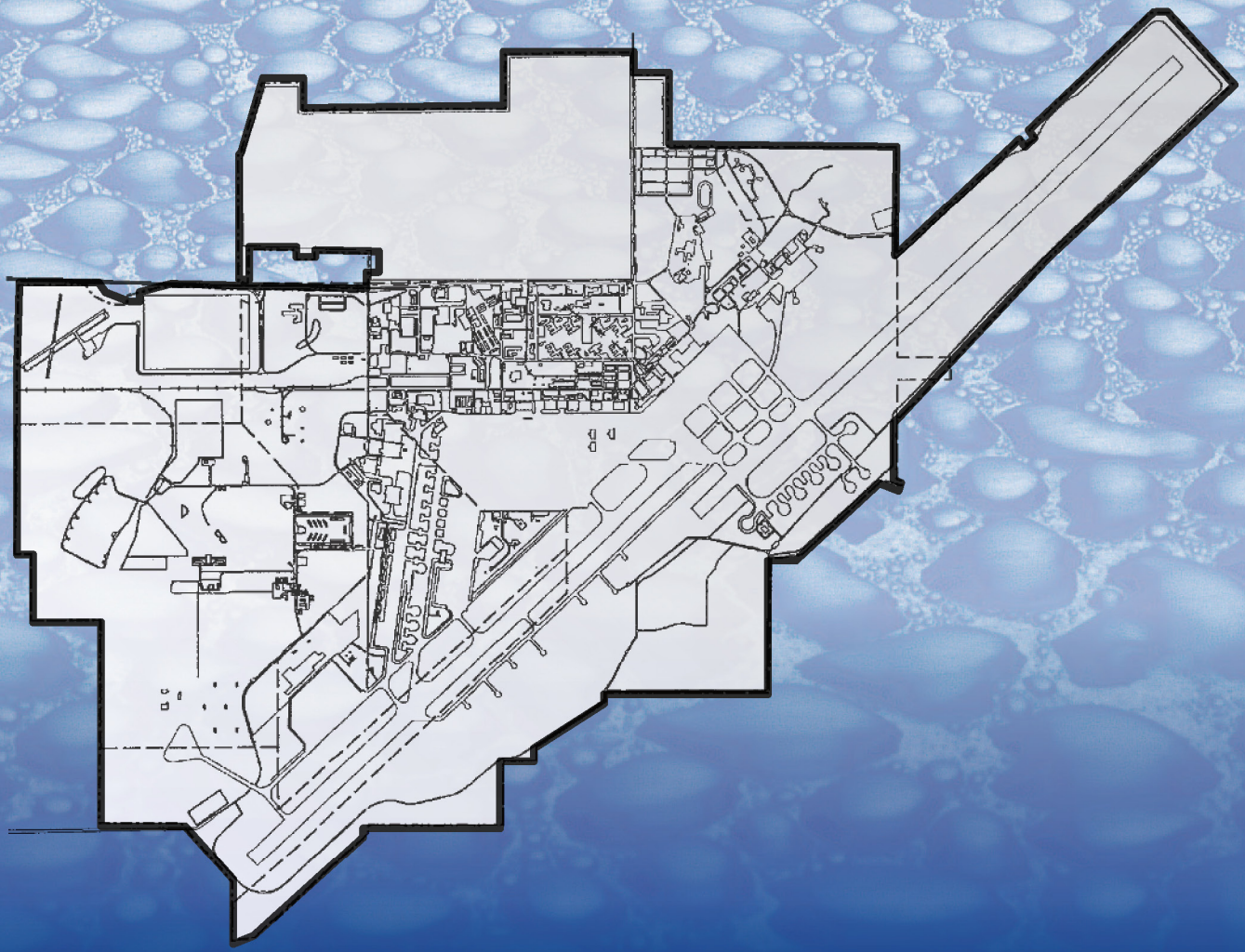
Environmental Restoration Program

Travis Air Force Base, California

Proposed Plan for Groundwater Cleanup

FINAL



OCTOBER 2012

Introduction

The U.S. Air Force (Air Force) seeks your comments on its proposed actions to clean up 19 contaminated **groundwater**[1] locations on Travis Air Force Base (AFB), as described in this Groundwater Proposed Plan. This Proposed Plan describes the groundwater contaminants at these 19 locations and the potential options that are available to clean them up. The Proposed Plan also identifies the Air Force's preferred options and the rationale for their preferences. You may comment on the potential cleanup options from October 10 to November 9, 2012, by any of the methods listed on page 21 of this Proposed Plan. You are also invited to discuss these cleanup options at a public meeting at 7:00 p.m. on October 18, 2012, at the Northern Solano County Association of Realtors building located at 3690 Hilborn Road in Fairfield. The back cover contains a map of the public meeting building.

The 19 groundwater locations are within two geographical areas at Travis AFB, known as the West/Annexes/Basewide Operable Unit (WABOU) and the North, East, West Industrial Operable Unit (NEWIOU). The WABOU and NEWIOU are called **operable units (OUs)** and allow for the efficient investigation and cleanup of the contaminants within them.

The information in this Proposed Plan is presented in much greater detail in the Basewide Groundwater Focused **Feasibility Study (FS)** Report. You are encouraged to visit the Travis AFB **Information Repository (IR)** in Vacaville to review this and other relevant documents. You can also visit the Travis AFB **Environmental Restoration Program (ERP)** web site to obtain an electronic copy of the FS Report. The back cover provides the address of the IR; the web site is shown below. Another source of online environmental information is the Air Mobility Command **Administrative Record** for Travis AFB, which is available at www.amcadminrec.com/travis.

Contents

The selection of the final groundwater cleanup actions will be reported in a formal decision document, known as a **Record of Decision (ROD)**. The Travis AFB Groundwater ROD will be approved and signed by the Air Force, the U.S. Environmental Protection Agency (EPA), the California Department of Toxic Substances Control (DTSC), and the San Francisco Bay Regional Water Quality Control Board (RWQCB). The three regulatory agencies provide technical oversight and project management to Travis AFB to promote the decision making process. The ROD documents the agreement between the Air Force and the regulatory agencies as to how the cleanup actions will take place and how clean the groundwater must be before the cleanup actions are considered finished. The ROD also allows Travis AFB to request funding for the groundwater cleanup actions.

The Air Force, together with the EPA and the State of California, knows that community input and acceptance are critical to the success of any cleanup action. Your participation in the review and discussion of all proposed cleanup actions supports the selection of the final remedies at the 19 groundwater locations.

The Air Force as the lead agency for environmental restoration activities on Travis AFB has issued this Proposed Plan as part of its public participation responsibilities under Section 117(a) of the **Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA)**, 42 U.S. Code Section 9617(a), and 40 Code of Federal Regulations Section 300.430(f)(2) of the National Oil and Hazardous Substances Pollution Contingency Plan. The EPA, DTSC, and RWQCB, as support agencies, have concurred with this Proposed Plan in accordance with CERCLA and have approved it as satisfying the requirements of applicable State of California response laws.

[1] Words in the text highlighted in boldface are defined in the Glossary on Page 26 of this Proposed Plan.

Please visit our Environmental Restoration Program web site at http://www.travis.af.mil/enviro for more restoration information.

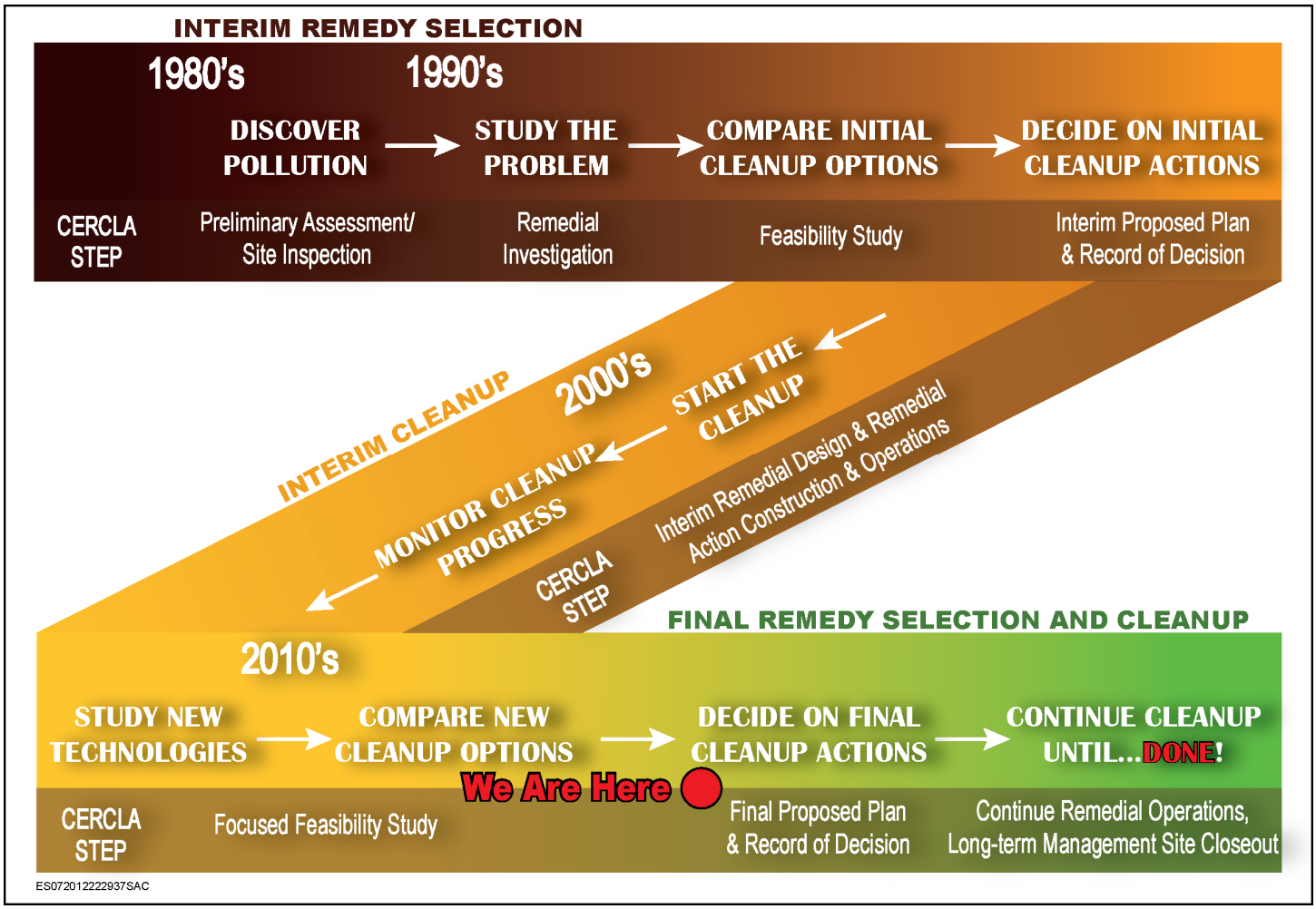


Figure 1. Status of Groundwater Remedy Selection at Travis AFB

Site Background

Travis AFB occupies approximately 6,368 acres in Solano County, California, midway between San Francisco and Sacramento and near the cities of Fairfield and Vacaville. It is located in primarily agricultural or range land, although recent years have seen residential development to the southwest and commercial development to the north and west.

Travis AFB has provided strategic airlift support to military forces worldwide since it was established in 1943. It is home to the largest mobility organization in the Air Force, with a fleet of C-5 Galaxy and C-17 Globemaster III cargo aircraft, and KC-10 Extender aerial refueling aircraft. Various hazardous materials, such as oils, fuels, and solvents, are used to maintain these aircraft.

In 1983, Travis AFB established an Installation Restoration Program (now called the ERP) to investigate and clean up contamination from past base activities. Releases of hazardous waste occurred from leaking pipelines, spills, or waste disposal to landfills. Although the materials handling and disposal practices of the past complied with environmental regulations at the time, they resulted in soil and groundwater contamination and have since been stopped. Travis AFB now follows current environmental guidelines for the management and disposal of hazardous materials and waste.

In 1989, after evaluating initial Installation Restoration Program data, the EPA placed Travis AFB on the **National Priorities List (NPL)**. The cleanup of NPL **sites** must follow the applicable procedures outlined in CERCLA and supporting regulations. Figure 1 shows the sequence of CERCLA-based steps that the Travis AFB groundwater program has followed and the current status of the groundwater remedy selection process.

