Former Castle Air Force Base
Atwater, California

Fifth Five-Year Review Report for Former Castle Air Force Base Merced County, California

Final

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Prepared for
Air Force Civil Engineer Center
JBSA Lackland, Texas 78236-9853

by

2485 Natomas Park Drive, Suite 600
Sacramento, California 95833

Under Subcontract to

12037 Starcrest Drive
San Antonio, Texas 78247-4349

Stephen G. TerMaath

STEPHEN G. TERMAATH, GS-15, DAF
Chief, BRAC Program Management Division
Installations Directorate
Air Force Civil Engineer Center

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Date

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LIST OF ABBREVIATIONS AND ACRONYMS

µg/kg	microgram(s) per kilogram
µg/L	microgram(s) per liter
ARAR	applicable or relevant and appropriate requirement
bgs	below ground surface
BCT	BRAC Cleanup Team
BRAC	Base Realignment and Closure
BoP	Bureau of Prisons
BV	biovent
CAFB	Castle Air Force Base
CB	comprehensive basewide
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CH2M	CH2M HILL
CPCMP	Closure and Post-Closure Maintenance Plan
COC	contaminant of concern
CVRWQCB	Central Valley Regional Water Quality Control Board
DA	discharge area
DBCP	dibromochloropropane
DCE	dichloroethene
DP	disposal pit
DTSC	California Department of Toxic Substances Control
E&D	excavation and disposal
EPA	United States Environmental Protection Agency
ETC	Earth Technology Corporation
FFS	focused feasibility study
FS	feasibility study
FTA	fire training area
FYR	five-year review
GAC	granular activated carbon
gpm	gallon(s) per minute
HDPE	high-density polyethylene
HH	human health
HHRA	human health risk assessment
HpCDF	heptachlorodibenzofuran
HQ	hazard quotient
HSZ	hydrostratigraphic zone
HxCDD	hexachlorodibenzodioxin
HxCDF	hexachlorodibenzofuran
IAG	Interagency Agreement
IC	institutional control
ID	site identification
IRP	Installation Restoration Program
LF	Landfill
LSS	Lower Subshallow (HSZ)
LTGSP	Long-Term Groundwater Sampling Program

LTEM	long-term ecological monitoring
LTM	long-term monitoring
MCL	maximum contaminant level
mg/kg	milligram(s) per kilogram
MOU	Memorandum of Understanding
NA	not applicable
ND	nondetect
O&M	operation and maintenance
OCDD	octachlorodibenzodioxin
OM&M	operations, maintenance, and monitoring
OU	operable unit
PAL	project action limit
PFC	perfluorinated compound
PFOS/PFOA	perfluorooctane sulfonate/perfluorooctanoic acid
PHA	Provisional Health Advisory
Q#/##	quarter (number)/(year)
RAO	remedial action objective
RI	remedial investigation
ROD	record of decision
RSL	regional screening level
SCOU	source control operable unit
SLUC	state land use covenant
SVE	soil vapor extraction
TBC	to be considered
TCE	trichloroethene
TCP	trichloropropane
TEPH	total extractable petroleum hydrocarbons
TPH	total petroleum hydrocarbons
TVPH	total volatile petroleum hydrocarbons
USAF	U.S. Air Force
USS	Upper Subshallow (HSZ)
UU/UE	unlimited use and unrestricted exposure
VOC	volatile organic compound
WQ	water quality
WQSA	Water Quality Settlement Agreement

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I. INTRODUCTION

The purpose of a Five-Year Review (FYR) is to evaluate the implementation and performance of a remedy to determine if the remedy is, and will continue to be, protective of human health and the environment. The methods, findings, and conclusions of reviews are documented in FYR reports, such as this one. In addition, FYR reports identify issues found during the review, if any, and document recommendations to address them.

The U.S. Air Force (USAF) is preparing this FYR pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Section 121, consistent with the National Contingency Plan (40 Code of Federal Regulations Section 300.430(f)(4)(ii)) and considering United States Environmental Protection Agency (EPA) policy and guidance.

This is the fifth FYR for the Former Castle Air Force Base (CAFB). The triggering action for this statutory review is the completion date of the previous FYR report. The FYR report has been prepared because the remedies will take more than 5 years from the time of remedy implementation to achieve unlimited use/unrestricted exposure (UU/UE) or hazardous substances, pollutants, or contaminants remain at the site above levels that allow for UU/UE.

The Base consists of two operable units (OUs), both of which will be addressed in this FYR report. The groundwater OU addresses the groundwater plumes and remedies and includes the Main Base Plume. It should be noted that two initial groundwater treatment systems installed and operated at CAFB were designated OU-1 and OU-2, and both became part of the Groundwater OU (also referred to as the Comprehensive Basewide Groundwater OU and referred to as OU-5 by EPA). The Castle Vista Plume, which was part of the groundwater OU and was included in the fourth FYR report (MWH, 2014), is not included in this FYR report because the remedy is complete and the site has been closed. The source control OU (SCOU) (referred to as OU-4 by EPA) addresses the vadose zone sites. SCOU sites addressed are Earth Technology Corporation (ETC)-10, Fire Training Area (FTA)-1, Landfill (LF)-4, and LF-5. Associated sites also addressed herein are Disposal Pit (DP)-5 and DP-6 at LF-4, and DP-8, DP-8A, and LF-5 trenches at LF-5. SCOU sites ETC-12 and LF-3, which were included in the fourth FYR report, are not included in this FYR report because their long-term ecological monitoring (LTEM) remedies are complete and the sites have been closed.

A. Site Background

The former CAFB is in central California within the San Joaquin Valley in Merced County, as shown on Figure 1. The site is approximately 6 miles northwest of Merced, near the communities of Winton (to the north and west) and Atwater (to the southwest). The former CAFB covered an area of 2,777 acres composed of runway and airfield operations, industrial areas, housing, recreational facilities, and several noncontiguous parcels of land located near the former CAFB. The largest noncontiguous parcels are two former housing annexes (Castle Gardens and Castle Vista) and a park, located southwest of the former Base (Figure 1). The sites included in this FYR report are presented on Figure 2.

Land use within a 3-mile radius of the former CAFB is mixed urban and agricultural. Several small dairies, a large chicken ranch, row crops, and open pasture land are located immediately east of the former CAFB. Open pasture land is predominant to the south. An urbanized area (City of Atwater) bounds the site to the southwest. Almond orchards and sweet potato fields are predominant to the west, while mixed orchards and pasture land are predominant to the north. There are several environmentally sensitive wetland areas within the former CAFB, mostly in the eastern and northern portions.

Numerous activities/facilities at the former CAFB resulted in releases of contaminants to soil and groundwater. Contamination at the former CAFB was first identified in 1978 when trichloroethene (TCE) was detected in groundwater samples from several on-base production wells. Source areas include engine and maintenance shops, wash racks and discharge areas, landfills and disposal pits, storage tanks and tank farms, utility pipelines, hazardous waste storage sites and solid waste management units, surface releases,

and fire training areas. These source areas resulted in groundwater contamination at the former CAFB within the Main Base Plume and other smaller plumes.

ETC-10 was an active skeet-shooting range until 1995. Wetlands are present to the north and south, as well as in the western portion of the site. The presence of clay pigeon shards and lead pellets was confirmed during a visual inspection of the site before the *SCOU Remedial Investigation (RI)/ Feasibility Study (FS)* (Jacobs, 1997a). Based on the ETC-10 site configuration, particulate deposits were distributed in a fan-shaped arc extending 300 to 500 feet radially from the shooting stand location.

FTA-1 was used for fire training exercises from 1955 through 1975. A 2,000-gallon storage tank was used for the weekly accumulation of fuel, waste oil, solvents, and other chemicals at the site. These stored materials were placed into soil pits and ignited. Other chemicals were stored in 55-gallon drums and were burned in an area adjacent to the soil pits. Several burn areas were identified from aerial photographs. The burn areas at FTA-1 were unlined with no surface fluid collection system. The land surface at FTA-1 is unpaved except for the area surrounding Building1888 (B1888). Wetlands are located to the north, east, and west of the site.

LF-4 was a landfill used between 1957 and 1970. It was a trench-and-fill style landfill operation, containing approximately 26,000 cubic yards of municipal-type waste. Minor amounts of chemical wastes may also have been disposed in LF-4. The northern third of the landfill (previously part of an agricultural field) was incorporated into LF-4 between 1957 and 1961. The southern two-thirds of the landfill includes twelve trenches that were excavated to approximately 16 feet below ground surface (bgs) before receiving waste materials. Disposal pits DP-5 and DP-6 were located at the southern end of LF-4 and were reportedly used for the disposal of industrial wastes (including solvents, oils, and other miscellaneous chemicals) between 1954 and 1970.

LF-5 was a landfill used between 1971 and 1977. The landfill was unlined and contained approximately 100,000 cubic yards of waste materials, primarily municipal wastes, construction wastes, and demolition debris. LF-5 contained 12 trenches (A through L; LF-5 trenches) and 5 disposal pits (DP-7, DP-8, DP-8A, DP-9, and DP-10). The trenches extended to a depth of approximately 15 feet bgs. Portions of the trenches and the disposal pits were reportedly used for the disposal of 55-gallon drums and uncontained liquid chemical wastes from CAFB operations. Wetlands are located to the south, east, and west of the site.

B. Five-Year Review Summary Form

SITE IDENTIFICATION		
Site Name: Former Castle Air Force Base		
EPA ID: CA3570024551		
Region: 9	**State:** CA	**City/County:** Atwater/Merced County
SITE STATUS		
National Priorities List Status: Final		
Multiple OUs?	**Has the site achieved construction completion?**	
Yes	Yes	
REVIEW STATUS		
Lead agency: Other Federal Agency ***[If "Other Federal Agency", enter Agency name]*:** USAF		
Author name (Federal or State Project Manager): CH2M		
Author affiliation: CH2M		
Review period: 6/30/2013 - 6/30/2018		
Date of site inspection: 7/12/2018		
Type of review: Statutory		
Review number: 5		
Triggering action date: 3/11/2014		
Due date *(five years after triggering action date)*: 3/11/2019		

II. RESPONSE ACTION SUMMARY

A. Basis for Taking Action

TCE and other volatile organic compounds (VOCs) were identified as contaminants of concern (COCs) in groundwater at the Main Base Plume because they were detected in groundwater at concentrations exceeding their respective maximum contaminant levels (MCLs). Table 1 presents the COCs, remedial action objectives (RAOs), and cleanup levels for the Main Base Plume as identified in the comprehensive basewide (CB) record of decision (ROD) Parts 1 and 2 (USAF, 1997a; AFRPA, 2006a).

Soil COCs at SCOU sites were identified based on their potential to affect human health, to result in concentrations in groundwater exceeding the federal or state MCLs, or to pose risk to ecological receptors. Table 1 presents the COCs, RAOs, and cleanup levels for sites ETC-10, FTA-1, LF-4, and LF-5 as identified in the *SCOU ROD – Part 3* (Jacobs, 2005).

Table 1: Selected Remedies, RAOs, COCs, and Cleanup Levels for Sites Addressed in this FYR Report

Site (USAF ID)	Remedy	RAOs	COCs (Basis)	ROD Cleanup Level	Decision Documents
Groundwater OU (OU-5)					
Main Base Plume (OT029 and OT030)	• Pump and treat system for plume capture and cleanup to MCLs • ICs to restrict groundwater use • Wellhead treatment or provision of an alternative supply for public and private drinking water wells that exceed an MCL due to impacts from a CAFB plume • Local treatment to remove contaminant mass and/or reduce potential contaminant impact on municipal water supply wells in the off-base Confined HSZ plume where plume capture is impractical	• Capture and clean up groundwater contamination to MCLs • Prevent exposure to groundwater from a CAFB plume containing chemicals of concern above the MCL • Protect the integrity of the remedial system(s), and the associated monitoring system, until the remedy is complete	Benzene (WQ) Cis-1,2-DCE (WQ) Carbon tetrachloride (WQ) Chloroform (WQ) Di-ethylhexyl phthalate (WQ) TCE (WQ) Tetrachloroethene (WQ)	1 µg/L 6 µg/L 0.5 µg/L 100 µg/L 4 µg/L 5 µg/L 5 µg/L	*CB ROD – Part 1* (USAF, 1997a) *CB ROD – Part 2* (AFRPA, 2006a)

Table 1: Selected Remedies, RAOs, COCs, and Cleanup Levels for Sites Addressed in this FYR Report

Site (USAF ID)	Remedy	RAOs	COCs (Basis)	ROD Cleanup Level	Decision Documents
Source Control OU (OU-4)					
ETC-10 (SS189)	ICs and LTEM	• Prevent use of the ETC-10 site that would result in potential human exposure to contaminated soils at ETC-10 under residential use conditions • No adverse impact to wetland habitat or species	Benzo(a)pyrene (HH)	0.089 mg/kg	*SCOU ROD – Part 3* (Jacobs, 2005)
FTA-1 (FT001)	SVE, BV, LTM, ICs, E&D, and LTEM	• Protect remedial system from damage and protect the integrity of the cap. • Prohibit activities that would limit access to any equipment and systems associated with monitoring and maintenance. • Prevent human exposure to contaminated soils below the FTA-1 cap • No adverse impact to wetland habitat or species	<u>Soil</u>: Arsenic (HH) Benzene (WQ) Benzo(a)pyrene (HH) Cadmium (HH) Chloroform (WQ) Cis-1,2-DCE (WQ) 1,2-Dichloroethane (WQ) Lead (HH) OCDD (HH) 1,2,3,4,6,7,8-HpCDF (HH) HxCDD (HH) HxCDF (HH) TCE (WQ) TEPH (WQ) TVPH (WQ) Freon 11 (WQ) 1,2,4-Trimethylbenzene (WQ) Zinc (WQ)	 9.9 mg/kg 68.4 µg/kg 0.12 mg/kg 15 mg/kg 68.4 µg/kg 21.5 µg/kg 8.5 µg/kg 755 mg/kg 24 µg/kg 2.4 µg/kg 0.24 µg/kg 0.24 µg/kg 47.8 µg/kg 1,500 mg/kg 100 mg/kg 8.5 µg/kg 28,480 µg/kg 319 mg/kg	*SCOU ROD – Part 3* (Jacobs, 2005)
			<u>Soil Vapor</u>: Benzene (WQ) Carbon tetrachloride (WQ) Chloroform (WQ) Cis-1,2-DCE (WQ) TCE (WQ) Toluene (WQ)	 5.8 µg/L 2 µg/L 19.8 µg/L 15.7 µg/L 6.8 µg/L 11.3 µg/L	

Table 1: Selected Remedies, RAOs, COCs, and Cleanup Levels for Sites Addressed in this FYR Report

Site (USAF ID)	Remedy	RAOs	COCs (Basis)	ROD Cleanup Level	Decision Documents
LF-4 (LF007, including DP106 and DP107)	LTM and ICs	• Prevent contact with landfill wastes and gases • Prevent or minimize migration of landfill contents to the vadose zone and to groundwater • Protect remedial system from damage and protect the integrity of the caps and associated systems • Prohibit activities that would limit access to any equipment and systems associated with monitoring and maintenance	Based on post-removal action conditions, there are no identified COCs for LF-4	NA	*SCOU ROD – Part 3* (Jacobs, 2005)
LF-5 (LF008, including DP095 and DP096)	LTM, ICs, and LTEM	• Prevent contact with landfill wastes and gases • Prevent or minimize migration of landfill contents to the vadose zone and to groundwater • Protect remedial system from damage and protect the integrity of the caps and associated systems • Prohibit activities that would limit access to any equipment and systems associated with monitoring and maintenance. • No adverse impact to wetland habitat or species	Metals (Eco)	NA	*SCOU ROD – Part 3* (Jacobs, 2005)

Notes

Basis indicates if risk was driven by HH, WQ, or ecological (Eco)

µg/kg = microgram(s) per kilogram
µg/L = microgram(s) per liter
BV = biovent
DCE = dichloroethene
E&D = excavation and disposal
HH = human health
HpCDF = heptachlorodibenzofuran
HSZ = hydrostratigraphic zone
HxCDD = hexachlorodibenzodioxin
HxCDF = hexachlorodibenzofuran
IC = institutional controls
ID = site identification
LTEM = long-term ecological monitoring
LTM = long-term monitoring
mg/kg = milligram(s) per kilogram
NA = not applicable
OCDD = Octachlorodibenzodioxin
SVE = soil vapor extraction
TEPH = total extractable petroleum hydrocarbons
TVPH = total volatile petroleum hydrocarbons
WQ = water quality

B. Pre-ROD Response Actions

Several pre-ROD groundwater and vadose zone removal actions were undertaken at the Former CAFB to address groundwater, soil, or soil gas contamination. Groundwater removal actions were implemented at former Main Base Plume source areas, including Discharge Area (DA)-4 and Wallace Road in 1991 and at Building 84 (B84) in 1993. Excavation and disposal (E&D) consolidation and capping, and soil vapor extraction (SVE) removal actions were completed at numerous SCOU sites. The removal actions are precursors to the remedial actions ultimately addressed in this FYR report as defined in the *CB ROD – Part 1* (USAF, 1997a), the *CB ROD – Part 2* (AFRPA, 2006a), and the *SCOU ROD – Part 3* (Jacobs, 2005) and are briefly discussed below.

DA-4 Groundwater Removal Action – The DA-4 groundwater treatment system (Figure 3), located adjacent to the DA-4 site, was implemented to address a hot spot area of groundwater contamination that had a maximum TCE concentration of approximately 2,000 µg/L at the time of system startup. The system operated from July 1991 until it was decommissioned in May 1995. TCE concentrations in the system influent ranged from approximately 2,000 µg/L at startup to 58 µg/L at shutdown. The system removed an estimated 414 pounds of TCE and treated approximately 341 million gallons of groundwater.

Wallace Road Groundwater Removal Action – The Wallace Road groundwater treatment system (Figure 3), located along the western Base boundary south of the DA-4 site, was implemented to address a hot spot area of groundwater contamination that had a maximum TCE concentration of approximately 120 µg/L at the time of system startup. The system was in operation from December 1991 until April 1996, when it was taken offline to accommodate construction of the OU-2 groundwater treatment plant. TCE concentrations in the system influent ranged from approximately 120 µg/L at startup, to 42 µg/L at shutdown. The system removed an estimated 438 pounds of TCE and treated approximately 969 million gallons of groundwater.

B84 Groundwater Removal Action – The B84 groundwater treatment system (Figure 3), located near SCOU sites B84, B54, and B51, was implemented to address a hot spot area of groundwater contamination that had a maximum TCE concentration of approximately 480 µg/L at the time of system startup. The system was in operation from January 1993 through May 1994, when it was taken offline to accommodate startup of the OU-1 system (July 1994). TCE concentrations in the system influent ranged from approximately 480 µg/L at startup, to about 130 µg/L at shutdown. The system removed an estimated 222 pounds of TCE and treated approximately 116 million gallons of groundwater.

OU-1 and OU-2 Groundwater Remedial Actions – The general location and extent of OU-1 and OU-2 correspond to the southeast and northwest portions of the Main Base Plume (Figure 3) and are part of the Groundwater OU. The *Interim OU-1 ROD* was finalized in August 1991 (USAF, 1991). The stated purpose of the OU-1 action was to remove contaminants from hot spots in the Shallow HSZ Main Base Plume. The system (completed in the Shallow HSZ) was placed in service on 29 July 1994, upgraded during the spring of 1996 to improve performance (a fifth extraction well was installed), and was taken offline in 2003. A ROD for OU-2 was finalized in November 1993 (USAF, 1993). The stated OU-2 groundwater treatment system objective was to remediate degraded groundwater in the OU-2 area, or that portion of the Main Base Plume as defined in 1992-1993 not covered by the OU-1 groundwater treatment system. The system (completed in the Shallow HSZ and Upper Subshallow [USS] HSZ) went online on 22 November 1996.

Removal actions conducted at SCOU sites ETC-10, FTA-1, LF-4, and LF-5 are briefly discussed below.

ETC-10 –Excavation and onsite disposal was selected as an interim remedy for ETC-10 as presented in the 1996 action memorandum (USAF, 1996). The removal action took place from 27 July 1997 through 10 August 1998. Approximately 5,050 cubic yards of contaminated soil was excavated and disposed of in LF-5. However, at completion of the removal action, lead and benzo(a)pyrene concentrations in soil met occupational but not residential RAOs. As part of the *CB RI/FS – Part 2* (Jacobs, 2002), two focused feasibility studies (FFSs) were performed for ETC-10 to address post-removal action concerns.

FTA-1 –A removal action comprising an SVE system and surface cap was implemented in 1996 as presented in the 1995 Action Memorandum (USAF, 1995). The SVE system operated intermittently through August 2005.

LF-4 –An LF-4 removal action—which included site preparation, excavation of waste from perimeter trenches, consolidation of LF-4 wastes and waste materials excavated from other authorized CAFB sites, confirmation sampling, backfilling excavated trenches, and cap installation—was initiated in October 1997 and completed in September 1999 as documented in the Action Memorandum (USAF, 1997b). Approximately 6,500 cubic yards of non-hazardous, non-designated waste was excavated from perimeter trenches at LF-4 and placed in the area to be capped. Approximately 240,000 cubic yards of waste material and contaminated soil meeting landfill acceptance criteria (non-hazardous and non-designated waste) was imported from other CAFB SCOU sites and placed in the area to be capped. The consolidated waste and soil was covered with an engineered alternative to a Class III cap. The caps (two separate areas were capped) consist of a gas collection layer, a low-permeability layer, a drainage layer, and a vegetative cover. The *LF-4 and LF-5 Closure Report* was finalized in May 2003 (Jacobs, 2003). A post-closure long-term maintenance and monitoring program was initiated, following capping.

LF-5 –The LF-5 removal action (as presented in the Action Memorandum [USAF, 1998])—which included site preparation, excavation of waste from perimeter trenches, consolidation of LF-5 wastes and waste materials excavated from other authorized CAFB sites, confirmation sampling, backfilling excavated trenches, and cap installation—was initiated in November 1998 and completed in September 1999. Approximately 19,000 cubic yards of non-hazardous, non-designated waste was excavated from perimeter trenches at LF-5 and placed in the area to be capped. Approximately 100,000 cubic yards of waste material and contaminated soil meeting landfill acceptance criteria (non-hazardous and non-designated wastes) was imported from other CAFB SCOU sites and placed in the area to be capped. The consolidated waste and soil was covered with an engineered alternative to a Class III cap. The cap consists of a gas collection layer, a low-permeability layer, a drainage layer, and a vegetative cover. The *LF-4 and LF-5 Closure Report* was finalized in May 2003 (Jacobs, 2003). A post-closure, long-term maintenance and monitoring program was initiated following capping. The ecological FFS identified LTEM as the preferred alternative to address concerns regarding the wetlands adjacent to LF-5 (Jacobs, 2002).

Table 1 presents the final selected remedy, RAOs, COCs, associated cleanup levels for each COC, and decision documents associated with the Main Base Plume, ETC-10, FTA-1, LF-4, and LF-5.

C. Status of Implementation

Main Base Plume – All portions of this remedy have been implemented. The following bullets note the status of the remedy implementation for each component:

- Pump and treat for plume capture:
  - Phase 1 consisted of the existing OU-1 and OU-2 systems (Figure 3), operational since July 1994 and November 1996, respectively, as discussed above under response actions. With regulatory approval, the OU-1 treatment system was taken offline on 27 May 2003 and decommissioned in July 2011. The OU-2 treatment system is still operational.
  - Phase 2 consisted of a separate groundwater treatment system (treatment plant and wells) established to address groundwater contamination in the deeper HSZs (USS, Lower Subshallow [LSS], and Confined) downgradient of the OU-1 system. Phase 2 began operation in September 1997 and was converted to the Phase 3 system in May 2000.
  - Phase 3 consisted of an expansion of the Phase 2 groundwater treatment system (Figure 3), including additional extraction and treatment capacity. The Phase 3 expansion came online in May 2000 and is still operational.
- Institutional Controls (ICs) to restrict groundwater use: ICs (land use restrictions) were incorporated as a grantee covenant in the deed formally transferring the former CAFB to Merced County. Similar ICs were incorporated as a grantee covenant in the deed transferring portions of the former Castle

Gardens and Castle Vista housing areas to private landowners. Groundwater use on the property transferred to the Bureau of Prisons (BoP) was already restricted by terms of the USAF/BoP Memorandum of Understanding (MOU).

- Wellhead treatment or provision of an alternative drinking water supply to protect against adverse impacts to public and private drinking water wells: Regular monitoring of contaminant concentration in public and domestic water supply wells downgradient of CAFB remains a component of the Long-Term Groundwater Sampling Program (LTGSP). If a COC (see Table 1) concentration in any drinking water well begins to exceed one half the MCL, the USAF has agreed that, in consultation with EPA, California Department of Toxic Substances Control (DTSC), and Central Valley Regional Water Quality Control Board (CVRWQCB), it will take immediate action, as necessary, to implement wellhead treatment or provide an alternative drinking water supply. The USAF was previously maintaining a wellhead treatment system at downgradient domestic well D5766, but the system was taken offline in 2016.
- Local treatment to remove contaminant mass and/or reduce potential contaminant impact on municipal water supply wells in the off-base Confined HSZ plume where plume capture is impractical: The USAF has installed and operated three wellhead treatment systems in the off-base Confined HSZ plume (MW941, MW951, and MW1009) to address contaminant migration toward AM18. Based on declining TCE concentrations, MW941 and MW1009 wellhead treatment systems were shut down in 2004 and 2008, respectively. The MW951 system remained in operation until June 2016, at which time it was taken offline to conduct a rebound study. Based on the results of the rebound study, the system was ultimately decommissioned in early 2018.

ETC-10 – All portions of this remedy have been implemented. The following bullets note the status of the remedy implementation for each component:

- ICs: currently in place and implemented as follows:
  - The USAF/BoP MOU precludes site alterations that would interfere with the Interagency Agreement (IAG) or Installation Restoration Program (IRP) activities without notification of EPA, DTSC, and the USAF and approval of the USAF.
  - The USAF/BoP MOU establishes access for the USAF and the Base Realignment and Closure (BRAC) Cleanup Team (BCT).
  - Other than access required pursuant to the IAG /IRP, the BoP's Preservation Area Mitigation and Management Plan (Berger, 1998) restricts access to activities that are necessary for implementation of the plan.
  - Elements of prison security (e.g., patrolled security fencing) restrict the potential for human exposure to site contamination.
- LTEM: Implemented in the spring of 2008 and conducted again in 2016. LTEM could not be conducted in 2013 as originally scheduled because of drought-like conditions. Both the 2008 (presented as Appendix B in the third FYR report [Jacobs, 2009]) and 2016 surveys (CH2M, 2016b) concluded there was no evidence that site contaminants had impacted the wetland habitats. Consequently, LTEM ceased in 2016.

FTA-1 – All portions of this remedy have been implemented. The following bullets note the status of the remedy implementation for each component:

- SVE: Implemented as part of a removal action starting in 1996 that included the construction of a surface cap consisting of a soil layer on top of a high-density polyethylene (HDPE) liner. SVE operated intermittently through August 2005.
- BV: At completion of the SVE removal action, it was determined that BV was not necessary.
- LTM: Initiated in 1999 concurrent with implementation of the post-closure maintenance and monitoring program for LF-4 and LF-5 and in accordance with the *Closure and Post-Closure*

Maintenance Plan [CPCMP] for Castle Airport Landfills (Jacobs, 1997c). LTM activities at FTA-1 include semiannual inspections of the cap, monitoring wells, drainage ditch elevations and condition (additional inspection after major rain events), site security, roads, and completion of any necessary repairs. The *CPCMP – Update 2* (AFRPA, 2006b) establishes inspection and monitoring requirements for semiannual activities, annual activities, and after major rain events. Reports documenting inspection results are prepared annually. Two new monitoring wells were installed at FTA-1 in 2013 because the previously monitored wells had gone dry. Long-term groundwater monitoring ceased at FTA-1 in 2014.

- ICs: currently in place and implemented as follows:
  - The USAF/BoP MOU precludes site alterations that would interfere with IAG or IRP activities without notification of EPA, DTSC, and the USAF and approval of the USAF.
  - The USAF/BoP MOU establishes access for the USAF and the BCT.
  - Other than access required pursuant to the IAG/IRP, the BoP's Preservation Area Mitigation and Management Plan (Berger, 1998) restricts access to activities that are necessary for implementation of the plan.
  - Elements of prison security (e.g., patrolled security fencing) restrict the potential for human exposure to site contamination.
- E&D: Completed in September and October 2004, consisted of the excavation and off-site disposal of two areas of metals-impacted soils (21.4 cubic yards of soil) outside of the existing cap that were determined to pose a risk to ecological receptors in the vicinity of FTA-1. The E&D removal action completion report was finalized in March 2005 (MWH, 2005).
- LTEM: Implemented in the spring of 2008 and conducted again in 2016. LTEM could not be conducted in 2013 as originally scheduled because of drought-like conditions. Both the 2008 (presented as Appendix B in the third FYR report [Jacobs, 2009]) and 2016 surveys (CH2M, 2016b) concluded there was no evidence that site contaminants had impacted the wetland habitats. Consequently, LTEM ceased in 2016.

LF-4 – All portions of this remedy have been implemented. The following bullets note the status of the remedy components:

- ICs: Land use restrictions were incorporated in the deed transferring the parcel containing LF-4 to Merced County and a State Land Use Covenant has been executed by Merced County with the State of California. These controls establish land use for the LF-4 site as non-irrigated open space and limit groundwater withdrawal and any construction or other site activities that would disturb the cap or any of the existing access control, drainage control, or monitoring facilities. The ICs include a 1,000-foot buffer around LF-4 within the base boundary.
- LTM: Initiated in 1999 and consisted of a post-closure monitoring and maintenance program for the caps, and a post-closure monitoring program for landfill gas and groundwater beneath the landfill. Cap monitoring and maintenance activities and landfill gas and groundwater monitoring are conducted in compliance with the approved *CPCMP for Castle Airport Landfills* (Jacobs, 1997c), *LF-4 and LF-5 CPCMP Update – Revision 1* (Jacobs, 2004). Cap monitoring and maintenance activities for LF-4 consist of semiannual inspections of the cap, vapor monitoring wells, drainage ditch elevations and condition (additional inspection after major rain events), settlement monuments, site security (i.e., fencing around LF-4 that serves to restrict access), roads, and completion of any necessary repairs. Reports documenting inspection results are prepared annually. Landfill gas monitoring and post-closure groundwater monitoring are conducted semiannually. Topographical aerial surveys are conducted every 5 years. The LF-4 post-closure groundwater monitoring program is conducted as an integrated part of the ongoing CAFB LTGSP. Current results of the LF-4 post-closure groundwater monitoring program are presented in each LTGSP annual and semiannual report. Originally, post-closure monitoring requirements included corrective action monitoring for parameters

present in groundwater before cap installation and detection monitoring to identify new releases of parameters to groundwater following cap installation. As a result of decreasing concentrations, the corrective action monitoring program for LF-4 ceased in 2006. Since that time, post-closure groundwater monitoring for LF-4 has consisted solely of detection monitoring.

