries briefly describe the status of the IRA, the IRG, and the estimated time to clean up the groundwater.

3.3.1.1 NEWIOU Groundwater Sites

Contaminated groundwater ERP sites within the NEWIOU that required IRAs in accordance with the Groundwater IROD for the NEWIOU include the following:

- **FT004 (Fire Training Area [FTA]-3):** Area used for fire training exercises from approximately 1953 through 1962. During this period, waste fuels, oils, and solvents were burned on open ground. Historical practices resulted in groundwater contamination with CVOCs, mainly TCE. The maximum TCE concentration at this site is 165 parts per billion (ppb). The IRG is 5 ppb. The IRA is prescribed as GET and monitored natural attenuation (MNA). The GET system is currently shut down for a rebound study through the remainder of the interim remediation period. The rebound study has shown that MNA is stopping the plume movement and reducing contaminant concentrations. The estimated site cleanup time is about 35 years.
- **FT005 (FTA-4):** Area used for fire training exercises from approximately 1962 through 1987. During this period, waste fuels, oils, and solvents were burned on open ground. Historical

practices resulted in groundwater contamination with CVOCs, mostly 1,2-dichloroethane (DCA). The contaminant plume extends onto off-base privately owned property. The maximum 1,2-DCA concentration at this site is 5.8 ppb. The IRG is 0.5 ppb. The IRA is prescribed as GET. The GET system is partially currently shut down for a rebound study. Three extraction wells remain in operation to address localized residual contamination. Most of the contaminant plume is already cleaned up. The estimated site cleanup time is about 10 years for the localized residual contamination.

- **LF006 (Landfill 1):** A general refuse landfill that used trench-and-cover methods from approximately 1943 through 1950. Historical practices resulted in groundwater contamination with CVOCs (mainly TCE) and petroleum-fuel hydrocarbons. The maximum TCE concentration at this site is 7.1 ppb. The IRG is 5 ppb. The IRA is prescribed as MNA. Data from 13 years of groundwater monitoring at Site LF006 indicate that the plume is contained and has, in fact, decreased in size over time. MNA is reducing contaminant concentrations. The estimated site cleanup time is about 5 years.
- **LF007B, C, and D (Landfill 2):** A general refuse landfill that used trench-and-cover methods from approximately 1950 through 1970. Historical practices resulted in groundwater contamination with chlorinated VOC, dioxins, and polychlorinated biphenyls (PCBs). The landfill is divided into three sub-areas, shown in italics below. The estimated site cleanup time is about 26 years, which is driven by Site LF007C.
 - *LF007B:* A sub-area of Landfill 2 with historical detections of CVOCs, semi-volatile organic compounds (SVOCs), petroleum fuel constituents, and PCBs. However, these chemicals have not been detected within LF007B for several years.
 - *LF007C:* A sub-area of Landfill 2 with a CVOC plume that extends onto off-base privately owned property. The maximum concentration of TCE within this area is 11.4 ppb. The IRG is 5 ppb. The IRA is prescribed as GET. The GET is undergoing remedial process optimizations to improve its performance.
 - *LF007D:* A sub-area of Landfill 2 that underlies the Travis AFB Corrective Action Management Unit (CAMU). Low concentrations of a CVOC (1,4-dichlorobenzene [DCB]) and fuel hydrocarbon (benzene) are limited to a small area around a single monitoring well. The maximum concentration of 1,4-DCB was detected at 12.6 ppb (IRG is 5 ppb), and benzene was detected at a concentration of 2.2 ppb (IRG is 1 ppb). The IRA is prescribed as MNA Assessment. MNA is reducing contaminant concentrations.
- **SS015 (Solvent Spill Area [SSA] and Facilities 808, 1832, 552):** Facilities used between approximately 1964 through 1980 for solvent stripping of aircraft parts, aircraft maintenance and repair, OWS activities, and hazardous waste accumulation. These activities contaminated groundwater with CVOCs, primarily TCE, 1,2-dichloroethene (1,2-DCE), and vinyl chloride. The maximum concentrations of TCE, cis-1,2-DCE, and vinyl chloride at the site are 432, 7,680, and 3,220 ppb, respectively. The IRGs are 5, 6, and 0.5 ppb, respectively. Currently, a fuel truck facility lies above the contaminated area. The IRA is prescribed as MNA Assessment. During this interim remediation period, various innovative bioremediation technologies were implemented at this site to promote MNA. A vegetable oil study in 2000 and initial EVO injections during a 2010 field demonstration project showed that bioremediation can effectively clean up chlorinated solvents at SS015. The estimated site cleanup time is about 70 years.
- **SS016 (Oil Spill Area [OSA]; Facilities 11, 13/14, 20, and 42/1941; and Portions of the Storm Sewer System):** Multiple flightline support activities throughout the history of Travis AFB consisted of degreasing operations, equipment maintenance and repair, aircraft and vehicle maintenance, hazardous materials storage, and aircraft and vehicle washing. Oil spills, leaking

OWSs, and surface runoff from these activities contaminated the groundwater with CVOCs, primarily TCE. The maximum concentration of TCE recently detected at the site is 319,000 ppb, the highest concentration of TCE found at Travis AFB. The IRG for TCE is 5 ppb. The IRA prescribed is GET. A bioreactor performance evaluation has shown that it can successfully treat high solvent concentrations in a very active aircraft parking and maintenance area. Because of the large and inaccessible contaminated groundwater area, it will take GET a long time to complete the cleanup. The estimated time of cleanup is 100 to 140 years.

- **SS029 (Monitoring Well (MW)-329 Area):** Undeveloped land near the south Base boundary. The historical uses resulting in groundwater contamination with CVOCs are unknown. The main groundwater contaminant is TCE, at a maximum concentration of 680 ppb. The IRG for TCE is 5 ppb. The IRA is prescribed as GET. The GET system is effectively cleaning up groundwater. Groundwater monitoring suggests that the SS016 and SS029 plumes have merged, significantly increasing their cleanup time. The estimated site cleanup time is about 100 to 140 years.
- **SS030 (MW-269 Area):** Unknown historical activities on undeveloped land near the southern Base boundary contaminated groundwater with CVOCs, mostly TCE. The contaminant plume extends onto off-base privately owned property that is used for animal grazing. The maximum concentration of TCE recently detected at the site is 50.4 ppb. The IRG for TCE is 5 ppb. The IRA is prescribed as GET. The GET system is effectively cleaning up groundwater off- and on-site. The estimated site cleanup time is about 22 years.
- **SD031 (Facility 1205):** The maintenance and repair of diesel generators, wash rack activities, operation of an OWS, and aircraft maintenance from approximately 1957 through the present day contaminated the local groundwater with CVOCs, primarily 1,1-DCE. The maximum concentration of 1,1-DCE recently detected at the site is 98.7 ppb. The IRG for 1,1-DCE is 6 ppb. The IRA is prescribed as GET and MNA Assessment. The GET system is currently shut down for a rebound study through the remainder of the interim remediation period. The rebound study has shown that MNA is stopping the plume movement and reducing contaminant concentrations. The estimated site cleanup time is about 15 years.
- **SD033 (Storm Sewer II, South Gate Area, Facilities 810 and 1917, and West Branch of Union Creek):** Fuel transport, aircraft maintenance, and aircraft washing, including the use of wash racks and OWSs, have contaminated groundwater with CVOCs, SVOCs, and petroleum hydrocarbons. TCE is the most prevalent of the contaminants at this site. The maximum TCE concentration recently detected is 76.6 ppb. The IRG for TCE is 5 ppb. The contaminated groundwater at SD033 has merged with plumes from five other sites (SD034, SS035, SD036, SD037, and SD043), so Travis AFB is addressing SD033 as a part of a single plume. The IRA prescribed is GET and MNA Assessment. The GET system is currently shut down for a rebound study through the remainder of the interim remediation period. The rebound study has shown that MNA is stopping the plume movement and reducing contaminant concentrations. The estimated site cleanup time for the merged plume is about 60 years.
- **SD034 (Facility 811):** A leaking OWS associated with an active aircraft wash rack facility released Stoddard solvent into the ground. Pure Stoddard solvent is less dense than water and floats on the groundwater table. A layer of Stoddard solvent was recently measured with a maximum thickness of 0.44 foot. The Stoddard solvent layer was discovered in 2Q11. The leaking OWS was replaced in 1994. Other past industrial activities contaminated the groundwater with CVOCs, SVOCs, and petroleum hydrocarbons. The contaminated groundwater at SD034 has merged with plumes from five other sites (SD033, SS035, SD036, SD037, and SD043), so Travis AFB is addressing SD034 as a part of a single plume. The IRA prescribed is GET and Passive Skimming. The GET system is currently shut down for a rebound study through the remainder of

the interim remediation period. Passive skimming is effectively removing pure Stoddard solvent from the water table. The rebound study shows that MNA is stopping plume movement and will reduce contaminant concentrations once all of the pure Stoddard solvent has been removed. The estimated site cleanup time for the merged plume is about 60 years.

- **SS035 (Facilities 818/819):** Past industrial activities associated with aircraft repair, painting, and washing have contaminated groundwater with CVOCs, primarily TCE. No TCE has been recently detected at the site at a concentration exceeding the IRG of 5 ppb. The contaminated groundwater at SS035 has merged with plumes from five other sites (SD033, SD034, SD036, SD037, and SD043), so Travis AFB is addressing SS035 as a part of a single plume. The IRA prescribed is GET. The GET system is currently shut down for a rebound study through the remainder of the interim remediation period. The rebound study has shown that MNA is stopping the plume movement and reducing contaminant concentrations. The estimated site cleanup time for the merged plume is about 60 years.
- **SD036 (Facilities 872/873/876):** Past industrial activities associated with multiple-use shops, including a wash rack and OWS, have contaminated groundwater with chlorinated VOCs, SVOCs, and petroleum hydrocarbons. TCE is the most prevalent of the contaminants at this site. The maximum concentration of TCE recently detected is 18,500 ppb. The IRG for TCE is 5 ppb. The contaminated groundwater at SD036 has merged with plumes from five other sites (SD033, SD034, SS035, SD037, and SD043), so Travis AFB is addressing SD036 as a part of a single plume. The IRA prescribed is GET and MNA Assessment. The GET system is currently shut down to evaluate biological cleanup of contaminated groundwater, followed by MNA to complete the cleanup. EVO injections during a SD036 field demonstration project have shown that bioremediation can effectively clean up high concentrations of chlorinated solvents at SD036. The estimated site cleanup time for the merged plume is about 60 years.
- **SD037 (Sanitary Sewer System; Facilities 837/838, 919, 977, 981; Ragsdale/V Street Area; and Area G Ramp):** Past industrial activities associated with the management of domestic and industrial wastewater, aircraft maintenance, heavy equipment maintenance, air cargo handling, vehicle washing, fuel transport, and waste accumulation have contaminated groundwater with CVOCs, SVOCs, and petroleum hydrocarbons. TCE is the most prevalent of the contaminants at this site. The maximum concentration of TCE recently detected is 2,070 ppb. The IRG for TCE is 5 ppb. The contaminated groundwater at SD037 has merged with plumes from five other sites (SD033, SD034, SS035, SD036, and SD043), so Travis AFB is addressing SD037 as a part of a single plume. The IRA prescribed is GET and MNA Assessment. The GET system is currently shut down to evaluate biological cleanup of contaminated groundwater, followed by MNA to complete the cleanup. EVO injections during a SD037 field demonstration project have shown that bioremediation can effectively clean up high concentrations of chlorinated solvents at SD037. The estimated site cleanup time for the merged plume is about 60 years.

3.3.1.2 WABOU Groundwater Sites

Contaminated groundwater ERP sites within the WABOU requiring groundwater IRAs in accordance with the final Groundwater IROD for the WABOU (Travis AFB, 1999) include the following:

- **LF008 (Landfill 3):** A series of shallow trenches that were used to dispose of pesticide containers in the 1970s. A cleanup of the pesticide-contaminated soil and debris took place in 2003. However, low concentrations of pesticides remain in the groundwater. For example, the current maximum concentration of alpha-chlordane is about 340 parts per trillion (ppt). The IRG is 100 ppt. The IRA prescribed is GET. The GET system is currently shut down for a rebound study through the remainder of the interim remediation period. In fact, the extent of the alpha-chlordane plume has decreased in size since the GET system was taken off-line. The rebound

study has shown that MNA is stopping the plume movement and reducing contaminant concentrations. The estimated site cleanup time is 100 to 110 years.

- **DP039 (Building 755, Travis AFB Battery and Electric Shop):** Prior to 1978, battery acid solutions and solvents were discharged from Building 755 into a sump, which contaminated the groundwater with CVOCs, primarily TCE. Building 755 was demolished in 2009, and the lot is currently vacant. The maximum concentration of TCE recently detected is 7,000 ppb. The IRG for TCE is 5 ppb. The IRA prescribed is GET, with additional testing of MNA for effectiveness through collection of additional data. Over the past 12 years, treatability studies and demonstration projects have shown that cleanup of this site should incorporate three main components (bioreactor, phytoremediation, and EVO permeable reactive biobarrier [PRB]) to effectively clean up high concentrations of chlorinated solvents. The estimated site cleanup time is 65 years.
- **SS041 (Building 905, Travis AFB Entomology Shop):** From 1983 to 1992, the entomology shop prepared pesticides and herbicides for use at Travis AFB. Outside the building, a wash rack was used to wash down tractors that towed pesticide- and herbicide-applicator vehicles. Overspray from the wash rack contaminated the groundwater with pesticides. The SS041 GET system was installed in 1999. From 2001 through 2003, laboratory analysis of all groundwater samples from the SS041 monitoring well network did not detect any pesticide contaminants. In December 2005, representatives from the Air Force and regulatory agencies signed a No Further Remedial Action Planned Consensus Statement to document the lack of detectable pesticides in SS041 groundwater and the conclusion that there was no need for further groundwater cleanup at SS041. It also documented the decision to decommission the SS041 extraction well system and remove the site from the Travis AFB GSAP Program. The cleanup of SS041 groundwater is complete.
- **SD043 (Building 916):** Building 916 is an emergency electric power facility. Beneath the interior diesel generators is a sump that formerly drained into an outdoor trench, creating a small TCE plume downgradient of the facility. The TCE concentrations have declined to a maximum concentration of 0.72 ppb. The IRG for TCE is 5 ppb. The contaminated groundwater at SD043 has merged with plumes from five other sites (SD033, SD034, SS035, SD036, and SD037), so Travis AFB is addressing SD043 as a part of a single plume. The IRA prescribed is GET. The GET system is currently shut down for a rebound study through the remainder of the interim remediation period. The rebound study has shown that MNA is stopping the plume movement and reducing contaminant concentrations. The estimated site cleanup time for the merged plume is about 60 years.

3.3.1.3 Petroleum-Only Contaminated Groundwater Sites

The Travis AFB POCO Sites Program manages sites with petroleum contamination. POCO sites are typically associated with surface and subsurface releases from fuel spills, piping leaks, OWSs, or underground storage tanks. The POCO Sites Program includes the removal of underground storage tanks and the remediation of POCO soil and groundwater using risk-based cleanup actions. The San Francisco Bay Water Board is the lead oversight agency for this program, because CERCLA excludes petroleum as a CERCLA contaminant. For this reason, the POCO sites are not addressed in either of the groundwater IRODs. However, the Air Force does address petroleum contamination under CERCLA if it is commingled with CERCLA contaminants. POCO sites SS014, ST027, and ST032 were included in the ERP program and were included in the 2008 five-year review because of possible commingled contamination. As explained below, these sites were transferred back to the POCO program, so they are not included in this five-year review.

Site SS014 has no commingled contamination with CERCLA contaminants and has only fuel hydrocarbons, as confirmed by recent groundwater 2010-2011 GSAP data (CH2M HILL, 2012e). Therefore, SS014 will remain a POCO groundwater site and is excluded from this five-year review.

Site ST027 has no commingled contamination; however, an investigation conducted in 2007 resulted in the discovery of TCE and several other CVOCs in groundwater in the southwestern part of the site. This area of the site impacted by CVOCs has been designated as Site ST027B. The area of the site impacted by fuel hydrocarbons has been designated as Site ST027A.

A remedy has not been established for the CVOC plume in Site ST027B; therefore, this site is not further evaluated in this five-year review. However, this site will be included in the Travis AFB Groundwater ROD. The Final Technical Memorandum Site ST027-Area B Characterization Results (CH2M HILL, 2010b) presented a preliminary evaluation of the effectiveness of natural attenuation for addressing the CVOC plume. MNA Assessment continues over the interim period leading up to the Travis AFB Groundwater ROD. Data collected to date indicate that MNA is a suitable remedy to address the Site ST027B plume. Per recent 2010-2011 GSAP data (CH2M HILL, 2012e), the plume has not migrated over the reporting period.

Site ST032 has no chlorinated hydrocarbons present, indicating that the SS016 plume has not migrated east to ST032. Contamination at Site ST032 consists of fuel released via undocumented surface spills or leaks from buried jet fuel lines. There are no identified sources of CERCLA-regulated contaminants within Site ST032. Therefore, this site was transferred to the POCO program in 2009.

3.3.2 Environmental Restoration Program Soil and Sediment Sites

Historically contaminated soil and sediment ERP sites within the NEWIOU and soil sites within the WABOU are discussed in the following subsections. The summaries below provide the year of the soil/sediment RA and the closure status.

3.3.2.1 NEWIOU Soil and Sediment Sites

Contaminated soil and/or sediment ERP sites within the NEWIOU that required RA in accordance with the final Soil, Sediment, and Surface Water ROD for the NEWIOU (Travis AFB, 2006) include the following:

- **SD001 (Union Creek):** Site SD001 contains Union Creek and its associated surface water facilities that follow along the main airstrip. Grass and weeds growing along Union Creek are regularly mowed and tilled to prevent birds and other migratory animals from inhabiting the area. Polynuclear aromatic hydrocarbons (PAHs) were identified in the soil at SD001; pesticides, PAHs, and metals were identified in the creek sediment. The sediment RA was completed in 2010 and residential cleanup levels were achieved. This site was closed on 12 July 2010.
- **FT003 (FTA-2):** Area used for firefighting training exercises used for burning waste fuels, oils, and solvents on open ground from approximately 1950 through 1952. Contaminants detected in the soil include PAHs, metals, pesticides, PCBs, and dioxins. The sediment RA was completed in 2007 and residential cleanup levels were achieved. This site was closed on 29 September 2008.
- **FT004 (FTA-3):** Area used for firefighting training exercises used for burning waste fuels, oils, and solvents on open ground from approximately 1953 through 1962. The site is now an unused, open field. Soil at the site contains dioxins and metals. The sediment RA was completed in 2007 and residential cleanup levels were achieved. This site is considered response complete for soil as of 29 September 2008.

- **FT005 (FTA-4):** Area used for firefighting training exercises used for burning waste fuels, oils, and solvents on open ground from approximately 1962 through 1987. From the early 1970s until the fire training area was closed, only waste fuels were burned. Contaminants detected in the soil include PCBs, metals, PAHs, dioxins, and pesticides. The soil RA was completed in 2011 and residential cleanup levels were achieved. This site is considered response complete as of 28 September 2012.
- **LF007 (Landfill 2):** A general refuse landfill that used trench-and-cover methods from the 1950s through 1974. The former landfill was primarily used for the disposal of general refuse, such as wood, glass, and construction debris. From the early 1950s until 1964, a portion of the eastern part of the site was used for storage of excess and waste materials, including oils, hydraulic fluid, and solvents for resale or disposal. Contaminants detected in the soil include PAHs, PCBs, SVOCs, and metals. Currently, LF007 is also the location of the Base CAMU. The CAMU received contaminated soil meeting acceptance criteria from the site-specific soil RAs in the NEWIOU and WABOU. The CAMU was capped in 2007. A soil RA for Area LF007E was completed in 2007 and residential cleanup levels were achieved. However, the Base CAMU (LF007) has a LUC.
- **SS015 (Solvent Spill Area and Facilities 808, 1832, and 552):** Areas used for solvent stripping of aircraft parts, aircraft maintenance and repair, OWS activities, and hazardous waste accumulation. Aircraft were chemically stripped of paint from approximately 1964 through 1980. In 2004, Facilities 550 and 552 were demolished to construct a petroleum, oil, and lubricants (POL) MILCON project consisting of an office building, a fuel truck maintenance facility, and a large, concrete truck-parking area. Historical practices resulted in areas of soil contaminated with metals and PAHs. A LUC is in place because cadmium concentrations in the soil exceed levels that allow for unlimited use and unrestricted exposure.
- **SS016 (OSA; Facilities 11, 13/14, 20, 42/1941; and Portions of the Storm Sewer System):** Flightline support areas subject to oil spills, degreasing operations, leaking OWS, equipment maintenance and repair, aircraft and vehicle maintenance, hazardous materials storage, aircraft and vehicle washing, and stormwater runoff. The OSA was used from the 1940s through the 1980s. Most of the areas were used from the 1940s through present day. Historical practices resulted in areas of PAH- and PCB-contaminated soil. A LUC is in place because PAH concentrations in the soil exceed levels that allow for unlimited use and unrestricted exposure.
- **SD033 (Storm Sewer II, South Gate Area, Facilities 810 and 1917, and West Branch of Union Creek):** Areas used to handle storm water runoff, fuel transport, aircraft maintenance, and aircraft washdown, including wash racks and OWS. Chemicals used in these areas included fuels, lubricating oils, hydraulic fluids, chlorinated solvents, and soap solutions. Metals, VOCs, and SVOCs were the contaminants detected in sediment at SD033. Surface soil contaminants included metals. A LUC is in place because cadmium and benzo(a)pyrene concentrations in the soil exceed levels that allow for unlimited use and unrestricted exposure. This site also had sediment contamination. The sediment RA was completed in 2010 and residential cleanup levels were achieved. This site is considered response complete as of 12 July 2010.
- **SD037 (Sanitary Sewer System; Facilities 837/838, 919, 977, 981; Ragsdale/V Street Area; and Area G Ramp):** Facilities are involved in the handling of domestic and industrial wastewater, aircraft maintenance, heavy equipment maintenance, air cargo, vehicle washing, fuel transport, and waste accumulation. Chemicals used and handled in this area include wastewater, oils, hydraulic fluids, fuels, transformer fluids, and chlorinated solvents. The Air Force began operating these facilities in the 1940s and continues operations to the present day. Soil contaminants identified at the site include PAHs, fuels, SVOCs, and metals. A LUC is in place

because lead concentrations in the soil exceed levels that allow for unlimited use and unrestricted exposure.

3.3.2.2 WABOU Soil Sites

Contaminated soil ERP sites within the WABOU that required RA in accordance with the final Soil ROD for the WABOU (Travis AFB, 2002) include the following:

- **DP039 (Building 755, Travis AFB Battery and Electric Shop):** Prior to 1978, battery acid solutions and solvents were discharged from Building 755 into a sump. These historical practices resulted in contamination of the soil with low concentrations of lead. The sump was removed in 1993. Left undisturbed, lead in the surface soil around the edges of the former sump area does not present an unacceptable risk to local workers or the environment. A LUC is in place because PAH concentrations in the soil exceed levels that allow for unlimited use and unrestricted exposure.
- **LF008 (Landfill 3):** An inactive historical landfill consisting of a series of small, unlined trenches used to dispose of old pesticide containers. Historical practices resulted in soil contamination with organochlorine pesticides. The soil RA was completed in 2002 and residential cleanup levels were achieved. This site achieved response complete on 27 August 2003.
- **LF044 (Landfill X):** Landfill X is not a landfill, but is actually an equipment training area and a stockpiling area for construction debris that contained metals (e.g., cadmium, lead, and silver) and an SVOC (benzo(a)pyrene). A LUC is in place because metals and SVOC concentrations in the soil exceed levels that allow for unlimited use and unrestricted exposure.
- **RW013 (Radioactive Burial Site 2/Dry Waste Landfill):** Historical practices resulted in soil contamination with low levels of uranium isotopes (U-234, U-235). This dry waste landfill was a fenced backfilled trench that was part of the former Fairfield Air Force Station, an Atomic Energy Commission facility that stored and maintained nuclear weapons. The soil RA was completed in 2003 and residential cleanup levels were achieved. This site was closed on 12 May 2004.
- **SD042 (Buildings 929/931/940):** Building 929 is a storage shed near a former hazardous waste accumulation area. Building 931 is a maintenance facility for portable electrical generators. Both facilities drain into an adjacent drainage ditch. Sediment within the ditch was contaminated with SVOCs and metals. The soil RA was completed in 2003 and residential cleanup levels were achieved. This site was closed on 24 June 2005.
- **SD043 (Building 916):** An emergency electric power facility. Historically, at least one electrical transformer on a concrete pad adjacent to the building leaked cooling oil containing a PCB into the surface soil. Left undisturbed, the concentration of PCB does not present an unacceptable risk to either local workers or the environment. A LUC is in place to restrict residential development and unauthorized disturbance and relocation of soil at this site.
- **SD045 (Former Small Arms Range):** Historical use as a small-arms training range resulted in lead contamination of the soil. The soil RA was completed in 2007 and residential cleanup levels were achieved. This site was closed on 29 September 2008.
- **SS041 (Building 905, Travis AFB Entomology Shop):** Historical maintenance activities contaminated the surface soil with organochlorine pesticides. The soil RA was completed in 2002 and residential cleanup levels were achieved. This site is considered response complete for soil as of 27 August 2003.

- **SS046 (Railhead Munitions Staging Area):** Historical railroad operations deposited metals and SVOCs into the surface soil. Left undisturbed, these compounds do not present an unacceptable risk to either local workers or the environment. A LUC is in place to restrict residential development and unauthorized disturbance and relocation of soil at this site.

3.4 Basis for Taking Action

IRAs to address groundwater contamination at ERP sites within the NEWIOU and WABOU are currently underway in accordance with the final Groundwater IROD for the NEWIOU and the final Groundwater IROD for the WABOU.

For the most part, the IRAs operated successfully during a period of interim remediation. However, after over a decade of interim remediation, the groundwater at most sites remains contaminated at concentrations that exceed federal and California maximum contaminant levels (MCLs). So Travis AFB implemented remedial process optimizations to accelerate and/or improve groundwater cleanup. Below are three concepts considered when considering optimizations. Optimizations of the IRA were performed in agreement with all regulatory agencies and are documented in various RPM meeting minutes and other documents (i.e., GSAPs, work plans, and reports).

GET System IRA Optimization. Over time, the energy-intensive IRA GET systems used at several ERP sites became less efficient and cost-effective as VOC concentrations decreased. Therefore, beginning in 2008 (documented in RPM Meeting minutes in December 2007), Travis AFB initiated a program of GET IRA optimization. The basic approach to optimizing the IRAs is to discontinue inefficient GET system operation and focus on the VOC plume source zones (i.e., areas of high residual contaminant concentrations) with an in-situ treatment technology. Through 2010, IRA optimizations included data gaps investigations followed by injections of EVO and installation of bioreactors. The performance of these optimization measures was and is being monitored for the remainder of the period of interim remediation. If the optimization action proves effective, then that technology may be incorporated into the final remedial action. At several sites, the GET IRA systems have been shut down for rebound studies. Travis AFB is monitoring the groundwater to assess if concentrations will remain stable, decrease, or increase without active pumping. Depending on the results of the rebound studies, the GET systems will remain off or be restarted, either fully or at selected extraction wells.

MNA Assessments. After about a decade of data collection, assessments of MNA performance were conducted for the sites where these actions were selected as either the IRA or part of the IRA. These assessments are provided in the final Natural Attenuation Assessment Report (NAAR) (CH2M HILL, 2010). The fundamental conclusion in the NAAR is that the data are sufficient to conclude that MNA can be an effective remedy, or part of the remedy, at most sites.

Sustainable Remediation. The various IRA optimizations being implemented by Travis AFB include provisions for sustainable remediation. This is a relatively new consideration in evaluating environmental site cleanup methods. Policy statements have been issued by Presidential Executive Order, the Department of Defense, and EPA stating that environmental cleanup programs should fully consider sustainable practices to achieve cleanup objectives. Travis AFB has applied the sustainability consideration in the optimization of the IRAs. Through 2010, sustainable technologies incorporated into the IRA optimizations included the use of solar-powered groundwater extraction wells, organic mulch bioreactors, and subsurface injection of food-grade EVO. Sustainable technology has proven effective during the period of interim remediation.

Soil and sediment RAs at ERP sites were conducted in accordance with the final Soil, Sediment, and Surface Water ROD for the NEWIOU and the final Soil ROD for the WABOU.

3.4.1 Groundwater Contamination

Groundwater contamination is currently present at multiple NEWIOU and WABOU ERP sites at concentrations exceeding the IRGs established by the Groundwater IROD for the NEWIOU and the Groundwater IROD for the WABOU.

The primary groundwater contaminants at NEWIOU and WABOU ERP sites include CVOCs, TCE, 1,1-DCE, cis-1,2-DCE, and 1,2-DCA. Petroleum-fuel constituents, organochlorine pesticides (alpha-chlordane), and other contaminants at concentrations below IRGs are also present at some sites.

Extensive and detailed documentation of historical and current groundwater contamination at Travis AFB is provided in GSAP reports. Travis AFB routinely conducts groundwater sampling and analysis activities at all ERP sites. The findings of these activities are regularly published in annual GSAP reports. The most current data are provided in the final 2010-2011 GSAP Report (CH2M HILL, 2012e). The GSAP's appendices provide data summaries of current groundwater contamination and chemical time-series plots and figures showing contaminant trends over time. More recently, the annual RPO Report for the Groundwater Treatment provides the annual data on the groundwater treatment plants (GWTPs) and process optimization measures that have been undertaken. The most current data are provided in the final 2011 RPO Report for the Groundwater Treatment Plants (CH2M HILL, 2012c).

3.4.2 Soil Contamination

Prior to RA, soil contamination was present at multiple ERP sites within the NEWIOU and WABOU at concentrations that exceeded the Soil Cleanup Levels established by the final Soil ROD for the WABOU and final Soil, Sediment, and Surface Water ROD for the NEWIOU. Soil contaminants included SVOCs, PCBs, and organochlorine pesticides.

All soil RAs at ERP sites within the WABOU have been completed. Soil RAs within the WABOU were performed in 2002, 2003, and 2007.

All soil RAs at ERP sites within the NEWIOU have been completed. Soil RAs within the NEWIOU were completed in 2007, 2009, and 2011.

3.4.3 Vapor Intrusion

In 2009, Travis AFB performed a vapor intrusion assessment for ERP Sites FT004, FT005, LF006, LF007, LF008, SS015, SS016, SS029, SS030, SD031, SD033, SD034, SS035, SD036, SD037, DP039, and SD043 to evaluate the potential for vapor intrusion at ERP groundwater sites within the WABOU and NEWIOU.

This assessment used a phased approach, and field work was conducted in three phases. Soil gas sampling (Phase 1) was performed at Sites FT004, SS029, DP039, and the WIOU. Subslab soil vapor, indoor air, and outdoor air sampling were also performed during Phase 1 at three buildings to support the development of a site-specific attenuation factor for industrial buildings. Phase 2 of the investigation consisted of performing building surveys in areas where shallow soil gas or groundwater data indicated a potential for vapor intrusion pathways to be a concern. Phase 3 of the investigation was performed at ERP Site SS016 and the WIOU, which included Sites SD033, SD034, SS035, SD036, and SD037. The purpose of the Phase 3 investigation was to close remaining data gaps at these sites that were identified upon completion of Phases 1 and 2. Phase 3 consisted of collecting sub-slab soil gas samples, indoor air samples, and outdoor air samples. The samples were collected in July 2009. Phase 3 samples were collected both by the EPA and CH2M HILL. The Final Vapor Intrusion Assessment Report was completed in March 2010 (CH2M HILL, 2010b), and was updated in 2013 (CH2M HILL, 2013) to reflect revised, federally promulgated toxicity criteria for various VOCs.

Based on the 2013 Vapor Intrusion (VI) Assessment Update (CH2M HILL, 2013), there are no sites currently requiring action based on the vapor intrusion pathway. The vapor intrusion pathway is a potential future concern under residential use at Sites FT004, LF007C, SS015, SS016, SS029, SS030, SD033, SD034, SS035, SD036, SD037, and DP039. The vapor intrusion pathway is a potential future concern under industrial use at Sites FT004, SS015, SS016, SS029, SD034, SD036, SD037, and DP039. The vapor intrusion pathway is not a potential future concern under either residential or industrial usage at Sites FT005, LF006, LF008, ST027B, SD031, and SD043.

At several sites overlying VOC plumes in groundwater, potential future buildings and associated residential and/or commercial/industrial use may result in estimated health risk levels above levels of concern. To ensure long-term protectiveness for occupants of potential future buildings constructed at these sites, LUCs consisting of passive ventilation systems and restrictions on placement of buildings within 100 feet of portions of VOC plumes exceeding groundwater-to-indoor-air RBCs are deemed necessary.

To date, LUCs in the form of passive ventilation systems and/or vapor barriers have been designed and built into the following three facilities: Building 554 (which overlies the SS015 plume), Building 837 (which overlies the SD037 plume), and Building 38 (which overlies the SS016 plume). These passive vent systems are in place and are functioning as designed.

As confirmed by the 2013 VI Assessment Update, there are no sites currently requiring action based on the vapor intrusion pathway. VOC concentrations in groundwater, which serve as the source for vapor intrusion, are currently decreasing at applicable sites. Long-term protectiveness for the vapor intrusion pathway is being addressed through continued monitoring of changes in VOCs in groundwater. If VOC concentrations in groundwater increase, an updated systematic evaluation of the vapor intrusion pathway will be triggered to ensure that potential future exposures are prevented. This process is expected to be memorialized in the Travis AFB Groundwater ROD, currently under review by the regulatory agencies.

Below is a summary of the site-by-site vapor intrusion analysis based on the 2013 VI Assessment Update. It should be noted that the assessment below accounts for shallow soil gas risk-based concentrations (SSG RBCs) and groundwater-to-indoor air risk-based concentrations (RBCs) that reflect values updated to federally promulgated toxicity criteria per the 2013 VI Assessment Update. Consistent with the 2013 VI Assessment Update, the term “insignificant exposure pathways” has been used below when describing vapor intrusion at sites where this exposure pathway is considered insignificant because VOC concentrations are below site-specific RBCs, cumulative risks for VOCs are within the EPA’s risk management range of 10^{-6} to 10^{-4} , and hazard indexes are less than 1, or when the pathway is incomplete.

FT004: Groundwater VOC concentrations exceed residential and industrial groundwater RBCs, while industrial SSG RBCs are exceeded at one sampling location and residential SSG RBCs are exceeded at five locations. Currently, the vapor intrusion pathway remains incomplete due to the absence of any buildings at the site.

Based on the above results, LUCs are necessary to manage vapor intrusion risk for potential residential and industrial future use scenarios in areas where groundwater concentrations continue to exceed RBCs.

SS015: The groundwater plume at Site SS015 is limited in extent and largely overlain by Facility 554, which was constructed in 2004. At Site SS015, maximum concentrations of TCE, vinyl chloride, and cis-1,2-DCE exceed groundwater-to-indoor air RBCs for both residential and industrial land use, while benzene concentrations only exceeded the residential RBCs.

Prior to construction of this facility, the Air Force constructed Facility 554 with a vapor barrier and passive vent system. Indoor air sampling at Facility 554 yielded VOC concentrations below industrial indoor air RBCs. Select VOCs were detected in indoor air at similar concentrations as those detected in ambient outdoor air samples. Hence, the vapor intrusion pathway is not a concern relative to current site use. In areas where groundwater concentrations exceed residential and industrial RBCs, there is a potentially significant vapor intrusion concern for future use. LUCs are necessary to manage vapor intrusion risk for potential residential and industrial future use scenarios in areas where groundwater concentrations continue to exceed RBCs.

SS016: Site SS016 is located on the flightline. Because of the negative impact on the Base mission and the restrictions for drilling, only sub-slab, indoor air, and outdoor air samples were collected at two facilities (16 and 18) closest to the groundwater plume (i.e, within 100 feet of the 100-microgram per liter [$\mu\text{g/L}$] TCE plume and within 15 feet of the dense non-aqueous phase liquid [DNAPL] source area).

At Site SS016, maximum concentrations of TCE, cis-1,2-DCE, 1,4-DCB, and vinyl chloride exceeded groundwater-to-indoor air RBCs for both residential and industrial land use. However, the sub-slab and indoor air sampling conducted at Facility 16 indicate that the Site SS016 groundwater plume does not pose a significant vapor intrusion risk under current land use at this facility. In areas where groundwater concentrations exceed industrial or residential RBCs, there is a potentially significant vapor intrusion concern for future use. LUCs are necessary to manage vapor intrusion risk for potential residential and industrial future use scenarios in areas where groundwater concentrations continue to exceed RBCs.

At Facility 18, located at Site SS016, the 2008–2010 vapor intrusion assessment concluded that there was potentially significant future risk from vapor intrusion at this facility because of the presence of DNAPL adjacent to the site and the high TCE concentrations in subslab soil vapor, although TCE concentrations detected in indoor air were low (below industrial RBCs at all but one indoor air sampling location). Facility 18 is not occupied, so there is no current exposure via the vapor intrusion exposure pathway. The results of the comparison against the updated RBC support the conclusion that while the vapor intrusion pathway is not a current concern, the vapor intrusion pathway is a potential concern under future use scenarios at Facility 18 because of the presence of DNAPL and the high TCE source area beneath the building.

SS029: Groundwater VOCs exceed residential and industrial RBCs, while industrial SSG RBCs and residential SSG RBCs were exceeded at seven and 14 locations, respectively. However, indoor air samples at Facility 1130 did not reveal any VOCs exceeding industrial indoor air RBCs. Moreover, the single building at the site is not routinely occupied and soil gas concentrations adjacent to the building are below industrial SSG RBCs. Therefore, the vapor intrusion pathway is considered insignificant under current land use.

In areas where groundwater concentrations exceed industrial or residential RBCs, there is a potentially significant vapor intrusion concern for future use. LUCs are necessary to manage vapor intrusion risk for potential residential and industrial future use scenarios in areas where groundwater concentrations continue to exceed RBCs.

WIOU (Sites SD033, SS035, SD036, SD037): WIOU Sites SD033, SS035, SD036, and SD037 were addressed together because of their proximity and similarity of site conditions and remedial solutions. VOC contamination from these sites has commingled to form a large VOC groundwater plume in the industrialized area of Travis AFB.

At these sites, groundwater VOC concentrations exceed residential and industrial RBCs, while shallow soil gas concentrations exceed industrial and residential SSG RBCs at two and 10 locations,

respectively. Moreover, indoor air and subslab VOC concentrations remain below industrial RBCs or are not indicative of a groundwater source.

Across these sites, few buildings directly overlie the groundwater plume, and soil gas, indoor air, and subslab data in and near existing buildings do not indicate the presence of a significant vapor intrusion risk under current and future industrial land use. The benefits of EVO injections in source areas within the VOC plume are expected to continue to help reduce risks associated with the vapor intrusion pathway, including reductions in cis-1,2-DCE and vinyl chloride, which temporarily increased at Sites SD036 and SD037. In areas where the groundwater concentrations exceed the residential RBCs, there is a potentially significant vapor intrusion risk for future residential use. Accordingly, LUCs are necessary to manage vapor intrusion risk for potential residential and industrial future use scenarios in areas where groundwater concentrations continue to exceed RBCs.

Site SD034: Groundwater VOCs exceed residential and industrial RBCs; however, industrial SSG RBCs were not exceeded at any sample locations, while the residential SSG RBCs were exceeded at only one location. Facility 881 at Site SD034 is a large, often open air craft hangar and is accordingly not enclosed during work hours; hence, the risk associated with the vapor intrusion pathway is considered insignificant under current land use. However, the presence of the floating product (Stoddard solvent) may pose a potentially significant vapor intrusion concern for both residential and future industrial usage. Accordingly, LUCs are necessary to manage vapor intrusion risk for potential residential and industrial future use scenarios in areas where groundwater concentrations continue to exceed RBCs.

Site DP039: VOCs in groundwater exceed residential and industrial RBCs, while industrial and residential SSG RBCs are exceeded at two and 11 locations, respectively. Indoor air and subslab VOC concentrations at former Facility 755 are below industrial RBCs.

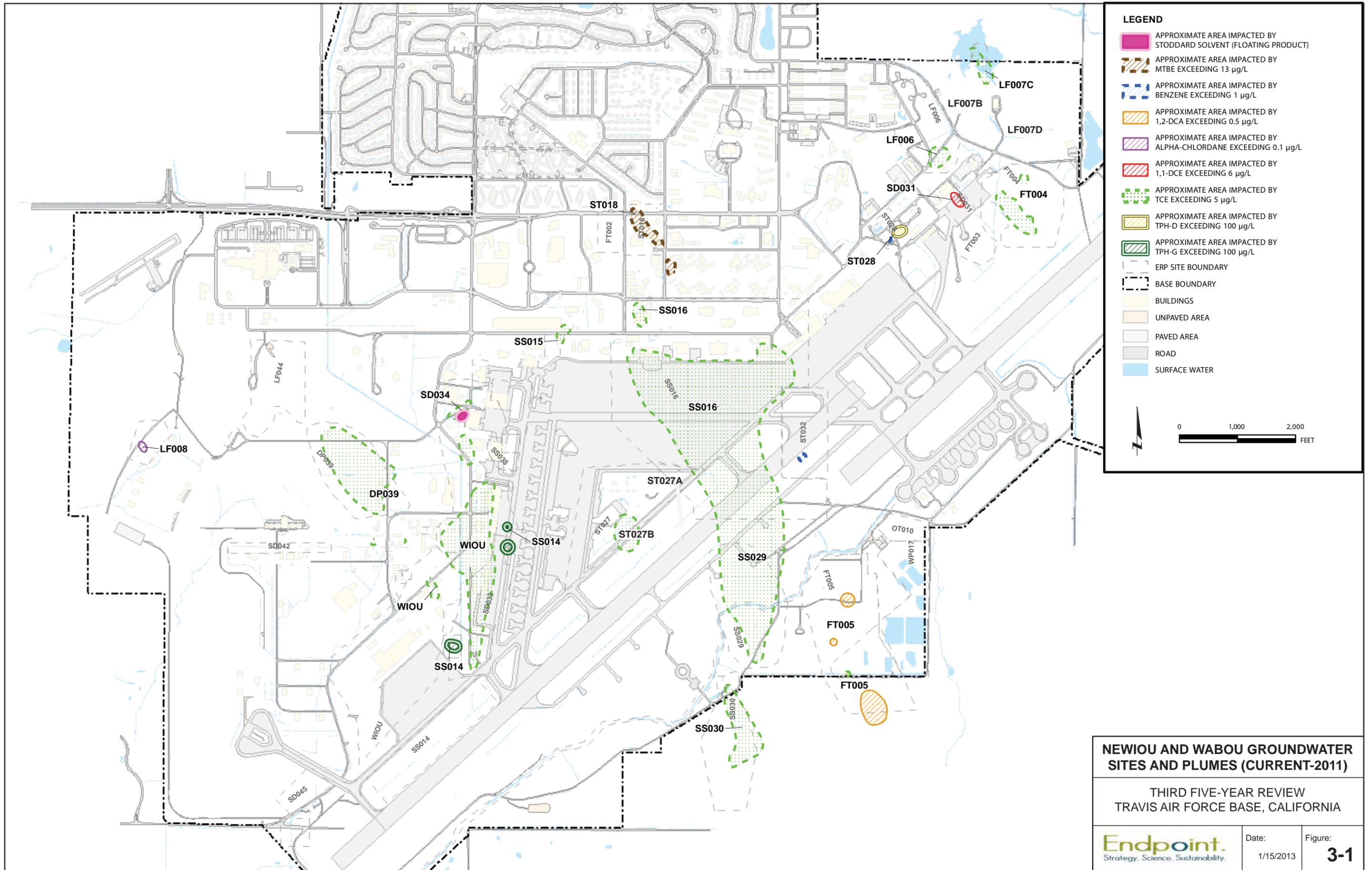
Given the aforementioned indoor air and subslab vapor concentrations, and because soil gas concentrations adjacent to the buildings overlying the groundwater plume are below industrial SSG RBCs, the risk of vapor intrusion is considered insignificant under current land use. However, in areas where groundwater concentrations exceed industrial or residential RBCs, there is a potentially significant vapor intrusion concern for future use. LUCs are necessary to manage vapor intrusion risk for potential residential and industrial future use scenarios in areas where groundwater concentrations continue to exceed RBCs.

LF007 and SS030: TCE in groundwater at Site LF007C and SS030 was detected at concentrations exceeding the residential groundwater-to-indoor-air risk-based concentration (RBC), but not the corresponding industrial RBC. However, the on-base portions of Site LF007C and SS030 are on a landfill and along a road, respectively, and neither is suitable for building construction. The off-base portion of both sites are controlled by easements already in place, which further limit building and well installations, rendering the vapor intrusion pathway incomplete. Combined, the presence of the landfill and road on-base and the off-base easements serve to eliminate potential exposure to VOC vapors from groundwater at both on-base and off-base portions of Sites LF007C and SS030.

In areas where groundwater concentrations exceed industrial or residential RBCs, there is a potentially significant vapor intrusion concern for future use. LUCs are accordingly necessary to manage vapor intrusion risk for potential residential and industrial future use scenarios in areas where groundwater concentrations continue to exceed RBCs.

FT005, LF006, LF008, ST027B, SD031, and SD043: These sites are considered to have insignificant risk of vapor intrusion under both residential and industrial scenarios because groundwater concentrations remain below site-specific screening levels. No further vapor intrusion investigation is needed at these sites.

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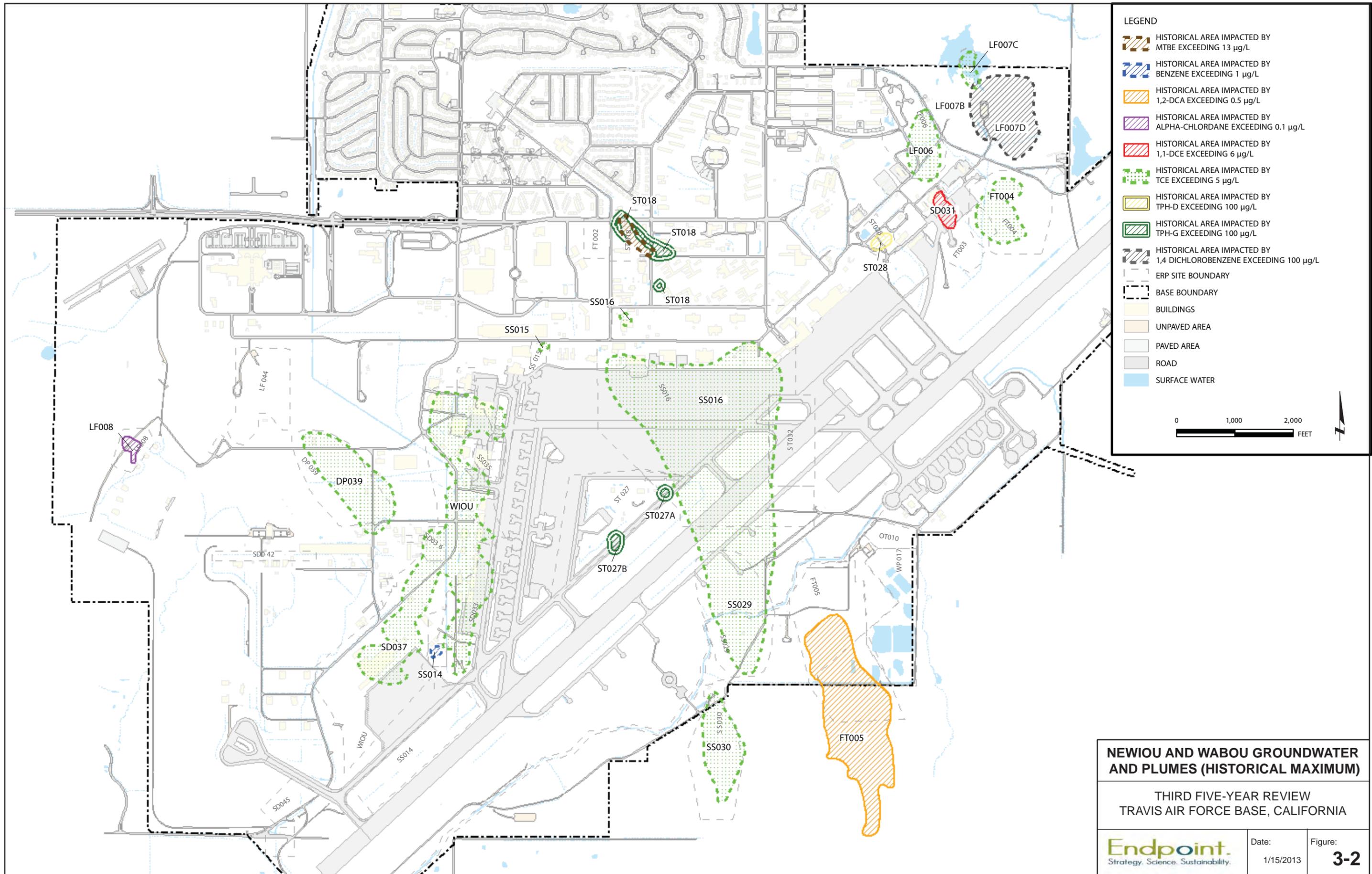


- LEGEND**
- APPROXIMATE AREA IMPACTED BY STODDARD SOLVENT (FLOATING PRODUCT)
 - APPROXIMATE AREA IMPACTED BY MTBE EXCEEDING 13 µg/L
 - APPROXIMATE AREA IMPACTED BY BENZENE EXCEEDING 1 µg/L
 - APPROXIMATE AREA IMPACTED BY 1,2-DCA EXCEEDING 0.5 µg/L
 - APPROXIMATE AREA IMPACTED BY ALPHA-CHLORDANE EXCEEDING 0.1 µg/L
 - APPROXIMATE AREA IMPACTED BY 1,1-DCE EXCEEDING 6 µg/L
 - APPROXIMATE AREA IMPACTED BY TCE EXCEEDING 5 µg/L
 - APPROXIMATE AREA IMPACTED BY TPH-D EXCEEDING 100 µg/L
 - APPROXIMATE AREA IMPACTED BY TPH-G EXCEEDING 100 µg/L
 - ERP SITE BOUNDARY
 - BASE BOUNDARY
 - BUILDINGS
 - UNPAVED AREA
 - PAVED AREA
 - ROAD
 - SURFACE WATER

NEWIOU AND WABOU GROUNDWATER SITES AND PLUMES (CURRENT-2011)

THIRD FIVE-YEAR REVIEW
TRAVIS AIR FORCE BASE, CALIFORNIA

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LEGEND

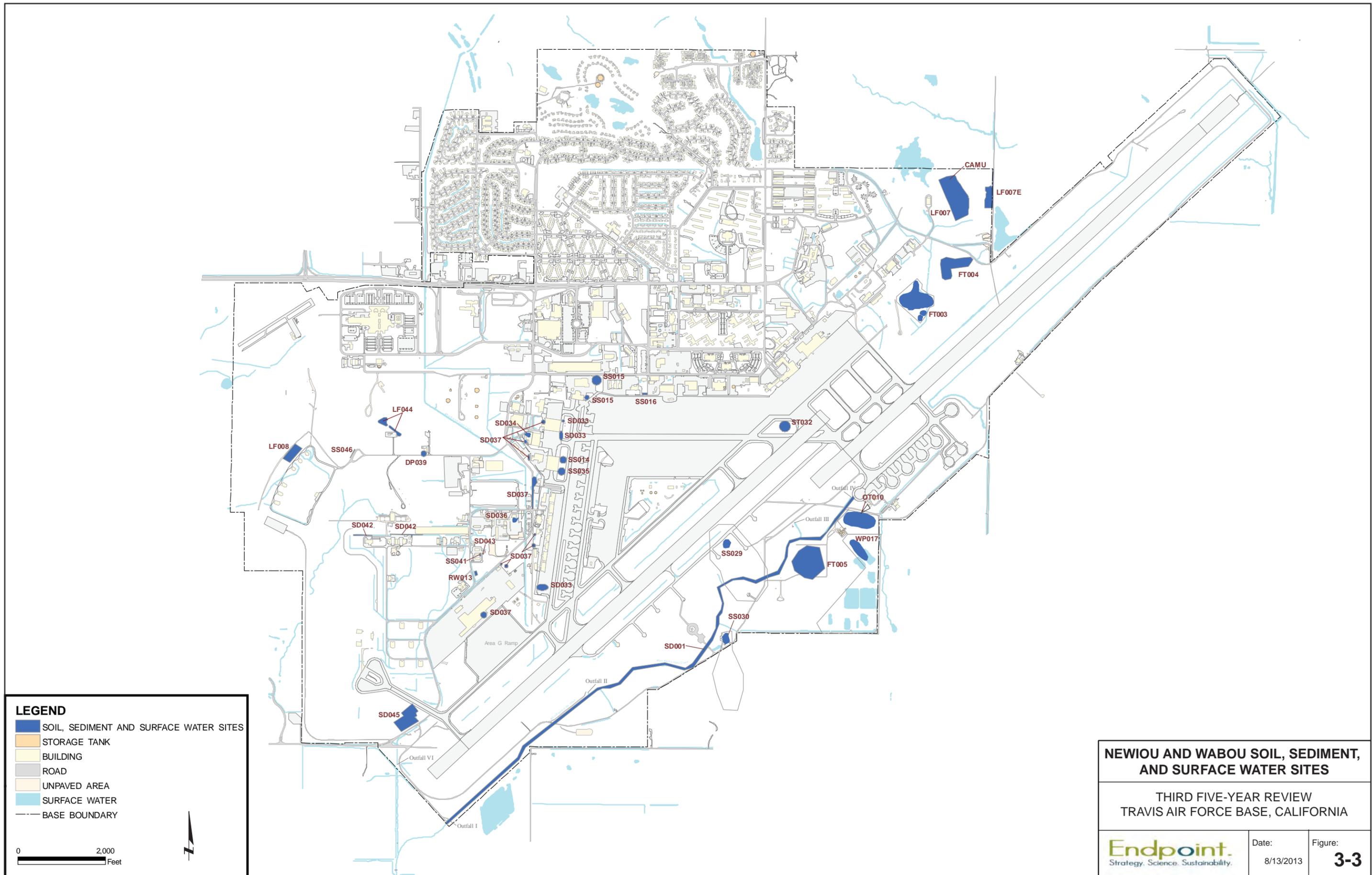
- HISTORICAL AREA IMPACTED BY MTBE EXCEEDING 13 µg/L
- HISTORICAL AREA IMPACTED BY BENZENE EXCEEDING 1 µg/L
- HISTORICAL AREA IMPACTED BY 1,2-DCA EXCEEDING 0.5 µg/L
- HISTORICAL AREA IMPACTED BY ALPHA-CHLORDANE EXCEEDING 0.1 µg/L
- HISTORICAL AREA IMPACTED BY 1,1-DCE EXCEEDING 6 µg/L
- HISTORICAL AREA IMPACTED BY TCE EXCEEDING 5 µg/L
- HISTORICAL AREA IMPACTED BY TPH-D EXCEEDING 100 µg/L
- HISTORICAL AREA IMPACTED BY TPH-G EXCEEDING 100 µg/L
- HISTORICAL AREA IMPACTED BY 1,4 DICHLOROBENZENE EXCEEDING 100 µg/L
- ERP SITE BOUNDARY
- BASE BOUNDARY
- BUILDINGS
- UNPAVED AREA
- PAVED AREA
- ROAD
- SURFACE WATER

0 1,000 2,000 FEET

NEWIOU AND WABOU GROUNDWATER AND PLUMES (HISTORICAL MAXIMUM)

THIRD FIVE-YEAR REVIEW
TRAVIS AIR FORCE BASE, CALIFORNIA

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NEWIOU AND WABOU SOIL, SEDIMENT, AND SURFACE WATER SITES

THIRD FIVE-YEAR REVIEW
TRAVIS AIR FORCE BASE, CALIFORNIA

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SECTION 4

Groundwater Interim Remedial Actions and Soil and/or Sediment Remedial Actions

This section describes the selection and implementation of groundwater IRAs and soil/sediment RAs at sites within the NEWIOU and WABOU.

4.1 Groundwater Interim Remedy Selection

The IRAs to address groundwater contamination at Travis AFB were selected in the final Groundwater IROD for the NEWIOU and the final Groundwater IROD for the WABOU.

For the most part, the IRAs operated successfully during a period of interim remediation. However, after over a decade of interim remediation, the groundwater at most sites remained contaminated at concentrations that exceeded federal and California MCLs. Furthermore, over time, the energy-intensive IRA GET systems used at several ERP sites became less efficient and cost-effective as VOC concentrations decreased.

Therefore, beginning in 2008 (documented in RPM December 2007 meeting minutes), Travis AFB initiated a program of GET IRA optimization. The basic approach to optimizing the IRAs is to discontinue inefficient GET system operation and focus on VOC plume source zones. (i.e., “hot-spots”) with in-situ treatment technology. Through 2010, IRA optimizations included data gaps investigations followed by injections of EVO and installation of bioreactors. The performance of these optimization measures is being monitored for the remainder of the period of interim remediation.

At several sites, the GET IRA systems have been shut down for rebound studies. Travis AFB is monitoring the groundwater to assess if concentrations will remain stable, decrease, or increase without active pumping. Depending on the results of the rebound studies, the GET systems will remain off or be restarted, either fully or at selected extraction wells.

Rebound of contaminants is evaluated as part of the annual groundwater sampling program and documented in the RPO Reports. The main focus of the rebound studies is to confirm, when the GET IRA systems are shut down, that natural attenuation is stopping plume movement and reducing contaminant concentrations.

Due to the success of remedial process optimizations and rebound studies during the period of interim remediation, Travis AFB has re-initiated the CERCLA process to implement the final RA at each groundwater site. Recommended groundwater RAs have been presented in the Final Proposed Plan for Groundwater Cleanup (October 2012). The pending Travis AFB Groundwater ROD is currently undergoing regulatory review and revision. It is expected that, by July 2013, the final groundwater RAs will be selected based on the Final Groundwater ROD.

4.1.1 Groundwater Interim Remedial Action Objectives

The groundwater IRAs (as specified in the two IRODs) and the remedial process optimizations (i.e., rebound studies and demonstration projects) have been designed and constructed to achieve the following objectives:

- Source Control
- Migration Control
- Off-Base Remediation
- Monitored Natural Attenuation

A summary of the IRA objectives for each ERP site and the RPO measures implemented at each site is provided in Table 4-1.

4.1.1.1 Source Control Objectives

The objective of source control is to hydraulically contain and remove contaminant mass from the groundwater and vadose zone using groundwater extraction and treatment GET and vapor extraction and treatment in areas where groundwater VOC concentrations are relatively high, typically greater than 1,000 µg/L. Source control actions using GET are taken where secondary sources of VOC contamination (i.e., LNAPL or DNAPL) are known or are reasonably thought to exist. Dissolved contaminant concentrations of approximately 3,000 µg/L are considered indicators of the possible presence of DNAPLs. However, as a conservative measure to address uncertainties in the distribution of contamination, source control actions are typically taken where groundwater VOC concentrations exceed 1,000 µg/L.

Source control actions are typically designed and constructed primarily to achieve hydraulic containment and removal of the highest concentrations of groundwater contamination (VOC contaminants at concentrations of 1,000 µg/L and higher), and to prevent these concentrations from migrating to areas with concentrations below 1,000 µg/L. During the past five years, RPOs such as bioreactors and EVO injections have been implemented to enhance source control. In some cases, the extraction well system was modified to improve hydraulic capture of the source.

Detailed discussion of the effectiveness of the RPOs and EVO activities implemented over the past five years is included in Section 7.1.1.2 and Appendix D.

4.1.1.2 Migration Control Objectives

The migration control objective is typically achieved using a GET system to hydraulically contain areas of contamination where groundwater concentrations are between 100 and 1,000 µg/L.

Migration control GET systems were designed and constructed primarily to prevent VOC contaminants at concentrations between 100 and 1,000 µg/L from migrating to areas with concentrations below 100 µg/L. However, in areas where it was found to be technically and economically feasible, migration control GET systems were installed to hydraulically contain contamination at lower concentrations. For example, at Site SS029, located near the southern Base boundary, the GET system was designed to hydraulically contain the leading edge of the plume and prevent any off-base migration of groundwater contamination.

Because at Site DP039 migration control was not achieved by its GET system, an RPO measure was implemented: installation of a PRB-containing EVO. Ongoing monitoring will verify whether mass reduction provided by the EVO PRB is sufficient to stabilize the distal portion of the plume.

At several sites, the GET system has been shut down as part of the MNA Assessment (a.k.a. rebound study). The MNA Assessment evaluated plume migration after shut down of the GET system. MNA was considered effective if the plume did not migrate.

4.1.1.3 Monitored Natural Attenuation Objectives

MNA relies on natural physical, chemical, and/or biological processes to limit the migration of a contaminant plume, or portion of a plume. Areas of groundwater with relatively low-concentration contamination located hydraulically downgradient of a GET system are typically included in MNA assessments at Travis AFB.

After about a decade of data collection, assessments of MNA performance were conducted for the sites where these actions were selected as either the IRA or part of the IRA. These assessments are provided in the final NAAR (CH2M HILL, 2010a). The fundamental conclusion in the NAAR is that the data are sufficient to conclude that MNA can be an effective remedy, or part of the remedy, at most sites.

The NAAR describes the results of an MNA Assessment at Travis AFB. The objective of the NAAR is to provide a summary of existing data and determine whether MNA is an effective remedy. The primary indication as to whether MNA is an appropriate remedy at a site is whether or not the groundwater plume is stable or has reduced in size. Over the interim period (8 to 10 years, depending on the site), the GSAP has monitored networks of wells at each site. At most sites, the plume has not only been stable, but has exhibited declining VOC concentrations during the interim period, indicating that MNA is an effective remedy at the site.

In the IRODs, MNA was selected as an interim remedy for one site (LF006) and as a potential remedy to be considered at all or portions of seven other sites (LF007, SS015, SS016, ST032, SD033, SD037, and DP039). With the exception of sites SS016 and ST032, MNA Assessments were performed at all the sites over this interim period. Because groundwater contamination at sites SS016 and ST032 was determined to be within the extent of hydraulic capture of the SS016 and SS029 GET systems, these sites were not evaluated for MNA, as was specified in the NEWIOU Groundwater IROD.

The downgradient portions of two adjacent sites, FT004 and SD031, were included for MNA evaluation over the interim period, although MNA evaluation was not specified for these sites in the IROD. GET was specified as the interim groundwater remedy at FT004 and SD031, but no interim remedial actions were specified for the downgradient portions of the plumes. However, Travis AFB recognized that, to provide a comprehensive remedy at these sites, the groundwater that is not captured by the GET system needs to be addressed. Therefore, the portions of these sites not affected by the pumping remedial action were evaluated for MNA over the interim period.

Site LF006 is the only site at which MNA was selected as all, or part, of the IRA in the IROD. At LF006, MNA is the selected IRA for the entire site. For DP039, MNA has been tested and is one component of a three-part IRA rather than a stand-alone remedy. As part of the RPOs, Site SS015 received EVO injections and Site DP039 received EVO injections in a barrier-like formation.