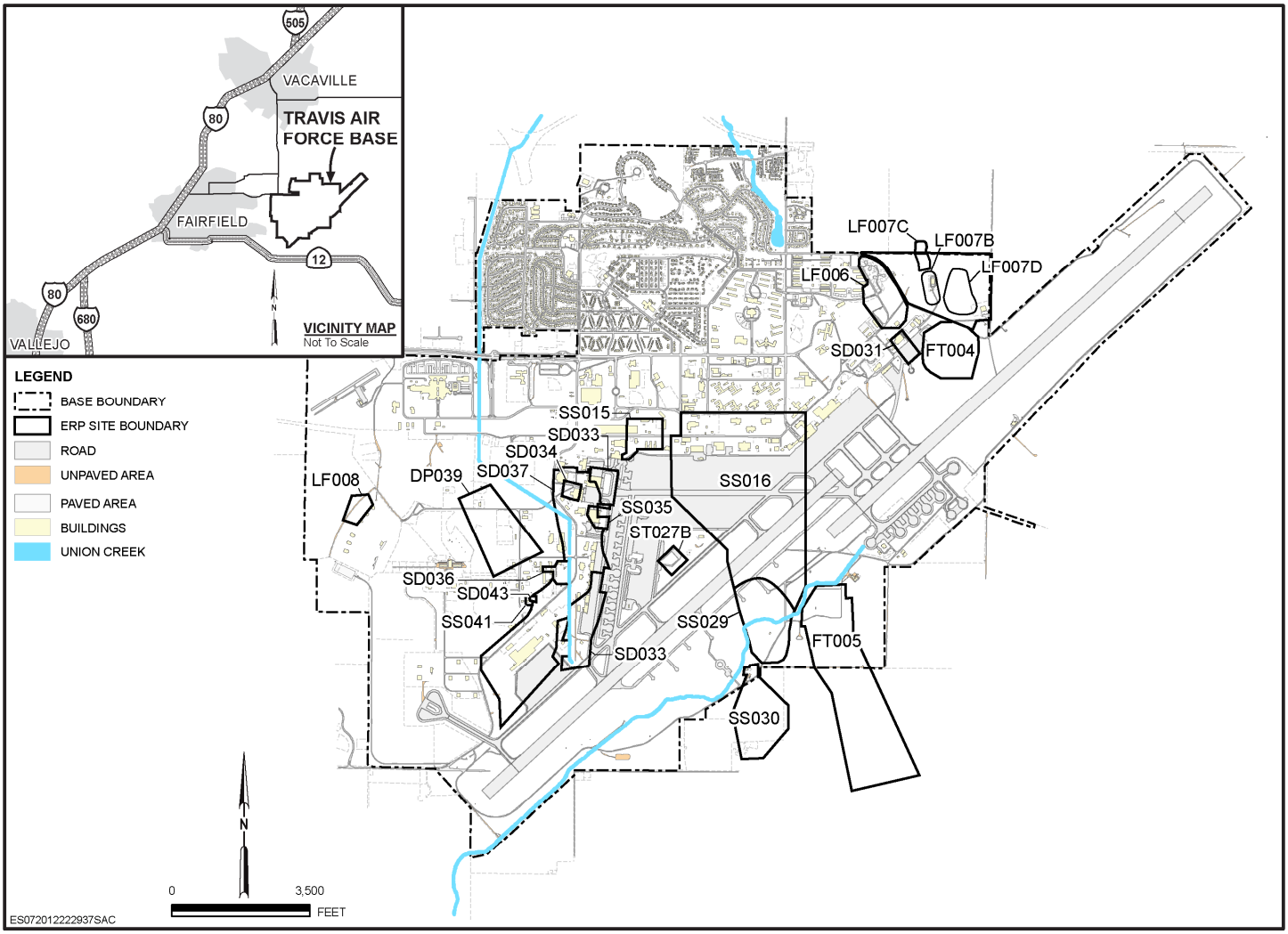


Figure 2. Groundwater Restoration Sites

After the Travis NPL listing, the Air Force entered into a legal agreement with the EPA and the State of California, known as a **Federal Facility Agreement (FFA)**. The FFA provides procedures and schedules for the investigation and cleanup of contamination at Travis AFB.

The 19 groundwater locations are called restoration sites and are referred to by alpha-numeric site designations, such as FT005 and LF007. Table 1 describes these restoration sites and their main contaminants. One restoration site (LF007) is beneath a landfill and is divided into three separate sub-areas (LF007B, LF007C, and LF007D) that contain different groundwater contaminants. With the exception of two pesticide restoration sites and one **Stoddard Solvent** restoration site, most of the contaminants are chlorinated **volatile organic compounds (VOCs)**. The activities that resulted in the solvent contamination have been discontinued. Figure 2 shows the extent of groundwater contamination at the restoration sites.

This Proposed Plan only covers the cleanup of contaminated groundwater. The Travis AFB ERP also addresses sediment and soil contamination. Currently, the cleanup of contaminated sediment is complete, and the base is wrapping up the cleanup of its last contaminated soil location.

Travis AFB also has petroleum contamination from the use of jet fuel. Because CERCLA does not deal with petroleum contamination, it is managed in a separate cleanup program regulated by the RWQCB.

TABLE 1 Summary of Groundwater Sites, Interim Remedies, Preferred Remedies, and Supporting Comments

Site Name	Site Designation	Site Description	Interim Remedy
Fire Training Area 3	FT004	An area used to train fire fighters from about 1953 through 1962. During this period, waste fuels, oils, and solvents were burned on open ground, contaminating the groundwater with chlorinated VOCs, mainly trichloroethene (TCE). The maximum TCE concentration at the site is 165 **parts per billion (ppb)**. The federal and California drinking water standard (**maximum contaminant level [MCL]**) for TCE is 5 ppb. The Cleanup Standards section on page 17 explains how drinking water standards are established.	**Groundwater Extraction and Treatment (GET)** and **Monitored Natural Attenuation (MNA)** Assessment
Fire Training Area 4	FT005	An area used to train fire fighters from about 1962 through 1987. During this period, waste fuels, oils, and solvents were burned on open ground, contaminating the groundwater with chlorinated VOCs, mostly 1,2-dichloroethane (DCA). The **contaminant plume** extends onto off-base privately owned property. The maximum concentration of 1,2-DCA at the site is 5.8 ppb. The federal and California drinking water standard (MCL) for 1,2-DCA is 0.5 ppb.	GET
Landfill 1	LF006	A waste disposal landfill that was used from about 1943 through 1950. The wastes contained chlorinated VOCs, mainly TCE, and petroleum fuel hydrocarbons that contaminated the local groundwater. TCE concentrations have declined to a maximum of only about 4.7 ppb. The federal and California drinking water standard (MCL) for TCE is 5 ppb. Petroleum fuel hydrocarbons have not been recently detected.	MNA
Landfill 2	LF007	A waste disposal landfill that was used from about 1950 through 1970. The wastes contained chlorinated VOCs, dioxins, and polychlorinated biphenyls (PCBs) that contaminated the local groundwater. The landfill is divided into three sub-areas, shown in *italics* below.	
	LF007B	A sub-area of Landfill 2 with historical detections of chlorinated VOCs, **semivolatile organic compounds (SVOCs)**, petroleum fuel constituents, and PCBs. However, these chemicals have not been detected within LF007B for several years.	MNA Assessment
	LF007C	A sub-area of Landfill 2 with a chlorinated VOC **plume** that extends onto off-base privately owned property. The maximum concentration of TCE within this area is 11.4 ppb. The federal and California drinking water standard (MCL) for TCE is 5 ppb.	GET
	LF007D	A sub-area of Landfill 2 that underlies the Travis AFB **Corrective Action Management Unit (CAMU)**. Low concentrations of a chlorinated VOC (1,4-dichlorobenzene [DCB]) and fuel hydrocarbon (benzene) above federal and California drinking water standards are limited to a small area around a single **monitoring** well.	MNA Assessment

Preferred Alternative	Comments
MNA Alternative 2	Alternative 2 at Site FT004 would discontinue GET and start MNA for the remaining contaminant plume. The existing GET system is currently shut down for a rebound study through the remainder of the interim remediation period. Groundwater monitoring and evaluation would continue. The estimated site cleanup time is about 35 years. Additional capital costs would be low, because the existing well network is adequate. Annual sampling and analysis costs would be about $2,700. Over a 35-year period, the estimated cost of Alternative 2 would be about $60,000. Rationale for preference: the rebound study has shown that MNA is stopping plume movement and reducing contaminant concentrations. Also, MNA lowers the base's energy usage and cleanup costs.
GET Alternative 3	Alternative 3 at Site FT005 would continue to run the FT005 GET system. The GET system is partially shut down for a rebound study. Three extraction wells remain in operation to address localized residual contamination. The estimated site cleanup time is about 10 years. Additional capital costs would be low, because the existing well network is adequate. Annual sampling and analysis costs would be about $2,600. Over a 10-year period, the estimated cost of Alternative 3 would be about $94,300. Rationale for preference: most of the contaminant plume is already cleaned up, and the operation of the FT005 GET system would continue until the cleanup of the residual contamination is complete.
MNA Alternative 2	Alternative 2 at Site LF006 would continue to use MNA to clean up the groundwater. The estimated site cleanup time is about 5 years. Additional capital costs would be low, because the existing well network is adequate. Annual sampling and analysis costs would be about $2,500. Over a 5-year period, the estimated cost of Alternative 2 would be about $12,000. Rationale for preference: MNA has shown its ability to clean up the groundwater at this site.
MNA Alternative 2	Alternative 2 at Site LF007B would continue to use MNA to clean up groundwater. Contaminant concentrations already meet preliminary cleanup goals (PCGs). Additional capital costs would be low, because the existing well network is adequate. Annual sampling and analysis costs would be about $800. Because the PCGs are met, the estimated cost of Alternative 2 would be about $4,000 to cover long-term management costs. Rationale for preference: MNA has shown its ability to clean up the groundwater at this sub-area.
GET Alternative 3	Alternative 3 at Site LF007C would continue to run the LF007C GET system. The estimated site cleanup time is about 26 years. Alternative 3 would need about $122,000 in capital costs to expand the existing GET system to improve its performance. Annual sampling and analysis costs would be about $15,260. Over a 26-year period, the estimated cost of Alternative 3 would be about $432,000. Rationale for preference: GET has shown its ability to clean up the groundwater at this sub-area. Also, the LF007C GET system runs on solar power and uses a small amount of the base's electricity.
MNA Alternative 2	Alternative 2 at Site LF007D would officially use MNA to clean up groundwater. The estimated site cleanup time is between 100 and 120 years. Low benzene concentrations in a small plume are stable but not decreasing. Additional capital costs would be low, because the existing well network is adequate. Annual sampling and analysis costs would be about $1,100. Over the long term, the estimated cost of Alternative 2 would be about $22,000. Rationale for preference: because of the plume's small size and location beneath a CAMU in a closed landfill, MNA offers a cost effective way to protect human health.

TABLE 1 Summary of Groundwater Sites, Interim Remedies, Preferred Remedies, and Supporting Comments

Site Name	Site Designation	Site Description	Interim Remedy
Landfill 3	LF008	A series of shallow trenches that were used to dispose of pesticide containers in the 1970s. A cleanup of the pesticide-contaminated soil and debris took place in 2003. However, low concentrations of pesticides remain in the groundwater. For example, the current maximum concentration of alpha-chlordane is about 340 **parts per trillion (ppt)**. Its California drinking water standard (MCL) is 100 ppt.	GET
Solvent Spill Area and Facilities 808, 1832, and 552	SS015	Former facilities conducted solvent stripping of aircraft parts, aircraft maintenance and repair, oil-water separator (OWS) operations, and hazardous waste accumulation from about 1964 through 1980. These activities contaminated groundwater with chlorinated VOCs, primarily TCE, cis-1,2-dichloroethene (DCE), and vinyl chloride. The maximum concentrations of TCE, cis-1,2-DCE, and vinyl chloride at the site are 432, 7,680, and 3,220 ppb, respectively. Their federal and California drinking water standard (MCL) are 5, 6, and 0.5 ppb, respectively. Currently, a fuel truck facility lies above the contaminated area.	MNA Assessment
Oil Spill Area and Facilities 11, 13/14, 20, 42/1941, 139/144, and Storm Sewer Right-of-way	SS016	Multiple flightline support activities throughout the history of Travis AFB consisted of degreasing operations, equipment maintenance and repair, aircraft and vehicle maintenance, hazardous materials storage, and aircraft and vehicle washing. Oil spills, leaking OWS, and surface runoff from these activities contaminated the groundwater with chlorinated VOCs, primarily TCE. The maximum concentration of TCE recently detected at the site is 319,000 ppb. This is the highest concentration of TCE found at Travis AFB. The federal and California drinking water standard (MCL) for TCE is 5 ppb.	GET
Facilities 1918, 1919, and 1754	ST027B	A restricted access area bound by aircraft taxiways and parking ramps formerly used for fuel storage and aircraft engine testing. These industrial activities contaminated groundwater with petroleum constituents and TCE. A portion of the plume with petroleum contamination is named Site ST027A and is managed under a separate program. The portion of the plume with TCE contamination is named Site ST027B. The maximum concentration of TCE recently detected at Site ST027B is 474 ppb. The federal and California drinking water standard (MCL) for TCE is 5 ppb.	MNA
Monitoring Well 329 Area	SS029	Unknown historical activities on undeveloped land located between the southern base boundary and an aircraft taxiway contaminated groundwater with chlorinated VOCs. The main groundwater contaminant is TCE, at a maximum concentration of 680 ppb. The federal and California drinking water standard (MCL) for TCE is 5 ppb.	GET
Monitoring Well 269 Area	SS030	Unknown historical activities on undeveloped land near the southern base boundary contaminated groundwater with chlorinated VOCs, mostly TCE. The contaminant plume extends onto off-base privately owned property that is used for animal grazing. The maximum concentration of TCE recently detected at the site is 50.4 ppb. The federal and California drinking water standard (MCL) for TCE is 5 ppb.	GET