LF-5 – All portions of this remedy have been implemented. The following bullets note the status of the remedy components:

- ICs: currently in place and implemented as follows:
  - The USAF/BoP MOU precludes site alterations that would interfere with IAG or IRP activities without notification of EPA, DTSC, and the USAF and approval of the USAF.
  - The USAF/BoP MOU establishes access for the USAF and the BCT.
  - Other than access required pursuant to the IAG/IRP, the BoP's Preservation Area Mitigation and Management Plan (Berger, 1998) restricts access to activities that are necessary for implementation of the plan.
  - Elements of prison security (e.g., patrolled security fencing) restrict the potential for human exposure to site contamination.
- LTM: Initiated in 1999 and consisted of a post-closure monitoring and maintenance program for the caps, and a post-closure monitoring program for landfill gas and groundwater beneath the landfill. Cap monitoring and maintenance activities and landfill gas and groundwater monitoring are conducted in compliance with the approved *CPCMP for Castle Airport Landfills 1, 3, and 5* (Jacobs, 1998) and the *LF-4 and LF-5 CPCMP Update – Revision 1* (Jacobs, 2004). Cap monitoring and maintenance activities for LF-5 consist of semiannual inspections of the cap, vapor monitoring wells, drainage ditch elevations and conditions (additional inspection after major rain events), settlement monuments, site security, roads, and completion of any necessary repairs. Reports documenting inspection results are prepared annually. Landfill gas monitoring and post-closure groundwater monitoring are conducted semiannually. Topographical aerial surveys are conducted every 5 years. The LF-5 post-closure groundwater monitoring program is conducted as an integrated part of the ongoing CAFB LTGSP. Current results of the LF-5 post-closure groundwater monitoring program are presented in each LTGSP annual and semiannual report. Originally, post-closure monitoring requirements included corrective action monitoring for parameters present in groundwater before cap installation and detection monitoring to identify new releases of parameters to groundwater following cap installation. As a result of decreasing concentrations, the corrective action monitoring program for LF-5 ceased in 2015. Since that time, post-closure groundwater monitoring for LF-5 has consisted solely of detection monitoring.
- LTEM: Implemented in the spring of 2008 and conducted again in 2016. LTEM could not be conducted in 2013 as originally scheduled because of drought-like conditions. Both the 2008 (presented as Appendix B in the third FYR report [Jacobs, 2009]) and 2016 surveys (CH2M, 2016b) concluded there was no evidence that site contaminants had impacted the wetland habitats. Consequently, LTEM ceased in 2016.

D. IC Summary Table

Table 2: Summary of Planned and/or Implemented ICs

Media, Engineered Controls, and Areas that Do Not Support UU/UE Based on Current Conditions	ICs Needed	ICs Called for in the Decision Documents	Impacted Parcel(s)	IC Objective	Title of IC Instrument Implemented and Date (or planned)
Main Base Plume (groundwater)	Yes	Yes	A (On-base and off-base areas overlying MCL plume)	Restrict installation of groundwater wells and groundwater use	Property deeds, USAF/BoP MOU, City of Atwater municipal code
ETC-10 (soil)	Yes	Yes	B-1	Prevent human exposure to contaminated soils.	USAF/BoP MOU, BoP's *Preservation Area Mitigation and Management Plan* (Berger, 1998)
FTA-1 (soil)	Yes	Yes	B-1	Prevent human exposure to contaminated soils.	USAF/BoP MOU for Parcels B1 through B4 March 1997, *CPCMP – Update 2, 2006* (AFRPA, 2006b)
LF-4 (soil)	Yes	Yes	A	Prevent human exposure to landfill waste and gases.	Parcel A Quit Claim Deed (Merced County Record #2007-0001242), *CPCMP – Update 2, 2006* (AFRPA, 2006b)
LF-5 (soil)	Yes	Yes	B-1	Prevent human exposure to landfill waste and gases.	USAF/BoP MOU for Parcels B1 through B4 March 1997, *CPCMP – Update 2, 2006* (AFRPA, 2006b)

E. Systems Operations, Maintenance, and Monitoring

The annual operations, maintenance, and monitoring (OM&M) reports for 2013 through 2017 (CH2M, 2014a; 2015a; 2016a; 2017; 2018a) and interviews with the OM&M contactor (Appendix C) were used to summarize the OM&M modifications and/or issues that occurred from 2013 to 2018 as presented below.

Main Base Plume

- In 2014, the groundwater monitoring program was revised to eliminate monitoring of the 0.5 µg/L TCE plume boundary. This resulted in the removal of approximately 35 wells from the sampling program that no longer had to be sampled on an annual basis.
- In 2014, an LSS HSZ monitoring well (MW1057) was installed adjacent to USS HSZ monitoring well MW804A to assess the vertical capture of the northern OU-2 plume. MW1057 was eventually replaced by MW1058 in 2015 because there was evidence that the integrity of the well seal was compromised. Data collected from MW1057 and MW1058 indicated the presence of TCE above the MCL, and thus, monitoring well MW1059 was installed to the west of MW1058 in 2017 to define the downgradient edge of the LSS HSZ plume.

- In 2016, attempts to increase flow at EW12 to enhance capture and remediation of the northern OU-2 plume were unsuccessful. EW12 flow is limited to its current rate of approximately 50 to 55 gallons per minute (gpm) by the declining water table.
- A larger pump was installed at EW20 in fourth quarter 2016 (Q4/16) and the flow rate was doubled from approximately 40 to 80 gpm to address the increased TCE concentrations detected at this well and to enhance remediation of the northern portion of the LSS HSZ plume.
- The D5766 wellhead treatment system was decommissioned with regulatory approval in May 2016.
- An OU-2 extraction well (EW40) was installed during the first half of 2017, which increased mass removal of the northern portion of the USS HSZ plume and provided vertical capture of the OU-2 plume in the LSS HSZ that was previously lacking. Installation of EW40 in the highest concentration portion of the OU-2 plume has allowed the shutdown of extraction well EW12. Although EW12 maintained lateral capture of the northern OU-2 plume, it was inefficient at mass removal because of its location along the upgradient edge of the plume. Since EW40 began operation in June 2017, TCE concentrations at this well have been much higher than those at EW12 had been, resulting in a 5 to 10 times greater mass removal efficiency.
- Extraction well EW24 was shut off in December 2017 because TCE concentrations in this area decreased below the MCL in 2017 and the well was not needed to maintain plume capture. Removal of this well improved the mass removal efficiency of the Phase 3 system.
- Three monitoring wells located in the highest concentration portions of the Main Base Plume (MW806A, MW918, and MW948) were converted to extraction wells and connected to the nearest treatment system. MW806A (Q3/14) and MW948 (Q2/14) were connected to the OU-2 system to address the central and southern portions of the USS HSZ OU-2 plume, respectively. MW918 was connected to the Phase 3 system in Q2/17 to speed remediation of the northern portion of the LSS HSZ Phase 3 plume.
- Three belowground pipeline leaks occurred during the last 5 years. All three leaks were on the injection pipelines, which carry clean treated water only. Two leaks occurred at the connections of pipe joints of the Phase 3 system and were caused by settling, while the other leak was caused by a local farmer that cut through an OU-2 pipeline while he was installing an irrigation line. The farmer failed to call USA dig alert before digging. Although valves had been closed to isolate unused sections of pipelines where practicable, in 2017, the USAF excavated, cut, and capped unused sections of the OU-2 pipelines to close off additional sections.
- The MW951 wellhead treatment system was shut down for a rebound study in June 2016. Both MW951 and MW1008 were sampled after shutdown to assess potential rebound. Results of 2017 sampling at MW951 and MW1008 indicate that TCE concentrations had not rebounded at either well, and the MW951 wellhead treatment system was decommissioned in early 2018. TCE concentrations at MW1008 have been relatively stable at levels above the MCL, and wellhead treatment at MW1008 is being evaluated.
- To simplify system flow and reduce the potential for leaks, the Phase 3 treatment plant piping was modified in January 2018 to bypass the unused 20,000-pound granular activated carbon (GAC) vessels.
- More than 100 monitoring, extraction, and injection wells were decommissioned between Q3/14 and Q2/18. These included primarily Shallow HSZ wells that had been dry for several years, along with several USS and LSS HSZ wells that were no longer needed for groundwater plume or elevation monitoring.

FTA-1

- MW1054 and MW1055 were installed in summer 2013 to replace dry wells. Because TCE concentrations at MW1054 and MW1055 were routinely less than the MCL, sampling ceased at these two wells as of Q3/14.
- To address the potential for ground squirrels penetrating the cap, bait stations were put out in November 2015 and a routine maintenance program was implemented to fill and monitor the bait stations and monitor burrowing activities.
- Because of a breach of ICs by the BoP at FTA-1 (as discussed further in Section IV, C. Site Inspection), additional signage was put in place at FTA-1 in 2018 and the access policy was reviewed with BoP.

LF-4

- In the summer of 2013, MW1053 was installed to replace dry background monitoring well MW888. MW1056 was installed during October 2014 to replace dry detection monitoring well MW847. In 2015, the USAF recalculated the concentration limits for LF-4 based on data collected from the new wells. The concentration limits represent the upper range of concentrations for constituents present in groundwater before installation of the cap and are used to indicate if there are any new landfill releases.
- To address the potential for ground squirrels penetrating the cap, bait stations were put out in November 2015, and a routine maintenance program was implemented to fill and monitor the bait stations and monitor burrowing activities.
- Water was identified in the center gas vent well at LF-4. Repairs were made in January 2018 to fix damage identified during inspection of the well.
- The 5-yearly topographic aerial survey of LF-4 was conducted in March 2015. Several ongoing areas of settlement were observed, which were primarily related to the existing underlying waste trenches. However, the settlement did not appear to have been substantial enough to have resulted in any damage to the underlying landfill cover geosynthetic materials. In addition, comparison of 2015 results with those from previous aerial surveys determined the settlement was within an acceptable range and that no additional cover investigation was needed. Settlement areas continue to be inspected following major rain events. Because no ponding has been observed, these areas do not require maintenance.
- As part of the LF-4 post-closure detection monitoring program, three downgradient wells (MW846, MW1048, and MW1056) and one upgradient well (MW1053) are required to be sampled semiannually. Sampling is typically conducted during both the wet season (Q2) and the dry season (Q4). However, because of the regionally declining water table, wells began going dry as of Q4/15. The water table has continued to decline through 2018, such that only MW1056 can currently be sampled semiannually. The determination of whether or not drying landfill wells should be replaced will be made after the Q2/19 sampling event. Groundwater levels will be monitored at existing landfill wells in Q4/18, Q1/19, and Q2/19 and samples collected if sufficient water volume is present. Results of this monitoring will be discussed before, or at, the 2019 BCT meeting (typically June or July) and a consensus reached on the need for replacement wells. Following this discussion, a work plan detailing number, location, and installation of wells will be provided for regulatory review and approval before any installation work.

LF-5

- In the summer of 2013, background monitoring well MW1050, and downgradient detection monitoring wells MW1051 and MW1052 were installed to replace dry wells at LF-5. In 2015, the USAF recalculated the concentration limits for LF-5 based on data collected from the new wells. The concentration limits represent the upper range of concentrations for constituents present in groundwater before installation of the cap and are used to indicate if there are any new landfill releases.
- To address the potential for ground squirrels penetrating the cap, bait stations were put out in November 2015, and a routine maintenance program was implemented to fill and monitor the bait stations and monitor burrowing activities.
- The LF-5 cap liner was inspected in Q4/15 in several areas of settling to verify that the liner was not being damaged. This inspection consisted of excavating a trench through the settlement area to remove the soil, exposing and inspecting the geocomposite and geomembrane layers, and then backfilling the trench. During one of the inspections, a small area of the liner was damaged with a hand tool. This area was repaired in May 2016. In addition to the inspections, a portion of the access road at LF-5 was re-routed to avoid driving over a settlement area.
- The 5-yearly topographic aerial survey of LF-5 was conducted in March 2015. Several ongoing areas of settlement were observed, which were primarily related to the existing underlying waste trenches. However, unlike at LF-4, the magnitude and location of the settlement areas at LF-5 indicated an increased potential for liner damage, and thus an additional landfill cover investigation was performed at LF-5. This investigation consisted of excavating four exploratory trenches across the area's greatest settlement. The geosynthetic materials at all four trench locations were inspected and found to be in good condition with no signs of stress or deterioration. Settlement areas continue to be inspected following major rain events. Because no ponding has been observed, these areas do not require maintenance.
- As part of the LF-5 post-closure detection monitoring program, three downgradient wells (MW1049, MW1051, and MW1052) and one upgradient well (MW1050) are required to be sampled semiannually. Sampling is typically conducted during both the wet season (Q2) and the dry season (Q4). However, because of the regionally declining water table, wells began going dry as of Q4/15. The water table has continued to decline through 2018, such that none of the wells can currently be sampled semiannually. The determination of whether or not drying landfill wells should be replaced will be made after the Q2/19 sampling event. Groundwater levels will be monitored at existing landfill wells in Q4/18, Q1/19, and Q2/19 and samples collected if sufficient water volume is present. Results of this monitoring will be discussed before, or at, the 2019 BCT meeting (typically June or July) and a consensus reached on the need for replacement wells. Following this discussion, a work plan detailing number, location, and installation of wells will be provided for regulatory review and approval before any installation work.

III. PROGRESS SINCE THE LAST REVIEW

This section includes the protectiveness determinations and statements from the last FYR, as well as the recommendations from the last FYR and the current status of those recommendations.

Table 3: Protectiveness Determinations/Statements from the 2014 FYR Report

Site(s)	Protectiveness Determination	Protectiveness Statement
Groundwater OU		
Main Base Plume	Protective	The remedial actions implemented for the CB Groundwater OU are protective of human health and the environment.
SCOU		
ETC-10, FTA-1, LF-4, LF-5	Protective	The remedial actions implemented for the SCOU are protective of human health and the environment.

Table 4: Status of Recommendations from the 2014 FYR Report

Site	Issue	Recommendations	Current Status	Current Implementation Status Description	Completion Date (if applicable)
Main Base Plume	Capture of the Northeast Base Plume Area in the Shallow HSZ	Should monitoring under the LTGSP indicate an increasing contaminant trend or plume migration, the USAF in consultation with the regulatory agencies, should evaluate if other action is warranted.	Ongoing	As of 2014, the wells defining the northeast base plume in the Shallow HSZ had gone dry. The plume descended into the USS HSZ and is now defined by USS HSZ well IW40. Monitoring is being conducted quarterly at IW40 (both screen intervals) and semiannually at downgradient wells (CH2M, 2018a).	NA
	Declining Water Levels Resulting in Dry Groundwater Wells	It is recommended that dry wells continue to be monitored and evaluated under the LTGSP.	Ongoing	The LTGSP continues to monitor dry wells and has a process in place for evaluating the need to replace them. Over 100 dry wells no longer needed for the LTGSP were decommissioned between Q3/14 and Q2/18. Discussion of the need to replace dry monitoring wells at LF-4 and LF-5 has been postponed until after the Q2/19 sampling event, with agency concurrence (CH2M, 2018b).	NA
	Higher TCE Concentrations and Longer Duration of Rebound in OU-2	Improve plume capture and contaminant mass removal by adding an extraction well from the existing well network (most likely a conversion of MW948 to an extraction well) and confirm hydraulic control by installing an LSS HSZ monitoring well in the area of MW804A.	Complete	MW806A and MW948 were converted to extraction wells and added to the OU-2 treatment system in 2014 to increase mass removal. MW1057 was installed in the LSS HSZ to evaluate vertical capture in September 2014 and was replaced with MW1058 in December 2015 (CH2M, 2016a). Drilled HydroPunch boring in March 2017 and installed new USS HSZ OU-2 extraction well EW40 near MW804A in April 2017. Operation of EW40 successfully captured the LSS HSZ plume and increased mass removal of the USS HSZ plume. MW1059 was installed in November 2017 in the LSS HSZ downgradient of MW1058 to confirm that the plume had not migrated (CH2M, 2018a).	April 2017
ETC-10	LTEM was not conducted in 2012 or 2013	It is recommended that LTEM occur during the next year that sufficient rainfall occurs.	Complete	LTEM was conducted in 2016. Based on the results, no impacts to ecological communities were identified, and LTEM is no longer required (CH2M, 2016b).	February 2016

Table 4: Status of Recommendations from the 2014 FYR Report

Site	Issue	Recommendations	Current Status	Current Implementation Status Description	Completion Date (if applicable)
FTA-1	Dry Ground Water Well	Monitoring of newly installed replacement wells should continue under the LTGSP to determine if TCE at levels exceeding the MCL remain at FTA-1.	Complete	MW1054 and MW1055 were installed at FTA-1 in Q3/13 to replace dry monitoring wells. Data from four consecutive quarters showed TCE concentrations were below the MCL and not increasing. These wells were removed from the LTGSP in Q3/14 with regulatory approval, and further monitoring for VOCs is no longer required (CH2M, 2015a).	Q3/14
	LTEM was not conducted in 2012 or 2013	It is recommended that LTEM occur during the next year that sufficient rainfall occurs.	Complete	LTEM was conducted in 2016. Based on the results, no impacts to ecological communities were identified, and LTEM is no longer required (CH2M, 2016b).	February 2016
	Potential presence of perfluorinated compounds (PFCs)	It is recommended that USAF perform their programmatic review at FTA-1 to determine if PFCs are present.	Complete	A site investigation was conducted in 2015 to evaluate the presence or absence of PFOS/PFOA (perfluorooctane sulfonate/perfluorooctanoic acid) at FTAs (Amec Foster Wheeler, 2016). The investigation included sampling of sediment, soil, and groundwater and installation of two monitoring wells. PFOS/PFOA were detected at FTA-1 but at concentrations less than the project action limits (PALs). Groundwater and surface water PALs for PFOS and PFOA were based on the 2009 EPA Provisional Health Advisory (PHA) values. The 2009 EPA drinking water PHA values were 0.2 µg/L for PFOS and 0.4 µg/L for PFOA. The EPA has set the lifetime health advisory in drinking water for both PFOA and PFOS at 0.070 µg/L and has recommended that when PFOA and PFOS co-occur in a drinking water source, the sum of the concentrations of PFOA and PFOS also be compared to the lifetime health advisory in drinking water value of 0.070 µg/L. In addition, the California State Water Resources Control Board has developed notification levels of 0.013 µg/L for PFOS and 0.014 µg/L for PFOA. Based on the changing screening levels, additional investigation may be warranted.	11/1/2016

Table 4: Status of Recommendations from the 2014 FYR Report

Site	Issue	Recommendations	Current Status	Current Implementation Status Description	Completion Date (if applicable)
LF-4	Dry Ground Water Wells	Continue the LTGSP to evaluate the newly installed MW1053 and monitor groundwater concentrations and flow directions before determining an appropriate location for the MW847 replacement well.	Ongoing	Groundwater flow directions and concentrations were evaluated in Q2/14, and it was determined to install the replacement well (MW1056) adjacent to MW847, which occurred during October 2014 (CH2M, 2015a). Determination of whether or not additional drying landfill wells should be replaced has been postponed until after the Q2/19 sampling event per regulatory agreement. Groundwater levels will be monitored at existing landfill wells in Q4/18, Q1/19, and Q2/19 and samples collected if sufficient water volume is present. Results of this monitoring will be discussed before, or at, the 2019 BCT meeting (typically June or July) and a consensus reached on the need for replacement wells. Following this discussion, a work plan detailing number, location, and installation of wells will be provided for regulatory review and approval before any installation work.	NA
LF-5	Dry Ground Water Wells	Continue the LTGSP to evaluate the newly installed wells (MW1050, MW1051, MW1052)	Ongoing	Installed wells continue to be monitored under the LTGSP but have recently begun going dry. Determination of whether or not drying landfill wells should be replaced has been postponed until after the Q2/19 sampling event per regulatory agreement. Groundwater levels will be monitored at existing landfill wells in Q4/18, Q1/19, and Q2/19 and samples collected if sufficient water volume is present. Results of this monitoring will be discussed before, or at, the 2019 BCT meeting (typically June or July) and a consensus reached on the need for replacement wells. Following this discussion, a work plan detailing number, location, and installation of wells will be provided for regulatory review and approval before any installation work.	NA
	LTEM was not conducted in 2012 or 2013	It is recommended that LTEM occur during the next year that sufficient rainfall occurs.	Complete	LTEM was conducted in 2016. Based on the results, no impacts to ecological communities were identified, and LTEM is no longer required (CH2M, 2016b).	February 2016

IV. FIVE-YEAR REVIEW PROCESS

A. Community Notification, Involvement, and Site Interviews

A public notice was made available by a newspaper posting in the Merced Sun Star on 13 September 2018 stating that there was an FYR and inviting the public to submit any comments to the USAF (Appendix B). The results of the review and the report will be made available at the information repository on the administrative record: http://afcec.publicadmin-record.us.af.mil/Search.aspx.

During the FYR process, interviews were conducted to document any perceived problems or successes with the remedies that have been implemented to date. As part of this FYR, interview forms were emailed to agency personnel (DTSC, EPA, CVRWQCB), nearby neighbors, Castle Airport staff, county officials, consultant staff that oversee the operations of the systems, and BoP personnel. The results of these interviews are summarized below and can be found in Appendix C.

Based on the responses from the participants that returned the surveys, the interviewees felt well informed about the project, were satisfied with the way the contractor was managing the project, and felt the USAF addressed all issues in a prompt and appropriate manner. One responder indicated that he thought the community was concerned about the quality of drinking water from the production wells on the base but that as far as he knew, the quality was good. The consultants managing the sites indicated that the remedial systems were working as expected and achieving significant contaminant and plume reduction.

The CVRWQCB indicated that they would like the USAF to consider evaluating residual VOC contamination left in the vadose zone at areas where groundwater levels are declining and hot spots may exist, as well installing wells in areas where groundwater levels have dropped. Additionally, they noted that the USAF has been investigating PFCs across the base and will need to be prepared to address it once standards are promulgated in the future as necessary.

B. Data Review

This section includes a review of the data collected over the last 5 years and the conclusions relevant to remedy performance based upon that data. Appendix D1 includes figures that present plume capture and TCE plume extents as of Q2/18 for the Main Base Plume as well as well locations. This data discussion is based on the annual OM&M reports for 2013, 2014, 2015, 2016, and 2017 (CH2M, 2014a; 2015a; 2016a; 2017; 2018a) and the semiannual LTGSP report for 2018 (CH2M, 2018b). The total mass removal information presented below is from start-up through the end of 2017 (CH2M, 2018a).

Main Base Plume

Because TCE is the primary COC in the Main Base Plume, the data discussion below focuses on TCE data only. No COCs exist above MCLs in areas within or outside the boundaries of the TCE plume. Dibromochloropropane (DBCP) and 1,2,3-trichloropropane (1,2,3-TCP) exceed their respective MCLs but are considered to be agricultural contaminants and not COCs. Additional investigation of 1,2,3-TCP is being conducted to determine if CAFB was a potential source of the 1,2,3-TCP concentrations.

Plume Capture:

Shallow HSZ: By 2014, the water table at CAFB had declined to the point that the Shallow HSZ was no longer saturated, and thus there has been no Shallow HSZ plume to capture since 2013. Before going dry, the Shallow HSZ plume consisted of three separate TCE plumes. Two were located in the area of the Phase 3 treatment system (referred to as the Phase 3 plume) and one was located east of the northern OU-2 treatment system (referred to as the northeast plume). Since the shutdown of the OU-1 treatment system in 2003, successful capture and remediation of the Phase 3 plume in the Shallow HSZ has been

accomplished by the Phase 3 extraction wells in the underlying USS HSZ (see the Q4/13 plume capture figure presented in Appendix D2).

As of 2013, capture of the northeast plume in the Shallow HSZ (which was defined by a single well [MW1015] slightly exceeding the MCL) was not occurring because regional water levels were too low to allow for extraction. However, groundwater flow patterns indicated that any contaminated groundwater that migrates would continue downgradient (west-southwest) and be captured by the OU-2 extraction wells (either EW11, EW12, or EW40, whichever is operating) in the underlying USS HSZ. To continue monitoring the now dry northeast plume, sampling of IW40 began in 2014. Data from this well, which is the closest downgradient well in the USS HSZ, confirmed that contaminants from the northeast plume had migrated vertically into the USS HSZ.

The northeast plume in the Shallow HSZ (west of the flightline) originated within the East Base Plume region (east of the flightline) and migrated downgradient beneath the airfield. The selected remedy for the East Base Plume presented in the *CB ROD – Part 1* (USAF, 1997a) was decommissioning of selected wells to prevent cross contamination of HSZs, plume monitoring, and annual evaluations to determine if pump and treat technology was necessary. At the time of the ROD, it was determined that the TCE concentrations (maximum of 45 µg/L at MW884 in Q2/94) and the limited extent of the East Base Plume did not warrant active remediation. Per the ROD, annual evaluations of the need for treatment were conducted, and wellhead treatment of the northeast plume was initiated at MW883 in 2001 in response to increased TCE concentrations. In 2002, the wellhead treatment system at MW883 was expanded to include MW1021, and a second wellhead treatment system was installed at the downgradient portion of the plume at MW824 (i.e., the northeast plume located west of the flightline). In 2004, the second wellhead treatment system was expanded to include MW1037, and the MW883/MW1021 wellhead system was permanently shut down with regulatory agency concurrence. The downgradient MW824/MW1037 wellhead system operated until October 2006, at which point it was shut down with regulatory agency concurrence because water levels had declined to the point that pumping could not be sustained. TCE concentrations in the northeast plume continued to be monitored and evaluated per the ROD until the plume went dry in 2014. Before the plume went dry, TCE concentrations slightly exceeded the MCL in one well (7.2 µg/L at MW1015).

USS HSZ: Based on data from 2013 to 2018, complete capture of the USS HSZ Phase 3 plume (i.e., southern portion of the USS HSZ Main Base Plume) was maintained. Capture of the USS HSZ OU-2 plume (i.e., northern portion of the USS HSZ Main Base Plume) was also maintained throughout the entire period with three exceptions. First, for approximately 3 weeks in spring of 2013, the northern portion of the OU-2 plume was not captured because EW12 had to be temporarily shut down to track down the source of a total petroleum hydrocarbons (TPH) detection in the OU-2 effluent. TPH was detected in the OU-2 effluent sample collected on 1 February 2013 at a concentration below discharge standards. To determine the source of the TPH, the OU-2 effluent and EW12, which was the only operating OU-2 extraction well at the time, were sampled for TPH on 7 March 2013. TPH was detected in both the OU-2 effluent and EW12 at concentrations similar to that detected in the February OU-2 effluent sample. Because these data appeared to indicate that the treatment system was not removing TPH, it was believed that the TPH detections were the result of contaminated sample jars. This was confirmed when TPH results were nondetect (ND) in OU-2 effluent and EW12 samples collected on 27 March 2018 using a new batch of sample jars. Capture of the northern portion of the OU-2 plume was restored on 12 April 2013, when EW12 was brought back on line.

The second exception has to do with uncertainty in the vertical capture of the northern OU-2 plume. As of 2013, there were no LSS HSZ wells in the northern portion of the OU-2 plume with which to evaluate vertical capture of the USS HSZ plume. Vertical capture of the central and southern portions of the OU-2 plume is supported by the lack of TCE in LSS HSZ wells MW942 and IW04. In September 2014, MW1057 was installed near MW804A in the LSS HSZ to assess vertical capture and determine if the northern portion of the USS HSZ OU-2 plume had migrated vertically into the LSS HSZ. TCE concentrations at MW1057 showed wide seasonal fluctuations, from a minimum of 5.2 µg/L in January 2015 to a maximum of 96 µg/L in July 2015. Because the TCE concentrations fluctuated so much at MW1057, it was initially thought that the well's integrity may have been compromised to the extent

that it was acting as a conduit for the migration of TCE from the USS HSZ to the LSS HSZ. Additional investigations conducted in Q2/15 and Q3/15 to help determine if this was the case included (1) collection of passive diffusion bag samples at the top and bottom of the MW1057 screen; (2) a video log and cement bond log of MW1057; (3) collection of water quality parameters from USS HSZ well MW804A and LSS HSZ wells MW1057, MW942, and IW18; and (4) installation of transducers in MW1057, MW942, MW804A, IW18, and IW04. The results of these additional investigations indicated that there was sufficient uncertainty in the integrity of MW1057 to warrant its replacement, and in December 2015, MW1057 was replaced with MW1058. Results of the MW1057 investigations and plans for the installation of MW1058 were discussed with the regulatory agencies at a Technical Working Group meeting on 10 September 2015 and presented in the *Monitoring Well MW1057 Replacement Work Plan* (CH2M, 2016c). TCE data collected subsequently from MW1058 showed similar seasonal variation but with smaller changes in amplitude (minimum of ND in February 2016 to a maximum of 30 µg/L in August 2016). Although the TCE concentrations at MW1057 and MW1058 showed considerable seasonal fluctuations, ranging from concentrations below the MCL in the winter months to concentrations well above the MCL in the summer months, the data showed that the northern portion of the OU-2 plume seasonally migrated downward into the LSS HSZ. The reason for the wide seasonal fluctuations is believed to be regional pumping from downgradient LSS HSZ irrigation wells in the summer and fall that create a downward vertical gradient and pull contamination down from the USS HSZ. In 2017, EW40 was installed adjacent to MW804A and MW1058 to obtain vertical capture of the northern portion of the OU-2 plume, and MW1059 was installed to the west to define the downgradient edge of the LSS HSZ plume. TCE concentrations at MW1059 have been ND since it was installed. Groundwater elevation and concentration data collected from northern OU-2 wells since EW40 came online in late Q2/17 show that pumping from EW40, installed in the USS HSZ, has greatly increased the upward vertical gradient from the LSS HSZ to the USS HSZ in the northern portion of the OU-2 plume. As a result, EW40 has successfully captured and remediated the LSS HSZ plume and prevented further vertical migration from the USS HSZ.

The third exception is the northeast plume (IW40 plume). Although this small plume would be captured by the OU-2 system should it migrate downgradient, it is not being captured at its current location. IW40 is a previous injection well and has an upper and lower screen, both of which are located within the USS HSZ. Sampling of IW40 began in 2014, and although TCE concentrations in both screens appear to fluctuate seasonally, they have been above the MCL in all but two sampling events. These data indicate that the northeast plume in the Shallow HSZ has descended to the USS HSZ as regional groundwater levels decline. TCE concentrations are typically higher in the upper screen, indicating that most of the contamination likely remains in the upper portion of the USS HSZ. Downgradient wells MW808A and MW901 are used to monitor horizontal migration of TCE within the USS HSZ, and based on the most recent Q2/18, concentrations of TCE in these wells remain stable compared to prior years and do not suggest significant migration has occurred. TCE concentrations at MW942, which is the nearest LSS HSZ downgradient well located approximately 2,000 feet west of IW40, have been ND from 2014 through 2018, which suggests that concentrations have not migrated vertically to the LSS. The IW40 plume continues to be monitored and evaluated annually as per the *CB ROD – Part 1* to determine if active treatment is warranted.

LSS HSZ: Based on data from 2013 to 2018, complete capture of the LSS HSZ Phase 3 plume has been maintained. However, TCE concentrations doubled in the southwestern portion of the plume between 2013 and 2016 (8.5 to 17 µg/L at MW975 and approximately 6 to 15 µg/L at EW20) and remained elevated in the northern portion of the plume (11 to 18 µg/L at MW918) during the same period. To address the increased concentrations and enhance remediation of the LSS HSZ Phase 3 plume (1) a larger pump was installed at EW20 in Q4/16 and the flow rate was doubled from approximately 40 to 80 gpm, which addresses the southwestern portion of the plume, and (2) MW918 was converted to a Phase 3 extraction well in Q2/17 to speed remediation of the northern portion of the LSS HSZ Phase 3 plume.

As discussed in the previous section for the USS HSZ, MW1057 was installed in the LSS HSZ in 2014 to determine if TCE had vertically migrated from the overlying USS HSZ. Data collected from MW1057, and its replacement well MW1058, from 2014 to early 2017 indicated the presence of a LSS HSZ TCE

plume in the northern portion of OU-2 that was not being captured. As previously described, the installation and startup of USS HSZ well EW40 in early 2017 has resulted in complete capture of the LSS HSZ OU-2 plume. In November 2017, monitoring well MW1059 was installed west of MW1058 to improve characterization and define the downgradient boundary of the LSS HSZ plume. As of 2017, the OU-2 LSS HSZ plume was remediated by EW40 and no longer exists.

Confined HSZ: Based on data from 2013 to 2017, the on-base portion of the Confined HSZ Phase 3 plume was captured. There is no Confined HSZ plume in the OU-2 area. Operation of EW24 from Q4/14 through Q4/17 resulted in the remediation of the on-base portion of the Confined HSZ Main Base Plume that had reemerged in 2014. Although EW24 was originally shutoff in Q2/02 when the on-base portion of the Confined HSZ TCE plume was first remediated, it was restarted in Q4/15 in response to increased TCE concentrations at adjacent well MW603.

Complete capture of the off-base portion of the Confined HSZ plume (MW1008) is impractical because of the overriding influence of municipal wells AM16 and AM18. The wellhead treatment system at MW951 captured a portion of the remaining off-base Confined HSZ plume segment through June 2016. However, as a result of decreasing TCE concentrations at both MW951 and MW1008, the MW951 wellhead system was shut down for a rebound study in June 2016 and was decommissioned in early 2018. With the shutdown of the MW951 system, there is no longer any remedial extraction occurring in the Confined HSZ. TCE concentrations at MW1008, which remains the only Confined HSZ well above the MCL, have remained relatively stable around 10 µg/L since MW951 was shut down. TCE concentrations at downgradient well MW995 have also remained relatively stable at concentrations of approximately 2 µg/L or less, indicating that TCE is not migrating towards municipal wells AM16 and AM18.