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TABLE 4-1
Summary of NEWIOU and WABOU Groundwater Sites and Groundwater Interim Remedial Actions and Remedial Process Optimizations
Third Five-Year Review Report, Travis AFB, California

IRA	Site	IRA Objective ^a					Optimization Measures			Comments
		Source Control	Migration Control	Off-Base Remediation	MNA	MNA Assessment	GET shutdown / GET adjustment	EVO injections	Bioreactor	
North IRA	FT004	√				√ ^b	√			The North Groundwater Treatment Plant (NGWTP) GET shut down in March 2009 for a rebound study of Sites FT004 and SD031. The rebound study demonstrated that MNA is stopping plume movement and reducing contaminant concentrations. Site cleanup is estimated at 35 years for FT004 and 15 years for SD031.
	SD031	√				√ ^b	√			
	LF006					√				No remedial process optimization measures implemented. MNA is cleaning up site. Site cleanup is estimated at 5 years.
	LF007B					√				Site LF007B has already met preliminary cleanup goals by MNA. No optimization measures implemented at this site.
	LF007C		√	√		- ^c	√			In December 2009, the NGWTP GET was reconfigured to treat extracted groundwater from only the Site LF007C solar-powered extraction wells with granular activated carbon (GAC). All of the energy needed to process the groundwater through the GAC vessels is provided by the solar-powered extraction wells. Optimization measures continue as Travis AFB defines the downgradient extent of the TCE plume, which includes expansion of existing GET system. The current strategy is to increase the pump size in the extraction well to increase the hydraulic influence; aquifer tests are pending to support pump size determination. Site cleanup is estimated at 26 years.
	LF007D					√				MNA will clean up Site LF007D; no remedial process optimization measures implemented at this site. Site cleanup is estimated at 23 years.
South IRA	SS030	√	√	√			√			The remedial process optimization of the GET system aims to increase capture of the VOC plume by eliminating the hydraulic influence of adjacent extraction wells at Site FT005. In 2007, the extent of capture of the Site SS030 GET improved by shutting down most of the Site FT005 extraction wells. The 2Q11 groundwater elevation contours indicate that the eastern portion of the plume is within the extent of hydraulic capture. Site cleanup is estimated at 22 years.
	SS029		√							Because groundwater contamination beyond the hydraulic control of the Site SS016 IRA is migrating to Site SS029, groundwater remediation at Site SS029 will likely continue after Sites FT005 and SS030 have reached cleanup goals. Site cleanup is estimated at 100 to 140 years.
	FT005			√			√			Groundwater remediation has nearly been achieved at Site FT005, so a rebound study was initiated. The GET system was shut down in December 2007 and all 15 extraction wells were shut down for a rebound study. In 2010, 1,2-DCA was detected above IRGs; consequently, three extraction wells were brought back on-line. Site cleanup is estimated at 10 years.
Central IRA	SS016	√					√		√	A bioreactor was installed in the area with the highest TCE concentrations as an interim remedy optimization in 2010. Site cleanup is estimated at 100 to 140 years.
	ST027B					√				No remedial process optimizations were implemented. MNA is proving to be effective at this site. Site cleanup is estimated at 50 years.
West IRA	SD033 ^d		√			√	√			The WIOU GET shut down in April 2010 for a rebound study of Sites SD033, SD034, SD035, SD036, SD037, and SD043. The data obtained from the WIOU between 2Q10 and 4Q11 indicate that significant rebound of the contaminant plume is not occurring. The rebound study demonstrated that MNA is stopping plume movement and reducing contaminant concentrations. At sites SD036 and SD037, injections of EVO have promoted biological cleanup of contaminated groundwater. Site cleanup is estimated at 60 years at each of the sites within the WIOU.
	SD034 ^e	√	√				√			Source control by removal of Stoddard solvent floating product is ongoing via a passive skimmer.
	SS035 ^f		√ ^b			-	√			
	SD036 ^g	√	√			-	√	√		Initial EVO injections during field demonstrations have shown that bioremediation can effectively clean up high concentrations of chlorinated solvents.
	SD037 ^h	√	√			√	√	√		
	SS041 ⁱ		√				√			The cleanup of site is complete.
SD043 ^j		√				√				

TABLE 4-1
Summary of NEWIOU and WABOU Groundwater Sites and Groundwater Interim Remedial Actions and Remedial Process Optimizations
Third Five-Year Review Report, Travis AFB, California

IRA	Site	IRA Objective ^a					Optimization Measures			Comments
		Source Control	Migration Control	Off-Base Remediation	MNA	MNA Assessment	GET shutdown / GET adjustment	EVO injections	Bioreactor	
West IRA	SS015					√		√		EVO injections during field demonstrations in December 2010 and January 2011 have shown that bioremediation can effectively clean up high concentrations of chlorinated solvents. Vegetable oil injection pilot tests conducted in June and December 2000 may have promoted growth of bacteria. Site cleanup is estimated at 70 years.
	DP039	√	--			√	√	√	√	Remedial process optimizations, treatment studies and demonstration projects over the past 12 years have shown that a combination of bioreactor, phytoremediation, and EVO PRB can clean up chlorinated solvent at Site DP039. Site cleanup is estimated at 65 years.
	LF008		√				√			In December 2008, GET shut down for rebound study. In 2012, Travis AFB performed a study to determine why pesticide plume decreased in size once the GET was shut down. The results of this study indicate that pesticides are bound to the fine-grained sediments at Site LF008 rather than dissolved in the groundwater. GET cannot be an effective remedy and, in fact, appears to be counterproductive. The rebound study demonstrated that MNA is stopping plume movement. Site cleanup is estimated at 100 to 110 years.

^a IRA objective specified in the Groundwater NEWIOU and WABOU IRODs.

^b IRA not specified in the Groundwater IROD for the NEWIOU, but implemented by the Air Force to address entirety of commingled plume.

^c Assessment of MNA not implemented because of plume interactions with the LF007C groundwater extraction system.

^d ERP Site SD033 comprises five noncontiguous sites: Facility 810, Facility 1917, Storm Sewer System II, the South Gate area, and the West Branch of Union Creek.

^e ERP Site SD034 is associated with Facility 811.

^f ERP Site SS035 is associated with Facilities 818 and 819.

^g ERP Site SD036 is associated with Facilities 872, 873, and 876.

^h ERP Site SD037 is associated with the Sanitary Sewer System; Facilities 837, 838, 919, 977, 981; the Area G Ramp; and the Ragsdale/V Street area.

ⁱ ERP Site SS041 is associated with Facility 905.

^j ERP Site SD043 is associated with Facility 916.

Notes:

-- = Migration control not implemented pending evaluation of MNA and phytoremediation effectiveness.

NGWTP = North Groundwater Treatment Plant

4.1.1.4 Off-Base Remediation Objectives

The objective of off-base remediation is to prevent further migration of groundwater contaminants by using GET to hydraulically contain and remediate the off-base portion of plumes down to the contaminant-specific IRG specified in the Groundwater IROD for the NEWIOU. All known off-base contaminant plumes originate from sites located within the NEWIOU. These sites include FT005, LF007C, and SS030.

The FT005 GET network was modified (i.e., 3 out of the 15 extraction wells are currently operational) to focus solely on preventing off-site migration, as source control has been achieved. When this adjustment occurred, hydraulic capture improved at the Site SS030 GET system. Historically, when FT005's 15 extraction wells were all operating, it was adversely influencing the groundwater capture at Site SS030. Remedial process optimizations are currently ongoing at Site LF007C. Site LF007C's GET system was modified to improve hydraulic capture. Specifically, the solar powered extraction wells were modified to include batteries, so the wells could function at night when solar energy is not available.

4.1.2 Institutional Controls on Groundwater Use

Travis AFB has LUCs in place at sites with groundwater contamination. These LUCs are described in paragraph 5.6 of the WABOU Groundwater IROD, in paragraph 5.1.2 of the NEWIOU Groundwater IROD, and further clarified in an October 2008, Travis AFB memorandum, "*Institutional Land Use Controls at Travis Air Force Base Groundwater Sites.*" The LUCs are also detailed in the Travis AFB General Plan (GP). Additionally, Travis AFB performs annual inspections to confirm that institutional controls on groundwater are effective. Figure 4-13 shows the LUC boundaries.

The Travis AFB GP is a long-range planning tool that provides a framework for selecting the locations of future facilities needed to carry out Travis AFB's mission. The GP describes the specific LUCs for each site, the reasons for the controls, and the areas where the controls are applied. It is web-based and accessible to all base personnel who are authorized to use the Travis AFB local area network.

Another tool for LUC enforcement is the Air Force Form 332 (AF332) or Base Civil Engineer Work Request. This form must be submitted and approved before the start of any building project at Travis AFB. Approval of this form involves the comparison of the building site with the constraints in the GP. The AF332 serves as the document for communicating any construction constraints to the appropriate offices. Any constraints at the site result in the disapproval of the form unless the requester makes appropriate modifications to the building plans.

Travis AFB also uses the 60th Air Mobility Wing Form 55 or Excavation Permit to enforce the residential development and soil and sediment disturbance restrictions. The requester submits the permit to the Civil Engineer Squadron for any project that involves mechanical soil or sediment excavation, such as digging trenches for underground lines or excavating soil for building foundations. If constraints involving soil disturbance or worker safety exist at the excavation area, the permit describes the appropriate procedures that will prevent unknowing exposure to contamination and measures that the workers must implement before the start of excavation.

Both AF332s and excavation permits are subject to an Environmental Impact Analysis Process (EIAP) analysis, conducted pursuant to the National Environmental Policy Act, as promulgated for the Air Force in 32 CFR 989, et. seq. An Air Force Form 813 initiates the EIAP process. The proponent of a proposed action is required to submit the AF332 or excavation permit with the Form 813 so that the appropriate environmental analysis of the proposed action and alternatives to the proposed action is accomplished prior to any construction activities. The EIAP process works to ensure that proposed construction sites are reviewed in accordance with the GP. The process also

ensures that all environmental factors, as well as established LUCs, are considered in selecting locations for construction projects.

An administrative control that pertains to groundwater sites involves the protection of future buildings against indoor intrusion of vapors from VOC plumes in groundwater. Travis AFB performed a vapor intrusion assessment in 2009, with updated assessments in 2012 and 2013; a systematic evaluation for the potential for vapor intrusion at all applicable sites is included in Section 3.4.3, herein. To summarize, there are no sites currently requiring action based on the vapor intrusion pathway. The vapor intrusion pathway is a potential future concern under residential use at Sites FT004, LF007C, SS015, SS016, SS029, SS030, SD033, SD034, SS035, SD036, SD037, and DP039. The vapor intrusion pathway is a potential future concern under industrial use at Sites FT004, SS015, SS016, SS029, SD034, SD036, SD037, and DP039. The vapor intrusion pathway is not a potential future concern under either residential or industrial usage at Sites FT005, LF006, LF008, ST027B, SD031, and SD043.

For sites where the vapor intrusion pathway is a potential future concern, the 2013 VI Assessment Update has identified LUCs in the form of passive ventilation systems to be implemented as part of construction of future buildings in order to ensure protection of indoor air quality. In addition, the vapor intrusion assessment has outlined a 100-foot buffer beyond the area of groundwater contamination (as defined by isoconcentration contours) exceeding groundwater-to-indoor-air RBCs, where future buildings may be placed.

The vapor intrusion assessment for Facility 18 supports the conclusion that while the vapor intrusion pathway is not a current concern, the vapor intrusion pathway is a potential concern under future use scenarios because of the presence of DNAPL and the TCE source area beneath the building. Facility 18 is not occupied, so there is no current exposure via the vapor intrusion exposure pathway. To address potential future exposure, a LUC has been implemented to restrict the use of this facility for storage purposes. This LUC was put into place after the 2010 Vapor Intrusion Assessment Report was finalized. This control is documented in the GP.

Three plumes of contaminated groundwater have migrated off-base; they are associated with Sites LF007C, FT005, and SS030 and lie beneath private property. To manage the groundwater IRAs for these sites, Travis AFB purchased long-term easements that grant access rights to the United States, its representatives, agents, and contractors for the purpose of conducting an environmental response on the properties. The easements restrict the landowners from interfering or abridging the exercise of the government's rights under the easement. The United States would view any residential development and any well drilling on the properties covered by the easements as interfering with the government's easement and would take appropriate action to prevent interference with its rights under the easement. The Air Force will purchase additional easements in the event that the off-base plumes remain contaminated at the expiration of the terms of the easements, to restrict new well construction within the contaminated plumes.

Further, Solano County Ordinance, Chapter 13.10, makes it a misdemeanor to construct a well without a Solano County permit and requires the permit requester to notify the County of all wells within a 100-foot radius of the proposed well site. Given the number of monitoring and extraction wells the government is operating on the easements, this ordinance ensures that Travis AFB will be notified of a landowner's well drilling plans. Additionally, Travis AFB's wells are frequently monitored, and any landowner actions potentially interfering with the easements would be observed. The landowner would be contacted to rectify the situation. To date, no such activities have been observed and there are no known drinking water wells that draw water from the plumes, as confirmed by the frequent presence of base and contractor personnel in the off-base area as part of conducting the interim remedy.

Throughout their duration, the easements restrict development of new wells and incompatible use of the water below the property.

4.2 Groundwater Remedy Implementation

Travis AFB has constructed interim groundwater remedies to achieve the groundwater IRA objectives stated in the Groundwater IROD for the NEWIOU and the Groundwater IROD for the WABOU. Beginning in 2009, remedial process optimizations have been implemented to improve the groundwater remedies' ability to achieve IRA objectives. RPO measures include reconfiguration of GET networks, injection of EVO, and installation of bioreactors.

Routine groundwater monitoring of the interim remedies, including RPO measures, is conducted under the GSAP, and in the future will be implemented under the Groundwater Remediation Implementation Program (GRIP).

4.2.1 NEWIOU Groundwater Interim Remedial Actions

For NEWIOU groundwater sites, the IRA specified in the Groundwater IROD for the NEWIOU includes the following:

- Alternative 2 – Natural Attenuation/Monitoring (i.e., MNA)
- Alternative 3 – Extraction, Treatment, and Discharge

At most sites, the formal selection of Alternative 2 – MNA was deferred pending the completion of MNA assessments to evaluate the feasibility of implementing MNA for all or part of several contaminant plumes. At the NEWIOU LF006 site, MNA was the selected IRA.

After about a decade of data collection, assessments of MNA performance were conducted. The data collected during this interim period are sufficient to conclude that MNA can be an effective remedy. Also, as part of remedial process optimizations to enhance attenuation, EVO injections were performed at Sites SS015, SD036, and SD037.

Alternative 3 uses GET to hydraulically capture areas of groundwater contamination and remove contaminant mass. As part of an RPO of the groundwater treatment plant and to support rebound studies, the GET system was shut down at NEWIOU Sites FT004, SD031, SD033, SD034, SD035, SD036, and SD037. RPO measures were implemented at GET systems within the NEWIOU, which included reconfiguring the groundwater extraction network by taking extraction wells off-line, installing a bioreactor, and/or removing air stripper treatment units. These NEWIOU sites are LF007, SS030, and FT005.

Because of unexpected field conditions observed during the field investigation at Site SS016, optimization of the groundwater IRA was changed from an EVO injection to the installation of a bioreactor. This change was discussed and agreed upon at the March 30, 2010, Remedial Program Manager's Meeting. The unexpected field condition observed was high concentrations of TCE that were indicative of the source of the groundwater plume. The high concentrations of TCE were observed in weathered and fractured bedrock that contained little groundwater. Due to the lack of groundwater in the subsurface area to distribute the EVO after injection and the high concentration of TCE observed, it was determined that a bioreactor was a better approach.

4.2.2 WABOU Groundwater Interim Remedial Actions

For the WABOU groundwater sites, the IRAs specified in the Groundwater IROD for the WABOU include the following:

- Alternative G3 – Containment/Treatment/Discharge
- Alternative G5 – Residual source area and Groundwater Extraction/Treatment/MNA

Similar to the Groundwater IROD for the NEWIOU Alternative 3, the IRA specified in the Groundwater IROD for the WABOU as Alternative G3 is a GET action to prevent the migration of groundwater contamination into hydraulically downgradient areas. As part of a remedial process optimization of the groundwater treatment plant and to support rebound studies, the GET system was shut down at WABOU sites LF008, SS041, and SD043.

Under Alternative G5, a vacuum-enhanced version of GET is used to hydraulically contain and remove relatively high concentrations of VOC from the vadose zone and groundwater at the source of contamination. The GET action is combined with a program of MNA Assessment to address the relatively lower levels of contamination at the leading edge of a plume. After about a decade of data collection, assessments of MNA performance were conducted for the sites where these actions were selected as part of the IRA. The data collected during this interim period are sufficient to conclude that MNA can be an effective remedy.

At Site DP039, the dual-phase GET was discontinued as part of the RPO of the groundwater treatment plant. The combination of a bioreactor, phytoremediation tree stand, and EVO PRB in series is the preferred approach to clean up the groundwater. This approach is supported by treatability studies and demonstration projects over the last 12 years.

4.2.3 Site Consolidation

Travis AFB has constructed multiple groundwater IRAs to achieve the source control, migration control, and off-base remediation objectives specified in the Groundwater IROD for the NEWIOU and the Groundwater IROD for the WABOU. Travis AFB consolidates site-specific IRAs with common key components into regional IRAs. The primary objective of this holistic grouping is to maximize contaminant mass removal by avoiding interference between individual groundwater extraction systems. The secondary objective is to reduce costs by avoiding redundancies in the operation and documentation of sites with common components.

The primary criteria for grouping site-specific IRAs into consolidated, regional IRAs include the following:

- Commingled groundwater contaminant plumes
- Shared groundwater conveyance and treatment systems
- Hydraulic interactions between site-specific groundwater extraction systems
- Consolidation is consistent with the IRA objective(s) provided in the applicable IROD

These criteria led to the strategic groupings of individual contaminated groundwater sites into consolidated IRAs as follows:

- **North IRA** – ERP Sites FT004, SD031, LF006, LF007B, LF007C, and LF007D
- **South IRA** – ERP Sites SS030, SS029, FT005
- **Central IRA** –ERP Sites SS016 and ST027B
- **West IRA** –West Industrial Operable Unit (WIOU; includes ERP Sites SS014, SD033, SD034, SS035, SD036, and SD037 and WABOU Sites SS041 and SD043), ERP Sites, DP039, and LF008.

The locations of the consolidated, regional IRAs and associated ERP sites are shown on Figure 4-1.

Summary descriptions of these IRAs are provided in the following subsections.

4.2.3.1 North IRA

The North IRA comprises consolidated groundwater interim actions at NEWIOU ERP Sites FT004, SD031, LF006, LF007B, LF007C, and LF007D. The main components of the North IRA are summarized in Table 4-2. A site map of the North IRA area is provided on Figure 4-2.1 and Figure 4-2.2.

TABLE 4-2

Summary of the North Groundwater Interim Remedial Action and Optimization Actions
Third Five-Year Review Report, Travis AFB, California

Site	Objective ^a	Implemented IRA	Original IRA Components & IRA Optimization Actions	Post-IRA Optimization Actions
FT004	Source Control / MNA ^b	GET / Groundwater monitoring	Dual-phase extraction (DPE) wells, performance monitoring wells, NGWTP air stripper/VGAC. <i>Air stripping discontinued and replaced with LGAC treatment at NGWTP.</i> <i>GET system shut down for a rebound study in 2007.</i>	Monitoring to evaluate rebound study is ongoing.
SD031	Source Control / MNA ^b	GET / Groundwater monitoring	DPE wells, performance monitoring wells, NGWTP air stripper/VGAC. <i>Air stripping discontinued and replaced with LGAC treatment at NGWTP.</i> <i>GET system shut down for a rebound study in 2007.</i>	Monitoring to evaluate natural attenuation processes is continuing. Monitoring to evaluate rebound study is ongoing.
LF006	MNA	Groundwater monitoring	Trigger, point-of-compliance, and guard wells. <i>No optimization actions implemented at this site.</i>	Monitoring to evaluate natural attenuation processes is continuing.
LF007B	MNA ^b	Groundwater monitoring	Trigger, point-of-compliance, and guard wells. <i>No optimization actions implemented at this site.</i>	Monitoring to evaluate MNA processes is continuing.
LF007C	Migration Control / Off base Remediation	GET	On-base groundwater extraction wells and performance monitoring wells, NGWTP air stripper/VGAC / Off-base performance monitoring wells (groundwater extraction wells located on base). <i>Air stripping discontinued and replaced with LGAC treatment at NGWTP.</i> <i>Additional site characterization in 2011 and potential expansion of the GET system.</i>	Continuing to resolve site access limitations because of the presence of a vernal pool and associated access restrictions imposed by USFWS. Most of the site is located on off-base private property. Pending in 2013, additional aquifer tests as part of pump selection to increase hydraulic capture.
LF007D	MNA ^b	Groundwater monitoring	Trigger, point-of-compliance, and guard wells. <i>No optimization actions implemented at this site.</i>	Monitoring to evaluate natural attenuation processes is continuing.

^a IRA objective specified in Groundwater IROD for the NEWIOU (Travis AFB, 1998)

^b MNA Assessment.

Notes:

DPE = dual-phase extraction

VGAC = vapor-phase granulated activated carbon

LGAC = liquid-phase granulated activated carbon

Since the second five-year review in 2008, several groundwater MNA and optimization studies have been performed, resulting in more effective groundwater cleanup strategies. These strategies will be

incorporated into the Travis AFB Groundwater ROD, which is currently under regulatory review and revision and is expected to be signed by July 2013.

Routine operations and maintenance (O&M) is conducted in accordance with the NGWTP O&M Manual, Sites FT004, SD031, and LF007 Area C (URS Group, Inc. [URS], 2005).

4.2.3.2 Central IRA

The Central IRA comprises groundwater IRAs at the OSA and Tower Area Removal Action (TARA) areas within the northern portion of NEWIOU ERP Sites SS016 and ST027B. Table 4-3 summarizes the main components and the remedial process optimizations of the Central IRA. A site map of the Central IRA area is provided on Figure 4-3.1 and Figure 4-3.2.

TABLE 4-3

Summary of the Central Groundwater Interim Remedial Action and Optimization Measures
Third Five-Year Review Report, Travis AFB, California

Site	Objective ^a	Implemented IRA	Original IRA Components & IRA Optimization Actions	Post-IRA Optimization Actions
SS016	Source control	GET	<p>2-Phase[®] extraction well (TPE-W), three horizontal extraction wells, two groundwater extraction wells, performance monitoring wells, vapor treatment with ThOx, groundwater treatment at the CGWTP with UV/Ox/LGAC.</p> <p>2-Phase[®] extraction within OSA discontinued in 2010. UV/Ox and Th/Ox discontinued in 2010.</p> <p><i>Groundwater treatment replaced by LGAC at CGWTP. Data gaps investigation within OSA conducted in 2010. OSA bioreactor installation in 2010 (for bioreactor features, see Figure 4-3.3).</i></p>	<p>Performance monitoring and evaluation of the 2010 bioreactor installation in the OSA is ongoing.</p> <p>Site access is limited. The site is adjacent to, or within, an active area of military flightline operations (i.e., parking apron, taxiways, and runways).</p>
ST027B	MNA (POCO)	Groundwater monitoring	<p>Trigger, point-of-compliance, and guard wells.</p> <p><i>Data gaps investigation within Site ST027B conducted during 2010.</i></p>	<p>Monitoring to evaluate natural attenuation processes is continuing.</p> <p>Site is bounded by military flightline operations.</p>

^a IRA objective specified in the Groundwater IROD for the NEWIOU (Travis AFB, 1998).

Notes:

ThOx = thermal oxidation
 UV/Ox = ultraviolet oxidation
 LGAC = liquid-phase granulated activated carbon

The portion of the commingled Site SS016 plume that is not hydraulically captured by its source control GET systems is eventually hydraulically captured by the downgradient Site SS029 GET system.

Site ST027 has historically been managed as part of the POCO program at Travis AFB because petroleum hydrocarbons were believed to be the only contaminants present at this site. However, an investigation conducted in 2007 resulted in the discovery of TCE and several other CVOCs in groundwater in the southwestern part of the site. The site was subsequently subdivided into Site ST027A (fuels contamination only) and Site ST027B (CERCLA contaminants).

Routine O&M is conducted in accordance with the CGWTP O&M Manual, Revision 1 (URS, 2002).

4.2.3.3 West IRA

The West IRA comprises consolidated groundwater interim actions at WIOU ERP Sites SS015, SD033, SD034, SS035, SD036, SD037; and WABOU ERP Sites SS041, SD043, LF008, and DP039. Table 4-4 summarizes the main components of the West IRA. Additionally, Tables 4-5, 4-6, and 4-7 summarize the components of the noncontiguous SS015, DP039, and LF008 sites of the West IRA. Site maps of the WIOU portion of the West IRA area are provided on Figures 4-4. Site maps for non-contiguous Sites SS015, DP039, and LF008 are provided on Figures 4-6.1, 4-7.1, and 4-8, respectively.

Construction of the West IRA is complete and currently in long-term operation (LTO).

Routine O&M is conducted in accordance with the CGWTP O&M Manual (URS, 2002).

TABLE 4-4

Summary of the West Groundwater Interim Remedial Action and Optimization Actions
Third Five-Year Review Report, Travis AFB, California

Site	Objective ^a	Implemented IRA	Original IRA Components & IRA Optimization Actions	Post-IRA Optimization Actions
SD034	Source control	GET	DPE wells, performance monitoring wells, free-product removal with active skimmers, VGAC vapor treatment at WTP, UV/Ox/LGAC groundwater treatment at CGWTP via WTP. UV/Ox groundwater treatment and VGAC vapor treatment discontinued in 2009-2010 and replaced by LGAC at CGWTP. WIOU GET system, including Site SD034, shut down for a rebound study.	Passive skimming operations are continuing. Monitoring to evaluate rebound study is ongoing. The site is a component of the overall WIOU plume.
SD036/ SD037 ^b	Source control	GET	DPE wells, performance monitoring wells, VGAC vapor treatment at WTP, UV/Ox/LGAC groundwater treatment at CGWTP via WTP. UV/Ox groundwater treatment and VGAC vapor treatment discontinued in 2009-2010 and replaced by LGAC treatment at CGWTP. WIOU GET system, including Site SD037 and SD036, shut down for a rebound study in 2010. Data gaps investigation conducted during 2010. EVO injections in 2010. Figures 4-5.1 and 4-5.2 feature the EVO injection locations.	Performance monitoring and evaluation of the 2010 EVO injection in the site is ongoing. Monitoring to evaluate natural attenuation processes is continuing. Monitoring to evaluate rebound study is ongoing. The site is a component of the overall WIOU plume.
SD033/ SD034/ SS035/ SD036/ SD037/ SD043 ^b	Migration Control / MNA ^c	GET / Groundwater monitoring	Conventional extraction wells, performance monitoring wells, VGAC vapor treatment at WTP, UV/Ox/LGAC groundwater treatment at CGWTP via WTP. For MNA: trigger, point-of-compliance, and guard wells. UV/Ox groundwater treatment discontinued in 2010 and replaced by LGAC at CGWTP. WIOU GET system shut down for a rebound study.	Monitoring to evaluate rebound study is ongoing. WIOU includes Sites SD033, SD033, SD034, SS035, SD036, SD037 and SD043.
SS041	Migration Control	GET	Site SS041 has been in NFRAP status. The NFRAP status is documented in a 14 December 2005 consensus statement.	From 2001 to 2003, no pesticide contaminants detected in groundwater. In 2005, GET system was decommissioned. The groundwater cleanup is complete.

^a IRA objective specified in Groundwater NEWIOU or WABOU IROD

^b WIOU is a commingled plume

^c MNA assessment

TABLE 4-5

Summary of the SS015 Component of the West Groundwater Interim Remedial Action and Optimization Actions
Third Five-Year Review Report, Travis AFB, California

Site	Objective ^a	Implemented IRA	Original IRA Components & IRA Optimization Actions	Post-IRA Optimization Actions
SS015	Migration Control	MNA ^b	Trigger, point-of-compliance, and guard wells. In 2010, data gaps investigation, installation of injection wells, EVO injection, and installation of additional monitoring wells. Figure 4-6.2 features the EVO injection locations.	Performance monitoring and evaluation of the 2010 EVO injection in the site is ongoing.

^a IRA objective specified in the Groundwater IROD for the NEWIOU.

^b MNA assessment

TABLE 4-6

Summary of the DP039 Component of the West Groundwater Interim Remedial Action and Optimization Actions
Third Five-Year Review Report, Travis AFB, California

Site	Objective ^a	Implemented IRA	Original IRA Components & IRA Optimization Actions	Post-IRA Optimization Actions
DP039	Source control / MNA / Migration Control	GET and vapor extraction and treatment / Groundwater monitoring	DPE wells, performance monitoring wells, VGAC vapor treatment at WTTP, UV/Ox/LGAC groundwater treatment at CGWTP via WTTP. For MNA: Trigger, point-of-compliance, and guard wells. UV/Ox groundwater treatment and VGAC vapor treatment discontinued in 2009-2010 and replaced by LGAC treatment at South Base Boundary Groundwater Treatment Plant (SBBGWTP). GET system shut down in 2008. In-situ bioreactor installation conducted in 2008 as a technology demonstration project. Data gaps investigation conducted during 2010. EVO PRB installed in 2010. Figures 4-7.2 and 4-7.3 show location of bioreactor and EVO injections, respectively.	Performance monitoring and evaluations of the 2010 bioreactor and EVO PRB installations are ongoing. Monitoring to evaluate natural attenuation processes is continuing. A phytoremediation treatability study conducted at the site concluded that planted trees can contribute to remediation of the plume. Monitoring within the area of phytoremediation is continuing.

^a IRA objective specified in the Groundwater IROD for the WABOU (Travis AFB, 1999).

TABLE 4-7

Summary of the LF008 Component of the West Groundwater Interim Remedial Action and Optimization Actions
Third Five-Year Review Report, Travis AFB, California

Site	Objective ^a	Implemented IRA	Original IRA Components & IRA Optimization Actions	Post-IRA Optimization Actions
LF008	Migration Control	GET	Conventional extraction wells, performance monitoring wells, UV/Ox/LGAC groundwater treatment at CGWTP via WTTP. GET system shut down for a rebound study in 2008.	Monitoring to evaluate rebound study is ongoing.

^a IRA objective specified in the Groundwater IROD for the WABOU (Travis AFB, 1999).

4.2.3.4 South IRA

The South IRA comprises consolidated groundwater interim actions at NEWIOU ERP Sites FT005, SS029, SS030, and the southern portion of SS016. Table 4-8 summarizes the main components of the South IRA. A site map of the South IRA area is provided on Figure 4-9.

TABLE 4-8

Summary of the South Groundwater Interim Remedial Action and Optimization Actions
Third Five-Year Review Report, Travis AFB, California

Site	Objective ^a	Implemented IRA	Original IRA Components & IRA Optimization Actions	Post-IRA Optimization Actions
SS030	Source Control / Off-Base Remediation	GET	Interceptor trench, conventional extraction wells, performance monitoring wells, air stripper groundwater treatment at SBBGWTP. Air stripping discontinued and replaced with LGAC groundwater treatment at SBBGWTP. Increased groundwater extraction rates to improve hydraulic capture of the off-base plume.	Monitoring to evaluate GET system performance is continuing. Most of the site is located on off-base private property.
SS029	Migration Control	GET	Conventional extraction wells, performance monitoring wells, air stripper groundwater treatment at SBBGWTP. Air stripping discontinued and replaced with LGAC groundwater treatment at SBBGWTP.	Monitoring to evaluate GET system performance is continuing. Also capturing distal portion of SS016 plume. A large portion of the site is within an area of military flightline operations.
FT005	Migration Control / Off base Remediation	GET	Conventional extraction wells, performance monitoring wells, air stripper groundwater treatment at SBBGWTP. Air stripping discontinued and replaced with LGAC treatment at SBBGWTP. GET system shut down for a rebound study in 2009. In 2010, three extraction wells back on-line to address rebound of 1,2-DCA.	Monitoring to evaluate rebound study is ongoing. The GET is capturing the on-base portion.

^a IRA objective specified in the Groundwater IROD for the NEWIOU.

Construction of the South IRA is complete and currently in LTO.

Routine O&M is conducted in accordance with the South Base Boundary Groundwater Treatment Plant (SBBGWTP) O&M Manual, Revision 3 (CH2M HILL, 2004).

4.3 Groundwater Systems Operation and Maintenance

The Annual RPO report serves as the annual report for the O&M and RPO of the CGWTP, NGWTP, and SBBGWTP at Travis AFB. Specifically, the 2011 Annual RPO report provides detailed descriptions of treatment plant processes, plant optimizations/modifications, volumes of water and soil vapor treated, reuse of treated water, compliance with discharge requirements, field measurements and observations, influent concentration trends, flow rates and the rate of mass removal, treatment plant uptime/downtime, operating costs, evaluations of effectiveness, issues, and optimization activities. This information was used to prepare the summary of groundwater systems O&M outlined below.

Plant performance goals and metrics discussed in the Annual RPO are in accordance with the Long-Term Operation Strategic Plan. The plant's effectiveness is based on meeting four main objectives:

- Meet IRAOs.
- Reduce operating costs.
- Reduce cleanup time.
- Maintain compliance with IROD discharge limits.

The technical assessment and evaluation of the performance of the O&M systems across Travis AFB are included as part of the Groundwater IRA Performance (Section 7.1.1.2), and further discussed in Appendix D.

4.3.1 Groundwater Treatment Systems

Detailed descriptions of treatment plant-specific O&M activities are regularly reported to the regulatory agencies in monthly data sheets and in annual O&M reports. The most current O&M treatment plant data are provided in the 2011 RPO Report for the Groundwater Treatment Plants (CH2M HILL, 2012c).

The CGWTP receives groundwater from up to four extraction wells at Site SS016 and up to 24 extraction wells from the WIOU and WABOU. Groundwater from all WIOU and WABOU extraction wells is pumped through the WTTP before being conveyed to the CGWTP. Of the 24 wells connected to the WTTP, 19 are in the WIOU and five are in the WABOU. At one time, there were six wells in the WABOU, but one extraction well (EW542x41) was decommissioned in 2004. The WTTP did not transfer any groundwater to the CGWTP in 2011 because the WTTP was taken off-line for a rebound study in April 2010 and did not operate in 2011.

The NGWTP is designed to treat groundwater from up to 13 extraction wells: eight located in Site FT004, three located in Site SD031, and two located in Site LF007C. Six wells at Sites FT004 and SD031 were shut down as part of a rebound study beginning in December 2007. The remaining extraction wells at Site FT004 were taken off-line in February 2009. No extraction wells from Sites FT004 or SD031 operated during 2011.

The SBBGWTP receives groundwater from up to 29 extraction wells: 15 in Site FT005, seven in Site SS029, and seven in Site SS030. All FT005 extraction wells were taken off-line in 2009; three were brought back on line in 2010 due to rebound of contaminants.

For each of the three treatment plants, the 2011 Annual RPO report provides detailed descriptions of treatment plant processes, plant optimizations/modifications, volumes of water and soil vapor treated, reuse of treated water, compliance with discharge requirements, field measurements and observations, influent concentration trends, flow rates and the rate of mass removal, treatment plant uptime/downtime, operating costs, evaluations of effectiveness, issues, and optimization activities. Rolling 12-month operating cost curves for each treatment plant are shown on Figures 4-10, 4-11, and 4-12.

Routine O&M of groundwater treatment facilities is conducted in accordance with the O&M manuals developed for the NGWTP (URS, 2005), CGWTP (URS, 2002), and SBBGWTP (CH2M HILL, 2004).

4.3.2 Monitored Natural Attenuation Assessments

The Final Natural Attenuation Assessment Report (CH2M HILL, 2010a) provides detailed data and analysis summarizing MNA assessments performed at relevant ERP sites throughout Travis AFB. Included are detailed data supporting concentration trends over time, biological degradation indicator parameters used to evaluate the past and potential future occurrence of MNA in groundwater, and analyses of the mechanisms and rates of MNA. The findings of the MNA assessment at relevant ERP sites are summarized in the discussion below.

In the IRODs, MNA was selected as an interim remedy for one ERP site (LF006) and as a potential remedy for consideration at all or portions of seven other ERP sites (LF007, SS015, SS016, ST032, SD033, SD037, and DP039). Therefore, with the exception of sites LF007, SS016, and ST032, natural attenuation assessments were performed at all the sites over the interim period. Because

groundwater contamination at ERP sites SS016 and ST032 was determined to be within the extent of hydraulic capture of the SS016 and SS029 GET systems, these sites were not evaluated for natural attenuation as was specified in the NEWIOU Groundwater IROD. Furthermore, Site ST032 was transferred to the POCO program in 2009.

The downgradient portions of two adjacent sites, FT004 and SD031, were included for MNA evaluation over the interim period, although MNA evaluation was not specified for these sites in the NEWIOU Groundwater IROD. GET was specified for Sites FT004 and SD031; no interim remedial actions were specified for the downgradient portions of the plumes. However, the Air Force recognized that, to provide a comprehensive remedy at these sites, the groundwater that is not captured by the GET system needs to be addressed. Therefore, the portions of these sites not affected by the pumping remedial action were also evaluated for natural attenuation over the interim period.

The primary indication of whether natural attenuation is an appropriate remedy at a site is whether or not the groundwater plume is stable or has reduced in size. Over the interim period (8 to 10 years, depending on the site), the GSAP has monitored networks of wells at each site. At most sites, the plume has not only been stable, but has exhibited declining VOC concentrations during the interim period, indicating that MNA is an effective remedy at the site. The conclusions of the study are presented in the Final Natural Attenuation Assessment Report (CH2M HILL, 2010a) and will support the final RAs in the Travis AFB Groundwater ROD. Table 4-9 presents the results of the MNA assessment performed at the select ERP sites.

Technical assessment of the MNA has been performed for each site, as documented beginning in Section 7.1.1.3 and further outlined within Appendix D.

TABLE 4-9
MNA ASSESSMENT CONCLUSIONS

Third Five-Year Review Report, Travis AFB, California

Site	Interim Remedy	Has the Plume Been Stable over the Interim Period?	Dominant Natural Attenuation Mechanism	Conclusion of MNA Assessment
FT004	MNA assessment in distal portion of plume	Yes; in fact, the plume has receded.	Physical	MNA is an appropriate remedy for the distal portion of the plume.
LF006	MNA for entire site	Yes; in fact, the plume has receded.	Physical	MNA is an appropriate remedy for the entire plume.
LF007B	MNA assessment for entire subarea	Yes; in fact, COCs are no longer detected in groundwater.	Physical	MNA is an appropriate remedy for the entire plume.
LF007D	MNA assessment for entire subarea	Yes; in fact, the plume has receded.	Biological in center of plume, physical in distal areas	MNA is an appropriate remedy for the entire plume.
SS015	MNA for entire site	The plume was stable for several years but now appears to be migrating. The long period of plume stability is due to vegetable oil injection performed in 2000-2001 (enhanced MNA).	Biological (enhanced by vegetable oil injection)	Enhanced MNA is a potential remedy for the site.
SD031	MNA assessment in distal portion of plume	Yes; in fact, the plume has receded.	Physical	MNA is an appropriate remedy for the distal portion of the plume.
SD033	MNA assessment in distal portion of plume	Yes; in fact, the plume has receded.	Physical	MNA is an appropriate remedy for the distal portion of the plume.
SD037	MNA assessment in distal portion of plume	Yes; in fact, the plume has receded.	Physical	MNA is an appropriate remedy for the distal portion of the plume.
DP039	MNA assessment in distal portion of plume	Uncertain. The southern toe of the plume has remained stable over the interim period. However, increasing COC trends at some areas within the plume suggest that MNA alone may not be sufficient to prevent plume migration.	Physical	Enhanced MNA is an appropriate remedy for the distal portion of the plume. Existing bioreactor will provide enhanced biodegradation of residuals. The biobarrier will enhance degradation in the central portion of the plume.

Note: Distal portion of the plume is defined as the portion of the plume beyond the influence of the active treatment area.

4.3.3 Free-Product Removals

Free-product removal is ongoing at Site SD034, which continues to have measurable amounts of LNAPL in site monitoring wells. The wells at Site SD034 had measurable amounts of LNAPL reported during 2Q11. This site has an LNAPL plume (Stoddard solvent), and free-product removal is ongoing at this site. Passive hydroskimmers are removing accumulated product in five wells. From 1998 through 2Q11, approximately 44.4 gallons of floating product were removed from the site.

DNAPL has never been directly observed at Travis AFB. Groundwater samples from three ERP sites (Sites DP039, SS016, and SD036) have contained VOCs at concentrations high enough (greater than 3,000 µg/L) to suggest the potential presence of DNAPL.

At Site DP039, the suspected DNAPL was initially addressed by dual-phase extraction (DPE) in the former acid neutralization sump area. The DPE addressed both the vadose zone and the groundwater. The DPE, which began in 2001, resulted in a decline in VOC concentrations by several orders of magnitude. To address remaining VOC mass, a bioreactor was installed in the former sump area in 2008, and an evaluation of its performance is ongoing. VOC concentrations currently detected in groundwater are not indicative of the presence of DNAPL.

At Site SS016, a horizontal extraction well (EW003x16) and a DPE well (TPE-W) were installed to address the area where elevated VOC concentrations indicated that DNAPL may be present. However, the effectiveness of the groundwater extraction remedy was hampered by the continued low yield from the groundwater extraction wells, and TCE concentrations continued to exceed 3,000 µg/L. In 2010, the Site SS016 groundwater treatment was enhanced by the installation of a bioreactor. During installation, the area with the highest TCE concentration was excavated, removing as much of the contaminant mass as practicable. Wells in the vicinity of the excavation were tested for the presence of DNAPL with a product interface probe during the 2Q11 sampling event. None was detected, although TCE concentrations in these wells historically exceeded 10,000 µg/L.

At Site SD036, TCE was detected at concentrations exceeding 10,000 µg/L in two new monitoring wells installed in 2010 as part of RPO activities. The source of the elevated TCE in this area is suspected to be a break or breaks in the sanitary sewer line. MW2061Ax36 and MW2061Bx36 were tested for the presence of DNAPL with a product interface probe during the 2Q11 sampling event. None was detected. RPO, consisting of injection of EVO into the area with the highest residual contaminant concentration, was performed in 4Q10.

4.4 Soil and Sediment Remedy Selection

Soil and sediment RAs at sites within the NEWIOU and WABOU are specified in the final NEWIOU Soil, Sediment, and Surface Water ROD and the final Soil ROD for the WABOU.

4.5 Soil and Sediment Remedy Implementation

Summaries of the soil and sediment RAs that were specified in the RODs for the NEWIOU and WABOU sites are provided in Table 4-10 and Table 4-11.

TABLE 4-10

Summary of NEWIOU Sites Soil and Sediment Remedial Actions
Third Five-Year Review Report, Travis AFB, California

ERP Site	ROD-Specified Remedial Action ^a
SD001	Excavation and LUCs
FT003	Excavation ^b and LUCs
FT004	Excavation ^b and LUCs
FT005	Excavation ^b and LUCs
LF007	Excavation ^b and LUCs
SS015	LUCs
SS016	LUCs
ST032	LUCs
SD033 (soil)	LUCs
SD033 (sediment)	Excavation ^b and LUCs ^c
SD037	LUCs

^a Soil RA objective specified in the final NEWIOU Soil, Sediment, and Surface Water ROD.

^b Excavated soil placed in on-base CAMU.

^c Land use controls will be required if the levels of hazardous substances remaining in the soil or sediment after excavation do not allow for unlimited use and unrestricted exposure. At LF007, land use controls will also be required to protect the integrity of the CAMU cover at that site.

TABLE 4-11

Summary of WABOU Sites Soil Remedial Actions
Third Five-Year Review Report, Travis AFB, California

ERP Site	ROD-Specified Remedial Action ^a
LF008	Excavation/Off-base Disposal
RW013	Excavation/Off-base Disposal
DP039	Land Use and Access Restrictions (i.e., LUCs)
SS041	Excavation/On-base Consolidation ^b
SD042	Excavation/On-base Consolidation ^b
SD043	Land Use and Access Restrictions (i.e., LUCs)
LF044	Land Use and Access Restrictions (i.e., LUCs)
SD045	Excavation/On-base Consolidation ^b
SS046	Land Use and Access Restrictions (i.e., LUCs)

^a Soil RA objective specified in the final Soil ROD for the WABOU.

^b Excavated soil placed in on-base CAMU.

4.5.1 Soil and Sediment Remedial Action Objectives

The basic objective of the soil and sediment RAs, as specified in the two RODs, is to reduce contaminant concentrations to industrial cleanup levels so that the sites are safe for Base workers.

Under both RODs, if excavation reduces residual contaminant concentrations to those that allow for unlimited use and unrestricted exposure, then LUCs will not be required. However, if excavation only reduces contaminant concentrations to industrial cleanup levels, LUCs will be implemented to restrict site access and usage. At several sites, LUCs are the only selected remedy.

4.5.2 NEWIOU Soil and Sediment Remedial Actions

For NEWIOU soil/ sediment sites, the RAs specified in the *NEWIOU Soil, Sediment, and Surface Water ROD* (Travis AFB, 2006) include the following:

- **Alternative 17 – Land Use Controls:** Future land use and soil and sediment disturbance activities are restricted.
- **Alternative 18 – Excavation:** Contaminated soils are excavated and placed in the designated CAMU at Travis AFB or taken to an off-base landfill.

4.5.3 WABOU Soil Remedial Actions

For the WABOU soil sites, the RA specified in the final Soil ROD for the WABOU (Travis AFB, 2002a) includes the following:

- **Alternative S2 – Land Use and Access Restrictions:** Similar to NEWIOU ROD Alternative 17
- **Alternative S6 – Excavation/On-Base Consolidation:** Similar to NEWIOU ROD Alternative 18

The descriptions of NEWIOU and WABOU ROD soil RA alternatives may vary, but their objectives are identical – to remove contaminated soil down to levels protective of on-base workers and/or to restrict residential development and the unauthorized disturbance or relocation of soil.

On-base consolidation of contaminated soil excavated from both NEWIOU and WABOU sites is conducted at the CAMU, located within NEWIOU Site LF007. Descriptions of the CAMU approach to the on-base consolidation of excavated soil are provided in Section 4.4 of the final Soil, Sediment, and Surface Water ROD for the NEWIOU. In the WABOU ROD, Section 4.2 describes the CAMU, and Section 5.1.4 provides more details concerning the construction of the CAMU and the development of the CAMU soil acceptance levels.

4.5.4 Land Use Controls

The requirements for implementation of LUCs at soil/sediment sites are described in Section 5.4 of the final Soil ROD for the WABOU and Section 5.4 of the final NEWIOU Soil, Sediment, and Surface Water ROD. The sites with LUCs as all, or part, of the site-specific RA are listed in Table 4-10 and Table 4-11. Figure 4-13 shows the LUC boundaries. The LUC remedy includes administrative and physical measures to restrict access and ensure effectiveness of the remedy, including incorporation of the site in the Travis AFB GP, notification to regulatory agencies, maintenance of existing administrative controls, and annual inspections. A LUC inspection was performed on 30 October 2012 as part of the five-year review process. The LUC Inspection Report is included as Appendix C. In summary, five year review activities for LUC evaluation included document reviews, site interviews, site inspections, and making a protectiveness determination.

The Travis AFB GP is a long-range planning tool that provides a framework for selecting the locations of future facilities needed to carry out Travis AFB's mission. The GP describes the specific LUCs for each site, the reasons for the controls, and the areas where the controls are applied. It is web-based and accessible to all base personnel who are authorized to use the Travis AFB local area network.

Another tool for LUC enforcement is the Air Force Form 332 (AF332) or Base Civil Engineer Work Request. This form must be submitted and approved before the start of any building project at Travis AFB. Approval of this form involves the comparison of the building site with the constraints in the GP. The AF332 serves as the document for communicating any construction constraints to the

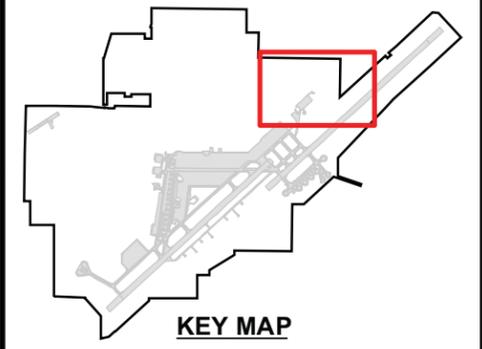
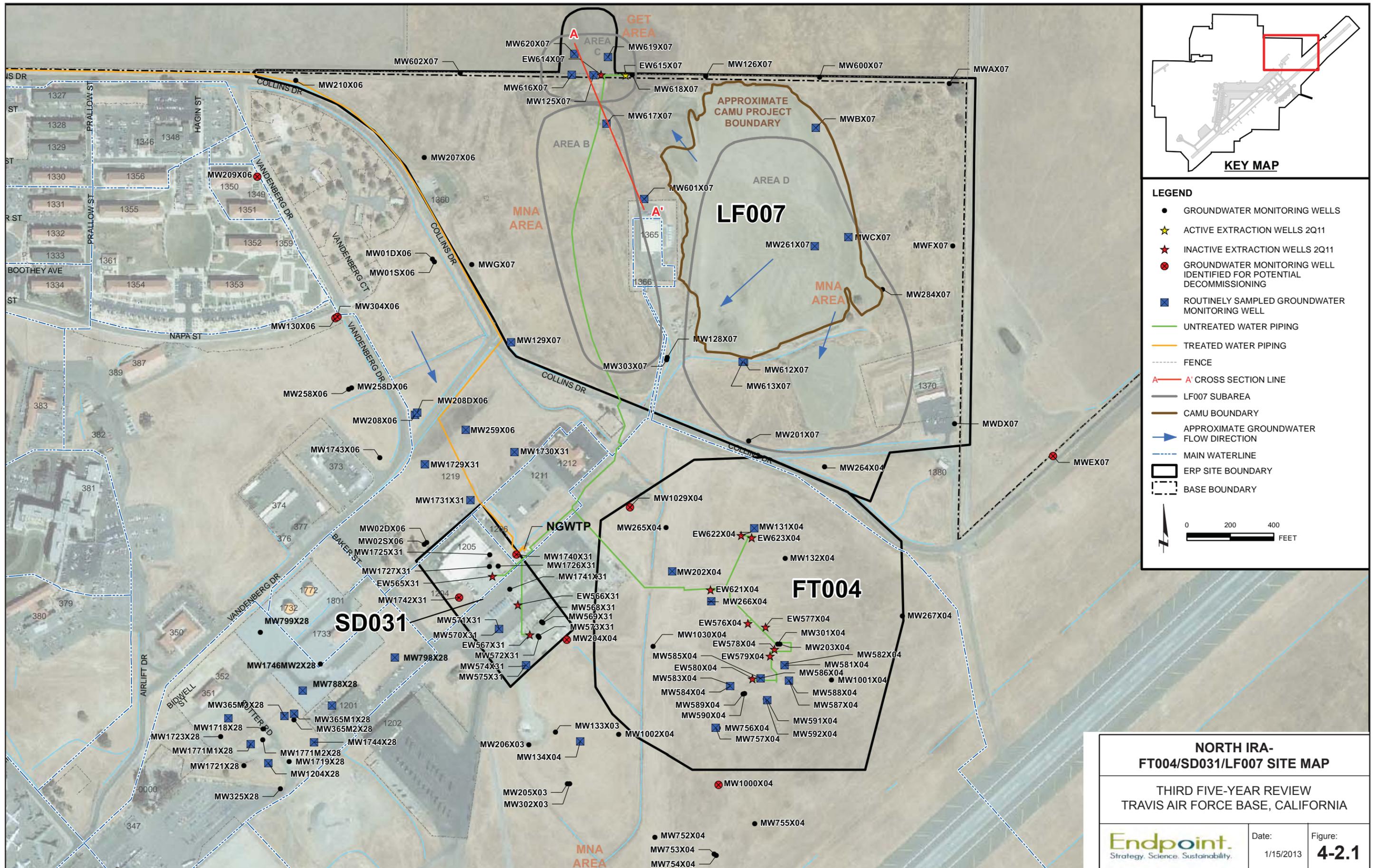
appropriate offices. Any constraints at the site result in the disapproval of the form unless the requester makes appropriate modifications to the building plans.

Travis AFB also uses the 60th Air Mobility Wing Form 55 or Excavation Permit to enforce the residential development and soil and sediment disturbance restrictions. The requester submits the permit to the Civil Engineer Squadron for any project that involves mechanical soil or sediment excavation, such as digging trenches for underground lines or excavating soil for building foundations. If constraints involving soil disturbance or worker safety exist at the excavation area, the permit describes the appropriate procedures that will prevent unknowing exposure to contamination and measures that the workers must implement before the start of excavation.

Both AF332s and excavation permits are subject to an EIAP analysis, conducted pursuant to the National Environmental Policy Act, as promulgated for the Air Force in 32 CFR 989, et. seq. An Air Force Form 813 initiates the EIAP process. The proponent of a proposed action is required to submit the AF332 or excavation permit with the Form 813 so that the appropriate environmental analysis of the proposed action and alternatives to the proposed action is accomplished prior to any construction activities. The EIAP process works to ensure that proposed construction sites are reviewed in accordance with the GP. The process also ensures that all environmental factors, as well as established LUCs, are considered in selecting locations for construction projects.

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LEGEND

- GROUNDWATER MONITORING WELLS
- ★ ACTIVE EXTRACTION WELLS 2Q11
- ★ INACTIVE EXTRACTION WELLS 2Q11
- GROUNDWATER MONITORING WELL IDENTIFIED FOR POTENTIAL DECOMMISSIONING
- ROUTINELY SAMPLED GROUNDWATER MONITORING WELL
- UNTREATED WATER PIPING
- TREATED WATER PIPING
- FENCE
- A— A' CROSS SECTION LINE
- LF007 SUBAREA
- CAMU BOUNDARY
- ➔ APPROXIMATE GROUNDWATER FLOW DIRECTION
- MAIN WATERLINE
- ▭ ERP SITE BOUNDARY
- ▭ BASE BOUNDARY

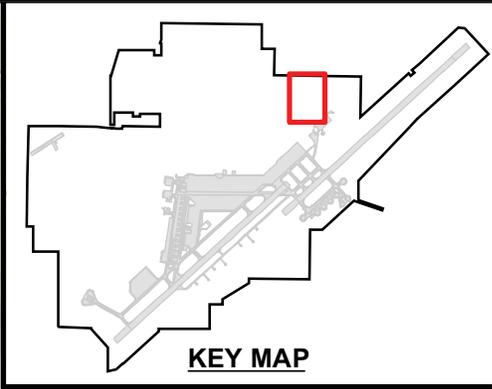
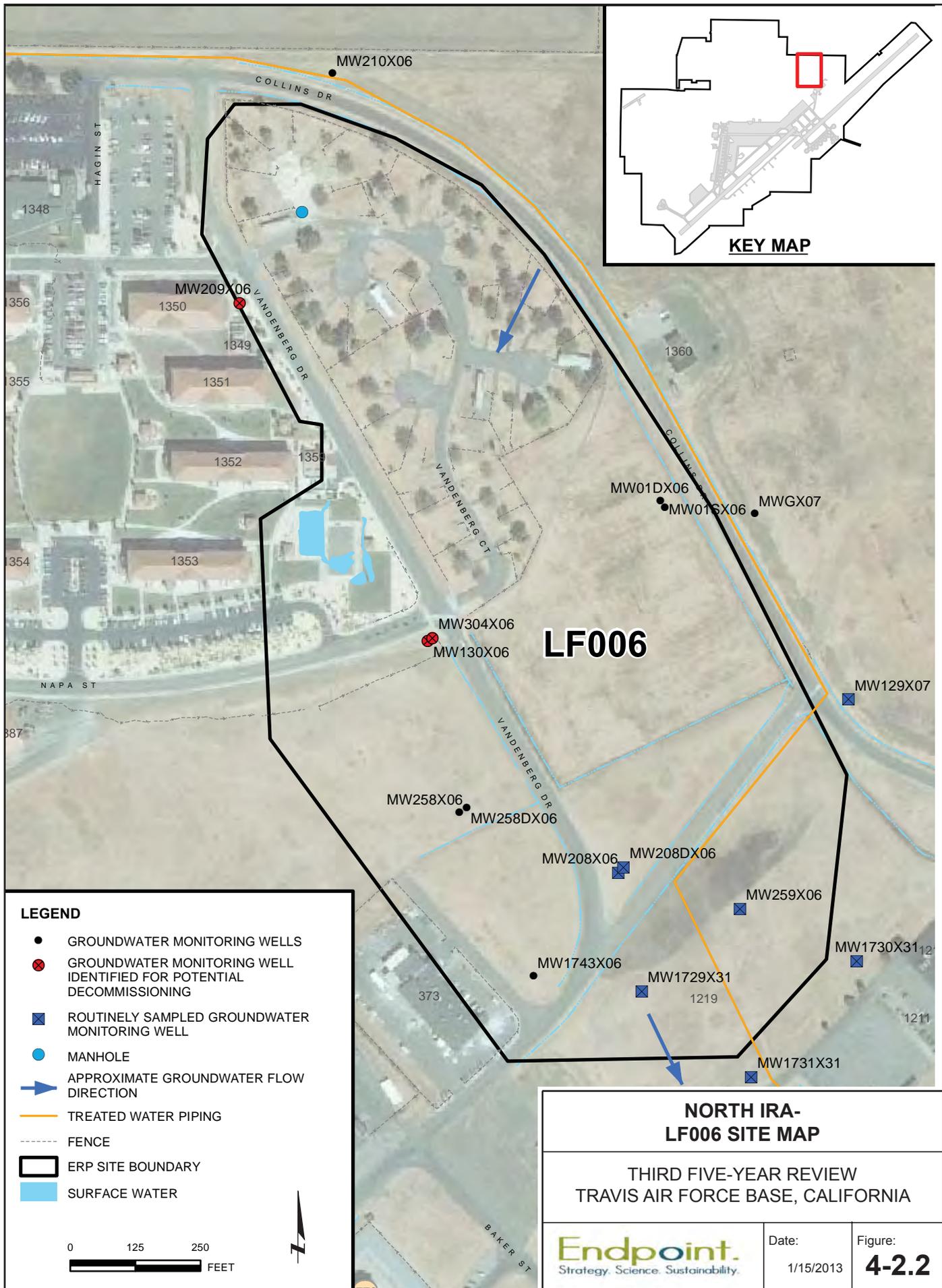
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**NORTH IRA-
FT004/SD031/LF007 SITE MAP**

THIRD FIVE-YEAR REVIEW
TRAVIS AIR FORCE BASE, CALIFORNIA

	Date:	Figure:
	1/15/2013	4-2.1

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LF006

COLLINS DR

HAGIN ST

MW209X06

1350

1349

1351

1352

1353

1353

NAPA ST

MW304X06

MW130X06

MW01DX06

MW01SX06

MWGX07

1360

MW129X07

MW258X06

MW258DX06

MW208X06

MW208DX06

MW259X06

MW1730X31

MW1743X06

MW1729X31

373

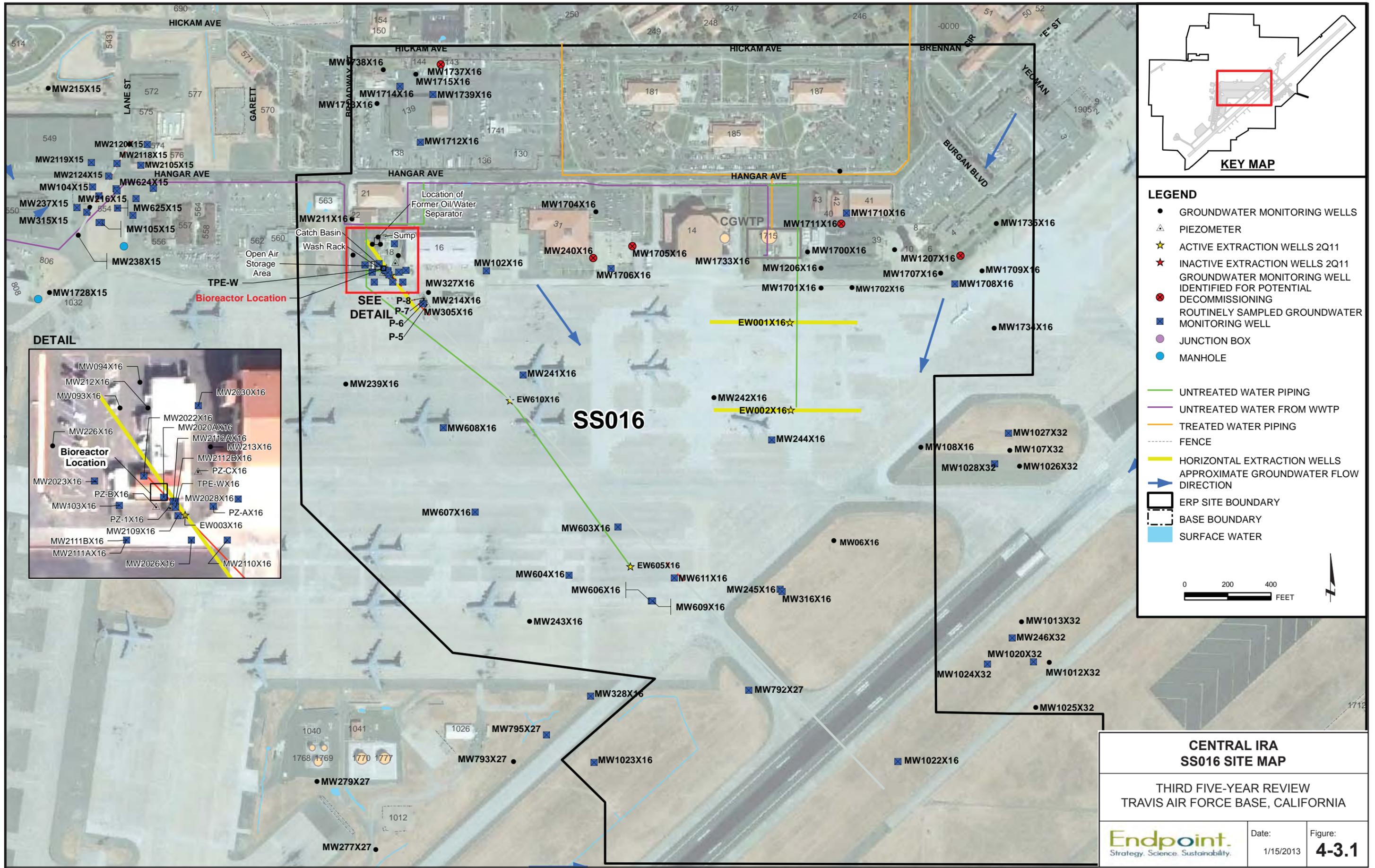
1219

1211

MW1731X31

BAKER ST

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LEGEND

- GROUNDWATER MONITORING WELLS
- △ SURFACE WATER SAMPLE LOCATIONS
- PIEZOMETER
- ★ ACTIVE EXTRACTION WELLS
- ★ INACTIVE EXTRACTION WELLS
- ⊗ GROUNDWATER MONITORING WELL IDENTIFIED FOR POTENTIAL DECOMMISSIONING
- ROUTINELY SAMPLED GROUNDWATER MONITORING WELL
- ➡ APPROXIMATE GROUNDWATER FLOW DIRECTION
- FENCE
- UNTREATED WATER PIPING
- - - - - MAIN WATER LINE
- SURFACE WATER
- ▭ ERP SITE BOUNDARY

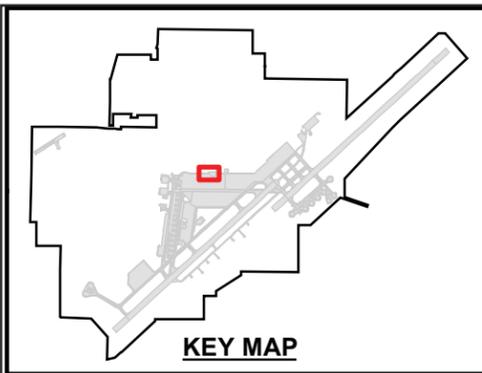
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**CENTRAL IRA
ST02B SITE MAP**

THIRD FIVE-YEAR REVIEW
TRAVIS AIR FORCE BASE, CALIFORNIA

	Date: 1/15/2013	Figure: 4-3.2
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LEGEND

- GROUNDWATER MONITORING WELL
- ▲ PIEZOMETER
- ★ EXTRACTION WELL
- A—A' CROSS SECTION LINE
- ➡ APPROXIMATE GROUNDWATER FLOW DIRECTION
- OSA HORIZONTAL EXTRACTION WELL, SURVEYED 2010
- ||| OSA HORIZONTAL EXTRACTION WELL SCREENED INTERVAL
- UNTREATED WATER PIPING

TCE CONCENTRATIONS (µg/L)

- 5 ≤ TCE < 100
- 100 ≤ TCE < 1,000
- 1,000 ≤ TCE < 10,000
- 10,000 ≤ TCE < 100,000
- TCE ≥ 100,000

- FENCE
- ▭ BIOREACTOR
- ▭ ThOx UNIT
- ▭ BUILDINGS
- ▭ UNPAVED AREA
- ▭ PAVED AREA
- ▭ ROAD

SAMPLE LOCATION — MW591X04
TCE (µg/L) — 0.21J
FLAG —

NOTES:
TPE-W IS A VERTICAL 2-PHASE EXTRACTION WELL FORMALLY USED AT THE THOX SYSTEM.

DATA SHOWN ARE THE MOST CURRENT THROUGH NOVEMBER 2011 AND DO NOT REFLECT BASELINE CONDITIONS.