Preferred Alternative	Comments
MNA Alternative 2	Alternative 2 at Site LF008 would discontinue GET and start MNA to clean up groundwater. The existing GET system is currently shut down for a rebound study through the remaining interim remediation period. The estimated site cleanup time is between 100 and 110 years. Concentrations of residual pesticides are stable but not decreasing. Additional capital costs would be low, because the existing well network is adequate. Annual sampling and analysis costs would be about $2,300. Over the long term, the estimated cost of Alternative 2 would be about $46,000. Rationale for preference: because of the plume's small size and location within a high security ammunition storage facility, MNA offers a cost effective way to protect human health.
Emulsified Vegetable Oil (EVO) and **Enhanced Attenuation (EA)** Alternative 5	Alternative 5 at Site SS015 would use injections of EVO to promote biological cleanup of contaminated groundwater, followed by enhanced attenuation (an enhancement of MNA) to complete the cleanup. The estimated site cleanup time is about 70 years. Additional capital costs would be low, because the existing well network is adequate. Annual sampling and analysis costs would be about $1,600. Over a 70-year period, the estimated cost of Alternative 5 would be about $358,000. Rationale for preference: a vegetable oil study in 2000 and initial EVO injections during a recent SS015 field demonstration project have shown that **bioremediation** can effectively clean up chlorinated solvents at SS015. Also, this alternative does not interfere with the fuel truck maintenance activities.
Bioreactor and GET Alternative 4	Alternative 4 at Site SS016 consists of the operation of a bioreactor along with the existing GET system. A bioreactor was installed in the area with the highest TCE concentration as an interim remedy optimization in 2010. The estimated site cleanup time is between 100 and 140 years. Most of the contaminated groundwater lies beneath the aircraft parking ramp and flightline and is inaccessible to any significant treatment system expansion. There are no additional capital costs, because the bioreactor and GET system are already installed. Annual sampling and analysis, GET system operation, and bioreactor maintenance costs would be about $35,200. The estimated cost of Alternative 4 would be about $1,116,000. Rationale for preference: the bioreactor performance evaluation has shown that it can successfully treat high solvent concentrations in a very active aircraft parking and maintenance area. Because of the large and inaccessible contaminated groundwater area, it will take GET a long time to complete the cleanup.
MNA Alternative 2	Alternative 2 at Site ST027B would continue to use MNA to clean up groundwater. The estimated site cleanup time is about 50 years. Additional capital costs would be low, because the existing well network is adequate. Annual sampling and analysis costs would be about $2,500. Over a 50-year period, the estimated cost of Alternative 2 would be about $50,000. Rationale for preference: groundwater monitoring has shown that MNA is stopping plume movement and reducing contaminant concentrations. Also, the location of the groundwater contamination in the middle of aircraft operations prevents the use of active cleanup technologies.
GET Alternative 3	Alternative 3 at Site SS029 would continue to run the SS029 GET system. The estimated site cleanup time is between 100 and 140 years. Groundwater monitoring suggests that the SS016 and SS029 plumes have merged, significantly increasing their cleanup time. Additional capital costs would be low, because the existing GET system is adequate. Annual sampling and analysis costs would be about $20,500. The estimated cost of Alternative 3 would be about $340,000. Rationale for preference: GET is effectively cleaning up SS029 groundwater.
GET Alternative 3	Alternative 3 at Site SS030 would continue to run and potentially expand the SS030 GET system. The estimated site cleanup time is about 22 years. The capital cost of a SS030 GET system expansion would be about $17,500. Annual sampling and analysis costs would be about $20,500. Over a 22-year period, the estimated cost of Alternative 3 (including the expansion) would be about $294,000. Rationale for preference: GET is effectively cleaning up the on-base and off-base portions of SS030 groundwater.

TABLE 1 Summary of Groundwater Sites, Interim Remedies, Preferred Remedies, and Supporting Comments

Site Name	Site Designation	Site Description	Interim Remedy
Facility 1205	SD031	The maintenance and repair of diesel generators, wash rack activities, operation of an OWS, and aircraft maintenance from approximately 1957 through the present day contaminated the local groundwater with chlorinated VOCs, primarily 1,1-dichloroethene (1,1-DCE). The maximum concentration of 1,1-DCE recently detected at the site is 98.7 ppb. The federal and California drinking water standard (MCL) for 1,1-DCE is 6 ppb.	GET and MNA Assessment
Storm Sewer II, South Gate Area, Facilities 810 and 1917, and the West Branch of Union Creek	SD033	Fuel transport, aircraft maintenance, and aircraft washing, including the use of wash racks and OWS, have contaminated groundwater with chlorinated VOCs, SVOCs, and petroleum hydrocarbons. TCE is the most prevalent of the contaminants at this site. The maximum TCE concentration recently detected is 76.6 ppb. The federal and California drinking water standard (MCL) for TCE is 5 ppb. The contaminated groundwater at SD033 has merged with plumes from five other sites (SD034, SS035, SD036, SD037, and SD043), so the base is addressing SD033 as a part of a single plume.	GET and MNA Assessment
Facility 811	SD034	A leaking OWS associated with an active aircraft wash rack facility released Stoddard Solvent into the ground. Pure Stoddard Solvent is less dense than water and floats on the groundwater table. A layer of Stoddard Solvent was recently measured with a maximum thickness of 0.44 foot. The leaking OWS was replaced in 1994. Other past industrial activities contaminated the groundwater with chlorinated VOCs, SVOCs, and petroleum hydrocarbons. The contaminated groundwater at SD034 has merged with plumes from five other sites (SD033, SS035, SD036, SD037, and SD043), so the base is addressing SD034 as a part of a single plume.	GET and **Passive Skimming**
Facility 818/819	SS035	Past industrial activities associated with aircraft repair, painting, and washing have contaminated groundwater with chlorinated VOCs, primarily TCE. No TCE has been recently detected at the site at a concentration exceeding the federal or California drinking water standard (MCL) of 5 ppb. The contaminated groundwater at SS035 has merged with plumes from five other sites (SD033, SD034, SD036, SD037, and SD043), so the base is addressing SS035 as a part of a single plume.	GET
Facility 872/ 873/876	SD036	Past industrial activities associated with multiple-use shops, including a wash rack and OWS, have contaminated groundwater with chlorinated VOCs, SVOCs, and petroleum hydrocarbons. TCE is the most prevalent of the contaminants at this site. The maximum concentration of TCE recently detected is 18,500 ppb. The federal and California drinking water standard (MCL) for TCE is 5 ppb. The contaminated groundwater at SD036 has merged with plumes from five other sites (SD033, SD034, SS035, SD037, and SD043), so the base is addressing SD036 as a part of a single plume.	GET and MNA Assessment

Preferred Alternative	Comments
MNA Alternative 2	Alternative 2 at Site SD031 would discontinue GET and start MNA to clean up groundwater. The existing GET system is currently shut down for a rebound study through the remainder of the interim remediation period. The estimated site cleanup time is about 15 years. Additional capital costs would be low, because the existing well network is adequate. Annual sampling and analysis costs would be about $2,500. Over a 15-year period, the estimated cost of Alternative 2 would be about $30,500. Rationale for preference: the rebound study has shown that MNA is stopping plume movement and reducing contaminant concentrations. Also, MNA lowers the base's energy usage and cleanup costs.
MNA Alternative 2	Alternative 2 at Site SD033 would discontinue GET and start MNA to clean up groundwater. The existing GET system is currently shut down for a rebound study through the remainder of the interim remediation period. The estimated site cleanup time for the merged plumes is about 60 years. Additional capital costs would be low, because the existing well network is adequate. Annual sampling and analysis costs would be about $2,100. Over a 60-year period, the estimated cost of Alternative 2 would be about $42,100. Rationale for preference: the rebound study has shown that MNA is stopping plume movement and reducing contaminant concentrations. Also, MNA lowers the base's energy usage and cleanup costs.
Passive Skimming and EA Alternative 7	Alternative 7 at Site SD034 would continue the removal of Stoddard Solvent from the water table, discontinue GET, and start EA to clean up the groundwater. The existing GET system is currently shut down for a rebound study through the remainder of the interim remediation period. The estimated site cleanup time for the merged plumes is about 60 years. Additional capital costs would be low, because the existing well network is adequate. Annual sampling and analysis costs would be about $3,700. Over a 60-year period, the estimated cost of Alternative 7 would be about $80,600. Rationale for preference: passive skimming is effectively removing pure Stoddard Solvent from the water table. The rebound study has shown that EA is stopping plume movement and should reduce contaminant concentrations once all of the pure Stoddard Solvent has been removed. Also, EA lowers the base's energy usage and cleanup costs.
MNA Alternative 2	Alternative 2 at Site SS035 would discontinue GET and start MNA to clean up groundwater. The estimated site cleanup time for the merged plumes is about 60 years. Additional capital costs would be low, because the existing well network is adequate. Because of the small size of Site SS035, annual sampling and analysis costs and the overall estimated cost of Alternative 2 are combined with the costs of Site SD037. Rationale for preference: the rebound study has shown that MNA is stopping plume movement and reducing contaminant concentrations. Also, MNA lowers the base's energy usage and cleanup costs.
EVO and EA Alternative 5	Alternative 5 at Site SD036 would discontinue GET and use injections of EVO to promote biological cleanup of contaminated groundwater, followed by EA to complete the cleanup. The estimated site cleanup time for the merged plumes is about 60 years. Additional capital costs would be low, because the existing well network is adequate. Annual sampling and analysis costs would be about $1,600. Taking into account the periodic reinjections of EVO over a 60-year period, the estimated cost of Alternative 5 would be about $760,000. Rationale for preference: initial EVO injections during a recent SD036 field demonstration project have shown that bioremediation can effectively clean up high concentrations of chlorinated solvents at SD036. Also, this alternative does not interfere with base activities.

TABLE 1 Summary of Groundwater Sites, Interim Remedies, Preferred Remedies, and Supporting Comments

Site Name	Site Designation	Site Description	Interim Remedy
Sanitary Sewer System, Facilities 837/ 838, 919, 977, 981, Ragsdale/ V Area, and Area G Ramp	SD037	Past industrial activities associated with the management of domestic and industrial wastewater, aircraft maintenance, heavy equipment maintenance, air cargo handling, vehicle washing, fuel transport, and waste accumulation have contaminated groundwater with chlorinated VOCs, SVOCs, and petroleum hydrocarbons. TCE is the most prevalent of the contaminants at this site. The maximum concentration of TCE recently detected is 2,070 ppb. The federal and California drinking water standard (MCL) for TCE is 5 ppb. The contaminated groundwater at SD037 has merged with plumes from five other sites (SD033, SD034, SS035, SD036, and SD043), so the base is addressing SD037 as a part of a single plume.	GET and MNA Assessment
Building 755	DP039	Prior to 1978, battery acid solutions and solvents were discharged from Building 755 into a sump, which contaminated the groundwater with chlorinated VOCs, primarily TCE. Building 755 was demolished in 2009, and the lot is currently vacant. The maximum concentration of TCE recently detected is 7,000 ppb. The federal and California drinking water standard (MCL) for TCE is 5 ppb.	GET and MNA Assessment
Building 905	SS041	From 1983 to 1992, the base entomology shop prepared pesticides and herbicides for use at Travis AFB. Outside of the building, a wash rack was used to wash down tractors that towed pesticide- and herbicide-applicator vehicles. Overspray from the wash rack contaminated the groundwater with pesticides. The maximum concentration of heptachlor epoxide at the start of the interim groundwater cleanup was 0.023 ppb. The federal and California drinking water standard (MCL) for heptachlor epoxide is 0.01 ppb.	GET
Building 916	SD043	Building 916 is an emergency electric power facility. Beneath the interior diesel generators is a sump that formerly drained into an outdoor trench, creating a small TCE plume **downgradient** of the facility. The TCE concentrations have declined to a maximum concentration of 0.72 ppb. The federal and California drinking water standard (MCL) for TCE is 5 ppb. The contaminated groundwater at SD043 has merged with plumes from five other sites (SD033, SD034, SS035, SD036, and SD037), so the base is addressing SD043 as a part of a single plume.	GET