Plume Reduction:

USS HSZ: The Q4/17 measurements indicate an approximate 82 percent reduction in areal extent of the USS HSZ Main Base Plume since Q4/96. Plume extent decreased approximately 7 percent from Q4/16 through Q4/17 (because of the contraction of the northern end of the Phase 3 Main Base Plume).

LSS HSZ: The Q4/17 measurements indicate an approximate 72 percent reduction in areal extent since Q4/96. Plume extent decreased approximately 4 percent from Q4/16 through Q4/17 because of the elimination of the small plume at OU-2 well MW1058 in the OU-2 plume. New USS HSZ extraction well EW40 was installed adjacent to MW1058 to capture the OU-2 plume in the LSS HSZ and speed up remediation of the northern portion of the OU-2 plume in the USS HSZ. EW40 came online on 14 June 2017 at approximately 20 gpm. Pumping at this location greatly increased the upward vertical gradient and resulted in the remediation of the LSS HSZ plume at MW1058. Concentrations at MW1058 were highest in 2016, with a detected concentration of 30 µg/L, but have decreased since the operation of EW40 and have been ND from Q3/17 to Q2/18.

Confined HSZ: The Q4/17 measurements indicate an approximate 99 percent reduction in areal extent since Q4/96. Plume extent decreased approximately 19 percent from Q4/16 through Q4/17 because of the elimination of the small on-base plume at MW603.

Treatment System Operation:

The OU-2 plant has treated approximately 5.6 billion gallons of groundwater and has removed approximately 872 pounds of TCE from startup through the end of 2017; the OU-2 plant treated approximately 59 million gallons of groundwater and removed approximately 4 pounds of TCE during 2017. OU-2 system optimization (i.e., installation and operation of EW40) resulted in an approximate 35 percent increase in the mass removal rate (pounds removed per gallons treated) between 2016 and 2017.

The Phase 3 plant has treated approximately 8.6 billion gallons of groundwater and has removed approximately 1,297 pounds of TCE from startup through the end of 2017; the Phase 3 plant treated approximately 159 million gallons of groundwater and removed approximately 9 pounds of TCE during 2017. Phase 3 system optimizations (i.e., installation of a new pump and increased flow rate at EW20;

conversion of MW918 to an extraction well) resulted in an approximate 5 percent increase in the mass removal rate between 2016 and 2017.

The combined Main Base Plume remedial systems have treated approximately 15.8 billion gallons of groundwater and have removed a total of approximately 2,888 pounds of TCE from startup through the end of 2017.

In an effort to assess the concentrations of PFOS/PFOA entering the groundwater treatment systems, sampling and analysis is being conducted of the influent and effluent of the Phase 3 and OU-2 groundwater treatment systems as presented in Addendum 2 to the *Final Installation-Specific Work Plan for Groundwater Treatment System Monitoring* (Wood, 2018). The results of this sampling will be included in a forthcoming report.

ETC-10

No data are collected at ETC-10 as part of the remedy; therefore, a data review is not provided. Details of LTEM and ICs are discussed in Section V, Technical Evaluation.

FTA-1

Groundwater Monitoring: Because MW320 and MW886 were dry and could not be sampled, replacement wells (MW1054 and MW1055) were installed in Q3/13. Subsequent groundwater sampling of MW1054 and MW1055 showed that TCE concentrations near FTA-1 were less than the MCL, and as recommended in the LTGSP *2014 Semiannual Report* (CH2M, 2015b), monitoring for TCE ceased at FTA-1 as of Q3/14. Dry wells MW320 and MW886 were decommissioned in 2017. In 2015, two monitoring wells were installed and sampled to investigate the presence of PFOS/PFOA at FTA-1 (Amec Foster Wheeler, 2016). In addition, MW1054 was also sampled for PFOS/PFOA. Concentrations of PFOS and PFOA were detected in one of the three wells at concentrations of 0.135 and 0.146 µg/L, respectively. These detections were less than the PALs used at the time of the investigation, which were based on the 2009 EPA PHA drinking water values. The 2009 EPA PHA drinking water values were 0.2 µg/L for PFOS and 0.4 µg/L for PFOA. EPA has set the lifetime health advisory in drinking water for both PFOA and PFOS at 0.070 µg /L and has recommended that when PFOA and PFOS co-occur in a drinking water source, the sum of the concentrations of PFOA and PFOS also be compared to the lifetime health advisory in drinking water value of 0.070 µg /L. Based on the changing screening levels, additional investigation may be warranted.

LF-4

Landfill Gas Monitoring: Landfill gas monitoring was conducted from 2013 to 2018. Methane concentrations from the eight perimeter monitoring wells were ND throughout the entire period, indicating that no migration is occurring. In 2013, methane was detected in the landfill cap gas vents at concentrations ranging from 0.4 to 4.0 percent by volume in air, indicating that landfill gas is being vented as designed. In accordance with the agency-approved *Technical Memorandum – Reduction in Sampling Frequency for the Landfill Gas Perimeter Wells and Landfill Cap Gas Vents at Landfill 4 and Landfill 5 at Former Castle Air Force Base* (CH2M, 2014b), subsequent monitoring of the five passive landfill cap gas vents was not required because methane did not exceed the regulatory compliance threshold of 5 percent methane by volume in air in the perimeter wells from 2014 to 2018.

Groundwater Monitoring: The three downgradient detection monitoring wells (MW846, MW1048, and MW1056) and one upgradient monitoring well (MW1053) were sampled between 2013 and 2018 to monitor LF-4. MW1048, MW1053, and MW1056 were installed as replacement wells for wells that had gone dry before 2013. Because concentration limits were based on shallow wells that had gone dry, the concentration limits were recalculated based on data from the downgradient monitoring wells in 2015. The concentration limits represent the upper range of concentrations for constituents present in groundwater before installation of the cap and are used to indicate if there are any new landfill releases. Only one detected monitoring parameter (1,2,3-TCP in 2016) exceeded its concentration limit at any

sampled LF-4 monitoring well from 2013 to 2018. Implementation of the retest/verification steps specified in the *CPCMP Update – Revision 1* (Jacobs, 2004) was not warranted because the source of 1,2,3-TCP was believed to be the adjacent agricultural field. None of the detected monitoring parameters exceeded their concentration limits during any other sampling events and none of the historical groundwater contaminants (i.e., TCE and cis-1,2-DCE) were detected at concentrations above reporting limits. As with previous wells, the new monitoring wells have also begun going dry, and MW1056 is the only well that had sufficient water to sample during every monitoring event. Determination of whether or not drying landfill wells should be replaced again has been postponed until after the Q2/19 sampling event per regulatory agreement (CH2M, 2018b).

LF-5

Landfill Gas Monitoring: Landfill gas monitoring was conducted from 2013 to 2018. Methane concentrations from the seven perimeter monitoring wells were ND throughout the entire period, indicating that no migration is occurring. In 2013, methane was detected in the landfill cap gas vents at concentrations ranging from 0.4 to 4.0 percent by volume in air, indicating that landfill gas is being vented as designed. In accordance with the agency-approved *Technical Memorandum – Reduction in Sampling Frequency for the Landfill Gas Perimeter Wells and Landfill Cap Gas Vents at Landfill 4 and Landfill 5 at Former Castle Air Force Base* (CH2M, 2014b) subsequent monitoring of the three passive landfill cap gas vents was not required because methane never exceeded the regulatory compliance threshold of 5 percent methane by volume in air in the perimeter wells from 2014 to 2018.

Groundwater Monitoring: The three downgradient detection monitoring wells (MW1049, MW1051, and MW1052) and one upgradient monitoring well (MW1050) were sampled between 2013 and 2018 to monitor LF-5. These wells were installed as replacement wells for wells that had gone dry before 2013. In 2014, several inorganics and toluene exceeded their concentration limits at one or more LF-5 wells. However, comparison of these data against the then-current concentration limits was likely inappropriate because the limits were based on data collected from the previous detection monitoring wells before they became dry, and these were screened shallower in the aquifer. In 2015, the concentration limits were recalculated based on data from the replacement wells, and none of the analytes detected in 2015 exceeded the recalculated concentration limits. The concentration limits represent the upper range of concentrations for constituents present in groundwater before installation of the cap and are used to indicate if there are any new landfill releases. In 2016, only two detected monitoring parameters, lead and potassium, exceeded their concentration limits. However, the lead and potassium exceedances were believed to be anomalous because appreciable sediment was present in the sample. As with previous wells, the new monitoring wells have also begun going dry and MW1049 is the only well that had sufficient water to sample during 2017 and 2018. Determination of whether or not drying landfill wells should be replaced again has been postponed until after the Q2/19 sampling event per regulatory agreement.

C. Site Inspection

Initial FYR site inspections were conducted at ETC-10, FTA-1, LF-4, LF-5, and the Main Base Plume on 12 July 2018. The purpose of the inspections was to assess the protectiveness of the remedies. Present at the initial site inspections were Roy Willis (AFCEC), Andy Cramer (CH2M), Nikki Carlton (CH2M), Nadia Hollan Burke (EPA), Dawn Bascomb (DTSC), John Murphy (CVRWQCB), Bill Hughes (SpecPro Professional Services), and Gary Yuki (SpecPro Professional Services). The general condition of each site was inspected briefly by walking and/or driving by the sites. At FTA-1, the sign providing the USAF contact information was noted to have fallen off the fence. The sign was re-attached to the fence during the site inspection. The group met with the BoP to discuss plans for repairing the damaged liner at FTA-1 that occurred when BoP inmate crews removed several fence posts and fencing, and disturbed soils within drainage swales to gather stones from the swales to construct improvements to the entrance of the prison (as discussed in more detail below). At LF-4, a damaged vent well cap was discovered and was subsequently repaired.

More detailed follow-up site inspections were conducted by CH2M staff in support of the FYR on 19 July 2018 for ETC-10, FTA-1, LF-4, LF-5, and the Main Base plume. Appendix E presents the site inspection checklist and site visit photos for each site based on the 19 July 2018 inspection. In general, the operation and maintenance (O&M) systems at the Main Base Plume were found to be in good working order, and the caps and/or ICs at ETC-10, FTA-1, LF-4, and LF-5 appeared to be enforced and preventing exposures. The following issues were noted and repaired, as needed, during the site inspections:

- **Main Base Plume**: EW34 and EW36 valves were found to have minor drips; therefore, the valves were sealed.
- **FTA-1**: Burrows were evident over the surface of the vegetative surface cover; however, the burrows were mostly inactive and do not appear to have negatively impacted the HDPE liner or the stability of the soil cover. While this site inspection did not directly identify issues with implementation of the ICs, on 16 February 2018, the USAF was notified by its support contractor that portions of the fencing and HDPE liner material within drainage swales near FTA-1 had been disturbed by BoP Atwater inmate work crews. According to the BoP Atwater Facilities Manager, their work crews mistakenly removed several fence posts and fencing, and disturbed soils and the margin of the HDPE liner material within drainage swales to gather stones from the swales to construct improvements to the entrance of the prison. The HDPE material is part of the cap liner that originally extended from the cap into the swale as a continuous unit. Despite the disturbance of the swales, the FTA-1 cap does not appear to have been significantly damaged. Based on a review of where the contaminants were located beneath the cap, no risk to human health or the environment is anticipated to have occurred due to the incident. BoP will restore the disturbed portion of the liner and protective soil layer.
- **LF-4**: The culverts appear to be functioning as designed. Burrows were evident over the surface of the vegetative surface cover; however, the burrows were mostly inactive and do not appear to have negatively impacted the HDPE liner or the stability of the soil cover.
- **LF-5**: The culverts appear to be functioning as designed. Burrows were evident over the surface of the vegetative surface cover; however, the burrows were mostly inactive and do not appear to negatively impact the HDPE liner or the stability of the soil cover.

V. TECHNICAL ASSESSMENT

A. Main Base Plume

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

Question A Summary:

Yes, the remedy is functioning as intended by the decision documents both during the review period and at the time of reporting. As discussed below, the remedial action performance is adequate, the OM&M systems are operating as anticipated, and the ICs are in place and effective.

Remedial Action Performance

Remedial action performance is assessed in terms of hydraulic control and treatment system operation (cumulative amount of groundwater treated and contaminant mass removed), and TCE plume reduction (plume extent and concentration) over time. Information on current conditions is derived from plume and treatment system monitoring conducted under the LTGSP. The primary LTGSP documents used to support this FYR are the OM&M Annual Reports from 2013 to 2017 (CH2M, 2014a; 2015a; 2016a; 2017; 2018a) and the semiannual LTGSP report from 2018 (CH2M, 2018b).

During the review period, capture of all zones within the Main Base Plume was occurring except for those instances associated with the northeast plume in the Shallow HSZ, USS HSZ OU-2 plume, and the off-base portion of the Confined HSZ plume as discussed in Section IV.B, Data Review. Areal extent of the plumes from Q4/96 to Q4/17 have reduced by an approximate 82 percent within the USS HSZ Main Base Plume, 72 percent within the LSS HSZ Main Base Plume, and 99 percent within the confined HSZ Main Base Plume. The combined Main Base Plume remedial systems have treated approximately 15.8 billion gallons of groundwater and have removed a total of approximately 2,888 pounds of TCE from startup through the end of 2017.

Based on a review of factors presented in Section IV.B, Data Review, the remedy is functioning as intended by the decision documents for the Main Base Plume.

Systems OM&M

The groundwater treatment systems comprising the Main Base Plume remedial system are operated in accordance with an approved O&M plan. Biweekly system checks document a high percentage of uptime for all treatment systems, which maintain the documented effectiveness of the remedial system. During the review period and at the time of reporting, the groundwater treatment systems were functioning as intended and have been optimized when necessary as discussed in Section II, Response Action Summary. Upgrades and modifications include installing extraction wells or converting monitoring wells into extraction wells, decommissioning wellhead treatment systems D5766 and MW951, installing a larger pump at EW20 to enhance flow rates, and modifying the Phase 3 treatment plant piping in January 2018 to bypass the unused 20,000-pound GAC vessels to simplify system flow and reduce the potential for leaks.

One pipeline breach occurred on 5 April 2017, when a local farmer cut through the OU-2 effluent line running to injection wells IW04 and IW08. Because it was an effluent line, only clean effluent water was released, and the pipeline was capped in place. This breach did not compromise the protectiveness of the remedy. To minimize chances of this recurring, unused portions of the OU-2 system pipelines were capped at strategic locations to isolate as much unused pipeline as practicable. The pipeline feeding the entire offline southern extraction well field was cut and capped at the OU-2 treatment plant. The OU-2 extraction and injection pipelines along Wallace Road were cut and capped immediately west and downstream of EW14 and IW02, respectively.

In 2016 and 2017, treatment plant effluents consistently met discharge standards established in the CB ROD – Part 1 (USAF, 1997a) (i.e., no organic or inorganic compounds exceeded discharge standards). However, one or more inorganics exceeded discharge standards at one or more of the treatment systems (OU-2, Phase 3, and MW951 wellhead treatment system) in 2013, 2014, and 2015. Exceedance of certain

inorganic discharge standards in Main Base Plume treatment plant effluent has been a regular occurrence throughout the remedial action at CAFB. The exceedances reflect the differences in inorganic background levels for each of the HSZs and occur because of the mixing of water extracted from multiple HSZs and the subsequent injection of treated water into a single HSZ. These exceedances have been monitored in accordance with the LTGSP and coordinated with the regulatory agencies. These inorganic discharge standard exceedances do not represent a protectiveness issue because the exceedances do not exceed background concentrations.

Implementation of ICs and Other Measures

As discussed in Section II.C, Status of Implementation, ICs are in place to restrict groundwater use within plumes exceeding an MCL. ICs (land use restrictions) were incorporated as a grantee covenant in the deed formally transferring the former CAFB to Merced County. Similar ICs were incorporated as a grantee covenant in the deed transferring portions of the former Castle Gardens housing areas to private landowners. Groundwater use on the property transferred to the BoP was already restricted by terms of the USAF/BoP MOU.

Following publication of the *CB ROD – Part 2* (AFRPA, 2006a), the USAF notified the City of Atwater, Merced County, and private landowners in the unincorporated portion of Merced County overlying a plume exceeding an MCL (off-base OU-2 plume area) that the groundwater should not be used for human consumption. Although three contaminants currently exceed the MCL (DBCP, 1,2,3-TCP, and TCE), TCE is the only one that is a known USAF contaminant. DBCP is an agricultural contaminant. 1,2,3-TCP is also an agricultural contaminant, and 1,2,3-TCP data collection is ongoing to determine if CAFB was a potential contributing source for the concentrations being detected. The location and extent of off-base TCE plumes exceeding the MCL are updated and documented each year in the LTGSP annual report. If monitoring results show that a TCE plume exceeding an MCL has migrated, newly affected parcel owners will be notified by the USAF. Finally, a review is made on an annual basis to assure that new wells have not been installed in areas overlying a TCE groundwater plume exceeding an MCL.

No such restrictions exist for properties in the unincorporated areas of Merced County, although the County does require the submittal of analytical results for new wells and notifies the property owners of health risks that may be associated with use of the water. No new water supply wells are known to have been installed on the former base property or within the current (Q4/17) off-base plume areas.

Groundwater use restrictions for properties within the City of Atwater are implemented via an existing local ordinance that prohibits well installations within city limits. State land use covenants (SLUCs) for Castle Park and Castle Gardens reinforce those groundwater use restrictions. Merced County conducts an annual inspection of the property deeded to the county to determine if any state land use covenant (SLUC) restrictions have been violated. The annual SLUC report is submitted to the USAF, DTSC, and the CVRWQCB. Annual inspections were reviewed for 2013, 2014, 2015, 2016, and 2017 (Merced County, 2014; 2015; 2016; 2017; 2018). Results of the inspections indicated that no violations were found, and all appropriate covenants were recorded with property transfers.

The annual OM&M reports provide a remedy protectiveness evaluation on an annual basis. The annual reports for 2013, 2014, 2015, 2016, and 2017 (CH2M, 2014a; 2015a; 2016a; 2017; 2018a) indicate no new municipal, production, or domestic groundwater wells were installed on the former base property or within the then current off-base plume areas. Monitoring results indicate the extent of the TCE plumes exceeding the MCL have not migrated and that no new parcel owners have been affected. The municipal, domestic, and irrigation well monitoring network was evaluated and is determined to be sufficient (i.e., the municipal, domestic, and irrigation wells have been adequately identified under the LTGSP and monitored in accordance with the LTGSP sampling decision tree).

The USAF conducts site inspections and maintains regular communications with the BoP to ensure site conditions have not changed. Within the BoP property, no groundwater wells have been constructed and there have been no changes to the land use that would impact the remedial actions. No violations to IC restrictions were noted. Similarly, as discussed in Section IV.C, Site Inspection, the FYR site inspections

conducted in July 2018 identified no issue with enforcement of ICs. Consequently, the ICs and SLUCs have been properly implemented and are effective and no issues have been identified.

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

Question B Summary:

Yes, exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of the remedy selection are still valid as discussed below.

Changes in Standards and To Be Considereds (TBCs)

Seven VOCs were identified as COCs for the Main Base Plume (Table 1). The lower of the state or federal MCLs were selected as the standards for these COCs as presented in Table 1. The only MCL to change since the *CB ROD – Part 1* (USAF, 1997a) is for chloroform. The MCL at the time of the ROD was 100 µg/L. As of 2018, the MCL for chloroform (as total trihalomethanes) is 80 µg/L. This change in the MCL does not affect the protectiveness of the remedy because current concentrations of chloroform are much less than the current MCL of 80 µg/L.

Since the issuance of the ROD, a new MCL has been promulgated for 1,2,3-TCP. While this was not identified as a COC at the time of the ROD, some concentrations of 1,2,3-TCP exceed the recently issued MCL. Although the source of this 1,2,3-TCP is unknown, the two most likely sources are the use of nematicides in off-base agriculture and the use of solvents on base. 1,2,3-TCP was not identified as a COC in either the *CB ROD – Part 1* (USAF, 1997a) or *CB ROD – Part 2* (AFRPA, 2006a), and the USAF considers 1,2,3-TCP at the former CAFB to be an agricultural contaminant. However, following the State of California's establishment of a 1,2,3-TCP MCL (0.005 µg/L) in 2017, the USAF began an investigation to help determine the source and extent of 1,2,3-TCP contamination in groundwater at and near CAFB. This included the use of a low-level 1,2,3-TCP analytical method (SW8260SIM) with a reporting limit equal to the MCL (0.005 µg/L). Before this time, 1,2,3-TCP was analyzed using SW8260, for which the detection limit was approximately 30 times the concentration recently established as the MCL.

In Q2/18, the USAF sampled 49 groundwater wells using low-level 1,2,3-TCP analysis. The CVRWQCB collected split samples from an additional 16 wells. Based on data collected in Q2/18, 1,2,3-TCP appears to exceed the MCL almost exclusively in off-base wells west and southwest of CAFB and in on-base wells along the extreme western base boundary. A full evaluation of the data will be presented in the *Operations, Maintenance, and Monitoring 2018 Annual Report*. Initial review indicates that the source of the majority of 1,2,3-TCP contamination is off-base agricultural use.

1,2,3-TCP exceeded the MCL in every off-base domestic and irrigation well sampled as part of the LTGSP in Q2/18, with concentrations ranging from 0.0079 to 0.31 µg/L. Q1/18 data from the City of Atwater show that 1,2,3-TCP exceeded the MCL in all of its municipal wells with the exception of AM21, which is located on base. 1,2,3-TCP concentrations in these wells ranged from 0.0051 to 0.14 µg/L. 1,2,3-TCP exceedances in on-base wells located along the western base boundary ranged from 0.0057 to 1.7 µg/L in Q1/18 and Q2/18, respectively.

Because most of the 1,2,3-TCP contamination at and near CAFB is not collocated with the Main Base TCE plume, much of it is not being captured and remediated by the OU-2 and Phase 3 treatment systems. Monthly plant sampling indicates that OU-2 and Phase 3 are capturing and remediating a portion of the 1,2,3-TCP MCL plume. In order to evaluate the impact of 1,2,3-TCP on carbon usage, monthly samples of influent, primary effluent, and final effluent for both treatment plants began being collected in August 2018 for a period of 1 year and analyzed with the low-level SW8260SIM method.

Because of historical use of firefighting foam containing PFOS/PFOA, groundwater at the Main Base Plume has been impacted by PFOS/PFOA. The USAF is taking a programmatic approach at BRAC facilities regarding potential emerging chemical contamination associated with PFOS/PFOA. This

USAF-wide initiative evaluates candidate sites for the potential presence of PFOS/PFOA compounds and includes sampling at the selected sites at CAFB to determine if PFOS/PFOA are present as detailed in the Site Investigation Work Plan (Amec Foster Wheeler, 2017). Some of the areas of investigation are located upgradient of the Main Base Plume and may be a source of PFOS/PFOA to the plume. In addition, PFOS/PFOA sampling and analysis is being conducted for the influent and effluent of the Phase 3 and OU-2 groundwater treatment systems as presented in Addendum 2 to the *Final Installation-Specific Work Plan for Groundwater Treatment System Monitoring* (Wood, 2018). These contaminants were not included as COCs for the Main Base Plume. While EPA Lifetime Health Advisory for drinking water value of 0.070 µg/L (PFOS + PFOA) and the California State Water Resources Control Board's notification level of 0.013 µg/L for PFOS and 0.014 µg/L for PFOA have been developed, no promulgated standards have been released by EPA for PFOS/PFOA. Currently, the presence of PFOS/PFOA would not have an impact on the protectiveness of the remedy considering no standards are promulgated and the groundwater treatment systems are capturing the plumes and treating them in a manner that would likely remediate PFOS/PFOA. However, the presence of PFOS/PFOA and the impact on remedy protectiveness will continue to be evaluated.

Changes in Toxicity and Other Contaminant Characteristics

The cleanup levels are based on MCLs and, except for chloroform as discussed above, MCLs have not changed since the ROD. Since the previous changes to toxicity criteria for TCE, tetrachloroethene, and cis-1,2-DCE discussed in the fourth FYR (MWH, 2014), no changes to toxicity values have occurred during the last 5 years that would impact the protectiveness of the remedy. Additionally, contaminant characteristics have not changed.

Changes in Risk Assessment Methods

For the Main Base Plume, the third FYR (Jacobs, 2009) included an evaluation of potential risks associated with vapor intrusion of TCE from groundwater to indoor air under a residential scenario. The vapor intrusion evaluation used DTSC's version of the Johnson and Ettinger vapor intrusion model (DTSC, 2005), Cal-EPA toxicity values, and a TCE concentration in groundwater of 25 µg/L, and calculated cancer risk and noncancer hazard estimates assuming sand as a default soil type and silt as the site-specific soil type. Cancer risk estimates for default and site-specific soil types were 1E-06 and 2E-07, respectively, while noncancer hazard quotient (HQ) estimates for default and site-specific soil types were 0.0021 and 0.00043, respectively. The fourth FYR (MWH, 2014) estimated risks using EPA's revised toxicity values for TCE (EPA, 2011), with the original TCE concentration in groundwater of 25 µg/L and previous model input parameters. These cancer risk estimates were within or below EPA's acceptable cancer risk range of 1E-06 to 1E-04, and the updated noncancer hazard estimates were less than the acceptable HQ of 1.

DTSC updated the Screening-Level Model Spreadsheet for Groundwater to Indoor Air Vapor Intrusion in 2014 to incorporate updated default exposure parameters by EPA (2014). Using DTSC's revised spreadsheet, with the current maximum TCE concentration in groundwater of 21 µg/L as of Q2/18 and previous model input parameters, results in cancer risk estimates for default and site-specific soil types of 1E-06 and 8E-07, respectively, while noncancer HQ estimates for default and site-specific soil types are 0.38 and 0.25, respectively. These updated cancer risk estimates do not exceed EPA's acceptable cancer risk management range or an HQ of 1. Therefore, no significant vapor intrusion concerns are anticipated at current concentrations of TCE in groundwater within the Main Base Plume, and the remedy is considered protective relative to vapor intrusion.

Changes in Exposure Pathways

There have been no changes to exposure parameters, potential exposure pathways or site/land use conditions since the last FYR (MWH, 2014).

Expected Progress Towards Meeting RAOs

Significant progress has been made toward meeting the RAO for the Main Base Plume of cleanup to MCLs, both in terms of plume reduction (size and concentrations) and removal of VOC mass from groundwater as discussed in the Data Review section. ICs are in place to prevent inadvertent use of contaminated groundwater, and procedures are in place to minimize impact to municipal and domestic water supply wells.

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

No unanticipated natural disasters have occurred at this site and no site changes or vulnerabilities because of climate change have been identified that could impact the protectiveness of the remedy. However, dropping groundwater levels have reduced the monitoring well network used to evaluate the groundwater plumes. The LTGSP routinely identifies the dry wells and evaluates the need for replacement. Factors that help determine whether a well should be replaced include (1) the importance of the well's function; (2) the well's distance from, and its location relative to, the MCL plume; (3) the size of the MCL plume and its proximity to downgradient receptors; (4) whether an alternative well can be used to accomplish the dry well's monitoring objective; and (5) historical data associated with the dry well. Discussions with the agencies about the need to replace dry wells is ongoing but the dry wells do not impact the protectiveness of the remedy because other adjacent or downgradient wells are considered sufficient for assessing migration and contaminant trends.

B. ETC-10

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

Question A Summary:

Yes, the remedy is functioning as intended by the decision documents. As discussed below, the LTEM portion of the remedy is complete and the ICs have been properly implemented and are effective.

Remedial Action Performance

Remedial action performance is assessed in terms of the effectiveness of ICs and the results of LTEM. Information on the effectiveness of ICs is based on the nature of the controls in place and current site conditions as observed during recent site inspections and past IC inspections. The results of LTEM are based on the wetland invertebrate (fairy shrimp) and plant surveys conducted at ETC-10 in 2008 and 2016.

Systems OM&M

There are no operating systems in place at ETC-10; however, LTEM was conducted as part of the remedy. After the 2008 wetland invertebrate (fairy shrimp) and plant surveys, EPA requested one more round of surveys before monitoring could be terminated. Results of both the 2008 and 2016 surveys concluded there was no evidence that site contaminants had impacted the wetland habitats. Consequently, the 2016 LTEM report (CH2M, 2016b) recommended no further ecological monitoring and this portion of the remedy is considered complete.

Implementation of ICs and Other Measures

ETC-10 is located within the BoP United States Penitentiary, Atwater Complex; and public access is, and will be for the foreseeable future, prohibited and controlled by prison security (fencing and guard patrols). In addition, the USAF/BoP MOU precludes any site altering activities within the prison parcel, including ETC-10, without notification of EPA, DTSC, and the USAF and the approval of such activities by the USAF. No requests for site altering activities have been received to date by the USAF for ETC-10 or its vicinity. Further, no evidence of any regular site use, construction, or other site-altering activities were

observed within the ETC-10 site during site inspections on 12 July 2018 and 19 July 2018. The ICs have been properly implemented and are effective and no issues have been identified.

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

Question B Summary:

Yes, exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of the remedy selection are still valid as discussed below.

Changes in Standards and TBCs

Applicable or relevant and appropriate requirements (ARARs) and TBCs related to site soil contamination are relevant to the IC and LTEM remedies addressed herein. The only COC identified at ETC-10 was benzo(a)pyrene and a cleanup level of 0.089 mg/kg for a residential exposure scenario was established as part of the *SCOU ROD – Part 3* (Jacobs, 2005). The current EPA residential risk-based screening level for benzo(a)pyrene in residential soil is 0.11 mg/kg and is less conservative than the value selected in the ROD, therefore, the conclusions made in the ROD that no risk is predicted based on an industrial land use scenario are still applicable. Additionally, ICs are in place to restrict residential land use, thus preventing exposures to COCs in soil. Consequently, the remedy is still considered protective.

Changes in Toxicity and Other Contaminant Characteristics

There have been no significant changes in contaminant characteristics for benzo(a)pyrene. However, toxicity values of benzo(a)pyrene were updated in 2017 (EPA, 2017) as discussed above. This included an update of carcinogenic toxicity values (oral slope factor = 1 mg/kg-day, inhalation unit risk = 6×10^{-4} µg/m^3) and new noncancer toxicity values (RfD = 3×10^{-4} mg/kg-day, and RfC = 2×10^{-6} mg/m^3). The updated carcinogenic toxicity values are less conservative, while new noncancer toxicity values are more conservative for benzo(a)pyrene. The current EPA residential risk-based screening level for benzo(a)pyrene in residential soil is 0.11 mg/kg and is less conservative than the value (0.089 mg/kg) selected in the ROD. Consequently, the remedy remains protective.

Changes in Risk Assessment Methods

The standard risk assessment methods for evaluating benzo(a)pyrene in soil have not changed significantly since the human health risk assessment (HHRA), and the remedy is still considered protective.

Changes in Exposure Pathways

There have been no changes in the potential exposure pathways at ETC-10. Exposure pathways of concern, and those addressed by the *SCOU ROD – Part 3* (Jacobs, 2005) remedies, are human exposure to residual soil contamination and vernal pool fairy shrimp and plant exposure to contaminants from past and present soil contamination at the site.

Expected Progress Towards Meeting RAOs

The objectives of the IC remedy for ETC-10 is being achieved. Site access is controlled and there has been no uncontrolled human access or use of the site during the period of this FYR. Additionally, a final round of LTEM was conducted, and the LTEM report (CH2M, 2016b) recommended discontinuing additional LTEM. Consequently, the LTEM portion of the remedy is considered complete.

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

No unanticipated natural disasters have occurred at this site and no site changes or vulnerabilities because of climate change have been identified that could impact the protectiveness of the remedy.

C. FTA-1

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

Question A Summary:

Yes, the remedy is generally functioning as intended by the decision documents, although ICs were breached within the BoP boundary, as discussed below.