* - WELL IS PART OF THE PERFORMANCE MONITORING NETWORK

BLUE TCE RESULTS SAMPLED APRIL TO AUGUST 2011
RED TCE RESULTS SAMPLED NOVEMBER 2011

0 35 70 FEET



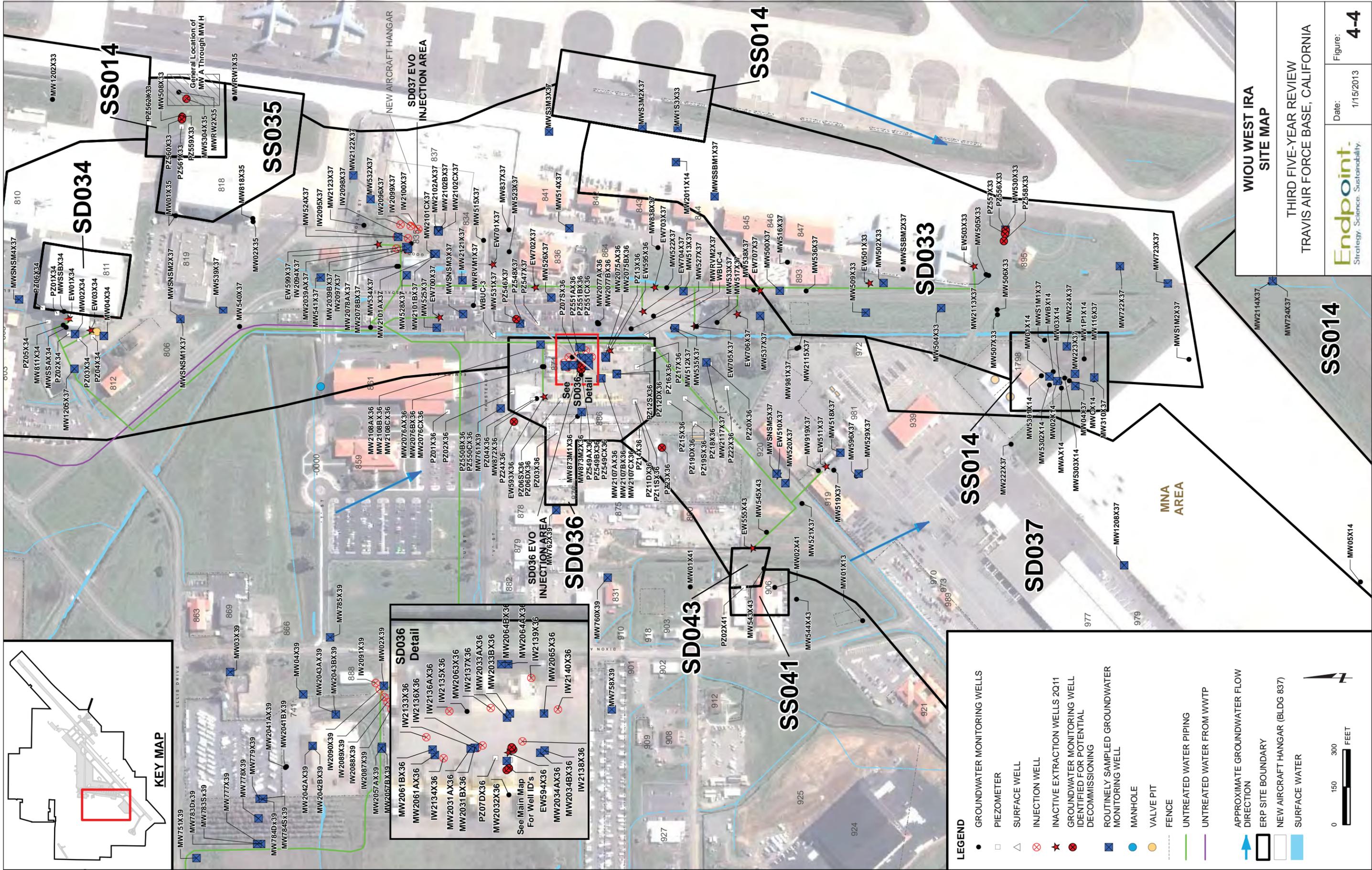
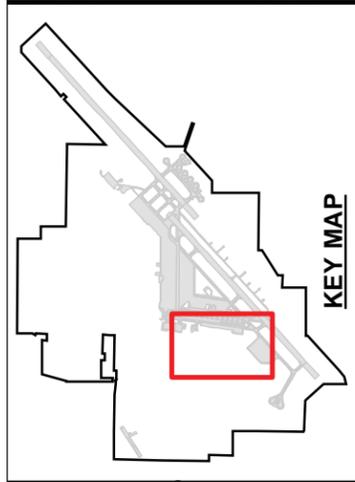
**CENTRAL IRA - SS016
BIOREACTOR FEATURES MAP**

THIRD FIVE-YEAR REVIEW
TRAVIS AIR FORCE BASE, CALIFORNIA

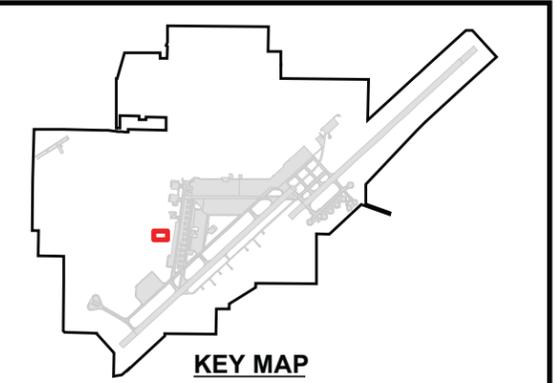
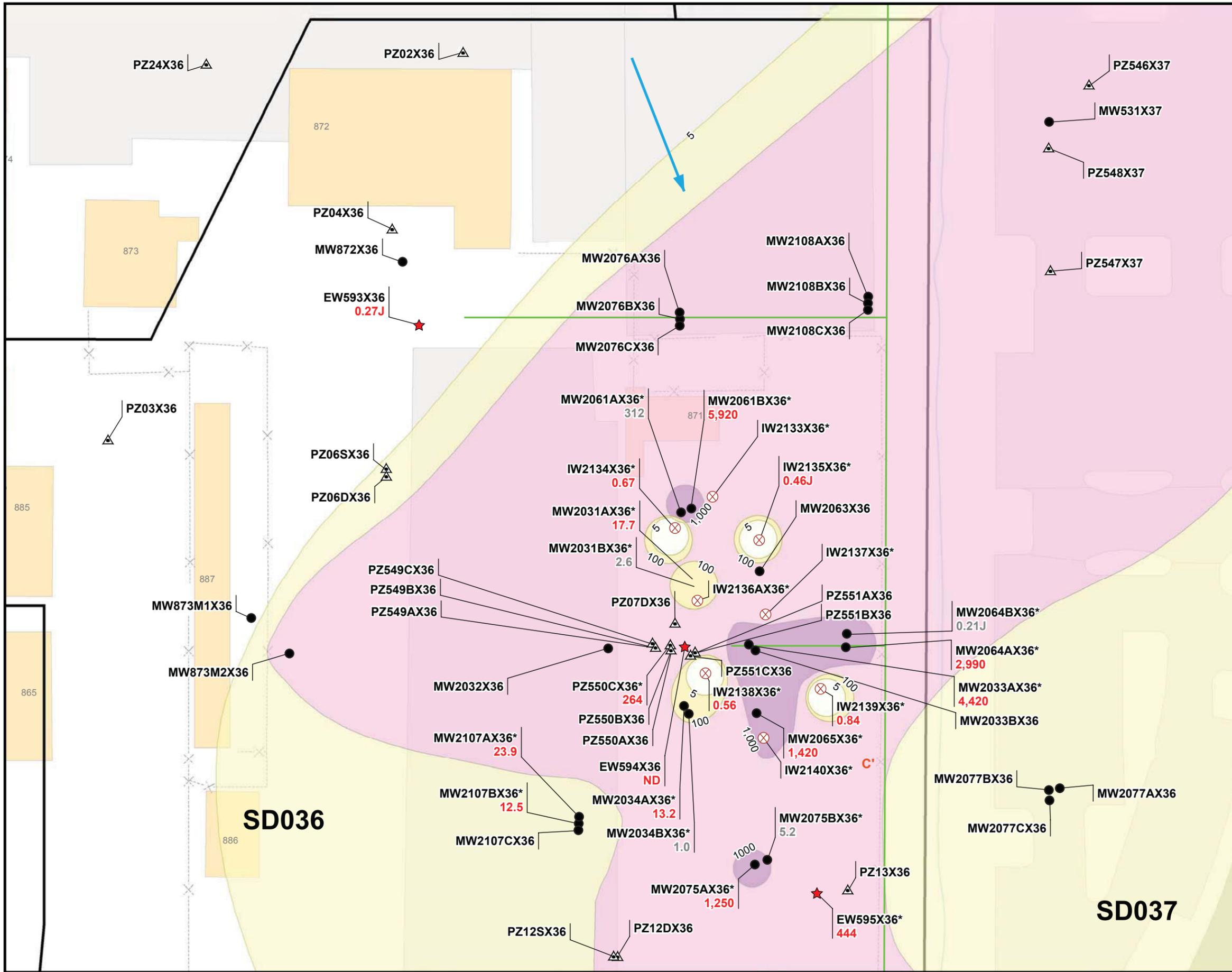
Endpoint.
Strategy. Science. Sustainability.

Date: 1/15/2013
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LEGEND

- GROUNDWATER MONITORING WELL
- ▲ PIEZOMETER
- ⊗ INJECTION WELL
- ★ EXTRACTION WELL
- ➡ APPROXIMATE GROUNDWATER FLOW DIRECTION
- UNTREATED WATER PIPING
- UNTREATED FROM WTPP
- SURFACE WATER
- - - FENCE
- BUILDINGS
- UNPAVED AREA
- PAVED AREA
- ROAD
- ▭ ERP SITE BOUNDARY

TCE CONCENTRATION THROUGH NOVEMBER 2011 (µg/L)

- 5 ≤ TCE < 100
- 100 ≤ TCE < 1,000
- 1,000 ≤ TCE < 10,000
- 10,000 ≤ TCE < 100,000

TCE CONCENTRATIONS SHOWN IN GRAY FONT WERE NOT USED FOR CREATING THE ISOCONTOUR LINES.

NOTES:
TCE CONCENTRATIONS SHOWN REFLECT ANALYTICAL RESULTS FROM SAMPLES COLLECTED IN NOVEMBER 2011 AND DO NOT REFLECT BASELINE CONDITIONS.

* - WELL IS PART OF THE PERFORMANCE MONITORING NETWORK.

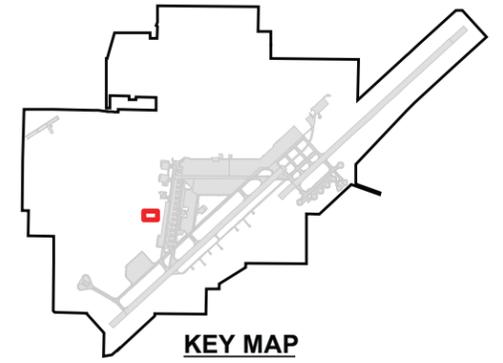
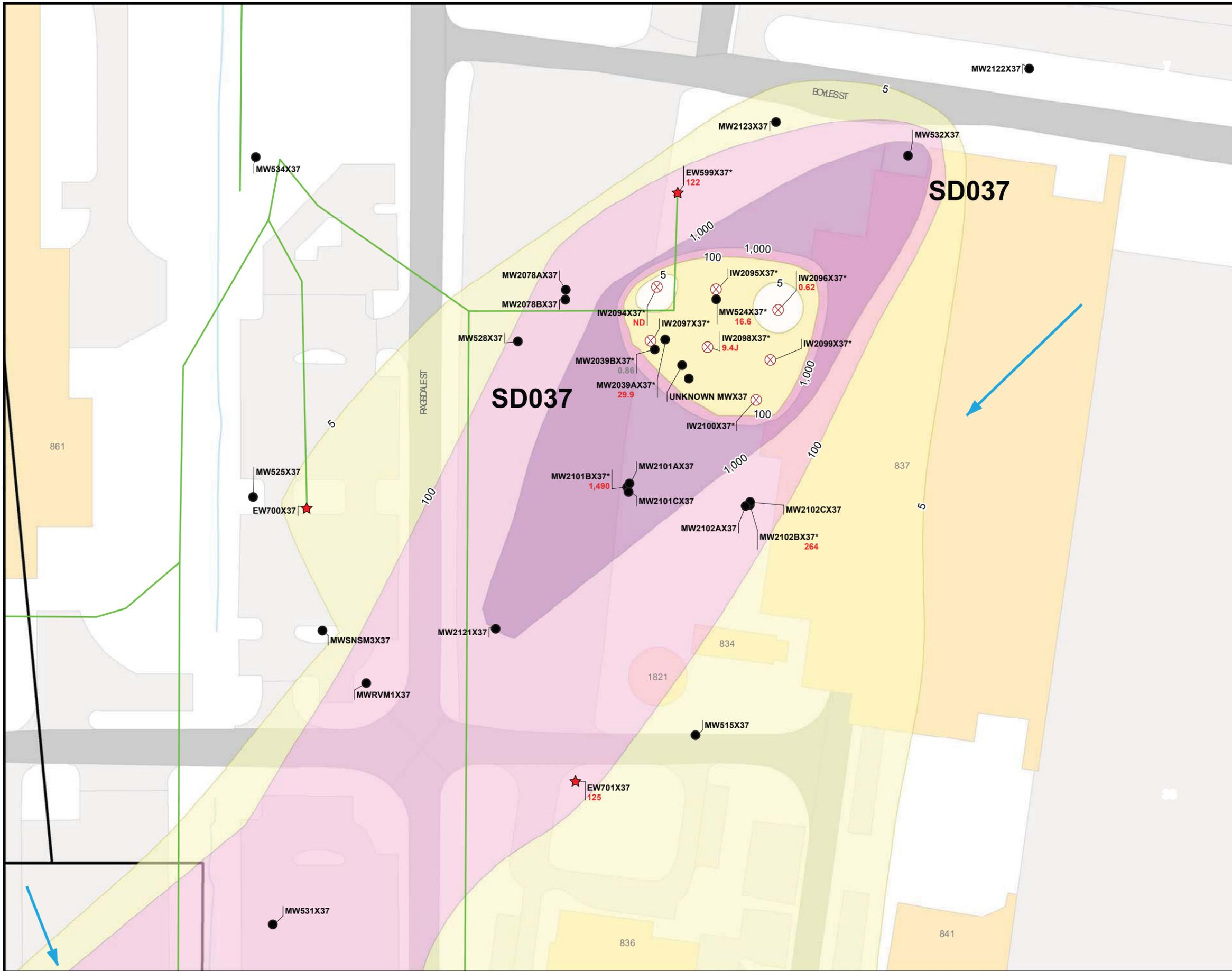
0 22.5 45 FEET

**WIOU
SD036 EVO INJECTIONS MAP**

THIRD FIVE-YEAR REVIEW
TRAVIS AIR FORCE BASE, CALIFORNIA

Endpoint. <small>Strategy. Science. Sustainability.</small>	Date: 1/15/2013	Figure: 4-5.1
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LEGEND

- GROUNDWATER MONITORING WELL
- ⊗ INJECTION WELL
- ★ EXTRACTION WELL
- ➡ APPROXIMATE GROUNDWATER FLOW DIRECTION
- UNTREATED WATER PIPING
- UNTREATED FROM WTPP
- SURFACE WATER
- FENCE
- BUILDINGS
- UNPAVED AREA
- PAVED AREA
- ROAD
- ▭ ERP SITE BOUNDARY

TCE CONCENTRATION THROUGH NOVEMBER 2011 (µg/L)

- 5 ≤ TCE < 100
- 100 ≤ TCE < 1,000
- 1,000 ≤ TCE < 10,000
- 10,000 ≤ TCE < 100,000

TCE CONCENTRATIONS SHOWN IN GRAY FONT WERE NOT USED FOR CREATING THE ISOCONTOUR LINES.

NOTES:
TCE CONCENTRATIONS SHOWN REFLECT ANALYTICAL RESULTS FROM SAMPLES COLLECTED IN NOVEMBER 2011 AND DO NOT REFLECT BASELINE CONDITIONS.

* - WELL IS PART OF THE PERFORMANCE MONITORING NETWORK.

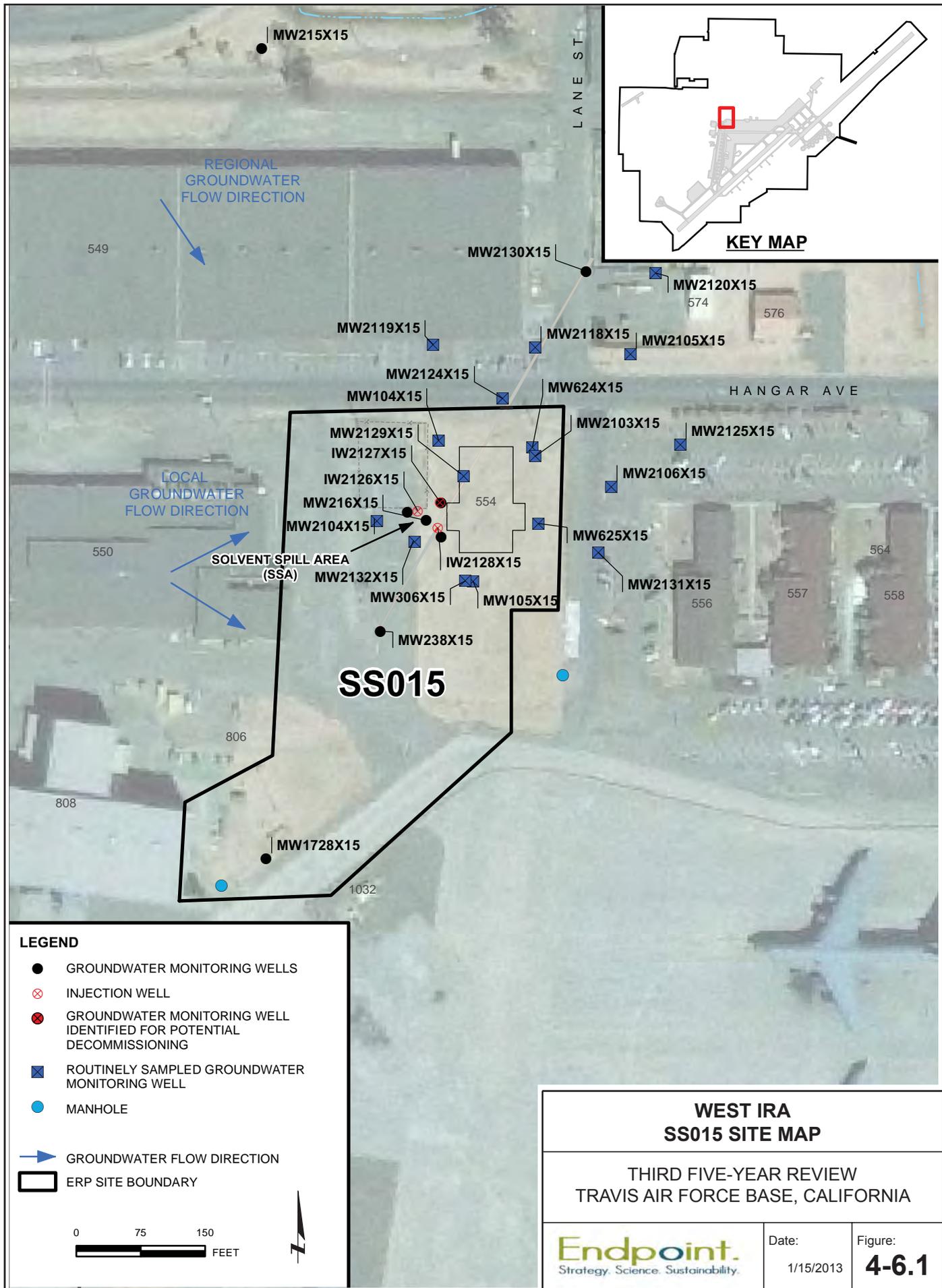
0 22.5 45 FEET

**WIOU
SD037 EVO INJECTIONS MAP**

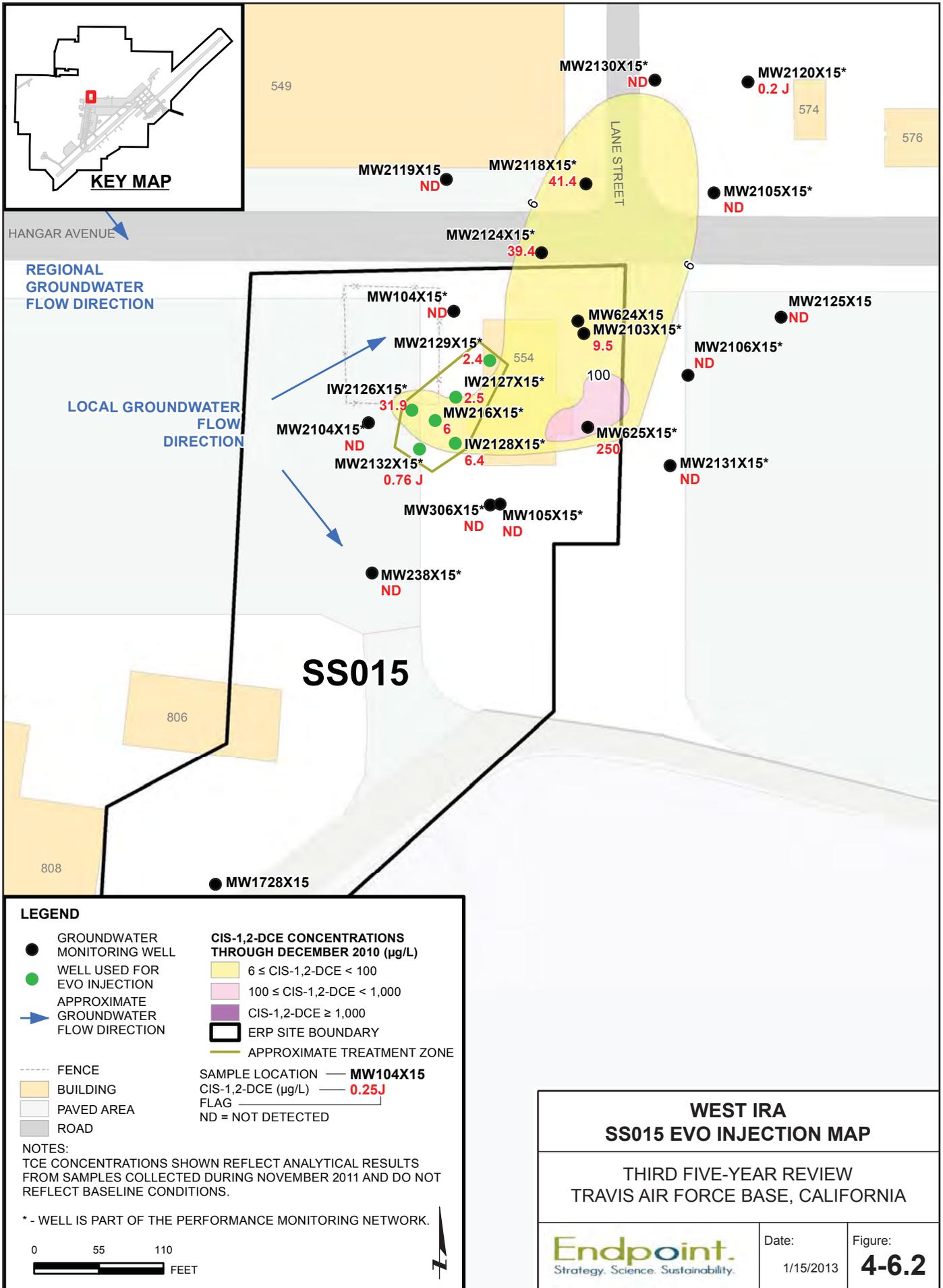
THIRD FIVE-YEAR REVIEW
TRAVIS AIR FORCE BASE, CALIFORNIA

	Date:	Figure:
	1/15/2013	4-5.2

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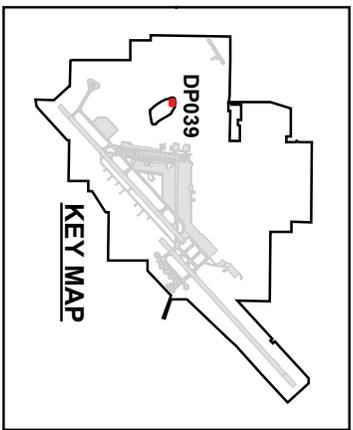


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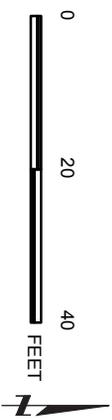
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LEGEND

- GROUNDWATER MONITORING WELL
- PIEZOMETER
- ★ GROUNDWATER EXTRACTION WELL
- APPROXIMATE GROUNDWATER FLOW DIRECTION

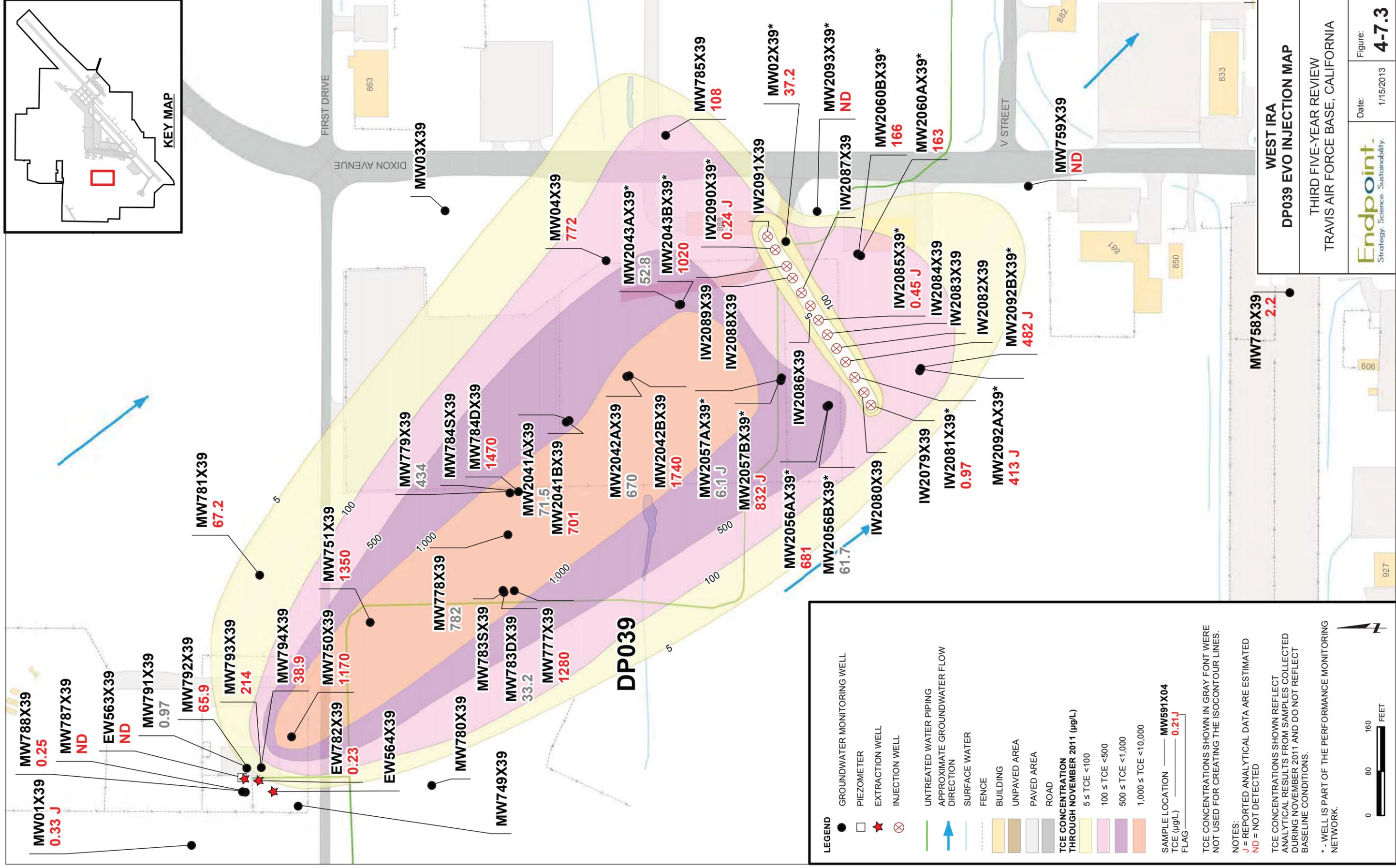
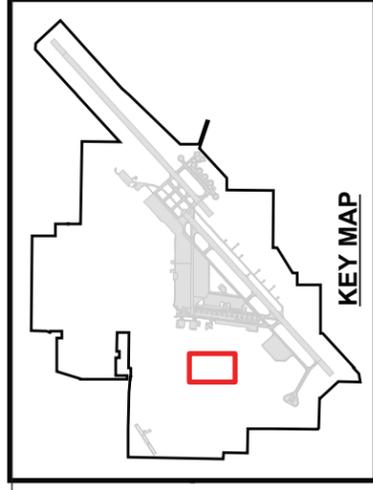
- NEW BELOWGROUND ELECTRICAL
- EXISTING UNDERGROUND EXTRACTION WELL UTILITIES
- EXISTING UNDERGROUND EXTRACTION WELL UTILITIES (TO BE ABANDONED)
- EXISTING ABOVEGROUND ELECTRICAL
- EXISTING BELOWGROUND ELECTRICAL
- FENCE
- ▨ EXCAVATION AREA TO 6 INCHES
- ▩ EXCAVATION AREA TO 20 FEET



**WEST IRA - DP039
BIOREACTOR FEATURES MAP**

THIRD FIVE-YEAR REVIEW
TRAVIS AIR FORCE BASE, CALIFORNIA

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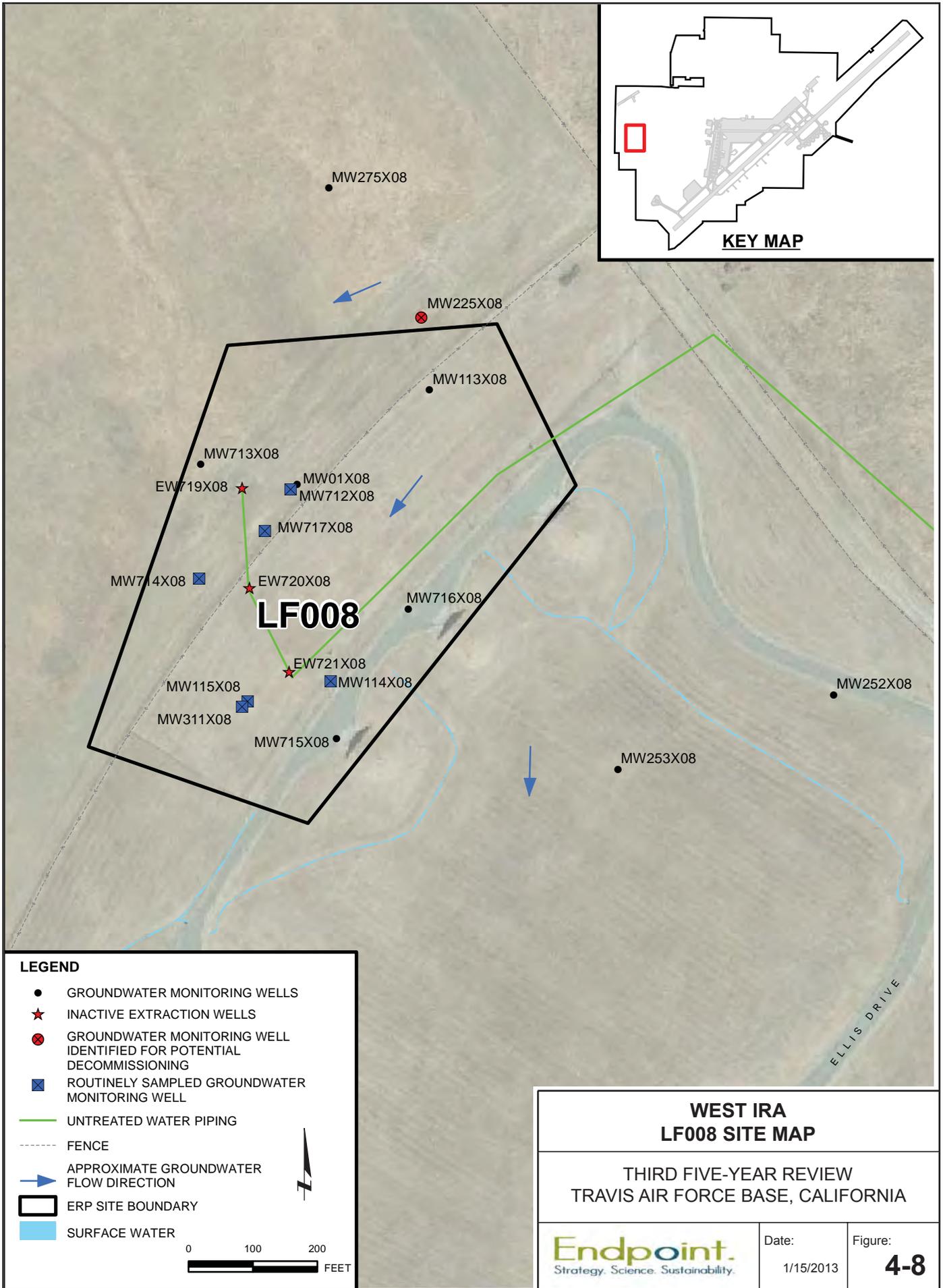
WEST IRA
DP039 EVO INJECTION MAP

THIRD FIVE-YEAR REVIEW
 TRAVIS AIR FORCE BASE, CALIFORNIA

Endpoint
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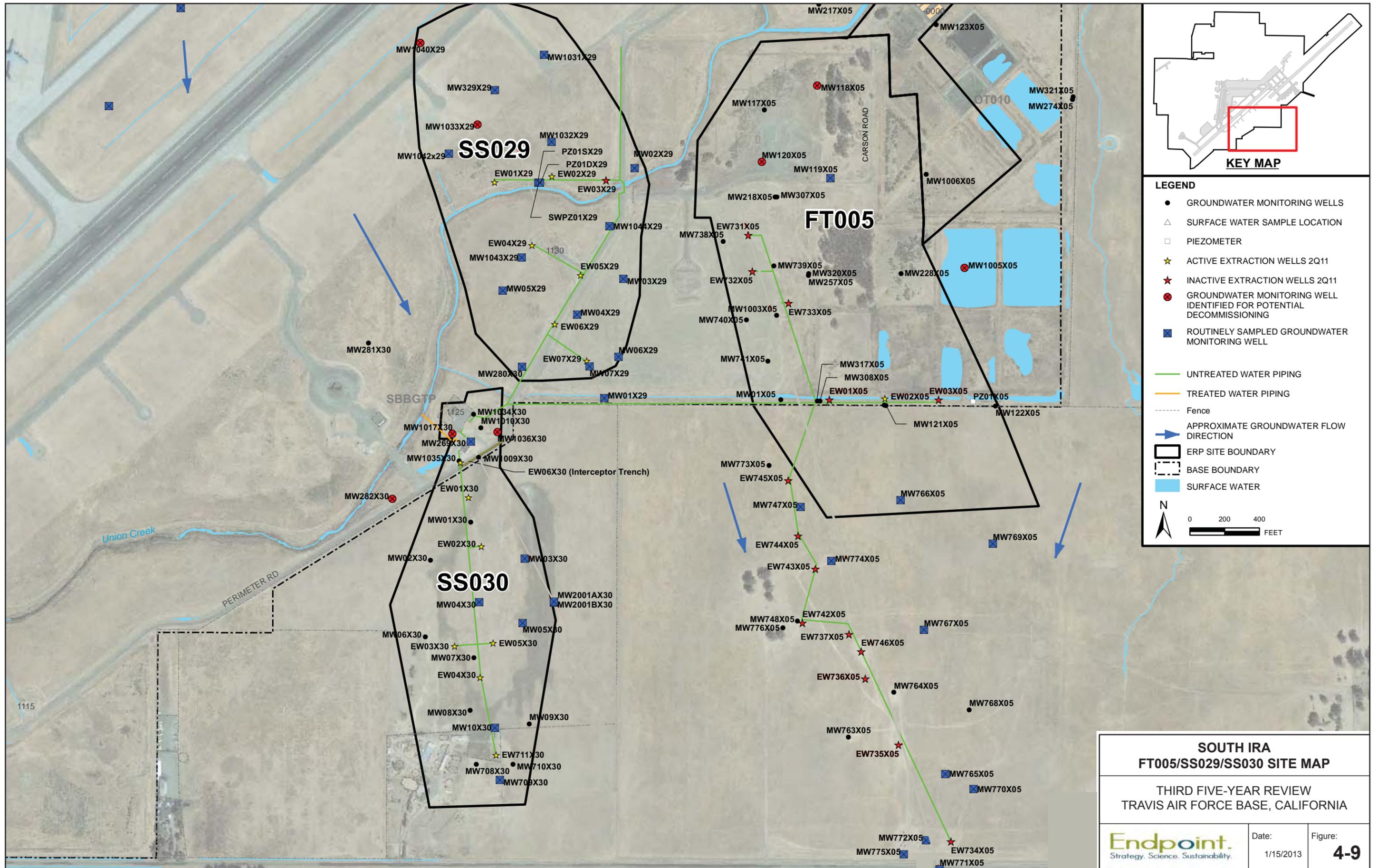
Date: 1/15/2013 Figure: **4-7.3**

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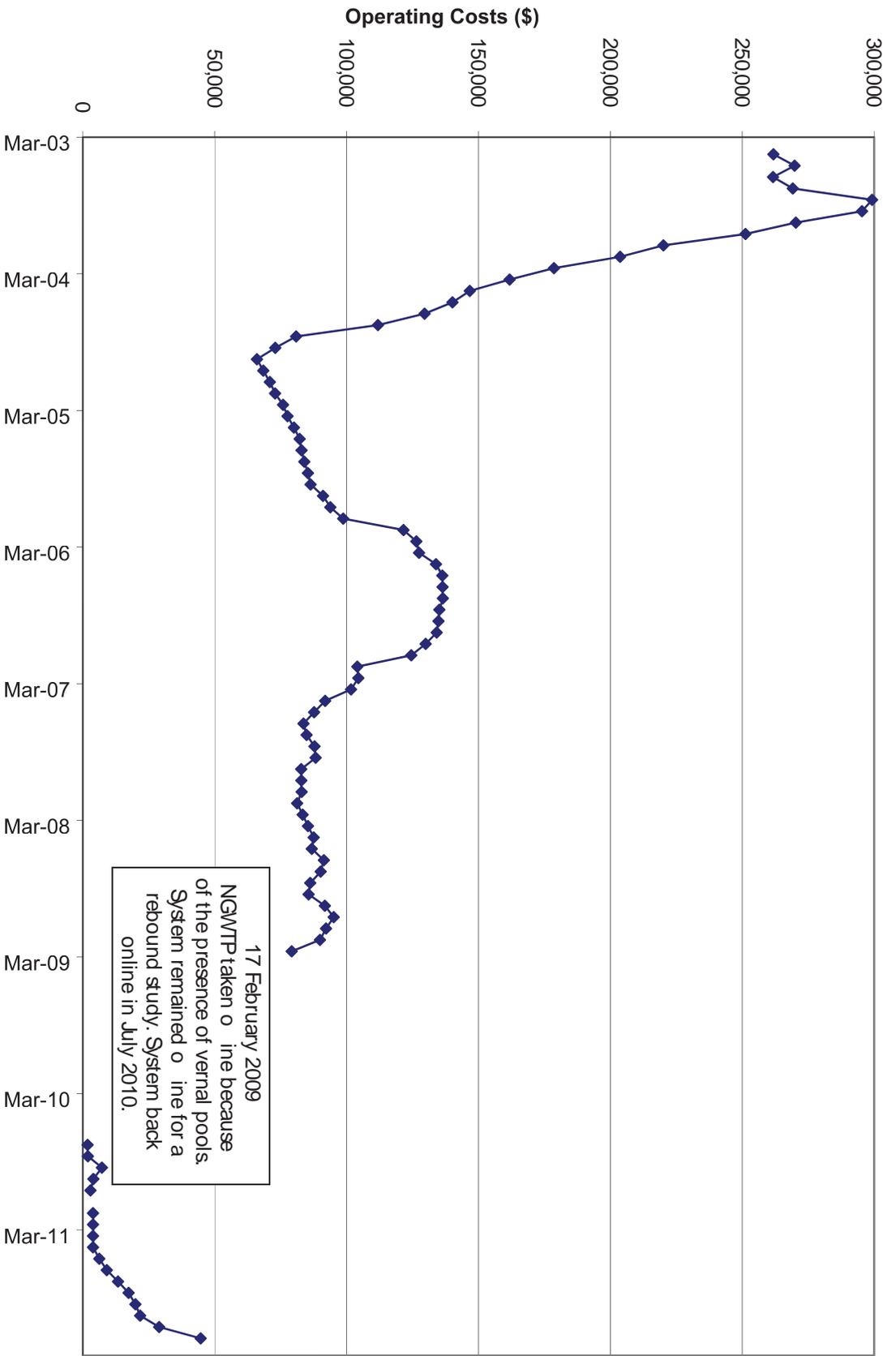


WEST IRA LF008 SITE MAP		
THIRD FIVE-YEAR REVIEW TRAVIS AIR FORCE BASE, CALIFORNIA		
	Date: 1/15/2013	Figure: 4-8

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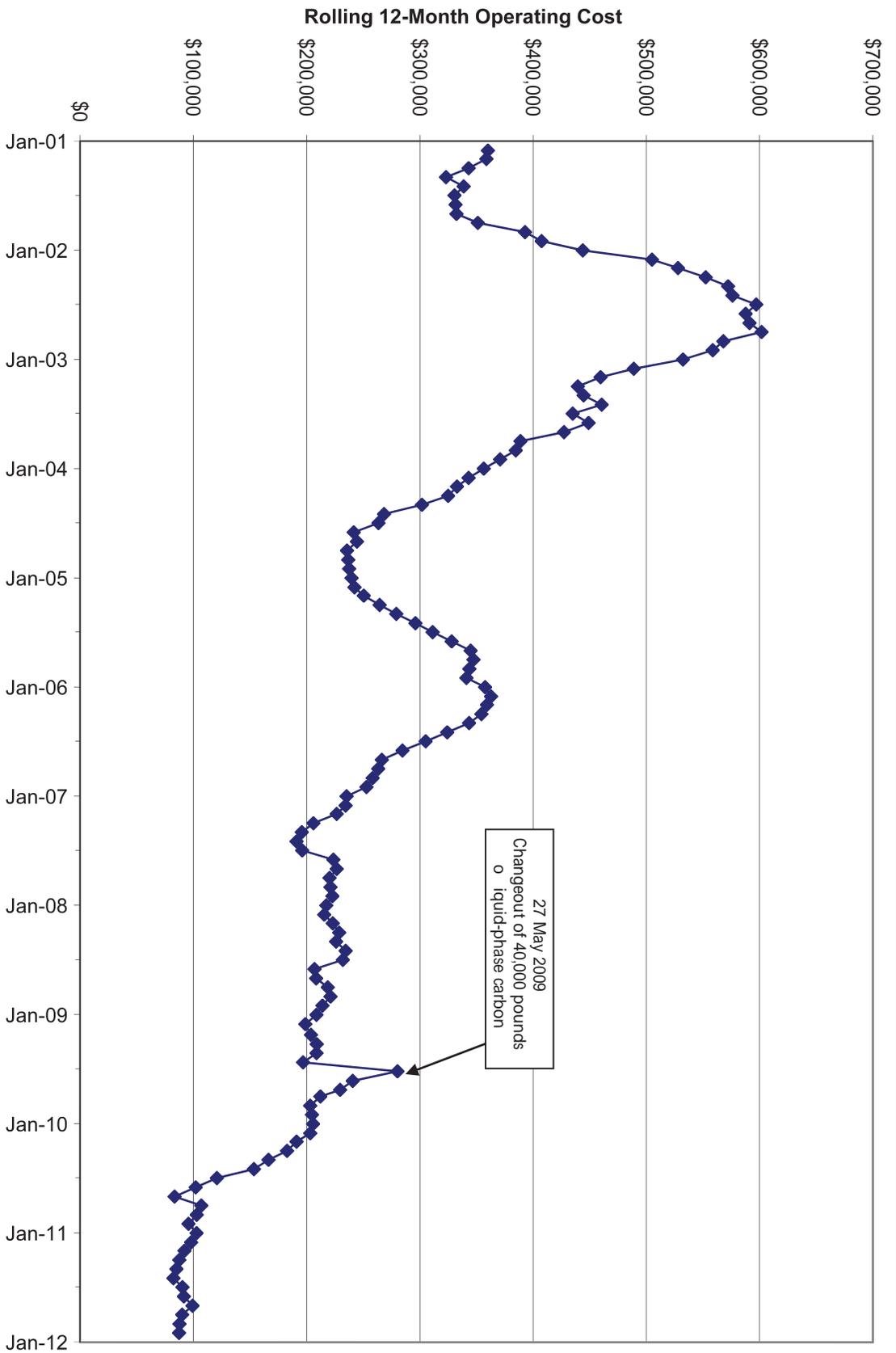
**NNGWTP ROLLING 12-MONTH OPERATING COSTS VS. TIME
 APRIL 2003 - DECEMBER 2011**

THIRD FIVE-YEAR REVIEW
 TRAVIS AIR FORCE BASE, CALIFORNIA



Date:
2/15/2013

Figure:
4-10



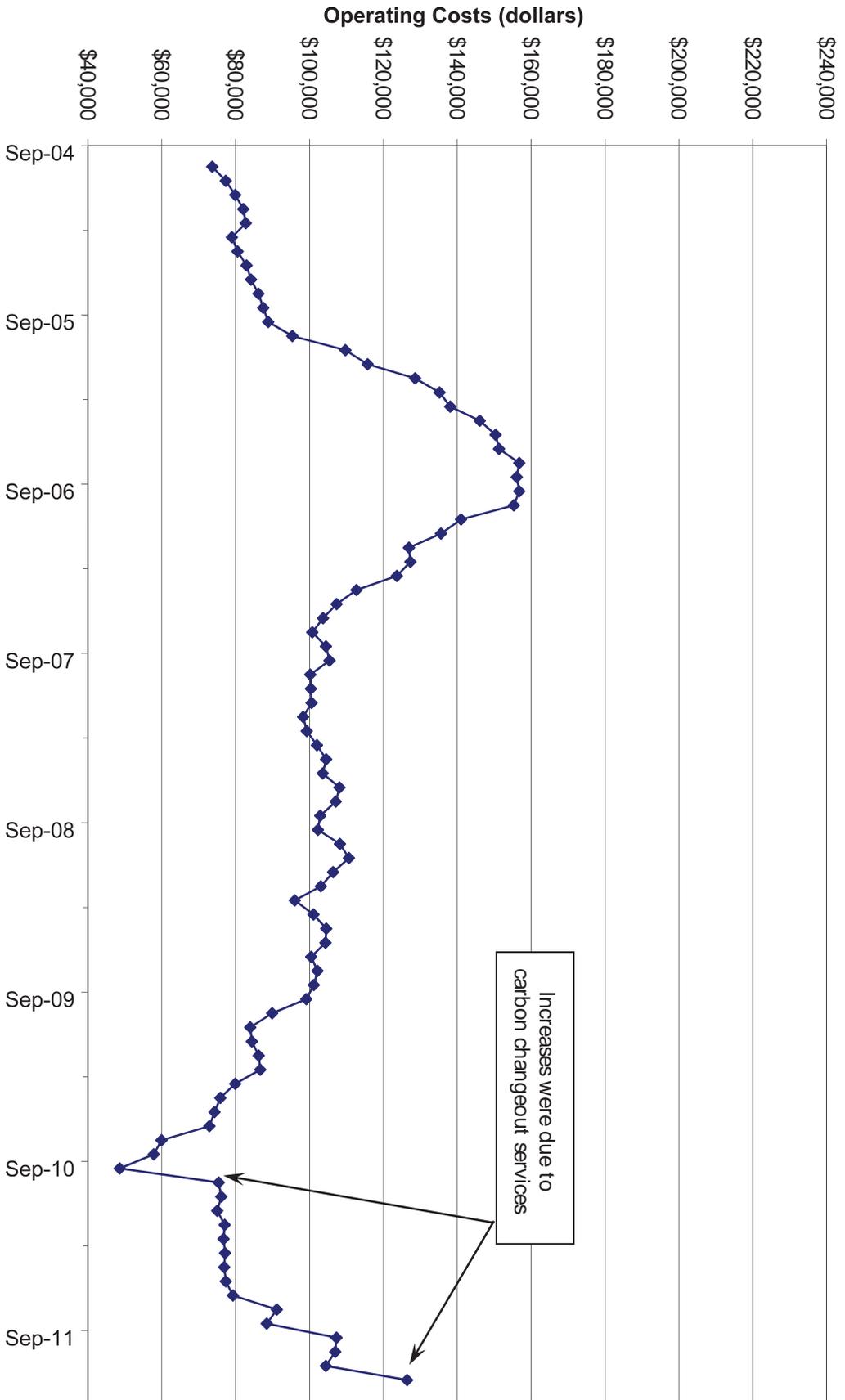
**CGWTP ROLLING 12-MONTH
OPERATING COSTS VS. TIME
FEBRUARY 2001 - DECEMBER 2011**

THIRD FIVE-YEAR REVIEW
TRAVIS AIR FORCE BASE, CALIFORNIA

Endpoint
Strategy. Science. Sustainability.

Date:
2/15/2013

Figure:
4-11



**SBBGWTP ROLLING 12-MONTH
OPERATING COSTS VS. TIME
OCT 2004 – DEC 2011**

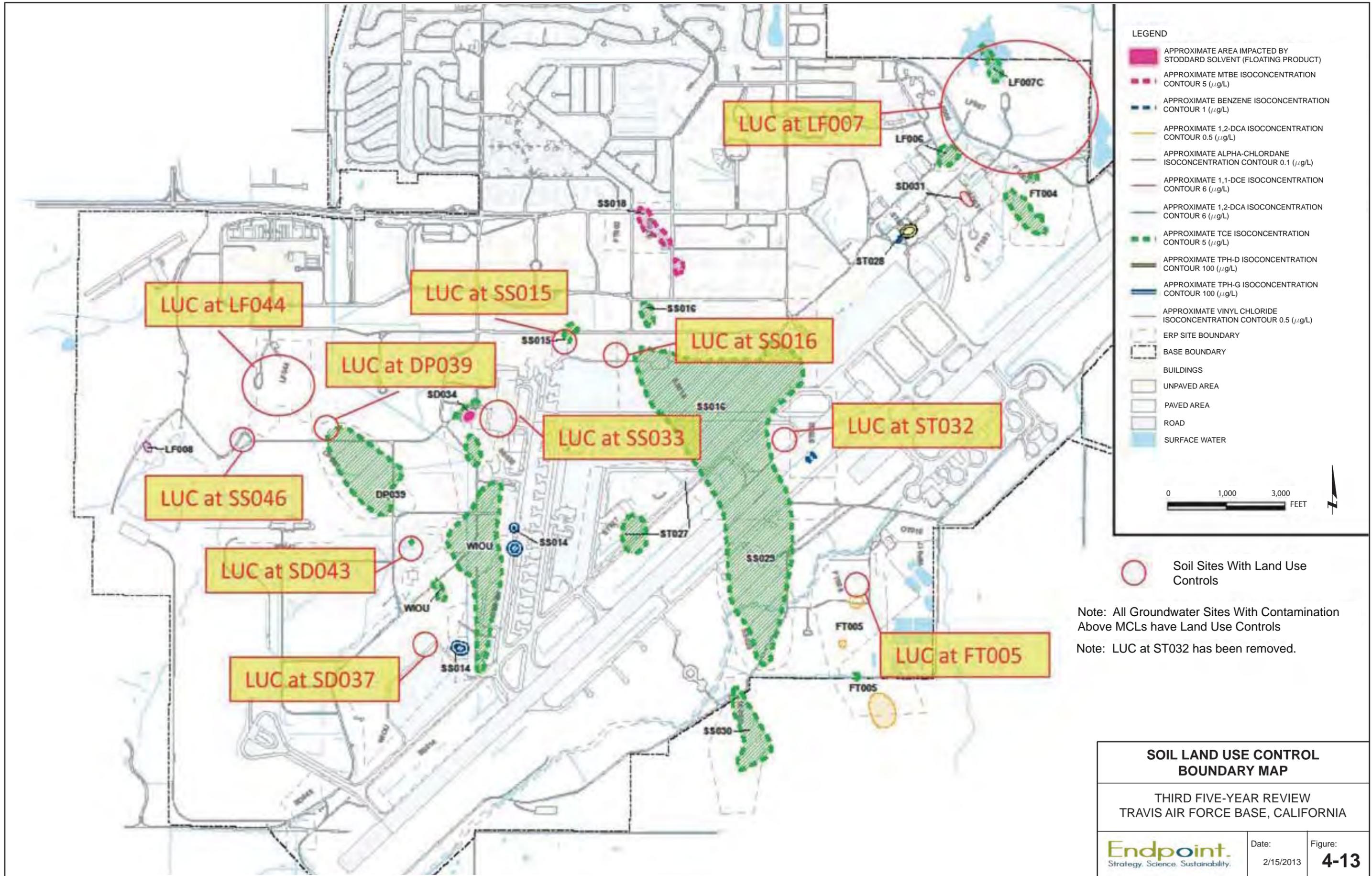
THIRD FIVE-YEAR REVIEW
TRAVIS AIR FORCE BASE, CALIFORNIA

Endpoint
Strategy. Science. Sustainability.

Date:
2/15/2013

Figure:
4-12

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SOIL LAND USE CONTROL BOUNDARY MAP

THIRD FIVE-YEAR REVIEW
 TRAVIS AIR FORCE BASE, CALIFORNIA

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SECTION 5

Progress Since the Last Five-Year Review

This section describes the progress made since the second Five-Year Review Report was finalized in September 2008. The second review addressed groundwater IRAs within the NEWIOU and WABOU and Soil RAs within the WABOU and NEWIOU.

5.1 Second Five-Year Review Protectiveness Statements

Protectiveness statements from the second five-year review of NEWIOU and WABOU groundwater IRAs and soil RAs are stated below in *italics*. The performance of the groundwater IRAs from the second five-year review are summarized in Table 5-1.

The three questions posed in the second assessment of interim remedy protectiveness, and the answers to those questions, included the following:

- A. Is the remedy functioning as intended by the decision document? – Yes
- B. Are the assumptions used at the time of remedy selection still valid? – Yes
- C. Has any other information come to light that could call into question the protectiveness of the remedy? – No

Groundwater Second Five-Year Review Protectiveness Statement

The groundwater interim remedies within the NEWIOU and WABOU currently protect human health and the environment because exposure pathways that could result in unacceptable risks are being controlled. However, in order for the remedy to be protective in the long term, final remedial action objectives and a final remedy must be chosen and completed in order to ensure long-term protectiveness. Also, for the remedies at Sites LF007C, SS030, and DP039 to be protective in the long term, follow-up actions need to be taken.

Soil Second Five-Year Review Protectiveness Statement

Completed Soil Remedial Actions

Because RAs at all NEWIOU and WABOU soil sites are protective, the remedies are protective of human health and the environment.

Pending Soil/Sediment Remedial Actions

The soil RA at NEWIOU Site FT005 and the sediment RAs at NEWIOU Sites SD001 and SD003 will be protective of human health and the environment once the remedies are completed. In the interim, LUCs are in place to restrict residential development and soil/sediment disturbance activities.

The soil remedy at Site FT005 and the sediment remedies at Sites SD001 and SD033 will be carried out as soon as they can be programmed and scheduled into the next available construction season.

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TABLE 5-1
Summary of Protectiveness Statements from the Second Five-Year Review (2008)
Third Five-Year Review Report, Travis AFB, California

IRA	Site	IRA Objective ^a					Performance Assessment Criteria			Performance Assessment Summary
		Source Control	Migration Control	Off-Base Remediation	MNA	MNA Assessment	Question A – Functioning as Intended by IROD?	Question B – Remedy Assumptions Still Valid?	Question C – New Information Regarding Protectiveness?	
North IRA	FT004	√				√ ^b	Yes	Yes	No	The combination of GET and MNA appears to be effective. Hydraulic capture of the plume has been achieved. The effectiveness of GET is further demonstrated by declining VOC concentrations observed in the majority of site monitoring wells. Declining trends are observed both in shallow and deep monitoring wells, indicating both the horizontal and vertical extent of the target areas are being addressed. MNA also appears to be a viable remedy. Overall, contaminant concentrations are stable or declining in the FT004 and SD031 MNA wells. The MNA network includes both shallow and deep monitoring wells; MNA appears to be effective throughout the entire thickness of the plume.
	SD031	√				√ ^b	Yes	Yes	No	
	LF006				√		Yes		No	
	LF007B					√	Yes		No	
	LF007C		√	√		..c	No	Yes	No	
	LF007D					√	Yes		No	
South IRA	SS030	√	√	√			Yes	Yes	No	The source control, migration control, and off-base remediation objectives of the SS030 IRA have largely been achieved. Contaminant concentrations are declining in all of the extraction wells and all but two of the monitoring wells. The off-base plume is being captured on the south and west sides of the plume. However, increasing TCE concentrations on the east side of the off-base plume indicate contamination may be escaping hydraulic capture. There are insufficient monitoring wells in this area to fully assess the extent of contaminant migration and the local groundwater flow direction. No contaminants have been detected in the privately owned domestic well (DWSET1x30) located downgradient of the SS030 plume.
	SS029		√				Yes	Yes	No	
	Southern SS016		√ ^d			..e	Yes	Yes	No	
	FT005		√	√			Yes	Yes	No	
Central IRA	Northern SS016	√					Yes	Yes		Hydraulic capture of the SS016 TARA area has been achieved. Within the SS016 OSA, concentrations have decreased, but the extent of hydraulic capture is less certain. However, declining VOC concentrations in shallow and deep monitoring wells downgradient of the OSA and TARA areas indicate that the horizontal and vertical extent of the SS016 plume are being addressed by these extraction wells. The portion of the commingled SS016 plume (OSA/TARA/ST032) that is not hydraulically captured by the source control GET actions is eventually hydraulically captured by the downgradient SS029 migration control GET system.
	ST032	√	√ ^d			..e	Yes	Yes	No	

TABLE 5-1
Summary of Protectiveness Statements from the Second Five-Year Review (2008)
Third Five-Year Review Report, Travis AFB, California

IRA	Site	IRA Objective ^a					Performance Assessment Criteria			Performance Assessment Summary
		Source Control	Migration Control	Off-Base Remediation	MNA	MNA Assessment	Question A – Functioning as Intended by IROD?	Question B – Remedy Assumptions Still Valid?	Question C – New Information Regarding Protectiveness?	
West IRA	SS014 ^f	√	√			√ ^b	Yes	Yes	No	GET systems installed within the WIOU sites are achieving the source control and migration control objectives. Estimates of the extent of hydraulic capture indicate that VOC concentrations above 100 µg/L are being captured by the WIOU GET system. Decreasing trends in VOC concentrations are observed throughout the WIOU plume. The decreasing trend is observed in both shallow and deep monitoring wells, indicating that the horizontal and the vertical extent of the plume are being addressed by the GET system. The combination of GET in the WIOU and MNA assessment in the downgradient area appears to be a viable remedy. Groundwater contamination in the southern WIOU does not appear to be migrating. However, historical and current detections of petroleum hydrocarbons in downgradient wells require continued monitoring. If concentrations increase in these wells, implying that migration is occurring, additional downgradient monitoring wells may be necessary.
	SD033 ^g		√			√	Yes	Yes	No	
	SD034 ^h	√	√				Yes	Yes	No	
	SS035 ⁱ		√ ^b			.. ^e	Yes	Yes	No	
	SD036 ^j	√	√			.. ^e	Yes	Yes	No	
	SD037 ^k	√	√			√	Yes	Yes	No	
	SS041 ^l		√				Yes	Yes	No	
	SD043 ^m		√				Yes	Yes	No	
	SS015					√	Yes		No	MNA appears to be a viable remedy. Data from monitoring wells indicate that groundwater contamination at SS015 is not migrating.
	DP039	√	.. ^f			√	Yes	Yes	No	The DP039 source control objective is being partially achieved. TCE concentrations in the former acid neutralization sump area are declining, and the residual contamination in the vicinity of the former sump is being hydraulically contained. TCE concentrations continue to exceed 1,000 µg/L in areas downgradient of the former sump area. This area extends about 800 feet beyond the source control GET system and underlies an ongoing demonstration of phytoremediation. The effectiveness of the phytoremediation system at controlling migration of the plume continues to be evaluated. However, the DPE system does appear to prevent additional contamination from migrating downgradient of the sump area and thereby decreases VOC concentrations. Migration control through MNA appears to be generally achieved in the downgradient portion of the DP039 plume. However, TCE concentrations may be increasing in some wells downgradient of the phytoremediation area. The data are not conclusive, and the wells will continue to be monitored under the GRIP to determine if the plume is migrating. The southern toe of the plume remains stable. Concentrations of TCE in this area have not been greater than the IRG.
	LF008		√				Yes	Yes	No	The migration control objective at LF008 is being achieved by the GET system. Hydraulic capture of the plume has been achieved. The distribution of contamination in monitoring wells also indicates containment of the plume.

^aIRA objective specified in the Groundwater NEWIOU and WABOU IRODs.

^bIRA not specified in the Groundwater IROD for the NEWIOU (Travis AFB, 1998), but implemented by the Air Force to address entirety of commingled plume.

^cAssessment of MNA not implemented because of interactions with the LF007C GET system.

^dSS016/ST032 plume hydraulically captured by SS029 groundwater extraction system.

^eAssessment of MNA not implemented because plume is hydraulically captured by adjacent GET system.

^fMigration control not implemented pending evaluation of MNA and phytoremediation.

5.2 Progress with Groundwater Interim Remedial Actions

Since the second five-year review of groundwater IRAs was conducted in 2008, several groundwater MNA and optimization studies have been performed, resulting in more effective groundwater cleanup strategies. These strategies will continue to be implemented until the Travis AFB Groundwater ROD is executed (which is expected in late 2013). Of the 19 ERP groundwater sites, only the cleanup of SS041 groundwater is considered complete.

For the most part, the interim remedies have operated successfully from the late 1990s to present. After more than a decade of interim remediation, the residual contaminant concentrations at most of the ERP sites are much lower than initial values but are still high enough to require continued and, in most cases, more effective cleanup actions. As a result, optimization measures were performed at several ERP sites involving bioreactors and EVO.

RPOs have been performed at Sites SS015, SS016, DP039, and the WIOU because IRAOs were either not being achieved or persisting elevated residual concentrations indicated that the IRAOs could be achieved more efficiently. In 2010, RPOs consisting of EVO injections were performed at Site SS015 and at Sites SD036 and SD037 of the WIOU.

An RPO consisting of the installation of an in-situ bioreactor was performed at Site SS016 in 2010. Several RPOs have been performed at Site DP039, including the installation of an in-situ bioreactor (2008), establishment of a phytoremediation area (1998), and an EVO PRB (2010). Performance monitoring data collected to date indicate that all of the recent RPOs are operating as designed and supporting achievement of IRAOs.

Site LF007C remains the only area where IRAOs have not been achieved. However, RPO is planned for Site LF007C in 2013. The RPO for Site LF007C may include enhancement of the existing groundwater extraction and treatment system.

IRAs as currently optimized are reducing the size of the contaminated areas and reducing the contaminant levels. Travis AFB is now transitioning out of interim remediation and starting the process to select and implement final remedial actions at each site based on the success of RPO studies. The Proposed Plan for Groundwater Cleanup was finalized in late October 2012; the next step is execution of the Travis AFB Groundwater ROD, which is expected in July 2013.

5.3 Progress with Soil Remedial Actions

Since the second five-year review, soil and sediment RAs have been completed at the three outstanding NEWIOU ERP sites: FT005, SD001, and SD033. Additionally, no new soil LUCs were established within the past five years.

5.3.1 Progress with WABOU Soil Remedial Actions

All the RAs within the WABOU were completed before the second five-year review. No new WABOU RAs have occurred since the last (second) five-year review report. Below is a summary of WABOU soil RAs that have been completed in accordance with the Soil ROD for the WABOU.

- **LF008 – Excavation/Off-Base Disposal:** In 2003, Travis AFB removed 1,984 cubic yards of pesticide-contaminated soil from Landfill 3 and placed the soil in the on-base CAMU. Excavated debris was transported to an off-base disposal facility for incineration. Residential cleanup levels were achieved and no LUCs were required.

- **RW013 – Excavation/Off-Base Disposal:** During 2002 to 2003, Travis AFB removed 38 cubic yards of low-level U-234- and U-235-contaminated soil and waste from Radioactive Burial Site #2 and transported them to an off-base landfill. Residential cleanup levels were achieved and no LUCs were required.
- **DP039 – Land Use and Access Restrictions:** Ongoing management of LUCs since 2002.
- **SS041 – Excavation/On-Base Consolidation:** In 2003, Travis AFB removed 49 cubic yards of pesticide-contaminated soil from Building 905 and placed the soil in an on-base CAMU. Residential cleanup levels were achieved, and no LUCs were required.
- **SD042 – Excavation/On-Base Consolidation:** In 2003, Travis AFB removed 11 cubic yards of metals-and PAH-contaminated soil from Buildings 929/931/940 and placed them in an on-base CAMU. Residential cleanup levels were achieved, and no LUCs were required.
- **SD043 – Land Use and Access Restrictions:** Ongoing management of LUCs since 2002.
- **LF044 – Land Use and Access Restrictions:** Ongoing management of LUCs since 2002.
- **SD045 – Excavation/On-Base Consolidation:** In 2007, lead-contaminated soil was removed from the Former Small Arms Range and placed in the on-base CAMU. Residential cleanup levels were achieved, and no LUCs were required.
- **SS046 – Land Use and Access Restrictions:** Ongoing management of LUCs since 2002.