Preferred Alternative	Comments
EVO and EA Alternative 5	Alternative 5 at Site SD037 would discontinue GET and use injections of EVO to promote biological cleanup of contaminated groundwater, followed by EA to complete the cleanup. The estimated site cleanup time for the merged plumes is about 60 years. Additional capital costs would be low, because the existing well network is adequate. Annual sampling and analysis costs would be about $1,600. Taking into account the periodic reinjections of EVO over a 60-year period, the estimated cost of Alternative 5 would be about $1,299,000. Rationale for preference: initial EVO injections during a recent SD037 field demonstration project have shown that bioremediation can effectively clean up high concentrations of chlorinated solvents at SD037. Also, this alternative does not interfere with base activities.
Bioreactor, **Phytoremediation**, EVO **Permeable Reactive Barrier (PRB)**, and EA Alternative 6	Alternative 6 at Site DP039 would discontinue dual-phase GET and use a bioreactor, a phytoremediation tree stand, and an EVO PRB in series to clean up the groundwater, followed by EA to complete the cleanup. The estimated site cleanup time is about 65 years. Additional capital costs would be low, because the existing well network is adequate, the bioreactor and phytoremediation tree stand are in place, and the EVO PRB is already injected. Annual sampling and analysis costs would be about $2,600. Taking into account the periodic reinjections of EVO over a 65-year period, the estimated cost of Alternative 6 would be about $1,178,000. Rationale for preference: treatability studies and demonstration projects over the last 12 years have shown that the three main components of Alternative 6 (bioreactor, phytoremediation, and EVO PRB) can effectively clean up high concentrations of chlorinated solvents at DP039. Also, the bioreactor and the phytoremediation tree stand rely on solar power, so along with EA, they lower the base's energy usage and cleanup costs.
No Further Action Alternative 1	Alternative 1 would officially discontinue GET. The SS041 GET system was installed in 1999. Contaminated groundwater from SS041 was sent to the West Treatment and Transfer Plant where it was then transferred to the Central Groundwater Treatment Plant for treatment. From 2001 through 2003, laboratory analysis of all groundwater samples from the SS041 monitoring well network did not detect any pesticide contaminants. In December 2005, representatives from the Air Force and regulatory agencies signed a No Further Remedial Action Planned Consensus Statement to document the lack of detectable pesticides in SS041 groundwater and the conclusion that there is no need for further groundwater cleanup at SS041. It also documented the decision to decommission the SS041 extraction well system and remove the site from the base Groundwater Sampling and Analysis Program. Rationale for preference: The cleanup of SS041 groundwater is complete.
MNA Alternative 2	Alternative 2 at Site SD043 would discontinue GET and start MNA to clean up groundwater. The existing GET system is currently shut down for a rebound study through the remainder of the interim remediation period. The estimated site cleanup time is about 60 years. Additional capital costs would be low, because the existing well network is adequate. Annual sampling and analysis costs would be about $1,300. Over a 60-year period, the estimated cost of Alternative 2 would be about $26,300. Rationale for preference: the rebound study has shown that MNA is stopping plume movement and reducing contaminant concentrations. Also, MNA lowers the base's energy usage and cleanup costs.

Site Characteristics

The top of the water table beneath Travis AFB is close to the soil surface (between 5 and 15 feet deep at most restoration sites), and the soil below the water table consists mostly of silt and clay. Groundwater flows slowly through this type of soil, so dissolved contaminants do not spread quickly. Also, contaminants often cling to clay particles, which makes groundwater cleanup more challenging.

The regional groundwater flow direction is south to southeast. The depth to bedrock at some restoration sites is as close as 5 feet to the soil surface, which can alter the flow direction locally. The local topography is generally flat.

The Interim Approach

Currently, groundwater cleanup actions at Travis AFB are interim in nature and are described in the Groundwater Interim ROD for the WABOU and the Groundwater Interim ROD for the NEWIOU. Both documents are posted on the library page of the Travis AFB ERP web site. The base used this approach to quickly begin groundwater cleanup efforts. It also gave the Air Force the time to build groundwater cleanup facilities, evaluate their long-term performance, and then test innovative technologies that could speed up the cleanup of each restoration site. This approach was accepted by the regulatory agencies and the Travis AFB **Restoration Advisory Board (RAB)**. Table 1 identifies the interim remedy in place at each restoration site.

Basis for Response Action

It is the Air Force's current judgment that the Preferred Remedies identified in this Proposed Plan, or one of the other active measures considered in the Proposed Plan, are needed to protect public health or welfare or the environment from actual or threatened releases of hazardous substances into the environment and from actual or threatened releases of pollutants or contaminants from these groundwater restoration sites which may present an imminent and substantial endangerment to public health or welfare.

For the most part, the interim remedies have operated successfully from the late 1990s to the present date. At most restoration sites, they consist of heavily engineered extraction well and piping networks, large water treatment plants, and an extensive **monitoring** well network. The interim remedies can treat large volumes of highly contaminated groundwater. After more than a decade of interim remediation, the residual contaminant concentrations at most restoration sites are much lower than their initial values but are still high enough to require continued and, in most cases, more effective cleanup action.

Summary of Site Risks

There is no immediate human health or ecological risk associated with contaminated groundwater beneath Travis AFB. This groundwater is not used for drinking, cooking, or bathing. Also, this water supply is too deep to be used by the local wildlife. However, cleanup activities are still required in order to protect people from potential risks. Potential risks are associated with the slow movement of contaminated groundwater to the southeast where groundwater is used as drinking water or with construction workers coming into contact with contaminants during trenching operations.

If a person routinely swallows a groundwater contaminant (or if it repeatedly comes into contact with skin), the contaminant can potentially damage an organ system or increase the potential of developing cancer; this is why it is so important to prevent exposure to contaminants before a groundwater cleanup is complete. As a precaution, the Travis AFB Environmental Management Office tracks contaminant plumes and reviews construction projects that involve trenching to ensure that residents and workers are protected from exposure to groundwater contaminants.

Potential risks are also associated with the transfer of dissolved contaminants into the air between soil particles and the movement of that contaminated air into occupied buildings through cracks in their foundations. The term **vapor intrusion** describes this potential health issue. A 2009 study showed that vapor intrusion is not taking place in existing buildings on Travis AFB, so the concern is with the construction of new buildings over contaminated groundwater. To protect the health of office workers in these buildings, passive

ventilation systems that prevent vapor intrusion are designed and installed during building construction.

Potential human health risks from exposure to contaminated groundwater at Travis AFB are documented in the following reports:

- Appendix C of the North Operable Unit (NOU) Remedial Investigation (RI) Report (Radian, 1995)
- Appendix K.6 of the East Industrial Operable Unit (EIOU) RI Report (Weston, 1995)
- Appendix H of the West Industrial Operable Unit (WIOU) RI Report (Radian, 1996)
- Appendix G1 of the WABOU RI Report (CH2M HILL, 1997)
- Site ST027 Area B Human Health Risk Assessment (CH2M HILL, 2011)
- Vapor Intrusion Assessment Report (CH2M HILL, 2010)
- Draft Vapor Intrusion Assessment Update (CH2M HILL, 2012)

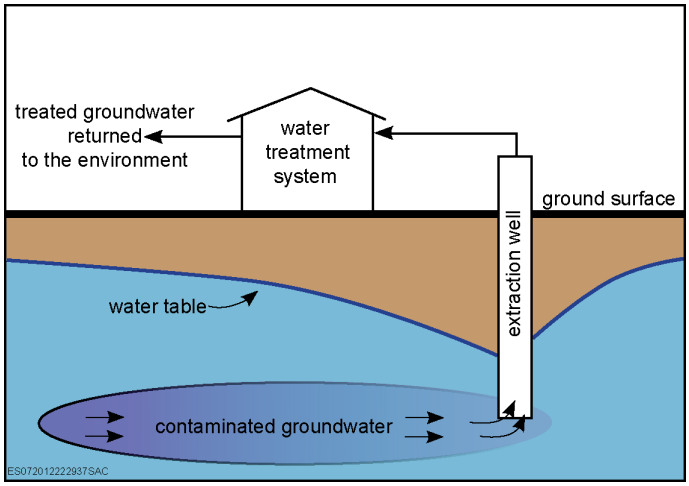
The Path to Final Remedies

The interim remedies are shrinking the size of contaminated areas and reducing contaminant levels and their associated potential risks. They are also generating a great deal of real-world performance data. By using these data to evaluate other possible cleanup technologies, Travis AFB is transitioning out of interim remediation and into the selection of the final cleanup actions for each restoration site. Three basic actions are evaluated for this transition:

1) Continue the interim remedy
2) Modify the interim remedy
3) Discontinue the interim remedy and implement one or more different technologies

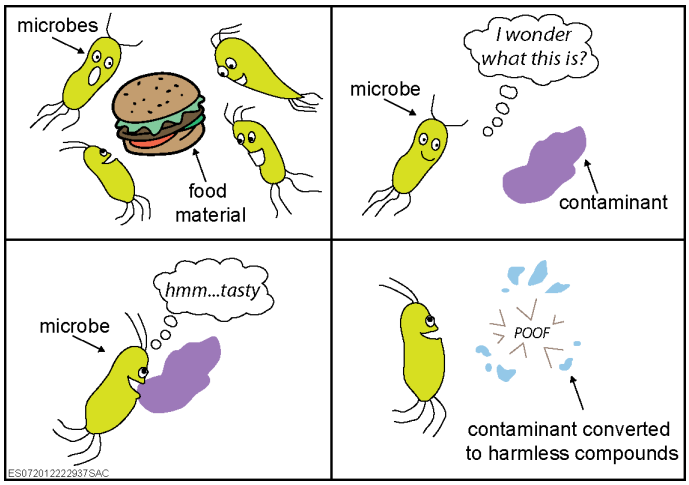
To identify the most appropriate action for each restoration site, the Air Force conducted a Groundwater Focused FS. The FS took a second look at the performance of the interim remedies and noted that operational costs increased and system efficiency decreased as contaminant concentrations dropped. It also evaluated a number of cleanup technologies, focusing on innovative ones that were thought to be promising, but unproven at the time when the interim remedies were selected. Innovative technologies have become more accepted as a result of scientific advances and through practical demonstrations at Travis AFB and other government and commercial facilities across the nation. Several of the more effective technologies that were evaluated in the FS are described below.

GET – a common groundwater cleanup method that is often referred to as "**pump and treat**." Pumps in extraction wells bring contaminated water to the surface, where it is cleaned by one of many varied



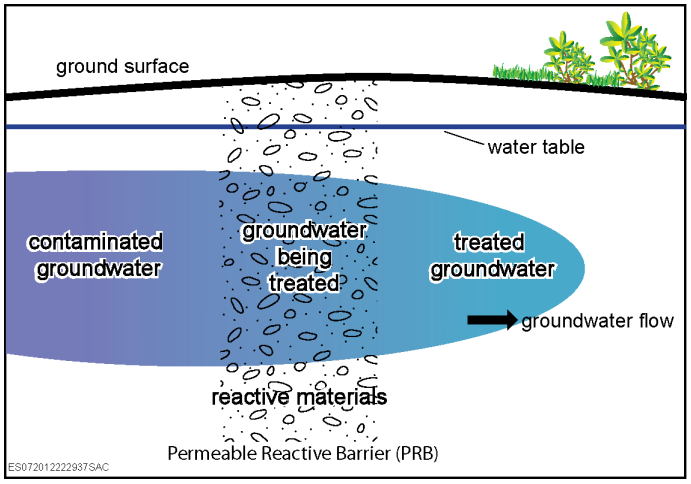
treatment technologies. The treated water is either returned to the water table, deposited into a creek or pond, or stored for a future beneficial use, such as landscape irrigation or dust control in a construction area. This tends to be a slow cleanup method, depending on the amount of contaminant in the subsurface, how deep it is found, and the type of soil and rock in the extraction area. It can be used to stop the flow of contaminants toward drinking water wells. Travis AFB relied heavily on this cleanup method to initiate interim groundwater cleanup at most of its restoration sites.

Bioremediation – an innovative cleanup method that relies on microbes that live in the groundwater to eat contaminants and convert them to harmless compounds. Some classes of microbes need oxygen to survive, and they can eat petroleum-based compounds. Other microbes can only live in the absence of oxygen, and they use chlorinated compounds (e.g., solvents) as a food source. To promote the cleanup of contaminated groundwater by microbe activity, environmental specialists can pump air, nutrients, food materials, or even batches of

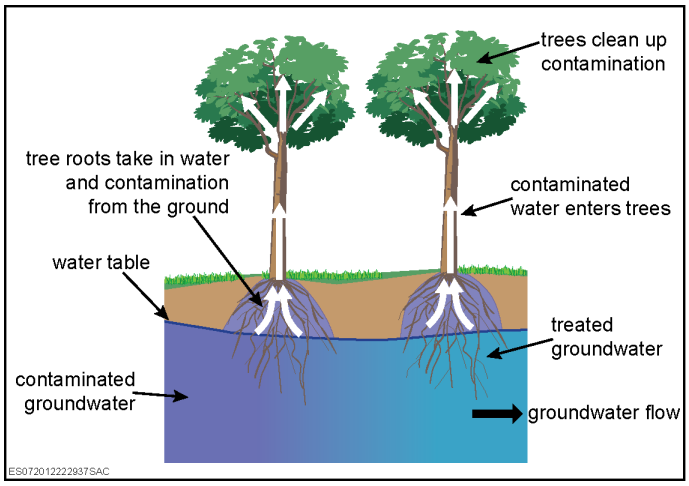


microbes underground to create the right conditions for microbial growth. Although there are a variety of food materials that can be used by microbes, EVO works well in clay soil and promotes microbe activity. Once the cleanup is complete and the contaminants are "eaten," the microbes die off. The cleanup time can vary from a few months to many years, depending on the type and amount of contaminant in the subsurface and soil conditions. Also, some compounds in the middle of the breakdown process (e.g., vinyl chloride) are considered more dangerous than the original contaminants, so environmental specialists have to monitor the microbes' activity and take action to ensure the contaminant breakdown is complete.