Remedial Action Performance

Remedial action performance is assessed in terms of the ICs and the results of LTM and LTEM. Information on the effectiveness of the ICs is based on the nature of the controls in place, site conditions reported for the annual evaluation of site activities and conditions, and site conditions observed during a recent site inspection. The results of LTM are based on the cap inspection and monitoring conducted semiannually for FTA-1 and a recent site inspection. Groundwater monitoring was also part of the LTM at FTA-1 per the *SCOU ROD – Part 3* (Jacobs, 2005), but was discontinued in 2014. The results of LTEM are based on the wetland invertebrate (fairy shrimp) and plant surveys conducted at FTA-1 in 2008 and 2016.

Systems OM&M

Inspections:

Semiannual inspections of the FTA-1 cap were performed from 2013 through 2017 as documented in the annual OM&M reports (CH2M, 2014a; 2015a; 2016a; 2017; 2018a). The first of two site inspections in 2018 was completed at FTA-1 in July of 2018 and will be summarized in the forthcoming 2018 annual OM&M report. The semiannual cap inspections evaluate the ICs, the access roads, fencing and gates, access issues/vandalism, the cap and vegetative cover, mowing activities, drainage swales, site periphery, and the presence of trash or debris. In addition, an annual IC inspection is also performed to ensure the ICs are adequately implemented and was conducted most recently in March 2018. No findings from the IC or cap inspections were noted that would impact the effectiveness of the remedy. Significant findings based on inspections conducted between 2013 and 2018 are as noted below:

- Burrows were noted during all inspections; however, no damage to the liner was noted. To address the recurring issue of ground squirrels penetrating the cap, bait stations were put out and a routine maintenance program was implemented in 2015 to fill and monitor the bait stations and burrowing activities.
- In early June 2015, a grass fire burned the dry vegetation in the southern and western portions of the cap. The cause of this fire is unknown. No further actions were required because vegetative growth was reestablished throughout the cap during the rainy season.
- A portion of the fence that traversed the drainage swale was noted as having been removed during the June 2017 inspection; however, posts were still in place and there was no disturbance to the drainage swale during the 2017 inspection. In February 2018 when staff were on site for other reasons, the BoP breach of ICs including the liner disturbance was noted as discussed previously in Section C, Site Inspection. During the March 2018 inspection, it was noted that there was evidence of disturbance to the landfill cover. The fence was replaced in 2018.
- During the 12 July 2018 site inspection for this FYR, the signage at FTA-1 was observed to have fallen off the fence and was located on the ground. It was secured back on the fence during the site inspection.

Groundwater Monitoring:

MW1054 and MW1055 were installed in summer 2013 to replace monitoring wells that had gone dry. MW1054 was installed downgradient of MW886, and MW1055 was installed at the downgradient edge of the FTA-1 cap. One year of quarterly sampling was conducted at both wells from Q3/13 through

Q2/14. Over the four quarters, TCE concentrations at MW1054 decreased steadily from 4.8 to 0.58 µg/L, while those at MW1055 remained within a range of 2.3 to 2.9 µg/L. Because the TCE concentrations at these two wells were less than the MCL and did not show any evidence of an increasing trend, groundwater sampling for VOCs ceased at FTA-1 in Q3/14 in accordance with the *SCOU ROD – Part 3* (Jacobs, 2005) and with regulatory agency approval. Because the plume appears to have been remediated, further monitoring of these wells is not required. The groundwater monitoring portion of this remedy is considered complete.

LTEM:

The results of LTEM are based on the wetland invertebrate (fairy shrimp) and plant surveys conducted at FTA-1 in 2008 and 2016. After the 2008 survey, EPA requested one more round of surveys before monitoring could be terminated. The second round of monitoring was conducted in 2016. Results of both the 2008 and 2016 surveys concluded there was no evidence that site contaminants had impacted the wetland habitats. Consequently, the 2016 LTEM report (CH2M, 2016b) recommended no further ecological monitoring and this portion of the remedy is considered complete.

Implementation of ICs and Other Measures

FTA-1 is located within the BoP United States Penitentiary, Atwater Complex; and public access is, and will be for the foreseeable future, prohibited and controlled by prison security (fencing and guard patrols). In addition, the USAF/BoP MOU prohibits any site-altering activities within the prison parcel, including FTA-1, without notification of EPA, DTSC, and the USAF and the approval of such activities by the USAF. IC inspections are conducted annually as discussed above under "Systems OM&M." While these annual inspections did not identify any issues with implementation of the ICs before 2018, on 16 February 2018, the USAF was notified by its support contractor that portions of the fencing and HDPE liner material within drainage swales near FTA-1 had been disturbed by BoP Atwater inmate work crews. According to the BoP Atwater Facilities Manager, their work crews mistakenly removed several fence posts and fencing, and disturbed soils within drainage swales to gather stones from the swales to construct improvements to the entrance of the prison. The HDPE material is part of the cap liner that extends from the cap into the swale as a continuous unit. Despite the disturbance of the swales, the FTA-1 cap does not appear to have been significantly damaged. Based on a review of where the contaminants were located beneath the cap, no risk to human health or the environment is anticipated to have occurred because of the incident. To avoid breaches in the future, additional signs were installed at FTA-1 and the BoP Atwater Facilities Manager has advised his staff that prior approval is required for any work conducted in the environmental areas, which include FTA-1, as well as ETC-10 and LF-5, and to immediately report to him any work they see being done in these areas by any BoP staff or inmates.

No requests for site-altering activities have been received to date by the USAF for FTA-1 or its vicinity. In accordance with the *CPCMP – Update 2* (AFRPA, 2006b), annual monitoring is conducted to identify any activity that is inconsistent with the IC objective or use restrictions or any action that may interfere with the effectiveness of the ICs. An IC checklist is completed during the inspection and included in the annual OM&M reports. The annual reports for 2013, 2014, 2015, 2016, and 2017 (CH2M, 2014a; 2015a; 2016a; 2017; 2018a) indicate there were no issues with the annual IC evaluation during the fifth FYR period. However, as discussed previously, a breach of ICs occurred in early 2018. No evidence of any other irregular site use, construction, or other site-altering activities was observed within the FTA-1 site during a site inspection on 12 July 2018.

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

Question B Summary:

Yes, exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of the remedy selection are still valid as discussed below.

Changes in Standards and TBCs

ARARs and TBCs related to site soil contamination are relevant to the IC, LTM, and LTEM remedies addressed herein. Chemical-specific ARARs were not selected for soil contaminants; however, changes to adopted TBCs for all the soil COCs have occurred since the time of remedy selection as discussed below. However, because the remedy includes a cap and ICs, the remedy is preventing exposure to soil and soil vapor under a residential scenario and is still considered protective.

Because of historical fire training activities at FTA-1, the area may have been impacted by PFOS/PFOA, an emerging contaminant, used in fire-fighting foams. PFOS/PFOA were not identified as COCs at the time of the ROD. The USAF is taking a programmatic approach at BRAC facilities regarding potential emerging chemical contamination associated with PFOS/PFOA. This USAF-wide initiative evaluates candidate sites for the potential presence of PFOS/PFOA and includes sampling at the selected sites to determine if PFOS/PFOA are present. FTA-1 was evaluated for PFOS/PFOA as part of the 2016 Site Investigation (Amec Foster Wheeler, 2016). Investigation activities included installing two monitoring wells and sampling and analyzing sediment, soil, and groundwater. Based on this evaluation, PFOS/PFOA were detected in soil, sediment, and groundwater samples from FTA-1 but at concentrations that were less than the PALs used at the time of the investigation, which were based on the 2009 EPA PHA values. The 2009 EPA PHA drinking water values were 0.2 µg/L for PFOS and 0.4 µg/L for PFOA. The EPA has set the Lifetime Health Advisory in drinking water for both PFOA and PFOS at 0.070 µg /L and has recommended that when PFOA and PFOS co-occur in a drinking water source, the sum of the concentrations of PFOA and PFOS also be compared to the Lifetime Health Advisory in drinking water value of 0.070 µg /L. Additionally, the California State Water Resources Control Board's notification level of 0.013 µg/L for PFOS and 0.014 µg/L for PFOA was subsequently developed. Based on the changing screening levels, additional investigation may be warranted to assess risk from PFOS/PFOA and impact on remedy protectiveness.

Changes in Toxicity and Other Contaminant Characteristics

Soil COCs based on an occupational scenario as presented in the ROD include arsenic, benzo(a)pyrene, cadmium, lead, and dioxin/furans as presented in Table 1. As noted in the fourth FYR report (MWH, 2014), the preliminary remediation goal for lead of 750 mg/kg (as documented in the ROD) was superseded by the 2013 regional screening level (RSL) for lead of 800 mg/kg which is less conservative and does not impact protectiveness of the remedy. Additionally, the cleanup level for arsenic is based on background and is not risk-based; therefore, changes to RSLs for arsenic would have no effect on the selected arsenic cleanup level or the protectiveness of the remedy. The RSLs for benzo(a)pyrene (2.1 mg/kg), cadmium (980 mg/kg), and OCDD (0.07 mg/kg) (EPA, 2018) have been updated since the ROD and are all less restrictive than the cleanup standards selected in the ROD (Table 1). This is from updates in standard default exposure parameters in 2014 (EPA, 2014) as discussed below, changes in toxicity values of benzo(a)pyrene (EPA, 2017), and incorporation of updated Agency for Toxic Substances and Disease Registry toxicity values of cadmium to RSLs (EPA, 2013). The current RSLs for dioxin congeners 1,2,3,4,6,7,8-HpCDF, HxCDD, HxCDF are slightly more restrictive but not significantly (0.0024 vs 0.0022 mg/kg and 0.00024 vs 0.00022 mg/kg). Consequently, RAOs that were set in the ROD remain protective.

Changes in Risk Assessment Methods

The standard default exposure parameters used in HHRAs for occupational workers were updated by EPA in 2014 (EPA, 2014). The changes in exposure parameters relevant for soil exposure to workers include an update in default body weight (70 to 80 kilograms), skin surface area (3,300 to 3,527 square centimeters), and worker soil adherence factor (0.2 to 0.12). These exposure factors are less conservative for body weight and adherence factor and more conservative for skin surface area. However, these changes would result in less restrictive RSLs (as discussed above for each COC) and indicate that the RAOs selected in the ROD remain protective.

Changes in Exposure Pathways

There have been no changes in the potential exposure pathways at FTA-1. The exposure pathways of concern, and those addressed by the *SCOU ROD – Part 3* (Jacobs, 2005) remedies, are human exposure to residual soil contamination under the cap and vernal pool fairy shrimp and plant exposure to contaminants from former soil contamination at the site. The potential exposure pathway of vapor intrusion to future buildings from residual shallow VOCs that may be present at FTA-1 is not an issue because human use of the site is restricted by ICs in the USAF/BoP MOU and, in addition, human use or building on the site is precluded since the site is within the BoP Vernal Pool Preservation Area.

Expected Progress Towards Meeting RAOs

The objectives of the IC and LTEM remedies for FTA-1 are being achieved. Site access is controlled and there has been no uncontrolled human access or use of the site during the period of this FYR, except as previously noted. Additionally, a final round of LTEM was conducted, and the LTEM report (CH2M, 2016b) recommended discontinuing additional LTEM. Consequently, the LTEM portion of the remedy is considered complete.

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

No unanticipated natural disasters have occurred at this site and no site changes or vulnerabilities because of climate change have been identified that could impact the protectiveness of the remedy.

D. LF-4

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

Question A Summary:

Yes, the remedy is functioning as intended by the decision documents. As discussed below, the remedial action performance is adequate, the OM&M inspections and monitoring did not identify any issues, and the ICs are in place and effective.

Remedial Action Performance

Remedial action performance is assessed in terms of the effectiveness of ICs and the results of LTM. Information on the effectiveness of ICs is based on the nature of the controls in place, site conditions reported for the annual evaluation of site activities and conditions, and site conditions observed during a recent site inspection. The results of LTM are based on the cap inspection and monitoring conducted semiannually for LF-4, the results of post-closure groundwater monitoring conducted as part of the LTGSP, and a recent site inspection.

Systems OM&M

Semiannual inspections of the LF-4 cap were performed from 2013 through 2017 as documented in the annual OM&M reports (CH2M, 2014a; 2015a; 2016a; 2017; 2018a). The semiannual inspections evaluate the ICs, the access roads, fencing and gates, access issues/vandalism, the cap and vegetative cover, mowing activities, drainage swales, site periphery, and the presence of trash or debris. In addition, an annual IC inspection is also performed to ensure the ICs are adequately implemented. Results of the IC inspections are also included in the annual reports. The 2018 IC inspection was conducted in March 2018 and will be presented in the forthcoming 2018 annual OM&M report. Based on the cap and IC inspections, no findings were noted that would impact the effectiveness of the remedy. Significant findings between 2013 and 2018 are as noted below:

- Burrows were noted during all inspections; however, no damage to the liner was noted. To address the recurring issue of ground squirrels penetrating the cap, bait stations were put out, and a routine maintenance program was implemented in 2015 to fill and monitor the bait stations and burrowing

activities. In 2017, some damage to fence posts was observed and it was noted that the gate was warped but still functional.

- Water was identified in the center gas vent at LF-4 in 2017. An inspection of the well determined that there was a hole in the upper sleeve of the vent and that the sealant between the upper sleeve and the pipe boot was not completely intact. Repairs were conducted in January 2018 to replace the sleeve and pipe boot, and the vent is again water tight.
- Based on a 2015 site inspection, it was recommended that the northwestern perimeter access road on LF-5 be re-routed as a portion of the road traverses a location where the geosynthetic material is bridged because of settling of the underlying waste trench. This portion of the road was re-routed in 2016 to avoid the area where waste was settling.
- Several large burrows were observed near perimeter monitoring well LF4SVE-B in 2017. The area around the well was restored in early 2018.

Groundwater Monitoring:

The results of groundwater monitoring as discussed in the Data Review section indicate that contaminants are not migrating from the landfill into the groundwater and the remedy is functioning as intended. The only analyte that exceeded its limit was 1,2,3-TCP, which the USAF believes is coming from the adjacent agricultural field and not from LF-4.

Because of declining groundwater levels, several of the wells have been dry or had too little water to sample for several years. Decisions related to the installation of new monitoring wells to replace the dry wells will be revisited in Q2/19. Because the historical monitoring data have indicated that the landfill is not acting as a source of contaminants to groundwater, the remedy is still considered protective despite the dry wells.

Landfill Gas Monitoring:

Landfill gas monitoring was conducted from 2013 to 2018. Methane concentrations from the eight perimeter monitoring wells were ND throughout the entire period, indicating that no migration is occurring and the remedy is working as intended. In 2013, methane was detected in the landfill cap gas vents at concentrations ranging from 0.4 to 4.0 percent by volume in air, indicating that landfill gas is being vented as designed. Subsequent to 2013, collection of additional landfill cap gas vent data was not warranted.

Implementation of ICs and Other Measures

Land use restrictions for LF-4 were incorporated in the deed transferring the parcel containing LF-4 to Merced County (deed recorded 8 January 2007, Merced County Recorders document #2007-001242), and a State Land Use Covenant has been executed by Merced County with the State of California (deed recorded 8 January 2007, Merced County Recorders document #2007- 001241). These controls limit site use to non-irrigated open space and preclude any groundwater withdrawal or other activity that would disturb the closed landfill, including the cap, access roads and security fencing, drainage features, and monitoring probes/wells.

In accordance with the *CPCMP – Update 2* (AFRPA, 2006b), annual monitoring is conducted to identify any activity that is inconsistent with the IC objective or use restrictions, or any action that may interfere with the effectiveness of the ICs. An IC checklist is completed during the inspection and is included in the annual OM&M reports. The annual reports from 2013 to 2017 (CH2M, 2014a; 2015a; 2016a; 2017; 2018a) and annual site inspection conducted in March 2018 indicate there were no issues with the annual IC evaluation of LF-4 during this FYR period. Furthermore, no evidence of any irregular site use, construction, or other site-altering activities were observed within LF-4 during site inspections on 12 and 19 July 2018. The ICs have been properly implemented and are effective and no issues have been identified.

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

Question B Summary:

Yes, exposure assumptions and RAOs used at the time of the remedy selection are still valid as discussed below. However, because no COCs were identified for LF-4 based on post-removal conditions, changes in toxicity data and cleanup levels are not relevant to the selected remedy. It should be noted that while the removal action has eliminated the COCs by eliminating the potential routes of exposure, there may be COCs present within the waste material now capped at LF-4 that exceed human health or Water Quality Settlement Agreement (WQSA) RAOs.

Changes in Standards and TBCs

Based on post-removal action conditions, there are no identified COCs for LF-4. Consequently, changes in standards or TBCs would not impact RAOs or remedy protectiveness.

Changes in Toxicity and Other Contaminant Characteristics

As discussed above, no COCs were identified for LF-4 based on post-closure conditions.

Changes in Risk Assessment Methods

As discussed above, no COCs were identified for LF-4 based on post-closure conditions.

Changes in Exposure Pathways

There have been no changes in the potential exposure pathways at LF-4. The exposure pathways of concern, and those addressed by the *SCOU ROD – Part 3* (Jacobs, 2005) remedies, are human exposure to residual soil contamination under the cap and groundwater contamination by leachate from the capped waste. The potential exposure pathway of vapor intrusion to future buildings from residual shallow VOCs that may be present at LF-4 is not an issue because human use of the site is restricted by ICs that were incorporated in the deed transferring the parcel containing LF-4 to Merced County and in the State Land Use Covenant that has been executed by Merced County with the State of California.

Expected Progress Towards Meeting RAOs

The objectives of the IC and LTM remedies for LF-4 are being achieved. Site access is controlled and there has been no uncontrolled human access or use of the site during the period of this FYR. Cap monitoring and maintenance is being performed semiannually, and there have been no significant issues with the caps.

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

No unanticipated natural disasters have occurred at this site and no site changes or vulnerabilities because of climate change have been identified that could impact the protectiveness of the remedy. However, dropping groundwater levels have reduced the monitoring well network used to evaluate the effectiveness of the LF-4 remedy. The LTGSP routinely identifies the dry wells and evaluates the need for replacement. Factors that help determine whether a well should be replaced include (1) the importance of the well's function; (2) the well's distance from, and its location relative to, the MCL plume; (3) the size of the MCL plume and its proximity to downgradient receptors; (4) whether an alternative well can be used to accomplish the dry well's monitoring objective; (5) historical data associated with the dry well; and (6) whether the well is needed to meet post-closure detection monitoring requirements. Discussions with the agencies about the need to replace dry wells is ongoing, but the dry wells do not impact the protectiveness of the remedy because the historical monitoring data have indicated that the landfill is not acting as a source of contaminants to groundwater.

E. LF-5

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

Question A Summary:

Yes, the remedy is functioning as intended by the decision documents. As discussed below, the remedial action performance is adequate, the OM&M inspections and monitoring did not identify any issues, and the ICs are in place and effective.

Remedial Action Performance

Remedial action performance is assessed in terms of the effectiveness of ICs and the results of LTM and LTEM. Information on the effectiveness of ICs is based on the nature of the controls in place, site conditions reported for the annual evaluation of site activities and conditions, and site conditions observed during a recent site inspection. The results of LTM are based on the cap inspection and monitoring conducted semiannually for LF-5, the results of post-closure groundwater monitoring conducted as part of the LTGSP, and a recent site inspection. The results of LTEM are based on the wetland invertebrate (fairy shrimp) and plant surveys conducted at LF-5 in 2008 and 2016.

Systems OM&M

Inspections:

Semiannual inspections of the LF-5 cap were performed from 2013 through 2017 as documented in the annual OM&M reports (CH2M, 2014a; 2015a; 2016a; 2017; 2018a). The semiannual inspections evaluate the ICs, the access roads, fencing and gates, access issues/vandalism, the cap and vegetative cover, mowing activities, drainage swales, site periphery, and the presence of trash or debris. In addition, an annual IC inspection is also performed to ensure the ICs are adequately implemented. Results of the IC inspections are also included in the annual reports. The 2018 IC inspection was conducted in March 2018 and will be presented in the forthcoming 2018 annual OM&M report. Based on the cap and IC inspections, no findings were noted that would impact the effectiveness of the remedy. Significant findings between 2013 and 2018 are as noted below:

- Burrows were noted during all inspections; however, no damage to the liner was noted. To address the recurring issue of ground squirrels penetrating the cap, bait stations were put out, and a routine maintenance program was implemented in 2015 to fill and monitor the bait stations and burrowing activities. During Q3/14, evidence of geotextile material (filter fabric) was observed near the openings of the rodent holes; however, hand excavations of the burrows indicated that the geosynthetic cap material had not been compromised.
- Minor puncture damage of cover geomembrane material at Location 1 trench at LF-5 was repaired on 11 May 2016.

Groundwater Monitoring:

The results of groundwater monitoring as discussed in the Data Review section indicate that contaminants are not migrating from the landfill into the groundwater and the remedy is functioning as intended. However, because of declining groundwater levels, several of the wells have been dry or had too little water to sample for several years. Decisions related to the installation of new monitoring wells to replace the dry wells will be revisited in Q2/19. Because the historical monitoring data have indicated that the landfill is not acting as a source of contaminants to groundwater, the remedy is still considered protective despite the dry wells.

Landfill Gas Monitoring:

Landfill gas monitoring was conducted from 2013 to 2018. Methane concentrations from the eight perimeter monitoring wells were ND throughout the entire period, indicating that no migration is occurring and the remedy is working as intended. In 2013, methane was detected in the landfill cap gas

vents at concentrations ranging from 0.4 to 4.0 percent by volume in air, indicating that landfill gas is being vented as designed. Subsequent to 2013, collection of additional landfill cap gas vent data was not warranted.

Implementation of ICs and Other Measures

LF-5 is located within the BoP United States Penitentiary, Atwater Complex; and public access is, and will be for the foreseeable future, prohibited and controlled by prison security (fencing and guard patrols). In addition, the USAF/BoP MOU precludes any site-altering activities within the prison parcel, including LF-5, without notification of EPA, DTSC, and the USAF and the approval of such activities by the USAF. No requests for site-altering activities have been received to date by the USAF for LF-5 or its vicinity.

In accordance with the *CPCMP – Update 2* (AFRPA, 2006b), annual monitoring is conducted to identify any activity that is inconsistent with the IC objective or use restrictions, or any action that may interfere with the effectiveness of the ICs. An IC checklist is completed during the inspection and is included in the annual OM&M reports. The annual reports from 2013 to 2017 (CH2M, 2014a; 2015a; 2016a; 2017; 2018a) and annual site inspection conducted in March of 2018 indicate there were no issues with the annual IC evaluation of LF-5 during this FYR period. Furthermore, no evidence of any irregular site use, construction, or other site-altering activities were observed within LF-5 during site inspections on 12 July 2018 and 19 July 2018. The ICs have been properly implemented and are effective and no issues have been identified.

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

Question B Summary:

Yes, exposure assumptions and RAOs used at the time of the remedy selection are still valid as discussed below. However, because no COCs were identified based on post-removal conditions with the exception of metals that were only qualitatively identified as COCs, no chemical-specific ARARs or TBCs were identified for LF-5. Consequently, changes in toxicity data and cleanup levels are not relevant to the selected remedy. It should be noted that while the removal action has eliminated the COCs by eliminating the potential routes of exposure, there may be COCs present within the waste material now capped at LF-5 that exceed human health or WQSA RAOs.

Changes in Standards and TBCs

Metals were qualitatively identified as ecological COCs at LF-5 based on potential risk to nearby wetland habitats. However, the remedy addresses these COCs based on ecological monitoring and no chemical-specific ARARs or TBCs were identified for LF-5. Consequently, changes in standards or TBCs would have no impact on protectiveness of the remedy.

Changes in Toxicity and Other Contaminant Characteristics

No contaminant characteristics have changed since the ROD. As discussed above, metals were qualitatively identified as ecological COCs at LF-5 based on potential risk to nearby wetland habitats. However, the remedy addresses these COCs based on ecological monitoring and no chemical-specific ARARs or TBCs were identified for LF-5. Consequently, changes in toxicity criteria would have no impact on protectiveness of the remedy.

Changes in Risk Assessment Methods

As discussed above, metals were qualitatively identified as ecological COCs at LF-5 based on potential risk to nearby wetland habitats. Significant changes in the ecological risk assessment process have not occurred since the time the risk assessment was completed.

Changes in Exposure Pathways

There have been no changes in the potential exposure pathways at LF-5. The exposure pathways of concern, and those addressed by the *SCOU ROD – Part 3* remedies, are human exposure to residual soil contamination under the cap and groundwater contamination by leachate from the capped waste. The potential exposure pathway of vapor intrusion to future buildings from residual shallow VOCs that may be present at LF-5 is not an issue because human use of the site is restricted by ICs that were incorporated in the USAF/BoP MOU. The potential exposure pathway of vapor intrusion to future buildings adjacent to LF-5 is also not an issue. The Atwater prison was constructed in the central portion of the BoP parcel. The remainder of the parcel, including LF-5 and vicinity, constitutes a buffer area for the prison and is to remain open space. LF-5 is located along the northern boundary (fenceline) of the BoP parcel, but, given the nature of the facility, no buildings will ever be considered or allowed to be built near the fence defining prison property—either inside or outside the fence. In addition, the Federal-to-Federal transfer letter requires the BoP to consult with the USAF and the regulatory agencies if they plan to construct or operate any type of facility at or adjacent to LF-5.

Expected Progress Towards Meeting RAOs

The objectives of the IC, LTM, and LTEM remedies for LF-5 are being achieved. Site access is controlled and there has been no uncontrolled human access or use of the site during the period of this FYR. Cap monitoring and maintenance is being performed semiannually, and there have been no significant issues with the caps. In addition, the LF-5 cap liner was inspected in Q4/15 in several areas of settling to verify that the liner was not being damaged. This inspection consisted of excavating a trench through the settlement area to remove the soil, exposing and inspecting the geocomposite and geomembrane layers, and then backfilling the trench. This inspection found that the liner was not impacted by the settlement. A final round of LTEM was conducted, and the LTEM report (CH2M, 2016b) recommended discontinuing additional LTEM. Consequently, the LTEM portion of the remedy is considered complete.

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

No unanticipated natural disasters have occurred at this site and no site changes or vulnerabilities because of climate change have been identified that could impact the protectiveness of the remedy. However, dropping groundwater levels have reduced the monitoring well network used to evaluate the effectiveness of the LF-5 remedy. The LTGSP routinely identifies the dry wells and evaluates the need for replacement. Factors that help determine whether a well should be replaced include (1) the importance of the well's function; (2) the well's distance from, and its location relative to, the MCL plume; (3) the size of the MCL plume and its proximity to downgradient receptors; (4) whether an alternative well can be used to accomplish the dry well's monitoring objective; (5) historical data associated with the dry well; and (6) whether the well is needed to meet post-closure detection monitoring requirements. Discussions with the agencies about the need to replace dry wells is ongoing but the dry wells do not impact the protectiveness of the remedy because the historical monitoring data have indicated that the landfill is not acting as a source of contaminants to groundwater.

VI. ISSUES/RECOMMENDATIONS

Issues/Recommendations
Sites without Issues/Recommendations Identified in the Five-Year Review:
ETC-10, LF-4, LF-5

Issues and Recommendations Identified in the Five-Year Review:				
Affect Current Protectiveness	**Affect Future Protectiveness**	**Party Responsible**	**Oversight Party**	**Milestone Date**
No	Yes	Federal Facility	EPA/State	Ongoing
Site: FTA-1	**Issue Category:** Monitoring			
	Issue: Evaluation of PFOS/PFOA			
	Recommendation: Continue to investigate the presence, extent, and potential for risk from PFOS/PFOA in groundwater and evaluate the impact on remedy protectiveness.			

Affect Current Protectiveness	**Affect Future Protectiveness**	**Party Responsible**	**Oversight Party**	**Milestone Date**
No	Yes	Federal Facility	EPA/State	Ongoing
Site: Main Base Plume	**Issue Category:** Monitoring			
	Issue: Evaluation of PFOS/PFOA			
	Recommendation: Continue to investigate the presence and potential for risk from PFOS/PFOA in groundwater and evaluate the impact on remedy protectiveness. Additionally, determine if the presence of PFOS/PFOA would increase the frequency of carbon changeouts for the treatment systems.			

A. Other Findings

In addition, the following are recommendations that were identified during the FYR that may improve performance of the remedy, but do not affect current and/or future protectiveness:

Affect Current Protectiveness	Affect Future Protectiveness	Party Responsible	Oversight Party	Milestone Date
No	No	Federal Facility	EPA/State	Ongoing
Site: Main Base Plume	**Issue Category:** Monitoring			
	Issue: Declining Water Levels			
	Recommendation: Continue to evaluate water levels at the Main Base Plume and the impact on monitoring and remediation systems.			

Affect Current Protectiveness	Affect Future Protectiveness	Party Responsible	Oversight Party	Milestone Date
No	No	Federal Facility	EPA/State	2019
Site: Main Base Plume	**Issue Category:** Monitoring			
	Issue: Evaluation of 1,2,3-TCP			
	Recommendation: Determine if CAFB is a contributing source to the 1,2,3-TCP concentrations detected at the downgradient base boundary and off base.			

Affect Current Protectiveness	Affect Future Protectiveness	Party Responsible	Oversight Party	Milestone Date
No	No	Federal Facility	EPA/State	2019
Site: Main Base Plume	**Issue Category:** Monitoring			
	Issue: Concentrations of TCE exceeded 10 µg/L during 2Q/18 at MW1008.			
	Recommendation: Determine if wellhead treatment at MW1008 is necessary based on recent sampling results.			

Affect Current Protectiveness	Affect Future Protectiveness	Party Responsible	Oversight Party	Milestone Date
No	No	Federal Facility	EPA/State	Ongoing
Site: Main Base Plume	**Issue Category:** Monitoring			
	Issue: TCE at IW40			
	Recommendation: Continue to monitor concentrations at IW40 and downgradient wells and evaluate if wellhead treatment or additional remedial actions are necessary to ensure ROD compliance. The evaluation for wellhead treatment or additional remedial action at IW40 and downgradient wells will be included in the Annual OM&M reports.			

Affect Current Protectiveness	Affect Future Protectiveness	Party Responsible	Oversight Party	Milestone Date
No	No	Federal Facility	EPA/State	1/1/2019
Site: FTA-1	**Issue Category:** Operations and Maintenance			
	Issue: Impairment of HDPE liner at FTA-1 and breach of ICs			
	Recommendation: Ensure that BoP repairs the HDPE liner that was damaged by inmate crews in early 2018, ensure access policy is enforced, and ensure signage is firmly secured.			

Affect Current Protectiveness	Affect Future Protectiveness	Party Responsible	Oversight Party	Milestone Date
No	No	Federal Facility	EPA/State	Q2/19
Sites: LF-4 and LF-5	**Issue Category:** Monitoring			
	Issue: Dry Wells			
	Recommendation: Continue evaluation of dry wells as part of the LTGSP and determine if additional wells are necessary at LF-4 and LF-5 to maintain compliance with SCOU ROD – Part 3 (Jacobs, 2005) and CPCMP requirements. Groundwater levels will be monitored at existing landfill wells in Q4/18, Q1/19, and Q2/19 and samples collected if sufficient water volume is present. Results of this monitoring will be discussed before, or at, the 2019 BCT meeting and a consensus reached on the need for replacement wells. Following this discussion, a work plan detailing number, location, and installation of wells will be provided for regulatory review and approval before any installation work.			

Affect Current Protectiveness	Affect Future Protectiveness	Party Responsible	Oversight Party	Milestone Date
No	No	Federal Facility	EPA/State	Q2/19
Sites: LF-4 and LF-5	**Issue Category:** Monitoring			
	Issue: Evaluation of 1,2,3-TCP			
	Recommendation: Conduct additional sampling of LF-4 and LF-5 groundwater wells to determine if either landfill is a contributing source to the 1,2,3-TCP concentrations detected at the downgradient base boundary and off base. If the USAF is a contributing source of TCP, the USAF will evaluate the need for additional remedial actions and incorporation of TCP into the ROD and CPCMP as appropriate.			

VII. PROTECTIVENESS STATEMENT

Protectiveness Statement(s)	
OU:	*Protectiveness Determination:*
Comprehensive Basewide Groundwater OU (OU-5)	Short-term Protective
Protectiveness Statement:	
The remedial actions implemented for the CB Groundwater OU currently protect human health and the environment. However, further investigation of the presence, extent, and potential for risk of PFOS/PFOA is necessary to ensure long-term protectiveness.	