These completed soil RAs have achieved the RAOs identified in the Soil ROD for the WABOU. The soil RAs conducted at Sites LF008, RW013, SS041, SD042, and SD045 achieved residential cleanup levels. Therefore, no soil LUCs are required at these sites. Furthermore, these sites are closed as documented in respective RARs. At Sites DP039, SD043, LF044, and SS046, LUCs were installed to restrict site access and prohibit the residential use of the property. Travis AFB is successfully managing the Land Use and Access Restrictions remedy in accordance with Section 5.4 of the final Soil ROD for the WABOU.

5.3.2 Progress with NEWIOU Soil and Sediment Remedial Actions

All soil and sediment RAs at NEWIOU sites have been completed in accordance with the final NEWIOU Soil, Sediment, and Surface Water ROD. Below is a summary of all NEWIOU soil/sediment RAs that have been completed in accordance with the Soil ROD for the NEWIOU.

- **SD001 – Excavation and LUCs:** In 2009, Travis AFB removed 304 cubic yards of PAH-contaminated sediments from the Main Branch of Union Creek. Excavated sediments were disposed of off-site at the Hay Road Landfill in Dixon, California. Residential cleanup levels were achieved, and no LUCs were required.
- **FT003 – Excavation and On-Base Consolidation:** In 2007, Travis AFB removed 2,957 cubic yards of PAH- and PCB-contaminated soil and placed the soil in an on-base CAMU. Residential cleanup levels were achieved, and no LUCs were required.
- **FT004 – Excavation and On-Base Consolidation:** In 2007, Travis AFB removed 10,753 cubic yards of lead- and dioxin-contaminated soil and placed the soil in an on-base CAMU. Residential cleanup levels were achieved, and no LUCs were required.
- **FT005 – Excavation and On-Base Consolidation:** In 2007, a 25,000-gallon aboveground storage tank (AST) was removed and transported off-site. In 2011, Travis AFB removed 11,792

cubic yards of PAH-contaminated soil. Excavated soils were disposed of off-site at a landfill. Residential cleanup levels were achieved, and no LUCs were required.

- **LF007 – Excavation and LUCs:** In 2007, Travis AFB removed 5,059 cubic yards of Aroclor-1260-contaminated soil and placed the soil in an on-base CAMU. Residential cleanup levels were achieved, and no LUCs were required.
- **SS015 – LUCs:** Ongoing management of LUCs since 2007.
- **SS016 – LUCs:** Ongoing management of LUCs since 2007.
- **SS032 – LUCs:** Ongoing management of LUCs since 2007.
- **SD033 (soil) – LUCs:** Ongoing management of LUCs since 2007.
- **SD033 (sediment)– Excavation and LUCs:** In 2009, Travis AFB removed 407 cubic yards of PAH-contaminated sediments from the West and Main Branches of Union Creek. Excavated sediments were disposed of off-site at the Hay Road Landfill in Dixon, California. Residential cleanup levels were achieved, and no LUCs were required.
- **SD037 – LUCs:** Ongoing management of LUCs since 2007.

Travis AFB successfully conducted soil or sediment excavations at Sites FT003, FT004, FT005, LF007E, SD001, and SD033 in accordance with the final NEWIOU Soil, Sediment, and Surface Water ROD. These actions achieved cleanup levels that allow for unlimited use and unrestricted exposure at each site. Therefore, no LUCs were required at these sites. Furthermore, these sites are closed as documented in respective RARs.

LUCs were successfully implemented at Sites SS015, SS016, ST032, and SD037. At these sites, a LUC was the only remedy selected in the ROD. Travis AFB is successfully implementing the LUCs in accordance with Section 5.4 of the final NEWIOU Soil, Sediment, and Surface Water ROD. Travis AFB has also implemented LUCs at all of the other areas within Site LF007, including the area of the CAMU.

5.4 Status of Follow-Up Actions from the Second Five-Year Review

A summary of the key follow-up actions from the second five-year review is provided in Table 5-2.

TABLE 5-2

Summary of Key Recommendations and Follow-up Actions from the Second Five-Year Review^a*Third Five-Year Review Report, Travis AFB, California*

Issues from Previous Review	Follow-Up Actions	Action Taken and Outcome	Date of Action
The LF007C plume is migrating off-base. The existing solar-powered extraction wells are probably inadequate to control migration or remediate the plume. Additional characterization of off-base contaminant distribution, groundwater flow direction, and potential extraction system modifications are being evaluated by the Air Force.	Investigate the extent of TCE contamination above the IRG in the off-base area. Verify the groundwater flow direction(s). After the off-base plume is characterized, evaluate installing one or more additional extraction wells to hydraulically capture the plume and fully achieve the migration control and off-base remediation objectives. Evaluate adding batteries to permit operation of extraction wells during night-time hours.	Data gaps investigations were performed from October 3 through December 30, 2011, to further characterize the horizontal and vertical extent of the groundwater VOC contamination. The results of the characterization and updated groundwater modeling were used to prepare a plan to optimize the existing GET system. GET system optimization consists of modifying existing extraction wells to pump at higher rates and/or adding a new extraction well in the southern portion of the site. Implementation of the optimization plan for site LF007C is planned for 2013. Batteries were added so the pumps could operate all day and all night, which ultimately increased yield from the wells.	2011 pending 2009
A portion of the off-base SS030 plume may be migrating toward Site FT005 under the hydraulic influence of the FT005 GET system.	Characterize the extent of groundwater contamination to the east of the off-base portion of the SS030 plume. Install one or more additional monitoring wells in this area for long-term compliance monitoring. Evaluate installing one or more extraction wells on the east side of the off-base SS030 plume to prevent contaminant migration in that area.	Because the TCE plume had migrated eastward, an additional well pair, MW2001Ax30/MW2001Bx30, was installed in 4Q09 along the eastern site boundary. The two additional wells (MW2001Ax30 and MW2001Bx30) installed at SS030 achieved the goal of characterizing the extent of contamination to the east of the off-base portion of the plume, and have helped demonstrate that this portion of the plume remains under capture of the GET system. The hydraulic capture at Site SS030 was improved by bringing extraction well EW03x30 back on-line. There was no need to install more extraction wells. The influence of the FT005 extraction system on SS030 hydraulic capture was eliminated when the majority of FT005 extraction wells were taken off-line.	2009 2010
The portion of the DP039 plume that is downgradient of the current zone of hydraulic capture may be migrating	Continue to monitor concentration trends in downgradient wells and evaluate potential extraction system modifications	Permeable reactive barrier wall installed to treat downgradient portion of plume migrating beyond the extraction system.	2010
Travis AFB will place a memorandum into the Administrative Record that documents the LUCs for all groundwater sites in the groundwater IRODs for the NEWIQU and the WABOU		Travis AFB placed memo in Administrative Record. The memo is an addendum to the annual LUC reports	2008
After the second five-year review of groundwater IRAs, there will be sufficient data to support the Travis AFB Groundwater ROD.		Travis AFB issued The Proposed Plan for Groundwater Cleanup in October 2012; the Travis AFB Groundwater ROD is expected to be signed in July 2013.	Pending

^a Travis AFB Second *Five-Year Review Report* (CH2M HILL, 2008)

5.5 Progress on Comments on Second Five-Year Review

The second Five-Year Review Report was submitted as a draft document for regulatory agency reviews in April 2008. Comments were received only from EPA, including initial comments on June 12, 2008, followed by supplemental comments on August 4, 2008. The review comments and Travis AFB responses are provided as Appendix E to the Final Second Five-Year Review Report (CH2M HILL, 2008). All of the issues raised by EPA were resolved either by clarifying language in the report or by continuing the issues as follow-up actions for the third five-year review. The Air Force finalized the Report on September 25, 2008 and EPA approved it September 29, 2008. The follow-up actions are discussed in Table 5-2, above.

The second Five-Year Review Report identified an emerging issue at Travis AFB, a potential vapor intrusion (VI) exposure pathway from the migration of VOCs through the vadose zone and potentially into overlying buildings. To resolve this issue, Travis AFB performed a VI assessment in 2009 and an updated assessment in 2012. In sum, the assessments indicate that groundwater contamination at portions of Sites FT004, SS015, SS016, SS029, and DP039 poses a potential indoor air VI risk to industrial workers. Risks are also posed to potential future residents at these sites and at Sites LF007, SS030, SD033, SS035, SD036, and SD037. Specific LUCs to address VI risks are proposed in the draft Travis AFB Groundwater ROD to restrict industrial building construction on portions of Sites FT004, SS015, SS016, SS029, and DP039 unless vapor barriers and/or passive venting systems are included. The VI LUCs will be maintained until concentrations of volatile COCs in groundwater posing a potential indoor air risk are at such levels that VOCs emanating from groundwater to indoor air do not pose unacceptable risk to human health.

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SECTION 6

Five-Year Review Process

This section provides descriptions of the administrative components of this *Third Five-Year Review Report*, including the community notification and involvement activities conducted by Travis AFB; the relationship of environmental restoration activities and Travis AFB land use planning; summaries of the key guidance, decision, and technical documents reviewed; and interviews conducted in support of preparing this document.

6.1 Administrative Components

Travis AFB is the lead agency for the groundwater IRAs and soil RAs being evaluated in this five-year review report. The San Francisco Bay Water Board, EPA Region 9, and DTSC participate in this review and provide regulatory agency oversight of the groundwater IRAs and soil RAs implemented at Travis AFB. Other regulatory agencies that may provide guidance on the decisions made by Travis AFB Asset Management Flight include the Bay Area Air Quality Management District, the California Department of Fish and Game, the United States Fish and Wildlife Service, and the Solano County Environmental Management Office.

As the lead federal agency, the Air Force is required to perform the five-year reviews for Travis AFB under CERCLA Section 104, 120 under Executive Order 12580. EPA is required to assure that the review adequately addresses the protectiveness of the remedies. The San Francisco Bay Water Board and DTSC represent the interests of the State of California. The DTSC serves as the lead State of California regulatory agency.

6.2 Community Notification and Involvement

A copy of the Draft Third Five-Year Review Report was reviewed by the Technical Review Focus Group of the Restoration Advisory Board (RAB) in May 2013. Public notices will be published in the *Vacaville Reporter*, the *Fairfield Daily Republic*, and the Travis AFB *Tailwind* in October 2013. A copy of the final report will also be placed in the Vacaville Public Library at 1020 Ulatis Drive, Vacaville, California 95688, (707) 449-6290.

6.3 Document Review

6.3.1 Guidance Documents

Travis AFB has prepared this *Third Five-Year Review Report* in accordance with the EPA Comprehensive Five-Year Review Guidance (EPA, 2001) and other guidance documents, fact sheets, and memoranda, including:

- Five-Year Review – Questions & Answers (EPA, 2004)
- Five Year Review Process in the Superfund Program (EPA, 2003)
- Recommended Evaluation of Institutional Controls: Supplement to the “Comprehensive Five-Year Review Guidance” (EPA, 2011)
- Recent Environmental Protection Agency Guidance on Five-Year Reviews (EPA, 2011)

- Transmittal of the updated Five-Year Summary Form (EPA, 2011)
- Clarifying the Use of Protectiveness Determinations for CERCLA Five-Year Reviews (EPA, 2012)

6.3.2 Decision Documents

Several regulatory decision documents that are specific to the Travis AFB ERP have also been used in the development of this *Third Five-Year Review Report*. These documents include the following:

- Final Groundwater IROD for the NEWIOU (Travis AFB, 1998)
- Final Groundwater IROD for the WABOU (Travis AFB, 1999)
- Final Soil ROD for the WABOU (Travis AFB, 2002)
- Final NEWIOU Soil, Sediment, and Surface Water ROD (Travis AFB, 2006)

As appropriate for each NEWIOU and WABOU ERP site, these IRODs and RODs specify the groundwater IRAs, soil RAs, groundwater IRA objectives, groundwater interim remediation/cleanup goals, soil cleanup levels, and the Applicable or Relevant and Appropriate Requirements (ARARs).

6.4 Technical Data Review

Technical information regarding the implementation and performance of groundwater IRAs and soil and/or sediment RAs was also derived from several sources. The primary documents reviewed during development of this five-year review report included the documents listed below. Appendix B, References, is a complete list of documents reviewed to perform this five-year review.

As an optimization measure in 2012, Travis AFB and the regulatory agencies agreed to a change in the reporting schedule, which would allow the annual GSAP and the annual RPO reports to be combined. The combined Annual GSAP and RPO Report will include all data collected in 2012 and will be prepared in 1Q13. Because of the delay in the 2012 reporting schedule, the Annual GSAP Report for 2012 was not available for this five-year report.

The most recent groundwater data available for this five year review were compiled in the 2010-2011 (GSAP) Annual Report. In addition, a draft technical memorandum was available for review which presents limited 4Q12 GSAP monitoring data for sites LF008 and LF007D only. The 2010-2011 GSAP Annual Report summarizes the groundwater data collected during two sampling events, November through December 2010 (4Q10) and April through June 2011 (2Q11). In addition to the wells sampled under the GSAP, several monitoring wells were sampled over the same time period (November 2010 through June 2011) in support of site-specific RPOs.

- 2012 GSAP Technical Memorandum (CH2M HILL, 2012a)
- Final RPO Baseline Implementation Report (CH2M HILL, 2012b)
- Final 2011 RPO Report for Ground Water Treatment Plants (CH2M HILL, 2012c)
- Final 2010-2011 Annual GSAP Report (CH2M HILL, 2012e)
- Final Focused Feasibility Study Report (CHM2 HILL, 2011)
- Final Natural Attenuation Assessment Report (CH2M HILL, 2010a)
- Final Sites SD001 and SD033 Remedial Action Report; (ITSI, 2010)

- Final Site FT005 Remedial Action Report (ITSI, 2012)
- Final Annual Report on the Status of LUCs on Restoration Sites in 2011 (Travis AFB, 2012b)

6.5 Interviews

On October 30 and 31, 2012, interviews were conducted in support of performing a LUC evaluation in concert with EPA Guidance “Recommended Evaluation of Institutional Controls: Supplement to the Comprehensive Five-Year Review Guidance,” dated September 2011. The details of these interviews, including participants and list of questions, are outlined in Appendix C. To summarize, the purpose of the interviews was to gather information on LUCs related to their implementation, maintenance, and enforcement. Travis AFB staff interviewed included an engineer, hydrogeologist, environmental planner, and community planner, providing valuable information on LUCs related to their implementation, maintenance, and enforcement. The interviews revealed a list of proactive oversight activities ongoing to protect the LUCs, as summarized in Appendix C. The information obtained from the interviews, coupled with subsequent site inspections relative to the LUCs, also outlined in Appendix C, were used to formulate the evaluations outlined throughout this *Five-Year Review Report* relative to the LUCs in place at Travis AFB.

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SECTION 7

Technical Assessment

This section provides discussions regarding the protectiveness of the groundwater IRAs and soil and/or sediment RAs implemented at Travis AFB. The protectiveness of the remedies is determined by answering the following three key questions:

- **Question A:** Is the remedy functioning as intended by the decision documents?
- **Question B:** Are the assumptions used at the time of remedy selection still valid?
- **Question C:** Has any other information come to light that could call into question the protectiveness of the remedy?

The following subsections provide the answers to these questions for the NEWIOU and WABOU groundwater IRAs and soil/sediment RAs.

7.1 Groundwater Interim Remedy Assessment

7.1.1 Question A: Is the Groundwater Remedy Functioning as Intended by the Decision Documents?

Yes, the groundwater interim remedies, modified through a series of remedial process optimizations, are functioning as intended by the decision documents, with the exception of LF007C, which is **No**. The technical data and observations that support this answer are provided in the following subsections.

The IRAs to address groundwater contamination at Travis AFB were selected in two decision documents:

- Final Groundwater IROD for the NEWIOU
- Final Groundwater IROD for the WABOU

The Air Force developed the groundwater IRODs for NEWIOU and WABOU, rather than a final groundwater ROD, to allow groundwater remediation to begin quickly to reduce contamination and risk. The groundwater IROD establishes an interim period to evaluate the effectiveness of the IRAs and to monitor the status of each contaminant plume.

For the most part, the groundwater interim remedies have operated successfully. After more than a decade of the interim remediation, the residual contaminant concentrations at most of the ERP sites are much lower than initial values but are still high enough to require continued and, in most cases, more effective cleanup actions. This prompted the Air Force to consider more aggressive groundwater cleanup strategies. As a result, RPOs were performed at several ERP sites. RPOs consisted of bioreactors (the installation of which included excavating contaminated soil), EVO, and modified GET systems (including taking extraction wells off-line and/or installing new extraction wells). The activities were performed with concurrence from the regulatory agencies. Agreements were documented in RPM meeting minutes and/or approved work plans.

The Air Force used data gathered during the interim remediation period to establish final groundwater cleanup levels and select technically and economically feasible long-term actions in the final Travis

AFB Groundwater ROD. The Air Force has begun the process to release a basewide Groundwater ROD. A Final Proposed Plan for Groundwater Cleanup was released in October 2012. The Travis AFB Groundwater ROD is expected to be signed in July 2013.

7.1.1.1 Groundwater IRA Objectives

The groundwater IRA objectives specified in the two IRODs include the following:

- Source Control – achieved via GET
- Migration Control – achieved via GET and/or MNA or MNA assessment
- Off-Base Remediation – achieved via GET

More complete descriptions of the source control, migration control, and off-base remediation IRA objectives are provided in Section 4.

7.1.1.2 Groundwater IRA Performance

Table 7-2 summarizes the performance of each of the IRAs, based on physical and analytical data collected through 2Q11. IRAOs have been achieved at ERP Sites FT004, FT005, LF006, LF007B, LF007D, LF008, SS015, SS016, SS029, SS030, SD031, DP039, and WIOU.

RPOs have been performed at Sites SS015, SS016, DP039, and the WIOU because IRAOs were either not being achieved or persisting residual concentrations indicated that the IRAOs could be achieved more efficiently. In 2010, RPOs consisting of EVO injections were performed at Site SS015 and at Sites SD036 and SD037 of the WIOU. An RPO consisting of the installation of an in-situ bioreactor was performed at Site SS016 in 2010. Several RPOs have been performed at Site DP039, including the installation of an in-situ bioreactor (2008), establishment of a phytoremediation area (1998), and the installation of an EVO PRB (2010). Performance monitoring data collected to date indicate that all of the recent RPOs are operating as designed and supporting achievement of IRAOs.

Site LF007C remains the only area where IRAOs have not been achieved. However, an RPO is planned for Site LF007C in 2013. The RPO plan is to modify existing extraction wells to pump at higher rates and/or to add a new extraction well in the southern portion of the site.

The following data are used to assess the performance of the groundwater IRAs against the IRA objectives stated in the IROD:

- Changes in chemical concentrations in individual wells
- Contaminant-specific plume maps
- Influent concentrations at the groundwater treatment plants
- Hydraulic containment evaluations

Changes in Chemical Concentrations in Individual Wells. Overall, COC concentrations in individual wells within the groundwater IRAs are decreasing. Contaminant concentrations measured in individual wells during the 2010-2011 groundwater monitoring event are provided in the 2011 GSAP Report (CH2M HILL, 2012e). Additional information regarding groundwater contamination in extraction and monitoring wells and the contaminant concentration trends for those wells are also provided in Appendix D, Groundwater Sites and Contamination.

Contaminant data for individual monitoring and extraction wells are primarily obtained through the Travis AFB GSAP. Detailed descriptions of the groundwater monitoring program findings and

current analytical data are provided in the final 2010-2011 Annual GSAP Report (CH2M HILL, 2012e).

Contaminant-Specific Plume Maps. Overall, chemical concentrations within the groundwater IRA contaminant plumes are decreasing. Changes in groundwater contaminant plumes at ERP sites within the North, Central, West, and South IRAs between the time of the second five-year review in 2008 and this third five-year review in 2012 are depicted on Figures 7-1 through 7-8.

Influent Concentrations at the Groundwater Treatment Plants. Groundwater influent concentrations at the NGWTP, CGWTP, and SBBGWTP are depicted on Figures 7-9, 7-10, and 7-11. The concentration trends for the NGWTP are decreasing and close to zero. For the CGWTP and SBBGWTP, the influent trends are a little inconsistent but, in general, a decreasing trend.

The three treatment plants receive contaminated groundwater from numerous extraction wells within each ERP site. Fluctuations in the influent concentrations are most common during the first few years of treatment plant operations, as operating adjustments are made, new extraction wells are added or shut down, and other treatment process improvements are incorporated.

- **NGWTP** – The NGWTP can receive contaminated groundwater from extraction wells located within Sites FT004, LF007C, and SD031. Since 2007, NGWTP received groundwater from only two extraction wells while treating groundwater from Site LF007C alone. At the NGWTP, groundwater VOC concentrations are monitored monthly when the system is operational (i.e., not during periods of shutdown when vernal pools are present at Site LF007C). Concentrations at individual extraction wells are monitored annually. The NGWTP was brought on-line on 19 May 2011 for startup sample collection, and returned to continuous operation on 9 June 2011. The NGWTP operated continuously for the remainder of 2011. Figure 7-9 shows the influent total VOC concentrations in groundwater at the NGWTP from January 2001 through December 2011. The influent total VOC concentration at the NGWTP exhibits an overall decreasing trend through approximately January 2009, at which time the influent concentration becomes nearly asymptotic near the bottom of the chart. In 2011, influent total VOC concentrations in groundwater remained consistent with the near-zero concentrations seen in 2009. Influent total VOC concentrations in 2011 ranged from non-detect in July and August 2011 to 4.98 µg/L in September 2011. Influent concentrations during 2011 were all below the effluent concentration limits.
- **CGWTP** – The CGWTP receives contaminated groundwater from extraction wells located at Site LF008, Site DP039, multiple sites within the WIOU, and Site SS016. The concentrations of total VOCs in the influent between July 1999 through December 2011 are shown on Figure 7-10. The figure shows a general declining trend from 1999 to 2007. The sharp increase in June and July 2008 is likely the result of restarting groundwater extraction from EW003x16, which had been off-line since September 2002. During 2011, total influent VOC concentrations ranged between 233 and 459 µg/L, which is a slightly lower range compared with data collected during 2010 (between 323 and 540 µg/L). Overall, total influent VOC concentrations at the CGWTP have declined over time.
- **SBBGWTP** – The SBBGWTP receives contaminated groundwater from extraction wells located within Sites FT005, SS029, and SS030. The concentrations of total VOCs in the influent from 2003 through December 2011 are shown on Figure 7-11. From October 2006 through July 2009, concentrations increased significantly. This overall increase in VOC concentration may reflect the higher level of repair and maintenance of extraction well pumps that began in late 2006. Repairing and replacing these pumps have improved capture of groundwater contamination. Increased VOC concentrations may also reflect the migrating groundwater contamination to Site SS029 from upgradient Site SS016. Influent VOC concentrations in 2011 (and beginning in December 2009) decreased substantially through December 2011. Influent VOC concentrations

in 2011 ranged from 36.4 to 87.4 µg/L, as compared with the range of 52.8 to 118 µg/L in the period from November 2006 through June 2009.

Detailed descriptions of the groundwater treatment plant O&M activities are regularly reported to the regulatory agencies in monthly data sheets and in annual O&M reports. The most current O&M treatment plant data are provided in the 2011 Annual Remedial Process Optimization Report for Groundwater Treatment Plants (CH2M HILL, 2012c).

Hydraulic Containment Evaluation. Groundwater extraction wells that are currently on-line are generally providing effective hydraulic containment of contaminant plumes, or portions of plumes, as applicable to the sites within each IRA. The off-base portions of the LF007C plume may not be captured via the current remedy. Appendix D discusses hydraulic capture on a site-specific basis. For most sites, hydraulic capture could not be determined, as the GET system was taken off-line.

Evaluations of groundwater elevation measurements and numerical computer modeling indicate that hydraulic containment of contaminant plumes is largely being achieved at sites undergoing GET. The following are descriptions of the evaluations:

- **Empirical Data Evaluation** – Hydraulic capture-zone estimates under the GSAP are estimated from groundwater elevation data. The most recent site-specific capture zone analyses are presented in Section 4 of the *2010-2011 Annual GSAP Report* (CH2M HILL, 2012). Capture zones are estimated as the areas where groundwater is interpreted to flow toward an extraction well. First, the groundwater elevation contours (i.e., piezometric maps) are generated with Surfer® Version 8.0 software and refined using professional judgment. The piezometric maps are used to interpret groundwater flow direction, with flow being perpendicular to the contour lines. The result of this interpretation is an estimated extent of capture for the groundwater extraction system. Contaminant plumes are then drawn using groundwater monitoring well and extraction well sampling data. The contaminant plumes are delineated based on the IRG specified in the applicable IROD. For example, TCE contaminant plumes are delineated using the 5 µg/L concentration specified as the IRG in the NEWOU and WABOU groundwater IRODs. The estimated capture zone is then compared to the GET target area. If an estimated capture zone encompasses the target area, then the target area is interpreted as captured. All capture zone estimates are developed with professional judgment according to hydrogeology, calculated groundwater velocities, aquifer thickness, data density, and pumping rates.
- **Numerical Modeling** – The groundwater modeling effort was limited to update only the Travis Basewide Groundwater Flow Model for Site LF007C with new geological data, hydrogeological data, analytical data, and aquifer test results from the data gaps investigations in the Site LF007C vicinity. More information on the details of the numerical computer modeling conducted for site LF007C is provided in the Site LF007C Data Gaps Investigation Results Technical Memorandum (CH2M HILL, 2012d).

7.1.1.3 Groundwater Interim Remedial Action Performance Summaries

The following subsections provide summaries of the performance of the GET, MNA, and RPOs at the sites within each groundwater IRA. Additional and more detailed information on IRA performance is also provided in Appendix D.

North IRA Groundwater Extraction and Treatment System – Site LF007C. Only the Site LF007C GET system was operational during the reporting period. The Site LF007C GET system IRAO is migration control at the Base boundary and off-base remediation. The two Site LF007C extraction wells, EW614x07 and EW615x07, were brought on-line in August 2004. However, these wells are in a vernal pool area; therefore, they operate only in the summer. Only one extraction well (EW615x07) was operational during the 2Q11 groundwater elevation survey. The influence of groundwater

extraction from this well is not evident on the groundwater elevation contours; therefore, no hydraulic capture was estimated based on the groundwater elevation data. Available groundwater elevation data indicate variable groundwater flow directions at the Base boundary, and the extent to which hydraulic capture is achieved is uncertain. Based on GSAP data collected through 2Q11, the following conclusions are drawn:

- TCE has migrated off-base at Site LF007C at concentrations above the IRG. The extent of this off-base contamination was unclear. Subsequently, in 2011, an additional investigation was conducted in the off-base area to further characterize the horizontal and vertical extent of the TCE groundwater plume and to confirm groundwater flow direction when extraction wells are pumping. The study confirmed that, though the regional groundwater gradient is to the south, the local groundwater flow radiates from a groundwater mound near monitoring well MW261x07 (located to the southeast of Site LF007C). The TCE groundwater plume was defined both vertically and horizontally.
- Based on available groundwater elevation data and analytical data, the effectiveness of the Site LF007C GET is uncertain. However, TCE concentrations have long-term declining trends in two of the three Site LF007C plume wells (MW125x07 and MW617x07). TCE concentrations have also recently declined in off-base monitoring well MW620x07. The maximum TCE concentration detected at the site in 2Q11 was 10.3 µg/L. Historically, the maximum TCE concentration detected at the site was 87 µg/L at well MW125x07, located on the Base boundary.

North IRA – Sites FT004 and SD031 Rebound and MNA Evaluation. The GET system at Sites FT004 and SD031 has been shut down for a rebound study. The attenuation capacity of the aquifer is being evaluated while the GET system is off-line. The source control objective (capture of VOC concentrations greater than 100 µg/L) had been achieved at Site SD031 prior to the start of the rebound study. Since the SD031 GET system was taken off-line, VOC concentrations within Site SD031 have remained below 100 µg/L.

At Site FT004, VOC concentrations in a small portion of the plume (near monitoring wells MW131x04, MW266x04, and MW585x04) remain above 100 µg/L. However, no significant rebound was observed over the reporting period. In fact, VOC concentrations continued to decline in most Site FT004 extraction wells and monitoring wells, indicating that the attenuation capacity of the aquifer exceeds the mass loading from residual contamination. Only two Site FT004 monitoring wells have statistically significant increasing TCE concentration trends: MW134x04 and MW591x04. These wells are located in the downgradient portion of the plume. The increasing trend at MW134x04 is slight; the maximum TCE concentration detected is 2.4 µg/L (below the IRG). The TCE concentrations detected at MW591x04 over the reporting period are below the maximum concentration detected (14.4 µg/L).

On the basis of the data collected to date, MNA is a viable remedy for the residual groundwater contamination at Sites FT004 and SD031. Overall, COC concentrations are stable or declining in the Site FT004 and SD031 wells. No VOCs were detected at concentrations exceeding IRGs in the downgradient wells during the reporting period. The monitoring network includes both shallow and deep monitoring wells; MNA appears to be effective throughout the entire thickness of the plume.

North IRA – Sites LF007B and LF007D Rebound and MNA Evaluation. Sites LF007B and LF007D at Site LF007 were selected for MNA assessment over the interim period. No Site LF007B COCs were detected in Site LF007B wells sampled during the reporting period. Sample results indicate that MNA is an appropriate remedy for Site LF007B. Groundwater contamination at Site LF007D is restricted to a small area in the vicinity of MW261x04, the only location at which Site LF007D COCs were detected. No Site LF007D COCs migrated off-base to the north or east of Site LF007D; therefore, MNA continues to be an effective remedy for Site LF007D.

At LF007D, MNA also appears to be a viable remedy. Groundwater contamination is limited to a small area in the vicinity of one well. Contamination does not appear to be migrating.

North IRA – Site LF006 MNA Evaluation. TCE was the only site COC that exceeded IRGs over the reporting period. The maximum concentration of TCE detected was 7.1 J µg/L. TCE shows significantly decreasing trends at several Site LF006 plume wells, according to the Mann-Kendall trend analysis and time-series plots. No monitoring wells have increasing TCE trends. The TCE plume has reduced in size over time. Total petroleum hydrocarbons as diesel (TPH-D) and TPH as gasoline (TPH-G) were not detected over the reporting period. Migration control is the objective for Site LF006. Groundwater contamination at Site LF006 is contained, and the plume is not migrating. In fact, COC concentrations are declining. Therefore, as the NAAR (CH2M HILL, 2010a) concluded, MNA is an effective remedy for Site LF006.

North IRA – Optimization Measures.

- Groundwater extraction wells at Sites FT004 and SD031 are shut down for a rebound study during the remainder of the interim period. Groundwater extraction will continue during the dry season at Site LF007C.
- TCE concentrations in MW620x07 are above the IRG, and the downgradient extent of off-base contamination has not been defined. Data gaps investigations were performed from October 3 through December 30, 2011, to further characterize the horizontal and vertical extent of the groundwater VOCs. The results of the characterization and updated groundwater modeling were used to prepare a plan to optimize the existing GET system. The proposed GET system optimization consists of modifying existing extraction wells to pump at higher rates and/or adding a new extraction well in the southern portion of the site. Implementation of the optimization plan for site LF007C is planned for 2013.

Central IRA Site SS016 Groundwater Extraction and Treatment System. The Site SS016 NEWIOU Groundwater IROD source control objective is capture of VOC concentrations greater than 3,000 µg/L, but the Site SS016 GET was designed to capture VOC concentrations greater than 1,000 µg/L. VOC concentrations within the TARA have declined and are below 1,000 µg/L. Most of the monitoring wells within the TARA have statistically significant decreasing COC trends. Design capture has been achieved in the TARA.

After several years of operation, it was determined that GET in the OSA was not cost-effective, and the IRA was optimized by the installation of a bioreactor. OSA extraction well EW003x16 is currently used to recirculate groundwater through the bioreactor rather than to provide source control.

GET continues to be used to control plume migration. TCE concentrations are declining in extraction wells EW605x16 and EW610x16 and most monitoring wells downgradient of the bioreactor. No downgradient monitoring wells have increasing COC trends. The declining COC trends downgradient of the OSA indicate that the OSA GET system is achieving the IRAO of source control.

Although TCE concentrations are generally declining throughout Site SS016, increasing TCE concentrations at some upgradient Site SS029 monitoring wells indicate that the groundwater contamination has migrated beyond the Site SS016 boundaries to Site SS029. However, VOC contamination that escaped the Site SS016 extraction system is currently being captured by the Site SS029 GET and is treated at the SBBGWTP.

Central IRA Site SS016 Bioreactor. Based on the first two quarters of performance data, the bioreactor is performing as designed. Geochemical data collected from the bioreactor are favorable for ERD. ERD has resulted in high rates of TCE, DCE, and vinyl chloride removal. Based on the 2Q11 data, the bioreactor is removing over 99 percent of the TCE and nearly 93 percent of the total

molar CVOCs entering the bioreactor. Significant levels of ethene in MW2020Ax16 also confirm that destruction of vinyl chloride is underway in the bioreactor. Vinyl chloride has not migrated away from the bioreactor.

Central IRA – Site ST027B MNA Evaluation. An IRA has not been established for the CVOC plume at Site ST027B. MNA assessment continues over the interim period leading up to the Travis AFB Groundwater ROD. Data collected to date indicate that MNA is a suitable remedy to address the Site ST027B TCE plume. The TCE plume has not migrated over the monitoring period. The presence of petroleum hydrocarbons within the Site ST027B plume is conducive to reductive dechlorination. The presence of cis-1,2-DCE and vinyl chloride within the plume indicates that reductive dechlorination is occurring. Although decreasing COC trends are not evident in the Site ST027B wells, the monitoring history for these wells is relatively short.

Central IRA Optimization Measures. In September 2010, the OSA groundwater treatment was enhanced by installation of a bioreactor. During installation, most of the residual mass was removed. The remaining mass will continue to be treated in situ through enhanced biodegradation.

West IRA Groundwater Extraction and Treatment System – WIOU Sites, Site DP039, and LF008. The WIOU, DP039, and LF008 GET systems were taken off-line to support rebound studies and/or to implement remedial process optimizations to improve groundwater cleanup activities.

West IRA – DP039 Bioreactor Evaluation. Since startup of the bioreactor, TCE concentrations in the former sump area have declined to below 200 µg/L. The relatively low TCE concentrations in the former sump area indicate that most of the remaining mass was removed during bioreactor excavation and that dissolved contamination moving away from the former sump area is being effectively treated by the reducing conditions established by the bioreactor. Through 2Q11, TCE reductions of more than 99 percent and total molar CVOC reductions of more than 93 percent have occurred in the aquifer within 30 feet of the bioreactor.

Monitoring well MW750x39 experienced rebound in TCE concentrations in the interval between the shutdown of the GET and the installation of the bioreactor. However, as expected, TCE concentrations subsequently decreased once reducing conditions were achieved at the bioreactor and the high concentrations of TCE near this well were flushed downgradient.

The bioreactor is performing as designed.

West IRA – DP039 EVO PRB Evaluation. Performance monitoring data show significant (one to three orders of magnitude) reductions in TCE concentrations, minor cis-1,2-DCE accumulation, and no vinyl chloride accumulation along the EVO PRB. Geochemical data collected from the injection wells support ERD. High methane, high dissolved iron and manganese, and depressed sulfate are all positive geochemical signatures for anaerobic conditions favoring ERD. TCE concentrations in MW02x39, located immediately downgradient of the PRB wall, declined from 4Q10 to 2Q11. Prior to the EVO injection, this monitoring well exhibited an increasing TCE concentration trend. Monitoring data collected to date indicate that the EVO PRB is performing as designed.

West IRA – WIOU Sites EVO Injection Evaluation. The quarterly RPO performance monitoring indicates that the EVO injections in both the Site SD036 and Site SD037 areas have resulted in ERD. TCE concentrations have decreased significantly (one to two orders of magnitude) in target wells. Cis-1,2-DCE concentrations have increased in the treatment zone. Vinyl chloride is also being formed within the treatment zone. The presence of ethane and ethene within the treatment zone indicates that complete dechlorination of the cis-1,2-DCE and vinyl chloride is occurring. Consistent detections of vinyl chloride concentrations exceeding the IRG (0.5 µg/L) are restricted to the EVO injection areas; vinyl chloride is not migrating away from the EVO injection areas.

The dissolved total organic carbon (TOC) supply in both areas of high residual contaminant concentration subjected to injection remains high and is sustaining a rapid rate of ERD. Geochemical data collected from these areas support ERD. However, it is also apparent that sulfate levels in excess of 200 milligrams per liter (mg/L) are present in the WIOU, and sulfate reduction will be competing with TCE reduction. A continuing influx of sulfate will deplete the TOC supply and eventually slow TCE and 1,2-DCE removal.

Monitoring data collected to date indicate that the EVO injections are performing as designed.

West IRA – SS015 EVO Injection Evaluation. The EVO injection has resulted in a significant decline (one to two orders of magnitude) in CVOC concentrations in the treatment area. TCE, cis-1,2-DCE, and vinyl chloride concentrations all declined. The decline in vinyl chloride concentrations and the detections of ethane and ethene in the injection area indicate that vinyl chloride is being completely destroyed. Along with CVOC concentration trends, elevated TOC concentrations and geochemical parameters all support the conclusion that ERD is occurring in the EVO injection area.

In 2Q11, TCE concentrations in the injection area wells declined to below 100 µg/L. Elevated cis-1,2-DCE concentrations (exceeding 100 µg/L) and vinyl chloride (exceeding 10 µg/L) are restricted to the immediate vicinity of the EVO injection.

The effects of the EVO injection are not yet expected to be observed in the distal portion of the plume. CVOC concentrations have been declining in some of the distal plume wells (MW2103x15 and MW2124x15); however, the declines began prior to the EVO injection. One well, MW625x15, has recently had a trend of increasing COC concentrations. COC concentrations are expected to decline in this well following future groundwater treatment.

Monitoring data collected to date indicate that the EVO injection is performing as designed. Enhanced attenuation appears to be a viable remedy for Site SS015.

West IRA – DP039 MNA Evaluation. Beyond the EVO PRB, the Site DP039 plume is being monitored for natural attenuation. TCE concentrations continued to increase in downgradient MW758x39 and MW760x39 through 2Q11. TCE concentrations slightly exceeded the IRG at both of these wells for the first time in 2Q11. The EVO PRB was installed because increasing TCE concentration trends in these downgradient wells and some of the Site DP039 plume monitoring wells indicated that natural attenuation alone was not sufficient to prevent plume migration. Both MW758x60 and MW760x39 are located several hundred feet downgradient of the EVO PRB; therefore, TCE concentrations are not expected to be immediately affected by the EVO PRB. However, TCE concentrations are expected to decline in these wells as the contaminant mass is reduced by the EVO PRB. Continued monitoring is needed to determine whether the leading edge of the plume has stabilized.

Decreasing TCE concentration trends are evident in downgradient monitoring wells MW759x39 and MW762x39. TCE was not detected at either of these downgradient wells in 2Q11.

Changes in the magnitude and extent of the DP039 TCE plume between 2008 and 2011 (Figure 7-6) primarily reflect the impacts of the aforementioned remediation efforts, but the addition of new wells in this time frame to more accurately define the extent of the plume and associated concentration trends has also contributed to the observed differences in plume configurations shown on Figure 7-6.

West IRA – WIOU Sites Rebound and MNA Evaluation. The GET system was shut down in 2Q10 to facilitate the EVO injections and support a rebound study. Outside of the two EVO injection areas, the WIOU plume is being monitored for rebound.

TCE and other COC concentrations continued to decline or were stable in most of the extraction wells, plume wells, and downgradient monitoring wells sampled over the reporting period. No rebound was evident in the plume, although by 2Q11 the GET system had been shut down for 1 year. The stable and decreasing COC concentration trends indicate that the attenuation capacity of the aquifer exceeds the mass loading from residual contamination at Sites SD036 and SD037. No VOCs were detected at concentrations exceeding IRGs in the downgradient wells during the reporting period. On the basis of the data collected to date, MNA is a viable remedy for the distal portion of the WIOU plume. The monitoring network includes both shallow and deep monitoring wells; MNA appears to be effective throughout the entire thickness of the plume.

West IRA – LF008 Rebound and MNA Evaluation. Pesticides in groundwater at Site LF008 were addressed by a GET system from 2000 through 2008. In December 2008, the three Site LF008 extraction wells were taken off-line, and a rebound study was initiated.

- Alpha-chlordane remains the most widespread groundwater contaminant at the site.
- In 2Q11, pesticides were detected only in the three inactive extraction wells. Only two pesticides, alpha-chlordane and heptachlor epoxide, were detected at concentrations exceeding IRGs.
- Alpha-chlordane exceeded the IRG at two extraction wells, and heptachlor epoxide exceeded the IRG at one extraction well. The maximum alpha-chlordane concentration detected was 0.43 J µg/L; the IRG is 0.1 µg/L. Heptachlor epoxide was detected at a concentration of 0.017 J µg/L; the IRG is 0.01 µg/L.
- Over 7.5 years of operation, the GET had minimal impact on pesticide concentrations at Site LF008. During operation of the GET, pesticide concentrations were stable and the extent of groundwater contamination remained unchanged. This is likely due to the strong adsorption of alpha chlordane and other pesticides to natural organic carbon or fine-grained soil particles in the subsurface and the low permeability of the saturated sediments.
- No significant rebound of alpha-chlordane or any other site COC has been evident during the 2.5 years since the rebound study began. The extent of the alpha chlordane plume has decreased in size since the GET system was taken off-line.
- A long-term decreasing alpha-chlordane concentration trend was identified by the Mann-Kendall analysis for extraction well EW721x08 and monitoring well MW712x08. No long-term concentration trends were identified by the Mann-Kendall analysis in the well data, although the chemical time-series plots indicate alpha-chlordane concentrations have also decreased at EW719x08, EW720x08, MW01x08, and MW717x08.

West IRA Optimization Measures.

- (*WIOU*) Floating product was detected at Site SD034 in 2Q11. Passive skimming devices will continue to be used at this site to address the accumulated product.
- (*WIOU*) In 2010, EVO injections were performed in the two areas of high residual contaminant concentration at Sites SD036 and SD037, where VOC concentrations continued to exceed 1,000 µg/L. Performance monitoring for this RPO is ongoing and will be outlined in the GSAP beginning in 2Q12 and will continue through the GRIP reporting.
- (*WIOU*) No rebound was evident in the WIOU plume during the year the GET system was off-line; therefore, the rebound study will continue and the WIOU extraction wells will remain off-line. The WIOU extraction wells were sampled semiannually in 2011-2012 to monitor for rebound.

- (SS015) In December 2010 and January 2011, EVO injections were performed in the area of high residual contaminant concentrations at Site SS015, where CVOC concentrations exceeded 1,000 µg/L. Performance monitoring for this RPO is ongoing.
- (SS015) While petroleum fuel constituents are not COCs at Site SS015, TPH-G, TPH-D, benzene, and methyl tert-butyl ether (MTBE) were detected at concentrations exceeding IRGs over the reporting period. The source(s) of the fuel constituents are unknown. Therefore, Site SS015 monitoring wells will be sampled in 2Q12 for TPH to provide additional data on these constituents at the site.
- (DP039) An intermittent or pulsed operation of the bioreactor (e.g., 1 week on and 4 weeks off) may lead to more effective operation and to conservation of the small quantities of TOC being generated in the bioreactor.
- (DP039) TOC supply along the EVO PRB is still adequate for ERD (ranging from 128 to 3,080 mg/L). However, TOC is dropping in two of the three injection wells that were sampled. The rate of TOC depletion will be closely monitored to better estimate the recharge frequency for the EVO PBR.
- (DP039) TCE concentrations display increasing trends in several wells located along the northern portion of the Site DP039 plume. While TCE concentrations have been stable in the farthest downgradient of these northern wells (MW785x39), TCE concentrations exceed 100 µg/L at this monitoring well. The extent of the TCE plume is not confined to the IRG along the northeastern portion of the plume. An additional monitoring well to the southeast of MW785x39 is needed.
- (LF008) Based on the limited COC mass removed using the GET system and the rebound study results, groundwater extraction at Site LF008 will remain shut down for a continued rebound evaluation during the remainder of the interim period.

South IRA Groundwater Extraction and Treatment System – Sites SS029, and SS030. The South IRA GET systems at SS029 and SS030 are reducing contaminant concentrations and largely achieving hydraulic capture of contaminant plumes (Figure 7-8).

- **Site SS029** – The primary IRAO for the Site SS029 plume is migration control. The Site SS029 IRAO has been achieved. The target area (TCE exceeding 5 µg/L) is within the 2Q11 estimated extent of hydraulic capture. TCE was not detected in the farthest downgradient monitoring wells (MW01x29, MW06x29, and MW07x29) near the Base boundary. Upgradient Site SS029 wells MW1031x29 and MW1032x29 have exhibited recent trends of increasing COC concentrations. Both of these wells are upgradient from the Site SS029 extraction system, and increasing concentrations at these locations are the result of VOC migration from the upgradient Site SS016 plume. Available physical and analytical data indicate that the Site SS029 GET is capturing the VOC contamination that has migrated from Site SS016.
- **Site SS030** – The on-base IRAO for the Site SS030 plume is migration control. The IRAO for the off-base component of the Site SS030 plume is groundwater remediation to the IRG. The migration control IRAO has been achieved. Groundwater monitoring wells with TCE concentrations exceeding the IRG are within the estimated 2Q11 extent of hydraulic capture. The remedial objective of off-base groundwater remediation is ongoing. The southern and western portions of the Site SS030 plume have been remediated, and VOCs are no longer detected in these areas. TCE remains above the IRG only in the eastern portion of the off-base plume.
- Historically, groundwater elevation contours and the increasing contaminant trends at eastern plume wells MW03x30 and MW05x30 have indicated that contamination may be escaping the

Site SS030 GET in this area and flowing toward the southeast, influenced by the Site FT005 extraction system. However, the 2Q11 groundwater elevation contours indicate that the shutdown of most of the Site FT005 extraction wells improved the Site SS030 system capture. Groundwater elevation contours indicate that wells MW03x30 and MW05x30, as well as new well pair MW2001Ax30 and MW2001Bx30, are within the extent of hydraulic capture of the SS030 GET. In addition, TCE concentrations in the eastern portion of the plume have remained stable (MW03x30) or declined (MW05x30) over the last few years, indicating that the plume is no longer migrating eastward. Although the monitoring history is short at easternmost well pair MW2001Ax30/MW2001Bx30, TCE concentrations declined slightly at these wells between 2Q10 and 2Q11. Ongoing monitoring is needed to determine long-term concentration trends at this well pair. It is expected that TCE concentrations in this well pair will continue to decline if plume capture is achieved.

- In August 2010, three Site FT005 extraction wells were brought back on-line because of a rebound in 1,2-DCA concentrations. Because groundwater extraction at Site FT005 affects the hydraulic capture at Site SS030, Site SS030 groundwater flow directions and VOC concentrations were evaluated for evidence of reduced hydraulic capture. No reduction in hydraulic capture was evident in the 2010-2011 GSAP sampling event.

South IRA – Site FT005 Rebound Evaluation. Because the IRAO of groundwater remediation has nearly been achieved for Site FT005, a rebound study, which began in December 2007, is underway at the site. Over the reporting period, all but three Site FT005 extraction wells (EW02x05, EW734x05, and EW735x05) were off-line. EW02x05, EW734x05, and EW735x05 were brought back on-line in August 2010 because some rebound in 1,2-DCA concentrations had been evident in these extraction wells in 2Q10. With the exception of these extraction wells, the Site FT005 monitoring wells and extraction wells continued to have decreasing or stable 1,2-DCA concentrations through the rebound study period. Over the reporting period, 1,2-DCA concentrations also declined in the active extraction wells. In 2Q11, 1,2-DCA was detected at only three wells in Site FT005: on-base monitoring well MW119x05, on-base extraction well EW733x05, and off-base monitoring well MW766x05.

South IRA – Optimization Measures.

- Groundwater extraction at Site FT005 is reaching its limit of effectiveness; concentrations of 1,2-DCA remain below the IRG in most monitoring and extraction wells. Because the Site FT005 extraction system reduces the extent of capture of the adjacent Site SS030 GET and it is not cost-effective to extract clean groundwater, only extraction wells located in portions of Site FT005 where 1,2-DCA concentrations recently exceeded the IRG are currently operating. Limited groundwater extraction will continue in portions of Site FT005 where 1,2-DCA concentrations have recently exceeded the IRG. Therefore, extraction well EW02x05, along the Base boundary, and extraction wells EW734x05 and EW735x05 will continue to operate. If 1,2-DCA concentrations remain below the IRG through 2012, these wells will again be considered for shutdown.
- The TCE concentration detected in Site SS029 extraction well EW03x29, which had been taken off-line because of low VOC concentrations, continues to exceed the IRG. This extraction well was brought back on-line in 4Q11.
- The extent of capture of the Site SS030 GET has been improved by bringing all of the extraction wells on-line and shutting down most of the Site FT005 extraction wells. The 2Q11 groundwater elevation contours indicate that the eastern portion of the plume is within the extent of hydraulic capture. Therefore, all the Site SS030 extraction wells will continue to operate and only limited groundwater extraction will be performed at Site FT005.

7.1.1.4 Systems Operations and Maintenance

Continued O&M of the groundwater IRA GET systems will maintain the effectiveness of the IRAs. There are no indicators of potential problems or issues beyond those associated with normal O&M and optimization activities.

Detailed descriptions of the groundwater treatment plant O&M activities are regularly reported to the regulatory agencies in monthly data sheets and in annual O&M reports. The most current O&M treatment plant data are provided in the 2011 Remedial Process Optimization Report for the Groundwater Treatment Plants (CH2M HILL, 2012).

7.1.1.5 Opportunities for Optimization

Travis AFB routinely evaluates opportunities for optimization of the groundwater IRAs being implemented at the various ERP sites. A summary of current optimization opportunities for each groundwater IRA is discussed in Section 7.1.1.3.

Additional recommendations for optimization of basewide groundwater monitoring are regularly provided in GSAP reports and will continue in the GRIP reports.

7.1.1.6 Early Indicators of Potential Issues

There are no early indicators of potential issues that would place the protectiveness of the groundwater IRAs at risk. Normal O&M activities have been successful at keeping GET systems operating.

7.1.1.7 Implementation of Groundwater Institutional Controls and Other Measures

On-Base Locations. Travis AFB has institutional controls in place at sites with groundwater contamination. More extensive descriptions of these measures are provided in Section 4.1.2.

7.1.2 Question B: Are the Assumptions Used at the Time of Groundwater Remedy Selection Still Valid?

Yes, the assumptions used at the time of groundwater interim remedy selection are still valid. There have not been significant changes in regulatory standards, exposure pathways, contaminant toxicity, or risk assessment protocols that call into question the protectiveness of the groundwater IRAs at Travis AFB.

7.1.2.1 Changes in Standards and TBCs

There have been no changes in the standards identified in the WABOU IROD or the NEWIOU IROD that call into question the protectiveness of the groundwater IRAs at Travis AFB.

USEPA's Region IX Preliminary Remediation Goals (PRGs), now referred to as Regional Screening Levels (RSLs), for PAHs in residential soils served as the basis for several RAs conducted at Travis AFB. Since those RAs were implemented, the RSLs have been updated, resulting in revised residential soil RSLs for several PAHs, including benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, dibenzo(a,h)anthracene, and indeno(1,2,3-c,d)pyrene. Section 7.2.2.1 includes an assessment of these changes in TBCs, concluding that these changes did not affect the protectiveness of the RAs implemented at Travis AFB.

Action-Specific ARARs. There are no major changes to the action-specific ARARs identified in the WABOU or NEWIOU IRODs.

As referenced in Section 4.1.2, an October 2008 Travis AFB letter entitled "Institutional Land Use Controls at Travis Air Force Base Groundwater Sites" clarified the applicability of 22 *California*

Code of Regulations (CCR), Chapter 39, Section 67391.1, effective 19 April 2003 to Travis AFB groundwater sites by placement of the letter in the Administrative Record files as a minor change to the WABOU and NEWIOU Groundwater IRODs.

Chemical-Specific ARARs. There are no changes to chemical-specific ARARs identified in the WABOU or NEWIOU IRODs.

Location-Specific ARARs. There are no changes to the location-specific ARARs identified in the WABOU or NEWIOU IRODs.

7.1.2.2 Changes in Exposure Pathways

There have been no significant changes in land use, contaminant types, new contaminant sources, or physical site conditions at any of the NEWIOU or WABOU groundwater sites that affect exposure pathways or reduce the effectiveness of the groundwater IRAs.

Travis AFB performed a vapor intrusion assessment in 2009 and an updated assessment in 2012. In sum, the assessments indicate that groundwater contamination at portions of Sites FT004, SS015, SS016, SS029, and DP039 poses a potential indoor air vapor intrusion risk to industrial workers. Risks are also posed to potential future residents at these sites and at Sites LF007, SS030, SD033, SS035, SD036, and SD037. Specific LUCs to address vapor intrusion risks are proposed in the draft Travis AFB Groundwater ROD to restrict industrial building construction on portions of Sites FT004, SS015, SS016, SS029, and DP039 unless vapor barriers and passive venting systems are included. The vapor intrusion LUCs will be maintained until concentrations of volatile COCs in groundwater posing a potential indoor air risk are at such levels that VOCs emanating from groundwater to indoor air do not pose unacceptable risk to human health.

7.1.2.3 Changes in Toxicity and Other Contaminant Characteristics

There have been no changes in contaminant toxicity or other contaminant characteristics that call into question the protectiveness of the groundwater IRAs at Travis AFB.

Changes in toxicity values may ultimately lead to a lowering of the MCLs established in the National Primary Drinking Water Standards (40 CFR, Part 141). These MCLs have not changed during the period of interim groundwater remediation. Final groundwater cleanup levels currently referenced in the Final Proposed Plan for Groundwater Cleanup (Travis AFB, 2012a) and the Final Focused Feasibility Study Report (CH2M HILL, 2011) are the same as those referenced in both groundwater IRODs. There will likely be no change in groundwater cleanup goals in transition from IROD to Travis AFB Groundwater ROD.

Since the original vapor intrusion assessment performed in 2009-2010, toxicity values for TCE have changed. The changes in toxicity values for TCE correspond to revised inhalation unit risks for carcinogens and reference concentrations for noncarcinogenic effects. In response to these changes, industrial and residential groundwater, indoor air, slab, and soil gas RBCs were recalculated in the 2013 VI Assessment Update, as summarized in Section 3.4.3 of the Five-Year Review Report. The updated toxicity values were therefore accounted for in the vapor intrusion assessment and related recommendations documented in this Five-Year Review Report, and which have been incorporated into the pending Travis AFB Groundwater ROD.

In addition to TCE, the 2013 VI Assessment Update incorporated federally promulgated toxicity criteria for the following COCs:

- Carbon tetrachloride
- Chlorobenzene

- Chloroform
- Chloromethane
- 1,1-Dichloroethene
- 1,2-Dichloroethane
- Tetrachloroethene
- Toluene
- 1,1,2-Trichloroethane

The changes in the toxicity values did not result in any corresponding changes to the MCLs for these chemicals, nor were these chemicals targeted for soil removal actions performed at Travis AFB; hence, the changes in toxicity did not affect the protectiveness of the remedies implemented at Travis AFB.

7.1.2.4 Changes in Risk Assessment Methods

There have been no changes in risk assessment methods that question the protectiveness of the groundwater IRAs at Travis AFB.

Risk assessment methodologies that have changed since the two groundwater IRODs are largely limited to methods for assessing potential exposure pathways involving indoor intrusion of VOC vapors. In 2009, Travis AFB conducted a vapor intrusion assessment at all sites where the potential for vapor intrusion exists. Site-specific risk-based screening levels were developed for indoor air using EPA's Regional Screening Levels for Chemical Contaminants at Superfund Sites and for soil gas and groundwater using DTSC's version of EPA's Screening-level Johnson & Ettinger model. The assessment demonstrated that vapor intrusion is not taking place in existing buildings, and that construction of new buildings over contaminated groundwater will require passive ventilation systems that prevent vapor intrusion. The Travis AFB Groundwater ROD will account for the vapor intrusion pathway and related methods in setting forth the final groundwater cleanup levels.

7.1.2.5 Expected Progress toward Meeting Groundwater Interim Remedial Action Objectives

The groundwater IRA objectives specified in the final Groundwater IROD for the NEWIOU and final Groundwater IROD for the WABOU are being achieved. Optimization of the groundwater IRAs at some sites were implemented and evaluated by the Air Force. The evaluation showed that the optimizations to the original groundwater IRAs helped to achieve IRA objectives.

7.1.3 Question C: Has Any Other Information Come to Light that Could Call into Question the Protectiveness of the Groundwater Remedy?

No; no additional information has become available since the second five-year review, conducted in 2008, that questions the protectiveness of the groundwater IRAs.

No newly identified ecological risks have been found and there have been no impacts from natural disasters (e.g., earthquake, floods, or fires).

7.1.4 Groundwater Remedy Technical Assessment Summary

A summary of the groundwater IRA objectives and a performance assessment summary for each groundwater IRA are provided in Table 7-1.

Answers to the three key questions regarding the protectiveness of the groundwater interim remedies are summarized as follows:

- **Question A:** Is the remedy functioning as intended by the decision documents?

Yes; except for Site LF007C, the groundwater IRAs are functioning as intended by the final Groundwater IROD for the NEWIOU and the final Groundwater IROD for the WABOU. Remedial process optimizations implemented at several sites improved the effectiveness of the groundwater IRAs.

No; for Site LF007C, the groundwater IRAs are not functioning completely as intended by the IRODs, but the Air Force is taking steps to optimize the remedy.

- **Question B:** Are the assumptions used at the time of remedy selection still valid?

Yes; the assumptions used at the time of groundwater IRA selection are still valid. There have not been significant changes in regulatory standards, exposure pathways, contaminant toxicity, or risk assessment protocols that call into question their protectiveness.

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

No; no additional information has become available since the second five-year review that questions the protectiveness of the groundwater IRAs.

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TABLE 7-1
Summary of Groundwater Interim Remedial Action Performance
Third Five-Year Review Report, Travis AFB, California

IRA	Site	IRA and RPO (if applicable)	IRA Objective ^a					Performance Assessment Criteria			Performance Assessment Summary
			Source Control	Migration Control	Off-Base Remediation	MNA	MNA Assessment	Question A – Functioning as Intended by IROD?	Question B – Remedy Assumptions Still Valid?	Question C – New Information Regarding Protectiveness?	
North IRA	FT004	GET	√				√ ^b	Yes	Yes	No	The combination of GET and MNA has been effective. VOC concentrations at Site SD031 have declined below the target concentration (100 µg/L). With the exception of a small area, VOC concentrations at Site FT004 have also declined below the target concentrations. Consequently, the GET system at both sites has been shut down for a rebound study. The rebound study will be continued over the interim period leading up to the groundwater ROD. No rebound was observed over the 2010-2011 reporting period. MNA appears to be a viable remedy for the residual groundwater contamination at Sites FT004 and SD031. MNA appears to be an effective remedy. Data from monitoring wells indicate that groundwater contamination at Site LF006 is not migrating. In fact, COC concentrations are declining. MNA appears to be an effective remedy. No Site LF007B COCs were detected in Site LF007B wells sampled during the 2010-2011 GSAP events. The migration control and off-base remediation objectives do not appear to be fully achieved. The Site LF007C GET system does not appear to be fully effective at hydraulically capturing and remediating the TCE plume. TCE has migrated off-base at concentrations above the IRG, and off-base TCE concentrations are not declining. Data gaps investigations were performed from October 3 through December 30, 2011, to further characterize the horizontal and vertical extent of the groundwater VOC. The results of the characterization indicated that the TCE groundwater plume extends approximately 200 feet off-base. Vertically, the TCE plume extends from the water table to the alluvium-bedrock boundary. TCE contamination does not extend into the bedrock, as generally the bedrock was dry and did not contain groundwater when encountered during drilling. The TCE plume appears to be migrating to the north-northwest, crossgradient to the local groundwater flow direction; it is likely that the flow direction of the Site LF007C TCE plume is being controlled by the bedrock depression at Site LF007C. Based on the data collected during the investigation, updated groundwater modeling was used to prepare a plan to optimize the existing GET system. GET system optimization consists of modifying existing extraction wells to pump at higher rates and/or adding a new extraction well in the southern portion of the site. Implementation of the optimization plan for site LF007C is planned for 2013. MNA appears to be an effective remedy. Groundwater contamination at Site LF007D is restricted to a small area near MW261x04 (the only well at which groundwater contaminants were detected at concentrations exceeding IRGs over the 2010-2011 reporting period). Contaminants do not appear to be migrating off-base to the north or east of Site LF007D.
	SD031	MNA Assessment in Distal Area	√				√ ^b	Yes	Yes	No	
	LF006	MNA					√	Yes	Yes	No	
	LF007B	MNA Assessment					√	Yes	Yes	No	
	LF007C	GET		√	√		.. ^c	No	Yes	No	
	LF007D	MNA Assessment					√	Yes	Yes	No	
South IRA	SS030	GET	√	√	√			Yes	Yes	No	The source control, migration control, and off-base remediation objectives of the Site SS030 IRAs have largely been achieved. Contaminant concentrations are declining in all of the extraction wells and all but two of the monitoring wells. Investigation into the extent of contamination in the eastern portion of the plume was performed in 2009-2010. The extent of capture of the Site SS030 GET has been improved by bringing all of the extraction wells on-line and reducing groundwater extraction at adjacent Site FT005 GET, which had been influencing groundwater flow directions at Site SS030. The 2Q11 groundwater elevation contours indicate that the eastern portion of the plume is within the extent of hydraulic capture. Continued monitoring of the easternmost monitoring wells will be needed to verify the capture extent. TCE concentrations in the easternmost well pair MW2001A/Bx30 declined slightly over the reporting period. It is expected that TCE concentrations will continue to decline at this well pair.
	SS029	GET		√				Yes	Yes	No	The migration control objective has been achieved. The Site SS029 GET system has achieved hydraulic capture of the plume and is preventing off-base migration of the contaminant plume.
	FT005	GET		√	√			Yes	Yes	No	The migration control and off-base remediation objectives at Site FT005 have largely been achieved. A large portion of the Site FT005 plume has been remediated to non-detect. Consequently, the Site FT005 GET was shut down for a rebound study, which will continue through the interim period leading up to the groundwater ROD. However, groundwater extraction continues in areas of Site FT005 where COC concentrations continue to exceed the IRGs.