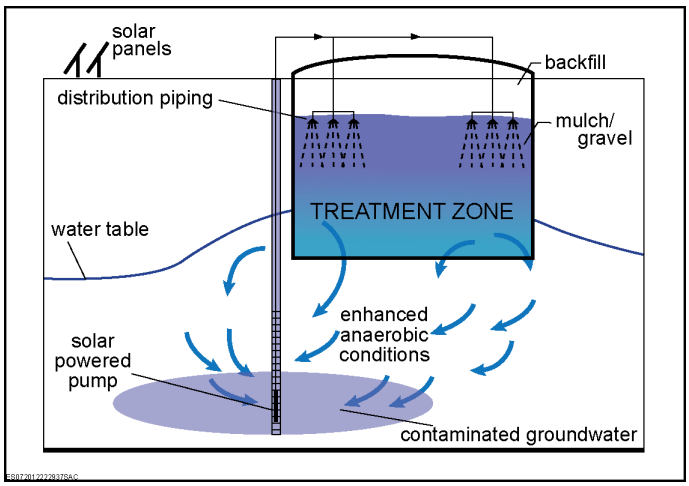
PRB – an innovative cleanup method that involves an underground wall. The wall is permeable, which means that it allows groundwater to flow through it. Reactive materials in the wall, such as mulch or **zero valent iron**, either trap the contaminants or break them down into harmless compounds. Clean water flows out the other end of the wall. A PRB can also be installed by placing a row of EVO injection wells across a plume to form a straight treatment zone. This can be a slow cleanup method, depending on the amount of contaminant in the subsurface and the speed of groundwater flow through the wall. However, a PRB offers a number of advantages over pump and treat. It has no moving parts that require maintenance, is quiet, costs less than other methods, and does not interfere with the use of the land above the wall during the groundwater cleanup.



Phytoremediation – an innovative cleanup method that uses plants to remove contaminants from the subsurface when their roots take in water and nutrients. Plants clean up contaminants as deep as their roots can grow. Once in the plant, the contaminants can be stored in the roots, stems, or leaves; converted to harmless compounds; or released into the air as a gas when the plant transpires (breathes). This low-cost cleanup method can be slow, depending on the type and number of plants used, the type and amount of contaminants in the subsurface, the size and depth of the contaminated area, and other soil conditions. Phytoremediation uses no electricity and is one of the few technologies that actually increases its efficiency over time as the roots grow and increase the size and depth of the treatment area.

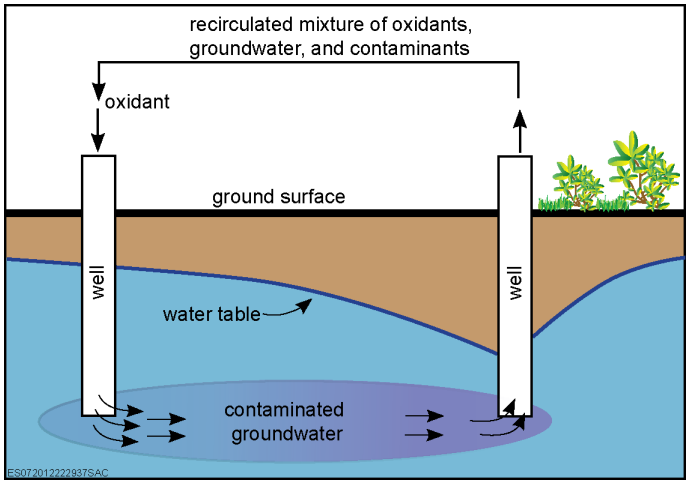


Bioreactor – an innovative cleanup method that uses bioremediation to clean up groundwater with higher concentrations of residual contamination. A bioreactor consists of a hole in the middle of an area with high residual contaminant concentrations. The hole is filled with a mulch/gravel mixture.



Microbes attach themselves to the gravel particles and live off of the carbon in the mulch. A bioreactor looks like an underground percolator, because contaminated groundwater is pumped into the top of the bioreactor, and the microbes break down the contaminants as the water flows through the mulch. Clean water exits the bottom of the hole and is recirculated back into the bioreactor. It is this recirculation that brings contaminants back into the bioreactor for treatment. Also, some of the mulch slowly dissolves into the clean water, mixes with the contaminated groundwater beneath the bioreactor, and expands the area where contaminant breakdown takes place. To promote a clean environment, solar panels provide the electricity for the pump.

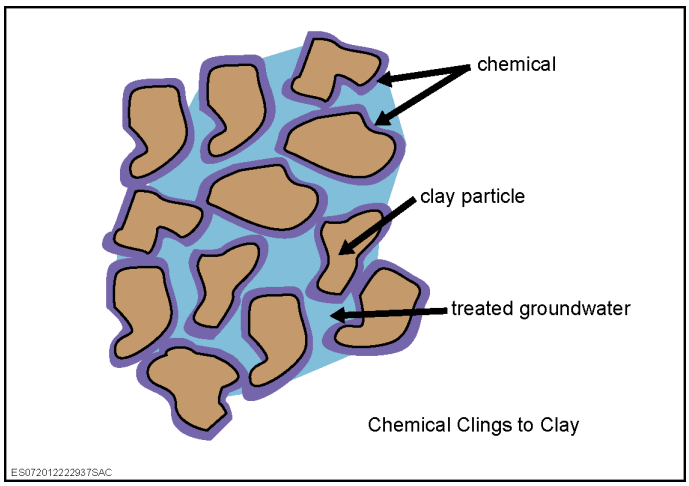
Chemical Oxidation – an innovative cleanup method that uses chemicals called oxidants to convert contaminants into harmless compounds. The oxidants have to be pumped underground so that they are in direct contact with the contaminants. **Chemical oxidation** offers quick cleanup times compared with other cleanup methods, depending on the size of the cleanup area, soil conditions, and the speed of groundwater flow. However, oxidants can corrode certain materials and must be handled carefully by environmental specialists to avoid injuries. Also, it can be challenging to pump oxidants into tight clays, such as those found in Solano County. In some cases, the oxidants will react with other naturally occurring compounds, such as iron and sulfur, and break down before they reach the contaminants.

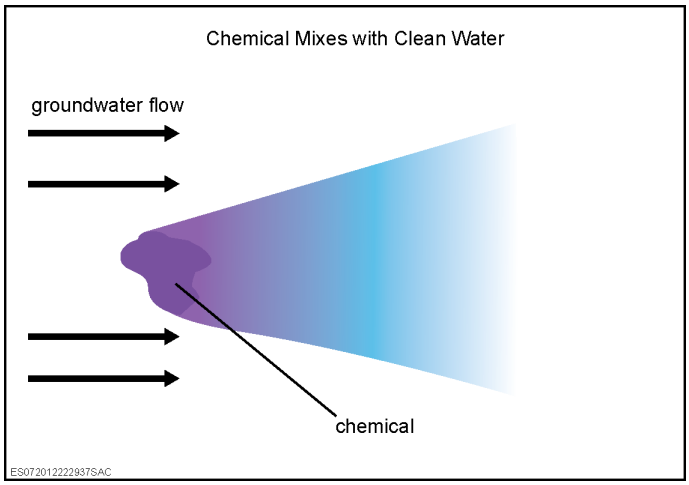


Passive Skimming – a standard way to clean up petroleum products that float on top of groundwater. A skimmer is placed in a well to passively collect the petroleum that enters the well. The skimmer is manually pulled out of the well, the collected fuel is poured into a container and sent to a recycler, and the skimmer is returned to the well. Passive skimming has been successfully used at Site SD034 to remove Stoddard Solvent from the groundwater for years.

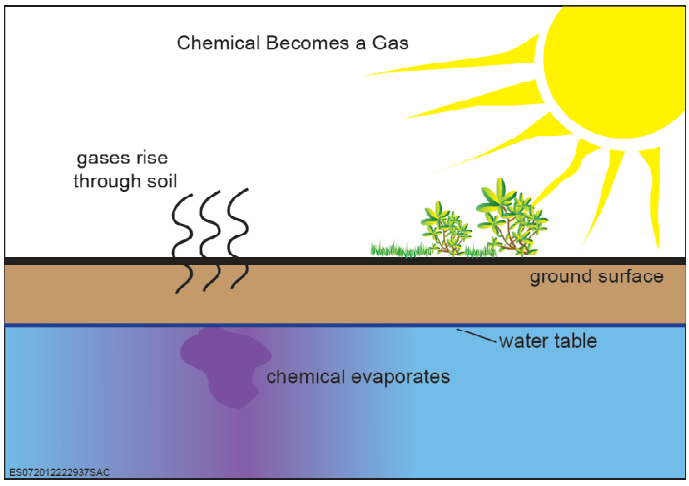
MNA – a cleanup approach that relies on natural processes to clean up or attenuate contaminants. To be effective, the right conditions have to be present in the groundwater for the processes to reach the cleanup standard in a reasonable amount of time. To make sure that natural attenuation is working, environmental specialists monitor the conditions. The processes can be described as biological (using microbes as described in the above bioremediation section) or physical (sticking to soil particles, mixing with clean water to lower the concentration, or evaporating into the air).

MNA is not an acceptable cleanup alternative when high residual concentrations of contamination are still present. The strategy of removing these high concentrations of residual contaminants first to allow





MNA to work properly is often referred to as EA. The time for MNA to reach the cleanup standard varies, depending on the type and amount of contaminants, the size and depth of the treatment area, and the soil conditions. Because MNA usually cleans up low concentrations of residual contaminants, the cleanup can take years or decades to complete. This is preferred when other cleanup methods will not work or take almost as much time.



Although they are not a cleanup technology, **land use controls (LUCs)** are an integral part of cleanup alternatives and are described in the following section.

Land Use Controls

A LUC is an action that uses physical (e.g., a fence), legal (e.g., an easement), or administrative (e.g., a base digging permit) ways to prevent people from coming into contact with contamination in groundwater, soil, and, in some cases, vapor. It is also used to protect the infrastructure for a groundwater remedy from unintentional damage. For example, a base digging permit prevents a backhoe from accidently hitting an underground pipe that transports contaminated water to a treatment plant. LUCs were placed at restoration sites when the interim remedies were selected and have proven to be effective.

At each restoration site, Travis AFB restricts the land use to industrial purposes only, prohibits on-base water supply well construction and consumption of contaminated groundwater, and restricts soil excavation and other subsurface work where a worker might encounter contaminated groundwater or vapors. These restrictions are described in the Base General Plan and managed through administrative requirements. The administrative requirements are the base Civil Engineer work request, the base excavation permit, and the environmental impact analysis process.

Except for Alternative 1 – No Further Action, each alternative requires Travis AFB to continue to enforce existing LUCs that prevent base personnel from coming into contact with contaminated water until the cleanup standards that allow for unlimited use and unrestricted exposure are reached. Also, if an alternative uses a new technology, the LUCs at the site may need to be adjusted to fit the needs of the technology. For example, a LUC for the phytoremediation portion of Alternative 6 would prevent the trees in the treatment area from getting cut down.

The Air Force is responsible for implementing, maintaining, monitoring, reporting, and enforcing LUCs. Once established, the Air Force cannot change or remove LUCs without regulatory approval of any necessary ROD modification. The upcoming Travis AFB Groundwater ROD will describe all requirements for LUC management, including performance objectives, responsibilities of base personnel (including tenants) and contractors, notification requirements, property transfers, monitoring frequency and reporting, and correction of deficiencies.

The solvent plumes from FT005, LF007C, and SS030 extend off-base, and the off-base portions are not subject to the administrative requirements described above. To carry out the necessary cleanup activities on private property, Travis AFB purchased access and environmental response easements from the landowners. These easements contain legal restrictions that prevent landowners from engaging in water development or soil disturbing activities that could interfere with cleanup activities.

Also, Solano County Ordinance, Chapter 13.10, makes it a misdemeanor to construct a well without a Solano County permit and requires the permit requester to provide information in the permit application of all wells within a 100-foot radius of the proposed well site. Given the number of monitoring and extraction wells on the easements, this Ordinance ensures that Travis AFB will be notified of a landowner's well drilling plans. Additionally, Travis AFB frequently monitors its wells and would observe any landowner actions that could potentially interfere with cleanup activities. In these cases, the base works with the landowner to resolve the situation.