Protectiveness Statement(s)	
OU:	*Protectiveness Determination:*
Source Control OU (OU-4)	Short-term Protective
Protectiveness Statement:	
The remedial actions implemented for the SCOU are currently protective of human health and the environment. However, further investigation of the presence, extent, and potential for risk of PFOS/PFOA at FTA-1 is necessary to ensure long-term protectiveness.	

VIII. NEXT REVIEW

The next FYR will be completed by 11 March 2024.

FIGURES

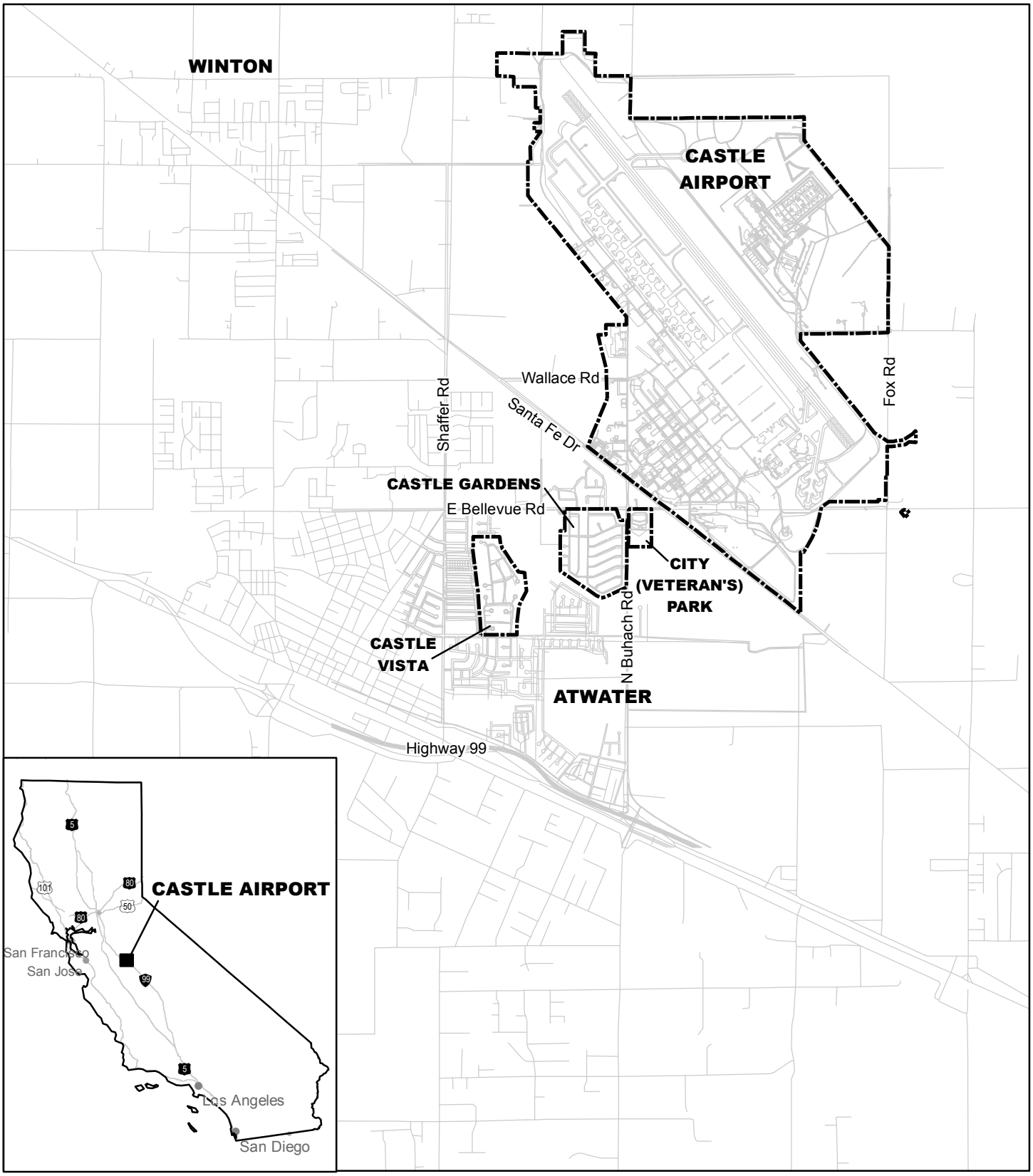
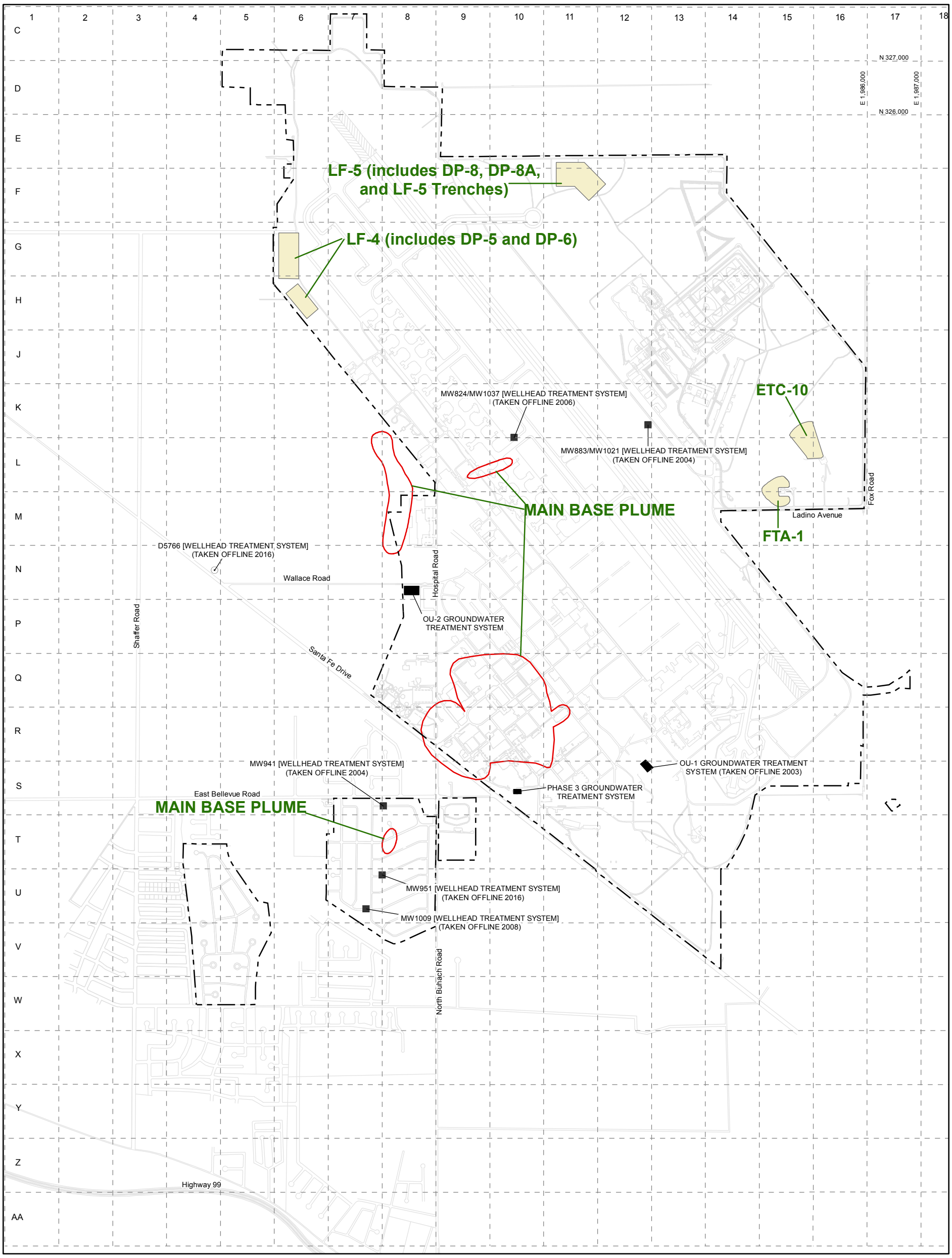


Figure 1
Former Castle Air Force Base
Vicinity Map
Fifth Five-Year Review Report
Former Castle AFB, Atwater, California



LEGEND

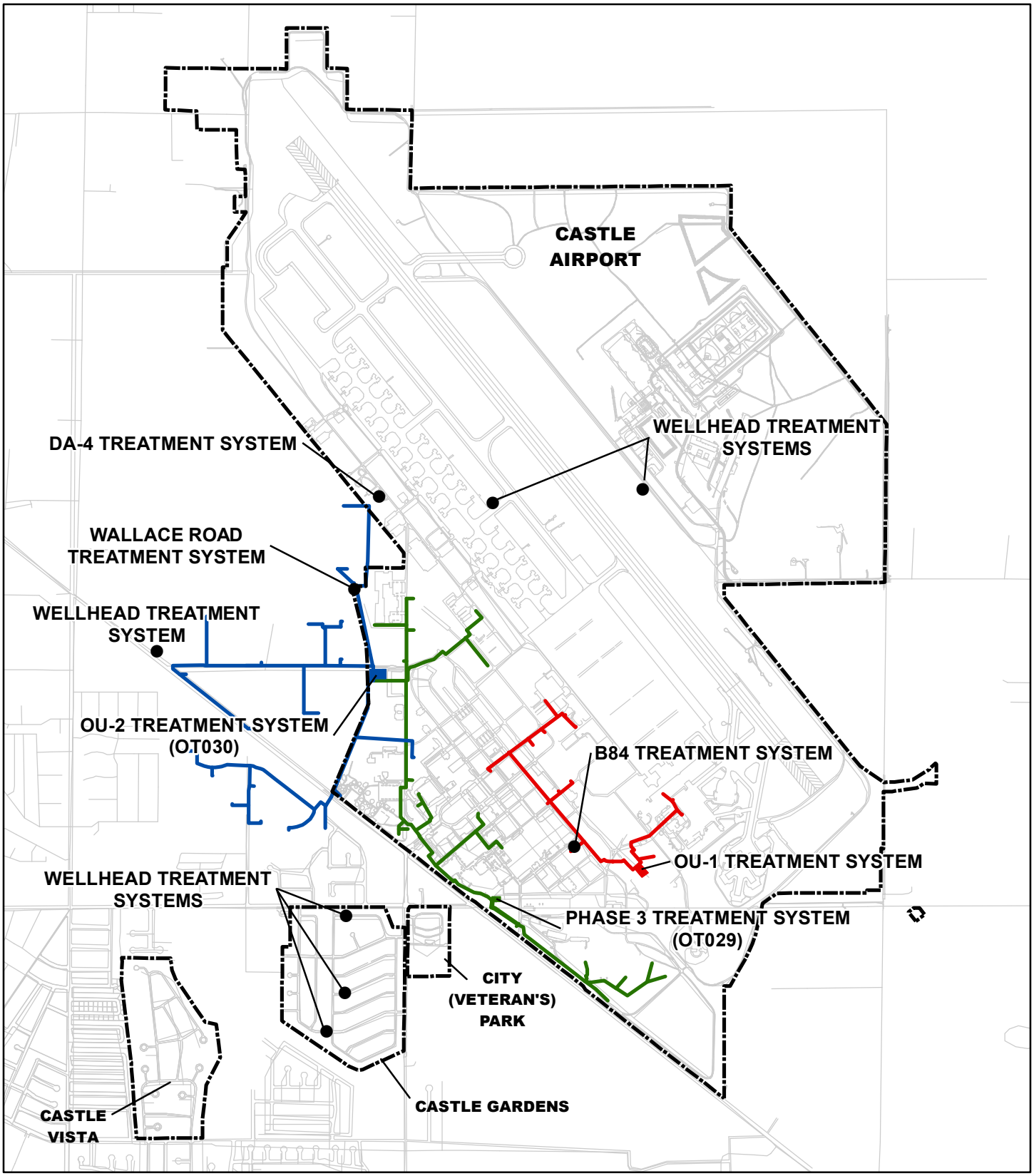
- MCL Contour for TCE (Q2 2018; all HSZs)
- Property Boundary
- Groundwater Treatment System
- SCOU Site Included in Five-Year Review
- Extraction Well
- Domestic Well

N

0 900 1,800

Feet

FIGURE 2
Sites Included in the Five-Year Review
Fifth Five-Year Review Report
Former Castle AFB, Atwater, California



LEGEND

- OU-1 Groundwater Treatment System (Taken Offline in 2003 and Decommissioned in 2011)
- OU-2 Groundwater Treatment System
- Phase 3 Groundwater Treatment System
- Other Decommissioned Groundwater Treatment Systems

N

0 0.25 0.5

Miles

Figure 3
Groundwater Treatment Systems Associated with Main Base Plume
Fifth Five-Year Review Report
Former Castle AFB, Atwater, California

SAC X:\CASTLENORTON\CASTLE\MAPFILES\2018\5YEAR\FIGURE3.MXD RVANEGAS 10/4/2018

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APPENDIX A
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APPENDIX A – REFERENCE LIST

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APPENDIX B
PUBLIC NOTICE

MERCED SUN-STAR | ENTERPRISE
CHOWCHILLA NEWS | Chronicle | Atwater Signal | Vida

AFFIDAVIT OF PUBLICATION

Account #	Ad Number	Identification	PO	Cols	Lines
689087	0003849866	CASTLE AFB 5 YR REV CLEANUP KELLY TEPLITSKY	LE AFB CLEANUP REV KELLY TI	2	56

Attention:

JACOBS
2485 NATOMAS PARK DRIVE SUITE 600
SACRAMENTO, CA 95833

Declaration of Publication
2015.5 C.C.P.

STATE OF CALIFORNIA)
) **ss.**
County of Merced)

I am a citizen of the United States; I am over the age of eighteen years, and not a party to or interested in the above entitled matter. I am the principal clerk of the printer of the Merced Sun-Star, a newspaper of general circulation, printed and published in the city of Merced, County of Merced, and which newspaper has been adjudged a newspaper of general circulation by the Superior Court of the County of Merced, State of California, under the date of July 14, 1964 Case Number 33224 that the notice, of which the annexed is a printed copy, has been published in each regular and entire issue of said newspaper and not in any supplement thereof on the following dates, to wit:

September 13, 2018

I certify (or declare) under penalty of perjury that the foregoing is true and correct and that this declaration was executed at Merced, California on:

Date: 13th, day of September, 2018

Cynthia A. Mathamay

Signature

Environmental Cleanup Five-Year Review Begins At Former Castle Air Force Base

U.S. Air Force

The Five-Year Review is a formal evaluation of the ongoing environmental cleanup activities at Castle AFB, Atwater, CA. The report will be issued in 2019 and we are informing you that the process has begun.

If you have any issues or concerns about Castle's cleanup program, or if you have direct knowledge regarding the cleanup remedies, the Air Force would like to talk to you. Please contact Roy Willis, Air Force Environmental Program Manager, using the contact information listed below.

The review is basically a report card for the Air Force's cleanup operation, underway at Castle since the 1980s. Past disposal of hazardous materials, such as solvents and other chemicals, resulted in soil and groundwater contamination. Several treatment systems are operating and removing the contamination. While the Air Force is the lead agency conducting this review, the U.S. Environmental Protection Agency and the State of California (Department of Toxic Substances Control and the California Regional Water Quality Control Board) review the Five-Year Review report, which includes a determination on whether the cleanup remedies in place are protective of human health and the environment. The report also provides recommendations if any deficiencies are found.

The last Castle Five-Year Review was completed in 2014 and determined that all remedies were protective and working as intended. This review will evaluate whether the current groundwater remedies, long-term landfill cap maintenance/monitoring, and prescribed institutional controls are protective of human health and the environment.

The Five-Year Review is scheduled to be completed in early 2019 and another public notice will be issued informing the community the review is complete. The Five-year Review will then be available to the public online at the Air Force Administrative Record at http://afcec.publicadmin-record.us.af.mil/Search.aspx.

For more information contact:
Roy Willis, Air Force Civil Engineering Center
210-395-9452
roy.willis@us.af.mil

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APPENDIX C
FIVE-YEAR REVIEW INTERVIEWS

INTERVIEW DOCUMENTATION FORM

The following is a list of individual interviewed for this five-year review. See the attached contact record(s) for a detailed summary of the interviews.

Name	Title/Position	Organization	Date
Ben Fries	Remedial Project Manager	DTSC	08/27/2018
Nadia Burke	Remedial Project Manager	USEPA	09/05/2018
John Murphy	Remedial Project Manager	CVRWQCB	09/14/2018
Scott Malta	Manager	Castle Airport	09/10/2018
Nick Sjaarda	Task Manager	Jacobs	09/13/2018
Dan Chern	Field Manager	Jacobs	09/11/2018
Ed Munoz	Property Manager	Castle Gardens	No response
Jason Lane	General Forman	Atwater Complex	No Response
Jerry Rai	Private Landowner		No Response

Former Castle Air Force Base Five-Year Review
Interview
Remedial Project Manager – DTSC

Interview Completion Date: August 27, 2018

Full Name: Ben Fries

Relationship: DTSC Remedial Project Manager

Complete Address: 8800 Cal Center Drive, Sacramento, California 95826

Phone: (916) 322-8701

Email: Ben.Fries@dtsc.ca.gov

1. What is your overall impression of the project? (general sentiment)

   Positive overall impression that project is well managed and diligently pursued.

2. Have there been routine communications or activities (site visits, inspections, reporting activities, etc.) conducted by your office regarding the site? If so, please give purpose and results.

   One orientation van tour site visit that was very informative, to demonstrate and display the site activities to me and others.

   Some offsite meetings that were very productive.

   Ongoing email dialog and document deliverables that keep me informed and updated on the progress of project activities.

3. Have there been any complaints, violations, or other incidents related to the site requiring a response by your office? If so, please give details of the events and results of the responses.

   One violation that breached the fencing surrounding an active remediation site. Castle team was very responsive in remedying the violation.

4. Do you feel well informed about the site's activities and progress?

   Yes

5. Do you have any comments, suggestions, or recommendations regarding the site's management or operation?

   Continue as you have been doing.

Former Castle Air Force Base Five-Year Review
Interview
Remedial Project Manager – USEPA Region IX

Interview Completion Date: September 5, 2018

Full Name: Nadia Burke

Relationship: USEPA Remedial Project Manager

Complete Address: 75 Hawthorne Street, SFD-8-1, San Francisco, California 94105

Phone: (415) 972-3187

Email: burke.nadiahollan@epa.gov

1. What are your overall impression of the project (general sentiment)?

   Overall, the project is well managed, and a lot of progress addressing concerns with data gaps has been made over the last few years.

2. Have there been routine communications or activities (site visits, inspections, reporting activities, etc.) conducted by your office regarding the site? If so, please give purpose and results.

   Yes, EPA is routinely involved in annual Base Closure Team meetings with the Air Force and State regulatory agencies, as well as any technical meetings that arise. EPA also participated in the site visit July 12, 2018 to observe a portion of the Five-Year Review inspection.

3. Have there been any complaints, violations, or other incidents related to the site requiring a response by your office? If so, please give details of the events and results of the responses.

   Yes, there was a breach of Institutional Controls at Site FTA-1 by work being done by the Bureau of Prisons (BoP). Portions of a fence were removed and damage to the liner was made. The Air Force is working with the BoP to repair the liner that was damaged, and the fence has already been repaired.

4. Do you feel well informed about the site's activities and progress? Yes.

   NA

5. Do you have any comments, suggestions, or recommendations regarding the site's management or operation? Please refer to the annual Reports for more information about suggestions and recommendations regarding the remedy progress at Castle.

   NA

Former Castle Air Force Base Five-Year Review
Interview
Remedial Project Manager – Central Valley Region Water Quality Control Board (CVRWQCB)

Interview Completion Date: September 14, 2018

Full Name: John Murphy

Relationship: CVRWQCB Remedial Project Manager

Complete Address: 11020 Sun Center Drive #200, Rancho Cordova, California 95670

Phone: 916-464-4636

Email: john.murphy@waterboards.ca.gov

1. What is your overall impression of the project? (general sentiment)

   The Air Force is successfully implementing most of the remedial actions specified in Castle's Records of Decision (RODs). Further evaluation of the extent of contamination in the OU2 area was adequately addressed in 2017, and the Air Force has been proactive with investigating the impact from emerging contaminants of concern such as 1,2,3-trichloroprane (1,2,3-TCP) and per- and polyfluoroalkyl substances (PFAS). The Air Force contractors also accommodate Central Valley Water Board staff site visits any time and allow staff to collect split groundwater samples for analyses.

2. Have there been routine communications or activities (site visits, inspections, reporting activities, etc.) conducted by your office regarding the site? If so, please give purpose and results.

   The Air Force coordinators, including the now retired Stanley Pehl and Roy Willis, maintain regular communication and provide site information in a timely manner. Meetings, phone conferences, and site visits are scheduled as needed. In addition, the Air Force contractors also maintain regular communication with the Central Valley Water Board and respond to comments and requests on technical documents efficiently. Routine site visits occur at the site by Central Valley Water Board staff and the Air Force plans at least two meetings per year with all project regulators and Air Force contractors. The Air Force also provides semi-annual and annual monitoring reports that provide updates on project activities.

3. Have there been any complaints, violations, or other incidents related to the site requiring a response by your office? If so, please give details of the events and results of the responses.

   There are occasional minor releases of untreated groundwater, typically caused by mechanical or electrical failures in the extraction/treatment systems or by accidents. Agricultural activity also occasionally breaches underground influent or effluent lines. In addition, the Fire Training Area 1 Landfill cap was breached in early 2018 by prison workers from the on-site United States Penitentiary (USP), Atwater. The Air Force has addressed these issues promptly and reported them in a timely manner to the project regulatory team along with the corrective

actions that were implemented. The Air Force is also currently overseeing corrective actions being implemented by USP-Atwater.

4. Do you feel well informed about the site's activities and progress?

   Yes.

5. Do you have any comments, suggestions, or recommendations regarding the site's management or operation?

   1. **Falling groundwater levels continues to be a persistent problem for the Air Force, especially at landfill monitoring wells and site monitoring wells in the Shallow Hydrostratigraphic Zone (HSZ). The Air Force acknowledges these issues but corrective actions and well replacements can take a significant amount of time.**
   2. **The 2014 Five-Year Review Interview with Marcus Pierce from the Central Valley Water Board also included a discussion on the concerns of the declining water table. Mr. Pierce stated volatile organic compounds (VOCs) left behind in the vadose zone could pose a future threat to water quality or to human health. Although this may not be a base-wide problem, the Air Force should consider investigating residual VOC concentrations in a few of the former hotspots in the Shallow HSZ.**
   3. **Initial site investigations focused on evaluating PFAS contamination on the base indicate a significant groundwater plume in multiple HSZs. Although a maximum contaminant level (MCL) has not yet been promulgated for PFAS' by the State of California, it is highly probably groundwater at the site will exceed future MCLs. The Air Force will need to complete additional investigations and remedial actions to address this issue.**

Former Castle Air Force Base Five-Year Review
Interview
Castle Airport Manager

Interview Completion Date: 9-10-18

Full Name: Scott Charles Malta

Relationship: Castle Airport Manager

Complete Address: 1900 Airdrome Entry, Atwater, CA 95301

Phone: 209-385-7686, Ext. 4180

Email: smalta@countyofmerced.com

1. What is your overall impression of the project? (general sentiment)

   As I understand it, progress is being made. The contractors I work with are very responsive and keep me well informed of what's going on.

2. What effects have site operations had on the surrounding community?

   Little, if any effect at all. Most of the project is still within the confines of the Castle Air Force Base/Castle Commerce Center/Castle Airport boundaries.

3. Are you aware of any community concerns regarding the site or its operation and administration? If so, please give details.

   I am not aware of anything except the quality of the drinking water being produced by the two Castle wells… incidentally; the water quality is good in all respects.

4. Are you aware of any events, incidents, or activities at the site such as vandalism, trespassing, or emergency responses from local authorities? If so, please give details.

   None.

5. Do you feel well informed about the site's activities and progress?

   Yes, the site managers/contractors keep me well informed of any and all activities on the site.

6. Do you have any comments, suggestions, or recommendations regarding the site's management or operation?

   No, please don't try to fix what isn't "broke".

7. Do you have any insight and/or clarification on decisions made during remedy selection and implementation that you would like to offer?

   None.

Former Castle Air Force Base Five-Year Review
Interview
Task Manager – CH2M HILL

Interview Completion Date: 9/13/2018

Full Name: Nick Sjaarda

Relationship: Task Manager

Complete Address: 2485 Natomas Park Drive, Suite 600, Sacramento, CA 95833

Phone: (916) 286-0324

Email: nick.sjaarda@jacobs.com

1. What is your overall impression of the project?

   (general sentiment) The project is well managed and continues to make excellent progress.

2. Is the remedy functioning as expected? How well is the remedy performing?

   Yes. The groundwater pump-and-treat remedy has resulted in very significant plume reductions. The Castle Vista plume has been fully remediated, and the site was closed in January 2017. The areal extents of the Main Base Plume in the USS, LSS, and Confined HSZs have been reduced by 82, 77, 99 percent, respectively, between 1996 and 2017. The areal extent of the Shallow HSZ plume was reduced by 96 percent before going dry in 2014.

3. What does the monitoring data show? Are there any trends that show contaminant levels are decreasing?

   Overall, TCE concentrations have shown steady a decreasing trend in all HSZs. Maximum TCE concentrations have decreased from nearly 1,000 µg/L to approximately 20 µg/L as of Q2/18. Although TCE concentrations in the northern OU-2 plume area began increasing at several wells in 2010, the installation of additional extraction wells over the last several years has resulted in reduced concentrations and the return to decreasing trends.

4. Is there a continuous on-site O&M presence? If so, please describe staff and activities. If there is not a continuous on-site presence, describe staff and frequency of site inspections and activities.

   There has not been a continuous on-site O&M presence since the beginning of 2018. Currently, routine site inspections are conducted by one staff person biweekly. Treatment plant sampling is conducted by one staff person monthly. Other visits are made as needed.

5. Have there been any significant changes in the O&M requirements, maintenance schedules, or sampling routines since start-up or in the last five years? If so, do they affect the protectiveness or effectiveness of the remedy? Please describe changes and impacts.

   Yes. A new pipeline was installed at the Phase 3 treatment plant to reduce the potential for

leaks by bypassing all of the unused GAC vessels and the bag filters. Bag filters are no longer needed at Phase 3 and thus the maintenance of these has been eliminated. In addition, the number of GAC vessels at OU-2 has been reduced from four to two, which reduced the number of monthly preliminary effluent samples to one. Reductions in TCE concentrations allowed the elimination of one pair of vessels.

6. Have there been unexpected O&M difficulties or costs at the site since start-up or in the last five years? If so, please give details.

Three belowground pipeline leaks occurred during the last 5 years. All three leaks were on the injection pipelines which carry clean treated water only. Two leaks occurred at the connections of pipe joints of the Phase 3 system and were caused by settling, while the other leak was caused by a local farmer that cut through an OU-2 pipeline while he was installing an irrigation line. He failed to call USA dig alert before digging. Although valves had been closed to isolate unused sections of pipelines where practicable, in 2017, CH2M went a step further and excavated, cut, and capped unused sections of the OU-2 pipelines to close off additional sections.

7. Have there been opportunities to optimize O&M, or sampling efforts? Please describe changes and resultant or desired cost savings or improved efficiency.

- **Installation of extraction well EW40 at the hotspot of the OU-2 plume has allowed the shutdown of extraction well EW12. Although EW12 maintained capture of the northern OU-2 plume it was very inefficient at mass removal because of its location upgradient of the plume. Since EW40 began operation in June 2017, TCE concentrations at this well have been much higher than those at EW12, resulting in a 5 to 10 times greater mass removal efficiency.**
- **Three monitoring wells located in the highest concentration portions of the Main Base Plume (OU-2 wells MW806A and MW948, and Phase 3 well MW918) were converted to extraction wells and connected to the nearest treatment system. Although these did not result in the shutdown of existing extraction wells as with the installation of EW40, they increased the overall treatment plant influent concentrations and thus, increased the mass removal efficiency.**
- **Extraction well EW24 was shut off in December 2017 because TCE concentrations in this area decreased below the MCL in 2017 and the well was not needed to maintain plume capture. Removal of this well improved the mass removal efficiency of the Phase 3 system.**
- **In early 2018, the MW951 wellhead treatment system was decommissioned because it had met the cleanup objective of mass removal. Before shutdown, the system was only removing 0.02 pounds of TCE per month and thus, it's shutdown greatly increased the mass removal efficiency of the program as a whole.**
- **In 2014, the groundwater monitoring program was revised to eliminate monitoring of the 0.5 µg/L boundary. This resulted in the removal of approximately 35 wells from the sampling program that no longer had to be sampled on an annual basis.**

8. Do you have any comments, suggestions, or recommendations regarding the project?

No.

Former Castle Air Force Base Five-Year Review
Interview
Field Manager/Environmental Engineer – CH2M HILL

Interview Completion Date: 9/11/18

Full Name: Dan Chern

Relationship: Field Manager/Environmental Engineer

Complete Address: 2485 Natomas Park Dr. Ste 600, Sacramento, CA 95833

Phone: 916-286-0339

Email: daniel.chern@jacobs.com

1. What is your overall impression of the project? (general sentiment)

   The project is going smoothly with good operational uptime on the treatment systems and containment of the groundwater plumes. The landfills are in good condition. Overall the project is going very well.

2. Is the remedy functioning as expected? How well is the remedy performing?

   I believe, the extraction wells are mostly controlling the groundwater plumes. The remedy is protecting the environment and the public.

3. What does the monitoring data show? Are there any trends that show contaminant levels are decreasing?

   I have not reviewed the recent monitoring well data, so I cannot comment. The groundwater treatment sampling results had been decreasing; however, with the addition of new extraction wells, influent concentrations have rebounded slightly. This shows better capture of the groundwater contamination.

4. Is there a continuous on-site O&M presence? If so, please describe staff and activities. If there is not a continuous on-site presence, describe staff and frequency of site inspections and activities.

   Up through the end of 2017, there was continuous O&M presence on site by a field technician. Beginning in 2018, there is not continuous onsite presence. Field staff (staff engineer) visit the site at least twice a month to check on the systems, collect readings/samples, and inspect the site.

5. Have there been any significant changes in the O&M requirements, maintenance schedules, or sampling routines since start-up or in the last five years? If so, do they affect the protectiveness or effectiveness of the remedy? Please describe changes and impacts.

   The MW951 GW extraction system has been decommissioned as concentrations remained below the MCL for several years.

At the OU-2 GW treatment plant, the northern pair of GAC vessels have been removed from the treatment stream. Only the southern pair of GAC vessels are used. A new extraction well (EW40) was installed and connected to the OU-2 treatment system. EW12 was shut down.

At the Phase 3 GW treatment plant, monitoring well MW918 was converted to an extraction well and connected to the treatment system.

The PFFA SVE and biovent systems have been decommissioned and the site has been closed.

6. Have there been unexpected O&M difficulties or costs at the site since start-up or in the last five years? If so, please give details.

Several leaks have occurred along the GW conveyance lines, mostly from the treated groundwater injection lines.

7. Have there been opportunities to optimize O&M, or sampling efforts? Please describe changes and resultant or desired cost savings or improved efficiency.

New extraction wells have been installed and plumbed into the GW treatment systems to better capture and contain the GW plumes. As mentioned above, MW951 GW treatment plant has been decommissioned. In addition, the treatment systems have been running efficiently, therefore, only requiring site visits approximately twice a month. In late 2018 or early 2019, the instrumentation and controls will be upgraded to remotely view and control the systems. At that point, the site may only require monthly inspections.