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			Source Control	Migration Control	Off-Base Remediation	MNA	MNA Assessment	Question A – Functioning as Intended by IROD?	Question B – Remedy Assumptions Still Valid?	Question C – New Information Regarding Protectiveness?	
Central IRA	Northern SS016	GET Bioreactor ^d	√					Yes	Yes	No	<p>Hydraulic capture of the Site SS016 TARA has been achieved, and VOC concentrations have declined below the target concentration (1,000 µg/L). OSA remediation has been hampered by the continued low yield from groundwater extraction wells. Therefore, in September 2010, the groundwater treatment was enhanced by installation of a bioreactor. During installation of the bioreactor, most of the contaminant mass was removed. The remaining residual mass will be treated in situ through enhanced biodegradation. Based on the first two quarters of performance data, the bioreactor is performing as designed; the bioreactor is removing over 99 percent of the TCE and nearly 93 percent of the total molar CVOCs entering the bioreactor.</p> <p>The portion of the commingled Site SS016 plume (OSA/TARA) that is not addressed by the bioreactor and is not hydraulically captured by the Source Control GET actions is ultimately hydraulically captured by the downgradient Site SS029 Migration Control GET system.</p>
	ST027B			√			√	Yes*	Yes	No	<p>Site ST027 has historically been managed as part of the POCO program at Travis AFB because petroleum hydrocarbons were believed to be the only contaminants present at this site. However, an investigation conducted in 2007 resulted in the discovery of TCE and several other CVOCs in groundwater in the southwestern part of the site. This area of the site impacted by CVOCs has been designated as Site ST027B.</p> <p>MNA has been selected as the final remedy for the remaining fuels contamination, which is located in the eastern part of Site ST027 (designated as ST027A). MNA is an effective remedy for the fuel hydrocarbons at Site ST027A, based on the stable or decreasing BTEX and TPH concentrations observed at the site through 2011.</p> <p>*A remedy has not been established for the CVOC plume in Site ST027B. The Final Technical Memorandum Site ST027-Area B Characterization Results (CH2M HILL, 2010b) presented a preliminary evaluation of the effectiveness of natural attenuation for addressing the CVOC plume. MNA assessment continues over the interim period leading up to the groundwater ROD. Data collected to date indicate that MNA is a suitable remedy to address the Site ST027B plume. The plume has not migrated over the reporting period.</p>

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			Source Control	Migration Control	Off-Base Remediation	MNA	MNA Assessment	Question A – Functioning as Intended by IROD?	Question B – Remedy Assumptions Still Valid?	Question C – New Information Regarding Protectiveness?			
West IRA	SD033f	GET		√				√	Yes	Yes	No	<p>The combination of GET and MNA has been effective; however, VOC concentrations continued to exceed 1,000 µg/L in two small areas of the WIOU plume. As an RPO, these areas of high residual contaminant concentrations (Site SD036 and SD037) underwent EVO injection in 4Q10. To support the RPO, the WIOU GET has been shut down for a rebound study for the remainder of the interim period.</p> <p>The quarterly RPO performance monitoring indicates that the EVO injections in both the Site SD036 and Site SD037 areas have resulted in ERD. TCE concentrations have decreased significantly (one to two orders of magnitude) in target wells. Cis-1,2-DCE concentrations have increased in the treatment zone. Vinyl chloride is also being formed within the treatment zone. The presence of ethane and ethene within the treatment zone indicates that complete dechlorination of the cis-1,2-DCE and vinyl chloride is occurring. Consistent detections of vinyl chloride concentrations exceeding the IRG (0.5 µg/L) are restricted to the EVO injection areas; vinyl chloride is not migrating away from the EVO injection areas. Monitoring data collected to date indicate that the EVO injections are performing as designed.</p> <p>Outside of the two EVO injection areas, the WIOU plume is being monitored for rebound. TCE and other COC concentrations continued to decline or were stable in most of the extraction wells, plume wells, and downgradient monitoring wells sampled over the reporting period. No rebound was evident in the plume, although by 2Q11, the GET system had been shut down for 1 year. The stable and decreasing COC concentration trends indicate that the attenuation capacity of the aquifer exceeds the mass loading from residual contamination in the Site SD036 and SD037 areas. No VOCs were detected at concentrations exceeding IRGs in the downgradient wells during the reporting period. The data collected to date indicate that MNA is a viable remedy for the distal portion of the WIOU plume.</p>	
	SD034g	MNA Assessment in Distal Area	√	√					Yes	Yes	No		
	SS035 ^h	EVO Injection ^d		√ ^b					..e	Yes	Yes		No
	SD036 ⁱ			√	√				..e	Yes	Yes		No
	SD037 ^j			√	√				√	Yes	Yes		No
	SS041 ^k				√					Yes	Yes		No
	SD043 ^l				√					Yes	Yes		No
	SS015	EVO Injection ^d						√	Yes	Yes	No	<p>A vegetable oil injection treatability study was performed at this site in 2000-2001. Elevated concentrations of breakdown products (cis-1,2-DCE and vinyl chloride) relative to the concentration of parent compounds (PCE and TCE) in the injection area confirmed that the vegetable oil injection (2000-2001) enhanced biodegradation. However, TCE and PCE concentrations began to rebound in 2007, indicating that insufficient vegetable oil remained to complete the degradation process. An RPO of EVO injection was performed in 4Q10.</p> <p>The EVO injection has resulted in a significant decline (one to two orders of magnitude) in CVOC concentrations. TCE, cis-1,2-DCE, and vinyl chloride concentrations all declined. The decline in vinyl chloride concentrations and the detections of ethane and ethene in the injection area indicate that vinyl chloride is being completely destroyed. Along with CVOC concentration trends, elevated TOC concentrations and geochemical parameters all support the conclusion that ERD is occurring in the EVO injection area. Monitoring data collected to date indicate that the EVO injection is performing as designed. Enhanced attenuation appears to be a viable remedy for Site SS015.</p>	
	DP039	GET Testing of MNA component of Alternative in Distal Area Bioreactor ^d Phytoremediation ^d EVO PRB ^d	√					√	Yes	Yes	No	<p>The DPE wells of the original GET system effectively removed a large amount of mass from the former sump area; however, residual concentrations of TCE remained. In 2008, a bioreactor was installed at Site DP039 as an Air Force Center for Engineering and the Environment (AFCEE; now Air Force Civil Engineer Center [AFCEC]) technical demonstration project. Through 2Q11, TCE reductions of more than 99 percent and total molar reductions of more than 95 percent have occurred in the aquifer within 30 feet of the bioreactor.</p> <p>Beyond the former sump area, increasing TCE trends in some plume and downgradient monitoring wells indicated that MNA alone may not be an effective remedy for the distal portion of the plume. Consequently, the Air Force implemented enhanced natural attenuation by installing an EVO PRB in the middle of the plume in 2Q10. Performance monitoring data are showing significant (one to three orders of magnitude) reduction in TCE concentrations, minor cis-1,2-DCE accumulation, and no vinyl chloride accumulation along the EVO PRB. Monitoring data collected to date indicate that the EVO PRB is performing as designed.</p> <p>Ongoing monitoring is needed to verify whether mass reduction provided by the EVO PRB is sufficient to stabilize the distal portion of the plume.</p>	

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IRA	Site	IRA and RPO (if applicable)	IRA Objective ^a					Performance Assessment Criteria			Performance Assessment Summary
			Source Control	Migration Control	Off-Base Remediation	MNA	MNA Assessment	Question A – Functioning as Intended by IROD?	Question B – Remedy Assumptions Still Valid?	Question C – New Information Regarding Protectiveness?	
West IRA (continued)	LF008	GET		√				Yes	Yes	No	<p>While the GET IRAO has been achieved (the plume has not migrated), the GET has had minimal impact on the remaining low-level pesticide concentrations at Site LF008, based on stable long-term pesticide concentration trends and the unchanging extent of groundwater contamination over time. This is likely due to the strong adsorption of alpha-chlordane and other pesticides to natural organic carbon or fine-grained soil particles in the subsurface and the low permeability of the saturated sediments.</p> <p>In December 2008, the three Site LF008 groundwater extraction wells were shut down to perform a rebound study. No rebound in COC concentrations was evident over the 2010-2011 reporting period. In fact, the extent of the alpha-chlordane plume has decreased in size since the GET system was taken off-line.</p>

^a IRA objective specified in the Groundwater NEWIOU and WABOU IRODs.

^b IRA not specified in the Groundwater IROD for the NEWIOU (Travis AFB, 1998), but implemented by the Air Force to address entirety of commingled plume.

^c Assessment of MNA not implemented because of interactions with the LF007C GET system.

^d RPO.

^e Assessment of MNA not implemented because plume is hydraulically captured by adjacent GET system.

^f ERP Site SD033 comprises five (5) noncontiguous sites: Facility 810, Facility 1917, Storm Sewer System II, the South Gate area, and the West Branch of Union Creek.

^g ERP Site SD034 is associated with Facility 811.

^h ERP Site SS035 is associated with Facilities 818 and 819.

ⁱ ERP Site SD036 is associated with Facilities 872, 873, and 876.

^j ERP Site SD037 is associated with the Sanitary Sewer System; Facilities 837, 838, 919, 977, 981; the Area G Ramp; and the Ragsdale/V Street area.

^k ERP Site SS041 is associated with Facility 905.

^l ERP Site SD043 is associated with Facility 916.

7.2 Soil Remedy Assessment

7.2.1 Question A: Is the Soil Remedy Functioning as Intended by the Decision Documents?

Yes, the soil remedies implemented at Travis AFB are functioning as intended by the decision documents.

The RAs to address soil and sediment contamination at Travis AFB were selected in two decision documents:

- Final NEWIOU Soil, Sediment, and Surface Water ROD
- Final Soil ROD for the WABOU

7.2.1.1 Soil Remedial Action Objectives

The objectives of the soil and sediment RAs are to remove contaminated soil down to industrial cleanup levels that are protective of on-base workers and/or to restrict residential development and the unauthorized disturbance or relocation of soil.

Under both RODs, if excavation reduces contaminant concentrations to those that allow for unlimited use and unrestricted exposure (i.e., to residential cleanup levels), then LUCs will not be required. However, if excavation reduces contaminant concentrations only to industrial cleanup levels, LUCs will be implemented to restrict site access and usage. At several sites, LUCs are the only remedy specified in the applicable ROD.

7.2.1.2 Soil Remedial Action Performance

All soil and sediment RAs have been completed and have achieved the RA objectives stated in the two RODs.

NEWIOU Sites Soil and Sediment Remedial Action Performance. All soil and sediment RAs at ERP sites within the NEWIOU are completed and were conducted in accordance with the final Soil, Sediment, and Surface Water ROD for the NEWIOU (Travis AFB, 2006). A summary of the NEWIOU sites soil and sediment RA performance is provided in Table 7-2 and the following list of key performance information:

- The soil RAs conducted at Sites FT003, FT004, FT005, and LF007E achieved residential cleanup levels. Therefore, no LUCs are required at these sites.
- LUCs are being successfully implemented at NEWIOU Sites SS015, SS016, SD033 (soil), and SD037 to restrict residential development and unauthorized disturbance and relocation of soil. These LUCs were the only soil RAs implemented at these sites. The results of site inspections conducted by Travis AFB indicate that the LUCs are functioning as designed and are effective at restricting land use to industrial purposes only. There was no evidence of unauthorized land uses or unauthorized soil disturbances in controlled areas (Travis AFB, 2011).
- The sediment RAs conducted at Sites SD001 and SD033 achieved residential cleanup levels. Therefore, no LUCs are required at these sites.

TABLE 7-2
 Summary of NEWIOU Sites Soil and Sediment Remedial Actions
Third Five-Year Review Report, Travis AFB, California

ERP Site	Objective ^a	Implemented RA	Land Use Controls Status	Performance Summary
SD001	Remove sediment contaminants to industrial cleanup levels.	Excavation and LUCs	No LUC required.	RA complete in 2010. Residential cleanup levels achieved. Site closed on 12 July 2010.
FT003	Remove soil contaminants to industrial cleanup levels.	Excavation and LUCs	No LUC required.	RA complete in 2007. Residential cleanup levels achieved. Site closed on 29 September 2008.
FT004	Remove soil contaminants to industrial cleanup levels.	Excavation and LUCs	No LUC required.	RA completed in 2007. Residential cleanup levels achieved. Site is considered response complete for soil as of 29 September 2008.
FT005	Remove soil contaminants to industrial cleanup levels.	Excavation and LUCs	No LUC required.	Two-phase RA, AST removed in 2007 and contaminated soil removed in 2011. Residential cleanup levels achieved. Site is considered response complete for soil as of 29 September 2008. .
LF007	Remove soil contaminants to industrial cleanup levels.	Excavation and LUCs	Land use restricted to industrial activities for CAMU portion of LF007.	RA completed in 2007. Base CAMU for consolidation of RA soil. Residential soil cleanup goals reached at LF007E, with no LUCs required. LUC inspection at CAMU portion of LF007 performed on 30 October 2012. No issues found.
SS015	Restrict site access to prohibit residential use. Prevent surface-disturbing activities that could create a risk of human exposure.	LUCs	Land use restricted to industrial activities only.	LUC inspection on 30 October 2012. No issues found.
SS016	Restrict site access to prohibit residential use. Prevent surface-disturbing activities that could create a risk of human exposure.	LUCs	Land use restricted to industrial activities only.	LUC inspection on 30 October 2012. No issues found.
SD033 (soil)	Restrict site access to prohibit residential use. Prevent surface-disturbing activities that could create a risk of human exposure.	LUCs	Land use restricted to industrial activities only.	LUC inspection on 30 October 2012. No issues found.

TABLE 7-2
Summary of NEWIOU Sites Soil and Sediment Remedial Actions
Third Five-Year Review Report, Travis AFB, California

ERP Site	Objective ^a	Implemented RA	Land Use Controls Status	Performance Summary
SD033 (sediment)	Remove contaminated sediment to industrial cleanup levels.	Excavation and LUCs	No LUC required.	RA complete in 2010. Residential cleanup levels achieved. Site is considered response complete for sediment as of 12 July 2010.
SD037	Restrict site access to prohibit residential use. Prevent surface-disturbing activities that could create a risk of human exposure.	LUCs	Land use restricted to industrial activities only.	LUC inspection on 30 October 2012. No issues found.

^a Soil and Sediment RA objectives specified in the final NEWIOU Soil, Sediment, and Surface Water ROD (Travis AFB, 2006).

WABOU Sites Soil Remedial Action Performance. All soil RAs at ERP sites within the WABOU are completed and were conducted in accordance with the final Soil ROD for the WABOU (Travis AFB, 2002). A summary of the WABOU sites soil RA performance is provided in Table 7-3, with the following list of key performance information:

- The soil RAs conducted at Sites LF008, RW013, SS041, SD042, and SD045 achieved residential cleanup levels. Therefore, no LUCs are required at these sites.
- LUCs are being successfully implemented at Sites DP039, SD043, LF044, and SS046 to restrict residential development and unauthorized disturbance and relocation of soil. These LUCs were the only soil RAs implemented at these sites. The results of site inspections conducted by Travis AFB indicate that the LUCs are functioning as designed and are effective at restricting land use to industrial purposes only. There was no evidence of unauthorized land uses or unauthorized soil disturbances in controlled areas (Travis AFB, 2011).

TABLE 7-3
Summary of WABOU Sites Soil Remedial Actions
Third Five-Year Review Report, Travis AFB, California

ERP Site	Objective ^a	Implemented RA	Land Use Controls Status	Performance Summary
LF008	Remove soil contaminants to industrial cleanup levels.	Excavation/Off-Base Disposal	No LUC required.	RA complete. Residential cleanup levels achieved by excavation. Site is considered response complete for soil.
RW013	Remove soil contaminants to industrial cleanup levels.	Excavation/Off-Base Disposal	No LUC required.	RA complete. Residential cleanup levels achieved by excavation. Site closed on 12 May 2004.

TABLE 7-3
 Summary of WABOU Sites Soil Remedial Actions
Third Five-Year Review Report, Travis AFB, California

ERP Site	Objective ^a	Implemented RA	Land Use Controls Status	Performance Summary
DP039	Restrict site access to prohibit residential use. Prevent surface-disturbing activities that could create a risk of human exposure.	Land Use and Access Restrictions	Land use restricted to industrial activities only.	LUC inspection on 30 October 2012. No issues found.
SS041	Remove soil contaminants to industrial cleanup levels.	Excavation/On-base Consolidation	No LUC required.	RA complete. Residential cleanup levels achieved. Site is considered response complete for soil as of 27 September 2003.
SD042	Remove soil contaminants to industrial cleanup levels.	Excavation/On-Base Consolidation	No LUC required.	RA complete. Residential cleanup levels achieved. Site closed on 24 June 2005.
SD043	Restrict site access to prohibit residential use. Prevent surface-disturbing activities that could create a risk of human exposure.	Land Use and Access Restrictions	Land use restricted to industrial activities only.	LUC inspection on 30 October 2012. No issues found.
LF044	Restrict site access to prohibit residential use. Prevent surface-disturbing activities that could create a risk of human exposure.	Land Use and Access Restrictions	Land use restricted to industrial activities only.	RA complete. Recent construction of an AST facility in accordance with LUC provisions. LUC inspection on 30 October 2012. No issues found.
SD045	Remove soil contaminants to industrial cleanup levels.	Excavation/On-Base Consolidation	No LUC required.	RA completed in 2007. Residential cleanup levels achieved. Site closed on 29 September 2008.
SS046	Restrict site access to prohibit residential use. Prevent surface-disturbing activities that could create a risk of human exposure.	Land Use and Access Restrictions	Land use restricted to industrial activities only.	LUC inspection on 30 October 2012. No issues found.

^a Soil RA objective specified in the *Soil ROD for the WABOU* (Travis AFB, 2002).

7.2.1.3 Systems Operations/O&M

The only ongoing system operations issue related to the soil RAs completed at the NEWIOU and WABOU sites is continued implementation of LUCs at the sites where they are in place.

7.2.1.4 Opportunities for Optimization

There will be no opportunities for optimization of the soil RAs implemented at Travis AFB, as all soil RAs have been completed.

7.2.1.5 Early Indicators of Potential Issues

Early indicators of potential issues related to the soil RAs at Travis AFB cannot be analyzed, as all soil RAs have been completed.

7.2.1.6 Implementation of Institutional Controls and Other Measures

In accordance with the two soil RODs, Travis AFB implements land use and access restrictions at soil RA sites not remediated to residential cleanup standards. The purpose of these LUCs is to restrict residential development and unauthorized disturbance and relocation of soil. Travis AFB conducts formal annual inspections of the LUC measures to monitor their performance. The most recent inspection was conducted in October 2012. No issues were identified at any of the sites.

More complete descriptions of LUCs are provided in the final Soil Record of Decision for the WABOU, the final NEWIOU Soil, Sediment, and Surface Water ROD, and Section 4.5.4 of this *Third Five-Year Review Report*. Also, since the signing of the two RODs, the Travis AFB GP has been revised to document the presence of soil contaminants and to enforce the land use restriction, particularly regarding unauthorized disturbance and use of soil at the sites.

7.2.2 Question B: Are the Assumptions Used at the Time of Soil Remedy Selection Still Valid?

Yes, the assumptions used at the time of soil/sediment remedy selection are still valid. There have not been significant changes in regulatory standards, exposure pathways, contaminant toxicity, or risk assessment protocols that call into question the protectiveness of the remedies.

However, there have been select changes in regulatory standards (a chemical-specific ARAR) for select chemicals remediated. As a result, soil cleanup goals for six PAHs have reduced since completion of all the soil/sediment RAs. An evaluation of all closed soil/sediment sites demonstrated that the lowered PAH soil cleanup goals had minimal impact on the remedy protectiveness of the soil/sediment RAs.

7.2.2.1 Changes in Standards and TBC

There have been no changes in the standards identified in the WABOU ROD or the NEWIOU ROD that call into question the protectiveness of the remedies in the soil and/or sediment at Travis AFB.

Action-Specific ARARs. There are no changes to the action-specific ARARs identified in the ROD.

The regulatory requirement applicable to property that contains hazardous waste (22 CCR, Chapter 39, Section 67391.1, effective 19 April 2003) requires all land use covenants to be signed by the DTSC and the landowner, and to be recorded in the county where the land is located. The signature requirement is considered applicable to soil management units where groundwater wells will be used for monitoring or injection purposes only. Furthermore, federal property cannot be transferred to a nonfederal entity without the appropriate land use covenant, executed by the federal government and recorded in the county where the land is located. In the event that recordation of a land use covenant is not feasible, other mechanisms such as master plans, agreements, or institutional controls can be used to ensure that future land use is compatible with the levels of hazardous materials, wastes, constituents, or substances which remain on the property.

The extent to which this state regulation is relevant to federal property will be incorporated into a letter placed in the administrative record files as a minor change to the WABOU and NEWIOU Soil RODs.

Location-Specific ARARs. There are no changes to the location-specific ARARs identified in the RODs.

Chemical-Specific ARARs. To evaluate changes in chemical-specific cleanup goals, all soil/sediment sites closed with unrestricted use were screened against current cleanup goals. As a precautionary measure, the Air Force also considered soil sites closed before 2008.

Chemical-specific requirements were developed for Travis AFB using the 2002 and 2004 Preliminary Remediation Goal (PRG) tables developed by EPA. In 2008, EPA released Regional Screening Levels (RSLs) to replace the PRGs. Based on the comparison of residential soil cleanup goals in the final soil NEWIOU and WABOU RODs to the most recent RSLs, six residential soil cleanup goals have reduced. Residential soil cleanup goals have been lowered for Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Benzo(a,h)anthracene, and Indeno(1,2,3-c,d)pyrene (collectively called “PAHs”). The sites with these specific soil cleanup goals are FT003, FT005, and SD042.

FT003, FT005, and SD042 were evaluated to ensure continued effectiveness of the soil RAs against 2013 residential soil cleanup goals for PAHs. For each soil site, post-remediation confirmation soil samples were compared with 2013 residential soil cleanup goals for the PAHs listed above using the following criteria:

- When the confirmation soil samples reported PAH concentrations lower than the current cleanup goals, soil remedial actions remain protective.
- When confirmation soil samples reported PAH concentrations higher than the 2013 residential soil cleanup goals, the frequency of PAH detection and estimated cancer risk were considered to evaluate soil remedial action protectiveness.

For sites closed prior to 2008, this assessment is summarized in Table 7-4. For sites closed from 2008 through 2013, this assessment is summarized in Table 7-5. The post-remediation confirmation soil sample is **bolded** in the table if it is greater than the 2013 residential soil cleanup goal.

The above assessment demonstrates that the soil RAs remain protective at Sites FT003, FT005, and SD042. At each of the three sites, there is an exceedance of one of the six soil residential cleanup goals for PAHs. However the exceedances correspond to estimated cancer risks (residential) that lie within the low end (i.e., well less than 1×10^{-5}) of the risk management range of 1×10^{-4} to 1×10^{-6} . Therefore, the soil RAs remain protective and the referenced changes in soil regulatory standards are considered insignificant relative to the remedial actions implemented to date.

Assessment of the areal extent of the detections above the updated RSLs did not reveal any observable geographic trends and most individual sample exceedances were accompanied by nearby samples that were either non-detect or below the updated RSL. The detections above RSLs remain sporadic (in part exemplified by the frequency of detections) and as previously indicated, the remaining levels of PAHs reflected by confirmation sample results do not pose potential adverse health risks.

TABLE 7-4

Confirmation of Cleanup Goals for Soil Remedial Actions (Prior to 2008)
Third Five-Year Review Report, Travis AFB, California

Site	Contaminant	Soil Cleanup Objectives in ROD ¹ (ppm)	Current Cleanup Objectives ² (ppm)	Confirmation Soil Sample Result (ppm) ³	Still Protective (Y/N)
SD042 Site closed on 24 June 2005	Benzo(a)pyrene	0.062	0.015	0.0079	Y
	Dibenz(a,h)anthracene	0.062	0.015	0.0885	The maximum concentration for D(a,h)AN in confirmation soil samples exceeds current cleanup goals. D(a,h)AN was detected in 2 of 12 confirmation samples (both samples were above the current cleanup objective). This exceedance corresponds to an estimated cancer risk (residential) of 2×10^{-6} , and is within the low end of the risk management range.
	Benzo(b)fluoranthene	0.62	0.15	0.0290	
	Indeno(1,2,3-c,d)pyrene	0.62	0.15	0.0059	

TABLE 7-5

Confirmation of Cleanup Goals for Soil/ Sediment Remedial Actions (2008-2013)
Third Five-Year Review Report, Travis AFB, California

ERP Site	Contaminant	Soil/Sediment Cleanup Objectives in ROD ¹ (ppm)	Current Cleanup Objectives ² (ppm)	Confirmation Soil Sample Result (ppm) ³	Still Protective (Y/N)
FT003 Site closed on 29 Sept 2008	Benzo(a)anthracene	0.62	0.15	0.025	Y
	Benzo(a)pyrene	0.062	0.015	0.021	95% UCL concentration for B(a)P in confirmation soil samples exceeds current cleanup objectives. B(a)P was detected in 25 of 35 confirmation samples (10 samples were above the current cleanup objective). This exceedance corresponds to an estimated cancer risk (residential) of 1×10^{-6} , and is within the low end of the risk management range.
	Benzo(b)fluoranthene	0.62	0.15	0.030	
	Benzo(k)fluoranthene	6.2	1.5	0.016	
	Dibenzo(a,h)anthracene	0.062	0.015	0.007	
	Indeno(1,2,3-c,d)pyrene	0.62	0.15	0.019	
FT005 Site closed on 28 Sept 2012	Benzo(a)anthracene	0.62	0.15	0.068	Y
	Benzo(a)pyrene	0.062	0.015	0.049	95% UCL concentration for B(a)P in confirmation soil samples exceeds current cleanup objectives. B(a)P was detected in 23 of 39 confirmation samples (12 samples were above the current cleanup objective). This exceedance corresponds to an estimated cancer risk (residential) of 3×10^{-6} , and is within the low end of the risk management range.
	Benzo(b)fluoranthene	0.62	0.15	0.090	
	Benzo(k)fluoranthene	6.2	1.5	0.029	
	Dibenzo(a,h)anthracene	0.062	0.015	0.007	
	Indeno(1,2,3-c,d)pyrene	0.62	0.15	0.047	

¹ Soil and Sediment RA cleanup objectives specified in the final NEWIOU Soil, Sediment, and Surface Water ROD or the Soil ROD for the WABOU.

² 2013 RSLs obtained from EPA website.

³ This value represents either the maximum or 95th Upper Confidence Level (UCL) using EPA's PRO UCL, calculated from confirmation soil samples obtained during soil removal action, and are documented in RARs. If the number of detections within a data set was less than 5, the maximum value was used for comparisons instead of 95th UCL.

7.2.2.2 Changes in Exposure Pathways

There have been no significant changes in land use, contaminant types, new contaminant sources, or physical site conditions at any of the NEWIOU or WABOU soil and/or sediment sites that affect exposure pathways or reduce the effectiveness of the remedies.

7.2.2.3 Changes in Toxicity and Other Contaminant Characteristics

There have been no significant changes in contaminant toxicity or other contaminant characteristics that question the protectiveness of the soil RAs at Travis AFB.

Since the original vapor intrusion assessment performed in 2009-2010, toxicity values for TCE changed. The changes in toxicity values for TCE correspond to revised inhalation unit risks for carcinogens and reference concentrations for noncarcinogenic effects. In response to these changes, industrial and residential groundwater, indoor air, subslab, and soil gas RBCs were recalculated in the 2013 VI Assessment Update, as summarized in Section 3.4.3 of the Five-Year Review Report. The updated toxicity values were therefore accounted for in the vapor intrusion assessment and related recommendations documented in this Five-Year Review Report, and which have been incorporated into the pending Travis AFB Groundwater ROD.

In addition to TCE, the 2013 VI Assessment Update incorporated federally promulgated toxicity criteria for the following COCs:

- Carbon tetrachloride
- Chlorobenzene
- Chloroform
- Chloromethane
- 1,1-Dichloroethene
- 1,2-Dichloroethane
- Tetrachloroethene
- Toluene
- 1,1,2-Trichloroethane

The changes in the toxicity values did not result in any corresponding changes to the MCLs for these chemicals, nor were these chemicals targeted for soil removal actions performed at Travis AFB; hence, the changes in toxicity did not affect the protectiveness of the remedies implemented at Travis AFB.

7.2.2.4 Changes in Risk Assessment Methods

There have been no significant changes in risk assessment methods that question the protectiveness of the soil and/or sediment RAs at Travis AFB.

7.2.2.5 Expected Progress toward Meeting Soil and/or Sediment Remedial Action Objectives

Expected progress cannot be determined, as all soil and/or sediment RAs are completed.

7.2.3 Question C: Has Any Other Information Come to Light that Could Call into Question the Protectiveness of the Soil Remedy?

No, no additional information has been obtained since completion of the soil/sediment remedies in 2011 that questions the protectiveness of those remedies.

No newly identified ecological risks have been found, and there have been no impacts from natural disasters (e.g., earthquake, floods, fires).

7.2.4 Soil Remedy Technical Assessment Summary

A summary of the soil and/or sediment RA objectives and a performance evaluation for NEWIOU soil and/or sediment sites is provided in Tables 7-2 and 7-4. A similar summary is provided in Tables 7-3 and 7-5 for the WABOU soil sites.

Answers to the three key questions regarding the protectiveness of the soil and/or sediment remedies are summarized as follows:

- **Question A:** Is the remedy functioning as intended by the decision documents?

Yes, the soil and/or sediment RAs are functioning as intended by the final NEWIOU Soil, Sediment, and Surface Water ROD, and final Soil ROD for the WABOU.

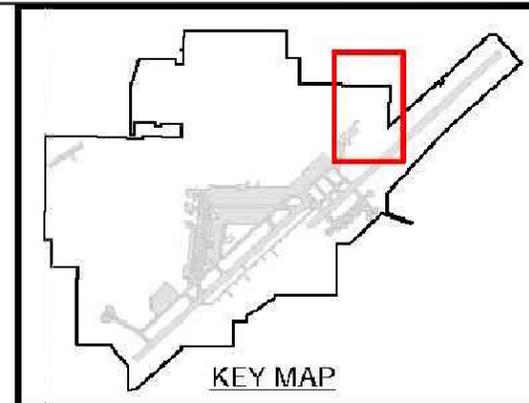
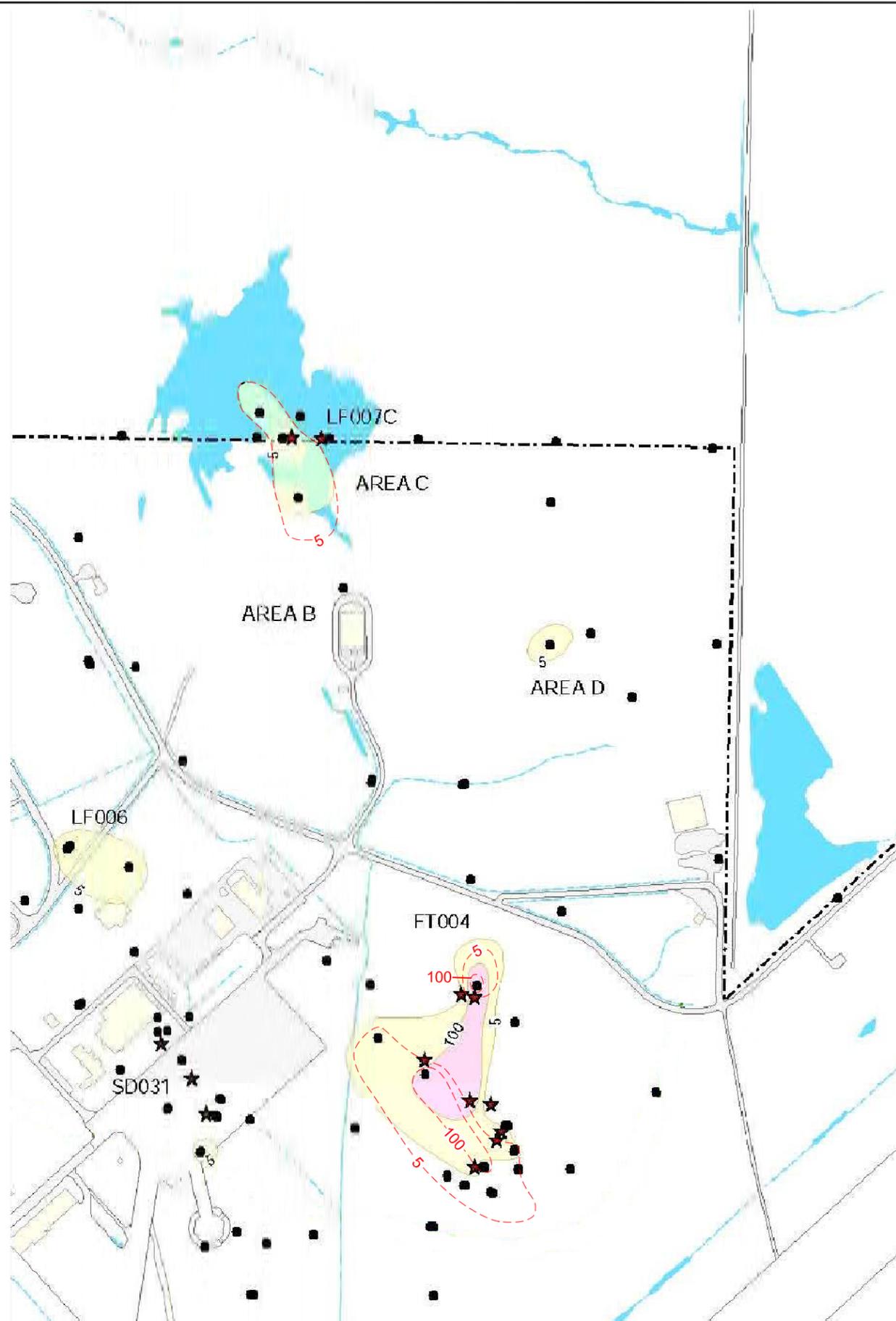
- **Question B:** Are the assumptions used at the time of soil and/or sediment remedy selection still valid?

Yes, the assumptions used at the time of soil and/or sediment remedy selection are still valid. There were no significant changes in regulatory standards, exposure pathways, contaminant toxicity, or risk assessment protocols that question the protectiveness of the remedies.

- **Question C:** Has any other information come to light that could question the protectiveness of the remedy?

No, no additional information has been obtained since completion of the soil/sediment remedies in 2011 that questions the protectiveness of those remedies.

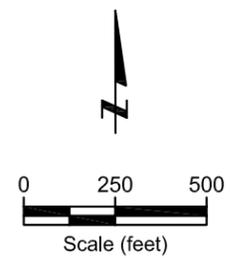
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- LEGEND**
- GROUNDWATER MONITORING WELL
 - ★ EXTRACTION WELL
 - TCE CONCENTRATIONS ($\mu\text{g/L}$), 2008
 - 5 \leq TCE < 100
 - 100 \leq TCE < 1,000
 - TCE \geq 1,000
 - - 5 - - APPROXIMATE TCE ISOCONCENTRATION CONTOUR, 2011
 - BASE BOUNDARY
 - BUILDINGS
 - UNPAVED AREA
 - PAVED AREA
 - ROAD
 - SURFACE WATER

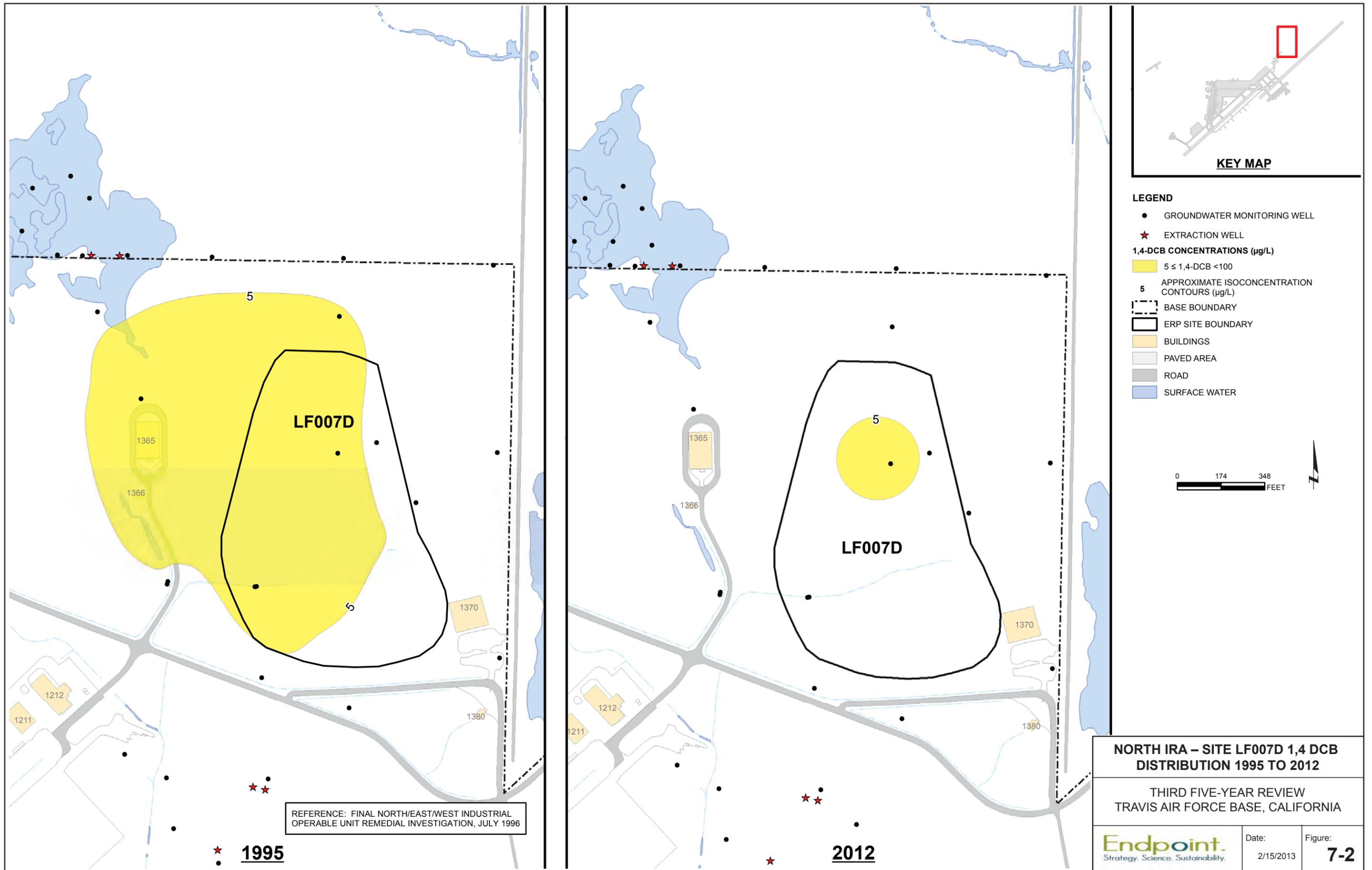
- NOTES:**
1. THE PLUMES SHOWN REPRESENT GROUNDWATER CONTAMINANT CONDITIONS WITHIN THE SATURATED ALLUVIUM THICKNESS OF THE SINGLE AQUIFER UNDERLYIN TRAVIS AFB.
 2. PLUME MAPPING DATES: 10 APRIL 2008 AND 10 OCTOBER 2011.

GROUNDWATER IRA:
SOURCE CONTROL, MIGRATION CONTROL,
OFFBASE REMEDIATION, MNA

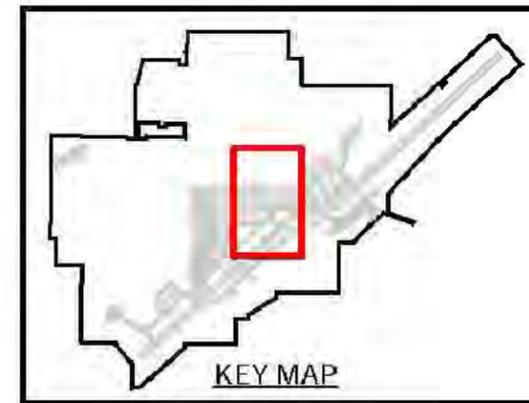
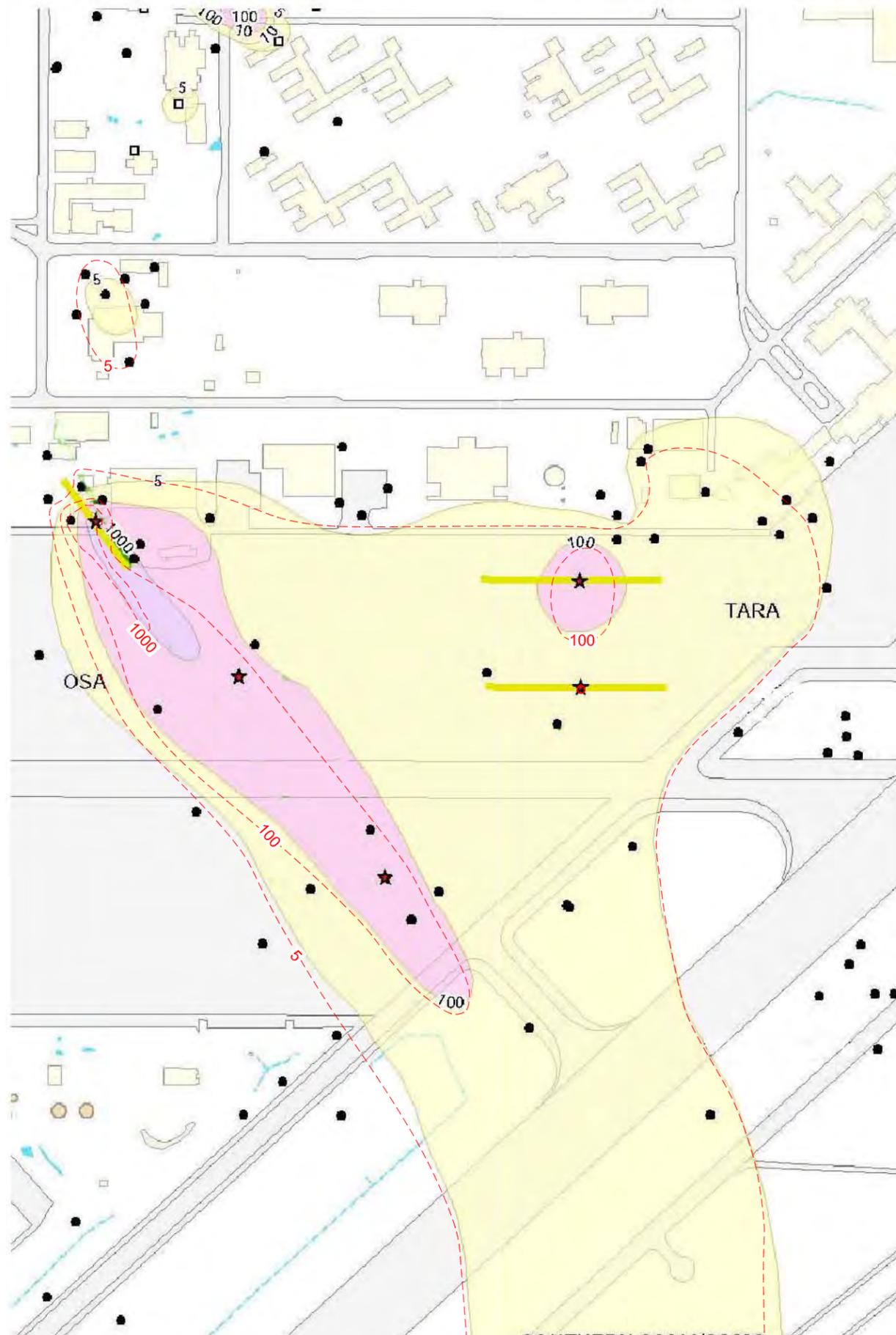


NORTH IRA - SITE FT004, SD031, AND LF007C TCE DISTRIBUTION 2008 TO 2011		
THIRD FIVE-YEAR REVIEW TRAVIS AIR FORCE BASE, CALIFORNIA		
Date: 2/15/2013	Figure: 7-1	

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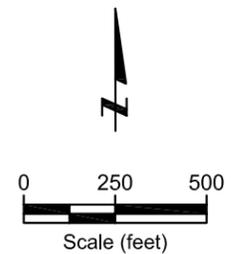
LEGEND

- PIEZOMETER
- GROUNDWATER MONITORING WELL
- ★ VERTICAL EXTRACTION WELL
- HORIZONTAL EXTRACTION WELL
- TCE CONCENTRATIONS ($\mu\text{g/L}$), 2008
- 5 ≤ TCE < 100
- 100 ≤ TCE < 1,000
- TCE ≥ 1,000
- - 5 - - APPROXIMATE TCE ISOCONCENTRATION CONTOUR, 2011
- ABOVEGROUND STORAGE TANKS
- BUILDINGS
- UNPAVED AREA
- PAVED AREA
- ROAD
- SURFACE WATER

NOTES:

1. THE PLUMES SHOWN REPRESENT GROUNDWATER CONTAMINANT CONDITIONS WITHIN THE SATURATED ALLUVIUM THICKNESS OF THE SINGLE AQUIFER UNDERLYING TRAVIS AFB.
2. PLUME MAPPING DATES: 10 APRIL 2008 AND 10 NOVEMBER 2011
3. THE OSA AND TARA HORIZONTAL EXTRACTION WELLS ARE SCREENED APPROXIMATELY 30 FEET BELOW GROUND SURFACE NEAR THE BEDROCK INTERFACE.

GROUNDWATER IRA:
SOURCE CONTROL, MIGRATION CONTROL



CENTRAL IRA - SITE SS016 AND SS029 TCE DISTRIBUTION 2008 TO 2011

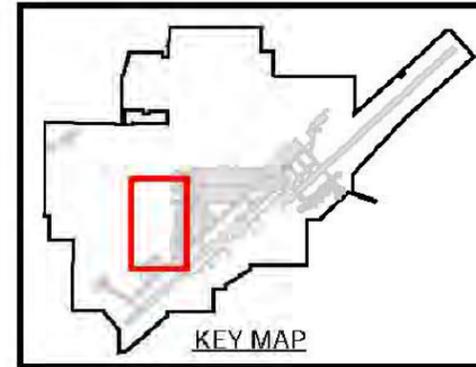
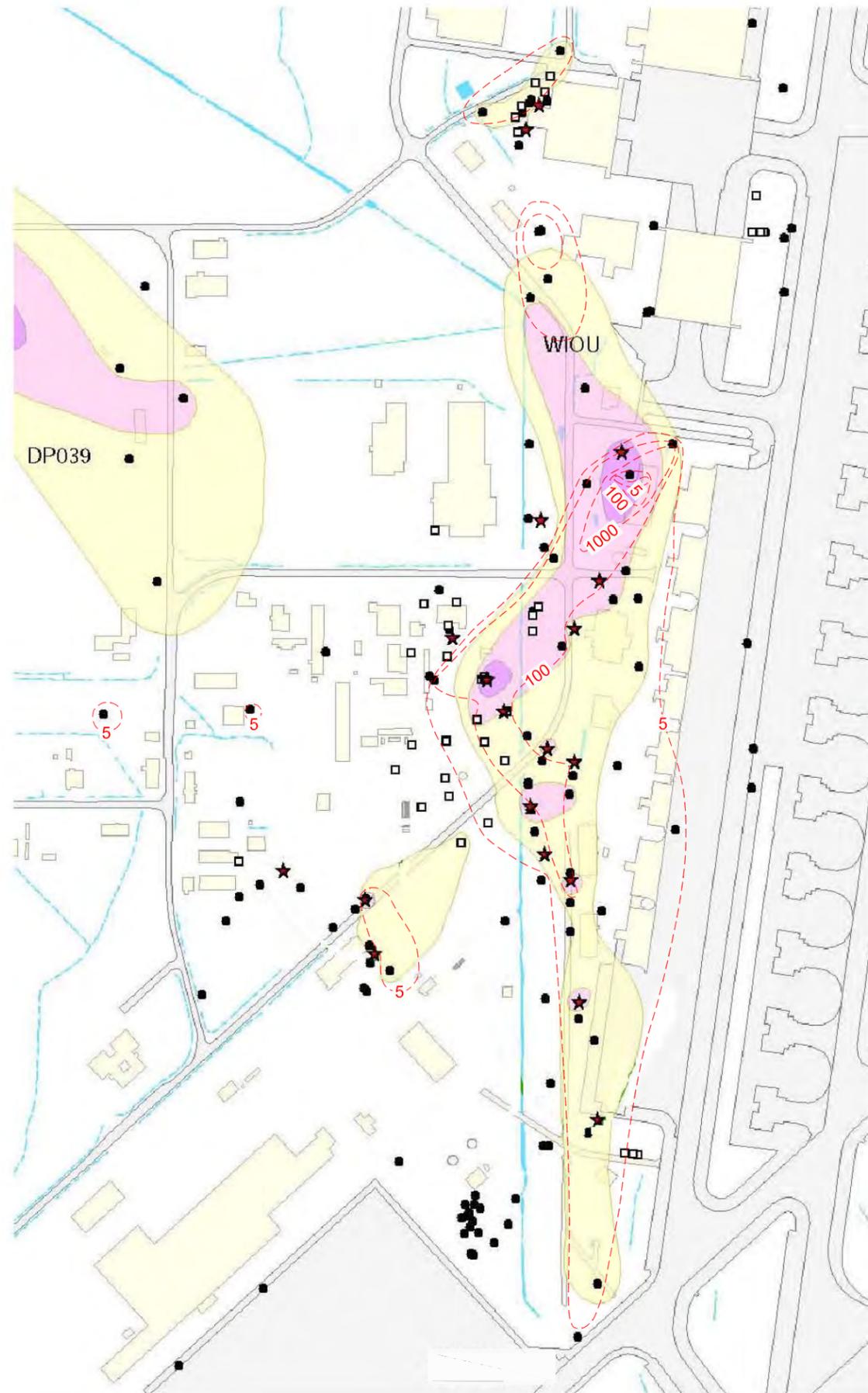
THIRD FIVE-YEAR REVIEW
TRAVIS AIR FORCE BASE, CALIFORNIA

Endpoint.
Strategy. Science. Sustainability.

Date:
2/15/2013

Figure:
7-3

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LEGEND

- PIEZOMETER
- GROUNDWATER MONITORING WELL
- ★ EXTRACTION WELL

TCE CONCENTRATIONS ($\mu\text{g/L}$), 2008

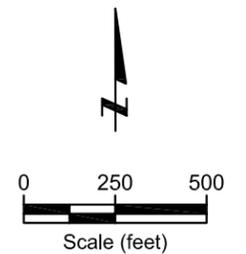
- 5 ≤ TCE < 100
- 100 ≤ TCE < 1,000
- TCE ≥ 1,000
- ABOVEGROUND STORAGE TANKS
- BUILDINGS
- UNPAVED AREA
- PAVED AREA
- ROAD
- SURFACE WATER

--5-- APPROXIMATE TCE ISOCONCENTRATION CONTOUR, 2011

NOTES:

1. THE PLUMES SHOWN REPRESENT GROUNDWATER CONTAMINANT CONDITIONS WITHIN THE SATURATED ALLUVIUM THICKNESS OF THE SINGLE AQUIFER UNDERLYING TRAVIS AFB.
2. PLUME MAPPING DATES: 10 APRIL 2008 AND 10 NOVEMBER 2011.

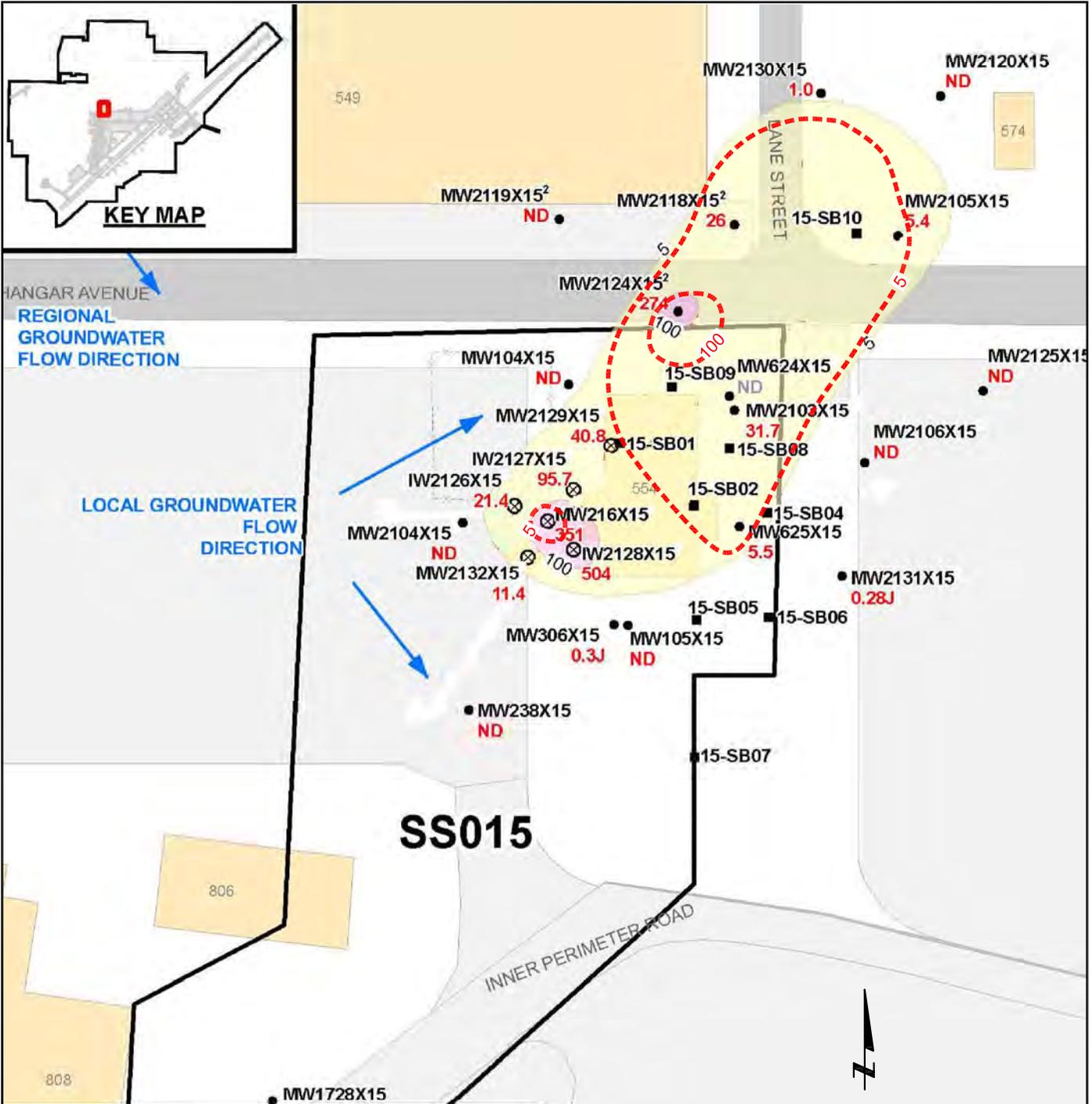
GROUNDWATER IRA:
SOURCE CONTROL, MIGRATION CONTROL,
MNA ASSESSMENT



**WEST IRA - WIOU SITE
TCE DISTRIBUTION 2008 TO 2011**

THIRD FIVE-YEAR REVIEW
TRAVIS AIR FORCE BASE, CALIFORNIA

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LEGEND

- IN SITU SAMPLE (JUN - AUG 1998)
- GROUNDWATER MONITORING WELL
- ⊗ INJECTION WELL
- FENCE
- APPROXIMATE GROUNDWATER FLOW DIRECTION
- SAMPLE LOCATION — MW104X15
- TCE (µg/L) — 0.25J
- FLAG —
- ND = NOT DETECTED

TCE CONCENTRATIONS (µg/L), 2008

- 5 ≤ TCE < 100
- 100 ≤ TCE < 1,000
- ERP SITE BOUNDARY
- BUILDINGS
- PAVED AREA
- ROAD

APPROXIMATE TCE ISOCONCENTRATION CONTOUR, 2011

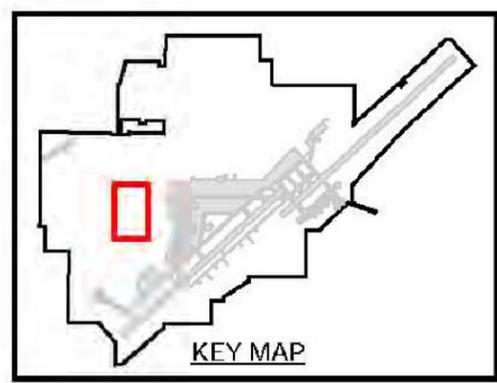
- 5--

**WEST IRA - SITE SS015
TCE DISTRIBUTION 2008 TO 2011**

THIRD FIVE-YEAR REVIEW
TRAVIS AIR FORCE BASE, CALIFORNIA

	Date: 2/15/2013	Figure: 7-5
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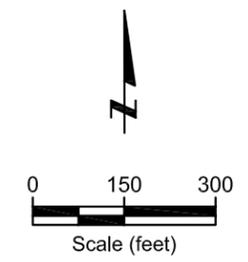


- LEGEND**
- PIEZOMETER
 - GROUNDWATER MONITORING WELL
 - ★ EXTRACTION WELL
 - - 5 - - APPROXIMATE TCE ISOCONCENTRATION CONTOUR, 2011
 - ▨ PHYTOREMEDIATION AREA
 - TCE CONCENTRATIONS (µg/L), 2008
 - 5 ≤ TCE < 100
 - 100 ≤ TCE < 1,000
 - TCE ≥ 1,000
 - ABOVEGROUND STORAGE TANKS
 - BUILDINGS
 - UNPAVED AREA
 - PAVED AREA
 - ROAD
 - SURFACE WATER

NOTES:

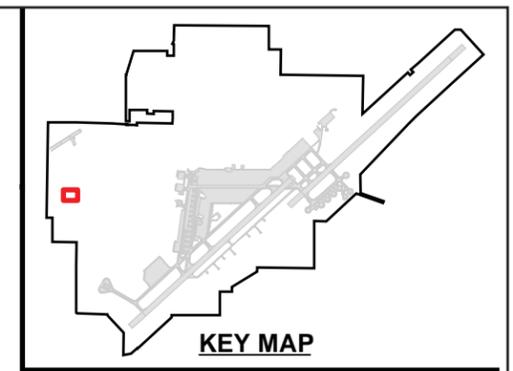
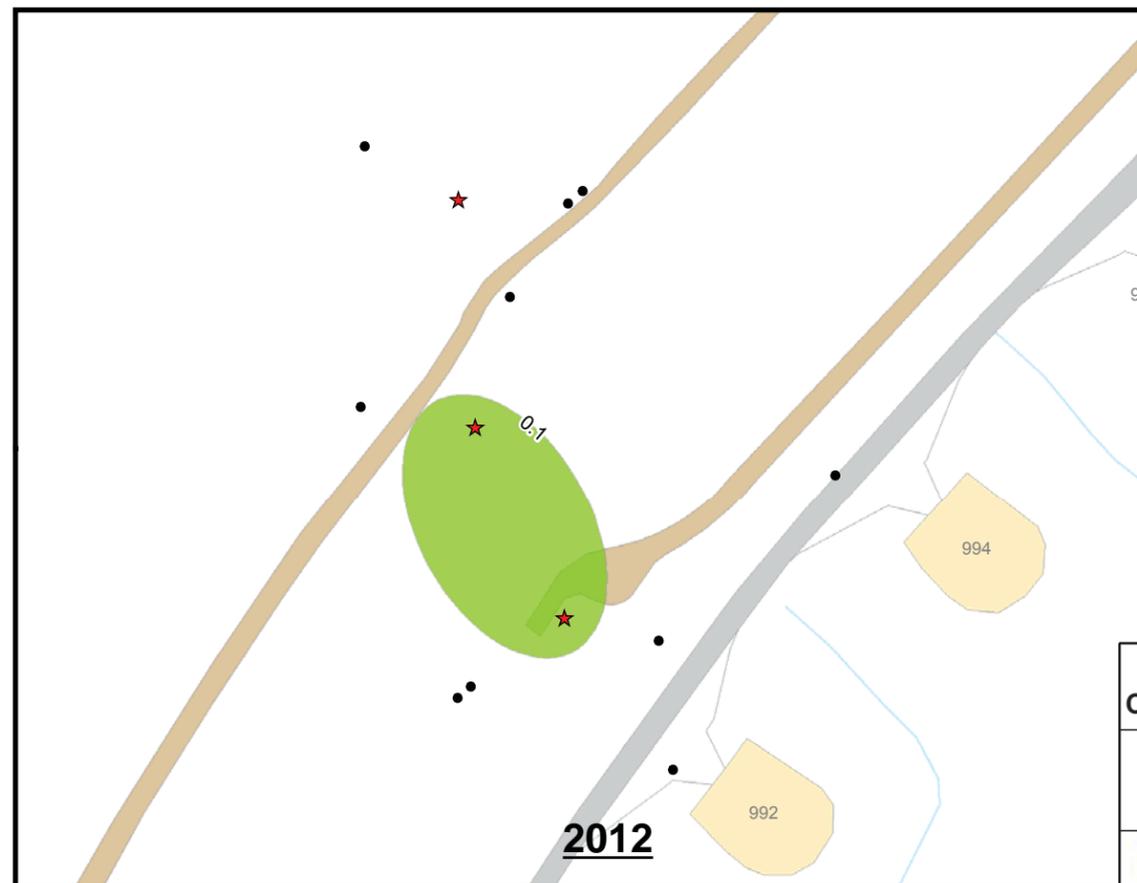
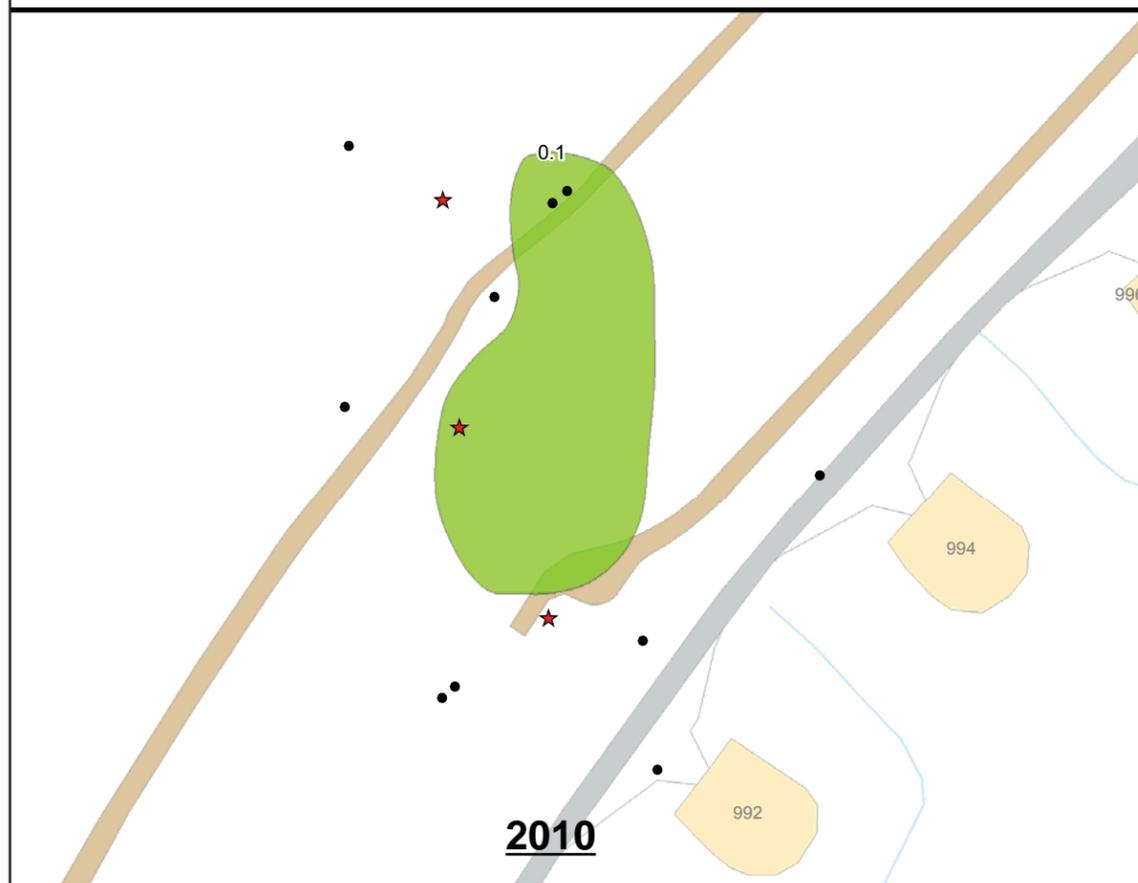
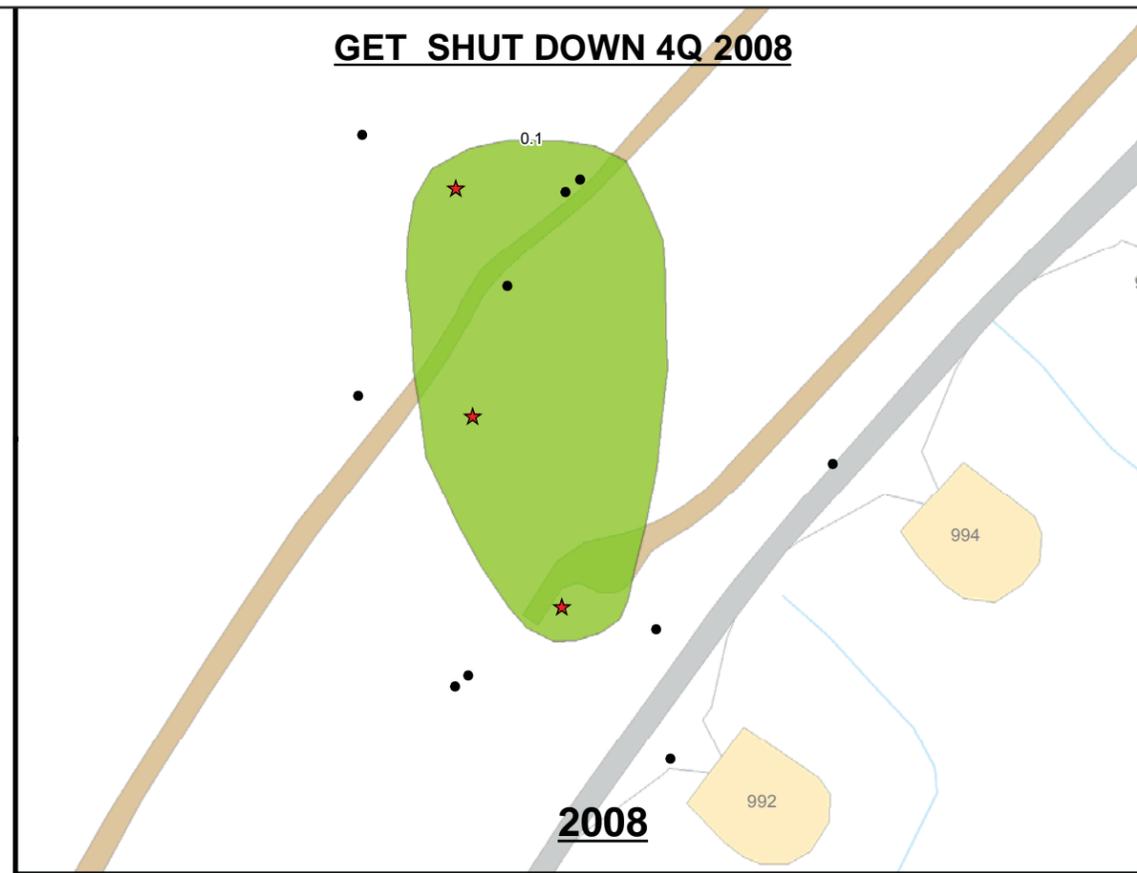
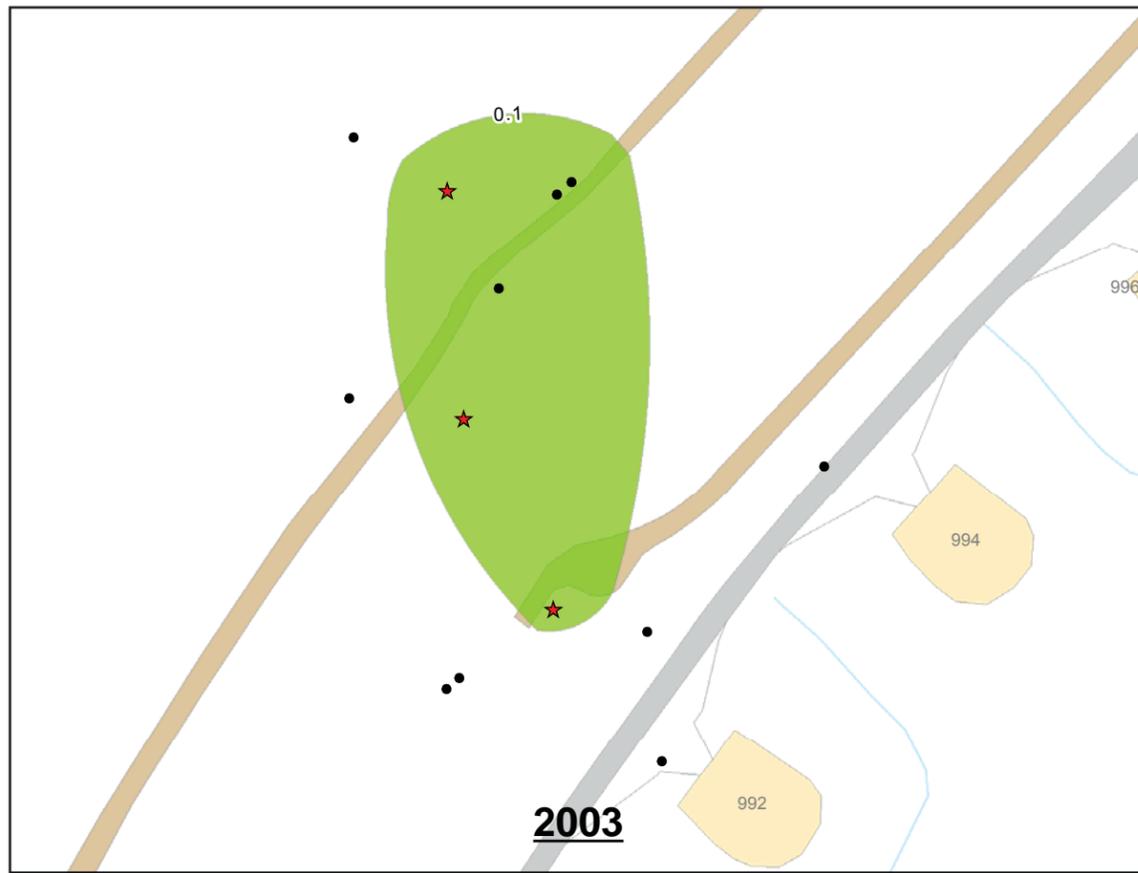
1. THE PLUMES SHOWN REPRESENT GROUNDWATER CONTAMINANT CONDITIONS WITHIN THE SATURATED ALLUVIUM THICKNESS OF THE SINGLE AQUIFER UNDERLYING TRAVIS AFB.
2. PLUME MAPPING DATES: 10 APRIL 2008 AND 10 NOVEMBER 2011.