The LUC restrictions imposed by the environmental easements around Travis AFB remain in place until the easements expire. If contaminant concentrations in the off-base plumes are still above cleanup standards when the current easements expire, the Air Force will purchase additional easements to continue the environmental cleanup and LUC restrictions.

Remedial Action Objectives

Remedial Action Objectives (RAOs) describe what a proposed cleanup is expected to accomplish. The RAOs that were developed in the FS are summarized below:

Human Health

- Prevent people from drinking or touching contaminated groundwater
- Prevent people from breathing vapors that may come from contaminated groundwater

Environmental Protection

- Clean up contaminated groundwater to federal or California cleanup standards
- Remove chemicals that are floating on top of the water table
- Prevent contaminated groundwater from flowing away from each restoration site
- Take no actions that could expose protected plants or animals to contaminated groundwater

The Cleanup Standards

If groundwater contains contaminants and may be used as a source of drinking water, then the cleanup technology identified as part of remedy selection must be capable of removing contaminants to ensure the groundwater is safe to drink. The EPA and State of California have studied this topic extensively and have established drinking water standards, known as MCLs, which represent the highest contaminant levels that are allowed in drinking water. MCLs are enforceable standards that take into account the best available treatment technology and cost. When the EPA and California MCLs differ for a contaminant, the lower value is always used. Table 2 provides the lower of the federal or state MCLs for the major groundwater contaminant at each restoration site.

TABLE 2 Groundwater Contaminants	PCGs (ppb)
TCE	5
cis-1,2-DCE	6
Vinyl chloride	0.5
1,2-DCA	0.5
1,1-DCE	6
Total petroleum hydrocarbons (TPH) as gasoline	5
TPH as Diesel	100
1,4-DCB	5
Tetrachloroethene (PCE)	5
1,1,1-Trichloroethane (TCA)	200
1,1,2-TCA	5
Chloroform	100
Bromodichloromethane	100
Bis(2-ethylhexyl)phthalate	4
Nickel	100
Benzene	1
Chlorobenzene	70
1,2-Dichloropropane	5
Aldrin	0.023
Alpha-chlordane	0.1
Heptachlor	0.01
Heptachlor epoxide	0.01
Methyl tert butyl ether (MTBE)	13
Toluene	150
Carbon tetrachloride	0.5
Chloromethane	1.5
Naphthalene	20
Acetone	5,110
Methylene chloride	5

To support the evaluation of cleanup alternatives, the FS developed preliminary cleanup goals (PCGs) that protect human health and the environment. A groundwater PCG is the lower of the EPA or California MCL and is used to verify that the cleanup alternative is appropriate for a site, to compare the merits of each alternative, and to calculate cleanup times. Table 2 lists the PCGs for all groundwater contaminants found beneath Travis AFB. The Air Force proposes to use the PCGs as the cleanup standards for the final groundwater cleanup actions.

Some inorganic compounds, such as metals, are naturally present in the environment and are not viewed as contaminants. Background concentrations help to tell the difference between naturally occurring compounds and contaminants from Air Force activities. The established cleanup standard is not lower than the background concentration, except under rare circumstances.

The Cleanup Alternatives

The FS identified technologies that clean up groundwater and used the more effective technologies to develop cleanup alternatives. These alternatives were compared, using the first seven of the nine EPA-established criteria. Figure 3 describes all nine EPA criteria.

Some of the alternatives consist of groups of cleanup technologies and are often described as "treatment trains." A treatment train installs each technology at the portion of a site where it can do the most good. The seven alternatives are as follows:

- Alternative 1 – No Further Action
- Alternative 2 – MNA
- Alternative 3 – GET
- Alternative 4 – Bioreactor and GET
- Alternative 5 – EVO and EA
- Alternative 6 – Bioreactor, Phytoremediation, EVO PRB, and EA
- Alternative 7 – Passive Skimming and EA

Table 3 briefly describes the seven potential alternatives.

Figure 3
Evaluation Criteria for Superfund Cleanup Alternatives

1 **Overall Protectiveness of Human Health and the Environment**
Determines whether an alternative eliminates, reduces, or controls threats to public health and the environment through institutional controls, engineering controls, or treatment.

2 **Compliance with State and Federal Environmental Requirements**
Evaluates alternatives for compliance with Federal and State environmental statutes, regulations, and other requirements that pertain to a site.

3 **Long-term Effectiveness**
Considers an alternative's ability to maintain reliable protection of human health and the environment after implementation. Effectiveness is assessed over time.

4 **Reduction of Toxicity, Mobility, or Volume of Contaminants through Treatment**
Evaluates an alternative's use of treatment to reduce the harmful effects of principal contaminants, their ability to move in the environment, and the amount of contamination present.

5 **Cost**
Weighs estimated capital and annual operations and maintenance costs, as well as present worth cost. Present worth cost is the total cost of an alternative over time in terms of today's dollar value. Cost estimates are expected to be accurate within a range of +50 to -30 percent.

6 **Short-term Effectiveness**
Considers the length of time needed to implement an alternative and the potential risks the alternative poses to workers, residents, and the environment during implementation.

7 **Implementability**
Considers the technical and administrative feasibility of implementing an alternative, including factors such as the relative availability of goods and services.

8 **State Acceptance**
Considers whether the state favors or objects to any of the alternatives based on the available information.

9 **Community Acceptance**
Considers whether the local community agrees with the Air Force's analyses and preferred alternative for each site. Comments received on the Proposed Plan are an important indicator of community acceptance.

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TABLE 3 Summary of Potential Alternatives and Applicable Restoration Sites

Potential Alternative	Description	Sites Evaluated
1 – No Further Action	Federal regulations require the use of this alternative as a starting point for comparison with other alternatives. No groundwater cleanup action takes place.	All sites.
2 – MNA	Natural attenuation is a groundwater treatment strategy that relies on naturally occurring physical, chemical, and biological processes to break down contaminants into harmless byproducts. Groundwater monitoring is used to verify the effectiveness of this strategy. LUCs are enforced to limit exposure to contaminated groundwater and prevent vapor intrusion.	All sites except SS041
3 – GET	Extraction wells pump contaminated groundwater to the surface, where it is treated using **activated carbon** to state discharge standards and either discharged to Union Creek or used to maintain the water level in an on-base recreational pond. Groundwater monitoring is used to verify the effectiveness of this strategy. LUCs are enforced to limit exposure to contaminated groundwater and prevent vapor intrusion.	All sites except SS041
4 – Bioreactor and GET	Under this alternative, soil is excavated to remove the highest levels of contamination within the plume. Then, the hole is filled with an organic mulch to create a bioreactor to biologically treat source area contamination. The cleanup is augmented by extraction wells that pump contaminated groundwater from the remainder of the plume and prevent the migration of contaminants. The extracted groundwater is treated using activated carbon to state discharge standards and then discharged to Union Creek. Groundwater monitoring is used to verify the effectiveness of this strategy. LUCs are enforced to limit exposure to contaminated groundwater and prevent vapor intrusion.	Sites FT004, FT005, LF007D, SS015, SS016, ST027B, SD031, SD036, SD037, DP039
5 – EVO and EA	Under this alternative, food-grade EVO is injected into the portions of plumes with higher contaminant concentrations to biologically degrade contaminants. By treating the higher concentration areas, the movement of contaminants into the downgradient portions of plumes would be greatly reduced. This allows the natural attenuation processes in these downgradient areas to successfully clean up groundwater (this cleanup approach is referred to as EA). Groundwater monitoring is used to verify the effectiveness of this strategy. LUCs are enforced to limit exposure to contaminated groundwater and prevent vapor intrusion.	Sites FT004, FT005, LF007C, LF007D, SS015, SS016, ST027B, SS029, SS030, SD031, SD033, SD034, SD036, SD037, DP039
6 – Bioreactor, Phytoremediation, EVO PRB, and EA	This alternative applies only to Site DP039 and consists of a combination of a bioreactor, phytoremediation (i.e., planted trees), and an injected EVO PRB that would actively treat the highest levels of contaminated groundwater with biological processes. This treatment would greatly reduce the movement of contaminants into the lower concentration downgradient portions of the plume, and the natural attenuation processes in these downgradient areas would be enhanced. Groundwater monitoring is used to verify the effectiveness of this strategy. LUCs are enforced to limit exposure to contaminated groundwater and prevent vapor intrusion.	Site DP039
7 – Passive Skimming and EA	This alternative applies only to Site SD034. Passive skimmers would be used to remove Stoddard Solvent floating on the groundwater table. As a result of removing the product, the continuing source of contamination into the downgradient portions of the plume would be greatly reduced, and the natural attenuation processes in these downgradient areas would be enhanced. Groundwater monitoring is used to verify the effectiveness of this strategy. LUCs are enforced to limit exposure to contaminated groundwater and prevent vapor intrusion.	Site SD034

The Alternatives Evaluations

Table 4 compares the potential alternatives, based on the first seven of nine EPA criteria. The evaluation of how well the alternatives meet the last two criteria (State and Community Acceptance) will be reported in the upcoming Travis AFB Groundwater ROD.

The first two criteria (Overall Protection of Human Health and the Environment, and Compliance with **Applicable or Relevant and Appropriate Requirements** [**ARARs**]) are called threshold criteria. They have to be met for an alternative to be eligible for selection. ARARs are the requirements from federal and state environmental laws that pertain to the cleanup. The next five criteria are called balancing criteria and provide the technical standards that are used to decide whether an alternative can meet the RAOs. The last two criteria (State and Community Acceptance) are called modifying criteria and can be used to modify the way that a **preferred alternative** is designed or carried out. They can also result in the choosing of a new preferred alternative.

State acceptance is received when the DTSC and RWQCB accept the Air Force preferred alternative for each restoration site.

Community acceptance is received through the review of and comment on this Proposed Plan at the October 18, 2012, public meeting and during an associated 30-day public comment period.

The Preferred Alternatives

After weighing the merits and challenges that each cleanup alternative offers, the Air Force is proposing a preferred cleanup alternative for each restoration site. The Air Force expects each preferred alternative to satisfy all of the RAOs and proposes to use the PCGs as shown in Table 2 as the cleanup standards that will be selected in the upcoming Travis AFB Groundwater ROD. The Air Force also expects LUCs to adequately protect the infrastructure for each preferred remedy and to protect human health from potential vapor intrusion at each site.

Table 1 describes the transition of the existing interim remedy at each site with the Air Force preferred cleanup alternative. The transition reflects one of three possibilities: the preferred alternative is the same as the interim remedy, the preferred alternative is a modification of the interim remedy, or the Air Force prefers to replace the interim cleanup technology with a different technology that should perform better and cost less. Figure 4 shows the layout of the preferred alternative at each site.

Based on the information currently available, the Air Force believes the preferred alternatives meet the threshold criteria and provide the best balance of tradeoffs among the other alternatives with respect to the balancing and modifying criteria. The Air Force expects the preferred alternatives to satisfy the following statutory requirements of CERCLA subpart 121 (b): (1) be protective of human health and the environment, (2) comply with ARARs, (3) be cost effective, (4) use permanent solutions and alternative treatment technologies to the maximum extent practicable, and (5) satisfy the preference for treatment as a principal element.

The Air Force preferences take into consideration the site environmental conditions, the nature and extent of residual contamination, and the long-term performance of the current interim remedies. Also, the Air Force looked at the total impact that each alternative could have on the environment and preferred the use of **green and sustainable remediation** technologies where appropriate. For example, a solar-powered bioreactor that does not use any electricity from the Travis AFB power grid would have the edge over a pump and treat system that uses a lot of base electricity, as long as they perform equally well.

Generally, the preferred alternatives reflect a shift from highly engineered technologies that excel at treating large volumes of highly contaminated groundwater to biology-based technologies that work well when contaminant concentrations are relatively low. Engineered systems use a lot of energy and need a lot of maintenance. As contaminant concentrations drop, these systems become less efficient, and treatment costs rise significantly. On the other hand, biology-based systems use little to no energy, require little maintenance, and maintain a high level of efficiency throughout a groundwater cleanup. So, although the selection of engineered technologies was

appropriate for the interim remedies, the Air Force believes that a shift toward biology-based technologies will allow Travis AFB to efficiently continue and, in some cases expedite, the cleanup of its contaminated groundwater.

The identification of the Air Force preferred alternatives also weighed the benefits of potentially accelerating the cleanup at all sites (an Air Force policy goal) with the increased costs associated with this greater effort. Travis AFB conducted a Technical and Economic Feasibility Analysis (TEFA), which is designed to meet California water quality policy requirements and support the selection of final cleanup standards. The TEFA demonstrated that a cleanup beyond the MCL is not technically or economically feasible. It also showed that the cleanup times for most sites would not be significantly shortened by either an expansion of the preferred remedies or the use of more aggressive and costly technologies.

The Air Force acknowledges that its preferred alternatives are based on current information and that they could change in response to public comment or new information.