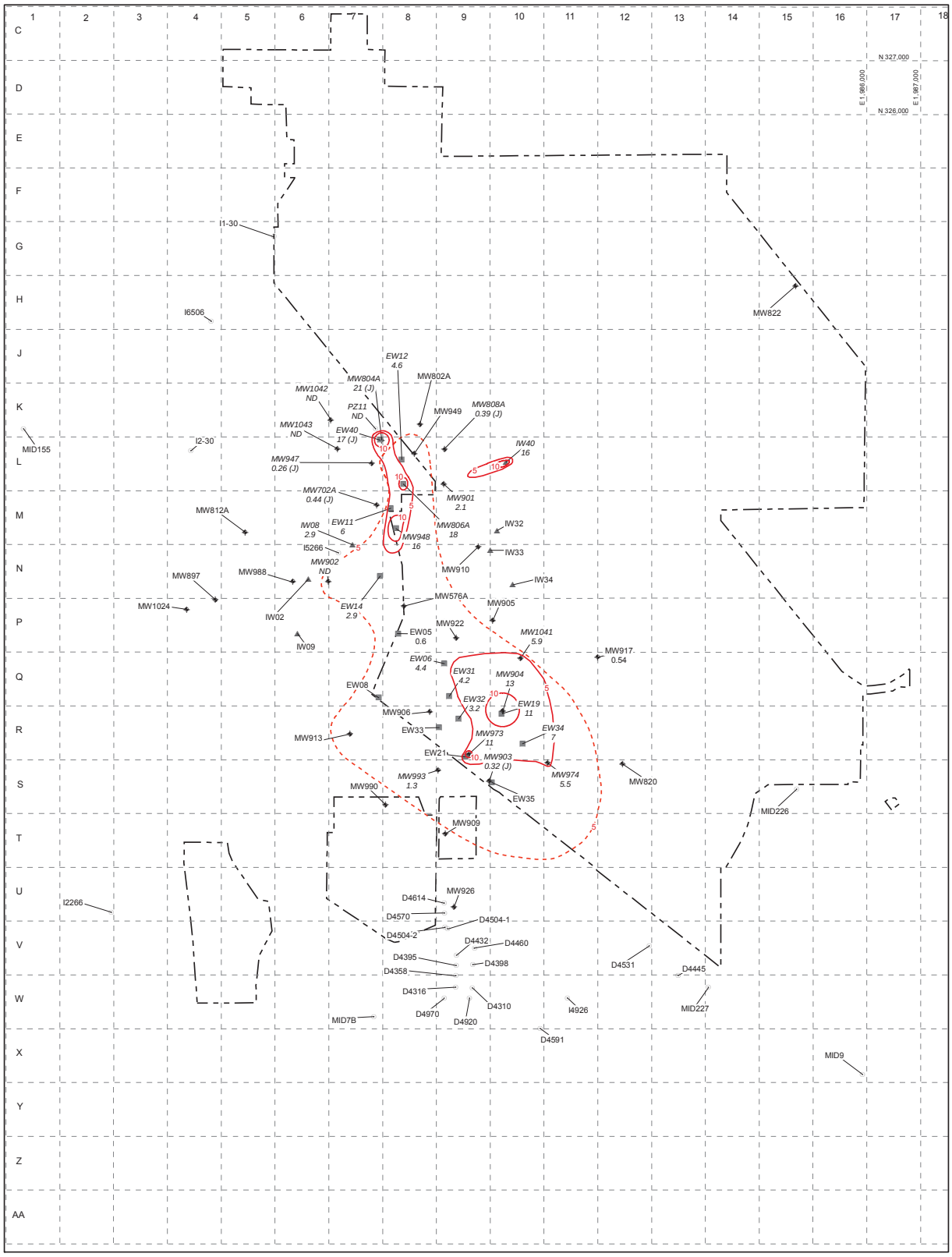
The PFFA SVE and biovent systems have been decommissioned. The site has been closed, so monitoring and sampling is no longer required, which saves on sampling and labor costs.

8. Do you have any comments, suggestions, or recommendations regarding the project?

None.

APPENDIX D
TCE PLUME DELINEATION AND PLUME CAPTURE FIGURES

D1 – Q2/18 TCE PLUME AND CAPTURE FIGURES



LEGEND

- Extraction well
- Injection well
- Monitoring well
- Other well
- TCE isoconcentration (≥ 5 µg/L)
- Q4/96 TCE MCL isoconcentration (5 µg/L)
- Property boundary
- 6.5 Data not used in contouring
- (J) Estimated value due to trace concentration or quality control deficiency

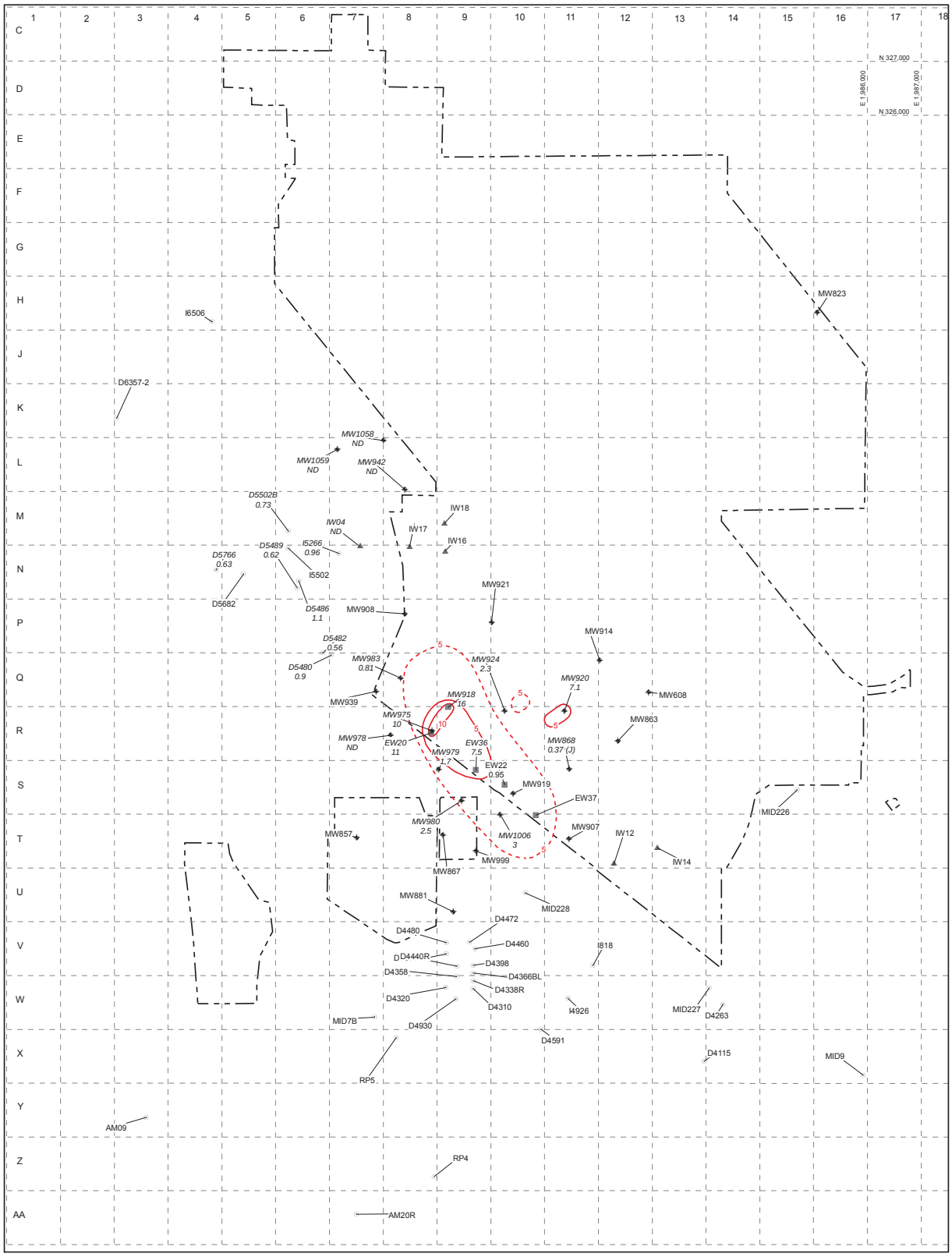
Note:
Data in *italics* represent most recent sample results from current quarter

Wells with no data are not currently in sampling program

N

0 900 1,800
Feet

FIGURE 4-1
TCE Plume Delineation Map, Second Quarter 2018
Upper Subshallow Hydrostratigraphic Zone
LTGSP 2018 Semiannual Report
Former Castle AFB, Atwater, California



LEGEND

- Extraction well
- Injection well
- Monitoring well
- Other well
- TCE isoconcentration (≥ 5 µg/L)
- Q4/96 TCE MCL isoconcentration (5 µg/L)
- Property boundary
- (J) Estimated value due to trace concentration or quality control deficiency

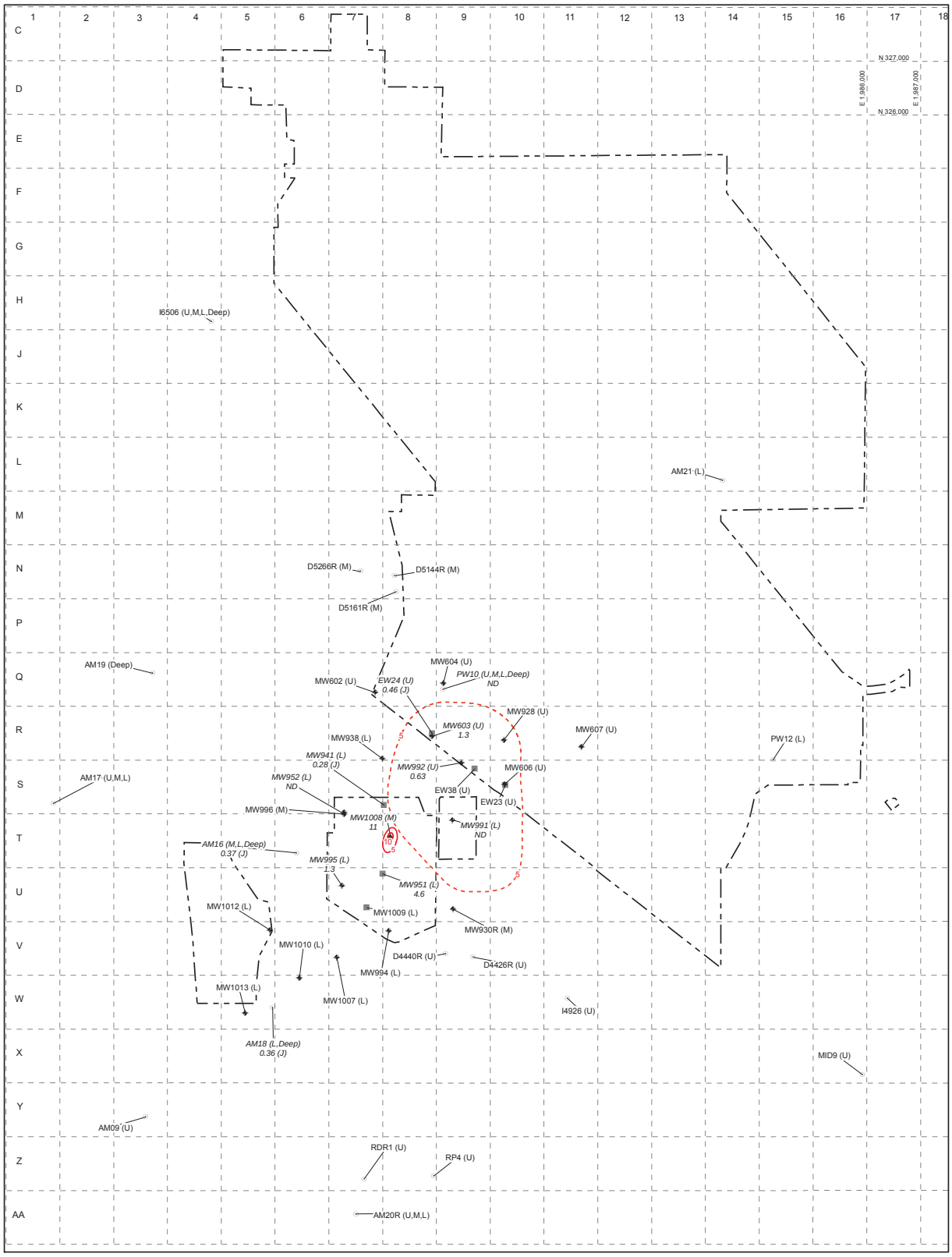
Note:
Data in *italics* represent most recent sample results from current quarter

Wells with no data are not currently in sampling program

N

0 900 1,800
Feet

FIGURE 4-2
TCE Plume Delineation Map, Second Quarter 2018
Lower Subshallow Hydrostratigraphic Zone
LTGSP 2018 Semiannual Report
Former Castle AFB, Atwater, California



LEGEND

- Extraction well
- Injection well
- Monitoring well
- Other well
- TCE isoconcentration (≥ 5 µg/L)
- Q4/96 TCE MCL isoconcentration (5 µg/L)
- Property boundary
- 6.5 Data not used in contouring
- (U) Well screened in upper (U), middle (M), and/or lower (L) layer of the Confined HSZ

Note:
Data in *italics* represent most recent sample results from current quarter

Wells with no data are not currently in sampling program

(Deep) Well screened in Deep HSZ

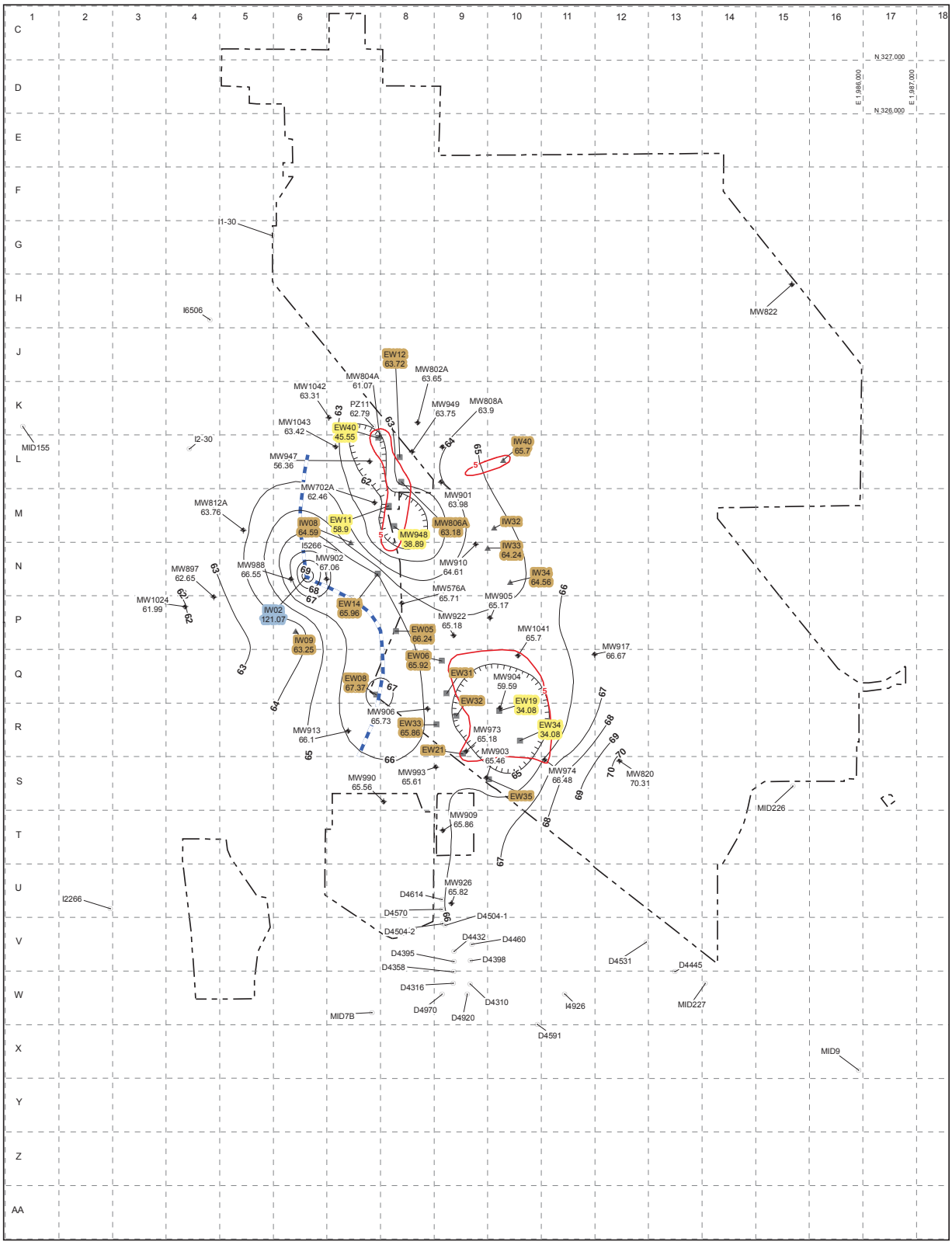
(J) Estimated value due to trace concentration or quality control deficiency

N

0 900 1,800
Feet

FIGURE 4-3
TCE Plume Delineation Map, Second Quarter 2018
Confined Hydrostratigraphic Zone
LTGSP 2018 Semiannual Report
Former Castle AFB, Atwater, California

ch2m



LEGEND

- Extraction well
- Injection well
- Monitoring well
- Other well
- 5 µg/L TCE isoconcentration contour
- Groundwater elevation (ft above msl)
- Groundwater depression
- Estimated zone of capture
- Property boundary

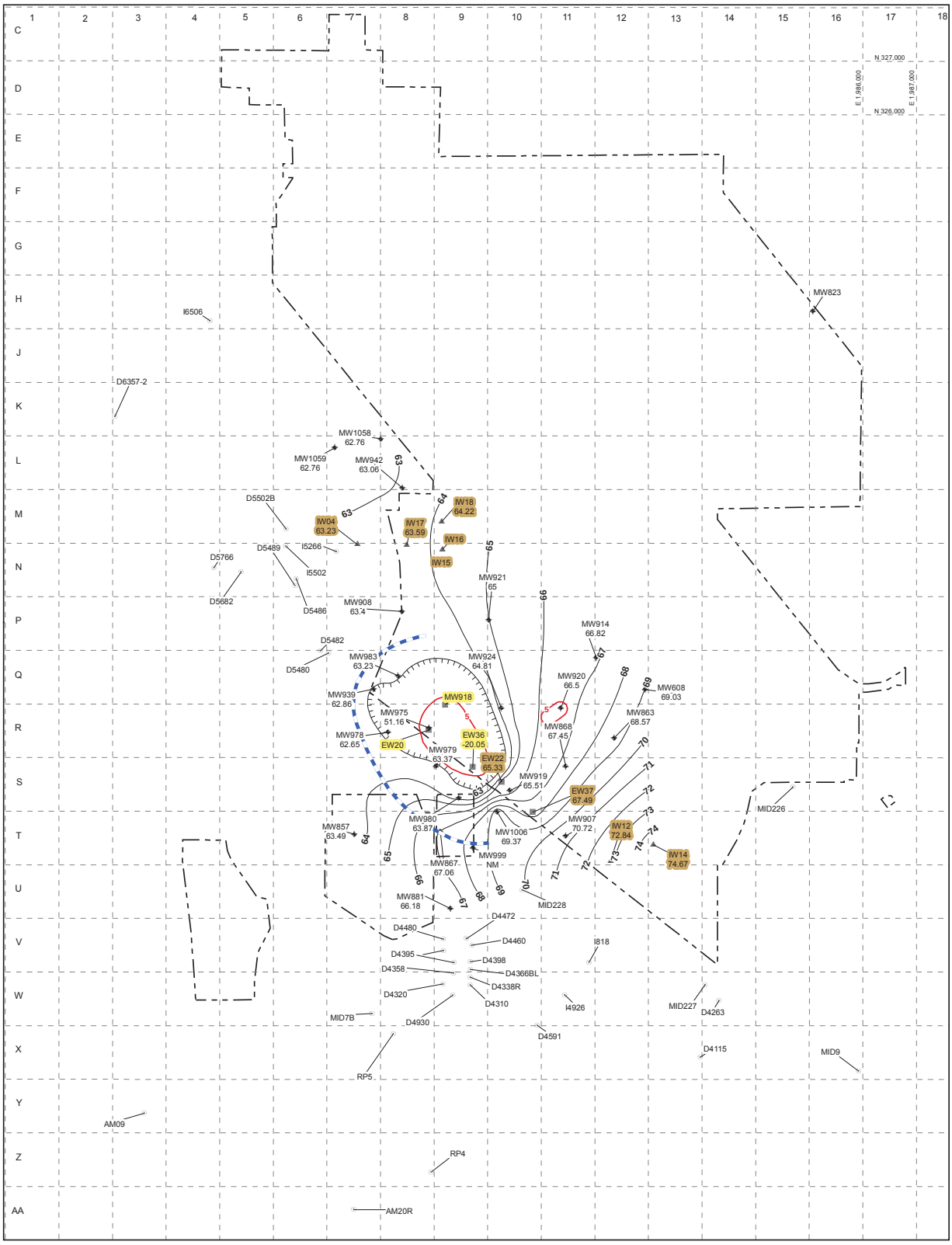
Note:

- EW39 Extraction well - online
- IW23 Injection well - online
- EW29 Extraction / injection well - offline

Wells with no data presented are not checked for water levels

FIGURE 5-1
Estimated Plume Capture, Second Quarter 2018
Upper Subshallow Hydrostratigraphic Zone
LTGSP 2018 Semiannual Report
Former Castle AFB, Atwater, California

SAC X:\CASTLENORTON\CASTLE\MAPFILES\2018\SEMIANNUAL\FIGURE_5-1.MXD RVANEGAS 8/24/2018



LEGEND

- Extraction well
- Injection well
- Monitoring well
- Other well
- 5 µg/L TCE isoconcentration contour
- Groundwater elevation (ft above msl)
- Groundwater depression
- Estimated zone of capture
- Property boundary
- NM Not measured

Note:

- EW39 Extraction well - online
- IW23 Injection well - online
- EW29 Extraction / injection well - offline

Wells with no data presented are not checked for water levels

N

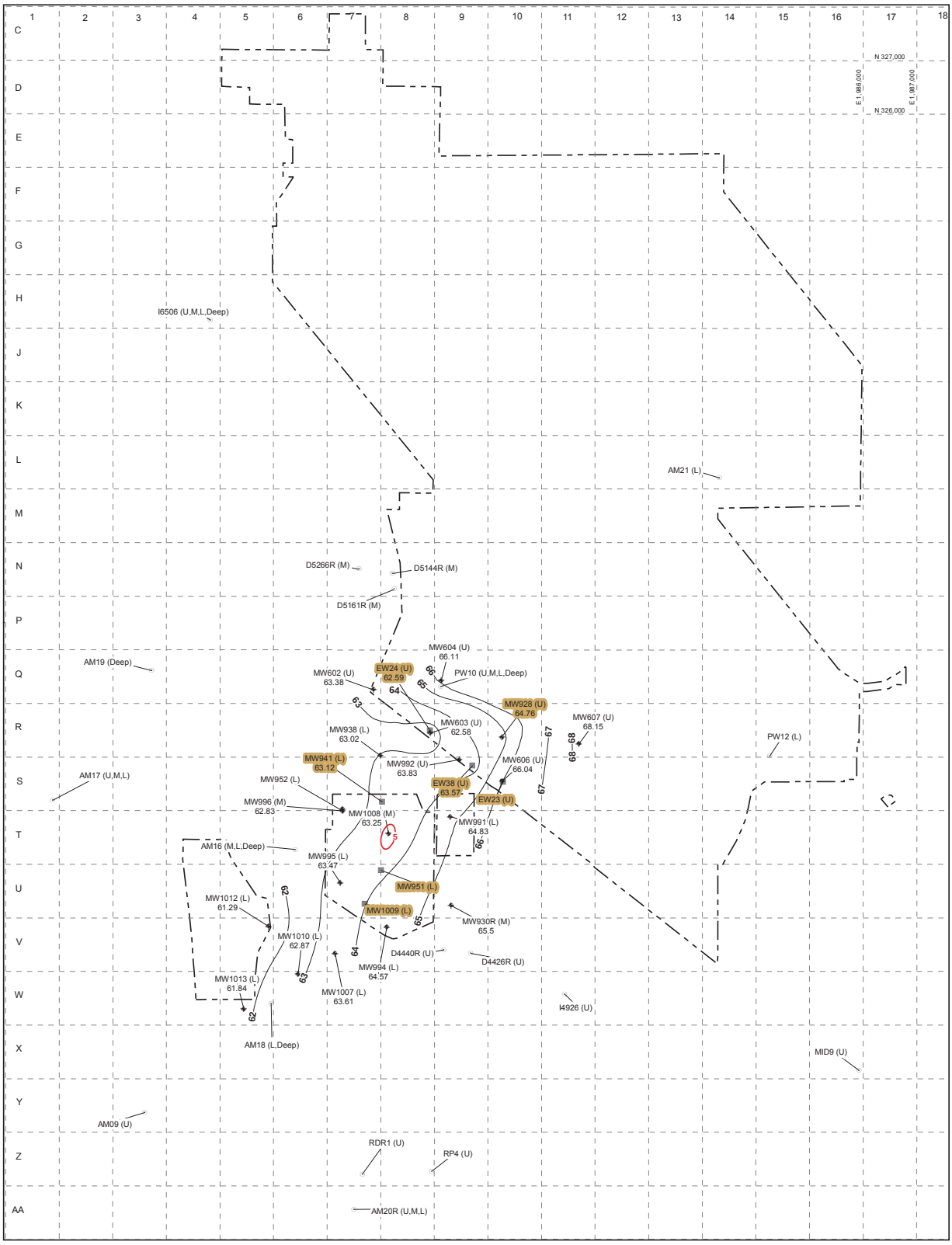
0 900 1,800

Feet

FIGURE 5-2
Estimated Plume Capture, Second Quarter 2018
Lower Subshallow Hydrostratigraphic Zone
LTGSP 2018 Semiannual Report
Former Castle AFB, Atwater, California

ch2m

SAC X:\CASTLENORTON\CASTLE\MAPFILES\2018\SEMIANNUAL\FIGURE_5-2.MXD RVANEGAS 9/18/2018



LEGEND

- Extraction well
- Injection well
- Monitoring well
- Other well
- 5 µg/L TCE isoconcentration contour
- Groundwater elevation (ft above msl)
- Groundwater depression
- Property boundary

Note:

- EW39 Extraction well - online
- IW23 Injection well - online
- EW29 Extraction / injection well - offline
- (U) Well screened in upper (U), middle (M), and/or lower (L) layer of the Confined HSZ
- (Deep) Well screened in Deep HSZ
- Wells with no data presented are not checked for water levels

N

0 900 1,800
Feet

FIGURE 5-3
Estimated Plume Capture, Second Quarter 2018
Confined Hydrostratigraphic Zone
LTGSP 2018 Semiannual Report
Former Castle AFB, Atwater, California

SAC X:\CASTLENORTON\CASTLE\MAPFILES\2018\SEMIANNUAL\FIGURE_5-3.MXD RVANEGAS 8/22/2018

D2 – Q4/13 TCE PLUME AND CAPTURE FIGURE

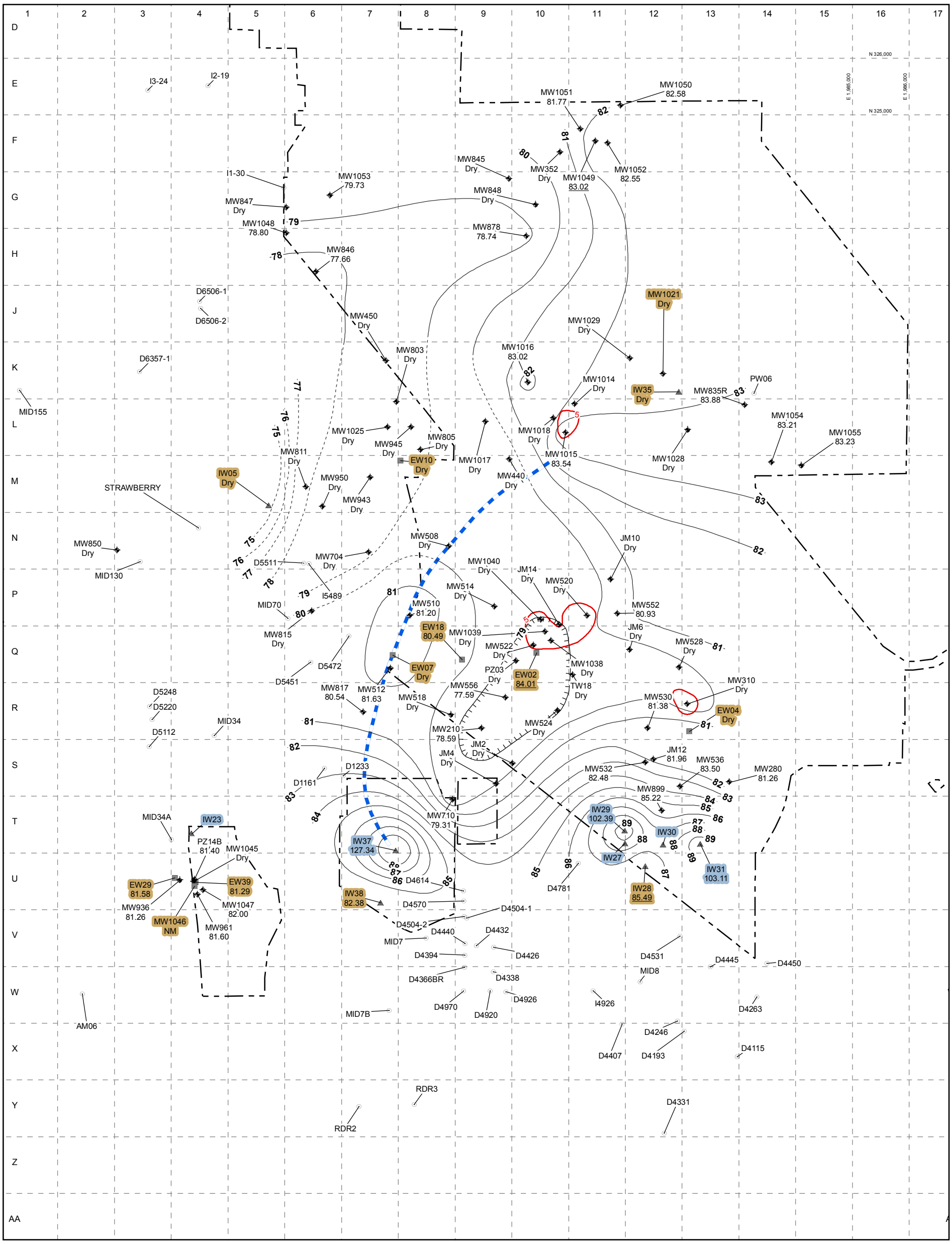


FIGURE 5-1B
Estimated Plume Capture, Fourth Quarter 2013
Shallow Hydrostratigraphic Zone
LTGSP 2013 Annual Report
Former Castle AFB, Atwater, California

APPENDIX E
SITE INSPECTION FORMS AND PHOTO LOGS

Five-Year Review Site Inspection Checklist

I. SITE INFORMATION	
Site name: Main Base Plume (OU-2, Phase 3)	**Date of inspection: 07/19/18**
Location and Region: Castle Airport	**EPA ID: CA3570024551**
Agency, office, or company leading the five-year review: United States Air Force	**Weather/temperature:**

Remedy Includes: (Check all that apply)

- ☐ Landfill cover/containment
- ☐ Access controls
- **x Institutional controls**
- **x Groundwater pump and treatment**
- ☐ Surface water collection and treatment
- ☐ Monitored natural attenuation
- ☐ Groundwater containment
- ☐ Vertical barrier walls

Attachments: Photographic log

II. INTERVIEWS (Check all that apply)

1. **O&M site manager** Nick Sjaarda (Name) Task Manager (Title) 07/12/18 (Date)
   Interviewed ☐ at site X at office ☐ by phone Phone no. _____
   Problems, suggestions; ☐ Report attached _____
   _____

2. **O&M staff** ____Jordan Ollanik_____ (Name) __Engineer_____ (Title) _____7/19/2018___ (Date)
   Interviewed X at site ☐ at office ☐ by phone Phone no. _____
   Problems, suggestions; ☐ Report attached _____
   _____

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

Agency _ **See interviews in Appendix C** _____
Contact _____ _____ _____ _____
Name Title Date Phone no.
Problems; suggestions; ☐ Report attached _____
_____

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

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

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

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

See interviews in Appendix C

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

1. **O&M Documents**

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

Remarks:

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

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

4. **Permits and Service Agreements**

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

Remarks_____

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

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

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

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

9. **Discharge Compliance Records**

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

Remarks_____

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

IV. O&M COSTS

1. **O&M Organization**

☐ State in-house ☐ Contractor for State
☐ PRP in-house ☐ Contractor for PRP
☐ Federal Facility in-house X Contractor for Federal Facility
☐ Other_____
_____

2. **O&M Cost Records**

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

Total annual cost by year for review period if available

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

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

Describe costs and reasons: __None_____
_____
_____
_____
_____
_____

V. ACCESS AND INSTITUTIONAL CONTROLS X Applicable ☐ N/A

A. Fencing

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

Remarks: OU-2 – system fence in good condition, the entry gate to farm land had been damaged but is still functional. All wells in good condition. EW12 is set to off due to high localized system pressure.