GROUNDWATER IRA:
SOURCE CONTROL, MNA



WEST IRA - SITE DP039 TCE DISTRIBUTION 2008 TO 2011		
THIRD FIVE-YEAR REVIEW TRAVIS AIR FORCE BASE, CALIFORNIA		
Date: 2/15/2013	Figure: 7-6	

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LEGEND

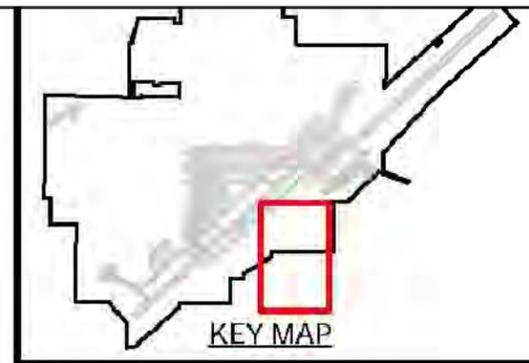
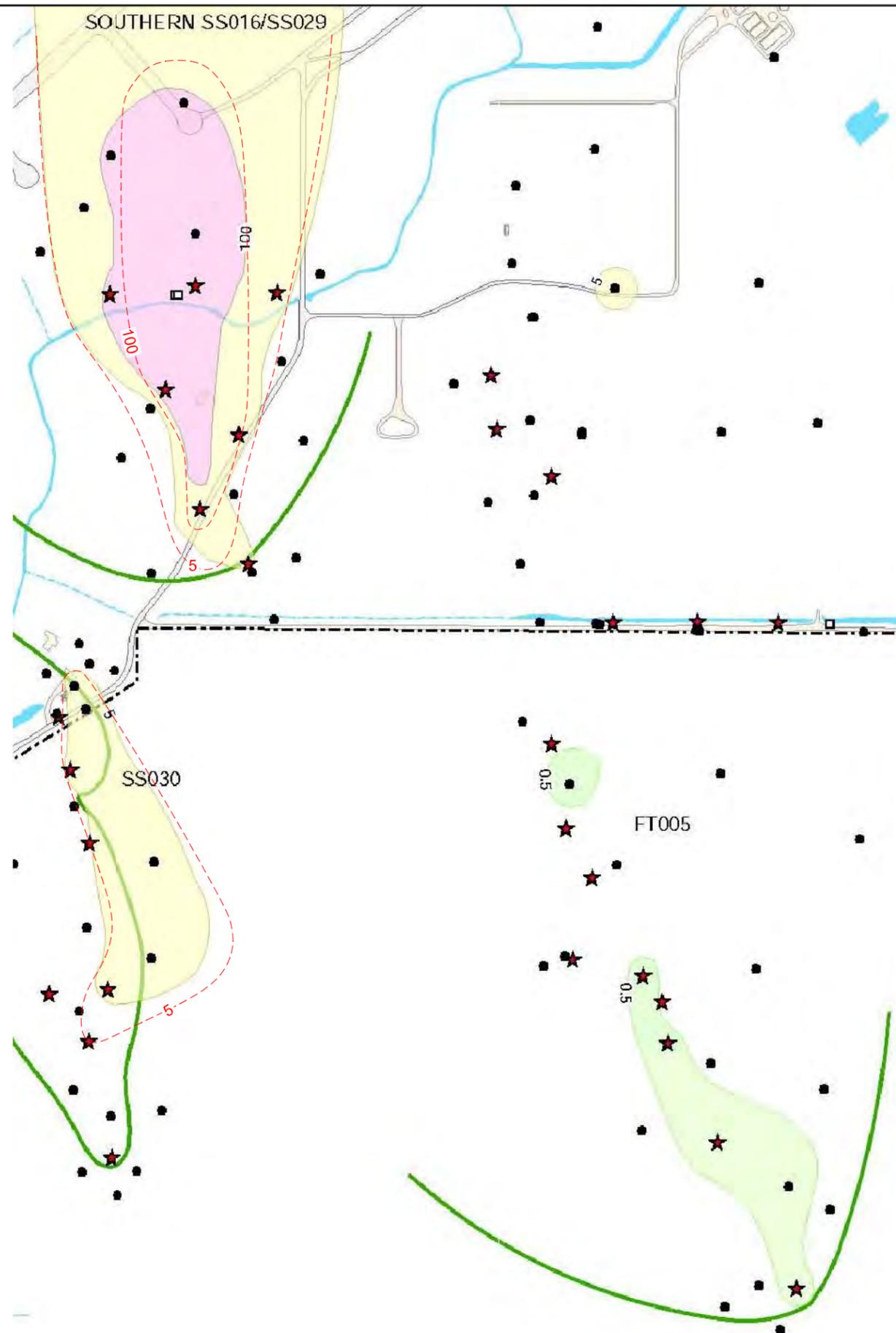
- GROUNDWATER MONITORING WELL
- ★ EXTRACTION WELL
- SURFACE WATER
- ALPHA-CHLORDANE ≥ 0.1 µg/L
- 0.1 APPROXIMATE ISOCONCENTRATION CONTOUR (µg/L)
- BUILDINGS
- PAVED AREA
- UNPAVED ROAD
- ROAD



WEST IRA – SITE LF008 ALPHA CHLORDANE DISTRIBUTION 2003 TO 2012

THIRD FIVE-YEAR REVIEW
TRAVIS AIR FORCE BASE, CALIFORNIA

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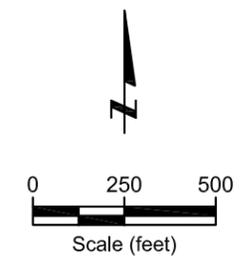


LEGEND

- PIEZOMETER
- GROUNDWATER MONITORING WELL
- ★ EXTRACTION WELL
- 1,2-DCA ≥ 0.5 µg/L
- TCE CONCENTRATIONS (µg/L), 2008
- 5 ≤ TCE < 100
- 100 ≤ TCE < 1,000
- TCE ≥ 1,000
- APPROXIMATE EXTENT OF HYDRAULIC CAPTURE (DASHED WHERE LESS CERTAIN)
- - 5 - - APPROXIMATE TCE ISOCONCENTRATION CONTOUR, 2011
- BASE BOUNDARY
- BUILDINGS
- UNPAVED AREA
- PAVED AREA
- ROAD
- SURFACE WATER

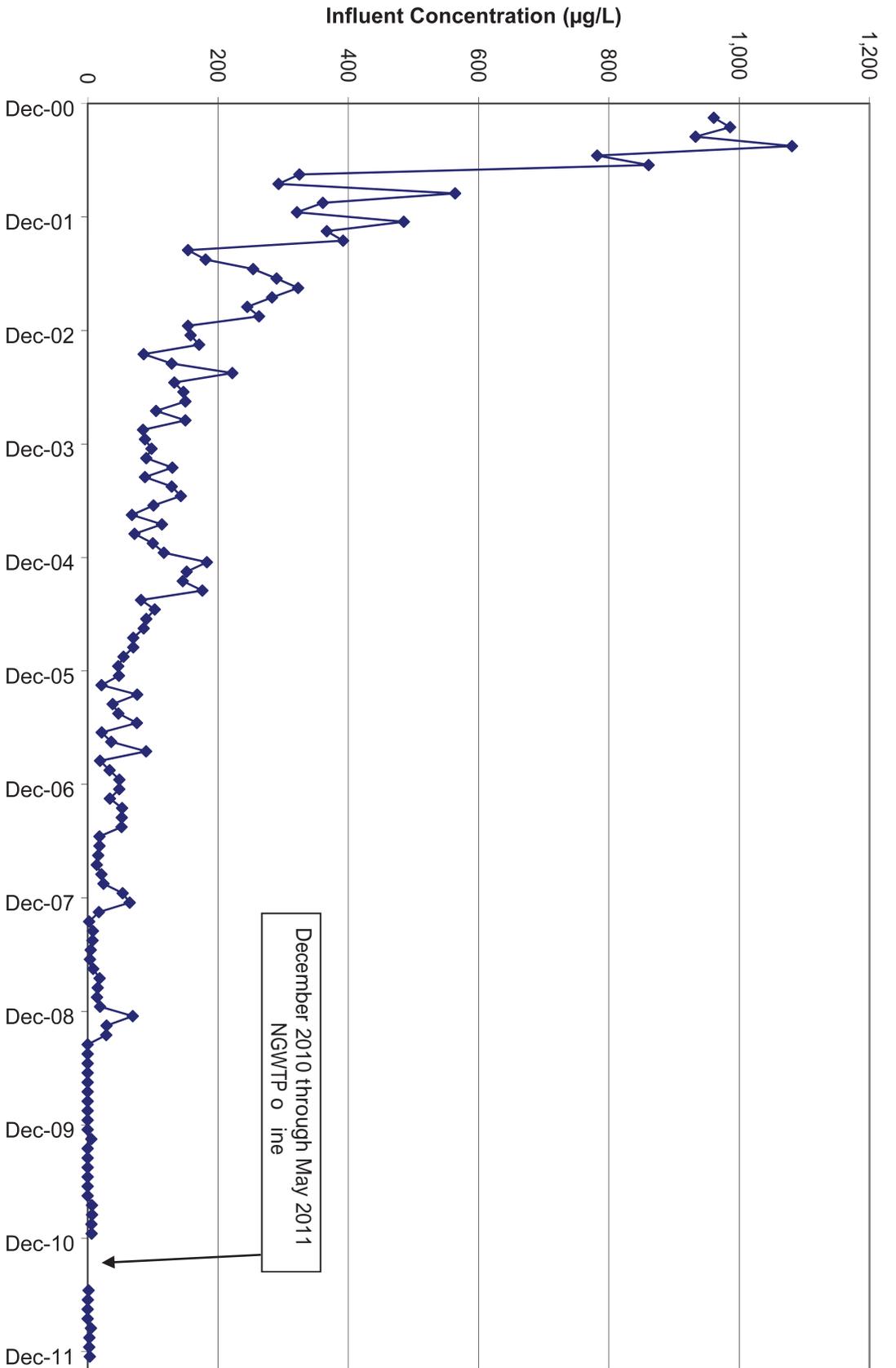
- NOTES:
1. THE PLUMES SHOWN REPRESENT GROUNDWATER CONTAMINANT CONDITIONS WITHIN THE SATURATED ALLUVIUM THICKNESS OF THE SINGLE AQUIFER UNDERLYING TRAVIS AFB.
 2. PLUME MAPPING DATES: 10 APRIL 2008 AND 19 OCTOBER 2011.

GROUNDWATER IRA:
SOURCE CONTROL, MIGRATION CONTROL,
OFFBASE REMEDIATION



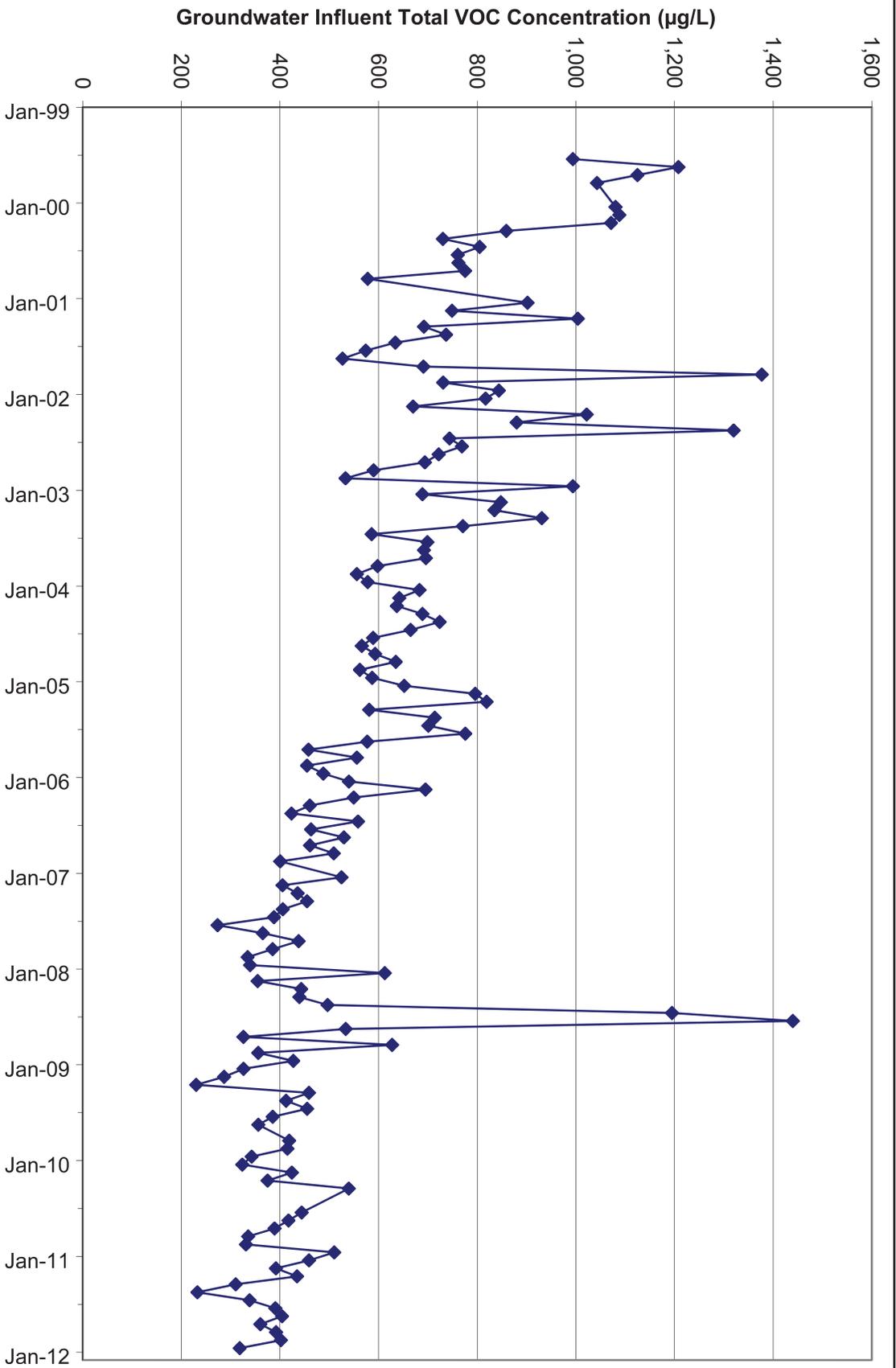
WEST IRA - WIOU SITES FT005, SS029, SS030 TCE DISTRIBUTION 2008 TO 2011		
THIRD FIVE-YEAR REVIEW TRAVIS AIR FORCE BASE, CALIFORNIA		
Date: 2/15/2013	Figure: 7-8	

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**NGWTP GROUNDWATER INFLUENT
TOTAL VOC CONCENTRATION VS. TIME
JANUARY 2001 – DECEMBER 2011**

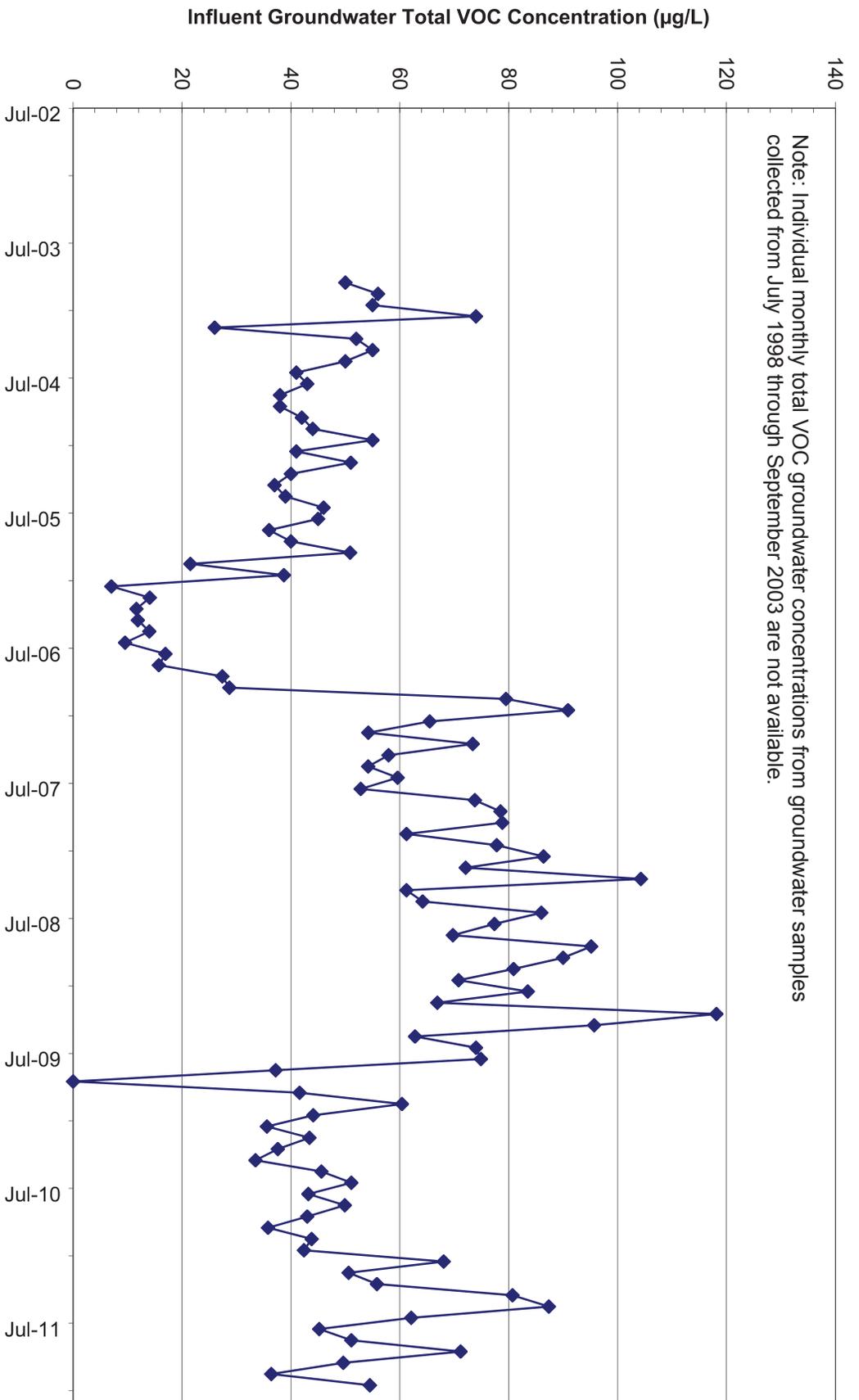
THIRD FIVE-YEAR REVIEW
TRAVIS AIR FORCE BASE, CALIFORNIA



**CGWTP GROUNDWATER INFLUENT
TOTAL VOC CONCENTRATION VS. TIME
JULY 1999 – DECEMBER 2011**

THIRD FIVE-YEAR REVIEW
TRAVIS AIR FORCE BASE, CALIFORNIA

Note: Individual monthly total VOC groundwater concentrations from groundwater samples collected from July 1998 through September 2003 are not available.



SBBGWTP Groundwater Influent Total VOC Concentration VS. Time
October 2003 – December 2011
 THIRD FIVE-YEAR REVIEW
 TRAVIS AIR FORCE BASE, CALIFORNIA

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SECTION 8

Issues and Follow-Up Actions

This section describes current issues and potential follow-up actions and/or improvements to current site operations, activities, or conditions that may affect the current and/or future protectiveness of the groundwater IRAs and soil and/or sediment RAs currently implemented or planned at Travis AFB.

Travis AFB is the lead agency for implementing all recommendations and follow-up actions related to the groundwater IRAs and soil RAs. EPA Region 9, San Francisco Bay Water Board, and DTSC will provide regulatory agency oversight of any actions that may be taken.

8.1 Groundwater Interim Remedial Action Issues and Follow-Up Actions

All groundwater IRAs at NEWIOU and WABOU sites are successfully operating to achieve interim remedial action goals (IROs), and remedial process optimizations have proven successful at achieving IROs more efficiently and effectively; the exception to this is VOC groundwater plume at Site LF007C, which is not achieving capture. Additionally, in areas where groundwater concentrations exceed industrial or residential RBCs, there is a potentially significant vapor intrusion concern for future use. LUCs are accordingly necessary to manage vapor intrusion risk for potential residential and industrial future use scenarios in areas where groundwater concentrations continue to exceed RBCs.

LF007C Plume Capture

The LF007C plume is migrating off-base. The existing extraction wells are inadequate to control migration or remediate the plume. Additional characterization of off-base contaminant distribution, groundwater flow direction, and potential extraction system modifications has been evaluated by Travis AFB. Future RPO actions should consider the following limitations and concerns:

- Groundwater extraction at this site has been hampered by the low permeability of the sediments and the seasonal restriction on operation. Future optimized remedies must address these physical hydrogeologic constraints.
- The supplemental investigation performed by Travis AFB revealed the apparent influence of the bedrock surface on the migration and spatial distribution of the TCE plume. The plume appears to be migrating crossgradient to groundwater flow, and in concert with the orientation of the bedrock surface. The influence of the bedrock surface has to be taken into account in RPOs.
- The current RPO proposed for this site in the Final Site LF007C Data Gaps Investigation Results, Technical Memorandum (CH2M HILL, 2012d) relies on increased pumping rates from existing wells, with significant assumptions related to the ability of the existing wells to sustain such rates into the future. Assumed sustainable extraction rates of wells should be tested under site-specific conditions.
- Numerical modeling was presented in the Final Site LF007C Data Gaps Investigation Results, Technical Memorandum (CH2M HILL, 2012d) to assess the ability of the GET system with increased pumping rates to capture both on- and off-site portions of the plume. The model simulations were conducted at steady-state conditions (i.e., infinite time), rather than in transient

mode, where the time frame to achieve the simulated capture zones can be defined. The modeling may be significantly overestimating the extent of the capture zones of the two extraction wells when conducted at steady-state.

- The vernal pool/wetland serves as a significant source of recharge to the aquifer, evidenced by the observed seasonal water level fluctuations (as high as 20 feet) in monitoring wells within the footprint of the TCE plume. Even in the dry season, when the wetland/pool may not be observable at the ground surface, subsurface soils are expected to be highly saturated and promoting above-average recharge rates.

Under actual field conditions, the occurrence of significant recharge near pumping wells results in minimizing the size of the cone of depression, and hence the capture zone, of extraction wells. Increases in well pumping rates typically do not have the expected effect of significantly increased capture zones, as the increased demand from the well is met by the ever-present recharge source. As long as the vernal pool/wetland remains present, this phenomenon is likely to significantly limit the benefits of GET operations at LF007C.

Vapor Intrusion Pathway

While there are no sites currently requiring action based on the vapor intrusion pathway, this pathway is a potential future concern under residential use at Sites FT004, LF007C, SS015, SS016, SS029, SS030, SD033, SD034, SS035, SD036, SD037, and DP039. The vapor intrusion pathway is also a potential future concern under industrial use at Sites FT004, SS015, SS016, SS029, SD034, SD036, SD037, and DP039. The vapor intrusion pathway is not a potential future concern under either residential or industrial usage at Sites FT005, LF006, LF008, ST027B, SD031, and SD043 with current groundwater conditions.

To ensure long-term protectiveness, it is recommended that prior to construction of future buildings at any of the aforementioned sites where this pathway is of concern, LUCs in the form of passive ventilation systems be implemented as part of construction of future buildings. In addition, the LUCs should ensure that future buildings be located outside of a 100-foot buffer beyond the area of groundwater contamination (as defined by isoconcentration contours) exceeding groundwater-to-indoor-air RBCs) at the time of construction.

It is also recommended that long-term protectiveness for the vapor intrusion pathway for the relevant groundwater sites be addressed through continued monitoring of changes in VOCs in groundwater. If VOC concentrations in groundwater increase, an updated systematic evaluation of the vapor intrusion pathway for buildings without a passive venting system will be triggered to ensure that potential future exposures are prevented, and confirm that the buildings with a passive venting system have achieved their objectives. This process is expected to be further memorialized in the Travis AFB Groundwater ROD, currently under review by the regulatory agencies.

8.2 Soil and/or Sediment Remedial Action Issues and Follow-Up Actions

All soil and sediment RAs have been completed at Travis AFB. There are no issues that prevent the NEWIOU and WABOU soil RAs from being protective. The two primary outcomes of the soil RAs completed at the sites include the following:

- Excavation achieved cleanup levels that permitted unrestricted use of the site.
- LUCs are being successfully enforced by Travis AFB to permit only industrial use of the site.

The Travis AFB has successfully enforced the LUCs utilizing a variety of mechanisms including the GP, the EIAP program (Form 332 and excavation permits), and annual inspections.

8.3 Next Five-Year Review

The next five-year review is required to be completed by September 29, 2018. The fourth review will include the final Travis AFB Groundwater ROD, which will supersede the NEWIOU and WABOU groundwater IRAs. Since all soil and sediment RAs have been completed, the fourth review for soil ERP will only include evaluation of the LUCs.

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SECTION 9

Protectiveness Statements

This section provides protectiveness statements for groundwater IRAs and soil and/or sediment RAs in the NEWIOU and WABOU.

9.1 Groundwater Interim Remedial Actions

Travis AFB is conducting groundwater IRAs at multiple sites within the NEWIOU and WABOU.

The Air Force developed groundwater IRODs for NEWIOU and WABOU instead of a final groundwater ROD, to allow groundwater remediation to begin quickly to reduce contamination and risk. The groundwater IROD establishes an interim period to evaluate the effectiveness of the IRAs and to monitor the status of each contaminant plume. The Air Force will use these data to establish final groundwater cleanup levels and select technically and economically feasible long-term actions in the final Travis AFB Groundwater ROD. The Air Force has published a final Proposed Plan for Groundwater Cleanup, and the draft Travis AFB Groundwater ROD is undergoing regulatory review and revisions. The final Travis AFB Groundwater ROD is expected to be signed in 2013.

9.1.1 NEWIOU Groundwater Interim Remedial Actions Protectiveness Statement

The groundwater interim remedies within the NEWIOU currently protect human health and the environment because exposure pathways that could result in unacceptable risks are being controlled. However, in order for the remedies to be protective in the long-term, the following actions need to be taken to ensure protectiveness:

- For the remedy at Site LF007C to be protective in the long term, follow-up actions relative to offsite plume capture need to be taken.
- At sites where groundwater-to-indoor-air and shallow soil gas risk-based concentrations are exceeded, LUCs to ensure long-term protectiveness for the vapor intrusion pathway are needed.

9.1.2 WABOU Groundwater Interim Remedial Actions Protectiveness Statement

The groundwater interim remedies within the WABOU currently protect human health and the environment because exposure pathways that could result in unacceptable risks are being controlled. However, in order for the remedies to be protective in the long-term, the following actions need to be taken to ensure protectiveness:

- At sites where groundwater-to-indoor-air and shallow soil gas risk-based concentrations are exceeded, LUCs to ensure long-term protectiveness for the vapor intrusion pathway are needed.

9.2 Soil and Sediment Remedial Actions

Travis AFB has completed all soil and sediment RAs within the NEWIOU and WABOU, however at select sites, unrestricted use and unrestricted exposure has not been achieved, and LUCs continue to be tracked and monitored according to the requirements of the RODs.

9.2.1 NEWIOU Soil and Sediment Remedial Action Protectiveness Statement

The remedies at the NEWIOU soil and sediment sites are protective of human health and the environment.

All RAs have been completed. RAOs for several sites included establishing LUCs which restrict the site to industrial land uses and prevent surface-disturbing activities. No issues were identified in LUC inspections conducted and LUCs are being successfully tracked and enforced by the Air Force.

9.2.2 WABOU Soil Remedial Action Protectiveness Statement

The remedies at the WABOU soil sites are protective of human health and the environment.

All RAs have been completed. RAOs for several sites included establishing LUCs which restrict the site to industrial land uses and prevent surface-disturbing activities. No issues were identified in LUC inspections conducted and LUCs are being successfully tracked and enforced by the Air Force.

Appendix A
Acronyms and Abbreviations

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APPENDIX A

Acronyms and Abbreviations

2008 RPO Report	<i>2008 Annual Remedial Process Optimization Report for the Central Groundwater Treatment Plant, North Groundwater Treatment Plant, and South Base Boundary Groundwater Treatment Plant</i>
µg/L	micrograms per liter
AFB	Air Force Base
AFCEC	Air Force Civil Engineer Center
AFCEE	Air Force Center for Engineering and the Environment
Air Force	U.S. Air Force
ARAR	Applicable or Relevant and Appropriate Requirement
AST	aboveground storage tank
BTEX	benzene, toluene, ethylbenzene, and xylene
CAMU	Corrective Action Management Unit
CCR	<i>California Code of Regulations</i>
CDFG	California Department of Fish and Game
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CGWTP	Central Groundwater Treatment Plant
COC	chemical of concern
COEC	chemical of ecological concern
CRP	Community Relations Plan
CVOCs	chlorinated VOCs
DCA	dichloroethane
DCB	dichlorobenzene
DCE	dichloroethene
DNAPL	dense non-aqueous phase liquid
DPE	dual-phase extraction
DTSC	California Department of Toxic Substances Control
EIAP	Environmental Impact Analysis Process
EIOU	East Industrial Operable Unit

EPA	U.S. Environmental Protection Agency
ERA	environmental risk assessment
ERD	enhanced reductive dechlorination
ERP	environmental restoration program
ET	evapotranspiration
EVO	emulsified vegetable oil
FFA	<i>Federal Facility Agreement</i>
FS	feasibility study
FTA	Fire Training Area [number]
GAC	granular activated carbon
GET	groundwater extraction and treatment
GP	General Plan
GRIP	Groundwater Remediation Implementation Program
GSAP	Groundwater Sampling and Analysis Program
GWTP	groundwater treatment plant
ICG	interim cleanup goal
IRA	interim remedial action
IRAO	Interim Remedial Action Objectives
IRG	interim remediation goal
IROD	Interim Record of Decision
IRP	Installation Restoration Program
LGAC	liquid-phase granulated activated carbon
LNAPL	light, nonaqueous-phase liquid
LTO	long-term operation
LUC	land use control
LUCIP	Land Use Control Implementation Plan
MCL	maximum contaminant level
mg/L	milligrams per liter
MMRP	Military Munitions Response Program
MNA	monitored natural attenuation
MRS	munitions response site

MTBE	methyl tert-butyl ether
NAAR	Natural Attenuation Assessment Report
NCP	National Contingency Plan
NEWIOU	North/East/West Industrial Operable Unit
NGWTP	North Groundwater Treatment Plant
NOU	North Operable Unit
NPL	National Priorities List
O&M	operations and maintenance
OSA	Oil Spill Area
OU	operable unit
OWS	oil-water separator
PAH	polynuclear aromatic hydrocarbon
PCB	polychlorinated biphenyl
PCE	tetrachloroethene
POCO	petroleum-only contaminated
POL	petroleum, oil, and lubricants
ppb	parts per billion
ppm	parts per million
ppt	parts per trillion
PRB	permeable reactive biobarrier
PRG	Preliminary Remediation Goal
RA	remedial action
RAB	Restoration Advisory Board
RAR	remedial action report
RI	Remedial Investigation
ROD	Record of Decision
RPM	Restoration Program Manager
RPO	remedial process optimization
RSL	Regional Screening Level
SBBGWTP	South Base Boundary Groundwater Treatment Plant
SSA	Solvent Spill Area

SSG RBC	shallow soil gas risk-based concentration
SVOC	semivolatile organic compound
TARA	Tower Area Removal Action
TBC	To Be Considered Information
TCE	trichloroethene
ThOx	thermal oxidation
TOC	total organic carbon
TPH	total petroleum hydrocarbons
TPH-D	TPH as diesel
TPH-G	TPH as gasoline
Travis AFB	Travis Air Force Base
UCL	Upper Confidence Level
URS	URS Group, Inc.
UST	underground storage tank
UV/Ox	ultraviolet oxidation
VGAC	vapor-phase granular activated carbon
VI	vapor intrusion
VOC	volatile organic compound
WABOU	West/Annexes/Basewide Operable Unit
WABOU Soil ROD	<i>West/Annexes/Basewide Operable Unit Soil Record of Decision</i>
Water Board	Regional Water Quality Control Board
WIOU	West Industrial Operable Unit
WTTP	Water Treatment and Transfer Plant

Appendix B

References

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APPENDIX B

References

Decision Documents

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Appendix C
LUC Summary Report and Pictures

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APPENDIX C

LUC Inspection Report and Pictures

A land use control (LUC) evaluation was performed as part of the five year review on 30-31 October 2012. The LUC evaluation was in accordance with EPA Guidance “Recommended Evaluation of Institutional Controls: Supplement to the Comprehensive Five-Year Review Guidance”, dated September 2011.

In summary, five year review activities for LUC evaluation included the components below.

1. Document Reviews
2. Site Interviews
3. Site Inspections
4. Making a protectiveness determination

C.1. Document Reviews

All LUC documents were reviewed to ensure that clear language was used to state required use restrictions and that legal descriptions reflected current conditions at the site. In addition maps that lay out restricted areas against the areas of known contamination are important tools for documenting the extent of LUCs.

The following documents were reviewed to evaluate the LUC implementation.

- Annual Report on the Status of Land Use Controls on Restoration Sites in 2011
- Base General Plan Revisions updated in 2012 (includes map)
- Various Air Force forms (AF Form 813, 60 AMW Form 55 [a.k.a.” dig permits”])

C.2. Interviews

Interviews were conducted consistent with the recommendations in the EPA memo cited above. The purpose of an interview is to gather information on LUCs related to its implementation, maintenance, and enforcement. Section 3.5.2 and Appendix C of the Five Year Review Guidance contain recommendations on how to conduct interviews during the five-year review. Interviews provide valuable information on LUCs related to their implementation, maintenance, and enforcement.

The interviews took place on October 30th and 31st, 2012. The interviews were conducted by Ms. Gina Kathuria of Endpoint Consulting, Inc. The interviewees were representatives of Travis AFB covering a wide range of disciplines, including Mr. Lonnie Duke (engineer), Mr. Glenn Anderson (hydrologist), Mr. Chris Krettecoc (environmental Planner), and Mr. Nate Pyron (community planner). Below is a list of questions that were posed to the interviewees, including a brief summary of their related answers.

1. Have any breaches of the LUCs occurred, complaints been filed, or unusual activities been noted at the site (e.g., citizens are consuming fish at a contaminated sediment site)? If so, how were

they addressed? No breaches of the LUCs have occurred.

2. Has the Air Force reported on the status of the LUCs as required? Yes; annual reports are prepared.
3. What type of monitoring is currently being conducted or has been conducted to determine institutional control (IC) compliance (e.g., follow-up inspections)? Annual inspections, the TerraDex alert system, and Air Force dig permits are used as means of monitoring for ICs.
4. Are LUCs being enforced? What is the enforcement plan in the event of an LUC breach? Yes, LUCs are enforced. In the event of a breach, ICs are immediately restored.
5. Are there any new developments, either constructed or planned, in the area of which the Air Force is aware? No new developments have been implemented.
6. Has land use changed or is it anticipated to change (e.g., housing developments, either constructed or planned, exist in the area)? Land use has not changed.
7. What procedures are in place for EPA and PRPs to receive notice of any proposed changes to the LUCs? No proposed changes to the ICs are expected; however, the Air Force may consider removing the ICs by remediating to residential standards.
8. Does the entity have an IC tracking system or other applicable database (e.g., Geographical Information System [GIS] maps) to keep information about LUCs? LUCs are maintained within Travis AFB's General Plan, which includes a GIS system.
9. Can the LUCs or engineering controls be registered in the state's one-call system? How has the IC process been working and are there any suggestions for improvement? LUCs have been registered in the state's TerraDEX alert system.
10. How is TerraDex Alert System working? The TerraDex system is working well. Travis AFB staff frequently receive calls from the State of California Department of Toxic Substances Control (DTSC) inquiring about alerts sent to DTSC by the system relative to field activities near LUCs.

All Travis AFB staff interviewed are very knowledgeable about LUCs implementation; and locations of soil and groundwater contamination relative to the land use. Furthermore, through interviews it was discovered that there are proactive oversight activities ongoing to protect the LUCs. Those activities are described below.

- *Weekly Dig Permit Meetings* are attended by Travis Air Force staff every Tues at 10:00 AM. This meeting provides notifications of all contractor activities occurring on base that entails disturbing soil. For example, if a contractor must dig a hole to service a utility line, he/she must obtain a dig permit before breaking ground. Review of all dig permits provides another opportunity for Travis Air Force staff to protect LUCs by ensuring the permits contain conditional requirements so as to not disturb soil and/or contamination.
- *TerraDex Alert* is another tool to protect LUCs. TerraDex Alert contacts Department of Toxic Substances Control (DTSC) when Underground Service Alert (USA) is contacted on a site with a LUC. Once DTSC is notified, DTSC

contacts Travis AFB staff to ensure that Travis AFB staff is aware of the USA request.

As an extension of the interviews, site inspections were conducted relative to the LUCs. Details of the site inspection, including a tabular summary of the inspection checklist and associated observations and conclusions are summarized in the sections below.

C.3. Site Inspections

The purpose of the site inspection was to evaluate the site and visually confirm the effectiveness of LUCs and the engineering components of the remedy. Below is a table summarizing the site inspections. In addition, photos are included to document the site inspection.

C.4. Making a Protectiveness Determination

The protectiveness of the LUC remedy is determined by answering the following three questions:

Question A: Is the remedy functioning as intended by the decision documents? **Yes**, the LUCs are in place and effective for all areas of the site that have not achieved residential standards.

Question B: Are exposure assumptions, toxicity data, cleanup levels, and remedial action objectives used at the time of the remedy selection still valid? **Yes**, there have been no changes in exposure pathways, land use, or zoning. Minor changes to toxicity data have not affected conclusions relative to protectiveness.

Question C: Has any other information come to light that could call into question the protectiveness of the remedy? **No**, no additional information has become available since the last five-year review conducted in 2008 that question the protectiveness of the LUCs.

Site Inspection Summary Table

Site	Picture Taken (Y/N)	Sign/Fence Posted (S/F)	Disturbed Surface (Y/N)	Land Use Changes (Y/N)	Observations/Notes	LUC Protective (Y/N)
LF007	Y	S,F	N	N	Wetlands on top part of this site 6 months out of year. Solar panels power on-site extraction wells. Site includes CAMU landfill with environtranspiration cap. Cap is undisturbed.	Y
SS015	Y	F	N	N	Within fenced area. Site is used for truck maintenance	Y
SS016	Y	S	N	N	Picture taken from same vantage point as last year annual inspection.	Y
SD033	Y	S	N	N	LUC protects a little area outside building on both sides. There are two discrete patches of contamination.	Y
SD037	Y	No posting	N	N	Cannot put sign up because LUC is in middle of road.	Y
DP039	Y	S	N	N	Surface soil looked recently restored. Soil was originally disturbed to install new remediation (bioreactor) system.	Y
SD043	Y	S	N	N		Y
LF044	Y	S	N	N	New ASTs were installed. Fence needs some repair.	Y
SS046	Y	S	N	N		Y
FT004	N	No posting	N	N	This site was inspected for land use controls on groundwater sites. It was observed to verify no residential development and no active well drilling.	Y

C.5. Pictures



Picture 1: LF007 CAMU Warning Sign



Picture 2: LF007 Fence Entrance



Picture 3: LF007 Warning Sign



Picture 4: LF007 Solar Powered Extraction Well



Picture 5: SS015 Warning Sign



Picture 6: SS016 Bioreactor



Picture 7: SS016 Warning Sign



Picture 8: SD033 Warning Sign



Picture 9: SD033 Warning Sign



Picture 10: SD033 Warning Sign



Picture 11: SD037 LUC In Middle of Road



Picture 12: SD037 LUC In Middle of Live Traffic



Picture 13: Site DP039 Bioreactor and Warning Sign



Picture 14: Site SD043 Warning Sign



Picture 15: SD043 Duplicate Posting of Warning Signs



Picture 16: LF044 Warning Sign In Next to Gate Entrance



**Picture 17: LF044 Warning Sign
(New AST Farm Constructed in Compliance with LUC Restrictions)**



Picture 18: LF044 LUC Includes Berm Area Around Site



Picture 19: Site SS046 Warning Sign



Picture 20: Site SS046 Warning Sign



Picture 21: Site SS030 Off Base To Inspect Groundwater LUC

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Appendix D
Groundwater Sites and Contamination

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D.2.1.2 Interim Remedy Description

The South Base Boundary Groundwater Treatment Plant (SBBGWTP) is designed to extract and treat groundwater from Sites SS030, FT005, and SS029 in the NEWIOU at Travis AFB. The extraction system consists of six on-base extraction wells and nine off-base extraction wells at Site FT005, seven on-base extraction wells at Site SS029, and six off-base extraction wells and a 200-foot on-base interceptor trench (EW06x30) at Site SS030.

Over the reporting period, the following extraction wells were offline:

- **Site FT005.** Extraction wells EW01x05, EW03x05, EW731x05, EW732x05, EW733x05, EW736x05, EW737x05, EW742x05, EW743x05, EW744x05, EW745x05, and EW746x05 were offline to support an ongoing rebound study that had been initiated in December 2007 because 1,2-DCA concentrations had declined below the IRG at most monitoring and extraction wells.
- **Site FT005.** Extraction wells EW734x05 and EW735x05 were initially offline as part of the rebound study. However, 1,2-dichloroethane (1,2-DCA) concentrations at the toe of the plume, where these extraction wells are located, increased above the IRG in 2Q10, and they were brought back online in 2010, along with extraction well EW02x05, located along the Base boundary. All three extraction wells were operational for most of the reporting period; however, wells EW734x05 and EW735x05 were only intermittently operational in June and July 2011 because of an inoperable water level transducer and pump, respectively. Thus, wells EW734x05 and EW735x05 were not online during the groundwater elevation survey. The wells were repaired and brought back online in 4Q11.
- **Site SS029.** Extraction well EW03x29 had been taken offline because of low VOC concentrations and was offline over the reporting period. However, VOC concentrations have been increasing at this well, and it was determined that the well should be brought back online. The pump and controls were in need of repair. The repairs were completed and the pump was brought back online in 4Q11.

After extraction, contaminated groundwater is conveyed to the SBBGWTP. The SBBGWTP treats and discharges approximately 80 gallons per minute (gpm) of groundwater to Union Creek. Since July 1998 (system startup), approximately 406 pounds of VOC mass have been removed by the SBBGWTP. From July 1998 through August 2011, a total of 748 million gallons of groundwater had been treated by the SBBGWTP.

D.2.2 Interim Remedy Evaluation

D.2.2.1 Capture Evaluation

Site SS029. The primary IRAO for the Site SS029 plume is migration control. The Site SS029 IRAO has been achieved. The target area (TCE exceeding 5 µg/L) is within the 2Q11 estimated extent of hydraulic capture. TCE was not detected in the farthest downgradient monitoring wells (MW01x29, MW06x29, and MW07x29) near the Base boundary.

Upgradient Site SS029 wells MW1031x29 and MW1032x29 have exhibited recent trends of increasing COC concentrations. Both of these wells are upgradient from the Site SS029 extraction system, and increasing concentrations at these locations are the result of VOC migration from the upgradient Site SS016 plume. Available physical and analytical data indicate that the Site SS029 GET is capturing the VOC contamination that has migrated from Site SS016.

Site SS030. The on-base IRAO for the Site SS030 plume is migration control. The IRAO for the off-base component of the Site SS030 plume is groundwater remediation to the IRG. The migration control IRAO has been achieved. Groundwater monitoring wells with TCE concentrations exceeding the IRG are within the estimated 2Q11 extent of hydraulic capture. The remedial objective of off-base groundwater remediation is ongoing. The southern and western sides of the Site SS030 plume have been remediated,

and VOCs are no longer detected in these areas. TCE remains above the IRG only in the eastern portion of the off-base plume.

Historically, groundwater elevation contours and the increasing contaminant trends at eastern plume wells MW03x30 and MW05x30 have indicated that contamination may be escaping the Site SS030 GET in this area and flowing toward the southeast, influenced by the Site FT005 extraction system. However, the 2Q11 groundwater elevation contours indicate that the shutdown of most of the Site FT005 extraction wells improved the Site SS030 system capture. Groundwater elevation contours indicate that wells MW03x30 and MW05x30 as well as new well pair MW2001Ax30 and MW2001Bx30 are within the extent of hydraulic capture of the SS030 GET. In addition, TCE concentrations in the eastern portion of the plume have remained stable (MW03x30) or declined (MW05x30) over the last few years, indicating that the plume is no longer migrating eastward. Although the monitoring history is short at easternmost well pair MW2001Ax30/MW2001Bx30, TCE concentrations declined slightly at these wells between 2Q10 and 2Q11. Ongoing monitoring is needed to determine long-term concentration trends at this well pair. It is expected that TCE concentrations in this well pair will continue to decline if plume capture is achieved.

In August 2010, three Site FT005 extraction wells were brought back online because of a rebound in 1,2-DCA concentrations. Because groundwater extraction at Site FT005 affects the hydraulic capture at Site SS030, Site SS030 groundwater flow directions and VOC concentrations will continue to be closely monitored for evidence of reduced hydraulic capture. No reduction in hydraulic capture was evident over the reporting period.

D.2.2.2 Rebound Evaluation

Site FT005. Because the IRAO of groundwater remediation has nearly been achieved for Site FT005, a rebound study, which began in December 2007, is under way at the site. Over the reporting period all but three Site FT005 extraction wells (EW02x05, EW734x05 and EW735x05) were offline. EW02x05, EW734x05, and EW735x05 were brought back online in August 2010 because some rebound in 1,2-DCA concentrations had been evident in these extraction wells in 2Q10. With the exception of these extraction wells, the Site FT005 monitoring wells and extraction wells continued to have decreasing or stable 1,2-DCA concentrations through the rebound study period. Over the reporting period, 1,2-DCA concentrations also declined in the active extraction wells. In 2Q11, 1,2-DCA was only detected at three (3) wells in Site FT005: on-base monitoring well MW119x05, on-base extraction well EW733x05, and off-base monitoring well MW766x05.

D.2.3 Optimization Measures

- Groundwater extraction at Site FT005 is reaching its limit of effectiveness; concentrations of 1,2-DCA remain below the IRG in most monitoring and extraction wells. Because the Site FT005 extraction system reduces the extent of capture of the adjacent Site SS030 GET and it is not cost effective to extract clean groundwater, only extraction wells located in portions of Site FT005 where 1,2-DCA concentrations recently exceeded the IRG are currently operating. Limited groundwater extraction will continue in portions of Site FT005 where 1,2-DCA concentrations have recently exceeded the IRG. Therefore, extraction well EW02x05, along the Base boundary, and extraction wells EW734x05 and EW735x05 will continue to operate. If 1,2-DCA concentrations remain below the IRG through 2012, these wells will again be considered for shut down.
- The TCE concentration detected in Site SS029 extraction well EW03x29, which had been taken offline because of low VOC concentrations, continues to exceed the IRG. This extraction well was brought back online in 4Q11.
- Because groundwater contamination beyond the hydraulic control of the Site SS016 IRA is migrating to Site SS029, groundwater remediation at Site SS029 will likely continue after Sites FT005 and

SS030 have reached cleanup goals. The Site SS029 IRA is being evaluated under a separate project for potential optimizations with the goal of increased sustainability.

- The extent of capture of the Site SS030 GET has been improved by bringing all of the extraction wells online and shutting down most of the Site FT005 extraction wells. The 2Q11 groundwater elevation contours indicate that the eastern portion of the plume is within the extent of hydraulic capture. Therefore, all the Site SS030 extraction wells will continue to operate and only limited groundwater extraction will be performed at Site FT005.

D.3 Central IRA Area—Site SS016

D.3.1 Site Description

Site SS016 covers approximately 210 acres near the Base Control Tower and runway. TCE is the primary groundwater contaminant at Site SS016. The following potential sources of groundwater contamination have been identified at Site SS016:

- Oil Spill Area (OSA) in the vicinity of Building 18 (a former degreasing facility)
- Facility 11 (flightline support equipment repair)
- Facilities 13/14 (former wash rack)
- Facility 20 (Base Control Tower, underground storage tank [UST])
- Facilities 42/1941 (fuel and waste oil storage, aboveground storage tank [AST], wash rack)
- Facilities 139/144 (vehicle maintenance, UST)
- Storm sewers in the Storm Sewer Right-of-Way

The results of a 2009-2010 Site SS016 source area investigation indicated that the OSA is the primary source of VOC groundwater contamination at Site SS016. The OSA is located in the northwestern portion of Site SS016 and is associated with Building 18. Building 18 and the associated former wash rack located to the south of the building were constructed in 1960 as a degreasing facility for Travis AFB. The former wash rack was used to degrease jet engines, and liquid wastes from Building 18 were also conveyed by a pipeline to the former wash rack catch basin. Historical degreasing operations were conducted in Building 18 and at the adjacent wash rack from 1960 through the 1990s.

The northern portion of Building 18 was the tank room where numerous tanks containing chemicals used in the degreasing process were located on a sub-grade floor. At the northern end of the sub-grade floor was a collection sump that was connected to a 28,000-gallon steel-reinforced concrete UST. The 28,000-gallon UST was located adjacent to the northwestern portion of Building 18 and was divided in half by an interior baffle. The eastern half of the UST was used as a retention tank, and the western half was used as an oil water separator (OWS). The OWS was removed in 1997, and the UST was removed from the building and disposed of in January 1998.

The southern portion of Building 18 was historically used as part of the degreasing process and contained tanks and spray booths. This area was later remodeled to house a laboratory, a bead blaster and oven room, and multiple offices.

Historically, wastes from Building 18 have been disposed of by different means. From approximately 1960 to 1968, wastes were disposed of through a north-south pipeline that extended from tanks in Building 18 to a catch basin underlying the adjacent wash rack and subsequently to the storm drain. From 1968 through 1998, wastes were disposed of through the OWS or by contracted disposal services. Some wastes may also have been sent to an on-base fire training facility.

Degreasing operations are no longer conducted at Building 18 or the associated wash rack. The northern portion of Building 18 is currently used as a storage facility; the southern portion is not currently in use. During installation of an in situ bioreactor in September 2010, the wash rack canopy, concrete pad, and catch basin were removed. When the catch basin was removed it was noted that the connector pipe between the catch basin and the stormwater drainage pipe was constructed of vitrified clay and had been slip lined, possibly to repair a break in the clay pipe. The source of the TCE release at the OSA is believed to be a break in the storm sewer drainage line immediately downgradient of the catch basin.

D.3.1.1 Interim Remedial Action Objectives

The NEWIOU Groundwater IROD (Travis AFB, 1997) selected GET to address groundwater contamination at Site SS016. The IRAO at Site SS016 is source control in the vicinity of the Base Control

Tower, the Tower Area Removal Action (TARA), and the OSA. The NEWIOU Groundwater IROD states that achieving source control requires the removal of groundwater with VOC concentrations greater than 3,000 µg/L. However, the Site SS016 GET was designed to capture VOC concentrations greater than 1,000 µg/L.

D.3.1.2 Remedy Description

The current IRA at Site SS016 is GET. However, with dense non-aqueous phase liquid (DNAPL) likely present in the OSA source area, a different method of remediation had to be considered that would target the main source of the OSA contaminant plume. During 2010, the existing Site SS016 treatment systems (thermal oxidation [ThOx] system and Central Groundwater Treatment Plant [CGWTP]) were optimized by excavation of contaminated soil and installation of a solar-powered in situ bioreactor in the OSA. The excavation was performed to remove high concentrations of TCE-impacted soil from the OSA source area. The bioreactor was installed to enhance the breakdown of chlorinated VOCs (CVOCs) (primarily TCE and its daughter products) in the source area and hydraulically downgradient portions of the plume. Bioreactors create an anaerobic environment needed to reductively degrade and destroy VOCs in situ, eliminating the need for aboveground treatment and extending the treatment into the soil/aquifer matrix. After the source area (approximately 529 square feet [23 by 23 feet]) was excavated to a depth of 25 feet, it was backfilled with a 50/50 mixture of gravel and tree mulch sprayed with approximately 500 gallons of food-grade vegetable oil. Iron pyrite sands (45 percent iron and 50 percent sulfur by weight) were mixed into the first few loads of mulch and placed at the bottom of the bioreactor. The addition of iron sulfides promotes abiotic reduction of VOCs.

In addition to the OSA source area bioreactor, GET is currently performed in both the TARA and OSA. Two horizontal groundwater extraction wells (EW001x16 and EW002x16) are located in the TARA. The OSA has one horizontal extraction well (EW003x16), which runs through the source area, and two vertical extraction wells (EW605x16 and EW610x16) located southeast of the OSA source area within the aircraft parking ramp. Groundwater extracted from wells EW001x16, EW002x16, EW605x16, and EW610x16 is conveyed to the CGWTP and treated with GAC. Groundwater extracted from horizontal well EW003x16, which has been equipped with a solar-powered pump, is circulated through the OSA bioreactor. Wells EW605x16 and EW610x16 are capable of extracting soil vapor as well as groundwater; however, only groundwater was extracted during the reporting period.

The CGWTP receives groundwater from four of the Site SS016 extraction wells (EW001x16, EW002x16, EW605x16, and EW610x16) and 24 extraction wells in the WIOU and the WABOU. Groundwater from all WIOU and WABOU extraction wells is pumped through the West Treatment and Transfer Plant (WTTP) before being conveyed to the CGWTP. However, over the reporting period, rebound studies were taking place in the WIOU and WABOU and consequently no groundwater was extracted from these areas of the Base. Between April 1997 and April 2010, soil vapor, in addition to groundwater, was extracted from Site SS016 extraction wells (except for EW001x16 and EW002x16). Soil vapor has also historically been extracted from the WIOU extraction wells. Soil vapor collected at Site SS016 had been treated via ThOx at the ThOx Unit, which was taken offline in 2010. Soil vapor extracted from the WIOU is treated with vapor-phase granular activated carbon (VGAC) at the WTTP. However, in support of an ongoing rebound study in the WIOU, soil vapor extraction did not occur over the reporting period. A total of 448 million gallons of contaminated groundwater were treated at the CGWTP from January 1, 1996, through August 31, 2011. The cumulative VOC mass removed from groundwater and soil vapor since January 1996 is approximately 11,239 pounds.

D.3.2 Interim Remedy Evaluation

D.3.2.1 Capture Evaluation

The Site SS016 NEWIOU Groundwater IROD source control objective is capture of VOC concentrations greater than 3,000 µg/L, but the Site SS016 GET was designed to capture VOC concentrations greater

D.4 West IRA Area—WIOU

D.4.1 Site Descriptions

The WIOU includes Sites SS014, SD033, SD034, SS035, SD036, and SD037. Nearby WABOU sites include Sites SS041 and SD043. Because of their proximity and the similarity of site conditions and remedial solutions, all but one of these sites are combined for discussion in this section. Site SS014, a POCO site, is addressed separately because of its unique site conditions and contaminants.

The sites included in the West IRA Area—WIOU are within industrialized areas of the western-central portion of Travis AFB. The West Branch of Union Creek flows through the WIOU, generally north to south, with the slope of the topography. Numerous buildings, shops, offices, freight handling and storage areas, vehicle maintenance shops, and aircraft maintenance facilities are included in the WIOU. Activities at the two WABOU sites in the West IRA Area include pesticide mixing and handling, and electrical power generation.

Although the GET IRA has reduced TCE concentrations throughout the WIOU, two hot spots remain where TCE concentrations exceed 1,000 µg/L. One hot spot is located within Site SD036, and the other is located within the northern portion of Site SD037. Additional investigations at these two hot spots were performed in 2009-2010. Results of the investigation at Site SD036 indicated that the source of the TCE contamination at Site SD036 was release from one or more breaks in the two north-south trending sanitary sewer segments located in the center of the site. The distribution of TCE contamination in this area is consistent with a direct discharge to groundwater from a break or breaks in the sanitary sewer line. The TCE concentrations detected at this site during the investigation exceeded 10,000 µg/L, which may indicate the presence of residual pure-phase TCE contamination. However, DNAPL has not been directly observed at the site.

Results of the 2009-2010 investigation indicate that the source of the remaining hot spot at Site SD037 (where TCE concentrations continue to exceed 1,000 µg/L) is also a break in the sanitary sewer line. Historical records indicate that the east-west segment of the sanitary sewer line adjacent to well MW532x37 had been previously damaged and recommended for repair. The distribution of TCE in groundwater is consistent with a release from the east-west segment of sanitary sewer line near well MW532x37.

D.4.1.1 Interim Remedial Action Objectives

The NEWIOU Groundwater IROD (Travis AFB, 1997) and the WABOU Groundwater IROD (Travis AFB, 1999) selected GET to address groundwater contamination within the WIOU. Source control and migration control are the IRAOs for WIOU Sites SD033, SD034, SS035, SD036, and SD037 and WABOU Sites SS041 and SD043. Source control actions address areas of groundwater contamination where VOC concentrations are 1,000 µg/L and greater. Migration control actions address areas of groundwater contamination where VOC concentrations are between 100 and 1,000 µg/L to prevent contaminants from migrating into the less-contaminated MNA areas. To achieve the IRAOs, the WIOU GET system was designed to capture VOC concentrations exceeding 100 µg/L.

MNA assessment is the selected interim remedy for the southern portion of the WIOU, where VOC concentrations are less than 100 µg/L. The downgradient portion of the site underwent a natural attenuation assessment in 2000-2001, as documented in the *WIOU Natural Attenuation Assessment Workplan* (CH2M HILL, 2001). A second natural attenuation assessment was performed in 2009 and is documented in the NAAR (CH2M HILL, 2010). The main objective of MNA is migration control.

D.4.1.2 Interim Remedy Description

GET is the IRA in the portion of the WIOU plume where VOC concentrations exceed 100 $\mu\text{g/L}$. The GET system was started up in February 2000 but is currently offline for a rebound study over the remainder of the period of interim remediation. The GET system has been offline since April 28, 2010.

There are 19 extraction wells in the WIOU and adjacent WABOU Site SD043. Thirteen of these wells are dual phase extraction (DPE) wells. WIOU extraction well EW542x41 was decommissioned in January 2004 because of the expansion of Building 906 (URS Group, Inc., 2004). Soil vapor extracted from the DPE wells was treated at the WTTP via VGAC. During operation of the GET system, groundwater from all WIOU and WABOU extraction wells was pumped through the WTTP before being conveyed to the CGWTP, located at Site SS016.

GET and DPE were effective at achieving source control in the WIOU. Areas where VOC contamination exceeds 1,000 $\mu\text{g/L}$ have been greatly reduced in size over the years of operation (2000-2010). However, as described above, after 10 years of operation two hot spots remained in the WIOU where VOC contamination exceeded 1,000 $\mu\text{g/L}$: one at Site SD036 and one (1) at Site SD037. In 4Q10, these two (2) hot spots underwent RPO consisting of EVO injection. The objective of this optimization is to actively treat the two (2) contaminant source areas and then rely on natural attenuation processes in the distal portion of the plume (enhanced attenuation).

The IRA for the distal portion of the WIOU plume (MNA assessment) is continued groundwater monitoring through the GSAP.

Floating product (Stoddard solvent) is present at Site SD034. The GET remedy at this site is supplemented by floating product removal using hydroskimmers. From 1998 through 2Q11, approximately 44.4 gallons of floating product were removed from the site. Passive hydroskimmers are currently installed in wells EW01x34, MW02x34, MW811x34, MWSSAx34, and MWSSBx34. In the most recent survey (2Q11), measurable product was detected at wells MWSSBx34 (0.44 foot) and MW811x34 (0.04 foot). Travis AFB will continue to address floating product as it occurs using passive skimmers.

D.4.2 Interim Remedy Evaluation

D.4.2.1 EVO Injection Evaluation

The quarterly RPO performance monitoring indicates that the EVO injections in both the Site SD036 and Site SD037 areas have resulted in ERD. TCE concentrations have decreased significantly (one to two orders of magnitude) in target wells. Cis-1,2-DCE concentrations have increased in the treatment zone. Vinyl chloride is also being formed within the treatment zone. The presence of ethane and ethene within the treatment zone indicates that complete dechlorination of the cis-1,2-DCE and vinyl chloride is occurring. Consistent detections of vinyl chloride concentrations exceeding the IRG (0.5 $\mu\text{g/L}$) are restricted to the EVO injection areas; vinyl chloride is not migrating away from the EVO injection areas.

The dissolved TOC supply in both of the hot spot injection areas remains high and is sustaining a rapid rate of ERD. Geochemical data collected from both of the hot spot areas support ERD. However, it is also apparent that sulfate levels in excess of 200 (mg/L) are present in the WIOU, and sulfate reduction will be competing with TCE reduction. A continuing influx of sulfate will deplete the TOC supply and eventually slow TCE and 1,2-DCE removal.

Monitoring data collected to date indicate that the EVO injections are performing as designed.

D.4.2.2 Rebound and MNA Evaluation

The GET system was shut down in 2Q10 to facilitate the EVO injections and support a rebound study. Outside of the two EVO injection areas, the WIOU plume is being monitored for rebound.

TCE and other COC concentrations continued to decline or were stable in most of the extraction wells, plume wells, and downgradient monitoring wells sampled over the reporting period. No rebound was evident in the plume, although by 2Q11 the GET system had been shut down for 1 year. The stable and decreasing COC concentration trends indicate that the attenuation capacity of the aquifer exceeds the mass loading from residual contamination in the Site SD036 and SD037 source areas. No VOCs were detected at concentrations exceeding IRGs in the downgradient wells during the reporting period. On the basis of the data collected to date, MNA is a viable remedy for the distal portion of the WIOU plume. The monitoring network includes both shallow and deep monitoring wells; MNA appears to be effective throughout the entire thickness of the plume.