The Final Decision

The Air Force will make a final decision on the groundwater actions based on the technical reports in the Administrative Record as well as public and state acceptance of the preferred alternatives in this Proposed Plan.

Comments received on this Proposed Plan during the public comment period from October 10 to November 9, 2012, will be used to evaluate public acceptance. The decisions will be formally documented in a Groundwater ROD. The responses to public comments will be published in a section of the ROD called the Responsiveness Summary. The Air Force expects to sign the ROD in early 2013, after which it will be made available for review at the Information Repository. The Air Force also will inform the community of the selected final groundwater actions through announcements in Vacaville and Fairfield newspapers including *The Vacaville Reporter*, the *Tailwind*, and the *Daily Republic*.

What Can I Do?

As a member of the local community, your thoughts on the cleanup issues presented in this Proposed Plan are important to the decision making process. You have several options available to ensure that your voice is heard:

1) Talk to us. There will be time during the public meeting on October 18, 2012, to let us know what you think of the proposed actions. Can't attend the meeting? Then call the Travis AFB Environmental Management Office, and ask for Merrie Schilter-Lowe, our Community Relations Specialist. Her phone number is on the back cover.
2) Write to us. You could write your comments and drop them off at the meeting. Or you could mail your comments to Merrie Schilter-Lowe. Her address is on the back cover.
3) Send us an e-mail. Merrie Schilter-Lowe also responds to e-mail from the public. Her e-mail address is on the back cover.

Thank you in advance for your time and support of these important issues that affect us all.

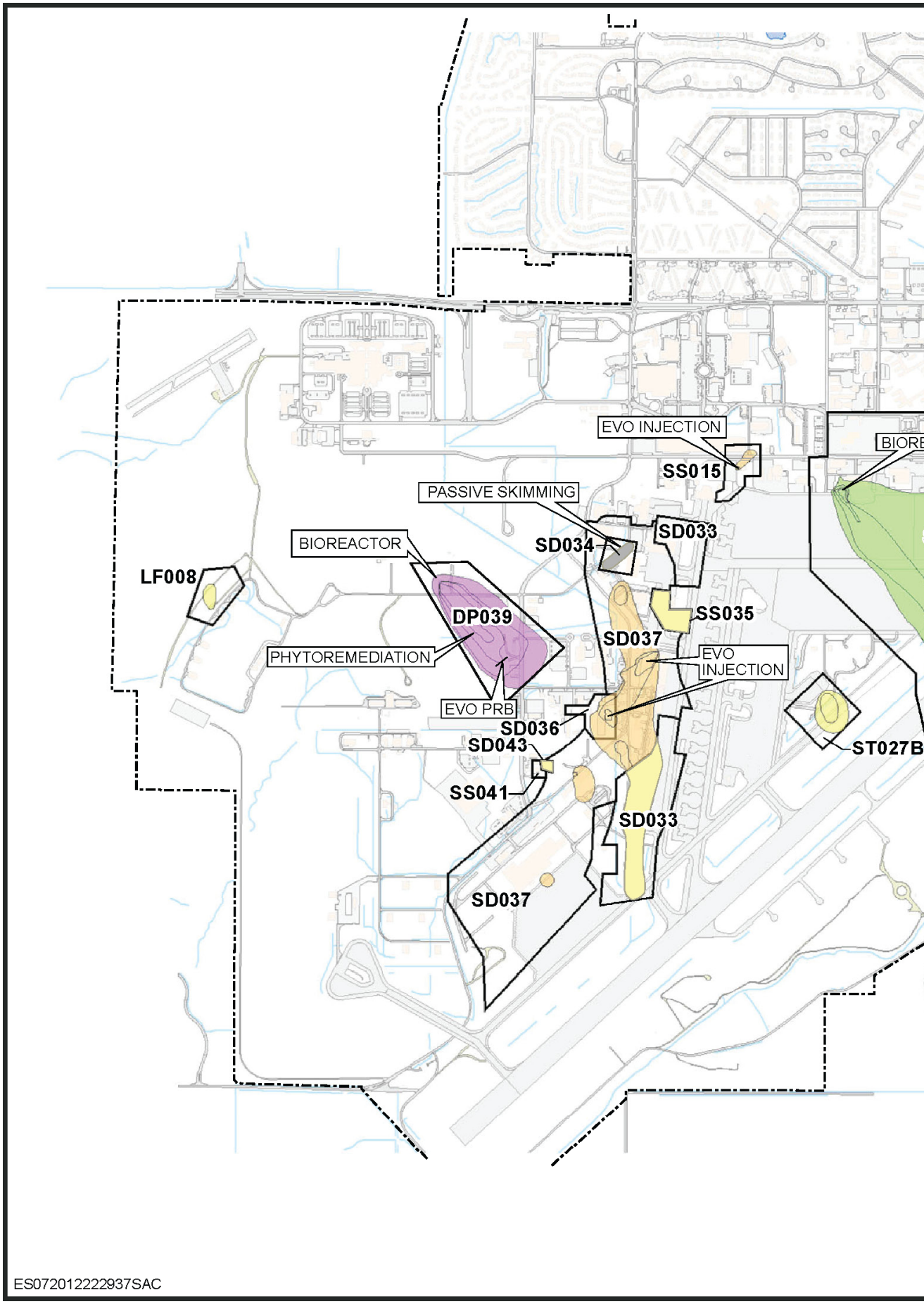
TABLE 4 Comparison of Potential Alternatives to EPA Cleanup Criteria

EPA Criteria[a]	Overall Protection of Human Health and the Environment	Compliance with ARARs	Long-term Effectiveness and Permanence
1 – No Further Action	Would not reduce risks to human or ecological receptors. Would be appropriate for sites with no risk.	Would be compliant for sites with no risks. Because no monitoring takes place, there is no act of compliance with ARARs.	No additional action would be taken; however, some contaminants may naturally degrade, and concentrations may drop over time.
2 – MNA	Provides a moderate amount of protection, particularly at low risk sites.	Natural attenuation processes can eventually achieve chemical-specific ARARs. monitoring well installation can meet location-specific ARARs.	Provides moderate long-term effectiveness and permanence, particularly at small plumes with low contaminant concentrations.
3 – GET	Provides overall protection to human health and the environment.	Complies with ARARs.	Provides long-term effectiveness and permanence, based on performance of the interim remedial actions (IRAs).
4 – Bioreactor and GET	Provides overall protection to human health and the environment.	Complies with ARARs.	Provides long-term effectiveness and permanence.
5 – EVO and EA	Provides overall protection to human health and the environment.	Complies with ARARs.	Provides long-term effectiveness and permanence.
6 – Bioreactor, Phytoremediation, EVO PRB, and EA	Provides overall protection to human health and the environment.	Complies with ARARs.	Provides long-term effectiveness and permanence.
7 – Passive Skimming and EA	Provides overall protection to human health and the environment.	Complies with ARARs.	Provides long-term effectiveness and permanence.

[a] State and Community Acceptance are modifying criteria that will be evaluated after the public comment period.

Reduction of Toxicity, Mobility, or Volume of Contaminants through Treatment	Cost	Short-term Effectiveness	Implementability
Provides no active treatment, although natural processes may take place to achieve criteria goals.	$0	Provides no protection during construction or implementation. No construction-related short-term exposures. No impact on existing habitat or infrastructure.	Yes
Provides no active treatment, although natural processes may achieve criteria goals. Active monitoring determines whether criteria goals are achieved.	FT004 – $60,000; FT005 – $102,000; LF006 – $12,000; LF007B – $4,000[b]; LF007D – $22,000; LF008 – $46,000; ST027B – $50,000; SD031 – $30,500; SD033 – $42,100; SD043 – $26,300	Provides moderate short-term effectiveness but tends to require longer cleanup times to achieve RAOs than an active remedy.	Yes. Most sites already have an adequate monitoring well network to carry out this alternative.
Active treatment can achieve criteria goals, as shown by performance of IRAs.	FT005 – $94,300; LF007C – $432,000; SS029 – $340,000; SS030 – $294,000	Provides short-term effectiveness as shown by IRA performance. However, asymtotic conditions could impede ability to reach cleanup goals.	Yes. Most sites already have an adequate extraction well system and monitoring well network to carry out this alternative.
Bioreactor offers significant treatment to sites with high source area contaminant concentrations.	SS016 – $1,116,000	Provides short-term effectiveness, similar to that of Alternative 3. Needs less time than IRA to achieve cleanup goals.	Yes, although base infrastructure limits placement of bioreactors.
Active treatment achieves criteria goals and promotes natural attenuation of downgradient contaminants.	SS015 – $358,000; SD036 – $760,000; SD037 – $1,299,000	Provides short-term effectiveness, similar to that of Alternative 3. In situ treatment requires a longer timeframe to achieve cleanup goals.	Yes. Most source area sites already have adequate injection well and monitoring well networks to carry out this alternative.
Provides high level of treatment to source area and downgradient portions of solvent plumes.	DP039 – $1,178,000	Provides short-term effectiveness, similar to that of Alternative 3. Requires less time than IRA to achieve cleanup goals.	Yes, although base infrastructure limits placement of bioreactor. Also, bird air strike hazard potential along active airfields limits placement of phytoremediation trees.
Provides no active treatment, although natural processes may achieve criteria goals. Skimming of floating product promotes contaminant removal and EA.	SD034 – $80,600	Provides short-term effectiveness, similar to that of IRA.	Yes. SD034 already has adequate monitoring wells to carry out this alternative.

[b] Costs associated with Alternative 2 for Site LF007B only cover long-term management (the step prior to site closure), because the PCGs for that site have already been achieved.


EVO INJECTION
SS015
PASSIVE SKIMMING
SD033
SD034
BIOREACTOR
LF008
DP039
SS035
SD037
PHYTOREMEDIATION
EVO INJECTION
EVO PRB
SD036
SD043
ST027B
SS041
SD033
SD037
ES072012222937SAC

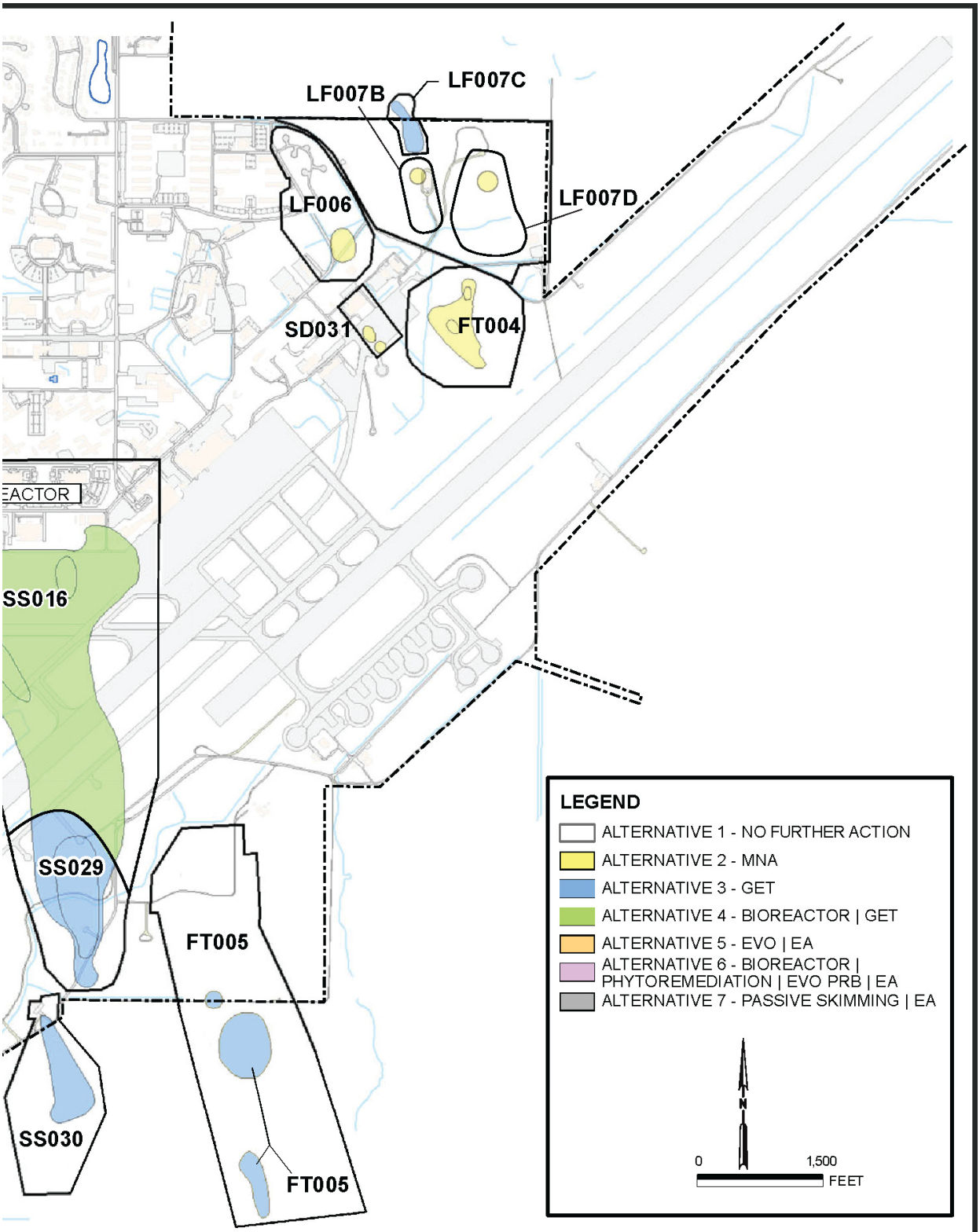


FIGURE 4
LAYOUT OF AIR FORCE PREFERRED ALTERNATIVES
TRAVIS AFB GROUNDWATER PROPOSED PLAN
TRAVIS AIR FORCE BASE, CALIFORNIA