B. Other Access Restrictions

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

Remarks:_ Signs in place on the system fences. There are no signs on the individual extraction and injections wells associated with OU-2 and Phase 3.

C. Institutional Controls (ICs)

1. **Implementation and enforcement**

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

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

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

Specific requirements in deed or decision documents have been met X Yes ☐ No ☐ N/A
Violations have been reported ☐ Yes X No ☐ N/A
Other problems or suggestions: ☐ Report attached
None. ICs to restrict the use of groundwater the exceeds MCLs are in place.
_____

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

D. General

1. **Vandalism/trespassing** ☐ Location shown on site map X No vandalism evident
Remarks: None present.

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

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

VI. GENERAL SITE CONDITIONS

A. Roads X Applicable ☐ N/A

1. **Roads damaged** ☐ Location shown on site map X Roads adequate ☐ N/A
Remarks: No signs of damage.
_____

B. Other Site Conditions

Remarks: Site is in good condition._____

_____

VII. LANDFILL COVERS ☐ Applicable X N/A

VIII. VERTICAL BARRIER WALLS ☐ Applicable X N/A

IX. GROUNDWATER/SURFACE WATER REMEDIES X Applicable ☐ N/A

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

1. **Pumps, Wellhead Plumbing, and Electrical**
X Good condition X All required wells properly operating ☐ Needs Maintenance ☐ N/A
Remarks: The following location-specific items were identified:
OU-2:
MW806A – Well operating at significantly diminished flow due to partially closed valve.
EW12 – Well off and potential scaling issues.
Phase-3
EW19 – Electrical panel corrosion cleaning and protection provided by Cecil Gore Winter 2018
EW34 – Valve sealed by removable plug, no longer drips
EW36 – Valve no longer leaks
IW27 – In use (D.C.)
IW28 – Not used.

2. **Extraction System Pipelines, Valves, Valve Boxes, and Other Appurtenances**
X Good condition☐ Needs Maintenance
Remarks_____
_____

3. **Spare Parts and Equipment**
X Readily available ☐ Good condition☐ Requires upgrade ☐ Needs to be provided
Remarks: Spare parts available at OU2 control housing or through local vendors.

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

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

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

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

C. Treatment System X Applicable ☐ N/A

1. **Treatment Train** (Check components that apply)
☐ Metals removal ☐ Oil/water separation ☐ Bioremediation
☐ Air stripping X Carbon adsorbers
☐ Filters_____
☐ Additive (*e.g.*, chelation agent, flocculent)_____
☐ Others_____
X Good condition ☐ Needs Maintenance
X Sampling ports properly marked and functional
X Sampling/maintenance log displayed and up to date
X Equipment properly identified
☐ Quantity of groundwater treated annually_____
☐ Quantity of surface water treated annually_____
Remarks:
OU-2 – Currently utilizes a single treatment train, each treatment train has two 2,000-lb GAC vessels. Two treatment trains available.

Phase 3 - Utilizes the existing Phase 3 system. An open tank for discharge of purge water that is run through the Phase 3 system is partially supported by a portion of PVC pipe beneath the tank.

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

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

4. **Discharge Structure and Appurtenances**
☐ N/A X Good condition☐ Needs Maintenance
Remarks_____
_____

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

6. **Monitoring Wells** (pump and treatment remedy)
☐ Properly secured/locked ☐ Functioning X Routinely sampled X Good condition
☐ All required wells located ☐ Needs Maintenance ☐ N/A
Remarks: Monitoring wells are in good condition_____
_____

D. Monitoring Data

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

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

X. OTHER REMEDIES ☐ Applicable X N/A

XI. OVERALL OBSERVATIONS

A. Implementation of the Remedy

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

_None

B. Adequacy of O&M

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

The OU-2 treatment system did not appear to leak upon inspection

C. Early Indicators of Potential Remedy Problems

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

__ None

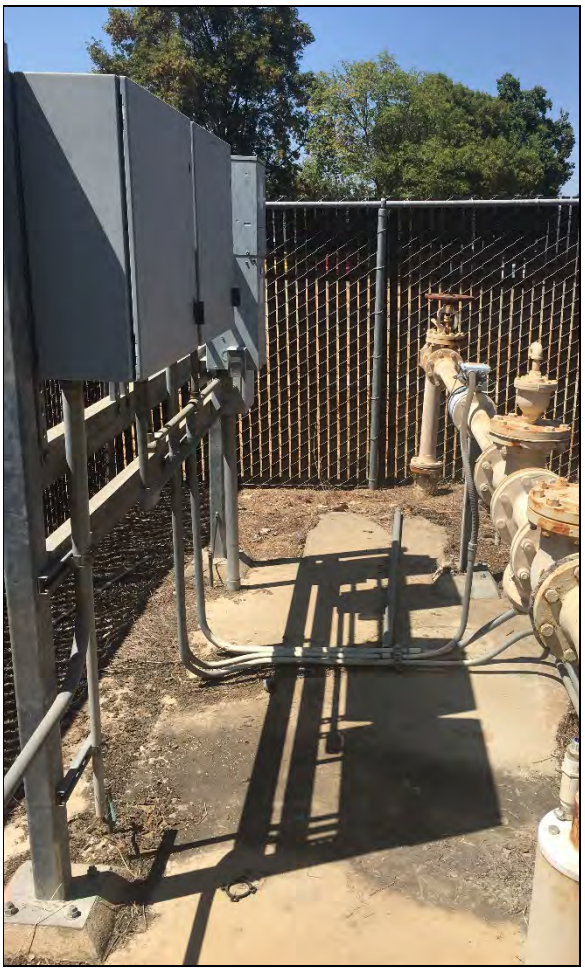
D. Opportunities for Optimization

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

__None

EW-19

EW-20, EW-24



EW-34

EW-36

MW-918

MW-918 Drip Fix

OU-2 North GAC Vessels

OU-2 South GAC Vessels

Phase 3 Flow Meter

Phase 3 Transfer Pipe

Phase 3 GAC Tanks

Five-Year Review Site Inspection Checklist

I. SITE INFORMATION	
Site name: ETC-10	**Date of inspection: 07/19/18**
Location and Region: Former Castle AFB	**EPA ID: CA3570024551**
Agency, office, or company leading the five-year review: United States Air Force	**Weather/temperature:**

Remedy Includes: (Check all that apply)

- ☐ Landfill cover/containment
- ☐ Access controls
- **x Institutional controls**
- ☐ Groundwater pump and treatment
- ☐ Surface water collection and treatment
- ☐ Monitored natural attenuation
- ☐ Groundwater containment
- ☐ Vertical barrier walls
- **x Other_Ecological monitoring consisting of wetland invertebrate (fairy shrimp) and plant surveys at selected vernal pools were initiated in the spring of 2008 and conducted again in 2016. Based on the results of the 2016 survey, further ecological monitoring is not recommended.**

Attachments: Photographic log

II. INTERVIEWS (Check all that apply)

1. **O&M site manager** Nick Sjaarda (Name) Task Manager (Title) 07/03/19 (Date)
   Interviewed ☐ at site X at office ☐ by phone Phone no. _____
   Problems, suggestions; ☐ Report attached None

2. **O&M staff** Jordan Ollanik (Name) Engineer (Title) 7/19/2018 (Date)
   Interviewed x at site ☐ at office ☐ by phone Phone no. (520) 461-3808
   Problems, suggestions; ☐ Report attached _____

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

Agency **See interviews in Appendix C**
Contact _____ _____ _____ _____
Name Title Date Phone no.
Problems; suggestions; ☐ Report attached _____
_____

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

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

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

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

See interviews in Appendix C

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

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

   Remarks_____

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

   Remarks_____

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

   Remarks_____

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

   Remarks_____

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

   Remarks_____

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

   Remarks_____

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

   Remarks_____

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

   Remarks_____

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

   Remarks_____

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

    Remarks_____

IV. O&M COSTS

1. **O&M Organization**

☐ State in-house ☐ Contractor for State
☐ PRP in-house ☐ Contractor for PRP
☐ Federal Facility in-house X Contractor for Federal Facility
☐ Other_____
_____

2. **O&M Cost Records**

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

Total annual cost by year for review period if available

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

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

Describe costs and reasons: None_____
_____
_____
_____
_____
_____

V. ACCESS AND INSTITUTIONAL CONTROLS X Applicable ☐ N/A

A. Fencing

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

Remarks_____
_____

B. Other Access Restrictions

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

Remarks_No signs in place_____
_____

C. Institutional Controls (ICs)

1. **Implementation and enforcement**

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

Type of monitoring (*e.g.*, self-reporting, drive by) __self-reporting_____
Frequency ____NA_____
Responsible party/agency _United States Air Force
_____
Contact _____ _____ _____ _____
Name Title Date Phone no.

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

Specific requirements in deed or decision documents have been met X Yes ☐ No ☐ N/A
Violations have been reported ☐ Yes X No ☐ N/A
Other problems or suggestions: ☐ Report attached
None. ICs to restrict site access and alteration are maintained as part of the Air Force/BoP memorandum of understanding.
_____

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

D. General

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

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

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

VI. GENERAL SITE CONDITIONS

A. Roads ☐ Applicable X N/A

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

B. Other Site Conditions

Remarks _____
Site is within United States Bureau of Prisons property and behind a perimeter fence. No signs of human activity observed._____

VII. LANDFILL COVERS ☐ Applicable X N/A

VIII. VERTICAL BARRIER WALLS ☐ Applicable X N/A

IX. GROUNDWATER/SURFACE WATER REMEDIES ☐ Applicable X N/A

X. OTHER REMEDIES

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

Ecological monitoring was conducted in 2008 and 2016 as part of the remedy. Based on the results of these surveys, additional ecological monitoring is not recommended.

XI. OVERALL OBSERVATIONS

A. Implementation of the Remedy

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

No issues observed that would impact the effectiveness and function of the remedy.

B. Adequacy of O&M

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

__Not applicable_____

C.	**Early Indicators of Potential Remedy Problems**
	Describe issues and observations such as unexpected changes in the cost or scope of O&M or a high frequency of unscheduled repairs, that suggest that the protectiveness of the remedy may be compromised in the future. None
D.	**Opportunities for Optimization**
	Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy. None

ETC-10 Facing East from FTA-1

ETC-10 Facing Northeast from FTA-1

Five-Year Review Site Inspection Checklist

I. SITE INFORMATION	
Site name: FTA-1 (FT001)	**Date of inspection: 07/19/18**
Location and Region: Former Castle AFB	**EPA ID: CA3570024551**
Agency, office, or company leading the five-year review: United States Air Force	**Weather/temperature:**

Remedy Includes: (Check all that apply)

- **x Landfill cover/containment**
- ☐ Access controls
- **x Institutional controls**
- ☐ Groundwater pump and treatment
- ☐ Surface water collection and treatment
- ☐ Monitored natural attenuation
- ☐ Groundwater containment
- ☐ Vertical barrier walls
- **x Other_Ecological monitoring consisting of wetland invertebrate (fairy shrimp) and plant surveys at selected vernal pools were initiated in the spring of 2008 and conducted again in 2016. Based on the results of these surveys, further ecological monitoring is not recommended.**

Attachments: Photographic Log

II. INTERVIEWS (Check all that apply)

1. **O&M site manager** __Nick Sjaarda_____ ___Task Manager_____ __07/03/18___
   Name Title Date
   Interviewed ☐ at site X at office ☐ by phone Phone no. _____
   Problems, suggestions; ☐ Report attached ___None_____
   _____

2. **O&M staff** _____Jordan Ollanik_____ ___Engineer_____ ____7/19/2018___
   Name Title Date
   Interviewed x at site ☐ at office ☐ by phone Phone no. _(520) 461-3808_____
   Problems, suggestions; ☐ Report attached _____
   _____

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

Agency _ **See interviews in Appendix C** _____
Contact _____ _____ _____ _____
Name Title Date Phone no.
Problems; suggestions; ☐ Report attached _____
_____

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

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

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

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

See interviews in Appendix C

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

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

   Remarks_____

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

   Remarks_____

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

   Remarks_____

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

   Remarks_____

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

   Remarks_____

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

   Remarks_____

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

   Remarks_____

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

   Remarks_____

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

   Remarks_____

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

    Remarks_____

IV. O&M COSTS

1. **O&M Organization**

☐ State in-house ☐ Contractor for State
☐ PRP in-house ☐ Contractor for PRP
☐ Federal Facility in-house X Contractor for Federal Facility
☐ Other_____
_____

2. **O&M Cost Records**

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

Total annual cost by year for review period if available

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

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

Describe costs and reasons: __None_____
_____
_____
_____
_____
_____

V. ACCESS AND INSTITUTIONAL CONTROLS X Applicable ☐ N/A

A. Fencing

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

Remarks_____
_____

B. Other Access Restrictions

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

Remarks__Signs in place_____
_____

C. Institutional Controls (ICs)

1. **Implementation and enforcement**

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

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

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

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

None. ICs to restrict site access and alteration are maintained as part of the Air Force/BoP memorandum of understanding._____

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

D. General

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

2. **Land use changes on site** ☐ N/A
Remarks___None_____

3. **Land use changes off site** ☐ N/A
Remarks___None_____

VI. GENERAL SITE CONDITIONS

A. Roads ☐ Applicable X N/A

1. **Roads damaged** ☐ Location shown on site map ☐ Roads adequate ☐ N/A
Remarks_____

B. Other Site Conditions

Remarks _____
Site is within United States Bureau of Prisons property and behind a perimeter fence. Portions of the fencing and HDPE liner material within drainage swales near FTA-1 had been disturbed by BoP Atwater inmate work crews in early 2018. According to the BoP Atwater Facilities Manager, their work crews mistakenly removed several fence posts and fencing, and disturbed soils within drainage swales to gather stones from the swales to construct improvements to the entrance of the prison. The HDPE material is part of the cap liner that extends from the cap into the swale as a continuous unit. Despite the disturbance of the swales, the FTA-1 cap does not appear to have been damaged. Based on a review of where the contaminants were located beneath the cap, no risk to human health or the environment is anticipated to have occurred due to the incident. The fence was replaced in 2018 and the liner is still pending repairs.
_____

VII. LANDFILL COVERS X Applicable ☐ N/A

A. Landfill Surface

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

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

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

4. **Holes** ☐ Location shown on site map X Holes not evident
Areal extent_____ Depth_____
Remarks__Holes not evident through HDPE liner_____
_____

5. **Vegetative Cover** ☐ Grass X Cover properly established ☐ No signs of stress
☐ Trees/Shrubs (indicate size and locations on a diagram)
Remarks: Burrowing animals evident over the surface of the vegetative surface cover. The burrows don't appear to negatively impact the HDPE liner or the stability of the soil cover. A portion of the cap was disturbed by BoP early in 2018 and the liner beneath was disturbed. Repair of the liner is pending.

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

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

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

Remarks_____

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

B. Benches ☐ Applicable X N/A

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

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

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

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

C. Letdown Channels ☐ Applicable X N/A

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

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

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

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

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

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

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

D. Cover Penetrations ☐ Applicable X N/A

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

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

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

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

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

E. Gas Collection and Treatment ☐ Applicable X N/A

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

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

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

F. Cover Drainage Layer ☐ Applicable X N/A

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

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

G. Detention/Sedimentation Ponds ☐ Applicable X N/A

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

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

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

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

H. Retaining Walls ☐ Applicable X N/A

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

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

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

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

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

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

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

VIII. VERTICAL BARRIER WALLS ☐ Applicable X N/A

IX. GROUNDWATER/SURFACE WATER REMEDIES ☐ Applicable X N/A

X. OTHER REMEDIES X Applicable ☐ N/A

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

Ecological monitoring was conducted in 2008 and 2016 as part of the remedy. Based on the results of these surveys, additional ecological monitoring is not recommended.

XI. OVERALL OBSERVATIONS

A. Implementation of the Remedy

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

None

B. Adequacy of O&M

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

None

C. Early Indicators of Potential Remedy Problems

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

____None

D. Opportunities for Optimization

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

_____None

FTA-1 Facing Northwest Toward Flightline

FTA-1 Facing South

FTA-1 Facing Southeast Toward Adjacent Structure

Five-Year Review Site Inspection Checklist

I. SITE INFORMATION	
Site name: LF-4 (LF007)	**Date of inspection: 07/19/18**
Location and Region: Former Castle AFB	**EPA ID: CA3570024551**
Agency, office, or company leading the five-year review: United States Air Force	**Weather/temperature:**

Remedy Includes: (Check all that apply)

- x **Landfill cover/containment**
- ☐ Access controls
- x **Institutional controls**
- ☐ Groundwater pump and treatment
- ☐ Surface water collection and treatment
- ☐ Monitored natural attenuation
- ☐ Groundwater containment
- ☐ Vertical barrier walls

Attachments: Photographic log

II. INTERVIEWS (Check all that apply)

1. **O&M site manager** Nick Sjaarda (Name) Task Manager (Title) 07/03/18 (Date)
   Interviewed ☐ at site X at office ☐ by phone Phone no. _____
   Problems, suggestions; ☐ Report attached _____

2. **O&M staff** Jordan Ollanik (Name) Engineer (Title) 7/19/2018 (Date)
   Interviewed x at site ☐ at office ☐ by phone Phone no. (520) 461-3808
   Problems, suggestions; ☐ Report attached _____

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

Agency _ **See interviews in Appendix C** _____
Contact _____ _____ _____ _____
Name Title Date Phone no.
Problems; suggestions; ☐ Report attached _____
_____

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

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

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

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

See interviews in Appendix C

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

1. **O&M Documents**

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

Remarks: As-builts are kept and updated as part of the drawing set that represent the composition of the covered landfill. The actual construction as-builts are maintained as part of the construction documentation report which is available on the administrative record.

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

3. **O&M and OSHA Training Records** X Readily available X Up to date ☐ N/A
Remarks_Available online on contractors intranet_____

4. **Permits and Service Agreements**

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

Remarks_____

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

6. **Settlement Monument Records** X Readily available X Up to date ☐ N/A
Remarks: Available on the administrative record. _____

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

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

9. **Discharge Compliance Records**

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

Remarks_____

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

IV. O&M COSTS

1. **O&M Organization**

☐ State in-house ☐ Contractor for State
☐ PRP in-house ☐ Contractor for PRP
☐ Federal Facility in-house X Contractor for Federal Facility
☐ Other_____
_____

2. **O&M Cost Records**

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

Total annual cost by year for review period if available

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

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

Describe costs and reasons: __None_____
_____
_____
_____
_____
_____

V. ACCESS AND INSTITUTIONAL CONTROLS X Applicable ☐ N/A

A. Fencing

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

Remarks_____
_____

B. Other Access Restrictions

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

Remarks: Signs in place_____
_____

C. Institutional Controls (ICs)

1. **Implementation and enforcement**

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

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

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

Specific requirements in deed or decision documents have been met ☐ Yes ☐ No X N/A
Violations have been reported ☐ Yes ☐ No X N/A
Other problems or suggestions: ☐ Report attached
None. ICs to restrict site access and alteration are maintained as part of the deed transferring the parcel to Merced County and a State Land Use Covenant executed by the Air Force and the State of California._____
_____

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

D. General

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

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

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

VI. GENERAL SITE CONDITIONS

A. Roads X Applicable ☐ N/A

1. **Roads damaged** ☐ Location shown on site map X Roads adequate ☐ N/A
Remarks: Landfill perimeter access roads do not show any signs of damage.
_____

B. Other Site Conditions

Remarks: Site appears to be in good condition and no unauthorized access.

_____

_____

_____

_____

_____

VII. LANDFILL COVERS X Applicable ☐ N/A

A. Landfill Surface

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

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

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

4. **Holes** ☐ Location shown on site map X Holes not evident
   Areal extent_____ Depth_____
   Remarks: Holes not evident through the HDPE liner
   _____

5. **Vegetative Cover** ☐ Grass ☐ Cover properly established X No signs of stress
   ☐ Trees/Shrubs (indicate size and locations on a diagram)
   Remarks: Burrows were evident over the surface of the vegetative surface cover; however, the burrows don't appear to negatively impact the HDPE liner or the stability of the soil cover. _

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

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

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

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

B. Benches ☐ Applicable X N/A
(Horizontally constructed mounds of earth placed across a steep landfill side slope to interrupt the slope in order to slow down the velocity of surface runoff and intercept and convey the runoff to a lined channel.)

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

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

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

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

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

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

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

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

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

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

D. Cover Penetrations X Applicable ☐ N/A

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

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

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

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

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

E. Gas Collection and Treatment ☐ Applicable X N/A

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

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

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

F. Cover Drainage Layer X Applicable ☐ N/A

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

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

G. Detention/Sedimentation Ponds ☐ Applicable X N/A

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

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

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

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

H. Retaining Walls ☐ Applicable X N/A

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

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

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

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

2. **Vegetative Growth** ☐ Location shown on site map ☐ N/A
☐ Vegetation does not impede flow
Areal extent_____ Type_____
Remarks:
Vegetation in drainage channels seems to help maintain soil stability and diminish water flow rate

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

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

VIII. VERTICAL BARRIER WALLS ☐ Applicable X N/A

IX. GROUNDWATER/SURFACE WATER REMEDIES ☐ Applicable X N/A

X. OTHER REMEDIES ☐ Applicable X N/A

XI. OVERALL OBSERVATIONS

A. Implementation of the Remedy

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

_None_____

B. Adequacy of O&M

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

The observed holes in the vegetative cover do not appear to penetrate the HDPE liner. Drainage ditches have vegetative growth.

C. Early Indicators of Potential Remedy Problems

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

__ None

D. Opportunities for Optimization

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

__None

LF-4 Eastern Drainage Channel Facing North

LF-4 Eastern Drainage Channel Facing South

LF-4 Landfill Cap Facing North

LF-4 Landfill Cap Facing Northeast

LF-4 Landfill Cap Facing South

LF-4 Landfill Cap Facing Southeast

LF-4 Southwestern Drainage Channel Facing North

LF-4 Southwestern Drainage Channel Facing South

Five-Year Review Site Inspection Checklist

I. SITE INFORMATION	
Site name: LF-5 (LF008)	**Date of inspection: 07/19/18**
Location and Region: Former Castle AFB	**EPA ID: CA3570024551**
Agency, office, or company leading the five-year review: United States Air Force	**Weather/temperature:**

Remedy Includes: (Check all that apply)

- **x Landfill cover/containment**
- ☐ Access controls
- **x Institutional controls**
- ☐ Groundwater pump and treatment
- ☐ Surface water collection and treatment
- ☐ Monitored natural attenuation
- ☐ Groundwater containment
- ☐ Vertical barrier walls
- **x Other_Ecological monitoring consisting of wetland invertebrate (fairy shrimp) and plant surveys at selected vernal pools were initiated in the spring of 2008 and conducted again in 2016. Based on the results of these surveys, further ecological monitoring is not recommended.**

Attachments: Photographic log

II. INTERVIEWS (Check all that apply)

1. **O&M site manager** Nick Sjaarda (Name) Task Manager (Title) 07/03/18 (Date)
   Interviewed ☐ at site X at office ☐ by phone Phone no. _____
   Problems, suggestions; ☐ Report attached _____

2. **O&M staff** _____Jordan Ollanik_____ (Name) _____Engineer_____ (Title) ____7/19/2018_ (Date)
   Interviewed x at site ☐ at office ☐ by phone Phone no. ___(520) 461-3808_____
   Problems, suggestions; ☐ Report attached _____

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

Agency _ **See interviews in Appendix C** _____
Contact _____ _____ _____ _____
Name Title Date Phone no.
Problems; suggestions; ☐ Report attached _____
_____

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

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

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

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

See interviews in Appendix C

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

1. **O&M Documents**

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

Remarks: Landfill as-builts are maintained and represent the final composition of the landfill. Construction as-builts are maintained as part of the construction documentation report which is available on the administrative record.

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

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

4. **Permits and Service Agreements**

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

Remarks_____

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

6. **Settlement Monument Records** X Readily available X Up to date ☐ N/A
Remarks: Available on the administrative record_____

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

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

9. **Discharge Compliance Records**

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

Remarks_____

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

IV. O&M COSTS

1. **O&M Organization**

☐ State in-house ☐ Contractor for State
☐ PRP in-house ☐ Contractor for PRP
☐ Federal Facility in-house X Contractor for Federal Facility
☐ Other_____
_____

2. **O&M Cost Records**

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

Total annual cost by year for review period if available

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

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

Describe costs and reasons: __None_____
_____
_____
_____
_____
_____

V. ACCESS AND INSTITUTIONAL CONTROLS X Applicable ☐ N/A

A. Fencing

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

Remarks_____
_____

B. Other Access Restrictions

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

Remarks: Signs noticeable_____
_____

C. Institutional Controls (ICs)

1. **Implementation and enforcement**

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

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

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

Specific requirements in deed or decision documents have been met X Yes ☐ No ☐ N/A
Violations have been reported ☐ Yes X No ☐ N/A
Other problems or suggestions: ☐ Report attached
None. ICs to restrict site access and alteration are maintained as part of the Air Force/BoP memorandum of understanding.

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

D. General

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

2. **Land use changes on site** ☐ N/A
Remarks:_None_____

3. **Land use changes off site** ☐ N/A
Remarks:__None_____

VI. GENERAL SITE CONDITIONS

A. Roads X Applicable ☐ N/A

1. **Roads damaged** ☐ Location shown on site map X Roads adequate ☐ N/A
Remarks: Landfill perimeter access road does not show any signs of damage.

B. Other Site Conditions

Remarks: Site is within United States Bureau of Prisons property and behind a perimeter fence. No signs of human activity observed._____

_____

VII. LANDFILL COVERS X Applicable ☐ N/A

A. Landfill Surface

1. **Settlement** (Low spots) ☐ Location shown on site map X Settlement not evident
Areal extent_____ Depth_____
Remarks: There are various depressions in the landfill surface.
The depth and extent of depressions should be evaluated as part of the aerial survey.

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

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

4. **Holes** ☐ Location shown on site map X Holes not evident
Areal extent_____ Depth_____
Remarks: Holes not evident through the HDPE liner
_____

5. **Vegetative Cover** ☐ Grass X Cover properly established ☐ No signs of stress
☐ Trees/Shrubs (indicate size and locations on a diagram)
Remarks: Animal burrows are evident over the surface of the vegetative cover which do not appear to have negatively affected the integrity of the HDPE liner nor impacted the stability of the vegetative soil cover.

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

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

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

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

B. Benches ☐ Applicable X N/A

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

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

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

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

C. Letdown Channels X Applicable ☐ N/A

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

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

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

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

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

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

6. **Excessive Vegetative Growth** Type_____
☐ No evidence of excessive growth
☐ Vegetation in channels does not obstruct flow
☐ Location shown on site map Areal extent_____
Remarks:
Vegetation in drainage channels maintains soil stability and decreases the velocity of flow of water off the cap.

D. Cover Penetrations X Applicable ☐ N/A

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

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

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

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

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

E. Gas Collection and Treatment ☐ Applicable X N/A

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

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

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

F. Cover Drainage Layer X Applicable ☐ N/A

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

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

G. Detention/Sedimentation Ponds ☐ Applicable X N/A

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

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

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

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

H. Retaining Walls ☐ Applicable X N/A

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

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

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

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

2. **Vegetative Growth** ☐ Location shown on site map ☐ N/A
☐ Vegetation does not impede flow
Areal extent_____ Type_____
Remarks: Vegetation in drainage channels seems to help maintain soil stability and decrease the rate of flow of water off the cap.

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

4. **Discharge Structure** X Functioning ☐ N/A
Remarks:

VIII. VERTICAL BARRIER WALLS ☐ Applicable X N/A

IX. GROUNDWATER/SURFACE WATER REMEDIES ☐ Applicable X N/A

X. OTHER REMEDIES X Applicable ☐ N/A

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

Ecological monitoring was conducted in 2008 and 2016 as part of the remedy. Based on the results of these surveys, additional ecological monitoring is not recommended.

XI. OVERALL OBSERVATIONS

A. Implementation of the Remedy

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

_None_____

B. Adequacy of O&M

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

The observed holes in the vegetative cover do not appear to penetrate the HDPE liner. The drainage ditches do have minor vegetative growth.

C. Early Indicators of Potential Remedy Problems

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

_____

___ None _____

_____

_____

_____

_____

_____

_____

_____

D. Opportunities for Optimization

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

_____

___None_____

_____

_____

_____

_____

_____

_____

_____

LF-5 Southeast Drainage Ditch Facing Northwest Landfill Cap

LF-5 East Drainage Ditch Facing Northwest

LF-5 Southeast Drainage Ditch Facing North

LF-5 Southwest Drainage Ditch Exit

LF-5 Southwest Drainage Ditch Facing Northeast

LF-5 Western Drainage Ditch Facing East Toward Landfill Cap

APPENDIX F
RESPONSES TO AGENCY COMMENTS

Responses to Agency Comments on the Draft Final Castle AFB Five-Year Review Report

Responses to Water Board Comments

The Water Board provided comments to the USAF on the *Draft Final Fifth Five Year Review Report (FYR) for the Former Castle Air Force Base in Atwater, Merced County, California* via email on 25 February 2019. Those comments are presented below and are followed by USAF responses in bold.

Comment 1

The Air Force adequately responded to Central Valley Water Board comments and concerns, and Central Valley Water Board staff concur with the Draft Final FYR. However, in response to Comment 7, Central Valley Water Board staff request notification of landfill sampling events so staff can collect split samples for independent PFAS analyses. Central Valley Water Board staff concur with the Air Force's assessment that PFAS was not applied in the landfill areas but due to the ubiquitous nature of PFAS constituents and the landfill histories at the Site (e.g. landfill consolidation), Central Valley Water Board staff still consider the landfill areas to be potential source areas of PFAS and the landfills should be investigated further.

Response: **Comment noted. The USAF will notify Central Valley Water Board staff prior to upcoming sampling events at the landfills.**

Responses to USEPA Comments

The USEPA provided comments to the USAF on the *Draft Final Fifth Five Year Review Report (FYR) for the Former Castle Air Force Base in Atwater, Merced County, California* via email on 21 February 2019. Those comments are presented below and are followed by USAF responses in bold.

Comment 1

EPA's comments have been addressed with the exception of Comment 4. We do not concur with this portion of the response to EPA Comment 4 associated with the Main Base Plume: "However, while PFOS/PFOA should be evaluated relative to the Main Base Plume, because that plume is being captured and the treatment process is effective at remediating PFOS/PFOA, the remedy remains protective for Main Base Plume. Consequently, the PFOS/PFOA investigation finding has been kept in the "Other Findings" section for Main Base Plume while the PFOS/PFOA issue for FTA-1 has been added to the Issues portion of Section VI."

Although initial data suggests that the treatment system in place for the Main Base Plume is effective at removing PFOS/PFOA, until additional data can be collected over time to demonstrate the long-term effectiveness of the system, it cannot be assumed it is effective at remediating the PFOS/PFOA. The presence of co-contaminants changes the efficiency of removal and may require optimization, such as adjustment to the carbon changeout frequency. Additionally, until the investigation of the extent of contamination is completed, it is unclear if modifications to the extraction well network may be necessary to ensure plume capture. We still recommend adding this as an issue and modifying the protectiveness determination to Protective in the Short Term for the Main Base Plume until more data

can be collected and evaluated to establish whether the effectiveness of the treatment system for PFAS will continue over the long-term and if optimization may be necessary.