D.4.3 Optimization Measures

- Floating product was detected at Site SD034 in 2Q11. Passive skimming devices will continue to be used at this site to address the accumulated product.
- In 2010, EVO injections were performed in the two hot spots at Sites SD036 and SD037 where VOC concentrations continued to exceed 1,000 µg/L. Performance monitoring for this RPO is ongoing and will be performed by the GSAP beginning in 2Q12.
- No rebound was evident in the WIOU plume during the year the GET system was offline; therefore the rebound study will continue and the WIOU extraction wells will remain offline. The WIOU extraction wells will be sampled semiannually in 2011-2012 to monitor for rebound.

D.5 West IRA Area—Site SS015 (Solvent Spill Area and Facilities 550 and 552)

D.5.1 Site Description

Site SS015 occupies 3.5 acres in the central portion of Travis AFB. Three potential sources of groundwater contamination have been identified at Site SS015: former Facility 550, former Facility 552 (including the area at Facility 1832), and the Solvent Spill Area (SSA) east of Facility 550. Of these, the primary source area is currently considered to be the SSA.

The SSA occupied 1.4 acres east of Facility 550. Paint was stripped from aircraft in the area for an undocumented period of time. Accidental releases included an estimated 100 to 150 gallons per month of methyl ethyl ketone, toluene, or tetraethylene glycol dimethyl ether from work trays used to collect stripping wastes. Soil is visibly stained in the SSA in aerial photographs taken before 1970 (Roy F. Weston, 1995).

Former Facility 550 was south of Hangar Avenue. Beginning in 1952, the facility housed a corrosion control shop, metals processing shop, and fiberglass shop. Paints, paint thinners, methyl ethyl ketone, acids, and stripping wastes were used or generated at the facility. A floor drain connected to the sanitary sewer was used to discharge wastes from the corrosion control shop.

Former Facility 552 was a fenced, bermed concrete pad located south of Hangar Avenue and immediately east of Facility 550. Historically, the facility was used as a hazardous waste collection area. Paint, chromic acid, and waste solvents generated during aircraft maintenance activities at Facility 550 were stored in Facility 552. From 1954 to 1980, radomes were stripped of paint in an area adjacent to Facility 552. The associated Facility 1832 is a 15,000-gallon OWS that received liquids generated at a wash rack on the aircraft parking apron. In 1992, a new hazardous waste accumulation facility was constructed at the site.

In 2004, Facilities 550 and 552 were demolished to construct a petroleum, oil, and lubricants (POL) military compound consisting of an office building, a fuel truck maintenance facility, and a large concrete truck parking area. The POL building (Building 554) was constructed with a vapor barrier and passive vent system to protect the building from potential vapor intrusion from the underlying groundwater plume.

D.5.1.1 Interim Remedial Action Objective

Site SS015 was selected for MNA assessment in the NEWIOU Groundwater IROD. The main objective of MNA assessment is to determine whether the groundwater plume is migrating, stable, or decreasing in size.

D.5.1.2 Interim Remedy Description

The initial Site SS015 MNA assessment was delayed because after MNA assessment was selected as the IRA, the site was subsequently selected for a treatability study of enhanced MNA using vegetable oil injection. A limited treatability study was conducted at the site during 2000-2001, during which approximately 227 pounds of soybean oil was injected at the site in two phases (June and December 2000). The treatability study was terminated early because of a military construction project at the site. Building 554 was constructed over a portion of the vegetable oil injection area. Although the vegetable oil injection treatability study was concluded prematurely, the initial results were promising and demonstrated that suitable bacterial populations were present and reductive dechlorination was occurring at the site.

In 2009, a natural attenuation assessment was performed for Site SS015, which is documented in the

NAAR (CH2M HILL, 2010). The NAAR concluded that MNA alone may not be a sufficient remedy at the site because of recent increasing contaminant trends in some monitoring wells. Consequently, RPO was performed in 2010 and 2011 at Site SS015. In December 2010 and January 2011, EVO was injected within the Site SS015 source area. The objective of this optimization is to actively treat the contaminant source area and then rely on natural attenuation processes in the distal portion of the plume (enhanced attenuation).

D.5.2 Interim Remedy Evaluation

The source area EVO injection has resulted in a significant decline (one to two orders of magnitude) in CVOC concentrations in the source area. TCE, cis-1,2-DCE, and vinyl chloride concentrations all declined. The decline in vinyl chloride concentrations and the detections of ethane and ethene in the source area indicate that vinyl chloride is being completely destroyed. Along with CVOC concentration trends, elevated TOC concentrations and geochemical parameters all support the conclusion that ERD is occurring in the EVO injection area.

In 2Q11, TCE concentrations in the source area wells declined to below 100 µg/L. Elevated cis-1,2-DCE concentrations (exceeding 100 µg/L) and vinyl chloride (exceeding 10 µg/L) are restricted to the immediate vicinity of the EVO injection.

The effects of the EVO injection are not yet expected to be observed in the distal portion of the plume. CVOC concentrations have been declining in some of the distal plume wells (MW2103x15 and MW2124x15); however, the declines began prior to the EVO injection. One (1) well, MW625x15, has recently had a trend of increasing COC concentrations. COC concentrations are expected to decline in this well following treatment of the source area.

Monitoring data collected to date indicate that the EVO injection is performing as designed. Enhanced attenuation appears to be a viable remedy for Site SS015.

D.5.3 Optimization Measures

In December 2010 and January 2011 EVO injection was performed in the Site SS015 hot spot where CVOC concentrations exceeded 1,000 µg/L. Performance monitoring for this RPO is ongoing.

While petroleum fuel constituents are not COCs at Site SS015, TPH as gasoline and diesel (TPH-G and TPH-D, respectively), benzene, and MTBE were detected at concentrations exceeding IRGs over the reporting period. The source(s) of the fuel constituents are unknown. Therefore, Site SS015 monitoring wells will be sampled in 2Q12 for TPH, to provide additional data on these constituents at the site.

Groundwater Sites and Contamination

This appendix provides additional information to support the evaluations of the performance of groundwater extraction and treatment (GET) systems and monitored natural attenuation (MNA) assessments, and remedial process optimization measures presented Section 7.0 of the Third Five-Year Review Report. The statements and conclusions provided in this appendix regarding statistically significant decreases or increases in well contaminant concentrations are based on the Mann-Kendall trend analyses provided in the 2010-2011 Groundwater Sampling and Analysis Program (GSAP) report for Travis Air Force Base (AFB or Base). More expansive discussions of the groundwater interim remedial actions (IRA) and groundwater contaminant conditions are also provided in the GSAP report. The GSAP also includes figures with detailed information on monitoring well locations and the distribution of groundwater contamination.

D.1 North IRA Area—Sites FT004, SD031, and LF007

Site Descriptions

Sites FT004, SD031, and LF007 are described in this section. These sites are combined in this section because of their proximity and shared IRA (a combination of GET and MNA). The groundwater extracted from these sites had been treated at the North Groundwater Treatment Plant (NGWTP). However, the GET systems at Sites FT004 and SD031 have been shut down since March 2009 for rebound studies. In December 2009, the NGWTP was reconfigured to be able to treat extracted groundwater from only the Area LF007C solar-powered extraction wells with granular activated carbon (GAC). Three GAC vessels plumbed in series are used in the treatment train. All of the energy needed to process the groundwater through the GAC vessels is provided by the solar-powered extraction wells.

Site FT004 covers approximately 30 acres in the northeastern portion of the East Industrial Operable Unit (EIOU) and is the former Fire Training Area No. 3 (FTA-3). The site was used for fire training exercises from 1953 to 1962. During these exercises, waste fuel, oils, and solvents were dumped onto frames or onto the ground and burned. Soil staining and stressed vegetation were observed during historical field investigations. The site is currently an unused, open field.

Site SD031, west of Site FT004, covers approximately 5.5 acres and encompasses Facility 1205 in the northeastern part of the EIOU. Facility 1205 was constructed in 1957, and operations included the maintenance and repair of diesel-powered generators. Wastes generated at the facility include oils, antifreeze, and solvents. A wash rack, just south of the facility, is still used to clean diesel engine parts; it discharges to an oil/water separator (OWS). Accidental releases in the vicinity of this wash rack appear to be the source of groundwater contamination in the area. Since the discovery of the releases, proper material handling and process controls were implemented to prevent additional releases. Historical aerial photographs taken from 1958 to 1963 indicate that Facility 1205 may have been used as an aircraft maintenance hangar during that time.

Site LF007 is former Landfill 2 in the NOU; it encompasses approximately 73 acres. The landfill was operated using trench-and-cover methods beginning in the early 1950s, following the closure of Landfill 1 (Site LF006). The landfill was used primarily for the disposal of general refuse, such as wood, glass, and construction debris. Small amounts of industrial wastes and fuel sludge from tank-cleaning operations

also were reported to have been disposed of at Landfill 2. Use of Landfill 2 ceased in 1974. From the early 1950s until 1964, a portion of the eastern part of the landfill was used by the Defense Reutilization and Marketing Office to store excess waste materials, including oils, hydraulic fluid, and solvents, for resale or disposal. As determined by aerial photographs, a skeet range also was located at the site around 1953; however, the exact dates of operation are not known.

In addition to the Base Corrective Action Management Unit (CAMU), current Site LF007 operations include the operations at the Affiliate Radio System, the permitted hazardous waste storage facility, and a small arms range. Several large vernal pools are within the site boundaries; some extend north across the Base boundary. The land north of Site LF007, beyond the Base boundary, is privately owned and used for pasture. Until 2002, extensive seasonal ponding occurred in the eastern-central portion of the site because of the subsidence of the soil cover overlying the former landfill trenches. The elimination of the depressions caused by settling reduced seasonal surface water ponding at the landfill. A groundwater interceptor trench was constructed upgradient (relative to groundwater movement across the site) from the CAMU to physically capture groundwater and maintain a minimum of 5 feet of separation between contaminated soil in the CAMU and groundwater. Collected groundwater is conveyed around the CAMU and discharged into an infiltration pit downgradient from the CAMU. During the NOU RI, Site LF007 was divided into three (3) study areas designated as Areas LF007B, LF007C, and LF007D.

D.1.1 Interim Remedial Action Objectives (IRAO)

Sites FT004/SD031. The North, East, and West Industrial Operable Unit (NEWIOU) Groundwater IROD selected GET as the IRA to address groundwater contamination at Sites FT004/SD031. The IRAO at Sites FT004/SD031 is source control of chlorinated solvents, including hydraulic containment and mass removal. The source control target areas were defined initially as those areas where VOC contamination is present at concentrations greater than 1,000 µg/L. However, the Air Force designed the GET system to extract and treat groundwater with VOC concentrations greater than 100 µg/L.

An IRA was not specifically identified in the IROD to remedy groundwater contamination beyond the source control target area. However, the Air Force recognized the need to conduct monitoring and evaluate natural attenuation to address contamination not captured by the extraction and treatment system in the southern portions of the plumes at Sites FT004 and SD031. Therefore, the Air Force has performed an MNA assessment during the interim period in the portions of the plumes downgradient from the 100-µg/L isopleths. Sites FT004 and SD031 underwent a combined initial MNA evaluation in 2000-2001, as specified in the *Natural Attenuation Assessment Workplan (NAAW)* (CH2M HILL, 1998) and documented in the *FT004/SD031 Natural Attenuation Assessment Workplan* (CH2M HILL, 2001). A second MNA evaluation was performed in 2009 and is documented in the *Natural Attenuation Assessment Report (NAAR)* (CH2M HILL, 2010). The main IRAO of MNA at Sites FT004/SD031 is migration control.

Site LF007. The NEWIOU Groundwater IROD selected GET to address groundwater contamination in the off-base portion of Area LF007C. The IRAO for the off-base portion of Area LF007C is migration control (preventing further off-base contaminant migration) and remediation of off-base groundwater contamination above the trichloroethylene (TCE) interim remediation goal (IRG) (5 µg/L).

Areas LF007B and LF007D were selected for MNA assessment during the interim period. Areas LF007B and LF007D underwent an initial MNA evaluation in 1997-1999, as specified in the NAAW (CH2M HILL, 1998) and documented in the *Natural Attenuation Assessment Workplan for LF007* (Radian, 1999). A second MNA evaluation was performed in 2009 and is documented in the NAAR (CH2M HILL, 2010). The main IRAO of MNA is migration control.

D.1.1.1 Interim Remedy Description

The Site FT004/SD031 GET began operation in 2000. The Area LF007C GET began operation in August 2004. Eight extraction wells exist at Site FT004 (EW576x04, EW577x04, EW578x04, MW579x04, EW580x04, EW621x04, EW622x04, and EW623x04); three extraction wells exist at Site SD031 (EW565x31, EW566x31, and EW567x31); and two extraction wells exist at Site LF007 (EW614x07 and EW615x07).

All Site FT004 and SD031 extraction wells are currently offline for a rebound study. All of the Site SD031 extraction wells and the selected Site FT004 extraction wells EW578x04, EW579x04, and EW580x04 were shut down in December 2007 for a 1-year rebound study. The results of the study were reported in the *2008 Annual Remedial Process Optimization Report for the Central Groundwater Treatment Plant, North Groundwater Treatment Plant, and South Base Boundary Groundwater Treatment Plant* (2008 RPO Report) (CH2M HILL, 2009). No significant rebound was observed over the 1-year period. Therefore, it was determined that the rebound study would continue during the interim period. In addition, the Site FT004 extraction wells that had continued to pump during the 1-year rebound study performed in 2007 and 2008 (EW576x04, EW577x04, EW621x04, EW622x04, and EW623x04) were also shut down (in March 2009) for ongoing rebound evaluation.

Groundwater extraction at Area LF007C occurs only during the dry season, when the vernal pools are dry in Area LF007C, to avoid impacts on the vernal pool habitat. Groundwater extraction typically occurs at this site from June through October. The Area LF007C extraction system was offline because of standing water conditions in the vernal pools from December 2010 through May 2011 and was brought back online in June 2011. However, only one extraction well, EW615x07, was operational. The pump for well EW614x07 had failed and was replaced in August 2011. EW614x07 was then back online.

Groundwater extracted from Sites FT004/SD031/LF007 had been treated at the NGWTP. Because groundwater extraction has ceased at Sites FT004 and SD031 and is seasonal at Area LF007C, the NGWTP has been reconfigured with three liquid GAC vessels in series to make treatment of the small volume of water generated from Area LF007C more cost effective and sustainable.

The IRA at Areas LF007B and LF007D and the downgradient portions of Sites FT004 and SD031 (MNA) consists of continued groundwater monitoring to assess whether migration control is being achieved via MNA.

D.1.2 Interim Remedy Evaluation

D.1.2.1 Capture Evaluation

Area LF007C. Only the Area LF007C GET system was operational during the reporting period. The Area LF007C GET system IRAO is migration control at the Base boundary and off-base remediation. The two Area LF007C extraction wells, EW614x07 and EW615x07, were brought online in August 2004. However, these wells are in a vernal pool area; therefore, they only operate in the summer. Only one extraction well (EW615x07) was operational during the 2Q11 groundwater elevation survey. The influence of groundwater extraction from this well is not evident on the groundwater elevation contours; therefore, no hydraulic capture was estimated based on the groundwater elevation data. Available groundwater elevation data indicate variable groundwater flow directions at the Base boundary, and the extent to which hydraulic capture is achieved is uncertain. Based on GSAP data collected through 2Q11, the following conclusions are made:

- TCE has migrated off-base at Area LF007C at concentrations above the IRG. The extent of this off-base contamination is unclear.
- Based on available groundwater elevation data and analytical data, the effectiveness of the Area LF007C GET is uncertain. However, TCE concentrations have long-term declining trends in two of

the three Area LF007C plume wells (MW125x07 and MW617x07). TCE concentrations have also recently declined in off-base monitoring well MW620x07. The maximum TCE concentration detected at the site in 2Q11 was 10.3 µg/L. Historically, the maximum TCE concentration detected at the site was 87 µg/L at well MW125x07, located on the Base boundary.

Additional investigation in the off-base area is planned for 4Q11. The results of the characterization indicated that the TCE groundwater plume extends approximately 200 feet off-base. Vertically, the TCE plume extends from the water table to the alluvium-bedrock boundary. TCE contamination does not extend into the bedrock as generally the bedrock was dry and did not contain groundwater when encountered during drilling. The TCE plume appears to be migrating to the north-northwest, crossgradient to the local groundwater flow direction; it is likely that the flow direction of the Site LF007C TCE plume is being controlled by the bedrock depression at Site LF007C. Based on the data collected during the investigation, updated groundwater modeling was used to prepare a plan to optimize the existing GET system. GET system optimization consists of modifying existing extraction wells to pump at higher rates and/or adding a new extraction well in the southern portion of the site. Implementation of the optimization plan for site LF007C is planned for 2013.

D.1.2.2 Rebound and MNA Evaluation

Sites FT004 and SD031. The GET system at Sites FT004 and SD031 has been shut down for a rebound study. The attenuation capacity of the aquifer is being evaluated while the GET system is offline. The source control objective (capture of VOC concentrations greater than 100 µg/L) had been achieved at Site SD031 prior to the start of the rebound study. Since the SD031 GET system was taken offline, VOC concentrations within Site SD031 have remained below 100 µg/L.

At Site FT004, VOC concentrations in a small portion of the plume (near monitoring wells MW131x04, MW266x04, and MW585x04) remain above 100 µg/L. However, no significant rebound was observed over the reporting period. In fact, VOC concentrations continued to decline in most Site FT004 extraction wells and monitoring wells, indicating that the attenuation capacity of the aquifer exceeds the mass loading from residual contamination in the source area. Only two Site FT004 monitoring wells have statistically significant increasing TCE concentration trends: MW134x04 and MW591x04. These wells are located in the downgradient portion of the plume. The increasing trend at MW134x04 is slight; the maximum TCE concentration detected is 2.4 µg/L (below the IRG). The TCE concentrations detected at MW591x04 over the reporting period are below the maximum concentration detected (14.4 µg/L).

On the basis of the data collected to date, MNA is a viable remedy for the residual groundwater contamination Sites FT004 and SD031. Overall, contaminants of concern (COC) concentrations are stable or declining in the Site FT004 and SD031 wells. No VOCs were detected at concentrations exceeding IRGs in the downgradient wells during the reporting period. The monitoring network includes both shallow and deep monitoring wells; MNA appears to be effective throughout the entire thickness of the plume.

Area LF007B and LF007D. Areas LF007B and LF007D at Site LF007 were selected for MNA assessment over the interim period. No Area LF007B COCs were detected in Area LF007B wells sampled during the reporting period. Sample results indicate that MNA is an appropriate remedy for Area LF007B. Groundwater contamination at Area LF007D is restricted to a small area in the vicinity of MW261x04, the only location at which Area LF007D COCs were detected. No Area LF007D COCs migrated off-base to the north or east of Area LF007D; therefore, MNA continues to be an effective remedy for Area LF007D.

D.1.3 Optimization Measures

- Groundwater extraction wells at Sites FT004 and SD031 are shut down for a rebound study during the remainder of the interim period. Groundwater extraction will continue during the dry season at Area LF007C.
- TCE concentrations in MW620x07 are above the IRG, and the downgradient extent of off-base contamination has not been defined. In 4Q11, additional investigation will be performed, weather permitting, to define the extent of off-base contamination and further evaluate the effectiveness of the current Area LF007C GET. Based on the results of the investigation and evaluation of the IRA, modifications of the current extraction system may be implemented.

D.2 South IRA Area—Sites FT005, SS029, and SS030

D.2.1 Site Descriptions

Site FT005 (former FTA-4) is located in the southeastern portion of Travis AFB. The site encompasses an area of soil and groundwater contamination at former FTA-4. Soil contamination is generally limited to FTA-4; however, groundwater contamination has migrated off-base. 1,2-DCA is the indicator chemical for Site FT005. Concentrations of 1,2-DCA are relatively low; however, they exceed the IRG of 0.5 µg/L at some locations.

Contamination at Site FT005 is the result of fire training exercises conducted between 1962 and approximately 1986. Historical photographs indicate that the area may have been used for munitions storage prior to 1958. From 1962 until the early 1970s, waste fuels, oils, and solvents were used as ignitable materials during fire training exercises. In the early 1970s, the use of oil and solvent was discontinued, and only contaminated fuel was used in the training. As late as 1988, airplane mockups and an airplane fuselage were observed at the site. From 1990 to 1994, the area was used as a dump site for miscellaneous wastes, such as concrete, fencing, and street sweepings. These activities ceased in 1994, and some of the debris was removed. The site is currently inactive.

Site SS029 (former MW329x29 Area) also is located in the southeastern portion of Travis AFB, south of the runway and west of Site FT005. Site SS029 is an open field south of Taxiway R. Site topography is relatively flat and slopes gently from the north-northwest to the south-southeast. Union Creek traverses the middle of the site and flows from northeast to southwest.

Groundwater contamination at Site SS029 has been defined primarily as a TCE and cis-1,2-dichloroethylene (cis-1,2-DCE) plume that lies within the boundaries of Travis AFB. The source of groundwater VOC contamination at Site SS029 is unknown. Historical photographs indicate that airplanes had been parked in the vicinity of MW329x29, but little is known about historical activities at the site. Site SS029 was investigated initially during a remedial investigation (EIOU RI) to assess the downgradient extent of groundwater contamination originating at Site SS016 (upgradient). The data from this investigation and subsequent investigations indicated a discrete groundwater plume and source area. However, these investigations did not identify the specific source of the groundwater contamination (Roy F. Weston, 1995). Subsequent investigations have confirmed that groundwater contamination originating from Site SS016 has migrated to the northern edge of Site SS029.

Site SS030 (former MW-269 Area) is south of Facility 1125 (a radar facility) and southwest of Site SS029, in the southeastern portion of Travis AFB. The Site SS030 boundary encompasses an area of groundwater contamination (primarily TCE) that migrated off-base. MW269x30 was installed originally during the EIOU RI to evaluate groundwater quality along the southeastern Base boundary. No known historical activities indicated that groundwater contamination would be detected. However, the EIOU RI and subsequent investigations revealed that the groundwater was contaminated with TCE. Historical activities associated with Building 1125 in the vicinity of MW269x30 are believed to be the source of the solvent contamination at Site SS030.

D.2.1.1 Interim Remedial Action Objectives

The NEWIOU Groundwater IROD (Travis AFB, 1997) selected GET to address groundwater contamination at Sites FT005, SS029, and SS030. Migration control is the primary IRAO for the on-base portions of the plumes at Sites FT005, SS029, and SS030. Groundwater remediation is the primary IRAO for the off-base portions of the plumes at Sites FT005 and SS030. Source control is also an IRAO for Site SS030.

D.2.1.2 Interim Remedy Description

The South Base Boundary Groundwater Treatment Plant (SBBGWTP) is designed to extract and treat groundwater from Sites SS030, FT005, and SS029 in the NEWIOU at Travis AFB. The extraction system consists of six on-base extraction wells and nine off-base extraction wells at Site FT005, seven on-base extraction wells at Site SS029, and six off-base extraction wells and a 200-foot on-base interceptor trench (EW06x30) at Site SS030.

Over the reporting period, the following extraction wells were offline:

- **Site FT005.** Extraction wells EW01x05, EW03x05, EW731x05, EW732x05, EW733x05, EW736x05, EW737x05, EW742x05, EW743x05, EW744x05, EW745x05, and EW746x05 were offline to support an ongoing rebound study that had been initiated in December 2007 because 1,2-DCA concentrations had declined below the IRG at most monitoring and extraction wells.
- **Site FT005.** Extraction wells EW734x05 and EW735x05 were initially offline as part of the rebound study. However, 1,2-dichloroethane (1,2-DCA) concentrations at the toe of the plume, where these extraction wells are located, increased above the IRG in 2Q10, and they were brought back online in 2010, along with extraction well EW02x05, located along the Base boundary. All three extraction wells were operational for most of the reporting period; however, wells EW734x05 and EW735x05 were only intermittently operational in June and July 2011 because of an inoperable water level transducer and pump, respectively. Thus, wells EW734x05 and EW735x05 were not online during the groundwater elevation survey. The wells were repaired and brought back online in 4Q11.
- **Site SS029.** Extraction well EW03x29 had been taken offline because of low VOC concentrations and was offline over the reporting period. However, VOC concentrations have been increasing at this well, and it was determined that the well should be brought back online. The pump and controls were in need of repair. The repairs were completed and the pump was brought back online in 4Q11.

After extraction, contaminated groundwater is conveyed to the SBBGWTP. The SBBGWTP treats and discharges approximately 80 gallons per minute (gpm) of groundwater to Union Creek. Since July 1998 (system startup), approximately 406 pounds of VOC mass have been removed by the SBBGWTP. From July 1998 through August 2011, a total of 748 million gallons of groundwater had been treated by the SBBGWTP.

D.2.2 Interim Remedy Evaluation

D.2.2.1 Capture Evaluation

Site SS029. The primary IRAO for the Site SS029 plume is migration control. The Site SS029 IRAO has been achieved. The target area (TCE exceeding 5 µg/L) is within the 2Q11 estimated extent of hydraulic capture. TCE was not detected in the farthest downgradient monitoring wells (MW01x29, MW06x29, and MW07x29) near the Base boundary.

Upgradient Site SS029 wells MW1031x29 and MW1032x29 have exhibited recent trends of increasing COC concentrations. Both of these wells are upgradient from the Site SS029 extraction system, and increasing concentrations at these locations are the result of VOC migration from the upgradient Site SS016 plume. Available physical and analytical data indicate that the Site SS029 GET is capturing the VOC contamination that has migrated from Site SS016.

Site SS030. The on-base IRAO for the Site SS030 plume is migration control. The IRAO for the off-base component of the Site SS030 plume is groundwater remediation to the IRG. The migration control IRAO has been achieved. Groundwater monitoring wells with TCE concentrations exceeding the IRG are within the estimated 2Q11 extent of hydraulic capture. The remedial objective of off-base groundwater remediation is ongoing. The southern and western sides of the Site SS030 plume have been remediated,

and VOCs are no longer detected in these areas. TCE remains above the IRG only in the eastern portion of the off-base plume.

Historically, groundwater elevation contours and the increasing contaminant trends at eastern plume wells MW03x30 and MW05x30 have indicated that contamination may be escaping the Site SS030 GET in this area and flowing toward the southeast, influenced by the Site FT005 extraction system. However, the 2Q11 groundwater elevation contours indicate that the shutdown of most of the Site FT005 extraction wells improved the Site SS030 system capture. Groundwater elevation contours indicate that wells MW03x30 and MW05x30 as well as new well pair MW2001Ax30 and MW2001Bx30 are within the extent of hydraulic capture of the SS030 GET. In addition, TCE concentrations in the eastern portion of the plume have remained stable (MW03x30) or declined (MW05x30) over the last few years, indicating that the plume is no longer migrating eastward. Although the monitoring history is short at easternmost well pair MW2001Ax30/MW2001Bx30, TCE concentrations declined slightly at these wells between 2Q10 and 2Q11. Ongoing monitoring is needed to determine long-term concentration trends at this well pair. It is expected that TCE concentrations in this well pair will continue to decline if plume capture is achieved.

In August 2010, three Site FT005 extraction wells were brought back online because of a rebound in 1,2-DCA concentrations. Because groundwater extraction at Site FT005 affects the hydraulic capture at Site SS030, Site SS030 groundwater flow directions and VOC concentrations will continue to be closely monitored for evidence of reduced hydraulic capture. No reduction in hydraulic capture was evident over the reporting period.

D.2.2.2 Rebound Evaluation

Site FT005. Because the IRAO of groundwater remediation has nearly been achieved for Site FT005, a rebound study, which began in December 2007, is under way at the site. Over the reporting period all but three Site FT005 extraction wells (EW02x05, EW734x05 and EW735x05) were offline. EW02x05, EW734x05, and EW735x05 were brought back online in August 2010 because some rebound in 1,2-DCA concentrations had been evident in these extraction wells in 2Q10. With the exception of these extraction wells, the Site FT005 monitoring wells and extraction wells continued to have decreasing or stable 1,2-DCA concentrations through the rebound study period. Over the reporting period, 1,2-DCA concentrations also declined in the active extraction wells. In 2Q11, 1,2-DCA was only detected at three (3) wells in Site FT005: on-base monitoring well MW119x05, on-base extraction well EW733x05, and off-base monitoring well MW766x05.

D.2.3 Optimization Measures

- Groundwater extraction at Site FT005 is reaching its limit of effectiveness; concentrations of 1,2-DCA remain below the IRG in most monitoring and extraction wells. Because the Site FT005 extraction system reduces the extent of capture of the adjacent Site SS030 GET and it is not cost effective to extract clean groundwater, only extraction wells located in portions of Site FT005 where 1,2-DCA concentrations recently exceeded the IRG are currently operating. Limited groundwater extraction will continue in portions of Site FT005 where 1,2-DCA concentrations have recently exceeded the IRG. Therefore, extraction well EW02x05, along the Base boundary, and extraction wells EW734x05 and EW735x05 will continue to operate. If 1,2-DCA concentrations remain below the IRG through 2012, these wells will again be considered for shut down.
- The TCE concentration detected in Site SS029 extraction well EW03x29, which had been taken offline because of low VOC concentrations, continues to exceed the IRG. This extraction well was brought back online in 4Q11.
- Because groundwater contamination beyond the hydraulic control of the Site SS016 IRA is migrating to Site SS029, groundwater remediation at Site SS029 will likely continue after Sites FT005 and

SS030 have reached cleanup goals. The Site SS029 IRA is being evaluated under a separate project for potential optimizations with the goal of increased sustainability.

- The extent of capture of the Site SS030 GET has been improved by bringing all of the extraction wells online and shutting down most of the Site FT005 extraction wells. The 2Q11 groundwater elevation contours indicate that the eastern portion of the plume is within the extent of hydraulic capture. Therefore, all the Site SS030 extraction wells will continue to operate and only limited groundwater extraction will be performed at Site FT005.

D.3 Central IRA Area—Site SS016

D.3.1 Site Description

Site SS016 covers approximately 210 acres near the Base Control Tower and runway. TCE is the primary groundwater contaminant at Site SS016. The following potential sources of groundwater contamination have been identified at Site SS016:

- Oil Spill Area (OSA) in the vicinity of Building 18 (a former degreasing facility)
- Facility 11 (flightline support equipment repair)
- Facilities 13/14 (former wash rack)
- Facility 20 (Base Control Tower, underground storage tank [UST])
- Facilities 42/1941 (fuel and waste oil storage, aboveground storage tank [AST], wash rack)
- Facilities 139/144 (vehicle maintenance, UST)
- Storm sewers in the Storm Sewer Right-of-Way

The results of a 2009-2010 Site SS016 source area investigation indicated that the OSA is the primary source of VOC groundwater contamination at Site SS016. The OSA is located in the northwestern portion of Site SS016 and is associated with Building 18. Building 18 and the associated former wash rack located to the south of the building were constructed in 1960 as a degreasing facility for Travis AFB. The former wash rack was used to degrease jet engines, and liquid wastes from Building 18 were also conveyed by a pipeline to the former wash rack catch basin. Historical degreasing operations were conducted in Building 18 and at the adjacent wash rack from 1960 through the 1990s.

The northern portion of Building 18 was the tank room where numerous tanks containing chemicals used in the degreasing process were located on a sub-grade floor. At the northern end of the sub-grade floor was a collection sump that was connected to a 28,000-gallon steel-reinforced concrete UST. The 28,000-gallon UST was located adjacent to the northwestern portion of Building 18 and was divided in half by an interior baffle. The eastern half of the UST was used as a retention tank, and the western half was used as an oil water separator (OWS). The OWS was removed in 1997, and the UST was removed from the building and disposed of in January 1998.

The southern portion of Building 18 was historically used as part of the degreasing process and contained tanks and spray booths. This area was later remodeled to house a laboratory, a bead blaster and oven room, and multiple offices.

Historically, wastes from Building 18 have been disposed of by different means. From approximately 1960 to 1968, wastes were disposed of through a north-south pipeline that extended from tanks in Building 18 to a catch basin underlying the adjacent wash rack and subsequently to the storm drain. From 1968 through 1998, wastes were disposed of through the OWS or by contracted disposal services. Some wastes may also have been sent to an on-base fire training facility.

Degreasing operations are no longer conducted at Building 18 or the associated wash rack. The northern portion of Building 18 is currently used as a storage facility; the southern portion is not currently in use. During installation of an in situ bioreactor in September 2010, the wash rack canopy, concrete pad, and catch basin were removed. When the catch basin was removed it was noted that the connector pipe between the catch basin and the stormwater drainage pipe was constructed of vitrified clay and had been slip lined, possibly to repair a break in the clay pipe. The source of the TCE release at the OSA is believed to be a break in the storm sewer drainage line immediately downgradient of the catch basin.

D.3.1.1 Interim Remedial Action Objectives

The NEWIOU Groundwater IROD (Travis AFB, 1997) selected GET to address groundwater contamination at Site SS016. The IRAO at Site SS016 is source control in the vicinity of the Base Control

Tower, the Tower Area Removal Action (TARA), and the OSA. The NEWIOU Groundwater IROD states that achieving source control requires the removal of groundwater with VOC concentrations greater than 3,000 µg/L. However, the Site SS016 GET was designed to capture VOC concentrations greater than 1,000 µg/L.

D.3.1.2 Remedy Description

The current IRA at Site SS016 is GET. However, with dense non-aqueous phase liquid (DNAPL) likely present in the OSA source area, a different method of remediation had to be considered that would target the main source of the OSA contaminant plume. During 2010, the existing Site SS016 treatment systems (thermal oxidation [ThOx] system and Central Groundwater Treatment Plant [CGWTP]) were optimized by excavation of contaminated soil and installation of a solar-powered in situ bioreactor in the OSA. The excavation was performed to remove high concentrations of TCE-impacted soil from the OSA source area. The bioreactor was installed to enhance the breakdown of chlorinated VOCs (CVOCs) (primarily TCE and its daughter products) in the source area and hydraulically downgradient portions of the plume. Bioreactors create an anaerobic environment needed to reductively degrade and destroy VOCs in situ, eliminating the need for aboveground treatment and extending the treatment into the soil/aquifer matrix. After the source area (approximately 529 square feet [23 by 23 feet]) was excavated to a depth of 25 feet, it was backfilled with a 50/50 mixture of gravel and tree mulch sprayed with approximately 500 gallons of food-grade vegetable oil. Iron pyrite sands (45 percent iron and 50 percent sulfur by weight) were mixed into the first few loads of mulch and placed at the bottom of the bioreactor. The addition of iron sulfides promotes abiotic reduction of VOCs.

In addition to the OSA source area bioreactor, GET is currently performed in both the TARA and OSA. Two horizontal groundwater extraction wells (EW001x16 and EW002x16) are located in the TARA. The OSA has one horizontal extraction well (EW003x16), which runs through the source area, and two vertical extraction wells (EW605x16 and EW610x16) located southeast of the OSA source area within the aircraft parking ramp. Groundwater extracted from wells EW001x16, EW002x16, EW605x16, and EW610x16 is conveyed to the CGWTP and treated with GAC. Groundwater extracted from horizontal well EW003x16, which has been equipped with a solar-powered pump, is circulated through the OSA bioreactor. Wells EW605x16 and EW610x16 are capable of extracting soil vapor as well as groundwater; however, only groundwater was extracted during the reporting period.

The CGWTP receives groundwater from four of the Site SS016 extraction wells (EW001x16, EW002x16, EW605x16, and EW610x16) and 24 extraction wells in the WIOU and the WABOU. Groundwater from all WIOU and WABOU extraction wells is pumped through the West Treatment and Transfer Plant (WTTP) before being conveyed to the CGWTP. However, over the reporting period, rebound studies were taking place in the WIOU and WABOU and consequently no groundwater was extracted from these areas of the Base. Between April 1997 and April 2010, soil vapor, in addition to groundwater, was extracted from Site SS016 extraction wells (except for EW001x16 and EW002x16). Soil vapor has also historically been extracted from the WIOU extraction wells. Soil vapor collected at Site SS016 had been treated via ThOx at the ThOx Unit, which was taken offline in 2010. Soil vapor extracted from the WIOU is treated with vapor-phase granular activated carbon (VGAC) at the WTTP. However, in support of an ongoing rebound study in the WIOU, soil vapor extraction did not occur over the reporting period. A total of 448 million gallons of contaminated groundwater were treated at the CGWTP from January 1, 1996, through August 31, 2011. The cumulative VOC mass removed from groundwater and soil vapor since January 1996 is approximately 11,239 pounds.

D.3.2 Interim Remedy Evaluation

D.3.2.1 Capture Evaluation

The Site SS016 NEWIOU Groundwater IROD source control objective is capture of VOC concentrations greater than 3,000 µg/L, but the Site SS016 GET was designed to capture VOC concentrations greater

than 1,000 µg/L. VOC concentrations within the TARA have declined and are below 1,000 µg/L. Most of the monitoring wells within the TARA have statistically significant decreasing COC trends. Design capture has been achieved in the TARA.

After several years of operation, it was determined that GET in the OSA source area was not cost effective, and the IRA was optimized by the excavation of the source area and installation of a bioreactor. OSA extraction well EW003x16 is currently used to recirculate groundwater through the bioreactor rather than provide source control.

Downgradient of the bioreactor, GET continues to be used to control plume migration. TCE concentrations are declining in extraction wells EW605x16 and EW610x16 and most monitoring wells downgradient of the source area. No downgradient monitoring wells have increasing COC trends. The declining COC trends downgradient of the OSA source area indicate that the OSA GET system is achieving the IRAO of source control.

Although TCE concentrations are generally declining throughout Site SS016, increasing TCE concentrations at some upgradient Site SS029 monitoring wells indicate that the groundwater contamination has migrated beyond the Site SS016 boundaries to Site SS029. However, VOC contamination that escaped the Site SS016 extraction system is currently being captured by the Site SS029 GET and is treated at the SBBGWTP.

D.3.2.2 Bioreactor Evaluation

Based on the first two quarters of performance data, the bioreactor is performing as designed. Geochemical data collected from the bioreactor are favorable for enhanced reductive dechlorination (ERD). ERD has resulted in high rates of TCE, DCE, and vinyl chloride removal. Based on the 2Q11 data, the bioreactor is removing over 99 percent of the TCE and nearly 93 percent of the total molar CVOCs entering the bioreactor. Significant levels of ethene in MW2020Ax16 also confirm that destruction of vinyl chloride is under way in the bioreactor. Vinyl chloride has not migrated away from the bioreactor.

D.3.3 Optimization Measures

- In September 2010, the OSA source area treatment was enhanced by installation of a bioreactor. During installation, most of the source area mass was removed. The remaining source area mass will continue to be treated in situ through enhanced biodegradation.

D.4 West IRA Area—WIOU

D.4.1 Site Descriptions

The WIOU includes Sites SS014, SD033, SD034, SS035, SD036, and SD037. Nearby WABOU sites include Sites SS041 and SD043. Because of their proximity and the similarity of site conditions and remedial solutions, all but one of these sites are combined for discussion in this section. Site SS014, a POCO site, is addressed separately because of its unique site conditions and contaminants.

The sites included in the West IRA Area—WIOU are within industrialized areas of the western-central portion of Travis AFB. The West Branch of Union Creek flows through the WIOU, generally north to south, with the slope of the topography. Numerous buildings, shops, offices, freight handling and storage areas, vehicle maintenance shops, and aircraft maintenance facilities are included in the WIOU. Activities at the two WABOU sites in the West IRA Area include pesticide mixing and handling, and electrical power generation.

Although the GET IRA has reduced TCE concentrations throughout the WIOU, two hot spots remain where TCE concentrations exceed 1,000 µg/L. One hot spot is located within Site SD036, and the other is located within the northern portion of Site SD037. Additional investigations at these two hot spots were performed in 2009-2010. Results of the investigation at Site SD036 indicated that the source of the TCE contamination at Site SD036 was release from one or more breaks in the two north-south trending sanitary sewer segments located in the center of the site. The distribution of TCE contamination in this area is consistent with a direct discharge to groundwater from a break or breaks in the sanitary sewer line. The TCE concentrations detected at this site during the investigation exceeded 10,000 µg/L, which may indicate the presence of residual pure-phase TCE contamination. However, DNAPL has not been directly observed at the site.

Results of the 2009-2010 investigation indicate that the source of the remaining hot spot at Site SD037 (where TCE concentrations continue to exceed 1,000 µg/L) is also a break in the sanitary sewer line. Historical records indicate that the east-west segment of the sanitary sewer line adjacent to well MW532x37 had been previously damaged and recommended for repair. The distribution of TCE in groundwater is consistent with a release from the east-west segment of sanitary sewer line near well MW532x37.

D.4.1.1 Interim Remedial Action Objectives

The NEWIOU Groundwater IROD (Travis AFB, 1997) and the WABOU Groundwater IROD (Travis AFB, 1999) selected GET to address groundwater contamination within the WIOU. Source control and migration control are the IRAOs for WIOU Sites SD033, SD034, SS035, SD036, and SD037 and WABOU Sites SS041 and SD043. Source control actions address areas of groundwater contamination where VOC concentrations are 1,000 µg/L and greater. Migration control actions address areas of groundwater contamination where VOC concentrations are between 100 and 1,000 µg/L to prevent contaminants from migrating into the less-contaminated MNA areas. To achieve the IRAOs, the WIOU GET system was designed to capture VOC concentrations exceeding 100 µg/L.

MNA assessment is the selected interim remedy for the southern portion of the WIOU, where VOC concentrations are less than 100 µg/L. The downgradient portion of the site underwent a natural attenuation assessment in 2000-2001, as documented in the *WIOU Natural Attenuation Assessment Workplan* (CH2M HILL, 2001). A second natural attenuation assessment was performed in 2009 and is documented in the NAAR (CH2M HILL, 2010). The main objective of MNA is migration control.

D.4.1.2 Interim Remedy Description

GET is the IRA in the portion of the WIOU plume where VOC concentrations exceed 100 µg/L. The GET system was started up in February 2000 but is currently offline for a rebound study over the remainder of the period of interim remediation. The GET system has been offline since April 28, 2010.

There are 19 extraction wells in the WIOU and adjacent WABOU Site SD043. Thirteen of these wells are dual phase extraction (DPE) wells. WIOU extraction well EW542x41 was decommissioned in January 2004 because of the expansion of Building 906 (URS Group, Inc., 2004). Soil vapor extracted from the DPE wells was treated at the WTTP via VGAC. During operation of the GET system, groundwater from all WIOU and WABOU extraction wells was pumped through the WTTP before being conveyed to the CGWTP, located at Site SS016.

GET and DPE were effective at achieving source control in the WIOU. Areas where VOC contamination exceeds 1,000 µg/L have been greatly reduced in size over the years of operation (2000-2010). However, as described above, after 10 years of operation two hot spots remained in the WIOU where VOC contamination exceeded 1,000 µg/L: one at Site SD036 and one (1) at Site SD037. In 4Q10, these two (2) hot spots underwent RPO consisting of EVO injection. The objective of this optimization is to actively treat the two (2) contaminant source areas and then rely on natural attenuation processes in the distal portion of the plume (enhanced attenuation).

The IRA for the distal portion of the WIOU plume (MNA assessment) is continued groundwater monitoring through the GSAP.

Floating product (Stoddard solvent) is present at Site SD034. The GET remedy at this site is supplemented by floating product removal using hydroskimmers. From 1998 through 2Q11, approximately 44.4 gallons of floating product were removed from the site. Passive hydroskimmers are currently installed in wells EW01x34, MW02x34, MW811x34, MWSSAx34, and MWSSBx34. In the most recent survey (2Q11), measurable product was detected at wells MWSSBx34 (0.44 foot) and MW811x34 (0.04 foot). Travis AFB will continue to address floating product as it occurs using passive skimmers.

D.4.2 Interim Remedy Evaluation

D.4.2.1 EVO Injection Evaluation

The quarterly RPO performance monitoring indicates that the EVO injections in both the Site SD036 and Site SD037 areas have resulted in ERD. TCE concentrations have decreased significantly (one to two orders of magnitude) in target wells. Cis-1,2-DCE concentrations have increased in the treatment zone. Vinyl chloride is also being formed within the treatment zone. The presence of ethane and ethene within the treatment zone indicates that complete dechlorination of the cis-1,2-DCE and vinyl chloride is occurring. Consistent detections of vinyl chloride concentrations exceeding the IRG (0.5 µg/L) are restricted to the EVO injection areas; vinyl chloride is not migrating away from the EVO injection areas.

The dissolved TOC supply in both of the hot spot injection areas remains high and is sustaining a rapid rate of ERD. Geochemical data collected from both of the hot spot areas support ERD. However, it is also apparent that sulfate levels in excess of 200 (mg/L) are present in the WIOU, and sulfate reduction will be competing with TCE reduction. A continuing influx of sulfate will deplete the TOC supply and eventually slow TCE and 1,2-DCE removal.

Monitoring data collected to date indicate that the EVO injections are performing as designed.

D.4.2.2 Rebound and MNA Evaluation

The GET system was shut down in 2Q10 to facilitate the EVO injections and support a rebound study. Outside of the two EVO injection areas, the WIOU plume is being monitored for rebound.

TCE and other COC concentrations continued to decline or were stable in most of the extraction wells, plume wells, and downgradient monitoring wells sampled over the reporting period. No rebound was evident in the plume, although by 2Q11 the GET system had been shut down for 1 year. The stable and decreasing COC concentration trends indicate that the attenuation capacity of the aquifer exceeds the mass loading from residual contamination in the Site SD036 and SD037 source areas. No VOCs were detected at concentrations exceeding IRGs in the downgradient wells during the reporting period. On the basis of the data collected to date, MNA is a viable remedy for the distal portion of the WIOU plume. The monitoring network includes both shallow and deep monitoring wells; MNA appears to be effective throughout the entire thickness of the plume.

D.4.3 Optimization Measures

- Floating product was detected at Site SD034 in 2Q11. Passive skimming devices will continue to be used at this site to address the accumulated product.
- In 2010, EVO injections were performed in the two hot spots at Sites SD036 and SD037 where VOC concentrations continued to exceed 1,000 µg/L. Performance monitoring for this RPO is ongoing and will be performed by the GSAP beginning in 2Q12.
- No rebound was evident in the WIOU plume during the year the GET system was offline; therefore the rebound study will continue and the WIOU extraction wells will remain offline. The WIOU extraction wells will be sampled semiannually in 2011-2012 to monitor for rebound.

D.5 West IRA Area—Site SS015 (Solvent Spill Area and Facilities 550 and 552)

D.5.1 Site Description

Site SS015 occupies 3.5 acres in the central portion of Travis AFB. Three potential sources of groundwater contamination have been identified at Site SS015: former Facility 550, former Facility 552 (including the area at Facility 1832), and the Solvent Spill Area (SSA) east of Facility 550. Of these, the primary source area is currently considered to be the SSA.

The SSA occupied 1.4 acres east of Facility 550. Paint was stripped from aircraft in the area for an undocumented period of time. Accidental releases included an estimated 100 to 150 gallons per month of methyl ethyl ketone, toluene, or tetraethylene glycol dimethyl ether from work trays used to collect stripping wastes. Soil is visibly stained in the SSA in aerial photographs taken before 1970 (Roy F. Weston, 1995).

Former Facility 550 was south of Hangar Avenue. Beginning in 1952, the facility housed a corrosion control shop, metals processing shop, and fiberglass shop. Paints, paint thinners, methyl ethyl ketone, acids, and stripping wastes were used or generated at the facility. A floor drain connected to the sanitary sewer was used to discharge wastes from the corrosion control shop.

Former Facility 552 was a fenced, bermed concrete pad located south of Hangar Avenue and immediately east of Facility 550. Historically, the facility was used as a hazardous waste collection area. Paint, chromic acid, and waste solvents generated during aircraft maintenance activities at Facility 550 were stored in Facility 552. From 1954 to 1980, radomes were stripped of paint in an area adjacent to Facility 552. The associated Facility 1832 is a 15,000-gallon OWS that received liquids generated at a wash rack on the aircraft parking apron. In 1992, a new hazardous waste accumulation facility was constructed at the site.

In 2004, Facilities 550 and 552 were demolished to construct a petroleum, oil, and lubricants (POL) military compound consisting of an office building, a fuel truck maintenance facility, and a large concrete truck parking area. The POL building (Building 554) was constructed with a vapor barrier and passive vent system to protect the building from potential vapor intrusion from the underlying groundwater plume.

D.5.1.1 Interim Remedial Action Objective

Site SS015 was selected for MNA assessment in the NEWIOU Groundwater IROD. The main objective of MNA assessment is to determine whether the groundwater plume is migrating, stable, or decreasing in size.

D.5.1.2 Interim Remedy Description

The initial Site SS015 MNA assessment was delayed because after MNA assessment was selected as the IRA, the site was subsequently selected for a treatability study of enhanced MNA using vegetable oil injection. A limited treatability study was conducted at the site during 2000-2001, during which approximately 227 pounds of soybean oil was injected at the site in two phases (June and December 2000). The treatability study was terminated early because of a military construction project at the site. Building 554 was constructed over a portion of the vegetable oil injection area. Although the vegetable oil injection treatability study was concluded prematurely, the initial results were promising and demonstrated that suitable bacterial populations were present and reductive dechlorination was occurring at the site.

In 2009, a natural attenuation assessment was performed for Site SS015, which is documented in the

NAAR (CH2M HILL, 2010). The NAAR concluded that MNA alone may not be a sufficient remedy at the site because of recent increasing contaminant trends in some monitoring wells. Consequently, RPO was performed in 2010 and 2011 at Site SS015. In December 2010 and January 2011, EVO was injected within the Site SS015 source area. The objective of this optimization is to actively treat the contaminant source area and then rely on natural attenuation processes in the distal portion of the plume (enhanced attenuation).

D.5.2 Interim Remedy Evaluation

The source area EVO injection has resulted in a significant decline (one to two orders of magnitude) in CVOC concentrations in the source area. TCE, cis-1,2-DCE, and vinyl chloride concentrations all declined. The decline in vinyl chloride concentrations and the detections of ethane and ethene in the source area indicate that vinyl chloride is being completely destroyed. Along with CVOC concentration trends, elevated TOC concentrations and geochemical parameters all support the conclusion that ERD is occurring in the EVO injection area.

In 2Q11, TCE concentrations in the source area wells declined to below 100 µg/L. Elevated cis-1,2-DCE concentrations (exceeding 100 µg/L) and vinyl chloride (exceeding 10 µg/L) are restricted to the immediate vicinity of the EVO injection.

The effects of the EVO injection are not yet expected to be observed in the distal portion of the plume. CVOC concentrations have been declining in some of the distal plume wells (MW2103x15 and MW2124x15); however, the declines began prior to the EVO injection. One (1) well, MW625x15, has recently had a trend of increasing COC concentrations. COC concentrations are expected to decline in this well following treatment of the source area.

Monitoring data collected to date indicate that the EVO injection is performing as designed. Enhanced attenuation appears to be a viable remedy for Site SS015.

D.5.3 Optimization Measures

In December 2010 and January 2011 EVO injection was performed in the Site SS015 hot spot where CVOC concentrations exceeded 1,000 µg/L. Performance monitoring for this RPO is ongoing.

While petroleum fuel constituents are not COCs at Site SS015, TPH as gasoline and diesel (TPH-G and TPH-D, respectively), benzene, and MTBE were detected at concentrations exceeding IRGs over the reporting period. The source(s) of the fuel constituents are unknown. Therefore, Site SS015 monitoring wells will be sampled in 2Q12 for TPH, to provide additional data on these constituents at the site.

D.6 West IRA Area—Site DP039

D.6.1 Site Description

Site DP039 primarily consists of the former Travis AFB Battery and Electric Shop (Building 755). In 1968, Building 755 was originally used to test rocket engines, but only petroleum-based liquid fuel was used at the site as part of this testing. Afterwards, Building 755 became the Battery and Electric Shop. Prior to 1978, battery acid solutions and chlorinated solvents were dumped into a sink within Building 755 and conveyed by a pipeline less than 100 feet to a rock-filled acid neutralization sump. This practice was discontinued in 1978, when the pipeline was dismantled and reconnected to the sanitary sewer line. In July 1993, the sump was excavated and disposed of off-base. The removed sump was 8 feet long, 8 feet wide, and 4 feet deep. Building 755 was demolished in 2009, and the lot is currently vacant.

D.6.1.1 Interim Remedial Action Objectives

The WABOU Groundwater IROD (Travis AFB, 1999) selected two IRA alternatives at Site DP039: source area GET with MNA assessment for the downgradient portion of the plume, and containment, treatment, and discharge. The IRAOs in the source area are containment and removal. Source control was selected at Site DP039 because of the suspected presence of residual liquid-phase TCE beneath the former sump area.

The downgradient portion of the site underwent a natural attenuation assessment in 2000-2001, as documented in the *DP039 Natural Attenuation Assessment Workplan* (CH2M HILL, 2001). A second natural attenuation assessment was performed in 2009 and is documented in the NAAR (CH2M HILL, 2010). For the MNA assessment portion of the plume, the IRAO is migration control.

D.6.1.2 Interim Remedy Description

Until 2008, the Site DP039 groundwater extraction system consisted of two DPE wells (EW563x39 and EW782x39) that addressed groundwater and soil vapor. In November 2008, both of these extraction wells were taken offline to facilitate construction and operation of a source area bioreactor as an Air Force Center for Engineering and the Environment (AFCEE) demonstration project. The bioreactor was constructed in an approximately 400-square-foot excavation to a depth of 20 feet bgs surrounding extraction well EW563x39. The excavation was backfilled with a 50/50 mixture of gravel and tree mulch sprayed with vegetable oil. Extraction well EW563x39 was salvaged and is currently used as a monitoring well for the bioreactor study. Extraction well EW782x39 is located approximately 8 feet downgradient of the edge of the bioreactor and is currently used to circulate groundwater within the bioreactor. EW782x39 is equipped with a solar-powered pump and is plumbed to the bioreactor.

Downgradient of the bioreactor, a phytoremediation treatability study area was established in 1998. The phytoremediation treatability study area consists of tree plantings engineered to hydraulically control and remove VOC mass from the groundwater.

Contamination in the middle portion of the Site DP039 plume, downgradient from the phytoremediation study area, is being addressed by an EVO permeable reactive biobarrier (PRB). The PRB consists of 13 injection wells (IW2079x39 through IW2091x39) installed perpendicular to the direction of groundwater flow. The EVO PRB was designed to treat groundwater with TCE concentrations exceeding 500 µg/L. EVO was injected into these wells in June and July 2010.

In the downgradient portion of the plume, which extends from the EVO PRB to the 5-µg/L TCE isocontour at the distal end of the plume, the interim remedy at Site DP039 consists of natural attenuation. Groundwater monitoring is designed to confirm whether the downgradient portion of the plume at Site DP039 is migrating or if it is stable.

D.6.2 Interim Remedy Evaluation

D.6.2.1 Capture Evaluation

The Site DP039 GET was shut down in November 2008 to support the bioreactor demonstration project; therefore, there is currently no hydraulic capture.

D.6.2.2 Bioreactor Evaluation

Since startup of the bioreactor, TCE concentrations in the source area have declined below 200 µg/L. The relatively low TCE concentrations in the source area indicate that most of the remaining source was removed during bioreactor excavation and that dissolved contamination moving away from the source area is being effectively treated by the reducing conditions established by the bioreactor. Through 2Q11, TCE reductions of more than 99 percent and total molar reductions of more than 95 percent have occurred in the aquifer within 30 feet of the source area bioreactor.

Monitoring well MW750x39 experienced rebound in TCE concentrations in the interval between the shutdown of the GET and the installation of the bioreactor. However, as expected, TCE concentrations subsequently decreased once reducing conditions were achieved at the bioreactor and the high concentrations of TCE near this well were flushed downgradient.

The bioreactor is performing as designed.

D.6.2.3 EVO PRB Evaluation

Performance monitoring data show significant (one [1] to three [3] orders of magnitude) reductions in TCE concentrations, minor cis-1,2-DCE accumulation, and no vinyl chloride accumulation along the EVO PRB. Geochemical data collected from the injection wells support ERD. High methane, high dissolved iron and manganese, and depressed sulfate are all positive geochemical signatures for anaerobic conditions favoring ERD. TCE concentrations in MW02x39, located immediately downgradient of the PRB wall declined from 4Q10 to 2Q11. Prior to the EVO injection, this monitoring well exhibited an increasing TCE concentration trend. Monitoring data collected to date indicate that the EVO PRB is performing as designed.

D.6.2.4 MNA Evaluation

Beyond the EVO PRB, the Site DP039 plume is being monitored for natural attenuation. TCE concentrations continued to increase in downgradient MW758x39 and MW760x39 through 2Q11. TCE concentrations slightly exceeded the IRG at both of these wells for the first time in 2Q11. The EVO PRB was installed because increasing TCE concentration trends in these downgradient wells and some of the Site DP039 plume monitoring wells indicated natural attenuation alone was not sufficient to prevent plume migration. Both MW758x60 and MW760x39 are located several hundred feet downgradient of the EVO PRB; therefore, TCE concentrations are not expected to be immediately affected by the EVO PRB. However, TCE concentrations are expected to decline in these wells as the contaminant mass is reduced by the EVO PRB. Continued monitoring is needed to determine whether the leading edge of the plume has stabilized.

Decreasing TCE concentration trends are evident in downgradient monitoring wells MW759x39 and MW762x39. TCE was not detected at either of these downgradient wells in 2Q11.

D.6.3 Optimization Measures

- An intermittent or pulsed operation of the bioreactor (e.g., 1 week on and 4 weeks off) may lead to more effective operation and to conservation of the small quantities of TOC being generated in the bioreactor.
- TOC supply along the EVO PRB is still adequate for ERD (ranging from 128 to 3,080 mg/L).

However, TOC is dropping in two (2) of the three (3) injection wells that were sampled. The rate of TOC depletion will be closely monitored to better estimate the recharge frequency for the EVO PBR.

- TCE concentrations have increasing trends in several wells located along the northern portion of the Site DP039 plume. While TCE concentrations have been stable in the furthest downgradient of these northern wells (MW785x39), TCE concentrations exceed 100 µg/L at this monitoring well. The extent of the TCE plume is not defined to the IRG along the northeastern portion of the plume. An additional monitoring well to the southeast of MW785x39 is needed.

D.7 West IRA Area—Site LF008 (Landfill 3)

D.7.1 Site Description

Site LF008 contained multiple burial trenches used to dispose of approximately 30 cubic yards of pesticide containers during the 1970s. All of the trenches were located within Bunker A of the Weapons Storage Area, a secured area surrounded by a fence with a locked gate. An RI of the WABOU in 1995-1996 used geophysical surveys, exploration trenching, and soil borings to identify the approximate locations of these burial trenches. Debris was discovered in six of the nine excavated trenches and included 1- and 5-gallon metal containers, plastic and paper bags, other paper and plastic debris, 1-gallon glass bottles, and two 55-gallon drums.

The *West/Annexes/Basewide Operable Unit Soil Record of Decision* (WABOU Soil ROD) (Travis AFB, 2002) selected excavation and offsite disposal to address soil contamination at Site LF008. In 2003, nine disposal trenches within Site LF008 were excavated, and the recovered debris was shipped offsite for disposal. Residual soil contamination was below the surface and subsurface residential soil cleanup levels established in the WABOU Soil ROD. Soil remediation at Site LF008 is therefore complete.

D.7.1.1 Interim Remedial Action Objectives

The WABOU Groundwater IROD (Travis AFB, 1999) selected GET to address groundwater contamination at Site LF008. There are two main objectives for groundwater extraction at Site LF008:

- Prevent the downgradient migration of groundwater containing contaminants exceeding IRG concentrations, using extraction wells near the leading edge of the plume.
- Treat the portion of the plume containing higher concentrations of contaminants.

D.7.1.2 Interim Remedy Description

Three extraction wells (EW719x08, EW720x08, and EW721x08) were installed around the pesticide trenches to prevent contaminated groundwater from moving away from the site. Each of the wells is conventional (i.e., vertical with no vacuum enhancement). In June 2001, the Site LF008 extraction wells were brought online. Extracted groundwater from the WTTP is transferred to the CGWTP for treatment and discharge. Because of the low permeability of the alluvial sediments, extraction rates are approximately 1 gpm for the wells at this site. In December 2008, all three extraction wells were shut down to perform a rebound study. The rebound study concluded that pesticide concentrations had not rebounded and that the GET system should remain shut down for a continued rebound evaluation through the remainder of the interim period (leading up to the Basewide Groundwater ROD). The results of the rebound study are presented in the technical memorandum *Rebound Study Completion at Site LF008* (CH2M HILL, 2010).

Because the ongoing rebound evaluation, the extraction wells were not operational during the 2Q11 groundwater sampling event and groundwater elevation survey.

D.7.2 Remedy Evaluation

GSAP data collected through 2Q11 indicate the following:

- Alpha-chlordane remains the most widespread groundwater contaminant at the site.
- Over 7.5 years of operation, the GET had minimal impact on pesticide concentrations at Site LF008. During operation of the GET, pesticide concentrations were stable and the extent of groundwater contamination remained unchanged. This is likely due to the strong adsorption of alpha-chlordane and other pesticides to natural organic carbon or fine-grained soil particles in the subsurface and the low

permeability of the saturated sediments.

- Once GET ceased, the extent of the pesticide plume decreased. In 2012, the pesticide alpha-chlordane was detected in only two wells at concentrations exceeding the interim remediation goal (IRG) of 0.1 microgram per liter ($\mu\text{g/L}$). During the 2Q12 sampling event, alpha-chlordane was the only pesticide detected. A study was initiated during the 2Q12 to research this phenomenon.

D.7.3 Alpha-Chlordane Rebound Study

The ineffectiveness of the GET system and lack of rebound was thought to be due to the strong sorption of pesticides to the fine-grained sediments present at the site. The organic carbon/water partition coefficient (K_{oc}), which describes how strongly a chemical sorbs to soil material, is extremely high (86,650 milliliters per gram [mL/g]). The alpha-chlordane K_{oc} is approximately 1,000 times higher than the K_{oc} for trichloroethene (TCE), which is 67 mL/g . However, alpha-chlordane's high K_{oc} did not explain why the plume would rapidly decrease in extent over a period of a few years once the GET system was shut down. Given the high K_{oc} , it would be expected for the groundwater plume to remain stable for decades.

The Air Force hypothesized that the pesticides at Site LF008 are not dissolved in groundwater but rather sorbed to fine clay particles that are captured in the groundwater samples collected at the site. To test this hypothesis, two (2) sets of groundwater samples were collected at Site LF008 during the 2Q12 GSAP monitoring event. One set of samples was field filtered, and the other set of samples was not. Both sets of samples were sent to the laboratory and analyzed for pesticides by Method SW8081. Alpha-chlordane was the only pesticide detected. Alpha-chlordane was detected in six of the non-filtered samples collected, but was detected in only one of the filtered samples collected.

The results of this study indicate that pesticides are bound to the fine-grained sediments at Site LF008 rather than dissolved in the groundwater. GET cannot be an effective remedy, and in fact, appears to be counterproductive. Extracting groundwater mobilizes the fine-grained sediments and results in pesticide detections over a larger area. Under static conditions, because of the high K_{oc} and fine-grained sediments, the pesticides will not migrate.

D.7.4 Optimization Measures

Based on the limited COC mass removed using the GET system and the rebound study results, groundwater extraction at Site LF008 will remain shut down for a continued rebound evaluation during the remainder of the interim period.