Acronyms and Abbreviations	
AFB	Air Force Base
Air Force	U.S. Air Force
ARAR	applicable or relevant and appropriate requirement
CAMU	Corrective Action Management Unit
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
DCA	dichloroethane
DCE	dichloroethene
DTSC	Department of Toxic Substances Control
EA	enhanced attenuation
EIOU	East Industrial Operable Unit
EPA	U.S. Environmental Protection Agency
ERP	Environmental Restoration Program
EVO	emulsified vegetable oil
FFA	Federal Facility Agreement
FS	Feasibility Study
GET	groundwater extraction and treatment
IR	Information Record
IRA	interim remedial action
LUC	land use control
MCL	maximum contaminant level
MNA	monitored natural attenuation
MTBE	methyl tert butyl ethyl
NEWIOU	North, East, West Industrial Operable Unit
NOU	North Operable Unit
NPL	National Priorities List
OU	operable unit
OWS	oil-water separator
PCB	polychlorinated biphenyl
PCE	tetrachloroethene
PCG	preliminary cleanup goal
ppb	part(s) per billion
ppt	part(s) per trillion
PRB	permeable reactive barrier
RAB	Restoration Advisory Board
RAO	Remedial Action Objective
RI	Remedial Investigation
ROD	Record of Decision
RWQCB	San Francisco Bay Regional Water Quality Control Board
SVOC	semivolatile organic compound
TCA	trichloroethane
TCE	trichloroethene
TEFA	Technical and Economic Feasibility Analysis
TPH	total petroleum hydrocarbon
VOC	volatile organic compound
WABOU	West/Annexes/Basewide Operable Unit
WIOU	West Industrial Operable Unit
ZVI	zero valent iron

References

CH2M HILL. 2012. *Vapor Intrusion Assessment Update.* Prepared for Travis Air Force Base, California. Draft. September.

CH2M HILL. 2011. *Site ST027 Area B Human Health Risk Assessment.* Prepared for Travis Air Force Base, California. Final. December.

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Radian. 1996. *West Industrial Operable Unit Remedial Investigation.* Installation Restoration Program. Travis Air Force Base. Final. February.

Radian. 1995. *Remedial Investigation Report for the North Operable Unit.* Installation Restoration Program. Travis Air Force Base. Final. July.

Weston, Roy F., Inc. (Weston). 1995. *East Industrial Operable Unit Remedial Investigation Report.* Travis Air Force Base, California. Final. October.

Glossary

Activated Carbon: A processed form of carbon that is produced from organic materials, such as coconut shells, peat, coal, or wood. Because organic compounds like to stick to the surface of activated carbon, this material in granular form is often used to remove organic contaminants from water.

Administrative Record (AR): The collection of information – including reports, public comments, and correspondence – the Air Force uses to select a cleanup action. The AR makes legally required information available to the public and is available for review at the Information Repository at the Vacaville Public Library.

Applicable or Relevant and Appropriate Requirements (ARARs): The federal and state environmental cleanup standards and other substantive requirements that a selected remedy must meet.

Bioreactor: An in situ remediation technology in which contaminated soil is excavated and the hole is backfilled with a mixture of organic mulch and gravel. One or more extraction wells then circulate contaminated groundwater through the mulch mixture. Naturally occurring bacteria are stimulated to grow and consume groundwater contaminants.

Bioremediation: A cleanup approach that relies on microbes to 'eat' contaminants, converting them into harmless compounds.

Chemical Oxidation: A cleanup approach that involves the injection of a chemical oxidant, such as sodium permanganate or hydrogen peroxide, into a contaminant plume. The oxidant breaks down the contaminants upon contact into harmless compounds.

Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA): Also known as the Superfund Act. The federal law that establishes a program to identify, evaluate, and remediate sites where hazardous substances have been released to the environment and that present an unacceptable risk to human health or the environment.

Contaminant plume: A body of contamination with measurable horizontal and vertical dimensions that is suspended in and moves with groundwater.

Corrective Action Management Unit (CAMU): A designated area within a facility that is designed to carry out a corrective action, such as contaminated soil management. The Travis AFB CAMU is an on-base soil repository that is built on a closed landfill.

Downgradient: The direction in which groundwater flows (decreasing potential); similar to "downstream" for surface water. Groundwater flows from areas of higher fluid potential (or hydraulic head) to lower potential.

Emulsified Vegetable Oil (EVO): An edible vegetable oil mixture used to provide a food source for naturally occurring bacteria in the groundwater. The bacteria consume the oil as they break down contaminants into harmless byproducts.

Enhanced Attenuation (EA): The breakdown of groundwater contaminants into harmless byproducts using naturally occurring physical, chemical, and biological processes. The difference between EA and MNA is that EA is always used in conjunction with an active remedy. The highest levels of contaminants are treated so that natural processes can work more effectively in the remainder of the plume.

Environmental Restoration Program (ERP): The program established under the Defense Environmental Restoration Program (DERP at 10 USC §§ 2701 et seq) that evaluates and cleans up sites where hazardous substances have been released to the environment. Formerly called the Installation Restoration Program, the ERP is implemented at Travis AFB and is consistent with CERCLA.

Feasibility Study (FS): A study required under CERCLA and the ERP to identify and evaluate potential remedial technologies and to compare the technologies for cleanup of a particular site or sites. An FS report is prepared using information contained in the Remedial Investigation report.

Federal Facility Agreement: A legal agreement between multiple government agencies that is designed to manage the cleanup of environmentally contaminated property. Its purpose is to ensure that past or present activities on a property are carefully investigated and that appropriate remedies are taken to protect public health and the environment.

Green and sustainable remediation: The practice of considering all environmental effects of remedy implementation and incorporating options to maximize the net environmental benefit of cleanup actions.

Groundwater: Underground water that fills pores in soil or openings in rocks to the point of saturation. Groundwater is often used as a source of drinking water via municipal or domestic wells.

Groundwater Extraction and Treatment (GET): The most common way to clean up contaminated groundwater. Pumps in extraction wells bring contaminated water to the surface, where it is cleaned by one of many varied treatment technologies. The technologies that are picked to extract and treat groundwater depend on site conditions.

Information Repository (IR): A source of information about an installation's environmental restoration activities that is readily available to the

public. At a minimum, the IR contains all documentation found in the AR and all public documents associated with the RAB. The Travis AFB IR is located in the Vacaville Public Library.

Land Use Controls (LUCs): Administrative, legal, or physical measures used to prevent exposure to contaminants that remain onsite either during or after remedial action and that present an unacceptable risk to human health or the environment. LUCs include restrictions on the use of the land that will be incorporated into the Base General Plan.

Maximum Contaminant Level (MCL): A legally enforceable regulatory standard occurring under the Safe Drinking Water Act that must be met by all public drinking water systems to which they apply. Primary MCLs can be found in Title 22 California Code of Regulations.

Monitored Natural Attenuation (MNA): The breakdown of groundwater contaminants into harmless byproducts using naturally occurring physical, chemical, and biological processes. Monitoring wells are typically used to collect the samples needed to assess how well the processes are working.

Monitoring: Ongoing collection of information about the environment that helps gauge the effectiveness of a cleanup action. The monitoring of groundwater contamination is typically conducted using shallow wells installed at strategic locations and depths.

National Priorities List (NPL): EPA's published list of the highest priority hazardous waste sites in the United States for investigation and cleanup.

Operable Unit (OU): A geographic area that contains one or more cleanup sites. Often, the sites in an OU have similar characteristics, such as contaminants, industrial processes, or location.

Part per Billion (ppb): A unit of measurement used to express low concentrations of contaminants. One ppb of Compound X is equal to one ounce of Compound X in one billion ounces of water. Here is another way to look at it: if one drop of Compound X is mixed in an Olympic-size swimming pool, the water will contain about 1 ppb of Compound X.

Part per Trillion (ppt): A unit of measurement used to express very low concentrations of contaminants. One ppt of Compound X is equal to one ounce of Compound X in one trillion ounces of water. Here is another way to look at it: if one drop of Compound X is mixed in the water from 1,000 Olympic-size swimming pools, the water will contain about 1 ppt of Compound X.

Passive Skimming: A standard way to clean up petroleum products that float on top of the groundwater. Most skimmers contain a membrane that only allows petroleum to flow through it. The skimmer collects the petroleum and is manually pulled out of the well. The collected petroleum is poured into a separate container that is sent to a recycler, and the skimmer is lowered back into the well.

Permeable Reactive Barrier (PRB): A wall built below the ground to clean up contaminated groundwater. The wall is permeable, which means it has tiny holes that allow groundwater to flow through it. Reactive materials in the wall trap harmful chemicals or change the chemicals into harmless ones. Contaminated groundwater flows into the wall. Clean groundwater flows out the other side of the wall.

Phytoremediation: The use of plants to remove contaminated groundwater through uptake and consumption in order to contain or control the migration of contaminants.

Plume: A body of contamination with measurable horizontal and vertical dimensions that is suspended in and moves with groundwater.

Preferred Alternative: The cleanup alternative proposed for implementation at a site. Selection is based on the best protection of human health and the environment, achievement of RAOs, compliance with applicable laws, and performance against other CERCLA evaluation criteria.

Pump and Treat: A general term that describes the extraction of contaminated groundwater and the removal or destruction of the dissolved contaminants.

Record of Decision (ROD): A document that explains and legally commits the lead agency to the cleanup alternatives to be used at a site. The ROD is based on information and technical analyses generated during the Remedial Investigation and Feasibility

Study, and considers public comments and community concerns. The ROD is signed by the Air Force, EPA, and state agencies.

Remedial Investigation (RI): An investigation of a contaminated site to determine the nature and extent of contamination, to assess human health and environmental risks posed by the contaminants, and to provide a basis for development of remedial alternatives to clean up the site.

Restoration Advisory Board (RAB): A group of interested community members and federal and state government representatives who provide valuable input into the investigation and cleanup activities on Travis AFB.

Semivolatile organic compounds (SVOCs): Carbon containing compounds (that is, organic compounds) that may evaporate at temperatures above room temperature.

Site: In Superfund terms, a site is a facility of any kind where contamination is present as a result of a release of hazardous material. Thus, Travis AFB is a Superfund site. The word “site” can also mean specific locations or facilities within Travis AFB where contaminants have been released to the environment. To avoid confusion, this Proposed Plan refers to a location of contaminated groundwater as a restoration site.

Stoddard Solvent: Often called “mineral spirits,” a common organic solvent used in painting, decorating, and dry cleaning.

Vapor Intrusion: The movement of contaminated gas into the basements or cracked foundations of buildings. The gas mixes with the air we breathe, creating a potential human health risk. The contaminated gas often comes from contaminated soil or groundwater.

Volatile Organic Compounds (VOCs): Carbon containing compounds (that is, organic compounds) that readily evaporate at room temperature. The most common VOC at Travis AFB is TCE.

Zero Valent Iron (ZVI): Pure iron in the form of tiny particles. ZVI is often used in the construction of permeable reactive barriers to treat contaminated groundwater.

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USE THIS SPACE TO WRITE YOUR COMMENTS

Your input on the Travis AFB Groundwater Proposed Plan is important to the Air Force. Comments provided by the public will help the Air Force select a final cleanup remedy for each site.

Please use this space for your comments, then mail them to: Environmental Restoration Program, 60 AMW/PA, 400 Brennan Circle, Travis AFB, CA 94535. Comments must be postmarked by November 9, 2012. If you have questions about the comment period, please contact Ms. Merrie Schilter-Lowe at (707) 424-2011. You may e-mail your comments to the Air Force at the following address: merrie.schilterlowe@us.af.mil.

Name: _____

Address: _____

City: _____

State: _____ Zip: _____

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Travis AFB
Public Meeting

7:00 p.m. - October 18, 2012
Northern Solano County Association of Realtors
3690 Hilborn Road
Fairfield, California

Location of Information Repository

Vacaville Public Library
1020 Ulatis Drive
Vacaville, California 95687
Mon. to Thurs. 10–9
Fri. and Sat. 10–5
Sun. 1–5
(866) 572-7587

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