Response: **The status has been changed to protective in the short term as requested because the characterization of PFOS/PFOA is ongoing. Until the investigation of the extent of PFOS/PFOA contamination is complete, it is uncertain if modifications to the extraction well network are necessary to ensure plume capture. For the OU-2 and Phase 3 treatment systems, initial data indicate that the systems are effectively treating PFOS/PFOA based on data collected over four sampling events. All effluent concentrations collected prior to carbon change out and shortly after in October, November, and December of 2018 and in January of 2019 were either not detected or less than the lifetime health advisory; however, data collection is ongoing. Based on these initial data, VOCs remain the driver for the carbon change out schedule.**

Responses to DTSC Comments

The DTSC provided comments to the USAF on the *Draft Final Fifth Five Year Review Report (FYR) for the Former Castle Air Force Base in Atwater, Merced County, California* via email on 14 February 2019. Those comments are presented below and are followed by USAF responses in bold.

Comment 1

The report specifies that extraction well EW-40, screened in the Upper Sub-shallow Hydrostatic Zone (USS HSZ), has been responsible for an upward gradient, plume capture and remediation of the OU-2 plume in the northern portion of Lower Sub-shallow Hydrostatic Zone (LSS HSZ). However, the report fails to produce sufficient data or analysis to support this claim.

Additionally, the report does not adequately support the conceptual model used to explain the presence of TCE in the northern LSS HSZ. The Air Force speculated the TCE was solely the result of a faulty well-seal and small gap in the well-casing of former Monitoring Well MW-1057.

Additional hydrologic and water quality data and analysis should be provided in subsequent reports to support the claim that EW-40 has successfully remediated the LSS HSZ.

Response: **EW40 was installed in April 2017. An updated conceptual site model for the source of the LSS HSZ plume was presented in the Northern Operable Unit 2 Plume Investigation and Well Installation Work Plan (Final in August 2017), which was the work plan describing the installation of EW40. Data supporting the claim that the operation of EW40 has created an upward vertical gradient resulting in the capture and remediation of the LSS HSZ plume were presented in the Operations, Maintenance, and Monitoring 2017 Annual Report (Executive Summary, Table 7-1, and Sections 3.3.2, 4.3, 5.1.4, and 7.1). These data and the updated conceptual site model were also presented and discussed in depth with the regulatory agencies at the January 2018 Technical Working Group Meeting and the July 2018 BCT meeting. An update on the status of EW40 and its capture of the LSS HSZ plume will be presented in the Operations, Maintenance, and Monitoring 2018 Annual Report and in future annual reports as needed.**

Responses to Agency Comments on the Draft Castle AFB Five-Year Review Report

Responses to Water Board Comments

The Water Board provided comments to the USAF on the *Draft Fifth Five Year Review Report (FYR) for the Former Castle Air Force Base in Atwater, Merced County, California* via email on 27 December 2018. Those comments are presented below and are followed by USAF responses in bold.

Comment 1

Issues: In Section VI, Issues/Recommendations, the Air Force identifies several issues and recommendations to address those issues within the next five-year review period. Central Valley Water Board staff believe additional or supplemental recommended actions should be included with several of the issues identified by the Air Force. The identified Air Force issues presented in Section VI and Central Valley Water Board concurrence or requests for supplemental recommendations and rationale are provided below.

Air Force Defined Issue	Central Valley Water Board Additional Recommendations to Supplement the Air Force Recommendations
Evaluation of PFOS/PFOA	*Issues*: Central Valley Water Board staff anticipate the issuance of a California Maximum Contaminant Level (MCL) for PFAS compounds, at least PFOS and PFOA, within the next five-year review period. At this time, groundwater in the Main Base Plume exceeds State and Federal health recommendations for PFOS and PFOA and it is expected an MCL will be set at or below current health advisories and notification levels. *Recommended Actions*: Should California or the Federal Environmental Protection Agency (EPA) promulgate an MCL for PFAS compounds, the Air Force will need to amend the ROD either through a ROD amendment of Explanation of Significant Difference (ESD) to include PFAS compounds as a contaminant of concern in groundwater at the Site. The appropriate path forward (i.e. Remedial Investigation, Feasibility Study, Proposed Plan, etc.) should be discussed with the regulatory agencies as well. Furthermore, the Air Force will also need to determine whether the existing pump and treat system is capturing all PFAS contamination and containing the PFAS groundwater plume on-Site. Additional evaluation for PFAS contamination may also be necessary in the landfill areas due to the predominance of PFAS compounds in municipal products associated with buried material at LF-4 and LF-5.
Response	**Comment noted. However, given that the MCL has not yet been issued, no changes to the FYR have been made.**
Declining Water Levels	Central Valley Water Board staff concur with the Air Force recommendations for declining water levels. However, the dry monitoring wells at LF-4 and LF-5 were not mentioned in Section VI. Central Valley Water Board's request for inclusion of dry landfill wells in Section VI is discussed in Comment 2 below.
Response	**See response to Comment 2 below.**
Evaluation of 1,2,3-TCP	*Issues*: The Air Force consistently states 1,2,3-TCP is an agricultural contaminant and not a COC at the Site. However, Central Valley Water Board staff have observed landfills acting as source areas for 1,2,3-TCP contamination in the Central Valley of California. There are and were multiple landfills at the Site that may be sources of 1,2,3-TCP to groundwater. 1,2,3-TCP has also been identified at LF-4, an area that may be upgradient of agricultural sources. In Section IV, Five-Year Review Process, Part B, Data Review, the FYR states the source of 1,2,3-TCP at LF-4 is agricultural and not the landfill. Central Valley Water Board staff do not yet concur with this assessment because additional evaluation and monitoring is required.

Air Force Defined Issue	Central Valley Water Board Additional Recommendations to Supplement the Air Force Recommendations
	Recommended Actions: Central Valley Water Board staff request the Air Force also sample for 1,2,3-TCP in groundwater at LF-4 and LF-5 monitoring wells to assess whether the landfills are a source of 1,2,3-TCP. If it is determined that the landfills are sources of 1,2,3-TCP contamination, additional remedial actions should be discussed with the regulatory agencies within the next five-year review period. It may also be necessary to incorporate a ROD amendment or Explanation of Significant Difference (ESD) to add 1,2,3-TCP as a contaminant of concern for the landfills or modify the *Closure and Post-Closure Maintenance Plan for Castle Airport Landfills* (CPCMP, Jacobs, 1997).
Response	**The FYR report states in multiple locations that the Air Force "believes" or "considers" 1,2,3-TCP to be an agricultural contaminant, but that additional investigation "is being" and "will be" conducted to determine if CAFB is a contributing source. An additional issue has been added to Section VI, Issues/Recommendations to specifically address 1,2,3-TCP investigation at LF-4 and LF-5.**
Monitoring (TCE at MW1008)	*Issues*: Although the selected remedy for the off-base plume is wellhead treatment, the trichloroethylene (TCE) plume at MW1008 is not currently being captured by wellhead treatment. In addition, the MW951 wellhead treatment system that may have partially captured the MW1008 plume was recently decommissioned. Consequently, the TCE plume at MW1008 does not meet requirements set forth in the CB ROD – Part 2. *Recommended Actions*: Central Valley Water Board staff concur with the recommendation to determine if wellhead treatment at MW1008 is necessary. However, wellhead treatment appears to be necessary because the well is not in compliance with ROD requirements.
Response	**As part of the ongoing evaluation of wellhead treatment at MW1008, the well was resampled on November 15 and December 3, 2018 and TCE concentrations were 3.8 µg/L and 4.8 µg/L, respectively. Because TCE concentrations have decreased below the MCL, wellhead treatment is not warranted at this time. MW1008 will continue to be monitored quarterly and results evaluated to determine if wellhead treatment is warranted. Because these samples were collected outside the timeframe of the FYR, the recommendation to "Determine if wellhead treatment at MW1008 is necessary based on recent sampling results" was not changed.**
TCE at IW40	*Issues*: The recommendations do not consider an evaluation for wellhead treatment or contaminant mass removal in the IW-40 vicinity. At this time, TCE concentrations at IW-40 are sufficiently high that the well is not in compliance with ROD requirements. The most recent sampling event from June 2018 had a concentration of 11 µg/L at IW40 which is above the MCL and ROD screening level of 5 µg/L. *Recommended Actions*: Central Valley Water Board staff recommend the Air Force also include an evaluation for wellhead treatment or remedial actions at IW-40. An evaluation for remedial actions at IW-40 should be addressed in the Annual Operations, Maintenance, and Monitoring (OM&M) reports and discussed with the regulatory agencies to ensure ROD compliance.
Response	**As requested, the Air Force will include an evaluation for wellhead treatment or additional remedial action at IW40 and downgradient wells in the Annual Operations, Maintenance, and Monitoring (OM&M) reports. In addition, the recommendation for IW40 in Section VI of the FYR has been revised to reflect this. However, the Air Force does not agree that IW40 is in noncompliance with the ROD for the following reasons:** **The northeast plume (now defined by IW40) originated in the Shallow HSZ east of the runway and was part of the East Base Plume Region at the time of the CB ROD – Part 1. In 1998, the northeast plume was made part of the Main Base Plume Region. At the time of the ROD, it was determined that the TCE concentrations (maximum of 45 µg/L at MW884 in Q2/94) and the limited extent of the northeast plume did not warrant active remediation. Thus, the selected remedy for the East Base Plume Region (including the northeast plume) was decommissioning of selected wells to prevent cross contamination of HSZs, plume monitoring, and annual evaluations to determine if pump and treat technology was necessary.**

Air Force Defined Issue	Central Valley Water Board Additional Recommendations to Supplement the Air Force Recommendations
	Well decommissioning was completed and annual monitoring and evaluation of the need for treatment was presented in the LTGSP Annual Reports. After having first decreased to near the MCL during the late 1990s, TCE concentrations in the northeast plume increased to over 30 µg/L by 2001, and wellhead treatment was initiated in both the upgradient and downgradient portions of the plume in 2001 and 2002, respectively. It is important to point out that because the northeast plume is upgradient, and within the hydraulic control, of the OU-2 treatment system, it was already being captured and that the sole purpose of these wellhead systems was to speed up remediation by removing contamination closer to the source. The upgradient wellhead system at MW883/MW1021 was permanently shut down with regulatory agency concurrence in 2004 because it had reached its goal of mass removal (TCE concentrations at MW1021 had been reduced from 84 µg/L at startup in Q3/02 to 8.4 µg/L in Q3/04). In 2006, water levels had declined to the point that pumping could not be sustained at the downgradient wellhead system at MW824/MW1037. Because remediation of the northeast plume was no longer practical at this location, the Air Force decided to permanently shut down the MW824/MW1037 wellhead system with regulatory agency concurrence. The maximum TCE concentration in the northeast plume at the time of shutdown was 12 µg/L (MW1027). Evaluations of the northeast plume (including IW40) since that time have confirmed that wellhead treatment is not warranted and that the plume should be allowed to migrate downgradient where it will be remediated by the OU-2 treatment system. **Whether the selected remedy for the current northeast plume is considered to be that of the East Base Plume Region (monitoring and annual evaluation of need for treatment) or the Main Base Plume Region (capture and cleanup to the MCL), it is the Air Force's position that the northeast plume (now defined by IW40) is in full compliance with the ROD. Because the IW40 plume is upgradient, and within the hydraulic control, of the OU-2 system, it is currently being captured and will be remediated by the OU-2 system as it migrates further downgradient.** **Monitoring of TCE concentrations will continue quarterly at IW40 and semiannually at downgradient wells MW808A and MW901 so that changes to the plume can be evaluated. In addition, annual evaluations of the need for wellhead treatment at IW40 will be included in the OM&M reports.**
Impairment of HDPE Liner at FTA-1 and breach of ICs.	Central Valley Water Board staff concur with the Air Force recommendations for repair oversight of the breached HDPE liner at FTA-1.
Response	**Comment noted.**

Comment 2

Issues:

1. The Air Force does not include issues or recommendations for the dry landfill wells in the Section VI of the Report. However, the declining water levels at LF-4 and LF-5 is making it difficult for the Air Force to remain in compliance with ROD and CPCMP requirements.
2. The Air Force has completed an evaluation of vapor intrusion of TCE from groundwater to indoor air for the FYR using a Johnson and Ettinger vapor intrusion model and corresponding California Department of Toxic Substances Control (DTSC) guidelines. Current modeling indicates no significant vapor intrusion concerns at current TCE concentrations in groundwater within the Main Base Plume. However, groundwater in the Shallow Hydrostratigraphic (HSZ) Zone has drastically dropped and very few Shallow groundwater monitoring wells remain at the Site. Furthermore, DTSC, the Federal Environmental Protection Agency (EPA), and the California State Water Resources Control Board are finalizing a new vapor intrusion guidance document that uses far more conservative approaches and screening levels to evaluate vapor intrusion concerns. It is thus possible additional actions such as soil vapor sampling may be necessary at the Site to address the new regulatory guidance within the next FYR period.

Recommended Actions:

1. Central Valley Water Board staff require the inclusion of the dry landfill issue in Section VI of the report. Recommendations for the dry landfill issue should include evaluation of groundwater levels, the need to replace dry groundwater monitoring wells, and compliance with ROD and CPCMP requirements.
2. Central Valley Water Board staff recommend the Air Force include a potential future evaluation of vapor intrusion as a recommendation in Section VI, Issues/Recommendation for the FYR.

Response:

3. The issue of dry landfill wells has been included in Section VI of the report for both LF-4 and LF-5. The recommendations section has been revised to include agreements made at the 2018 BCT meeting regarding evaluation of Q2/19 water levels to determine the need for well replacement.

4. Because new guidance for soil vapor intrusion has yet to be issued, no changes have been made to the FYR. However, this issue will be evaluated in the next FYR if new guidance has been issued at that time.

Comment 3

Section II Main Base Plume Clarification

Issues: In Section II, Response Action Summary, Part C, Status of Implementation, Main Base Plume section, the FYR states that if a contaminant concentration in any drinking water well begins to exceed one half the MCL, the Air Force will act to implement wellhead treatment or provide an alternative drinking water supply. This section does not specifically define which contaminant(s) would trigger Air Force Action. This may cause confusion to the reader because, for example, 1,2,3-trichloropropane (1,2,3-TCP) and 1,2-dibromo-3chloropropane (DBCP) exceed the MCL in several drinking water wells near the Site boundary, but the Air Force has not completed wellhead treatment or provided an alternative drinking water supply at these locations.

Recommended Actions: Central Valley Water Board staff recommend the Air Force define which contaminants would specifically require a response if contaminants exceed one half their respective MCLs in drinking water wells (e.g. see Table 1 COCs).

Response: **The text has been amended to specify the relevant COCs.**

Comment 4

Section II Main Base Plume MW1057

Issues: Section II, Response Action Summary, Part E, Systems Operations, Maintenance, and Monitoring, the FYR discusses the Annual OM&M modifications and/or issues that occurred from 2013 to 2018. However, the installation of monitoring well MW1057 and its destruction and subsequent installation of monitoring wells MW1058 and MW1059 were not discussed in this section.

Recommended Actions: Central Valley Water Board staff request the Air Force summarize the installation of monitoring wells MW1057, MW1058, and MW1059 in Section E of the FYR and provide rationale for why the wells were installed. A description of why MW-1057 was replaced with MW-1058 should also be included.

Response: **The installation of MW1057, MW1058, and MW1059 has been summarized in Section II, Response Action Summary, Part E, Systems Operation, Maintenance, and Monitoring, Main Base Plume, as requested. Details on why MW1057 was replaced with MW1058 have been added to Section IV, Five-year Review Process, Part B, Data Review, Main Base Plume.**

Comment 5

Discharge Requirements

Issues: In Section V, Technical Assessment, Part A, Main Base Plume, the FYR states treatment plant effluents consistently met discharge requirements during the most recent five-year period. The discharge requirements are not defined in the FYR and it is unknown from where the requirements are derived (e.g. RODs, Central Valley Water Board Waste Discharge Requirements, National Pollutant Discharge Elimination System Requirements, etc.).

Recommended Actions: Please define what is meant by "discharge requirements" and the source that defines those requirements for treatment plant effluents in the FYR.

Response: **The text has been modified to state, "In 2016 and 2017, treatment plant effluents consistently met discharge standards established in the CB ROD – Part 1 (USAF, 1997a) (i.e., no organic or inorganic compounds exceeded discharge standards)."**

Comment 6

Landfill Contaminants of Concern

Issues: There are several sections in the FYR review that state there are no identified contaminants of concern (COCs) for groundwater monitoring at Landfill 4 (LF-4) and Landfill 5 (LF-5). The FYR states metals were "qualitatively" identified as COCs in LF-5 but they are only relevant for ecological assessments, not groundwater. However, there are groundwater monitoring requirements at the landfills that are stipulated by the Source Control Operable Unit (SCOU) Record of Decision (ROD) – Part 3 (Jacobs, 2005). The Air Force regularly samples landfill groundwater wells to monitor for potential contaminant releases from the landfills.

The Air Force states COCs are not applicable to landfills because of "post-removal actions" and conditions. The definition of "post-removal actions" is not provided, and it is unclear why the Air Force needs to monitor landfill groundwater if there are no COCs.

Recommended Actions: Central Valley Water Board staff recommend the Air Force define "post-removal actions" and describe how these actions removed COCs. The Air Force should also further elaborate on the necessity of a monitoring program at the landfills if there are no COCs (e.g. Title 27 requirements, SCOU ROD – Part 3 requirements, etc.).

Response: **The FYR report does not state that "post-removal actions removed COCs." Instead it states "Based on post-removal action <u>conditions</u>, there are no identified COCs for LF-4." This conclusion, which is presented in the SCOU ROD – Part 3, does not imply there were any "post-removal actions" that took place, but rather that the COCs were eliminated by the removal action itself (i.e., consolidation and capping). However, while the removal action has eliminated the COCs by eliminating the potential routes of exposure, there may be COCs present within the waste material now capped at LF-4 (as well as LF-5) that exceed human health or WQSA RAOs. The post-closure monitoring program was implemented to detect potential future releases to groundwater from the landfill, in the event of cap failure. The potential presence of COCs beneath the caps has been added to the text for LF-4 and LF-5 in Section V, Technical Assessment, Parts D and E, Question B Summary.**

Comment 7

Landfills OM&M

Issues: In the FYR, the Air Force states "the remedial action performance is adequate, the OM&M inspections and monitoring did not identify any issues, and the [institutional controls (ICs)] are in place and effective." Central Valley Water Board staff do not concur that the remedial action performance is

adequate and the OM&M inspections and monitoring did not identify any issues. Groundwater monitoring wells at both LF-4 and LF-5 are going dry or are dry. Thus, the Air Force is not in compliance with the respective CPCMP and cannot sufficiently evaluate whether there is a potential release from the landfills to groundwater. Furthermore, the extent of 1,2,3-TCP and PFAS contamination in groundwater near the landfill wells also needs to be evaluated.

Recommended Actions: Central Valley Water Board staff require the Air Force replace dry landfill groundwater monitoring wells at LF-4 and LF-5. It is likely the replacement monitoring wells will need to be placed in the Upper Subshallow HSZ due to falling water levels in the Shallow HSZ. Central Valley Water Board staff further recommend the Air Force evaluate the extent of 1,2,3-TCP and PFAS at landfill groundwater monitoring wells.

Response: **The issue of the replacement of drying landfill wells was discussed at the July 11, 2018 Base Realignment and Closure Cleanup Team (BCT) meeting. As agreed to at that meeting and as stated in the LTGSP 2018 Semiannual Report, Table 7-1, "The determination of whether or not drying landfill wells should be replaced has been postponed until after the Q2/19 sampling event. Groundwater levels will be monitored at existing landfill wells in Q4/18, Q1/19, and Q2/19 and samples collected if sufficient water volume is present. Results of this monitoring will be discussed before, or at, the 2019 BCT meeting (typically June or July) and a consensus reached on the need for replacement wells. Following this discussion, a work plan detailing number of wells, location of wells, and installation of wells will be provided for regulatory review and approval before any installation work." This additional discussion has been added to the Issues/Recommendations section for LF-4 and LF-5.**

The evaluation of the source of 1,2,3-TCP contamination is ongoing, and additional sampling and investigation (including LF-4 and LF-5) is planned for 2019. The following text has been added to the Recommendations under Other Findings in Section VI, "If the AF is a contributing source of TCP, the AF will evaluate the need for additional remedial actions and incorporation of TCP into the ROD and CPCMP as appropriate."

Based on the Site Investigation of Potential Perfluorinated Compound (PFC) Release Areas at Multiple United States Air Force Base Realignment and Closure Installations Installation-Specific Work Plan (Amec, Foster, Wheeler, 2017), eighteen areas were identified as locations where AFFF may have been stored, used, conveyed, handled, discharged, or incidentally released at Castle AFB. LF-4 and LF-5 were not identified as potential sources of PFOS/PFOA and sampling specifically related to LF-4 and LF-5 for PFOS/PFOA is not planned.

Comment 8

LF-4 IC Addition

Issues: In Section II, Response Action Summary, Part C, Status of Implementation, the Air Force does not mention fencing as an institutional control in the status of remedy components for LF-4. However, there is a fence that surrounds the LF that was installed for IC requirements.

Recommended Actions: Central Valley Water Board staff request the Air Force also include fencing in the IC description for LF 4 in Section II, Part C of the FYR.

Response: **The presence of the fence has been added to the text as requested as part of LTM of the site because the fencing is an engineering control rather than an IC.**

Comment 9

Dry Landfill Wells in Section II

Issues: Section II, Response Action Summary, Part E, Systems Operations, Maintenance, and Monitoring of the FYR discusses the Annual OM&M modifications and/or issues that occurred from 2013 to 2018.

For the landfills section, the FYR does not mention the persistence and emergence of dry landfill groundwater monitoring wells, even for the recently replaced wells.

Recommended Actions: Central Valley Water Board staff recommend the Air Force also include a discussion of dry landfill monitoring wells in Section E of the FYR.

Response: **A discussion of dry wells has been added to Section II, Response Action Summary, Part E, Systems Operations, Maintenance, and Monitoring for both LF-4 and LF-5.**

Comment 10

CPCMP Requirements

Issues: In Section V, Technical Assessment, the FYR discusses how groundwater monitoring wells are evaluated for replacement for both LF-4 and LF-5. Five criteria are presented in the FYR for which the Air Force consults to determine whether a dry landfill well should be replaced. However, the criteria do not include requirements from the CPCMP.

Recommended Actions: Central Valley Water Board staff recommend the Air Force include the CPCMP as additional criteria for evaluating whether dry groundwater monitoring wells need to be replaced at LF-4 and LF-5.

Response: **The following criterion was added to Section V, Technical Assessment, Parts D&E: "(6) whether the well is needed to meet post-closure detection monitoring requirements."**

Comment 11

Table 4 FTA-1 PFAS

Issues: Table 4 states that per- and polyfluoroalkyl substances (PFAS) detected in groundwater at FTA-1 were below project action limits. However, the project action limits used when groundwater was collected at FTA-1 for perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA) in 2016 of 0.2 µL (PFOS + PFOA) is well above the current EPA Public Health Advisory of 0.070 µL (PFOS + PFOA) and the California State Water Resources Control Boards Notification Level of 0.013 µL for PFOS and 0.014 µL for PFOA.

Recommended Actions: Central Valley Water Board staff request the Air Force define the project action limits used when groundwater from FTA-1 was sampled for PFAS analyses and discuss the changes in EPA Public Health Advisories and California Notification Levels since the work was completed. It is likely additional investigations will be required in the FTA-1 area should a MCL be promulgated for PFAS.

Response: **The following text has been added to Table 4: "Groundwater and surface water PALs for PFOS and PFOA were based on the 2009 EPA Provisional Health Advisory (PHA) values. The 2009 EPA drinking water PHA values were 0.2 micrograms per liter (µg/L) for PFOS and 0.4 µg/L for PFOA. The EPA has set the lifetime health advisory in drinking water for both PFOA and PFOS at 0.070 µg/L, and has recommended that when PFOA and PFOS co-occur in a drinking water source, the sum of the concentrations of PFOA and PFOS also be compared to the lifetime health advisory value of 0.070 µg/L. In addition, the California State Water Resources Control Board has developed Notification Levels of 0.013 µg/L for PFOS and 0.014 µg/L for PFOA. Based on the changing screening levels, additional investigation may be warranted."**

Comment 12

TPH at OU-2 Effluent

Issues: In Section IV, Five-Year Review Process, Part B, Data Review, the FYR states a total petroleum hydrocarbon (TPH) detection was identified in the OU-2 effluent. The Air Force states this turned out to be anomalous but does not identify criteria used to classify the sample as anomalous.

Recommended Actions: Please further elaborate on the criteria used to classify the TPH detection in an OU-2 effluent as "anomalous."

Response: **The TPH detection in the effluent was at a concentration less than the discharge standard. Additional details on why the TPH detection was determined to be "anomalous" have been added to Section IV, Five-year Review Process, Part B, Data Review.**

Comment 13

Missing Abbreviations & Acronyms

Issues: The individual site names are not included on the List of Abbreviations & Acronyms page. For example, DA, FTA, ETC, LF, etc. are not defined.

Recommended Actions: Central Valley Water Board staff request the Air Force define the acronyms on the List of Abbreviations & Acronyms page for individual sites discussed in the main text of the FYR.

Response: **The acronyms have been added as requested.**

Comment 14

Typographical Errors

Issues: Central Valley Water Board staff identified some minor typographical errors and unclear sentences throughout the FYR. The page number and typographical error are noted in the table below.

Page #	Typographical Error	Comments
1	"…resulted in soil and groundwater contaminants"	Where did the contaminants go?
11	"…the excavation and ofF-site disposal…"	Should be off-site
27	"..with the BoP to insure site conditions have not changed."	Should be ensure
42	…concentrations detected at the downgradient base boundary and off base. .	Remove the extra period.
Figure 2	OU-2 Groundwater Treatment	Figure 2 has two OU-2 groundwater treatment systems marked. The one to the east of the Phase 3 groundwater treatment system states it was taken offline in 2003. Central Valley Water Board staff believe the treatment system marked OU-2 to the east of the Phase 3 groundwater treatment system is improperly marked and should instead read OU-1.

Response: **The changes have been updated as requested.**

Responses to USEPA Comments

The USEPA provided comments to the USAF on the *Draft Fifth Five Year Review Report (FYR) for the Former Castle Air Force Base in Atwater, Merced County, California* via email on 26 December 2018. Those comments are presented below and are followed by USAF responses in bold.

Comment 1

On page 3, the period of performance should reflect the time period of the review.

Response: **The beginning date of the review period was selected based on the ending date of the last five-year review period and the end data was based on the requirement to have a final version by March 2019. However, because all of the 2013 data were reviewed for this FYR, the start date has been changed to 6/30/2013 so the review period reflects a full 5 years.**

Comment 2

It would be helpful to include a more detailed summary of the PFAS sampling that has taken place to date. Throughout the document, there are references to PFAS sampling in both the FTA and Main Base Plume, but limited details (e.g., results were below the HAs) are only provided for the FTA.

Response: **Additional detail about the PFOS/PFOA sampling at FTA-1 has been added to the Data Review section as follows: "In 2015, two monitoring wells were installed and sampled to investigate the presence of PFOS/PFOA at FTA-1 (Amec Foster Wheeler, 2016). In addition, MW1054 was also sampled for PFOS/PFOA. Concentrations of PFOS and PFOA were detected in one of the three wells at concentrations of 0.135 µg/L and 0.146 µg/L, respectively. These detections were less than the project action levels (PAL) used at the time of the investigation, which were based on the 2009 EPA Provisional Health Advisory (PHA) drinking water values. The 2009 EPA drinking water PHA values were 0.2 µg/L for PFOS and 0.4 µg/L for PFOA. The EPA has set the lifetime health advisory in drinking water for both PFOA and PFOS at 0.070 µg/L and has recommended that when the PFOA and PFOS co-occur in a drinking water source, the sum of the concentrations of PFOA and PFOS also be compared to the lifetime health advisory in drinking water value of 0.070 µg/L. Based on the changing screening levels, additional investigation may be warranted."**

Because sampling was not specifically conducted for the Main Base plume, specific results are not presented in the Data Review section. Data were collected at eighteen areas identified as potential source areas as presented in the *Site Investigation of Potential Perfluorinated Compound (PFC) Release Areas at Multiple United States Air Force Base Realignment and Closure Installations Installation-Specific Work Plan* (Amec Foster Wheeler 2017). Some of the areas of investigation are located upgradient of the Main Base Plume and may be a source of PFOS/PFOA to the plume. However, the data collected from this investigation were not published until July of 2018 which is outside the review period of this FYR.

PFOS/PFOA sampling and analysis is being conducted for the influent and effluent of the Phase 3 and OU-2 groundwater treatment systems as presented in Addendum 2 to the *Final Installation-Specific Work Plan for Groundwater Treatment System Monitoring* (Wood, 2018). However, these data were not collected within the FYR review period. Consequently, the following text has been added to the Data Review section for Main Base Plume, "In an effort to assess the concentrations of PFOS/PFOA entering the groundwater treatment systems, sampling and analysis is being conducted of the influent and effluent of the Phase 3 and OU-2 groundwater treatment systems as presented in Addendum 2 to the *Final Installation-Specific Work Plan for Groundwater Treatment System Monitoring* (Wood, 2018). The results of this sampling will be included in a forthcoming report."

If results of these sampling efforts indicate that PFOS/PFOA have impacted the Main Base Plume, additional evaluation will be conducted to evaluate remedy protectiveness as noted in the Issues/Recommendations section of the FYR.

Comment 3

The incorporation of PFAS status in the document is inconsistent and should be edited so that it is consistent throughout. Specifically:

5. Data Review (Section IV) only discussed the FTA.
6. Technical Assessment (Section V) included PFAS in the Main Base Plume under "Changes in Standards and TBAs" while it included PFAS in the FTA under "Changes in Toxicity and Other Contaminant Characteristics".
7. The Issues/Recommendations (Section VI) only included PFAS under Main Base Plume and not FTA.

Response:

8. **As discussed above in Comment 2, data were only collected specifically for FTA-1 during the PFOS/PFAS investigations. As noted in the Main Base Plume discussion in Section V under Changes in Standards and TBCs, sampling of the influent and effluent of the treatment systems is being conducted and will be presented in a forthcoming report. It was not discussed further in the FYR because it was published after the review period (June 30, 2018).**
9. **The discussion of PFOS/PFOA for FTA-1 has been moved to the "Changes in Standards and TBCs" section.**
10. **PFOS/PFOA has been added as an issue under FTA-1.**

Comment 4

Because PFAS is known to be present, but has not been fully characterized, we would suggest that the protectiveness statement should be modified to "short-term protectiveness", pending completion of the investigation.

Response: **The protectiveness statement has been changed to "short term protectiveness" because PFOS/PFOA is not fully characterized and concentrations at FTA-1 exceed the current lifetime health advisories for drinking water. However, while PFOS/PFOA should be evaluated relative to the Main Base Plume, because that plume is being captured and the treatment process is effective at remediating PFOS/PFOA, the remedy remains protective for Main Base Plume. Consequently, the PFOS/PFOA investigation finding has been kept in the "Other Findings" section for Main Base Plume while the PFOS/PFOA issue for FTA-1 has been added to the Issues portion of Section VI.**

Comment 5

Please add EPA's Operable Unit (OU) Number designations to the document, particularly in Section 1. Introduction, Table 1, and Section VII. Protectiveness Statement. EPA designates the source control OU as OU4 and the groundwater OU as OU5.

Response: **EPAs OU Number designations have been added as requested.**

Responses to DTSC Comments

The DTSC provided comments to the USAF on the *Draft Fifth Five Year Review Report (FYR) for the Former Castle Air Force Base in Atwater, Merced County, California* via email on 26 December 2018. Those comments are presented below and are followed by USAF responses in bold.

Comment 1

GSU has reviewed comments regarding the Draft Fifth 5-year Report submitted by the United State Environmental Protection Agency (USEPA) on December 26, 2018, and concurs with those comments.

Response: **Comment noted.**

Comment 2

In the subsection, "Changes in Standards and To Be Considered (TBCs)" in Section V (Technical Assessment) of the Draft Fifth 5-year Report, GSU recommends considering the inclusion of the California drinking water notification levels (NLs) issued on July 13, 2018, for PFOA of 14 parts per trillion (ppt) and for PFOS of 13 ppt. These NLs could be included for informational purposes, as they are nonregulatory, health-based, advisory levels only.

Response: **A discussion of the noted levels has been added as requested.**

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