Appendix E
Response to Comments

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**Final Responses to EPA Region IX Comments on the
Travis Air Force Base Draft Third Five Year Review Report for NEWIOU and WABOU Groundwater Interim
Remedial actions, NEWIOU Soil and Sediment Remedial Actions, WABOU Soil Remedial Actions**

No.	Comments	Responses
REVIEW COMMENTS –Nadia Hollan Burke, EPA Region IX dated July 22, 2013		
Nadia Hollan Burke, EPA Region IX dated August 27, 2012		
GENERAL COMMENTS		
1.	The Draft Third Five Year Review Report for NEWIOU and WABOU Groundwater Interim Remedial Actions, NEWIOU Soil and Sediment Remedial Actions, WABOU Soil Remedial Actions, Travis Air Force Base, California, dated May 2013 (Five-Year Review) inconsistently documents the date that the Travis Air Force Base (TAFB) Groundwater Record of Decision (ROD) is expected to be finalized. The Executive Summary, on Page ES-2; Table 2-1, Chronology of Key Events; and Section 2.5, Travis AFB Groundwater Record of Decision, all note that the Groundwater ROD is expected to be signed in July 2013. However, the Executive Summary, on Page ES-9, notes that the Groundwater ROD is expected to be signed in May 2013 whereas Section 1.3.1, Groundwater Interim Remedial Actions, on Page 1-3, notes that the Groundwater ROD is expected to be finalized in September 2013. Please revise the Five Year to consistently document the date the TAFB Groundwater ROD is expected to be finalized.	The expected date of the Final TAFB Groundwater ROD remains uncertain. To help minimize this uncertainty within the Five Year Review Report, we removed the month from the estimated date of the Final ROD and modified the text on Table 2-1 and pages ES-2, ES-9, 1-3, and 2-4 to refer only to the expected date of “2013”.
2.	The language used for the Protectiveness Statements in the Five-Year Review for those remedies determined to be protective (i.e., North/ East/ West Industrial Operable Unit [NEWIOU] Soil/ Sediment Remedial Actions [RAs],	We modified the protectiveness statements in Section 9.2 of the Five Year Review Report as follows: “The soil remedies at NEWIOU are protective of human health and

No.	Comments	Responses
	<p>West/ Annexes/ Basewide Operable Unit [WABOU] Soil RAs) is inconsistent with the recommended language presented in the September 13, 2012 United States Environmental Protection Agency (U.S. EPA) Memorandum Clarifying the Use of Protectiveness Determinations for Comprehensive Environmental Response Compensation and Liability Act Five Year Reviews (OSWER 9200.2-111; September 2012 Memo). The recommended language for a Protectiveness Determination of "Protective" is as follows: "The remedy at OUX is protective of human health and the environment." This statement should then be followed with a description of the elements of the remedy that protect human health and the environment and how the Remedial Action Objectives (RAOs) have been met or are being met. Please revise the Protectiveness Statements for the NEWIOU Soil/ Sediment RAs and the WABOU Soil RAs to use the language recommended in the September 2012 Memo.</p>	<p>the environment. The RAs completed at NEWIOU soil/sediment sites achieved residential cleanup levels or otherwise included LUCs which protect human health and the environment.</p> <p>"The soil remedies at WABOU soil sites are protective of human health and the environment. The RAs completed at WABOU soil sites achieved residential cleanup levels or otherwise included LUCs which protect human health and the environment."</p>
2a.	<p>The response partially addresses the comment. The language utilized for the Protectiveness Statements in the Five-Year Review (FYR) for those remedies determined to be protective (i.e., North/ East/ West Industrial Operable Unit [NEWIOU] Soil/ Sediment Remedial Actions [RAs], West/ Annexes/ Basewide Operable Unit [WABOU] Soil RAs appears to be inconsistent with the recommended language presented in the September 13, 2012 United States Environmental Protection Agency (U.S. EPA) Memorandum Clarifying the Use of Protectiveness Determinations for Comprehensive Environmental Response Compensation and Liability Act Five Year Reviews (OSWER 9200.2-111; September 2012 Memo. Per the September 2012 Memo, it is recommended that the protectiveness statements read as</p>	<p>We modified the soil protectiveness statements in Section 9.2 of the Five Year Review Report as follows:</p> <p>"The remedies at the NEWIOU soil and sediment sites are protective of human health and the environment.</p> <p>Remedial Action Objectives (RAOs) for Sites SD001, SD033 (sediment) FT003, FT004 and FT005 included the removal of contaminated soil or sediments to achieve residential cleanup levels and allowed for unlimited use and unrestricted exposure at these sites.</p> <p>RAOs for Sites LF007, SS015, SS016, SD033 (soil) and SD037 included establishing Land Use Controls (LUCs) which restrict the</p>

No.	Comments	Responses
	<p>follows for the NEWIOU soil/sediment sites:</p> <p>The remedies at the NEWIOU soil and sediment sites are protective of human health and the environment.</p> <p>Remedial Action Objectives (RAOs) for Sites SD001, SD033 (sediment) FT003, FT004 and FT005 included the removal of contaminated soil or sediments to achieve residential cleanup levels and allowed for unlimited use and unrestricted exposure at these sites.</p> <p>RAOs for Sites LF007, SS015, SS016, SD033 (soil) and SD037 included establishing Land Use Controls (LUCs) which restrict the site to industrial land uses and prevent surface-disturbing activities. No issues were identified in LUC inspections conducted on October 30, 2012 and LUCs are being successfully tracked and enforced by the Air Force using Travis AFB General Plan (GP), Environmental Impact Analysis Process (EIAP) program (form 332 and excavation permits) and annual inspections. The Air Force has programmed the development of a Land Use Control Implementation Plan (LUCIP) to ensure long-term LUC tracking and enforcement. The LUCs are therefore protective of human receptors in an industrial use scenario.</p> <p>The remedies at the WABOU soil sites are protective of human health and the environment.</p> <p>Remedial Action Objectives for Sites LF008, RW013, SS041, SD042 and SD 045 included the removal of contaminated soil to achieve industrial clean up levels; however, residential</p>	<p>site to industrial land uses and prevent surface-disturbing activities. No issues were identified in LUC inspections conducted on October 30, 2012 and LUCs are being successfully tracked and enforced by the Air Force using Travis AFB General Plan (GP), Environmental Impact Analysis Process (EIAP) program (form 332 and excavation permits) and annual inspections. The Air Force has programmed the development of a Land Use Control Implementation Plan (LUCIP) to ensure long-term LUC tracking and enforcement. The LUCs are therefore protective of human receptors in an industrial use scenario.</p> <p>The remedies at the WABOU soil sites are protective of human health and the environment.</p> <p>Remedial Action Objectives for Sites LF008, RW013, SS041, SD042 and SD 045 included the removal of contaminated soil to achieve industrial clean up levels; however, residential cleanup levels were achieved allowing for unlimited use and unrestricted exposure at these sites.</p> <p>RAOs for Sites DP039, SD043, LF044 and SS046 included establishing LUCs to restrict the site to industrial land uses and prevent surface-disturbing activities. No issues were identified in LUCs inspections conducted on October 30, 2012 and LUCs are being successfully tracked and enforced by the Air Force using Travis AFB GP, EIAP program (form 332 and excavation permits) and annual inspections. The Air Force has programmed the development of a LUCIP to ensure long-term LUC tracking and enforcement. The LUCs are therefore protective of human receptors in an industrial use scenario.”</p>

No.	Comments	Responses
	<p>cleanup levels were achieved allowing for unlimited use and unrestricted exposure at these sites.</p> <p>RAOs for Sites DP039, SD043, LF044 and SS046 included establishing LUCs to restrict the site to industrial land uses and prevent surface-disturbing activities. No issues were identified in LUCs inspections conducted on October 30, 2012 and LUCs are being successfully tracked and enforced by the Air Force using Travis AFB GP, EIAP program (form 332 and excavation permits) and annual inspections. The Air Force has programmed the development of a LUCIP to ensure long-term LUC tracking and enforcement. The LUCs are therefore protective of human receptors in an industrial use scenario.</p>	
3.	<p>The Five-Year Review concludes that trichloroethylene (TCE) in groundwater has migrated off-base at Site LF007C at concentrations above the Interim Remedial Goal (IRG); but does not clearly describe the controls in place to prevent exposures or make specific recommendations to control off-site migration of this plume, with the exception of testing extraction rates in the extraction wells. The Five-Year Review should describe controls in place to prevent exposures related to offsite migration of the TCE in groundwater (e.g. either through direct contact with contaminated groundwater or in terms potential vapor intrusion [VI] risk). Section 4.1.2, Institutional Controls on Groundwater Use, discusses an easement purchased to grant access to the private property associated with off-site areas of Site LF007C to restrict residential development and well drilling, but it is unclear if there are other land use controls (LUCs) in place that address potential VI concerns. The Five-Year Review should clarify whether there are LUCs in place to limit these complete or</p>	<p>TCE in groundwater at Site LF007C was detected at concentrations exceeding the residential groundwater-to-indoor-air risk-based concentration (RBC), but not the corresponding industrial RBC. However, the on-base portions of Site LF007C are on a landfill, which is not suitable for building construction. Moreover, the off-base portion of Site LF007C is controlled by an easement which further prevents building construction, well drilling, and associated residential exposure; vapor intrusion is accordingly considered an incomplete pathway for the off-base portions of the site. Combined, the presence of the landfill on-base and the off-base easement serve to eliminate potential exposure to VOC vapors from groundwater at both on-base and off-base portions of Site LF007C. We revised Sections 3.4.3 and 4.1.2 of the Five Year Review Report to incorporate this information.</p> <p>Please see response to Specific Comment 28 relative to recommendations to prevent offsite migration of the TCE plume at</p>

No.	Comments	Responses
	<p>potentially complete exposure pathways. Also, the Five-Year Review should also document specific recommendations to control off-site migration of the LF007C plume. Please revise the Five-Year Review to address these concerns associated with off-site migration of groundwater at LF007C.</p>	<p>Site LF007C.</p>
4.	<p>A VI assessment was conducted at TAFB in 2009 and updated in 2012 made recommendations for mitigation and/or LUCs for several sites (Section 3.4.3, Vapor Intrusion); however, the Five Year Review does not clearly indicate if and when these recommendations were implemented. If the recommendations have been implemented, it is unknown if they are functioning as intended, which is a necessary component of the Five-Year Review technical assessment to determine the protectiveness of the remedy. Section 4.1.2, Institutional Controls on Groundwater Use, indicates that a LUC at Facility 18 within Site SS016 was instituted to limit the use of Facility 18 to storage purposes only, but the Five-Year Review does not indicate when this LUC was implemented or whether this LUC is functioning as intended. Furthermore, Section 4.1.2 indicates that specific LUCs to address VI risks are proposed in the draft Travis AFB Groundwater ROD to restrict industrial building construction on portions of Sites FT004, SS015, SS016, SS029, and DP039 unless vapor barriers and/or passive venting systems are included, but there is no mention of LUCs to address potential exposure to future residents at these sites and at Sites LF007, SS030, SD033, SS035, SD036, and SD037. The Five-Year Review should be revised to present a more cohesive and systematic look at potential VI issues. The Five-Year Review should systematically evaluate the potential for VI at all applicable sites (i.e., where volatile organic compounds [VOCs] in groundwater are above target screening levels).</p>	<p>The VI-related information within the Draft Five Year Review Report was based on the 2009-2010 VI assessments, and excluded the 2013 Vapor Intrusion Assessment Update. We have modified the Five Year Review Report text in Section 3.4.3 to reflect the revised findings of the 2013 Vapor Intrusion Assessment Update, which necessarily address the points raised in this comment. Relative to this comment, specific changes made to Section 3.4.3 include the following:</p> <p>“There are no sites currently requiring action based on the vapor intrusion pathway. The vapor intrusion pathway is a potential future concern under residential use at Sites FT004, LF007C, SS015, SS016, SS029, SS030, SD033, SD034, SS035, SD036, SD037, and DP039. The vapor intrusion pathway is a potential future concern under industrial use at Sites FT004, SS015, SS016, SS029, SD034, SD036, SD037, and DP039. The vapor intrusion pathway is not a potential future concern under either residential or industrial usage at Sites FT005, LF006, LF008, ST027B, SD031, and SD043.</p> <p>For site where the vapor intrusion pathway is a potential future concern, the 2013 Vapor Intrusion Assessment Update has identified LUCs in the form of passive ventilation systems to be implemented as part of construction of future buildings in order to ensure protection of indoor air quality. In addition, the VI Assessment has outlined a 100-foot buffer beyond the area of groundwater contamination (as defined by isoconcentration contours) exceeding groundwater-to-indoor-air RBCs, where future buildings may</p>

No.	Comments	Responses
	<p>Specifically the systematic evaluation should clearly identify sites which require LUCs or other mitigation measures, indicate if and when the LUCs or mitigation measures were or will be implemented, and evaluate the effectiveness of those LUCs/mitigation measures. This information is necessary to determine the protectiveness of the remedy. The Issues/Recommendations section of the Five-Year Review Summary Form and all applicable sections of the Five-Year Review document should identify those sites at which LUCs or mitigation measures are recommended but have not yet been implemented. Please revise the Five-Year Review to acknowledge all sites at which the potential for VI exists and state whether LUCs and/or mitigation measures to address VI have been implemented at each site.</p>	<p>be placed.”</p> <p>“At the time of writing of this report, LUCs in the form of passive ventilation systems and/or vapor barriers have been designed and built into the following three facilities: Building 554 (which overlies the SS015 plume), Building 837 (which overlies the SD037 plume), and Building 38 (which overlies the SS016 plume). These passive vent systems are in place and are functioning as designed.”</p> <p>Relative to the LUC for Facility 18 within Site SS016, we have also modified the text in Section 4.1.2 as follows: “The VI assessment for Facility 18 supports the conclusion that while the vapor intrusion pathway is not a current concern, the vapor intrusion pathway is a potential concern under future use scenarios because of the presence of DNAPL and the TCE source area beneath the building. Facility 18 is not occupied, so there is no current exposure via the vapor intrusion exposure pathway. To address potential future exposure, an LUC has been implemented to restrict the use of this facility for storage purposes. This LUC was put into place after the 2010 Vapor Intrusion Assessment Report was finalized.”</p> <p>A systematic evaluation of the potential for VI at all applicable sites is included in Section 3.4.3 of the Five Year Review Report. This evaluation was based on the 2009-2010 VI assessment, but has now been updated for the findings of the 2013 Vapor Intrusion Assessment Update. This section lists all sites which require LUCs for VI protection, including sites which have already implemented the LUCs. In response to this comment, a reference to this systematic evaluation (referring to Section 3.4.3) has been added to the text in Section 4.1.2.</p>

No.	Comments	Responses
		<p>Section 8.1 of the Five Year Review Report related to groundwater issues and follow-up actions has also been expanded to include formal recommendations relative to the need for VI-related LUCs at specific sites where future buildings are to be constructed above VOC plumes in groundwater. Specifically, we have modified Section 8.1 as follows:</p> <p>“The vapor intrusion pathway from groundwater is a potential future concern relative to potential future construction of buildings at Sites FT004, SS015, SS016, SS029, SD034, SD036, SD037, and DP039. To ensure long-term protectiveness, it is recommended that prior to construction of future buildings at any of these sites, LUCs in the form of passive ventilation systems be implemented as part of construction of each building. In addition, the LUCs should ensure that future buildings be located outside of a 100-foot buffer beyond the area of groundwater contamination (as defined by isoconcentration contours) exceeding groundwater-to-indoor-air RBCs) at the time of construction. The need for these LUCs has been incorporated into the pending TAFB Groundwater ROD and should be assessed as part of future five year reviews with the TAFB Groundwater ROD in effect.”</p>
4a.	<p>The response partially addresses the comment. The comment response states that for sites where vapor intrusion (VI) pathway is a potential future concern, the FYR has been updated to include a statement that a systematic evaluation of the potential for VI at all applicable sites is included in Section 3.4.3 and updated to include the 2013 VI Assessment Update. However, to address long-term protectiveness, a discussion is needed which addresses the plans for documentation of these procedures in a decision document. Please revise the text to state that exposure to the VI pathway is currently prevented as</p>	<p>We supplemented the response to General Comment 4 (above) as follows:</p> <p>“As confirmed by the 2013 VI Assessment Update, there are no sites currently requiring action based on the vapor intrusion pathway. VOC concentrations in groundwater, which serve as the source for vapor intrusion, are currently decreasing at applicable sites. Long-term protectiveness for the vapor intrusion pathway is being addressed through continued monitoring of changes in VOCs in groundwater. If VOC concentrations in</p>

No.	Comments	Responses
	<p>verified by the 2013 VI Assessment Update, and VOC concentrations are currently decreasing at applicable sites. Long-term protectiveness is being addressed through continued monitoring of changes in VOCs in groundwater. If VOC concentrations in groundwater increase, a systematic evaluation of the VI pathway will be triggered to ensure that potential future exposures are prevented. This process is expected to be memorialized in the Travis AFB Groundwater Record of Decision (ROD), currently under review by the Regulatory Agencies.</p>	<p>groundwater increase, an updated systematic evaluation of the VI pathway will be triggered to ensure that potential future exposures are prevented. This process is expected to be memorialized in the Travis AFB Groundwater ROD, currently under review by the Regulatory Agencies.”</p>
4b.	<p>The revisions to the Draft Final Third Five-Year Report are partially adequate. As requested, the revisions address the concern about the need to include a reference to a decision document to provide long-term protectiveness associated with the LUCs. With respect to the LUC for Facility 18 within Site SS016, Section 4.1.2 was modified to address the results of the VI assessment at Facility 18. The revision to Section 4.1.2 is acceptable. However, text regarding the VI assessment at Facility 18 has been deleted from Section 3.4.3 and replaced by a summary of the VI assessment at Facility 16. Please put the discussion of Facility 18 VI assessment back into Section 3.4.3, under the subsection addressing Site SS016 or explain the reason for removing it from the text.</p>	<p>We have added the information regarding Facility 18 back into Section 3.4.3.</p>
5.	<p>Table ES-1, Summary of Groundwater Interim Remedial Action Performance, indicates that for Site SS030, under Performance Assessment Criteria, “Question A – Functioning as Intended by IROD [Interim Record of Decision].” that the interim remedy is not functioning as intended by the IROD, but no issues or recommendations are made for this site in the Five-Year Review Summary Form or in Section 8.1, Groundwater Interim Remedial Action Issues and Follow-Up</p>	<p>Appendix D provides a detailed assessment of the capture evaluation for the IRA activities at SS030; in turn, this detailed analysis is also summarized in Table ES-1.</p> <p>In short, the on-base IRAO for the Site SS030 plume is migration control, which has been achieved (see Appendix D). The IRAO for the off-base component of the Site SS030 plume is groundwater remediation to the IRG. The southern and western sides of the Site</p>

No.	Comments	Responses
	<p>Actions. Specifically, the Five-Year Review should discuss whether the upcoming basewide groundwater ROD will incorporate a modified remedy. The Performance Assessment Summary column of Table ES-1 indicates that additional monitoring of the easternmost monitoring wells in SS030 will be needed to verify the capture extent. This and/or other recommendations should be made for SS030 in the Five-Year Review Summary Form and Section 8.1 to address deficiencies since the interim remedy is not functioning as intended. Please revise the Five-Year Review to identify issues associated with the interim remedy at SS030 not functioning as intended by the IROD, provide recommendations to address the issues, and include information in the pending groundwater ROD related to the incorporation a modified remedy.</p>	<p>SS030 plume have been remediated, and VOCs are no longer detected in these areas. TCE remains above the IRG only in the eastern portion of the off-base plume. However, the 2Q11 groundwater elevation contours indicate that the shutdown of most of the Site FT005 extraction wells improved the Site SS030 system capture, with the two wells which exceeded IRGs and a new well pair added for additional monitoring all remaining within the extent of hydraulic capture of the SS030 groundwater extraction and treatment system (GET). In addition, TCE concentrations in the eastern portion of the plume have remained stable (MW03x30) or declined (MW05x30) over the last few years, indicating that the plume is no longer migrating eastward. Ongoing monitoring of the two historical and two newly added wells are needed; these monitoring activities are covered by the existing IRODs and have been further incorporated into the pending TAFB Groundwater ROD.</p> <p>Based on the above, while IRA activities have not yet met the objective of the IROD for a portion of the off-base plume, the interim remedy is functioning as intended and the progress toward achieving the remedial objectives for this site are considered ongoing (and covered by existing IROD and pending ROD). Hence, no formal recommendation relative to this site is needed in Section 8.1. However, we revised Table ES-1 (and Table 5-1) to indicate that the interim remedy is functioning as intended by the IROD.</p>
5a	<p>The response indicates that a detailed capture zone evaluation is provided in Appendix D for the SS030 site and that Table ES-1 has been changed to reflect that SS030 is functioning as intended by the Interim Record of Decision (IROD). Review of the Appendix D information appears to indicate that this</p>	<p>Please see the last sentence to the response to General Comment 5 (above), which indicates that we revised Table ES-1 to reflect that the interim remedy is functioning as intended by the IROD.</p>

No.	Comments	Responses
	change is appropriate. However, the Table ES-1 performance assessment statement should be revised to better support the change that the SS030 is functioning as intended.	
6.	The Old Skeet Range, located within the WABOU, does not appear to be addressed in this Five-Year Review. Please clarify how the Old Skeet Range and the recently proposed Non-Time Critical Removal Action (NTCRA) at this site relates to the WABOU Soil RAs and this Five-Year Review.	<p>The Old Skeet Range is not covered by any of the existing soil RODs and groundwater IRODs, nor will it be covered by the pending TAFB Groundwater ROD; hence, it is excluded from this Five Year Review Report and the proposed NTCRA is unrelated to the WABOU Soil RAs in this Five-Year Review.</p> <p>The Old Skeet Range is covered by the Military Munitions Response Program (MMRP), with remediation of chemical contamination focused on PAH impacts to soil. Corrective action at this site will be addressed in accordance to a Final Action Memo for this site; currently, a draft version of this Action Memo is in progress.</p> <p>Based on the above discussion, we added a new subsection 1.3.4 (Old Skeet Range) to the Five Year Review Report and the brief summary mentioned above, including exclusion of this site from the formal analysis within the Five Year Review Report, has been inserted into this section.</p>
7.	The text in Section 4.0, Groundwater Interim Remedial Actions and Soil and/or Sediment Remedial Actions, indicates that the 2012 data for many of the sites was not available until the first quarter of 2013; therefore the analytical data presented in the document in the form of tables and figures may not be current or the most recent. Please ensure that the data presented is current and up to date when the report is finalized.	As indicated on page ES-1 of the Five Year Review Report, the cutoff date for data reviewed for this report related to data published by February 2013. Inherently, data reviewed and used in this report may be of variable dates within the 2008 to (February) 2013 time frame, depending on the actual date of data collection. For groundwater remedial actions, this necessary limited the data reviewed to those documented in the 2010-2011 GSAP. Data published after February 2013 are not included in this report, and will be covered as part of the next (i.e, Fourth) Five

No.	Comments	Responses
		<p>Year Review Report.</p> <p>Based on the above rationale, we made no change to the Five Year Review Report in response to this comment.</p>
8.	<p>The Five-Year Review does not provide the date the public notice was published or provide a sufficient description of community involvement opportunities. Section 6.2, Community Notification and Involvement, Page 6-1 indicates public notices announcing this Five-Year Review were published in the Vacaville Reporter, Fairfield Daily Republic, and the Travis Air Force Base Tailwind in April 2013. The section further states that the final document will be placed in the Vacaville Public Library. Section 3.4 of the U.S. EPA Comprehensive Five-Year Review Guidance, dated June 2001 (the Guidance) states that, "At a minimum, your community involvement activities during the five-year review should include notifying the community that the five-year review will be conducted, notifying the community that the five-year review has been completed, and providing the results of the review to the local site repository." The discussion should explain why TAFB, a large Federal Facility in California, is not considered a high profile site warranting an increased level of community involvement. Further, the discussion should also indicate what measures were taken to gauge public interest in the project in order to ensure appropriate community involvement activities were incorporated into the Five-Year Review. The Guidance also recommends conducting additional community involvement activities at high profile sites or those with significant public interest. These additional activities can include the notification of public officials and relevant neighborhood and civic groups, public meetings, or other</p>	<p>The date provided for the public notices within the Vacaville Reporter, Fairfield Daily Republic, and the Travis Air Force Base Tailwind was a placeholder for the date which the Final Five Year Review Report will be advertised to the public. We have revised the date to September 2013 which is the deadline to finalize the report. We have further modified the text to indicate that the Technical Review Focus Group of the TAFB RAB reviewed the Five Year Review Report concurrently with the regulatory agencies.</p>

No.	Comments	Responses
	<p>activities that encourage a broader public involvement. Please revise the Five-Year Review to provide the date the public notice announcing the initiation of the review was published. Additionally, since the Five-Year Review appears to include the minimum level of community involvement, please provide additional discussion justifying the current level of community involvement.</p>	
9.	<p>The Five-Year Review does not provide a brief description and current status of all of the operable units (OU) at TAFB. The content checklist from the Guidance listed in Appendix E indicates that a brief description and the status of each are needed (i.e., based on the Checklist, Introduction, Bullet No. 6). Please include this information in Section 1.0 of the Five-Year Review.</p>	<p>The information sought by the comment is included on page 1-5 of the Five Year Review Report. In addition, Section 2 of the Five Year Review Report provides an introduction to the various OUs, including sites allocated to each OU. Lastly, Section 3 of the Five Year Review Report provides additional detail regarding the background, including physical characteristics and history of contamination across the various OUs.</p> <p>Based on the above rationale, we made no change to the Five Year Review Report in response to this comment.</p>
10.	<p>Section 3.2, Land and Resource Use, does not discuss projected future land use. The Five-Year review discusses current land use only. Please revise Section 3.2 to include information on projected future land use for TAFB.</p>	<p>Future land use at TAFB is expected to remain unchanged from the current land use. In response to the comment, we added the following text to Section 3.2:</p> <p>“The future land use at TAFB is expected to remain as an Air Force base; hence, future land use is expected to remain unchanged relative to the current land use summarized above.”</p>
11.	<p>Section 3.3, History of Contamination, does not include the volumes of contaminants released; estimated amounts still present at each site, or how the contamination was discovered. Examples include the volume of wastes in the landfills and the volume of contamination remaining for each groundwater site.</p>	<p>Reasonable estimates of volumes of contaminants historically released across TAFB are unavailable, as are current estimates of remaining contaminant mass which are largely dynamic in response to ongoing remediation efforts.</p> <p>Section 3.3.2 summarizes known information relative to the</p>

No.	Comments	Responses
	In addition, the text should discuss how the contaminants were discovered in each of the Soil OUs. Please revise the appropriate sub sections in Section 3.3 to include this information.	discovery of contaminants in each of the soil OUs. Additional information relative to the occurrence of soil contamination is unavailable. Based on the above rationale, we made no changes to the Five Year Review Report relative to this comment.
12.	Table 5-1, Summary of Protectiveness Statements from the Second Five-Year Review (2008), is not included in the list of Tables in the Table of Contents. Please ensure all sections, tables, figures, and appendices are accurately listed in the Table of Contents of the Five-Year Review.	We added Table 5-1 to the list of Tables within the Table of Contents of the Five Year Review Report.
13.	The Five-Year Review was printed single-sided, which does not meet the requirements of Executive Order 13514 Federal Leadership in Environmental, Energy, and Economic Performance, dated October 5, 2009 (Executive Order). Specifically, this Executive Order requires reducing printing paper use. The text and tables should be printed double-sided to reduce paper use. When this report is reprinted, please print it double-sided to the extent possible. Please ensure that future documents are printed double-sided.	The Draft Five Year Review Report contained page numbers corresponding to double-sided printing of the report. The Draft Five Year Review Report was intentionally printed as a single-sided document to ease entry of hand-marked comments/edits on the report pages. We will print the Final Five Year Review Report as a double-sided document.
SPECIFIC COMMENTS		
1.	Executive Summary, Page ES-10: In the Issues from the Second Five-Year Review subsection, the Five-Year Review notes that a VI study performed in 2009 “showed that vapor intrusion is not taking place in existing buildings on Travis AFB,” but this statement does not accurately reflect the conclusions of the study. The Five-Year Review should note that VI is a potentially complete pathway; however, existing buildings under their current use do not present exposures above industrial levels of concern. This same section also states that	We revised the text on Page ES-10 relative to the findings of the VI study to indicate: “The 2013 Vapor Intrusion Assessment Update indicated that VI is a potentially complete exposure pathway at sites where existing buildings overlie VOC plumes in groundwater; however, estimated health risks for potential occupants of existing buildings under current land use are below levels of concern. Therefore, there are no sites currently requiring action based on the vapor

No.	Comments	Responses
	<p>administrative controls were deemed necessary to protect future buildings against indoor intrusion of VOC vapors from groundwater, yet it does not describe the LUCs implemented or to be implemented in order to mitigate potential VI to indoor air of future buildings. Please revise the Second Five-Year Review subsection of the Executive Summary to present a more accurate description of the results of the 2009 VI study. Statements that indicate VI is not taking place should be deleted. Additionally, please describe the LUCs implemented and the mechanism by which they were implemented to mitigate exposures to potentially impacted indoor air of future onsite buildings via the VI pathway.</p>	<p>intrusion pathway.”</p> <p>“At several sites overlying VOC plumes in groundwater, potential future buildings and associated residential and/or commercial/industrial use may result in estimated health risk levels above levels of concern. To ensure long-term protectiveness for occupants of potential future buildings constructed at these sites, LUCs consisting of passive ventilation systems and restrictions on placement of buildings within 100 feet of portions of VOC plumes exceeding groundwater-to-indoor-air RBCs are deemed necessary. To date, passive ventilation systems have been successfully implemented as part of construction of three new commercial buildings to mitigate potential future exposures relative to the VI exposure pathway.”</p>
1a	<p>Suggest moving this section to before the previous section to avoid confusion from current issues and issues from last FYR. Also, much comments/revisions are being made to this to address the current FYR’s assessment, and it’s taking away from the purpose of this section, to identify any issues from the 2nd FYR. It seems more specifics about the issue itself is warranted, but less information about what was done to address it, as that should be in the text of the document.</p>	<p>We have moved the issues from the second five-year review, and have reduced the text to focus on the specific issue raised in the previous five-year review, as suggested by the comment.</p>
2.	<p>Executive Summary, Protectiveness Statements, Page ES-10: The reasons provided to explain why the soil/sediment remedies are protective of human health and the environment are not accurate for all sites. For both the NEWIOU Soil/Sediment Remedial Actions (RAs) and the WABOU Soil RAs, the protectiveness statements indicate that the RAs completed at these sites achieved residential cleanup levels, but not all soil/sediment sites have achieved unlimited use/unrestricted exposure status. Table ES-2, Summary of NEWIOU Sites Soil</p>	<p>Please see response to General Comment 2.</p>

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	<p>and Sediment Remedial Actions, and Table ES-3, Summary of WABOU Sites Soil Remedial Actions, note that LUCs are currently in place at some sites (e.g., SS015, SS016, etc.) to restrict land use to industrial activities only. Please revise the Protectiveness Statements to better describe the elements of the remedy (e.g., LUCs) that protect human health and the environment at some of the NEWIOU Soil/ Sediment and the WABOU Soil sites. This information should also be updated in Section 9.2, Soil and Sediment Remedial Actions.</p>	
3.	<p>Executive Summary, Table ES-2, Summary of NEWIOU Sites Soil and Sediment Remedial Actions, and Table ES-3, Summary of WABOU Sites Soil Remedial Actions: These tables identify the soil/sediment sites by their Environmental Restoration Program (ERP) Site Number, but it would also be helpful if the specific OU in which the ERP site is located is also identified to facilitate review between the table and figures. Please revise Tables ES-2 and ES-3 to include a column that identifies the OU of the ERP site.</p>	<p>Tables ES-2 and ES-3 list soil and/or sediment sites for NEWIOU and WABOU, respectively. The specific OU's to which the sites listed in these two tables belong are already reflected in the titles of these two respective tables (i.e, NEWIOU for sites listed on Table ES-2 and WABOU for sites listed on Table ES-3). Therefore, it seems redundant to add a column to each table wherein the same OU name is repeated for each site listed on each table. The tables as currently labeled are deemed to clearly define sites by their ERP site number and OU.</p> <p>To ensure that the names of the ERP sites match the nomenclature formally used by the EPA, we added footnotes to the bottom of Table ES-2 so that the site names may be cross-referenced with EPA OU designations.</p>
4.	<p>Section 1.2, Authority and Guidance, Page 1-1: The Five-Year Review is missing a list of the organizations that provided analyses in support of the Five-Year Review. This information includes groups such as contractors, other review participants and support agencies. Please provide this information in Section 1.2 of the document.</p>	<p>Based on discussions with the EPA on 7/30/13, the EPA withdrew this comment.</p>
5.	<p>Section 2.1, Key Events, and Table 2-1, Page 2-1: Section 2.1</p>	<p>As discussed with the EPA on 7/30/13, all key events within the</p>

No.	Comments	Responses
	<p>and Table 2-1 are missing the original remedial investigations, Remedial Investigation (RI) Reports for the individual operable units (East Industrial Operable Unit [EIOU], West Industrial Operable Unit [WIOU], and North Operable Unit [NOU]), as well as the removal actions that started the groundwater remediation at the OUs. Please include this information in Section 2.1 and Table 2.1.</p>	<p>last five years and significant CERCLA milestones are covered within Table 2-1. Hence, we made no changes to the Five Year Review in response to this comment.</p>
6.	<p>Section 2.3.1, NEWIOU Groundwater Sites, Page 2-3: The text in this section is misleading. The text states, “after more than a decade of the interim remediation, the residual contaminant concentrations ... are much lower,” but the interim remediation systems in the former EIOU have been operating for more than two decades. Use of a skewed timeframe will yield unrealistic timeframes for remediation. Please ensure that the dates and timeframes specified in the document are realistic and accurate.</p>	<p>The IRA activities in response to the RODs and IRODs were initiated in 1999; hence, they have not been in place for two decades, as implied by the comment. The existing reference to “more than one decade of interim remediation” is consistent with the general time frame of IRA activities (approximately 13 years).</p> <p>It should also be noted that the purpose of this section within the Five Year Review Report is to provide a summary of the status of the NEWIOU groundwater sites; chronology and time frame was not an intended target of the discussion in this section.</p> <p>Based on the above rationale, we made no changes to the Five Year Review Report relative to this comment.</p>
7.	<p>Figure 3-3, NEWIOU and WABOU Soil, Sediment, and Surface Water Sites: Figure 3-3 does not identify the locations of all NEWIOU and WABOU Soil, Sediment and Surface Water Sites addressed in this Five-Year Review and described in Section 3.3.2, Environmental Restoration Program Soil and Sediment Sites. The locations of FT003 (FTA-2), FT004 (FTA-3), FT005 (FTA-4), LF008 (Landfill 3), and SD045 (Former Small Arms Range) are not identified on Figure 3-3. Please revise Figure 3-3 to identify the locations of all NEWIOU and WABOU Soil, Sediment, and Surface Water Sites addressed in this Five-Year Review.</p>	<p>We added all ERP soil and sediment sites to Figure 3-3.</p>

No.	Comments	Responses
8.	<p>Section 3.4.3, Vapor Intrusion, Page 3-16: This section addresses a VI assessment conducted in 2009 but there is no mention of the VI assessment conducted in 2012. Section 4.1.2, Institutional Controls on Groundwater Use, on Page 4-8, notes that an updated VI assessment was conducted in 2012 but details of this assessment and results are not presented. Please revise Section 3.4.3 to include information from the 2012 VI assessment update.</p>	<p>As indicated in the response to General Comment 4, we revised the Five Year Review Report to include the findings of the 2013 Vapor Intrusion Assessment Update, including corresponding changes to Section 3.4.3.</p>
9.	<p>Section 3.4.3, Vapor Intrusion, Pages 3-16 to 3-18: For many of the sites evaluated in the VI assessment, mitigation or LUCs were recommended; however, it is unclear if the LUCs are currently in place. The specific LUCs implemented/to be implemented and mechanism by which they are/will be implemented are not described in this section. A reference to a section in the Five-Year Review that addresses these specific concerns is acceptable (i.e, Section 4.1.2, Institutional Controls on Groundwater Uses) provided that all sites at which LUCs were recommended are addressed. For transparency, please revise Section 3.4.3 to discuss or reference a discussion of the LUCs implemented or to be implemented to address unacceptable risk associated with VI.</p>	<p>In concert with the response to Specific Comment 1, we modified Section 3.4.3.</p>
10.	<p>Section 3.4.3, Vapor Intrusion, Page 3-17: This section indicates that an indoor air monitoring program will be established at Facility 554 (associated with Site SS015) to “monitor the continued efficacy of the vapor barrier and passive vent system” and the results from the sampling will be documented in the Groundwater Remediation Implementation Program (GRIP) for the base, but no further details regarding the frequency of sampling or results from this sampling have been included. Recent results should be used to evaluate the protectiveness of the remedy at this site. Please revise the Five-</p>	<p>The 2013 Vapor Intrusion Assessment Update included a recommendation for indoor air monitoring at Facility 554, to confirm that the passive ventilation and vapor barrier systems are functioning as intended. Despite indoor air quality data indicating the absence of VOCs exceeding levels of concern, this recommendation was set forth in the VI assessment as a precautionary measure triggered by localized increases in TCE degradation products in response to bioremediation efforts.</p> <p>However, the available indoor air quality data are below levels of</p>

No.	Comments	Responses
	<p>Year Review to provide additional information on the air-monitoring program at Facility 554 and discuss the results from recent sampling, if available. .</p>	<p>concern and increases in TCE daughter products in groundwater are temporary in response to bioremediation (i.e, EVO) efforts that have proven to effectively reduce VOC concentrations in groundwater and are performing as designed (see Section 7.1.1.3 and Appendix D). Therefore, monitoring for continued efficacy of the vapor barrier and passive ventilation system is considered unnecessary.</p> <p>As the groundwater IRA activities are transitioned to the final remedies that are described in the upcoming TAFB Groundwater ROD, the continued effectiveness of the EVO remediation efforts will continue to be assessed.</p> <p>Based on the above rationale, we modified the text in Section 3.4.3 to remove the reference to the indoor air monitoring program at Facility 554.</p>
11.	<p>Section 3.4.3, Vapor Intrusion, Page 3-18: For the description of the VI assessment results for Site DP039, the Five-Year Review states, “the VI exposure pathway is considered insignificant for current and future industrial use,” but this statement does not identify the specific problem. To better describe the results of the assessment, the reference to “insignificant” in regards to the VI exposure pathway should be replaced with the following: “The VI pathway may be complete but actual measured indoor air concentrations are within or below the risk range for the current land/building use.” Please incorporate this recommendation for all sites at which the VI exposure pathway was identified as “insignificant.”</p>	<p>The use of “insignificant” vapor intrusion pathways and risks in the Five Year Review Report were based on the definition used in the VI Assessment. Specifically, the VI Assessment refers to “insignificant exposure pathways” when corresponding to sites where the vapor intrusion exposure pathway is considered insignificant because VOC concentrations are below site-specific RBCs, cumulative risks for VOCs are within the EPA’s risk management range of 10⁻⁶ to 10⁻⁴, and hazard indexes are less than 1; or the pathway is incomplete.</p> <p>Consistent with the terminology in the VI Assessment and in response to this comment, we formally introduced the above definition into the related VI discussion in Section 3.4.3 and maintained the use of “insignificant exposure pathway” accordingly.</p>

No.	Comments	Responses
12.	<p>Section 3.4.2, Vapor Intrusion, Page 3-18: For Sites LF007 and SS030, Section 3.4.2 states, “Future risk for VI is uncertain at Sites LF007 and SS030 because groundwater data gaps pertaining to the extent of contamination remain,” but investigations to resolve the data gaps and/or mitigation measures to ensure protection against VI risks are not discussed. Please revise the Five Year Review to describe any proposed investigations and/or mitigation measures to ensure protection against VI risks under future land use scenarios. If this information is proposed in the pending draft groundwater ROD please revise Section 3.4.2 to include this information related to Sites LF007 and SS030.</p>	<p>It is assumed that this comment relates to Section 3.4.3, not 3.4.2, as stated in the comment.</p> <p>We updated the referenced text in Section 3.4.3 in concert with adding the findings of the 2013 Vapor Intrusion Assessment Update to the Five Year Review. Relative to VI issues pertaining to LF007 and SS030, we modified the text in Section 3.4.3 as follows:</p> <p>“TCE in groundwater at Sites LF007C and SS030 was detected at concentrations exceeding the residential groundwater-to-indoor-air RBC, but not the corresponding industrial RBC. However, the on-base portions of Sites LF007C and SS030 are on a landfill and along a road, respectively, and neither is suitable for building construction. The off-base portions of both sites are controlled by easements already in place which further limit building and well installations, rendering the vapor intrusion pathway incomplete.”</p>
13.	<p>Section 3.3.1.1, NEWIOU Groundwater Sites, Page 3-9: The last paragraph of this page states, “A layer of Stoddard solvent was recently measured with a maximum thickness of 0.44 foot,” but the text does not indicate the date this measurement was made. The text further states “The GET [groundwater extraction and treatment] system is currently shut down for a rebound study through the remainder of the interim remediation period. Passive skimming is effectively removing pure Stoddard solvent from the water table. The rebound study shows that MNA [monitored natural attenuation] is stopping plume movement and will reduce contaminant concentrations once all of the pure Stoddard solvent has been removed,” but does not estimate when all of the pure Stoddard solvent will be removed. Please revise the Five-Year Review to provide an estimate for complete removal of this layer of pure</p>	<p>The date of the Stoddard solvent detection is listed in Appendix D of the Five Year Review Report. We modified the text on page 3-9 of the Five Year Review Report to indicate that “The Stoddard solvent layer was discovered in 2Q11”.</p> <p>Page 3-9 of the Five Year Review Report indicates that the estimated time to achieve site cleanup is 60 years. This remediation time is based on the cleanup of the entirety of the WIOU plume, of which Site SD034 is a part.</p>

No.	Comments	Responses
	Stoddard solvent from the water table and specify when the product thickness measurement was made.	
14.	<p>Section 3.4.1, Groundwater Contamination, Page 3-15: This section only lists the primary contaminants and does not include all of the contaminants. The use of “CVOCs [chlorinated volatile organic compounds]” is not adequate as all of the groundwater contaminants being addressed under the IROD should be listed. Please revise the text to include all contaminants.</p>	<p>Section 3.4 of the Five Year Review provides an overview of the basis for corrective action implemented at TAFB. Included in this section is Subsection 3.4.1, which was intended to provide a summary of the groundwater contamination across TAFB, which in turn triggered the corrective action. Please note that while the text in Section 3.4.1 does refer to CVOCs as the primary COCs, it also lists the key CVOCs including TCE, 1,1-DCE, cis-1,2-DCE, and 1,2-DCA. In addition, the existing text in this section further refers to secondary COCs, including the presence of petroleum-fuel constituents, organochlorine pesticides (alpha-chlordane), and other chemicals present at concentrations below IRGs.</p> <p>Given the intent of this section to provide a general overview of groundwater contamination as the basis of corrective action, listing all individual COCs beyond the above summary seems unnecessary and excessive. Moreover, this brief listing is not intended to identify the comprehensive list of chemicals we reviewed in performing the technical assessment and protectively evaluation. The technical assessment relied on all data held within associated references cited in Section 7 of the Five Year Review Report, which for groundwater includes all data (and chemicals) reported within the 2010-2011 GSAP (see Page 7-2 of Five Year Review Report).</p> <p>Based on the above rationale, we made no change to the Five Year Review Report in response to this comment.</p>
15.	<p>Section 3.4.2, Soil Contamination, Page 3-16: The listing of contaminants in this section is too general. Currently the text states, “Soil contaminants included SVOCs [semi-volatile</p>	<p>Similar to the response to Specific Comment 14, Subsection 3.4.2 is intended to provide a summary of the soil contamination across TAFB, which in turn triggered the corrective action. The listing of</p>

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	organic compounds], PCBs [polychlorinated biphenyls], and organochlorine pesticides." Please revise the text to list the specific SVOCs, PCBs and organochlorine pesticides.	<p>contaminants in this section of the Five Year Review covers all chemical groups present based on analytical sampling performed across the various sites. Further detail in the form of each individual chemical detected seems unnecessary and would not make a significant contribution to the intended summary of soil contamination in Section 3.4.2.</p> <p>As with the response to Specific Comment 14, the groups of chemicals summarized in this section are not intended to identify the comprehensive list of chemicals we reviewed in performing the technical assessment and protective evaluation.</p> <p>Based on the above rationale, we made no change to the Five Year Review Report text relevant to this comment.</p>
16.	Section 3.4.3, SS015, SS016, Page 3-17: The text does not discuss any contaminant exceedance or comparisons with residential shallow soil gas risk-based concentrations (SSG RBC). Please revise the text to include this information.	<p>We modified the text in Section 3.4.3 relative to exceedance of RBCs at Sites SS015 and SS016 as follows:</p> <p>"At Site SS015, maximum concentrations of TCE, vinyl chloride, and cis-1,2-DCE exceed groundwater-to-indoor air RBCs for both residential and industrial land use, while benzene concentrations only exceeded the residential RBCs."</p> <p>"At Site SS016, maximum concentrations of TCE, cis-1,2-DCE, 1,4-DCB, and vinyl chloride exceeded groundwater-to-indoor air RBCs for both residential and industrial land use."</p>
16a	The response addresses the comment; however, it would be helpful to include a statement that the risk-based criteria (RBCs) are updated to federally promulgated toxicity criteria.	<p>We supplemented the response to Specific Comment 16 (above) with the following:</p> <p>"The SSG RBCs reflect values updated to federally promulgated toxicity criteria per the 2013 VI Assessment Update."</p>
17.	Section 4.1.1.1, Source Control Objectives, Page 4-2: This	Section 4 describes the selection and implementation of

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	<p>section states, “During the past five years, RPOs [remedial process options] such as bioreactors and EVO [edible vegetable oil] injections have been implemented to enhance source control;” however, the document does not provide specific details regarding the effectiveness of the RPOs. Please revise the appropriate sections and tables in Section 4.0 to provide additional details regarding the effectiveness of the RPOs.</p>	<p>groundwater IRAs and soil/sediment RAs at sites within the NEWIOU and WABOU. In turn, Subsection 4.1.1.1 is intended to provide a summary of source control objectives, which are one of the interim groundwater remediation objectives.</p> <p>As indicated on Page 4-2, GET is the primary source control measure used to meet these objectives. However, the specific sentence cited in the comment merely clarifies that in addition to GET, RPO and EVO have more recently been implemented in support of achieving source control objectives. Importantly, this section was not intended to provide a summary of the effectiveness of the RPO and EVO activities. Detailed discussion of the effectiveness of the RPOs and EVO activities implemented over the past five years is included in Section 7.1.1.2 and Appendix D.</p> <p>In response to this comment, we added a reference to both of these sections (i.e, 7.1.1.2 and Appendix D) to page 4-2.</p>
18.	<p>Tables 4-2 through 4-8, Pages 4-11 through 4-14: The tables do not include all of the remedy components, as listed in the Comprehensive Five-Year Review Guidance on Page E-23, Section IV, Remedial Actions checklist, item 4. Examples of required descriptions include: engineering controls, institutional controls, cleanup measures, and required monitoring. Additional descriptions from Page E-24 of the Guidance includes: dates of remedial designs (RDs), difficulties or changes during RD, dates RAs were started/completed, performance of each RA, and other Comprehensive Environmental Response Compensation and Liability Act CERCLA or non-CERCLA removal/response actions. Please revise the text to discuss and present this information.</p>	<p>Tables 4-2 through 4-8 summarize the groundwater interim remediation actions and optimization actions for the various groundwater remediation sites across the various OUs. These tables contain a column titled “Original IRA Components and Optimization Actions”, within which the various relevant engineering controls, institutional controls, and required monitoring are listed (for example, “DPE wells, performance monitoring wells, VGAC vapor treatment at WTTP, UV/Ox/LGAC groundwater treatment at CGWTP via WTTP” for SD-036/SD037 in Table 4-4;). In addition dates of remediation designs/implementation (for example, “In situ bioreactor installation conducted in 2008 as a technology demonstration project” for Site DP039 in Table 4-6) and/or completion dates for RAs (e.g, 2-Phase® extraction within OSA discontinued in 2010.</p>

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		<p>UV/Ox and Th/Ox discontinued in 2010" for SS016, Table 4-3) are also listed.</p> <p>Additional descriptions of Post IRA Optimization Actions are also listed in an adjacent column within each of these tables, including response actions such as passive skimming operations (e.g, at SD034-Table 4-4), rebound monitoring (e.g., at SD-033, Table 4-4), etc.</p> <p>As such, relevant remedy components listed in the Comprehensive Five-Year Review Guidance (Guidance) on Page E-23, Section IV, Remedial Actions checklist, item 4, are considered accounted for in Tables 4-2 through 4-8. Accordingly, we made no change to the Five Year Review Report relevant to this comment.</p>
19.	<p>Section 4.3, Groundwater Systems Operation and Maintenance, Page 4-15: The text does not provide adequate information to understand the operation and maintenance (O&M) of the systems. A description of the information needed can be seen in the Guidance on Page E-24, systems O&M. Specifically, items include O&M activities to date, problems encountered during system operations/O&M, original annual O&M cost estimates, actual O&M costs, and reasons for unanticipated or unusually high O&M costs. Please revise the text to include this information.</p>	<p>Section 4.3 of the Five Year Review Report provides a summary of the groundwater systems O&M and RPO of the CGWTP, NGWTP, and South Base Boundary Groundwater Treatment Plant (SBBGWTP) at TAFB. Included are specific discussions relative to groundwater treatment systems a, MNA assessments, and free product removal efforts. Each treatment system and specific O&M activities implemented are summarized. Also included are rolling 12-month operating cost curves (see Figure 4-10 through 4-12) for each treatment plant, which also highlight reasons for unusually high O&M costs. Also worth noting is that this section references the 2011 Annual RPO report which provides detailed descriptions of treatment plant processes, plant optimizations/modifications, volumes of water and soil vapor treated, reuse of treated water, compliance with discharge requirements, field measurements and observations, influent concentration trends, flow rates and the rate of mass removal, treatment plant uptime/downtime, operating costs, evaluations of effectiveness, issues, and optimization</p>

No.	Comments	Responses
		<p>activities.</p> <p>Based on the above, the required information relevant to systems O&M per the Guidance are considered already included in Section 4.3 of the Five Year Review Report, but this information reflects a summary of the groundwater systems O&M and RPOs implemented at TAFB. In order to help better direct the reader to the appropriate information, we added text prior to and after the existing Five Year Review text in this section. Specifically, we have added: 1) additional text indicating where information (relative to O&M systems) is available and where to find that information (this text was added prior to the location of the existing text in Section 4.3), and 2) additional text to refer to locations within the Five Year Review Report where the detailed analysis relative to O&M systems has been performed.</p> <p>Specifically, relative to item 1 above, we added the following text prior to the existing groundwater O&M system summary text in the report:</p> <p>“The Annual RPO report serves as the annual report for the O&M and RPO of the CGWTP, NGWTP, and South Base Boundary Groundwater Treatment Plant (SBBGWTP) at Travis AFB. Specifically, the 2011 Annual RPO report provides detailed descriptions of treatment plant processes, plant optimizations/modifications, volumes of water and soil vapor treated, reuse of treated water, compliance with discharge requirements, field measurements and observations, influent concentration trends, flow rates and the rate of mass removal, treatment plant uptime / downtime, operating costs, evaluations of effectiveness, issues, and optimization activities. This information was used to prepare the summary of groundwater</p>

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		<p>systems O&M outlined below.”</p> <p>Relative to item 2 above, we added the following text after the existing groundwater O&M system summary text in the report:</p> <p>“The technical assessment and evaluation of the performance of the O&M systems across TAFB are included as part of the Groundwater IRA Performance (Section 7.1.1.2), and further discussed in Appendix D.”</p>
20.	<p>Table 4-9, MNA Assessment Conclusions, Page 4-18: The table indicates that the MNA assessments concluded that MNA is either appropriate when implemented normally or through enhanced MNA methods, but supporting information for these conclusions has not been provided in text or tables. Please include additional information supporting the use of MNA at the sites being selected for MNA.</p>	<p>Table 4-9 provides a general summary and bases for MNA conclusions, and the text on page 4-18 refers to the Final MNA Report (2010) as providing the related information. We added the specific MNA assessment for each site to the Technical Assessment (Section 7) and Appendix D of the Five Year Review Report.</p> <p>Similar to the response to Specific Comment 19, in order to provide the reader with better direction, we added text to the report both prior to and after the existing text/table which merely provide a summary of the MNA assessments.</p> <p>Specifically, we modified the text prior to the existing text/table to refer to the Final MNA Report as follows: “The Final Natural Attenuation Assessment Report (CH2M HILL, 2010a) provides detailed data and analysis summarizing MNA assessments performed at relevant ERP sites throughout TAFB. Included are detailed data supporting concentration trends over time, biological degradation indicator parameters used to evaluate the past and potential future occurrence of MNA in groundwater, and analyses of the mechanisms and rates of MNA. The findings of the MNA assessment at relevant ERP sites are summarized in the discussion below.”</p>

No.	Comments	Responses
		<p>We also modified the text after the existing MNA assessment text/ table as follows: "Technical assessment of the MNA has been performed for each site, as documented beginning in Section 7.1.1.3 and further outlined within Appendix D."</p>
21.	<p>Section 5.2, Progress with Groundwater Interim Remedial Actions, Page 5-5: The text states that, "Site LF007C remains the only area where Interim Remedial Action Objectives (IRAOs) have not been achieved," but in Table 5-1, Summary of Protectiveness Statements from the Second Five-Year Review (2008), the information suggests that sites LF007C, SS030 and DP039 all did not function as intended by the IROD. Please provide additional information supporting the inclusion of sites SS030 and DP039 as achieving the associated IRAOs.</p>	<p>For Site SS030, please see response to General Comment 5.</p> <p>Section 7.1.1.2 and Appendix D of the Five Year Review Report provide details of the IRA activities implemented at DP039, including an evaluation of the effectiveness of such activities. These sections document the shutdown in 2008 of the GET system in support of implementing bioreactor and EVO PRB remediation, both of which have been successful in reducing TCE concentrations and are performing as designed (see Appendix D).</p> <p>As indicated in Sections 7.1.1.2 and Appendix D, the areas of the plume beyond the EVO PRB are being monitored for natural attenuation, and continued monitoring is needed to assess the effects of MNA at DP039; hence, while IRA activities have not yet met the objective of the IROD for a portion of the plume, the interim remedy is functioning as intended and the progress toward achieving the remedial objectives for this site are considered ongoing (and covered by existing IROD and pending TAFB Groundwater ROD). Hence, no formal recommendation relative to this site is needed in Section 8.1. However, we revised Table ES-1 and 5-1 to indicate that the interim remedy is functioning as intended by the IROD for DP039.</p>
22.	<p>Table 5-2, SS030 and DP039, Page 5-8: For SS030 the action taken and outcome column notes that an additional well pair was installed, but does not state whether this satisfied the goal of characterizing the extent of contamination to the east of the</p>	<p>As discussed in the response to General Comment 5, the two additional wells (MW2001Ax30 and MW2001Bx30) installed at SS030 did serve the goal of characterizing the extent of contamination to the east of the off-base portion of the plume, and</p>

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	<p>off-base portion of the plume. Also, for DP039, it is not clear how installation of a permeable reactive barrier (PRB) is a “potential extraction system modification.” Note that the Five-Year Review Checklist, in the Comprehensive Five-Year Review Guidance, page E06, Progress since last Five-Year Review, item 3, specifies “including whether they [implemented actions] achieved the intended effect.” Please revise the table to include the required information in the action taken and outcome column. Also, please explain how installation of a PRB is a “potential extraction system modification.”</p>	<p>have helped demonstrate that this portion of the plume remains under capture of the GET system. This finding is discussed in detail in Appendix D. We have also modified Table 5-2 to reflect this finding.</p> <p>Relative to DP039, we modified the text in Table 5-2 to eliminate the text implying that the installation of the PRB is a potential extraction system modification.</p>
23.	<p>Section 6, Five Year Review Process, Page 6-1: Section 6 is missing a discussion of the Site inspections and Interviews for each site. The missing inspection information includes items such as: the inspection date, participants, scope and procedures, results and conclusions, and an inspection checklist. The missing interview information includes such items as: interview dates and locations, participants, documentation, and summaries. Please revise the document to include this information for each site.</p>	<p>Much of this information is included in Appendix C of the Five Year Review Report. We updated Section 6 (and where necessary, Appendix C) to include inspection and interview information including dates, participants, scope and procedures, and conclusions (already stated in Appendix C).</p>
23a.	<p>The response and revisions to the Draft Final Third Five-Year Report does not include summaries of the interviews conducted as part of the 5YRR process, as requested in the comment. Please revise Appendix C to include summaries of the interviews described in Section C.2 of Appendix C</p>	<p>We have updated Appendix C to include summaries of the responses to the interview questions.</p>
24.	<p>Section 7.1.2.1, Changes in Standards and TBCs, Page 7-12: This section does not address changes in Preliminary Remediation Goals (PRGs)/ RSLs that have occurred since the last Five-Year Review. Since PRGs and later RSLs were used as Removal Action Levels (RALs) at several sites, changes to these To Be Considered (TBC) criteria (i.e., for TCE) should be</p>	<p>The sole RSLs (used as TBCs) that have changed since implementation of RAs were those associated with select PAHs, which were documented in Section 7.2.2.1 of the Five Year Review Report (see response to Specific Comment 27). We revised the text in Section 7.1.2.1 as follows:</p>

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	<p>presented. The text should also discuss whether any of these changes affect the protectiveness of the remedies. Please revise the Five-Year Review to describe changes in PRGs/RSLs since the last Five-Year Review and clarify whether any of these changes affect the protectiveness of the remedies.</p>	<p>“USEPA’s Region IX PRGs (now referred to as RSLs) for PAHs in residential soils served as the basis for several RAs conducted at TAFB. Since those RAs were implemented, the RSLs have been updated, resulting in revised residential soil RSLs for several PAHs, including benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, dibenzo(a,h)anthracene, and indeno(1,2,3-c,d)pyrene. Section 7.2.2.1 includes an assessment of these changes in TBCs, concluding that these changes did not affect the protectiveness of the RAs implemented at TAFB.”</p> <p>It should be noted that there were no changes to the TCE MCL used in support of IRAs for groundwater. With the addition of the 2013 Vapor Intrusion Assessment Update to the Five Year Review Report, the toxicity changes associated with TCE (and PCE) which impacted development of RBCs for VI are now relevant and have been incorporated into Sections 7.1.2.3 and 7.2.2.3 in accordance to the response to Specific Comment 25.</p>
25.	<p>Sections 7.1.2.3 and 7.2.2.3, Changes in Toxicity and Other Contaminant Characteristics, Pages 7-13 and 7-26: These sections do not discuss the recent changes in TCE and tetrachloroethylene (PCE) toxicity data. Please revise the text to include the required information on these changes and how these changes affect the protectiveness of the remedies at all applicable sites.</p>	<p>The 2013 Vapor Intrusion Assessment Update was largely prompted by the recent changes in TCE toxicity data. With the findings of this VI update now added to the Five Year Review Report (per response to General Comment 4), we modified the text to pages 7-13 and 7-26 as follows:</p> <p>“Since the original VI Assessment performed in 2009-2010, toxicity values for TCE changed. The change in toxicity values for TCE correspond to revised inhalation unit risks for carcinogens and reference concentrations for noncarcinogenic effects. In response to these changes, industrial and residential groundwater, indoor air, subslab, and soil gas RBCs were recalculated in the 2013 Vapor Intrusion Assessment Update, as summarized in Section 3.4.3 of</p>

No.	Comments	Responses
		<p>the Five Year Review Report. The updated toxicity values were therefore accounted for in the VI assessment and related recommendations documented in this Five Year Review Report, and which have been incorporated into the pending TAFB Groundwater ROD.</p> <p>The changes in the toxicity values did not result in any corresponding changes to the MCLs for these chemicals. Nor were these chemicals targeted for soil removal actions performed at TAFB; hence, the changes in toxicity did not affect the protectiveness of the remedies implemented at TAFB.”</p>
25a	<p>The response addresses the comment; however, the discussion focuses only on TCE toxicity criteria and does not include a discussion of updates for other volatile organic compounds (VOCs) that are contaminants of concern (COCs). Please also include a statement that toxicity criteria are updated for other COCs, as appropriate and documented in the 2013 Vapor Intrusion Update.</p>	<p>We supplemented the response to Specific Comment 25 (above) with the following:</p> <p>“In addition to TCE, the 2013 Vapor Intrusion Assessment Update incorporated federally promulgated toxicity criteria for the following COCs:</p> <ul style="list-style-type: none"> Carbon tetrachloride Chlorobenzene Chloroform Chloromethane 1,1-Dichloroethene 1,2-Dichloroethane Tetrachloroethene Toluene 1,1,2-Trichloroethane “
26.	<p>Figure 7-6, West IRA Site DP039 TCE distribution 2008-2011: The plume configurations depicted for 2008 and 2011 are quite different. It is not clear if this is due to the installation of</p>	<p>Comparison of the two plume configurations shown on Figure 7-6 (for 2008 and 2011) reveal changes in both magnitude and extent in the TCE plume over this time period. As discussed extensively in</p>

No.	Comments	Responses
	<p>additional monitoring wells or plume migration. Please revise the associated text to discuss this information.</p>	<p>Section 7.1.1.3 of the Five Year Review Report, various IRA activities including the startup of the bioreactor, implementation of the EVO PRB, and MNA have all contributed to declining concentrations and plume extent across various portions of the TCE plume at DP039. As additional wells have been installed and monitored throughout this plume over the past several years, some of the observed changes in the extent of the plume are in part been due to placement of new wells and availability of data from locations previously not monitored. Therefore, we modified the text on page 7-8 (DP039 MNA Evaluation) as follows: "Changes in the magnitude and extent of the DP039 TCE plume between 2008 and 2011 (Figure 7-6) primarily reflect the impacts of the aforementioned remediation efforts, but the addition of new wells in this time frame to more accurately define the extent of the plume and associated concentration trends have also contributed to the observed differences in plume configurations shown on Figure 7-6."</p>
27.	<p>Section 7.2.2.1, Changes in Standards and TBC, Page 7-24: The second bulleted item on Page 7-24 states, "When confirmation soil samples reported PAH [polynuclear aromatic hydrocarbon] concentrations higher than the 2013 residential soil cleanup goals, the frequency of PAH detection and estimated cancer risk were considered to evaluate soil remedial action protectiveness." Frequency of detection is not sufficient to reach conclusions regarding the protectiveness of the remedies. This determination should be made considering total risk and juxtaposition as well as areal extent of the detections. Please revise the evaluation of the changes in chemical-specific cleanup goals to consider total risk and juxtaposition as well as areal extent of the detections, rather than frequency of</p>	<p>Frequency of detection was one of a combination of information/evidence used to determine if changes in soil PAH standards over the past five years had a significant impact on satisfactory completion of soil RAs and associated site closure.</p> <p>As the first step of the evaluation, the frequencies of detections were calculated as they helped put into perspective the quantity of PAH detections above detection limits and above the updated residential RSLs in confirmation samples collected following the soil RAs. As indicated on page 7-24 of the Five Year Review Report, the next step in the evaluation included screening of the maximum or 95% upper confidence limit of the mean concentration (UCL) of PAHs within the confirmation samples to the updated RSLs. Lastly, estimates of potential cancer risks were</p>

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	<p>detections above the soil cleanup goal.</p>	<p>back-calculated based on the 95% of the PAH analyses and the relevant RSLs. As indicated by the analysis, estimated health risks are within the lower end of the EPA’s risk management range; therefore, the resulting change in the cleanup goal was deemed to have an insignificant impact on the protectiveness of the remedies implemented.</p> <p>Assessment of the areal extent of the detections above the updated RSLs did not reveal any observable geographic trends and most individual sample exceedances were accompanied by nearby samples that were either non-detect or below the updated RSL. The detections above RSLs remain sporadic (in part exemplified by the frequency of detections) and as previously indicated, the remaining levels of PAHs reflected by confirmation sample results do not pose potential adverse health risks.</p> <p>We revised the text on page 7-24 to reflect the discussion above on the areal extent.</p>
28.	<p>Section 8.1, Groundwater Interim Remedial Action Issues and Follow-up Actions, Page 8-1: The text does not include any recommendation to address/control off-site plume migration. The recommendation to “test extraction rates,” is not sufficient. For example, Section 9.1.1 states that follow-up actions need to be taken, but Section 8.1 should provide specific follow-up action recommendations. Please revise Section 8.1 to provide a recommendation to address/control off-site plume migration.</p>	<p>The text on Page 8-1 of the in the Five Year Review Report indicates that that the existing extraction wells are inadequate to control migration or remediate the plume. This section of the Five Year Review Report further acknowledges that in response to additional site investigations activities (described in detail in Appendix D), extraction system modifications and RPO activities have been identified as the basis for addressing this inadequacy. However, the Five Year Review Report lists several concerns and recommendations relative to the proposed modifications/RPOs that must be considered. The specific concerns/recommendations listed in Section 8.1 include:</p> <ul style="list-style-type: none"> - Accounting for physical hydrogeologic constraints which

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		<p>can significantly impact the number of necessary extraction wells, their placement and operational patterns, and well capture zones;</p> <ul style="list-style-type: none"> - accounting for the influence of the bedrock surface on the migration and spatial distribution of the TCE plume, which in turn can significantly affect well placement and operation patterns necessary to capture the TCE plume off-base; - the need to test the proposed refined well extraction rates (which were defined by modeling) to ensure they are in fact sustainable under actual field conditions (as opposed to estimates based on simplified conditions represented in the model which may overestimate well capture zones); and - accounting for the fact that the vernal pool serves as a significant source of groundwater recharge capable of minimizing the extent of well capture zones. <p>Through the above list, the Five Year Review Report has recommended a comprehensive evaluation of GET system expansion, upgrade, and RPO, accounting for many factors that can significantly influence operation of the system and plume capture off-base. "Testing of well extraction rates", as suggested by the comment, is only one component of the recommendations listed in the report relative to control of LF007C off-base plume.</p> <p>Based on the above rationale, we made no changes to the Five Year Review Report relative to this comment.</p>

No.	Comments	Responses
29.	Miscellaneous comments on Five-Year Review Form and Issues/Recommendations, and Protectiveness Statements per September 11, 2013 email from EPA.	We modified the Five-Year Review Form and updated issues/recommendations and protectiveness sections in the ES, Review Form, and Sections 8 and 9 of the report, in response to the EPA comments.